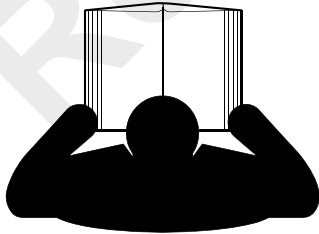


OPERATOR MANUAL

Supplement

Crane Warm-up Procedures

	<p style="text-align: center;">⚠ DANGER</p> <p>An untrained operator subjects himself and others to death or serious injury. Do not operate this crane unless:</p> <ul style="list-style-type: none">• You are trained in the safe operation of this crane. Manitowoc is not responsible for qualifying personnel.• You read, understand, and follow the safety and operating recommendations contained in the crane manufacturer's manuals and load charts, your employer's work rules, and applicable government regulations.• You are sure that all safety signs, guards, and other safety features are in place and in proper condition.• The Operator Manual and Load Chart are in the holder provided on crane.
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Reference Only

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

COLD CLIMATE ENGINE OPERATION

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

CRANE WARM-UP PROCEDURES

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

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

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

CAUTION

Crane Damage Hazard!

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

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

Engine

Warm-up Procedures for All Temperature Ranges:

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

Transmission

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

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

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

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

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

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

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

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

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

Hoist

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

Warm-up Procedures:

1. Without operating the hoist function, warm the hydraulic oil (see *Hydraulic Oil System*, page 2-2).
2. Once the hydraulic system is warm, operate the unloaded hoist, in both directions, at low speeds several times to prime all hydraulic lines with warm hydraulic oil and to circulate gear lubricant through the planetary gear sets.

Swing Drive and Turntable Bearing

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

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

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

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

Axles

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

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

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

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

Hydraulic Oil System

Operating Limits and Warm-up Procedures:

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

GROVE

OPERATOR'S MANUAL

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

5540F/YB5515

Crane Model Number

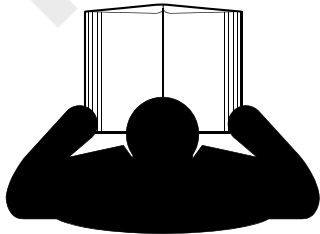
This Manual is divided into the following sections:

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

NOTICE

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

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



⚠ DANGER

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

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

 **CALIFORNIA
PROPOSITION 65 WARNING**

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

 **CALIFORNIA
PROPOSITION 65 WARNING**

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

See End of this Manual for Alphabetical Index

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Reference Only

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THE MANUAL

This operator's manual provides the information you need to correctly operate and maintain the 5515 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.

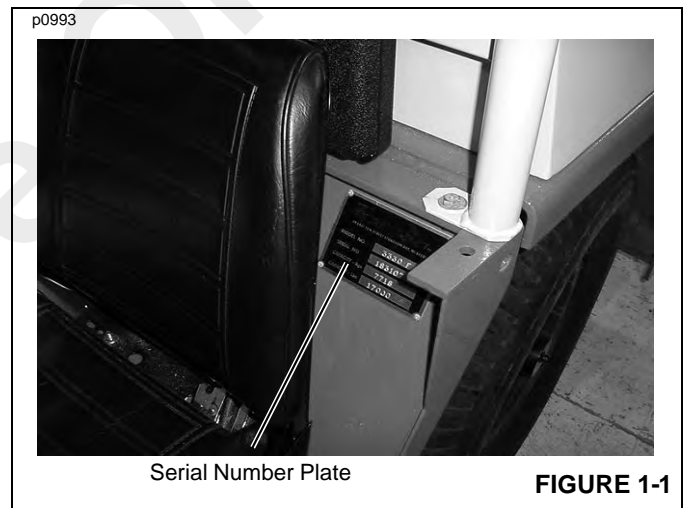
DIRECTIONAL REFERENCE

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 PLATE

For easy reference, when contacting the Grove dealer/Crane Care Customer Service at Grove about this machine, record the machine's serial number in the space provided in the next column. The numbers are stamped on the serial plate which is located behind the operator's seat. See Figure 1-1. Components, such as the pump, transmission, engine, axles, etc., have their own serial 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 at Grove authorized replacement part may adversely affect the performance, durability, or safety of this product and will void the warranty. Crane Care Customer Service at Grove assumes no liability for unauthorized replacement parts which adversely affect the performance, durability, or safety of this product.



Serial Number _____

REPORTS

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

DISCLAIMER

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

CUSTOMER SUPPORT

Manitowoc and our Dealer Network want to ensure your satisfaction with our products and customer support. Your local dealer 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 dealer's service management to coordinate the contact on your behalf.

New Owners

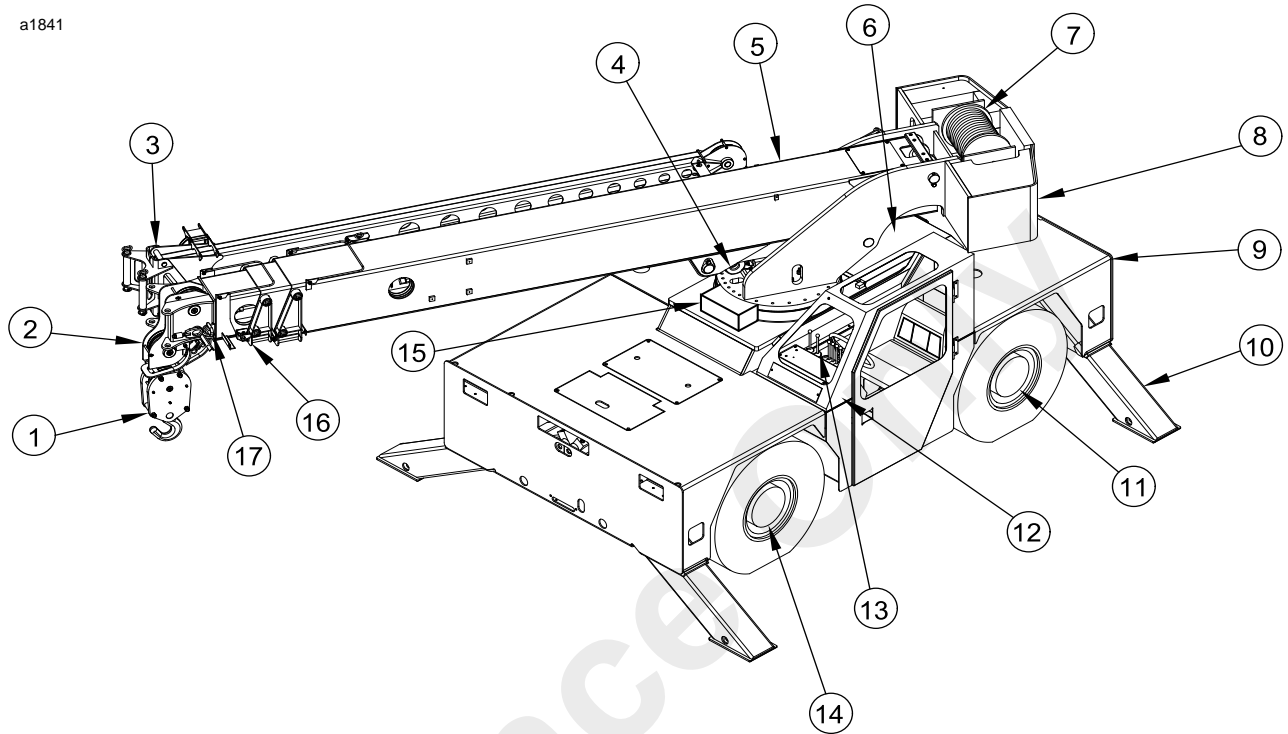
If you are the new owner of a Grove crane, please register it with Manitowoc Crane Care so we have the ability to contact you if the need arises.

Go to: http://www.manitowoccranes.com/MCG_CARE/Includes/EN/changeOfOwnership.cfm and complete the form.

Reference Only

NOMENCLATURE

a1841



Item	Description	Item	Description
1	Drop Block	10	Outrigger (4)
2	3rd Boom Section (3 Section Boom) 4th Boom Section (4 Section Boom)	11	Rear Drive Axle (Steerable & Non-Steerable)
3	Optional Boom Extension	12	Enclosed Operator's Cab (Shown) Optional Cab Guard (Not Shown)
4	Lift Cylinder	13	Main Control Valve Location
5	1st Boom Section	14	Front Steering Drive Axle
6	Engine Compartment	15	Swing Motor and Gearbox Location
7	Main Hoist Assembly	16	2nd Boom Section
8	Mast Assembly	17	3rd Section Boom
9	Main Frame Assembly		

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Reference Only

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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.

ACCIDENTS

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

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

The Manitowoc Company, Inc.

1565 East Buchanan Trail
Shady Grove, PA 17256-0021

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

Fax: 717-593-5152

E-mail: product.safety@manitowoc.com

OPERATOR'S INFORMATION

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

The *Operator's 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's 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'S QUALIFICATIONS

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

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

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



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

You must not operate this machine unless:

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

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

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

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

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

OPERATIONAL AIDS

Manitowoc remains committed to providing reliable products that enable users and operators to safely lift and position loads. Manitowoc has been an industry leader in the incorporation of operational aids into the design of its cranes. Federal law requires that cranes be properly maintained and kept in good working condition. The manuals that Manitowoc

provides that are specific for each crane and the manufacturer's manuals for the operational aids shall be followed. If an operational aid should fail to work properly, the crane user or owner must assure that repair or recalibration is accomplished as soon as is reasonably possible. If immediate repair or recalibration of an operational aid is not possible and there are exceptional circumstances which justify continued short-term use of the crane when operational aids are inoperative or malfunctioning, the following requirements shall apply for continued use or shutdown of the crane:

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

Load Moment Indication (LMI) Systems (If Equipped)

Your crane may be equipped with an LMI system which is intended to aid the operator. 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 load moment indicating system installed on the crane, see the manufacturer's manual supplied with the crane.

Anti-Two-Blocking Device

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

Two-blocking occurs when the load block (hook block, headache ball, rigging, etc.) comes into physical contact with the boom (boom nose, sheaves, boom extension, etc.). Two-blocking can cause hoist lines (wire rope), rigging, reeving, and other components to become highly stressed and overloaded in which case the wire 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 wire 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 wire rope as the boom is lowered. Keep load handling devices a minimum of 42 in (107 cm) 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.

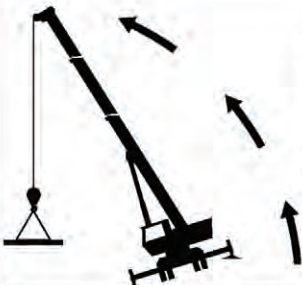

Work Area Definition System (WADS) (If Equipped)

If your crane is equipped with a WADS, you must read and understand the manufacturer's *Operator's Manual* before operating the system. Become familiar with all proper

operating procedures and with the identification of symbol usage.

The work area definition system is intended as an aid to the operator. It is not a substitute for safe crane operating practices, experience and good operator judgements.

! DANGER

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

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FOLLOW INSTRUCTIONS IN OPERATOR'S AND SAFETY HANDBOOK.

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CRANE STABILITY/STRUCTURAL STRENGTH

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

Ensure all pins and floats are properly installed and outrigger beams are properly extended before lifting on outriggers. On models equipped with outriggers that can be pinned at the mid-extend position (vertical strip, 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.

(For cranes with center front stabilizers)

! DANGER

TIPPING HAZARD

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SERIOUS INJURY OR DEATH COULD RESULT FROM IMPROPER CRANE SET-UP ON OUTRIGGERS.

CENTER FRONT STABILIZER MUST BE PROPERLY EXTENDED BEFORE OPERATING CRANE ON OUTRIGGERS.

BEFORE EXTENDING CENTER FRONT STABILIZER:

1. BOOM MUST BE RETRACTED AND IN BOOM REST,
2. MAIN OUTRIGGERS MUST BE PROPERLY EXTENDED AND CRANE LEVELED.

CENTER FRONT STABILIZER WILL RETRACT WHEN ANY MAIN OUTRIGGER STABILIZER IS RETRACTED.

IF ANY MAIN OUTRIGGER STABILIZER IS EXTENDED OR RETRACTED AFTER INITIAL SET-UP, CENTER FRONT STABILIZER MUST BE RESET AFTER REPEATING STEPS 1 AND 2 ABOVE.

REFER TO OPERATOR'S AND SAFETY HANDBOOK.

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Carefully follow the procedures in this Operator's 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 Load Moment Indicating (LMI) 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.



DANGER

**DEATH OR SERIOUS INJURY
COULD RESULT FROM IMPROPER
CRANE SET-UP ON OUTRIGGERS**

**FAILURE TO FOLLOW THESE INSTRUCTIONS
CAN RESULT IN THE CRANE OVERTURNING**

- BE SURE OUTRIGGERS ARE PROPERLY EXTENDED AND SET AND CRANE IS LEVEL FOR OPERATION ON OUTRIGGERS.
- ALL FOUR OUTRIGGER BEAMS MUST BE EQUALLY EXTENDED TO THE APPROPRIATE VERTICAL STRIPE BEFORE BEGINNING OPERATION.
- ALL FOUR OUTRIGGER BEAM LOCK PINS MUST BE ENGAGED BEFORE OPERATING FROM THE MID-EXTEND POSITION.
- OPERATOR MUST SELECT PROPER LOAD CHART AND LMI PROGRAM FOR THE OUTRIGGER POSITION SELECTED.

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 affect the stability of the crane.

Wind Forces

Wind can have a significant affect 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.). To assist you in determining prevailing wind conditions, refer to Table 2-1.

Wind forces can exert extreme dynamic loads. **Manitowoc recommends that a lift not be made if the wind can cause a loss of control in handling the load.** Manitowoc recommends that, if the wind speed (velocity) is between 20 mph (32 km/h) to 30 mph (48 km/h), the load capacities shall be reduced to account for the size and shape of the load and the wind direction in relation to the machine for all boom and boom extension lengths. Further, operation of the crane in wind velocities over 30 mph (48 km/h) is not recommended.

Table 2-1

Wind Force		Wind Velocity mph (km/h)	Visible Indicator Effects of wind as observed on land
Beauford Scale	Designation		
Zero (0)	Calm	less than 1 (<2)	No wind; smoke rises vertically
1	Light Air	1-3 (2-5)	Wind direction seen by smoke but not by wind vanes
2	Light Breeze	4-7 (6-11)	Wind felt on face; leaves rustle; wind vane moves slightly
3	Gentle Breeze	8-12 (13-19)	Leaves/small twigs in constant motion; wind extends flag
4	Moderate Breeze	13-18 (21-29)	Raises dust & loose paper; moves small branches
Reduce crane load ratings and operating parameters at 20 mph (32 km/h)			
5	Fresh Breeze	19-24 (31-39)	Small trees in leaf begin to sway; on ponds, crested wavelets form
6	Strong Breeze	25-31 (40-50)	Large branches in motion; telegraph wires whistle; umbrellas used with difficulty
Cease all craning operations at 30 mph (48 km/h); lower & retract boom			
7	Moderate Gale	32-38 (52-61)	Whole trees in motion; walking against wind is inconvenient

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 LMI is programmed for the crane configuration. Refer to the LMI handbook 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.

Use only one hoist at a time when lifting loads.

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 wire rope.

Counterweight

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

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

Outrigger Lift Off

Regarding "lifting" of an outrigger pad during craning activities, be advised that the rated loads for these cranes, as indicated on the crane's *Load Chart*, do not exceed 85% of the tipping load on outriggers as determined by SAE J765 OCT80 "Cranes Stability Test Code." An outrigger pad may lift off the ground during operation of the crane within the capacity limits of the *Load Chart*, yet the crane will not have reached instability. The "balance point" for stability testing according to SAE and Manitowoc criteria is a condition of loading wherein the load moment acting to overturn the crane is equal to the maximum moment of the crane available to resist overturning. This balance point or point of instability for a crane does not depend on "lifting" of an outrigger but rather on comparison of the "opposing" load moments.

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

Provided the crane is properly set up, the crane is in good working condition, that all operator's aids are properly programmed, that the qualified crane operator adheres to the instructions found in the applicable *Load Chart*, *Operator's 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 engineer.

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 engineer to direct the operation.
- Use one qualified signal person.
- Coordinate lifting plans with the operators, engineer, 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 cranes and rigging of equal capabilities and use the same boom length.
- Use outriggers on cranes so equipped.
- Be certain cranes are of adequate lifting capacity.
- 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.

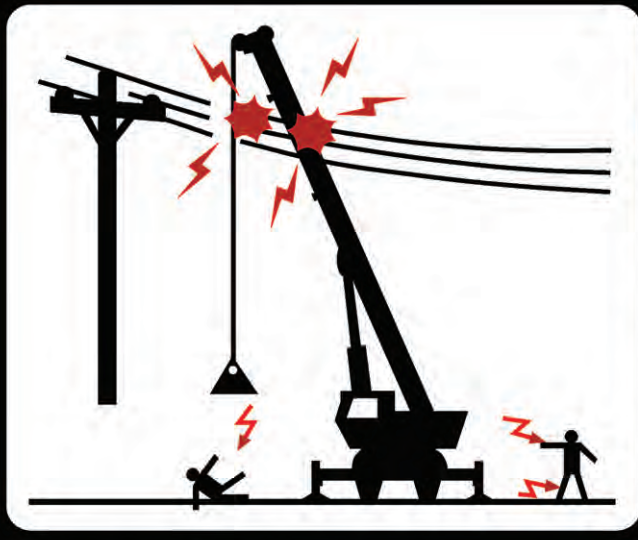
ELECTROCUTION HAZARD

To avoid death or serious injury, keep all parts of the crane, rigging and load at least 20 feet (6 meters) away from any energized power line. You **must** follow the OSHA requirements set forth in 29CFR 1926.1407 through 1926.1411.

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

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

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



! DANGER

ELECTROCUTION HAZARD
 TO AVOID DEATH OR SERIOUS INJURY

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

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

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

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THIS CRANE IS NOT INSULATED.

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

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

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

If the load, wire rope, boom, or any portion of the crane contacts or comes too close to an electrical power source,

everyone in, on, and around the crane can be seriously injured or killed.

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

The rules in this *Operator's 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.

Thoroughly read, understand, and abide by all applicable federal, state, and local regulations.

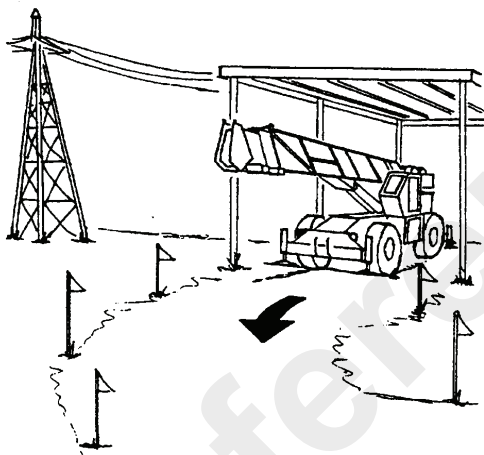
Set-Up and Operation

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 20 ft (6 m) of electrical power lines or equipment. This includes the crane boom (fully extended to maximum height, radius, and length) and all attachments (boom extensions, rigging, loads, etc.). Overhead lines tend to blow in the wind so allow for lines' movement when determining safe operating distance.

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

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



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

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

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

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

Electrocution Hazard Devices

The use of insulated links, insulated boom cages/guards, proximity warning devices, or mechanical limit stops does

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

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

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

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

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

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

Some variables you must know and understand are:

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

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

Electrical Contact

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

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

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

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

PERSONNEL HANDLING

The American Society of Mechanical Engineers issued a new American National Standard entitled, *Personnel Lifting Systems, ASME B30.23-2005*. This standard provides, "lifting and lowering of personnel using ASME B30 Standard hoisting equipment shall be undertaken only in circumstances when it is not possible to accomplish the task by less hazardous means. Unless all of the applicable requirements of this volume are met, the lifting or lowering of personnel using ASME B30 Standard equipment is prohibited." This new standard is consistent with the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) regulations for Construction that state, in 29CFR1926.1431: "General requirements. The use of a crane or derrick to hoist employees on a personnel platform is prohibited, except when the erection, use, and dismantling of conventional means of reaching the worksite, such as a personnel hoist, ladder, stairway, aerial lift, elevating work platform or scaffold, would be more hazardous or is not possible because of structural design or worksite conditions." Additional requirements for crane operations are stated in *ASME B30.5, Mobile And Locomotive Cranes*, and in *OSHA regulations 29CFR1910.180 for General Industry and 29CFR1926.1431 for Construction*.

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

- The requirements of the applicable national, state and local regulations and safety codes are met.
- A determination has been made that use of a crane to handle personnel is the least hazardous means to perform the work.
- The crane operator shall be qualified to operate the specific type of hoisting equipment used in the personnel lift.
- The crane operator must remain at the crane controls at all times when personnel are off the ground.

- The crane operator and occupants have been instructed in the recognized hazards of personnel platform lifts.
- The crane is in proper working order.
- The crane must be equipped with a boom angle indicator that is visible to the crane operator.
- The crane's *Load Chart* is affixed at the operator's station and readily accessible to the operator. The total weight of the loaded personnel platform and related rigging shall not exceed 50 percent of the rated capacity for the radius and configuration of the crane.
- The crane is level within one percent of level grade and located on a firm footing. Cranes with outriggers shall have them all deployed following manufacturer's specifications.
- The crane's *Operator's Manual* and other operating manuals are at the operator's station and readily accessible to the operator.
- The platform meets the requirements as prescribed by applicable standards and regulations.
- For wire 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:
 - Use only Manitowoc approved personnel platforms attached to the boom.
 - The platform is properly attached and secure.

To avoid death or serious injury:

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

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

- *ASME (formerly ANSI) B30 Series American National Safety Standards For Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings; ASME B30.5, Mobile*

And Locomotive Cranes, and ASME B30.23, Personnel Lifting Systems, are available by mail from the ASME, 22 Law Drive, Fairfield, New Jersey, 0700-2900

- US DOL/OSHA Rules and Regulations are available by mail from the Superintendent of Documents, PO Box 371954, Pittsburgh, PA, 15250-7954.

ENVIRONMENTAL PROTECTION

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

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

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

When filling and draining crane components, observe the following:

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

MAINTENANCE

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

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

Shut down the crane while making repairs or adjustments.

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

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

Keep the crane free of mud, dirt, and grease at all times. Dirty equipment introduces hazards, wears-out faster, and makes proper maintenance difficult. Cleaning solutions used

should be non-flammable, non-toxic and appropriate for the job.

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

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 Manitowoc dealer for assistance.

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

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

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

Hydraulic Fluid:

- Do not use your hand or any part of your body to check for hydraulic fluid leaks when the engine is running or the hydraulic system is under pressure. Fluid in the hydraulic system can be under enough pressure that it will penetrate the skin, causing serious injury or death. Use a piece of cardboard, or piece of paper, to search for leaks. Wear gloves to protect your hands from spraying fluid.
- If any hydraulic fluid is injected into the skin, obtain medical attention immediately or gangrene may result.

- Do not attempt to repair or tighten any hydraulic hose or fitting while the engine is running, or when the hydraulic system is under pressure.
- Never disconnect any hydraulic lines unless the boom is fully lowered, the engine is shut off, and the hydraulic pressure is relieved. To relieve hydraulic pressure, stop the engine and move the hydraulic controls in both directions several times.
- Hot hydraulic fluid will cause severe burns. Wait for the fluid to cool before disconnecting any hydraulic lines.
- Hydraulic fluid can cause permanent eye injury. Wear appropriate eye protection.

Moving Parts:

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

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

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

After maintenance or repairs:

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

Lubrication

The crane must be lubricated according to the manufacturer's recommendations for lubrication points, time

intervals, and types. Lubricate at more frequent intervals when working under severe conditions.

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

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

Tires



WARNING

Possible equipment damage and/or personal injury!

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

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

Ensure all lug nuts are properly torqued.

Ensure pneumatic tires are inflated to the proper pressure (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.

Wire Rope

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

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

Always make daily inspections of the wire rope, keeping in mind that all wire rope will eventually deteriorate to a point where it is no longer usable. Refuse to work with worn or damaged wire rope. Wire 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 wear of the individual outside wires of 1/3 of the original wire diameter.
- Any kinking, bird caging, crushing, corrosion, or other damage resulting in distortion of the rope structure.
- Rope that has been in contact with a live power line or has been used as a ground in an electric circuit (eg. welding) may have wires that are fused or annealed and must be removed from service.
- In standing ropes, more than three (3) breaks in one rope lay in sections beyond the end connection or more than two (2) broken wires at an end connection.
- Core deterioration, usually observed as a rapid reduction in rope diameter, is cause for immediate removal of the rope.

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

- Wire ropes wear out. The strength of a wire rope begins to decrease when the rope is put to use and continues to decrease with each use. Wire 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 wire rope should be considered the straight line pull which will actually break a new unused rope. The nominal strength of a wire rope should never be used as its working load.
- Each type of fitting attached to a wire rope has a specific efficiency rating which can reduce the working load of the wire rope assembly or rope system.
- Never overload a wire rope. This means never use the wire rope where the load applied to it is greater than the working load determined by the rope manufacturer.
- Never "shock load" a wire 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 wire 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 wire 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 wire 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 wire ropes and attachments, keep all parts of your body and clothing away from rotating hoist drums and all rotating sheaves. Never handle the wire rope with bare hands.

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

- Sheaves that are too small, worn or corrugated cause damage to a wire rope.
- Broken wires mean a loss in strength.
- Kinks permanently damage a wire rope and must be avoided.
- Wire ropes are damaged by knots. Wire 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 wire rope inspection procedure is given in the *Service Manual*.

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

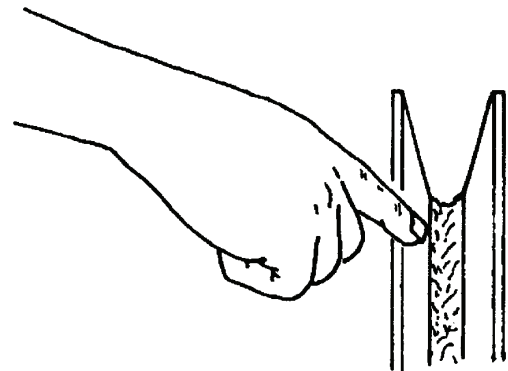
When installing a new rope:

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

When using a wedge socket:

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

Sheaves



Inspect the boom nose and hook block sheaves for proper operation, excessive wear, and damage every 50 hours or weekly. Inoperable, damaged and/or worn sheaves cause rapid deterioration of wire 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 wire 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 (nylatron) sheaves, as compared with metallic sheaves, may change the replacement criteria of rotation-resistant wire rope.

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

Batteries

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

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

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

Engine

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

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

Be careful when checking the engine coolant level. The fluid may be hot and under pressure. Shut down the engine and

allow the radiator time to cool before removing the radiator cap.

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

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

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

TRANSPORTING THE CRANE

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

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

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

Ensure the crane is adequately secured to the transporting vehicle.

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

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 slack provided at the center line of sheave to anchor point. Care must be exercised anytime any crane function is being performed while the cable is hooked into the hookblock tie down. Do not draw cable taut.

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 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.

This machine is manufactured with no axle suspension system. Traveling at high speeds, especially on rough ground, may create a bouncing affect that can result in loss of control. If bouncing occurs, reduce travel speed. (RT and Shuttle Lift Only)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Stay alert at the wheel.

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

Slopes:

- 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.
- Ascend or descend slopes with the boom pointing up the slope.
- When operating on a downhill slope, reduce travel speed and downshift to a low gear to permit compression braking by the engine and aid the application of the service brakes.

WORK PRACTICES

Personal Considerations

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

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

Crane Access



WARNING

Fall Hazard!

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

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

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

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

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

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

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

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

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

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

Wear shoes with a highly slip-resistant sole material. Clean any mud or debris from shoes before entering the crane cab/operator's station or climbing onto the crane superstructure. Excessive dirt and debris on the hand-holds, access steps,

or walking/working surfaces could cause a slipping accident. A shoe that is not clean might slip off a control pedal during operation.

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

Job Preparation

Before crane use:

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

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

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

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

Working

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

Know the location and function of all machine controls.

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

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

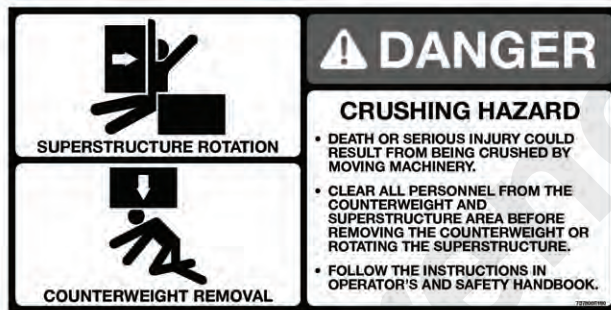
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

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

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

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

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



Keep unauthorized personnel clear of the working area during operation.

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

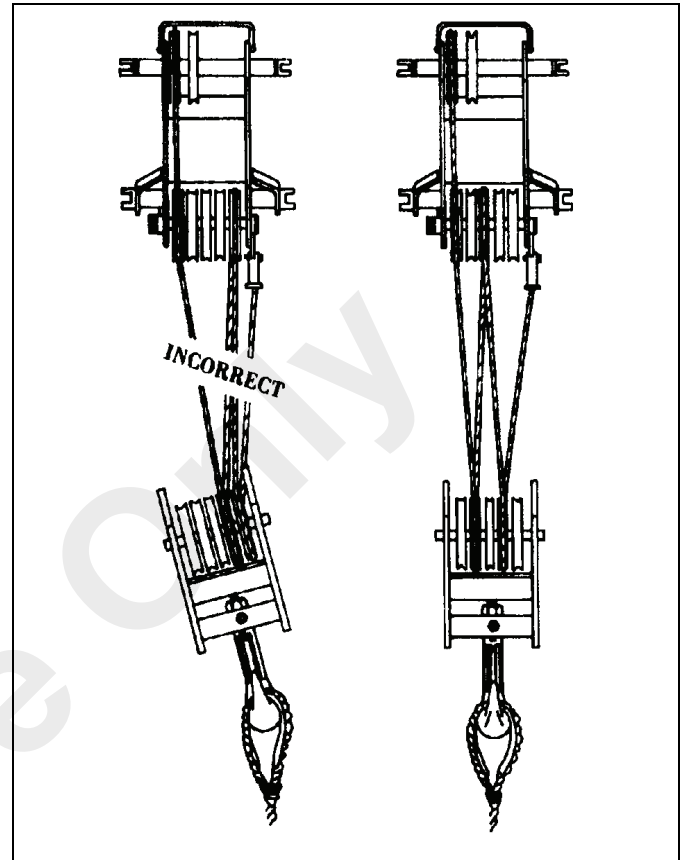
You must always be aware of everything around the crane while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the crane or making a lift. Sound the horn to warn personnel.

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



Lifting

Use enough parts of line for all lifts and check all lines, slings, and chains for correct attachment. To obtain maximum lifting capacities, the hook block must be set up with enough parts of line. Too few parts of line can result in failure of the wire rope or hoist. **No less than three wraps** of wire 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).

Do not pull posts, pilings, or submerged articles. Be sure the load is not frozen or attached to the ground before lifting.

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

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

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

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

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

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

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

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

Hand Signals

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

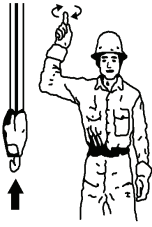

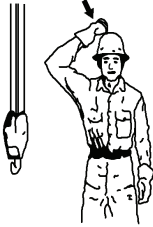
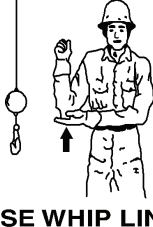
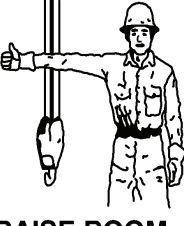
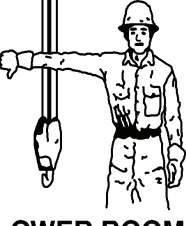
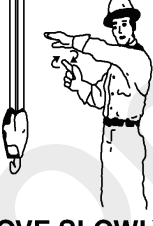

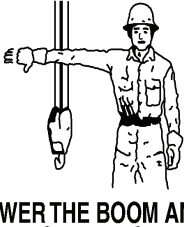
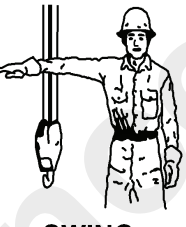
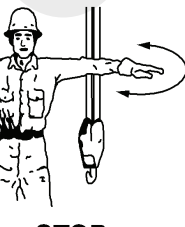
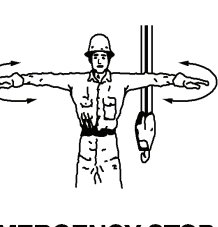

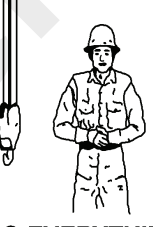
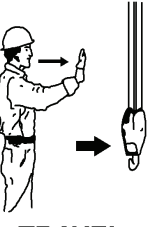
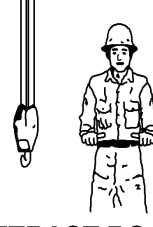
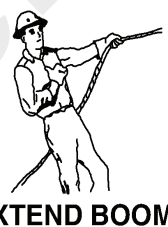
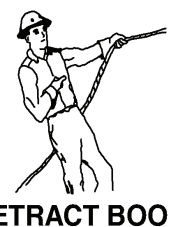
- Working in the vicinity of power lines.
- The crane operator cannot clearly see the load at all times.
- Moving the crane in an area or direction in which the operator cannot clearly see the path of travel.

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

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

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

Obey a signal to stop from anyone.

 <p>HOIST</p>	 <p>LOWER</p>	 <p>USE MAIN HOIST</p>	 <p>USE WHIP LINE (Auxiliary Hoist)</p>
 <p>RAISE BOOM</p>	 <p>LOWER BOOM</p>	 <p>MOVE SLOWLY</p>	 <p>RAISE THE BOOM AND LOWER THE LOAD</p>
 <p>LOWER THE BOOM AND RAISE THE LOAD</p>	 <p>SWING</p>	 <p>STOP</p>	 <p>EMERGENCY STOP</p>
 <p>EXTEND BOOM</p>	 <p>DOG EVERYTHING</p>	 <p>TRAVEL</p>	 <p>RETRACT BOOM</p>
 <p>EXTEND BOOM (ONE HAND)</p>	<p>101492</p> <h1>HAND SIGNALS</h1> <p>Reprinted by permission of The American Society of Mechanical Engineers</p>		 <p>RETRACT BOOM (ONE HAND)</p>

BOOM EXTENSION

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

Install and secure all pins properly.

Control movement of boom extension at all times.

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



DANGER

Boom Extension Hazard!

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

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

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

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

Stay outside of boom extension sections and lattice work.

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

PARKING AND SECURING



WARNING

Tipping Hazard!

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

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

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

Section 3 of this manual provides instructions for parking and securing a crane when it is to be left unattended. These instructions are intended to allow the crane to be placed in the most stable and secure position. However, Manitowoc recognizes that certain jobsite conditions may not permit the boom and boom extension of a crane to be fully lowered to

the ground. When a qualified person at a jobsite determines that it is not practical to lower the boom to the ground, we recommend the following additional instructions be followed:

- The crane should be left in the smallest, most stable, valid operational configuration that the job site practically allows.
- The crane can not be left running, with a load on the hook, or in erection mode, or in wind conditions in excess of allowed values.
- The boom should be retracted as far as is practical, the crane configured in as stable a configuration as possible (boom angle, superstructure orientation, boom extension angle, etc.)
- In high winds the boom and boom extensions should be lowered, or secured. Changing weather conditions including but not limited to: wind, ice accumulation, precipitation, flooding, lighting, 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.
- Place controls in neutral position.
- Shut down the engine and remove the ignition key.
- Chock the wheels, if not on outriggers.
- Lock the operator's cab (if applicable) and install vandal guards, if used.

In cold weather, never park the crane where the tires can become frozen to the ground.

COLD WEATHER OPERATION

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

Check operating procedures in this manual for cold weather starting.

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

Clean the crane of all ice and snow.

Allow ample time for hydraulic oil to warm up.

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

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

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 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 0.00043 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 25 ft in which the oil cools 60°F would retract approximately 7 3/4 in (see chart below). A cylinder extended 5 feet in which the oil cools 60°F would only retract approximately 1 1/2 in. The rate at which the oil cools depends on many factors and will be more noticeable with a larger difference in oil temperature verses the ambient temperature.

Thermal contraction coupled with improper lubrication or improper wear pad adjustments may, under certain conditions, cause a "stick-slip" condition in the boom. This "stick-slip" condition could result in the load not moving smoothly. Proper boom lubrication and wear pad adjustment is important to permit the boom sections to slide freely. Slow

movement of the boom may be undetected by the operator unless a load is suspended for a long period of time. To minimize the effects of thermal contraction or "Stick-slip" it is recommended that the telescope control lever is activated periodically in the extend position to mitigate the effects of cooling oil.

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

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

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

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

Table 2-2: BOOM DRIFT CHART (Cylinder length change in inches)

Coeff. = 0.00043 (in ³ /in ³ / °F)											
STROKE (FT.)	Temperature Change (°F)										
	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. (in³/in³/ °F) X 12 in/ft



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.



WARNING

Overload Hazard!

