Supplement to Service Manual

Boom Cable Tensioning

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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

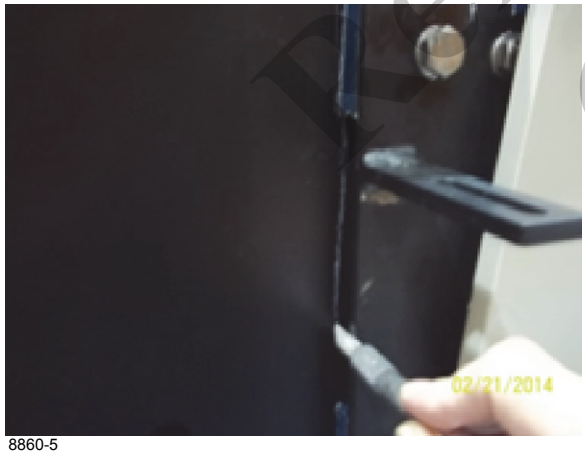
Tensioning Setup Procedure

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.



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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

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

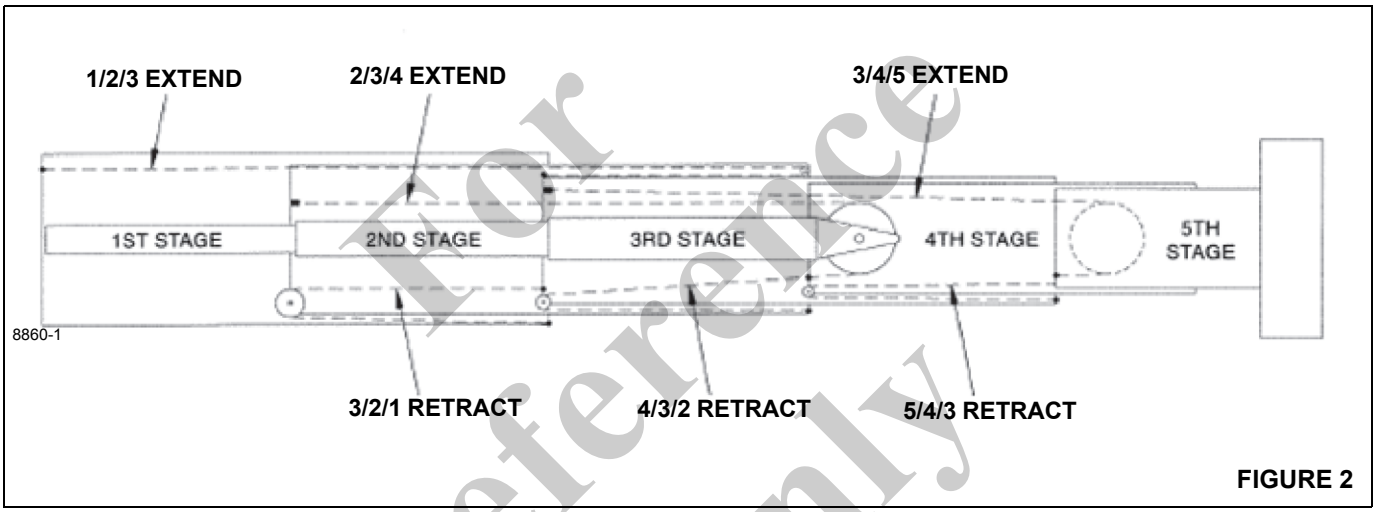


FIGURE 2

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.

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.

