Supplement to Service Manual

Boom Cable Tensioning

Reference Only

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Reference Only

This Supplement provides information regarding the proper *Tensioning of Extend and Retract Cables and Positive Lock* of adjustment hardware on National Crane Boom cable assemblies. The information provided here supplements the *Service Manual* and must be used in conjunction with all other manuals.

GENERAL

A boom assembly is considered properly timed when telescoping sections extend equally relative to each other and bottom out simultaneously at full retraction and do not spring back out after retract pressure is returned to neutral.

Hydraulic extend cylinder construction will dictate which extendable section will be the driver that the other extend sections will need to be adjusted to utilizing cable adjustment.

A single stage cylinder will control first extendable section.

A dual stage cylinder will control second extendable section.

Timing sequence of cables will depend on number of sections and the extend cylinder construction.

Design intent of the cable tensioning is to balance the preload of extend and retract cables for each extendable section. In addition, sequencing of the sections during retraction requires retract cables of every section to be indexed relative to each other.

Cable Tensioning

Tensioning Setup Procedure

Tensioning must be done with the boom in the horizontal position.

When tightening/loosening the first (adjustment) nuts on cables, secure cable using the wrench flats at the front of the cable ends to prevent cable twist. Excess twisting of cables can cause premature failure.

Ensure boom is completely assembled and fully retracted.

1. Mark the front of each section with a chalk line as indicated in Figure 1.
2. Extend and retract boom several times to establish working state of cables.
3. Extend boom so scribed lines are exposed by approximately 12 inches.
4. Measure the extension gaps between each boom section and scribed line and note values.
5. Retract boom so that the scribed lines are exposed by approximately 6 inches.
6. Measure the retraction gaps between each boom section and scribed line and note values.
7. Extend and retract the boom a few times and then repeat measuring the extension gaps.
8. Adjust all corresponding cables according to ***Cable Tightening Sequence*** instructions.



8860-5


8860-6

FIGURE 1

Cable Tension Sequence

Five section boom with two stage cylinder.

Cable tensioning (See Figure 2) to be in the following order:

1. 321 retract cables
2. 123 extend (synchronizing) cables.
3. 234 extend cables
4. 432 retract cables.
5. 345 extend cables

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6. 543 retract cables.

Four section boom with two stage cylinder.

Cable tensioning to be in the following order:

1. 321 retract cables
2. 123 extend (synchronizing) cables.
3. 234 extend cables
4. 432 retract cables.

Four section boom with one stage cylinder.

Cable tensioning to be in the following order:

1. 123 extend cables.
2. 321 retract cables.
3. 234 extend cables.
4. 432 retract cables.

Three section boom with one stage cylinder.

Cable tensioning to be in the following order:

1. 123 extend cables.
2. 321 retract cables.

5 - Section Boom w/ 2 Stage Cylinder Cable Positioning

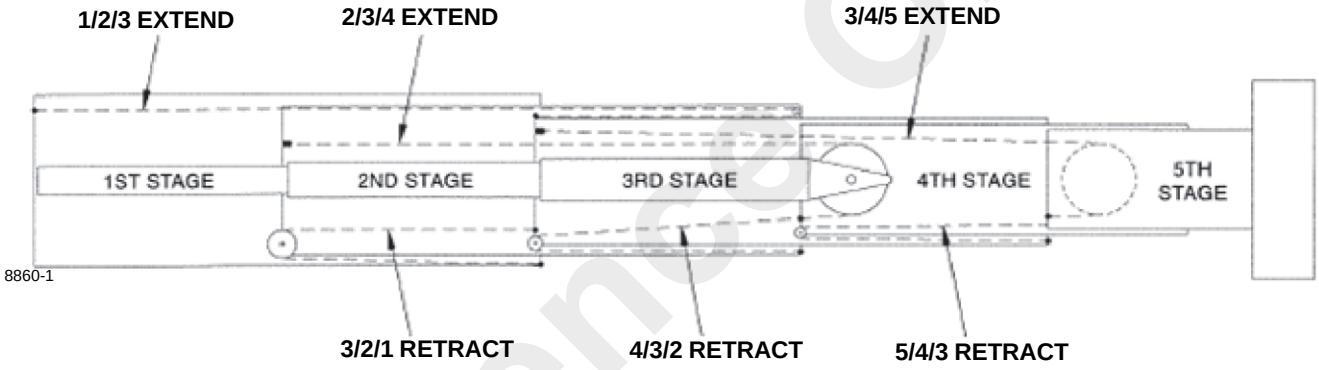


FIGURE 2

Cable Tightening Sequence 5 Section Boom with Two Stage Extend Cylinder

Boom must be in horizontal position when adjusting cable tension (See Figure 2.) Retract boom fully ensuring sections are bottomed out on section stops and do not spring back. (Reference Tensioning Setup Procedure)

321 and 123 cable balancing

Extension

1. Measure the extension gaps between the first and second section and the second and third section.

If the extension gap between first and second section is less than the extension gap between the second and third section;

2. Tighten **321** retract cable located at the front bottom of the base section the difference in the extension gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

The second section should have moved out.

4. Tightening until the extension gap between the first and second section and the extension gap between the second and the third are equal.

If when tightening the **321** retract cable the third section starts to go out with the second section the **123** synchronizing cable located at the top back of the base section may need to be loosened.

Retraction

1. Measure the retraction gaps between the first and second section and the second and third section.

If the retraction gap is greater between the first and second section than the retraction gap between the second and third section;

2. Tighten the **123** synchronizing cable located at the back of the base section the difference in the retraction gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The third section should have moved out.

Reference Only

4. Tightening until the retraction gap between the first and second section and the retraction gap between the second and the third are equal.

At this time the second and first extendable sections should extend and retract equally and bottom out against the stops simultaneously.

234 and 432 cable balancing

Extension

1. Measure the extension gaps between the third and fourth section and the second and third section.

If the extension gap between third and fourth section is less than the extension gap between the second and third section;

2. Tighten the **234** extend cable located at the back top of the second section the difference in the extension gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

The fourth section should have moved out.

4. Tightening until the extension gap between the third and fourth section is equal to the extension gap between the second and third section.

Retraction

1. Measure the retraction gaps between the second and third section and the third and fourth section.

If the retraction gap is greater between the third and fourth section than the retraction gap between the second and third section;

2. Tighten the **432** retract cable located at the front bottom of the second section the difference in the retraction gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The fourth section should have moved in.

4. Tightening until the retraction gap between the third and fourth section is equal to the retraction gap between the second and third section.

At this time the third, second and first extendable sections should extend and retract equally and bottom out against the stops simultaneously.

345 and 543 cable balancing

Extension

1. Measure the extension gaps between the fourth and fifth section and the third and fourth section.

If the extension gap between fourth and fifth section is less than the extension gap between the third and fourth section;

2. Tighten the **345** extend cable located at the back top of the third section the difference in the extension gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

The fifth section should move outward.

4. Tightening until the extension gap between the fifth and fourth section is equal to the extension gap between the fourth and third section.

Retraction

1. Measure the retraction gaps between the fourth and fifth section and the third and fourth section.

If the retraction gap is greater between the fourth and fifth section than the retraction gap between the third and fourth section;

2. Tighten the **543** retract cable located at the front bottom of the third section the difference in the retraction gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The fifth section should have moved in.

4. Tightening until the retraction gap between the fifth and fourth section is equal to the retraction gap between the fourth and third section.

At this time the all extendable sections should extend and retract equally and bottom out against the stops simultaneously.

Reference Only

4- Section Boom w/ 2 Stage Cylinder Cable Positioning

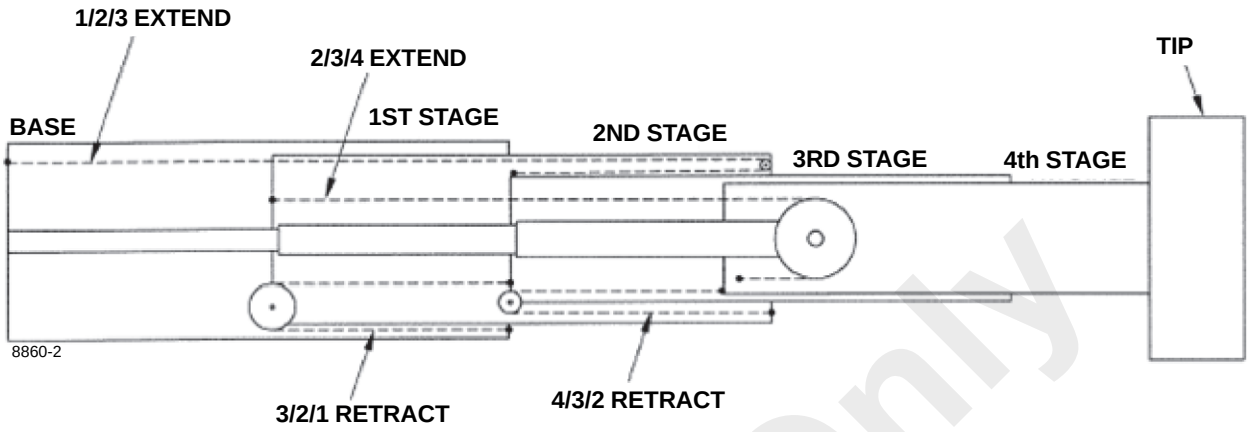


FIGURE 3

Cable Tightening Sequence 4 Section Boom with Two Stage Extend Cylinder

Boom must be in horizontal position when adjusting cable tension (See Figure 3.) Retract boom fully ensuring sections are bottomed out on section stops. Ensure all sections are fully bottomed out and do not spring back.(Reference Tensioning Setup Procedure)

321 and 123 cable balancing

Extension

1. Measure the extension gaps between the first and second section and the second and third section.

If the extension gap between first and second section is less than the extension gap between the second and third section;

2. Tighten **321** retract cable located at the front bottom of the base section the difference in the extension gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

The second section should have moved out.

4. Tightening until the extension gap between the first and second section and the extension gap between the second and the third are equal.

If when tightening the **321** retract cable the third section starts to go out with the second section the **123** synchronizing cable located at the top back of the base section may need to be loosened.

Retraction

1. Measure the retraction gaps between the first and second section and the second and third section.

If the retraction gap is greater between the first and second section than the retraction gap between the second and third section;

2. Tighten the **123** synchronizing cable located at the back of the base section the difference in the retraction gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The third section should have moved out.

4. Tightening until the retraction gap between the first and second section and the retraction gap between the second and the third are equal.

At this time the second and first extendable sections should extend and retract equally and bottom out against the stops simultaneously.

234 and 432 cable balancing

Extension

1. Measure the extension gaps between the third and fourth section and the second and third section.

If the extension gap between third and fourth section is less than the extension gap between the second and third section;

2. Tighten the **234** extend cable located at the back top of the second section the difference in the extension gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

Reference Only

The fourth section should have moved out.

4. Tightening until the extension gap between the third and fourth section is equal to the extension gap between the second and third section.

Retraction

1. Measure the retraction gaps between the second and third section and the third and fourth section.

If the retraction gap is greater between the third and fourth section than the retraction gap between the second and third section;

2. Tighten the **432** retract cable located at the front bottom of the second section the difference in the retraction gap measurements.

3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The fourth section should have moved in.

4. Tightening until the retraction gap between the third and fourth section is equal to the retraction gap between the second and third section.

At this time the all extendable sections should extend and retract equally and bottom out against the stops simultaneously.

4- Section Boom w/ 1 Stage Cylinder Cable Positioning

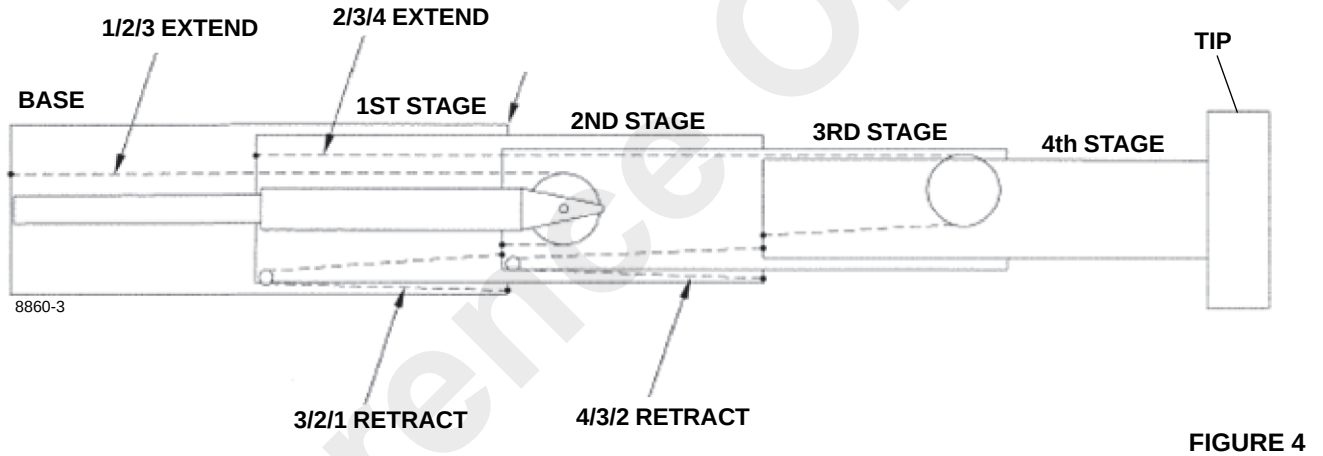


FIGURE 4

Cable Tightening Sequence 4 Section Boom with (1) Stage Extend Cylinder

Boom must be in horizontal position when adjusting cable tension (See Figure 4.) Retract boom fully ensuring sections are bottomed out on section stops. Ensure all sections are fully bottomed out and do not spring back.(Reference Tensioning Setup Procedure)

321 and 123 cable balancing

Extension

1. Measure the extension gaps between the first and second section and the second and third section.

If the extension gap between second and third section is less than the extension gap between the first and second section;

2. Tighten **123** extend cable located at the back top of the base section the difference in the extension gap measurements.

3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

The third section should have moved out.

4. Tightening until the extension gap between the first and second section and the extension gap between the second and the third are equal.

Retraction

1. Measure the retraction gaps between the first and second section and the second and third section.

If the retraction gap is greater between the second and third section than the retraction gap between the first and second section;

2. Tighten the **321** retract cable located at the front bottom of the base section the difference in the retraction gap measurements.

3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The third section should have moved in.

Reference Only

4. Tightening until the retraction gap between the first and second section and the retraction gap between the second and the third are equal.

At this time the second and first extendable sections should extend and retract equally and bottom out against the stops simultaneously.

234 and 432 cable balancing

Extension

1. Measure the extension gaps between the third and fourth section and the second and third section.

If the extension gap between third and fourth section is less than the extension gap between the second and third section;

2. Tighten the **234** extend cable located at the back top of the second section the difference in the extension gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

The fourth section should have moved out.

4. Tightening until the extension gap between the third and fourth section is equal to the extension gap between the second and third section.

Retraction

1. Measure the retraction gaps between the second and third section and the third and fourth section.

If the retraction gap is greater between the third and fourth section than the retraction gap between the second and third section;

2. Tighten the **432** retract cable located at the front bottom of the second section the difference in the retraction gap measurements.
3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The fourth section should have moved in.

4. Tightening until the retraction gap between the third and fourth section is equal to the retraction gap between the second and third section.

At this time the all extendable sections should extend and retract equally and bottom out against the stops simultaneously.

3- Section Boom w/ 1 Stage Cylinder Cable Positioning

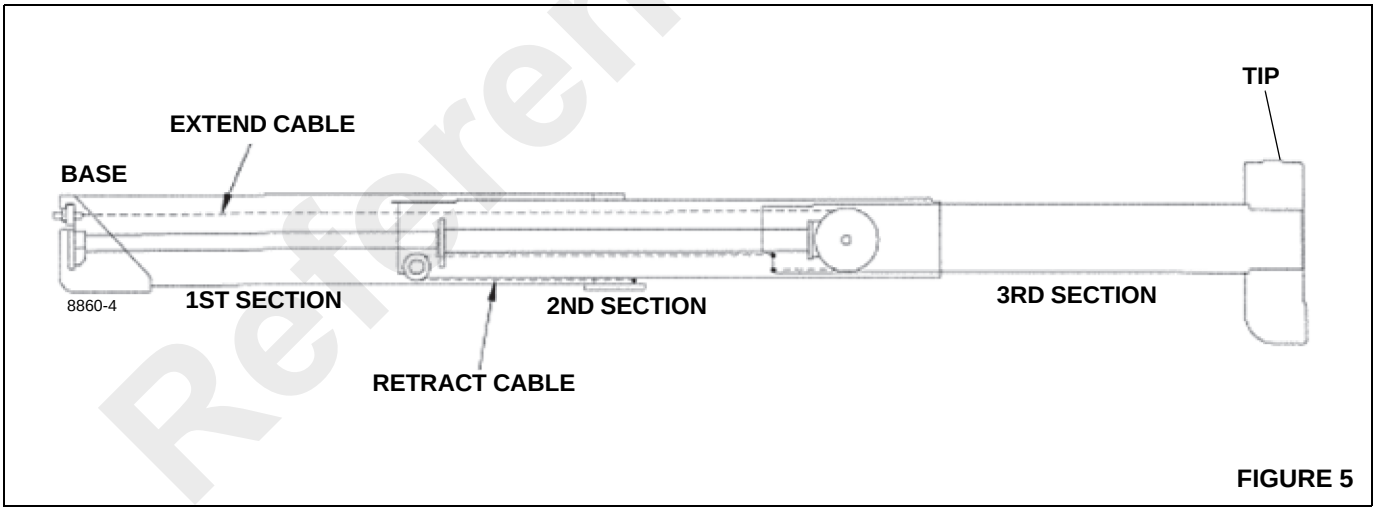


FIGURE 5

Cable Tightening Sequence 3 Section Boom with (1) Stage Extend Cylinder

Boom must be in horizontal position when adjusting cable tension (See Figure 5.) Retract boom fully ensuring sections are bottomed out on section stops. Ensure all sections are fully bottomed out and do not spring back.(Reference Tensioning Setup Procedure)

321 and 123 cable balancing

Extension

1. Measure the extension gaps between the first and second section and the second and third section.

If the extension gap between second and third section is less than the extension gap between the first and second section;

2. Tighten **123** extend cable located at the back top of the base section the difference in the extension gap measurements.

Reference Only

3. Extend and retract the boom a few times and then repeat measuring the extension gaps.

The third section should have moved out.

4. Tightening until the extension gap between the first and second section and the extension gap between the second and the third are equal.

Retraction

1. Measure the retraction gaps between the first and second section and the second and third section.

If the retraction gap is greater between the second and third section than the retraction gap between the first and second section;

2. Tighten the **321** retract cable located at the front bottom of the base section the difference in the retraction gap measurements.

3. Extend and retract the boom a few times and then repeat measuring the retraction gaps.

The third section should have moved in.

4. Tightening until the retraction gap between the first and second section and the retraction gap between the second and the third are equal.

At this time the all extendable sections should extend and retract equally and bottom out against the stops simultaneously.

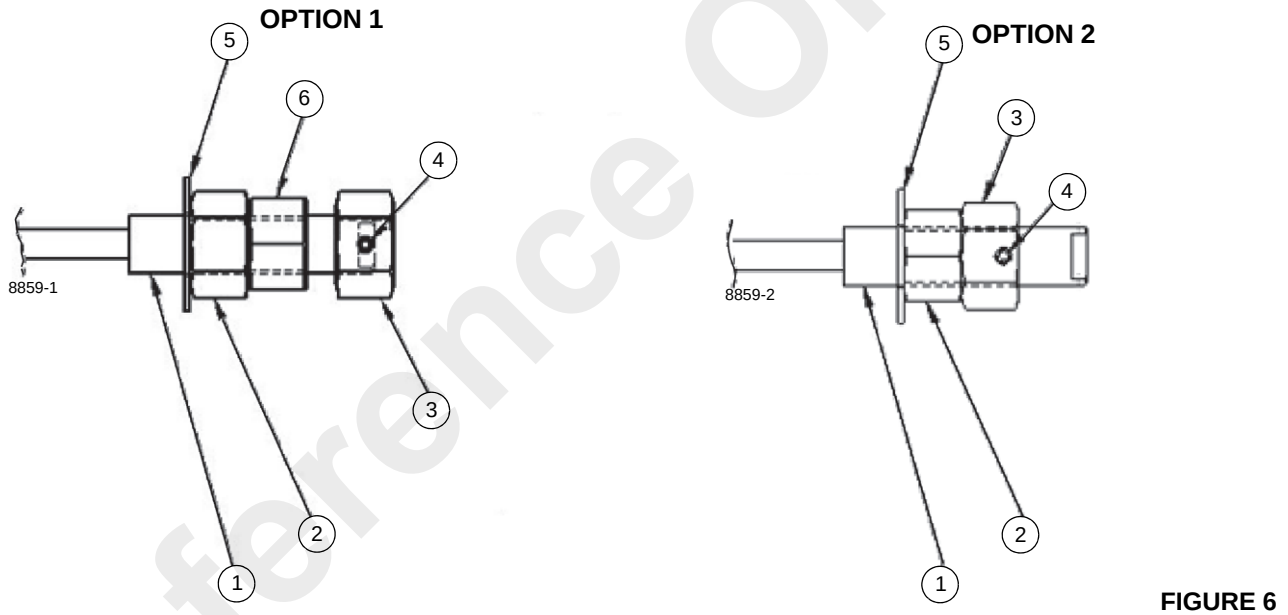


FIGURE 6

Cable Retention

Cable Retention Hardware

Item	Description
1	Threaded Cable End
2	Nut (Adjustment)
3	Nut (Positive Lock)
4	Setscrew
5	Washer
6	Nut (Torqued)

Nut configuration (see Figure 6) will be First Nut (ADJUSTMENT) and Second Nut (TORQUED).

NOTE: (**OPTION 2**) method used ONLY when space constraints prevent **OPTION 1** usage.

When tightening/loosening the first (adjustment) nuts on cables, secure cable using the wrench flats at the front of the cable ends to prevent cable twist.

After the cable adjustment procedure is completed for the entire boom assembly. The second (torqued) nut must be installed on all retract and extend cables.

The second nut should be hand tightened until it comes in contact with the back of the first nut.

Hold the first (adjustment) nut stationary and a torque wrench to tighten the second (torqued) nut against the first (adjustment) nut to the values indicated in TORQUE VALUES for Second Nut:

Reference Only

Third (positive lock) nut installation is to be placed on each of the extend cables. The retract cables do not require the third (positive lock) nut.

The third nut should be hand tightened until the tapped hole for the set screw is tangent to the end face of the wrench flat.

Install set screw into Third nut and tighten.

(**OPTION 2**) method used ONLY when space constraints prevent **OPTION 1** usage (see Figure 6).

TORQUE VALUES for Second Nut:

Inch Series with Coarse Threads (UNC)

Cable end Thread Size	Minimum Nut Strength GRADE	Nut Type	TORQUE ft lbf
1/2-13	SAE 2	Hex Jam (HALF)	12
5/8-11	SAE 2	Hex Jam (HALF)	31
3/4-10	SAE 2	Hex Jam (HALF)	47
7/8-9	SAE 2	Hex Jam (HALF)	63
1-8	SAE 2	Hex Jam (HALF)	199
1 ¼-7	SAE 2	Hex Jam (HALF)	203
1 ½-6	SAE 5	Hex Jam (FULL)	250
1 ¾-5	ASTM B	Hex Jam (FULL)	250

Metric Series with Coarse Threads

Cable end Thread Size	Minimum Nut Property Class	Nut Type	TORQUE Nm
M16x2	5	Hex Jam (THIN)	26
M20x2.5	5	Hex Jam (THIN)	66

Reference Only

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Service Bulletin N14-003

√ **Information Only**
Product Update - Warranty
Product Update - Non Warranty

Date:
January 23, 2014

To:
All National Crane Service Managers

Subject:
Boom Extend Cables Service Manual Update

Model(s) Affected:
All National Crane Cable Extend Booms
(Including non-current and current production models)

PURPOSE:

The purpose of this bulletin is to advise of a change being made to the service manual on cable extend booms on National Crane Boom Trucks. The current recommendation is to replace the boom extend cables every five (5) years.

Going forward the recommendation has been changed to replace the extend cables every seven (7) years.

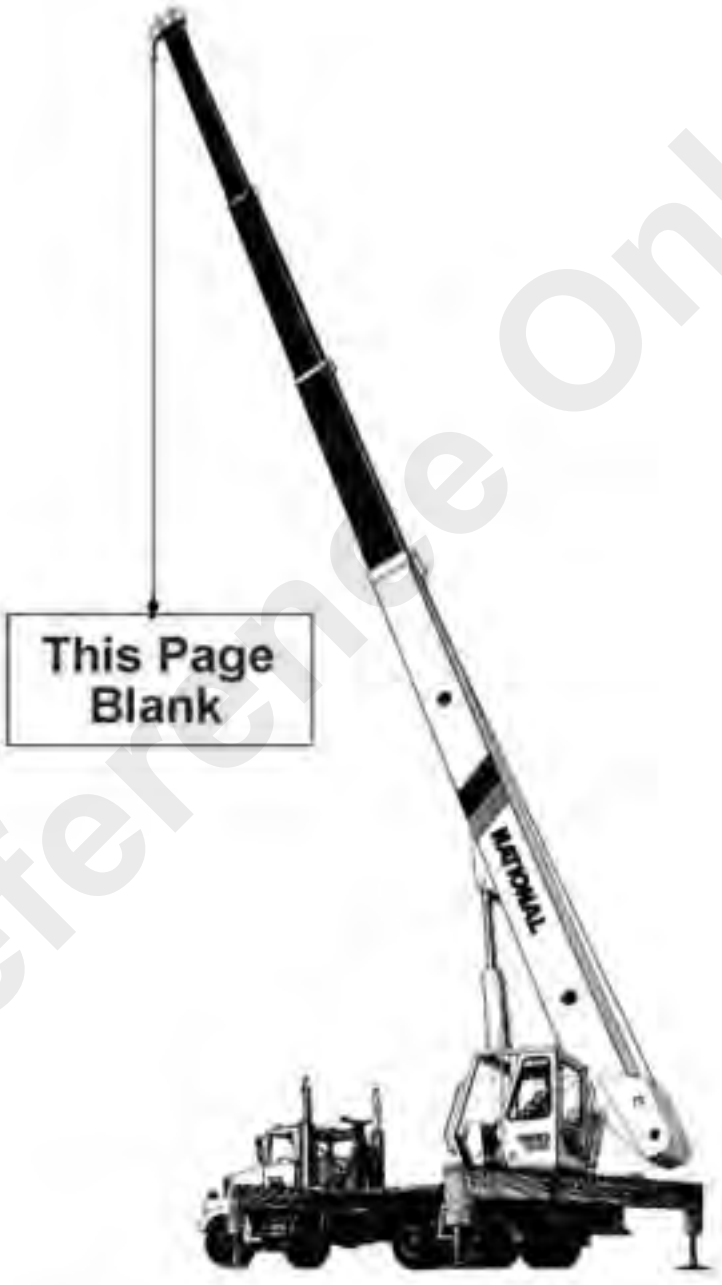
OPERATIONS REQUIRED:

Please include a copy of this service bulletin in the machines services manuals.

If you have any questions regarding this Service Bulletin, please contact Manitowoc Crane Care.

Manitowoc
Crane Care

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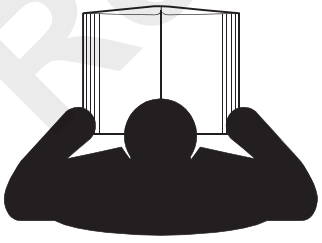
Reference Only

OPERATOR MANUAL

Supplement

Crane Warm-up Procedures

Reference Only



⚠DANGER

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

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

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SECTION CONTENTS

Crane Warm-up Procedures 1
Engine 1
Transmission 1
Hoist 1
Swing Drive and Turntable Bearing 1
Axles 2
Hydraulic Oil System 2

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 Manual*s and must be used in conjunction with these manuals.

CRANE WARM-UP PROCEDURES

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

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

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

CAUTION

Crane Damage Hazard!

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

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

Engine

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

Warm-up Procedures for All Temperature Ranges:

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

Transmission

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

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

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

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. 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.

Reference Only

Axles

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

Hydraulic Oil System

Operating Limits and Warm-up Procedures:

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

Reference Only

National Crane 400B

Operator and Service Manual



Reference Only

Grove Manitowoc National Crane Potain

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NATIONAL CRANE
by Manitowoc

OPERATOR AND SERVICE MANUAL

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

400B

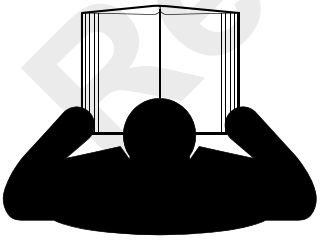
This Manual is divided into the following sections:

SUPPLEMENT
TABLE OF CONTENTS
SECTION 1 SAFETY INFORMATION
SECTION 2 OPERATION
SECTION 3 MAINTENANCE
SECTION 4 LUBRICATION
SECTION 5 SERVICE
SECTION 6 SPECIFICATIONS
SECTION 7 CRANE INSTALLATION

NOTICE

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

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



DANGER

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

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

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CALIFORNIA PROPOSITION 65 WARNING

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

CALIFORNIA PROPOSITION 65 WARNING

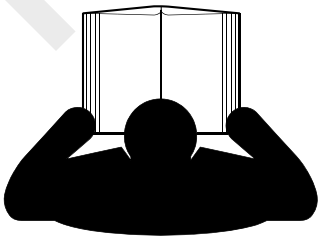
Battery posts, terminals, and related accessories contain chemical lead and lead compounds, chemicals known to the State of California to cause cancer, birth defects or other reproductive harm. Wash hands after handling.

Reference Only

OPERATOR AND SERVICE MANUAL
SUPPLEMENT

400B

Reference Only



DANGER

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- 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.

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Reference Only

The information provided here supplements the *Operation and Service Manuals* and must be used in conjunction with the *Operation and Service Manuals*.

INTRODUCTION

GENERAL

This manual has been compiled to assist you in properly operating and maintaining your Model 400B Series National Crane (Figure 1).

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

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

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

The 400B has been designed for maximum performance with minimum maintenance. With proper care, years of trouble-free service can be expected.

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

National Crane and our 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.

Supplemental Information

Supplemental Information regarding Safety & Operation, Specifications, Service & Maintenance, Installation, and parts for options such as remote controls, augers, varying control configurations, baskets, grapples, etc. are included in separate manuals.

Whenever a question arises regarding your National product or this publication, please consult your National Dealer for the latest information. Your National Dealer is equipped with the proper tools, necessary parts, and trained personnel to properly maintain and service your crane.

Safety Information

A Safety Compact Disc (CD) which includes sections on Operation, Safety and Maintenance for National Crane operators and owners is supplied when the crane is purchased new. Additional copies are available from your local distributor.



FIGURE 1

Reference Only

New Owner

If you are the new owner of a Manitowoc crane, please register it with Manitowoc Crane Care so we have the ability to contact you if the need arises. Go to: www.manitowoccranes.com/MCG_CARE/Includes/EN/changeOfOwnership.cfm and complete the form.

NOTICE TO OWNER/USER

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

Reference Only

GENERAL MAINTENANCE

The suggestions listed below are helpful in analyzing and correcting problems:

- Determine the problem.
- List possible causes.
- Devise checks.
- Conduct checks in a logical order to determine the cause.
- Consider the remaining service life of components against the cost of parts and labor to replace them.
- Make the repair.
- Test the equipment to ensure the problem is fixed.

NOTE: Safety is the number one consideration when working around machines. Safety is a matter of understanding the job to be done and the application of good common sense. It is not just a list of do's and don'ts. Stay clear of all moving parts.

Cleanliness

Cleanliness is important in preserving the life of the machine. Keep dirt out of working parts and compartments. Keep filters and seals clean. Whenever hydraulic, fuel, lubricating oil lines, or air lines are disconnected, clean the adjacent area as well as the point of disconnect. Cap and plug each line or opening to prevent entry of foreign material.

Clean and inspect all parts. Be sure all passages and holes are open. Cover all parts to keep them clean. Be sure parts are clean when they are installed. Leave new parts in their containers until ready for assembly. Clean the rust preventive compound from all machined surfaces of new parts before installing them.

Removal and Installation

Do not attempt to manually lift heavy parts that require hoisting equipment. Do not put heavy parts in an unstable position.

When raising a portion or a complete crane, ensure the weight is supported by blocks rather than by lifting equipment.

When using hoisting equipment, follow the hoist manufacturers recommendations. Use lifting devices that achieve the proper balance of the assemblies being lifted. Unless otherwise specified, use an adjustable lifting attachment for all removals requiring hoisting equipment. Some removals require the use of lifting fixtures to obtain proper balance.

All supporting members (chains and cables) need to be parallel to each other and as near perpendicular as possible to the top of the object being lifted.

CAUTION

The capacity of an eyebolt diminishes as the angle between the supporting members and the object becomes less than 90°. Eyebolts and brackets should never be bent and should only have stress in tension.

If a part resists removal, check to be sure all nuts and bolts have been removed and that an adjacent part is not interfering.

Disassembly And Assembly

Complete each step in turn when disassembling and assembling a component. Do not partially assemble one part and start assembling some other part. Make all adjustments as recommended. Always check the job after it is complete to see that nothing has been overlooked. Recheck the various adjustments by operating the machine before returning it to the job.

Pressing Parts

When one part is pressed into another, use an anti-seize compound or a molybdenum disulfide base compound to lubricate the mating surfaces.

Assemble tapered parts dry. Before assembling parts with tapered splines, be sure the splines are clean, dry, and free from burrs. Position the parts together by hand to mesh the splines before applying pressure.

Parts which are fitted together with tapered splines are always very tight. If they are not tight, inspect the tapered splines and discard the part if the splines are worn.

Locks

Lock washers, flat metal locks, or cotter pins are used to lock nuts and bolts. For flat metal locks, bend one end of the lock around the edge of the part and the other end against one flat surface of the nut or bolt head.

Always use new locking devices on components which have moving parts.

Use a steel flat washer between aluminum housings and lock washers.

Shims

When shims are removed, tie them together and identify them as to location. Keep shims clean and flat until they are reinstalled.

Reference only

Bearings

Antifriction Bearings

When an antifriction bearing is removed, cover it to keep out dirt and abrasives. Wash bearings in non-flammable cleaning solution and allow them to drain dry. The bearing may be dried with compressed air BUT do not spin the bearing. Discard the bearings if the races and balls or rollers are pitted, scored, or burned. If the bearing is serviceable, coat it with oil and wrap it in clean waxed paper. Do not unwrap new bearings until time of installation. The life of an antifriction bearing is shortened if not properly lubricated. Dirt can cause an anitfriction bearing to lock and result in the shaft turning in the inner race or the outer race turning within the cage.

Double Row, Tapered Roller

Double row, tapered roller bearings are precision fit during manufacture and components are not interchangeable. The cups, cones, and spacers are etched with the same serial number and letter designator. If no letter designators are found, wire the components together to assure correct installation. Reusable bearing components should be installed in their original positions.

Heating Bearings

Bearings which require expansion for installation should be heated in oil not to exceed 121°C (250°F). When more than one part is heated to aid in assembly, they must be allowed to cool and then pressed together again. Parts often separate as they cool and contract.

Installation

Lubricate new or used bearings before installation. Bearings that are to be preloaded must have a film of oil over the entire assembly to obtain accurate preloading. When installing a bearing, spacer, or washer against a shoulder on a shaft, be sure the chamfered side is toward the shoulder.

When bearings are pressed into a retainer or bore, apply pressure to the outer race uniformly. If the bearing is pressed on the shaft, apply pressure on the inner race uniformly.

Preload

Preload is an initial load placed on the bearing at the time of assembly. Consult the disassembly and assembly instructions to determine if the bearing can be preloaded.

Be careful in applying preload to bearings requiring end clearance. Otherwise, bearing failure may result.

Sleeve Bearings

Do not install sleeve bearings with a hammer. Use a press and be sure to apply the pressure directly in line with the bore. If it is necessary to drive on a bearing, use a bearing driver or a bar with a smooth flat end. If a sleeve bearing has an oil hole, align it with the oil hole in the mating part.

Gaskets

Be sure the holes in the gaskets correspond with the lubricant passages in the mating parts. If it is necessary to make gaskets, select material of the proper type and thickness. Be sure to cut holes in the right places. Blank gaskets can cause serious damage.

Hydraulic Systems

⚠ DANGER

Pressurized hydraulic fluid can cause serious injury. Depressurize the hydraulic system before loosening fittings.

Visual Inspection

Do a visual inspection daily on all hydraulic components for missing hose clamps, shields, guards, excessive dirt build up, and leaks. Do a monthly or 250 hour inspection for the items listed in the inspection procedure below.

Valves and Manifolds

Inspect valves and manifolds for leaking ports or sections.

Hoses and Fittings

Inspect all hoses and fittings for the following:

- Cut, kinked, crushed, flattened, or twisted hoses.
- Leaking hoses or fittings.
- Cracked, blistered, or hoses charred by heat.
- Damaged or corroded fittings.
- Fitting slippage on hoses.

If any of the above conditions exist, evaluate and replace as necessary.

The climate in which the crane operates affects the service life of the hydraulic components. The climate zones are defined in the table on page g. Recommended replacement of hoses is as follows:

- Climate zone C after 8000 hours of service.
- Climate zones A and C with high ambient temperatures and duty cycles after 4000 to 5000 hours of service.
- Climate zones D and E after 4000 to 5000 hours of service.

Cleanliness

Contaminants in a hydraulic system affects operation and results in serious damage to the system components.

Reference Only

Keep The System Clean

When removing components of a hydraulic system, cover all openings on both the component and the crane.

If evidence of foreign particles is found in the hydraulic system, flush the system.

Disassemble and assemble hydraulic components on a clean surface.

Clean all metal parts in a nonflammable cleaning fluid. Then lubricate all components to aid in assembly.

Sealing Elements

Inspect all sealing elements (O-ring, gaskets, etc.) when disassembling and assembling the hydraulic system components. Installation of new elements is recommended.

Hydraulic Lines

When disconnecting hoses, tag each one to ensure proper identification during assembly.

When installing metal tubes, tighten all bolts finger-tight. Then, in order, tighten the bolts at the rigid end, the adjustable end, and the mounting brackets. After tubes are mounted, install the hoses. Connect both ends of the hose with all bolts finger-tight. Position the hose so it does not rub the machine or another hose and has a minimum of bending and twisting. Tighten bolts in both couplings.

Due to manufacturing methods there is a natural curvature to a hydraulic hose. Reinstall the hose so any bend is with this curvature.

Electrical

Batteries

Clean the batteries with a solution of baking soda and water. Rinse with clear water and dry. Clean the battery terminals with fine sandpaper and coat the terminals dielectric grease. Do not use a non-dielectric grease.

Remove the batteries If the machine is not used for an extended period of time. Store the batteries in a warm, dry place, preferably on wooden shelves. Never store on concrete. A small charge should be introduced periodically to keep the specific gravity rating at recommended level.

CAUTION

Disconnect batteries prior to working on the electrical system.

When disconnecting wires, tag each one to ensure proper identification during reassembly.

Connectors, Harnesses, Wires, and Connectors

Visually inspect all electrical harnesses, cables, and connectors every month or 250 hours for the following:

- Damaged, cut, blistered, or cracked insulation.
- Exposed bare wires.
- Kinked or crushed wires and cables.
- Cracked or corroded connectors, battery terminals, and ground connections.

If any the above conditions exist, evaluate and replace as necessary.

The climate in which the crane operates affects the service life of the electrical components. The climate zones are defined in the table on page g. Recommended replacement of harness and cables is as follows:

- Climate zone C after 10,000 hours of service.
- Climate zones A and C with high ambient temperatures and duty cycles after 8000 hours of service.
- Climate zones D and E after 10,000 hours of service.
- Salt water conditions after 8000 hours of service

Climate Zone Classification

Zone	Classification
A (Tropical Moist)	Latitude 15° - 25° North and South (All months average above 64°F [18°C])
B (Dry or Arid)	Latitude 20° - 35° North and South (Deficient of precipitation most of the year)
C (Moist Mid-Latitude)	Latitude 30° - 50° North and South (Temperate with mild winters)
D (Moist Mid-Latitude)	Latitude 50° - 70° North and South (Cold winters)
E (Polar)	Latitude 60° - 75° North and South (Extremely cold winters and summers)

Reference Only

Fatigue Of Welded Structures

Highly stressed welded structures are subject to cracking (fatigue) when repeatedly subjected to varying stresses caused by twisting, shock, bending, and overloads. Inspect equipment periodically for weld fatigue. The frequency of inspections depends on the age of the equipment, the severity of the application, and the experience of the operators and the maintenance personnel. The following are known high stress areas and should be inspected as part of a preventive maintenance program:

- Hydraulic cylinder and boom pivot attaching points.
- Outrigger pads, beams, boxes and attachment structures.
- On the frame in the area of doubler plates and crossmembers.
- Turntable bearing connection (where bearing is welded to the crane turret).
- Counterweight support structures (were applicable).
- Hydraulic cylinder end connections.

The above is provided only as a guide and your inspection plan should not be limited to the areas listed. A visual inspection of all weldments is good practice.

Loctite

DANGER

Loctite type adhesives contain chemicals that may be harmful if misused. Read and follow the instructions on the container.

Follow the directions on the Loctite container. There are different Loctite types for different applications. The following types of Loctite brand adhesives are available from the parts department of the local National distributor.

Application of Medium Strength Loctite

NOTE: The fastener can be re-used and the adhesive can be re-applied over cured adhesive residue.

The following procedure covers the proper application and curing method for medium strength Loctite adhesive/sealant (Loctite #242) and primer (Locquic Primer T7471).

Primer Application

NOTE: It is not necessary to bathe the threads in primer.

Clean dirt and oil from the threaded surfaces, both male and female. Apply a light spray coating of primer to both surfaces to clean and accelerate the curing process. Allow the part to dry prior to adhesive/sealant application.

Adhesive/Sealant Application

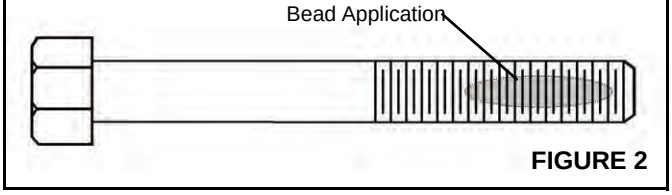


FIGURE 2

1. Apply a bead several threads wide in the approximate area of threaded contact (Figure 2).
2. In a blind hole application, apply several drops of adhesive in the bottom of the hole so that the adhesive is forced up when the bolt is installed.
3. After installation, fixturing occurs within five (5) minutes if primed prior to engagement or up to 30 minutes on unprimed parts.
4. The time required to achieve full strength is 24 hours. Maximum strength is achieved using no primer with this specific threadlocking adhesive.

Fasteners And Torque Values

Use bolts of the correct length. A bolt which is too long may bottom before the head is tight against the part it is to hold. If a bolt is too short, there may not be enough threads engaged to hold the part securely. Threads can be damaged. Inspect them and replace fasteners, as necessary.

Torque values should correspond to the type bolts, studs, and nuts being used.

The torque tables are provided by Manitowoc for reference when performing maintenance.

Use of proper torque values is extremely important. Improper torquing can seriously affect performance and reliability.

Identification of fastener grade is always necessary. When marked as a high strength bolt (grade 5, 8, etc.), the mechanic must be aware that he/she is working with a highly stressed component and the fastener should be torqued accordingly.

NOTE: Some special applications require variation from standard torque values. Reference should always be made to component overhaul procedures for recommendations.

Special attention should be given to the existence of lubricant, plating, or other factors that might require variation from standard torque values.

The use of lubricants on zinc-flake coated parts shall be prohibited since this will change the required torque value.

When maximum recommended torque values have been exceeded, the fastener should be replaced.

Reference Only

Previously installed bolts and nuts of Grade 8 or Class 10.9 and higher may not be reused.

When referring to the applicable torque charts, use values as close as possible to the torque values shown to allow for wrench calibration tolerance.

Torque Wrenches

Flexible beam type wrenches, even though they might have a pre-set feature, must be pulled at right angle and the force must be applied at the center of the handle. Force value readings must be made while the tool is in motion. Rigid handle type, with torque limiting devices that can be pre-set to required values, eliminate dial readings and provide more reliable, less variable readings.

NOTE: If multipliers and/or special tools are used to reach hard to get at areas, ensure torque readings are accurate.

Torque wrenches are precision instruments and must be handled with care. To ensure accuracy, calibrations must be made on a scheduled basis. Whenever there is a possibility that a torque wrench may have been either overstressed or damaged, it should immediately be removed from service until recalibrated. When using a torque wrench, any erratic or jerking motion can result in the application of excessive or improper torque. ALWAYS use a slow, even movement and STOP when the predetermined value has been reached.

When using step wrenches, calculated wrench settings are valid only when the following conditions are met:

- Torque wrenches must be those specified and forces must be applied at the handle grip. The use of handle extensions will change applied torque to the bolt.
- All handles must be parallel to the step wrench during final tightening. Multiplier reaction bars may be misaligned no more than 30° without causing serious error in torque.
- Multiplier bar handles must be propped or supported within the outer 1/4 of the handle length, or serious under or over tightening will occur.

To convert pounds-foot (lb-ft) of torque to newton meters (Nm), multiply the pounds-foot quantity by 1.3558.

To convert pounds-inch (lb-in) of torque to newton meters (Nm), multiply the pounds-inch quantity by 0.11298.

Torque Values

The following tables list the torque values for both ASME standard and metric fasteners. The tables list the values for grade 5 and grade 8 zinc-flake coated, untreated (black) finish and stainless steel fasteners.

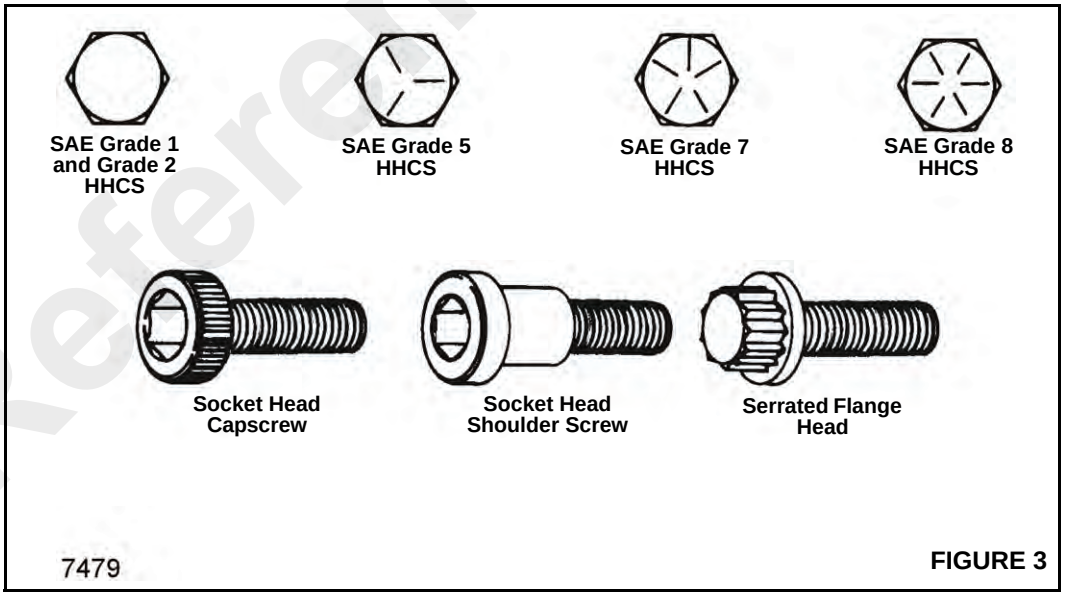


FIGURE 3

Reference Only

Table 1: UNC (Course) Thread: Torque Values for Zinc-Flake Coated and Untreated Fasteners

		Bolt Diameter - Inches												
		Torque Values (Pounds-Foot, Maximum/Minimum)												
	SAE Grade	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/8	1-1/4	1-1/2
Zinc-Flake	**5**	7	14	25	40	61	88	121	213	342	512	636	884	1532
	8	10	20	36	57	86	124	171	301	483	723	1032	1433	2488
Untreated	**5**	9.0	19	32	52	78	114	156	270	416	606	813	1141	2028
		7.7	17	30	48	72	106	144	249	384	560	751	1053	1865
	8	12.5	26	48	73	120	161	234	385	615	929	1342	2043	3276
		11.5	24	44	67	110	143	216	355	567	857	1234	1885	3024

NOTE: Studs shall be torqued using capscrew values when grade is known.

Table 2: UNF (Fine) Thread: Torque Values for Zinc-Flake Coated and Untreated Fasteners

		Bolt Diameter - Inches												
		Torque Values (Pounds-Foot, Maximum/Minimum)												
	SAE Grade	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/8	1-1/4	1-1/2
Zinc-Flake	**5**	8	15	28	44	66	95	132	229	364	543	785	944	1654
	8	11	22	39	61	94	134	186	323	514	766	1109	1530	2682
Untreated	**5**	10	21	36	57	88	126	182	312	458	658	882	1251	2288
		9	19	34	53	81	116	167	287	421	606	814	1155	2105
	8	14.5	26	53	85	125	177	250	425	672	1009	1500	2092	3640
		13.5	24	49	79	115	163	230	393	620	931	1380	1925	3360

NOTE: Studs shall be torqued using capscrew values when grade is known.

Reference Only

Table 3: Metric Fasteners, Coarse Thread, Zinc-Flake Coating

Bolt Diameter - Metric Torque Values (Nm)																
Grade	**M4 0,157**	**M5 0,197**	**M6 0,236**	**M8 0,315**	**M10 0,394**	**M12 0,472**	**M14 0,551**	**M16 0,630**	**M18 0,709**	**M20 0,787**	**M22 0,866**	**M24 0,945**	**M27 1,06**	**M30 1,18**	**M33 1,18**	**M36 1,18**
8.8	2,6	5,2	9,0	21,6	42,4	73,1	116	178	250	349	467	600	877	1195	1608	2072
10.9	3,7	7,5	12,5	31,5	62,0	110	170	265	365	520	700	900	1325	1800	2450	3150
12.9	4,3	9,0	15,0	36,0	75,0	128	205	315	435	615	830	1060	1550	2125	2850	3700

Table 4: Metric Fasteners, Coarse Thread, Untreated

Bolt Diameter - Metric Torque Values (Nm, Maximum/Minimum)																
Grade	**M4 0,157**	**M5 0,197**	**M6 0,236**	**M7 0,276**	**M8 0,315**	**M10 0,394**	**M12 0,472**	**M14 0,551**	**M16 0,630**	**M18 0,709**	**M20 0,787**	**M22 0,866**	**M24 0,945**	**M27 1,06**	**M30 1,18**
8.8	3,1	6,5	11	19	27	53	93	148	230	319	447	608	774	1134	1538
	2,8	5,9	10	17	25	49	85	136	212	294	413	562	714	1046	1420
10.9	4,5	9,2	16	26	38	75	130	212	322	455	629	856	1089	1591	2163
	4,1	8,5	14	24	35	69	120	195	298	418	581	790	1005	1469	1997
12.9	5,4	11	19	31	45	89	156	248	387	532	756	1029	1306	1910	2595
	4,9	10	17	28	42	83	144	228	357	490	698	949	1206	1763	2395

Table 5: Metric Fasteners, Fine Thread, Zinc-Flake Coating

Bolt Diameter - Metric Torque Values (Nm)														
Grade	**M8x1 0,157**	**M10x1 0,197**	**M10x1,25 0,236**	**M12x1,5 0,315**	**M14x1,5 0,394**	**M16x1,5 0,472**	**M18x1,5 0,551**	**M20x1,5 0,630**	**M22x1,5 0,709**	**M24x2 0,787**	**M27x2 0,866**	**M30x2 0,945**	**M33x2 1,06**	**M36x3 1,18**
8.8	23	46	44	75	123	185	270	374	496	635	922	1279	1707	2299
10.9	34	71	66	113	188	285	415	575	770	980	1425	2025	2500	3590
12.9	41	84	79	135	220	335	485	675	900	1145	1675	2375	2900	4200

Table 6: Metric Fasteners, Fine Thread, Untreated

Bolt Diameter - Metric Torque Values (Nm, Maximum/Minimum)														
Grade	**M8x1 0,157**	**M10x1 0,197**	**M10x1,25 0,236**	**M12x1,5 0,315**	**M14x1,5 0,394**	**M16x1,5 0,472**	**M18x1,5 0,551**	**M20x1,5 0,630**	**M22x1,5 0,709**	**M24x2 0,787**	**M27x2 0,866**	**M30x2 0,945**	**M33x2 1,06**	**M36x3 1,18**
8.8	29	57	57	100	160	248	345	483	657	836	1225	1661	—	—
	27	53	53	92	147	229	318	446	607	771	1130	1534	—	—
10.9	41	81	81	1140	229	348	491	679	924	1176	1718	2336	—	—
	38	75	75	130	211	322	451	627	853	1085	1587	2157	—	—
12.9	49	96	96	168	268	418	575	816	1111	1410	2063	2800	—	—
	45	90	90	156	246	386	529	754	1025	1302	1904	2590	—	—

Reference Only

Table 7: UNC (Course) Thread: Torque Values for Stainless Steel Fasteners with Oil Lubrication

Size	Torque Value	
	lb-in	lb-ft
#5 (0.125)	6.9	—
#8 (0.164)	18	—
#10 (0.190)	21	—
1/4	68	—
5/16	120	10
3/8	210	17.5
7/16	340	28
1/2	—	39
5/8	—	74
3/4	—	114

NOTE: Stainless steel fasteners tend to gall while being tightened. To reduce this risk, lubricate the threads with oil or molybdenum disulfide and torque at low speeds without interruptions. Do not use excessive pressure. Impact wrenches are not recommended.

Table 8: Metric Course Thread: Torque Values for Stainless Steel Fasteners with Oil Lubrication

Size	Torque Value
	Nm
M2.5	0,4
M3	0,9
M4	1,5
M5	3,1
M6	5,3
M8	13,0
M10	27,0
M12	45,0
M14	71,1
M16	109
M18	157
M20	220

NOTE: Stainless steel fasteners tend to gall while being tightened. To reduce this risk, lubricate the threads with oil or molybdenum disulfide and torque at low speeds without interruptions. Do not use excessive pressure. Impact wrenches are not recommended.

Weld Studs

Unless otherwise specified the following grade 2 torque values (+/- 10%) apply.

Table 9: Weld Stud Torque Values

STUD SIZE	TORQUE	
#10	20	lb-in
1/4 in	4	lb-ft
5/16 in -18	9	lb-ft
5/16 in -24	10	lb-ft
3/8 in	14	lb-ft
1/2 in	35	lb-ft
5/8 in	70	lb-ft

Reference Only

WIRE ROPE

General

The following information includes inspection, replacement, and maintenance guidelines for wire rope as established by ANSI/ASME B30.5, federal regulations, and National Manitowoc specifications. The inspection interval shall be determined by a qualified person and shall be based on expected rope life as determined by experience, severity of environment, percentage of capacity lifts, frequency of operation, and exposure to shock loads. Periodic inspections need not be at equal calendar intervals and should be performed at shorter time intervals as the wire rope approaches the end of its useful life. A periodic inspection shall be performed at least once a year. The following information contains inspection and maintenance procedures for wire ropes used on National products as load lines, hoisting cables, boom extension and retraction cables, pendant cables, and hook block tie down cables.

Environmental Conditions

The life expectancy of wire rope may vary due to the degree of environmental hostility. Variation in temperature, continuous excessive moisture levels, exposure to corrosive chemicals or vapors, or subjecting the wire rope to abrasive material can shorten wire rope life. Frequent inspections and maintenance of the wire rope is recommended for preventing premature wear and to insure long-term performance.

Dynamic Shock Loads

Subjecting wire rope to abnormal loads shortens the ropes life expectancy. Examples of this type of loading are as follows:

- High velocity movement followed by abrupt stops (hoisting or swinging of a load).
- Suspending loads while traveling over irregular surfaces such as railroad tracks, potholes, and rough terrain.
- Moving a load that is beyond the cranes rated capacity.

Lubrication

The object of rope lubrication is to reduce internal friction and to prevent corrosion. New lubricant neeeds be added throughout the life of the rope. It is important that lubricant applied needs to be compatible with the original lubricant. Consult the rope manufacturer for proper lubricant. The lubricant applied shall be of the type which does not hinder visual inspection. Those sections of rope which are located over sheaves or otherwise hidden during inspection require special attention when lubricating rope.

During fabrication, ropes receive lubrication which provides the rope with protection for a reasonable time if stored under proper conditions. After the rope is put into service, periodic applications of a suitable rope lubricant are required. The wire rope lubricant should have the following characteristics:

- Be free from acids and alkalis and should have sufficient adhesive strength to remain on the ropes.
- Be of a viscosity capable of penetrating the interstices between wires and strands.
- Not be soluble in the medium surrounding it under the actual operating conditions (i.e. water).
- Have a high film strength.
- Resist oxidation.

Remove dirt from the rope before applying lubrication. Use a stiff wire brush and solvent, compressed air, or live steam to clean the rope. Lubricate the rope immediately after cleaning. Methods of lubrication are bath, dripping, pouring, swabbing, painting, or pressure spray (Figure 4). Apply the lubricant at the top bend in the rope because at that point the strands are spread and more easily penetrated. Do not lubricate a loaded rope. The service life of wire rope is directly proportional to the amount of lubricant reaching the working parts of the rope.

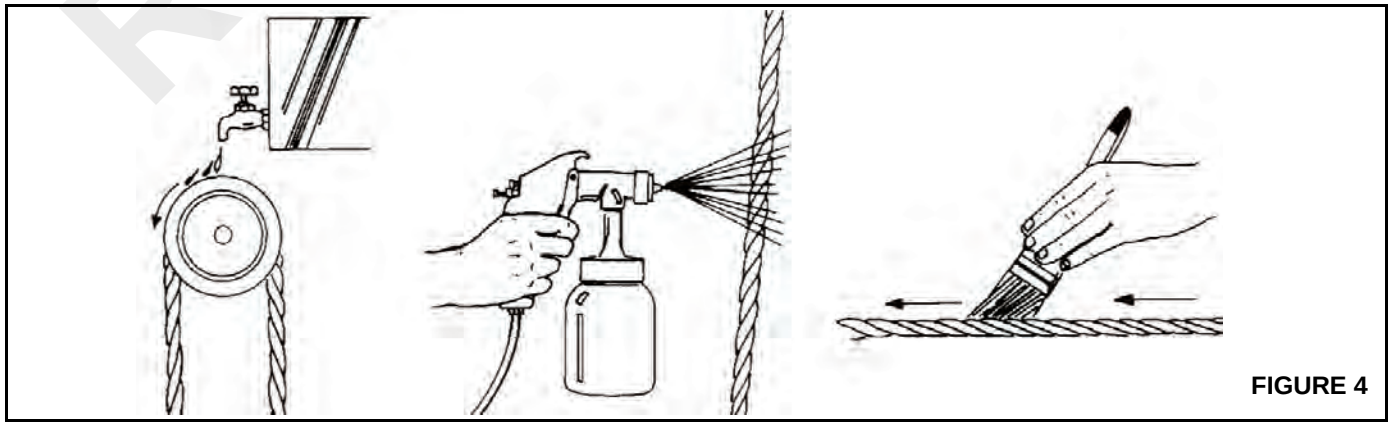


FIGURE 4

Reference Only

Recommendations for Servicing Wire Rope

- Lock out equipment power when removing or installing wire rope assemblies.
- Use safety glasses for eye protection.
- Wear protective clothing, gloves, and safety shoes.
- Use supports and clamps to prevent uncontrolled movement of wire rope, parts, and equipment.
- When replacing fixed length cable assemblies (e.g. pendants) having permanently attached end fittings, use only pre-assembled lengths of wire rope as supplied from Manitowoc Crane Care. Do not build lengths from individual components.
- Replace an entire wire rope assembly. Do not attempt to rework damaged wire rope or wire rope ends.
- Never electroplate wire rope assemblies.
- Do not weld wire rope assemblies or components unless recommended by the wire rope manufacturer.
- Do not allow welding spatter to come in contact with the wire rope or wire rope ends.
- Do not allow the wire rope to become an electrical path during other welding operations.
- Wire ropes are manufactured from special steels. If the wire rope is heated, discard the entire length of rope.
- Wire rope sets must be replaced as a set.
- Do not paint or coat wire ropes with any substance except approved lubricants.

Wire Rope Inspection

Inspect wire rope in accordance with the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies. Recommended inspection intervals depend on the machine, environmental conditions, frequency of lifts, and exposure to shock loads. The inspection intervals may also be predetermined by state and local regulatory agencies.

NOTE: Wire rope is available from Manitowoc Crane Care.

Record any deterioration of the wire rope in the equipment inspection log. Determination of wire rope replacement must be made by a qualified person.

Daily Inspection

A daily visual inspection is recommended for all ropes in service. Use the daily inspection to monitor progressive degradation and to identify damages that require wire rope replacement such as:

- Distortion, kinking, crushing, un-stranding, bird caging, reduction of diameter, etc.
- General corrosion.
- Broken or cut strands.

Yearly Inspection

Inspect the total length of wire rope annually or more often if necessitated by adverse conditions. Only inspect the outer surface of the wire rope. Do not attempt to open the strands of the rope. Items to include in the yearly inspection are items listed in the daily inspection plus the following:

- reduction of rope diameter below nominal diameter.
- severely corroded or broken wires at end connections.
- severely corroded, cracked, bent, worn, or improperly applied end connections.
- areas subjected to rapid deterioration such as:
  - sections in contact with saddles, equalizer sheaves, or other sheaves where wire rope travel is limited.
  - sections at or near terminal ends where corroded or broken wires may protrude.
  - sections in contact with stationary surfaces where abrasion or chafing may take place as a result of equipment vibration.
- boom nose sheaves, hook block sheaves, boom jib sheaves, auxiliary boom nose sheaves, and hoist drums for wear. Damaged sheaves or hoist drums can accelerate wear and cause rapid deterioration of the wire rope.

Boom Extension and Retraction Cables

Periodic Inspection

Do a periodic inspection of the total length of all boom extension and retraction cables. Use this inspection to monitor degradation and identify damage that requires wire rope replacement or equipment repair. Inspect the rope for:

- reduction of rope diameter below nominal diameter.
- severely corroded or broken wires at end connections.
- severely corroded, cracked, bent, worn, or improperly applied end connections.
- deterioration in areas such as:
  - sections in contact with saddles, equalizer sheaves, or other sheaves where rope travel is limited.
  - sections of wire rope at or near terminal ends where corroded or broken wires may protrude.
  - sections of wire rope in contact with stationary surfaces where abrasion or chafing may take place as a result of equipment vibration.

Reference Only

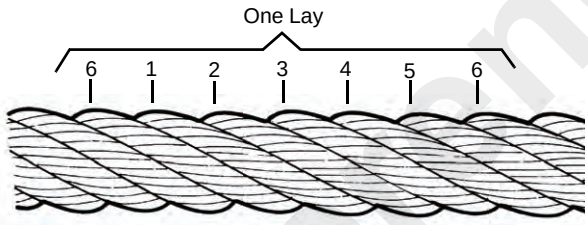
- damaged or wobbly boom extension and retraction sheaves which can cause rapid deterioration of wire rope.
- unusual cable sag/stretch. Be sure cables used in sets all have an equal tension applied. Repeated need for adjustment of an individual cable is evidence of cable stretch and indicates the need for a more thorough inspection to determine and correct the cause.

Wire Rope Replacement (All Wire Rope)

No precise rules can be applied to wire rope replacement because of the variables involved. Determining the condition of the wire rope depends largely upon the judgement of a qualified person.

The information below is excerpted from a National Consensus Standard as referenced by Federal Government Agencies and Manitowoc Crane Care recommendations to help determine when wire rope needs to be replaced. Wire rope shall be taken out of service when any of the following conditions exist:

- In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay (Figure 5).



One lay is parallel to the rope center-line and is the distance for one strand to make a complete spiral around the rope.

FIGURE 5

- Wear of one-third the original diameter of outside individual wires.
- Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.
- Evidence of heat damage.
- Reductions from nominal diameter of more than:
  - 1/64 in for diameters up to and including 5/16 in.
  - 1/32 in for diameters 3/8 and 1/2 in inclusive.
  - 3/64 in for diameters 9/16 to 3/4 in inclusive.
  - 1/16 in for diameters 7/8 to 1 1/8 in inclusive.
  - 3/32 in for diameters 1 1/4 to 1 1/2 in inclusive.
- In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.
- National recommends that for cable extended booms, a single damaged wire rope assembly shall require replacement of the complete set of extension cables.
- National recommends that boom extension cables be replaced every seven (7) years.

Seizing Wire Rope

It is important to seize the ends of rotation resistant wire ropes to prevent the displacement and unraveling of the individual wires and strands at the ends. All preformed and non-preformed styles of wire rope need to be seized prior to cutting. Seizings must be placed on both sides of the point where the wire rope is to be cut. The two methods for seizing wire ropes are described below.

Method 1

Using a length of soft annealed wire, place one end in the groove between two strands of the wire rope. Turn the long end of the annealed wire at right angles to the wire and wrap it tightly over the portion in the groove.

The two ends of the annealed wire should be twisted together tightly. Cut off the excess wire and pound the twist flat against the wire rope (Figure 6).

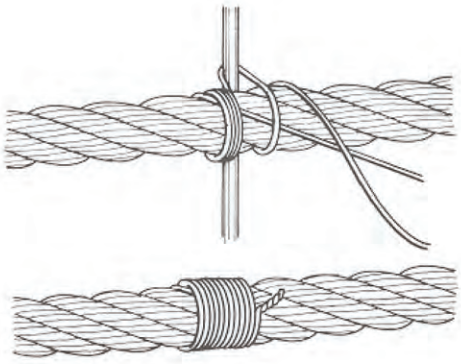


FIGURE 6

Method 2

Wind a length of soft annealed wire around the wire rope at least seven times. Twist the two ends together in the center of the seizing. Tighten the seizing by alternately prying and twisting. Cut off both ends of the wire and pound the twist flat against the rope (Figure 7).

Reference Only

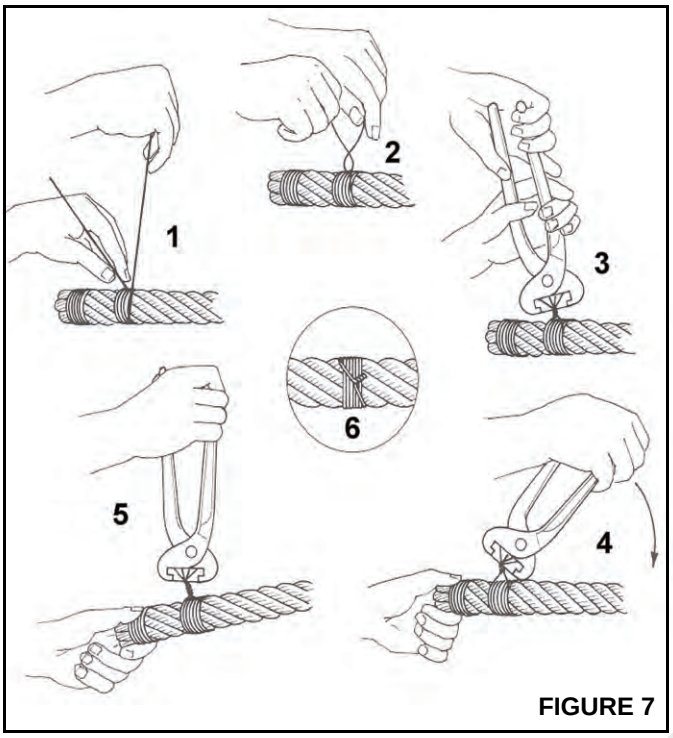


FIGURE 7

NOTE: Non-preformed wire rope should have two seizings located on each side of the cut (Figure 8).