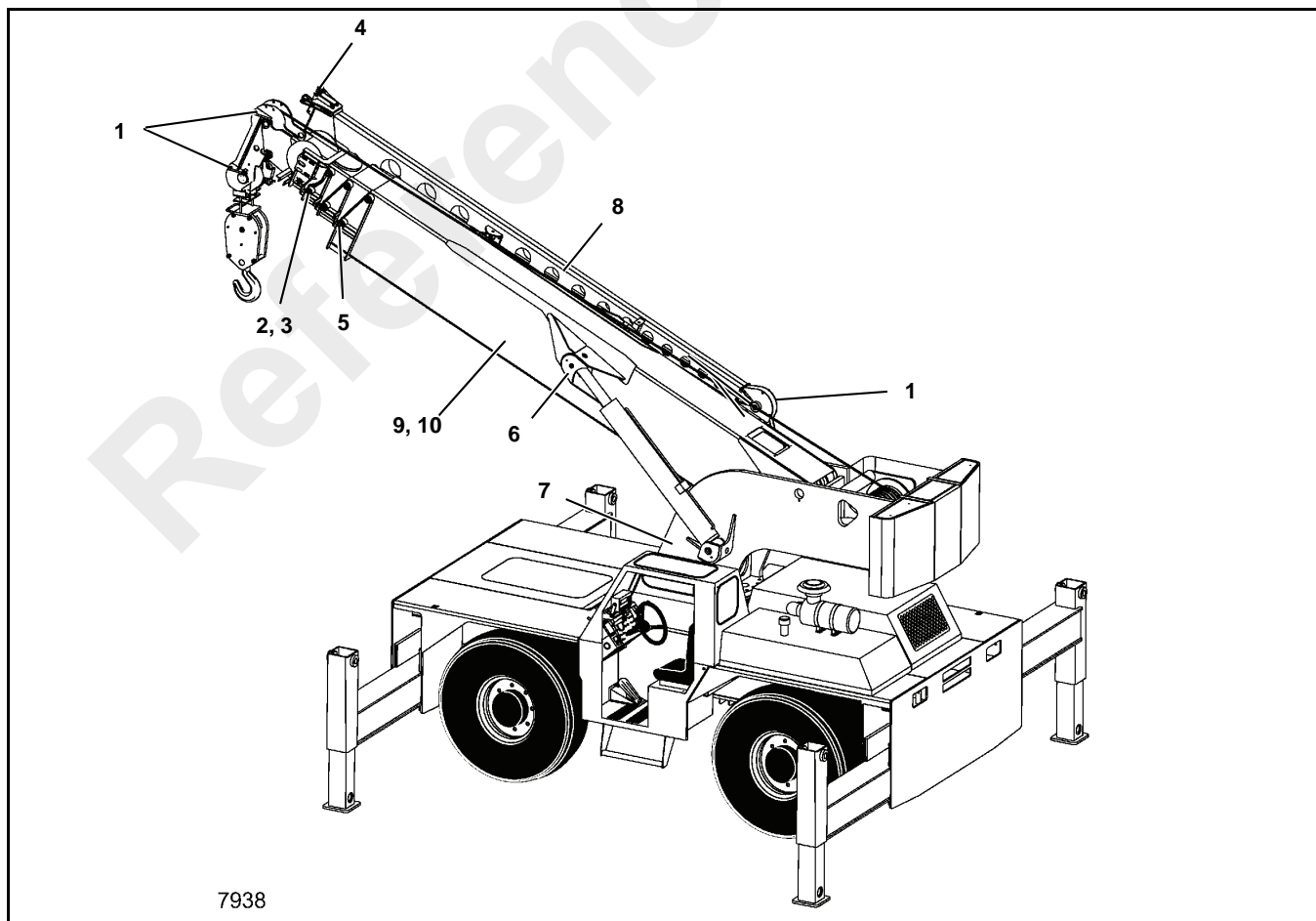
To avoid an accident caused by overload damage to your crane:

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

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

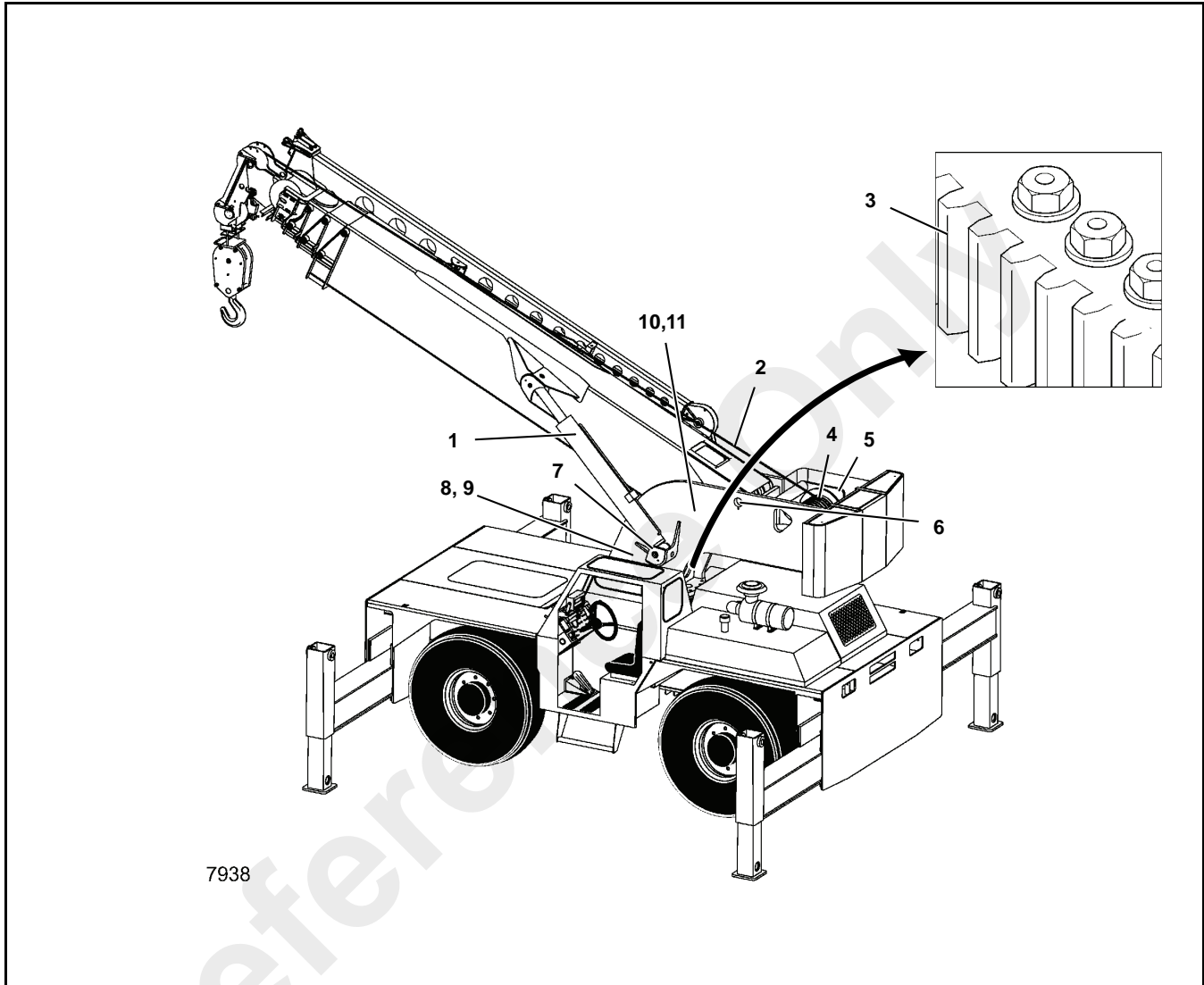
Overload warnings do NOT indicate real time events! Warnings could be sent 24 hours (or more) after the actual event.

Boom Inspection



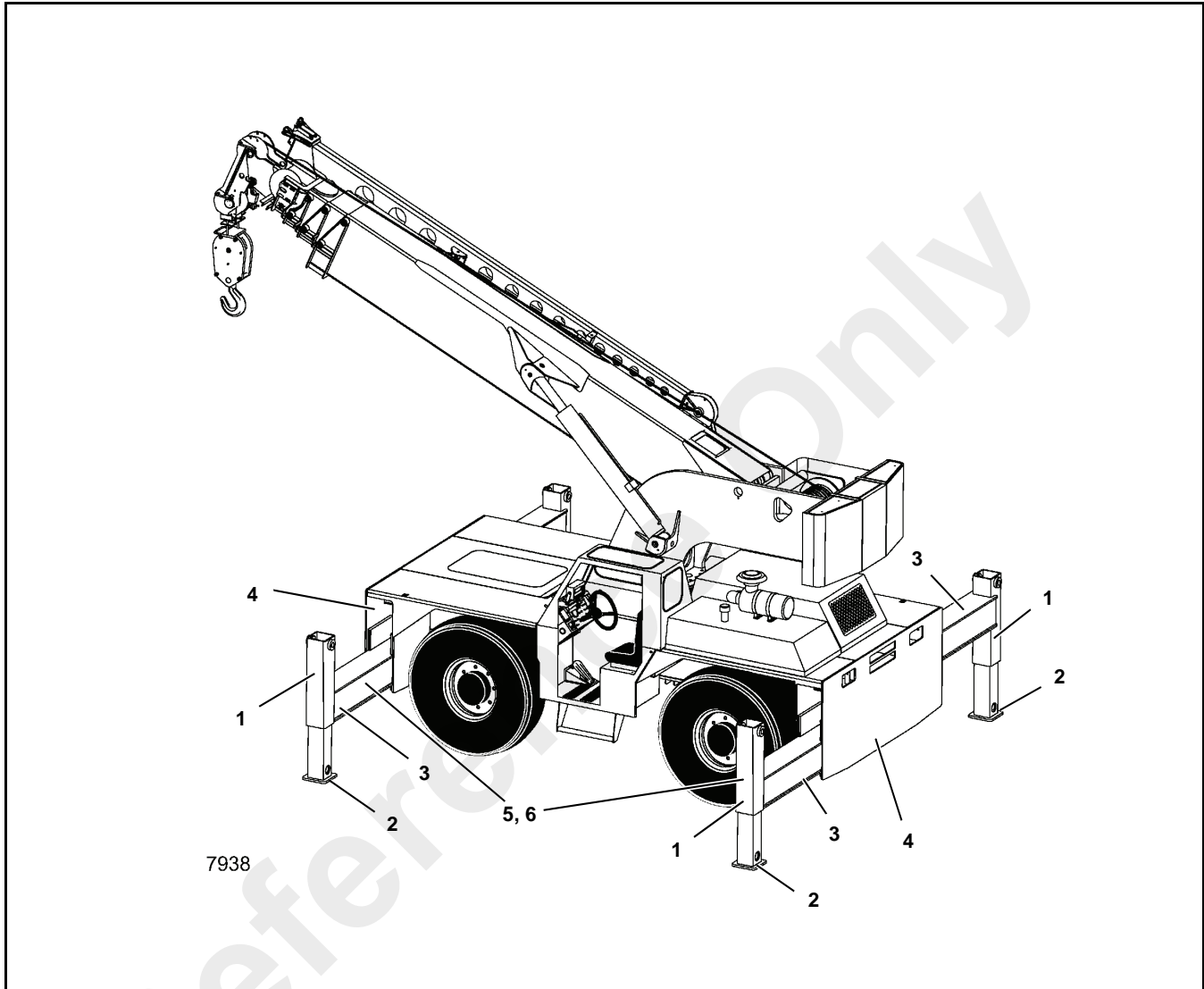
Overload less than 25%			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect for damage.	
Overload from 25% to 49%			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect all for damage.	
3	Collar-welds	Inspect all for damage.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

Superstructure Inspection



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.	

Carrier Inspection



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

Reference Only

SECTION 3 OPERATING CONTROLS AND PROCEDURES

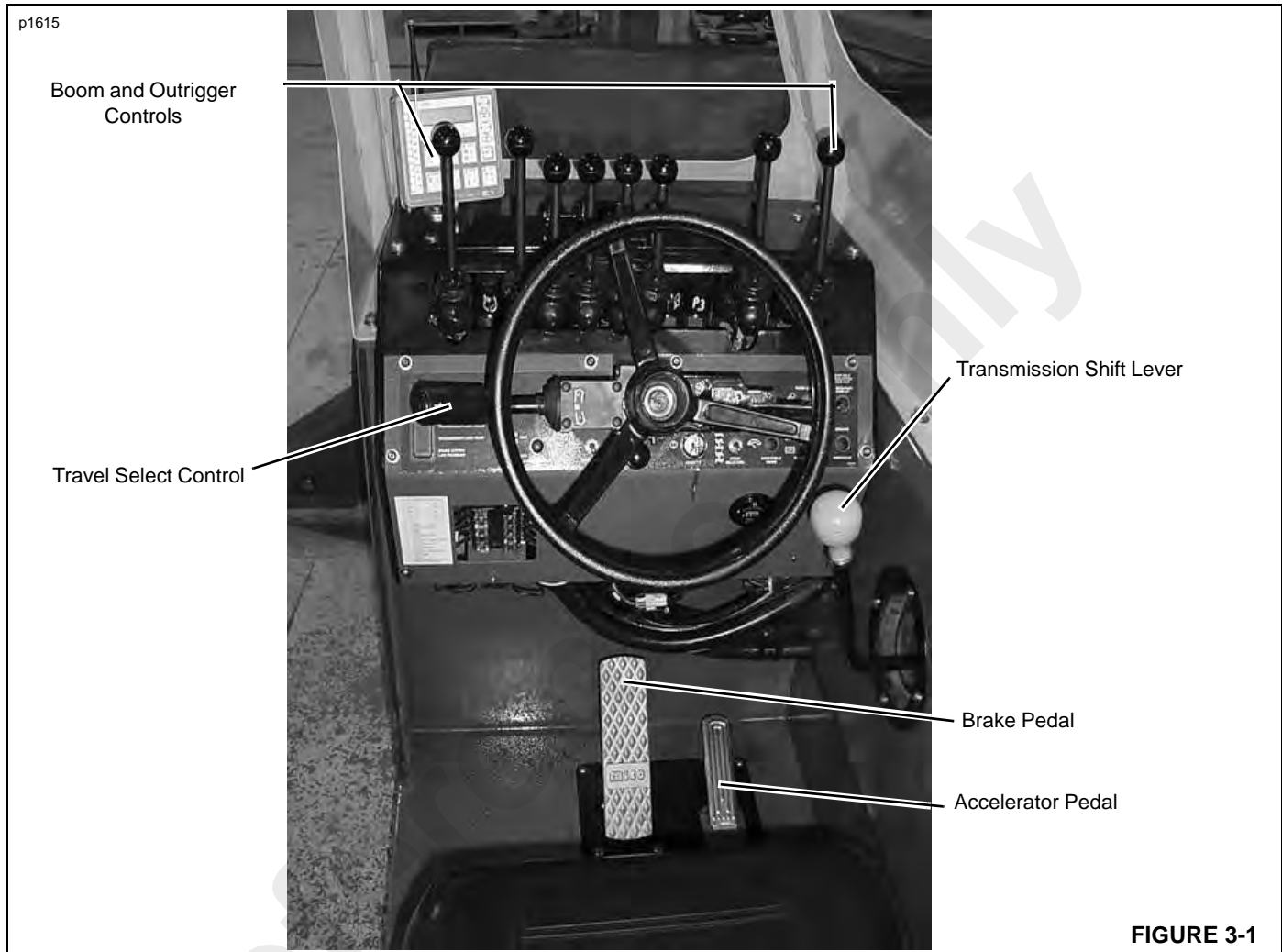
SECTION CONTENTS

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Reference

CONTROLS, SWITCHES, AND GAUGES

Cab Controls

**Brake Pedal**

See Figure 3-1 for the following procedure.

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

Accelerator Pedal

See Figure 3-1 for the following procedure.

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

Travel Select Lever

See Figure 3-1 for the following procedure.

Selects the forward and reverse travel of the crane.

For more information see *Traveling with the Crane* in this section.

Transmission Shift Lever

See Figure 3-1 for the following procedure.

The transmission shift lever, manually shifts the transmission to any one of four gear ratios.

For more information see *Shifting Gears (Travel Speed)* in this section.

Boom Controls

See Figure 3-2 for the following procedure.

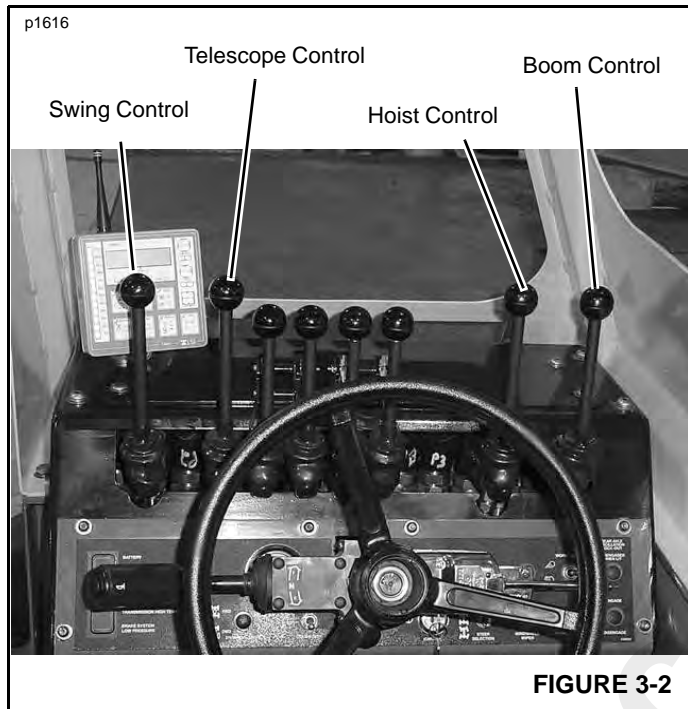


FIGURE 3-2

Swing Control

See Figure 3-2 for the following procedure.

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

Telescope Control

See Figure 3-2 for the following procedure.

The telescope control extends and retracts the boom sections.

Hoist Control

See Figure 3-2 for the following procedure.

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

Boom Control

See Figure 3-2 for the following procedure.

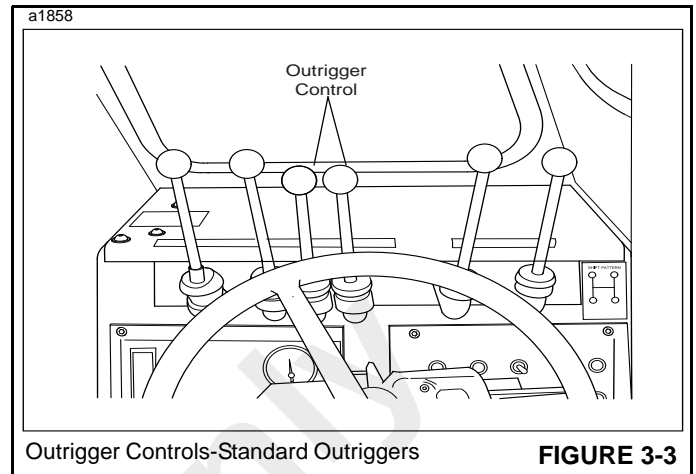
The boom control raises or lowers the boom assembly.

Outrigger Controls

See Figure 3-3 and Figure 3-4 for the following procedure.

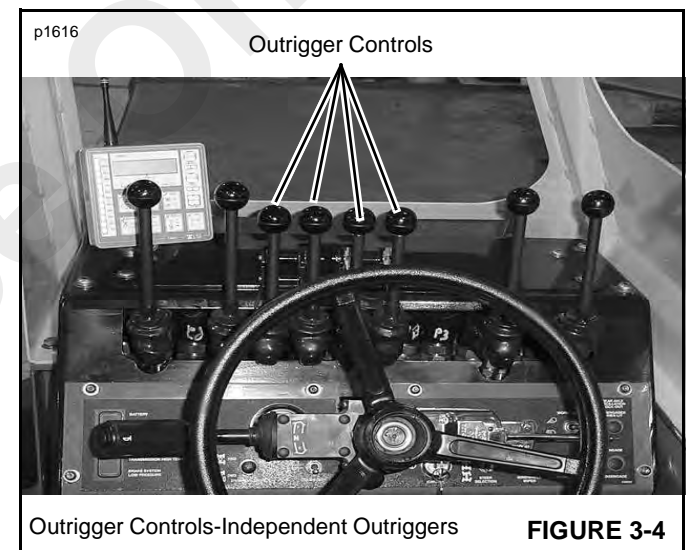
This set of controls extends and retracts the outriggers.

See *Operating the Outrigger Controls* in this section.



Outrigger Controls-Standard Outriggers

FIGURE 3-3



Outrigger Controls-Independent Outriggers

FIGURE 3-4

Panel Switches

Dual Fuel Switch (Option)

See Figure 3-5 for the following procedure.

Cranes with a dual fuel engine can switch between gasoline and liquid petroleum gas (L.P.G). See Fuel Change Over instructions.

Work Light/Head Light Switch

See Figure 3-5 for the following procedure.

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

Up position illuminates the work lights, head and tail lights and the instrument panel lights.

Center position turns off all lights.

Down position illuminates the head lights, tail lights and the instrument panel lights.

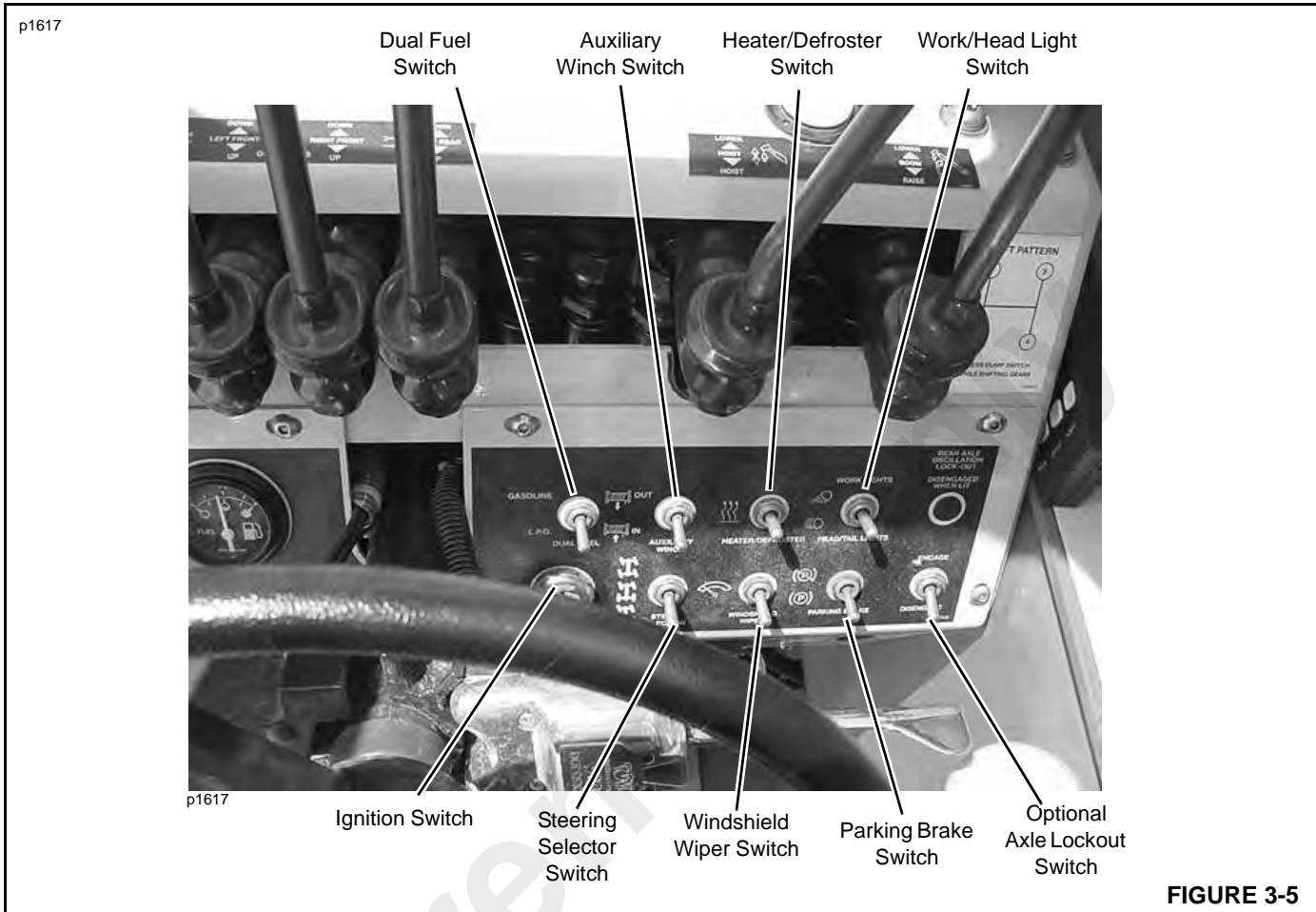


FIGURE 3-5

Parking Brake Switch

See Figure 3-5 for the following procedure.

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

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

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

Auxiliary Winch Switch (Optional)

See Figure 3-5 for the following procedure.

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

To **UNWIND** rope from the winch drum, hold the switch lever up.

To **WIND** rope on the winch drum, hold the switch lever down.

Windshield Wiper Switch (Optional)

See Figure 3-5 for the following procedure.

Move the switch lever down to turn on the front windshield wiper motor.

Heater/Defroster Switch (Optional)

See Figure 3-5 for the following procedure.

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

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

Steering Selection Switch - Standard

See Figure 3-5 for the following procedure.

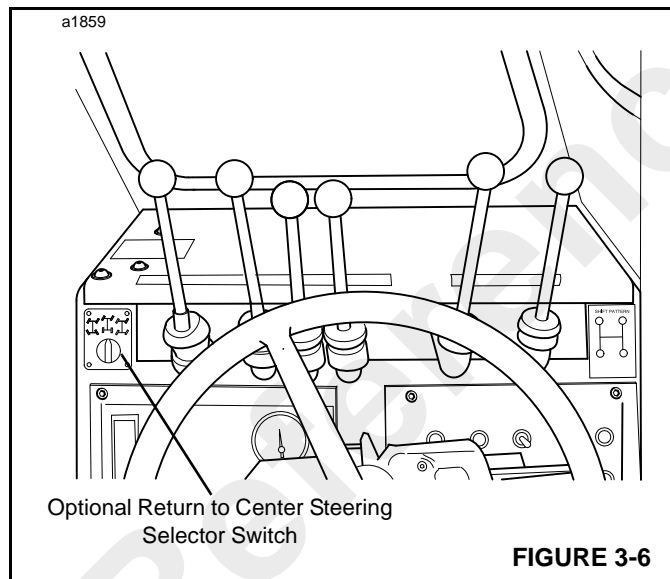
This switch is used to select one of three steering modes in which the crane can be steered. The wheels must be aligned in a straight forward direction before switching into another steering mode. See *Steering the Crane* for more information.

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

Return to Center Steering Selection Switch - Optional

See Figure 3-6 for the following procedure.

This switch is used to select one of three steering modes in which the crane can be steered see *Standard Steering*. Steering will automatically switch from one steering mode to the other when the switch is actuated to a different mode. See *Return to Center Steering Selector Switch-Optional* for more information.

**FIGURE 3-6****Ignition Switch**

See Figure 3-5 for the following procedure.

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

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

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

Optional Axle Lockout Switch

See Figure 3-5 for the following procedure.

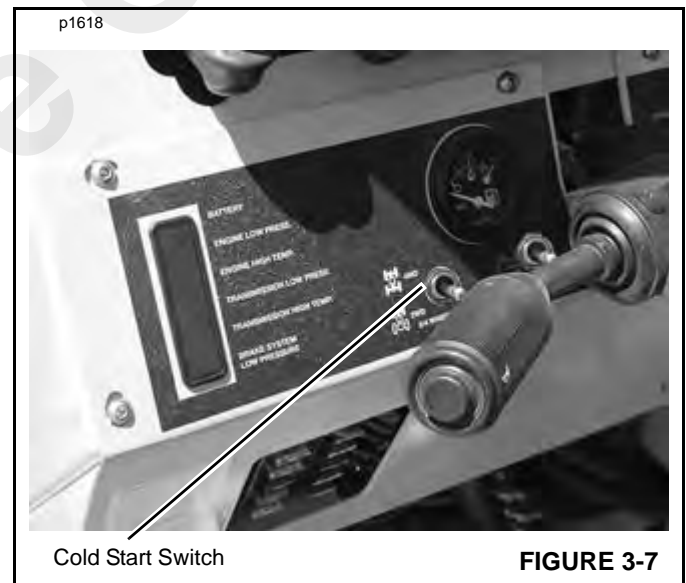
This switch engages and disengages the optional rear axle lockouts. The axle lockouts must be engaged when lifting on rubber and when traveling in crab steer. When traveling on rough terrain the axle lockouts must be disengaged.

The up position **ENGAGES** the axle lockouts and turns off the warning light.

The down position **DISENGAGES** the axle lockouts. When the axle lockouts are disengaged a red warning light will illuminate (See Figure 3-20).

Cold Start Switch (Diesel Engine - Optional)

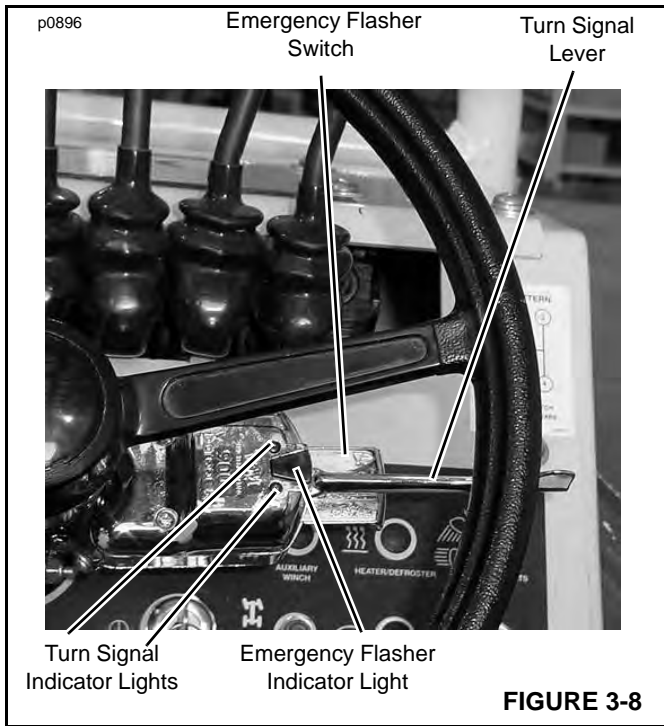
The cold start switch (Figure 3-7) is used to actuate a cold start ether cylinder to aid the starting of the diesel engine in cold weather. See to "Applying Starting Fluid" later in this chapter.

**FIGURE 3-7****Turn Signal Switch**

See Figure 3-8 for the following procedure.

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

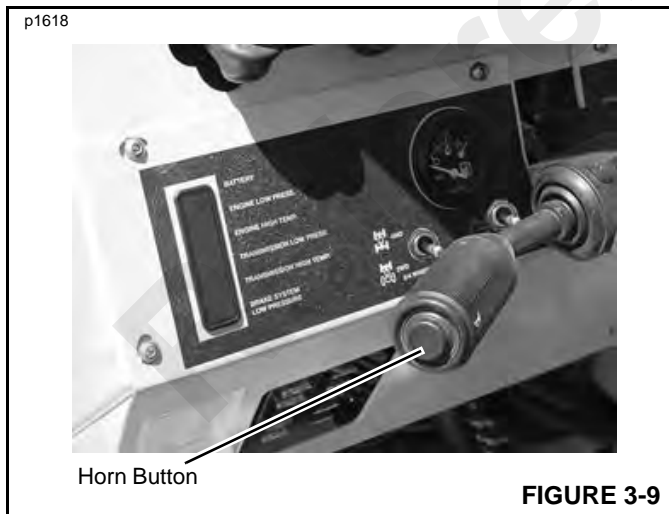
To simultaneously place all four turn signals in the flashing (emergency) mode. Pull the emergency switch out. In the out position, it will be locked in place and all turn signals will flash on and off, as well as the red emergency flasher light on the turn signal control will flash on and off. To release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



Horn Button

See Figure 3-9 for the following procedure.

Press the button on the end of the travel selector lever to sound the horn.



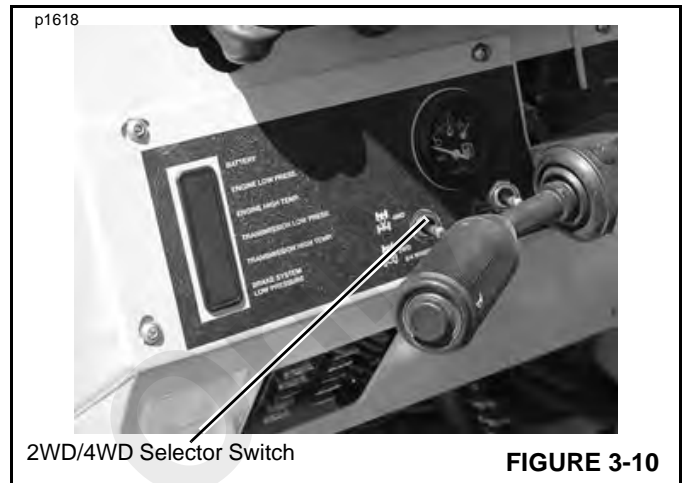
2WD/4WD Selector Switch (Optional)

See Figure 3-10 for the following procedure.

This switch selects between 2 wheel drive and 4 wheel drive functions.

The **up** position places the transmission in 4 wheel drive.

The **down** position places the transmission in 2 wheel drive.

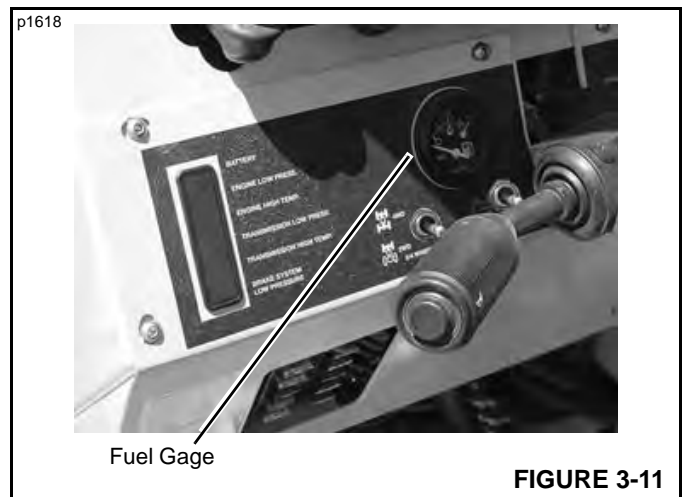


Gauges And Indicators

Fuel Gauge

See Figure 3-11 for the following procedure.

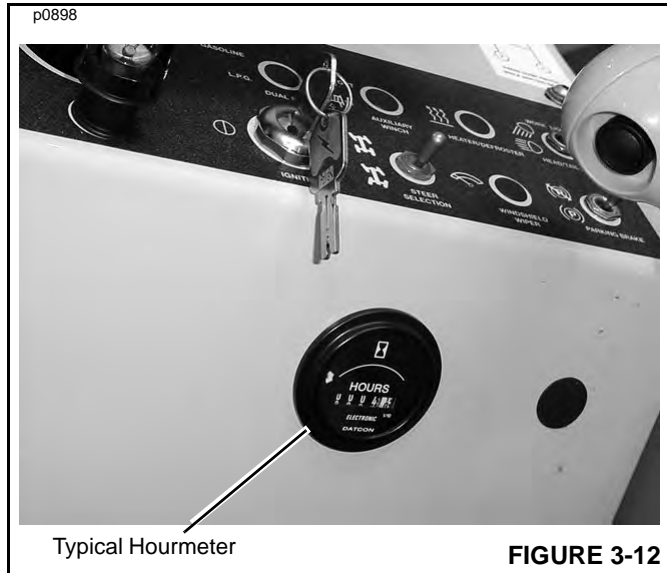
Indicates the amount of fuel in the fuel tank.



Hourmeter

See Figure 3-12 for the following procedure.

The hourmeter registers the total hours the engine has been operating. Use this gauge to perform preventive maintenance scheduling.



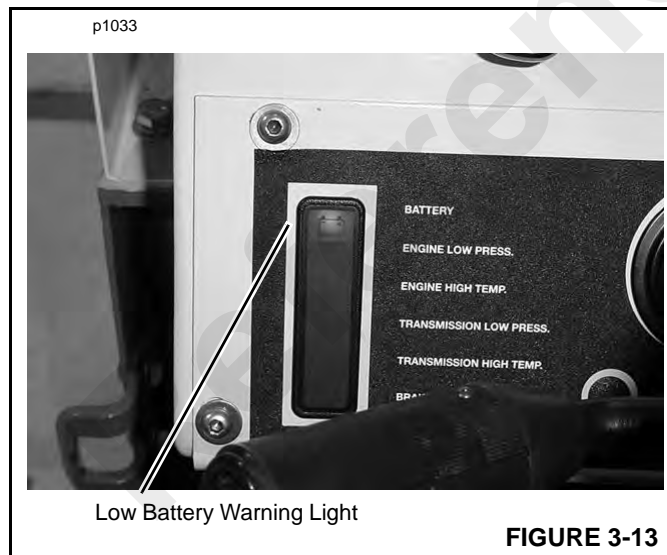
Typical Hourmeter

FIGURE 3-12

Low Battery Warning Light

See Figure 3-13 for the following procedure.

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



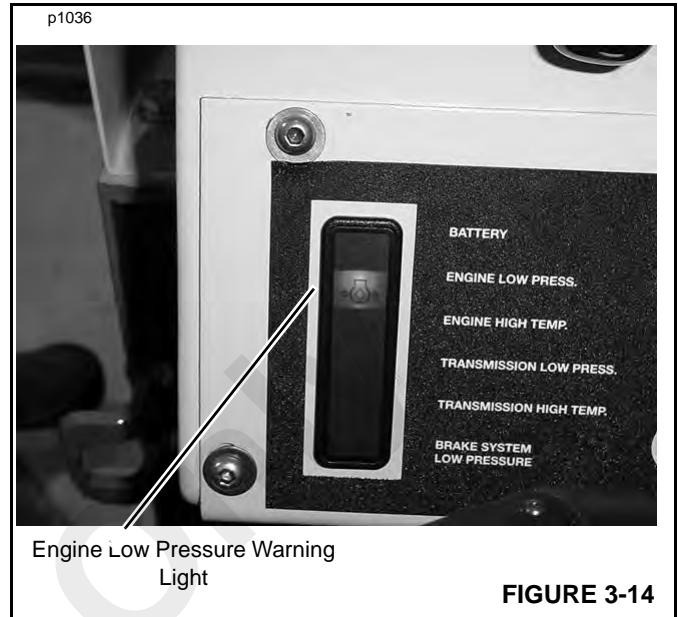
Low Battery Warning Light

FIGURE 3-13

Engine Low Pressure Warning Light

See Figure 3-14 for the following procedure.

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



Engine Low Pressure Warning Light

FIGURE 3-14

Engine High Temperature Warning Light

See Figure 3-15 for the following procedure.

When this light is illuminated it is an indication that the engine cooling system is not properly cooling the engine and that the engine temperature is above normal operating temperature. High temperature could damage the engine, therefore, if this light illuminates during operation, immediately shut down the engine and have the engine cooling system serviced.



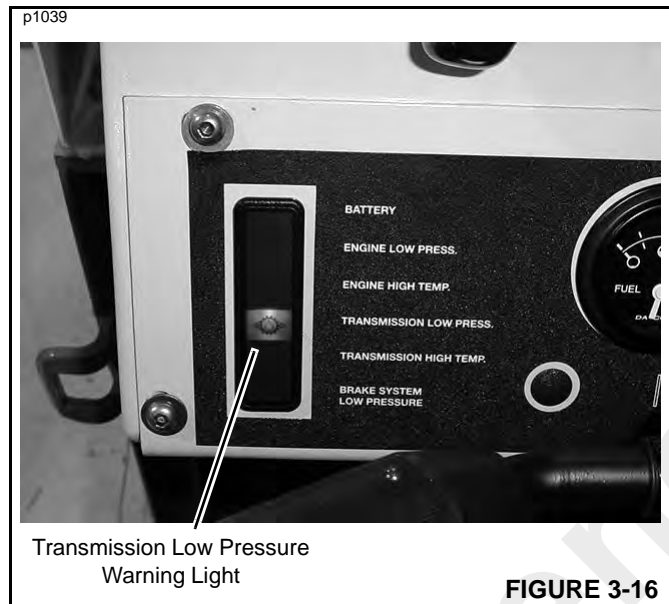
Engine High Temp. Warning Light

FIGURE 3-15

Transmission Low Oil Pressure Warning Light

See Figure 3-16 for the following procedure.