4- Section Boom w/ 2 Stage Cylinder Cable Positioning

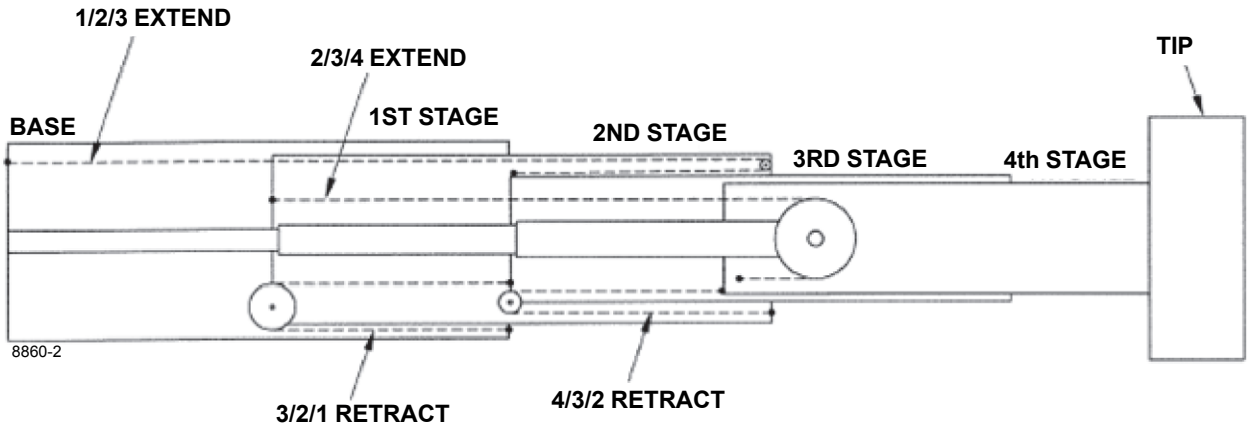


FIGURE 3

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.

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

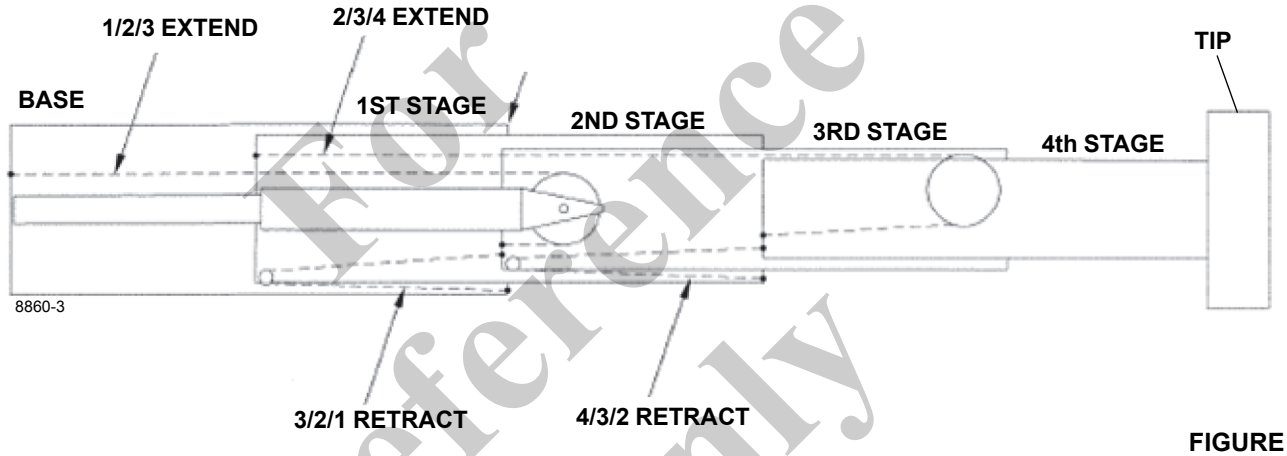


FIGURE 4

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.