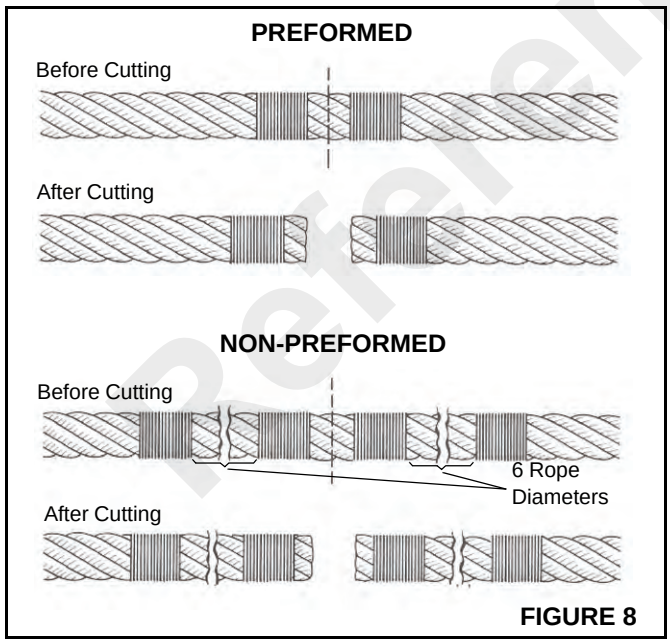


FIGURE 8

SET-UP

DANGER

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

OUTRIGGER SETUP

Proper Leveling of the Crane

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

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

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

Bubble Level Adjustment

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

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

Site Selection

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

Reference Only

- uneven
- rocky
- muddy

Setting the Outriggers

The outrigger setup procedure is as follows:

6. Remove the outrigger control box from the cab.

7. On the outrigger control box, select the desired outrigger beam with the extension switch and press the extend/retract switch to extend the outrigger beams.

8. Set all four outrigger beams to:

a. the fully retracted position. Does not require the outrigger beams to be extended.

b. the midpoint position. Engage the manual midspan over-center locks for the midpoint position.

c. the fully extended position.

⚠ DANGER

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

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

9. Remove the front outrigger floats from the carrying brackets and place the floats under the stabilizer.

10. Secure the front outrigger floats to the stabilizers with the pins and clips.

11. Select the desired stabilizer with the stabilizer selector switch and press the extend/retract switch to extend the stabilizer.

12. Extend all four stabilizers until the truck tires are about four inches off the ground.

13. Adjust the stabilizers until the bubble in the level indicator is in the center of the bulls eye. Do not allow the tires to touch the ground.

14. Using the level indicator, adjust the stabilizers until the bubble is in the center of the bulls eye. Do not allow the tires to touch the ground. If it is suspected that the bubble level indicator is out of adjustment, verify and adjust the bubble level using the procedures under *Bubble Level Adjustment*, page p.

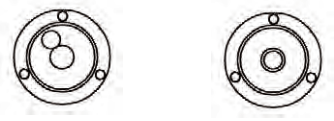


FIGURE 9

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.

15. Position the cable over the boom nose sheave and route to the hoist drum.

16. Position the hoist drum with the cable anchor slot on top.

17. Insert the cable through the slot and position around the anchor wedge (1) Figure 10.

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

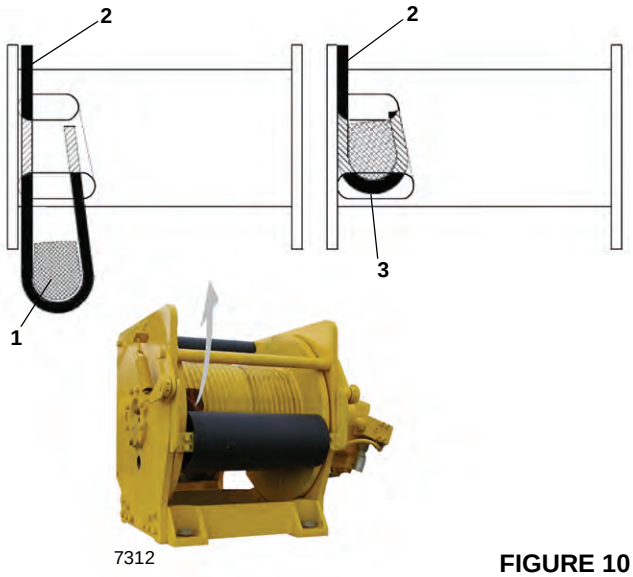


FIGURE 10

18. 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.

Reference Only



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19. Slowly rotate the drum, ensuring the first layer of cable is evenly wound onto the drum.

20. Install the remainder of the cable, as applicable.

WEDGE SOCKETS

To install a wedge socket:

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

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

Terminator Wedge Installation

The NBT50 is shipped with a terminator wedge socket which is National Crane's preferred type of socket (Figure 11). Other wedge socket types are discussed under "Wedge Socket Installation" on page s.

To attach a terminator wedge (Figure 11), use the following procedure:

1. Match the socket, wedge, and clip to wire rope size.
   - The wire rope must pass through the "go" hole in the wedge.
   - It must not pass through the "no go" hole in the wedge.

2. Align the live end of rope with center line of pin.

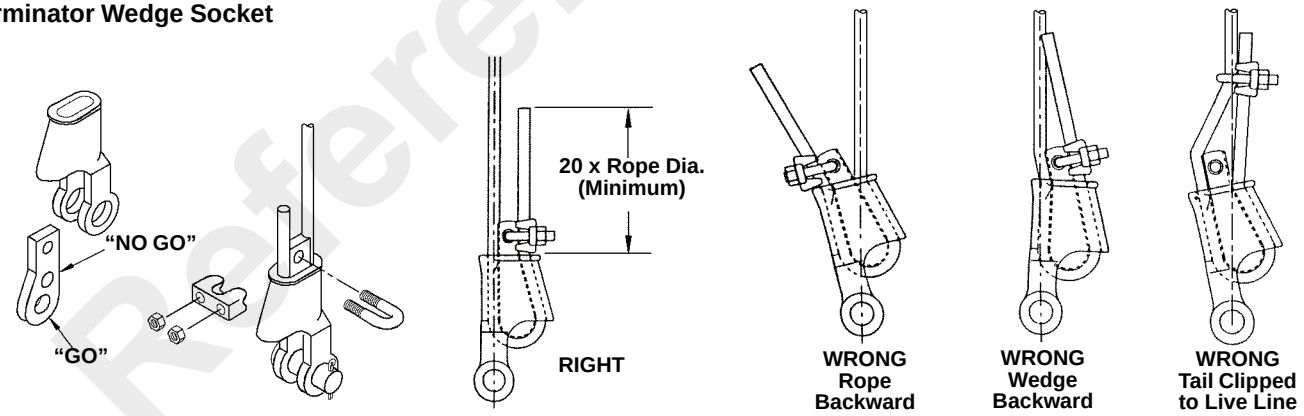
3. Secure dead end section of rope.

4. Tighten nuts on clip to recommended torque.

5. Do not attach dead end to live end or install wedge backwards.

6. Use a hammer to seat Wedge and Rope as deep into socket as possible before applying first load.

Terminator Wedge Socket



Torque Value Table

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

FIGURE 11

Reference Only

Wedge Socket Installation

1. Inspect the wedge and socket. Remove any rough edges and burrs.
2. The end of the wire rope should be seized using soft, or annealed wire or strand. If the end of the rope is welded, the welded end should be cut off. Do not weld on size 6X37 rope. This will allow the distortion of the rope strands, caused by the bend around the wedge, to adjust themselves at the end of the line. Refer to SECTION 1 - INTRODUCTION in the Service Manual for wire rope procedures.
3. Make sure the live-end (Figure 12) of the rope is directly in line with the ears of the socket and the direction of pull to which the rope will be subjected. If the rope is loaded into the socket incorrectly, under a load the rope will bend as it leaves the socket, and the edge of the socket will wear into the rope causing damage to the rope and eventual failure.

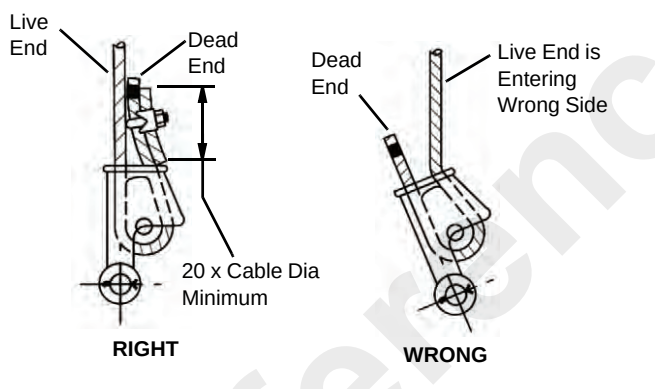


FIGURE 12

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 12) 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 13) 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 that 6 in (15,2 cm) for standard 6 to 8 strand ropes and 20 rope diameters but not less than 6 in (15,2 cm) for rotation resistant wire ropes.

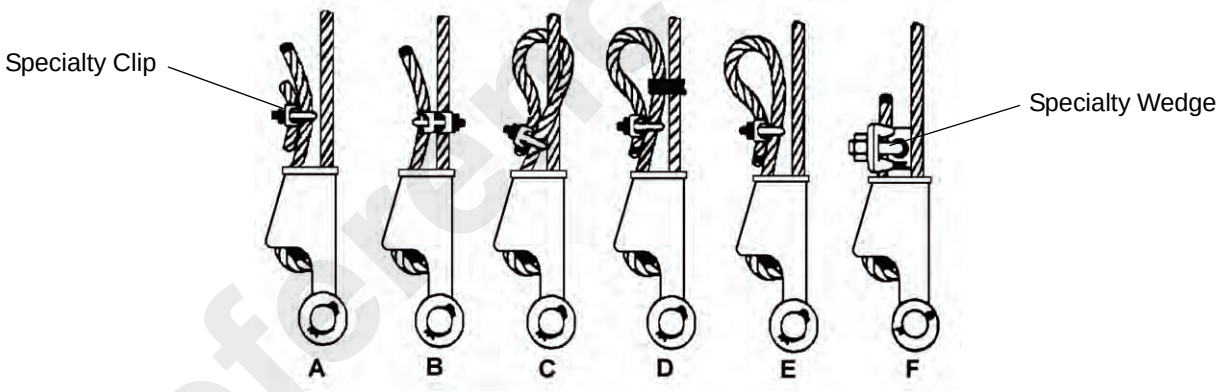
When using method A, place a wire rope clip around the dead end by clamping a short extra piece of rope to the rope dead end. DO NOT CLAMP THE LIVE END. The U-bolt should bear against the dead end. The saddle of the clip should bear against the short extra piece. Torque the U-bolts according to the table titled Wire Rope Clip Torque Values (Table 10).

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.

Reference Only

Table 10

Wire Rope Clip Torque Values			
Clip Sizes		**Torque**	
Inches	**mm**	**lb-ft**	**Nm**
1/8	3,18	4.5	6
3/16	4,76	7.5	10
1/4	6,35	15	20
5/16	7,94	30	40
3/8	13,28	45	60
7/16	11,11	65	90
1/2	12,70	65	90
9/16	14,29	95	130
5/8	15,88	95	130
3/4	19,05	130	175
7/8	22,23	225	300
1	25,40	225	300
1-1/8	28,58	225	300
1-1/4	31,75	360	490
1-3/8	38,68	360	490
1-1/2	38,10	360	490



Wedge Socket

FIGURE 13

OUTRIGGER MONITORING SYSTEM (OMS) (OPTIONAL—STANDARD IN NORTH AMERICA)

OPERATION

400B

The Outrigger Monitoring System (OMS) aids the operator in ensuring that the crane is properly setup on outriggers and stabilizers. The OMS utilizes one sensor in each outrigger and one proximity switch in each horizontally extending stabilizer to identify when the outriggers and stabilizer beams are extended to a point in which they provide maximum stability.

The OMS utilizes an LED indicator to communicate to the operator the position of the outriggers and stabilizers. The Outrigger Status Indicator (1, Figure 14) is a bi-color LED located at each control station. When power is on and the outrigger and stabilizer beams are extended to a point at which they provide maximum stability (stabilizers beams shall be fully extended on cranes equipped with Rear Stabilizer Out and Down (RSOD)), the Outrigger Status Indicator illuminates constant green, indicating a lift can be made. If power is on and one or more outrigger or stabilizer beams are not extended to a position which provides maximum stability, the Outrigger Status Indicator flashes red,

Reference Only

indicating a lift should not be made. If the Outrigger Status Indicator illuminates constant red, there is a fault in the OMS.

400B HO with Rear Stabilizer Hydraulic (RSH)

The Outrigger Monitoring System (OMS) aids the operator in ensuring that the crane is properly setup on outriggers. The OMS utilizes two switches, one switch in each horizontally extending outrigger, to identify when the outrigger beams are fully extended.

The OMS utilizes an LED indicator to communicate to the operator the position of the outriggers and stabilizers. The Outrigger Status Indicator (1, Figure 14) is a bi-color LED located at each control station. When power is on and the outrigger beams are fully extended, the Outrigger Status Indicator illuminates constant green, indicating a lift can be made. If power is on and one or both outrigger beams are not fully extended, the Outrigger Status Indicator flashes red, indicating a lift should not be made.

400B HO with Angled Stabilizer Hydraulic (ASH)

The Outrigger Monitoring System (OMS) aids the operator in ensuring that the crane is properly setup on outriggers and stabilizers. The OMS utilizes four proximity switches, one switch in each outrigger and one switch in each stabilizer, to identify when the outrigger beams are fully extended and the stabilizer beams are extended to a point at which they provide maximum stability.

The OMS utilizes an LED indicator to communicate to the operator the position of the outriggers and stabilizers. The Outrigger Status Indicator (1, Figure 14) is a bi-color LED located at each control station. When power is on and the outrigger beams are fully extended and the stabilizer beams are extended to a point at which they provide maximum stability, the Outrigger Status Indicator illuminates constant green, indicating a lift can be made. If power is on and one or more outrigger beams are not fully extended or one or more stabilizers beams are not extended to a point at which they provide maximum stability, the Outrigger Status Indicator flashes red, indicating a lift should not be made.

Reference Only

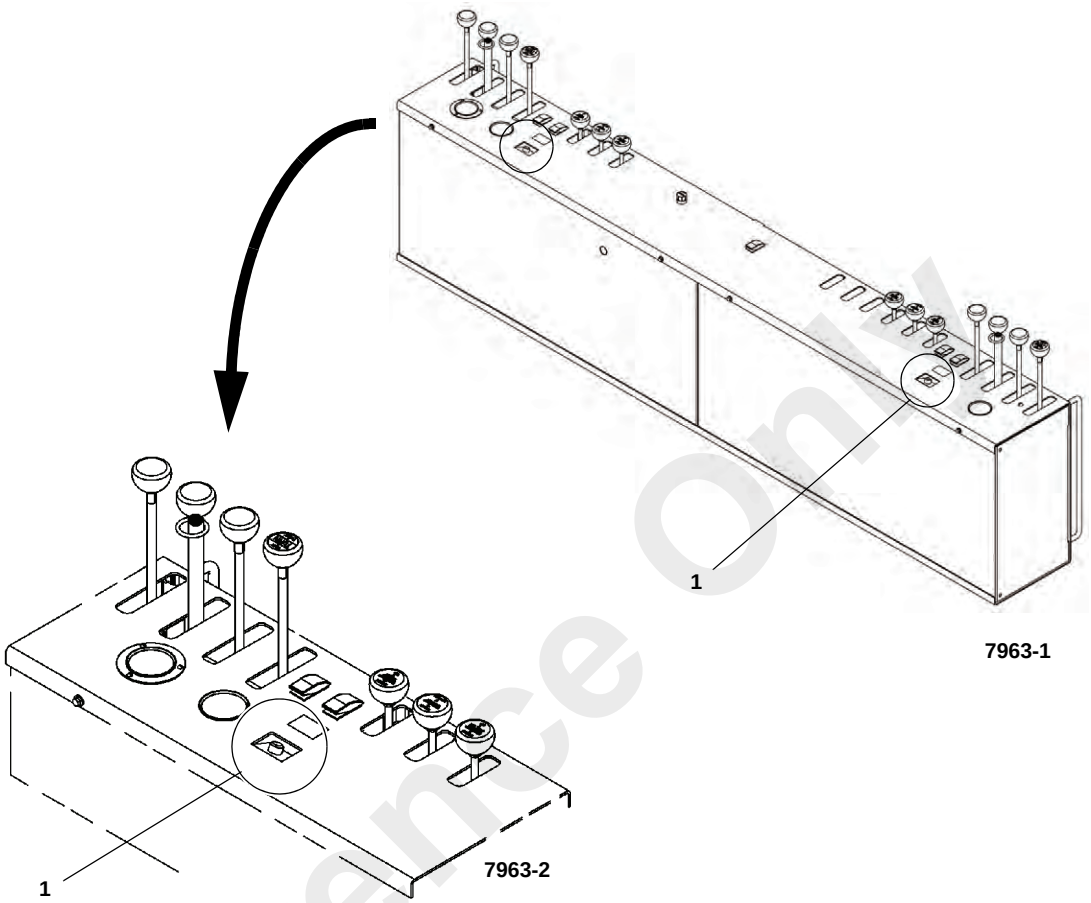


FIGURE 14

Reference Only

Outrigger Cylinder Length Sensor — 400B

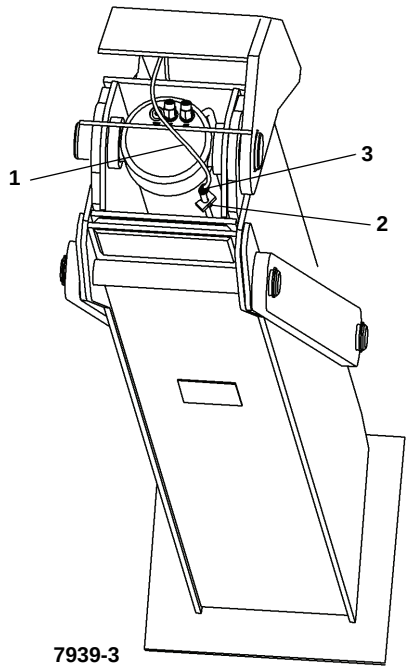


FIGURE 15

Remove

1. Fully retract outriggers.
2. Disconnect electrical connector (1, Figure 15) at sensor.
3. Remove setscrews (2, Figure 15) securing sensor holding plate.
4. Slide sensor (3, Figure 15) out of sensor holding bracket.

Install

1. Fully retract outriggers.
2. Slide sensor (3, Figure 15) into holding bracket.
3. Using the two setscrews (2, Figure 15) and sensor holding bracket, secure sensor (3) to the hydraulic cylinder.
4. Connect electrical connector (1, Figure 15) to sensor.
5. Calibrate sensor; refer to *Calibrate*, page w.

Calibrate

Calibrating the cylinder length sensor requires a laptop equipped with the HED Conductor software and a USB cable connector (p/n 80009992). Contact your Manitowoc dealer for further assistance.

Outrigger Proximity Switch — 400B HO

Version 1

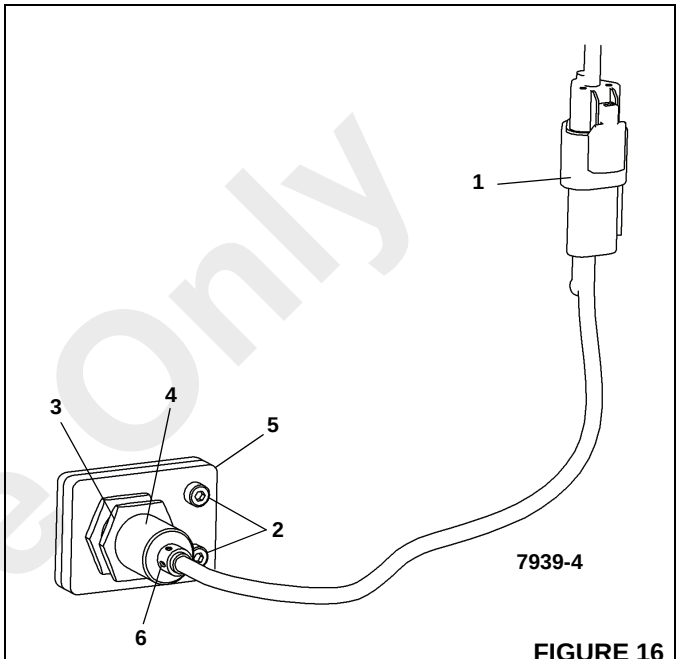


FIGURE 16

Remove

1. Disconnect electrical connector (1, Figure 16) at switch.
2. Remove the two screws (2, Figure 16) securing the mounting bracket/switch assembly to the stabilizer box.
3. Loosen jam nut (3, Figure 16) securing switch (4) to mounting bracket; remove switch.

Install

1. Fully extend stabilizer beam (horizontally).
2. Thread switch (4, Figure 16) into mounting bracket (5) so that face of switch protrudes 10 mm through bracket.
3. Using two screws (2, Figure 16), secure mounting bracket/switch assembly to stabilizer box.
4. Screw switch into stabilizer box until it contacts the stabilizer wear pad, then un-screw switch three full turns.
5. Tighten jam nut (3, Figure 16) on switch.
6. Connect electrical connector (1, Figure 16) to switch.
7. With power on and stabilizer beam fully extended, ensure LED (6, Figure 16) on proximity switch illuminates; retract stabilizer beam and ensure LED is not illuminated.

Reference Only

Version 2

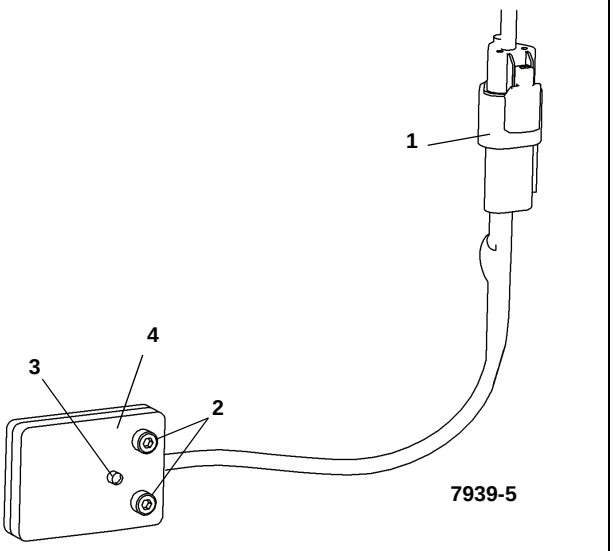


FIGURE 17

Remove

1. Disconnect electrical connector (1, Figure 17) at switch.
2. Remove the two screws (2, Figure 17) securing the switch (4) to the stabilizer box; remove switch.

Install

1. Fully extend stabilizer beam (horizontally).
2. Using two screws (2, Figure 17) secure the switch (4) to stabilizer box.
3. Connect electrical connector (1, Figure 17) to switch.
4. With power on and stabilizer beam fully extended, ensure LED (3, Figure 17) on proximity switch illuminates; retract stabilizer beam and ensure LED is not illuminated.

Stabilizer Proximity Switch — 400B and 400B HO with Angled Stabilizer Hydraulic (ASH)

Version 1

Remove

1. Disconnect electrical connector (1, Figure 16) at switch.
2. Remove the two screws (2, Figure 16) securing the mounting bracket/switch assembly to the stabilizer box.
3. Loosen jam nut (3, Figure 16) securing switch (4) to mounting bracket (5); remove switch.

Install

1. Fully extend stabilizer beam.
2. Thread switch (4, Figure 16) into mounting bracket (5) so that face of switch protrudes 10 mm through bracket.
3. Using two screws (2, Figure 16), secure mounting bracket/switch assembly to stabilizer box.
4. Tighten jam nut (3, Figure 16) on switch (4).
5. Connect electrical connector (1, Figure 16) to switch (4).
6. With power on and stabilizer beam fully extended, ensure LED (6, Figure 16) on proximity switch (4) illuminates; retract stabilizer beam and ensure LED is not illuminated.

Version 2

Remove

1. Disconnect electrical connector (1, Figure 17) at switch (4).
2. Remove the two screws (2, Figure 17) securing the switch (4) to the stabilizer box; remove switch.

Install

1. Fully extend stabilizer beam (horizontally).
2. Using two screws (2, Figure 17), secure the switch (4) to stabilizer box.
3. Connect electrical connector (1, Figure 17) to switch (4).
4. With power on and stabilizer beam fully extended, ensure LED (3, Figure 17) on proximity switch (4) illuminates; retract stabilizer beam and ensure LED is not illuminated.

SIDE FOLDING SWING-AROUND JIB OPERATION

The following note needs to be added to the Jib Deployment and Stowing procedures:

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

Reference Only

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SECTION 1
SAFETY INFORMATION

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

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

Reference Only

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.

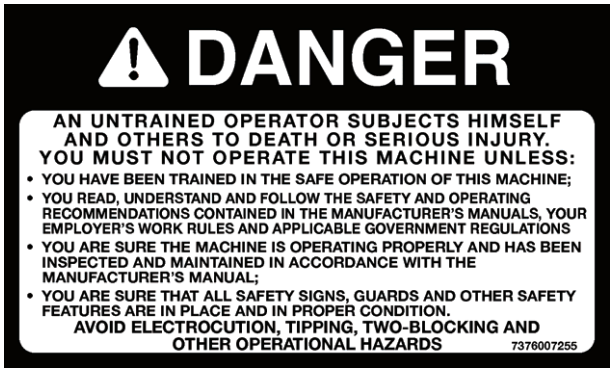
OPERATOR'S QUALIFICATIONS

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.

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

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



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

You must not operate this 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.

Reference Only

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

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

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

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

OPERATIONAL AIDS

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

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

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

Rated Capacity Limiter (RCL) Systems (If Equipped)

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

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

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

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

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

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

Reference Only

capacity limiter (RCL) throughout its *Operator's* and *Service Manuals*.)

Anti-Two-Blocking Device

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

Two-blocking occurs when the load block (hook block, headache ball, rigging, etc.) comes into physical contact with the boom (boom nose, sheaves, boom extension, etc.). Two-blocking can cause hoist 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.

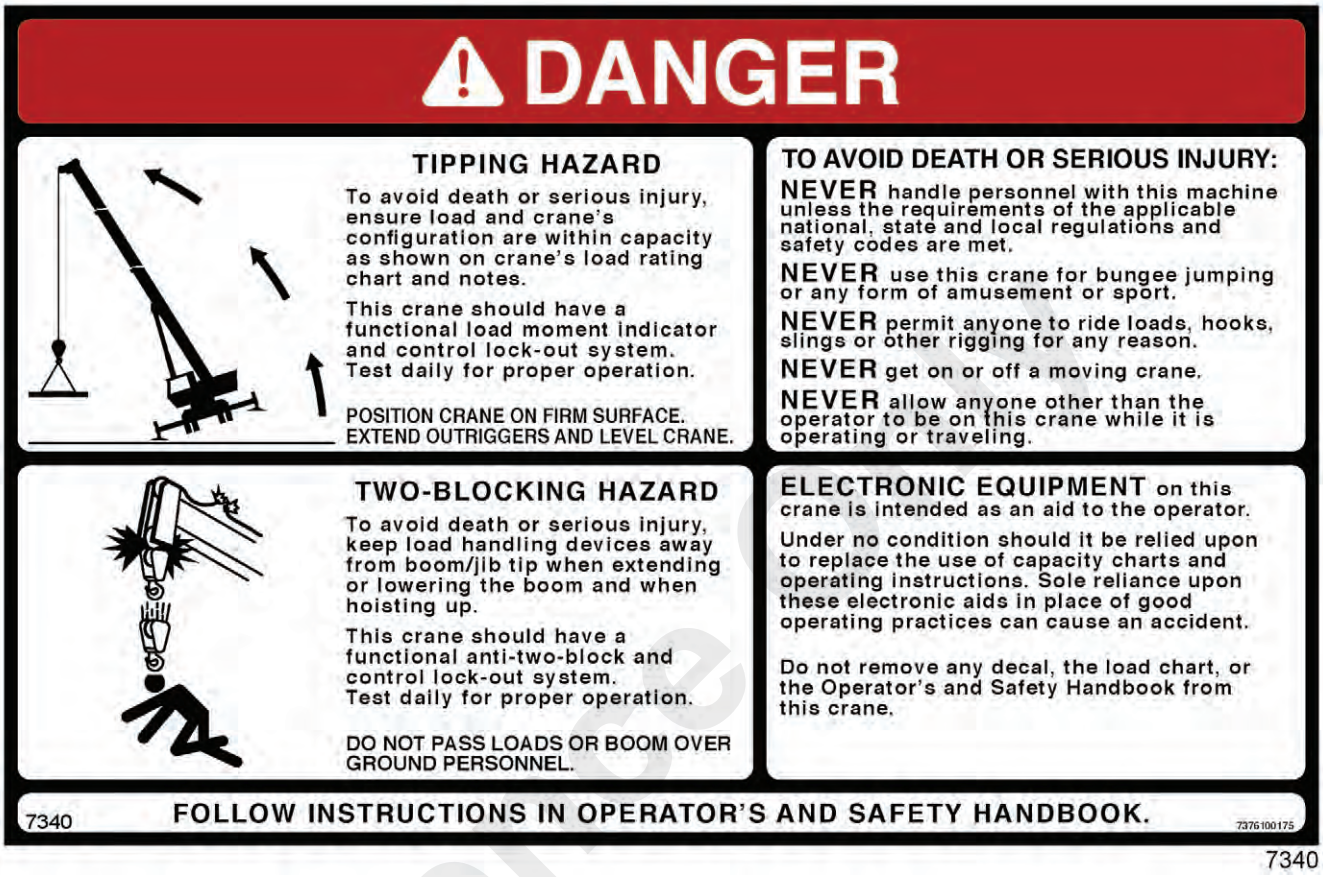
Never interfere with the proper functioning of operational aids or warning devices.

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.

Reference Only



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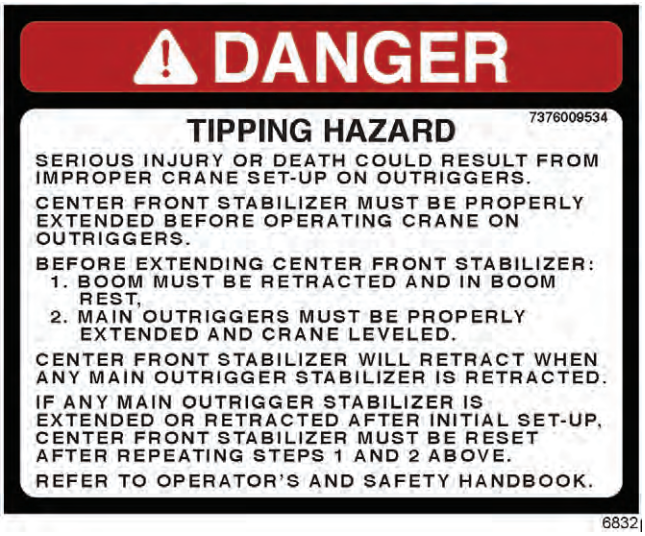
CRANE STABILITY/STRUCTURAL STRENGTH

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

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

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

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



Carefully follow the procedures in this Operator'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 Rated Capacity Limiter (RCL) System program for the outrigger position selected.

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

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

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

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



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

Load Charts

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

Load Chart capacities are based on freely suspended loads.

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

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

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

Work Site

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

Be aware of all conditions that could adversely 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 1-1.

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 32 km/h (20 mph) to 48 km/h (30 mph), 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 48 km/h (30 mph) is not recommended.

Table 1-1

Wind Force		Wind Velocity km/h (mph)	Visible Indicator Effects of wind as observed on land
Beauford Scale	Designation		
Zero (0)	Calm	less than 1 (<1)	No wind; smoke rises vertically
1	Light Air	1-5 (1-3)	Wind direction seen by smoke but not by wind vanes

Reference Only

Wind Force		Wind Velocity km/h (mph)	Visible Indicator Effects of wind as observed on land
Beauford Scale	Designation		
2	Light Breeze	6-11 (4-7)	Wind felt on face; leaves rustle; wind vane moves slightly
3	Gentle Breeze	12-19 (8-12)	Leaves/small twigs in constant motion: wind extends flag
4	Moderate Breeze	20-29 (13-18)	Raises dust & loose paper; moves small branches
Reduce crane load ratings and operating parameters at 32 km/h (20 mph)			
5	Fresh Breeze	29-38 (19-24)	Small trees in leaf begin to sway; on ponds, crested wavelets form
6	Strong Breeze	39-49 (25-31)	Large branches in motion; telephone wires whistle; umbrellas used with difficulty
Cease all craning operations at 48 km/h (30 mph); lower & retract boom			
7	Moderate Gale	50-61 (32-38)	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 Rated Capacity Limiter (RCL) is programmed for the crane configuration. Refer to the RCL operator's manual supplied with the crane.

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

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

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

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

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

The crane can tip over or fail structurally if:

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

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

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

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

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

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

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

Reference Only

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 designated person. If it is necessary to perform a multi-crane lift, the operator shall be responsible for assuring that the following minimum safety precautions are taken:

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

ELECTROCUTION HAZARD

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

United States federal law prohibits the use of cranes closer than 6 m (20 ft) to power sources up to 350 kV and greater distances for higher voltages unless the line's voltage is known [29CFR1910.180 and 29CFR1926.1400].

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

NOTE: For detailed guidelines on operating near power lines, refer to the current edition of OSHA 29CFR1926.1400 and ASME B30.5 American National Standard.

Reference Only

WARNING

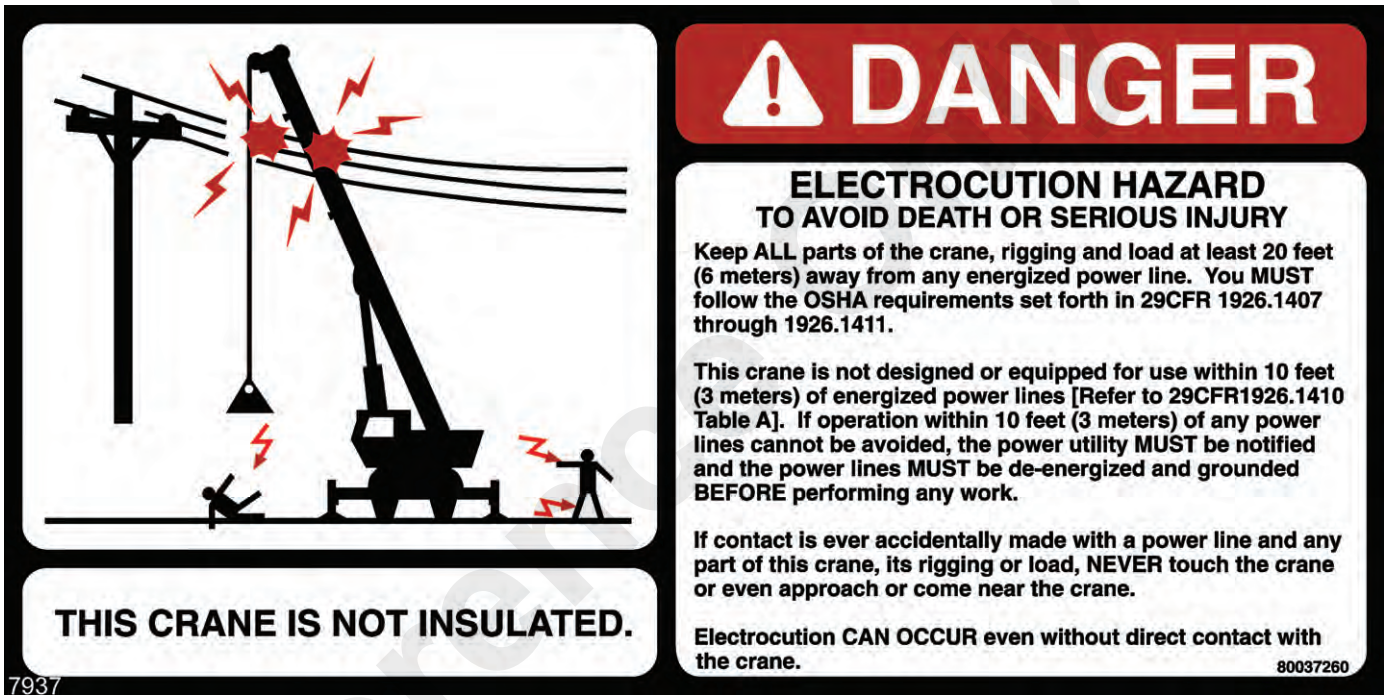
Electrocution Hazard!

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

If operation within 3 meters (10 feet) 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.



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.

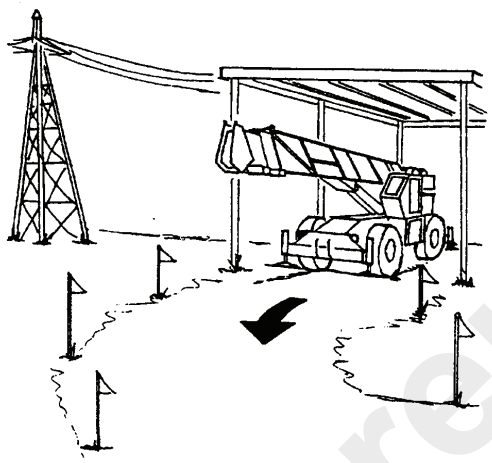
Set-Up and Operation

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

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

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

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



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.

Reference Only

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

Special Operating Conditions and Equipment

Never operate the crane during an electrical thunderstorm.

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

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

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

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 29CFRI926.1431:

> 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 29CFRI910.180 for General Industry* and *29CFRI926.1431 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.

Reference Only

- 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:
  - On cranes equipped with a boom mounted personnel platform, use only a platform approved by Manitowoc.
  - 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 rated capacity limiter and control lever lockout systems for all lifting operations.

Shut down the crane while making repairs or adjustments.

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

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

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

Routine maintenance and inspection of this crane must be performed by a qualified person(s) according to the

Reference Only

recommendations in the *Manitowoc Crane Care Maintenance and Inspection Manual*. Any questions regarding procedures and specifications should be directed to your Manitowoc distributor.

Service and Repairs

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 distributor for assistance.

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

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

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

Hydraulic Fluid:

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

Reference Only

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

Reference Only

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.

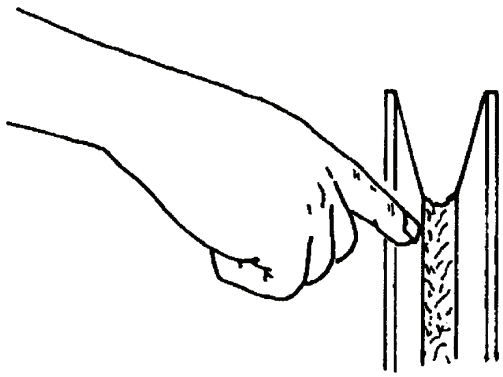
When installing a new rope:

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

Reference Only

NOTE: The use of cast nylon (polyamide) 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.

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.

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.

Reference Only

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.
- 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,

Reference Only

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. RCL).
- 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.

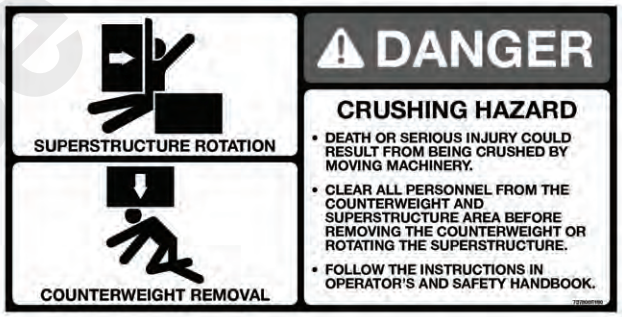
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

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

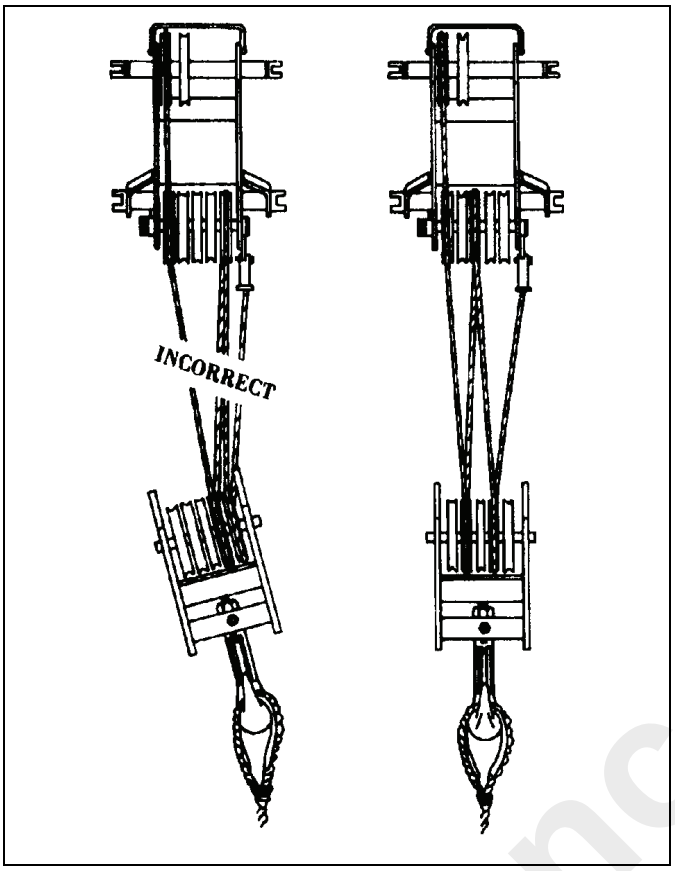
Operate the crane only from the operator's seat. Do not reach in a window or door to operate any controls.

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.

Reference Only



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).

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.

Reference Only

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

Hand Signals

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

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

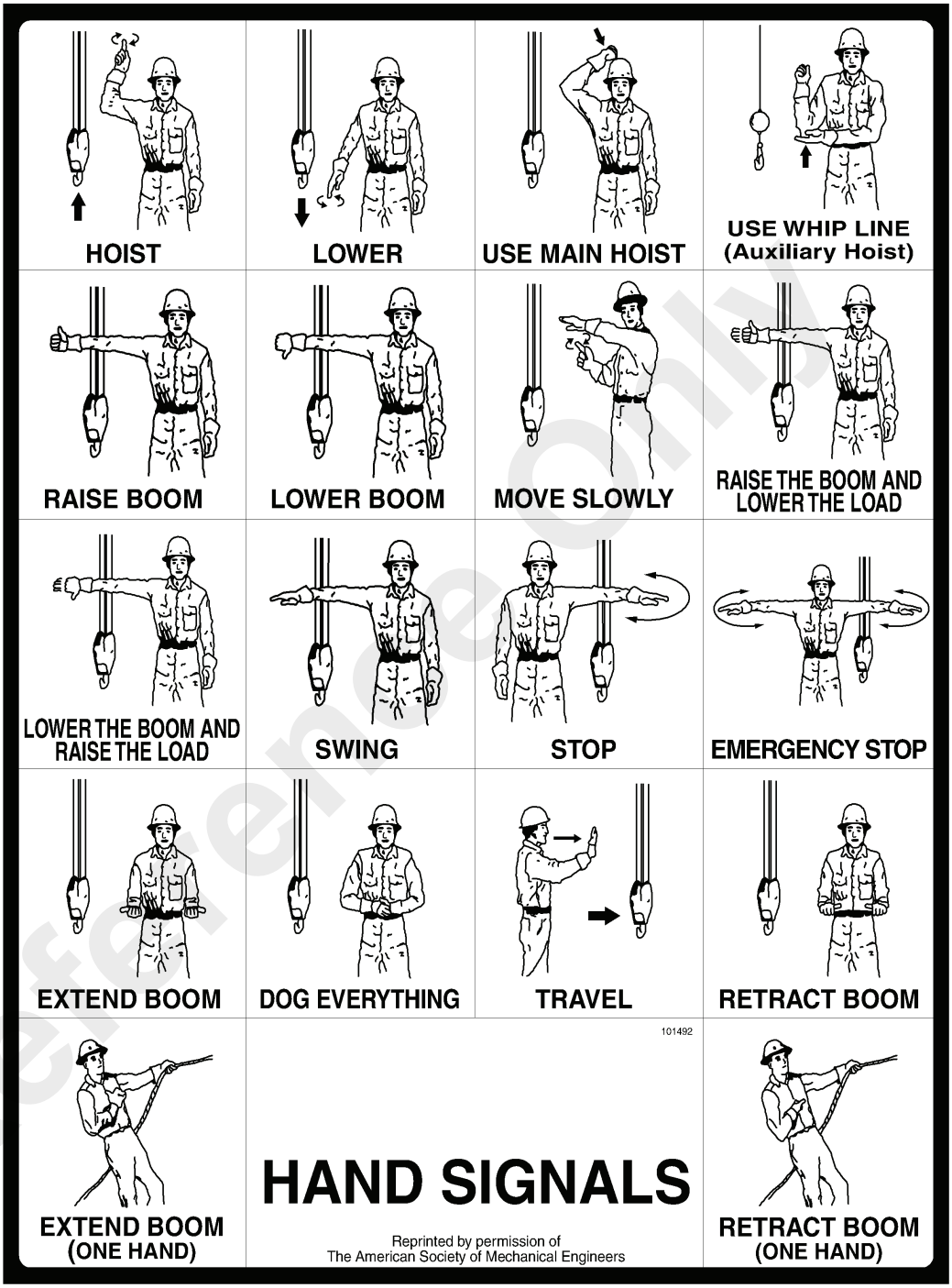
At all times use standardized hand signals - previously agreed upon and completely understood by the operator and signal person.

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

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

Obey a signal to stop from anyone.

Reference Only



Reference Only

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 for the Controls and Operating Procedures of this manual.

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

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

The Controls and Operating Procedures section of this manual provides instructions for parking and securing 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, lightning, etc. should be considered when determining the location and configuration of a crane when it is to be left unattended.

SHUT-DOWN

Use the following steps when shutting down the crane:

- Engage the parking brake.
- Fully retract and lower the boom.
- Engage the swing lock pin or 360 degree swing lock.
- Place controls in neutral position.
- Shut down the engine and remove the ignition key.
- Chock the wheels, if not on outriggers.
- Lock the operator’s cab (if applicable) and install vandal guards, if used.

COLD WEATHER OPERATION

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

Check operating procedures in this manual for cold weather starting.

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

Clean the 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.

Reference Only

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

Never store flammable materials on the crane.

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

TEMPERATURE EFFECTS ON HOOK BLOCKS

The following information applies to Gunnebo Johnston crane hook blocks:

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

Crane blocks shall not be heated above 180 degrees F. Craneblock Working Load Limit is valid between 180 degrees F and service temperature given on the identification tag with normal lifting precautions.

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

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

75% of the WLL must not be exceeded, when lifting in temperatures below -40 degrees F."

TEMPERATURE EFFECTS ON HYDRAULIC CYLINDERS

Hydraulic oil expands when heated and contracts when cooled. This is a natural phenomena that happens to all liquids. The coefficient of expansion for API Group 1 hydraulic oil is approximately 0.00043 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 Table 1-2). 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 1-2 and Table 1-3 have been prepared to assist you in determining the approximate amount of retraction/extension that may be expected from a hydraulic cylinder as a result of change in the temperature of the hydraulic oil inside the cylinder. The chart is for dry rod cylinders. If the cylinder rod is filled with hydraulic oil, the contraction rate is somewhat greater.

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

Reference Only

Table 1-2: Boom Drift Chart (Cylinder length change in inches)

Coeff. = 0.00043 (in^3/in^3/ °F)

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

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

Table 1-3Boom Drift Chart (Cylinder length change in millimeters)

Coeff. = 0.000774 (1/ °C)

STROKE	Temperature Change (°C)										
(m)	5	10	15	20	25	30	35	40	45	50	55
1.5	5.81	11.61	17.42	23.22	29.03	34.83	40.64	46.44	52.25	58.05	63.86
3	11.61	23.22	34.83	46.44	58.05	69.66	81.27	92.88	104.49	116.10	127.71
4.5	17.42	34.83	52.25	69.66	87.08	104.49	121.91	139.32	156.74	174.15	191.57
6	23.22	46.44	69.66	92.88	116.10	139.32	162.54	185.76	208.98	232.20	255.42
7.5	29.03	58.05	87.08	116.10	145.13	174.15	203.18	232.20	261.23	290.25	319.28
9	34.83	69.66	104.49	139.32	174.15	208.98	243.81	278.64	313.47	348.30	383.13
10.5	40.64	81.27	121.91	162.54	203.18	243.81	284.45	325.08	365.72	406.35	446.99
12	46.44	92.88	139.32	185.76	232.20	278.64	325.08	371.52	417.96	464.40	510.84
13.5	52.25	104.49	156.74	208.98	261.23	313.47	365.72	417.96	470.21	522.45	574.70
15	58.05	116.10	174.15	232.20	290.25	348.30	406.35	464.40	522.45	580.50	638.55
16.5	63.86	127.71	191.57	255.42	319.28	383.13	446.99	510.84	574.70	638.55	702.41
18	69.66	139.32	208.98	278.64	348.30	417.96	487.62	557.28	626.94	696.60	766.26

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

Reference Only

OVERLOAD INSPECTION

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

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

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

WARNING

Overload Hazard!

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

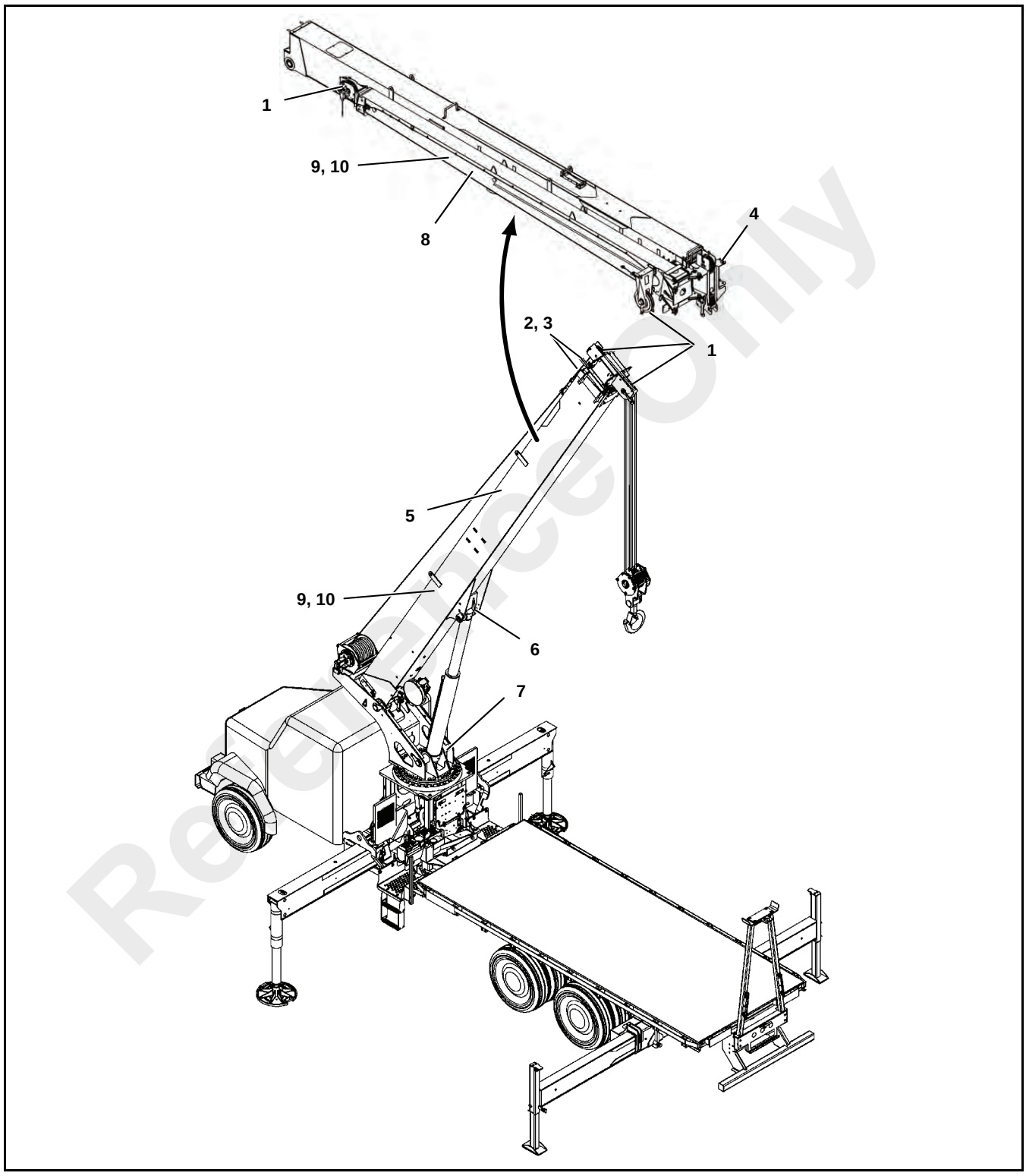
- Perform the inspections outlined in this publication for overloads up to 50%.
- Stop operating the crane and contact Manitowoc Crane Care immediately for overloads of 50% and higher.

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.

Reference Only

Boom Inspection

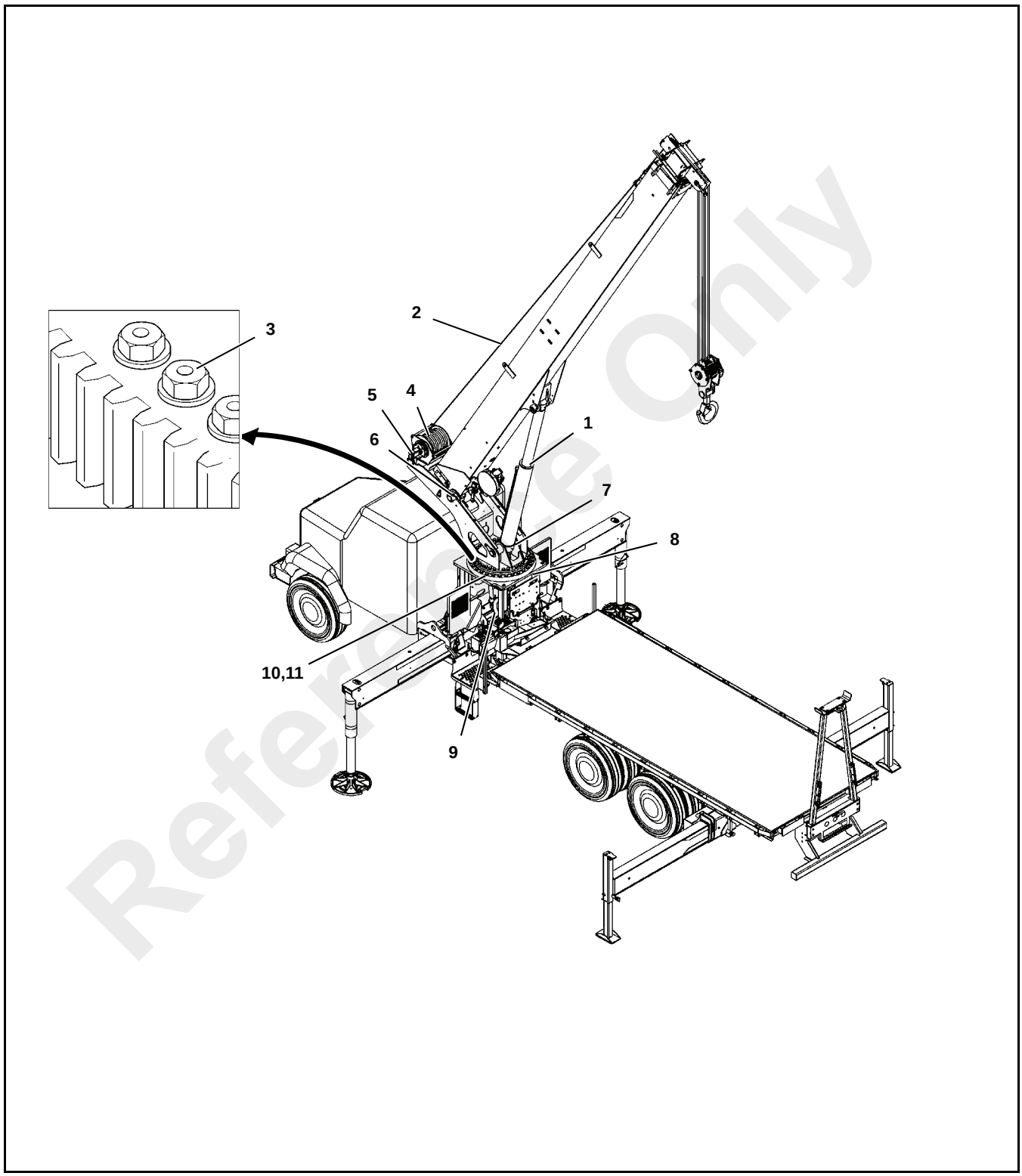


Reference Only

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.	

Reference Only

Superstructure Inspection

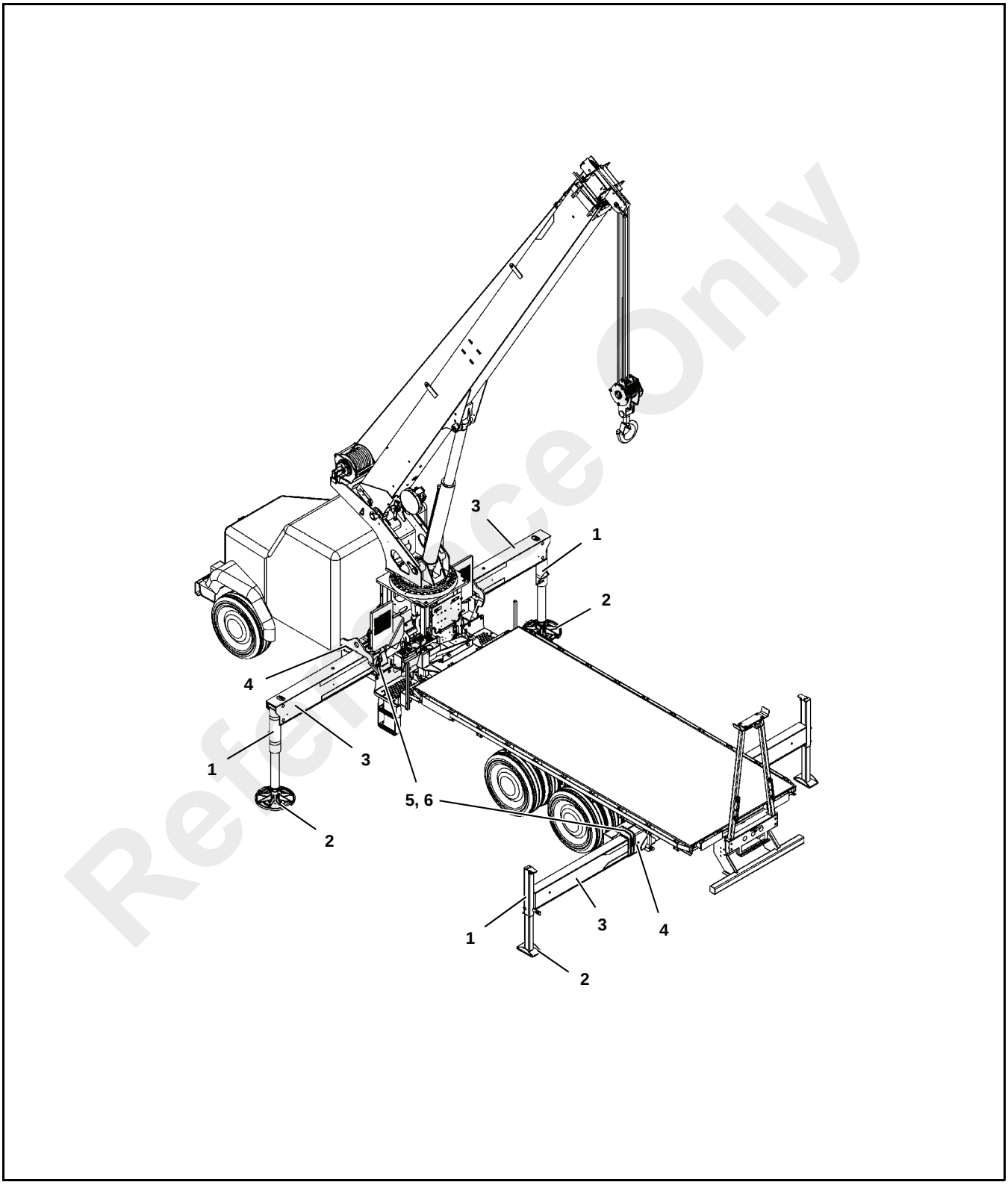


Reference Only

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.	

Reference Only

Carrier Inspection



Reference Only

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

Reference Only

Reference Only

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SECTION 2
OPERATION

CONTROLS

Truck cab controls

Crane Power

Electrical power to the crane is provided through a relay that is interconnected with the Power Take-Off control. Power is supplied to the crane only when the PTO control has been engaged.

Power Take-Off

Manual Shift Control – The PTO's are engaged when the knobs on dash or floor are pulled out and disengaged when the knobs are pushed in. The truck gear shift lever must be in neutral and the clutch depressed whenever the knobs are moved.

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

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

Power Shift Control – If the vehicle is equipped with automatic transmission, the power take-off must be engaged with the engine at idle. Refer to transmission manufacturer's instructions for special procedures.

Park Brake

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

Cold Weather Operation

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

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

Operation of cranes at full rated capacities in temperatures between -18°C (0°F) and -40°C (-40°F) or operators who possess the skill, experience, and dexterity to ensure smooth operation. Shock loading shall be avoided.

Operation Below -40°C

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

Operation Below -40°F

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

Crane Controls

The unit is equipped with control stations on each side of the main frame. Placards on the control knobs or next to the lever indicate the direction to actuate the controls for the various unit functions. Each station is complete and provides complete control of boom rotation, boom elevation, boom extension, hoist, outriggers, engine foot throttle, the engine emergency stop switch and a horn switch. All control handles except the outrigger controls are positioned in the same order at both control stations. The hydraulic system pressure gauge is located at only one operator's station.

Control Functions

Turn – Operate the lever to **RIGHT** to rotate the boom in a clockwise direction. Operate the lever to **LEFT** to rotate the boom in a counterclockwise direction as viewed from the top of the crane.

A mechanical rotation stop pulls the turn control lever back to the center position when engaged. The boom rotation is stopped over the front of the chassis. On rear mounted cranes, rotate the boom over the passenger side of the chassis when stowing and unstowing to prevent immediate contact with the mechanical rotation stop.

Boom – Operate the lever to **DOWN** to lower the boom. Operate the lever to **UP** to raise the boom.

Boom Telescope – Operate the lever to **OUT** to extend the boom. Operate the lever to IN to retract the boom.

Hoist—Operate the lever to **DOWN** to payout and lower the loadline. Operate the lever to **UP** to reel in and raise the loadline. Refer to hoist system operation section for additional information.

Reference Only

⚠ DANGER

Payout loadline before extending boom. Failure to do so may cause the loadline to break or damage the crane.

Stabilizers – Up/Down – Operate the lever to **DOWN** to lower and UP to raise.

Stabilizers – Extend/Retract – Operate the lever to **EXTEND** to move beams out and to **RETRACT** to move beams in.

Outriggers – Operate the lever to **UP** to raise the outrigger legs. Operate the lever to **DOWN** to lower the outrigger legs.

Foot Throttle – Depress the foot throttle to accelerate the truck engine speed. Release to return to idle speed. Increasing truck speed increases operating speed.

Kill Switch – Operate the switch to kill the truck engine under emergency conditions. Switch must be reset to on to operate truck from cab.

Horn – Operate horn button to warn fellow workers on construction site of pending movement of crane.

Pressure Gauge – Observe pressure gauge while booming up or down at end of stroke to determine system pressure.

HCAS Load Range Gauge – Aid in determining the load condition of crane. The gauge has three colors on the dial face: (1) Green – OK; (2) Yellow – Caution; and (3) Red – Overload. **Do not use the Load Range Gauge with a jib**. Refer to “Hydraulic Capacity Alert System” for more information.

HCAS Overload Light – Indicator light illuminates when HCAS detects crane overload and boom down, extend out and hoist up functions disabled.

A2B Light – Indicator light illuminates when a two block condition is detected.

Override Key Switch – Turn key switch to enable or disable HCAS and A2B override.

Override Button – With Override Key Switch in on position, depress button to override HCAS and A2B system. Do not use override to continue lifting operations in an overload or two blocked condition.

Capacity Chart – This chart shows capacities of crane at various operating areas and hoist capacities with appropriate reeving.

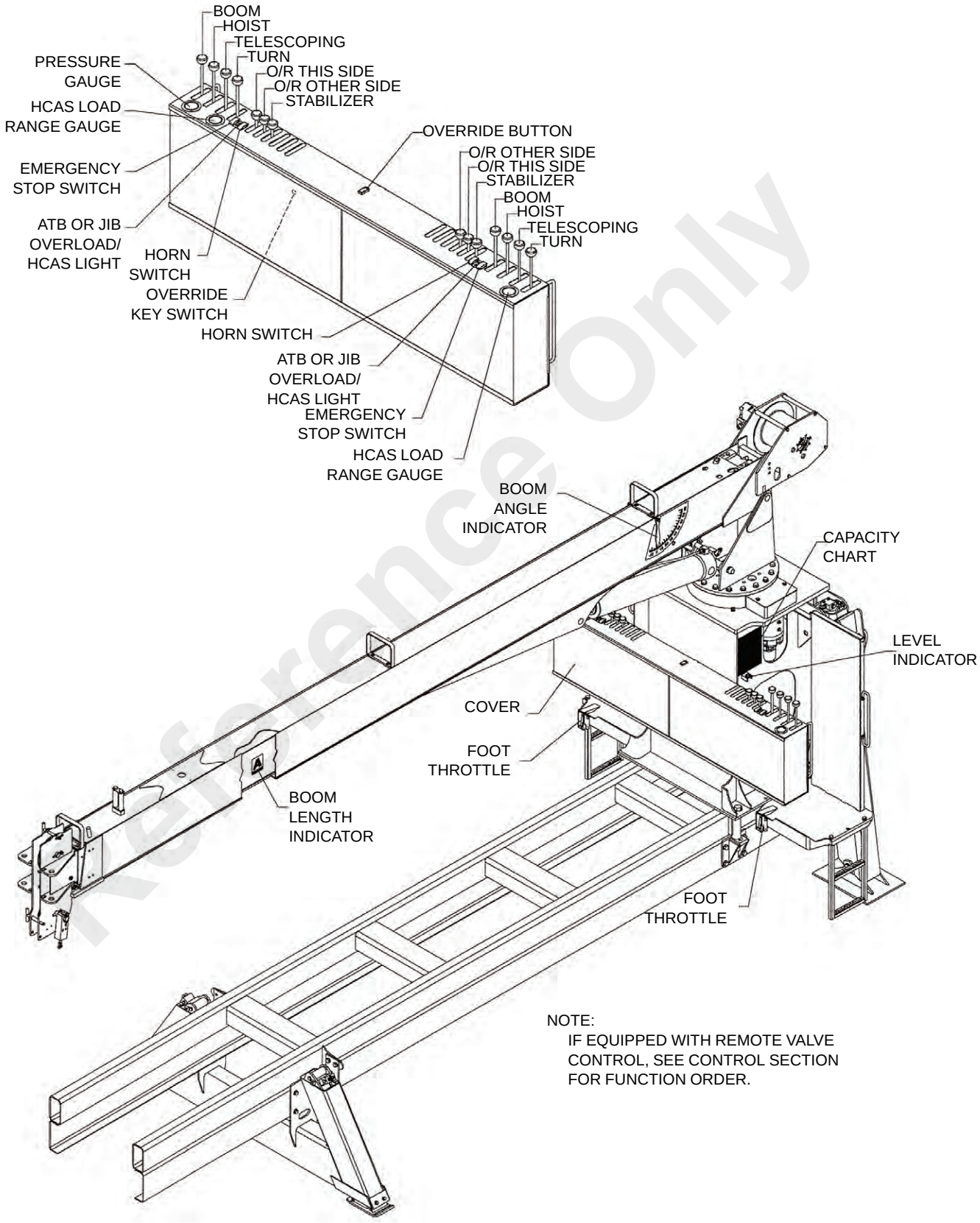
Boom Angle Indicator – Located on either side of the base boom section and used to determine main boom angle with respect to horizontal. For reference only.