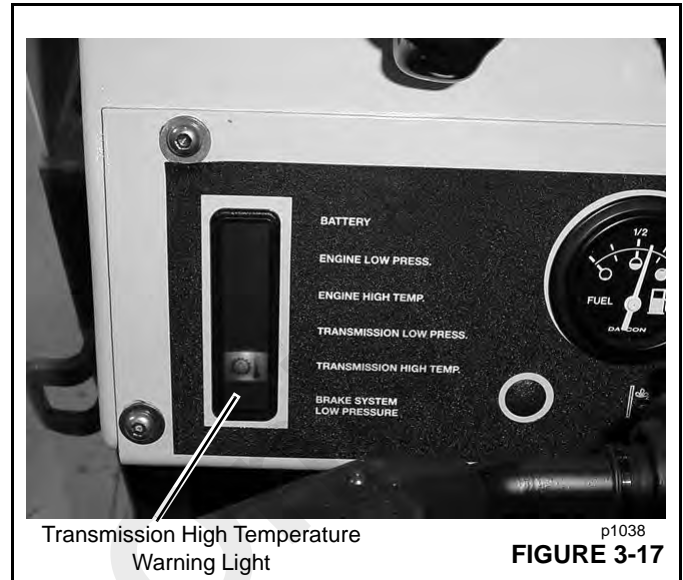
When this light is illuminated it is an indication that the transmission oil pressure is lower than what is recommended for proper operation of the transmission. The transmission could be damaged if it is run with low oil pressure. If this light illuminates during operation, immediately shut down the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



Transmission High Temperature Warning Light

See Figure 3-17 for the following procedure.

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



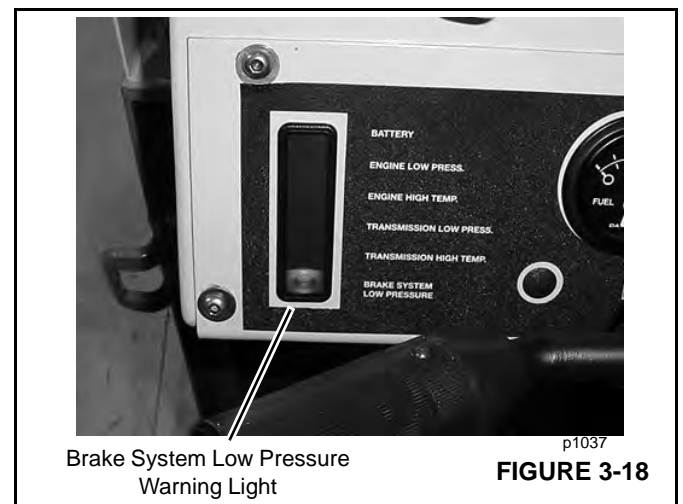
Brake System Low Pressure Warning Light

See Figure 3-18 for the following procedure.

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



When the low brake pressure warning light is illuminated, immediately stop and shut down 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.



Dual Fuel Engine Warning Light

See Figure 3-19 for the following procedure.

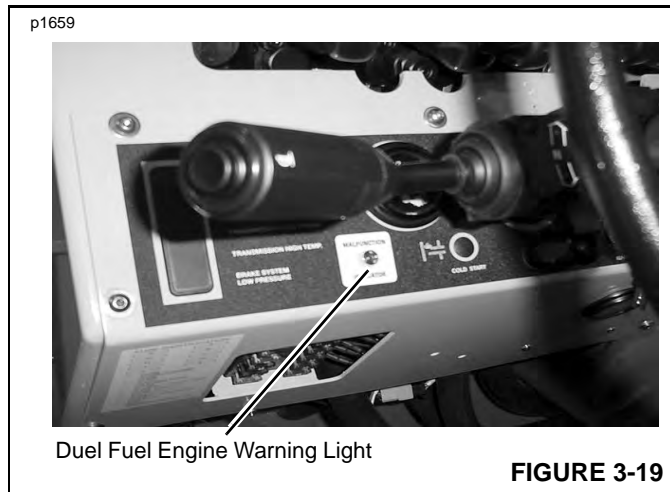


FIGURE 3-19

This light is for operator inspection upon powering the system with the ignition switch. This light displays error codes, if present, when the ignition switch is turned on, engine off. The codes are conveyed by flashing the light in such a manner that the first numeral flashed, a pause, and then the second number of the code flashed.

The light will flash a code 12 every time the ignition switch is moved to the ON position; this indicates the system is in the diagnostic mode. When a code has been set, the code will be indicated after the code 12 is flashed. For instance, if a code 24 has been set, the light will flash one time, pause, flash two times, after which it will flash two times and then four times, indicating the code 24. If multiple codes are set they will be displayed in numerical order, not in order of occurrence.

Error Codes	Error Description
12-	Diagnostic mode indicator.
13-	Oxygen sensor error
14-	Engine coolant temp - high
15-	Engine coolant temp - low
21-	Throttle position sensor error
22-	Throttle body actuator not responding

Error Codes	Error Description
23-	Inlet air temp sensor - low
24-	Inlet air temp sensor - high
25-	Electronic ignition control error
31-	Drive by wire error
32-	System voltage low
41-	Manifold absolute pressure sensor error
42-	Gasoline injector fault
51-	EPROM fault
52-	Analog to digital converter fault
61-	LP solenoid relay fault
62-	Fuel pump relay fault
63-	Dual fuel relay fault
64-	Ignition power relay out fault

Optional Axle Lockout Indicator Light

See Figure 3-20 for the following procedure.

When Illuminated (Red), this light indicates when the rear axle lockouts are disengaged. The axle lockouts must be disengaged whenever the crane is traveling over rough terrain.

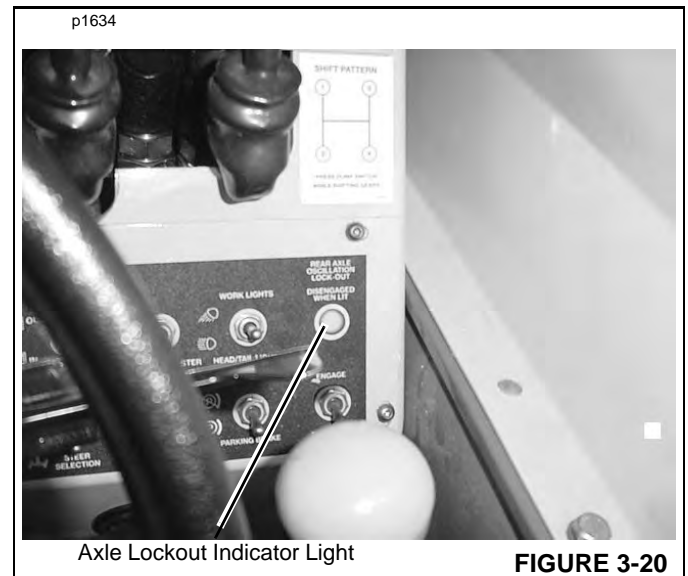


FIGURE 3-20

Crane Level Indicator

See Figure 3-21 for the following procedure.

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

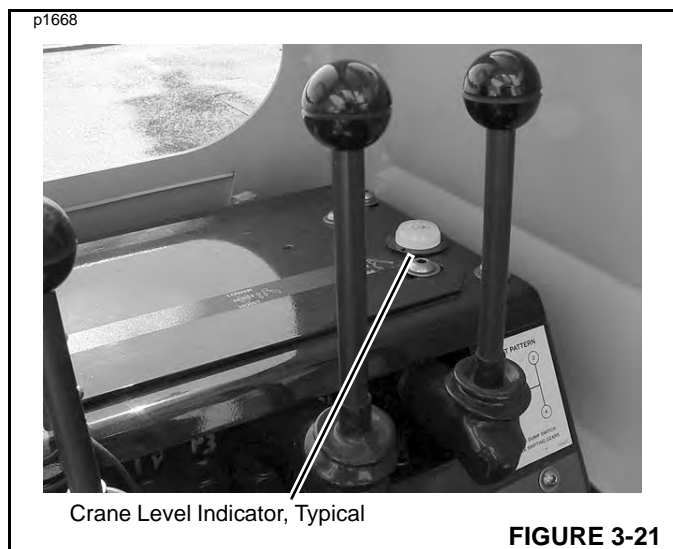


FIGURE 3-21

Boom Angle Indicator

See Figure 3-22 for the following procedure.

The boom angle indicator is a plumb arrow and a decal with angular graduations from 0° to 69°. It is located on both sides of the boom and is visible from the operator's cab in most boom positions. Use the indicator to determine the boom angle when reading the capacity chart. (See Using the Capacity Chart).

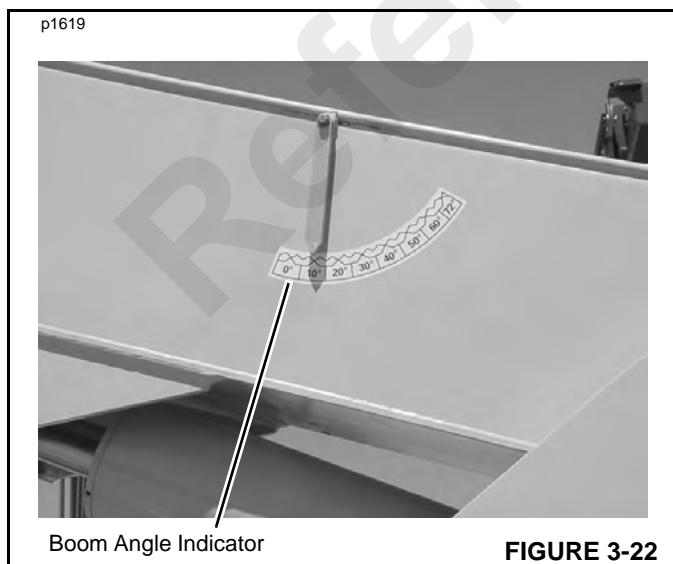


FIGURE 3-22

LSI Load Indicator Display Panel

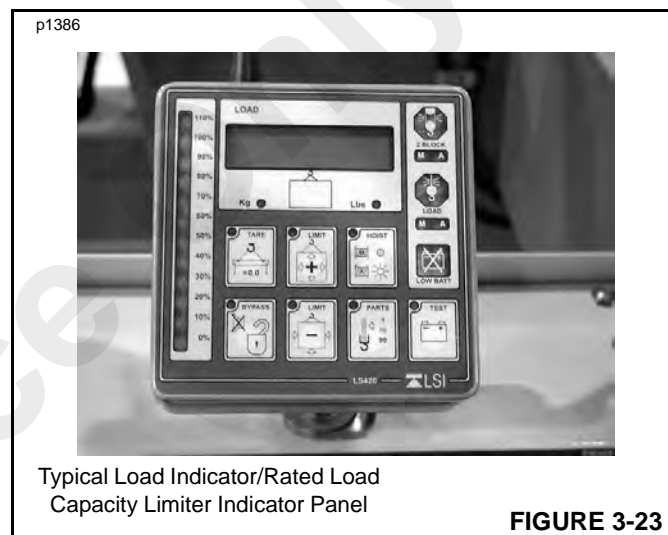
The load indicator panel (Figure 3-23) displays load and capacity related information and warns the operator when a

limit is exceeded. The operator is warned by a flashing light on the display panel.

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

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

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



Typical Load Indicator/Rated Load Capacity Limiter Indicator Panel

FIGURE 3-23

LSI Rated Capacity Limiter (RCL) - Optional

The rated capacity limiter is similar to the standard Load Indicator, but instead of warning the operator when a load limit is exceeded it stops the telescope out function and the boom lower function and hoist up function when the load limit has been exceeded. It uses a similar indicator panel as the Load Indicator (Figure 3-23) and the same transmitter and load pin, but the system also includes boom angle and boom length sensors and transmitter that sends boom angle and length information to the display panel. For operating instructions, see the *LSI Universal User Manual* furnished with the crane.

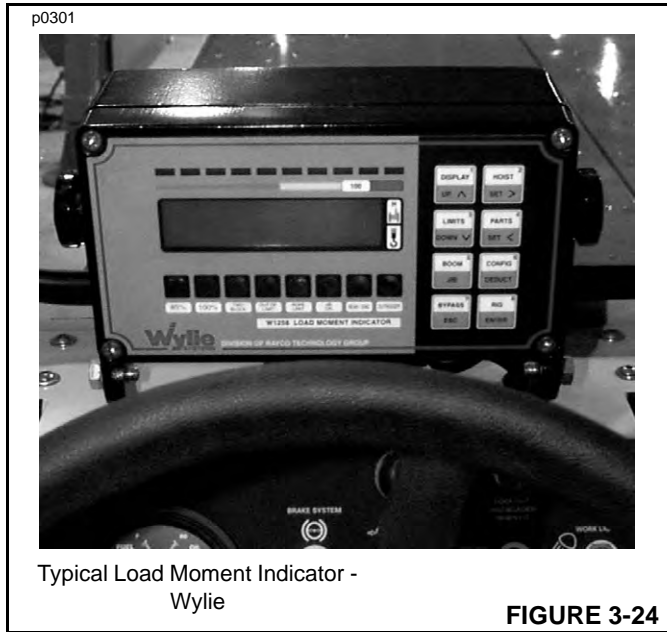
Optional Load Moment Indicator Display Panel (Wylie)

See Figure 3-24 for the following procedure.

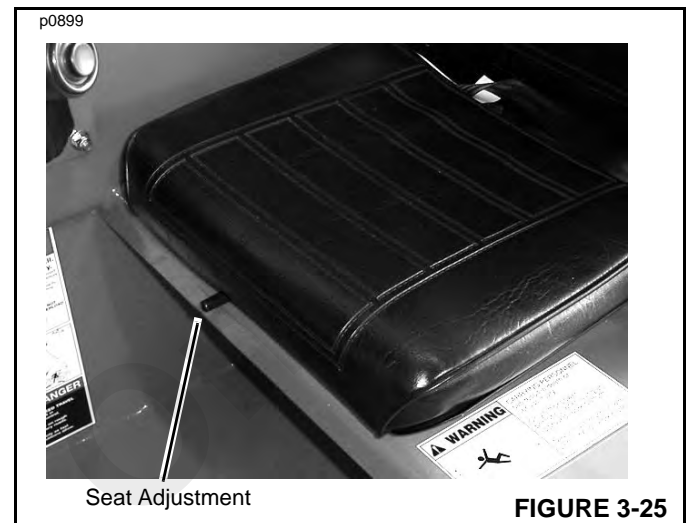
Provides visual indications of angle, load, radius, capacity, etc. and allows the operator to set limits on these indications.

The display panel includes a digital display screen, LED illuminated bar graph, eight indicator warning lights, audible alarm and an operations key pad.

For operating instructions, see the *LMI Operator's Manual* furnished with the crane.



SEAT FORE & AFT ADJUSTMENT - To adjust the seat, move the control lever (Figure 3-25) to the right. Move the seat to proper position and then move the control lever back to the left to lock the seat position.



OPERATOR'S CAB

Seat Belt

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



Seat Adjustment

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

Cab Door (Enclosed Cab)

Opening the Cab Door From Outside (Enclosed Cab)

Pull the door latch out to release the cab door latch (Figure 3-26).



Opening the Door From Inside (Enclosed Cab)

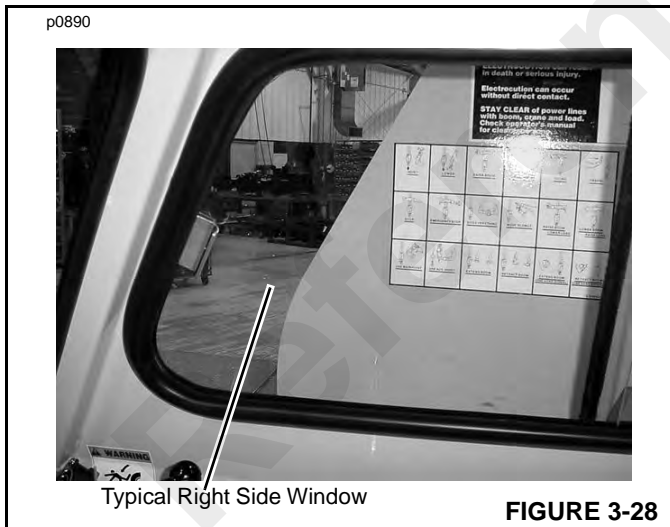
Pull the door handle back to release the cab door latch (Figure 3-27).



Opening the Sliding Side Windows (Enclosed Cab)

Both the left and right side windows open and close the same.

To open the window shown in Figure 3-28, pull the front portion of the side window toward the rear. To close the window, push the window forward in place.



Heater and Defroster

The cab heater (furnished as an option with enclosed cabs) is located under the operator's seat (Figure 3-29). The windshield defroster vent is located in the lower right corner of the front windshield (Figure 3-30).



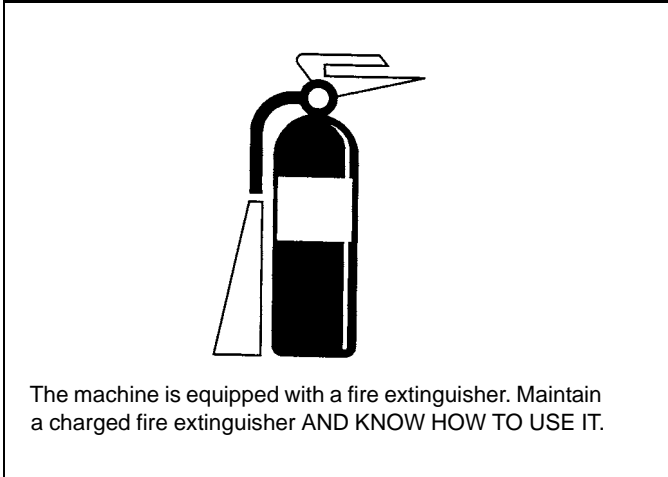
NOTE: Be sure the shut-off valve in the hot water supply line is open. The shut-off valve is located on the engine.

To operate the heater and defroster, use the heater and defroster switch located on the instrument panel (see Figure 3-4). Select the desired fan speed.

Position the vent (see Figure 3-29) on the heater for desired amount of air flow.

Fire Extinguisher

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



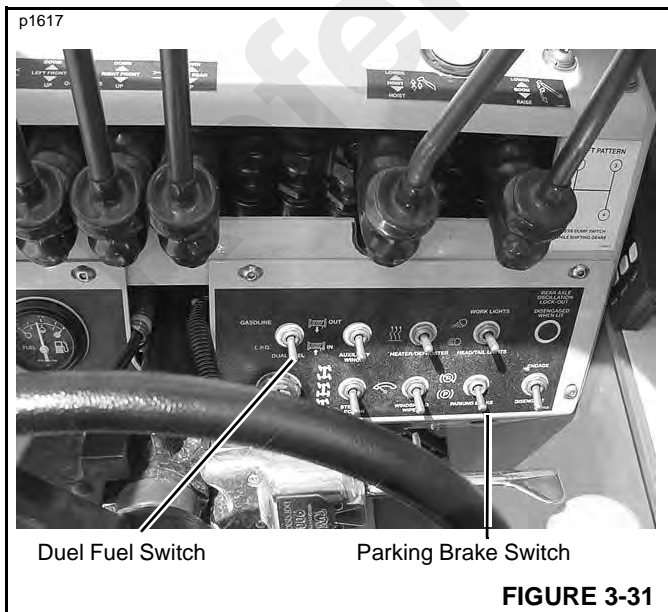
MACHINE OPERATION

Fuel Change Over Instructions - Dual Fuel Engines



Flammable liquids. When switching from Liquid Petroleum Gas (L.P.G) to liquid fuel, be sure that there is no spillage of liquid fuel from the carburetor float system. Fire and/or explosion is possible from spilled fuel.

1. To run the engine on gasoline, place the dual fuel switch in the "Gasoline" position (Figure 3-31).



2. To run the engine on Liquid Petroleum Gas, place the switch in the "LPG" position.

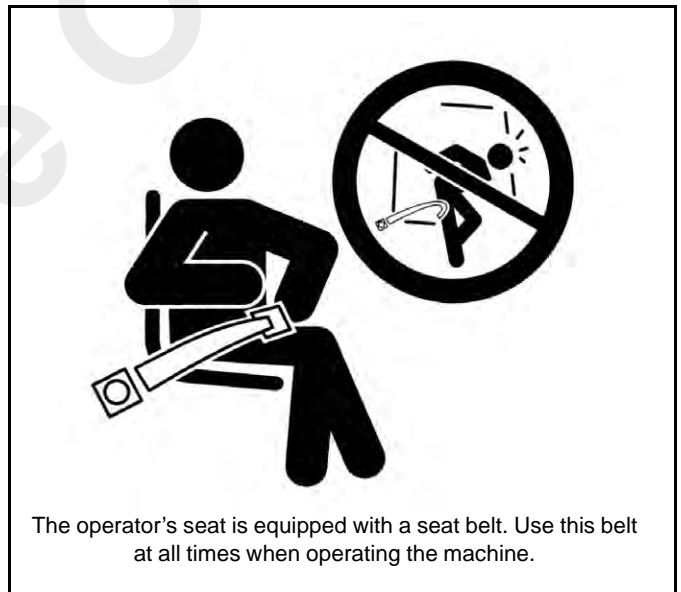
Starting The Engine

Normal Engine Starting

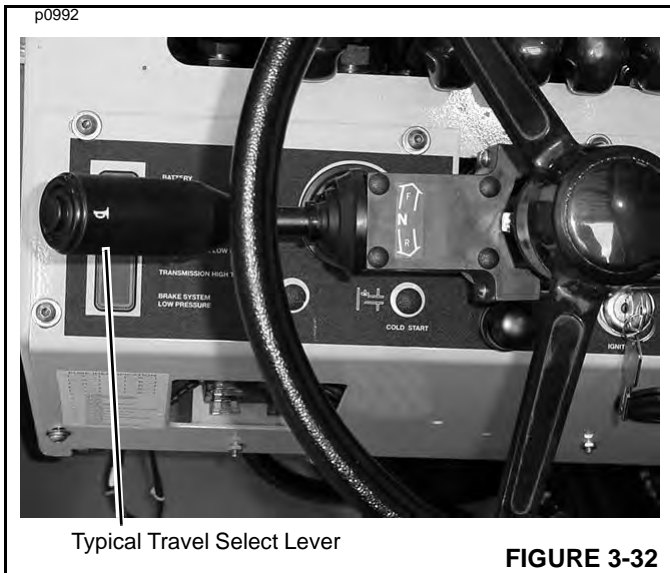
NOTE: Never leave the engine running while the crane is unattended. Shut off the engine to inhibit unauthorized persons from operating the controls.

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

1. Enter the cab and adjust the operator's seat for comfortable operation.
2. Fasten the seat belt.



3. Check that the parking brake is engaged (Figure 3-31).
4. Place the travel select lever in the neutral position (Figure 3-32).



Typical Travel Select Lever

FIGURE 3-32

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

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

NOTE: If the crane is equipped with a dual fuel engine it is also equipped with shut down gauges. They may be equipped as an option on diesel engines. Should the engine start but will not keep running, check to see if the engine oil low pressure or engine high temperature warning light is illuminated. If it is, either the engine oil pressure is low or the engine cooling system temperature is high. The engine will not start until the problem is repaired.

6. On diesel powered cranes, check the engine oil pressure warning light. If the warning light is illuminated, shut down the engine immediately. Have the engine serviced before placing the crane in service.
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 for more information.
8. Disengage the parking brake before you travel with the crane. See the Travel Instructions later in this section.

Engine Starting Procedures

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

DO NOT operate the engine at full RPM or apply a full load until the engine is warm. After a dual fuel engine is warm, do not let the engine run at idle for a long period of time. During cold weather, it may be necessary to run the engine at a higher speed to keep the correct operating temperature.

GASOLINE/L.P.G ENGINE STARTING PROCEDURE

Turn the ignition switch to the START position (fully clockwise) to crank the engine. Release the switch when the engine starts. If the engine fails to start on the first try, wait until the starter motor comes to a complete stop; then again crank the engine with the ignition key.

DIESEL ENGINE STARTING PROCEDURE

The diesel engine in this crane is not normally equipped with a metering cold starting aid. However, one is available as an option and is recommended when the crane is to be operated in temperatures below 10°F (-12°C).

NOTE: Temperature ranges will vary when using different oil weights. Consult the engine manufacturer's manual for the variables.

1. If necessary, apply a starting aid to the engine. See *Applying Starting Fluid to the Engine*.
2. Depress the accelerator pedal halfway to the floor.
3. Turn the ignition switch to the START position to crank the engine. Release the switch when the engine starts. If the engine fails to start on the first try, wait until the starter motor comes to a complete stop; then again crank the engine with the ignition key.

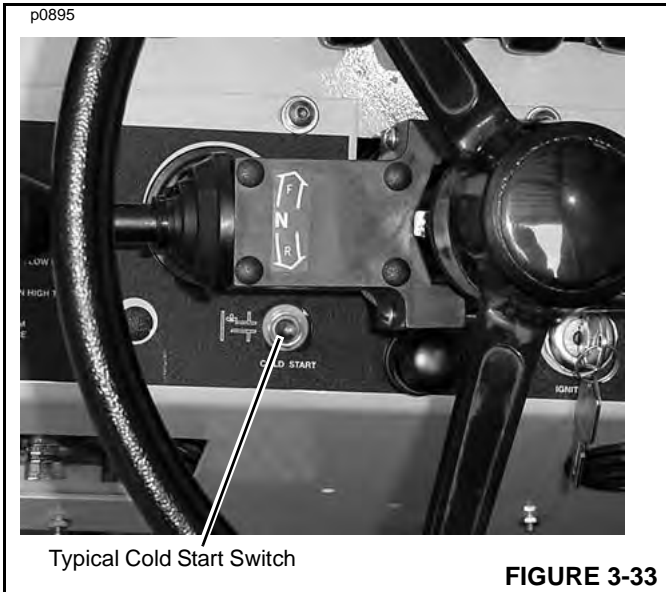
NOTE: Check the engine oil pressure warning light immediately after the engine starts. If the oil pressure warning light is illuminated, stop the engine and have the engine serviced.

Applying Starting Fluid To The Diesel Engine

Applying Fluid Using A Metered Injection-type Starting Aid (Optional)

An ether injection kit is available as an option for injecting pre-measured amounts of ether into the engine's intake manifold using a switch in the cab.

1. Push and hold the cold start switch on the instrument panel (see Figure 3-33) to inject a metered amount of fluid into the engine. Turn the ignition switch to the START position to crank the engine.



- If the engine does not start after the first injection of starting fluid, repeat Step 1 until the engine starts or it is determined it will not start.

NOTE: Avoid injecting too much starting fluid into the engine. Too much fluid will cause engine damage by washing lubricant from the cylinder bores.

! WARNING



Do not smoke while changing ether cylinders or where ether cylinders are stored. Keep ether cylinders away from open flames.

3

! WARNING



Ether is poisonous. Do not store ether cylinders in the operator's compartment. Breathing ether fumes can cause serious personal injury. Use ether only in well ventilated areas.

! WARNING



Discard spent ether cylinders per manufacturer's instructions. Do not puncture or burn. Ether cylinders can burst causing serious personal injury.

Applying Fluid From A Spray Canister

WARNING

NEVER use starting fluid near an open flame, or with an electric pre-heater, or with flame heating equipment. Serious injury or death could occur from explosion.

DO NOT breathe starting fluid fumes. Serious injury or death could result from the toxic fumes.

DO NOT use excessive amounts of starting fluid. Serious injury or death could result from a backfire of flame, which could ignite the starting fluid canister and cause an explosion.

NOTE: Two people are recommended to be present when attempting to start the engine using a starting fluid without a metered starting fluid system. One person is to operate the ignition switch, while the other sprays the starting fluid into the air cleaner intake. Avoid soaking the air cleaner element with fluid. This is extremely important, because a backfire of flame can completely destroy the air cleaner element, as well as cause other damage to the engine and possible personal injury.

1. Spray a small amount of starting fluid into the air cleaner intake opening.

NOTE: Avoid injecting too much starting fluid into the engine. Too much fluid will cause engine damage by washing lubricant from the cylinder bores.

2. Start the engine.
3. If the engine does not start, repeat the procedure until the engine starts or it is determined it will not start.

Towing or Pushing the Crane to Start the Engine

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

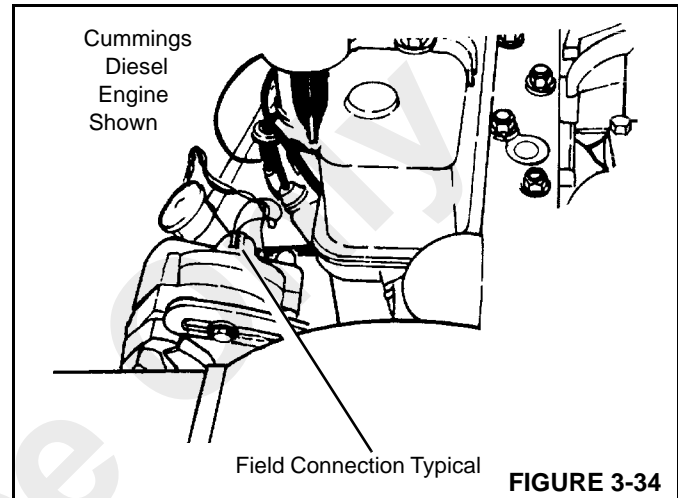
Jump Starting the Engine

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

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

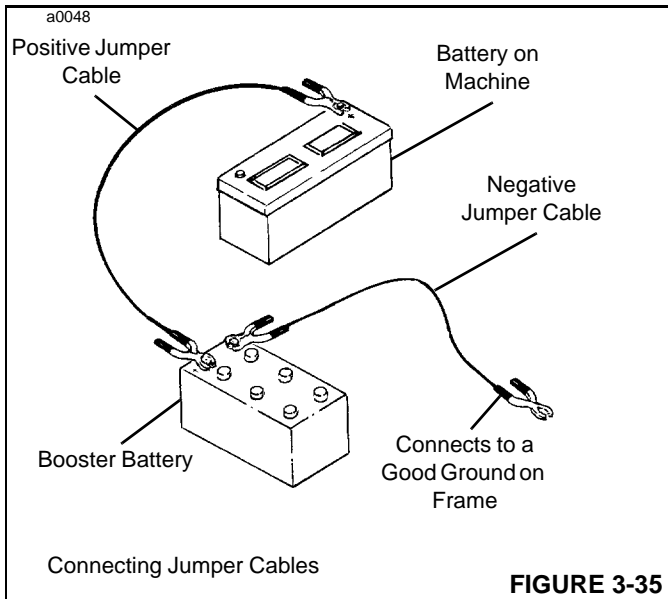
NOTE: **NEVER** jump start the engine directly to the starter or starter solenoid. Serious injury could result from the crane moving forward or back and running over the person performing the jump starting procedure.

5. Disconnect the FIELD connection from the alternator (Figure 3-34). The connection is generally marked with an "F".



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

6. If a booster battery is used, it must be a 12 Volt battery. If a vehicle is used, it must have a negative ground electrical system.
7. Connect one end of the positive (+) jumper cable (usually red) to the jump start connector. See Figure 3-35.
8. Connect the other end of the positive cable to the positive (+) post on the booster battery.
9. Connect one end of the negative (-) jumper cable (usually black) to the negative (-) post on the booster battery.
10. Make the final connection to the engine block or a ground point the furthest away from the discharged battery.
11. Follow the steps under Normal Starting.
12. When the engine starts, remove the jumper cables in reverse order (i.e., negative ground cable first, etc.). Install the alternator field connection.



Traveling with the Crane

⚠ WARNING

SAVE LIVES AND PREVENT INJURIES.

- Watch your path.
- Help people notice you.
- Use your horn.
- Be sure backup alarm is operating.

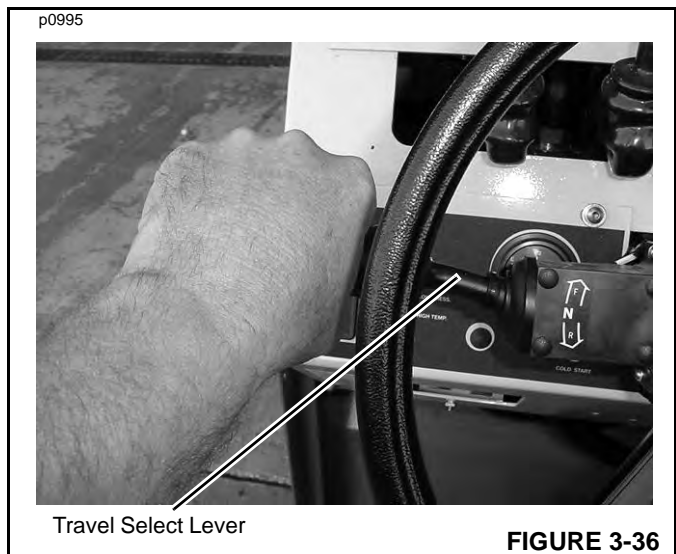
1100255

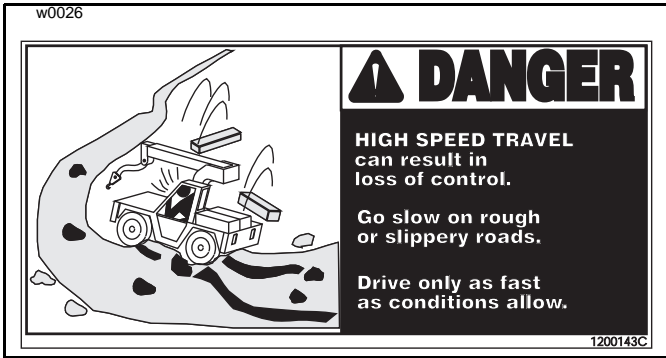
NOTE: If travel sight is restricted, do not attempt to travel with the crane until a signalman gives a signal that the crane is clear of obstacles in the wheel path. Remove any obstacles from the wheel path before moving.

NOTE: To help inhibit accidents, use a Slow Moving Vehicle sign and a flashing strobe light (where legal) for traveling on highways or public roads.

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

1. Enter the operator's cab, close the door, if equipped, and fasten the seat belt.
 2. Start the engine and disengage the parking brake.
- NOTE:** To avoid damage to the parking brake and crane, do not apply the parking brake while traveling.
3. Select either the Forward (F) or Reverse (R) travel position on the travel select lever. (See Figure 3-36). Pull the handle back and then move it up or down to select travel direction.



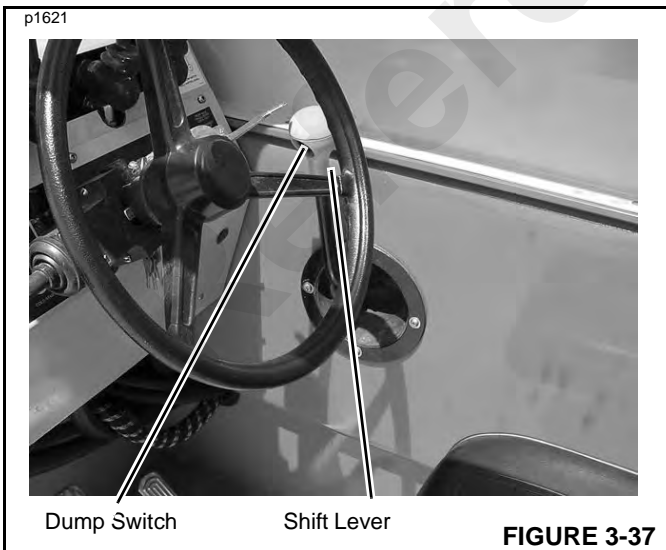


NOTE: The crane has no axle suspension. Traveling at high speeds, especially on rough roads, can create a bouncing effect that can result in loss of control. Personal injury, death and property damage could result. Reduce speed if bouncing occurs.

4. Start out traveling from a stopped position in 1st speed. Travel speed may be shifted from 1st to 2nd, 2nd to 3rd, 3rd to 4th when the crane is moving. See Shifting Gears, below. Avoid operating at too high of gear selection when moving a heavy load, as this may cause “lugging” on the engine. Use a lower gear when moving a heavy load; higher gear when moving a lighter load. **Selecting the correct travel speed will prolong engine life.**

Shifting Gears (Travel Speed)

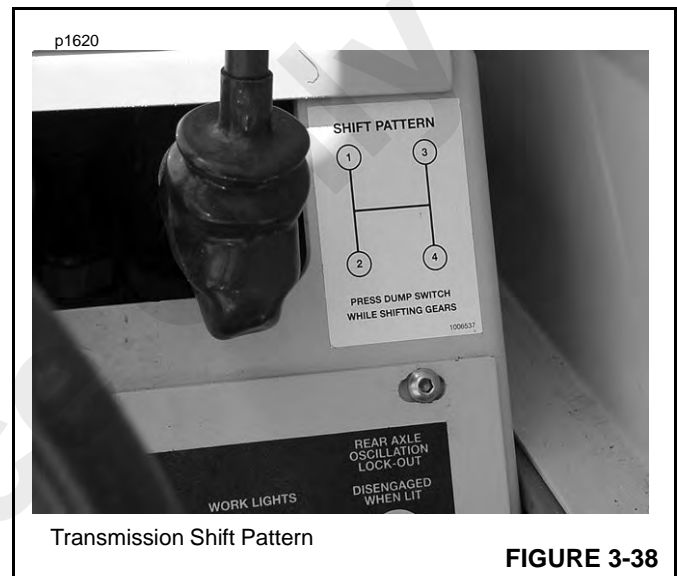
1. When the crane’s engine is shut off, the transmission can be shifted into any gear without first pressing and holding the dump switch (Figure 3-37).



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

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

3. To shift to the next gear, move the shift lever to the desired gear position. See shift pattern in Figure 3-38.

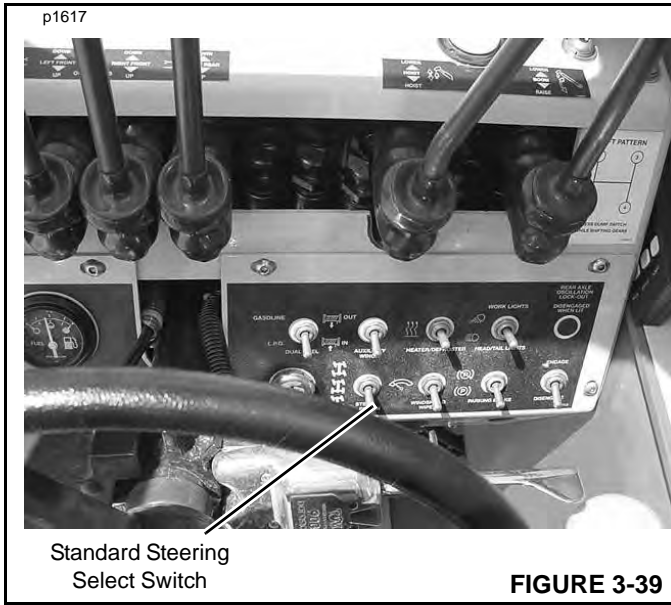


4. When downshifting, do not over-rev the engine. Allow the crane’s engine to slow down before pressing and holding the dump switch and shifting to the next lower gear.