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

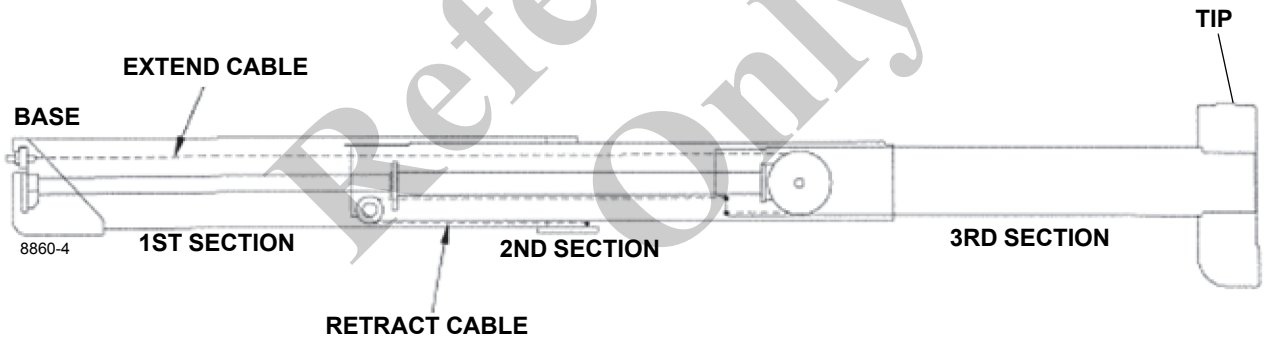


FIGURE 5

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.

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.

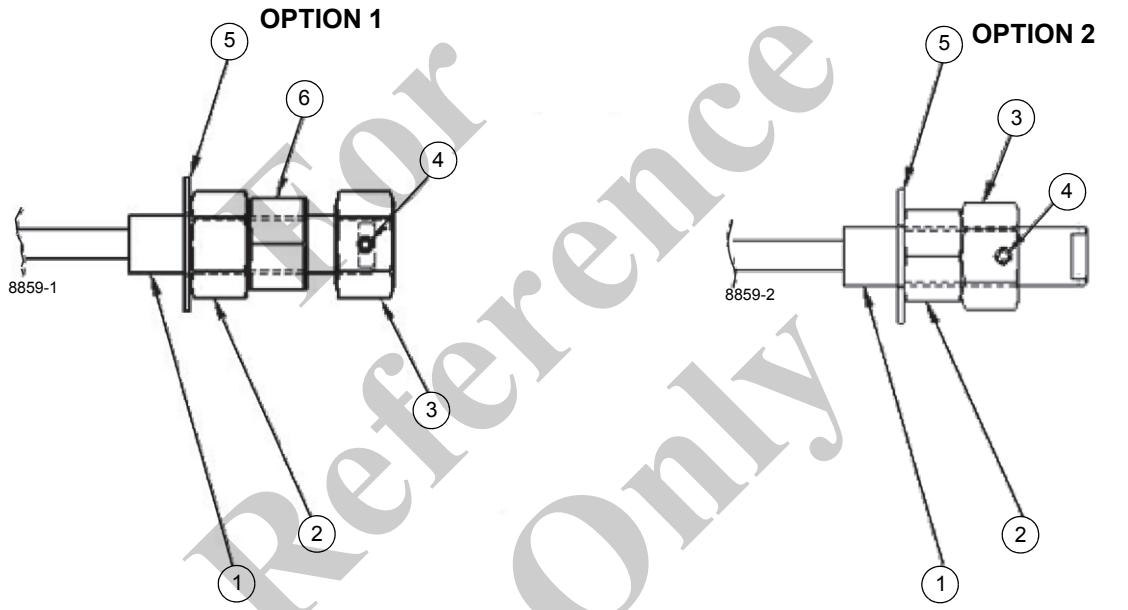


FIGURE 6

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:

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

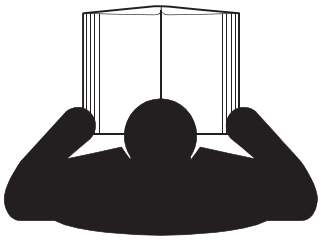
Metric Series with Coarse Threads

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

OPERATOR MANUAL

Supplement

Crane Warm-up Procedures



⚠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

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.

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.

National Crane 1400H

OPERATOR AND SERVICE MANUAL

Manitowoc

WARNING

California Proposition 65

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

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

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

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

California Spark Arrestor

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

The original language of this publication is English.