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

Load Radius – Horizontal distance from the center of rotation of the turret to the center of the loadline hook or load with the load suspended. Use boom angle and boom length as a reference to determine loadline or load radius. When lifting maximum rated load, always know the weight of the load and measure the radius with the load suspended.

Reference Only

Crane nomenclature



Reference Only

OPERATING PROCEDURES

Equipment Familiarization

All members of the crew should become thoroughly familiar with the location and operation of controls, the correct operating procedure, the maximum lifting capacities and the safety precautions applicable to the unit before operating. This crane is a complex piece of equipment and can be overloaded in many ways. Carefully follow the operating procedures outlined below and in the instructional pages of the load rating chart at the operator's station.

Equipment Checks

Perform the following checks prior to placing the unit in operation:

- Inspect for any unusual conditions such as pools of hydraulic fluid or lubricating oil under the chassis, any outrigger which may have crept down or up and any signs of damage or improper maintenance.
- Check that the tires are inflated to the proper pressure.
- Check the level of the hydraulic reservoir.
- Check the operation of the “stop” and horn circuits.
- Check for missing and loose bolts.
- Check for damaged structural members and welds.
- Check all rope guides and cable keepers.
- Check all sheaves for free turning.
- Check the load line cable for kinks, broken strands or other damage in accordance with instructions in the “Lubrication & Maintenance” section.
- Check to see that the hydraulic hoses and fittings are in good condition and show no signs of leaking. The hoses should be free from cuts and abrasions and there should be no evidence of binding. Any damage or leakage should be repaired immediately.
- Check HCAS, anti-two-block system and jib load limiting device for proper operation.

Note: Consult truck manufacturer's manual for vehicle checks.

Pre-Operation Inspection and Calibration Verification

1. Check the electrical wiring connecting the various parts of the system for physical damage.
2. Check the anti-two-block switches and weights for free movement.

⚠ DANGER

The following tests shall be performed with care to prevent damage to the machine or injury to personnel. Proper functioning of the system requires successful completion of these tests before operating the machine.

If the operator cannot see the load handling device approaching the boom nose, he shall have an assistant (signal person) watch the load handling device. The operator shall be prepared to stop the machine immediately should the anti-two-block system not function properly as indicated by lighting the red warning light, soundIng the audible alarm (jib-equipped cranes) and locking the crane movements, hoist up, telescope out and boom down.

Check the anti-two-block alarm light and the audible alarm (jib-equipped cranes) by performing one of the following tests:

- By manually lifting the weight attached to the anti-two-block switches. When the weight is lifted, the audible alarm (jib-equipped cranes) should sound, the anti-two-block alarm light should light.
- Slowly raise the main boom load handling deVIce to create a potential two-block condition. When the load handling device lifts the weight, the audible alarm (jib-equipped cranes) should sound, the anti-two-block alarm light should light and the motion of the load handling device should be stopped. Lower the load handling device slightly to eliminate this condition.
- Slowly extend (telescope) the boom to create a potential two-block condition. When the load handling device lifts the weight, the audible alarm (jib-equipped cranes) should sound, the anti-two block alarm light should light and the boom telescope out function should be stopped. Lower the load handling device slightly to eliminate this condition.

⚠ CAUTION

If the light and audible alarm (jib-equipped cranes) do not function as described and the crane movements are not stopped, the system is not working properly. The malfunction shall be corrected before operating the crane.

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

Reference Only

Work Site Position

Always seek the best possible work site when parking the crane. An ideal parking location at a job site is firm, level, dry ground or pavement located in close proximity to the work station. Avoid uneven, rocky or muddy terrain, steep grades or locations with unnecessary overhead obstructions. Location should be selected such that outriggers can be fully extended and the legs come down on a firm level surface. Particular care must be taken in selecting a site position to the location of overhead power lines so that proper clearance conditions can be maintained. Ideally, one should select a location at which the boom could not come within minimum recommended distance of the power lines at full extension.

It is best to select a location on the site such that most of the lifting can be done over the outrigger support or rear of the truck.

Before Leaving The Cab

1. Position the truck so that the outriggers can be extended without encountering obstructions. Set the truck park brake securely and turn front wheels into the curb. Wheel chocks may be required under certain conditions.
2. With the gear shift in neutral, depress clutch (if equipped with a manual transmission), and engage the power takeoff by pulling out the shifting knob.
3. Bring the hydraulic system up to operating temperature (oil reservoir warm to the touch) by allowing the system to operate by actuating the outrigger retract lever with all outriggers fully retracted.

Crane Set Up

⚠ DANGER

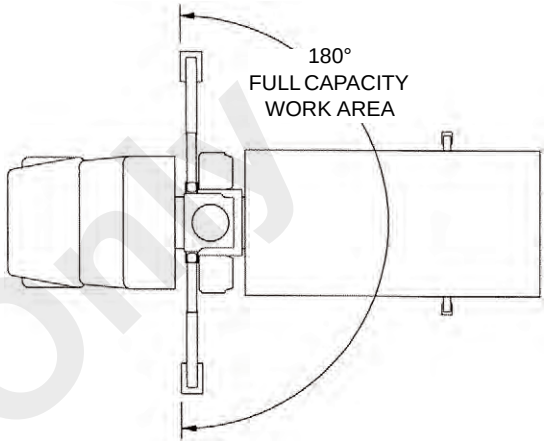
Do not operate the boom until all outriggers are extended and set providing firm support.

If operating on sloping ground provide blocks. When lifting is to be done on soft terrain or hot asphalt, support the outrigger and stabilizer pads with bearing pads. Some concrete and asphalt surfaces are relatively thin and cannot support outrigger or stabilizer loading. Concrete can break through and cause instability.

Variation in chassis, outrigger and mounting configurations will cause outrigger foot loading to differ on each crane, however, outrigger foot loads can be as high as 30,000 lb (13 608 kg) when outriggers are at full span [107 psi (0,7 MPa) on standard outrigger pads]. Support surface bearing capacities vary by a large amount—from 833 psi (5,7 MPa) on bed rock down to 14 psi (0,1 MPa) on soft clay. Loose sand or soft asphalt will support even less load. It is imperative that the operator take proper precautions to insure the outrigger foot has adequate cribbing for existing soil conditions.

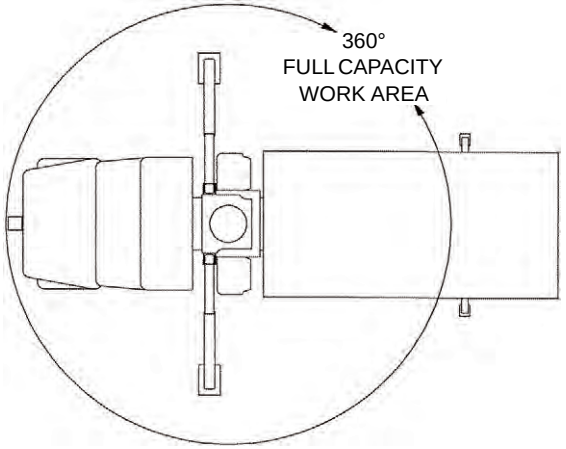
If specific outrigger foot loading is required for an individual crane, contact National Crane with actual chassis weights and crane details.

1. When Lifting Over the Rear of the Truck.



Before conducting any boom operations, extend both outriggers until the chassis weight is removed from the wheels. Level the crane from side-to-side. A level indicator is provided at either control station. Then extend and lower the rear stabilizers to level the crane front-to-back. Again refer to the level indicator to insure that the crane is properly leveled. Always keep the load as close to the ground as possible.

2. When Lifting Over the Front of the Truck and the Vehicle is Equipped with a Front Stabilizer.

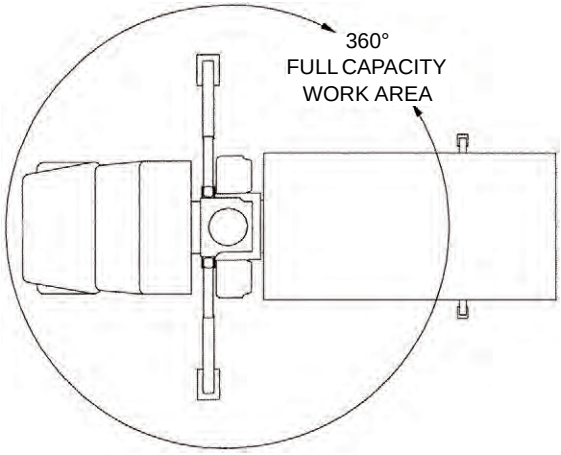


A front stabilizer is required when loads are to be lifted over the front of the vehicle. Before conducting any boom operations, extend both outriggers until the chassis weight is removed from the wheels. Level the crane side-to-side using the level indicator located at either control station as a reference. Then extend and lower the rear stabilizers to level the crane front-to-back. Again refer to the level indicator

Reference Only

to insure that the crane is properly leveled. After the crane is leveled side-to-side and front-to-back, extend the front stabilizer leg(s) until firm contact is made with the ground. Always keep the load as close to the ground as possible.

3. When lifting over the front of the truck and the vehicle is not equipped with front stabilizers.



This configuration is for occasional lifting over the front. If continually lifting over the front, the vehicle must be equipped with front stabilizer to eliminate fatigue on front axle components. Before conducting any boom operations, extend all outriggers to level the crane side to side. Then operate the stabilizers to level the crane front to back. A level indicator is provided at the control station. When setting outriggers, remove all of the vehicle weight from wheels but do not raise tires off ground. Once the weight is off the tires, little or nothing is gained by raising the vehicle further, and stability over the front (without front stabilizers) can be hampered by raising the vehicle excessively. Again refer to the level indicator to insure that the crane is properly leveled. Extreme caution must be used when operating in areas around the truck not supported by outriggers because of the cushion of tires and springs. Also, when swinging loads from areas supported by outriggers to areas not supported by outriggers, extreme caution must be used because of a potential sudden shifting of the support point. Always keep the load as close to the ground as possible when operating.

⚠ DANGER

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

4. Check to ensure that the jib, if so equipped, is stowed correctly on the first section boom.

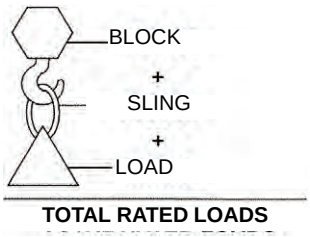
Before Making The Lift

1. Check all controls for proper operation by operating each system through one complete cycle. This is particularly important after the unit has been serviced or repaired. If any abnormal operations are detected, correct the condition before continuing.
2. During all operations, the controls should be metered when beginning or terminating a movement to prevent sudden starting or stopping which imposes undue shock loads on the equipment. This metering can be performed by metering the control lever and the foot throttle.
3. Check the operating area for electric power lines.

Reading And Understanding The Load Charts

The structures and components of your unit are designed to provide satisfactory service if the unit is not loaded in excess of the maximum rated loads specified on the load chart. Overloading can create serious potential safety hazards and can also shorten the service life of your unit. It is important that you know the weight and radius of any load that you are attempting to handle. This should be done by use of a dynamometer and tape measure or by contacting your supervisor.

Overloading a crane can cause many types of failure depending on the configuration and working position of the crane, i.e. structural damage to almost any part of the crane, hoist or cable failure and tipping the unit over.



The load chart shows the maximum rated loads including load (weight being lifted), load handling equipment such as slings, buckets, and downhaul weights, etc. which can be handled by the crane and the hoist. The weight of the load handling equipment and boom attachments must be deducted from the maximum load rating shown on the load chart to determine the payload which can be lifted. Additional reduction may be necessary to make allowance for such factors as the effects of freely swinging loads, wind, ground conditions, out-of-level conditions and operating speeds.

The ratings shown on the outrigger full span load chart are maximum loads and are based on the structural integrity of the crane in shaded areas, the stability of the crane in non-shaded areas. The stability or non shaded areas represent a stability tipping factor of 85% when:

1. All outriggers are extended with positive contact on firm, level surface, the tires are free of the ground and the machine is level within 1°.

Reference Only

2. The proper amount of counterweight has been installed, if required.
3. The unit is mounted in accordance with factory instructions on a vehicle with proper specifications.
4. The weight of load handling devices is considered as a part of the load being lifted.
5. The correct loadline reeving is used for the load to be lifted.
6. Adverse environmental conditions such as wind are not present.
7. The operator controls the loads smoothly.
8. Tires are inflated to the proper pressure.
9. The load to be handled does not exceed the maximum capacity at the boom length and loaded radius.
10. The loads are lifted in the proper area around the truck.

A stability test should have been performed on this crane and can be repeated by referring to the Installation Section.

All capacities are given in direct relationship to the boom length and loaded radius at which the load is being handled. All radii are measured from the centerline of rotation to the loadline with the load suspended. All variances of loads and radii of operation are shown on the load capacity chart mounted on the main frame. Boom angle should be used as reference only to aid in determining radius. The correct loaded radius must be measured and not exceeded during any point of the lifting operation. The placard is located at the operators platform for the purpose of informing the operator when a load can or cannot be handled. Load ratings cannot be interpolated between load points shown on the chart in the boom areas. When boom length or radius or both are between points listed on capacity chart, the smallest load shown at either the next larger radius or boom length shall be used. Capacities of the jib cannot be interpolated between angles nor at reduced lengths because the strength of the jib and its attachment point to the boom does not increase when the boom is shortened.

General

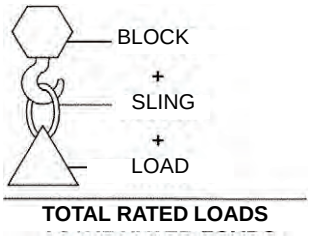
1. The equipment can be hazardous if improperly maintained or operated. Read and comply with the Operator's Manual supplied with this machine for information on safety, operation and maintenance before operating this machine. If these manuals are missing, order replacements from National Crane through the distributor.
2. Rated loads shown on the capacity chart pertain to this machine as originally manufactured and equipped. Modifications to the machine or use of equipment that is not factory specified or approved can be hazardous. Refer to capacity deduction chart for weights which must be deducted from rated loads when accessories are attached to boom or loadline.

Set-Up

1. Inspect vehicle and crane including crane operation prior to use each day.
2. Load ratings shown on the chart are maximum allowable loads with the crane mounted on a factory approved truck and all outriggers set on a firm level surface so the crane is level. This crane is not rated for use without outriggers.
3. Depending on the nature of the supporting surface, structural supports under the outrigger floats may be necessary to spread the load to a larger bearing surface.
4. Always level the crane with the level indicator located at the operator stations located on either side of the crane frame.

Operation

1. Operation of this equipment in excess of maximum load rating and disregard of instructions is hazardous. Always refer to the capacity chart for load and area limits before operating the crane. Rated loads at rated radius shall not be exceeded. Over loading this crane may cause structural collapse or instability. Do not rely on the HCAS system to weigh the load and control limiting boom angle and radius. Use the system as a backup to safe operation.
2. Use the angle indicator as a reference only. When lifting maximum loads, measure radius.
3. Rated loads do not exceed 85% of the tipping load as determined by SAE Crane Stability Test Code J765a when mounted on a factory recommended truck. Structural limited ratings on the capacity chart are shaded. Stability limited loads are not shaded. Machine will not always tip before structural damage occurs.



4. Rated loads include the weight of the hook block, slings, other lifting devices and boom accessories. Their weights must be subtracted from the listed rated load to determine the net load that can be lifted.
5. Rated loads are based on freely suspended loads. Always position the boom tip directly over the load

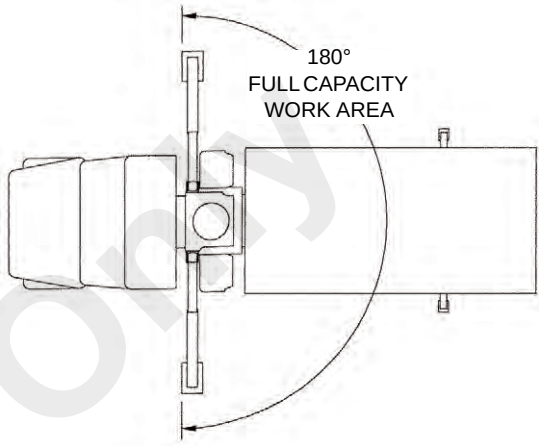
Reference Only

before lifting. No attempt shall be made to push down with the boom or move the load sideways in any direction by pulling or dragging the load.

6. The user shall operate at reduced ratings to allow for adverse job conditions such as soft or uneven ground, high winds or erratic operation which produce swinging (side) loads, experience of personnel, two machine lifts, or other hazardous conditions for safe operation.
7. When boom length or radius or both are between points listed on capacity chart, the smallest load shown at either the next larger radius or boom length shall be used.
8. Do not exceed jib capacities at any reduced boom length. If jib is between angle ratings on capacity chart, the smallest load shall be used.
9. It is safe to attempt to telescope or retract any load listed if rating is not exceeded. Capacities at retracted boom length cannot be telescoped without exceeding ratings.
10. Always pay out loadline before extending boom to avoid damaging loadline or crane structure.
11. Loads lifted must be within safe hoist capacity as well as safe crane capacity. Multiple part rope reeving must be used on loads exceeding hoist single part rated pull. Jibs are rated for single part use only.
12. Do not operate the boom over personnel or allow them to walk or stand beneath the boom or load.
13. Do not allow personnel on truck bed or crane frame area when operating crane.
14. Do not allow personnel to ride on hook, hook block, load or any device attached to the loadline. Use only National Crane approved baskets.
15. Operate controls slowly and smoothly to avoid damage to crane or personnel.
16. Boom must be in carrying rack and outriggers fully retracted for travel.
17. Do not operate crane within 10 ft (3,05 m) of live power lines.

Definitions

1. Load Radius-Horizontal distance from the centerline of rotation before loading to the center of the vertical load line or block with load applied.
2. Loaded Boom Angle-Loaded boom angle is the angle between the first section boom and the horizontal, after lifting the rated load at the rated radius. The boom angle before loading should be greater to account for deflections. The loaded boom angle combined with the boom length give only an approximation of the operating radius.
3. Working Area-Area measured in a circular arc above the center line of rotation as shown on the Working Area diagram. If no decal is present the work area is 360°.



WORK AREA DIAGRAM

4. Freely Suspended Load-Load hanging free with no direct external force applied except by the loadline.
5. Side Load-Horizontal side force applied to the lifted load either on the ground or in the air.
6. Boom Length-Length of the boom, from center line of rotation to wire rope on last main boom section. A decal on either side of the boom shows when certain boom lengths are reached. The letters on the intermediate boom lengths correspond to the letters on the capacity chart.
7. Range Diagram-Corresponds to the pictorial in the Capacity Chart. It shows the operating radius and height of the unloaded boom tip at all boom lengths and angles. It should be used as a guide to position unloaded loadline and to determine approximate height to which the load can be lifted.

The following procedure is a typical method which must be used to determine the crane's ability to handle a load. The crane is equipped with a standard hoist:

1. Determine the weight of the load and load handling equipment.
2. Determine the radius from center line of crane rotation to position of load.
3. Determine the radius from centerline of crane rotation to center of point where load is being moved to.

Reference Only

4. Refer to Capacity Chart for crane and determine that load and radius of lifting are within capacity of crane.
5. Refer to Capacity Chart for hoist to determine hoist reeving is proper.

The following examples are for illustrative purposes only. The examples utilize the capacity chart shown. The load chart ratings, component weights and dimensional data may not be the same as the actual unit. Always use actual information from the crane and job site when planning a lift.

Example 1

A load is to be lifted from the ground and weighs 1600 lb (726 kg) at a radius of 10 ft (3,04 m). It will be placed on the roof of a building at a radius of 30 ft (9,14 m) and a height of 30 ft (9,14 m) above the ground on the opposite side of the truck.

Step 1. Determine the load.

Load =	1600 lb	(726 kg)
1 Part Load Block =	90 lb	(41 kg)
Sling =	30 lb	(14 kg)
	1720 lb	(780 kg)

Step 2. Starting Radius

Given = 10 ft (3,04 m)

Step 3. Ending Radius

Given = 40 ft (12,19 m)

Step 4. Refer to crane Capacity Chart.

Starting point: Assuming the boom is fully retracted [15 ft 2 in (4,62 m) boom length], the capacity at a 10 ft (3,04 m) radius is 9800 lb (4445 kg).

In order to get the load on the roof, the load must be hoisted from the ground, swung around the rear of the truck (deadspot in rotation is over the cab), boom extended to 56 ft (17,07 m) extension, load hoisted to a height that will clear the top of the building, boom rotated to the point load is to be placed, boom tip lowered to 40 ft (12,19 m) radius and load lowered to building roof.

Ending Point: The load rating at the ending point is 1950 lb (885 kg). The boom will be at 56 ft (17,07 m) extension and the loaded radius is 40 ft (12,19 m).

The crane has enough capacity at each end of the lift to allow the lift to be made.

Step 5. Lastly refer to hoist Capacity Chart.

- Crane is reeved for single part line.
- Allowable load for single part line is 5840 lb (2649 kg) well above the 1720 lb (780 kg) to be lifted.

Operator should now proceed to lift the load as smoothly as possible.

Note: This load could not be lifted if the jib were being used on this machine as maximum capacity of the 18 ft jib at 40 ft (12,19 m) radius would only be 1300 lb (590 kg) at 59°. Note that the capacities remain the same even with the boom retracted. Also note this hoist can lift 5840 lb (2649 kg) while the boom is only able to withstand 1950 lb (885 kg) at 40 ft (12,19 m) radius. Therefore, one could easily damage crane by attempting to pull until hoist stops with a heavier load.

Example 2

Assume a load of 7000 lb (3175 kg) at 10 ft (3,04 m) radius on the ground beside the truck to be picked up, swung over and placed on the truck bed at an 6 ft (1,83 m) radius from the crane. Crane is reeved for single part.

Step 1. Weight of load and load handling equipment.

Load =	7000 lb	(3175 kg)
1 Part Line Block =	90 lb	(41 kg)
Slings =	50 lb	(22 kg)
	7140 lb	(3239 kg)

Step 2. Starting Radius

Given = 10 ft (3,04 m)

Step 3. Ending Radius

Given = 6 ft (1,83 m)

Step 4. Refer to crane Capacity Chart.

Using information in Example 1, Step 4, the crane capacity at the 10 ft (3,04 m) point is 9800 lb (4445 kg). Of course, at the 6 ft (1,83 m) radius, the capacity would be substantially more. Therefore, the crane capacity is adequate.

Step 5. Refer to hoist Capacity Chart.

The capacity of a 1 part line is 5840 lb (2649 kg), which is less than load to be lifted. Crane must be reeved for 2 part to lift the 7000 lb (3175 kg) load.

Note: Two part hoist capacity is 11,680 lb (5 298 kg).

Actually when one puts on the 2 part block, the load block weighs approximately 100 lb (45 kg) rather than the 90 lb (41 kg) figured in Step 1 so actual load lifted is 7150 lb (3243 kg). Load [7000 lb (3175 kg)] + 2 part block [100 lb (45 kg)] + slings [50 lb (22,67 kg)].

Reference Only

Example 3

A load of 1000 lb (454 kg) is to be lifted from the roof of a building at a radius of 30 ft (9,14 m) and a height of 70 in (21,33 m) and placed on the ground on the other side of the truck at a radius of 40 ft (12,19 m).

Step 1. Weight of load and load handling equipment.

Load =	1000 lb	(454 kg)
1 Part Line Block =	90 lb	(41 kg)
Slings =	30 lb	(14 kg)
	1020 lb	(508 kg)

Step 2. Starting Radius

Given = 30 ft (9,14 m)

Step 3. Ending Radius

Given = 40 ft (12,19 m)

Step 4. Refer to Crane Capacity Chart.

To reach the load on the roof, the jib must be utilized to clear the roof with the load. ***Important: Do not attempt to deploy the jib until reading and understanding jib operation information found later in this section of the manual.*** Both the retracted 18 ft jib length and extended 29 ft jib length have the necessary capacity at a 30 ft (9,14 m) radius. Only the retracted 18 ft jib has the capacity at the 40 ft (12,19 m) radius to accomplish the task.

Starting Point: With the 18 ft jib deployed and the boom fully extended, the capacity is 1750 lb (794 kg) at a 30 ft (9,14 m) radius and boom angle of 68°.

Ending Point: With the main boom still fully extended, the capacity is 1300 lb (590 kg) at a radius of 40 ft (12,19 m) and boom angle of 59°.

Note: The capacity of the jib remains the same even with the main boom retracted. Operate with jib by radius when main boom is fully extended and operate with jib by boom angle when main boom is not fully extended. Do not exceed rated jib capacities at any reduced boom lengths.

Step 5. Refer to hoist Capacity Chart.

The capacity of a 1 part line is 5840 lb (2649 kg) which is well above the 1020 lb (463 kg) to be lifted.

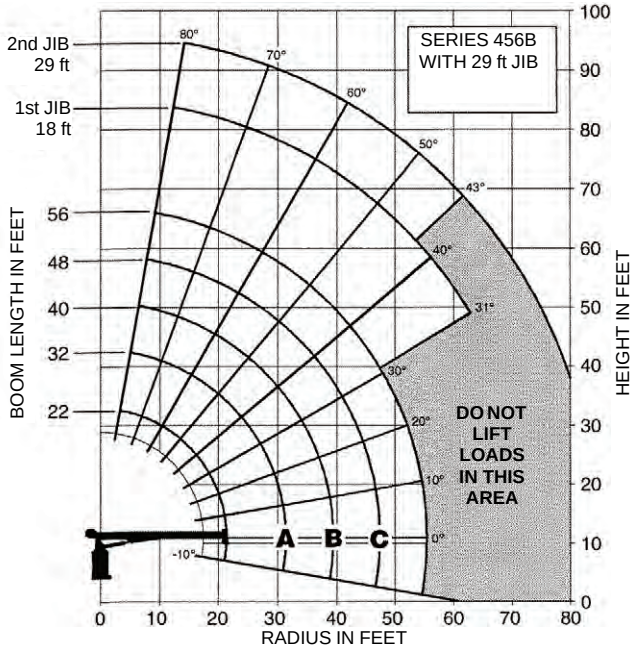
Note: The HCAS Load Range Gauge does not provide accurate indication of overload conditions when operating with a jib deployed. The Hydraulic Capacity Alert System will not prevent the crane from being operated in an overload condition. The jib is equipped with a jib load limiting device which will prevent the jib from being operated in an overload condition.

The operator should proceed to lift the load as smoothly as possible.

Reference Only

877775

NATIONAL CRANE CORPORATION



NOTE:

1. Operate with jib by radius when main boom is fully extended. If necessary increase boom angle to maintain loaded radius.
2. Operate with jib by boom angle when main boom is not fully extended. Do not exceed rated jib capacities at any reduced boom lengths.

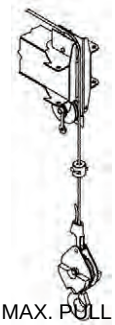
LOADLINE EQUIPMENT DEDUCT (lb)

Downhaul weight _____	90
One sheave block _____	185
Two sheave block _____	355

LOAD RATINGS

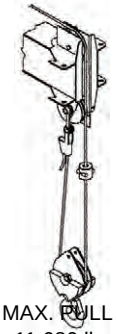
LOAD RADIUS (ft)	LOADED BOOM ANGLE	22 FT BOOM (lb)	LOADED BOOM ANGLE	A 32 FT BOOM (lb)	LOADED BOOM ANGLE	B 40 FT BOOM (lb)	LOADED BOOM ANGLE	C 48 FT BOOM (lb)	LOADED BOOM ANGLE	22 FT BOOM (lb)	LOAD RADIUS (ft)	LOADED BOOM ANGLE	18 FT JIB (lb)	LOADED BOOM ANGLE	295 FT JIB (lb)
5	77.5	20.000													
6	74.5	17.100													
8	70	12.600	76.5	10,800	79.5	10,300									
10	63	9800	73	8700	77	8550									
12	56.5	8600	69	7500	74	7150	76.5	7050							
14	50	7600	65	6700	70.5	6250	75	6050	77	5850	14	80	2800		
16	42.5	6700	61	5900	68.5	5550	72.5	5300	75.5	5100	16	78.5	2700		
18	34	5900	57.5	5300	65	5050	69.5	4800	73.5	4550	18	77	2500	79.5	1850
20	23	5200	53	4900	62	4650	67.5	4500	71	4150	20	75.5	2300	78	1800
25			40.5	3900	53.5	3750	61	3600	65.5	3350	25	72	2050	75	1550
30			22.5	3050	43.5	3050	53.5	2900	60	2750	30	68	1750	71.5	1350
35					31	2500	45.5	2500	53.5	2350	35	63.5	1500	68	1150
40							36	2000	46.5	1950	40	59	1300	64	1000
45							22.5	1650	39	1600	45	54.5	1100	60.5	900
50									29	1350	50	49.5	1000	56.5	800
55									13	1000	55	44	850	52.5	700
60											60	38	750	48	600
65											65	31	650	43	550
	0	3850	0	2200	0	1550	0	1,50	0	800					

1 PART LINE



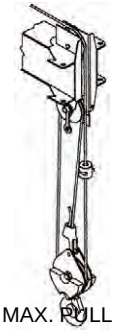
MAX. PULL
5,840 lb

2 PART LINE



MAX. PULL
11,680 lb

3 PART LINE



MAX. PULL
17,520 lb

4 PART LINE



MAX. PULL
20,000 lb

NOTICE

- Do not deadhead line block against boom tip when extending boom.
- Keep at least 3 wraps of loadline on drum at all times.
- Use only 1/2 in diameter rotation resistant cable with 29,200 lb breaking strength on this machine.
- Maximum capacity with “burst of speed” is 3000 lb.

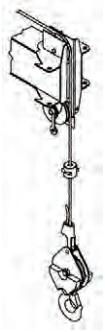
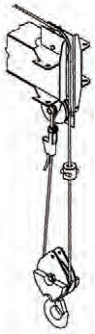
Reference Only

Hoist System Operation

The hoist is mounted at the rear of the first section boom. It has capacities totally independent of the rest of the crane and can normally pull more than the crane itself can withstand. Therefore, care must be taken to insure that the load being lifted is within boom rating. To lift some of the heavier loads on the capacity chart, it will be necessary to multiple part reeve the hoist block to increase the lifting capacity of the hoist (the speed is proportionately slower) and remain in the strength limitations of the hoist and wire rope.

Using Multiple Part Lines

The hoist load rating chart on each machine provides the information for pull limitations on the hoist with various applicable part reevings. These ratings are based on providing the proper operating safety factor on the wire rope supplied with the machine. Therefore, any replacement rope must meet the rope specification sections of this manual.

1 PART LINE	2 PART LINE	3 PART LINE	4 PART LINE
			
MAX. PULL 5840 lb	MAX. PULL 11,680 lb	MAX. PULL 17,520 lb	MAX. PULL 20,000 lb

General Rules When Operating Hoist

1. Always operate the hoist control to payout the loadline while extending the boom. This will maintain clearance between the boom tip and loadline hook.
2. Do not rely on anti-two-block system to eliminate two blocking. Use the system as a backup to safe operation.
3. Make certain the hoist cable is not twisted or kinked and that cable is properly seated on the drum and in the sheaves.
4. Before lifting a load, always make certain that three full wraps of rope will remain on the drum at all times throughout the lift.
5. When lifting a load approaching the rated hoist load, raise the load a few inches and return the control to neutral to determine if the brake is working properly.
6. Do not drag loads in any direction with the hoist
7. Never attempt to lift loads which are not loose and free, i.e. frozen down material or poles out of ground.
8. Maintain tension on the loadline at all times to prevent the cable from becoming twisted or kinked or improperly seated on the hoist drum or sheaves.

Lifting The Load

After the vehicle and crane have been properly set up and it has been determined the load to be lifted is within the ratings of the crane and hoist reeving system, again check the work area for electric power lines and other obstructions so that proper clearances can be maintained. (See Safety Rules.) If load is not visible to operator throughout lift, a person must be appointed to use hand signals as shown on the last page of this section. Proceed with lifting the load.

1. Rotate, extend or move up or down until boom tip is directly over the load.
2. The crane is normally equipped with a rotation stop. It is important that you be aware of the position of the stop before lifting in order to assure maximum rotation and prevent excessive handling of the load.
3. During operations, the controls should always be metered when beginning or terminating movement to prevent sudden starting or stopping, which imposes undue shock loads on the equipment. This is especially true when handling heavy loads. The control should be slightly actuated to begin movement and then slowly increased to desired operating speed. The results obtained from metering the oil flow with the control lever can also be aided by carefully coordinating the throttle control.

Reference Only

4. Lower loadline and attach load.
5. Control load by use of a non-conductive tag line.
6. Do not leave crane unattended with the boom elevated in operating position. Always secure the boom in the boom rest before leaving the work area.

Shutting Down And Preparing For Road Travel

1. Completely retract boom and place securely in boom rest.
2. Secure loadline block so that it cannot swing freely.
3. Anti-Two Block (A2B) Switch to prevent damage to the A2B switch, consider the following (See page 14):

   With loadline hook stowed properly, verify downhaul weight is resting against the terminator wedge socket bracket. Slack in the chain assembly must be present in order for weight to be removed from A2B switch.

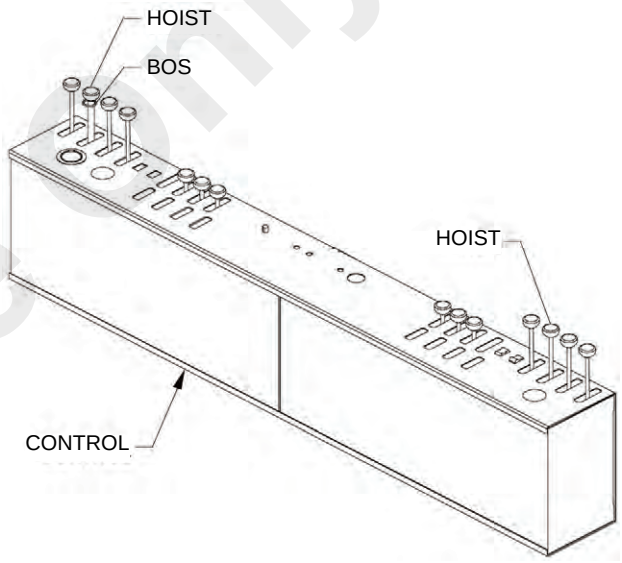
   DO NOT SHORTEN CHAIN AT ANYTIME.

   If slack in the chain assembly is still not present, add straps between anchor point and hook block to achieve weight removal from the A2B switch.
4. Retract all outriggers/stabilizers. Optional front stabilizer should always be retracted first, before main outriggers are retracted.
5. Secure any loads or lifting devices on truck bed or body.
6. Disengage Power Take Off (PTO).
7. Release park brake before moving truck.
8. When traveling on the road, check all underpasses to be sure there is sufficient clearance for the unit.

Optional Hoist Burst Of Speed Operation

The “Burst of Speed” will increase hoist line speed 60% over normal operation by diverting oil from the multi bank control valve to the hoist valve.

The “BOS” is engaged by operating the hoist control valve lever while pulling up on the BOS handle below the hoist knob. The “BOS” feature should only be operated in a temporary manner to reduce oil heat build up, prevent truck PTO overloading, and provide independent operation of the crane and hoist (normal hoist speed will not decrease when crane functions are used). If the “BOS” feature is run continuously or with an overload, damage to the crane or truck could occur. To start the “BOS” smoothly, first pull up on the BOS handle then operate the hoist lever. To stop the “BOS” smoothly, return the hoist lever to its neutral position then release the BOS handle.



Note: Maximum Capacity with “BOS”

- One Part Line - 3000 lb (1361 kg)
- Two Part Line - 6000 lb (2722 kg)
- Three Part Line - 9000 lb (4082 kg)
- Maximum line speed on third layer - 206 fpm (62 mpm), fourth layer - 225 fpm (68 mpm)

Reference Only

ANTI-TWO BLOCK SYSTEM

Description/operation

With untrained or inexperienced or distracted operators, two blocking the hoist cable is a very real possibility. When the hoist cable and end attachments contact the underside of the sheave case, whether by hoisting up or extending the boom without paying out the hoist cable, the hoist cable can be damaged by crimping or over tensioning.

The anti-two-block system provided on your National Crane can help prevent cable damage by sensing the position of the hoist cable end attachments with respect to the sheave case and disabling the functions that can cause a two block condition.

The anti-two-block system consists of normally open, work port unloader valves in the main and hoist control valves. When the cartridge solenoid is energized, the crane functions normally, when de-energized, the oil to the boom extend, boom down, and hoist up crane functions are diverted to tank. These solenoids are controlled by a limit switch, which is attached to the boom or jib sheave case. This switch is held in the closed position by a chain suspended weight. The weight, which is looped around the hoist cable, causes the contacts to remain closed until the hoist cable end attachments contact the weight and release the tension on the switch. At this point the contacts in the switch open, breaking electrical continuity through the circuit provided by the internal anti-two-block cord routed with a reel or through the boom. When this continuity is broken, the unloader cartridges de-energize and divert the function oil to tank.

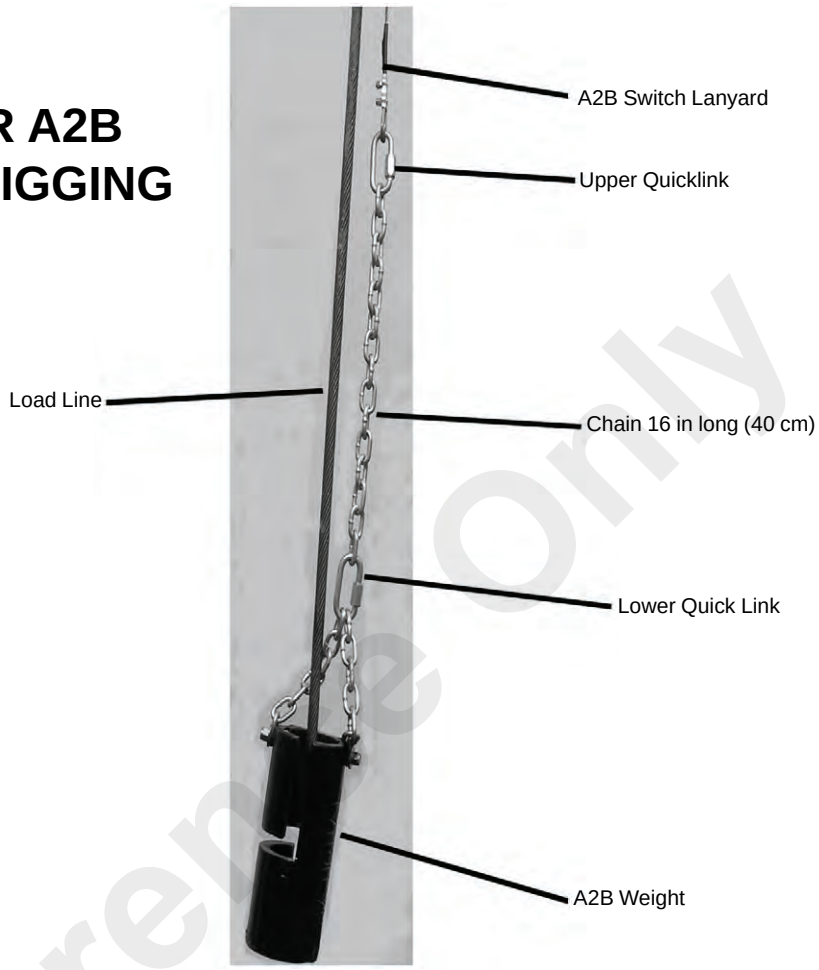
An audible and visual warning of the two block condition is provided by the display console of the RCL system. See RCL operators handbook for additional information.

If the machine is equipped with an optional Hydraulic Capacity Alert (HCA) system, an indicator light provided on the console will alert the operator when a two block condition is detected

Normal functioning is restored by hoisting down (or retracting boom) until the weight is once again suspended freely. Occasionally if the hoist up and boom extend functions are operated at maximum speed in the dump mode, the back pressure induced in the circuit will cause the hoist up or boom extend functions to creep slightly (with no load on the hook). Such a condition is not cause for alarm, as the back pressure is not of sufficient magnitude to damage the cable or end connections.

Reference only

PROPER A2B WEIGHT RIGGING



HYDRAULIC CAPACITY ALERT SYSTEM

System Description

The hydraulic capacity alert system is a hydraulically operated, maximum capacity sensing device that will stop all of the normal crane functions that cause overload when maximum capacity is exceeded. In the event that an over capacity condition occurs, the hydraulic capacity alert system is actuated by sensing excessive pressure in the lift cylinder which causes the boom down, extend out and hoist up functions to become inoperative. These are the functions that increase the over capacity condition. This system allows for continued operation of the hoist down, boom up and boom retract functions, the functions that normally allow the operator to bring the load to a shorter operating radius or set the load down in order to eliminate an over capacity condition. Once the excessive cylinder pressure has been reduced by bringing the load to a shorter radius or setting the load down, normal operation can be resumed. This hydraulic capacity alert system uses the work port unloader valves in the anti-two-block system as the hydraulic system dump circuit.

Two indicator lights located on the operator's console alert the operator of function power loss and discriminate between the hydraulic capacity alert and the anti-two-block systems as the cause of power loss. If crane is equipped with optional audible alert, an audible alarm will sound in an overload condition. **Do not use the override to continue lifting operations in an overload or two blocked condition.**

Reference Only

HYDRAULIC CAPACITY ALERT
ANTI-TWO-BLOCK
OVERRIDE

DANGER

HOLDING THIS OVERRIDE TO INCREASE LOADING OR TWO BLOCK THE CRANE WILL RESULT IN
DEATH OR SERIOUS INJURY
TO CORRECT THE CONDITION CAUSING THE CRANE SHUTDOWN REFER TO OWNERS MANUAL

876452

The hydraulic capacity alert system provides a load range gauge at each operator station. This gauge has three colors on the dial face: (1) Green – OK; (2) Yellow – Caution; and (3) Red – Overload. The gauge is plumbed directly to the lift cylinder and the indicator position can be used as an aid in determining the load condition of the crane. The lift control lever must be moved from boom up position to the neutral position to get the most accurate reading when using load range gauge. **Do not use the load range gauge with a jib.**

System Operation

The capacity alert system will operate as stated in the System Description Section. Once an over-capacity condition is reached, the system will not allow the operator to move the load to a greater radius. The truck may have to be repositioned closer to the load in order to set the load at the desired location.

When trip pressure is reached, the pressure sensing switch breaks electrical continuity to the cartridge solenoid valve in the main control valve. When power is removed from this solenoid, the unloader valves allow the oil flowing to hoist up, telescope out and boom down to flow to tank. This path to tank will prevent further operation of these functions. When the overload condition is corrected by hoisting down, retracting the boom, or raising the boom, the pressure sensing switch allows the solenoid to be powered thereby allowing the crane to function normally.

During the operation at near capacity loads, care must be taken to operate the controls smoothly or the system may be shocked into the dump mode prematurely.

Caution should be exercised when operating near 80° of boom elevation. If the boom lift cylinder is fully extended and pressurized above trip pressure, the system solenoid will deactivate and the boom will remain locked at 80°. To correct this condition, momentarily actuate the override key switch & push button to bleed off trapped pressure. See Controls & Hydraulics Section for additional description of this system.

The override system consists of a key switch and a momentary push button switch. The key switch provides power to the momentary push button switch located on the console. To momentarily override, activate key switch and depress push button on console. This will activate the anti-two-block solenoid and return power to hoist up, telescope out, and boom down functions. The override switch is not to be used during normal use of the crane or as an aid in using the crane in an overload or anti-two blocked condition.

The load range gauge is provided to aid the operator when operating near the rated capacity of the crane. The gauge only provides accurate indication when the lift control lever is in neutral. The gauge movement is not proportional to the load on the hook. It is not unusual for the indicator to be in the red area at less than rated load condition when operating the lift control, especially during boom down operation.

Reference Only

JIB LOAD LIMITING DEVICE

System Description

The jib load limiting device is an electro-mechanically operated, maximum capacity sensing device that will stop all of the normal crane functions that cause overload when maximum capacity of the jib is exceeded. In the event that an over capacity condition occurs, the jib load limiting device is actuated by sensing excessive force on a load cell which causes the boom down, extend out, and hoist up functions to become inoperative. These are the functions that increase the over capacity condition. On jibs with a manually extendable section, a configuration switch operated by the extension retaining pin distinguishes between an extended jib and a retracted jib. This system allows for continued operation of the hoist down, boom up, and boom retract functions, the functions that normally allow the operator to bring the load to a shorter operating radius or set the load down in order to eliminate an over capacity condition. Once the excessive force on the load cell has been reduced by bringing the load to a shorter radius or setting the load down, normal operation can be resumed. This system uses the work port unloader solenoid in the anti-two-block system as the hydraulic system dump circuit.

The jib load limiting system has an override switch and button located on the operator's console that momentarily overrides the hydraulic capacity alert, the jib load limiting device, and the anti-two-block system and restores power to crane functions. Two indicator lights located on the operator's console alert the operator of function power loss and discriminate between the hydraulic capacity alert and the anti-two-block or jib load limiting systems as the cause of power loss. In the event of a two-block or jib overload condition, an audible alarm will sound in addition to the lighting of the indicator light. **Do not use the override to continue lifting operations in an overload or two blocked condition**.

System Operation

The jib load limiting device will operate as stated in the System Description Section. Once an over-capacity condition is reached, the system will not allow the operator to move the load to a greater radius. The truck may have to be repositioned closer to the load in order to set the load at the desired location.

When trip force is reached, the jib load limiting device breaks electrical continuity to the work port unloader solenoid in the main control valve. When power is removed from this solenoid, the unloader valves allow the oil flowing to hoist up, telescope out and boom down to flow to tank. This path to tank will prevent further operation of these functions. When the overload condition is corrected by hoisting down, retracting the boom, or raising the boom, the jib load limiting device allows the work port unloader solenoid to be powered thereby allowing the crane to function normally.

During operation at near capacity loads, care must be taken to operate the controls smoothly or the system may be shocked into the dump mode prematurely.

The override system consists of a key switch and a momentary push button switch. The key switch provides power to the momentary push button switch located on the console. To momentarily override, activate key switch and depress push button on console. This will activate the work port unloader solenoid and return power to hoist up, telescope out, and boom down functions. The override switch is not to be used during normal use of the crane or as an aid in using the crane in an overload or two-blocked condition.

Reference Only

⚠ CAUTION

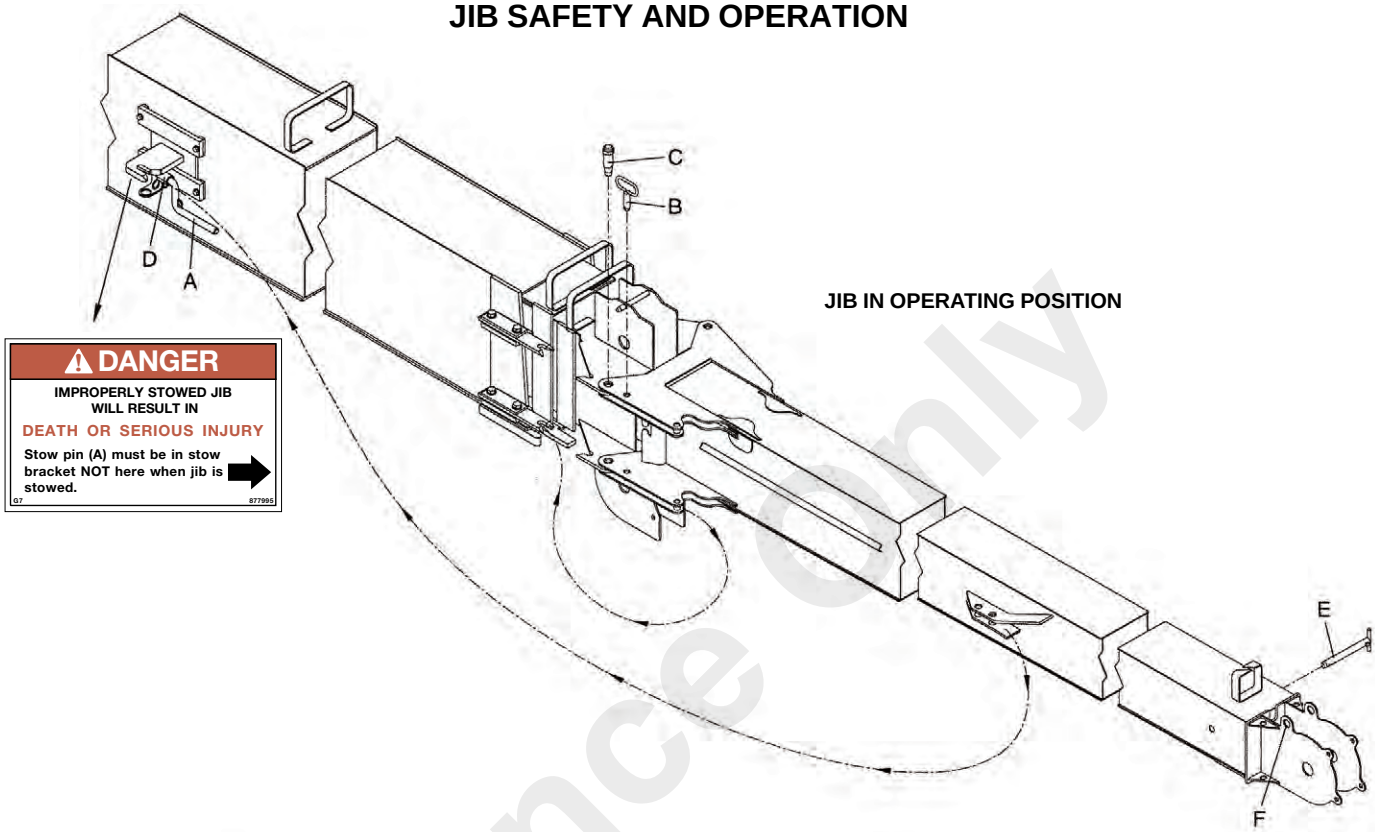
The Hydraulic Capacity Alert System and the Jib Load Limiting Device are intended to be used as aids to prevent most overload conditions. **Do not use the Hydraulic Capacity Alert System and the Jib Load Limiting Device as substitutes for safe operating practices as outlined in the "SAFETY AND OPERATION" section of this manual.**

Do not expect the Hydraulic Capacity Alert System and the Jib Load Limiting Device to detect all possible overload conditions. These systems **will not** prevent structural or stability overloads to the crane or hoist caused by:

1. Freely swinging loads or operating in an out-of-level condition which will result in excessive side loading.
2. Side loading due to pulling sideways on the boom with boom rotation or load hoist. Load must always be directly under boom tip.
3. Sudden load movements from erratic operation of the crane functions which will result in excessive shock loading.
4. Improper loadline reeving for loads larger than single line pull capacity.
5. Extending the boom without first paying out the loadline which can result in deadheading (two blocking) the loadline against the boom tip.
6. Loads in excess of capacity when operating with a jib deployed.
7. Loads with lift cylinder fully retracted.
8. Excessive induced loading during auger system operation.
9. Operation without outriggers and stabilizers fully deployed or inadequate footing for the outriggers and stabilizers.

Reference Only

JIB SAFETY AND OPERATION



JIB IN OPERATING POSITION

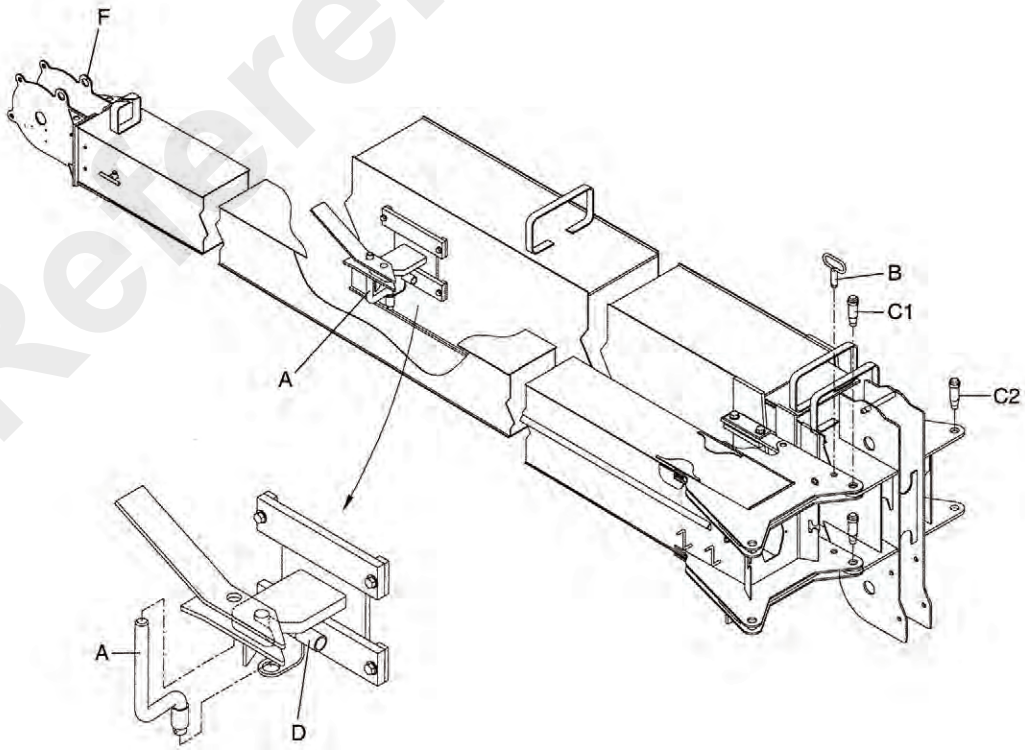
DANGER

IMPROPERLY STOWED JIB WILL RESULT IN

DEATH OR SERIOUS INJURY

Stow pin (A) must be in stow bracket NOT here when jib is stowed.

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JIB IN STOW POSITION

Reference Only

Safety Tips For Jib Operation

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

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

   b. When angle is between points listed on capacity chart, the load shown at next lower boom angle shall be used.
5. Ensure jib is stowed correctly.

   a. Removal of swing around pins, C, without proper installation of stow pin A and pin B, may allow jib to fall off.

   b. Extending boom with jib stowed and failure to remove swing pin, C, will damage unit upon extension.
6. Only attempt to swing jib to working or stowed position when boom is horizontal, stow pin A and pin B, are removed and swing pins, C, are in place. Jib could swing uncontrollably if boom is not horizontal.
7. Crane shall be fully set up according to proper set-up procedures outlined previously when stowing or unstowing jib.
8. Operate boom and turn functions very slowly and carefully when using jib since jibs can increase boom length by 50%.
9. Area where jib swings around must be clear of obstructions and power lines when stowing and unstowing jib.
10. Use safety glasses when pounding pins with hammer.
11. Do not extend/retract boom unless boom is horizontal when stow pin A and pin B are removed during stowing or unstowing procedures.
12. Always put spring clips in pins to ensure that they will stay in place.
13. When the jib is stowed, the boom can not be fully retracted if a boom tip attachment option is installed

⚠ CAUTION

- **Boom tip attachment can contact jib in stowed position when boom is fully retracted.**
- **Contact can cause damage to boom extension system and jib stow system.**
- **Boom must be left extended .5 ft (.2 m) to prevent contact.**
- **Boom attachment must be removed for retracted boom lifting operations.**

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Also, on manually extendable jib options:

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

Side Folding-swing Around Jib Operation

Deployment Procedure

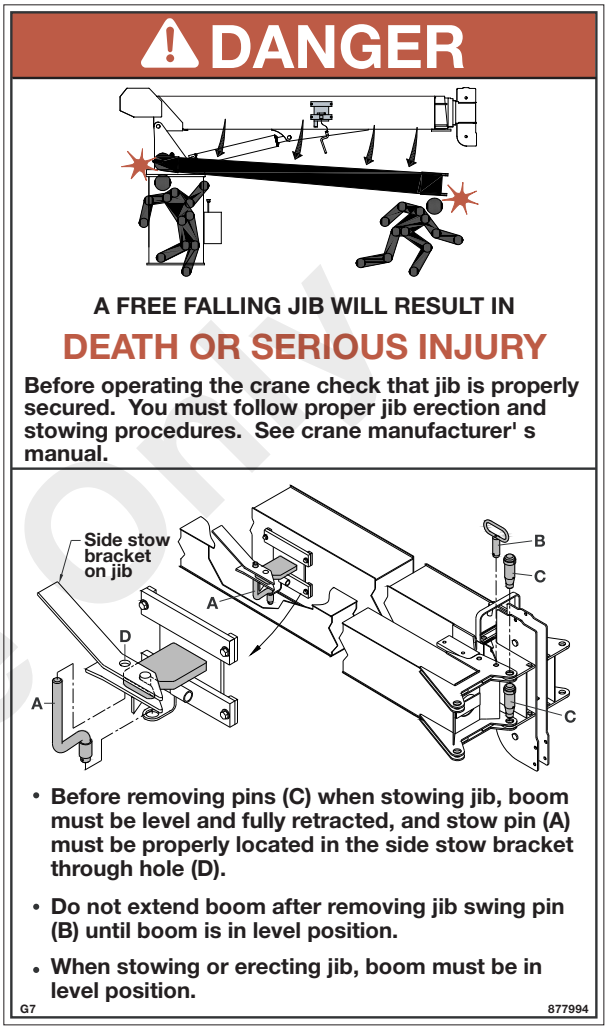
1. Using boom telescope function, fully retract boom.
2. Using lift function, lower boom to allow for easier access to jib deployment pins C1 and C2.
3. Install pins C1 in upper and lower jib ears. Install retainer spring clips. These pins will be used as a pivot point to swing jib into the deployed position.
4. Locate the stowed position of pins C2. If in jib attachment holes or boom sheave case jib holes, remove pins from storage location.
5. Remove t-handle Pin B from top ear of jib.
6. Remove stow Pin A from ramp/bracket assembly on jib and stow in Stow Loop D and install spring clip.
7. Using lift function, raise boom to a horizontal position.
8. Attach tag line to sheave case end of jib.
9. Using telescope function, slowly extend boom approximately one foot. This procedure will pull the jib out of the stow bracket.

Reference Only

⚠ CAUTION

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

10. Using tag line, swing jib into deployed position.
11. Remove cable keeper pins from boom sheave case and jib. Remove hook block. Pivot jib slightly to allow for loadline to be removed from boom sheave case. Remove loadline from boom sheave case and place in an area to minimize possible damage.
12. Pivot jib into place, visually aligning the upper C2 pin holes. Install upper C2 pin and keeper. A slight hammer strike may be necessary to install pins. Always use proper eye protection during this step.
13. Align lower C2 pin holes and install lower C2 pin and keeper. To aid in this installation of the lower C2 pin the end of the jib may be boomed down (very lightly) on ground to assist in lining up holes.
14. Using hoist function, unspool enough loadline to reeve loadline over jib sheave case. Keep slight tension on loadline to avoid bird caging of loadline on hoist drum.
15. Route loadline over jib sheave and install keeper. Install line block to end of loadline.
16. Remove anti-two-block switch and weight/chain assembly and install on jib tip. Be certain to use keeper provided with switch.
17. Disconnect twist lock quick coupler on anti-two-block cord going to boom anti-two-block switch and attach to quick coupler on jib anti-two-block wire on rear of jib between the upper and lower jib ears.
18. Install pin B and keeper into jib ears.
19. Unwrap ATB cord on side of jib to allow manually extending jibs to be deployed without damage to the cord.
20. For manually extendable jibs, pull extension retention pin E, and extend second section out by pulling on sheave case. The second section jib, as it extends, will hit a mechanical stop that allows for extension pin E installation. Install pin and keeper.
21. Make ATB cord connections as required.



Stowing Procedure

1. Using lift function, lower boom so that jib tip is close to the ground.
2. For manually extendable jibs, pull extension retention pin and fully retract extendable 2nd section jib into the 1st section. Retraction of 2nd section may be facilitated by attaching loadline wedge socket to attachment point F on the jib sheave case. Slowly activate the hoist up function until the 2nd section is fully retracted
3. Reinstall extension retention pin through the 1st and 2nd section jib assembly and install spring clip.
4. Remove loadline from jib sheave case. Place loadline in area to avoid possible damage from stow procedure.
5. Disconnect twist lock anti-two-block wire connector at rear of 1st section jib. Connect twist lock connector to anti-two-block switch connector on

Reference Only

boom tip. Move anti-two-block switch and weight/ chain assembly to boom tip.

6. Attach tag line to sheave case end of jib.
7. Remove spring clips from pins C2 on both upper and lower jib ears.
8. Remove pins C2 from upper and lower jib ears. Do not remove C1 pins at this time. C1 pins will be used as a pivot point to swing jib into stow position. A slight hammer strike may be necessary to remove pins. Always use proper eye protection during this step.
9. Using lift function, raise boom to a horizontal position.
10. Using extend function, extend boom approximately 1 foot.
11. Using tag line attached to jib sheave case, slowly swing jib into stow position (parallel with 1 st section boom). Pins C1 are the jib pivot points during this operation.

⚠ CAUTION

Use caution when swinging jib to avoid unnecessary impact with 1st section boom.

12. Install t-handle pin B through jib ear and boom sheave case holes. This pin will keep the jib assembly in line (parallel) with the 1st section boom. Pin B does not retain the jib in its stowed position on the 1st section boom.
13. Using boom telescope function, slowly retract boom. The ramp/bracket assembly on the side of the 1st section jib will engage the hook on the side of the 1st section boom, first lifting the jib and then engaging the jib stow bracket and the boom hook completely upon full retraction of the boom.
14. Install stow pin A with spring clip into the ramp/ bracket assembly on the jib. Complete engagement of stow brackets and proper installation of pin A is critical for secure jib stow attachment.
15. Remove pins C1 from upper and lower jib ears. A slight hammer strike may be necessary to remove pins. Always use proper eye protection during this step.
16. Reinstall loadline over boom sheave case.

⚠ CAUTION

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

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

- **Stow bracket completely engaged into stow hook with stow pin A properly in place.**
- **Both pins C1 in upper and lower jib holes properly in place through mating holes on boom tip.**

Jib Maintenance

1. Lubricate sheave pin on jib with grease gun containing chassis grease weekly.
2. Check for free rotation of jib sheave daily when using jib.

Jib Removal

The 29 ft jib weight is 600 lb (272 kg) at 104 in (264 cm) when retracted from mounting pin holes. The 18 ft jib weight is 400 lb (181 kg) at 104 in (264 cm) from mounting pin holes. Should jib removal from the boom become necessary, proceed as follows:

1. Unstow and swing jib into position on the boom tip according to Steps 1 - 1 0 in the preceding jib deployment section.
2. Support and raise the jib at its balance point and remove the two swing around pins. Jib is now free of boom.
3. To install, proceed in reverse order of removal.

Reference Only

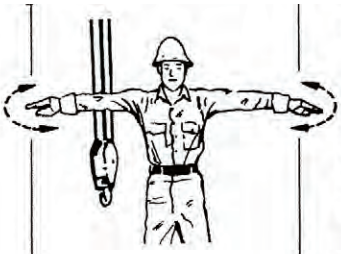
STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS



SWING. Arm extended, point with finger in direction of swing of boom.



STOP. Arm extended, palm down, move arm back and forth horizontally.



EMERGENCY STOP. Both arms extended, palms down, move arms back and forth horizontally.



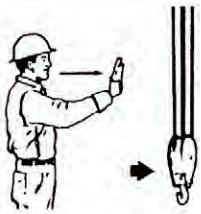
HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.



LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circle.



USE MAIN HOIST. Tap fist on head; then use regular signals.



TRAVEL. Arm extended forward, hand open and slightly raised, making pushing motion in direction of travel.



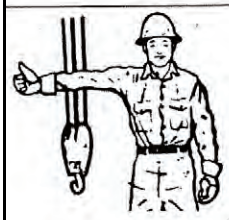
DOG EVERYTHING. Clasp hands in front of body.



TRAVEL (Both Tracks). Use both fists in front of body, making a circular motion about each other, indicating direction of travel, forward or backward. (For land cranes only.)



USE WHIPLINE (Auxiliary Hoist). Tap elbow with one hand; then use regular signals.



RAISE BOOM. Arm extended, fingers closed, thumb pointing upward.



LOWER BOOM. Arm extended, fingers closed, thumb pointing downward.



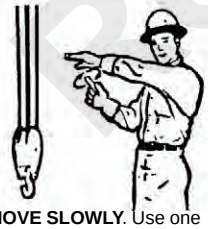
TRAVEL (One Track). Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body. (For land cranes only)



RETRACT BOOM (Telescoping Booms). Both fists in front of body with thumbs pointing toward each other.



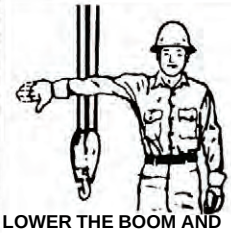
EXTEND BOOM (Telescoping Booms). Both fists in front of body with thumbs pointing outward.



MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist slowly shown as



RAISE THE BOOM AND LOWER THE LOAD. With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.



LOWER THE BOOM AND RAISE THE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.

EXTRACTED FROM ANSI STANDARD
ASME B30.5 - 2000
THIS COMPLIES WITH OSHA STANDARDS

Reference Only

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SECTION 3
MAINTENANCE

INSPECTION AND MAINTENANCE

A regular schedule of inspection and maintenance is essential to keep your unit in peak operating efficiency. Operators or service personnel responsible for the care of the unit must be completely familiar with the type and frequency of inspections and maintenance operations. The following pages outline the inspections and maintenance required to keep the crane in proper operating condition.

Inspection

The following pages list inspections which are to be conducted on your unit to help assure it is operating properly and safely. Check all items listed at the frequency listed and make necessary repairs prior to operating. Use applicable torque table requirements for missing or loose fasteners.

The inspections are separated into the following frequency classifications:

- ***Daily Inspections*** - These items should be visually inspected each day by the operator prior to using the unit.
- ***Weekly Inspections*** - These items should be visually inspected weekly by the operator.
- ***Monthly Inspections*** - These inspections are to be performed monthly by the personnel responsible for maintenance and service of the crane.
- ***Periodic Inspections*** - This inspection is a thorough inspection conducted at least every three months and includes all items listed under Daily, Weekly, and Monthly Inspection in addition to those items listed under periodic inspection. Federal Laws through OSHA and ANSI B30.5 require that dated and signed records of these periodic inspections be kept. A crane inspection log book is available from National Crane to assist you in keeping records.

Daily inspections

Check the following items:

1. Engine oil level.
2. Hydraulic oil level.
3. Radiator coolant level.
4. Loose parts or damage to structures or welds.
5. Operation of lights, safety equipment and gauges.
6. Condition of tires and suspension.
7. Condition of loadline and end attachment for corrosion, severe kinking, crushing, cutting, or slippage of cable clamps or wedge socket.
8. Loose parts or damage to loadline centering blocks.
9. Position of loadline with guides and on sheaves.
10. Free turning of sheaves.
11. Lubrication of points required by Lubrication Chart.
12. Evidence of oil leak from hoses, gearboxes or swivel.
13. Hand and foot controls for malfunction or misadjustment.
14. Truck parking brake operation.
15. Boom proportioning to insure that all boom sections extend and retract equally.
16. All securing hardware such as cotter pins, snap rings, hairpins, pin keepers and capscrews for proper installations.
17. Proper condition and operation of overload and anti-two-block operator aid system to include switch, weight and chain at boom tip (and jib tip if equipped), power cords and indicator lights on console. Cycle slowly to check for proper operation.
18. Presence and proper operation of load hook safety latch.
19. All drain holes at rear of first section boom are clear of all obstructions.
20. All fasteners retaining loadline centering block are in place and tight.
21. All safety covers for proper installation.