Steering The Crane

Standard Steering Selector Switch

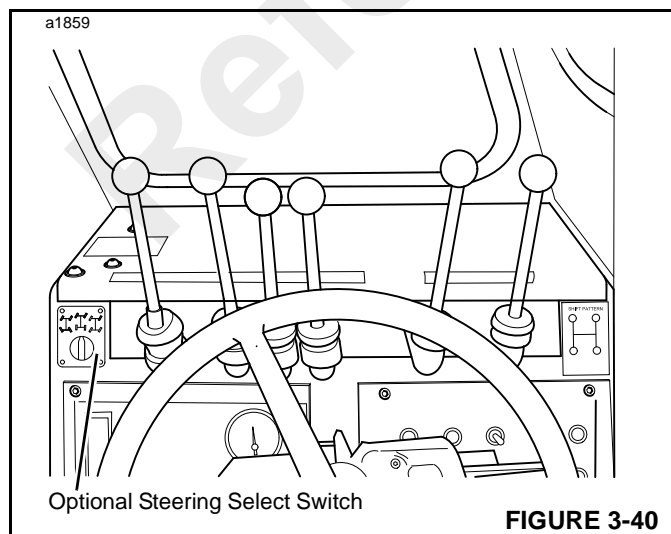
The crane can be operated in three steering modes: Two Wheel Steer, four Wheel Steer and Crab Steer. These modes are selected using the steering selector switch shown in Figure 3-39.



Before selecting different steering mode, all tires must be aligned in a straight forward position. If they are not, the steering may not index properly. Should this happen, follow the instructions later in this section for indexing procedures.

Optional Return to Center Steering Selector Switch

This switch acts the same as the standard steering selector switch in that three different steering modes can be selected: Two-Wheel Steer, Four-Wheel Steer and Crab Steering. Unlike the standard steering selector switch, the tires do not have to be aligned in a straight forward direction before switching to a different mode. After the steering mode is selected and the steering wheel is turned the steering mode will automatically switch when the tires are aligned in straight forward direction.

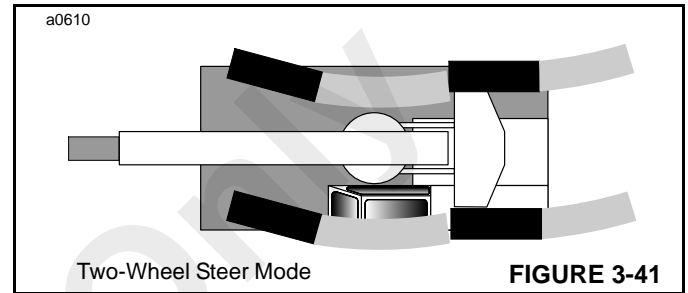


These modes are selected using the Steering Selector Switches shown in Figure 3-39 and Figure 3-40.

1. Two-Wheel Steer Mode

See Figure 3-41 for the following procedure.

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

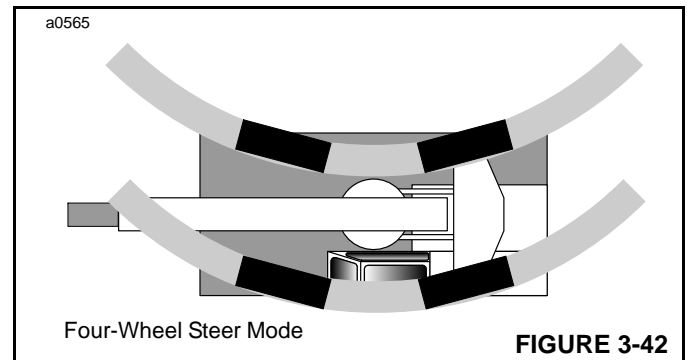


2. Four-Wheel Steer Mode

See Figure 3-42 for the following procedure.

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. This mode allows for an extremely short turning radius. It enables the rear wheels to follow the track of the front wheels. This is an advantage in muddy or sandy condition.

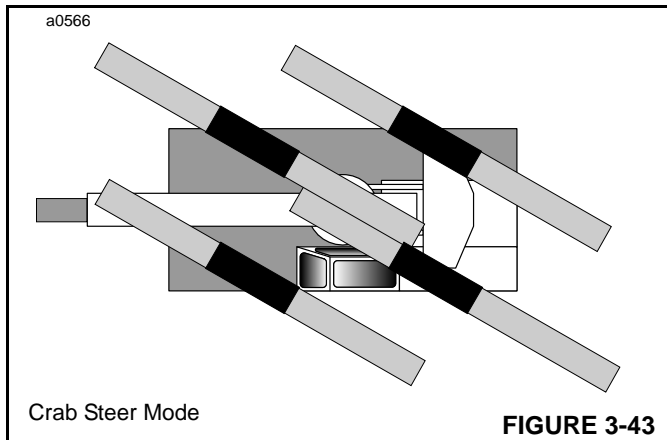


3. Optional Crab Steer Mode

See Figure 3-43 for the following procedure.

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

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



Four-wheel Steering Indexing Procedure (Standard Steering Select Switch)

Use this procedure whenever a steering mode can not be properly selected.

Units without Crab Steering

1. Place the steering mode selector switch in the four-wheel steer mode.
2. Turn the steering wheel until the rear wheels are in a straight forward position.
3. Place the steering selector switch in the two-wheel steering mode and align the front steering wheels in a straight forward position.
4. The crane should now be properly indexed and the steering selector switch can now be placed in the four-wheel steer mode.

Units with Crab Steering

1. Place the steering mode selector switch in the four-wheel steer mode.
2. Turn the steering wheel until the front wheels are in a straight forward position.
3. Place the steering selector switch in the two-wheel steering mode and align the rear steering wheels in a straight forward position.
4. The crane should now be properly indexed and the steering selector switch can now be placed in the four-wheel steer mode or the crab steer mode.

Changing Travel Direction

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

NOTE: To avoid possible damage to the transmission **DO NOT** attempt to start the engine by pushing or

towing with another vehicle. The power train does not allow starting this way, and transmission damage may occur.

NOTE: The following practices could result in transmission failure:

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

Stopping Travel

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

OPERATING THE OUTRIGGER CONTROLS

Standard Outriggers

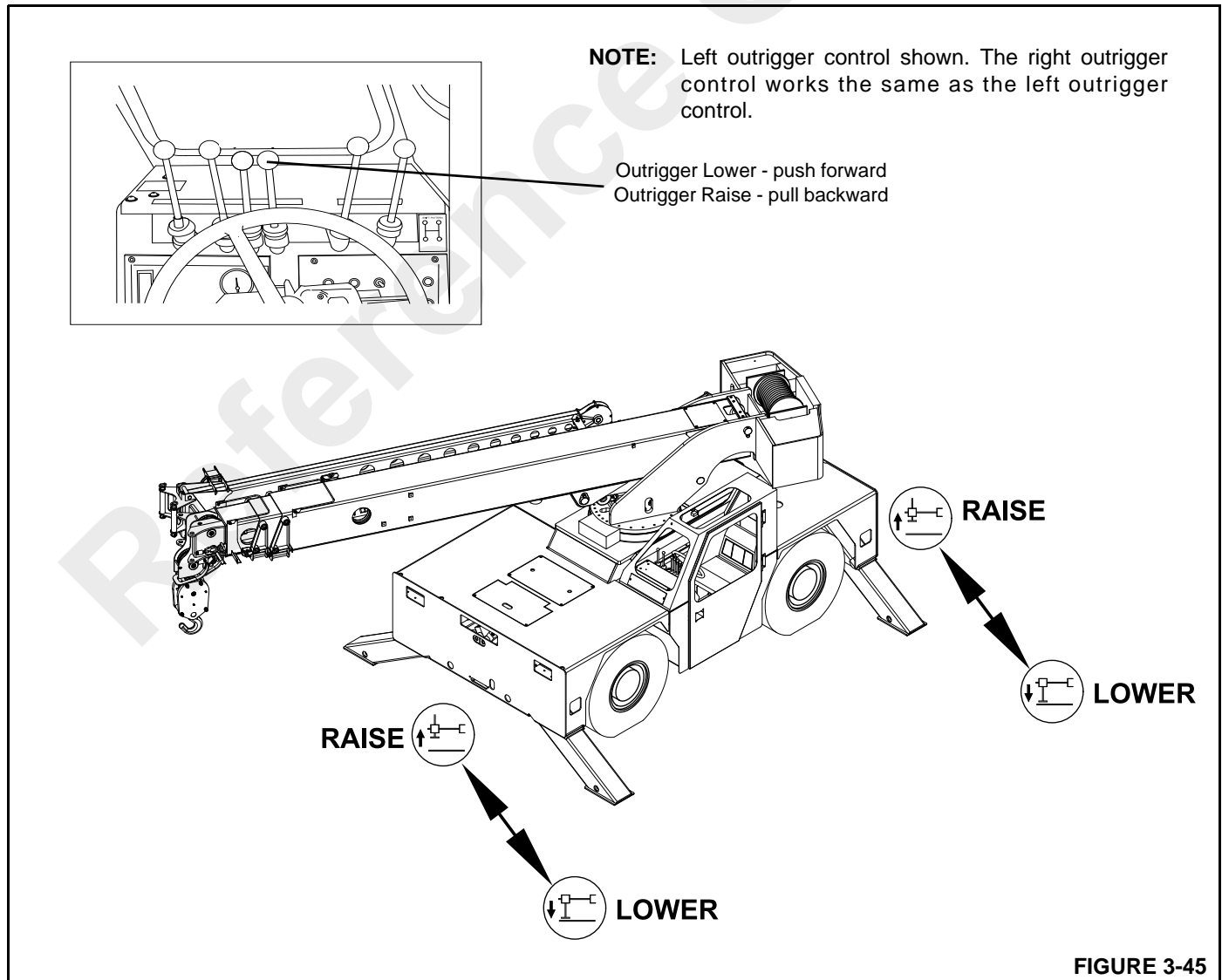
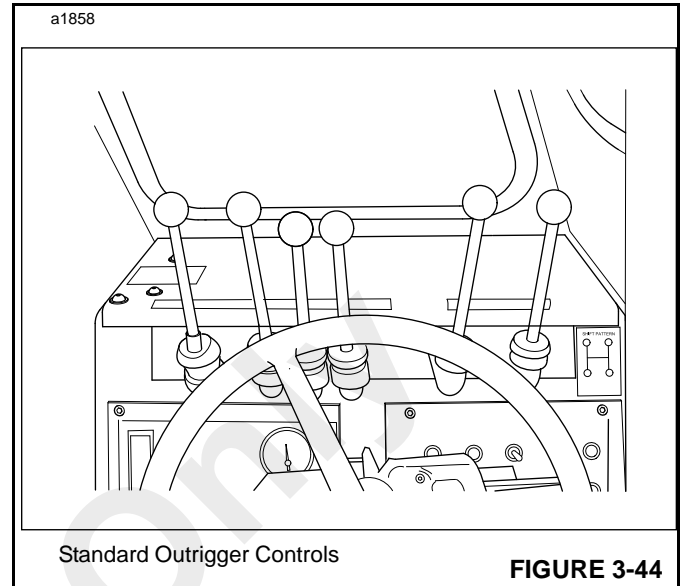
To Raise and Lower the Outriggers

On cranes equipped with standard outrigger controls, the left outriggers are controlled by the left control lever and the right outriggers are controlled by the right control lever. See Figure 3-44. When operating the left or right outrigger control lever, both left or right outriggers simultaneously raise or lower. All four outriggers may be raised or lowered simultaneously by actuating both control levers.

1. Determine which outriggers are to be raised or lowered; left, right or all.
2. **To Lower** - (Figure 3-45) Run the engine at idle speed (accelerator pedal released). Move the control lever forward to the LOWER position and hold it in position. Press the accelerator pedal to increase the engine speed, which will accelerate the outward movement of

the outriggers. Release the accelerator pedal and the outrigger control lever when the outriggers are fully extended.

3. **To Raise** - (Figure 3-45) Pull back on the control lever and hold it in the RAISE position. Press the accelerator pedal to increase the engine speed, which will accelerate the speed of the outriggers. Release the accelerator pedal and the control lever when the outriggers are fully raised.



Independent Outriggers

To Raise and Lower the Outriggers

On cranes equipped with independent outrigger controls, each outrigger is independently controlled (Figure 3-46). Two or more outriggers may be simultaneously lowered or raised by simultaneously actuating the controls for each of the outriggers.

1. Determine which outriggers are to be raised or lowered; left, right or all.
2. **To Lower** - (Figure 3-48) Run the engine at idle speed (accelerator pedal released). Move the control lever forward to the LOWER position and hold it in position. Press the accelerator pedal to increase the engine speed, which will accelerate the outward movement of the outrigger. Release the accelerator pedal and the outrigger control lever when the outrigger is extended.
3. **To Raise** - (Figure 3-48) Pull the control lever back to the RAISE position and hold it in position. Press the accelerator pedal to increase the engine speed, which will accelerate the retracting speed of the outrigger. Release the accelerator pedal and the control lever when the outrigger is fully raised.

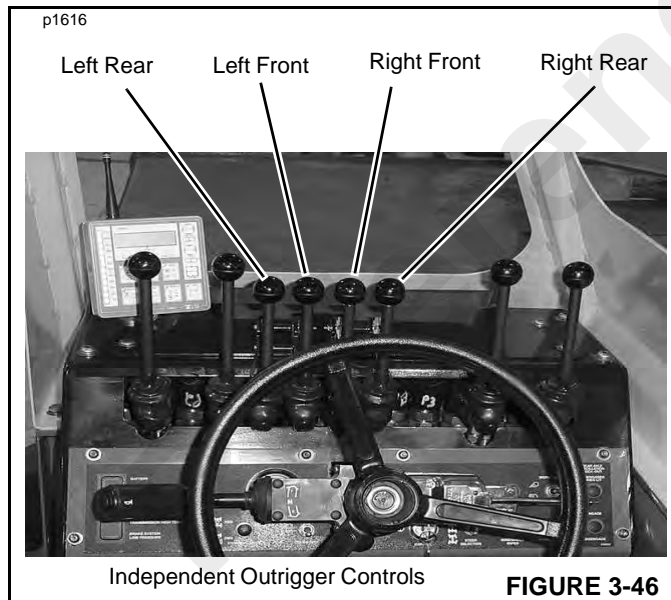


FIGURE 3-46

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

The Outrigger Monitoring System (OMS) aids the operator by using an indicator (1, Figure 3-47) on the control panel that lights when all outriggers are fully deployed. The OMS uses four proximity sensors, one per outrigger beam, to identify when an outrigger beam is fully extended.

Set up of the outriggers is the same for cranes equipped with OMS; refer to "Operating the Outrigger Controls" on page 20. The OMS indicator only indicates the fully extended

position of the outrigger beam and should not be used to deploy the beam.

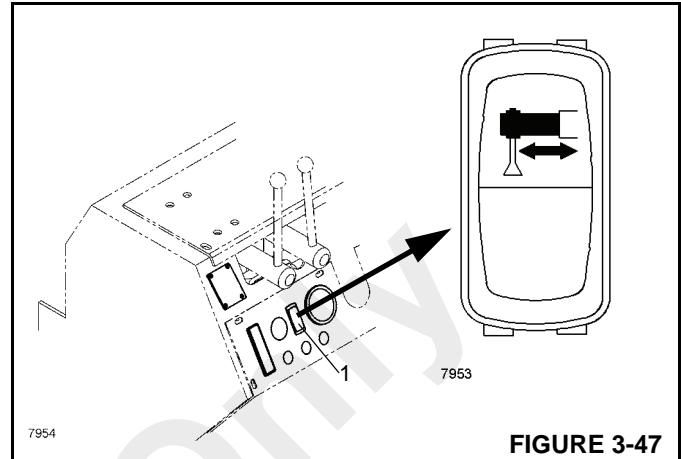


FIGURE 3-47

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

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

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

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

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



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

Outrigger lower - push forward
 Outrigger raise - pull backward

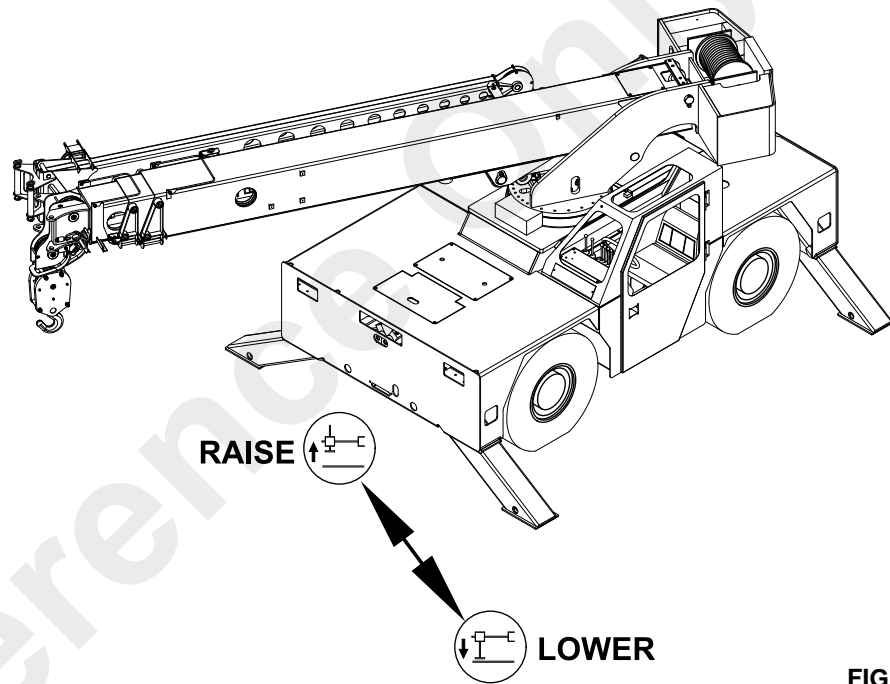
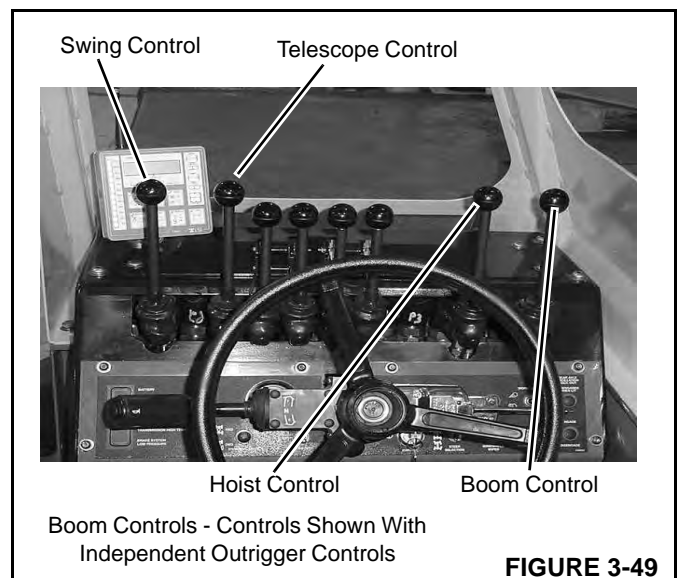


FIGURE 3-48

Operating the Boom Controls

Four levers in the operator's cab control the boom functions. See Figure 3-49. These levers are connected directly to the main control valves.

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



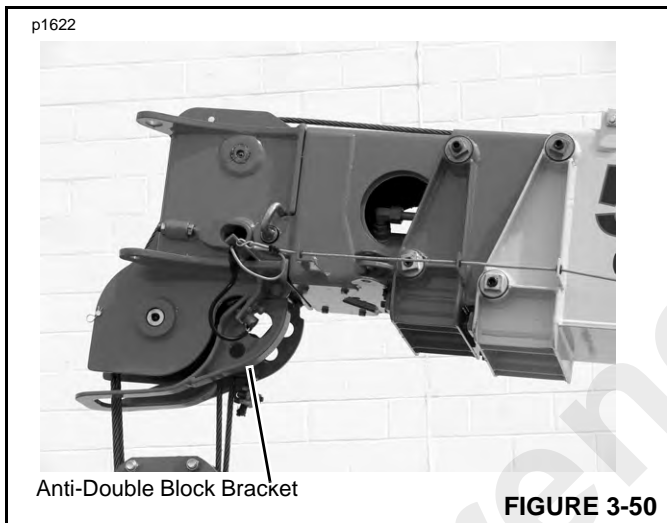
Boom Controls - Controls Shown With Independent Outrigger Controls

FIGURE 3-49

Anti-Double Blocking System

This system inhibits the hook block from being pulled into the boom head during extension of the booms, raising of the booms and during hoist operation. If the hook block touches the anti-double block bracket (Figure 3-50) under the boom head, a switch is actuated. This switch stops hydraulic oil flow to telescope out, boom lift and hoist motor raise functions. A horn is activated to give a warning to the operator in all cases. Before operation can resume, the hoist block must be first lowered away from the boom head

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



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 3-51) until the desired swing speed is obtained. The further the control is pulled back the faster the mast will rotate.

To Stop Rotation

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

To Rotate the Mast Right (Clockwise)

Press the accelerator pedal to increase the engine speed to maximum rpm. Slowly push forward on the swing control lever (Figure 3-51) until the desired swing speed is obtained. The further the control is pushed forward the faster the mast will rotate.

NOTE: 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.

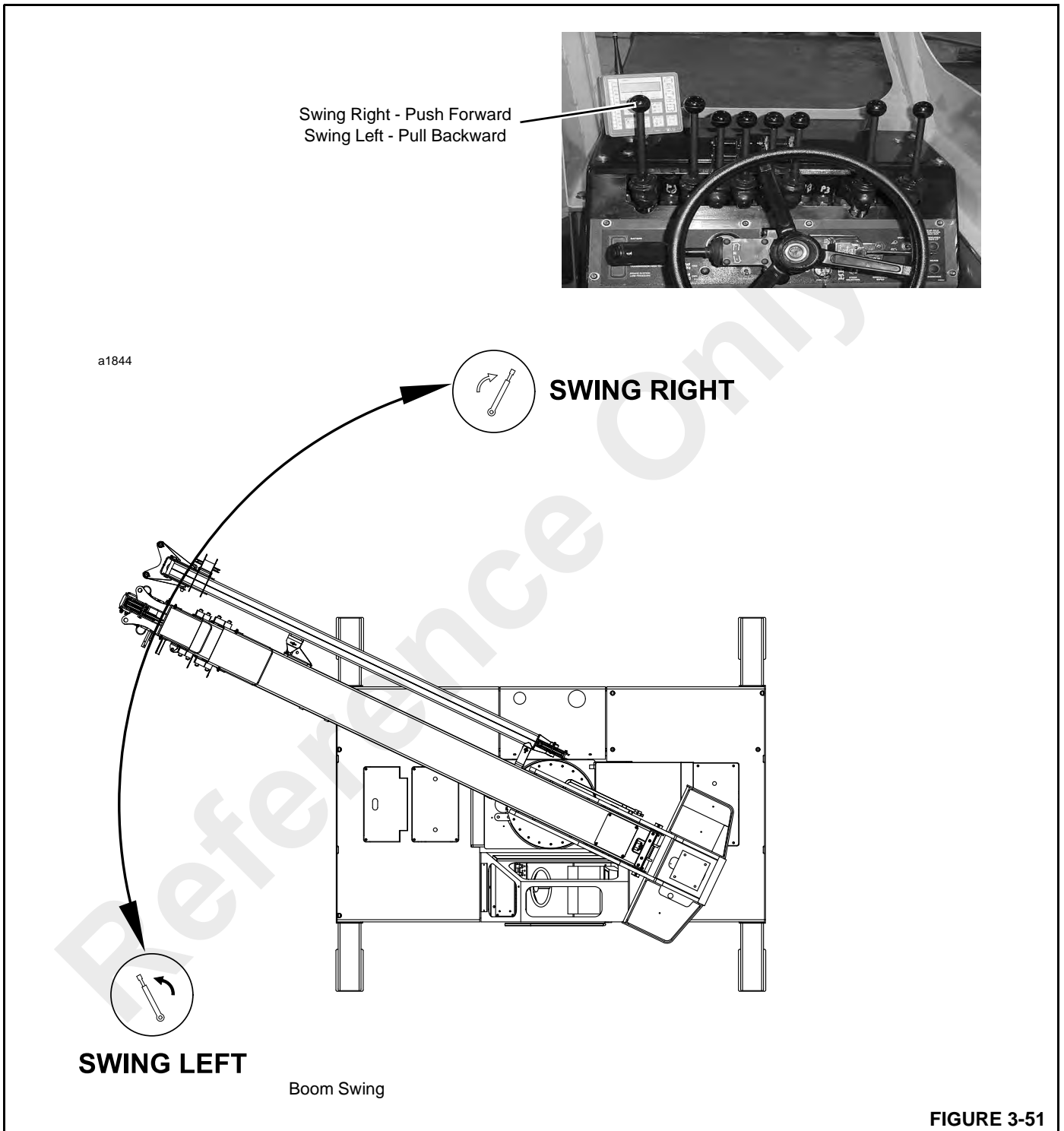


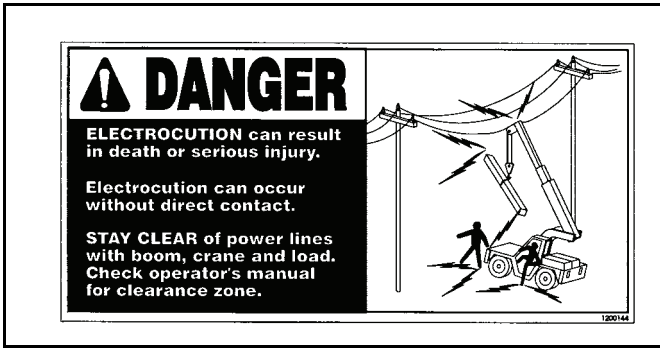
FIGURE 3-51

Boom Telescope Operation

NOTE: Always operate the hoist control to unwind the wire rope when extending the boom. **DO NOT** let the drop block touch the boom head. An automatic cutout device is installed on this crane to inhibit the drop block from being pulled into the boom head. When the drop block touches the anti-double blocking bracket (Figure 3-50) 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.



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 Extend the Booms

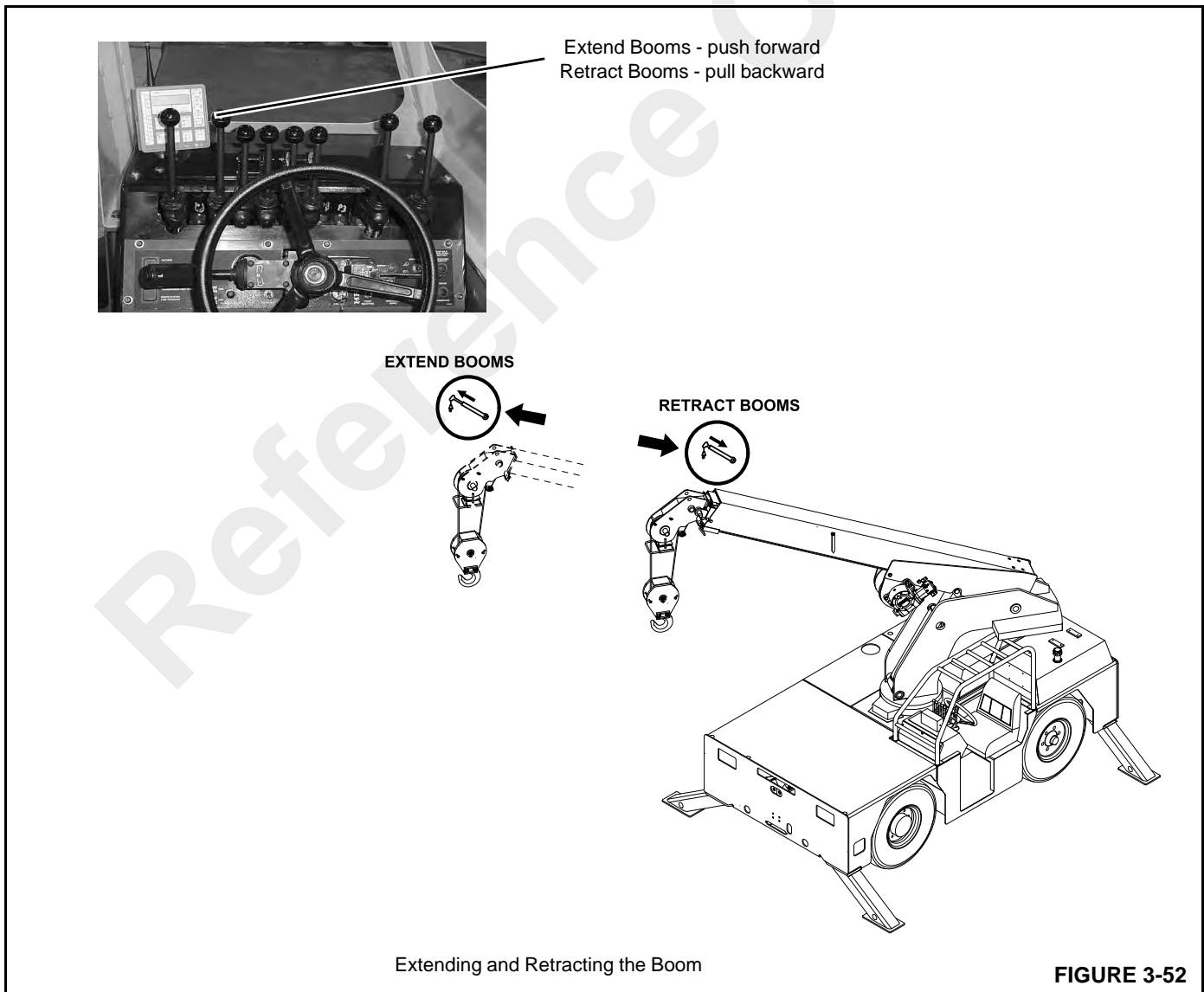
Press the accelerator pedal to increase the engine speed to maximum rpm. Slowly push forward on the telescope control lever (Figure 3-52) until the desired extend speed is obtained. The further the control is pushed forward the faster the boom will extend.

To Stop Extension/Retraction

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

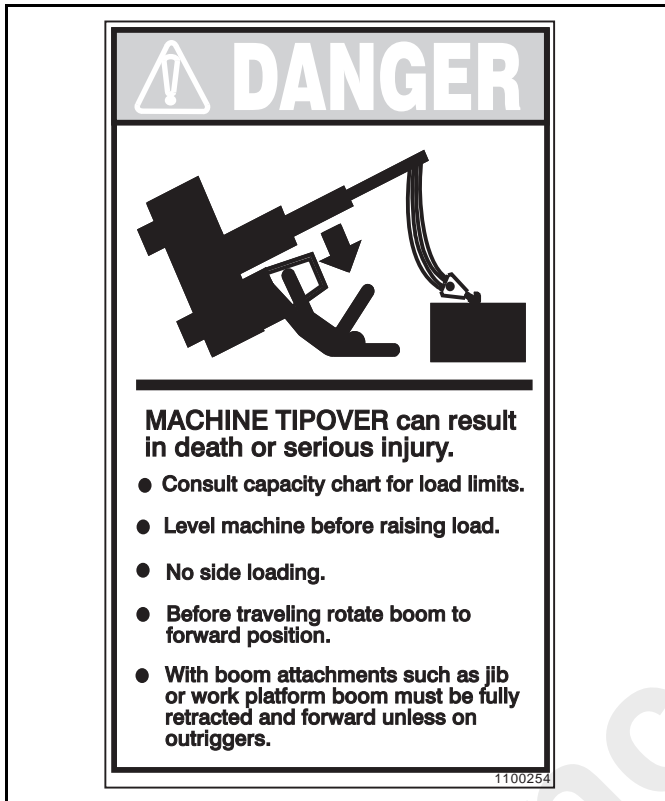
To Retract the Booms

Press the accelerator pedal to increase the engine speed to maximum rpm. Slowly pull back on the telescope control lever (Figure 3-52) until the desired retract speed is obtained. The further the control is pulled back the faster the boom will retract.

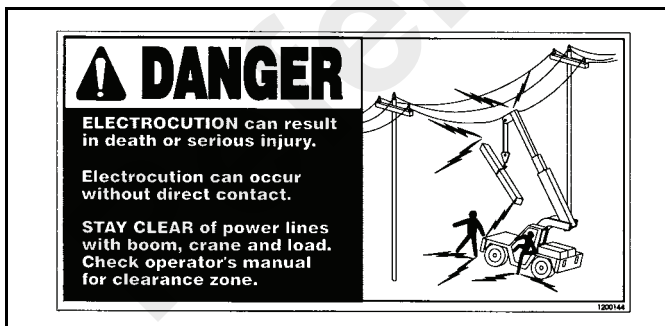


Extending and Retracting the Boom

FIGURE 3-52

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 how to read the capacity chart in Section 4 of this manual. A falling load or machine 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.

Always operate the hoist control to unwind the wire rope when raising the boom. **DO NOT** let the drop block touch the boom head. An automatic cutout device is installed on this crane to inhibit the drop block from being pulled into the boom head. When the drop block touches the anti-double blocking bracket (Figure 3-50) hanging from the boom head, a switch is activated and the hydraulic flow to extend the lift cylinder is stopped. A horn will sound, warning the operator that the block has touched the bracket. The operator must then lower the drop block to stop the horn and allow for the raising of the boom.

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

To Raise The Boom

Press the accelerator pedal to increase the engine speed to maximum rpm. Slowly pull back on the boom control lever (Figure 3-53) until the desired raising speed is obtained. The further the control is pulled back the faster the boom will raise.

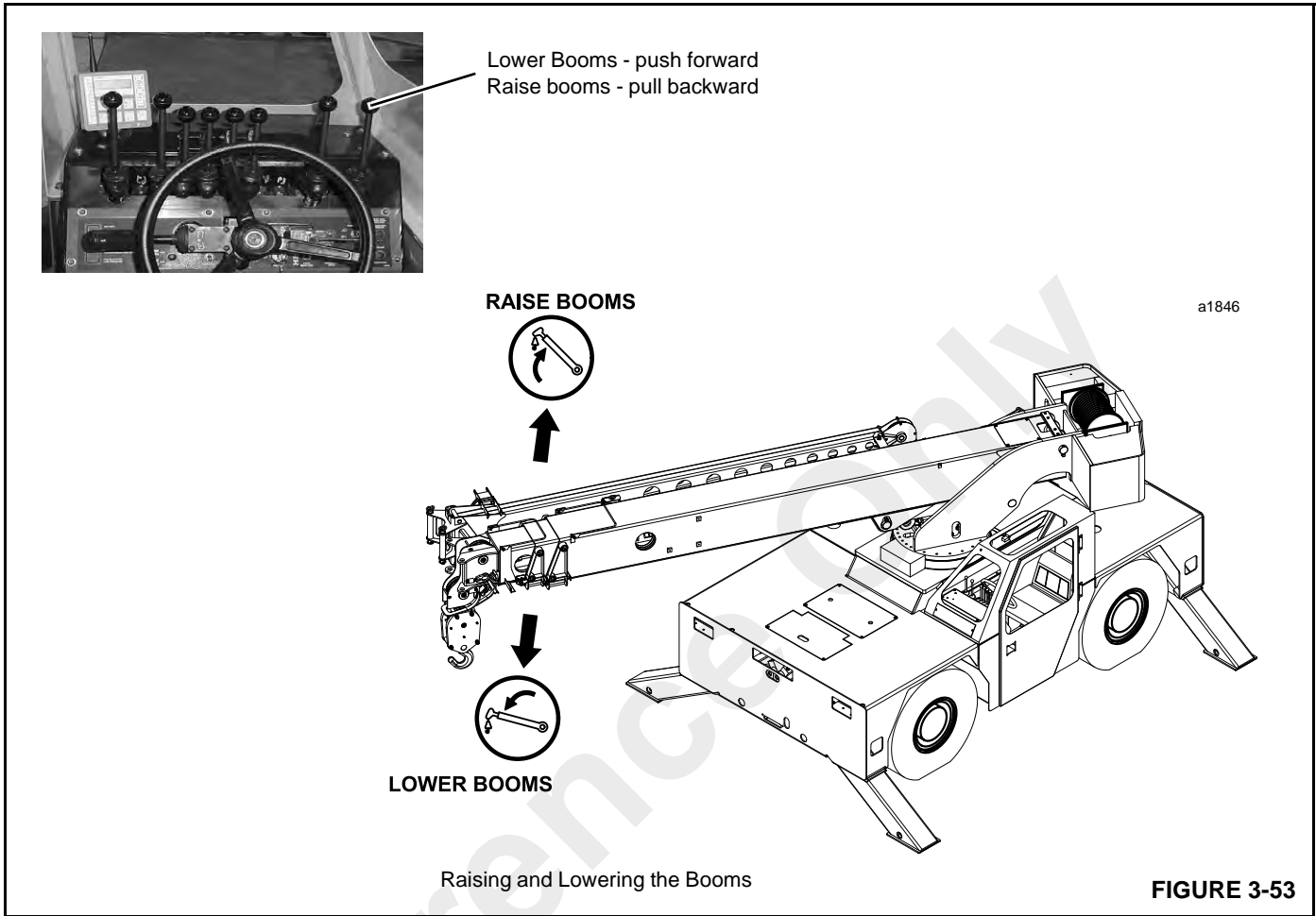
NOTE: If the crane is equipped with an LMI system, **DO NOT** fully raise the boom and dead end the cylinder. If the cylinder dead ends, the LMI will sense an overload situation and shutdown the hoist operation. The bypass switch on the LMI must then be actuated in order to resume operation.

To Stop Boom Movement

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

To Lower The Boom

Press the accelerator pedal to increase the engine speed to maximum rpm. Slowly push forward on the boom control lever (Figure 3-53) until the desired lowering speed is obtained. The further the control is pushed forward the faster the boom will lower.



Hoist Operation

⚠ DANGER

**CRANE FAILURE can kill.
Load may drop abruptly.**

NEVER use wire rope, sheaves, drums or fittings that are worn-out, damaged or abused. OBSERVE rope for proper reeving.

KEEP PEOPLE CLEAR

KNOW WEIGHT of load & ensure it is within crane capacity before lifting.