NATIONAL CRANE
by Manitowoc

OPERATOR AND SERVICE MANUAL

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

1400H

This Manual is Divided into the following Sections:

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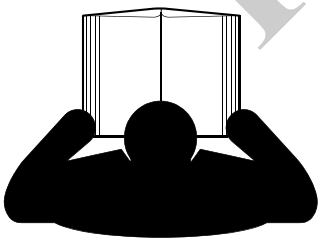
NOTICE

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 crane frame. ***Always furnish crane serial number*** when ordering parts or communicating service problems with your distributor or the factory.



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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 Manual and Load Chart are in the holder provided on crane.

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SECTION 1
SAFETY INFORMATION

SECTION CONTENTS

SAFETY MESSAGES

General

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

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 INFORMATION

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

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

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

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

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

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

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

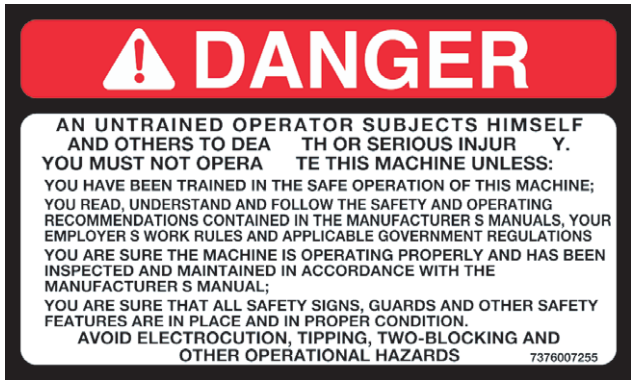
OPERATOR QUALIFICATIONS

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

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

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

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



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

You must not operate this machine unless:

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

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

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

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

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

OPERATIONAL AIDS

Operational aids are accessories that provide information to facilitate operation of a crane or that take control of particular functions without action of the operator when a limiting condition is sensed, as stated in the latest revision of the

ASME B30.5 and ASME B30.8 standards. Examples of such devices include, but are not limited to, the following: anti-two-block device, rated capacity indicator, rated capacity limiter, boom angle or radius indicator, boom length indicator, crane level indicator, hoist drum rotation indicator, load indicator, and wind speed indicator.

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

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

Rated Capacity Limiter (RCL) Systems (If Equipped)

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

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

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

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

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

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

Anti-Two-Blocking Device

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

Two-blocking occurs when the load block (hook block, headache ball, rigging, etc.) comes into physical contact with the boom (boom nose, sheaves, 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 107 cm (42 in) below the boom nose at all times.