Weekly inspections

Check the following items:

1. Battery water level.
2. Tire pressure.
3. Lubrication of points required by Lubrication Chart.
4. Boom lift and outrigger holding valves for proper operation.
5. Torque mounting bolts during first month of operation of machine and then during periodic inspections thereafter.

Reference Only

6. Hoist brake for proper operation at hoist capacity load.
7. Torque boom wear pad retaining bolts during first month of operation, then monthly thereafter.
8. Check to see that crane Owner's Manual is with the unit. If not, obtain serial number of unit and order manual immediately.

Monthly inspections

Check the following items:

1. All cylinders and valves for signs of leaks.
2. Lubrication of points required by Lubrication Chart.
3. Load hook for cracks or having more than 15% normal throat opening or 10° twist.
4. All structural members (boom, sub-base, turret and outriggers) for bends, cracks or broken members.
5. All welds for breaks or cracks.
6. All pins for proper installation.
7. All control, safety and capacity placards for readability and secure attachment.
8. Torque of cable clip bolts above wedge socket at end of loadline should be 95 lb-ft.
9. All boom wear pad retaining bolts.
10. Boom extension cables for proper tension or evidence of abnormal wear.
11. Sheaves and cable drums for wear and cracks.
12. Unspool loadline and check according to rope maintenance procedure.

Periodic inspection

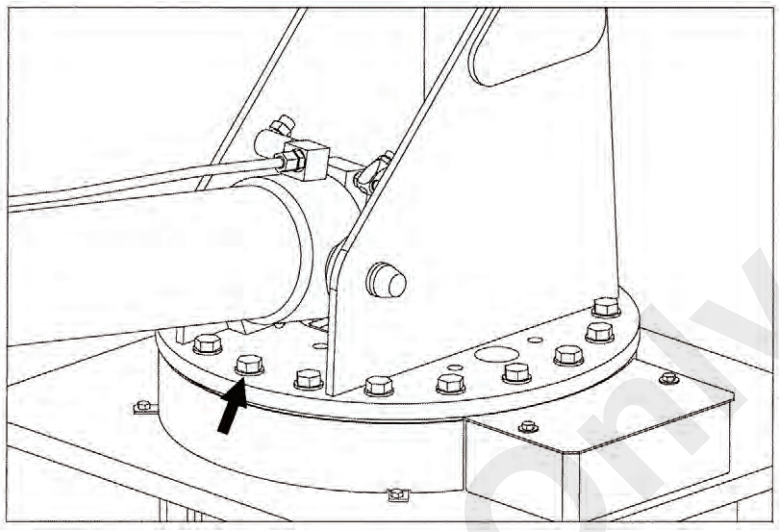
Check the following items:

1. All items listed under daily, weekly and monthly inspections.
2. Loose bolts and fasteners in all areas. Torque pin retainer bolts.
3. All pins, bearings, shafts, and gears for wear cracks or distortion to include all pivot, outriggers and sheave pins, and bearings.
4. Boom angle and boom length indicator for accuracy over full range.
5. Hydraulic systems for proper operating pressure.
6. Lift and outrigger cylinders for drift caused by leaking around piston.
7. Cylinders for:
   a. Damaged rods
   b. Dented barrels
   c. Drift from oil leaking by piston
   d. Leaks at rod seals, welds, or holding valves.
8. PTO drive line system for proper alignment, lubrication and tightness.
9. Hydraulic hose and tubing for evidence of damage such as blistering, crushing or abrasion.
10. Top and bottom wear pads for excessive wear.
11. Inspect all electrical wires and connections for worn, cut or deteriorated insulation and bare wire. Replace or repair wires as required.
12. Extend and retract cables, sheaves, pins and bearings for wear or abrasion.
13. Main frame and stabilizer mount bolts for proper torque (see Torque Chart).
14. Rotation bearing and gear box mounting capscrews for proper torque (see Torque Chart). Note that the turret to rotation bearing capscrew at the front of the turret, directly under the lift cylinder (see figure below), cannot be torqued unless the lower end of the lift cylinder is pivoted out of the way or a special tool is used. It is not required that this bolt be torqued as part of the normal periodic inspection, however an end wrench should be used to verify that it is tight at these times.

Other

1. Stability of unit throughout working area. Check stability procedure in Installation Section annually or when any change is made to crane or truck.
2. If the boom has not been disassembled and inspected in the last five years or 3000 hours of use, the boom is to be completely torn down to allow a thorough inspection of the extend and retract cables, sheaves, and pins.

Reference Only



WIRE ROPE INSPECTION AND MAINTENANCE

Inspection

Three scheduled inspections: daily, monthly and quarterly, should be made of all rope in daily service. These scheduled inspections vary in the degree of thoroughness as outlined below and should be made at the intervals recommended or sooner should the general appearance or use cycle of a particular rope indicate the need for more frequent or more thorough inspection. All rope which has been idle for a period of a month or more due to a shutdown or storage of a machine on which it is installed, shall be given a thorough inspection before it is placed in service. This inspection should cover all types of deterioration including:

1. Distortion of the rope such as kinking, crushing, unstranding, birdcaging, main strand displacement or core protrusion. Loss of rope diameter in a short rope length or unevenness of outer strands should provide evidence the rope or ropes be replaced.
2. General corrosion.
3. Broken or cut strands.
4. Number, distribution and type of visible broken wires.
5. Core failure in rotation resistant ropes.

Only the outer surface of a rope should be inspected. Never attempt to open the rope.

All running rope in continuous service should be inspected once each working day. This inspection is made before the rope is used for the first time on any particular day. It should cover the end and that portion of the rope used more extensively in daily operation. The end should be inspected thoroughly for abrasion, corrosion, broken wires and loose or broken servings. Inspect the remainder of the rope length normally used for daily operations for points showing kinks, sharp bends, or any other evidences of damage or excessive wear.

During the monthly inspections, the entire length of wire rope should be examined. A thorough inspection should be made of the end and the length of rope normally used in daily operations. Examine the remainder of the rope for kinked, crushed or otherwise damaged points.

The periodic inspection requires a thorough inspection of the entire rope length. This inspection will usually indicate greater wear at the eye end of the rope. Therefore, if the rope is in good condition and is to remain in service, it should be reversed on the drum so that the wear will more nearly equalize along the entire length.

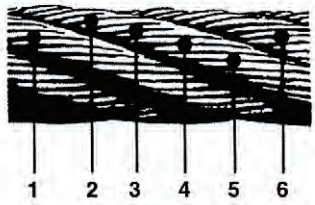
Rope replacement

It is extremely difficult to determine the exact time for replacement of wire rope since many variable factors are involved. Proper determination of the condition of a wire rope depends upon the good judgment of an experienced person in evaluating the remaining strength

in a used rope after allowance for deterioration disclosed by inspection. The following reasons are sufficient justification for consideration of rope replacement:

Reference Only

1. Six randomly distributed broken wires in one rope lay or three broken wires in one strand in one rope lay.



Rope is unsafe for further use if there are either three broken wires in one strand (Breaks 2,3,4) or a total of six broken wires in all strands in any one rope lay.

2. Wear of one-third the original diameter of outside individual wires.



Worn rope, usually indicated by flat spots on the outer wires as shown is unsafe for further use when less than two-thirds the thickness of the outer wire remains.

3. Necking down of the rope which would indicate core failure.



4. Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.
5. Evidence of heat damage from any cause.
6. Reductions from nominal diameter of more than 1/64 in (0,4 mm) for diameters to 5/16 in (8 mm), 1/32 in (0,8 mm) for diameters 3/8 in (9,5mm) to 1/2 in (12,7 mm), 3/64 in (1,2 mm) for diameters 9/16 in (14,3 mm) to 3/4 in (19,1 mm) and 1/16 in (1,6 mm) for diameters 7/8 in (22,2 mm) to 1-1/8 in (28,6 mm).
7. One outer wire broken at its point of contact with the core of the rope which has worked its way out of, and protrudes or loops out from the rope structure. Additional inspection of this section is required.

Care of wire rope

Care is required in the handling of wire rope to prevent damage to the rope or the individual wires which will affect the overall strength and performance of the rope. The formation of kinks should always be prevented as this displaces the strands of wire from their original position and relation to each other causing severe bending and unequal tensions in the strands. This distortion and wire displacement cannot be corrected even under high tension and a permanent weak point remains in the rope. Displaced or raised wires indicate a previous kink, but will not show the damaged condition of the inner rope wires.

Wire rope should never be pulled over a non-rotating support such as a spindle bar, a pin or an inoperative sheave. This practice causes severe abrasion to the outer strand wires. A properly operating sheave or snatch block is essential to safety and long service life of the rope.

The use of worn sheaves or sheaves with flat grooves should be avoided since they do not provide sufficient support to prevent the distortion and flattening of the rope as it passes over the sheave. Sheaves having nicked or broken flanges are likely to cut or otherwise damage the rope and should not be used.

An even distribution of wire rope coils over the hoist drum is essential to smooth operation and to prevent rope from either cutting down through or crushing other coils on the drum with resultant damage to the rope and difficulty in unreeling rope.

Rope Construction

If wire rope replacement is required for crane extension system, replacement ropes must be obtained through The National Crane Product Support Department. Extension ropes are prestretched and have special connections for proper operation.

Crane Loadline (Standard Planetary Hoist)

STANDARD	
1/2 in (12,7 mm)	Rotation Resistant
Dia. Wire Rope	Nominal Breaking Strength 14.60 tons (13 250 kg)
OPTIONAL	
1/2 in (12,7 mm)	6x25 General purpose
Dia. Wire Rope	Nominal Breaking Strength 13.30 tons (12 066 kg)

Crane Loadline (Optional High-Pull Hoist)

STANDARD	
9/16 in (14,3 mm)	Rotation Resistant

Reference Only

Dia. Wire Rope	Nominal Breaking Strength 19.25 tons (17 463 kg)
OPTIONAL	
9/16 in (14,3 mm)	6x25 General purpose
Dia. Wire Rope	Nominal Breaking Strength 16.80 tons (15 241 kg)

If wire rope replacement is required for crane loadline, care should be taken in selecting a wire rope suitable for crane use. Wire rope strength requirements are shown on the crane capacity chart to match the hoist option selected when the crane was purchased. Rope construction required is optional with 6 x 25 and Dyform being the most common lifting ropes. High strength, rotation resistant is preferred and furnished standard by National Crane. This rope eliminates single part line load spin. It also eliminates load block spin up when multi-part reeving is used which results in prolonged rope life. **Do not use a swivel on rotation resistant rope. A swivel on this rope will cause premature rope core failure.**

Adjustments and Repairs

Before adjustments and repairs are started on a crane, the following precautions shall be taken as applicable:

1. A warning tag should be placed in a conspicuous place at the controls stating that the machine requires adjustment or repair before it can be operated.
2. The crane should be placed where it will cause the least interference with other equipment or operations in the area.
3. All controls at the OFF position and all operating features secured from inadvertent motion by brakes or other means.
4. All methods used to start the truck's engine rendered inoperative.
5. Power plant stopped or disconnected at takeoff.
6. Boom lowered to the ground or otherwise secured against dropping.
7. Load block lowered to ground or otherwise secured against dropping.
8. Relieve hydraulic oil pressure from all hydraulic circuits before loosening or removing hydraulic components.

After adjustments and repairs have been made, the crane shall not be returned to service until all guards have been reinstalled, trapped air removed from hydraulic system if required, safety devices reactivated, and maintenance equipment and all warning tags removed.

Any hazardous conditions disclosed by the inspection requirements listed above shall be corrected before operation of the crane is resumed. Adjustments and repairs shall be done only by designated personnel who are properly trained. Use only National Crane supplied parts to repair the crane.

Reference Only

TIRE LOAD AND INFLATION TABLE

Definite tire inflation pressures are established for each tire size depending upon the load imposed on the tires. For greater stability, riding comfort and prolonged tire life, tires should be inflated for the loads carried. The “Load and Inflation Table” shown below indicates the proper inflation pressures.

TIRE LOAD AND INFLATION TABLES

Tire and Rim Association Standard Tire Loads At Various Inflation Pressures.
Load Range Letters and Corresponding Ply Rating

D = 8 ply • E = 10 ply • F = 12 ply • G = 14 ply
H = 16 ply • J = 18 ply • L = 20 ply • M = 22 ply • N = 24 ply

TIRES FOR TRUCKS IN NORMAL HIGHWAY SERVICE (TIRES MOUNTED ON 15° DROP CENTER RIMS)

TIRE SIZE DESIG-NATION	USAGE	TIRE LOAD LIMITS, lb (kg), AT VARIOUS COLD INFLATION PRESSURES, psi (kPa)												
		RADIAL PLY												
		60 (414)	65 (448)	70 (483)	75 (517)	80 (552)	85 (586)	90 (621)	95 (655)	100 (690)	105 (724)	110 (758)	115 (793)	120 (827)
9*22.5	DUAL	2960	3120	3270	3410	***3550 (E)***	3690	3820	***3950(F)***	4070	4200	***4320 (G)***		
		(1343)	(1415)	(1483)	(1547)	***(1610) (E)***	(1674)	(1733)	***(1792) (F)***	(1846)	(1905)	***(1960) (G)***		
	SINGLE	3010	3190	3370	3560	3730	3890	***4050 (E)***	4210	4350	***4500(F)***	4640	4790	***4920 (G)***
		(1365)	(1447)	(1529)	(1615)	(1692)	(1764)	***(1837) (E)***	(1910)	(1973)	***(2041) (F)***	(2105)	(2173)	***(2232) (G)***
10*22.5	DUAL	3510	3690	3870	4040(E)	4200	4360	***4520 (F)***	4670	4820	4970(G)			
		(1592)	(1674)	(1755)	***(1833) (E)***	(1905)	(1978)	***(2050) (F)***	(2118)	(2186)	***(2254) (G)***			
	SINGLE	3560	3770	4000	4210	4410	***4610 (E)***	4790	4970	***5150 (F)***	5320	5490	***5670(G)***	
		(1615)	(1710)	(1814)	(1910)	(2000)	***(2091) (E)***	(2173)	(2254)	***(2336) (F)***	(2413)	(2490)	***(2572) (G)***	
11*22.5	DUAL			4380	4580	4760(F)	4950	5120	***5300 (G)***	5470	5630	***5800 (H)***		
				(1987)	(2077)	***(2159) (F)***	(2245)	(2322)	***(2404) (G)***	(2481)	(2554)	***(2631) (H)***		
	SINGLE			4530	4770	4990	5220	***5430 (F)***	5640	5840	***6040 (G)***	6240	6430	***6610 (H)***
				(2055)	(2164)	(2263)	(2368)	***(2463) (F)***	(2558)	(2649)	***(2740) (G)***	(2830)	(2917)	***(2998) (H)***
11*24.5	DUAL			4660	4870	***5070 (F)***	5260	5450	***5640(G)***	5820	6000	***6170 (H)***		
				(2114)	(2209)	***(2300) (F)***	(2386)	(2472)	***(2558) (G)***	(2640)	(2722)	***(2799) (H)***		
	SINGLE			4820	5070	5310	5550	***5780 (F)***	6000	6210	***6430 (G)***	6630	6840	***7030(H)***
				(2186)	(2300)	(2409)	(2517)	***(2622) (F)***	(2722)	(2817)	***(2917) (G)***	(3007)	(3103)	***(3189) (H)***
12*22.5	DUAL			4780	4990	***5190 (F)***	5390	5590	***5780(G)***	5960	6150	***6320 (H)***		
				(2168)	(2263)	***(2354) (F)***	(2445)	(2536)	***(2622) (G)***	(2703)	(2790)	***(2867) (H)***		
	SINGLE			4940	5200	5450	5690	***5920 (F)***	6140	6370	***6590 (G)***	6790	7010	***7200 (H)***
				(2241)	(2359)	(2472)	(2581)	***(2685) (F)***	(2785)	(2889)	***(2989) (G)***	(3080)	(3180)	***(3266) (H)***
12*24.5	DUAL			5080	5300	***5520 (F)***	5730	5940	***6140 (G)***	6330	6530	***6720 (H)***		
				(2304)	(2404)	***(2504) (F)***	(2599)	(2694)	***(2785) (G)***	(2871)	(2962)	***(3048) (H)***		
	SINGLE			5240	5520	5790	6040	***6290 (F)***	6530	6770	***7000 (G)***	7220	7440	***7660 (H)***
				(2377)	(2504)	(2626)	(2740)	***(2853) (F)***	(2962)	(3071)	***(3175) (G)***	(3275)	(3375)	***(3475) (H)***

** Tire size designation will include “R” (Radial Ply)*
NOTE: Letters in parentheses denote Load Range for which Bold Face Loads are maximum.

Reference Only

WIDE BASE RADIAL TIRES FOR TRUCKS IN NORMAL HIGHWAY SERVICE (TIRES USED AS SINGLES)

TIRE SIZE DESIGNATION	TIRE LOAD LIMITS, lb (kg), AT VARIOUS COLD INFLATION PRESSURES, PSI (kPa)										
	70 (483)	75 (517)	80 (552)	85 (586)	90 (621)	95 (655)	100 (690)	105 (724)	110 (758)	115 (793)	120 (827)
445/65R19.5	7540 (3420)	7930 (3597)	8270 (3751)	8680 (3937)	9040 (4101)	9370 (4250)	9730 (4413)	10100 (4581)	***10500 (J)*** ***(4763) (J)***		
385/65R22.5	6380 (2894)	6710 (3044)	7040 (3193)	7350 (3334)	7650 (3470)	7950 (3606)	8230 (3733)	8510 (3860)	8790 (3987)	9050 (4105)	***9370 (J)*** ***(4250) (J)***
425/65R22.5	7590 (3443)	7990 (3624)	8370 (3797)	8740 (3964)	9100 (4128)	9450 (4286)	9790 (4441)	10100 (4581)	10500 (4763)		
445/65R22.5	8280 (3756)	8710 (3951)	9120 (4137)	9540 (4327)	9930 (4504)	10300 (4672)	10700 (4853)	11000 (4990)	***11400 (J)*** ***(S171) (J)***	11700 (5307)	***12300 (L)*** ***(5579) (L)***

NOTE: Letters in parentheses denote Load Range for which Bold Face Loads are maximum.

TIRES FOR TRUCKS IN NORMAL HIGHWAY SERVICE (TIRES MOUNTED ON FLAT BASE RIMS)

TIRE SIZE DESIGNATION	USAGE	TIRE LOAD LIMITS, lb (kg), AT VARIOUS COLD INFLATION PRESSURES, psi (kPa)										
		RADIAL PLY										
		70 (483)	75 (517)	80 (552)	85 (586)	90 (621)	95 (655)	100 (690)	105 (724)	110 (758)	115 (793)	120 (827)
10.00*20	DUAL	4380 (1987)	4580 (2077)	***4760 (F)*** ***(2159) (F)***	4950 (2245)	5120 (2322)	***5300 (G)*** ***(2404) (G)***	5470 (2481)	5630 (2554)	***5800 (H)*** ***(2631) (H)***		
	SINGLE	4530 (2055)	4770 (2164)	4990 (2263)	5220 (2368)	***5430 (F)*** ***(2463) (F)***	5640 (2558)	5840 (2649)	***6040 (G)*** ***(2740) (G)***	6240 (2830)	6430 (2917)	***6670 (H)*** ***(2998) (H)***
10.00*22	DUAL	4660 (2114)	4870 (2209)	***5070 (F)*** ***(2300) (F)***	5260 (2386)	5450 (2472)	***5640 (G)*** ***(2558) (G)***	5820 (2640)	6000 (2722)	***6170 (H)*** ***(2799) (H)***		
	SINGLE	4820 (2186)	5070 (2300)	5310 (2409)	5550 (2517)	***5780(F)*** ***(2622) (F)***	6000 (2722)	6210 (2817)	***6430 (G)*** ***(2917) (G)***	6630 (3007)	6840 (3103)	***7030 (H)*** ***(3189) (H)***
11.00*20	DUAL	4780 (2168)	4990 (2263)	***5190 (F)*** ***(2354) (F)***	5390 (2445)	5590 (2536)	***5780(G)*** ***(2622) (G)***	5960 (2703)	6150 (2790)	***6320 (H)*** ***(2867) (H)***		
	SINGLE	4940 (2241)	5200 (2359)	5450 (2472)	5690 (2581)	***5920 (F)*** ***(2685) (F)***	6140 (2785)	6370 (2889)	***6590 (G)*** ***(2989) (G)***	6790 (3080)	7010 (3180)	***7200 (H)*** ***(3266) (H)***
11.00*22	DUAL	5080 (2304)	5300 (2404)	***5520 (F)*** ***(2504) (F)***	5730 (2599)	5940 (2694)	***6140 (G)*** ***(2785) (G)***	6330 (2871)	6530 (2962)	***6720 (H)*** ***(3048) (H)***		
	SINGLE	5240 (2377)	5520 (2504)	5790 (2626)	6040 (2740)	***6290 (F)*** ***(2853) (F)***	6530 (2962)	6770 (3071)	***7000 (G)*** ***(3175) (G)***	7220 (3275)	7440 (3375)	***7660 (H)*** ***(3475) (H)***
11.00*24	DUAL	5390 (2445)	5630 (2554)	***5860 (F)*** ***(2658) (F)***	6090 (2762)	6310 (2862)	***6520 (G)*** ***(2957) (G)***	6730 (3053)	6930 (3143)	***7130 (H)*** ***(3234) (H)***		
	SINGLE	5570 (2527)	5860 (2658)	6140 (2785)	6420 (2912)	***6680 (F)*** ***(3030) (F)***	6940 (3148)	7190 (3261)	***7430 (G)*** ***(3370) (G)***	7670 (3479)	7900 (3583)	***8130 (H)*** ***(3688) (H)***
12.00*20	DUAL	5440 (2468)	5680 (2576)	5910 (2681)	***6140 (G)*** ***(2785) (G)***	6360 (2885)	6580 (2985)	***6790 (H)*** ***(3080) (H)***	7000 (3175)	***7200 (J)*** ***(3266) (J)***		
	SINGLE	5620 (2549)	5920 (2685)	6200 (2812)	6480 (2939)	6740 (3057)	***7000 (G)*** ***(3175) (G)***	7250 (3289)	7500 (3402)	***7740 (H)*** ***(3511) (H)***	7980 (3620)	***8210 (J)*** ***(3724) (J)***
12.00*24	DUAL	6120 (2776)	6390 (2898)	6650 (3016)	***6910 (G)*** ***(3134) (G)***	7160 (3248)	7410 (3361)	***7640 (H)*** ***(3465) (H)***	7870 (3570)	***8100 (J)*** ***(3674) (J)***		
	SINGLE	6330 (2871)	6660 (3021)	6980 (3166)	7280 (3302)	7580 (3438)	***7880 (G)*** ***(3574) (G)***	8160 (3701)	8450 (3833)	***8710 (H)*** ***(3951) (H)***	8970 (4069)	***9230 (J)*** ***(4187) (J)***

** Tire size designation will include "R" (Radial Ply)*
NOTE: Letters in parentheses denote Load Range for which Bold Face Loads are maximum.

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TIRES FOR TRUCKS IN NORMAL HIGHWAY SERVICE
(TIRES MOUNTED ON 15° DROP CENTER RIMS)

TIRE SIZE DESIGNATION	USAGE	TIRE LOAD LIMITS, lb (kg), AT VARIOUS COLD INFLATION PRESSURES, psi (kPa)											
		RADIAL PLY											
		65 (448)	70 (483)	75 (517)	80 (552)	85 (586)	90 (621)	95 (655)	100 (690)	105 (724)	110 (758)	115 (793)	120 (827)
225/70R19.5	DUAL	***2600 (D)***	2720	2860	***3000 (E)***	3115	3245	***3415(F)***	3490	3615	***3750 (G)***		
		(1179) (D)	(1234)	(1297)	***(1361) (E)***	(1413)	(1472)	***(1549) (F)***	(1583)	(1640)	***(1701) (G)***		
	SINGLE	***2755 (D)***	2895	3040	***3195 (E)***	3315	3450	***3640 (F)***	3715	3845	***3970 (G)***		
		(1250) (D)	(1313)	(1379)	***(1449) (E)***	(1504)	(1565)	***(1651) (F)***	(1685)	(1744)	***(1801) (G)***		
245/70R19.5	DUAL				3415	3515	3655	***3860 (F)***	3940	4075	***4300 (G)***	4345	***4540 (H)***
					(1549)	(1594)	(1658)	***(1751) (F)***	(1787)	(1848)	***(1950) (G)***	(1971)	***(2059) (H)***
	SINGLE				3640	3740	3890	***4080 (F)***	4190	4335	***4540 (G)***	4620	***4805 (H)***
					(1651)	(1696)	(1764)	***(1851) (F)***	(1901)	(1966)	***(2059) (G)***	(2096)	***(2180) (H)***
265/70R19.5	DUAL				3750	3930	4095	4300	4405	4415	***4675 (G)***		
					(1701)	(1783)	(1857)	(1950)	(1998)	(2003)	***(2121) (G)***		
	SINGLE				3970	4180	4355	4540	4685	4850	***5070 (G)***		
					(1801)	(1896)	(1975)	(2059)	(2125)	(2200)	***(2300) (G)***		
305/70R19.5	DUAL				4540	4670	4860	5070	5230	5410	***5675 (H)***	5770	***6005 (J)***
					(2059)	(2118)	(2204)	(2300)	(2372)	(2454)	***(2574) (H)***	(2617)	***(2724) (J)***
	SINGLE				4940	5130	5340	5510	5745	5945	***6175 (H)***	6340	***6610 (J)***
					(2241)	(2327)	(2422)	(2499)	(2606)	(2697)	***(2801) (H)***	(2876)	***(2998) (J)***
255/70R22.S	DUAL				3970	4110	4275	4410	4455	4610	***4675 (G)***	4915	***5070 (H)***
					(1801)	(1864)	(1939)	(2000)	(2021)	(2091)	***(2121) (G)***	(2229)	***(2300) (H)***
	SINGLE				4190	4370	4550	4675	4895	5065	***5205 (G)***	5400	***5510 (H)***
					(1901)	(1982)	(2064)	(2121)	(2220)	(2297)	***(2361) (G)***	(2449)	***(2499) (H)***
305/75R22.5	DUAL							5840	6025	6235	6610	6640	***6940 (J)***
								(2649)	(2733)	(2828)	(2998)	(3012)	***(3148) (J)***
	SINGLE							6395	6620	6850	7160	7300	***7610 (J)***
								(2901)	(3003)	(3107)	(3248)	(3311)	***(3452) (J)***
305/85R22.5	DUAL				5355	5550	5780	6005	6215	6435	***6780 (H)***		
					(2429)	(2517)	(2622)	(2724)	(2819)	(2919)	***(3075) (H)***		
	SINGLE				5840	6100	6350	6610	6830	7070	***7390 (H)***		
					(2649)	(2767)	(2880)	(2998)	(3098)	(3207)	***(3352) (H)***		

NOTE: Letters in parentheses denote Load Range for which Bold Face Loads are maximum.

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SECTION 4
LUBRICATION

LUBRICATION PROCEDURES AND CHARTS

Following the designated lubrication procedures is important in ensuring maximum crane lifetime and utilization. The procedures and lubrication charts in this section include information on the types of lubricants used, the location of the lubrication points, the frequency of lubrication, and other information. The information included in this section does not include lubrication requirements for the truck chassis. Refer to appropriate truck manufacturer's manual for this information.

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

Lubricants

Specific recommendations of brand and grade of lubricants are not made here due to regional availability, operating conditions, and the continual development of improved products. Where questions arise, refer to the component manufacturer's manual and a reliable supplier.

Chassis Grease. Lubricating grease of proper consistency is to be applied periodically at relatively frequent intervals with grease guns through grease fittings. Minimum apparent viscosity of 300 SUS (Saybolt Universal Seconds) at 100°F (38°C) is recommended.

Extreme Pressure Multipurpose Gear Lubricant (EPGL). This gear lubricant is compounded to achieve high load carrying capacity and meet the requirements of either API-GL-5 or MIL-L-2105C. Unless otherwise specified, SAE 80W-90 viscosity may be used for year round service. Low temperature usage is restricted as follows:

SAE VISCOSITY NUMBER	MINIMUM AMBIENT TEMPERATURE - °F (°C)
75W	- 40 (-40)
80W	- 15 (-26)
85W	+10 (-12)
90	+20 (-7)
140	+40 (+5)
250	+50 (+10)

Open Gear Lubricant (EP-OGL). This is a highly-graphited adhesive lubricant. This product is free of bitumen, heavy metals and solvents, has excellent adhesion and corrosion protection. Reduces fretting corrosion, is water resistant and forms a “dry lubricating film which does not attract dust.

Open Gear Lubricant. This is a special adhesive lubricant of heavy consistency for protection of wire rope and exposed gears where provision is not made for continuous lubricant replenishment. Select the viscosity that gives best protection and lubrication without peeling, scaling, or excessive throw off.

Chassis Grease Low Temp. This special grease for low temperature remains plastic at -60°F (-51°C) with melting point of 280°F (138°C). It is a heavy duty extreme pressure type lubricant (Lubriplate Low Temp or equal).

Coupling Lube Spline Lubricant. Coupling Lube Spline Lubricant is a synthetic-blend, heavy duty, anti-wear, extreme pressure coupling grease recommended for the lubrication of pump shaft/PTO splines when the pump is mounted directly to the PTO. It exhibits excellent reduced wear characteristics and has exceptional serviceability over a wide range of temperatures. It is available from Schaeffer Manufacturing Company, 102 Barton Street, St. Louis, Missouri.

Hydraulic oil

Oil in a hydraulic system serves as the power transmission medium, system lubricant and coolant. Selection of the proper oil is essential to ensure satisfactory system performance and life. The most important factors in selecting an oil for hydraulic service are viscosity and anti-wear additives.

Viscosity. The oil must have proper viscosity to provide a lubricating film at system operating temperature.

Oil viscosity is important because it has a direct bearing on efficient transmission of power. An oil must flow readily through the system with a minimum of pres-sure and flow loss. Positive lubrication depends on viscosity. The oil must be sufficiently light to get between the components machined surfaces and maintain a lubricating film at system operating temperatures. Oil too light may cause the following conditions in the system.

1. Excessive leakage.
2. Lower volumetric efficiency of the pump.
3. Increased component wear.
4. Loss of system pressure.
5. Lack of positive hydraulic control.

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6. Lower overall efficiency.

Oil too heavy may cause the following conditions in the system:

1. System pressure drop.
2. Increases system temperature.
3. Sluggish system operation.
4. Low mechanical efficiency.
5. Higher power consumption.

The following oil viscosity characteristics are recommended:

- 80 to 180 SUS optimum at system operating temperature.
- 60 SUS minimum at system operating temperature.
- 7500 SUS maximum at starting temperature.
- 90 Viscosity Index (VI) minimum.

Note: On units equipped with self-leveling platforms, low temperature service oils are necessary to provide proper boom functions at temperatures below +10°F (-12°C).

Regardless of temperature and oil viscosity, always use suitable start-up procedures to ensure adequate lubrication during system warm up.

Note: Operation of the crane with incorrect hydraulic oil in sub freezing temperature (below 32°F, 0°C) can cause damage to the extend cylinder.

Antiwear Additives. Excessive wear in the system may cause a loss in volumetric efficiency, and may cause shutdowns for maintenance. An efficient antiwear oil protects the components against rusting, resists oxidation and helps prevent wear.

Standard Hydraulic Oil. (32°F to 100°F) (0°C to 38°C) New cranes come from the factory with ISO Viscosity Grade 32 AW Hydraulic Oil. This fluid has a pour point of -15°F (-26°C).

Intermediate Hydraulic Oil. (-10°F to 80°F) (-23°C to 27°C) For colder operating environments, the standard fluid may be replaced with a Low Service Temperature Multi Viscosity Hydraulic Oil with High Viscosity Index 175+. Typical fluids are ESSO UNIVIS N-22 and CHEVRON RYKON PREMIUM Oil MV or equivalents.

Wide Range Intermediate Hydraulic Oil. (-30°F to 80°F) (-34°C to 27°C) For even colder operating conditions, the standard fluid may be replaced with a petroleum based fluid developed especially for colder environments. A typical fluid is Petro Canada Premium Plus All Season Hydraulic Oil or equivalent.

Arctic Hydraulic Oil. (-10°F and below) (-23°C and below). In general, petroleum based fluids developed especially for low temperature service may be used with satisfactory results. However, certain fluids, such as hologenated hydrocarbons, nitro hydrocarbons and phosphate ester hydraulic fluids might not be compatible with hydraulic system seals and wear bands. A typical fluid is Texaco Aircraft Hydraulic Oil 15 or equivalent. This hydraulic oil is not recommended for service in ambient temperatures above 32°F (0°C).

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

Lubrication points

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

All oil levels are to be checked with the crane parked on a level surface in transport position, and while the oil is cold unless otherwise specified.

On plug type check points, the oil levels are to be at the bottom edge of the fill port.

Over lubrication of non-sealed fittings will not harm the fittings or components, but under lubrication will definitely lead to a shorter lifetime.

Grease fittings that are worn and will not hold the grease gun, or those that have a stuck check ball, must be replaced.

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

Wire rope lubrication

Wire rope is lubricated during manufacturing so the strands, and individual wires in strands, may move and adjust as the rope moves and bends. A wire rope cannot be lubricated sufficiently during manufacture to last its entire life. Therefore, new lubricant must be added periodically throughout the life of a rope to replace factory lubricant which is used or lost.

The surface of some ropes may become covered with dirt, rock dust, or other material during their operation. This covering can prevent field applied lubricants from properly penetrating into the rope. Therefore, these ropes should be cleaned before being lubricated.

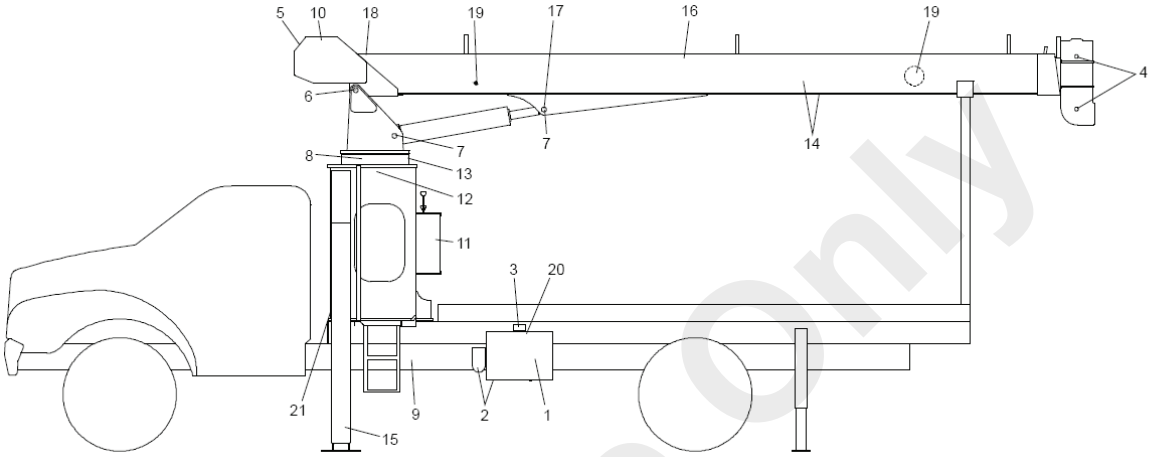
The lubricant applied should be light bodied enough to penetrate to the core of the rope. Lubricant may be applied effectively by various methods. It may be dripped on, sprayed on, or put on by brushing, but in any case it should be applied at a place where the rope is being bent, such as at a sheave. It should be applied at the top of the bend, because at that point the strands are spread by bending and

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are more easily penetrated. The service life of rope will be directly proportional to the effectiveness of the method used and amount of lubricant reaching the working parts of the rope.

A proper lubricant must reduce friction, protect against corrosion, adhere to every wire and be pliable and not crack or separate when cold and yet not drip when warm.

Lubrication chart



APPLICATION	RECOMMENDED LUBRICANT	PROCEDURE	FREQUENCY
1. Hydraulic Oil Reservoir	Hydraulic Oil	Check & Fill *(See Hydraulic Oil Reservoir Level Page)* Change	Weekly Semi-Annually
2. Oil Filter, Magnetic Plug		Change or Clean	After First 40 hrs. then Quarterly
3. Reservoir Breather		Clean	Monthly
4. Sheave Pins/Boom-2, Jib-1	Chassis Grease	Grease Gun	Weekly
5. Loadline - Wire Rope	Open Gear Lube	Brush or Spray	Semi-Annually
6. Boom Pivot Pin	Chassis Grease	Grease Gun	Monthly
7. Lift Cylinder Pins 2 ea.	Chassis Grease	Grease Gun	Monthly
8. Turntable Bearing	Chassis Grease	Grease until lubricant appears at seal while rotating crane	Monthly
9. Pump Drive U-Joint 2 ea. or Pump Spline Shaft (Direct Mount)	Chassis Grease Coupling Lube Spline Lubricant	Grease Gun Remove Pump and Apply to Shaft or Zerk Provided on PTO Housing Shaft	Monthly Semi-Annually
10. Hoist Drive	Refer to Hoist Manual for Oil Recommendation on Hoist	Check & Fill Change	Weekly Semi-Annually
11. Control Linkage	SAE-10W	Oil Can	Quarterly
12. Swing Drive Gearbox Swing Gearbox, Upper Bearing	EPGL Chassis Grease	Change Check & Fill Change Grease Gun	After 50 Operating Hours Weekly Semi-Annually Monthly
13. Swing Gear Teeth	EP-OGL	Spray	Monthly
14. Boom Extension Sides Bottom	 Chassis Grease Chassis Grease	 Brush or Roller Brush or Roller	 Monthly Monthly
15. Outrigger Beams	Low Temp Chassis Grease	Brush or Roller	Monthly

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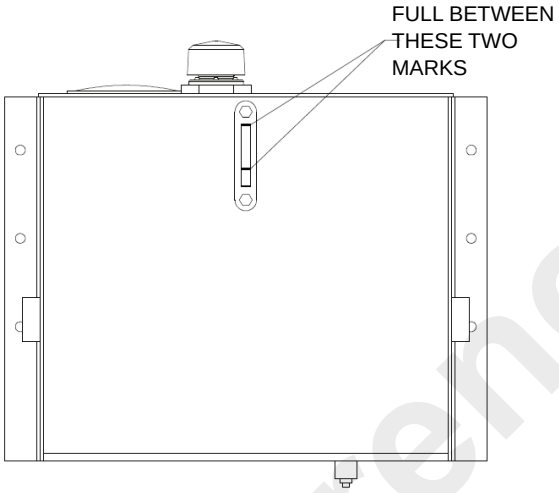
16. Wire Rope Cables & Boom	Open Gear Lube	Brush or Spray	Anytime Boom is Disassembled
17. Pin Joints	Penetrating Oil	Spray	Monthly
18. Boom Top Wear Pads	See Boom Pad Lubrication		
19. Sheave Bearings	Chassis Grease	Grease Gun with Nozzle Tip-See Boom Maintenance Section	Semi-Annually
20. Filter Strainer Basket		Clean	Semi-Annually with oil change
21. Outrigger Stow Pin	Chassis Grease	Brush	Monthly

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HYDRAULIC OIL RESERVOIR LEVEL

The hydraulic oil reservoir has a sight gauge located on the side of the reservoir. The hydraulic reservoir is full when the oil level is in between the upper and lower marks on the sight gauge with the crane parked on a level surface in the transport condition and while the oil is cold.

If the oil level is below the bottom mark on the sight gauge add the recommended type of hydraulic oil until the oil level is even with the upper mark on the sight gauge. If the oil level is above the upper mark on the sight gauge, oil should be removed until the level is in between the two marks on the sight gauge.



CARWELL© RUST INHIBITOR

Protecting Cranes From Corrosion

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

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

Carwell T32-CP-90 is a treatment, not a coating. It contains no silicones, solvents, CFCs or anything that would be classified as hazardous under OSHA Regulation 29CRF-19-10.1200. The product is a liquid blend of petroleum derivatives, rust inhibitors, water-repelling and water-displacing agents. Special equipment is used to spray a light film onto the entire undercarriage and various other areas of each new crane prior to shipment. When applied the product has a red tint to allow applicators to view coverage during application. This red tint will turn clear on its own within approximately 24 hours after application.

Once applied, Carwell T32-CP-90 can appear to leave a slightly “oily” residue on painted surfaces and until the red tinting fades could initially be mistaken for a hydraulic oil leak. While the product is not harmful to painted surfaces, glass, plastic or rubber, it must be removed using standard steam-cleaning techniques.

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

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

The most common causes of corrosion include the following:

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

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

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

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

Reference only

Cleaning Procedures

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

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

CAUTION

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

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

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

Inspection and Repair

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

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

CAUTION

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

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

For scratches and marks in areas of low visibility:

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

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

Application

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

It is recommended that Carwell T32-CP-90 be periodically reapplied by the crane owner after that time to help continue to protect against corrosion of the crane and its components.

However, if a crane is used and/or stored in harsh environments (such as islands, coastal regions, industrial areas, areas where winter road salt is regularly used, etc.), reapplication of Carwell T32-CP-90 is recommended sooner than 12 months, e.g., repeat treatment in 6-9 months.

- Do not apply to recently primered and painted areas for at least 48 hours after paint is properly dried and cured.

Reference Only

For minor touch up areas a 24 hour period is needed for cure time before applying Carwell.

NOTE: Unit must be completely dry before applying Carwell.

- Do not allow product to puddle or build-up on weather stripping, rubber gaskets, etc. Unit should not have puddles or runs evident anywhere.
- To ensure proper coverage of Carwell, the product needs to be fogged on the unit.
- Use of pressure pots to apply the Carwell to the unit being processed is recommended.
- Carwell T32-CP-90 is available in 16 ounce spray bottles from Manitowoc Crane Care (order part number 8898904099).
- After application of the Carwell is complete, wash or clean film residue from lights, windshield, grab handles, ladders/steps and all access areas to crane, as necessary.

Please contact Manitowoc Crane Care should you have any questions.

Areas of Application

- The underside of the unit will have full coverage of the rust inhibitor. These are the only areas that a full coat of the rust inhibitor is acceptable on the painted surfaces. Areas include; Valves, hose end and fittings, Swivel, pumps, axles, drivelines, transmission, all interior surfaces of the frame
- Frame application areas are; hose ends and fittings, all unpainted fasteners and hardware, all bare metal surfaces, outrigger pads, and back up alarms.
- Superstructure applications are; hose end and fittings, wire rope on hoist roller tensioning springs on hoists, all unpainted fasteners and hardware, valves, slew ring, all bare metal surfaces.
- Boom applications areas are; pivot pins, hose end and fittings, jib pins and shafts, all bare metal surfaces, headache ball / hook block pins and fasteners.
- All hardware, clips, pins, hose connections not painted will have Carwell applied.

Reference Only



Preliminary

Item	Description
1	Hoist Plumbing Connections
2	Pivot Shaft
3	All Hardware, Clips, Pi ns, Hose Connections not painted O/R Pins, Clips
4	Wire Rope
5	Boom Nose Pins, Clips
6	Hook Block/Headache Ball
7	Mirror Mounting Hardware
8	O/R Hose Connections

Item	Description
9	O/R Pins, Clips
10	Entire underside of unit
11	Turntable Bearing Fasteners
12	Valve Bank, Hose Connections Inside Turntable
13	Hose Connections
14	Power Train Hardware
15	Pins, Clips for Optional Jib (Not Shown)
16	Hanger Hardware for Optional Jib (Not Shown)

Reference Only

Reference Only

SECTION 5
SERVICE

SERVICE AND REPAIR

The information supplied in this section of the manual is designed to assist you in service and repair of your National Crane. Inspection, lubrication and general maintenance information are found in two previous sections of this manual. Before attempting to perform any service work, the machine must be shut down as outlined under Maintenance Procedure in the Maintenance section of this book.

Generally, a study of the hydraulic schematics in conjunction with a systematic procedure to locate and correct the problem will enable a skilled mechanic to determine the problem and correct it. If at any time you cannot find or correct the problem, contact your local distributor or National Crane Product Support Department. ***Be sure you have your parts and service book, model number and serial number at hand when you call.*** This information is on the serial number placard located on the crane frame.

The following general suggestions should be helpful in analyzing and servicing your crane. Use the following systematic approach should be helpful in finding and fixing problems:

1. Determine the problem.
2. List possible causes.
3. Devise checks.
4. Conduct checks in a logical order to determine the cause.
5. Consider the remaining service life of components against the cost of parts and labor necessary to replace them.
6. Make the necessary repair.
7. Recheck to ensure that nothing has been over-looked.
8. Functionally test the new part in its system.

Note: Your safety and that of others is always the number one consideration when working around cranes. Safety is a matter of thoroughly understanding the job to be done and the application of good common sense. It is not just a matter of “Do's” and “Don'ts”. Stay clear of all moving parts.

Cleanliness

An important item in preserving the long life of the crane is keeping dirt out of working parts. Enclosed compartments, seals, and filters have been provided to keep the supply of air, fuel and lubricants clean. It is important that these enclosures be maintained.

Whenever hydraulic, fuel, lubricating oil lines are disconnected, clean the adjacent area as well as the point of disconnect. As soon as the disconnection is made, cap, plug or tape each line or opening to prevent entry of foreign material. The same recommendation for cleaning and covering apply when access covers or inspection plates are removed.

Clean and inspect all parts. Be sure all passages and holes are open. Cover all parts to keep them clean. Be sure parts are clean when they are installed. Leave new parts in their containers until ready for assembly.

Hydraulic systems

Contaminants in a hydraulic system affect operation and will result in serious damage to the system -components. Dirty hydraulic systems are a major cause of component failures.

If evidence of foreign particles is found in the hydraulic system, flush the system.

Disassemble and assemble hydraulic components on a clean surface.

Clean all metal parts in a nonflammable cleaning fluid. Then lubricate all components to aid in assembly.

Inspect all sealing elements (O-ring, gaskets, etc.) when disassembling and assembling the hydraulic system components. Installation of new sealing elements is always recommended.

When installing metal hydraulic tubes, tighten all bolts finger tight. Then, in order, tighten the bolts at the rigid end, the adjustable end, and the mounting brackets. After tubes are mounted, install the hoses. Connect both ends of the hose with all bolts finger tight. Position the hose so it does not rub the machine or another hose and has a minimum of bending and twisting. Tighten bolts in both couplings.

Due to manufacturing methods, there is a natural curvature to a hydraulic hose. The hose should be installed so any bend is with this curvature.

In case of replacement hoses with angled stem re-usable fittings, the hose curvature must be taken into consideration when assembling and positioning the angled stem.

Fasteners and torque values

Use bolts of the correct length. A bolt which is too long may bottom before the head is tight against the part it is to hold. If a bolt is too short, there may not be enough threads engaged to hold the part securely. Threads can be damaged. Inspect

Reference Only

them and replace fasteners as necessary. (See Maintenance Section for Torque Chart.)

Torque values must correspond to the type bolts, studs, and nuts being used.

The torque tables are provided in the Maintenance Section for reference when performing maintenance.

Use of proper torque values is extremely important. Improper torquing can seriously affect performance and reliability.

Identification of fastener grade is always necessary. When marked as a high strength bolt (grade 8, 5, etc.), the mechanic must be aware that he is working with a highly stressed component and the fastener should be torqued accordingly.

If a fastener must be replaced and a similar grade is not available, always use a higher grade torqued to the same value as the original grade. As soon as available, the correct grade fastener should be installed to avoid a future state of confusion by the improper installation.

Special attention should be given to the existence of lubricant, plating, or other factors that might require variation from standard torque values.

When maximum recommended torque values have been exceeded, the fastener should be replaced.

Note: Temperature variation, vibration, and elasticity of metals can result in the gradual reduction of bolt torque. Bolts should be retorqued as outlined in the inspection and maintenance procedure.

Torque wrenches are precision instruments and are to be handled with care to ensure calibrated accuracy. Calibration checks should be made on a scheduled basis. Whenever the wrench might be either overstressed or damaged, it should immediately be removed from service until recalibrated. An erratic or jerking motion of the wrench can easily result in excessive torque. ALWAYS use a slow wrench movement and STOP when the predetermined value has been reached.

Label parts when disassembling

When removing or disconnecting a group of wires or cables, tag each one to ensure proper identification during re-assembly.

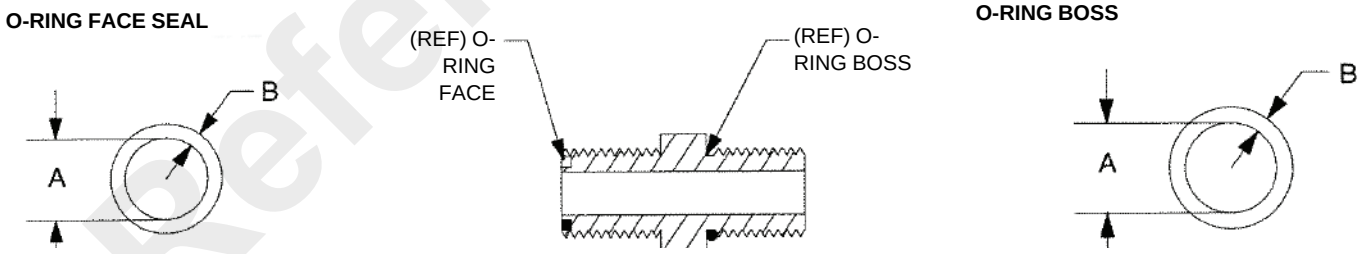
When shims are removed, tie them together and identify them as to location. Keep shims clean and flat until they are reinstalled.

Welding precautions

Sensitive truck computer system and crane's RCL computer system components may be damaged by welding on the truck or crane. The following precautions should be taken:

- Disconnect truck battery cables (positive and negative)
- Attach welding ground lead as close as possible to area to be welded.
- Remove the jib from the crane before welding on the crane, or remove the jib sheave case assembly from the jib before welding on the jib.

National crane fitting o-ring part numbers



O-RING FACE SEAL				FITTING SIZE		O-RING BOSS			
NATIONAL CRANE PART NO.	THREAD SIZE	B inches (mm)	A inches (mm)	TUBE O.D.	MFGR'S SIZE CODE	A inches (mm)	B inches (mm)	THREAD SIZE	NATIONAL CRANE PART NO.
**897063	9/16-18	0.07 (1,78)	0.301 (7,64)	.250	4	0.351 (8,92)	0.072 (1,83)	7/16-20	888412*
**897064	11/16-16	0.07 (1,78)	0.364 (9,24)	.375	6	0.458 (11,63)	0.078 (1,98)	9/16-18	888414*
**897065	13/16-16	0.07 (1,78)	0.489 (12,42)	.500	8	0.644 (16,36)	0.087 (2,21)	3/4-16	888415*

Reference Only

**897066	1-14	0.07 (1,78)	0.614 (15,60)	.625	10	0.755 (19,18)	0.097 (2,46)	7/8-14	888416*
**897067	1 3/16-12	0.07 (1,78)	0.739 (18,77)	.750	12	0.924 (23,47)	0.116 (2,95)	1 1/16-12	888417*
**897068	1 7/16-12	0.07 (1,78)	0.926 (23,52)	1.000	16	1.171 (29,74)	0.116 (2,95)	1 5/16-12	888419*
**897069	1 11/16-12	0.07 (1,78)	1.176 (29,87)	1.250	20	1.475 (37,46)	0.118 (3,00)	1 5/8-12	888420*
**897070	2-12	0.07 (1,78)	1.489 (37,82)	1.500	24	1.720 (43,69)	0.118 (3,00)	1 7/8-12	888421*

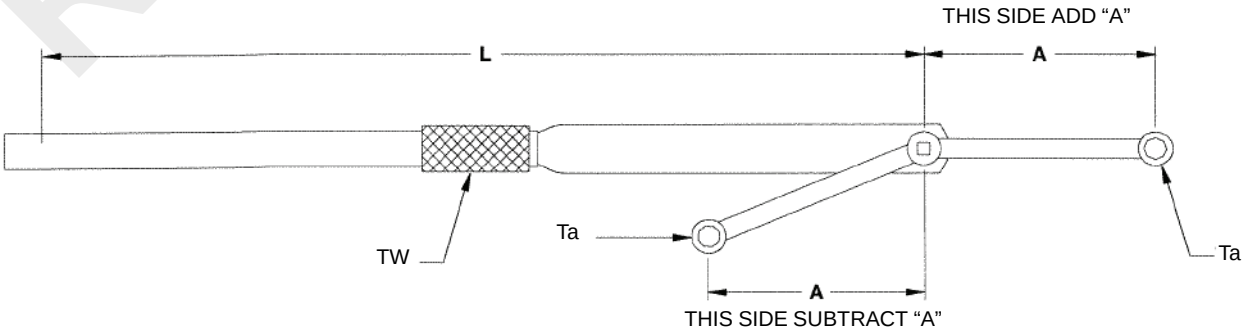
* 888422 O-Ring Boss Seal Kit (12 EA) ** 897234 O-Ring Face Seal Kit (12 EA)

USING TORQUE WRENCH EXTENSIONS

1. Torque wrench extensions are designed to extend the range or versatility of torque wrenches. Torque wrench scale readings or limit settings shall be computed with the following formulas when an extension handle is employed. The sketch below shows which formula is to be used, adding “A” or subtracting “A” when calculating the torque wrench setting.

$$TW = \frac{Ta \times L}{L+A} \quad \text{or} \quad TW = \frac{Ta \times L}{L-A}$$

Ta = Torque required (specified)
TW = Wrench scale reading or limit setting of torque wrench
L = Length of torque wrench in inches (center of drive tang to handle pivot pin or center of hand grip - extension handles are considered part of wrench length, when used)
A = Length of adapter extensions in inches.

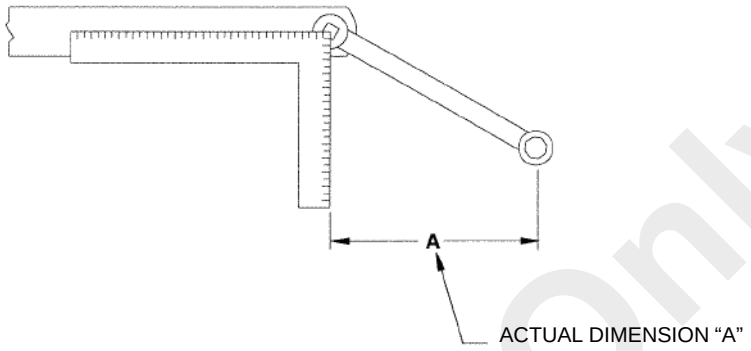


2. If the offset C/L is not in line with the torque wrench C/L, then you must measure the distance from the C/L of the

Reference Only

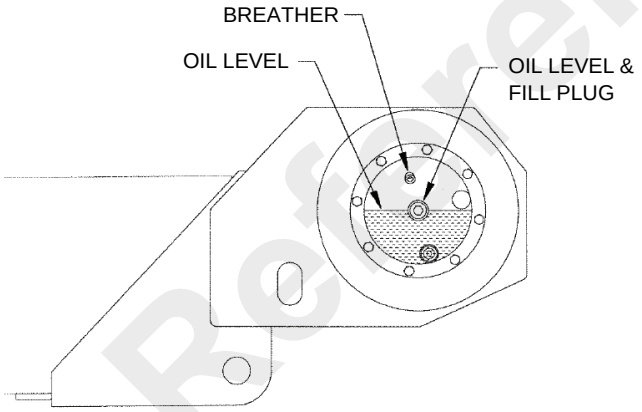
torque wrench to the C/L of the offset by using a square. Then apply this dimension to the torque wrench setting formula. See sketch below.

3. If offset is positioned at right angles to the torque wrench, then the offset will not change the effective length. Therefore, TW-wrench setting and Ta-applied torque, will be the same value as if no offset were used.

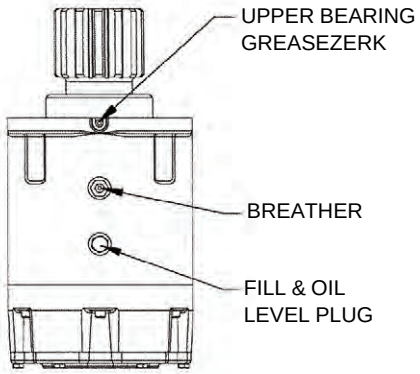


HOIST OIL LEVEL

To check or fill hoist drum and rotation gearbox with oil, remove fill plug and bushing. The oil should be level with this opening. If more oil is needed, refer to one of the manufacturer's recommended lubricants listed in the Manufacturer's Service Manual or to the Lubrication Chart in this manual.



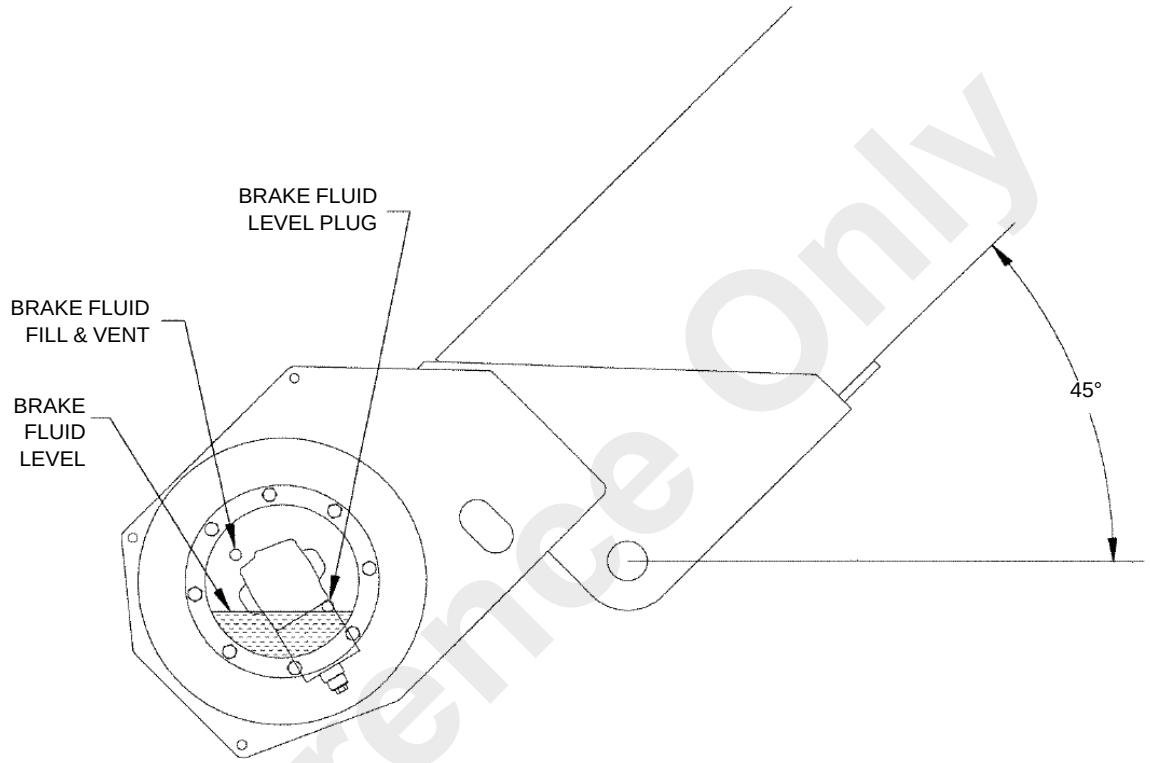
ROTATION GEARBOX OIL LEVEL



Reference Only

BRAKE OIL LEVEL

To check or fill brake fluid, elevate boom to 45° & remove brake fluid level plug, the fluid should be level with this opening. If more fluid is needed, refer to Manufacturer's Service Manual for list of lubricants.



Reference Only

TROUBLE DIAGNOSIS

The following chart lists malfunctions which may occur during equipment operation, followed immediately by possible cause and possible solution. These are not all inclusive but are designed to help isolate the problem and should be checked before calling the factory Service Department.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
No response to control	• Overload system inoperative.	• Insure overload system is working properly and Anti-Two-Block/Overload solenoid is powered.
	• Load too heavy.	• Check Capacity Chart.
	• PTO not engaged.	• Engage PTO.
	• Low hydraulic fluid supply.	• Check and fill as required.
	• Suction line blocked.	• Drain tank and hose and remove blockage.
	• Broken hydraulic pressure line.	• Replace as required.
	• Defective hydraulic pump.	• See Pump Service Manual.
	• Incorrect relief valve setting.	• Adjust relief.
	• Relief valve sticking.	• Clean relief.
Poor hydraulic system performance	• Pump not operating at proper speed.	• Check PTO ratio, pump size and engine speed for proper oil flow.
	• Low hydraulic fluid supply.	• Check and fill as required.
	• Relief valve sticking.	• Remove and clean.
	• Relief setting too low.	• Readjust to proper setting.
	• Worn pump, motor or cylinder.	• Replace bad part.
	• Plugged filter.	• Change filter.
	• Valve spools not fully open.	• Adjust linkage so valve has full throw.
	• Boom holding valves out of adjustment.	• Adjust or clean as required.
	• Oil temperature too high.	• Reduce engine speed, slow cycle time to cool oil or add oil cooler option.
	• Hydraulic oil too cold or dirty.	• Warm oil or use less viscous oil.
	• Line restricted.	• Check lines; clean and repair as necessary.
	• Internal control valve crack.	• Replace valve.
	• Load too heavy.	• Check Capacity Chart and reduce load.
Swing moves erratic or loosely (Standard system)	• Loose turntable bearing.	• Torque bearing mounting bolts.
	• Loose swing gearbox mounting bolts.	• Tighten bolts.
	• Worn gears or bearing.	• Replace worn parts or adjust gearbox spacing.
		• Operate controls smoothly.
	• Operator control of lever too erratic.	• Clean or replace counterbalance valves not set at 300 psi.
	• Motor counterbalance valves dirty or not set properly.	

Reference Only

TROUBLE DIAGNOSIS (CONTINUED)

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
Swing moves erratic or loosely (Standard system) (Cont'd)	• Brake not holding properly.	• Check for no pressure in brake pilot line when turn is in neutral. • Replace worn brake parts or shim brake to proper torque.
	• Brake releasing at wrong time or erratically.	• Bleed air from brake with bleed screw on side of brake.
Swing will not turn (Standard System)	• Attempting to swing up too much of incline. • Turn circuit relief valves sticking. • Turntable bearing drag. • Brake not releasing properly.	• Level machine. • Clean and check circuit pressure. • Lubricate thoroughly as rotating boom. • Check for 200 + PSI brake pilot pressure. Clean pilot line or adjust motor counterbalance valves. • Adjust or clean brake for proper release.
Excessive pump noise during operation	• Excessive pump speed. • Low oil temperature. • Low hydraulic oil supply. • Suction line kinked, collapsed or blocked. • Hydraulic oil too thick. • Relief valve chattering. • Hydraulic tubing vibration. • Tank breather plugged.	• Adjust foot throttle or check for too high PTO ratio. • Allow unit to warm up. • Check and fill. • Clear blockage. • Warm oil or use oil more applicable to environment. • Dirt in relief valve or damaged relief. • Check for loose tubing. • Clean breather.
Cylinders drift	• Not getting oil to cylinders. • Worn or damaged piston seals. • Air in hydraulic oil. • Loose holding valve. • Dirt in holding or check valve.	• Clean and replace as required. • Replace as required. • Cycle operate crane cylinder to remove air. • Tighten valve. • Clean valve.
Hoist will not lift or hold load	• Load too heavy. • Relief valve setting too low. • Motor worn excessively. • Counterbalance valve defective or leaking. • Anti-two-block system defective. • Brake worn out.	• Check load and change to applicable multipart reeving. • Check and adjust if required. • Replace motor. • Clean and replace as necessary. • Repair anti-two-block system. • Repair or replace brake.

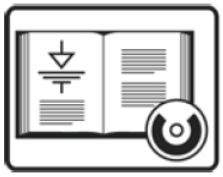
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TROUBLE DIAGNOSIS (CONTINUED)

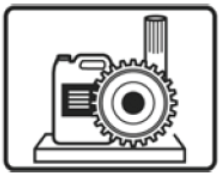
CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
Hoist gearbox heats	• Gearbox grease low. • Duty cycle too high.	• Check and fill as required. • Reduce cycle time or speed of hoist.
Truck engine will not start	• Kill switch on crane control console depressed.	• Pull up kill switch. • Check all other normal motor vehicle systems as outlined by normal practice.
Boom chatters during extension/ retraction or doesn't proportion properly	• Boom sections need lubrication. • Wear pads not shimmed correctly. • Worn wear pads. • Extension cables out of adjustment. • Extend or retract cables broken.	• Grease boom. • Reshim as described in boom assembly section. • Replace pads. • Readjust cables and tension properly. • Disassemble and inspect and replace cables.
Boom will not extend	• Proportioning cables not attached. • Anti-two-block system shut down. • Defective anti-two-block system.	• Reconnect, replace and/or adjust cables. • Lower hook, and extend load. • Check anti-two-block system; repair if defective.

Reference Only

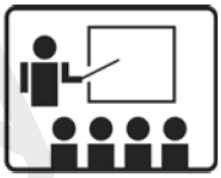
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Field Service


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Factory Service


Training

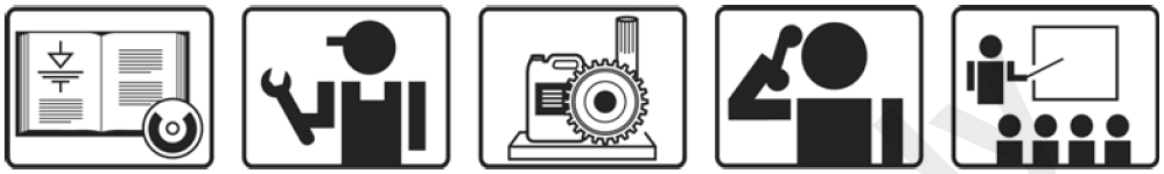
NATIONAL CRANE

NOTICE TO USERS OF THIS MANUAL:

The most current Schematics available at the time of printing will be found at the back of the manual.

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NATIONAL CRANE

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Reference Only

ANTI-TWO-BLOCK INTERNAL WIRE SYSTEM

Operation

The internal anti-two-block wire is routed from the control console to the hoist mount end of the boom, following the path of the extend cables to the rear of the 3rd section boom. This is the length of the wire that proportions in and out with the boom length, similar to the route of the extend cables. At this point at the rear of the 3rd section, the wire loops around and anchors at the anti-two-block cable clamp on the extend cable anchor. The anti-two-block wire, now attached at the rear of the 3rd, runs the length of the section and attaches to the 3rd section sheave case. The wire then loops around the clamp arrangement on the sheave case and routes through access holes in the side plate of the boom. The wire terminates at a quick connect / 2 conductor plug designed for anti-two-block switch or jib interface.

Maintenance

In the event of a break in continuity of the anti-two-block wire routed internally in the boom, the anti-two-block hydraulic system will sense a problem and make certain crane functions inoperative. Before repair or replacement of internal wire, check for continuity loss at the anti-two-block switch, damaged, missing, or corroded connectors and overall system condition. Due to the environmental exposure of the system, a thorough check of the circuit should be performed.

The procedure for removal and reinstallation of the anti-two-block wire can be accomplished using two different methods depending on the severity of the damage. Alternative #1 should be used if the wire has experienced a continuity failure in one or both of the conductors, but the rubber jacket of the wire is still intact. Alternative #2 is to be used if the wire has been completely cut or either end of the wire is inaccessible.

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

Alternative #1

This procedure pulls the replacement wire through the boom, following the path of the defective wire.