DO NOT OVERLOAD

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

⚠ DANGER

MACHINE TIPOVER can result in death or serious injury.

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

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

NOTE: 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. A moving load can cause injury or death and/or property damage.

Do not let the drop block touch the boom head. An automatic cutout device is installed on this crane to inhibit the drop block from being pulled into the boom head. When the drop block touches the anti-double blocking bracket (Figure 3-50) hanging from the boom head, a switch is activated and the hydraulic flow to raise the drop block is stopped. A horn will sound, warning the operator that the block has touched the bracket. The operator must then

lower the drop block to stop the horn and allow for other boom functions.

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

To Raise the Drop Block

Press the accelerator pedal to increase the engine speed to maximum rpm. Slowly pull back on the hoist control lever (Figure 3-54) until the desired raising speed is obtained. The further the control is pulled back the faster the drop block will raise.

To Stop Drop Block Movement

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

To Lower the Drop Block

Press the accelerator pedal to increase the engine speed to maximum rpm. Slowly push forward on the hoist control lever (Figure 3-54) until the desired lowering speed is obtained. The further the control is pushed forward the faster the drop block will lower.

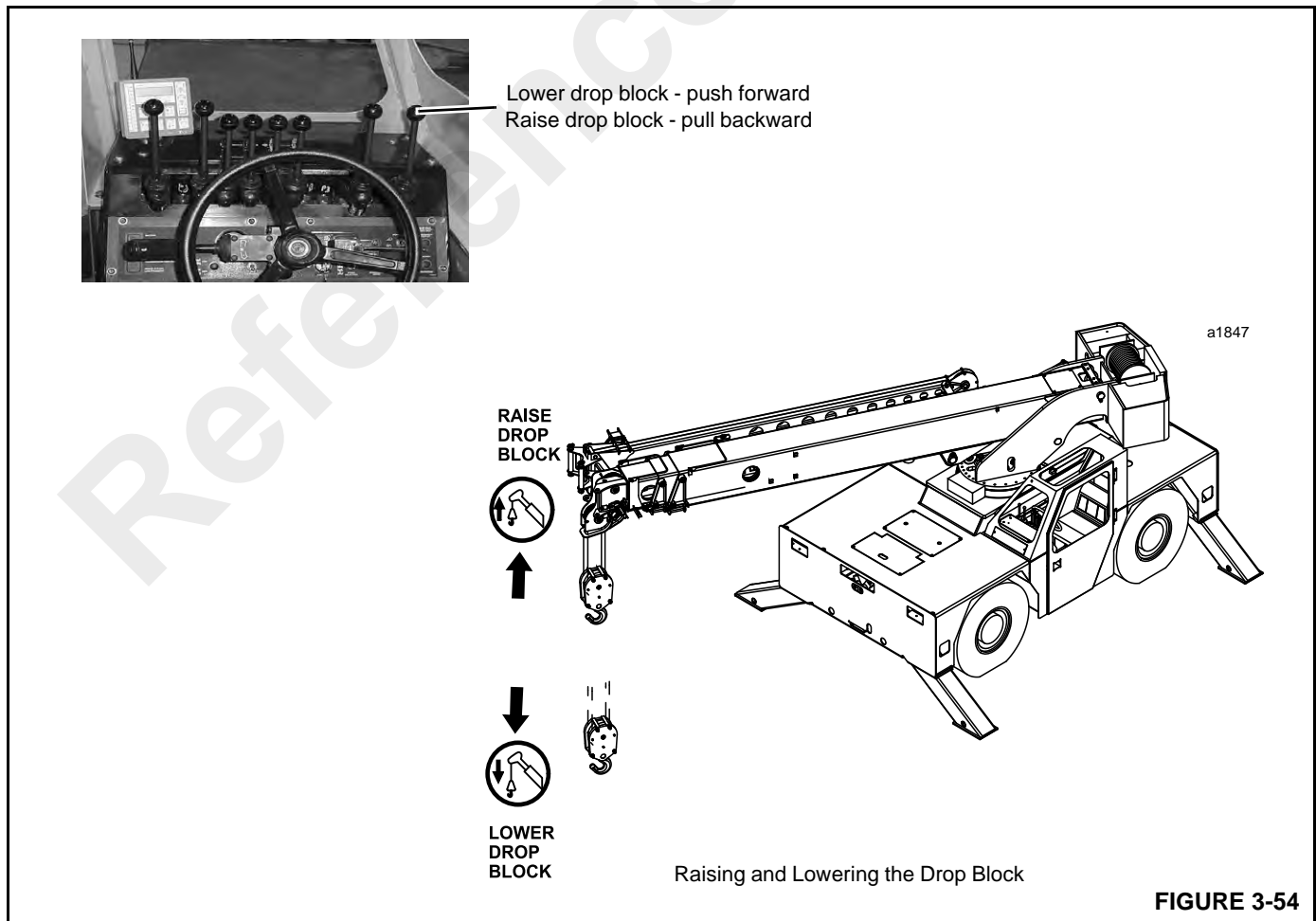


FIGURE 3-54

Optional Controls Operation

Auxiliary 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.

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

To Extend the Wire Rope

Hold the toggle switch in the up position (Figure 3-55). Keep tension on the wire rope to inhibit twisting of the wire rope on the winch drum.

To Stop the Winch

Release the toggle switch.

To Retract the Wire Rope

See Figure 3-55 for the following procedure.

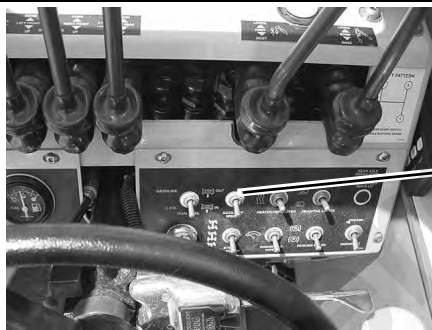
Hold the toggle switch in the down position

OPERATING PRACTICES

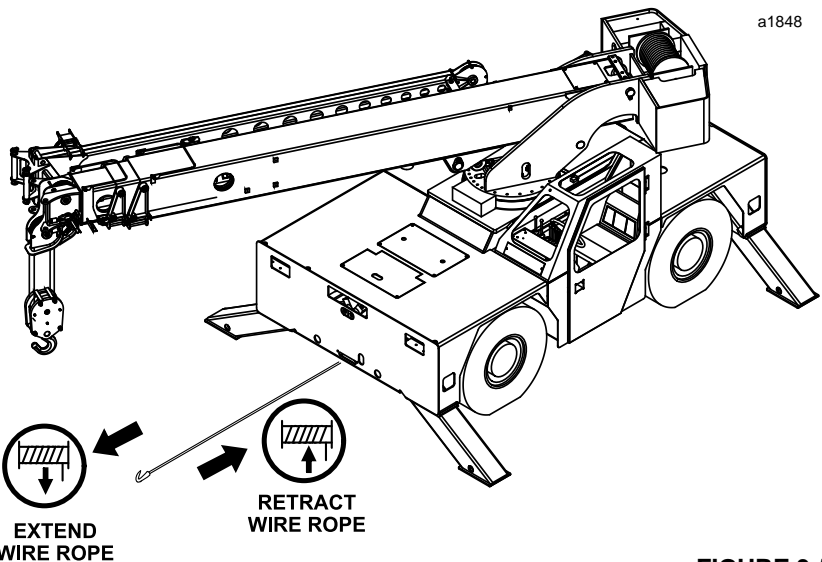
Handling A Load

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.



Retract wire rope - toggle switch up.
Extend wire rope - toggle switch down.



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FIGURE 3-55

Attaching the Load

The hoist rope must not be wrapped around the load as the wire rope will be damaged.

The load must be attached to the hook by means of slings or other devices of sufficient capacity.

Holding the Load

The operator must not leave the controls while a load is suspended. An exception to this is under those circumstances where a load is to be held suspended for a period of time exceeding normal lifting operations, the operator may leave the controls provided that, prior to that time, the appointed individual and operator establish the requirements for restraining the boom hoist, telescope, load, swing and outrigger functions, and provide notices, barricades or whatever other precautions may be necessary.

No person should be permitted to stand or pass under a suspended load.

Moving the Load

1. The person directing the lift must see that:
 - a. The crane is level and where necessary, blocked.
 - b. The load is well secured and balanced in the sling or lifting device before it is lifted more than a few inches.
 - c. The lift and swing path is clear of obstructions.
2. Before starting to lift the load, the following conditions should be noted:
 - a. That the boom when extended, is laterally straight.
 - b. That the hoist rope is not kinked or damaged.
 - c. That multiple-part lines are not twisted around each other.
 - d. That the hook is brought over the load in such a manner as to minimize swinging.
 - e. If there is a slack condition in the wire rope, it must be determined that the rope is seated on the hoist drum and in the sheaves as the slack is removed.
 - f. The effect of ambient wind on the load and crane stability.
3. During lifting operations care must be taken that:
 - a. There is no sudden acceleration or deceleration of the moving load.

- b. Load, boom and other parts of the crane do not contact any obstruction.

4. The load must not be lowered below a point where less than three full wraps of rope remain on the hoist drum.
5. When two or more cranes are used to lift one load, one designated person shall be responsible for the operation. That person must analyze the operation and instruct all personnel involved in the proper positioning, rigging the load and the movements to be made. Decisions such as the necessity to reduce crane ratings, load positions, boom location, ground support and speed of movement must be in accordance with this determination.
6. When rotating the boom with a load, sudden starts and stops must be avoided. Rotational speed must be such that the load does not swing out beyond the radius at which it can be controlled. A tag or restraint line must be used when rotation of the load is hazardous.

Traveling with a Load (Pick and Carry)

NOTE: Pick and carry is not allowed when the boom extension is attached and used to lift the load.

When traveling with a load, a designated person must be responsible for the operation. Decisions, such as the necessity to reduce crane ratings, load position, boom location, ground support, travel route and speed of movement must be in accordance with that person's determination. Specified tire pressure must be maintained. The boom should be carried in line with the direction of travel. Sudden starts and stops should be avoided. Tag and restraint lines should be used to control swinging of the load.

Turning Clearances

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

Machine Shutdown

1. Park the crane on level ground.
2. Place the travel select lever in Neutral (N) and engage the parking brake.
3. Lower any load to the ground and full retract and lower the boom.
4. Turn the ignition switch to the OFF position and remove the key.

Unattended Crane

! WARNING
Tipping Hazard!

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

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

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

Towing A Disabled Machine

If the crane becomes disabled and can not be moved under engine power, the crane may be towed for a distance of one mile (1.5 km) 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 15 mph (25 kmph).



If it is necessary to tow the crane for a distance in excess of one mile (1.5 km), the drive shafts must be disconnected to inhibit damage to the transmission system.

SECTION 4 CAPACITY CHART

SECTION CONTENTS

<p>Using the Capacity Chart 4-1</p> <p> Determine Operating Status 4-1</p> <p> Determining Lift Capacity 4-1</p>	<p>Things to Observe When Using the Capacity Chart 4-1</p> <p>Determining Lift Capacity at the Boom Extension . 4-2</p> <p>Pick And Carry Ranges 4-2</p>
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USING THE CAPACITY CHART

The capacity chart for this crane is located on the inside of the operator's cab to the right of the seat. The chart provides maximum loads that can be safely lifted and 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 4-3

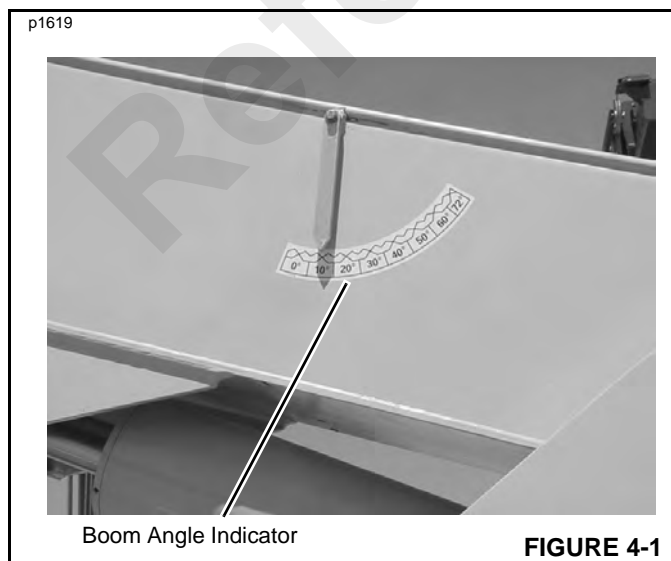


FIGURE 4-1

NOTE: To determine the exact lifting radius, use a tape measure and measure from the center rotation of

the mast to the center of the hook on either the drop block or the down haul weight, depending on which 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.
3. The weights of all load handling devices such as hooks, hook blocks, slings, jib boom, 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 either outriggers fully extended.
5. Ratings on rubber depend on tire capacity, condition of the tires and proper inflation pressure of 120 psi (827 kPa). Loads on rubber may be transported at a maximum speed of 2.5 mph (4 km/h) 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. With a load both on the boom (pick and carry) and on the crane's deck the maximum combined load is 16,000 lb. (7258 kg). The maximum load that can be placed only on the deck with nothing attached to the boom is 20,000 lb. (9070 kg).
8. Do not induce any external side loads to the boom or the boom extension.

Determining Lift Capacity at the Boom Extension

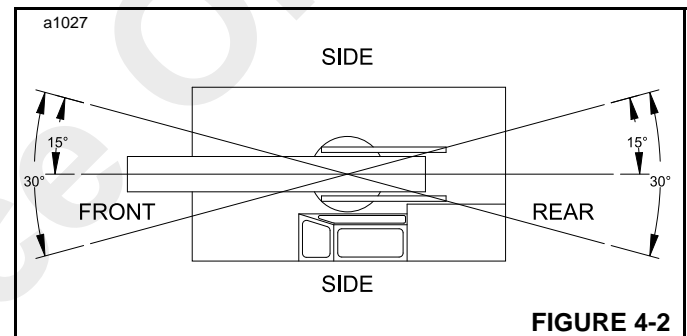
The boom extension increases the length of the boom assembly by 15 feet (4.57 m).

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 (jib 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.

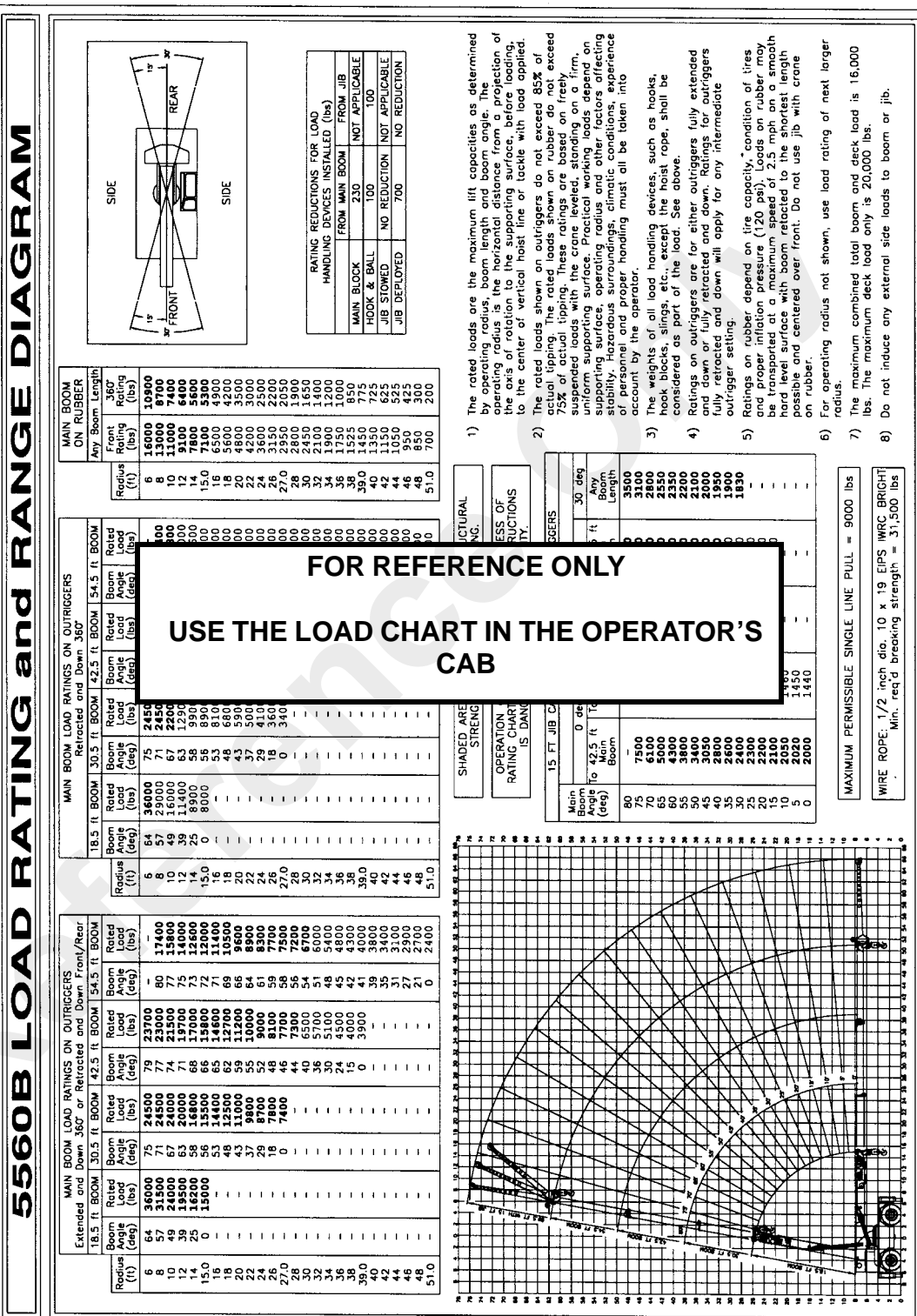
NOTE: Exceeding the Capacity is dangerous and voids the crane's warranty.

Pick and Carry Ranges

Figure 4-2 illustrates the range of operation for pick and carry loads. Do not pick and carry outside of the specified ranges. The crane could become unstable and tip over.



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Load Rating and Range Diagram Chart- 4 Section Boom

FIGURE 4-3

Reference Only

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SECTION 5 ATTACHMENTS

SECTION CONTENTS

<p>Hoist Block 5-1</p> <p style="padding-left: 20px;">Removing the Hoist Block..... 5-1</p> <p style="padding-left: 20px;">Installing the Hoist Block..... 5-2</p> <p>Fourth Boom Section 5-2</p> <p style="padding-left: 20px;">Extending the Fourth Boom Section..... 5-2</p> <p style="padding-left: 20px;">Retracting the Fourth Boom Section..... 5-4</p> <p>Boom Extension 5-5</p> <p style="padding-left: 20px;">Installing the Boom Extension 5-5</p>	<p style="padding-left: 20px;">Stowing the Boom Extension..... 5-5</p> <p>Down Haul Weight..... 5-7</p> <p style="padding-left: 20px;">Installing the Down Haul Weight 5-7</p> <p style="padding-left: 20px;">Removing the Down Haul Weight 5-8</p> <p>Installing Cable On The Hoist..... 5-8</p> <p>Wire Rope Wedge Socket..... 5-9</p> <p>4 Part Wire Rope Reeving..... 5-11</p>
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HOIST BLOCK

Removing the Hoist Block

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

CAUTION

Ensure that the hook assembly's safety latch (Figure 5-2) does not get damaged.

2. Remove the bolt and nut (Figure 5-1) securing the rope wedge socket to the boom head. Remove the wire rope dead end socket.



NOTE: When removing the hoist block to install the hook and ball assembly, the wire rope dead end assembly does not have to be disassembled.

3. Remove the three pins as indicated in Figure 5-2. Remove the hook assembly.
4. Pull the wire rope and dead end through the hoist block.
5. Install the hook assembly and four pins.

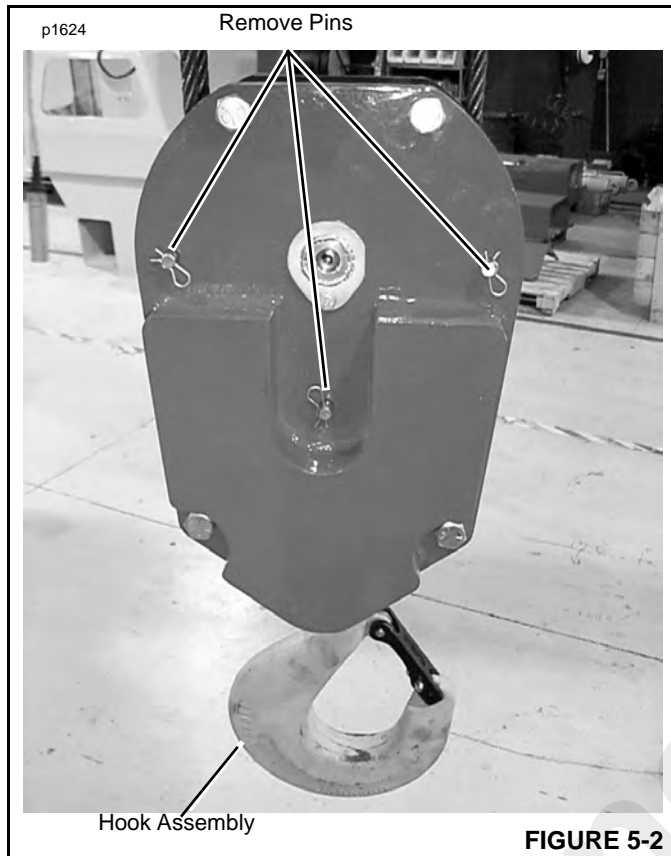


FIGURE 5-2

Installing the Hoist Block

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

FOURTH BOOM SECTION

The fourth boom section is an optional feature on this crane. Use the following procedure to extend and retract the fourth boom section.

Extending the Fourth Boom Section

1. Extend the outriggers.
2. Lower the boom to its horizontal position.
3. Completely retract the boom.
4. On the left side of the boom, remove pin "A" (Figure 5-3) from hole "D" by first removing the snapper pin retaining pin "A" and then the pin.
5. Hook the handle of pin "A" in hole "B".
6. Fully extend the fourth boom section (Figure 5-4), by actuating the telescope control lever in the cab.
7. Retract the telescope cylinder (Figure 5-5) The fourth section will remain in the extended position.
8. Unhook the handle of the pin "A" from hole "B".
9. Install pin "A" into holes "D" and "E" (Figure 5-5). Install the snapper pin to retain pin "A".

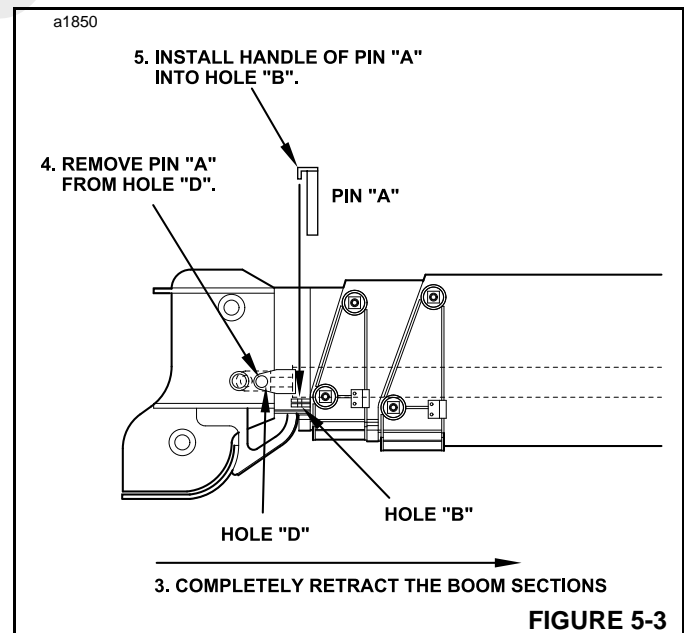
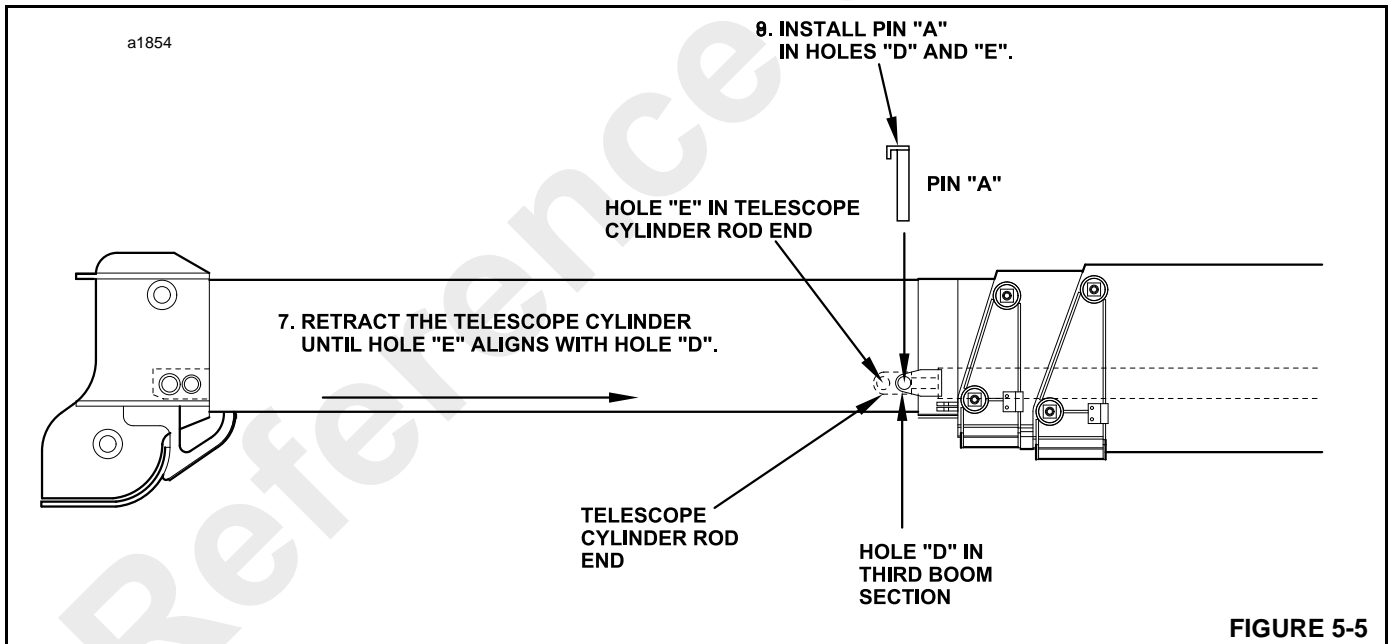
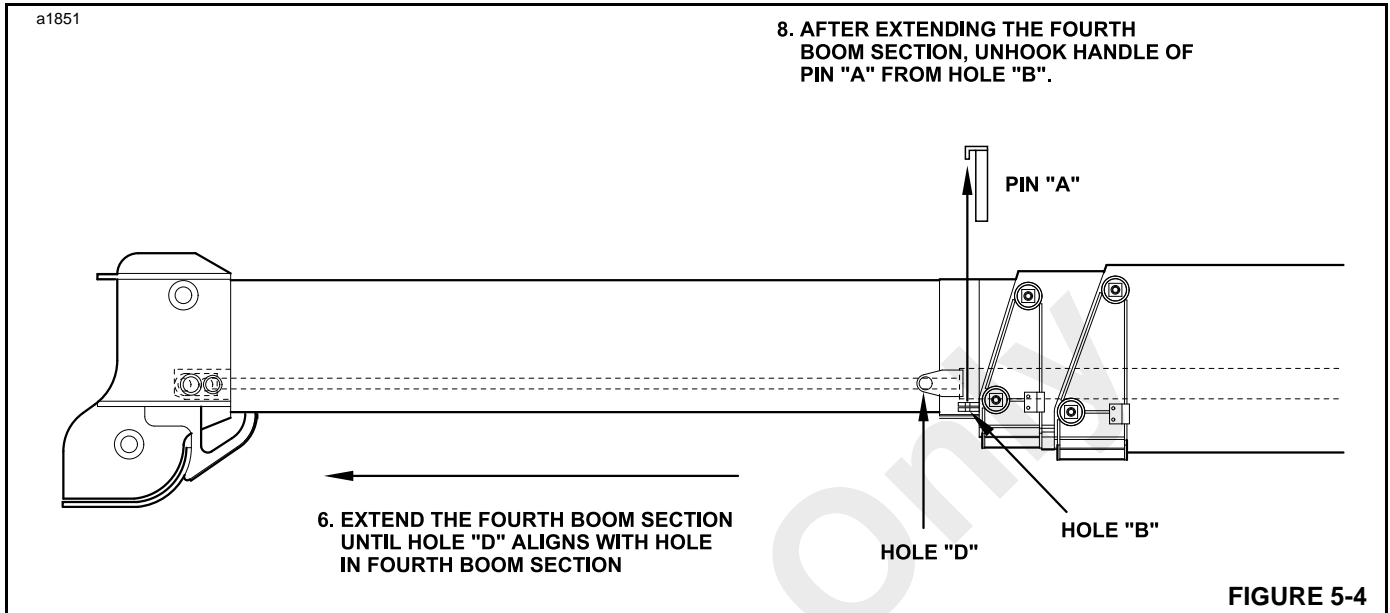
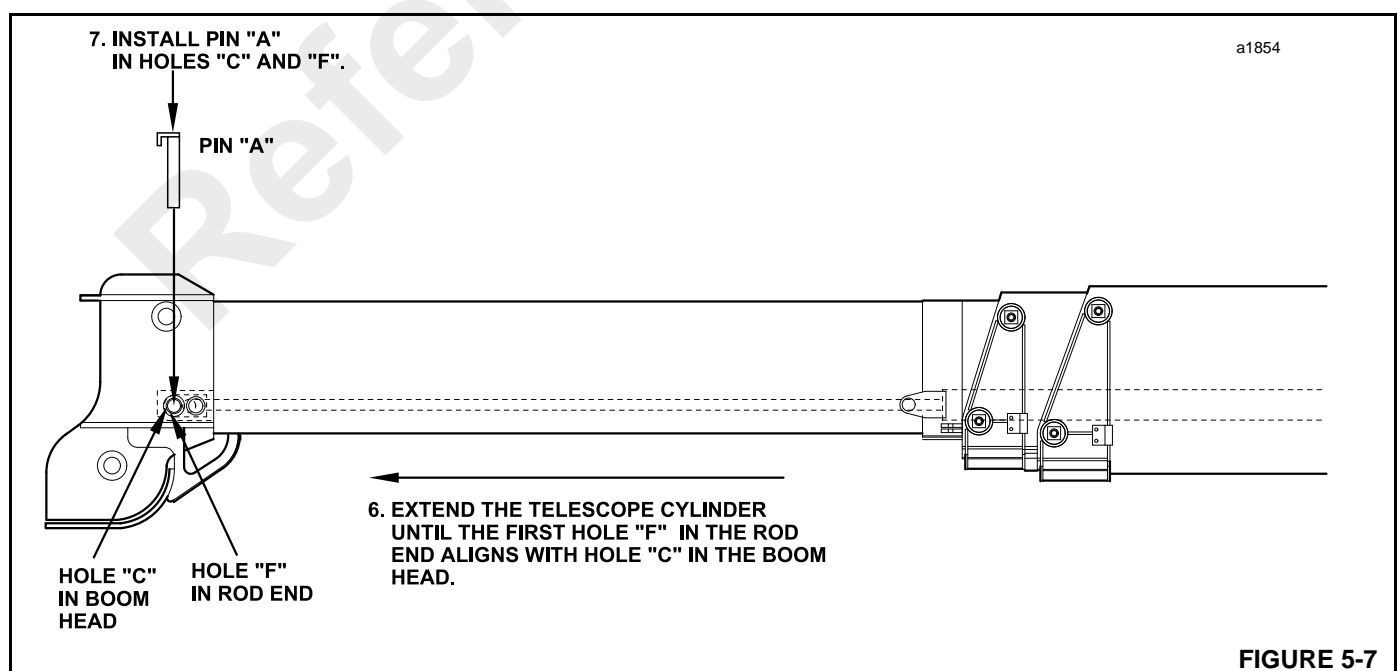
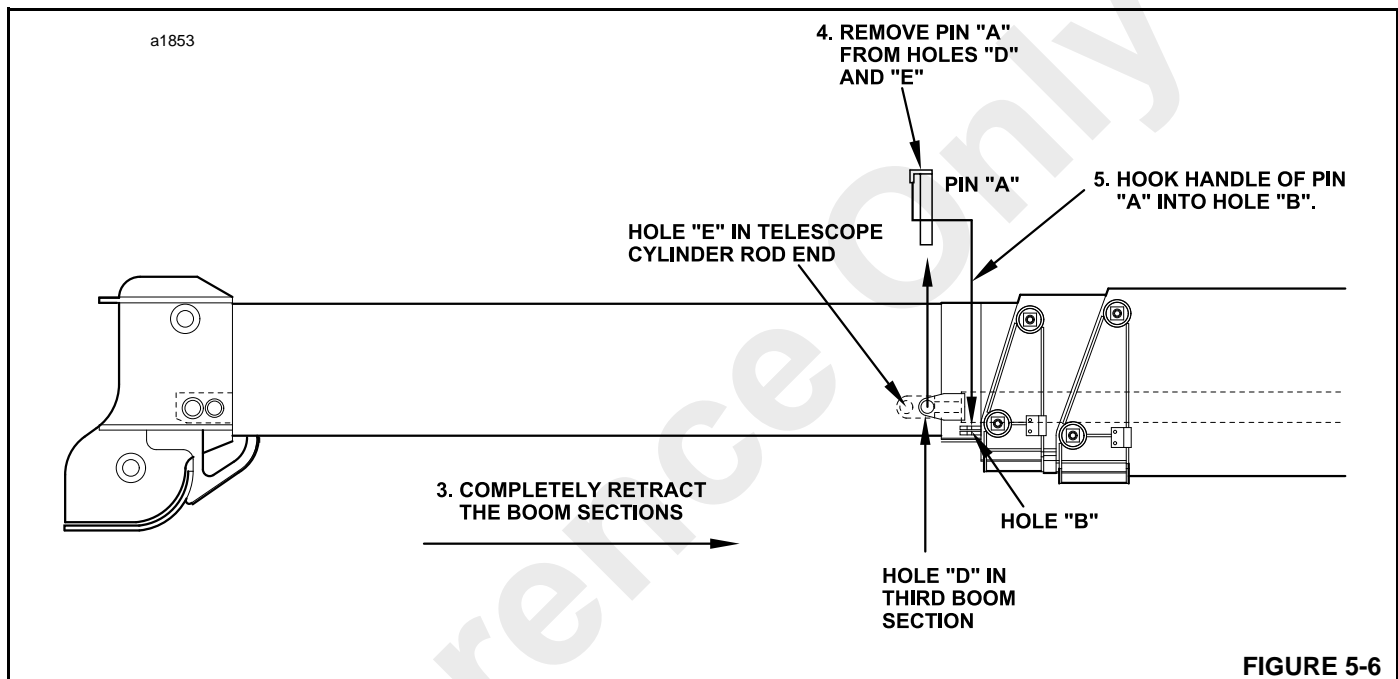


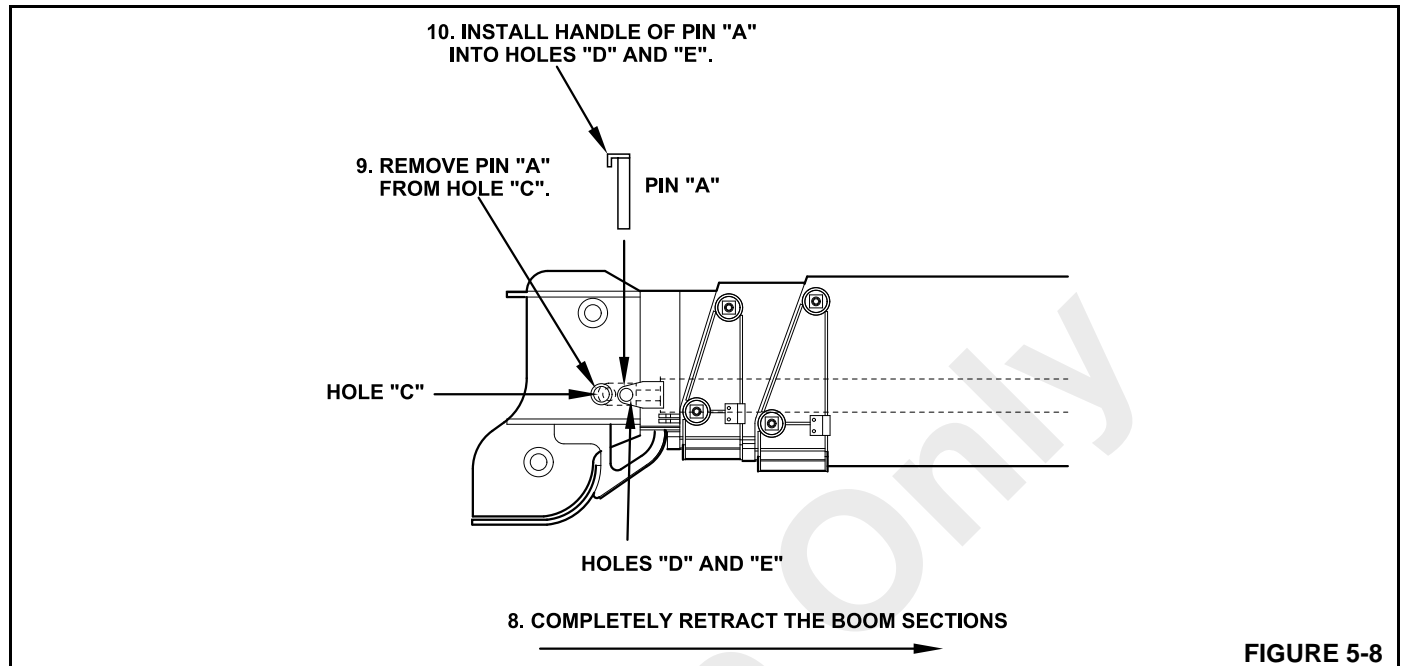
FIGURE 5-3



Retracting the Fourth Boom Section

1. Extend the outriggers.
2. Lower the boom to its horizontal position.
3. Completely retract the boom (Figure 5-6).
4. Remove the snapper pin from retaining pin "A" (Figure 5-6). Remove pin "A" from holes "D" and "E" at the rear of the fourth boom section and the bracket on the third boom section.
5. Hook the handle of pin "A" into hole "B".
6. Fully extend the telescope cylinder by actuating the telescope lever in the cab (Figure 5-7).
7. Install pin "A" into holes "C" and "F".
8. Completely retract the fourth boom section (Figure 5-8).
9. Remove pin "A" from hole "C".
10. Install pin "A" into holes "D" and "E". Install the snapper pin to retain pin "A".