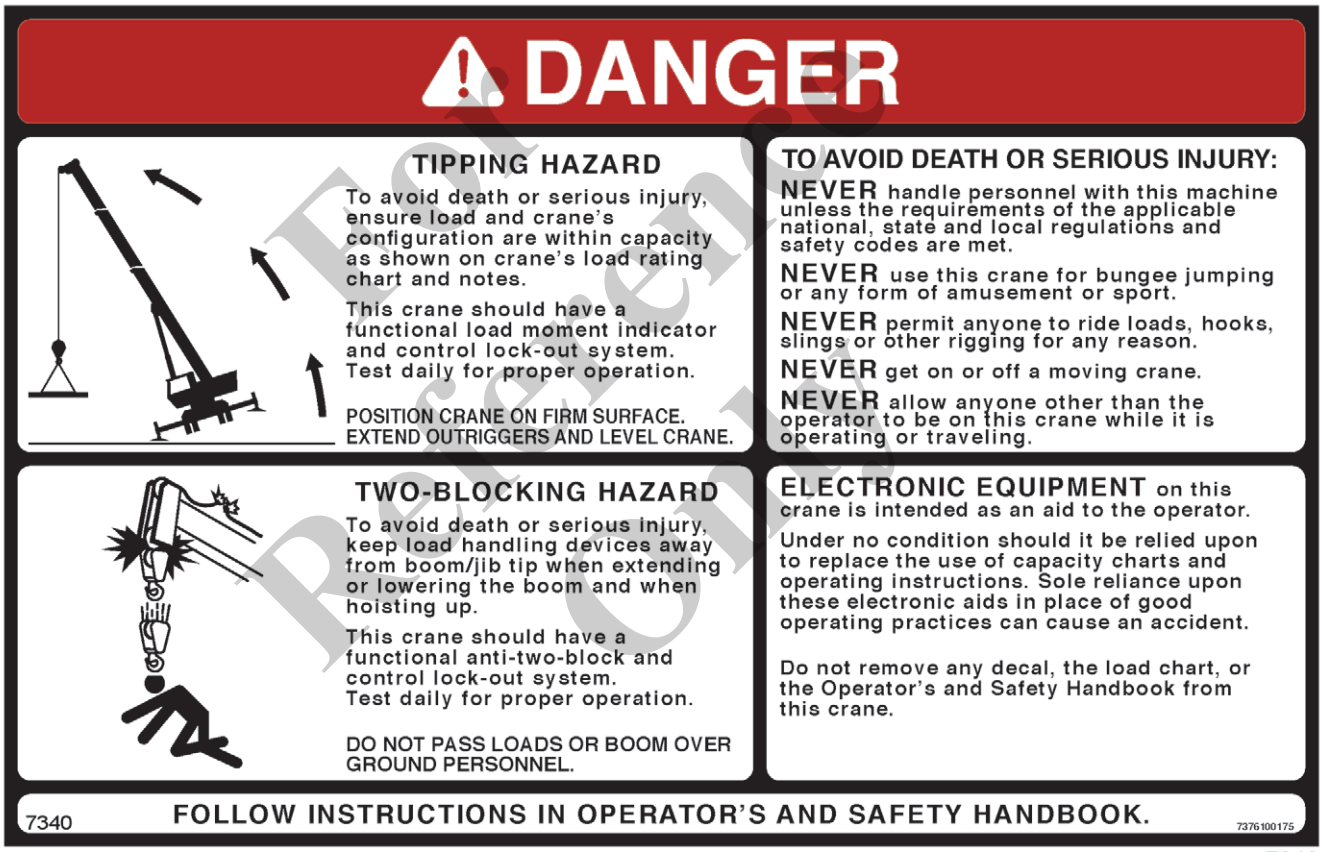
Two-blocking can be prevented. Operator awareness of the hazards of two-blocking is the most important factor in preventing this condition. An Anti-Two-Block System is intended to assist the operator in preventing dangerous two-block conditions. It is not a replacement for operator awareness and competence.

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

Working Area Limiter (If Equipped)

This crane may be equipped with a working area limiter as part of the RCL system, designated as either Work Area Definition System (WADS) or Working Range Limiter (WRL). You must read and understand the operator manual before operating the working area limiter system. Become familiar with all proper operating procedures and with the identification of symbol usage.

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



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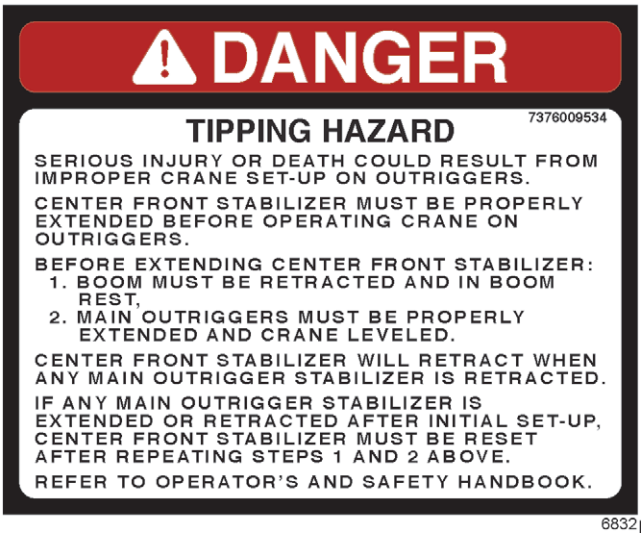
CRANE STABILITY/STRUCTURAL STRENGTH