Special tools or equipment:

- Two end-to-end electrical butt connectors
- Shrink tube or electrical tape

1. Retract boom completely.
2. Loosen and remove capscrew and cable clamp arrangement from sheave case attachment point of anti-two-block wire. Remove quick connect plug on anti-two-block wire by unscrewing base of plug and disconnecting individual wires from connections. Note pigtail length at this time and wire/terminal number location for proper reassembly.
3. Pull end of anti-two-block wire through side plates of 3rd section boom to gain in-line wire path.
4. Attach replacement anti-two-block wire to damaged wire with a “temporary splice”, securing the conductors with end to end butt connectors and shrink tube or electrical tape. This connection must be secured well enough to pull the new wire through the boom.
5. At the hoist mount end, reach into the rear of the boom and loosen the capscrew on the anti-two-block cable clamp enough to let the cable run around it with minimal effort. This clamp is located on the extend cable anchor.
6. Disassemble spade bolt anchor attaching anti-two-block wire to the extend cable plate on the hoist mount end of the boom.
7. Pull wire from hoist mount end. Replacement wire “temporary splice” may need assistance reeving around anti-two-block cable clamp in rear of 3rd section. If excessive force is needed to pull wire through, observe wire routing and make adjustments as needed to avoid breaking “temporary splice”. If splice fails at this point, wire routing Alternative #2 should be used.
8. Pull wire through boom, leaving enough wire on sheave case end to properly attach and terminate wire.
9. Tighten anti-two-block wire clamp located in rear of 3rd section.
10. Route sheave case end of anti-two-block wire around clamp in sheave case, and through holes in side plates. Pulling on this end will tension the static length of anti-two-block wire clamped in the 3rd. Approximately 15-25 lb (6-11 kg) will be sufficient to provide proper operation. Tighten sheave case anti-two-block wire clamp.
11. Reassemble quick disconnect plug to anti-two-block wire. Proper wire attachment is critical for proper anti-two-block system operation. Consult electrical schematic in this book for proper connector wiring.
12. “Temporary splice” should now be approximately 10 ft (3 m) past the hoist mount end of the boom. Break “splice” and slide strain relief/cord grip onto wire, into approximate position inside the boom.
13. Assemble spring and spade bolt to cord grip and reassemble anchor components to extend cable anchor plate on the hoist mount. Slide cord grip up

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anti-two-block wire into boom to increase spring tension on moving length of anti-two-block wire. Approximately 2 in (50 mm) of spring extension tension should be adequate for proper operation.

14. Visually inspect interior routing of anti-two-block wire for excess slack in wire, inaccurate routing of wire, etc. correct any problems before boom operation.

Alternative #2

This procedure is to be used for anti-two-block wire replacement in the event of a complete separation of the wire, or the inability to access one or both of the ends outside the boom assembly. This procedure routes a new anti-two-block wire through the boom without having an existing wire to pull it through (Alternative #1).

Special tools or equipment:

- Electrical tape
- Installation tool

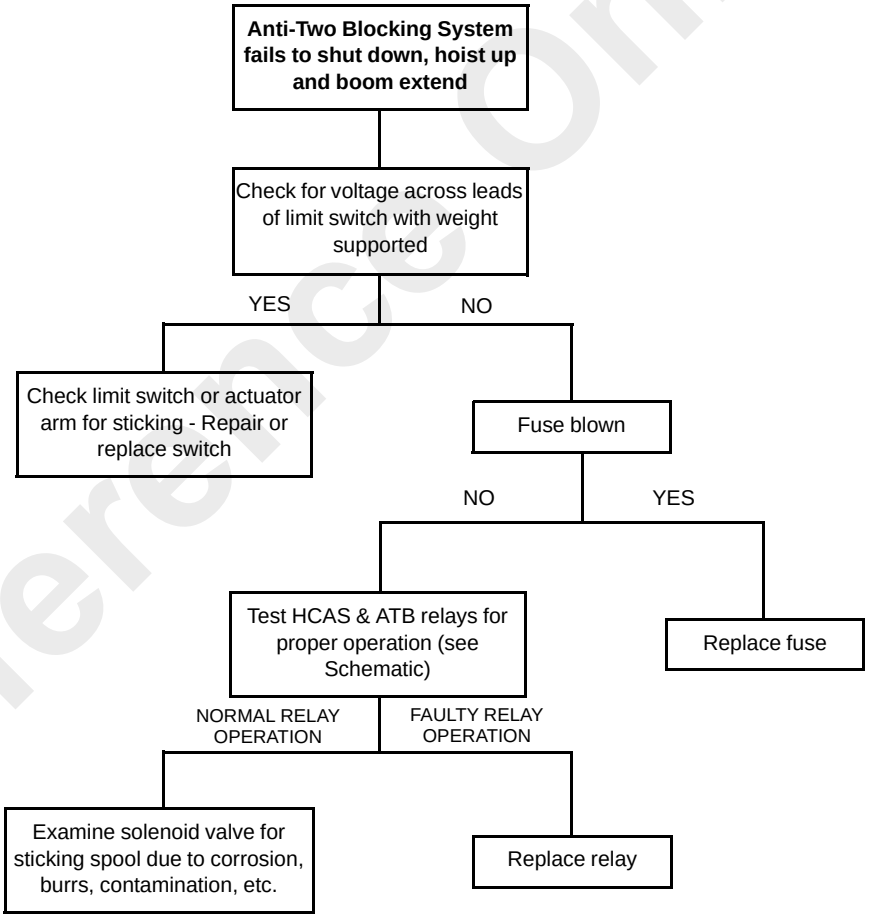
To route the wire the entire length of the boom, a long tube, to be used as a installation tool, must be utilized to transport the end of the anti-two-block wire from one end of the boom assembly to the other. A telescopic grease applicator for the boom, hydraulic tubing or electrical conduit are all possibilities for an installation tool. The installation tool should be at a minimum 2 ft longer than the retracted boom assembly.

1. Retract boom completely.
2. Loosen and remove anti-two-block cable clamp arrangements from sheave case and 3rd section extend anchor. Remove spade bolt anchor from extend cable anchor plate in the hoist mount end of boom.
3. Remove quick disconnect plug on anti-two-block wire by unscrewing base of plug and disconnecting individual wires from connections. Note pigtail length at this time, and wire/terminal number location for proper reassembly.
4. Pull anti-two-block wire out of boom assembly. Visually inspect boom interior from both ends to verify all the cable has been removed from the boom. Visually inspect center sheave on extend cylinder for damage.
5. Start installation of replacement wire on the sheave case end of the boom assembly. Using electrical tape, attach one end of replacement wire to the end of the installation tool.
6. Insert installation tool and wire into sheave case in the center open area between the sheave case side plates. Visually guide the wire and installation tool over the center sheave on the extend cylinder sheave case.
7. Push installation tool and wire through boom until it appears at the hoist mount end, detach wire from installation tool, route wire through open top of hoist mount and temporarily tie off to a convenient anchor point. Pull installation tool out sheave case end of boom.
8. From sheave case end of boom, attach other end of replacement wire to installation tool with electrical tape. Insert installation tool and wire into the boom sheave case, in the open area between the sheave case side plates. Visually guide this end under the center sheave on the extend cylinder sheave case.
9. Push installation tool and wire through boom until it appears at the hoist mount end. Do not detach wire from installation tool.
10. From hoist mount end of boom, locate installation tool and attached wire, and pull the wire out of the boom section, removing the slack loop from the sheave case end of the boom. This will place the wire close to, if not on the center sheave of the extend cylinder.
11. Move to the sheave case end of the boom. Visually determine if the wire has properly located itself onto the sheave. If not, manipulate the wire placement through the end of the boom and place the wire on the sheave. A 5 ft (1,50 m) long access tool (hook end) will simplify this procedure greatly.
12. From the hoist mount end of the boom, assemble the anti-two-block wire clamp on the extend cable anchor in the rear of the 3rd section. Loop anti-two-block wire around clamp and lightly tighten capscrew holding clamp together. Keeping a slight amount of tension on the wire at this point will keep the wire properly located on the sheave.
13. From the sheave case end, pull the installation tool and wire end out of the boom. The route of the anti-two-block wire in the boom is now complete.
14. Pull wire at either end of boom to adjust length of wire on sheave case end to properly attach and terminate wire.
15. Tighten anti-two-block wire clamp located in rear of 3rd section.
16. Route sheave case end of anti-two-block wire around clamp in sheave case and through holes in side plates. Pulling on this end will tension the static length of anti-two-block wire clamped in the 3rd. Approximately 15-25 lb (7-11 kg) will be sufficient to provide proper operation. Tighten sheave case anti-two-block wire clamp.

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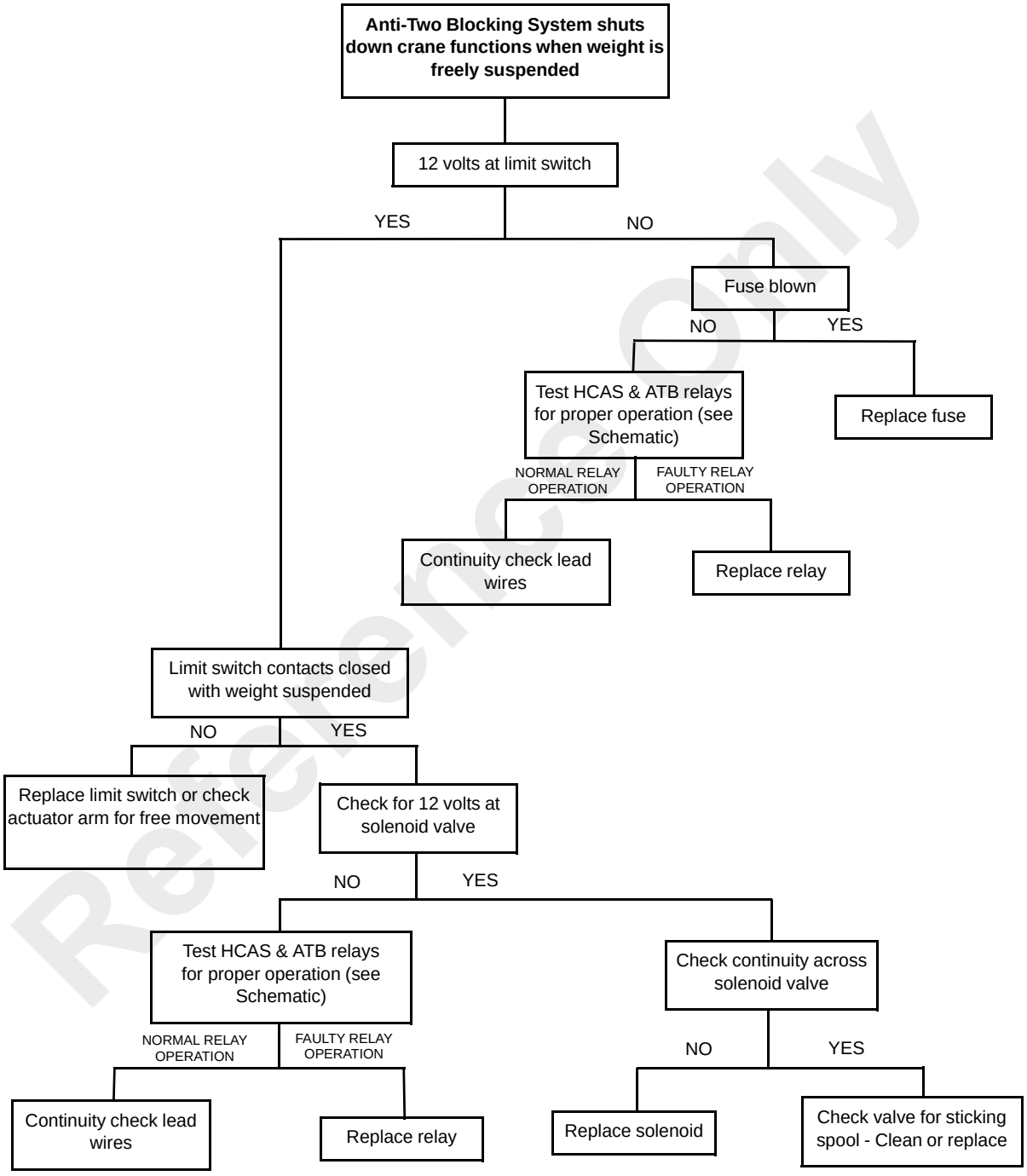
17. Reassemble quick disconnect plug to anti-two-block wire. Proper wire attachment is critical for proper anti-two-block system operation. Consult electrical schematic in this book for proper connector wiring
18. From hoist mount end of boom, slide strain relief/ cord grip onto wire, into approximately position inside the boom.
19. Assemble spring and spade bolt to cord grip and reassemble anchor components to extend cable anchor plate on the hoist mount. Slide cord grip up anti-two-block wire into boom to increase spring tension on moving length of anti-two-block wire. Approximately 2 inches (50 mm) of spring extension tension should be adequate for proper operation.
20. Visually inspect interior routing of anti-two-block wire for excess slack in wire, inaccurate routing of wire, etc. Correct any problems before boom operation.

ANTI-TWO BLOCK TROUBLE DIAGNOSIS - ELECTRICAL



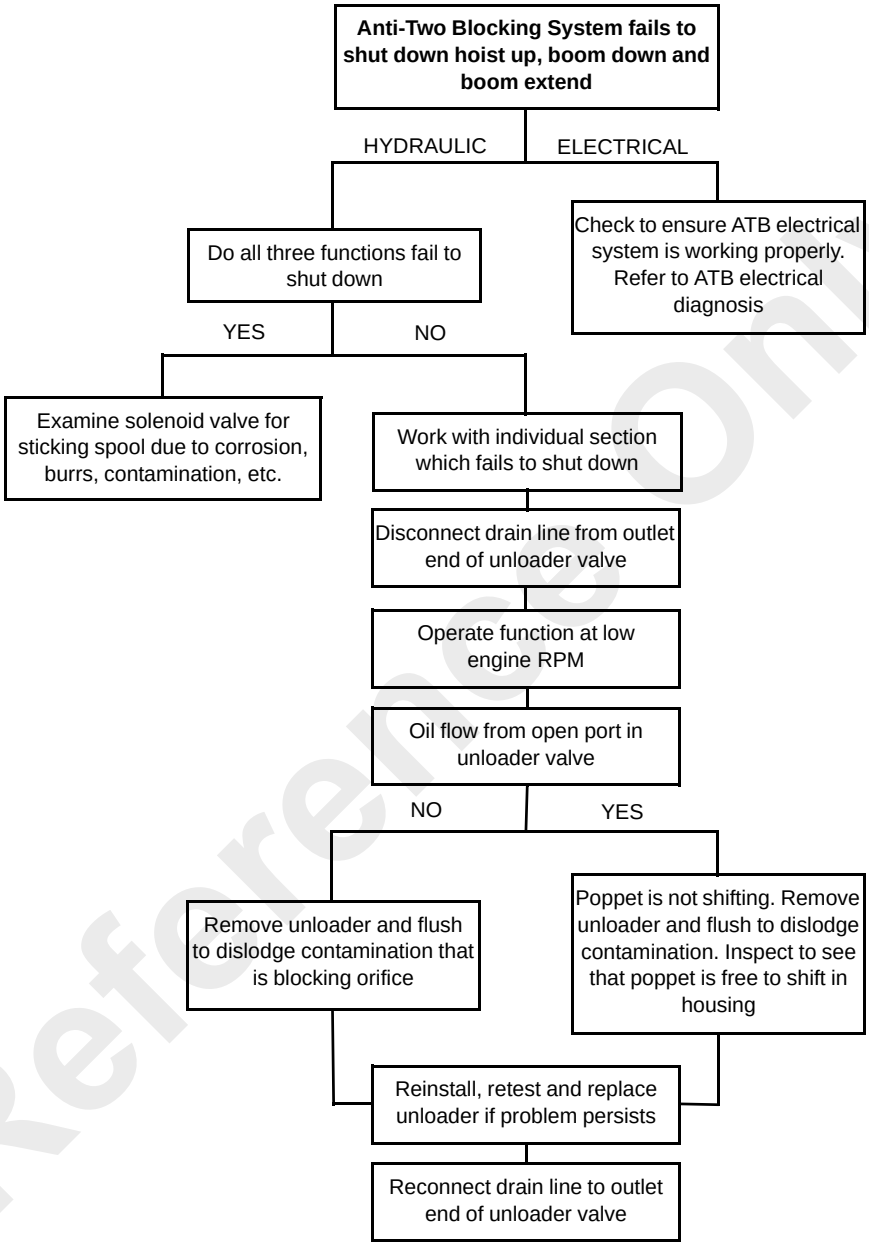
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ANTI-TWO BLOCK TROUBLE DIAGNOSIS - ELECTRICAL (CONTINUED)



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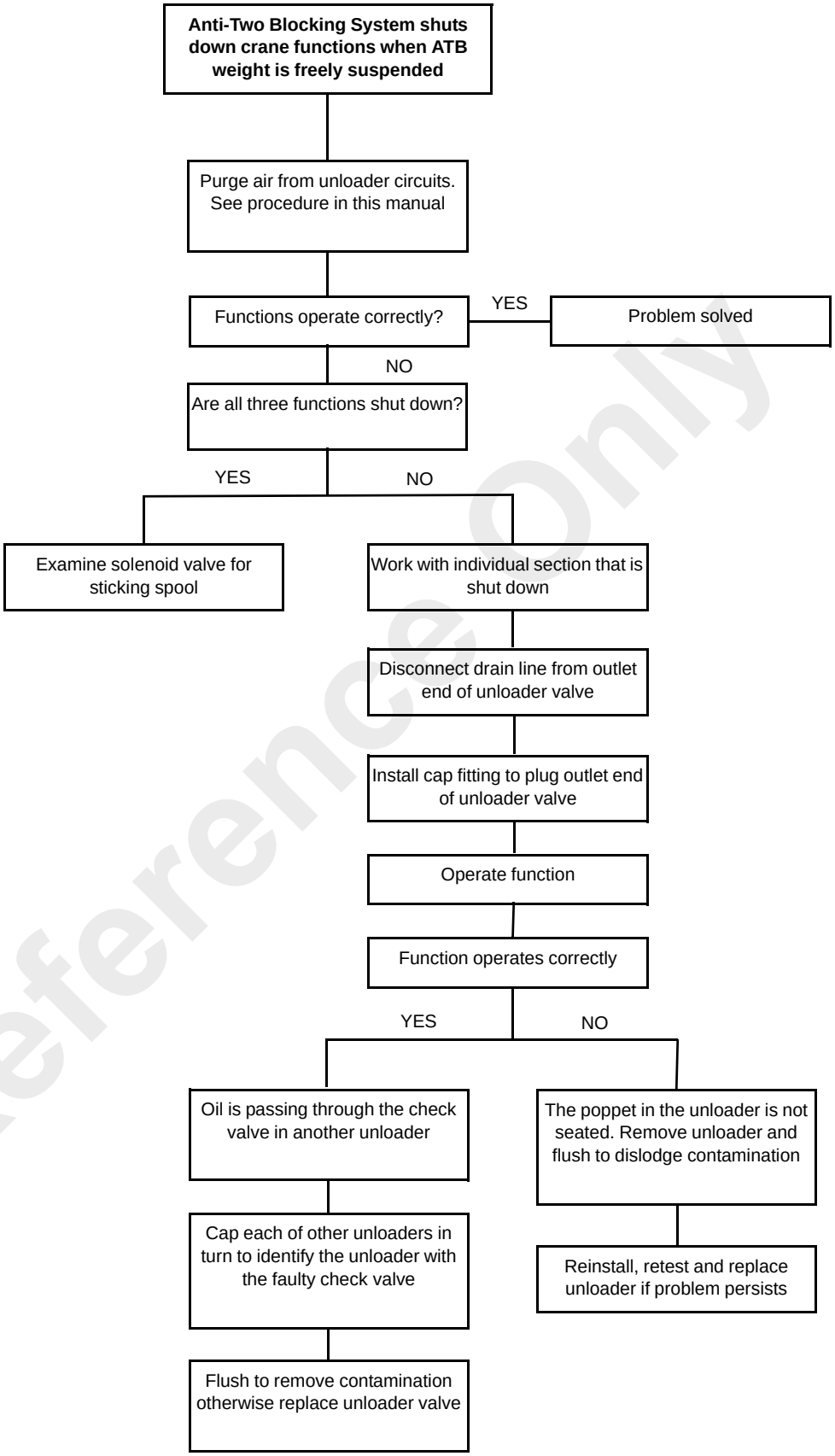
ANTI-TWO BLOCK TROUBLE DIAGNOSIS - HYDRAULIC



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NOTE: None of the internal parts of the unloader valves are serviceable.

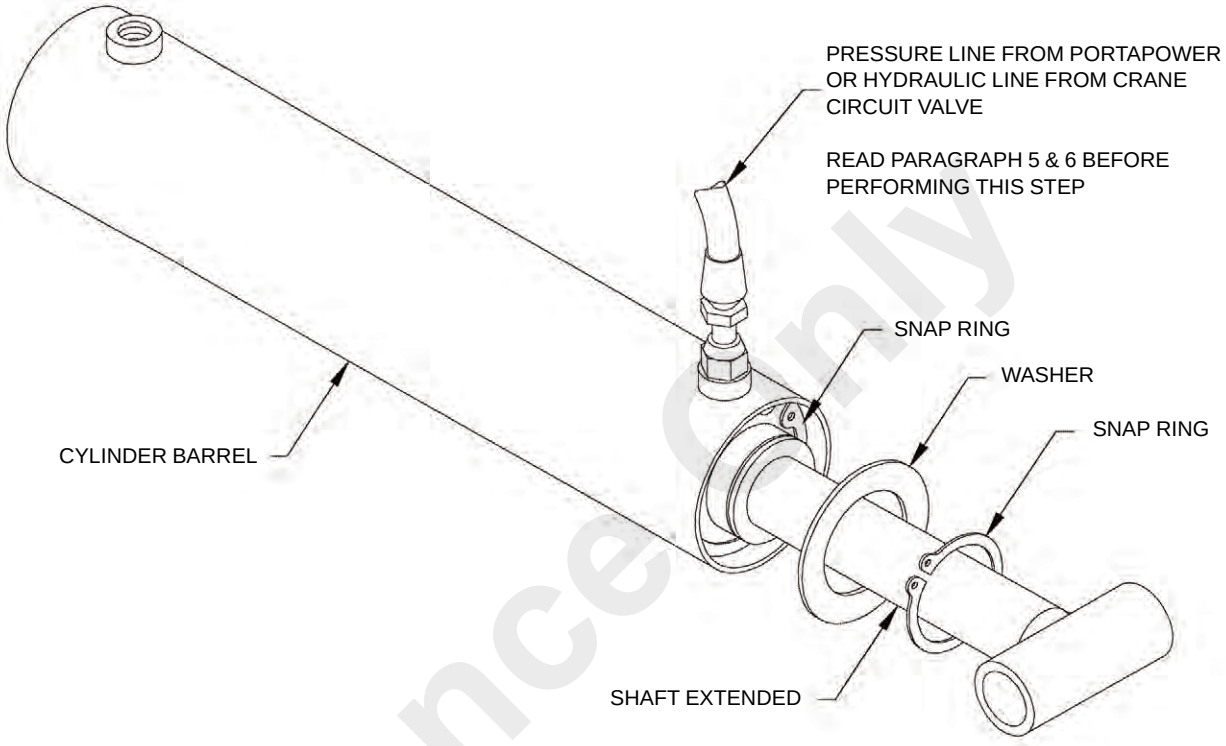
ANTI-TWO BLOCK TROUBLE DIAGNOSIS - HYDRAULIC (CONTINUED)



NOTE: None of the internal parts of the unloader valves are serviceable.

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CYLINDER DISASSEMBLY AND REPAIR



1. Disconnect shaft end of cylinder from machine.

2. Retract cylinder shaft with oil from the hydraulic system until about 12 in (30 cm) of shaft is extended. The barrel must be filled with oil to prevent a compressed air chamber being formed which could result in injury at disassembly.

3. Remove the cylinder from the machine and place on supports with an oil pan directly beneath the cylinder head area.

4. Using the proper size of internal snap ring pliers, compress the snap ring completely and remove from groove.

5. Attach a porta power hand pump or hydraulic line from crane circuit valve to the shaft end of the cylinder. Deburr snap ring groove edge. Failure to do so will damage barrel or packing gland.

6. Operate hand pump or crane circuit valve, preferably the boom telescope circuit, to force packing gland out of barrel.

7. Remove the shaft and piston assembly by hand.

8. Disassemble the piston set by removing nut, replace worn or damaged parts. Note: Loctite 680 is used during original assembly to secure nut to shaft. If necessary, heat nut to 400-500°F (204-260°C) to facilitate removal. If heat is necessary for removal, discard nut and replace with new equivalent nut as well as worn or damaged parts.

9. Wipe and inspect cylinder barrel for internal damage.

10. Wipe and inspect cylinder shaft for damage.

11. Remove shaft packing by removal of internal snap ring from packing gland. If spiral rings are used, they will have to be replaced each time they are removed. Replace parts as required.

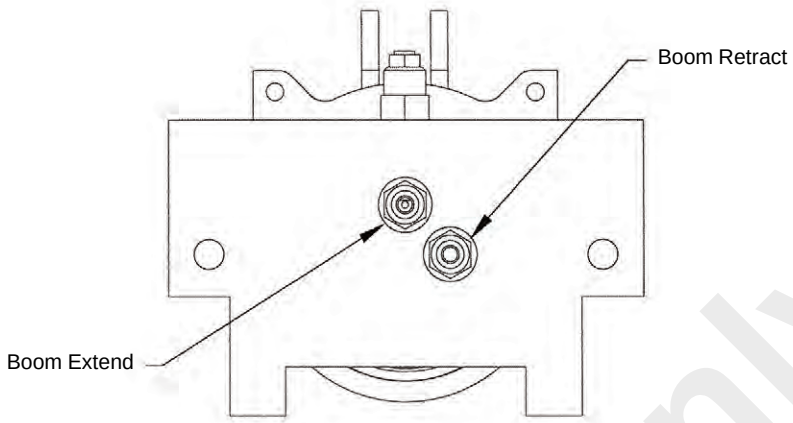
12. Lubricate piston head snap ring at O-ring seal area removing all nicks that have been formed at the snap ring area that would damage the O-ring before installation.

13. Reassemble shaft and piston set assembly. Loctite nut onto shaft using type 680 according to Loctite recommendations.

14. Reinstall shaft and head assembly being sure that snap ring expands completely and properly into the snap ring head groove.

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EXTEND CYLINDER



Extend Cylinder Disassembly

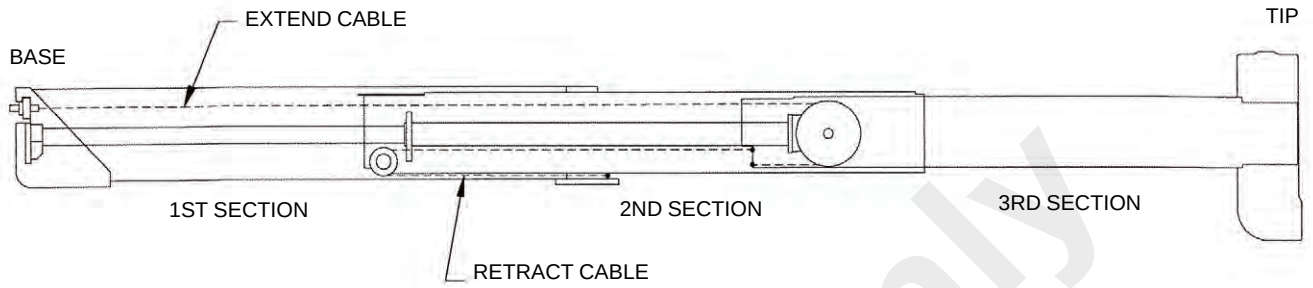
1. After cylinder has been removed from boom, place on supports and place drain pan under holding valve and cylinder head area.
2. Using hydraulic power (porta power or crane circuit) extend cylinder approximately 12 in (30 cm). Relieve any trapped hydraulic pressure which might remain in the cylinder.
3. Using a special drive tool, drive the packing gland into the barrel assembly to expose the round cross section retaining ring. Then use small needle nose locking pliers to clamp the round cross section retaining ring to prevent from rotating in the groove. Use two straight blade screw drivers; one to pry the end of the ring out of the groove and the other to pry the ring out of the barrel assembly.
4. Debur ring groove edge. Failure to do so will damage packing gland and or barrel assembly when packing gland is removed.
5. Plug retract port in the cylinder butt plate with SAE #6 O-Ring boss plug and pull on the rod assembly to force packing gland out of the barrel assembly.
6. If step 5 fails to break packing gland loose from the barrel assembly, remove the plug from the retract port and plug the extend port in the cylinder holding valve (SAE #6 O-Ring boss). Apply retract pressure to cylinder to break packing gland loose. Remove pressure and pull packing gland out by hand.
7. As soon as the packing gland is sufficiently loosened, properly support the rod assembly and carefully remove it. Place rod assembly on supports. Caution must be exercised in the support and removal of the rod assembly as damage to the chrome surface will necessitate rod assembly replacement.
8. Remove the two locking setscrews from piston.
9. Using proper spanner wrench loosen and remove threaded piston.
10. Remove piston, stop tube, packing gland and round ring. Replace any damaged or worn metal parts.
11. Replace all seals and bearings.
12. Wipe and inspect all cylinder internal and external surfaces for damage.
13. Inspect wear pad on barrel assembly and replace as required.

Extend Cylinder Assembly

1. Debur ring groove edge in barrel assembly and inspect all internal and external surfaces for damage.
2. Reassemble round ring, packing gland and stop tube on shaft assembly.
3. Install piston on shaft assembly and torque piston to 200 lb-ft (271 Nm). ***Loctite should not be used on threaded piston.***
4. Apply Loctite 242 to two setscrews and install in piston. Torque setscrews to 8 lb-ft (11 N·m).
5. Grease piston assembly and install the shaft assembly with piston, stop tube, packing gland and round ring into barrel assembly.
6. Using special drive tool, drive the packing gland into the barrel assembly.
7. Insert one end of round ring into groove in barrel assembly and spiral ring into groove with straight blade screw driver.
8. Cycle test cylinder to ensure no leaks exist. Support end of cylinder as it extends and retracts.

Reference Only

THREE SECTION BOOM OPERATION

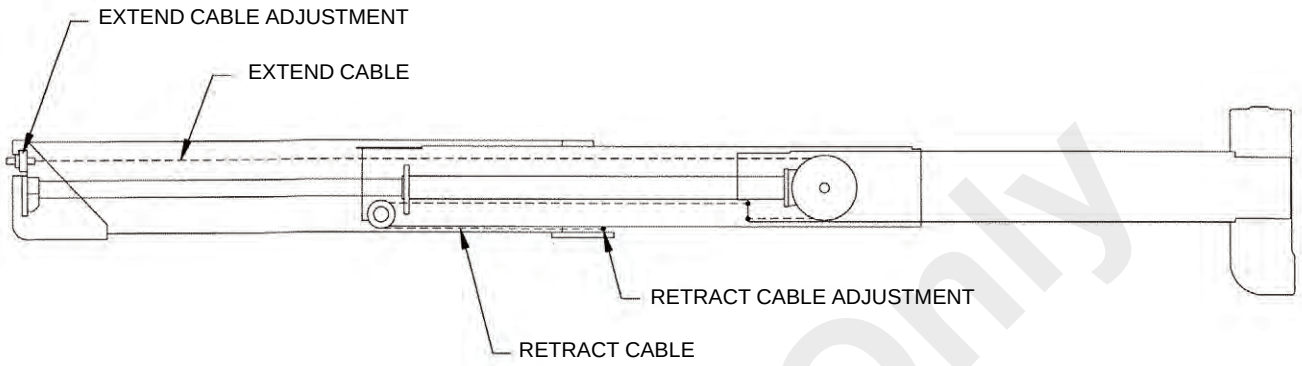


A rod-fed, double-acting cylinder, attached to the 1st and 2nd boom sections, supports and propels the 2nd boom section. The extend cables attach to the base end of the 1st boom section, are reeved around sheaves attached to the cylinder, and attach to the base end of the 3rd boom section, therefore providing support and extension of the 3rd boom section. The retract cables attach to the tip end of the 1 st boom section, are reeved around sheaves attached to the 2nd boom section, and attach to the base end of the 3rd boom section, therefore providing retraction of the 3rd boom section. This type of boom operation provides that the 2nd and 3rd section booms extend and retract equally. Proper service and maintenance is required to insure smooth and proper operation.

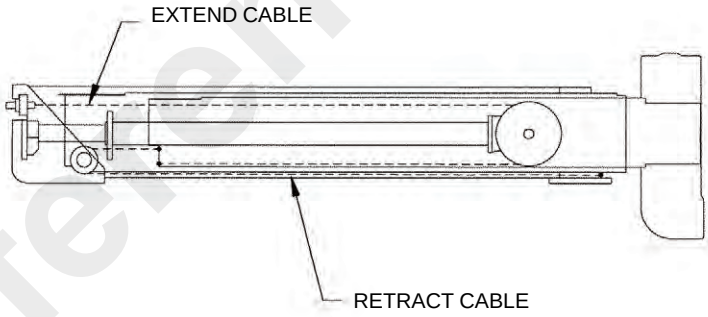
Reference Only

BOOM ILLUSTRATIONS

Boom extended



Boom Retracted



Reference Only

THREE SECTION BOOM MAINTENANCE

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

Internal Cable Sheave Lubrication

Special Tools: Nozzle or needle grease gun fitting. The lubrication points on the sheaves are not equipped with grease fittings (zerks), therefore a 0.25 in (6,35 mm) diameter nozzle grease gun tip will be required. Contact the National Crane Product Support Dept. to obtain this nozzle tip (NCC Part No. 955047), or numerous variations of the nozzle tip can be purchased at local hardware or auto parts retail outlets.

NOTE: Observation through the sheave case for the extend sheaves and the hoist mount for retract sheaves will visually determine the amount of grease necessary for proper lubrication. A slight amount of grease extrusion around the pin joint is adequate for proper lubrication.

Lubrication of the extend cable sheaves located on the boom tip end of the extend cylinder, and the retract cable sheaves located on the inside rear of the 2nd section are accomplished as follows:

1. Extend boom until grease access hole becomes visible in side plate of 2nd section as it extends out of 1st section [approximately 26 in (66 cm)].
2. Visually check alignment between the 2nd section access hole and the access hole in 3rd section. When these holes become aligned, the end of the extend cable sheave pin will be visible and accessible for lubrication.
3. This boom extended position will coincide with proper alignment of the access hole in the rear of the 1st section for lubrication of the retract sheaves attached to the rear of the 2nd section.

Three Section Cable Tensioning

After boom reassembly or from time to time if interior proportioning cables appear loose, cable tensioning may be required. Tensioning must be done with the boom horizontal

1. Slightly tighten all cables. Then cycle the boom approximately 4 ft (120 cm) out and in a few times to equalize the extend and retract cable/ boom section sequence positioning.
2. Fully retract boom. Do not induce and hold hydraulic pressure. At full retraction, observing through the hoist mount end of the boom, the second section should be bottomed on the extend cylinder butt plate, and the third section should be bottomed on the thick vertical side plates welded to the inside of the second section.
3. It is important to achieve these boom section positions before torquing. If the boom sections do not bottom out as specified (boom is out of sequence), adjust cables to achieve proper section positioning.
4. Torque retract cables to 6 lb-ft (8,13 N·m). Cable adjustment point is located at the sheave case end of the boom, on the bottom of the 1st section. Use the flats at the front of the cable ends to keep the cables from turning while torquing retainer nuts.
5. Torque extend cables to 10 lb-ft (13,56 N·m). Cable adjustment point is located at the rear of the boom on the cable anchor bar going through the hoist mount.
6. Repeat steps 4 and 5. Torque the retract cables to 10 lb-ft (13,56 N·m). Torque the extend cables to 17 lb-ft (23,04 N·m).
7. Cycle the boom fully, check that all cables are torqued properly and that all sections are retracted completely, then add jam nuts to all cables. All threaded cable ends must be equipped with retainer nuts and jam nuts.

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THREE SECTION BOOM SERVICE

Boom Removal

Boom Length	Boom Weight	CG from pivot point
56 ft	3305 lb (1499 kg)	113 in (2,87 m)
46 ft	2970 lb (1347 kg)	94 in (2,39 m)
37 ft	2660 lb (1207 kg)	78 in (1,98 m)
28 ft	2350 lb (1066 kg)	63 in (1,60 m)

NOTE: Boom weights include hoist and wire rope but not down haul weight or other line blocks.

1. Extend and set machine outriggers. Boom must be completely retracted and stowed in the boom rest.
2. If equipped, remove swing around jib according to procedures outlined in the “Safety & Operation” section.
3. Remove hook block or down haul weight, wind up rope on hoist drum and stow wedge socket on pegs provided on 1st section. Shut down truck engine.
4. Attach a lifting device to rod end of lift cylinder, remove boom lift cylinder pin keeper and pin from bottom of the 1st section boom. Lower lift cylinder to a suitable support.
5. Tag and disconnect extend cylinder lines and hoist hydraulic lines. Cap all open lines and ports.
6. Attach a lifting device to provide even weight distribution and raise the boom until weight is removed from the boom pivot pin. Remove boom pivot pin keeper and boom pivot pin. Lift boom free of turret.

Boom Disassembly

The 400B boom can be disassembled by using two different methods. Alternative #1 disassembles the boom in the conventional manner. Alternative #2 removes the extend cylinder from the rear of the boom, after removal of the hoist. This feature facilitates cylinder service without complete boom teardown.

For reference, the front of the boom refers to the sheave case end, the rear of the boom is the hoist mount end. Left and right are viewed from front to rear.

If the boom is to be unpinned from the turret of the crane structure, please refer to the Boom Removal Procedure section in this book. If the required service procedure is to be performed on the boom while still pinned to the turret, please follow these directions.

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

1. Extend and set the outriggers.
2. Fully retract the boom and place in a horizontal position.
3. Hoist removal optional, please refer to the Hoist Removal Procedure in this book.

Boom Disassembly Alternative #1

1. Gaining access through rear of boom, loosen capscrews retaining the extend cable anchor in the rear of the 3rd section as well as the capscrew on the anti-two-block wire clamp on the anchor assembly.
2. Extend boom 24 in (60 cm). Loosen and remove the nuts which secure the extend cables to the cable anchor plate. Remove nut from anti-two-block spade bolt. Tag and disconnect hydraulic lines to the extend cylinder.
3. Drape extend cables and anti-two-block cable inside boom, and slide cable anchor plate out of the side of the hoist mount if hoist has been removed from boom.
4. Loosen and remove two capscrews, lockwashers and spacers which anchor the extend cylinder rod butt plate to the rear of the 1st section.
5. Loosen and remove two capscrews and lockwashers securing spacer bar to the inside top of the front of the 1st section. Remove spacer bar.
6. Loosen and remove four capscrews securing wear pads to the bottom of the 1st section. Removal of side wear pads is optional. Adequate clearance exists between adjoining section side pads for boom disassembly. If side pad removal is required, tag all pads, shims, and corresponding locations for proper reassembly.
7. Support 2nd-3rd assembly at the front with an appropriate lifting method. Raise the 2nd-3rd assembly inside the 1st section to allow for front bottom pad removal. Remove bottom wear pads.
8. With the 2nd-3rd assembly supported, slide assembly out of the 1st. Relocation of the sling point on the 2nd-3rd assembly will be necessary for proper balancing of the assembly as it slides out of the 1st section. Keep tension on retract cables as the assembly is pulled out of the 1st, to minimize the chance of retract cable damage.
9. Place 2nd-3rd assembly on a suitable horizontal surface. Take care not to pinch or crush retract cables while lifting or supporting assembly.
10. Remove top rear wear pads on the 2nd section. They will lift off the cam plates easily. Do not remove or loosen the capscrews holding the cam plates to

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the section. This will affect side clearance during re-assembly.

11. Loosen and remove four capscrews securing the rear bottom wear pads on the 2nd section. This pad serves as a bottom and side pad as well as the retract cable keeper under the retract sheaves. Removal of this pad will allow the retract cables to uncoil off the retract sheaves. Place retract cable ends in a location to minimize the possibility of damage.

12. Loosen and remove four capscrews securing retract sheave pin and retract sheaves to 2nd section. Remove sheaves and pins.

13. Loosen and remove two capscrews functioning as upper retract cable keepers.

14. Loosen and remove two capscrews securing lock bar to the extend cylinder collar. This bar constrains the vertical movement of the extend cylinder. Remove bar.

15. Loosen capscrews retaining extend cable anchor to back of the 3rd section. Total removal of the capscrews will allow the cable anchor to be completely disassembled, backing capscrews out approximately 0.50 in (12 mm) will allow the anchor assembly to slide rearward out of the section as the extend cylinder is removed.

16. Support extend cylinder with an appropriate lifting device and pull the extend cylinder out of the boom while keeping the extend cables and anti-two-block wire tensioned slightly by hand to minimize the possibility of damage to the cables. Pull cylinder to within 3 ft (91 cm) of complete removal from the boom sections.

17. Reach into the rear of the 3rd section and loosen and remove the anti-two-block cable clamp on the extend cable anchor. Pull the extend cable anchor out from its retaining pocket on the bottom of the 3rd section. A slight angle applied to the anchor as it's being pulled to the rear will permit easier removal through the 2nd section.

18. Remove the extend cylinder from the boom. Remove extend cables. Place cylinder and cables in suitable area to prevent possible damage.

19. Remove retract cables from the back of the 3rd section by removing capscrews and cover plates from ends of cables. Place cables in location to prevent possible damage.

20. Anti-two-block wire can be removed if necessary. Loosen and remove capscrew and cable clamp arrangement from sheave case attachment point of anti-two-block wire. Remove quick connect plug on anti-two-block wire by unscrewing base of plug and disconnecting individual wires from connections. Note pigtail length at this time and wire/terminal number location for proper reassembly. Pull end of anti-two-block wire through side plates of 3rd section boom to gain in-line wire path and pull wire through boom.

21. Loosen and remove two capscrews, cable guide, wear pad and spacer bar from the front top of the second section.

22. Loosen and remove four capscrews attaching the bottom wear pads to the second section. Slightly lift third section, and remove pads.

23. Slide 3rd section out of 2nd section. Removal of side pads is optional, as the side pads have adequate clearance for boom disassembly. If removal of side pads is required, tag all shims, pads and corresponding locations for proper re-assembly.

24. Loosen and remove all remaining capscrews and wear pads from boom sections.

Boom Disassembly Alternative #2

The 400B boom design allows for removal of the extend cylinder from the rear of the boom without complete disassembly of the boom sections. This procedure allows quick access to the cylinder, retract cables, and various internal boom components for service or replacement.

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

1. Remove hoist. Please refer to the hoist removal section in this manual.

2. Remove anti-two-block wire from inside of boom. See Anti-Two-Block Internal Wire System.

3. Gaining access through rear of boom, locate the two capscrews that retain the extend cable anchor at the bottom rear of the 3rd section. Loosen these two capscrews and back them out approximately 1/2 in. This will free the anchor from the 3rd section but the anchor assembly will stay together. Remove the extend cylinder lock bar by loosening and removing the two screws that secure the bar. See illustration 1.

4. From full retraction extend the boom out 12 in (30 cm) and loosen and remove the nuts which secure the extend cables to the hoist anchor plate. Drape extend cables inside of boom. Then remove hoist anchor plate from boom. See illustration 1.

Reference Only

5. Loosen and remove the two capscrews and spacers which anchor the extend cylinder to the rear of the boom section. See illustration 1.
6. Retract the extend cylinder 4 in which will move the cylinder rod butt plate close to the back of the 2nd section. Then remove hoses from cylinder butt plate and cap the two fittings. See illustration 1.
7. Using the appropriate lifting device, lift the extend cylinder up and out of retaining slot on rear of the 2nd section. See illustration 2.
8. Pull the extend cylinder out through rear of boom assembly approximately one-half of the total length of cylinder. Keep the extend cables tight while moving the cylinder out of boom to minimize the possibility of damage to the cables. At this point lift extend cylinder up until it contacts the top of the boom sections. Then remove cable anchor located on bottom of 3rd section out of the rear of boom. See illustration 3.
9. Adjust lifting device to provide even weight distribution on extend cylinder. Then continue to pull extend cylinder and cables out of rear of boom. Store cylinder and cables in an area to minimize the possibility of damage.

Additional Maintenance, Disassembled Boom

1. Clean all boom sections and inspect for wear, dents, bent or bowed boom sections, gouged metal, broken welds or any abnormal conditions. Repair or replace as required.
2. Inspect all sheaves for excessive groove wear or abnormal rim wear. Replace as required.
3. Inspect all sheave bearings for excessive wear or cut liner material. If installed bearing diameter is 0.015 in (0.38 mm) larger than the pin diameter, bearing must be replaced. Any cut or gouge which causes the bearing liner to be distorted is cause for bearing replacement.
4. Clean and inspect all cable assemblies according to the wire rope inspection procedures in this section. Pay particular attention to any wire breakage within 6 ft (180 cm) of the end connections. Replace cable assemblies as required. Lubricate all cable assemblies before reinstalling them in the boom.
5. Inspect all sheave pins for nicks, gouges or pitting due to rust in the bearing surface area. Replace if any damage is evident.
6. Inspect anti-two-block wire full length for damage, check for electrical continuity.

Reference only

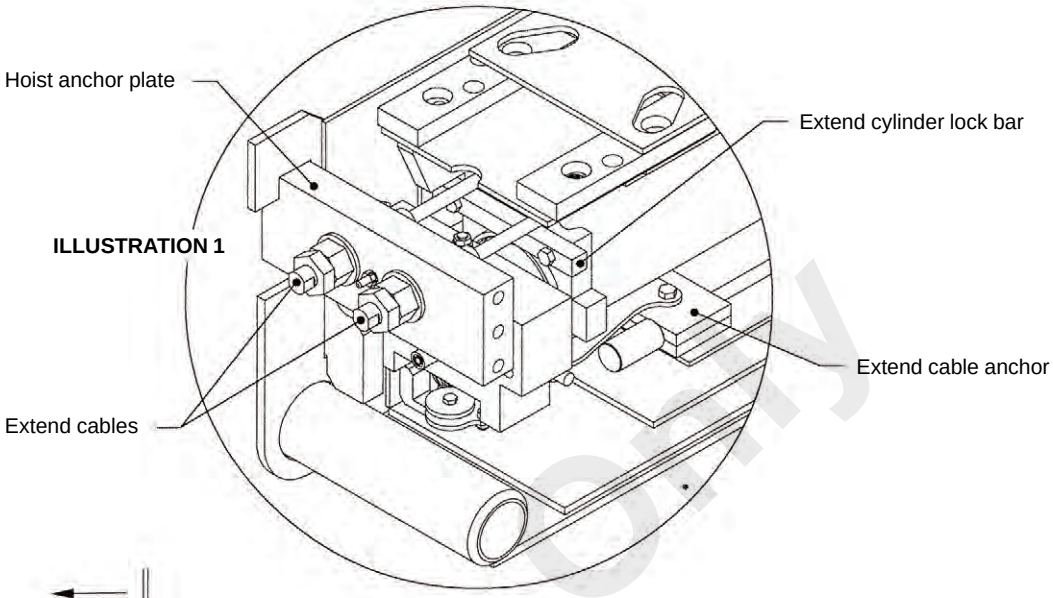


ILLUSTRATION 1

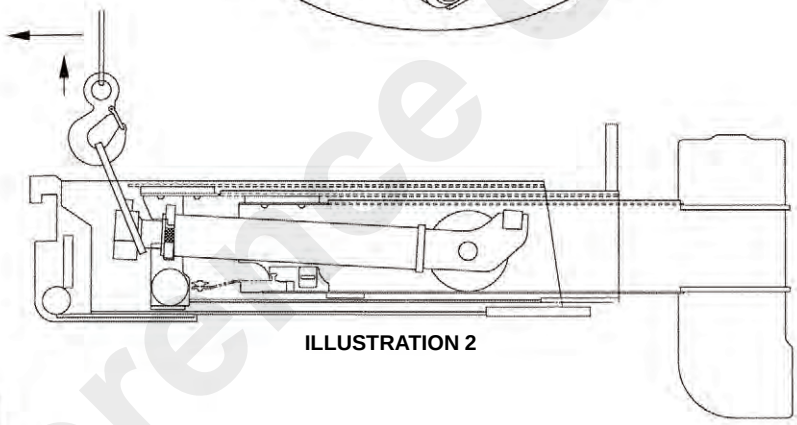


ILLUSTRATION 2

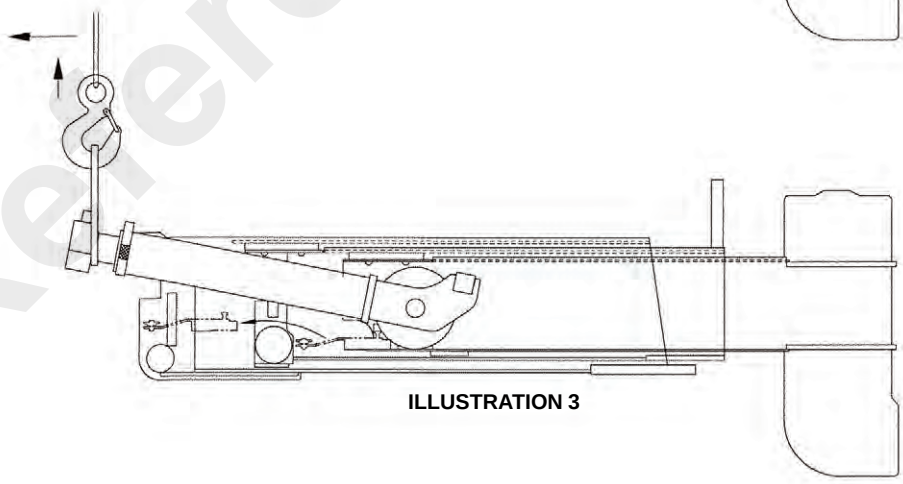


ILLUSTRATION 3

Reference Only

THREE SECTION BOOM ASSEMBLY

Note: Do not use Loctite on any cable threaded ends. Always use the locknut and nut provided.

When initially assembling threaded ends of cables, thread the first on past the flat in the cables so adjustment can be made later.

1. Assemble sheaves into 3rd section sheave case. Top sheave is to be installed to the left hand side of the boom with the spacer to the right hand side.
2. Attach rear wear pads on bottom of 3rd section.
3. Install 3rd section boom into 2nd section. Slide together approximately 5 ft (150 cm).
4. Assemble bottom front wear pads for 2nd section and Teflon plugs.
5. Using appropriate lifting device, lift 3rd section to allow for wear pad installation in front of 2nd. Install wear pads. Slide sections together within 12 in (30 cm) of full retraction.
6. Install front side wear pads with appropriate shims, between 3rd and 2nd sections. If boom has been disassembled, and no sections have been replaced, use same shim quantity and location as was previously used. If locations are in question, refer to shim calibration section in this book.
7. Route anti-two-block wire through 3rd section, keeping bulk of wire at the rear of the boom sections. Routing can be accomplished using an installation tool, such as a telescopic boom grease applicator, electrical conduit, or hydraulic tubing. Route anti-two-block wire between sheave case side plates.
8. Uncoil retract cable assemblies, and insert button end into anchors in back of the 3rd section. Secure button with cover plates. Place uncoiled cable in area that will minimize the potential for damage.
9. Assemble retract sheaves and retract sheave pins in rear of 2nd section. Coat surfaces of bearings with grease before assembly.
10. Place retract cables over top of retract sheaves. Install keeper capscrew above sheave to hold retract cables in place.
11. Reeve cables over retract sheave and install keeper/wear pad to bottom rear of 2nd section. This pad acts as a side pad, bottom pad, and a cable retainer.
12. Assemble exterior extend cylinder components. Install and center sheave pin into butt plate of extend cylinder. Install bearings into extend cable sheaves. Coat surface of bearings with grease and assemble extend sheaves on sheave pin.
13. Wrap approximately 10 ft (300 cm) of each 1/2 in (12,7 mm) diameter extend cable around extend sheaves and install extend cable anchor. Do not tighten capscrews clamping anchor together completely. These capscrews if tightened completely will not allow cable anchor to install into 3rd section. Route anti-two-block cable over center sheave on extend cylinder.
14. Install wear pad over extend cylinder sheave side plates. This serves as a wear pad to keep the end of the extend cylinder centered in the boom, as well as an extend cable retainer.
15. Slide extend cylinder/extend cables into 2nd/3rd boom assembly enough to assemble extend cable anchor into bottom rear of 3rd section. Route anti-two-block cable over extend cable anchor as anchor slides into 3rd section. Be aware of extend and anti-two-block cable location when inserting cylinder into boom sections, inadvertent crushing or other damage to cables will warrant replacement.
16. Tighten capscrews clamping extend anchor together. These capscrews will protrude through the 3rd section bottom plate, locking the anchor in position.
17. Loop anti-two-block cable at the extend cable anchor in the 3rd and install anti-two-block cable clamp. Do not completely tighten clamp capscrew.
18. Assemble anti-two-block clamp in the sheave case. Reeve anti-two-block cable around anchor and through holes in side plate of sheave case. Pull approximately 2 ft (60 cm) of cable out the end of the boom for proper routing and termination.
19. Tighten anti-two-block clamp on the extend cable anchor in the rear of the boom. Tension anti-two-block cable from the sheave case end of the boom, and tighten anti-two-block clamp located in sheave case.
20. Visually verify that the extend and anti-two-block cables are properly routed on their sheaves and continue to slide the extend cylinder and cables into the boom sections. Keep extend and anti-two-block cables supported and slightly tensioned during insertion of cylinder, to maintain proper cable placement.
21. As the extend cylinder keeper plate nears the 2nd section, adjust the height of the cylinder to allow the cylinder to access the cylinder keeper cutouts in the doubler plates on the sides of the 2nd section.

Reference only

22. Drop the cylinder down into the vertical cutouts in the doubler plates on the sides of the 2nd section.
23. Install lock bar and capscrews to the extend cylinder.
24. Position 2nd/3rd/cylinder assembly in position to be inserted into 1st section. Lay retract cables out under 2nd/3rd/cylinder to allow easy installation as the booms are assembled.
25. Slide 2nd/3rd/cylinder assembly into 1st section boom approximately 2 ft (60 cm). Use caution during this step to keep retract cables straight and on the correct side of the boom assembly as the sections are assembled.
26. Continue to slide 2nd/3rd/cylinder assembly into 1st until it is approximately halfway into 1st.
27. Assemble bottom front wear pads in 1st section, trapping ends of retract cables in slots on bottom of 1st section. Lift 2nd/3rd/cylinder assembly up to ease installation.
28. Slide boom together to within 12 in (30 cm) of complete retraction. Install upper front spacer bar in 1st section and upper front wear bar and cable guide assembly to 2nd.
29. Retract boom completely, using proper hardware and spacers, connect extend cylinder butt plate to the hoist mount. Hydraulic power source can be utilized at this time if slight cylinder length adjustment is necessary.
30. Slide extend cable anchor into position in hoist mount. Push threaded ends of extend cables through holes in anchor and assemble hex nuts onto threaded ends.
31. Assemble top rear wear pads to the top of the 2nd and 3rd boom sections. Wear pads can be inserted from the hoist mount end of the boom, and the cam plates dropped through the holes in the aligned boom top plates. Rotate cam plates with screwdriver to move wear pads against boom side plates. These cam plates function as rear side clearance adjustment.
32. Approximately 10 ft (300 cm) of anti-two-block cable will be available on the hoist mount end of the boom to route and hookup to the control console wiring. Find the end of this cable and slide the cord grip/ strain relief hookup onto it and slide it up the cable into approximate position inside the boom.
33. Assemble the extension spring and spade bolt to the cord grip. Assemble the spade bolt through the extend cylinder anchor with a hex nut. Adjust tension on anti-two-block cable by sliding cord grip down cable into the boom. Approximately 2 in (5 cm) of spring extension should be adequate for proper boom operation.
34. Visually check each end of boom for proper extend, retract and anti-two-block cable routing and placement. Make certain anti-two-block cable is correctly on sheave. Inspect from sheave case end.
35. Adjust slack out of extend and retract cables at hex nut adjustment points. Slowly cycle boom in and out several times. Torque cables per procedure located elsewhere in this book.

Reference Only

THREE SECTION TOP/BOTTOM PAD REPLACEMENT ASSEMBLED BOOM

Inspect top and bottom wear pads periodically for signs of abrasion or excessive wear. Excessive is defined as 3/16 in (4,76 mm) from the original pad thickness. Top rear pad thickness 0.75 in (19,05 mm), bottom front 1st section 1 in (25,4 mm), bottom front 2nd section 0.50 in (12,7 mm). Uneven pad wear of 3/ 32 in (2,38 mm) from side to side on the wear pad would be considered excessive as well. If any of these conditions exist, the top and bottom pads can be replaced without complete disassembly of the boom.

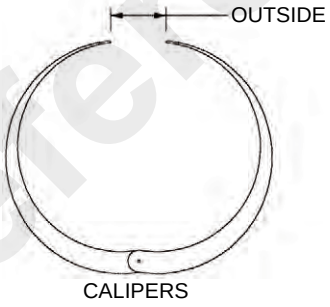
Top Rear Pad Replacement

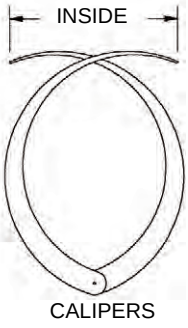
1. Retract boom completely.
2. Remove capscrews through access holes on top rear of sections.
3. Remove wear pads and cam plates from the rear of the boom through open hoist mount end.
4. Note all pad locations and tag accordingly.
5. Inspect pads for wear using previously mentioned inspection criteria.
6. Install new pads through hoist mount end of boom, drop cam plates through access holes and install capscrews.
7. Rotate cam plates in the direction that will move the wear pad against the adjoining boom section, hold cam plate in position and torque capscrew to proper specification. This top pad design also sets the rear side clearance for the boom sections, proper torque is critical for proper boom operation.

Front Bottom Pad Replacement

1. Extend boom approximately 4 ft (120 cm) out.
2. Using an appropriate lifting device, sling around the 3rd section boom and lift it up until weight is removed from the bottom pads in the front of the 2nd and 1st boom sections.
3. Loosen and remove the four capscrews holding the pad plate in between the 3rd and 2nd sections, remove pads. Note all pad locations and tag accordingly.
4. Loosen and remove the four capscrews holding the bottom front wear pads to the 1st section, remove pads. Retract cable adjustment ends may have to be loosened during this step. Note all pad locations and tag accordingly.
5. Replace all wear pads, wear pad plate and retorque retract cables if disassembly of cables was required.

INNER WEAR PAD CALIBRATION

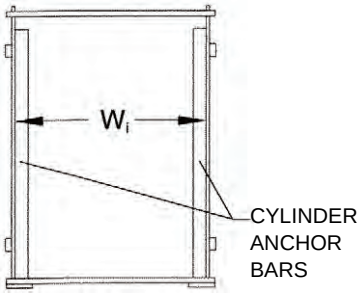




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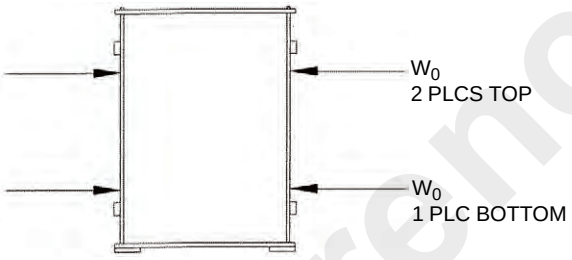
INNER SIDE PADS

1. With a pair of inside/outside calipers, measure the inside width of the outer section (W_j) at the front and back of the boom and record the smallest measurement. If the section has cylinder anchor bars, take a measurement directly in front of these bars.



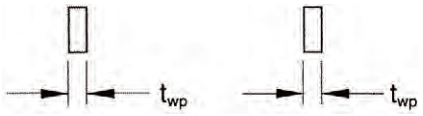
OUTER SECTION

2. With the inside/outside calipers, measure the outside width of the inner section (W_0) at each side pad location. Record the largest measurement.



INNER SECTION

3. Measure the thickness of the wear pads and record (t_{wp}).

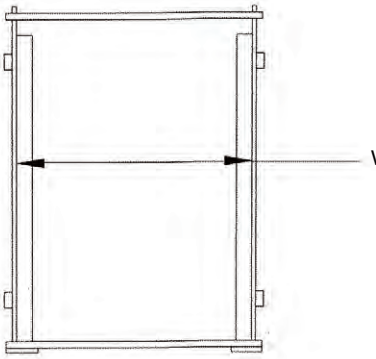


4. Subtract the largest outside width (W_0) of the inner section and the thickness of the two pads (t_{wp}) from the inside width of the outer section (W_j). Add shims as required [each shim is 0.03 inches (0.8 mm) thick] to tighten the pads so that there is 0.03 inch - 0.09 inch (0.8 mm - 2.3 mm) clearance between the widest part of the inner boom and the most narrow part of the outer boom when shims and pads are installed. In some cases it will be necessary to have an unequal number of shims behind the pads at the top and bottom side pad locations. See example.

Reference Only

EXAMPLE

NOTE: All measurements are in inches (mm).

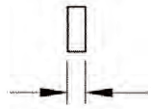


W_j = 12.12 (308) at front
12.06 (306) at back
near cylinder anchor
bars

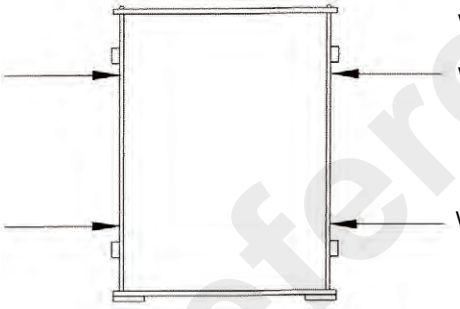


t_{wp}= .52 (13)

THIRD SECTION



t_{wp}= .52 (13)



W_0 = 10.94 (278) at top rear
pad location

W_0 = 11.00 (279) at top forward
pad location

W_0 = 10.94 (278) at bottom rear
pad location

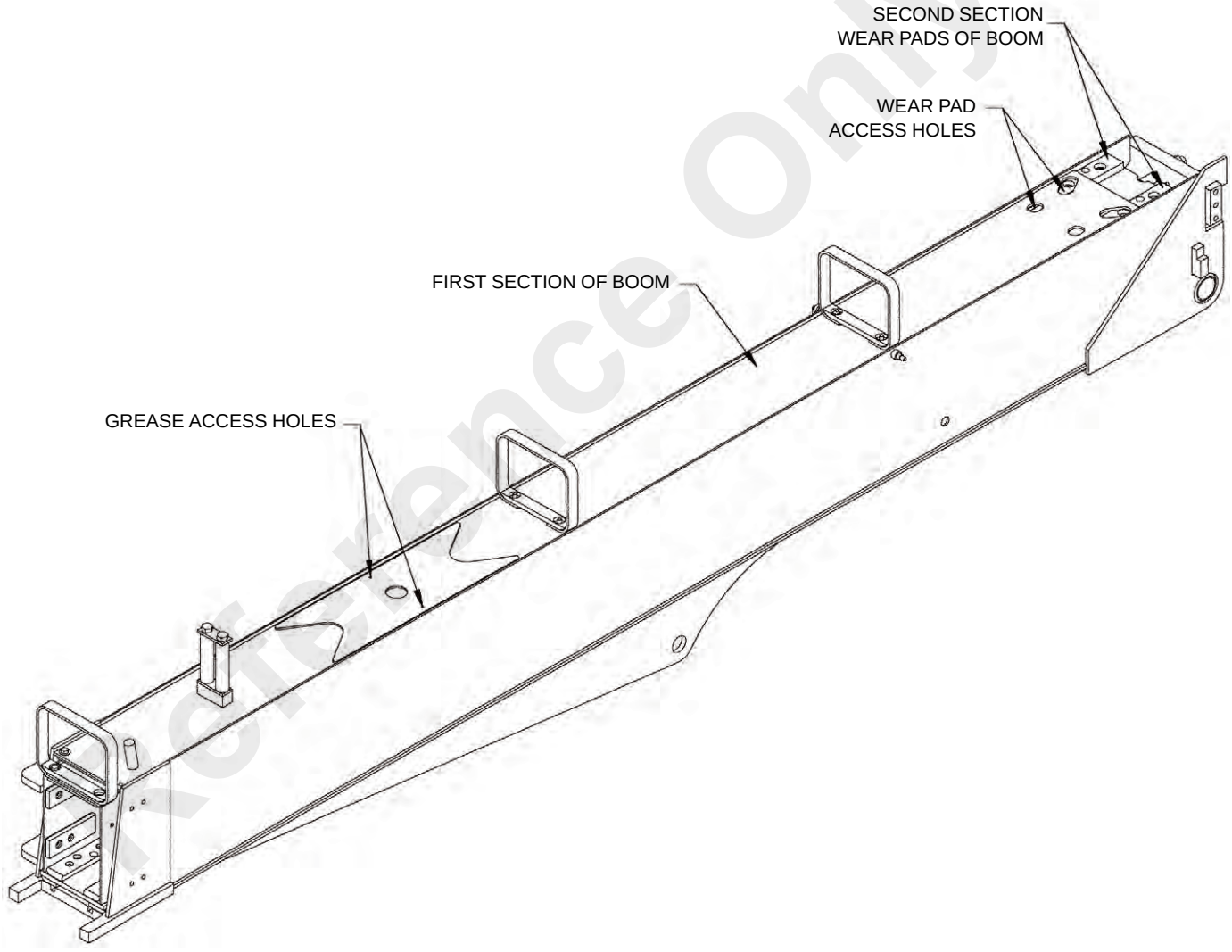
FOURTH SECTION

	TOP REAR		BOTTOM REAR	
W_j =	12.06	(306)	12.06	(306)
$-W_0$ =	–10.94	–(278)	–10.94	–(278)
$-t_{wp}$ =	–0.52	–(13)	–0.52	–(13)
$-t_{wp}$ =	–0.52	–(13)	–0.52	–(13)
Clearance before shims =	0.08	(2)	0.08	(2)
Left side shim =	–0.03	–(0,8)	–0.03	–(0,8)
Final Clearance =	**0.05**	**(1,2)**	**0.05**	**(1,2)**

Reference Only

INNER BOOM PAD LUBRICATION

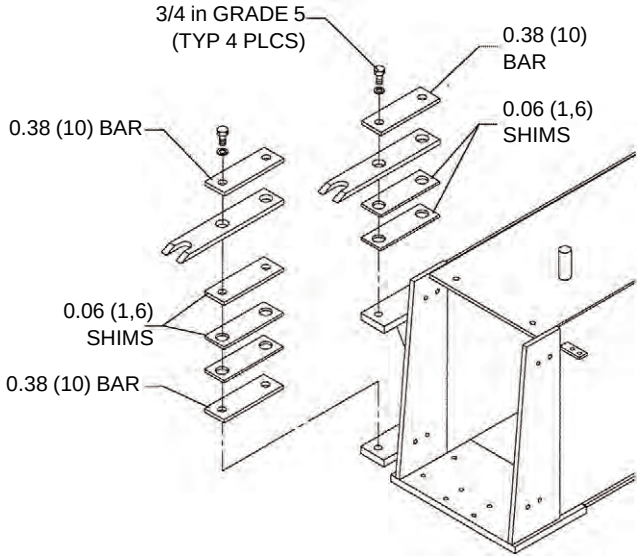
1. With the boom fully retracted, fill upper rear pad retention pockets (pad retainers) with grease. Access pockets thru holes in rear of boom top plates.
2. Extend boom to full extension at this time. The upper rear pad retention pockets will be directly under the 1/4 in grease access holes in the reinforcing plates on the top of the boom sections. Boom tip may be lowered onto ground ***very lightly*** to unload rear pads and facilitate better grease application.
3. Using a 1/4 in diameter nozzle grease gun adaptor, fill pad retention pockets with grease.
4. Retract boom. This should apply grease to the pad bearing area of the top plates of the boom sections.
5. These steps can be repeated as many times as necessary if unacceptable boom noise or chatter persists.