BOOM EXTENSION

Installing the Boom Extension

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

1. Completely retract the boom sections and lower the boom assembly to its horizontal position.
2. Remove the pin from the boom extension anchor bracket (Location No. 1 in Figure 5-9. Remove the pin at location No. 2.
3. Swing the boom extension at pivot point No. 3. Align and engage the boom extension with mounting hole (No. 4) on the boom head.

NOTE: It may be necessary to extend the boom slightly to align the holes on the boom head with the pin hole on the boom extension to install the pin.

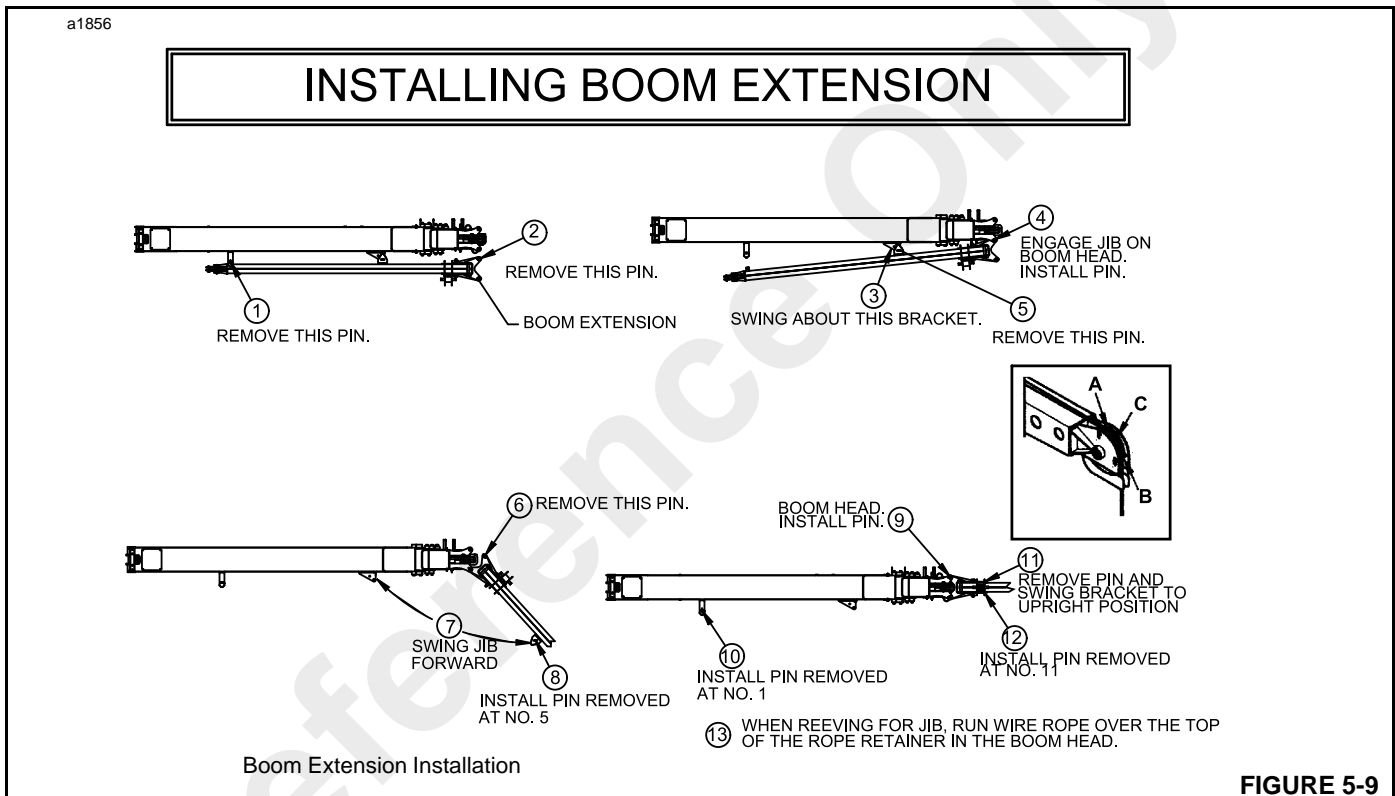
4. Remove the pins at locations No. 5 and No. 6. Swing the boom extension (No. 7) away from the boom assembly and install and secure pin No. 5 at location No. 8.
5. Continue swinging the boom extension around to the front of the boom head until pin No. 6 can be installed and secured at location No. 9.
6. Remove the outmost retaining pin at location No. 11. Flip the deflector sheave bracket into an upright position. Install and secure the pin removed at location No. 11 into location No. 12.
7. Remove the hoist block from the hoist wire rope.

8. Remove the wire rope from the boom head sheaves.
9. Using the hoist control release more wire rope from the hoist drum and install the wire rope over deflector sheave at the base of the boom extension.
10. Remove the two pins (A and B, Figure 5-9 inset) and place the wire rope over sheave No. C. Install and secure pins A and B. The pins must not interfere with the wire rope.
11. Disconnect the anti-double blocking switch wires from the connection at the boom head. Insert the wire connector from the anti-double blocking switch in the boom extension into the connector coming from the boom assembly.
12. Attach the downhaul block to the wire rope.

Stowing the Boom Extension

1. Lower the boom to its horizontal position. Fully retract the boom sections.
2. Remove downhaul weight.
3. Remove the two pins (A and B, inset Figure 5-9) from the boom extension head assembly.
4. Operate the hoist control and wind the wire rope onto the hoist drum. Be sure the rope winds properly onto the hoist drum. Install and secure the two pins.
5. Disconnect the anti-double blocking switch wires from the main boom wires at the connection at the boom head.

6. Remove pin at location No. 9 and swing the boom toward the stow position.
7. When it can be reached, remove pin from location No. 8.
8. Continue swinging the boom extension toward the stowing position, until the pin removed at location No. 8 can be installed into brackets on the boom extension and boom assembly at location No. 5. Install and secure the pin.
9. Remove the pin at location No. 4. and swing the boom into position so the pin removed at location No. 10 can be installed at location No. 1. Install and secure the pin.
10. Install and secure the pins removed from locations No. 4 and 9 back into those positions on the boom extension to inhibit losing the pins.
11. Remove the pin at location No. 12. Swing the deflector sheave bracket to its stowing position and install and secure the pin at location No. 11.
12. Reeve the boom head.
13. Install the drop block.



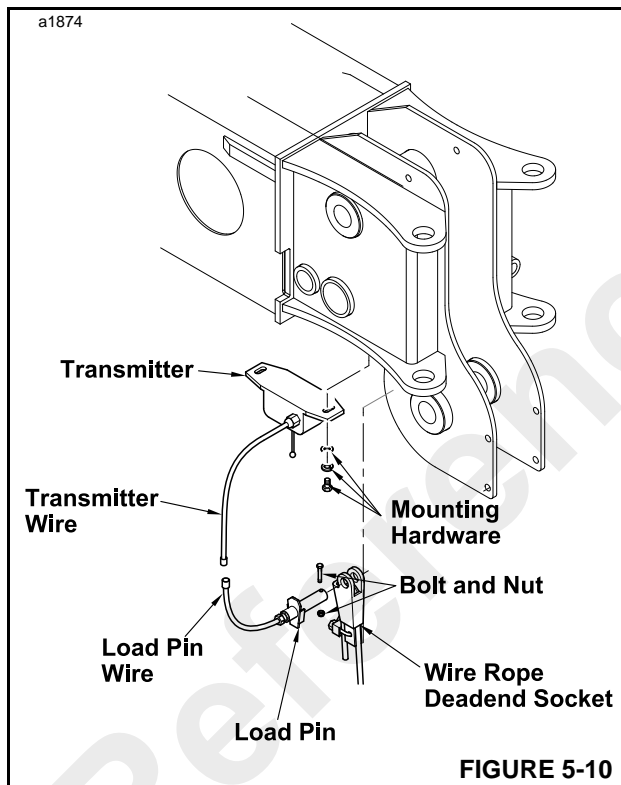
DOWN HAUL WEIGHT

Installing the Down Haul Weight

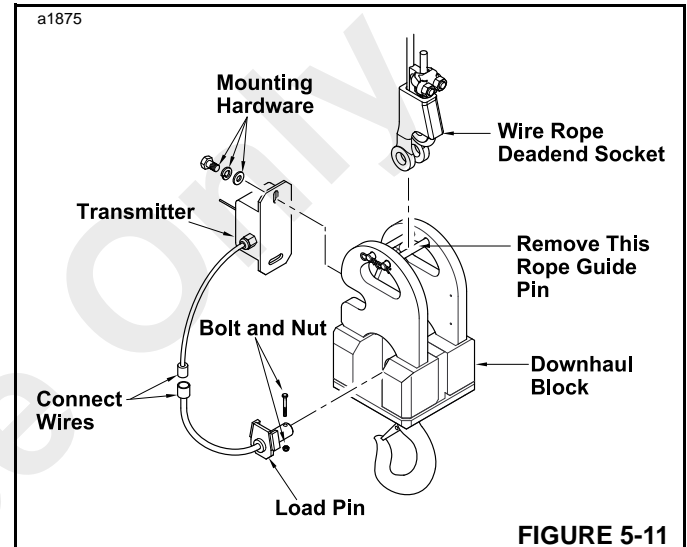
Whenever a single part line is used on a crane to lift a load, the load indicator transmitter must be removed from the boom head and installed onto the down haul weight. Without the transmitter installed and attached to the load pin, the load indicator receiver in the cab will not register the weight being lifted by the single part line.

To install the load indicator transmitter in the down haul block perform the following steps:

1. Disconnect the transmitter wire (Figure 5-10) from the load pin wire.



2. Remove the transmitter from the boom head by removing the transmitter mounting hardware (bolts, lockwashers and flat washers).
3. Follow instructions at the beginning of this section to remove the hoist block.
4. Using the hardware removed when removing the load indicator transmitter, install the transmitter onto the downhaul weight (See Figure 5-11).



5. Remove the rope guide pin indicated in Figure 5-11 from the down haul weight.
6. Attach the wire rope deadend socket to the down haul weight using the load pin removed when removing the hoist block. Install the bolt and nut.
7. Install the rope guide pin. Be sure the wire rope is placed between the two pins.
8. Connect the transmitter wire to the load pin wire.
9. Lift the hoist block off of the ground. Be sure the wire rope is engaged in all sheave grooves.

Removing the Down Haul Weight

Whenever the down haul block is removed, the load indicator transmitter must be removed from the down haul block and installed onto the boom head. Without the transmitter installed and attached to the load pin, the load indicator receiver in the cab will not register the weight being lifted by the crane.

To install the load indicator transmitter to the boom head perform the following steps:

1. Lower the down haul block to the ground.
2. Disconnect the transmitter load pin wire (Figure 5-11) from the transmitter wire.
3. Remove the rope guide pin indicated in Figure 5-11.
4. Remove the bolt and nut and the load pin from down haul weight. Remove the wire rope deadend socket. Install the rope guide pin in the down haul weight.
5. Remove the transmitter from the downhaul weight. Retain the hardware.
6. Install the transmitter to the boom head (Figure 5-10) using the existing hardware.
7. Install the hoist block using instructions in this section. Install the load pin.
8. Connect the transmitter wire (Figure 5-10) to the load pin wire.

INSTALLING CABLE ON THE HOIST

CAUTION

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

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

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

1. Position the cable over the boom nose sheave and route to the hoist drum.
2. Position the hoist drum with the cable anchor slot on top.

3. Insert the cable through the slot and position around the anchor wedge (1) Figure 5-12.

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

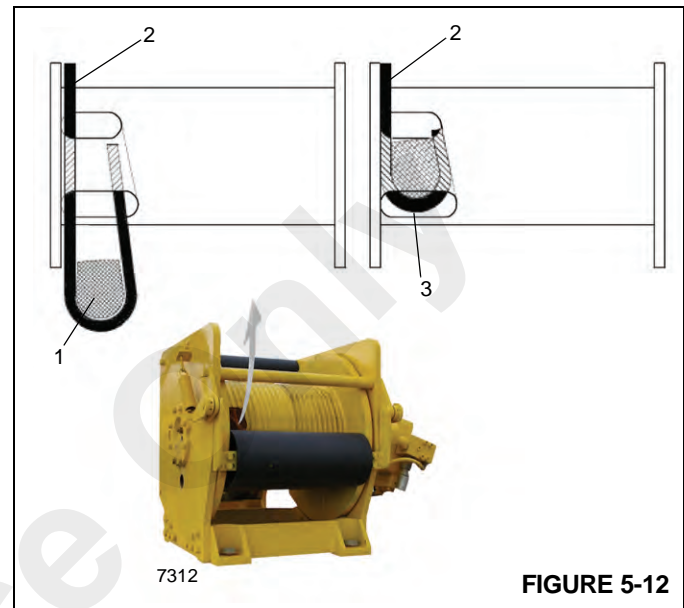


FIGURE 5-12

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.

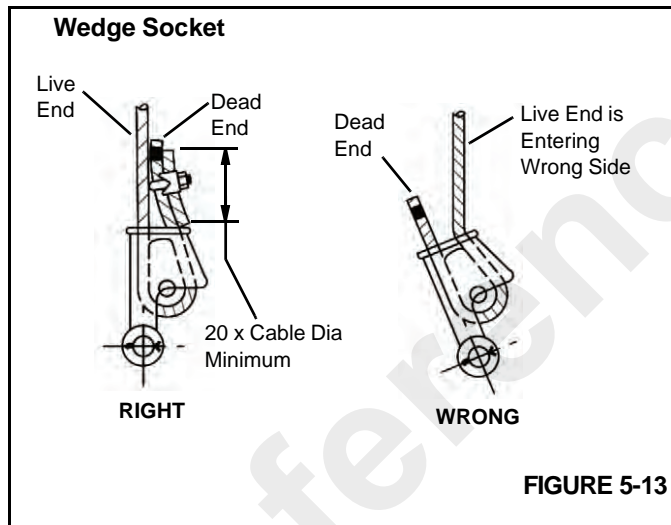


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5. Slowly rotate the drum, ensuring the first layer of cable is evenly wound onto the drum.
6. Install the remainder of the cable, as applicable.

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 6X37 rope. This will allow the distortion of the rope strands, caused by the bend around the wedge, to adjust themselves at the end of the line. Refer to SECTION 1 - INTRODUCTION in the Service Manual for wire rope procedures.
3. Make sure the live-end (Figure 5-13) of the rope is directly in line with the ears of the socket and the direction of pull to which the rope will be subjected. If the rope is loaded into the socket incorrectly, under a load the rope will bend as it leaves the socket, and the edge of the socket will wear into the rope causing damage to the rope and eventual failure.



4. Insert the end of the wire rope into the socket, form a loop in the rope, and route the rope back through the socket allowing the dead-end (Figure 5-13) 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 5-14) 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.

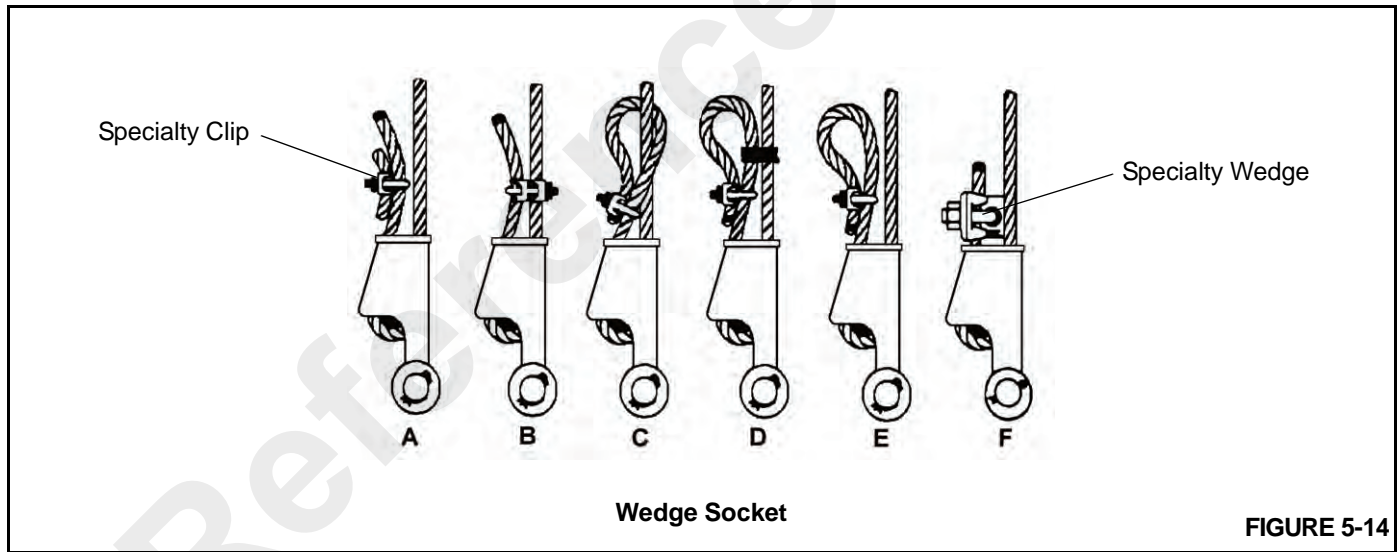
Of the methods shown below, Manitowoc prefers that method A or F be used, i.e., clipping a short piece of wire rope to the dead-end or using a commercially available specialty clip or wedge. Typically, it is recommended that the tail length of the dead-end should be a minimum of 6 rope diameters but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

When using method A, place a wire rope clip around the dead end by clamping a short extra piece of rope to the rope dead end. **DO NOT CLAMP THE LIVE END.** The U-bolt should bear against the dead end. The saddle of the clip should bear against the short extra piece. Torque the U-bolts according to the table titled Wire Rope Clip Torque Values (Table 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 manufacture." Wire ropes are addressed in ASME B30.5, section 5-1.7.2, ROPES, it states, in pertinent part, "(a) The ropes shall be of a construction recommended by the rope or crane manufacturer, or person qualified for that service." Additional information is published by the Wire Rope Technical Board in the Wire Rope Users Manual, latest revised edition.

Table 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

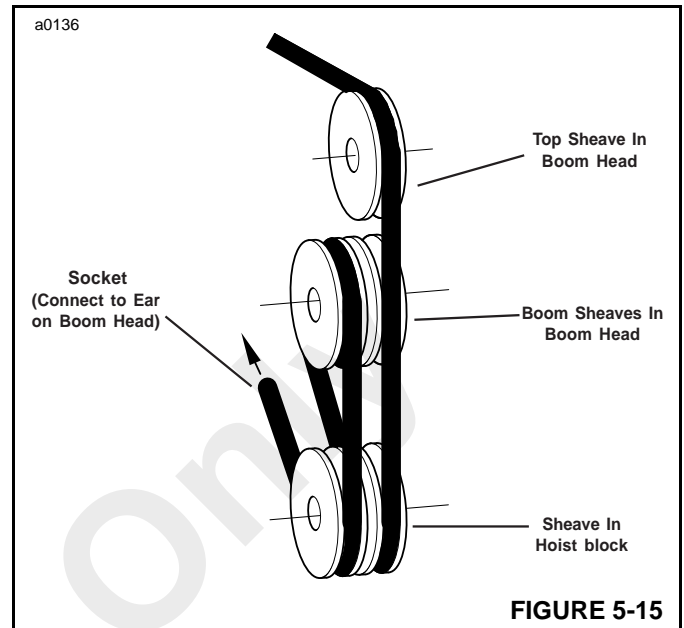


4 PART WIRE ROPE REEVING

Place the wire rope over the top sheave in the boom head and then down and over the lower left sheave. Thread rope through one of the sheaves in the hoist block and then over the second lower sheave in the boom head. Continue by threading the rope through the second sheave in the hoist block.

NOTE: It may be easier to place the wire rope over the sheaves if you remove the hair cotter pins and wire rope retaining pins from the boom head and hoist block. Install pins after the wire rope is installed.

Connect the loose end of the wire rope to the ear on the crane side of the boom head with a socket and wedge. See instructions in this section.



Reference Only

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SECTION 6 MAINTENANCE

SECTION CONTENTS

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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 inhibit 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 machine. Decrease these intervals if the machine 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 unit 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.

MAINTENANCE RECORDS

Dated records must be kept for inspection of critical components such as, brakes, crane hooks, wire ropes, hydraulic cylinders and relieve 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
- On diesel engines 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.

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.

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						
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 chains		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			

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 and brake lubricant level					X		
Lubricate the outrigger slides					X		
Add grease to swing gearbox					X		
Replace fuel filter elements (diesel)					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		
Clean and adjust spark plug gap (gasoline engine)					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 hoist gearbox lubricant						X	
Replace the hydraulic oil						X	
Replace the hydraulic oil filter						X	
Replace the L.P.G. inline filter						X	
Replace the in-line fuel filters (gasoline)						X	
Replace PVC valve (gasoline engine)						X	
Clean PVC hoses, tubes, and fittings (gasoline engine)						X	
Replace spark plugs (gasoline engine)						X	
Replace the engine coolant							X
Inspect the crane structure and booms for damage							X
Test the Load Management Indicator (LMI)							X
-optional							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.

Lubrication Points

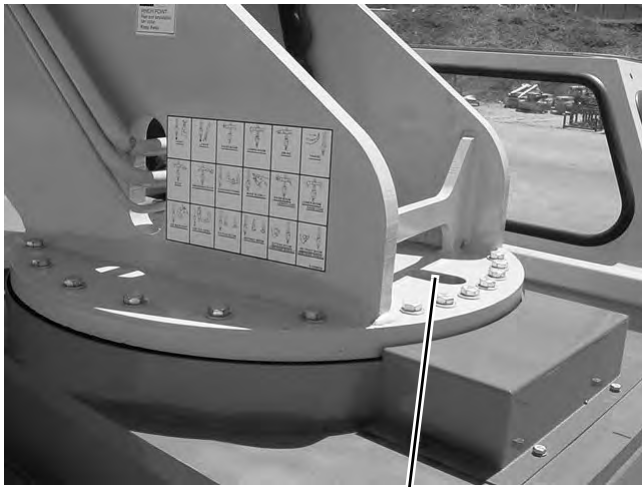
Apply grease to the following fitting after the first 20 hours of operation, thereafter every 50 hours of operation, whichever occurs first. Use a Lithium Base, E.P. No. 2 bearing grease or equivalent. Apply enough grease to remove the old grease.

Booms and Main Frame	
Location	QTY
Mast Bearing (see Figure 6-1)	2
Boom Pivot (see Figure 6-2)	2
Boom Head Sheaves and Pivot (see Figure 6-3)	2
Lift Cylinder Pivots (see Figure 6-5)	2

Drive Train	
Location	QTY
Steering Knuckles- front axle (see Figure 6-6)	4
Steering Knuckles- rear axle (see Figure 6-7)	4
Steering Link- front axle (see Figure 6-8)	2
Steering Link- rear axle (see Figure 6-9)	2
Steering Cylinder Pivot Ends- front axle (see Figure 6-10)	2
Steering Cylinder Pivot Ends- rear axle (see Figure 6-11)	2
Rear Axle Pivot (see Figure 6-12)	2

Optional Equipment and Accessories	
Location	QTY
Drop Block (see Figure 6-13)	2
Jib Boom Head Sheave (see Figure 6-14)	1
Jib Boom Deflector Sheave (see Figure 6-15)	1

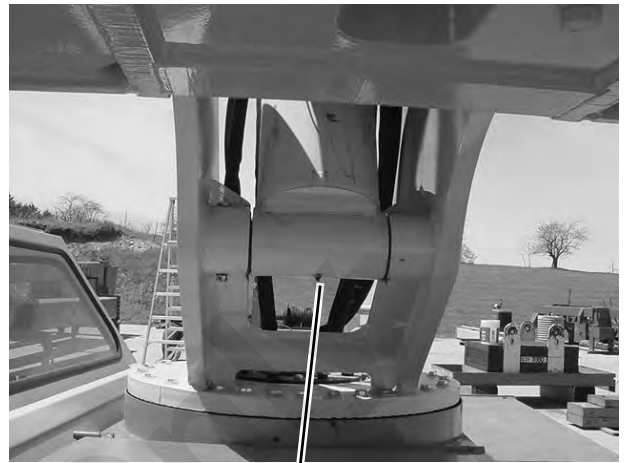
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Two Fittings Located On Inside Surface of Bearing Ring
Mast Bearing Lubrication Point

FIGURE 6-1

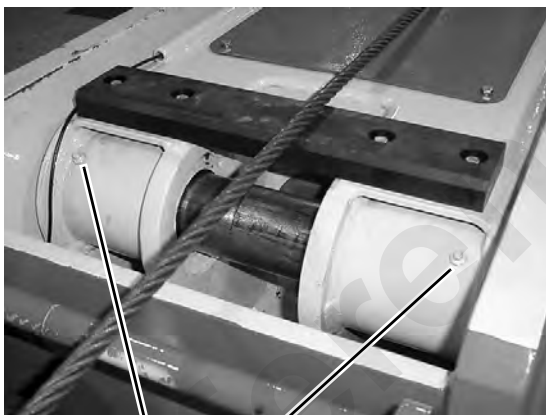
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Lift Cylinder Pivots Lube Points (Base End)

FIGURE 6-4

p1663



Boom Pivot Lubrication Points

FIGURE 6-2

p1664



Lift Cylinder Pivots Lube Point (Rod End)

FIGURE 6-5

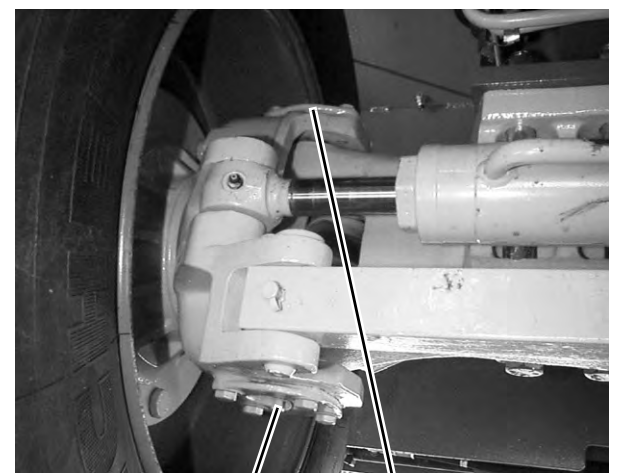
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Boom Head Sheaves and Pivot Lube Points

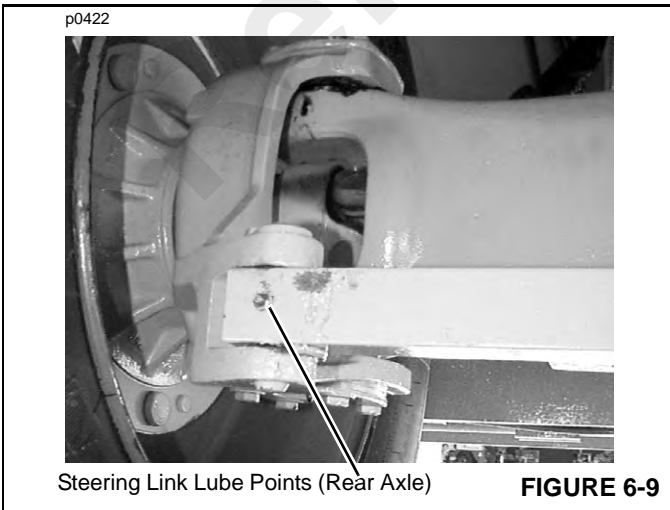
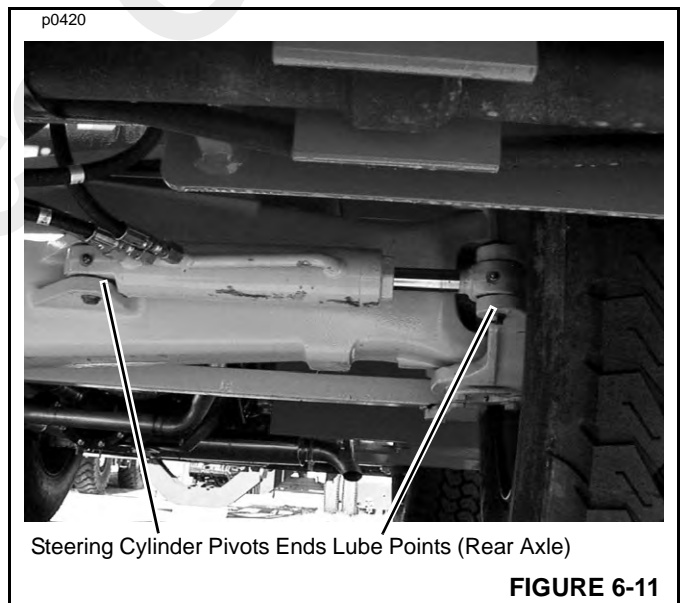
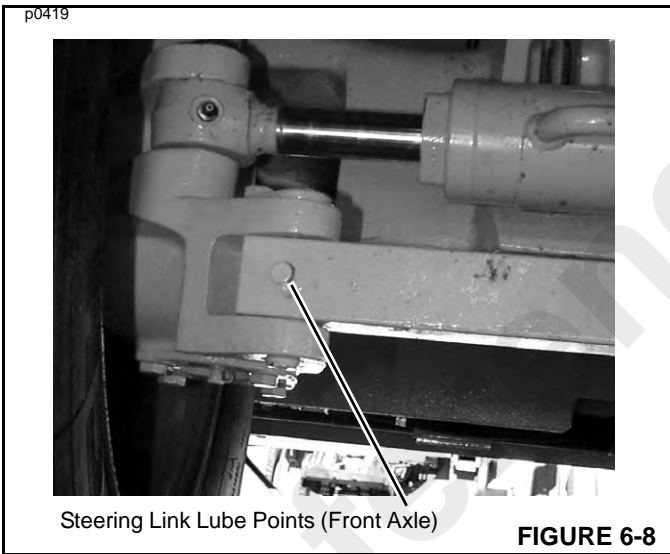
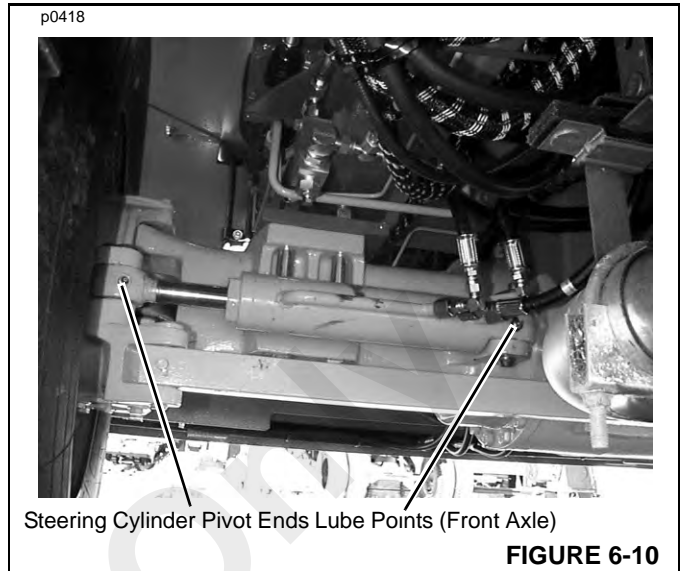
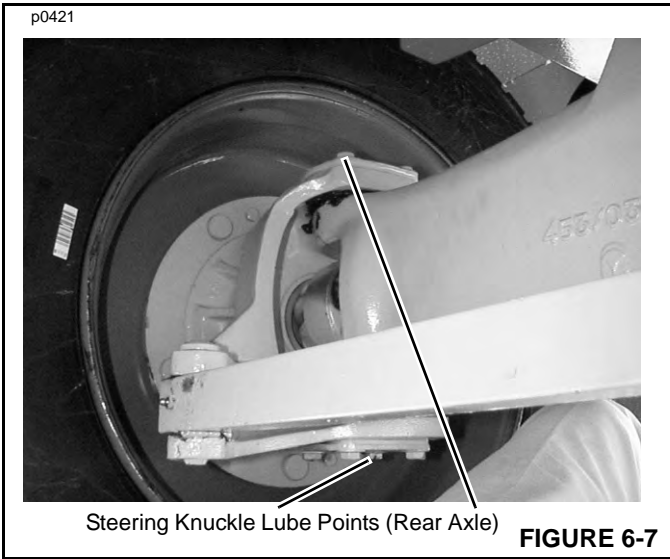
FIGURE 6-3

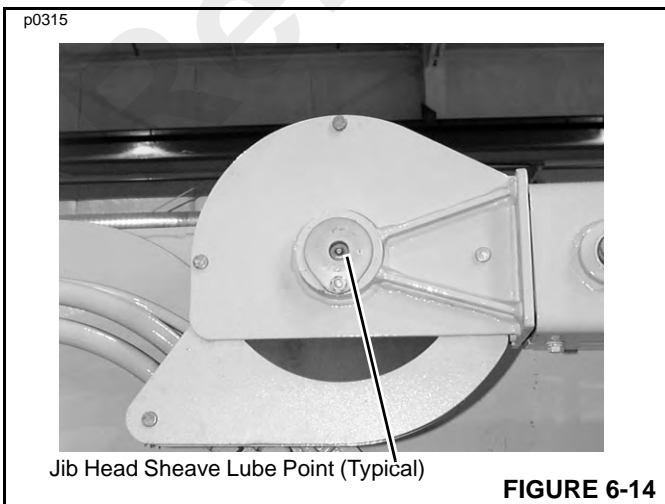
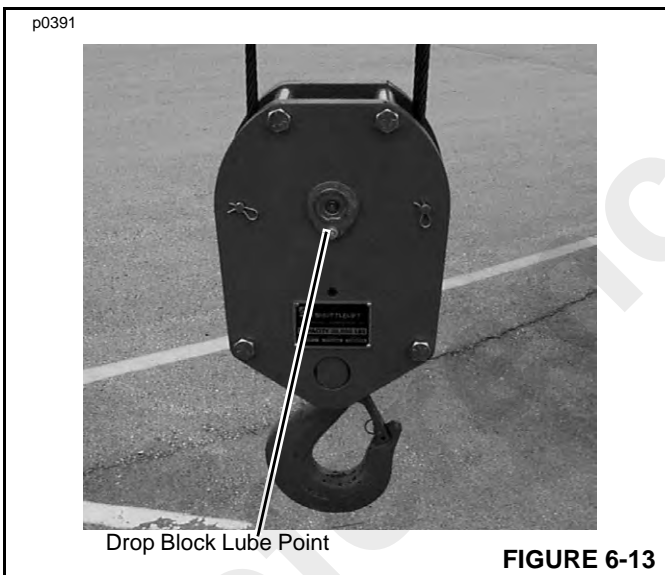
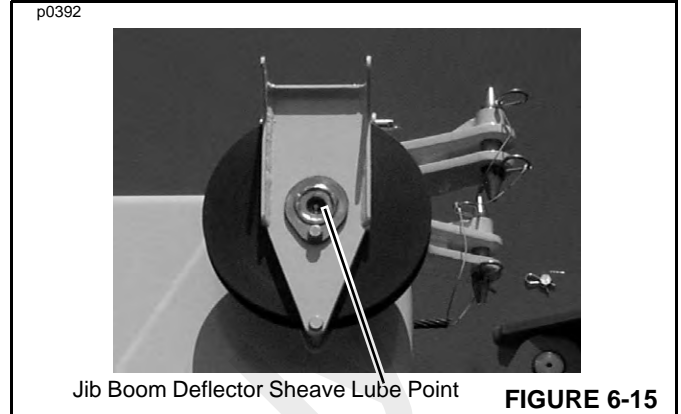
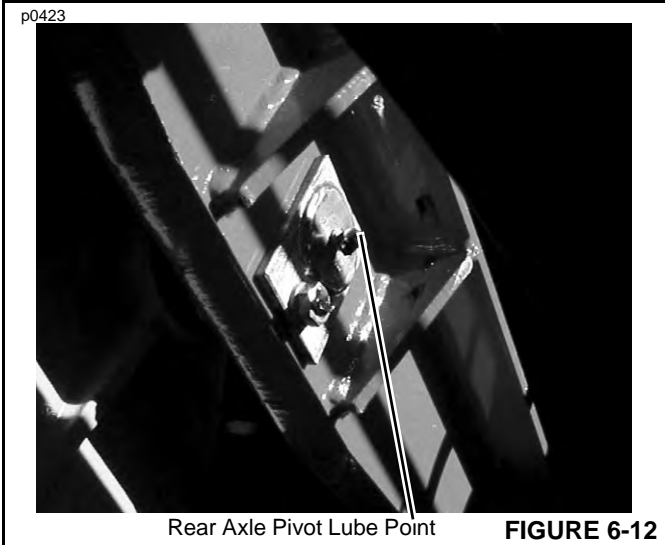
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Steering Knuckle Lube Points (Front Axle)

FIGURE 6-6





SCHEDULED MAINTENANCE

Daily (Walk-around) Inspection

NOTE: You must read and understand the warnings and basic safety rules, found in Section 2 of this manual, before performing any operation or maintenance procedures.

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

Inspections

Inspect the Anti-Double Blocking System

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 6-14, 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

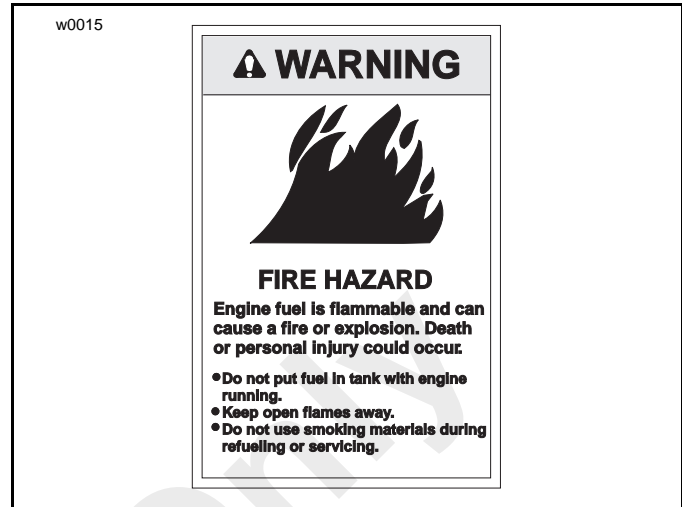
Each control should be checked for proper operation after the above inspections have been completed. Do not place the crane in service if any control is not functioning properly.

Component/System Checks

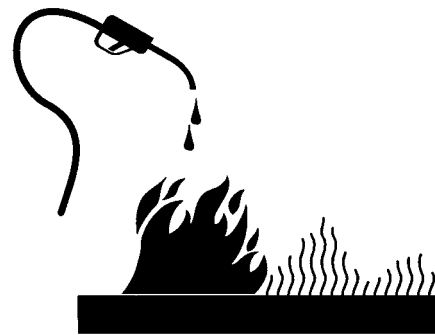
Check Fuel Level

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.