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

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

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

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



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

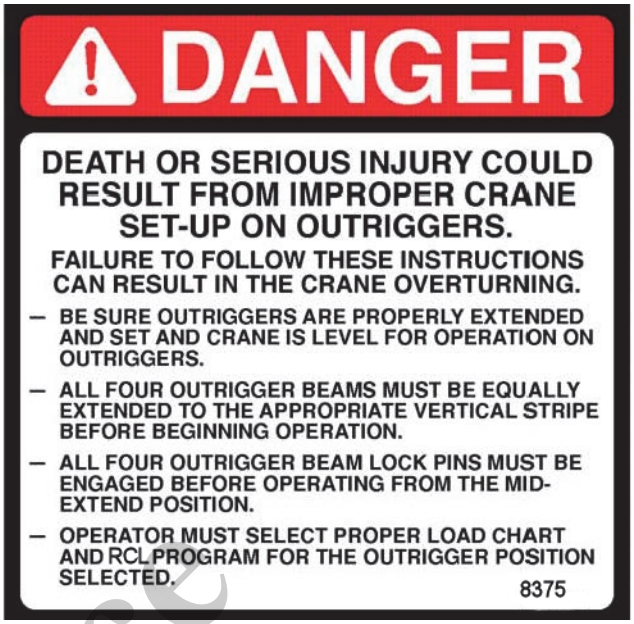
The operator must select the proper *Load Chart* and Rated Capacity Limiter (RCL) System program for the outrigger position selected.

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

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

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

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



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

Load Charts

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

Load Chart capacities are based on freely suspended loads.

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

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

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

Work Site

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

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

Wind Forces

Wind can have a significant effect on loads that may be lifted by a crane. Wind forces act differently on a crane depending

upon the direction from which the wind is blowing (e.g., wind on the rear of the boom can result in decreased forward stability, wind on the underside of the boom can result in decreased backward stability, wind on the side of the boom can result in structural damages, etc.). 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 Beaufort Wind Scale

Wind Force		Wind Velocity km/h (mph)	Visible Indicator Effects of wind as observed on land
Beaufort Scale	Designation		
Zero (0)	Calm	less than 1 (<1)	Calm; smoke rises vertically
1	Light Air	1.1-5.5 (1-3)	Smoke drift indicates wind direction. Leaves and wind vanes are stationary.
2	Light Breeze	5.6-11 (4-7)	Wind felt on exposed skin. Leaves rustle. Wind vanes begin to move.
3	Gentle Breeze	12-19 (8-12)	Leaves/small twigs constantly moving. Light flags extended.
4	Moderate Breeze	20-28 (13-17)	Dust and loose paper raised. Small branches begin to move.
Reduce crane load ratings and operating parameters at 32 km/h (20 mph)			
5	Fresh Breeze	29-38 (18-24)	Branches of a moderate size move. Small trees in leaf begin to sway.
6	Strong Breeze	39-49 (25-30)	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic bins tip over.
Cease all craning operations at 48 km/h (30 mph); lower & retract boom			
7	Moderate Gale	50-61 (31-38)	Whole trees in motion. Effort needed to walk against the wind.

Lifting Operations

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

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

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

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

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

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

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

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

The crane can tip over or fail structurally if:

- The load and crane's configuration is not within the capacity as shown on the applicable *Load Chart* and notes.

- The ground is soft and/or the surface conditions are poor.
- Outriggers are not properly extended and set. On models equipped with outriggers that can be pinned at the mid-extend position, the outriggers must also be pinned when operating from the mid-extend position.
- Cribbing under the outrigger pads is inadequate.
- The crane is improperly operated.

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

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

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

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

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

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

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

Never push or pull with the crane boom.