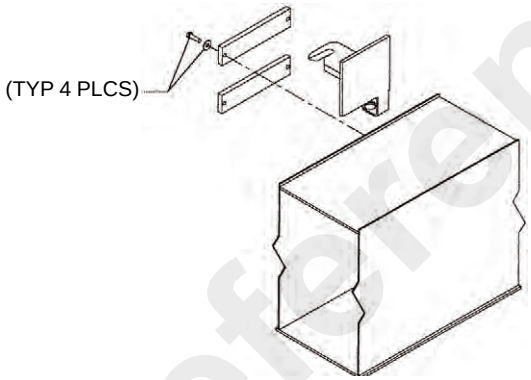
Reference Only

JIB INSTALLATION AND ADJUSTMENT

1. Loosely bolt the two ear assemblies with shims and bars as shown to the side of the first boom section. **Note: All measurements are in inches (mm).**

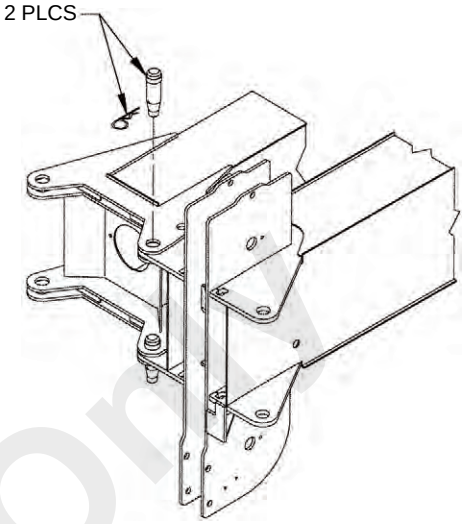


2. Loosely bolt the hook assembly to the side of the first boom section.

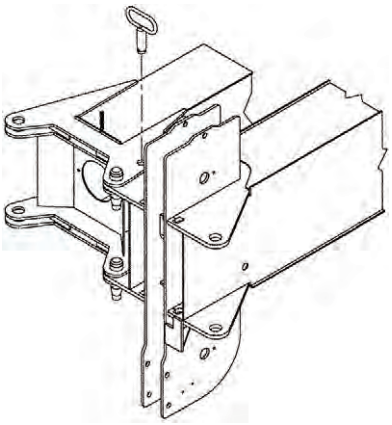


3. Extend the boom approximately one foot (300 mm).

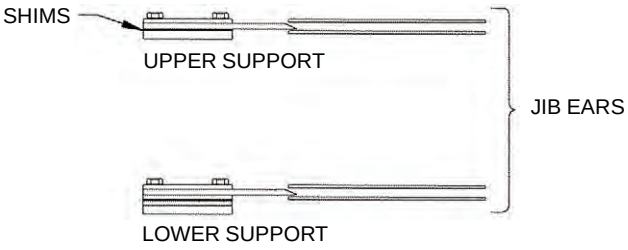
4. Using an overhead hoist, lift the jib assembly and align and pin the jib to the boom sheave head.



5. With jib pinned to the sheave head, swing the jib parallel to the boom and install the pin which keeps the jib from swinging (the pin is welded to a chain on the end of the jib).

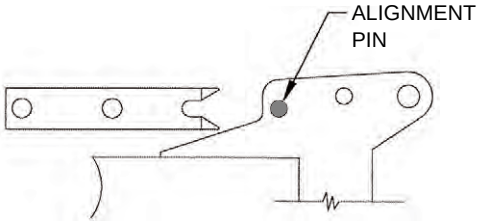


6. Slowly retract the boom until the jib ears are within 0.50 in (13 mm) of the ear assemblies on the first section. Observe the vertical alignment of the jib ears and ear assemblies and add or remove shims until the jib is supported by the jib ears. The jib will typically rest only on the upper support.

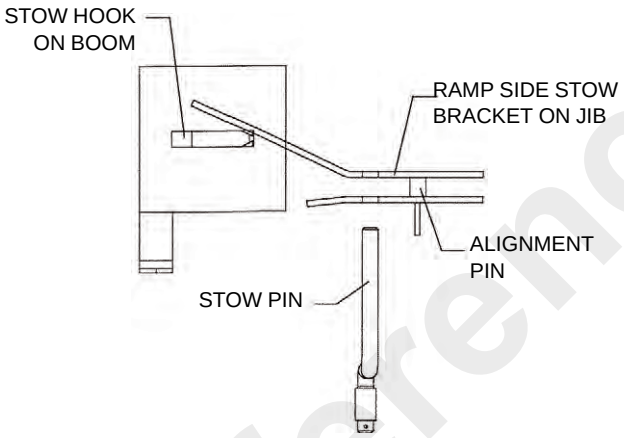


Reference Only

7. Observe the horizontal alignment of the slot in the ear assemblies and the stow pin in the jib. Horizontal adjustment of the stow ears is provided by oversize bolt holes in the stow ear. Move the ears in or out to achieve proper alignment. Position the top ear so it holds the top of the jib in toward the boom and the bottom ear so that it holds the bottom of the jib away from the bottom of the boom.

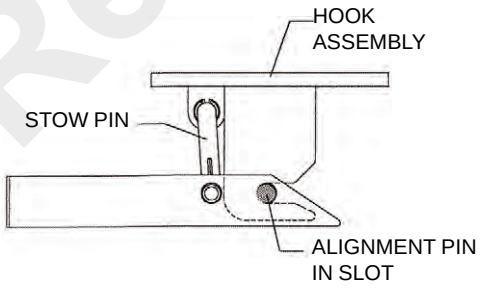


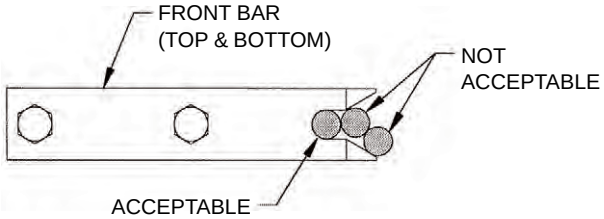
8. Retract the boom slowly. Observe the stow hook and lock assembly alignment as the boom is retracted.



⚠ CAUTION

Make sure the ramp slides up the stow hook and does not hit the end of the ramp.

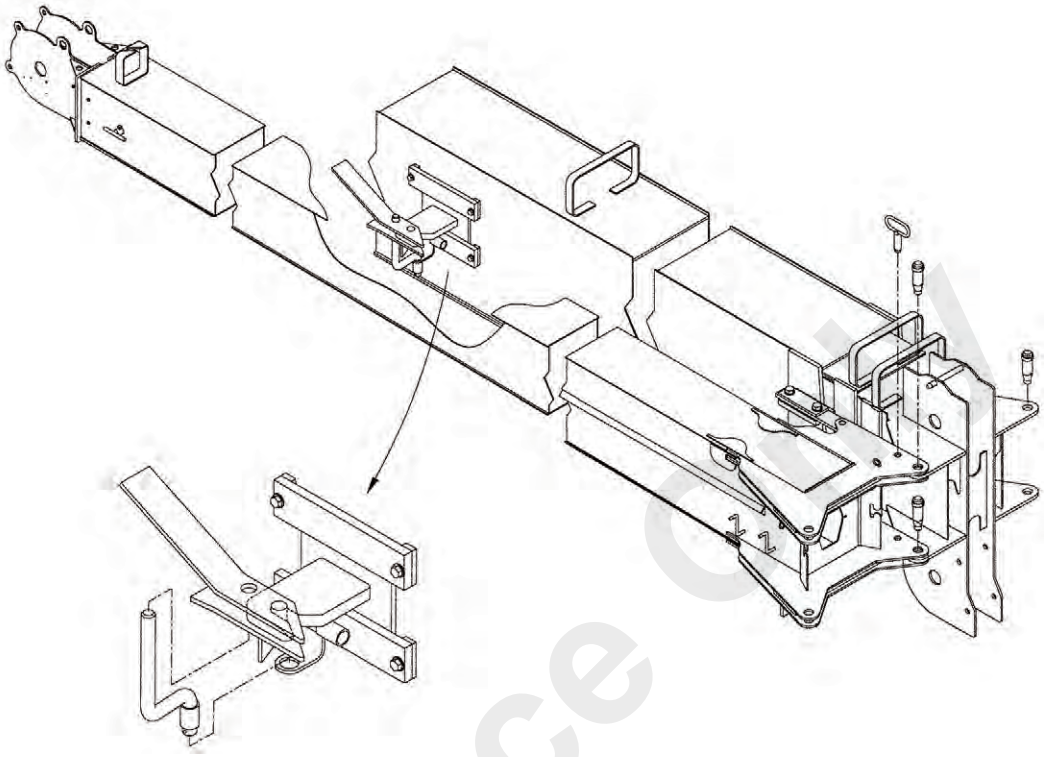




9. When the boom is fully retracted, the jib stow pins must be bottomed out securely in the ear assemblies. If the stow pins are not aligned properly, the hook assembly and front bars will have to be positioned as shown so the jib cannot slide forward or backward as the boom is elevated.
10. Try to remove the jib pins. If the pins are too tight, the stow hook assembly or front bars will have to be adjusted.
11. Torque all capscrews to their specified torque value (see table in Service & Maintenance Section). Install stow pin in lock assembly and remove the jib pins.
12. Extend and retract boom to insure proper alignment of jib pins.
13. Install jib pins and remove the stow pins.
14. Extend and retract the boom and jib to ensure proper alignment of jib stow brackets.
15. Install jib stow pins and remove jib pins.

Always save shims to allow future adjustment of jib stow if required.

Reference Only



Reference Only

(OPTIONAL) OIL COOLER SERVICE & MAINTENANCE

The heat exchanger must be kept clean to allow for efficient operation of the cooler system. Frequent washing of the heat exchanger core will eliminate oil film, road dirt and other foreign object buildup on the heat exchanger fins which reduces cooling efficiency.

Frequent inspection and tightening of hose clamp line connections will eliminate the possibility of end connection failure due to back pressure from cold startup. If cooler system fails to provide adequate performance, reduced air or oil flow through the heat exchanger is the probable cause. The cooling fan should be inspected for proper operation (see Specifications). Any obstructions in air flow should be corrected (cooler too close to other truck components, foreign matter in heat exchanger fins, etc.) All hydraulic lines should be periodically checked for obstructions, hose kinks or other flow restrictions.

DISASSEMBLY & ASSEMBLY INSTRUCTIONS FOR ROTATION GEARBOX

The 400B rotation gearbox is a double reduction planetary swing drive. Each reduction set has an individual ratio of 5.052 combined for a total reduction of 25.53. Its spring applied hydraulic released brake prevents movement of the pinion until released or an overload is encountered. The output pinion is supported by two tapered roller bearings. These bearings support the over hung and shock loading of the pinion.

General Information

Ratio: 25.53

Weight: 96 lbs.

Oil: EPGL

Brake: 800 in. lbs. (measured at input)

Brake Section

The spring applied hydraulic release brake has multiple friction discs that operate in common with the gear oil for cooling. As the rotation valve is opened, pressure rises and the brake is released; at this point, the gearbox is free to rotate. With the valve in neutral the spring force acting on the stator and friction disc prevents rotation of the pinion.

Trouble Shooting

Brake will not release:

1. The O-ring and back-up rings have failed allowing the brake release pressure to bypass. This will be indicated by hydraulic oil flowing from the gearbox vent.
2. Brake release pressure too low. If the release pressure is too low the piston will not have enough force to overcome the spring force. Install a pressure gauge in the brake release port. A pressure of 250 psi is needed for full release.

Brake Disassembly

1. Remove motor.
2. Remove the six capscrews (27) holding the brake section to the main housing.
3. With the brake section on a work bench remove the six capscrews (28) holding the cover in place.

⚠ CAUTION

The cover is spring loaded and the bolts (28) should be loosened in a sequence that will allow an even load distribution on the cover.

4. Remove the springs (15) and the brake driver (8).
5. Remove the snap rings (33) from the brake piston (5). Remove the stator plates (16) and the friction disc (17). Note the sequence of removal for reassembly.

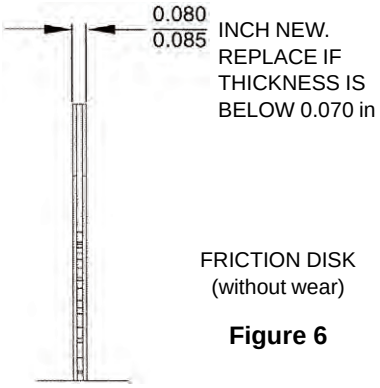


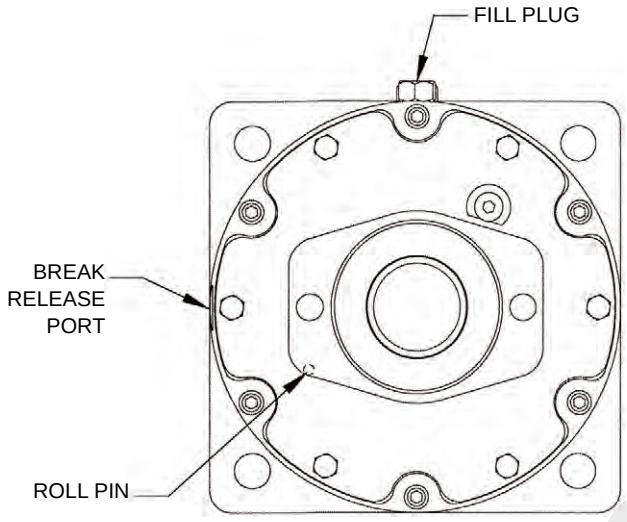
Figure 6

6. Inspect friction discs for wear. (See Figure 6.)
7. Inspect the stator plates for excessive grooving or burn spots. Replace if necessary.
8. The brake piston (5) can be removed by installing a port-a-power in the brake release port. Note the position of the roll pin (18) for reassembly (see Figure 9). Slowly operate the port-a-power and the piston will begin moving. Continue until the piston clears the top of the housing. The piston can now be removed.
9. Inspect the O-rings and back-up rings. Replace if necessary (19, 20, 21, 22).

Reference Only

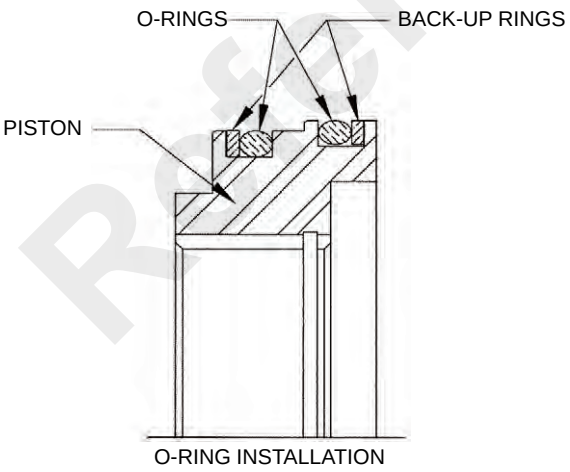
Brake Reassembly

1. Install the back-up rings and O-rings (see Figure 8) on piston. Lube the inside of the piston body with a light weight oil. Install piston into housing. Insure the roll pin (18) is clocked to the proper direction (see Figure 7).



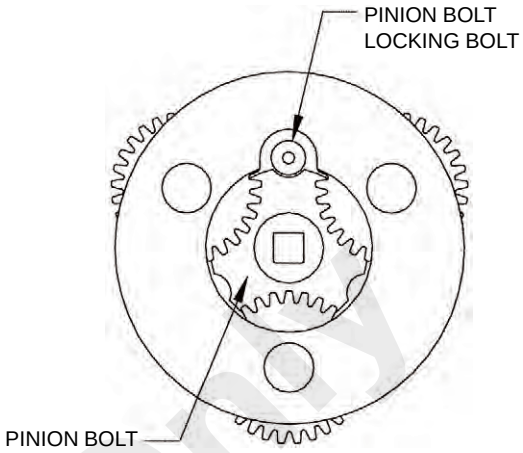
ROLL PIN TO BRAKE RELEASED PORT RELATIONSHIP

FIGURE 7



O-RING INSTALLATION

FIGURE 8



PLANETARY DRIVE KIT

FIGURE 9

2. With the brake driver in place (8), install the Stators (18) and the friction discs (17) into the piston. Install snap ring (33). Push the piston down by hand to lock the friction disc in place until the cover is installed. Make sure the brake driver (8) is centered in the piston.
3. Inspect the cover O-ring (24) and replace if necessary. Install the piston springs (15) in the cover (3). A small amount of a heavy grease will hold the springs in place for assembly. When installing the cover, note the position of the roll pin and install so that the pin will slide into the hole in the piston. Install the capscrew (28) and tighten in a sequence that pulls the cover down evenly. Reinstall on gear housing.

Gear Housing Disassembly

1. Remove brake section.
2. Remove input sun gear and thrust washer (7, 31) from the input planet set. Inspect for wear and replace if necessary.
3. Remove the input planet set (4) by pulling straight up and out of the housing.
4. Remove the pinion bolt retaining bolt (see Figure 9). With a special tool remove the pinion bolt. Lift the output planet set (3) out of housing.
5. Remove the pinion (6) by pressing from the gear housing side of the box. The pinion has a slight press fit to the bearing. Remove the seal (10) and

Reference Only

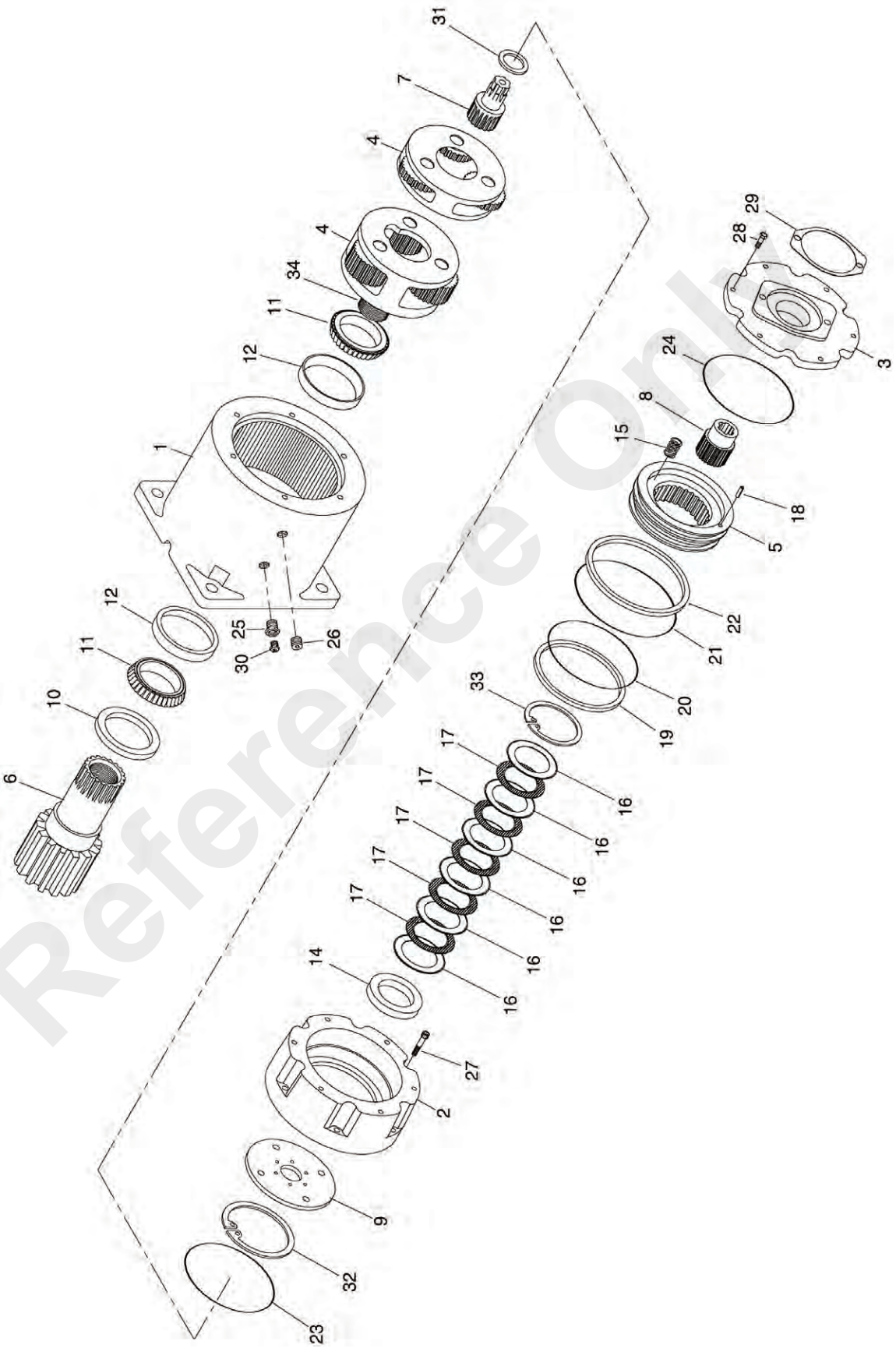
inspect the bearings for wear and replace if necessary.

Gear Housing Reassembly

1. Press new cup (12) into housing (1). Grease pack both cones (11) before installation. Install the cone and grease seal on the pinion side of the box.
2. Press pinion (6) into housing (1). Place the inside cone over the pinion shaft.
3. Apply Loctite to the pinion bolt and slide the output planet set into the housing. Using a special tool, tighten the bolt to 50 lb-ft then loosen and retighten to 25 lb-ft.
4. If the scallops in the side of the pinion retaining bolt do not align with the pinion locking bolt hole, tighten the pinion bolt until it does. Apply Loctite and install the pinion bolt locking bolt.
5. Install the input planet set, input sun gear and thrust washer.
6. Install brake housing.

Reference Only

Rotation Gearbox



Reference Only

ROTATION STOP-MECHANICAL

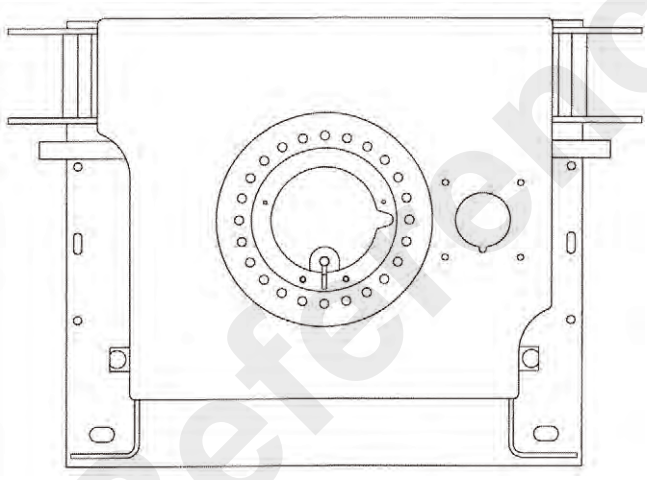
The rotation stop system is designed to stop crane rotation beyond 375 degrees in the clockwise or counterclockwise directions. This is accomplished by mechanically returning the control valve to the centered position as full rotation is approached. The operator will feel the control lever begin to pull in the opposite direction as full rotation is approached. The operator should not resist this counteracting force, but permit the rotation stop system to return the lever to neutral. If a load cannot be reached or placed due to the available rotation, the crane must be re-positioned. Attempting to override the rotation stop system will result in damage to the crane and possible injury to the operator.

Adjustment Procedure:

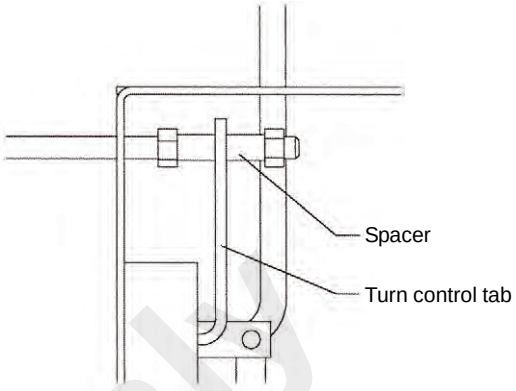
There are two methods that can be used for adjusting the rotation stop system.

Method 1

1. From inside of the frame, manually rotate the flag rod until it is centered between the two stop pins on either side of the flag.



2. Make certain that the turn lever is vertically aligned. If not, adjust the lever at the clevis connecting it to the control valve.
3. With the turn lever vertically adjusted, verify that the spacer is centered in the turn control rod tab.
4. If it is not centered, loosen the two nuts, one on either side of the spacer. Turn the nuts in the same direction until the spacer is centered. Tighten the nuts against the ends of the spacer to secure it in place.



5. Verify that the flag is still centered between the stop pins.

Method 2

1. Follow the crane set-up procedures in this manual to set outriggers and stabilizers and level the machine.
2. With the crane properly set-up, raise the boom to near full boom angle (75-80 degrees). This must be done with the boom fully retracted and with no load attached to the loadline.
3. Slowly rotate the boom until is directly over the front of the truck (behind cab mounting).With the boom directly over the front, place a mark at the top of the frame aligned with the center of the lift cylinder.
4. Rotate the crane clockwise, or counterclockwise until the rotation stop system centers the control lever.
5. Again make a mark at the crane frame aligned with the center of the lift cylinder.
6. Now rotate the crane in the opposite direction until the rotation stop system centers the control lever.
7. Make another mark on the crane frame aligned with the center of the lift cylinder.
8. If the rotation stop system is properly adjusted, the distance should be the same from the first mark made to the second mark, as it is from the first mark to the third mark.
9. If not, loosen the nut on either side of the spacer on the flag rod actuator rod and adjust the position of the spacer. Tighten the two nuts and repeat steps 3 thru 7 above until proper adjustment is achieved.

Reference Only

OUTRIGGER STOW LATCH ADJUSTMENT

Adjust the outrigger stow latch so it firmly retains outrigger in stowed position for road travel. The latch should be in firm contact with the pin on the frame when stowed. Stow the outriggers and adjust the latch down so it is in solid contact with the top of the pin. Tighten bolts, taking care to keep the latch square with the pin. Apply grease to the top of the pin to help the latch slide over the top of the pin. A periodic application of grease on the pin as required will help the latch slide over the top of the pin and the outrigger to stow properly.

SERVICING THE CONTROL VALVES

Disassembly And Reassembly Of Control Valves To Replace Seals

NOTE: For clarification, we shall call the inlet cover for the hoist section the right side of the valve assembly.

1. Before disassembly, it is suggested that each valve section be marked numerically to avoid incorrect reassembly.
2. Remove three assembly stud nuts from the end section using a 9/16 in thin wall socket.
3. Remove valve sections by sliding from assembly studs.
4. If valve sections are to be added or removed, use the proper length assembly stud.

NOTE: Use assembly nuts, three required, with all assembly studs. No lockwashers! All studs are stress-proof material and should be replaced only with original equipment replacement parts.

5. Thoroughly clean O-ring counterbores and ground surfaces of each section.
6. Replace the four O-rings for crane valve and three O-rings for hoist valve, two seals per section. Buna-N seals are standard.
7. Replace valve sections on assembly studs in the same order in which they were removed.

NOTE: Use care in replacing valve sections to avoid dislodging o-rings from counterbores.

8. When all valve sections are positioned on assembly studs, replace stud nuts and tighten evenly to 32 lb-ft (43 Nm) torque.

NOTE: If stud nuts are not tightened to the proper torque, valve spools may bind or stick, or cause section seals to extrude.

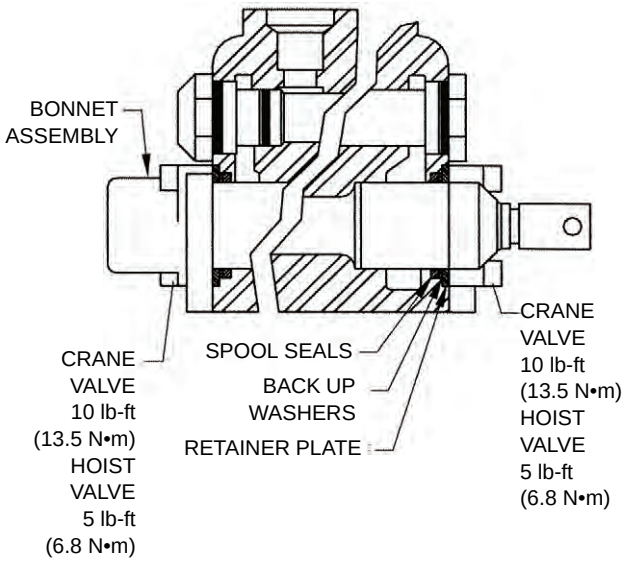
Replacing Spool Seals

Valve sections and covers are identified by numbers cast into the body.

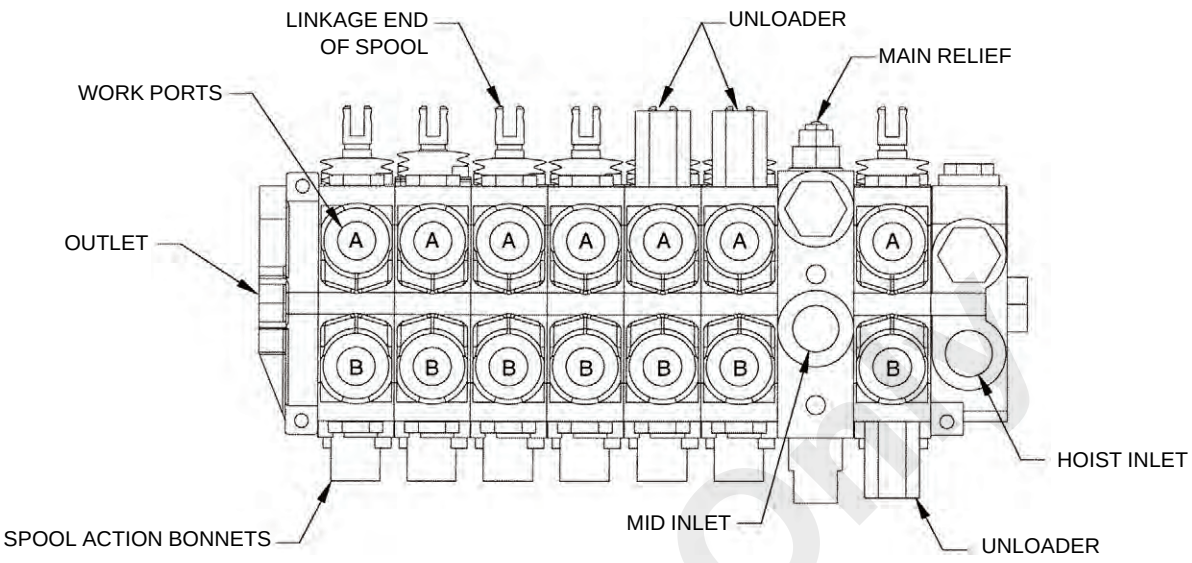
1. Remove bonnet assembly parts from back of valves and keep in order of disassembly.
2. Remove all parts connected to the spool on the front of the valve.

NOTE: Do not remove the spool as the seals can be replaced externally. Prevent spool from turning or moving by inserting a screw driver through clevis slot, or running a rod through the pin hole and using a handle. Do not hold the spool with a wrench. This will destroy the finish.

3. Remove retainer plate, retainer plate washers, back-up washers and spool seals.
4. Thoroughly clean counterbore.
5. Lightly oil new seals. Slide over valve spool and insert in seal counterbore.



Reference Only



Reference Only

UNLOADER DUMP VALVE - AIR PURGING INSTRUCTIONS

When a crane sits for a long period, the oil can drain back to the reservoir and air could get into the pilot lines of the unloader dump valves. This is likely to be more of a problem in colder weather as the oil will not flow back into the unloaders as easily when the crane is started. If the unloader pilot tubes have air in them, the dump functions will not work correctly. They might appear to be dumping the flow even though the ATB or overload switch has not been tripped. If this is suspected when checking the systems during start-up, first try to purge any air that may be in the system.

Purposely trip the ATB switch to open the dump solenoid. Engage each function that is being dumped (telescope out, hoist up, and boom down) separately at full throttle for about a minute, longer if the oil is cold. Then engage all three simultaneously. Remove the two block condition and check performance of each function. If there is no change, the procedure may be repeated. If again there is no improvement, follow the troubleshooting steps outlined for checking and inspecting the ATB solenoid and work port unloaders.

CONTROL VALVE RELIEF ADJUSTMENT

The control valves supplied on this crane are equipped with adjustable relief valves. After some time of use, it may be necessary to make some adjustment in pressure because of spring weakening, etc. The relief valves are adjustable only through a specific pressure range.

Both the mid-inlet for the main control valve and inlet of the hoist valve have screw adjustable main relief valves. Turning the relief in increases pressure relief setting; turning the relief out decreases pressure relief setting.

The turn circuit pressure can be checked by plugging a port on the turn motor with a pressure gage. The pressure on the main control valve stack should be checked by booming the lift cylinder down against the end of the cylinder stroke. The hoist circuit pressure can be checked by plugging a port on the hoist motor with a pressure gage.

Some valve sections include work port reliefs. The work port reliefs are shim adjustable. Adjustment is made by adding or taking out shims. Adding a 0.010 shim will increase pressure 100 psi (0.68 MPa). See "Specifications" section for correct pressure settings. **Never set pressure above recommendations.**

⚠ CAUTION

If the machine does not perform properly at these pressures, the problem is not the relief valve and no attempt should be made to readjust the setting. If the relief valves are set to higher pressures than those listed above, the warranty on the machine is void. Also the machine could operate in a manner such as to endanger personnel safety.

HYDRAULIC SYSTEM DESCRIPTION

The hydraulic system of this machine is an open center type consisting of a fixed displacement two section pump which supplies oil to a main control valve and a hoist control valve. The main control valve is equipped with a mid inlet. Some of the work sections in the main control valves contain work port reliefs which limit pressure in the hydraulic system to acceptable levels and control crane movements. See Specification Section for pressure settings.

The single section hoist control valve supplies oil to hoist up and down. The inlet section contains a screw adjustable main relief. The multi section main control valve controls all other crane functions which are (in order starting at mid inlet): boom telescope, boom lift, outrigger, stabilizer, turn and options. The oil to these sections is supplied by the mid inlet section which also contains a main relief valve. The hoist and the main circuits are all connected through a shuttle valve to a pressure gauge located on the control console.

The hydraulic oil is supplied by a truck frame mounted oil reservoir, which is equipped with a replaceable canister type return oil filter. The truck power take off driven hydraulic pump is sized to supply 25 gpm (94,6 lpm) to the hoist circuit, and 12 gpm (45,4 lpm) to the boom lift, telescope, turn functions at 1850 rpm pump shaft speed. Higher pump speeds may result in excessive heat generation in the hydraulic system. The pump is not bi-directional and can be used when the shaft rotates only in the proper direction. If you need to verify or change pump rotation, contact your National distributor or National Crane Product Support.

The crane hydraulic system includes a hydraulic capacity alert system. This system is a hydraulically operated, maximum capacity sensing device that monitors lift cylinder pressure. As pressure in the lift cylinder approaches its maximum predetermined level, which can be monitored on the console mounted range gauges, a hydraulic pressure switch activates an integral hydraulic dump circuit in the main control valve, disabling the crane functions which increase the over capacity condition.

All load bearing cylinders on this machine are protected from inadvertent movement or collapse due to hose failure by pilot operated check valves or by pilot operated counterbalance valves if overhung loads must be controlled.

The standard swing gearbox is locked in place by an integrally mounted spring applied brake and a dual counterbalance motor holding valve. The swing brake and counterbalances are piloted open and closed by operating swing left or right and are automatically reapplied by ceasing the swing function. Maximum swing speed can be limited using the swing speed adjustment valve.

Reference Only

HYDRAULIC CAPACITY ALERT SYSTEM

System Adjustment

The hydraulic capacity alert system should be checked for proper adjustment during initial crane startup and quarterly thereafter. The procedure for proper adjustment should be performed as follows: Trapped air must be bled from the system before adjustments are made.

1. Remove the console cover depending on crane model.

⚠ DANGER

Before loosening any fittings, support the boom.

2. Start the truck and set the crane up for operation as prescribed in the "Safety and Operation" Section.
3. Select a test weight that is equal to crane capacity at an intermediate boom length and radius. Work with loads which have loaded boom angles near 30°. Starting with the boom at the chosen reference angle and a radius less than the chosen radius, pick the weight up with the hoist and begin extending the boom. As the boom is extending, lower the load with the hoist to keep the load near the ground. Monitor the load range gage located in the console as the boom is extending. The gage is plumbed directly into the lift cylinder pilot line and the pressure reading should increase to what is defined as capacity load pressure as the selected intermediate boom length and radius is reached. The intermediate boom length is determined by a line and corresponding dimension decal on the side of the second section boom. The chosen radius is measured from the centerline of rotation to the loadline.
   If the gage reading does not increase while extending, lower the load to the ground and check the system plumbing according to the hydraulic schematic. Replumb the system according to the schematic and illustrated parts page or replace faulty pressure gage.

⚠ DANGER

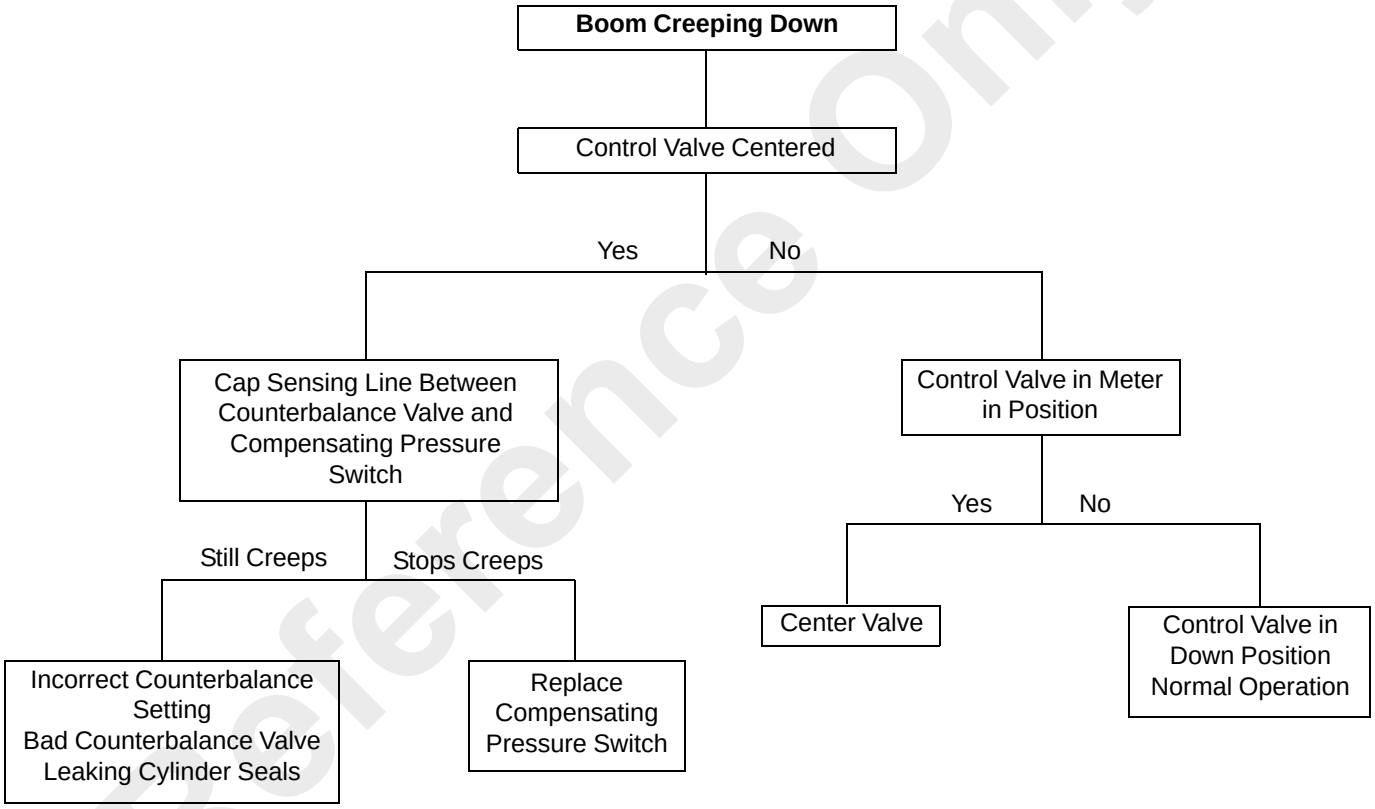
Before loosening any fittings, support the boom.

   When the pressure reaches capacity load pressure, the overload system should activate and boom extension will stop. This is defined as trip pressure. This point should be at or very close to the red/yellow color change on the load range gage.
4. Trip pressure should be reached as the boom extension reaches the chosen radius. If the overload system trips before the chosen radius is reached or allows extension beyond the chosen radius, adjustment is required. If the system is activated before trip pressure is reached, lower the load, remove acorn nut and loosen the locking nut on the compensating pressure switch and turn the setscrew clockwise to increase trip pressure.
5. When the gage reaches trip pressure, turn the setscrew counterclockwise until the system solenoid is deactivated and tighten the locking nut. Retract the boom until the pilot pressure is reduced enough to reactivate the system solenoid. The hydraulic capacity alert indicator light will go out when the solenoid is reactivated. Check the trip pressure setting by extending the load until the chosen radius is reached. As the chosen radius is reached, the system solenoid should be deactivated and the indicator light should come on. Readjust switch head if trip pressure is not correct.
6. Once proper adjustment is verified, return the boom to a firmly supported position, stop the truck engine and replace covers.

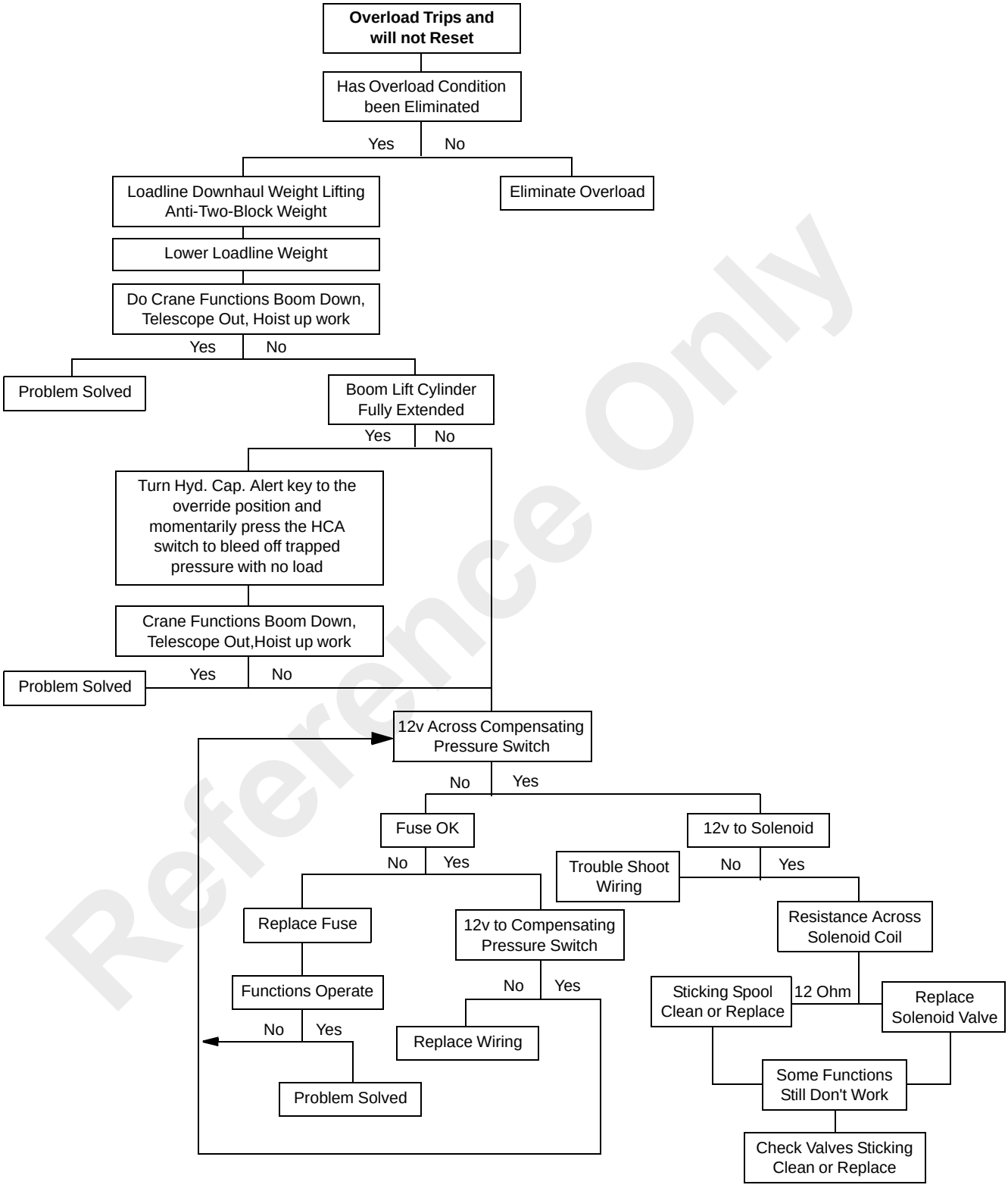
Reference Only

Hydraulic Capacity Alert System Trouble Diagnosis

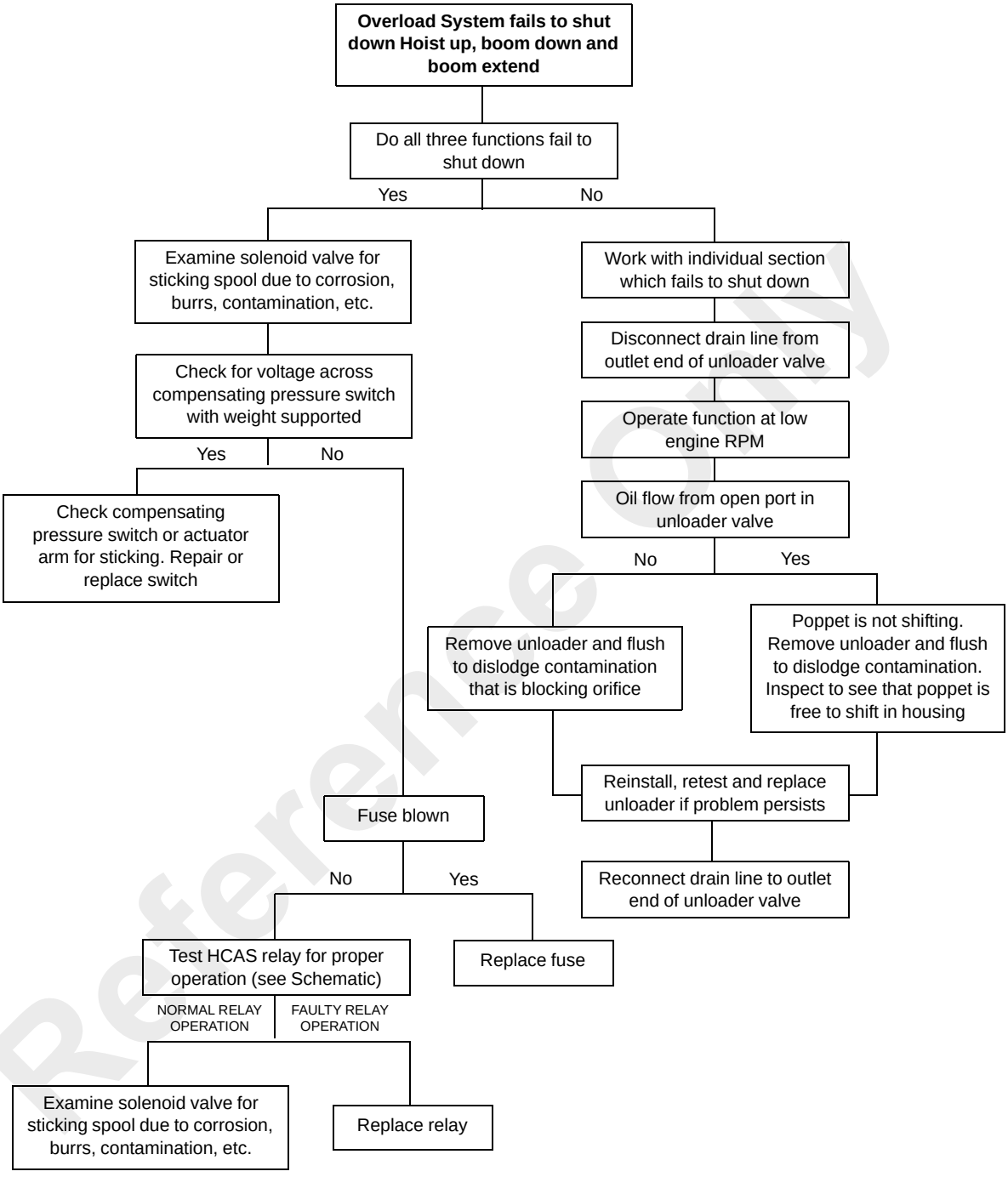
The following step-by-step analysis will be helpful in isolating and correcting almost every service problem if followed in a step-by-step systematic manner. Use this information with the Hydraulic Schematic and the Illustrated Parts Catalog to identify parts and follow flow paths. Start at top box and work downward step by step - don't try to start in the middle or skip steps.



Reference Only

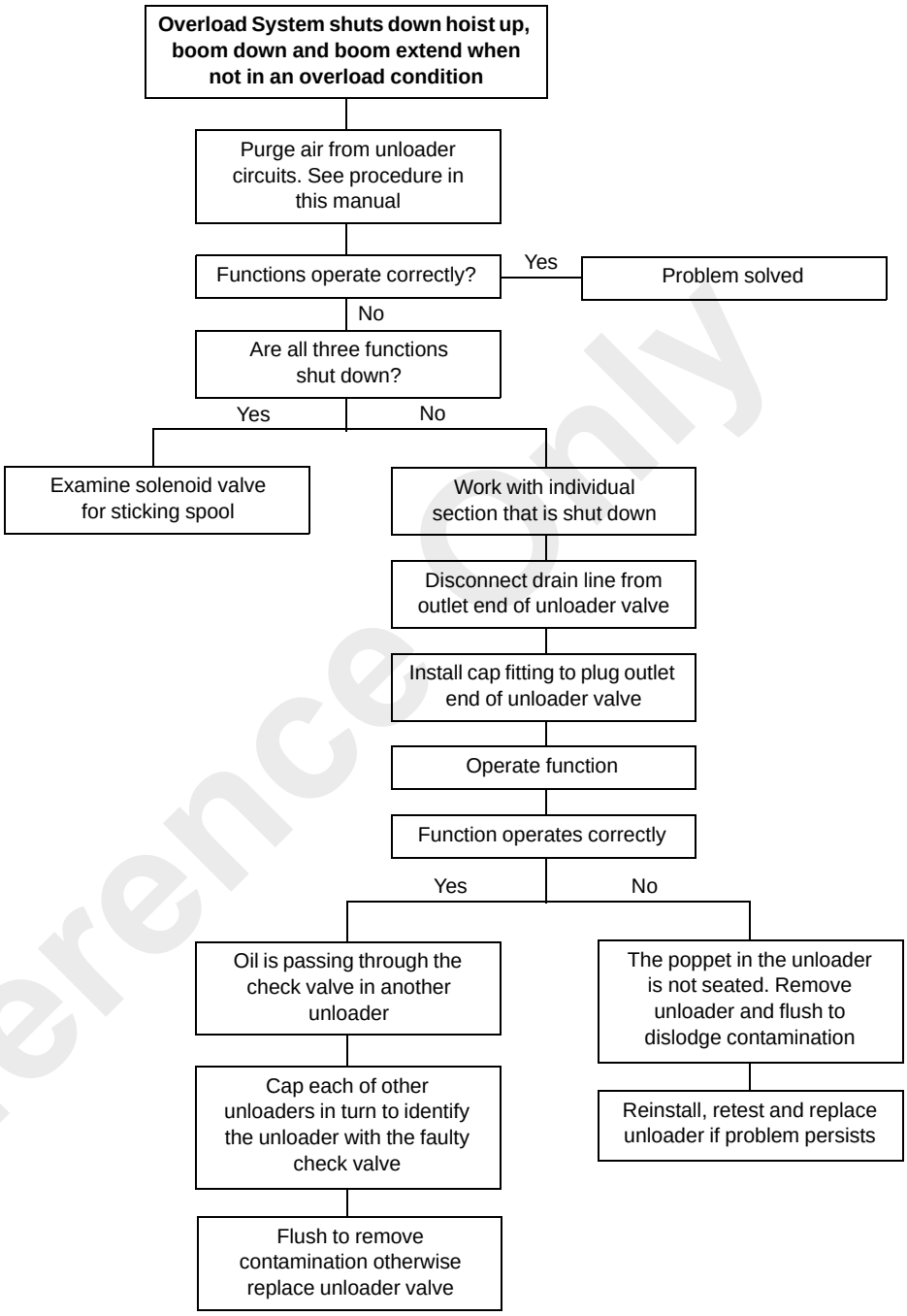


Reference Only



Reference Only

Note: None of the internal parts of the unloader valves are serviceable.



Reference Only

MAINTENANCE & REPAIR

1. Refer to Hydraulic Schematic and System Description to gain a thorough understanding of the capacity alert system before proceeding with any maintenance.
2. System adjustment must be checked every three months for accuracy. Refer to the preceding section on System Adjustment.
3. Always be sure the boom is adequately supported and no hydraulic pressure remains in the lines before the pilot pressure line fittings are loosened.

JIB LOAD LIMITING DEVICE

This system is designed to provide load limiting capability for jibs. This is accomplished with the use of an angle sensor, a load cell force sensor, a microprocessor, and enough memory to store 30 table sets containing the maximum force for a given jib head angle and given crane configuration. The system will compare the measured force to the table and will provide lockout when the table value is exceeded. The system should be checked for proper operation during initial crane start up and quarterly thereafter.

System installation

Before mounting the electronics box in the jib, the following procedure needs to be followed to match the jib load limiting device to the jib.

Remove the electronics from the housing. Set the switches to 10101010. Power the system—a 12V power supply is required. The system is powered when the power supply is plugged into the 3-conductor cord of the wire harness—12V to #2, ground to ground. Powering the system with the switches set as described clears the existing selection. Turn off power to the system. Choose the desired switch setting from the parts pages and set the switches. At the next power-up of the system, the desired selection will be stored. Replace the electronics into the housing, and mount the system in the jib as shown in the parts pages.

After assembling the jib, it is necessary to zero the angle sensor. Carefully level the jib from end to end. A level indicator should be placed near the tip end of the jib-directly over the electronics box. Power the system. Using a jumper wire short together pin #1 and the ground pin of the four-conductor cord from the electronics box. This is the cord that plugs into the ATB switch. Remove the jumper wire, plug the cord into the ATB switch, and remove the power supply. **Anytime the electronics box is removed from the jib, it must be rezeroed upon re-installation.**

Troubleshooting

Symptom	Possible Cause	Corrective Action
System is in a state of constant cut-out	**1.** Loose or incorrect wiring.	**1.** Carefully check the integrity of all circuits external to the electronics box, from the jib tip to the console. Compare to electrical schematic.
	2. Blown fuse.	**2.** Check fuse at crane console. Replace if necessary. Remove electronics box from jib, remove electronics from housing, and check 2A fuse on board. Replace if necessary.
	3. ATB switch open.	**3.** Ensure that ATB switch is closed.
	4. No table selected.	**5.** Follow procedure in system installation section to select the correct table for the application.
	6. Load cell not calibrated.	**5.** To set the zero point, remove all force from the load cell. Remove the electronics from the housing. Set the switch position 8 to ON. Power the system. Do not turn off power until both the zero point and the gain have been set. To set the zero point, press the button on the board. To set the gain, set switch position 8 to OFF. Set the switch to the correct code that matches the load cell gain. This code can be found on the tag that accompanies the load cell. Press the button.

Reference Only

TROUBLESHOOTING (continued)

Symptom	Possible Cause	Corrective Action
System cuts out too early or too late.	**1.** Wrong table selected.	**1.** Check to see which table is selected using the single character display. If the wrong table is selected, select the proper table using the procedure in the system installation section.
	2. Angle sensor not zeroed.	**2.** Ensure that the electronics box is tightly mounted to the jib. Zero the angle sensor using the procedure in the system installation section.
	3. Configuration switch stuck open or closed (two section jibs only).	**3.** Configuration switch must be closed when the jib is Retracted and open when the jib is extended. Adjust or replace switch as necessary.
	4. Pivot pin not free to move.	**5.** Ensure that pivot pin is free, well lubricated, and allows the jib head to pivot freely. Inspect and replace bearings in jib head assembly as required.
	6. Foreign object stuck between jib head assembly and jib. The only contacts between the jib head assembly and the jib are to be the load cell and the pivot pin.	**5.** Remove any foreign objects which interfere with jib head assembly operation.

Single character display

The electronics box of the jib load limiting device is equipped with a single character display that provides the following information: startup codes, table number selected, the current load reading, the current limit value, error codes, and the current angle reading.

On power-up, the unit first displays startup codes. The startup code can consist of up to four digits, but will usually be only the single digit "2". Each number will be displayed for only Y2 second. The codes are:

1. The eprom is being initialized. This should only happen the first time the unit is powered on after it is programmed.

2. The unit is checking for the combination of numbers that erase the previously stored table number in the EEPROM. This will be displayed when the unit is powered on and the switches are not set with this combination of numbers.

3. This is displayed only before a new table number is stored in EEPROM. The 2 will be displayed first.

8. The switches are set up with the combination of numbers to erase the table number. On the next power on, the table number will be read in and stored to EEPROM.

After the startup codes, the table number will be displayed in the form of 3 digits. The first digit will always be a zero. The digits will each be displayed for about 1 second.

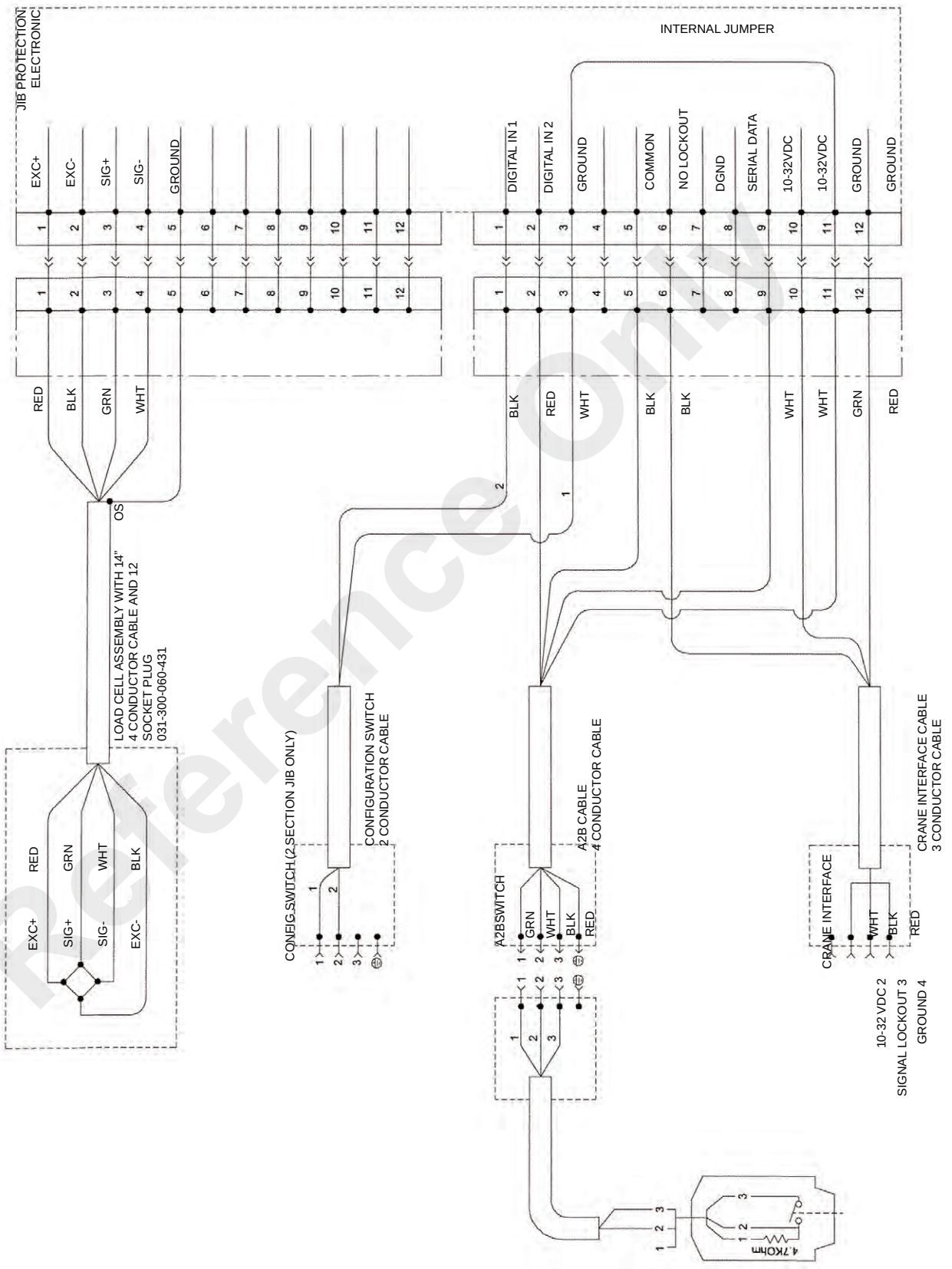
After the table number is displayed, the display will begin to sequence through the following information.

After reaching the end of the sequence, the display will start again at the current load reading.

- Current load reading (lbs.):
  4 digits, decimal point on
- Current limit value (lbs.):
  4 digits, decimal point flashing
- Error codes (only if an error exists):
  4 digits, first and last digits are blanks.
  0-invalid table number,
  1-load reading is higher than the limit.
- Current angle reading:
  4 digits, decimal point off, displays in tenths of degrees.

Reference Only

ELECTRICAL SCHEMATIC
(JIB PROTECTION SYSTEM ANGLE/LOAD LIMITER)



Reference Only

SECTION 6
SPECIFICATIONS

Dimensional specifications

NOTE:

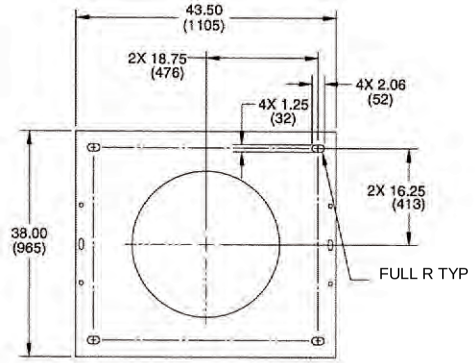
DIMENSIONS ARE IN inches (mm) UNLESS OTHERWISE SPECIFIED.

STANDARD SUBBASE WEIGHT: 1150 lb (520 kg)
CG IS 1 03 in (2617 mm) FROM CENTERLINE
SUBBASE DIMENSION:
35 in W (889 mm) x 254 in L (6452 mm) X 8 in H (203 mm)

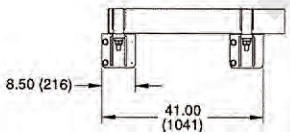
STANDARD SUBBASE SPACER WEIGHT: 230 lb (104 kg)
CG IS 0 in (0 mm) FROM CENTERLINE
SPACER DIMENSION:
35 in W X 37.50 in L x 8 in H

G CENTER OF GRAVITY			
SERIES	G	DRY WEIGHT'	W/OIL WEIGHT'
456B	47 in (1194 mm)	8100 lb (3675 kg)	8425 lb (3825 kg)
446B	36 in (914mm)	7775 lb (3525 kg)	8100 lb (3675 kg)
437B	29 in (737 mm)	7450 lb (3375 kg)	7775 lb (3525 kg)
428B	22 in (559 mm)	7150 lb (3250 kg)	7475 lb (3400 kg)

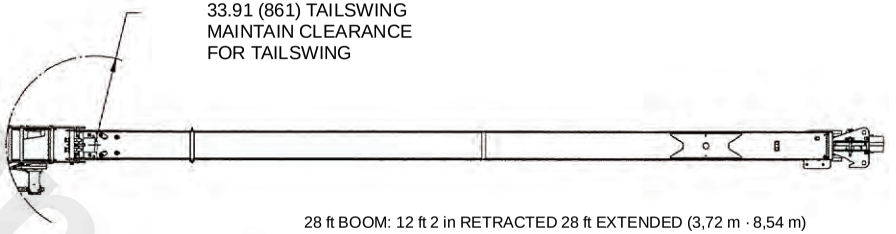
' ABOVE WEIGHTS DO NOT INCLUDE SUBBASE, REAR STABILIZERS, JIBS, PTO, PUMP, BOOM RESTS OR OPTIONS.



FRAME BASE PLATE

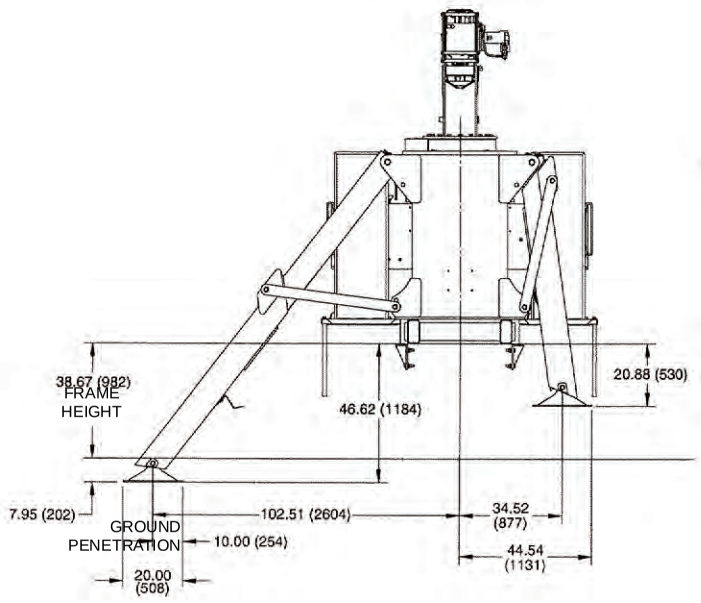


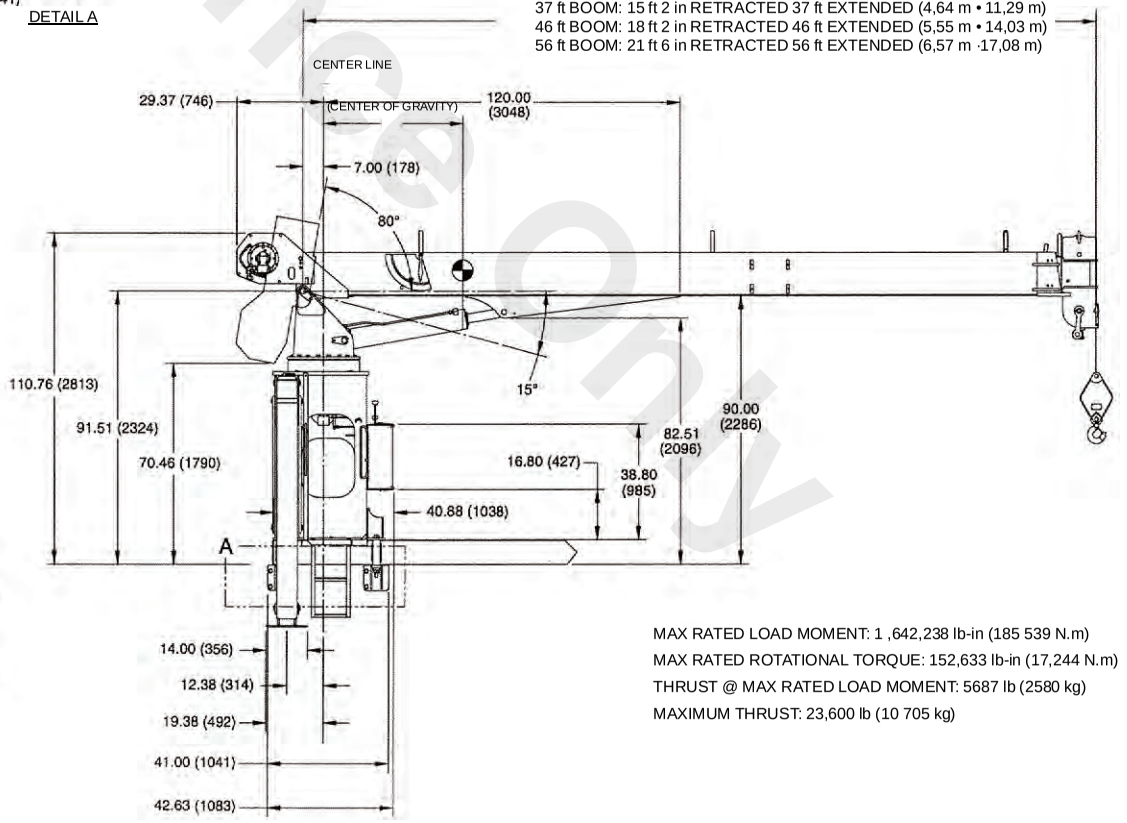
DETAIL A



33.91 (861) TAILSWING
MAINTAIN CLEARANCE
FOR TAILSWING

28 ft BOOM: 12 ft 2 in RETRACTED 28 ft EXTENDED (3,72 m · 8,54 m)
37 ft BOOM: 15 ft 2 in RETRACTED 37 ft EXTENDED (4,64 m • 11,29 m)
46 ft BOOM: 18 ft 2 in RETRACTED 46 ft EXTENDED (5,55 m • 14,03 m)
56 ft BOOM: 21 ft 6 in RETRACTED 56 ft EXTENDED (6,57 m ·17,08 m)





MAX RATED LOAD MOMENT: 1 ,642,238 lb-in (185 539 N.m)
MAX RATED ROTATIONAL TORQUE: 152,633 lb-in (17,244 N.m)
THRUST @ MAX RATED LOAD MOMENT: 5687 lb (2580 kg)
MAXIMUM THRUST: 23,600 lb (10 705 kg)

Reference Only

SPECIFICATIONS

12 FT 8 IN NARROW SPAN OUTRIGGER DIMENSIONAL SPECIFICATIONS

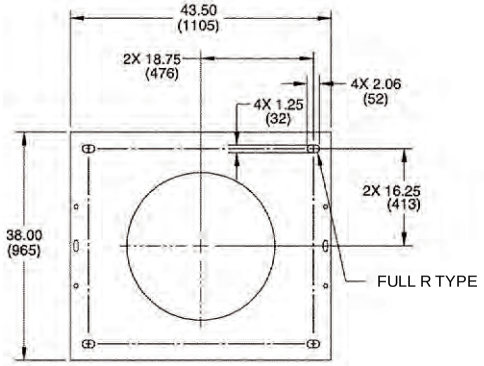
NOTE:
1. DIMENSIONS ARE IN INCHES (MM) UNLESS OTHERWISE SPECIFIED.
2. THIS DRAWING DEPICTS THE OPTIONAL 152" SPAN OUTRIGGERS.