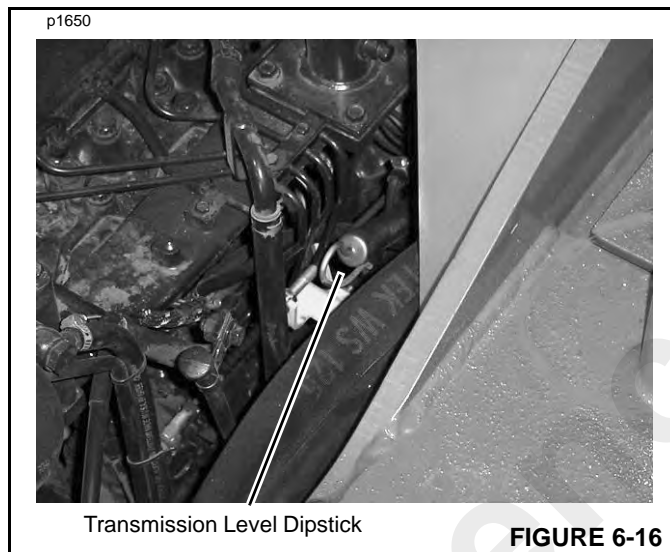
Tighten the fuel cap securely. If the cap is lost, replace only with original equipment.

Check the Engine Crankcase Oil Level

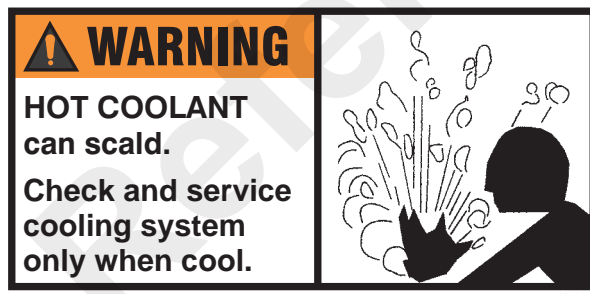
1. Level the crane, engage the parking brake and shut off the engine.
2. Lift the engine compartment cover and support in place using the furnished prop rod.
3. Remove the engine oil dipstick and check oil level. Oil should be visible within the crosshatched mark area on the dipstick.
4. If the oil is 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.

Check the Transmission Oil Level

1. Check the oil level when the oil is cold. 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. Remove the dipstick (Figure 6-16) 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.



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 120° F (50° C). 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 overflow bottle (Figure 6-17) is at least half full. If coolant is low, fill the overflow bottle 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 bottle is empty, **BE SURE THE ENGINE IS COOL** to below 120° F (50° C), 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.



Drain Water from Engine Fuel Filter (Diesel Engine)

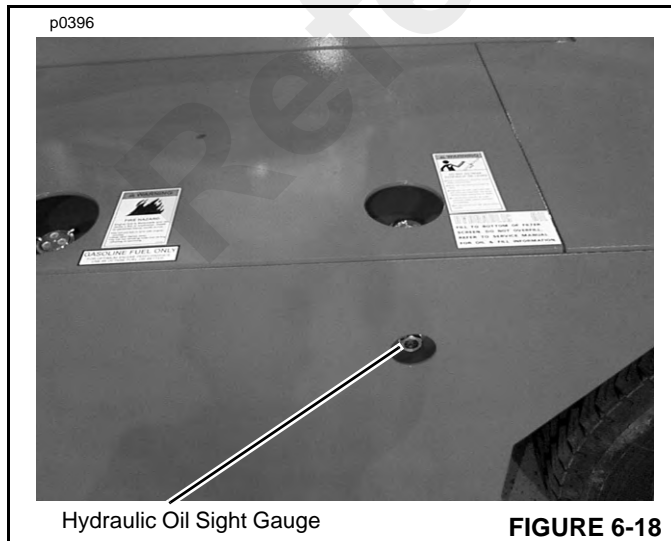
1. Shut off the engine and engage the parking brake.
2. See the engine manual furnished with the crane and follow the water draining instructions.

Check Hydraulic Oil Level

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



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 6-18). 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.

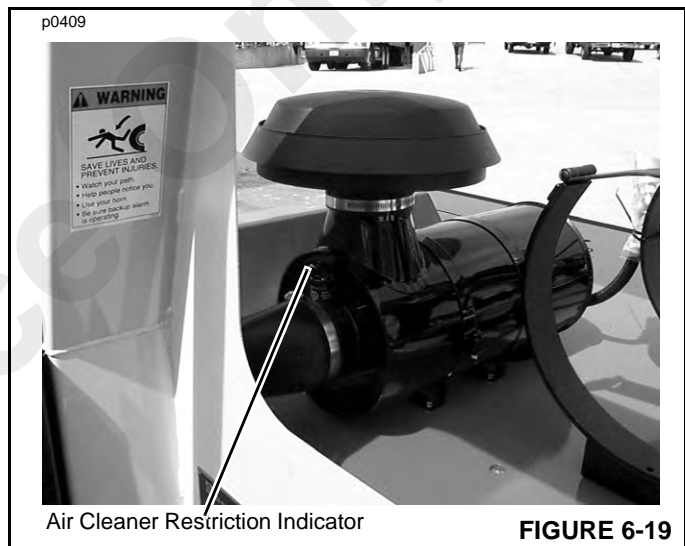


Check the Air Cleaner Restriction Indicator

The air cleaner is equipped with a filter restriction indicator (Figure 6-19). 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.



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 wing nut securing the air cleaner element to the air housing. 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 or cleaned 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 causes of engine contamination. Make sure that all hardened ridges are completely removed, both on the bottom and top of the housing.

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.

Clean the Element

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

NOTE: Air cleaner elements must be replaced after six cleanings, every three months or after every 500 hours of operation, whichever occurs first.

1. Clean the filter element with compressed air. Use compressed air with 30 psi (205 Nm) maximum pressure at the nozzle.
2. Direct the air inside the element and then move the nozzle up and down while rotating 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 the wing nut.
5. Reset the air cleaner restriction indicator by pushing in the reset button (Figure 6-31).
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 120 psi (828 kPa).

Also, check for broken studs, rim damage, loose nuts, cracks and other tire damage.

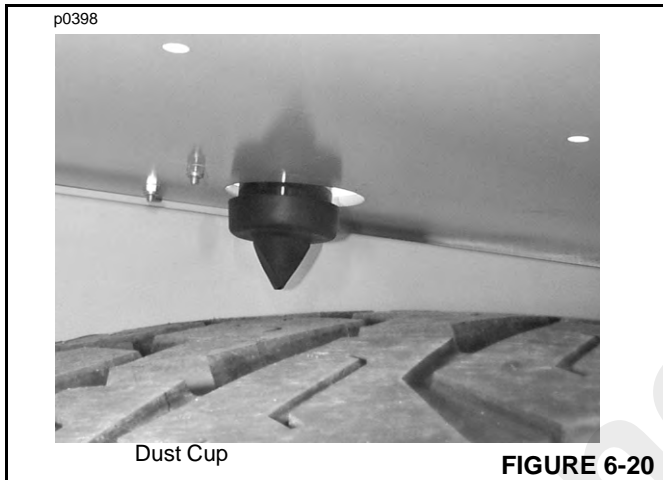
50 Hours of Operation (Weekly)

NOTE: You must read and understand the warnings and basic safety rules, found in Section 2 of this manual, before performing any operation or maintenance procedures.

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

Clean the Air Cleaner Dust Cup

Squeeze the dust cup (Figure 6-20) to remove any accumulation of dust or debris.



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.

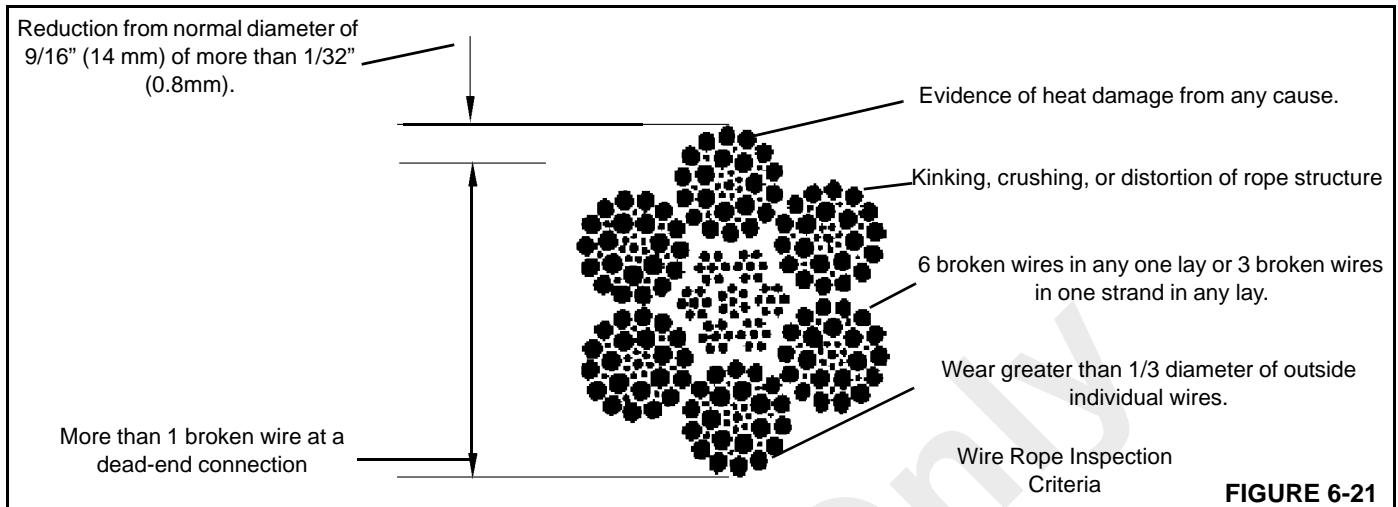
If you are not familiar with wire rope inspection, information on how to inspect wire rope, sheaves and drums is available from your dealer. Order Wireco Report No. 107.

General Inspection

NOTE: Always wear gloves when working with wire rope to inhibit hand injuries.

1. **Wire Rope** - Inspect for damage, rust or wear to the wire rope. Keep a record of each inspection. Replace the wire rope if any of the conditions in Figure 6-21 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.

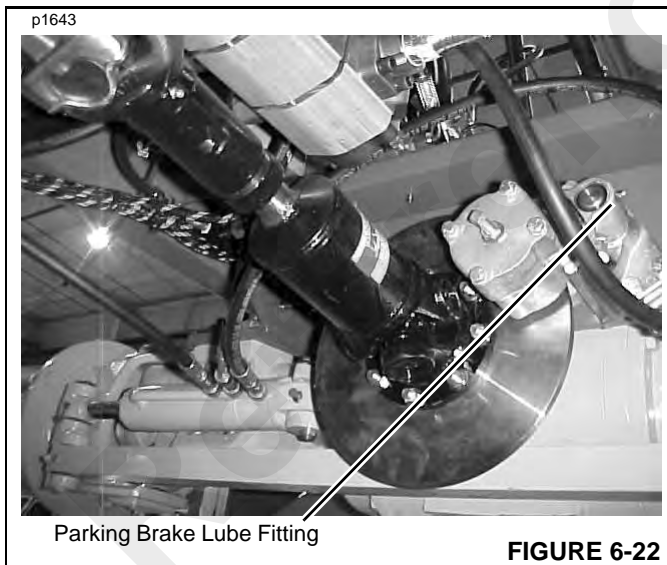


Grease Fittings

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

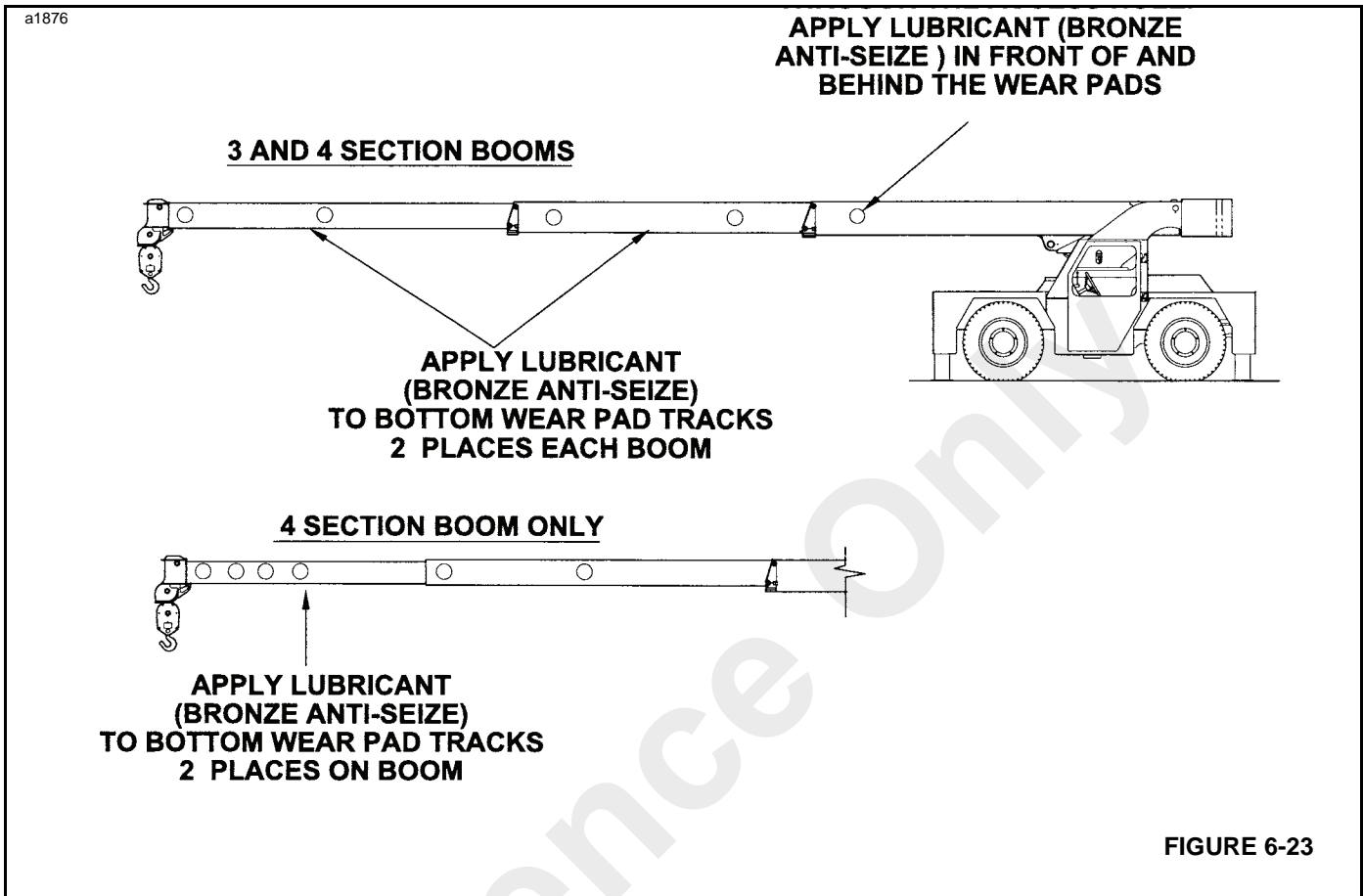
Lubricate Parking Brake

Apply grease to the fitting on the parking brake (Figure 6-22).



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 6-23) on the boom sections. Only use a small amount of lubricant for best results.
5. On four-section booms only, align the boom access holes (Figure 6-23) to gain access to the telescope cylinder rod end slide pad.
6. 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.



100 Hours of Operation (Two Weeks)

NOTE: You must read and understand the warnings and basic safety rules, found in Section 2 of this manual, before performing any operation or maintenance procedures.

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

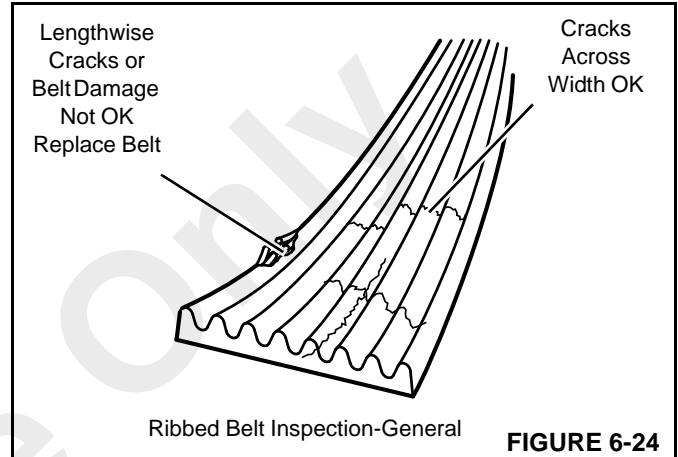
Inspect the Fan Belts

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 6-24.



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.

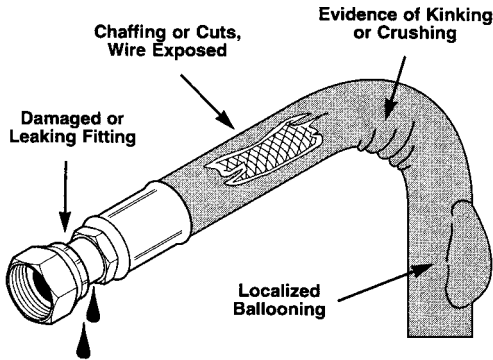
Check Wheel Nut Torque

Check the torque on each wheel nut in crisscross pattern. Wheel nut torque should be 500 lb-ft. (680 Nm).

250 Hours of Operation (Monthly)

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.

WARNING



DO NOT GO NEAR HYDRAULIC OIL LEAKS

- When checking for hydraulic system leaks, observe only.
- Never use your hands to check for leaks.
- Hydraulic oil from a pin hole leak can puncture your skin and cause serious injury, gangrene, or death.
- If injured by hydraulic oil under pressure, seek medical attention immediately.
- Oil can be hot and can cause severe burns.

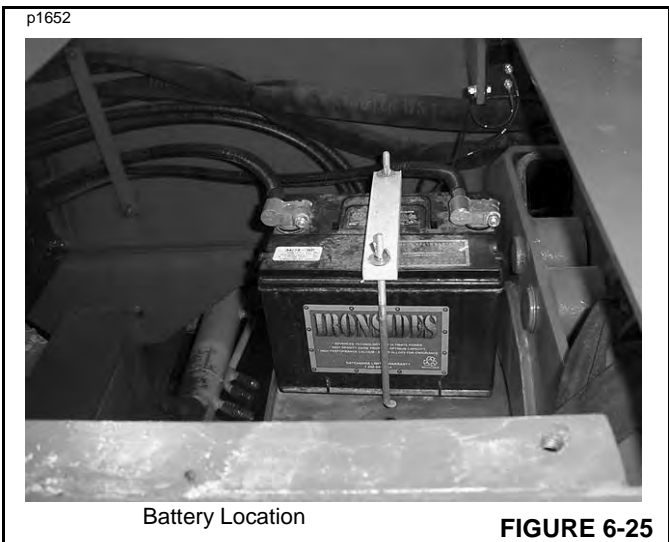
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Clean Battery and Cables

1. Remove the battery compartment cover.

	<p style="text-align: center;">WARNING</p> <p>EXPLOSIVE GASES can cause serious injury.</p> <p>Keep sparks, Flames, and Lighted Materials away from Batteries.</p>	<p>When Jump starting:</p> <ul style="list-style-type: none"> ● Wear safety glasses. ● Be certain that machines do not touch and batteries are not frozen. ● Follow jump starting directions contained in Operator's Manual.
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2. Tighten all battery hardware to keep the battery securely in place.
3. Disconnect the battery cables.
4. Sprinkle the batteries 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 inhibit 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 inhibit rust, corrosion and wear.

1. Unwind the wire rope from the hoist drum.
2. Thoroughly clean the wire rope prior to application of any lubricant. Use a wire brush and compressed air to remove all foreign matter and old lubricant.

NOTE: To inhibit 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 60° and 100°F (18° to 36° C). 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. Using a brush, apply open gear lube to the pinion and swing gear teeth (Figure 6-26).

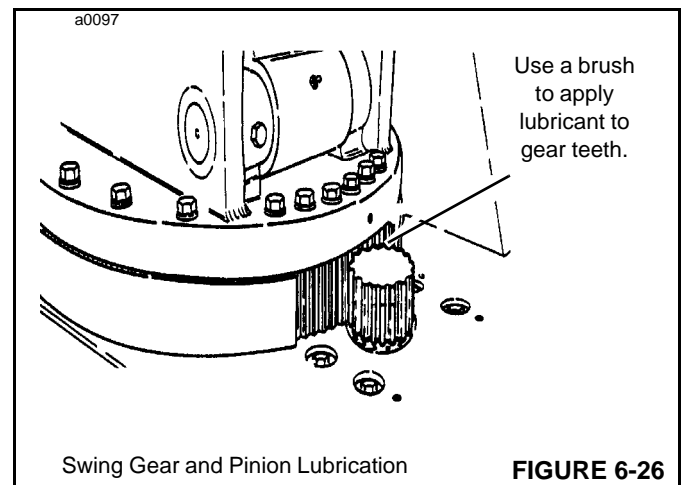


FIGURE 6-26

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

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 140° F (60° C).
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.

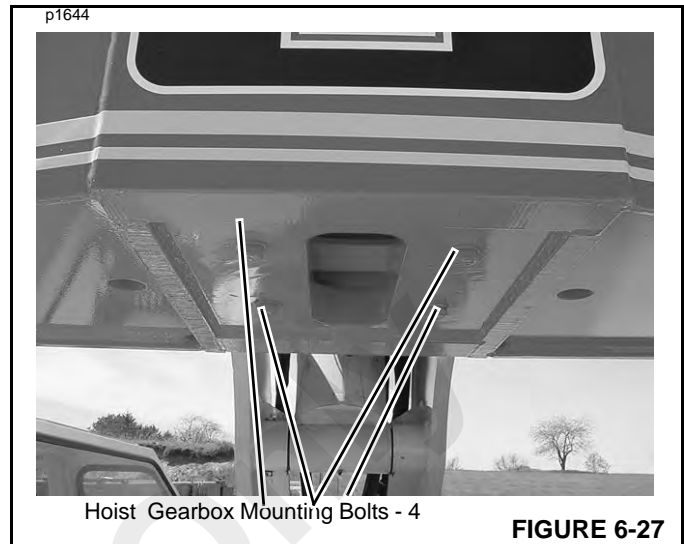
6. Fill the new filter with clean recommended lubricating oil (See engine operator's manual furnished with the crane).
7. Apply a small amount of clean engine oil to the gasket of the new oil filter. Turn the filter clockwise to tighten it until the gasket makes contact. Then, tighten the filter 1/2 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 machine.

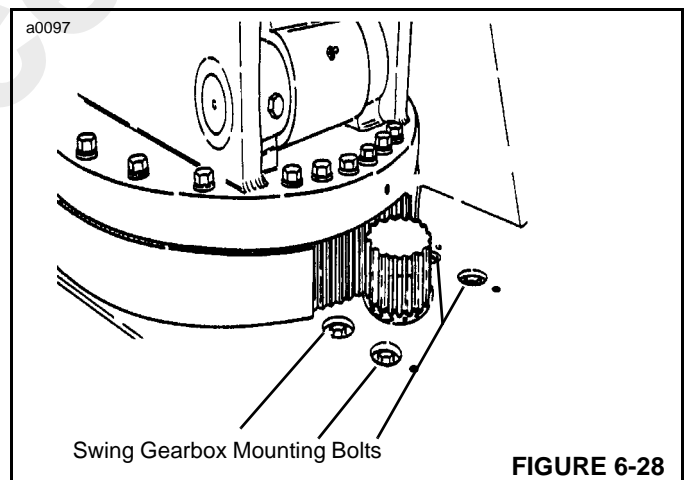
Hoist Gearbox Mounting Bolts

Torque the 3/4" mounting bolts (4) to 280 lb-ft. (380 Nm). See Figure 6-27.



Swing Gearbox Mounting Bolts

Torque the 3/4" gearbox mounting bolts (4) to 200 lb-ft. (272 Nm). See Figure 6-28. If the bolts are loose, check gear backlash.



Mast Mounting Bolts

Because of the cyclic loading on the mast bolts, it is important that these bolts be checked at regular intervals. 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 158 lb-ft. (215 Nm). The correct torque on each inside bolt (swing bearing to frame) should be 282 lb-ft. (381 Nm).

NOTE: Use only special Grade 8 for replacement of the mast bolts. Order the bolts from your dealer, 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 575 lb-ft. (782 Nm). See Figure 6-29.

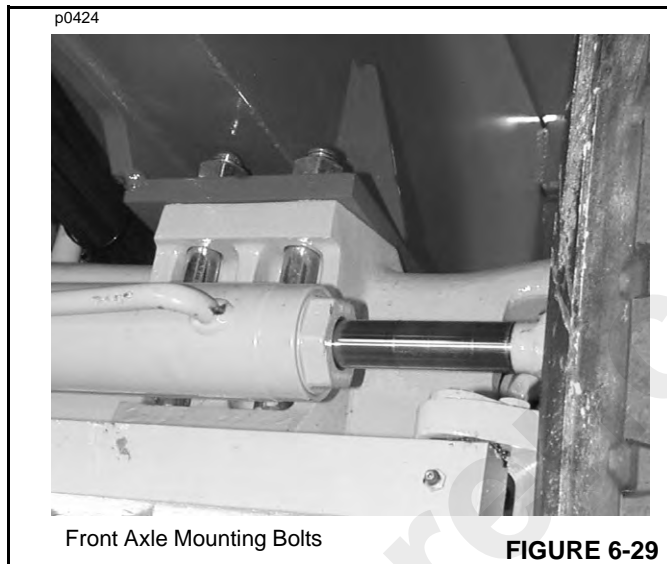


FIGURE 6-29

500 Hours of Operation (3 Months)

NOTE: You must read and understand the warnings and basic safety rules, found in Section 2 of this manual, before performing any operation or maintenance procedures.

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

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 6-30). Replace the brake pads if they are 0.028 inches (0.71 mm) thick or less.

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

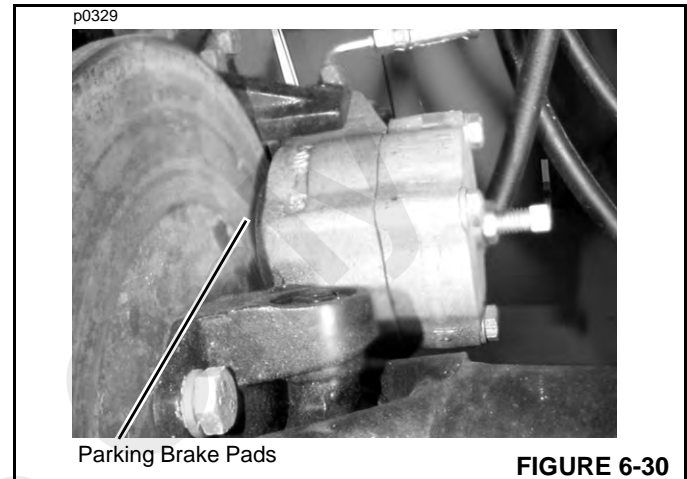


FIGURE 6-30

Replace Fuel Filter (Diesel Engine)

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.

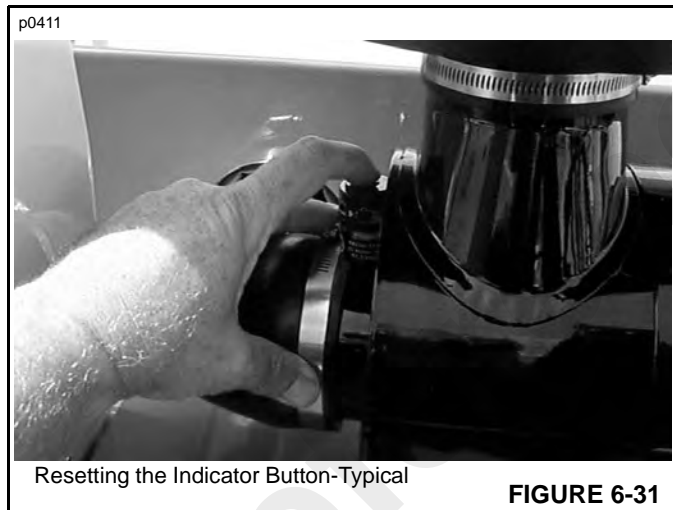
1. Remove the housing cover.
2. Remove the wing nut securing the air cleaner element to the air housing. Remove the element as gently as possible until you get it outside of housing. Accidentally bumping it while it is still inside the housing means dropped dirt and dust that may contaminate the clean 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, both on the bottom and top of the housing.

6. Install the safety element. Make sure it is seated all the way.

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

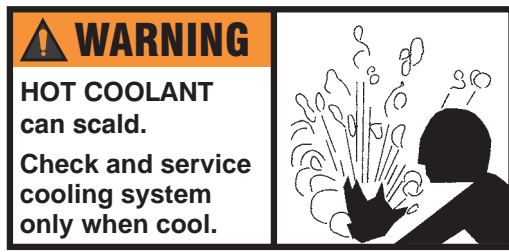
7. Install the new element over the stud in the housing and slide it all the way in.
8. Make sure the gasket is seating evenly. If you don't feel the gasket is seating evenly for a perfect seal, you won't have protection. Recheck to see if the sealing surface in the housing is clean, or if the element is not the right model number. It may be too short for the housing.
9. Install the air cleaner housing cover and the wing nut. Only hand tighten the wing nut.
10. Reset the air cleaner restriction indicator by pushing in the reset button (Figure 6-31).



Spark Plug Gap (Gasoline Engine)

Thoroughly clean the spark plugs, including the threads. Check the electrode gap with a 0.030 inch (0.76 mm) feeler gauge. If not correct, reset the gap.

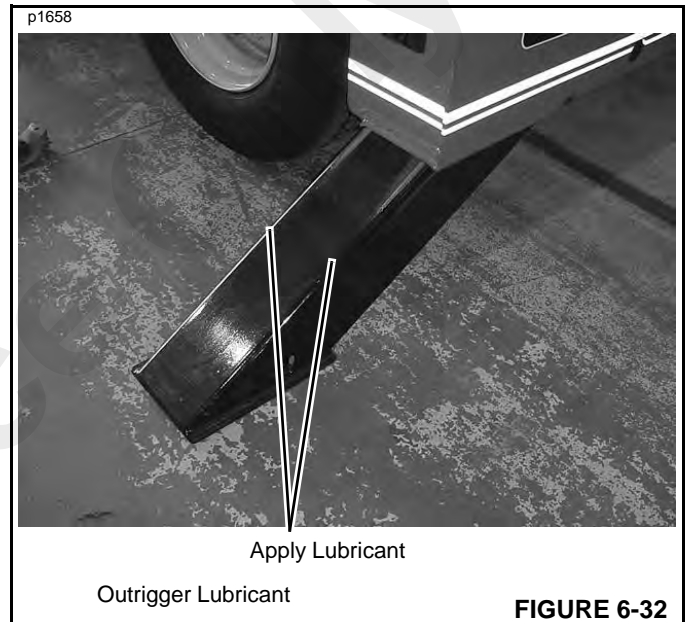
Add Rust Inhibitor to Engine Cooling System



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

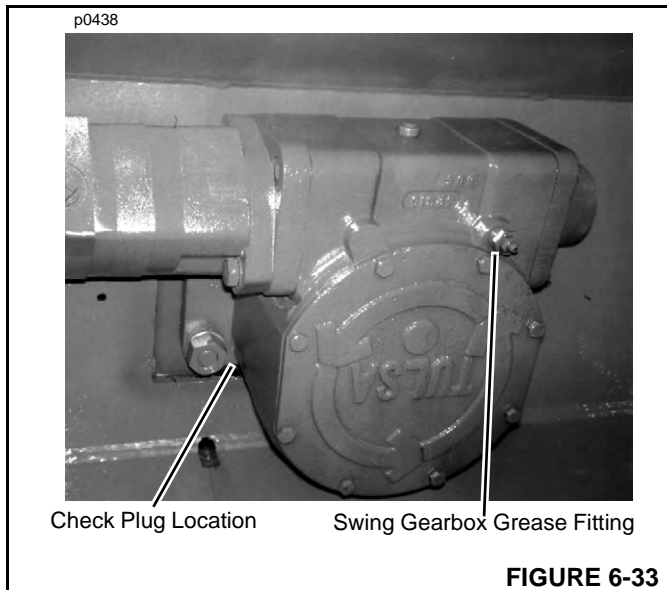
1. Lower the outriggers.
2. Clean the tops of the outriggers with a suitable solvent.
3. Apply Mobil EP grease, or equivalent, to the areas shown in Figure 6-32. Do not over lubricate. Raise and lower the outriggers several times to spread the grease.



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.

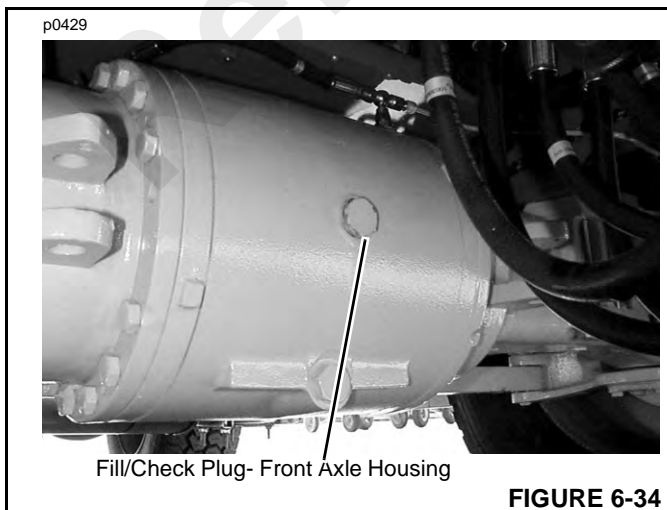


1. Engage the parking brake and shut off the engine. Remove the ignition key.
2. Clean the grease fitting and check plug (Figure 6-33).
3. Remove the check plug.
4. Apply Lithium Base, E.P. No. 2 bearing grease to the fitting. Fill gear box until grease exits the check plug hole. Install the check plug.

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.

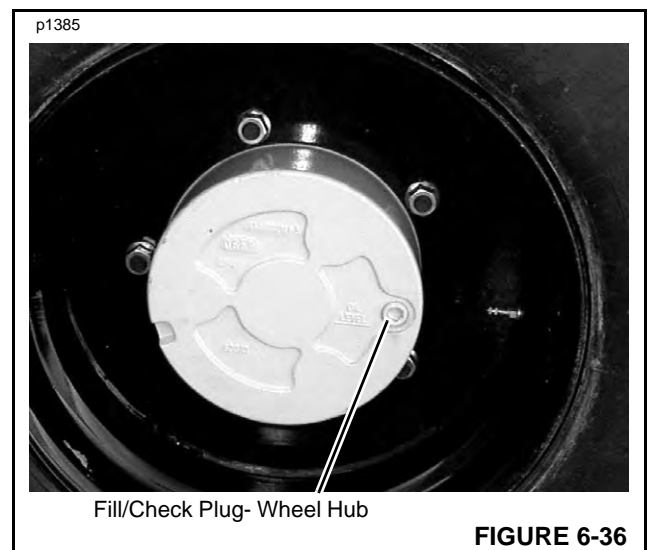
1. Clean around the axle housing fill/check plug (Figure 6-34 and Figure 6-35) and remove the plug.



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 wheel hubs until the fill/check plug is horizontal with the ground (Figure 6-43).



4. Clean around the plug and then remove it.
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 hubs.

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 fill/check plug (Figure 6-38) and then remove the plug.
4. Check the lubricant level, which should be to the bottom of the fill/check hole.
5. If necessary, add SAE 90 EP gear lube to gearbox until it reaches the bottom of the fill/check plug hole.
6. Clean around the area of the brake breather and check plug (Figure 6-45). Remove the check plug.

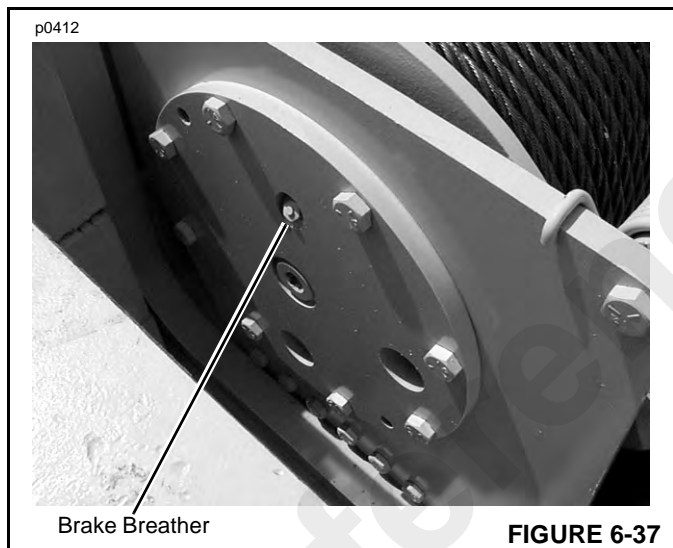


FIGURE 6-37

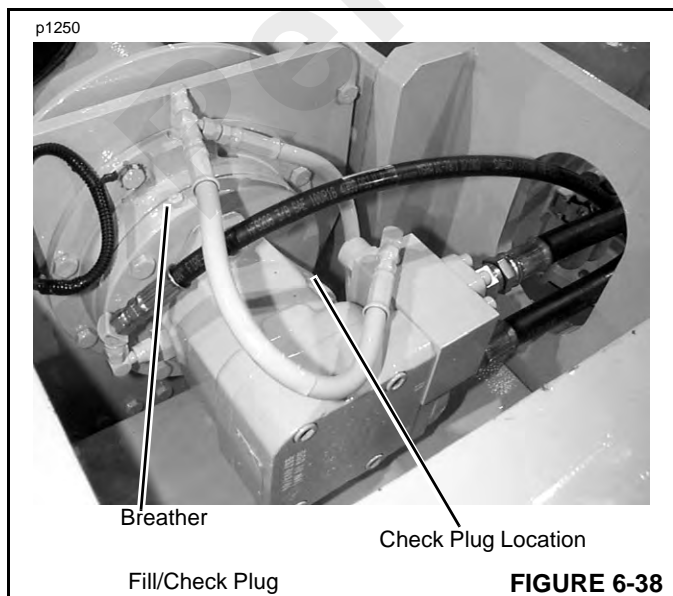


FIGURE 6-38

7. Check the lubricant level which should be level with the bottom of the check plug hole.



WARNING

DO NOT use EP type gear lubes in the brake section of this hoist. EP lubes may prevent the clutch from locking up, causing the load to fall and resulting in property damage, personal injury or death.