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

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 OCT90 "Cranes Stability Test Code." An outrigger pad may lift off the ground during operation of the crane within the capacity limits of the *Load Chart*, yet the crane will not have reached instability. The "balance point" for stability testing according to SAE and Manitowoc criteria is a condition of loading wherein the load moment acting to overturn the crane is equal to the maximum moment of the crane available to resist overturning. This balance point or point of instability for a crane does not depend on "lifting" of an outrigger but rather on comparison of the "opposing" load moments.

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

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

Multiple Crane Lifts

Multiple crane lifts are not recommended.

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

- Secure the services of a designated person to direct the operation.
- Use one qualified signal person.
- Coordinate lifting plans with the operators, designated person, and signal person prior to beginning the lift.
- Maintain communication between all parties throughout the entire operation. If possible, provide approved radio equipment for voice communication between all parties engaged in the lift.
- Use outriggers on cranes so equipped.
- Calculate the amount of weight to be lifted by each crane and attach slings at the correct points for proper weight distribution.

- Ensure the load lines are directly over the attach points to avoid side loading and transfer of loading from one crane to the other.
- Do not travel. Lift only from a stationary position.

PILE DRIVING AND EXTRACTING

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

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

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

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

- All pile driving and extracting operations shall be restricted to fully extended outriggers with all tires clear of the ground.
- The combined weight of the driver or extractor, piling, leads, attachments, etc., shall not exceed 80% of the published load chart values for on-outriggers operation.
- The pile driver or pile extractor and attachments shall be kept clear of the boom nose at all times.
- The pile driver and piling shall be suspended from a hoist cable with sufficient line speed to meet or exceed the rate of descent of the driver and piling to preclude impact loading or vibration from being induced into the boom and crane structure.
- Pile driving or extracting shall be restricted to over the main boom only and shall not be permitted over a boom extension or jib.
- Pile extraction using only the crane's hoist line is unsafe and not permitted since load values cannot be accurately determined. Only pile extraction devices that do not transmit vibration or shock loading into the crane are permitted. All possible precautionary measures shall be taken to prevent shock loads or vibration from being imposed on crane components, either directly through the hoist cable or indirectly from ground borne vibration.
- The load lines shall be kept vertical at all times during pile driving and pile extraction operations.
- The operator and other personnel associated with the pile driving and pile extraction operation shall have read and understood all safety standards applicable to crane operations as well as being thoroughly trained in the safe operation of pile driving and extracting equipment.

Crane Equipment

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

Crane Inspection

- In addition to the crane's frequent and periodic inspections, dated daily records shall be maintained showing inspections were performed on the crane during the time it was used for pile driving or extraction.
- All anti-two block warning devices and RCL systems shall be inspected daily and verified to be functional.
- All areas of the crane subject to fatigue shall be inspected monthly, and before the crane is to return to lifting service.
- The boom shall be inspected daily to ensure all wear pads remain in place. Cranes which utilize pinned boom sections shall be inspected daily to ensure the pinning mechanism operates properly and to check for undue wear at the pins and pinning plates. The hoist cable shall be inspected daily to ensure no chafing or wear is occurring.

ELECTROCUTION HAZARD

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

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

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.