STANDARD FULL LENGTH TORSION BOX
SUBBASE WEIGHT: 1150 lb (520 kg)
CG IS 103 in (2617 mm) FROM CENTERLINE OF ROTATION
SUBBASE DIMENSION:
35 in W (889 mm) x 254 in L (6452 mm) x 8 in H (203 mm)

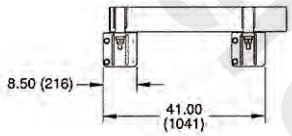
STANDARD SUBBASE SPACER WEIGHT: 230 lb (104 kg)
CG IS 0 in (0 mm) FROM CENTERLINE OF ROTATION
SPACER DIMENSION:
35 in W (889 mm) x 37.50 in L (953 mm) x S in H (203 mm)

G CENTER OF GRAVITY FROM CENTERLINE				
SERIES		G	DRY WEIGHT'	W/OIL WEIGHT'
	456B	47 in (1194 mm)	8100 lb (3675 kg)	8425 lb (3825 kg)
346C	446B	36 in (914mm)	7775 lb (3525 kg)	8100 lb (3675 kg)
337C	437B	29 in (737 mm)	7450 lb (3375 kg)	7775 lb (3525 kg)
328C	428B	22 in (559 mm)	7150 lb (3250 kg)	7475 lb (3400 kg)

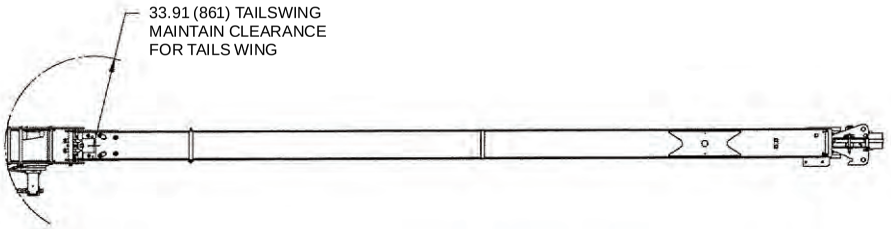
' ABOVE WEIGHTS DO NOT INCLUDE SUBBASE, REAR STABILIZERS, JIBS, PTO, PUMP, BOOM RESTS OR OPTIONS.

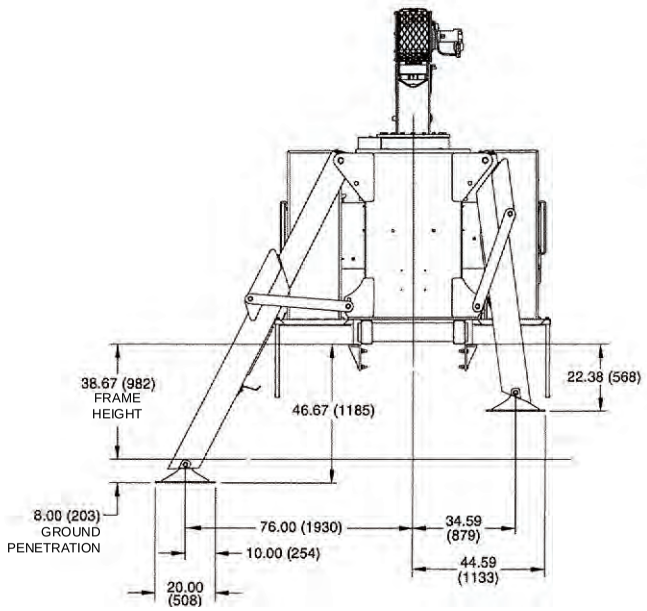


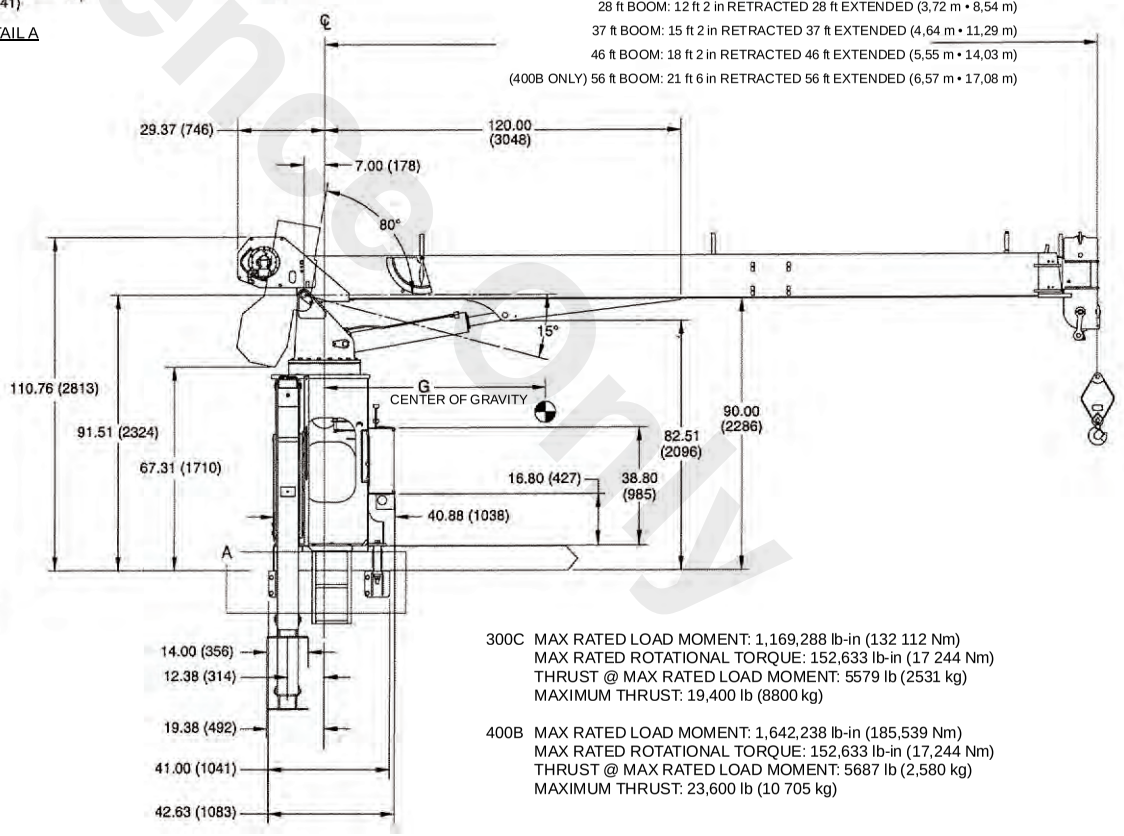
FRAME BASE PLATE



DETAIL A







300C MAX RATED LOAD MOMENT: 1,169,288 lb-in (132 112 Nm)
MAX RATED ROTATIONAL TORQUE: 152,633 lb-in (17 244 Nm)
THRUST @ MAX RATED LOAD MOMENT: 5579 lb (2531 kg)
MAXIMUM THRUST: 19,400 lb (8800 kg)

400B MAX RATED LOAD MOMENT: 1,642,238 lb-in (185,539 Nm)
MAX RATED ROTATIONAL TORQUE: 152,633 lb-in (17,244 Nm)
THRUST @ MAX RATED LOAD MOMENT: 5687 lb (2,580 kg)
MAXIMUM THRUST: 23,600 lb (10 705 kg)

Reference Only

Published 11-1-2012 Control # 038-07

SPECIFICATIONS

Hydraulic System

Requirements:

Pump:

- Section 1 (Hoist) _____ 25 gpm (94,6 lpm)
- Section 2 (Telescope. Boom. Turn. Outriaqer) _____ 12 gpm (45,4 lpm)

Control Valve:

- Boom, Telescope, Outrigger _____ 3050 psi + 100/-0 (21,02 MPa)
- Turn _____ 800 psi + 150/-0 (5,52 MPa)
- Hoist _____ 3050 psi + 100/-0 (21,02 MPa)

Reservoir Capacity _____ 39 gal (148 l)

System Capacity _____ 52 gal (197 l)

Filtration _____ 10 Micron Return

Option Sections_____ 3050 psi + 100/-0 (13,79 MPa)

Flow rates listed are at free flow condition (approx. 100 psi/ 1 MPa)

Hoist System

Wire Rope_____ ***Standard Hoist***

205 ft (62,5 m) of 1/2 in (12,7 mm) dia.

Rotation Resistant

Nominal Breaking Strength: 29,200 lb (13 245 kg)

Optional Hoist (Standard wire rope)

220 ft (67 m) of 9/16 in (14,3 mm) dia. Rotation Resistant

Nominal Breaking Strength: 38,500 lb (17 463 kg)

Optional Hoist (Optional wire rope)

220 ft (67 m) of 9/16 in (14,3 mm) dia.

6 x 25 IWRC constructed

Nominal Breaking Strength: 33,600 lb (15 241 kg)

Hoist Performance Standard

(with 1 part of line)

	Hoist Pull		Hoist Speed		BOS Hoist Speed	
Layer	lb	(kg)	fpm	(mpm)	fpm	(mpm)
1	6920	(3139)	152	(46)	225	(69)
2	6300	(2858)	167	(51)	247	(75)
3	5840	(2649)	182	(55)	270	(82)
Optional	Hoist Pull		Hoist Speed		BOS Hoist Speed	
Layer	lb	(kg)	fpm	(mpm)	fpm	(mpm)

Reference Only

1	10,200	(4627)	80	(24)	118	(36)
2	9200	(4173)	90	(27)	133	(41)
3	8400	(3810)	100	(30)	148	(45)

All ratings based on 25 GPM at 3050 psi. (94,6 lpm at 21,02 MPa)

Burst of Speed maximum pull = 3000 lb (1361 kg)

Crane Operating speeds

Turn, 375° _____ 36 sec. ±3 sec.

Boom Up. (-15° to 80°) _____ 18 sec. ±2 sec.

Boom Down. (80° to -15°) _____ 14 sec. ±2 sec.

Telescope Out _____ 41 fpm (12,50 mpm) ±4 fpm

Telescope In _____ 48 fpm (14,63 mpm) ±5 fpm

Speed based on 12 GPM flow at no load.

Reference Only

SECTION 7
CRANE INSTALLATION

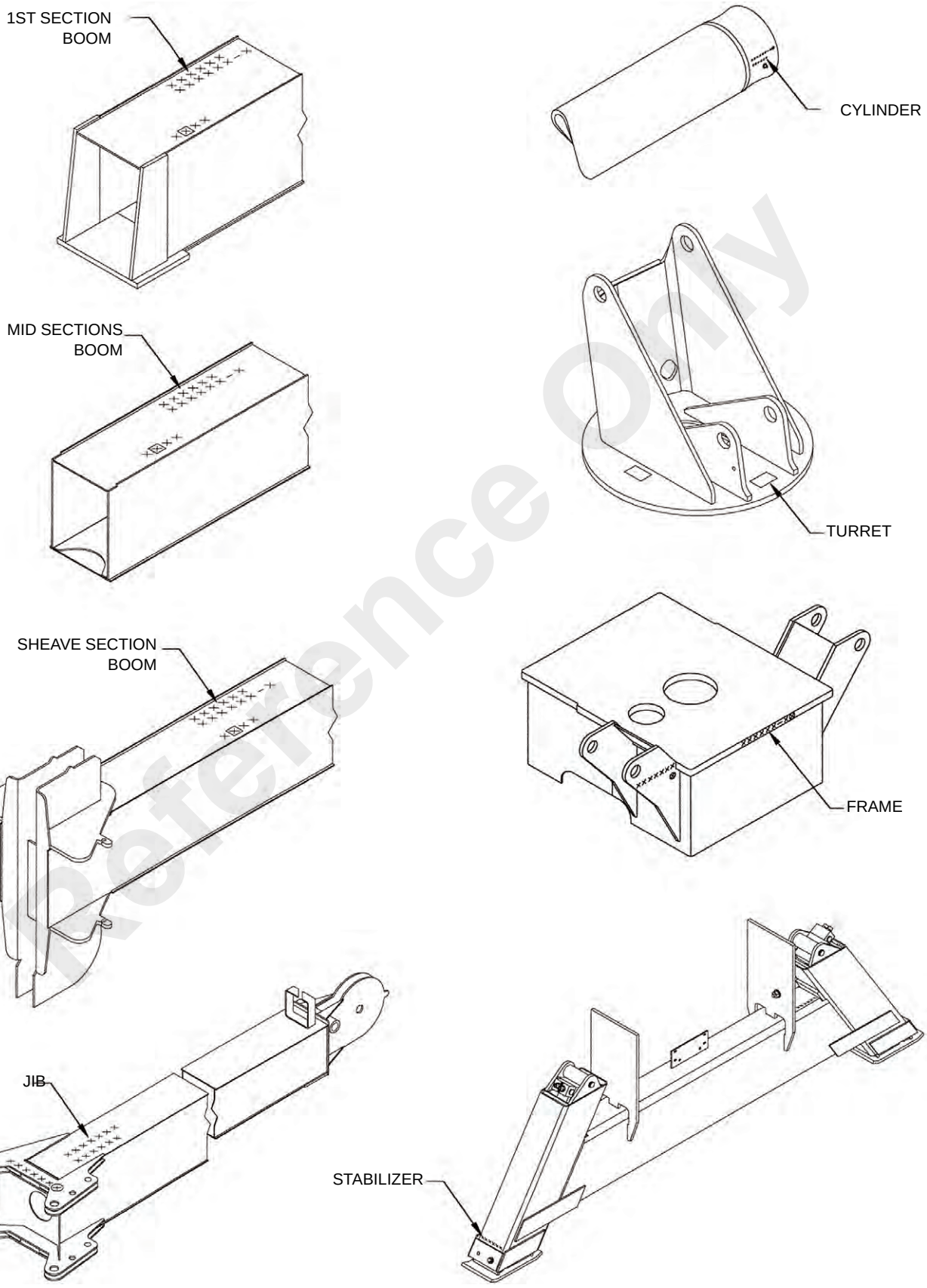
This installation section provides information for mounting and initial check out of the crane. One of the most important elements in good long lasting crane performance is proper mounting. Improper mounting can cause permanent damage to the truck, i.e. frame or transmission, and the crane, i.e. pump or non stability. Also Federal Department of Transportation Laws relating to vehicle manufacture and modification such as lights, brakes and axle loads must be met as well as State vehicle laws relating to weights and dimensional restrictions such as overall length, overhang, etc. This section is organized by first presenting detailed information relating to truck requirements and mounting configurations followed by a step-by-step installation procedure including PTO selection, Pump rotation selection, reinforcement, crane and stabilizer installation, counterweighting, boom rests and stability testing. The final manufacturer of the vehicle must certify that the axle ratings have not been exceeded with all permanently attached equipment including a full load of fuel and men [at 200 lb (90 kg) each].

National cranes should meet ASME/ANSI B30.5 (latest) when completed as cranes and ANSI A92.2 (latest) when completed as aerial devices. These standards require welds to meet AWS D14.3 or AWS D1.1 respectively. Therefore any work done in mounting should be done in compliance with these codes.

Note: The following page lists the typical locations for the Serial Number identification tags that are fastened to the main components of the crane. Before proceeding with the installation, verify that the number on the serial number plates on the major components match the main serial number which is found on the crane frame. If the serial numbers do not match, contact the factory before proceeding. Matching the serial number plates insures that accurate warranty information will be recorded at the factory and will aid in dispensing service bulletins and other pertinent information.

Reference Only

TYPICAL LOCATIONS / SERIAL NUMBER IDENTIFICATION



Reference Only

MINIMUM TRUCK REQUIREMENTS

Many factors must be considered in the selection of a proper truck for a 400B series crane. Items which must be considered are:

1. **Axle Rating**. Axle ratings are determined by the axles, tires, rims, springs, brakes, steering and frame strength of the truck. If any one of these components is below the required rating, the gross axle rating is reduced to its weakest component value.
2. **Wheelbase, Cab-to-Axle (CA)**. The wheelbase and CA required are in part determined by the mounting configuration but also by the boom length and the platform length of the particular unit. Match the platform length to the retracted boom length so that the boom doesn't overhang the rear of the bed by more than that required by legal regulations where the unit will be operated. The truck cab-to-axle dimension is then determined by the length of the bed (the bed should be approximately centered over the rear axle) and the mounting space that the crane frame takes up between the cab and the bed.
3. **Truck Frame**. Try to select a truck frame that will minimize or eliminate frame reinforcement or extension of the after frame (AF). Many frames are available that have the necessary after frame (AF) section modulus (S.M.) and resistance to bending moment (RBM) so that reinforcing is not required. The front hydraulic jack is used for a 360° working range around the truck. The frame under the cab through the front suspension must have the minimum S.M. and RBM because reinforcing through the front suspension is often difficult because of engine, radiator mounts and steering mechanics. See "Truck Requirements" and "Frame Strength" pages for the necessary section modulus and resistance to bending moment values.
4. **Additional Equipment**. In addition to the axle ratings, wheelbase, cab-to-axle requirements and frame, it is recommended that the truck is equipped with electronic engine control, increased cooling and a transmission with a PTO opening available with an extra heavy duty PTO. See "PTO Selection" pages. A conventional cab truck should be used for standard crane mounts.
5. **Neutral Start Switch**. If equipped with optional remote controls, the chassis must be equipped with a switch that prevents operation of the engine starter when the transmission is in gear.

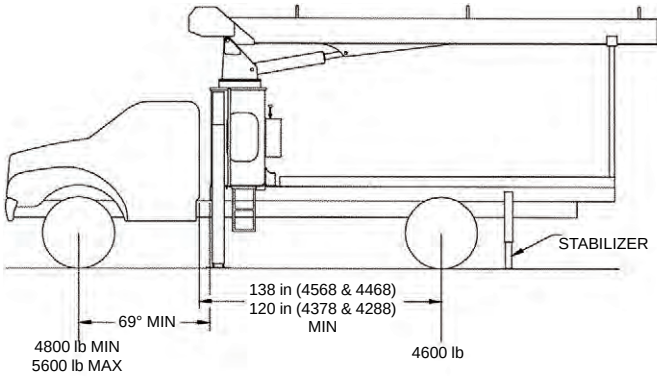
MOUNTING CONFIGURATIONS

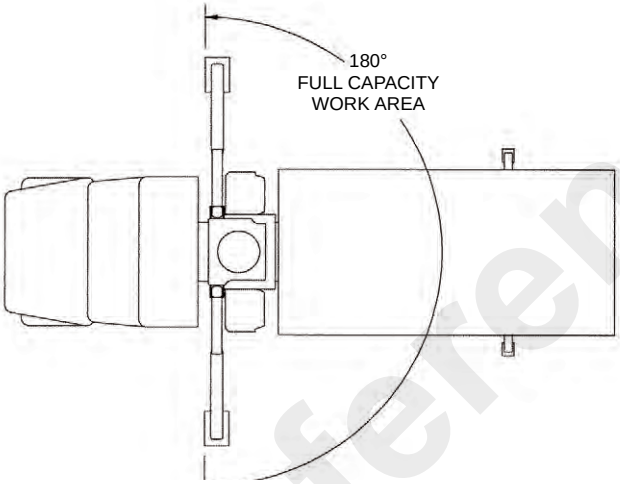
The Series 400B is a versatile machine and its versatility can be enhanced by the manner in which it is mounted. Following is a brief description of the mounting configurations and the advantages of each. The minimum weights listed below the front and rear axles for each configuration are estimated minimum front and rear axle weights for an 85% stability factor before the crane, stabilizers and sub-base, if required, are installed on the chassis. These weights include the permanently attached equipment on the chassis, such as pumps, PTO's, reinforcing, chassis mounted options, bed and counterweight. Before placing this unit in service, a final stability check as outlined in this section must be performed.The maximum weights listed below the front and rear axles for each configuration are estimated maximum front and rear axle weights for not exceeding axle capacities before the crane, stabilizers, and sub-base, if required, are

Reference Only

Configuration 1 - with subbase

This configuration allows the installation of the Series 400B on a chassis with a small frame by using the standard subbase. In most cases, the chassis will not require reinforcing and counterweight will not be required. With this configuration, a payload of approximately 6000 lb can be hauled on a minimum truck.



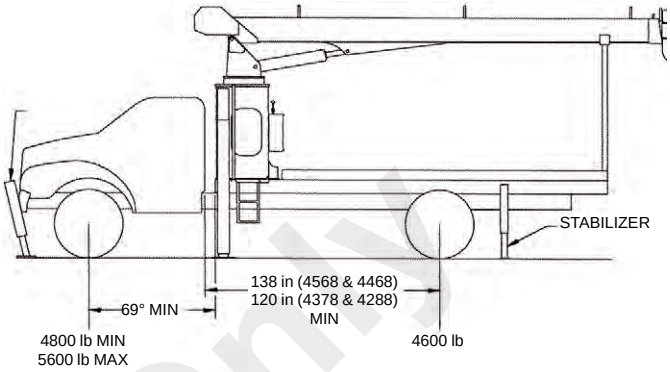


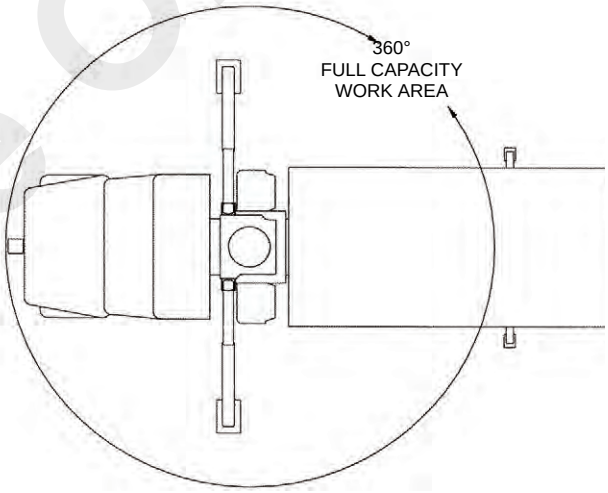
Requires 9,000 GAWRF, 19,000 GAWRR, 28000 GVWR, rear stabilizers and standard subbase. Full capacity move area is rear 180° of vehicle from outrigger to outrigger. Truck frame strength required is 13 in^3 section modulus between axles and 10 in^3 section modulus through rear suspension to rear stabilizers with 50,000 psi frame material or 10 in^3 section modulus between axles and 10 in^3 section modulus through suspension to rear stabilizers with 110,000 psi frame material.

Note: If truck front axle weight exceeds 5600 lb before mounting crane, a 9000 GAWRF will most likely not be adequate.

Configuration 2 - with subbase and SFO

This configuration requires a front stabilizer for full capacity 360° around the truck.





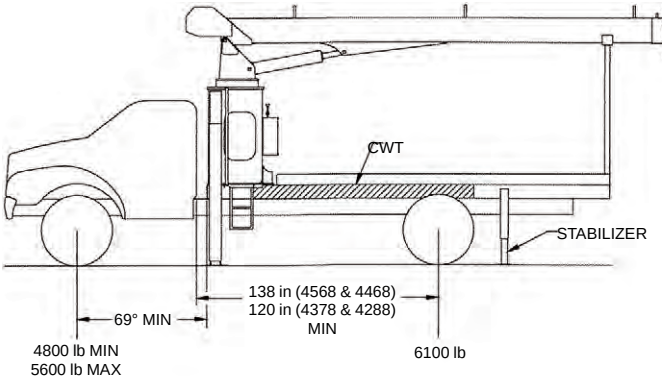
Requires 9000 GAWRF, 19000 GAWRR, 28000 GVWR, rear stabilizers, front stabilizers and standard subbase. Truck frame strength required is 13 in^3 section modulus between axles and 10 in^3 section modulus through rear suspension to rear stabilizers and 13.5 in^3 through front suspension to front bumper with 50,000 psi frame material. With 110,000 psi frame material section modulus requirements are 10 in^3 between axles, 10 in^3 through rear suspension to rear stabilizers and 6.2 in^3 through front suspension to front bumper. Normally a tapered frame cannot be reinforced to this requirement.

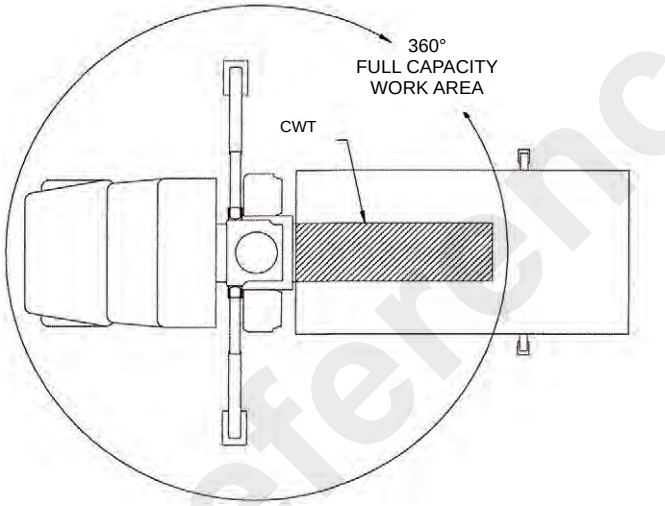
Note: If truck front axle weight exceeds 5200 lb, before mounting crane, a 9000 GAWRF will most likely not be adequate.

Reference Only

Configuration 3 - with subbase and counterweight

This mounting configuration allows full capacity loads to be lifted 360° around the truck. It requires additional weight at the back of the truck to reduce loading on the front axle. (If continually lifting over the front, the vehicle must be equipped with front stabilizer to eliminate fatigue on front axle components).



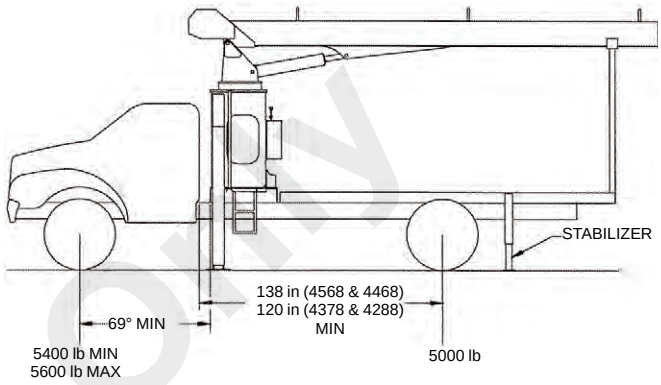


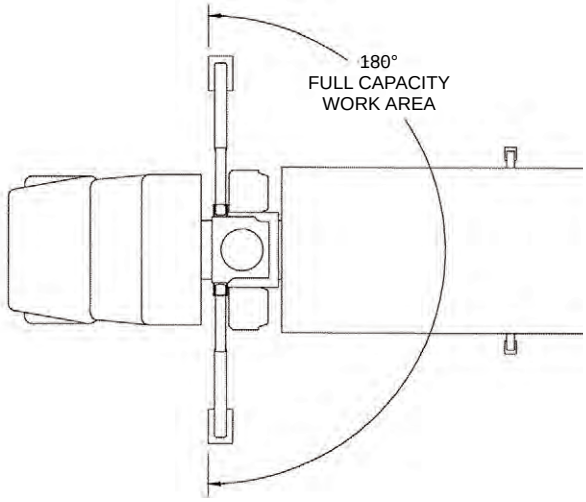
Requires 9000 GAWRF, 19000 GAWRR, 28000 GVWR, rear stabilizers, standard subbase and counterweight in the subbase or underside of bed. Truck frame strength requirements are the same as those listed in Configuration 2. This mount will generally require 1500 lb of counterweight and will have a payload capacity of approximately 5500 lb.

Note: If truck front axle weight exceeds 5600 lb before mounting crane, a 9000 GAWRF will most likely not be adequate.

Configuration 4 - without subbase

When the truck chassis has adequate frame strength, this method will allow installation of the Series 400B without the use of the standard subbase. A crane mounted in this manner will be 180° stable over the rear of the vehicle from outrigger to outrigger.





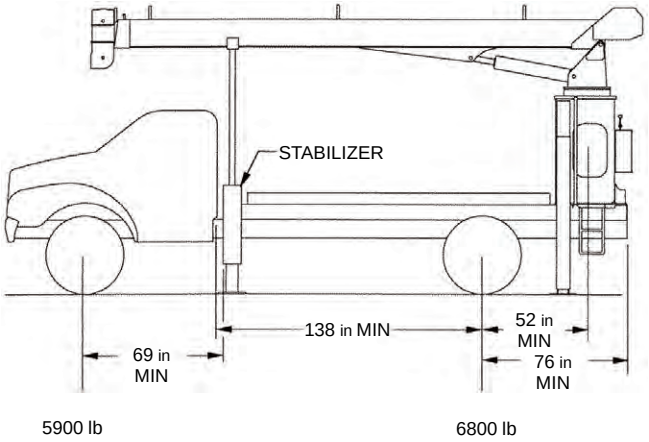
Requires 9000 GAWRF, 19000 GAWRR, 28000 GVWR, and rear stabilizers. Requires a truck chassis with a section modulus of 32 in^3 between the axles and 18 in^3 through the rear suspension to the rear stabilizers with 50,000 psi frame material and a section modulus of 15 in^3 between the axles and 10 in^3 through the rear suspension to the rear stabilizers with 110,000 psi frame material.

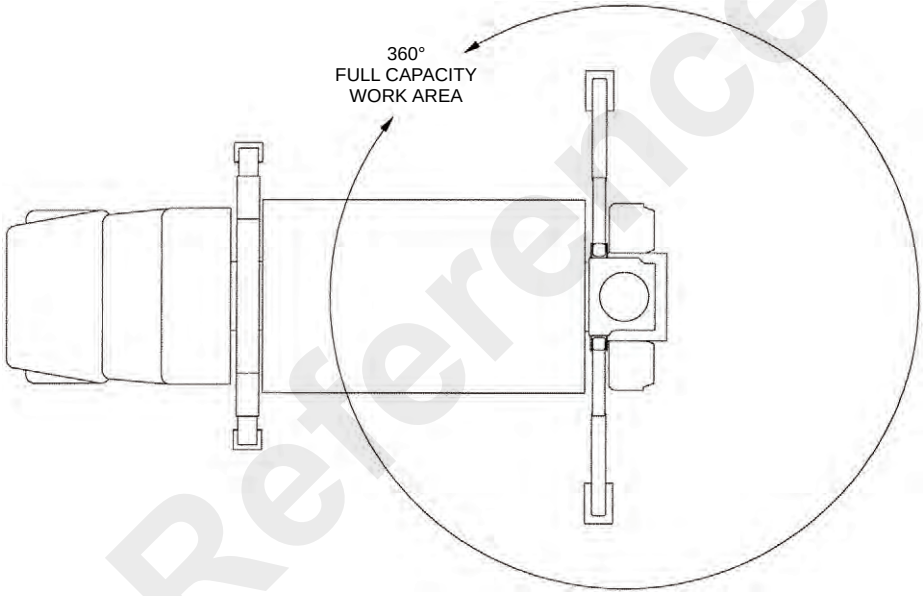
Note: If truck front axle weight exceeds 5600 lb before mounting crane, a 9000 GAWRF will most likely not be adequate.

Reference Only

Configuration 5 - rear mount with heavy duty subbase

The advantages of a rear- mounted 400B are: (1) allows the operator to effectively use the close-in working area to lift heavier loads and (2) 360° solid stability at full rated load.





Counterweight up to 3000 lb will be required on a minimum truck. Truck frame strength required is 15 in^3 section modulus from back of crane frame to the cab with 50,000 psi truck frame material or 13 in^3 section modulus from back of crane frame to the cab with 110,000 psi truck frame material. Options required for rear mounting include either ASHBC stabilizers or cross frame outriggers and heavy duty subbase. Minimum truck axle ratings required are 9000 GAWRF, 19,000 GAWRR and 28,000 GVWR. A payload of approximately 3500 lb can be hauled on a minimum truck with this mounting and configuration.

Configuration 6 - non-standard 152 in a-frame outriggers

Due to the special configuration of this 4008 crane, minimum truck weights and minimum truck axle weight ratings are not provided. Stability testing will determine the final chassis weight and the truck axle weight ratings must be sufficient to legally carry the unit. Truck frame strength required is 22 in^3 section modulus (S.M.) between axles and 13 in^3 S.M. through suspension with 50,000 psi truck frame material or 15 in^3 S.M. between axles and 10 in^3 S.M. through suspension with 110,000 psi truck frame material.

Reference Only

PTO HORSEPOWER REQUIREMENTS

A tandem pump hydraulic system is furnished with this crane. The unit is equipped with a two section pump that will supply 25 gpm (95 lpm) to the hoist, and 12 gpm (45 lpm) to the boom, outriggers and swing (turn) circuit. To provide these flows, the pump shaft must turn at 1850 rpm. The PTO requirement is a torque rating of at least 180 lb-ft (244 Nm) or 33 HP (25 KW) per 1000 RPM of PTO shaft speed.

Direct Mount Pump To PTO

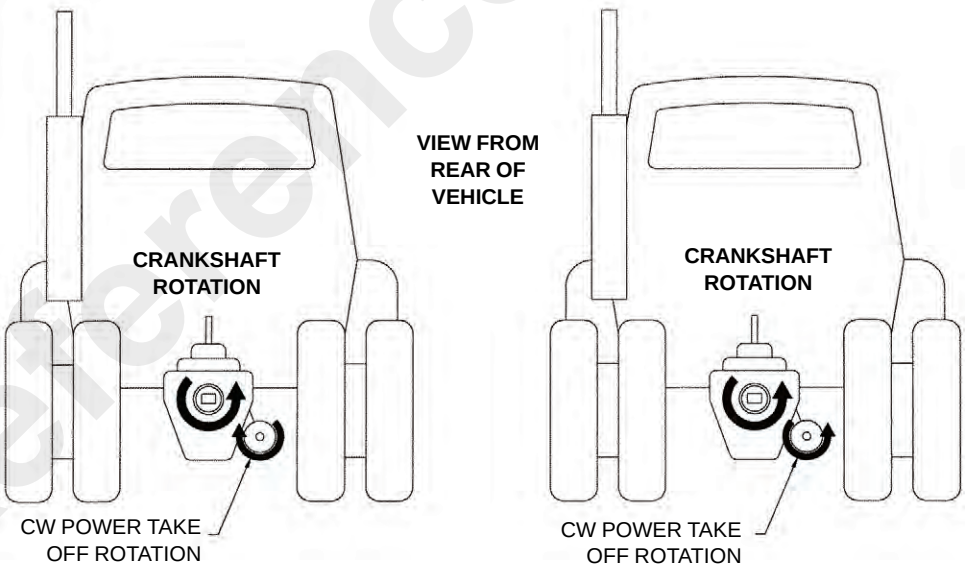
Most pump installations can be direct mounted to the PTO using adapter assemblies available from the PTO supplier. If the pump is direct mounted, its weight should be supported by a strap between the pump and the transmission. The splined shaft coupling in a direct mount pump installation requires lubrication. Coupling Lube Spline Lubricant should be applied to the shaft during original installation and reapplied to the shaft or zerk provided on PTO housing shaft semi-annually thereafter. It is available from Schaeffer Manufacturing Company, 102 Barton Street, St. Louis, Missouri.

Pump Rotation

It is imperative that the two section hydraulic pump installed in a 400B application be the correct pump rotation configuration for the truck drive train/power take off rotation direction. If it is desired to reverse the direction of drive rotation of pump see Pump Service Manual in Service and Maintenance Section.

Do not attempt to turn pump in the opposite direction of rotation. Scorning may result necessitating extensive repairs.

Do not confuse engine crankshaft rotation with power take off rotation. If the power take off shaft rotates opposite the engine crankshaft, it is turning in a clockwise (cw) direction when viewed from the rear of the truck. If the power take off shaft rotates the same as the engine crankshaft, it is turning in a counter-clockwise (ccw) direction when viewed from the rear of the truck. See illustration below.



0PP: OPPOSITE OF THE CRANKSHAFT ROTATION

CRNK: ENGINE CRANKSHAFT ROTATION

Reference Only

PTO SELECTION

Operating speeds and performance of the crane are based on proper pump outputs to the hoist, lift, telescope and swing circuits. A tandem pump system is standard equipment on the 400B. This pump supplies 25 (95), and 12 (45) gpm (lpm) to the appropriate crane circuits when operating at 1850 rpm.

The speeds shown below are optimum operating speeds. The engine must be operated at a speed such that the horsepower developed is adequate to pull the pumps under pressure.

Never operate pump at shaft speeds above 2500 RPM. This will result in permanent pump damage.

See pump rotation section to determine correct pump for your application.

	ENGINE SPEED (RPM) FOR 1850 RPM PUMP SHAFT SPEED	PTO RATIO
	2900	64%
Gasoline Engine	2800	66%
Optimum Speed	2600	71%
Range	2400	77%
	2200	84%
Diesel Engine	2000	93%
Optimum Speed	1850	100%
Range	1600	116%
	1500	123%

Reference Only

TRUCK FRAME STRENGTH

In order for a truck frame to be suitable for accepting a Series 400B size crane, the truck frame must have a requirement for rigidity so as not to allow excessive boom movement due to truck frame deflection, and it must be strong enough to resist the loading induced by the crane so as not to permanently bend or deform. Section Modulus (S.M.) is a measurement of the area of the truck frame and determines the rigidity of the frame. Resistance to bending moment (RBM) is a measurement of strength and is determined by multiplying the section modulus of each frame rail by the yield strength of the rail material.

For a standard, behind-the-cab mount, the Series 400B crane requires the following truck frame strength:

	Truck Frame or Reinforcing Material	Min. Section Modulus Under Crane	Min. Section Modulus Thru Rear Suspension	RBM Under Crane	RBM Thru Rear Suspension
Without Torsion Box	110,000 PSI 50,000 PSI	15 in^3 32 in^3	10 in^3 18 in^3	1,650,000 lb-in 1,600,000 lb-in	1,100,000 lb-in 900,000 lb-in
With Torsion Box	110,000 PSI 50,000 PSI	10 in^3 13 in^3	10 in^3 10 in^3	1,100,000 lb-in 650,000 lb-in	1,100,000 lb-in 500,000 lb-in

For truck frame requirements for other mounting configurations see Installation Section.

Section Modulus Tables

The following tables will determine the section modulus of the truck frame. Always measure the truck frame and check the tables to be sure that any truck factory listed section modulus is correct.

1. **Channel** (Table A). Table A provides the section modulus of channel frames in thicknesses of 3/16 in (4,76 mm), 1/4 in (6,35 mm), 5/16 in (7,94 mm), and 3/8 in (9,52 mm) with each grouping a flange width and web depth column. When the depth of frame channel and flange width is known, the point at which these two lines intersect is the section modulus from that particular channel.
   If the section modulus of the channel does not meet the requirements, the channel should be reinforced in the most applicable method following.
2. **Channel Reinforcement** (Table A). In order to provide more strength, a channel of suitable thickness can be added to the existing frame. The depth and flange width of this channel should be chosen so it fits over the existing frame. The section modulus of the needed channel is obtained from Table A and should be added to the section modulus obtained from the truck frame.
3. **Angle Reinforcement** (Table B). If the truck is reinforced with an angle, refer to Table B for the data on the added strength provided by the angle. Add this to the section modulus of the channel obtained from Table A.
4. **Fish Plate Reinforcement** (Table C). The frame can be strengthened by adding a fish plate of suitable thickness and depth equal to the frame. The section modulus of the fish plate can be obtained from Table C and this must be added to the section modulus of the frame to obtain the total section modulus.
5. Angle Under Reinforcement (Table D). This table lists the section modulus of an angle with the flange under the truck frame that is added to a frame with an angle reinforcement already added. Add the section modulus from Table D to the section modulus obtained from tables A and B to determine total section modulus.

The edges of the reinforcing angles or channels are to be flush with the edges of the frame.

Welding. Two rows of 1 in (25,4 mm) diameter plug welds are to be placed in a staggered pattern of the web; the rows to be spaced 5 in (127 mm) apart with welds at an interval of 4 in (102 mm). Do not weld on the flanges.

Where thickness, depth or flange width vary, interpolation between tables or variables within a given table will provide the strength for the section.

If you have any questions concerning frame strength or reinforcing, contact National Crane before proceeding.

Reference Only

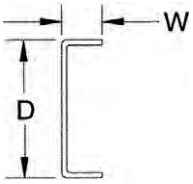


TABLE A

Section Modulus in^3 (cm^3)

THICKNESS 3/16 in (4,76 mm)

W in (mm) / D in (mm)	2½ (64)	3 (76)	3½ (89)	4 (102)
8 (203)	5.3 (87)	6.0 (98)	6.7 (110)	7.5 (123)
9 (229)	6.3 (103)	7.1 (116)	7.9 (130)	8.7 (143)
10 (254)	7.3 (120)	8.2 (134)	9.1 (149)	10.0 (164)
11 (279)	8.4 (138)	9.4 (154)	10.4 (170)	11.4 (187)
12 (305)	9.5 (156)	10.6 (174)	11.7 (192)	12.8 (210)
13 (330)	10.8 (177)	11.9 (195)	13.1 (215)	14.3 (234)
14 (356)	12.0 (197)	13.3 (218)	14.6 (239)	15.9 (261)
15(381)	13.4 (220)	14.7 (241)	16.1 (264)	17.5 (287)

THICKNESS 1/4 in (6,35 mm)

W in (mm) / D in (mm)	2½ (64)	3 (76)	3½ (89)	4 (102)
8 (203)	6.9 (113)	7.8 (128)	8.8 (144)	9.7 (159)
9 (229)	8.2 (134)	9.2 (151)	10.3 (169)	11.4 (187)
10 (254)	9.5 (156)	10.7 (175)	11.9 (195)	13.1 (215)
11 (279)	11.0 (180)	12.3 (202)	13.6 (223)	14.9 (244)
12 (305)	12.5 (205)	13.9 (228)	15.3 (251)	16.8 (275)
13 (330)	14.1 (231)	15.6 (256)	17.2 (282)	18.8 (308)
14 (356)	15.8 (259)	17.5 (287)	19.1 (313)	20.8 (341)
15 (381)	17.5 (287)	19.3 (316)	21.2 (348)	23.0 (377)

THICKNESS 5/16 in (7,94 mm)

W in (mm) / D in (mm)	2½ (64)	3 (76)	3½ (89)	4 (102)
8 (203)	8.4 (138)	9.5 (156)	10.7 (175)	11.9 (195)
9 (229)	10.0 (164)	11.3 (185)	12.6 (206)	13.9 (228)
10 (254)	11.6 (190)	13.1 (215)	14.6 (239)	16.0 (262)
11 (279)	13.4 (220)	15.0 (246)	16.6 (272)	18.3 (300)
12 (305)	15.3 (251)	17.1 (280)	18.8 (308)	20.6 (338)
13 (330)	17.3 (284)	19.2 (315)	21.1 (346)	23.1 (379)
14 (356)	19.4 (318)	21.4 (351)	23.5 (385)	25.6 (420)
15 (381)	21.6 (354)	23.8 (390)	26.0 (426)	28.3 (464)

THICKNESS 3/8 in (9,52 mm)

W in (mm) / D in (mm)	2½ (64)	3 (76)	3½ (89)	4 (102)
8 (203)	9.8 (161)	11.2 (184)	12.5 (205)	13.9 (228)
9 (229)	11.7 (192)	13.2 (216)	14.8 (243)	16.3 (267)
10 (254)	13.6 (223)	15.4 (252)	17.1 (280)	18.8 (308)
11 (279)	15.7 (257)	17.7 (290)	19.6 (321)	21.5 (352)
12 (305)	18.0 (295)	20.1 (329)	22.2 (364)	24.3 (398)
13 (330)	20.3 (333)	22.6 (370)	24.9 (408)	27.2 (446)
14 (356)	22.8 (374)	25.3 (415)	27.8 (456)	30.3 (497)
15 (381)	25.4 (416)	28.1 (461)	30.8 (505)	35.5 (582)

Reference Only

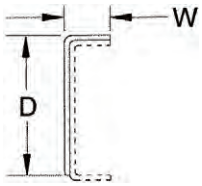


TABLE B

Section Modulus in^3 (cm^3)

THICKNESS 3/16 in (4,76 mm)

W in (mm) / D in (mm)	2¾ (70)	3¼ (83)	3¾ (95)	4¼ (108)
7½ (191)	2.2 (36)	2.3 (38)	2.3 (38)	2.4 (39)
8½ (216)	2.8 (46)	2.9 (48)	3.0 (49)	3.0 (49)
9½ (241)	3.4 (56)	3.5 (57)	3.6 (59)	3.7 (61)
10½ (267)	4.1 (67)	4.3 (70)	4.4 (72)	4.5 (74)
11½ (292)	4.9 (80)	5.1 (84)	5.2 (85)	5.4 (88)
12½ (318)	5.8 (95)	6.0 (98)	6.1 (100)	6.3 (103)
13½ (343)	6.7 (110)	6.9 (113)	7.1 (116)	7.3 (120)
14½ (368)	7.6 (124)	7.9 (129)	8.1 (133)	8.3 (136)

THICKNESS 1/4 in (6,35 mm)

W in (mm) / D in (mm)	2¾ (70)	3¼ (83)	3¾ (95)	4¼ (108)
7½ (191)	2.9 (48)	3.0 (49)	3.1 (51)	3.2 (52)
8½ (216)	3.7 (61)	3.8 (62)	3.9 (64)	4.0 (66)
9½ (241)	4.5 (74)	4.7 (77)	4.8 (79)	5.0 (82)
10½ (267)	5.5 (90)	5.7 (93)	5.8 (95)	6.0 (98)
11½ (292)	6.5 (106)	6.7 (110)	6.9 (113)	7.1 (116)
12½ (318)	7.6 (124)	7.9 (129)	8.1 (133)	8.3 (136)
13½ (343)	8.8 (144)	9.1 (149)	9.4 (154)	9.6 (157)
14½ (368)	10.1 (166)	10.5 (172)	10.7 (175)	11.0 (180)

THICKNESS 5/16 in (7,94 mm)

W in (mm) / D in (mm)	2¾ (70)	3¼ (83)	3¾ (95)	4¼ (108)
7½ (191)	3.6 (59)	3.7 (61)	3.9 (64)	4.0 (66)
8½ (216)	4.6 (75)	4.7 (77)	4.9 (80)	5.0 (82)
9½ (241)	5.6 (92)	5.8 (95)	6.0 (98)	6.2 (102)
10½ (267)	6.8 (111)	7.1 (116)	7.3 (120)	7.5 (123)
11½ (292)	8.1 (133)	8.4 (138)	8.6 (141)	8.9 (146)
12½ (318)	9.5 (156)	9.8 (161)	10.1 (166)	10.4 (170)
13½ (343)	11.0 (180)	11.4 (187)	11.7 (192)	12.0 (197)
14½ (368)	12.6 (206)	13.0 (213)	13.4 (220)	13.7 (224)

THICKNESS 3/8 in (9,52 mm)

W in (mm) / D in (mm)	2¾ (70)	3¼ (83)	3¾ (95)	4¼ (108)
7½ (191)	4.3 (70)	4.5 (74)	4.6 (75)	4.8 (79)
8½ (216)	5.5 (90)	5.7 (93)	5.9 (97)	6.0 (98)
9½ (241)	6.7 (110)	7.0 (115)	7.2 (118)	7.4 (121)
10½ (267)	8.1 (133)	8.4 (138)	8.7 (143)	8.9 (146)
11½ (292)	9.7 (159)	10.0 (164)	10.3 (169)	10.6 (174)
12½ (318)	11.3 (185)	11.7 (192)	12.1 (198)	12.4 (203)
13½ (343)	13.1 (215)	13.6 (223)	14.0 (229)	14.3 (234)
14½ (368)	15.1 (247)	15.5 (254)	16.0 (262)	16.4 (269)

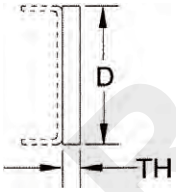


TABLE C

Section Modulus in^3 (cm^3)

W in (mm) / D in (mm)	8 (203)	9 (229)	10(254)	11 (279)	12 (305)	13 (330)	14 (356)	15 (381)	16 (406)
3/16 (4,76)	2.0 (33)	2.51 (41)	3.10 (51)	3.75 (61)	4.46 (73)	5.24 (86)	6.08 (100)	6.98 (114)	7.94 (130)
1/4 (6,35)	2.66 (44)	3.37 (55)	4.16 (68)	5.03 (82)	5.99 (98)	7.03 (115)	8.15 (134)	9.36 (153)	10.5 (172)
5/16 (7,94)	3.33 (55)	4.21 (69)	5.20 (85)	6.29 (103)	7.49 (123)	8.79 (144)	10.19 (167)	11.7 (192)	13.31 (218)
3/8 (9,52)	4.0 (66)	5.06 (83)	6.25 (102)	7.56 (124)	9.00 (148)	10.56 (173)	12.25 (201)	14.06 (230)	16.0 (262)
7/16 (11,11)	4.67 (76)	5.9 (97)	7.29 (119)	8.82 (144)	10.5 (172)	12.32 (202)	14.29 (234)	16.4 (269)	18.66 (306)

Reference Only

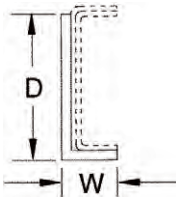


TABLE D

Section Modulus in^3 (cm^3)

THICKNESS 3/16 in (4,76 mm)

W in (mm) / D in (mm)	3 (76)	3½ (89)	4 (102)	4½ (114)
8½ (216)	5.7 (93)	6.4 (105)	7.0 (115)	7.7 (126)
9½ (241)	6.7 (110)	7.4 (121)	8.1 (133)	8.9 (146)
10½ (267)	7.7 (126)	8.5 (139)	9.3 (152)	10.1 (166)
11½ (292)	8.8 (144)	9.7 (159)	10.6 (174)	11.4 (187)
12½ (318)	10.0 (164)	10.9 (179)	11.9 (195)	12.8 (210)
13½ (343)	11.2 (184)	12.2 (200)	13.2 (216)	14.3 (234)
14½ (368)	12.5 (205)	13.6 (223)	14.6 (239)	15.7 (257)
15½ (394)	13.8 (226)	15.0 (246)	16.1 (264)	17.3 (284)

THICKNESS 1/4 in (6,35 mm)

W in (mm) / D in (mm)	3 (76)	3½ (89)	4 (102)	4½ (114)
8½ (216)	7.7 (126)	8.6 (141)	9.4 (154)	10.3 (169)
9½ (241)	9.1 (149)	10.0 (164)	10.9 (179)	11.9 (195)
10½ (267)	10.5 (172)	11.5 (188)	12.5 (205)	13.6 (223)
11½ (292)	11.9 (195)	13.1 (215)	14.2 (233)	15.4 (252)
12½ (318)	13.5 (221)	14.7 (241)	16.0 (262)	17.2 (282)
13½ (343)	15.2 (249)	16.5 (270)	17.8 (292)	19.2 (315)
14½ (368)	16.9 (277)	18.3 (300)	19.7 (323)	21.2 (347)
15½ (394)	18.7 (306)	20.2 (331)	21.7 (356)	23.3 (382)

THICKNESS 5/16 in (7,94 mm)

W in (mm) / D in (mm)	3 (76)	3½ (89)	4 (102)	4½ (114)
8½ (216)	9.8 (161)	10.8 (177)	11.9 (195)	12.9 (211)
9½ (241)	11.5 (188)	12.6 (206)	13.8 (226)	15.0 (246)
10½ (267)	13.3 (218)	14.5 (238)	15.8 (259)	17.1 (280)
11½ (292)	15.1 (247)	16.5 (271)	18.0 (295)	19.4 (318)
12½ (318)	17.1 (280)	18.6 (305)	20.2 (331)	21.7 (356)
13½ (343)	19.2 (315)	20.8 (341)	22.5 (369)	24.2 (397)
14½ (368)	21.4 (351)	23.1 (379)	24.9 (408)	26.7 (438)
15½ (394)	23.7 (388)	25.5 (418)	27.4 (449)	29.4 (482)

THICKNESS 3/8 in (9,52 mm)

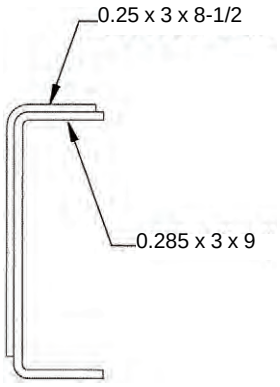
W in (mm) / D in (mm)	3 (76)	3½ (89)	4 (102)	4½ (114)
8½ (216)	11.9 (195)	13.2 (216)	14.4 (236)	15.6 (256)
9½ (241)	14.0 (229)	15.3 (251)	16.7 (274)	18.1 (297)
10½ (267)	16.2 (266)	17.7 (290)	19.2 (315)	20.7 (339)
11½ (292)	18.4 (302)	20.1 (329)	21.8 (357)	23.5 (385)
12½ (318)	20.9 (342)	22.6 (370)	24.5 (402)	26.3 (431)
13½ (343)	23.4 (384)	25.3 (415)	27.3 (447)	29.3 (480)
14½ (368)	26.0 (426)	28.1 (461)	30.2 (495)	32.4 (531)
15½ (394)	28.8 (472)	31.0 (508)	33.3 (546)	35.6 (583)

EXAMPLE:

A truck frame of 50,000 psi yield steel has the following dimensions: 0.285 thick, 3 in flanges and is 9.00 deep with inverted "**L**" reinforcement of 0.25 x 3 x 8-1/2 from axle to axle. To find this frame section modulus:

1. From Table A, 0.25 thickness, W (width) = 3, D (depth) = 9, section modulus = 9.2 in^3
2. From Table A, 0.31 thickness, W = 3, D = 9, Section Modulus = 11.3.
3. Interpolating between the two values:
   0.25 in thick channel = 9.2
   0.31 in deep channel = 11.3
   0.285 in thick channel = $\frac{9.2 + 11.3}{2}$ = 10.25
4. Now find the S.M. of the inverted "L" reinforcement from Table B.
   0.25x2-3/4x8-1/2 = 5.5
   0.25x3-1/4x8-1/2 = 5.7
   0.25x3x8-1/2 = $\frac{5.5 + 5.7}{2}$ = 5.60
5. Combined section modulus of the frame with inverted “L” reinforcement is 10.25 + 3.75 = 14.0 S.M.
6. This truck frame is suitable for mounting a Series 4008 with the torsion box because the 14 section modulus axle to axle is greater than the 13 section modulus required and the 10.25 section modulus through suspension is greater than the 10 section modulus required, all material 50,000 psi.

Reference only



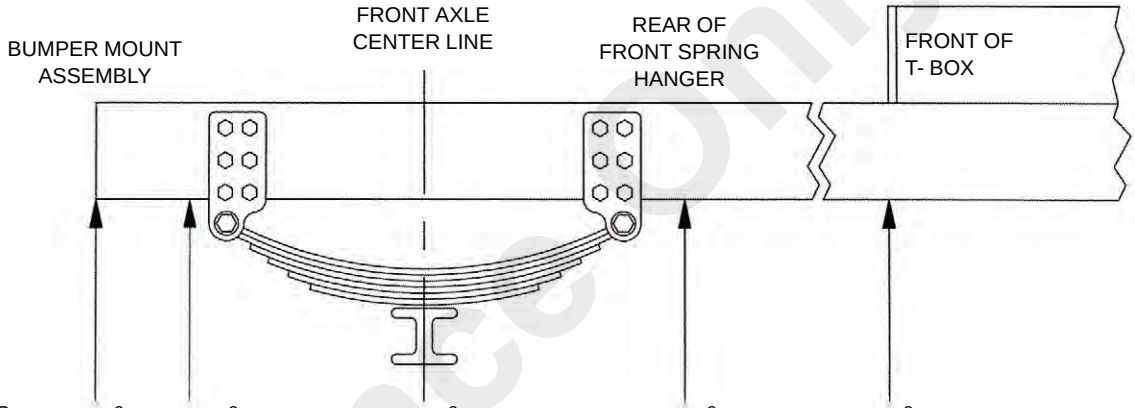
Reference Only

Truck Frame Requirements For Optional Front Stabilizer

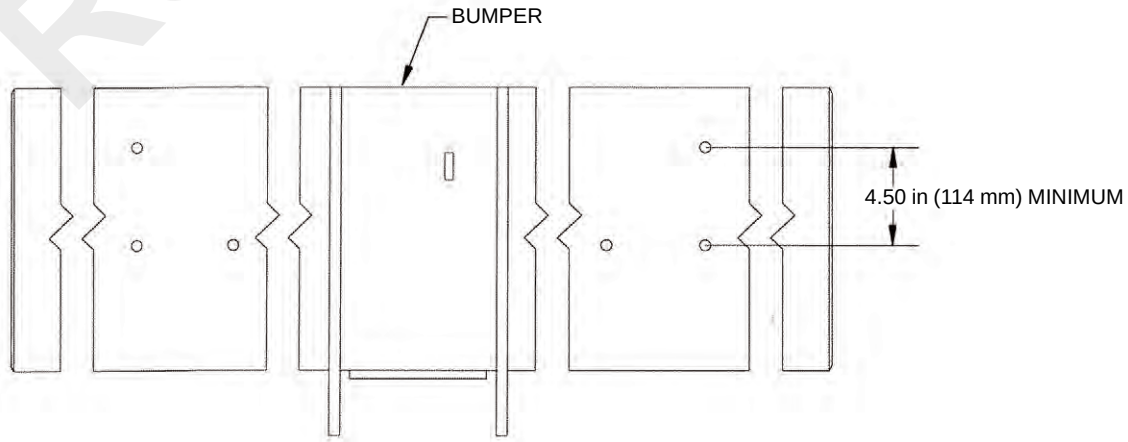
The truck frame must have adequate strength from under the crane frame through the front suspension to the bumper assembly for front stabilizer installation.

The following diagram shows the required section modulus at various stations along the front end of the truck frame for a standard behind-the-cab mount with torsion box.

In order to safely mount a front stabilizer in place of the normal front bumper, a minimum bolt pattern as shown is required. The bracket must be capable of supporting 0.50 in (12,7 mm) dia. Grade 8 bolts to their nominal breaking strength. Torque the mounting bolts supplied with the front stabilizer to 110 lb-ft (149 Nm). **Do not use spacers between the bumper bracket and the front stabilizer bumper assembly.** If the bumper bracket and front of the truck frame do not meet these specifications, an extended frame truck must be used. Contact factory for details. Details for mounting a stabilizer on an extended frame truck are included in that installation instruction. However, the Section Modulus requirements outlined below do apply.



SECTION MODULUS PER TRUCK FRAME RAIL [FRAME RAIL YIELD STRESS = 110,000 PSI (758 MPa)]	2.0 in^3 (33 cm^3)	6.2 in^3 (102 cm^3)	6.2 in^3 (102 cm^3)	6.2 in^3 (102 cm^3)	10 in^3 (164 cm^3)
[FRAME RAIL YIELD STRESS = 50,000 PSI (345 MPa)]	4.0 in^3 (66 cm^3)	13.5 in^3 (221 cm^3)	13.5 in^3 (221 cm^3)	13.5 in^3 (221 cm^3)	13.5 in^3 (221 cm^3)



Reference Only

Section Modulus Tables

Use Table E and Table F below along with Tables A through D in the preceding section of this manual for determining the section modulus of the truck frame.

Always measure the truck frame and check the tables to be sure that any truck factory listed section modulus is correct. It is also necessary to measure the frame and check the section modulus wherever the depth and/or flange width changes.

1. **Channel** (Table E). Table E supplements Table A for narrower truck frame flanges. Use the width of the narrow flanges for "W" to find the section modulus from Table E.
2. **Angle** (Table F). Use Table F for an angle section such as when a flange and part of the web of a truck frame channel is removed.

Where thickness, depth or flange width vary, interpolation between tables or variables within a given table will provide the strength for the section.

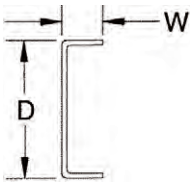
If you have any questions concerning frame strength or reinforcing, contact National Crane before proceeding.

Where thickness, depth or flange width vary, interpolation between tables or variables within a given table will provide the strength for the section.

If you have any questions concerning frame strength or reinforcing, contact National crane before proceeding.