8. If necessary, add SAE 20-20W motor oil through breather hole until oil is level with the bottom of the check plug hole.
9. Install the breather and check plug

1000 Hours of Operation (6 Months)

NOTE: You must read and understand the warnings and basic safety rules, found in Section 2 of this manual, before performing any operation or maintenance procedures.

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

Replace the Transmission Oil and Filter

1. Engage the parking brake and shut off the engine. Remove the ignition key.

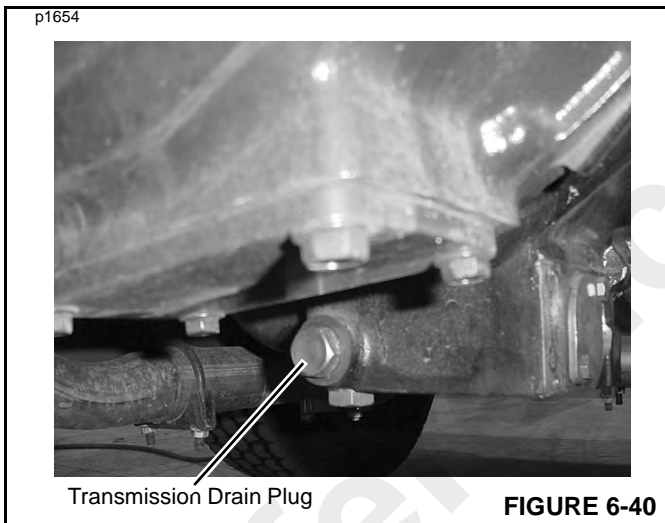
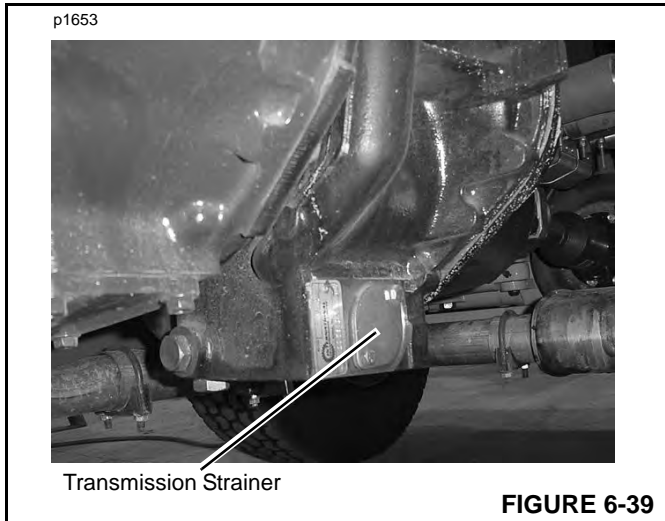
NOTE: It is necessary to climb under the crane to drain the transmission oil. Be sure engine is shut off, the ignition key is removed, parking brake is engaged and chock blocks are in place before climbing under the crane.

When the strainer is loosened/removed, oil will gush out. Keep to one side when you remove the strainer.

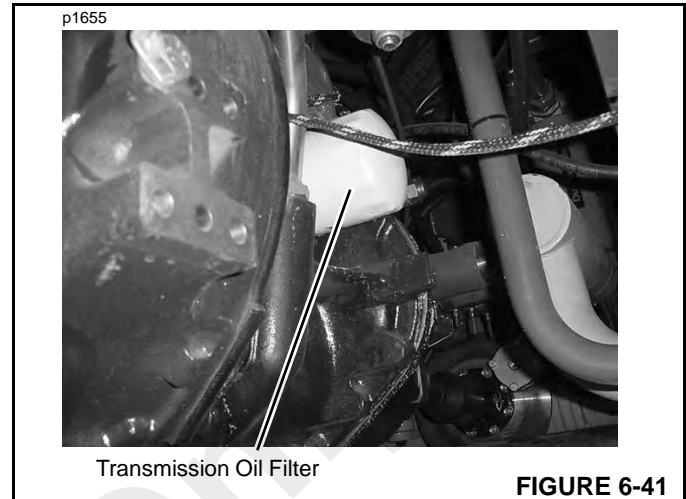
2. Place a suitable container under the strainer (Figure 6-36). Remove the strainer and gasket and drain the oil into the container. Discard the gasket.

NOTE: Before removing the strainer, be sure you have a new strainer gasket. The old strainer gasket will be damaged during removal of the strainer, and if it is installed with the strainer, leakage will occur. It is recommended that three gaskets be kept in supply at all times. This will cover a years maintenance and one for emergency maintenance.

3. Place the container under the drain plug and remove the drain plug (Figure 6-37). Drain any oil left in the transmission into the container. Install the drain plug.



4. Clean the strainer in a suitable solvent.
5. Install the cleaned strainer and new gasket. Tighten the strainer mounting bolts to a torque of 7.4 lb-ft. (10 Nm).
6. Remove the transmission oil filter by unscrewing it from the transmission housing (Figure 6-41). Properly discard the filter.
7. Coat the seal of the new filter with clean transmission oil.
8. Screw on the transmission filter until it touches the filter head. Then, turn the filter another 3/4 of a turn minimum to seat the seal.

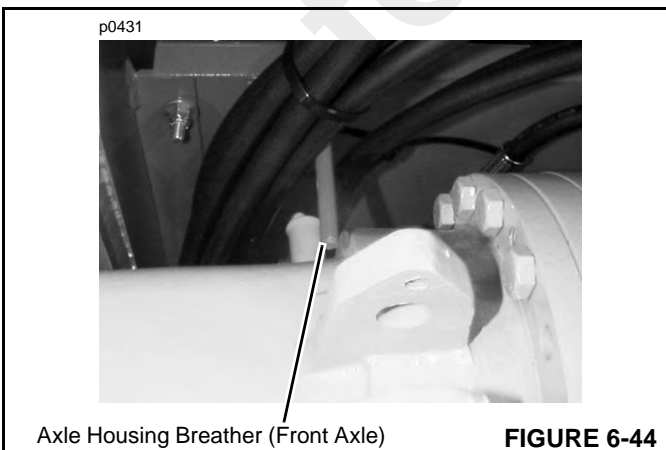
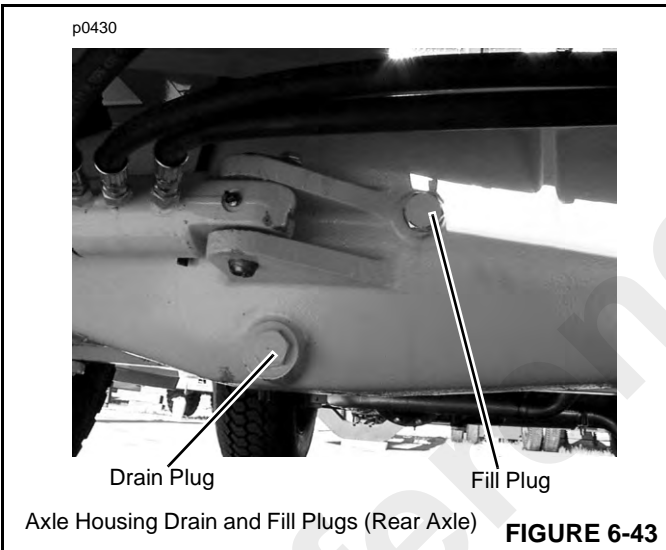
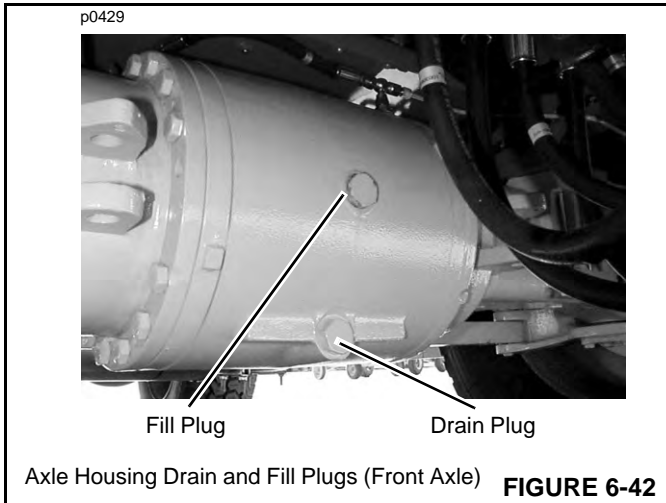


9. Fill the transmission with Mobil ATF 210, or equivalent, transmission fluid to the upper mark on the dipstick (approximately 3.43 gallons [13 liters]).
10. Start the engine and let it run at idle speed for a period not exceeding five minutes. This allows the oil to fill the transmission filter, torque converter and hoses.
11. Stop the engine, wait approximately one minute and then check oil level. If low, add oil to the upper mark on the transmission dipstick. **DO NOT OVERFILL.**

Replace the Axle Housing Lubricant

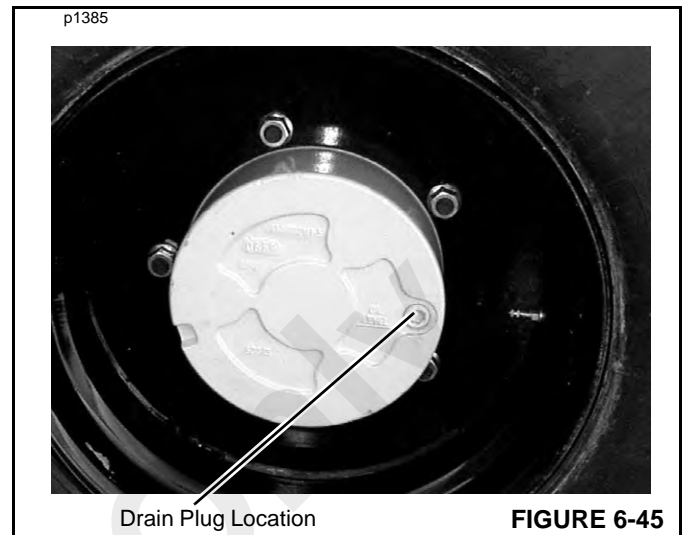
NOTE: It is necessary to climb under the crane to drain the axle housing lube. Be sure engine is shut off, the ignition key is removed and chock blocks are in place before climbing under the crane.

1. Clean around the fill plug in the axle housing (Figure 6-42 and Figure 6-43). Remove the plug.
2. Place a container under the axle housing drain plug (Figure 6-45 and Figure 6-46). Remove the drain plug and drain the fluid into the container. Install the drain plug.
3. Clean the front axle breather (Figure 6-44) with a suitable solvent. If the breather is removed, be sure that the hole in the breather tube is facing toward the axle hub (toward the right).

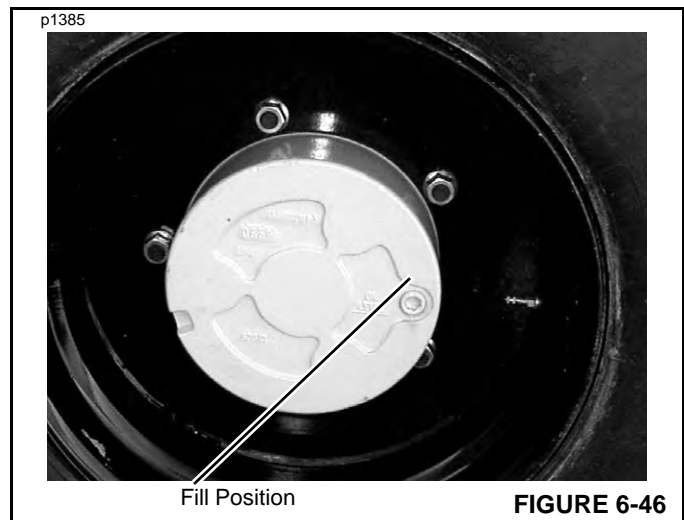


4. Fill the axle housing with recommended lubricant through the fill plug hole. Fill until the oil reaches the bottom of the fill hole.
5. Install the fill plug.

Replace Axle Wheel Hub Lubricant



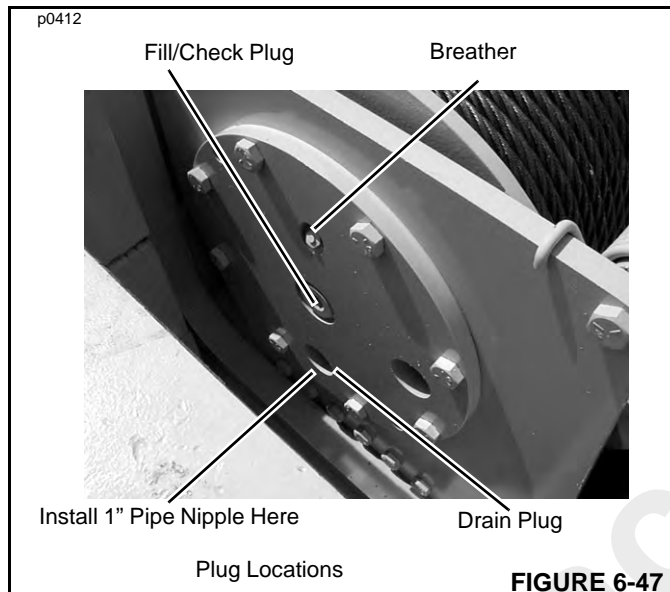
1. Using the outriggers, raise the tires slightly off of the ground.
2. Place the transmission in neutral and release the parking brake.
3. Turn one of the axle wheel hubs until the drain plug is located at the bottom of the wheel hub (Figure 6-45).
4. Clean around the drain plug and then remove it. Drain the wheel hub oil into a suitable container.



5. Turn the wheel hub until the drain hole is horizontal (Figure 6-46).
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 three wheel hubs.

Replace the Hoist Gearbox and Brake Lubricant**Hoist Gearbox**

1. Lower the boom to lowest position, engage the parking brake. Leave the engine running.
2. Rotate the drum until the drain plug is visible in the hole in the side of the mounting bracket.



3. Clean around the gearbox breather and the fill/check plug hole. Remove the gearbox breather (Figure 6-47) and clean it in a suitable solvent. After it is cleaned, install the breather.
4. Clean around the fill/check plug (Figure 6-47) and remove the plug.
5. Place a suitable container under the drain plug.
6. Screw a 1 inch pipe nipple into the hole in the mounting bracket (Figure 6-47). Using a ratchet wrench with an extension and a 3/8" hex wrench attached, remove the drain plug through the pipe nipple. 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.
7. Install the drain plug and remove the nipple.
8. Fill the gearbox through the fill hole until the fluid is even with the bottom of the fill hole. Fill with SAE 90 EP gear lube.
9. Install the fill/check plug.

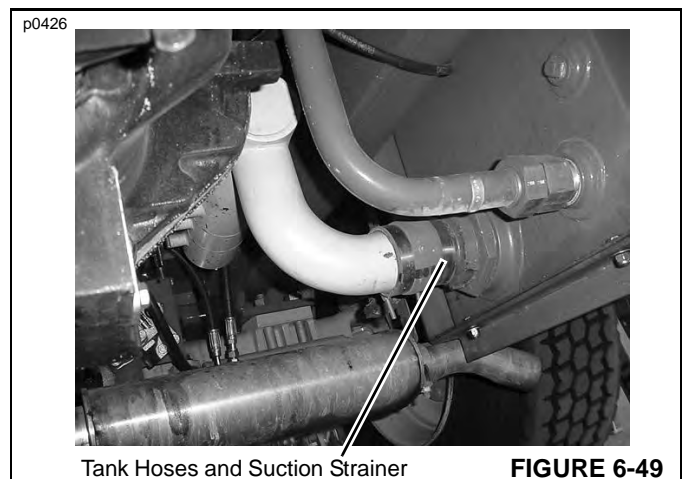
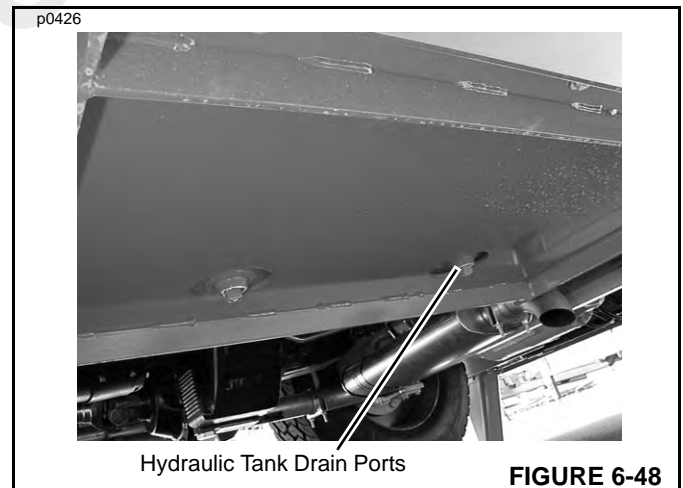
Replace the Hydraulic Oil

NOTE: ISO (International Standards Organization) #46/68 Hydraulic Oil (Mobil Fluid #424) is recommend 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.

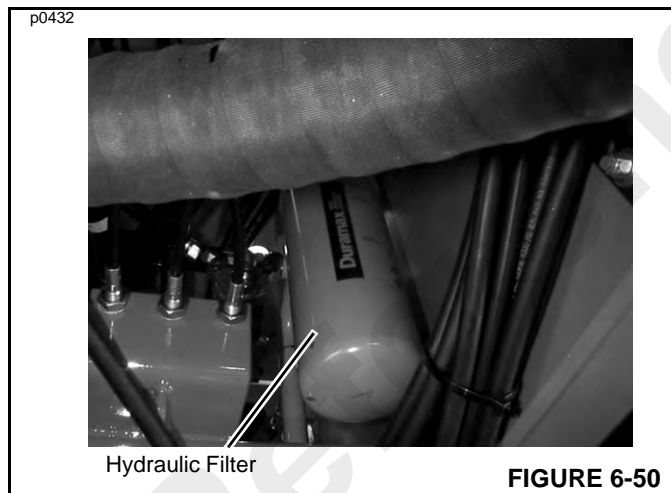
To change the hydraulic oil:

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 6-48).



6. When the tank is empty, disconnect the two hydraulic lines from the rear of the hydraulic oil tank (Figure 6-49). 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*.
10. Fill the hydraulic tank with Mobil Fluid 424 hydraulic oil to the level 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 to the level sight glass. Add hydraulic oil if necessary.
13. Visually check for leaks.

Replace the Hydraulic Oil Filter



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 machine (Figure 6-50).
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. 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.

Replace L.P.G. Inline Filter



WARNING

Before disconnecting any L.P.G. lines and fittings, be sure the gas supply is shut off at the tank.

Keep flames from the surrounding area when disconnecting L.P.G. lines.

L.P.G. gas is explosive and can cause serious personal injury or death.

Shut off the L.P.G. supply at the tank and slowly loosen the hose at the bottom of inline swivel until all gas has escaped. Then, disconnect the hose and remove the inline filter. Install a new filter and attach the hose. Open the L.P.G. supply and check for leaks, using a soap and water solution. Bubbles will appear if leaks are present. Do not operate the crane with gas leaks. Tighten any loose connections.

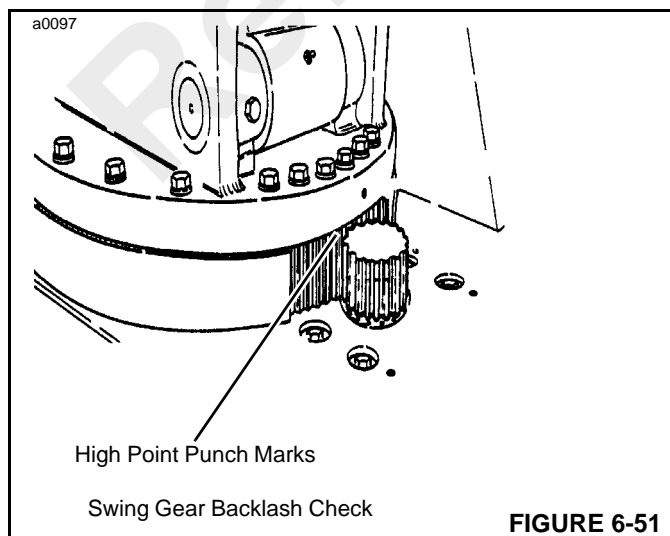
Check Swing Gear/Pinion Backlash

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



Rotating gears can cause injury. Keep hand clear of rotating pinion and gear while the mast is rotating. 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 6-51).

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 Section 6, Adjustments.

**Replace the Spark Plugs (Gasoline Engine)**

Disconnect one spark plug wire at a time and then replace the old spark plug with a new plug. Correct spark plug as AC 41-932 spark plug. The spark plug gap should be 0.030 inches (0.76 mm). Connect the spark plug wire and then remove the next wire.

Replacing the In-line Fuel Filter (Dual Fuel Engine)

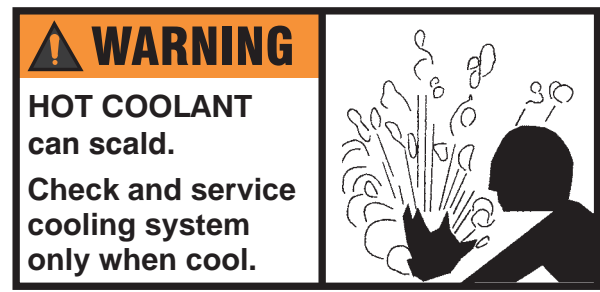
NOTE: It is necessary to climb under the crane to change the fuel filter. Be sure engine is shut off, the ignition key is removed and chock blocks are in place before climbing under the crane.

1. Engage the parking brake and shut off the engine.
2. Disconnect the two clamps and remove the filter.
3. Install a new filter between the hoses and secure it in place with the two clamps.

2000 Hours of Operation (Yearly)

NOTE: You must read and understand the warnings and basic safety rules, found in Section 2 of this manual, before performing any operation or maintenance procedures.

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

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:

1. Inspect for loose mounting hardware. Tighten any loose hardware.
2. 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 Grove distributor.
3. Inspect for missing or unreadable warning decals. Replace if necessary.
4. Inspect for excessive rust or corrosion on crane structure and booms. Paint any areas with excessive rust or corrosion.
5. Inspect for missing items. Replace if necessary.
6. Inspect the crane for any damage that might inhibit safe operation of the crane. Repair any damage.

Testing the Load Moment Indicator (Optional)

See the Load Moment Indicator 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:

Normal Operating Ranges

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 an qualified service technician.

Charging the Battery

Under normal conditions, the engine's alternator will have no problem keeping a charge on the batteries. The only condition in which the battery(s) may cause a problem is when they have been completely discharged for a long period of time. Under this condition the alternator may not be able to recharge the battery(s) and a battery charger will be required for charging the battery(s).

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*, in Section 3) 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 125° F [52° C]). If spewing or gasing occurs or temperatures exceed 125° F (52° C), the charging rate must be reduced or temporarily stopped to permit cooling.

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

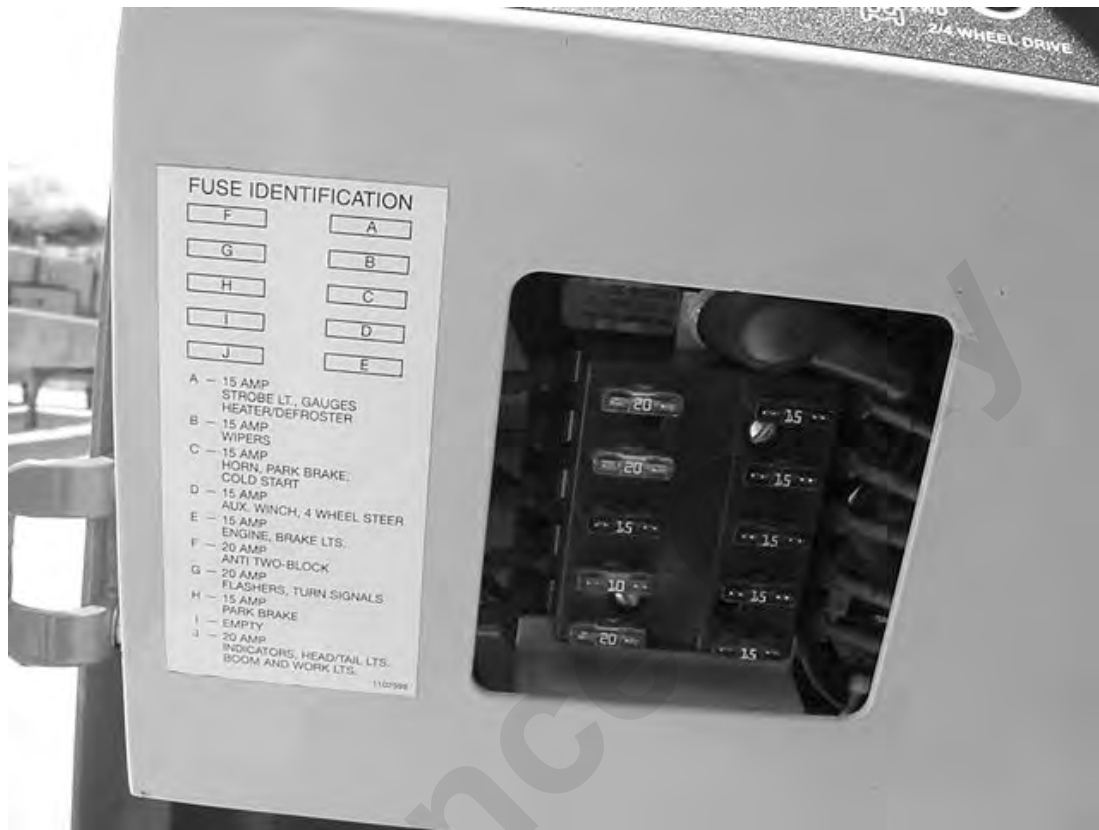
Storage of fuel for an extended period causes accumulation of sediment, dirt, water and other foreign materials in the fuel. Many engine problems are caused by dirty fuel and long storage periods.

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 Replacement

Ten fuses are located on a fuse block in the instrument panel (Figure 6-52).

p1645



Fuse Cover Location

FIGURE 6-52

**SECTION 7
ADJUSTMENTS**

SECTION CONTENTS

All adjustments must be performed by a qualified mechanic.	7-1	Refer to the Service Manual for the proper procedures.	7-1
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ALL ADJUSTMENTS MUST BE PERFORMED BY A QUALIFIED MECHANIC.

Refer to the Service Manual for the proper procedures.

Reference Only

Reference Only

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SECTION 8 SPECIFICATIONS

SECTION CONTENTS

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LUBRICANTS AND CAPACITIES

NOTE: The following list of lubricants does not constitute an unconditional guarantee of the performance of the lubricant mentioned. It is intended solely as a guide to the type of lubricant recommended for a given application.

Component	Capacity	Lubricant/fluid
Engine crankcase - gasoline engine		
-Without filter change	4.5 qts. (4.3 liters)	See Fuel Types
-With filter change	5.5 qts. (5.2 liters)	
Engine crankcase - diesel engine		
-Without filter change	10.0 qts. (9.5 liters)	See Fuel Types
-With filter change	11.5 qts (10.9 liters)	
Fuel tank	40 gal. (151.4 liters)	See Fuel Types
Cooling system	23 qts. (21.9 liters)	50/50 Mixture of Glycol Anti-freeze & water.
Hydraulic tank	40 gal. (151.4 liters)	Mobil Fluid 424 or equivalent (ISO 46/68) Very Cold Temperatures: SAE 5W or SAE 5W-20 oil if the viscosity will not be less than 60 SUS at maximum operating temperature.
Transmission 2WD 4WD	3.43 gal. (13.0 liters) 3.70 gal. (14.0 liters)	Mobil ATF 210 or equivalent
Front axle housing	6.1 gl. (23.0 liters)	Mobil Fluid 424 or equivalent (ISO 46/68)
Front axle wheel hubs (2)	1.65 qts. (1.5 liters)	Mobil Fluid 424 or equivalent (ISO 46/68)
Rear axle housing	4.8 gal. (18.0 liters)	Mobil Fluid 424 or equivalent (ISO 46/68)
Rear axle wheel hubs (2)	1.9 qts. (1.7 liters)	Mobil Fluid 424 or equivalent (ISO 46/68)
Swing gearbox	As required	Mobil Fluid 629 or equivalent (EP150) Spec # 6829100213

Component	Capacity	Lubricant/fluid
Hoist gearbox	1-1/2-2 qts. (1.4-1.9 liters)	SAE 90 EP gear lubricant or equivalent
Hoist brake	1/2-1 pt. (.2-.5 liters)	SAE 20-20 motor oil
Swing gear pinion	As required	Open gear lube

Engine Oil Specifications

Diesel Engine

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 with the viscosity grades shown in the following chart. 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 -10° F (-23° C) provided they meet the minimum viscosity at 212° F (100° C).

When there is no provision to keep the engine warm when operating in ambient temperatures consistently below -10° F (-23° C), 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 -31° F (-35° C) 0.16 in. (4.1 mm) Squared minimum at 212° F (100° C)
Pour Point (ASTM D-97)	Maximum of 41° F (5° C) below the lowest expected ambient temperature.
Sulfated ash content	Maximum at 1.85% by weight (ASTM D-874)

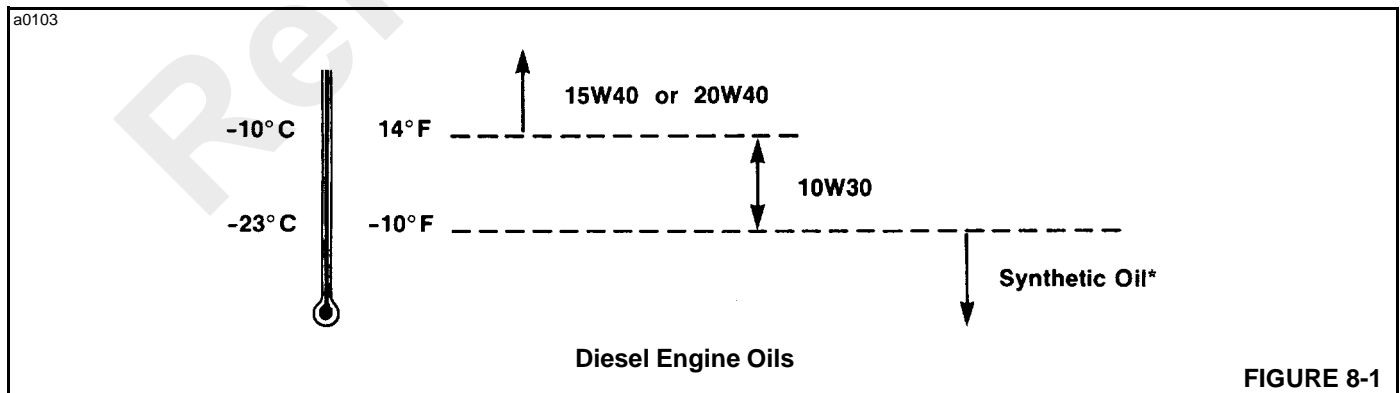


FIGURE 8-1

Gasoline Engine

To achieve proper engine performance and durability, it is important that only the correct type of engine oil be used in the engine. Quality oil provides maximum efficiency for crankcase ventilation systems, which reduces pollution.

NOTE: Use only engine oils displaying the American Petroleum Institute (API) Starburst Certification Mark **FOR GASOLINE ENGINE** on the container.

Gasoline engines that are converted for Liquid Propane Gas or Natural Gas fuel **MUST** use oils labeled **FOR GASOLINE ENGINE**. Do not use oils that are specifically formulated for Diesel Engines only. CC or CD classification oils, even when labeled Heavy Duty or for Natural Gas Engines, **ARE NOT ACCEPTABLE**.

Engine Oil Recommendation

Multi-viscosity oils are recommended, SAE 10W-30 is recommended from 0° F (-18° C) or above. If ambient temperatures are consistently below 0° F (-18° C), SAE 5W-30 oil should be used. Synthetic oils are not recommended for industrial engines.

FUEL TYPES

Diesel Fuel

The Cummins Diesel Engine operates most efficiently with No. 2 diesel fuel in temperatures above 32°F (0°C). When operating in temperatures below 32°F (0°C), use No. 1 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.

Gasoline

The GMC gasoline engine operates only on lead-free gasoline with the following minimum or higher octane ratings:

Anti-Knock Index Number (AKI) — 87

Research Octane Number (RON) — 91

NOTE: The use of gasoline with a lower octane than 87 AKI (91 RON) octane will result in serious damage to the engine. Engine damage resulting from use of a low octane gasoline is considered misuse of the engine and will void the engine warranty and the crane warranty.

Many types of gasoline being sold today contain alcohol. Two commonly used alcohol additives are Ethanol and Methanol.

RELIEF VALVE SETTINGS

Relief Valve	Pressure Setting
Hoist, Telescope & Boom Circuits	3500 ± 50 psi (241 ± 3.5 bar)
Swing Circuit	3000 ± 50psi (138 ± 3.5 bar)
Outrigger Circuit	3000 ± 50psi (241 ± 3.5 bar)
Steering Circuit	2500 ± 50psi (172 ± 3.5 bar)

GENERAL SPECIFICATIONS

Engine

Diesel

Make and model Cummins 4B3.3-85 diesel. Tier II
 Type of Aspiration Turbocharged
 Horsepower 85 hp @ 2500 rpm
 Low idle speed 800 rpm
 Maximum engine speed 2600 rpm

Gasoline/L.P.G.

Make and model GMC 4.3 L EFI V6, US ZEPa & CARB 2004 certified
 Horsepower 110 hp @ 2500 rpm
 Low idle speed 700 rpm
 Maximum engine speed 2600 rpm

Tires

Size 385/65R22.5
 Type Radial
 Air pressure 120 psi (828 kPa)
 Wheel nut torque 500 lb-ft. (680 Nm)

Electrical System

Rating 12 VDC negative ground
 Number and type of batteries:
 Standard One-maintenance free
 With optional cold weather start Two
 Battery rating 90 amp/hr
 Alternator 63 amps

Boom

Reach (from center line of rotation)
 3 Section Boom 41' 0" (12.50 m)

4 Section Boom	52' 3" (15.93 m)
Boom Extension (optional)	15 ft. (4.57 m)

Wire Rope

Size	1/2" (12.7 mm) 6 x 19 EIPS-IWRC
Length	
3 Section Boom	240 ft. (73.0 m)
4 Section Boom	290 ft. (88.4 m)

Hydraulic System

Filters	10 micron return line filter
.....	30 mesh suction filter in tank

Weight

Crane	26,300 lb. (11 930 kg)
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Travel Speeds

Two-Wheel Steer

• 1st gear	3.7 mph (6.0 km/hr)
• 2nd gear	75.8 mph (9.3 km/hr)
• 3rd gear	11.8 mph (19.0 km/hr)
• 4th gear	14.5 mph (23.3 km/hr)

Operating Dimensions

Two-Wheel Steer

• Outside turning radius (center line outside tires)	21' 6" (6.55 m)
• Minimum aisle space for 90° turn (center line inside tires)	12' 4" (3.76 m)

Four-Wheel Steer

• Outside turning radius (center line outside tires)	12' 4" (3.76 m)
• Minimum aisle space for 90° turn	6' 0" (1.83 m)

Boom Angle

• Maximum	69°
• Minimum	0°

DIMENSIONS

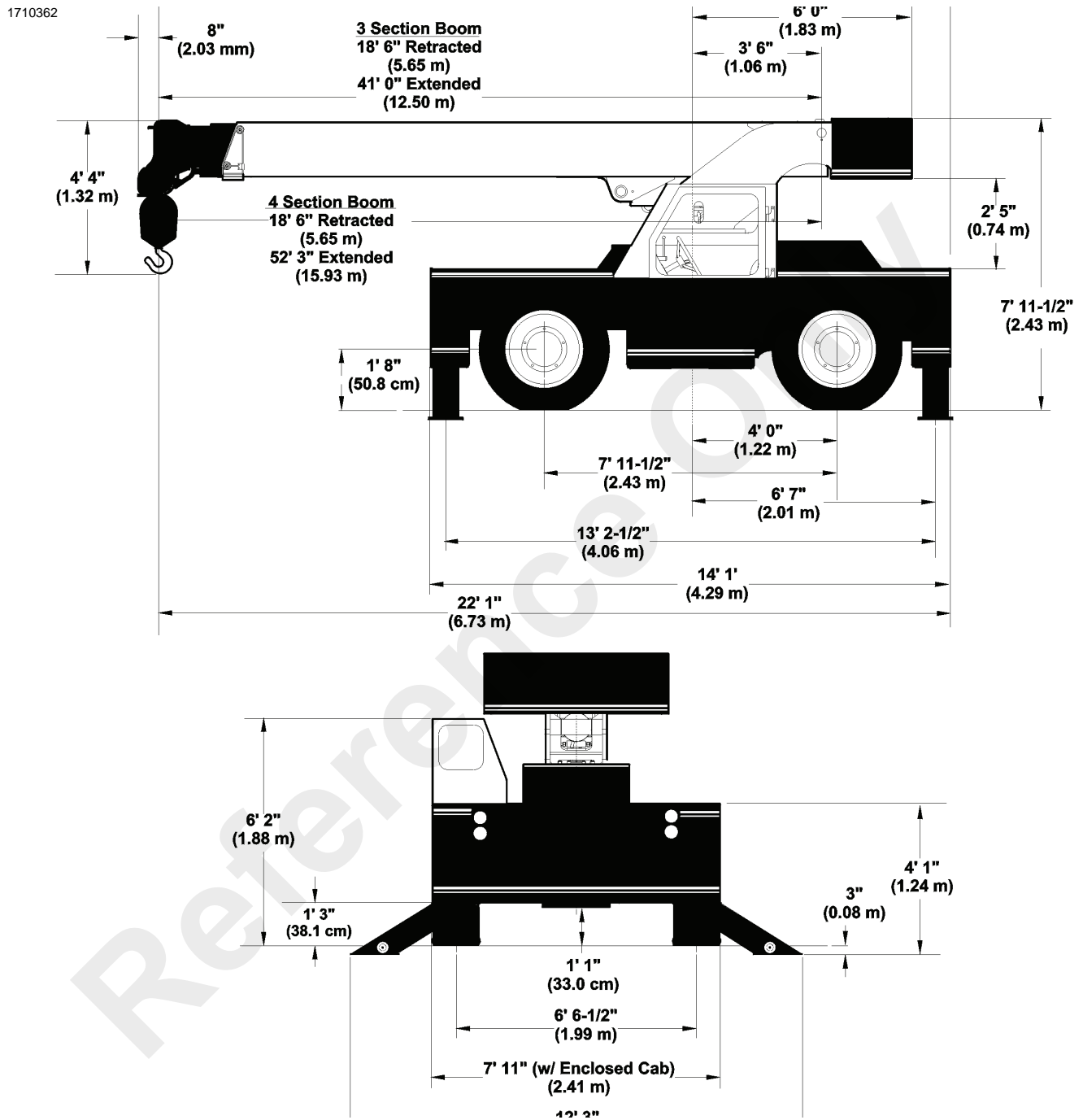


FIGURE 8-1

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Reference Only

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