TABLE E

Section Modulus in^3 (cm^3)



THICKNESS 3/16 in (4,76 mm)

D in (mm) \ W in (mm)	1 (25)	1½ (38)	2 (51)
8 (203)	3.2 (52)	3.9 (64)	4.6 (75)
9 (229)	3.8 (62)	4.7 (77)	5.5 (90)
10 (254)	4.6 (75)	5.5 (90)	6.4 (105)
11 (279)	5.4 (88)	6.4 (105)	7.4 (121)
12 (305)	6.3 (103)	7.4 (121)	8.5 (139)
13 (330)	7.2 (118)	8.4 (138)	9.6 (157)
14 (356)	8.2 (134)	9.5 (156)	10.8 (177)
15 (381)	9.3 (152)	10.6 (174)	12.0 (197)

THICKNESS 1/4 in (6,35 mm)

D in (mm) \ W in (mm)	1 (25)	1½ (38)	2 (51)
8 (203)	4.1 (67)	5.0 (82)	5.9 (97)
9 (229)	5.0 (82)	6.0 (98)	7.1 (116)
10 (254)	5.9 (97)	7.1 (116)	8.3 (136)
11 (279)	7.0 (115)	8.3 (136)	9.6 (157)
12 (305)	8.2 (134)	9.6 (157)	11.0 (180)
13 (330)	9.4 (154)	10.9 (179)	12.5 (205)
14 (356)	10.7 (175)	12.4 (203)	14.1 (231)
15 (381)	12.1 (198)	13.9 (228)	15.7 (257)

THICKNESS 5/16 in (7,94 mm)

D in (mm) \ W in (mm)	1 (25)	1½ (38)	2 (51)
8 (203)	4.9 (80)	6.1 (100)	7.2 (118)
9 (229)	6.0 (98)	7.3 (120)	8.6 (141)
10 (254)	7.2 (118)	8.7 (142)	10.1 (166)
11 (279)	8.5 (139)	10.1 (166)	11.8 (193)
12 (305)	9.9 (162)	11.7 (192)	13.5 (221)
13 (330)	11.5 (188)	13.4 (220)	15.3 (251)
14 (356)	13.1 (215)	15.2 (249)	17.3 (284)
15 (381)	14.8 (242)	17.1 (280)	19.3 (316)

THICKNESS 3/8 in (9,52 mm)

D in (mm) \ W in (mm)	1 (25)	1½ (38)	2 (51)
8 (203)	5.7 (93)	7.1 (116)	8.4 (138)
9 (229)	7.0 (115)	8.6 (141)	10.1 (166)
10 (254)	8.4 (138)	10.2 (167)	12.0 (197)
11 (279)	10.0 (164)	11.9 (195)	13.8 (226)
12 (305)	11.6 (190)	13.8 (226)	15.9 (261)
13 (330)	13.4 (220)	15.7 (257)	18.0 (295)
14 (356)	15.4 (252)	17.8 (292)	20.3 (333)
15 (381)	17.4 (285)	20.1 (329)	22.8 (374)

Reference Only

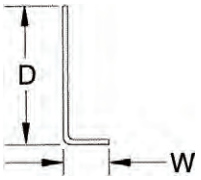


TABLE F

Section Modulus in^3 (cm^3)

THICKNESS 3/16 in (4,76 mm)

D in (mm) \ W in (mm)	2¾ (70)	3¼ (83)	3¾ (95)	4¼ (108)
3½ (89)	0.6 (10)	0.6 (10)	0.6 (10)	0.6 (10)
4½ (114)	0.9 (15)	1.0 (16)	1.0 (16)	1.0 (16)
5½ (140)	1.4 (23)	1.4 (23)	1.4 (23)	1.5 (25)
6½ (165)	1.8 (30)	1.9 (31)	2.0 (33)	2.0 (33)
7½ (191)	2.2 (36)	2.3 (38)	2.3 (38)	2.4 (39)
8½ (216)	2.8 (46)	2.9 (48)	3.0 (49)	3.0 (49)
9½ (241)	3.4 (56)	3.5 (57)	3.6 (59)	3.7 (61)
10½ (267)	4.1 (67)	4.3 (70)	4.4 (72)	4.5 (74)
11½ (292)	4.9 (80)	5.1 (84)	5.2 (85)	5.4 (88)
12½ (318)	5.8 (95)	6.0 (98)	6.1 (100)	6.3 (103)
13½ (343)	6.7 (110)	6.9 (113)	7.1 (116)	7.3 (120)
14½ (368)	7.6 (124)	7.9 (129)	8.1 (133)	8.3 (136)

THICKNESS 1/4 in (6,35 mm)

D in (mm) \ W in (mm)	2¾ (70)	3¼ (83)	3¾ (95)	4¼ (108)
3½ (89)	0.8 (13)	0.8 (13)	0.8 (13)	0.8 (13)
4½ (114)	1.2 (20)	1.3 (21)	1.3 (21)	1.3 (21)
5½ (140)	1.8 (30)	1.8 (30)	1.9 (31)	1.9 (31)
6½ (165)	2.4 (39)	2.5 (41)	2.6 (43)	2.6 (43)
7½ (191)	2.9 (48)	3.0 (49)	3.1 (51)	3.2 (52)
8½ (216)	3.7 (61)	3.8 (62)	3.9 (64)	4.0 (66)
9½ (241)	4.5 (74)	4.7 (77)	4.8 (79)	5.0 (82)
10½ (267)	5.5 (90)	5.7 (93)	5.8 (95)	6.0 (98)
11½ (292)	6.5 (106)	6.7 (110)	6.9 (113)	7.1 (116)
12½ (318)	7.6 (124)	7.9 (129)	8.1 (133)	8.3 (136)
13½ (343)	8.8 (144)	9.1 (149)	9.4 (154)	9.6 (157)
14½ (368)	10.1 (166)	10.5 (172)	10.7 (175)	11.0 (180)

THICKNESS 5/16 in (7,94 mm)

D in (mm) \ W in (mm)	2¾ (70)	3¼ (83)	3¾ (95)	4¼ (108)
3½ (89)	0.9 (15)	1.0 (16)	1.0 (16)	1.0 (16)
4½ (114)	1.5 (25)	1.5 (25)	1.6 (26)	1.6 (26)
5½ (140)	2.2 (36)	2.3 (38)	2.3 (38)	2.4 (39)
6½ (165)	3.0 (49)	3.1 (51)	3.2 (52)	3.2 (52)
7½ (191)	3.6 (59)	3.7 (61)	3.9 (64)	4.0 (66)
8½ (216)	4.6 (75)	4.7 (77)	4.9 (80)	5.0 (82)
9½ (241)	5.6 (92)	5.8 (95)	6.0 (98)	6.2 (102)
10½ (267)	6.8 (111)	7.1 (116)	7.3 (120)	7.5 (123)
11½ (292)	8.1 (133)	8.4 (138)	8.6 (141)	8.9 (146)
12½ (318)	9.5 (156)	9.8 (161)	10.1 (166)	10.4 (170)
13½ (343)	11.0 (180)	11.4 (187)	11.7 (192)	12.0 (197)
14½ (368)	12.6(206)	13.0 (213)	13.4 (220)	13.7 (224)

THICKNESS 3/8 in (9,52 mm)

D in (mm) \ W in (mm)	2¾ (70)	3¼ (83)	3¾ (95)	4¼ (108)
3½ (89)	1.1 (18)	1.1 (18)	1.1 (18)	1.2 (20)
4½ (114)	1.8 (30)	1.8 (30)	1.9 (31)	1.9 (31)
5½ (140)	2.6 (43)	2.7 (44)	2.7 (44)	2.8 (46)
6½ (165)	3.5 (57)	3.7 (61)	3.8 (62)	3.8 (62)
7½ (191)	4.3 (70)	4.5 (74)	4.6 (75)	4.8 (79)
8½ (216)	5.5 (90)	5.7 (93)	5.9 (97)	6.0 (98)
9½ (241)	6.7 (110)	7.0 (115)	7.2 (118)	7.4 (121)
10½ (267)	8.1 (133)	8.4 (138)	8.7 (143)	8.9 (146)
11½ (292)	9.7 (159)	10.0 (164)	10.3 (169)	10.6 (174)
12½ (318)	11.3 (185)	11.7 (192)	12.1 (198)	12.4 (203)
13½ (343)	13.1 (215)	13.6 (223)	14.0 (229)	14.3 (234)
14½ (368)	15.1 (247)	15.5 (254)	16.0 (262)	16.4 (269)

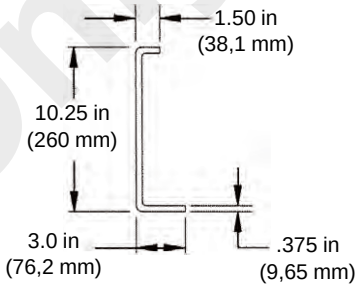
Reference Only

EXAMPLE:

Refer to the sample truck frame cross sections in Table E. Truck frame yield strength is 110,000 psi (758 MPa) with the following dimensions at the front axle location: 3/8 in (9,65 mm) thick, 1.50 in (38,1 mm) top flange, 3 in (76,2 mm) bottom flange, 10.25 in (260 mm) deep. To find the frame section modulus:

1. Use a channel with 1.50 in (38,1 mm) flanges since 1.50 in (38,1 mm) is the smaller flange width.
2. From Table E, 3/8 in (9,65 mm) thickness, W (width) = 1.50 in (38,1 mm), D (depth) = 10.0 in (254 mm) Section Modulus = 10.2 in^3 (167 cm^3).
3. From Table E, 3/8 in (9,65 mm) thickness, W = 1.50 in (38,1 mm), D = 11.0 in (279 mm) Section Modulus = 11.9 in^3 (195 cm^3).
4. Interpolate between the two values:
   10 in (254 mm) deep channel
   = 10.2 in^3 (167 cm^3)
   11 in (279 mm) deep channel
   = 11.9 $in.^3$ (195 cm^3)
   10.5 in (267 mm) deep channel
   $= \frac{10.2\ in^3 + 11.9\ in^3}{2} = 11.0\ in^3$
   $= \frac{167\ cm^3 + 195\ cm^3}{2} = 181\ cm^3$
5. Now interpolate between a 10.0 in (254 mm) deep channel and a 10.5 in (267 mm) deep channel to get the section modulus of a 10.25 in (260 mm) deep channel
   10.0 in (254 mm) deep channel
   = 10.2 in^3 (167cm^3)
   10.5 in (267 mm) deep channel
   = 11.0 in^3 (181cm^3)
   10.25 in (260 mm) deep channel
   $= \frac{10.2\ in^3 + 11.0\ in^3}{2} = 10.6\ in^3$
   $= \frac{167\ cm^3 + 181\ cm^3}{2} = 174\ cm^3$

Frame Section Modulus at the front axle location is 10.6 in^3 (174 cm^3). This is greater than the 6.2 in^3 (102 cm^3) required so the truck frame is strong enough at this location.



Reference Only

TRUCK PREPARATION

Plan installation completely before any work is done. Plan the location of the crane for the final front and rear axle weights and boom overhang. Check final weight (see Counterweighting Section to verify that final truck weight with crane, reinforcement, counterweight and options such as jib, etc. complies with the appropriate laws).

Welding Precautions

Sensitive truck computer system, the optional crane's RCL computer system and remote controls components may be damaged by welding on the truck or crane. The following precautions should be taken:

- Disconnect truck battery cables (positive and negative)
- Attach welding ground lead as close as possible to area to be welded.
- Remove the jib from the crane before welding on the crane or remove the jib sheave case assembly from the jib before welding on the jib.

Positioning Crane On Truck

The final user of the crane must be aware of all state axle and length laws in force at the time of crane mounting and position the crane on the truck accordingly. Following are items which must be considered.

1. **Overall Length:** Most states have a maximum straight truck length limit of 40 ft (12,19 m). Using too long a WB truck could cause the unit to exceed this limit.
2. **Axle Weights:** All states allow 20,000 lb (9072 kg) single axle weight and 34,000 lb (15 422 kg) tandem axle weights on primary roads, however, some states restrict axle weight to less on secondary roads or at certain times throughout the year. Be aware of your state's axle laws and the roads the machine will operate on for weight restrictions due to secondary roads, bridges, winter driving conditions, etc.
3. **Overhang:** The most restrictive overhang laws call for a maximum of 3 ft (0,91 m) in front of the truck. Many states have a maximum of 4 ft (122 cm) overhang in back of the truck. Check on your state requirements.
4. **Federal Bridge Law.** The Federal Bridge Law in effect currently states that in order to carry 54,000 lb (24 494 kg) on a three axle truck, the extremes of any group of axles must be at least 23.5 ft (7,16 m) apart. This equates to a truck with a wheelbase of at least 258 in (655 cm) with a minimum length of 24 in (60,96 cm) from the center of tandems to the center of the rear axle.

PTO, Pump, Reservoir

1. Select the PTO according to the PTO Selection pages shown earlier in this section. PTO's are not furnished by the factory.
2. Install the PTO and PTO shifting mechanism according to the PTO manufacturer's instructions. If PTO has a reverse gear, it must be blocked out. Pump must not run backwards.
3. If PTO integral mount flanges are to be used, the pump can be mounted directly to the PTO. Be sure adequate clearance exists for this type of pump mount. Sometimes the pump is powered through a drive line with the pump located no more than 42 in (107 cm) from the PTO. The drive line should not exceed a 15° angle. The drive line U-joint yokes on both ends of the drive shaft must be parallel with each other. Drive lines should be sized so they can safely carry the maximum pump horsepower requirements. See "PTO Selection" pages. Drive lines are not normally furnished by the factory.
4. Plan the location of the pump mounting bracket and drive line, if used, so that ample clearance is maintained between pump and truck drive shaft or exhaust system. Pump should be situated so that hydraulic lines can be connected without sharp bends especially the large suction line from the reservoir. Pump mounting brackets may be attached to existing frame crossmembers or a 6 in (15 cm) channel crossmember can be made and installed.
5. Install pump mounting bracket (driveline driven pumps only) securely to the truck frame. Attach pump to pump mounting plate or directly to the PTO using capscrews provided. Install the pump support bar at the rear of the pump and bolt or weld the upper end to a crossmember if the pump is driven by a driveline, or attach to a transmission bolt if the pump is direct mounted to the PTO. The rear of the pump must be supported regardless of the mounting method.

Note: Some of the pipe fittings used are sealed by means of two threaded tapered sections, one male and one female. When these two tapers meet, you will note a sudden increase in the force required to screw the fittings together. This is true of all tapered pipe threads. Further tightening will not only fail to increase the pressure tightness of the joint, but may ruin the connections and make correct assembly impossible.

Other fittings are of the o-ring boss type. These are installed by first screwing the lock nut flush to the upper thread land and installing fitting into port until the nut contacts the surface of the port. Adjust fitting to desired direction. Tighten locknut.

Reference Only

Most pressure fittings are the O-ring face seal types. A small O-ring is compressed between the male and the female fittings of the joint. Be sure the O-ring is present on the fitting and seated properly in its groove before the fittings are tightened.

6. Remove the dust covers from the pump inlet and outlet and determine that the suction and pressure sides of the pump are correct while rotating the pump in the same direction as the PTO. Rotate the pump in the mounting bracket so suction side is toward the reservoir suction port. Make sure pump is correct rotation.

7. If using a drive shaft type of mount, connect PTO drive shaft to pump and PTO. Drill a 0.31 in (7,87 mm) dia. x 0.12 in (3 mm) deep hole on the flat of the hex shaft at the fixed yoke end of the drive shaft to engage the yoke set screw. A small flat area should be ground in the O.D. of the splined pump shaft to engage the pump yoke set screw. Apply Loctite and tighten the shaft setscrews. Grease the PTO universal joints.

Reinforcing After Frame is Extended

1. Refer to "Truck Frame Strength" and "Section Modulus" tables. Determine section modulus by actual measurement of the truck frame. If reinforcing is required, always use at least 50,000 psi (345 MPa) steel to minimize the amount of reinforcing required. Use Grade 90 weld material for any welding to be done.

2. Strip the frame of obstructions in the area to be reinforced or extended, one side at a time. If the truck frame crossmembers are bolted in, remove the bolts. Do not attempt to remove any rivets.

3. Place the reinforcing on the truck frame and clamp in place. Mark the location of any rivets by striking the outside of the reinforcing over the rivet area so that the rivets make an impression on the inside of the reinforcing. Mark the approximate location of the crane mounting anchors so that no obstructions exist. Remove the reinforcing and drill or torch cut clearance holes for bolts or rivets. See Figure A.

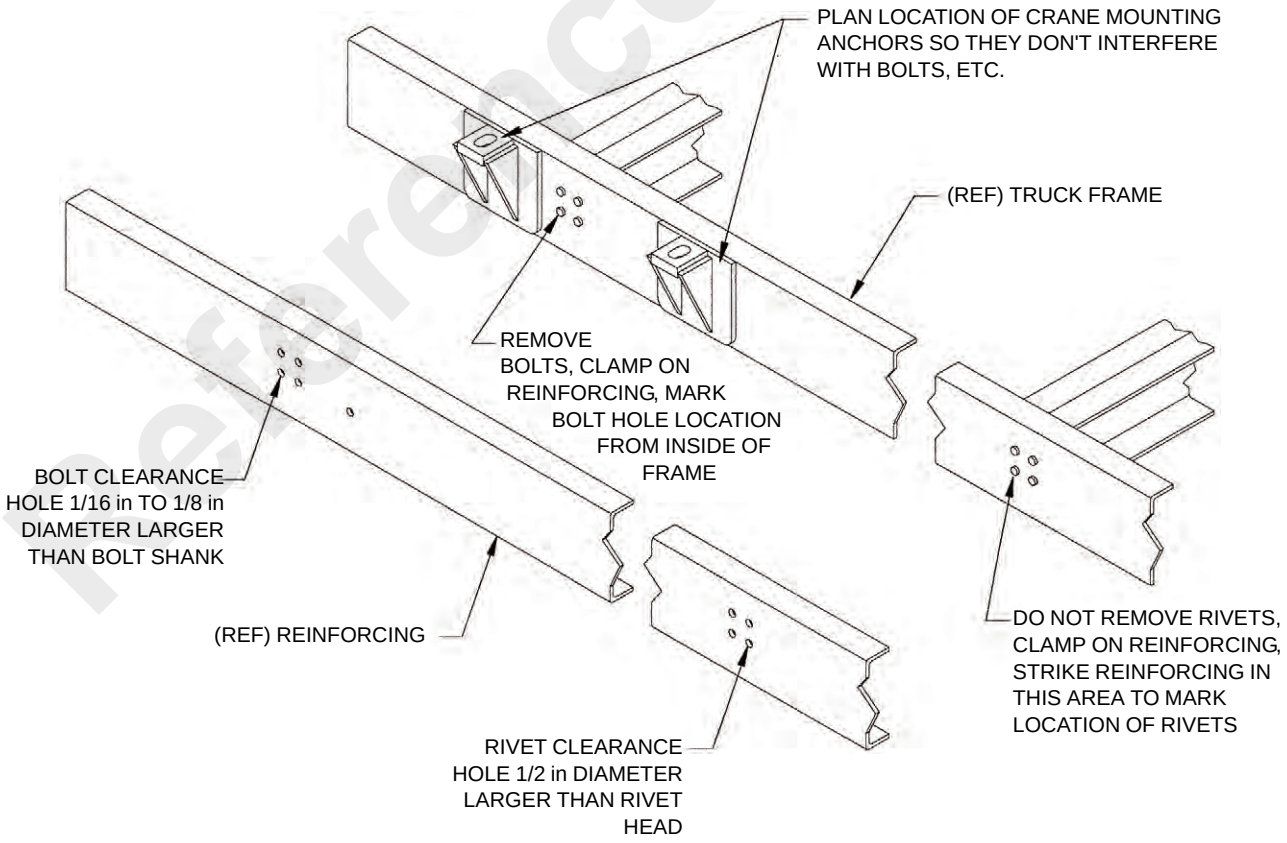


FIGURE A

Reference Only

4. If reinforcing is to be welded on, torch cut hole pattern in reinforcing being careful to clear crane mounting anchors. Install reinforcing, clamp in place, install any crossmember bolts that were previously removed and weld to truck frame as shown in Figure B.
   In some cases, because of customer stipulation or truck manufacturer voiding their warranty, bolt-on reinforcing is required. In these cases, install the reinforcing, clamp in place, install any crossmember bolts that were previously removed, then drill through reinforcing and truck frame being careful to clear crane mounting anchors and bolt reinforcing in place. See Figure C for recommended drilling and bolting procedure. Use 5/8, Grade 8 bolts, drill holes to 39/64 diameter, drive fit bolts and torque according to Torque Chart in Maintenance Section.

5. If the frame through the rear suspension doesn't meet minimum specifications for RBM and section modulus as shown on "Truck Frame Strength" table, it can be reinforced by adding an angle type of reinforcing as in Figure D. See "Section Modulus tables, Table B for the required size of reinforcing. Strip all easily removable equipment from the frame through the suspension such as spring stops, etc. Butt the reinforcing angle up against the reinforcing forward of the suspension and mark the areas that will require cutting so that the angle will slide up around the spring hangers and against the existing truck frame and forward reinforcing. Torch out the marked areas in the long leg of the angle deep enough so that the lip of the angle can be slid up from the underneath the frame to contact either existing truck frame or spring hanger brackets (if they extend down below the existing truck frame). If reinforcing angle is to be welded to truck frame, cut out plug weld hole pattern as in Figure B. Slide the reinforcing angle up from the bottom, butt it to existing forward reinforcing and weld rear suspension reinforcing to forward reinforcing. Replace as much of the spring hanger cut out areas as possible and butt weld these pieces in.

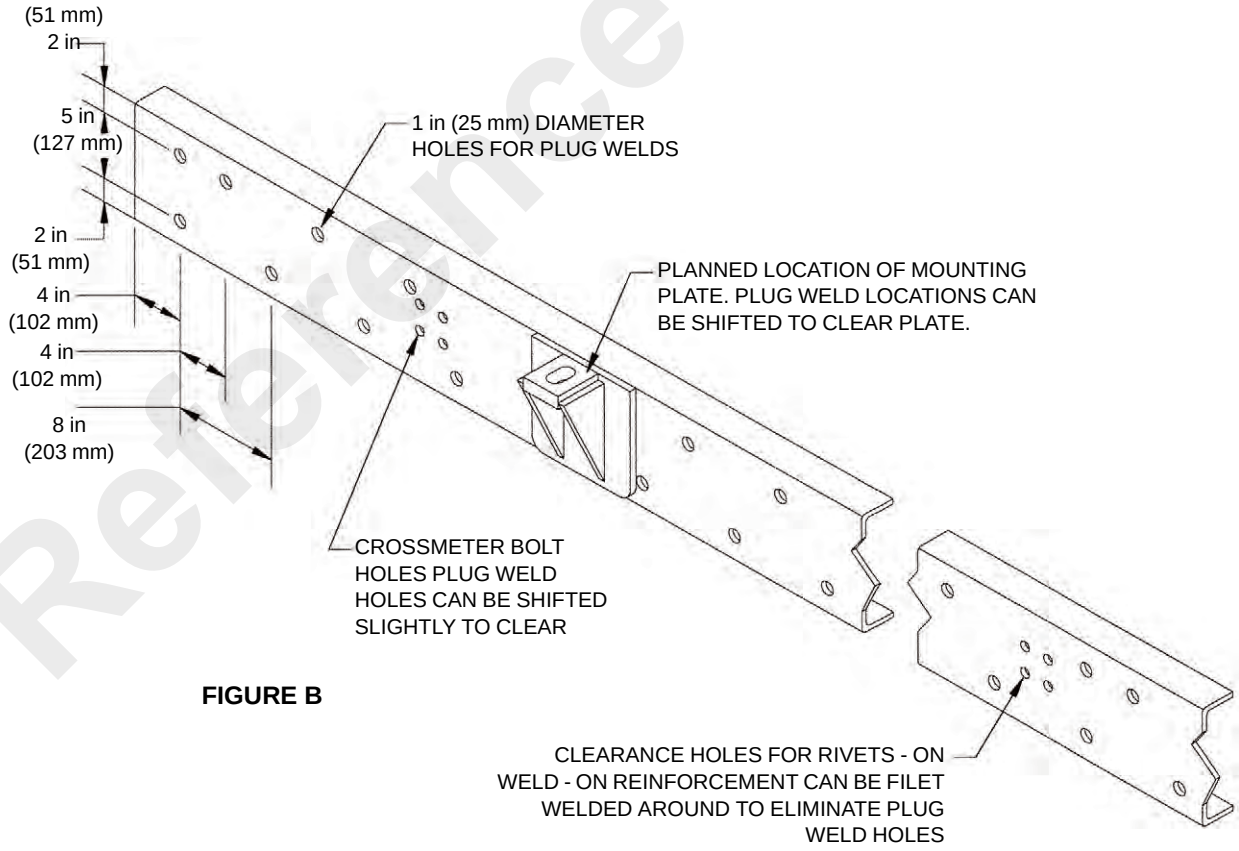


FIGURE B

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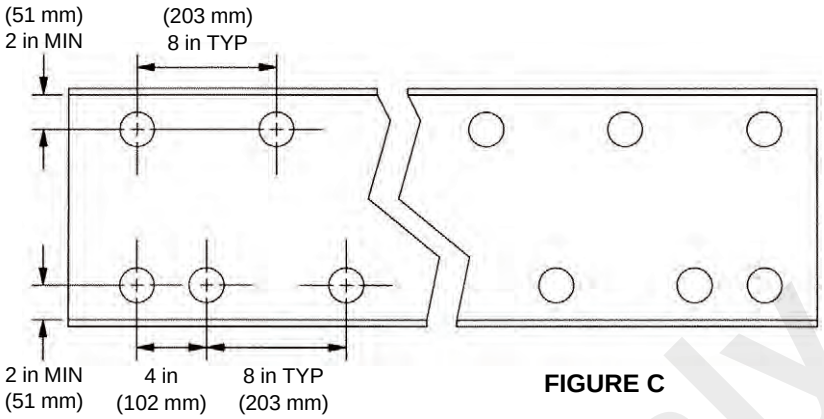


FIGURE C

If reinforcing angle is to be bolted on, drill hole pattern and install bolts according to Figure C. Reinforce spring hanger cut outs and the weld area, suspension reinforcing to forward reinforcing by adding bars under these areas. The bars should be of the same thickness, width and yield strength as the reinforcing angle lip, and should be long enough to extend at least 6 in (152 mm) beyond either side of the weld or cut out areas. Weld these reinforcing bars to the underside of the reinforcing with length-wise welds. ***Do not weld across the flanges.*** Replace any equipment that had been removed.

6. If additional suspension reinforcing is required, as may be the case with a truck frame that tapers down to approximately 6 in (15,24 cm) deep through the suspension, a channel may be fabricated through the suspension for additional strength. To do this, install the angle as described in the previous step, making sure that the long leg of the angle extends to the top of the truck frame. A bar of the same material strength, thickness, length and flange width as the reinforcing angle is then added to the top of the truck frame. The bar is butt welded to the top of the forward reinforcing, then skip-welded with 6 in (15,24 cm) of weld, 6 in (15,24 cm) no weld, etc., along both edges of the bar, front to back.

Reference Only

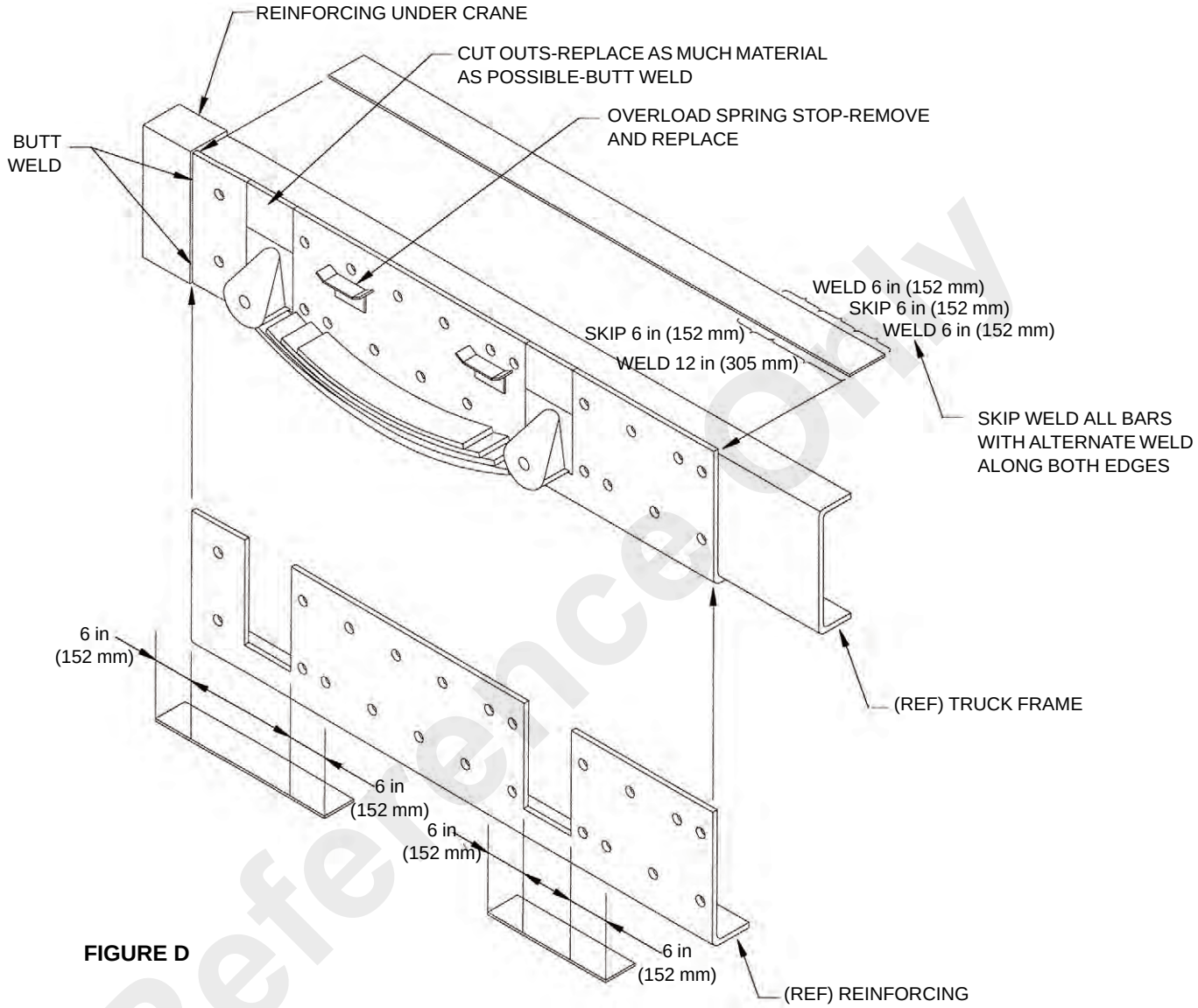


FIGURE D

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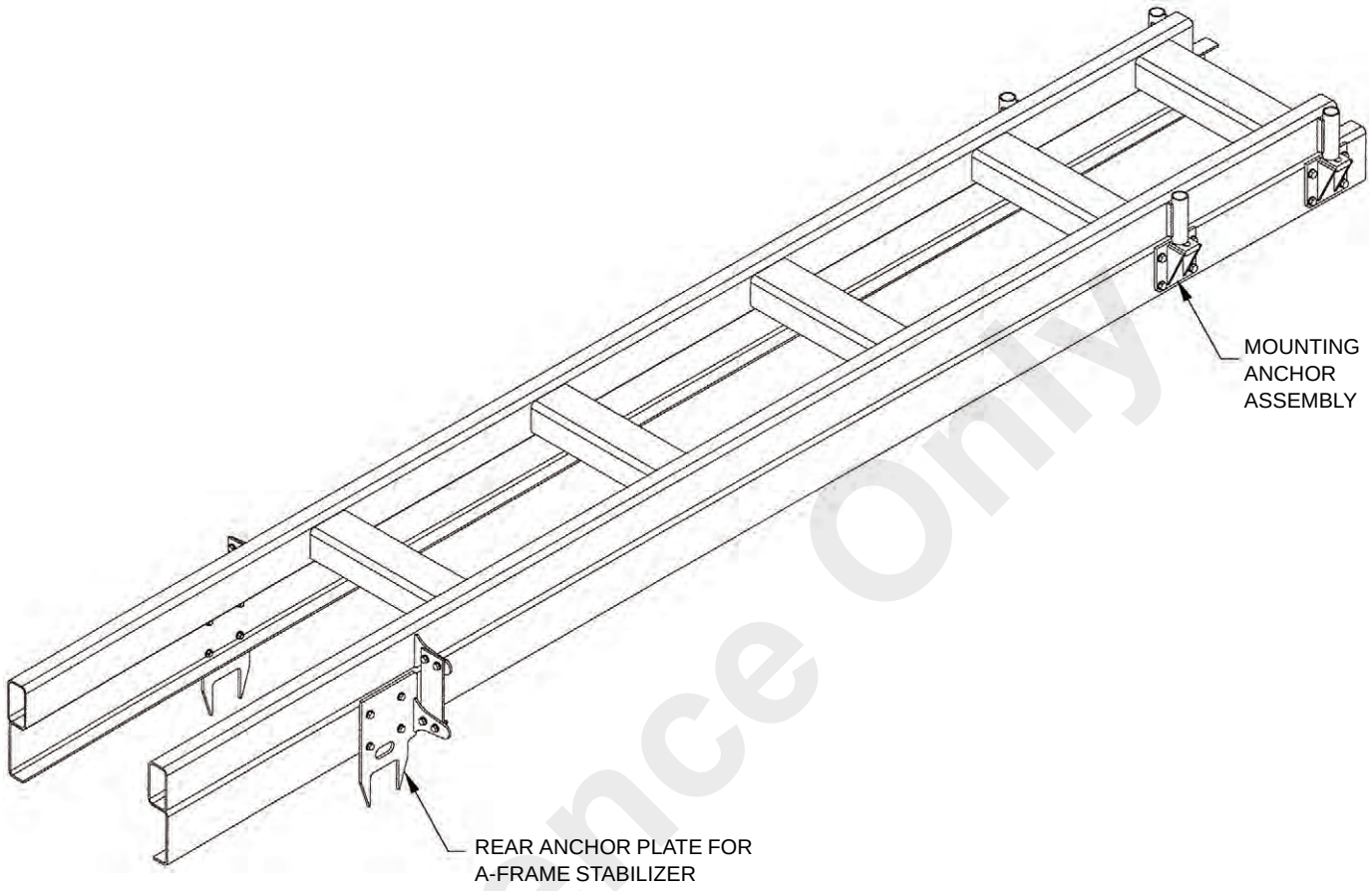
AFTER FRAME MODIFICATION

Length of after frame (AF) may have to be modified for crane installation. If AF is too long, cut off excess and remove any crossmembers from back of truck frame. If AF is too short, the frame will have to be lengthened. Use channels fabricated from 100,000 psi (758 MPa) yield material that are the same size as the truck frame. Weld these channels to the ends of the existing truck frame channels. Bevel the ends of the channels to get 100% weld joints with Grade 90 weld material. Fabricate an inner channel of the same thickness as the truck frame channels to span the weld joint for at least 12 in (30 cm) on each side of joint. Plug weld this channel to the inside of the truck frame, then skip weld the inside edge of the top and bottom flanges to the truck frame flanges.

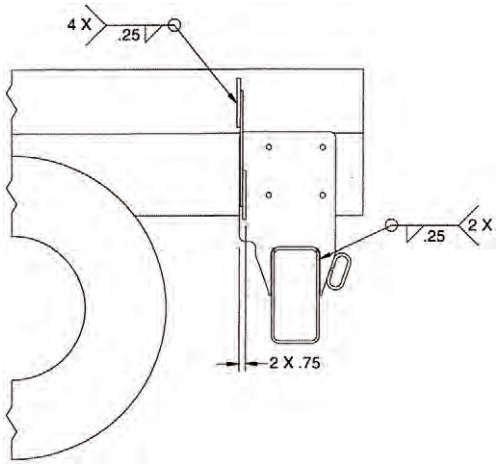
CRANE INSTALLATION

1. Determine installation position for the crane considering the operating area of the crane, space for saddle tanks, truck frame crossmembers, or anything that might affect installation and be sure the frame is clear of any obstructions that might interfere with proper installation.
2. Center the subbase on the chassis at the proper location. Loosely assemble two mount anchor assemblies per side to subbase and look for interference with truck crossmembers.
3. If subbase does not fit tightly on truck frame at all locations, do not force them together to remove gaps since they will not affect the unit's stiffness or strength. Add spacers as required to level truck bed before attaching it to the torsion box.
4. Drill four 3/4 in diameter holes through the truck frame at each mounting plate using the holes in the mount anchor assembly as pilot holes. Install 3/4 in diameter Grade 8 bolts, washers and nuts in mounting plates.
5. With rear ASH stabilizers retracted, determine the distance from the top of the stabilizer frame cross tube to ground level that will give you approximately 12 in (30 cm) of ground clearance to the bottom of the stabilizer foot. This will give approximately eight inches of stabilizer penetration. Keep in mind that the truck frame may settle slightly with the addition of the crane frame, boom, bed and payload. Using this determined vertical dimension position the rear anchor plate approximately 12 in (30 cm) behind the rear tires. The lobe on the anchor plate can be positioned either both lobes toward the front or rear of the truck. Check for truck frame bolt or rivet interference. Cut clearance holes for rivet heads. Mark and drill four 5/8 in bolt holes as specified through anchor plate and truck frame and install four 5/8 in Grade 8 bolts, washers and nuts. Tighten to proper torque.

Reference Only



6. Loosely assemble flex plate and two anchor ears as shown. Locate flex plate anchor ears to torsion box and ASH anchor plate as specified and tack in place. Remove flex plate and weld (E70) ears to torsion box and anchor plate as specified. Install flex plate with four 5/8" Grade 8 bolts, washers and nuts. Tighten to proper torque. Repeat flex plate installation procedure on other side. Raise and center the ASH frame cross tube into the throat of the stabilizer anchor plate and weld (E70) as shown.



7. Set the crane frame on the subbase and install the 1-1/8 in diameter Grade 8 mounting bolt at each corner. Bolt the crane to mounting anchors through tubes in the subbase and mounting anchors to truck frame. Tighten mounting bolts to the proper torque.

Reference Only

8. Find a location for and install hydraulic oil reservoir. Mounting brackets may be bolted to the truck frame. Connect suction line from pump before filling with oil.

9. Install the return line from the crane frame to the filter on the side of the reservoir. Clamp return hose to filter flange then check for leaks. Engage PTO and run the pump to circulate the oil.

   Important: The weight of suction and return hose and plumbing must be supported to prevent damage to the reservoir. Install support brackets and clamp or tie hoses up to eliminate strain on reservoir connections.

10. Install outriggers on crane frame as shown in illustrated parts pages. Attach the appropriate hoses to the outrigger cylinders. Cycle the outriggers to fill with oil completely and install the latch plate to hold outriggers in place during travel.

11. **Important: Before attempting to assemble the boom and lift cylinder to the frame, see "Hose Routing" page in "Controls & Hydraulics" Section and "Pin Bearing Inspection and Installation" and "Anti-Two-Block System Installation" pages in this section. Before connecting hoses, boom must be opposite (180°) the rotation stop to minimize hose twist**.

    Pin lift cylinder barrel in position in the turret. Pin boom pivot to turret. (It will be necessary to use an overhead hoist for lifting boom and lift cylinder.) Connect the hoses to the lift cylinder. Support outer end of boom securely and use the overhead hoist to position the lift cylinder with the control valve to pin the cylinder to the boom ears. Torque pin keeper capscrews to proper torque. Grease the three pin joints with gun grease and operate the boom and lift cylinder through several complete cycles before placing machine in operation.

12. Route the telescope hoses through the turret and to the back side of the boom. Connect the telescope cylinder connections at the back of the boom.

13. Route the hoist hoses through the turret then through the holes in the side of the hoist side plates and connect to the hoist fittings.

14. Unspool approximately 15 ft (8 m) of cable and route the cable through the boom cable guides from the front of the boom to the hoist.

15. Install one end of the loadline cable into the Hoist drum using the wedge socket provided. See "Hoist Service Manual" in the Service and Maintenance Section for proper placement of the wedge socket.

16. Remove the cable keeper T-handle pin from the sheave case and lay the cable over the top sheave. Replace the top cable keeper pin.

17. Unspool the remainder of the cable out from the back of the truck being sure the cable is straight and without kinks. Attach downhaul weight, wedge socket, hook and cable clamp to the end of cable as shown in Loadline Section. Torque cable clamp to 65 lb-ft (88 N-m) for 1/2 in rope and 95 lb-ft (129 N·m) for 9/16 in rope. This torque must be rechecked after initial operation of the crane. Be sure cable clamp is attached to the free end of the cable only. If equipped with optional 2/3 part block, omit downhaul weight and assemble as shown in Loadline Section. Special care should be taken to reeve the cable through the wedge socket as shown in Figure A.

18. Spool the load line onto the hoist drum while maintaining approximately 500 lb (250 kg) of tension on the cable (attaching a small vehicle to the end of the loadline with another person lightly riding the vehicle brakes while the cable is spooling on the drum will accomplish this). While the first half of the hoist bare drum is filling, it will be necessary to force the cable to wrap tightly against the preceding wrap by pounding the cable against the preceding wrap with a rubber mallet until at least half of the drum is full. The remaining half of the drum should wrap tightly because the fleet angle of the cable will tend to pull the cable to the center of the drum thus wrapping tightly.

19. Continue winding the cable on the second, third and fourth layer of the drum. Keep the cable paying in straight to the boom to avoid side loading the boom. The preceding layers will wrap smoothly guided by the first layer wrapping.

20. After cable is completely wrapped on drum, replace remaining cable keeper bolts on the sheave case.

21. Check for hoist mount tail swing clearance at top of cab. Any equipment that extends above the truck cab such as exhaust stacks or air horns may interfere with the hoist mount when the boom is elevated and rotated. Shorten exhaust stacks or move air horns, etc. to ensure clearance.

22. If crane is to be repainted, mask all decals prior to final paint or install all new decals in accordance with location drawings and illustrated parts catalog over final paint.

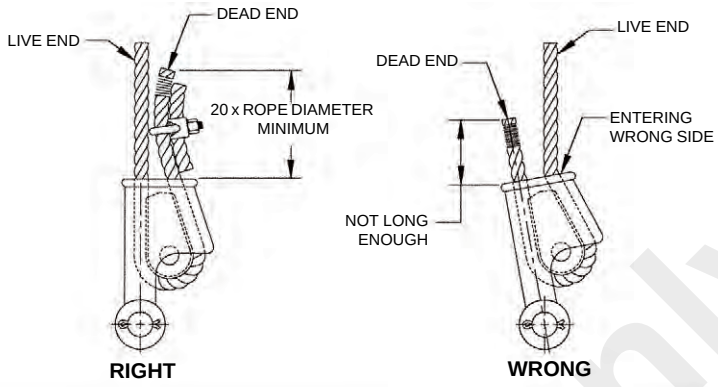
23. After installation, check all oil and lubricant levels and lubricate unit according to Lubrication Chart in Service and Maintenance Section.

24. Wire up emergency "kill" and horn switch. Diesel trucks will require electric solenoid shutoff available at local truck dealer. Air horns can be accommodated by installation of electric horn available at truck dealer. See Illustrated Parts Catalog (Mounting Section) for details.

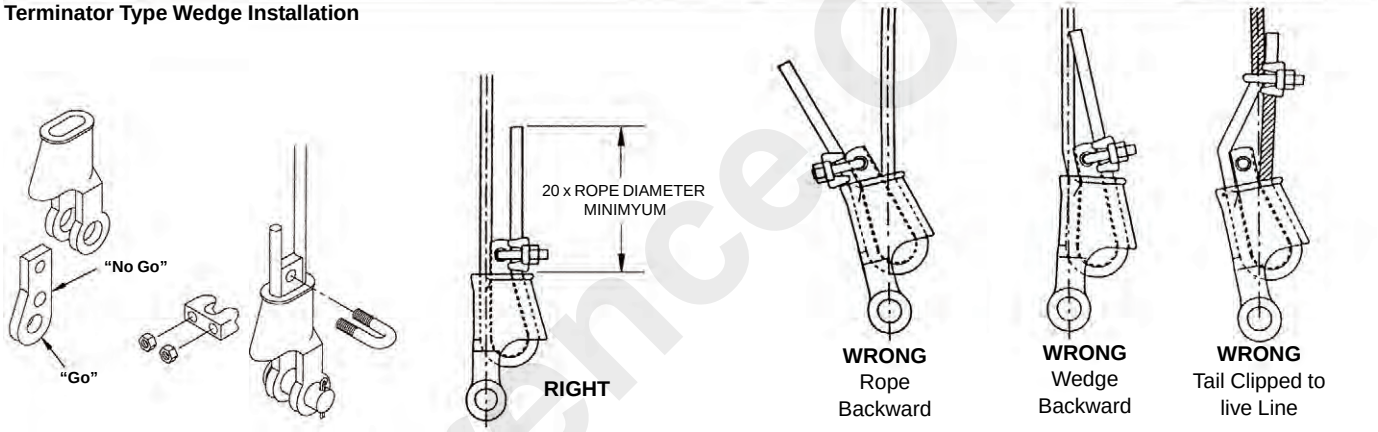
    On units equipped with remote control or rotating turret control options, wire the remote start function into the chassis start circuit. Be sure the start wire is connected

Reference Only

behind the chassis neutral start switch to prevent engine start when the transmission is in gear.



Terminator Type Wedge Installation



Rope Size	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/8	1-1/4
*Torque lb-ft (N·m)	45 (61)	65 (88)	65 (88)	95 (129)	95 (129)	130 (176)	225 (305)	225 (305)	225 (305)	360 (488)
* The tightening torque values shown are based upon the threads being clean, dry, and free of lubrication.										

- Properly match socket, wedge and clip to wire rope size. The wire rope must pass through the "go" hole in the wedge. It must not pass through the "no go" hole in the wedge.
- Align live end of rope, with center line of pin.
- Secure dead end section of rope.
- Tighten nuts on clip to recommended torque. (See Table)
- Do not attach dead end to live end or install wedge backwards.
- Use a hammer to seat Wedge and Rope as deep into socket as possible before applying first load.

FIGURE A

PIN BEARING INSPECTION AND INSTALLATION PROCEDURE

Pin inspection

1. Remove the protective covering from pins and inspect each pin for nicks, gouges or deep wide scratches. A small nick or gouge up to 1/8 in (3 mm) diameter can be repaired by dressing the edges of the imperfection with a file so that no metal protrudes above the circular surface of the pin.
2. A circular scratch of up to 1/16 in (1,5 mm) wide or deep can be repaired as in 1 above.
3. A lengthwise scratch on the pin of up to 1/32 in (0,8 mm) wide or deep can be repaired as in 1 above.
4. Pins with defects larger than those listed in 1, 2 or 3 should be replaced.

Reference Only

Bearing Inspection

1. The bearings furnished with this machine are made up of a tough epoxy impregnated wound glass backing shell with a thin inner layer of filament wound bearing material. The outer bearing material should be visually checked for imperfections. Bearings with cracks or gouges larger than 1/4 in (6 mm) diameter on the outside diameter should be replaced.
2. Inspect the inner diameter surface of the bearing. any scratches, cut or gouges which have penetrated through the inner liner may cause premature failure of the bearing. The bearing should be replaced.

Trunnion Inspection

1. The trunnion bore should either have a machined step or have a spring spacer installed to prevent inward movement of the bearing. If equipped with a spring spacer, check to make sure the opening is Positioned Over The Grease Hole.

Installation

1. Two bearings are to be installed in the boom pivot trunnion located directly below the hoist and the remaining four bearings are to be installed in the lift cylinder, two at each side of the rod end of the cylinder and two at each side of the butt end of the cylinder.
2. The bearings should be started in their respective bores by rotating the bearing while applying inward pressure with the hand. Once the bearing has been started squarely into its bore, it can be driven to its full counterbored depth by tapping lightly with a rubber mallet. The head diameter of the mallet should exceed the outside diameter of the bearing to ensure that the bearing is not damaged during assembly into the bore.
3. If the bearing appears to be loose in the bore (if it can be pushed in with hand pressure alone), it is permissible to tighten the bearing by center punching the bore diameter in approximately 50 places around and throughout the 2 in (51 mm) deep bored area. Center punching will raise the metal around the edge of the punch mark and this raised metal will hold the bearing firmly in place during machine operation.
4. After all bearings have been installed and before attempting to assemble the machine, insert the pins through both bearings in each end of the lift cylinder and through the boom pivot bearings to insure alignment and fit are correct. Also check the two sets of pin holes in the turret and the pin holes in the boom ears to ensure that the pins will slide freely through the leading hole and start in the opposite hole. If a pin starts to bind through the leading hole, do not force the pin any further to avoid damaging the pin surface finish. Remove the pin and clean any corrosion of burrs out of the holes with a round file or emery cloth.
5. When pinning the boom to the turret, and the lift cylinder to the turret and boom, use a round smooth bar of approximately 1-1/2 in (38 mm) diameter as a pry bar to align the pin holes. A pry bar with a sharp edge, such as a crowbar, can gouge or cut bearing and this may lead to premature bearing failure.

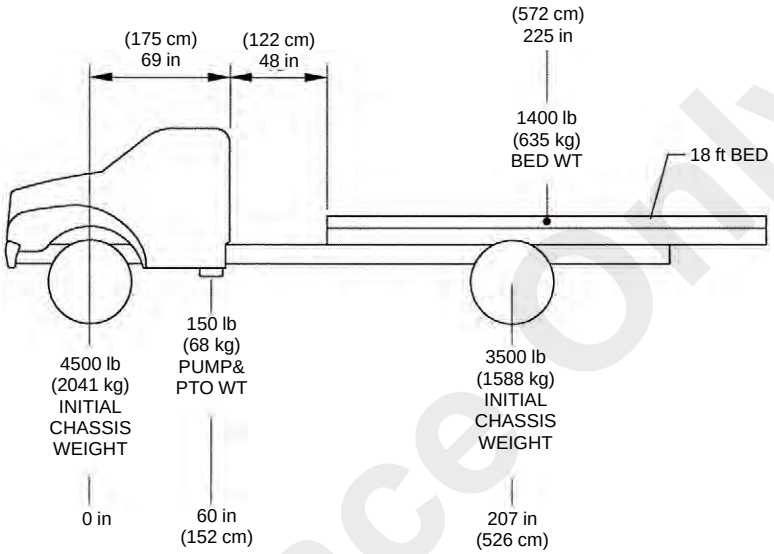
COUNTERWEIGHTING

1. Refer to "Mounting Configuration" pages in this section. The amount of counterweight and its location is dependent upon the stability working area (180° behind the truck or 360° around the truck), the weight of the truck and all permanently attached equipment. Permanently attached equipment which can be considered as counterweight includes the bed, reinforcing, PTO's and pumps, tool boxes, etc. The torsion resisting subbase and rear stabilizers are considered part of this crane and not part of the counterweight. Additional counterweight is usually added to the underside of the bed and/or to the torsion resisting subbase. On some trucks, a heavy front bumper may also be required for stability around the rear.
2. The 85% tipping factor as outlined in OSHA and ANSI specifications means that when lifting the full capacity loads most likely to cause the truck (with outriggers and stabilizer set) to overturn, the unit is at 85% of tipping over. Increasing this full capacity load by 117.6% (overloading) will cause the unit to tip over.
3. In order to determine the amount of counterweight required, it is necessary to add up the weight that each permanently attached piece of equipment will place on the front and rear axles of the truck along with the initial truck chassis weight and then compare the total front and rear axle weights with the weights listed on the "Mounting Configuration" (Installation Section) pages to determine the amount and location of counterweight required.

Reference Only

Example

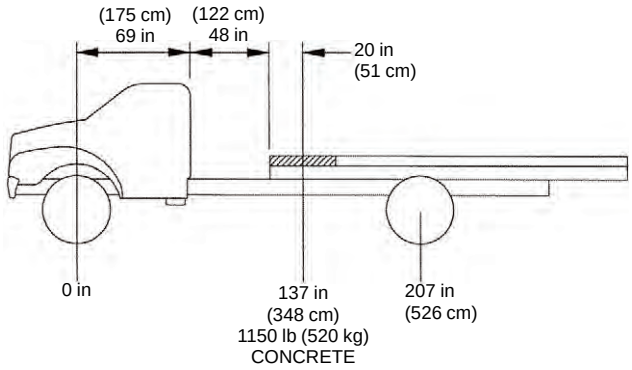
A typical truck is shown below with all the permanently attached equipment also shown. A Series 456 (B) crane will be mounted on this truck and a 180° stability working area around the rear of the truck is desired as in "Configuration 1" (See "Mounting Configuration" in Installation Section).



	Rear (Weight) x (Distance From Front Axle) / Wheel Base = Rear Axle Weight						Front Weight – Rear Axle Wt. = Front Axle Wt.					
	Rear Axle Weight						**Front Axle Weight**					
1. Initial front axle wt.	(4500) x 0 / 207	=	0 lb	*(2041) x 0 / 526*	=	*0 kg*	4500 - 0 =	4500 lb	*2041 - 0 =*		*2041 kg*	
2. Pump & PTO's	(150) x 60 / 207	=	43 lb	*(68) x 152 / 526*	=	*20 kg*	150 - 43 =	107 lb	*68 - 20 =*		*48 kg*	
3. Initial rear axle wt.	(3500) x 207 / 207	=	3500 lb	*(1588) x 526 / 526*	=	*1588 kg*	3500 - 3500 =	0 lb	*1588 - 1588 =*		*0 kg*	
4. Bed wt.	(1400) x 225 / 207	=	1522 lb	*(635) x 572 / 526*	=	*691 kg*	1400 - 1522 =	-122 lb	*635 - 691 =*		*-56 kg*	
5. Add front and rear axle wts.			5065 lb			*2299 kg*		4485 lb			*2033 kg*	
6. Compare with wt. required for this type of mount from "Mounting Configuration 1"			4600 lb			*2087 kg*		4800 lb			*2177 kg*	
Difference			**+465 lb**			***+212 kg***		**-315 lb**			***-144 kg***	

Reference Only

7. Two methods of counterweighting may be used: (A) a heavy front bumper and concrete in the bed or (B) concrete in the bed only. The easiest and most economical method is usually concrete in bed only. Use 1150 lb (520 kg) of concrete poured in the front of the bed. See "Counterweighting for 180° Stability" in this section.

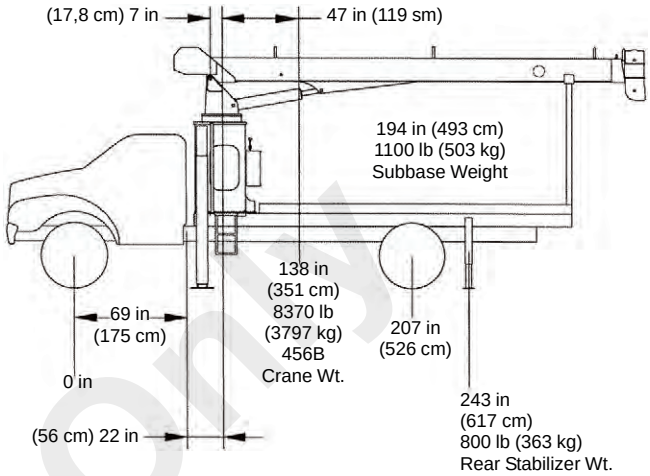


8. Determine axle weights added by the counterweight by using the same method as used before. Figure the center of the counterweight to determine where the weight acts. If the counterweight is oddly shaped, figure the center and weight of each regular shape. Weights ahead of the front axle require using a negative (-) distance in calculations.

	Rear Axle Wt.		Front Axle Wt.	
1150 lb (520 kg)	(1150) x 137 / 207	= 761 lb	(1150) - 761	= 389 lb
Bed Concrete	*(520) x 348 / 526*	= *344 kg*	*(520) - 344*	= *(176 kg)*
Required Counterweight		0 lb		315 lb
		0 kg		*144 kg*
Difference		**761 lb**		**74 lb**
		(344 kg)		***(34 kg)***

The rear axle weight is 1226 lb (556 kg) heavier than required and the front axle weight is 74 lb (34 kg) heavier than required.

9. Check the final weight of the unit with crane installed. See "Specifications Section" for weight of 4568 and center of gravity. Note that this weight does not include weight of rear ASH stabilizers [800 lb (363 kg)].



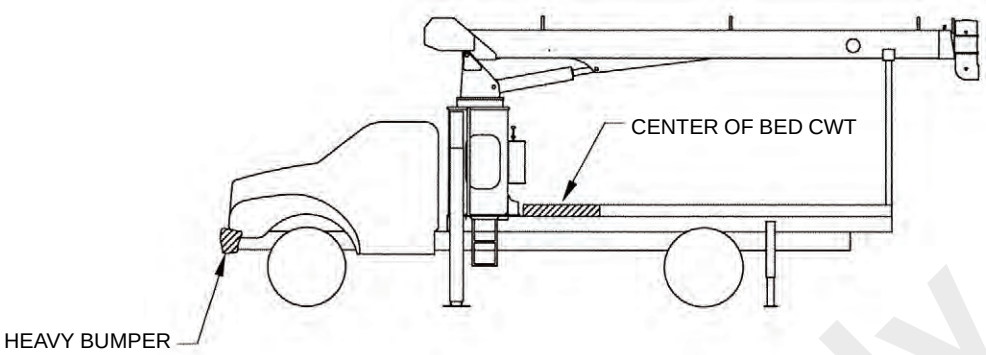
		Rear Axle Wt.		Front Axle Wt.
Base Unit		5065 lb		4485 lb
		2297 kg		*2034 kg*
Counterweight		761 lb		389 lb
		345 kg		*176 kg*
Add Crane Weight	8370 x 138 / 207	= 5580 lb	8370 - 5580	= 2790 lb
	3797 x 351 / 526	= *2534 kg*	*3797 - 2534*	= *1263 kg*
Rear Stabilizer Weight	800 x 243 / 207	= 939 lb	800 - 939	= -139 lb
	363 x 617 / 526	= *426 kg*	*363 - 426*	= *-63 kg*
Subbase Weight	111 0 x 194 / 207	= 1040 lb	1110 - 1040	= 70 lb
	503 x 491 / 526	= *471 kg*	*503 - 471*	= *32 kg*
Total		**13385 lb**		**7595 lb**
		6071 kg		***3445 kg***

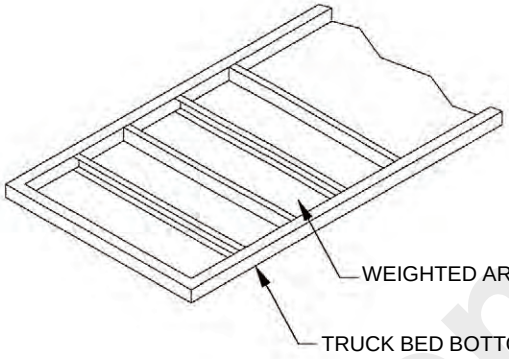
Check the final unit weight with a full load of diesel [@ 7.3 lb per gallon (0,87 kg per liter)] and men (@ 200 lb (90 kg) per man) to ensure that the axle ratings have not been exceeded so that DOT certification requirements can be met. After the unit is completely assembled, the stability test must be run in accordance with "Stability Test Procedure" page at the end of this section to verify crane stability.

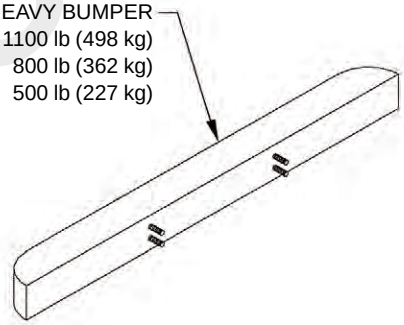
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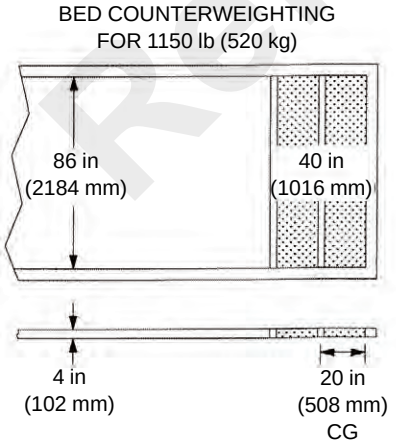
COUNTERWEIGHTING METHODS FOR STABILITY AROUND THE REAR 180°

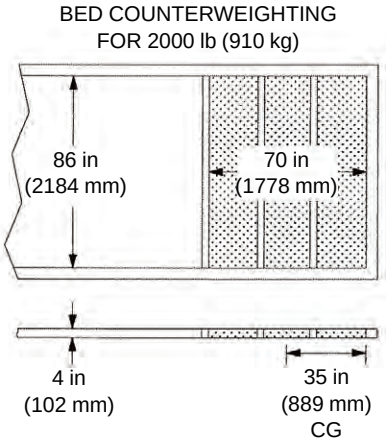
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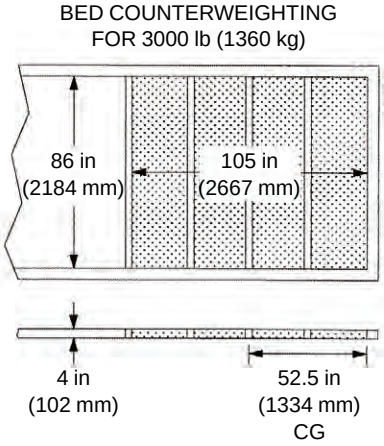






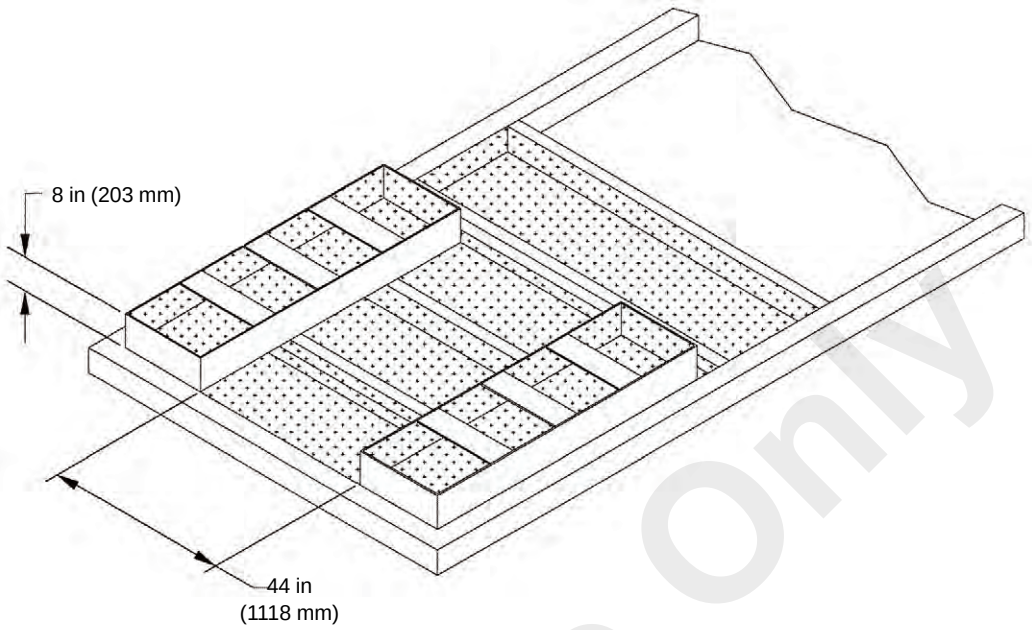






NOTE: SHADED AREAS INDICATE CONCRETE

Reference Only



The method shown above can be used to shift more weight to the front of the crane than the previous methods will. When using this method check for interference with hydraulic reservoir and truck tires. Bed attachment to truck should be planned in advance. If the bed is attached to torsion box by bolting through slots in torsion box, leave open area in concrete counterweight for hardware access. The weight of the concrete can be determined by multiplying the volume in cubic inches by 0.083 lb per cubic inch.

Example

Concrete poured in the bed measures 4 in (10,16 cm) deep by 86 in (218,44 cm) wide by 70 in (177,80 cm) long. The weight of the concrete is 4 x 86 x 70 x 0.083 = 2000 lb (907 kg). The center of this weight will be in the center of the concrete slab.

INITIAL CRANE RUN IN PROCEDURE

1. With the unit in an open area for testing that will permit full operation of all its functions, engage the PTO and run the truck engine at idle to activate the pump (approximately 600 rpm). Turn the crane power switch on and operate the crane and outriggers though all of their functions at least six (6) times to purge cylinders of air. Operate the control valves slowly with the truck engine at idle and cycle each cylinder through its complete stroke each time. Check to see that movement of outriggers and boom correspond with direction indicated on switches and levers. Refer to hydraulic or electrical schematic and parts pages to correct any problems.

   Note: Add oil to reservoir as required to keep air from reentering the system.

2. Set throttle according to engine RPM and PTO ratio to get 1850 RPM pump shaft speed.
3. When all cylinders have operated through complete cycles, stow crane and place the outriggers in the up position. The oil level should be visible between the two marks on the sight gauge.
4. Lift and stability test must now be performed on the unit. (See “Stability Test” page.) Hoist and crane tests should be conducted to insure proper performance.
5. After testing is completed, the mounting bolts and all cable clamp bolts should be retorqued to specifications.
6. Upon completion, overall height of crane vehicle combination must be measured and posted inside of cab informing driver of overall height.

BOOM RESTS

Before the mounting of a crane is complete, a boom rest must be installed. A rest must be supplied for transport to reduce vibratory stress on the crane and truck and protect rotation system from transient damage.

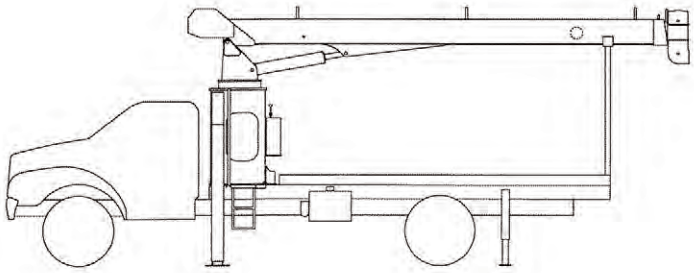
Below are shown configurations to meet application of the user. All of these configurations are available at your National distributor.

Reference Only

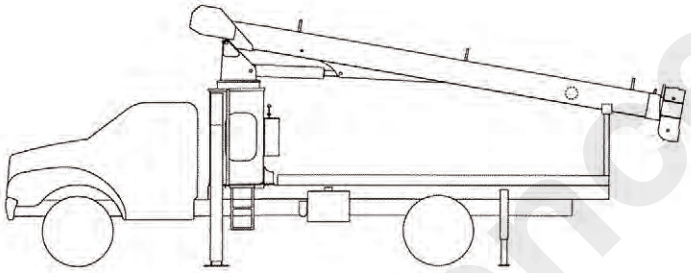
The loadline shall be hooked to some point on the bed, truck frame, etc. to secure the hook weight during transport. Install tie down point low enough to allow room for anti-two-block weight. Do not shorten chain.

The boom rest should be positioned to support the 1st section boom. Be careful to avoid contacting the boom at or near the end where the retract cables are located. Contact with these cables will result in costly repairs.

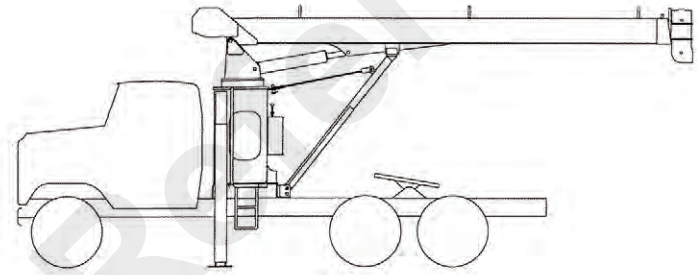
The boom rest saddle provided is designed to support the 1st section boom. It will be necessary to modify the saddle to make it narrower and reposition the support cushions under the boom side plates if the boom is extended to reach the boom rest.



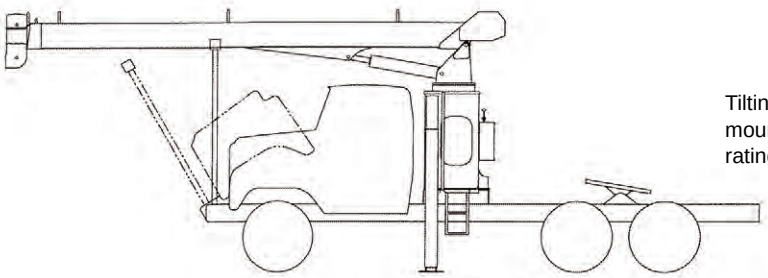
Horizontal rear bed mount or removable mount for greater load space



Low-profile rear bed mount for lower center or gravity



“A-frame” boom rest for tractor-trailer



Tilting or non-tilting tractor trailer front mount (requires higher front axle weight rating-consult factory)

Reference Only

STABILITY CHECK

The chassis weight, before the crane is mounted, is intended for use only as a guideline in determining the total weight required for the unit to be stable with an 85% tipping factor (i.e. when lifting capacity load, the unit is at 85% of tipping or less).

In order to ensure the stability of the unit with an 85% tipping factor, a live load stability test must be performed on each completed unit. Proceed as follows:

1. Test the unit for stability on a firm level surface.
2. A Series 400B crane requires rear stabilizers for stability. With the boom stowed, set the unit up level on the outriggers and stabilizers.
3. When stability testing this unit, select the load from the capacity chart that is listed at the longest boom extension and approximately 30° of boom elevation.

Model	Boom Length	Loaded Angle	Loaded Radius
428B	28 ft (8,53 m)	29°	25 ft (7,62 m)
437B	37 ft (11,28 m)	21°	35 ft (10,67m)
446B	46 ft (14,02 m)	31°	40 ft (12,19m)
456B	56 ft (17,07 m)	29°	50 ft (15,24 m)

The stability test load will be 1.18 times the load chosen from the load rating area of the capacity chart.

Example: 456B WITH NO JIB
Boom Length: 56 ft (17,07 m)
Loaded Radius: 50 ft (15,24 m)
Load Rating: 1500 lb (680 kg)
Stability Test Load: 1.18 x 1500 lb (680 kg) = 1770 lb (802 kg)
(Includes weights of slings and down haul blocks.)

Be sure the stability test weight is accurate. A 1% increase in stability test weight will mean up to a 10% increase in counterweight. Extend the boom to the maximum boom length and hoist the stability load off the ground. Slowly boom the load down so the load will swing out, until the loaded radius is reached. As the boom is lowered keep hoisting the load up to keep it about 6 inches off the ground.
Do not exceed loaded radius.
Slowly rotate the boom throughout the work area. As the boom is rotated, the boom will have to be raised and/or lowered to maintain the loaded radius because of subbase flexure.
On units not equipped with front stabilizers, tipping from stabilizer support to front wheel support will occur as the load or boom is swung around the front. Use caution and proceed slowly when this situation occurs.

Note: This does not apply to cranes equipped with a rear mount configuration.

Note: Weights of accessories installed on the boom or loadline (including downhaul weight) must be deducted from the calculated load when checking stability.

4. If slight tipping occurs, but load can be kept from - coming in contact with ground by hoisting the load up, unit is stable. If not, counterweighting will have to be added to get unit in a stable condition or decal must be added to define areas of full stability and areas of reduced capacity because of stability. If the unit is equipped with a jib, the stability test should be repeated. Use the fully extended jib capacity multiplied times 1.18 at the lowest angle that the jib is rated fully extended.
5. When adding counterweight to the vehicle, it is usually most effective when added as close to the crane as possible. After adding counterweight, the above procedure must be repeated to insure the added counterweight is adequate.
6. If unit is not stable 360° around the truck, a decal must be added showing the working area according to stability.

OPTIONAL CROSS FRAME OUTRIGGER INSTALLATION

1. See outrigger parts pages in “Outrigger and Stabilizer” section. Locate the outriggers on the truck frame directly in front of the torsion box and centered on the truck frame.
2. Weld plates between the free edges of both truck frame rails centered at the point directly over the outrigger to prevent the free edges from collapsing when the stabilizers are bolted on. See installation drawing for location of plates and weld callout.
3. With the outrigger legs fully retracted, raise the legs into position so that there is approximately 14 in clearance between the bottom of the leg pads and the ground. This will give 10 in of penetration with the 24 in stroke leg cylinder. See installation drawing for weld callouts.
4. Install the three spanner plates and four studs per side with one plate above the outrigger, one below the truck frame, and the third thinner spanner plate in between the outrigger box and the truck frame. (See Outrigger and Stabilizer Section of Illustrated Parts Catalog for Illustration). Torque 1 in-14 UNS studs to 450 lb-ft.
5. Connect hydraulic lines to the appropriate control valve sections and check that operation agrees with.

Reference only

Reference Only

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