WARNING

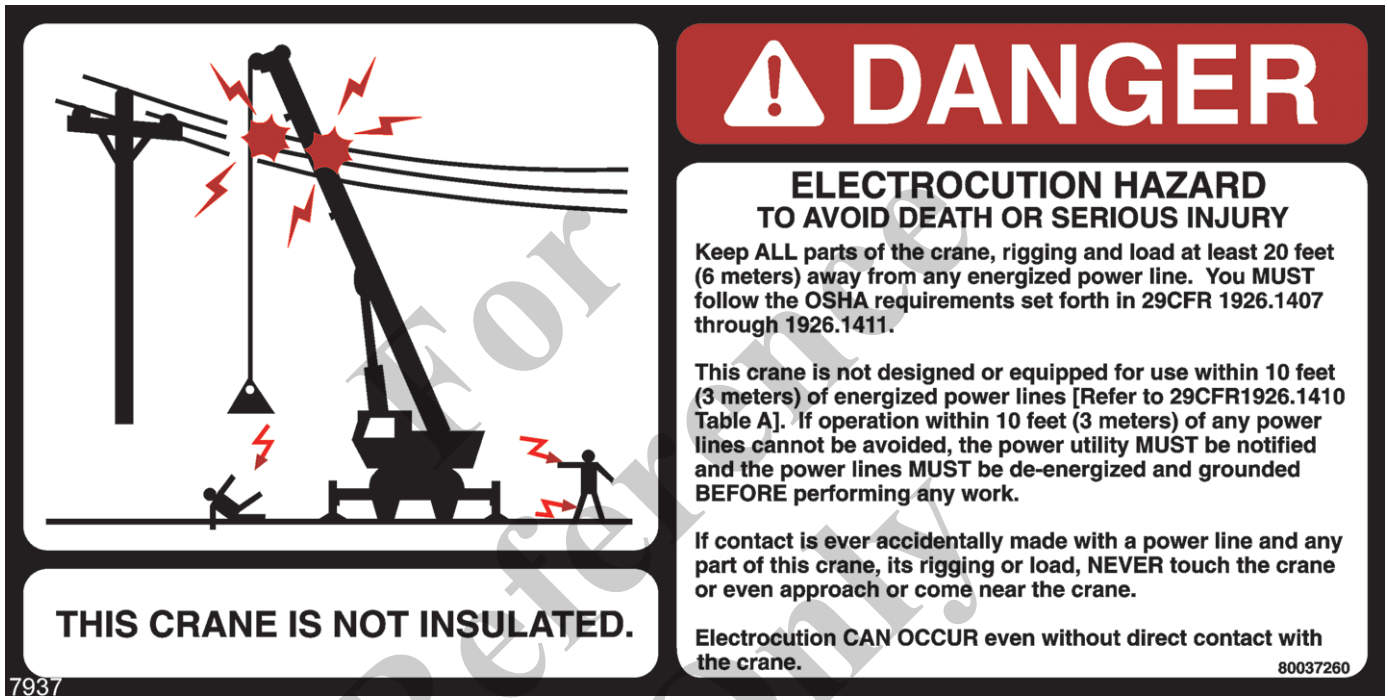
Electrocution Hazard!

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 m (10 ft) of any power lines cannot be avoided, the power utility **must** be notified and the power lines **must** be de-energized and grounded **before** performing any work.

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

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



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 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.

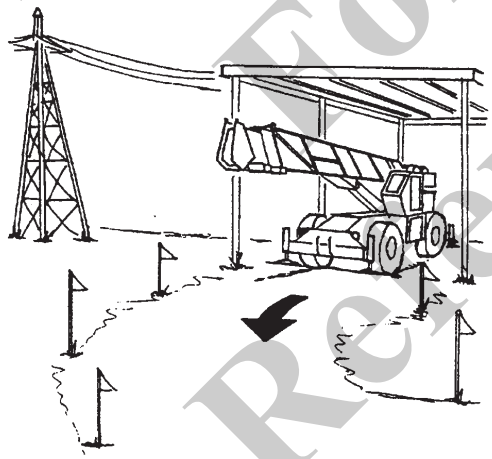
Set-Up and Operation

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.

Electrical Contact

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

1. Stay in the crane work station. **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 B30.23-2011:

> This Volume establishes the design criteria, equipment characteristics, and operational procedures that are required when hoisting equipment within the scope of the ASME B30 Standard is used to lift personnel. Hoisting equipment defined by the ASME 830 Standard is intended for material handling. It is not designed, manufactured, or intended to meet the standards for personnel handling equipment, such as ANSI/SIA A92 (Aerial Platforms). The equipment and implementation requirements listed in this Volume are not the same as that established for using equipment specifically designed and manufactured for lifting personnel. Hoisting equipment complying with the applicable Volumes of the ASME B30 Standard shall not be used to lift or lower personnel unless there are no less hazardous alternatives to providing access to the, area where work is to be performed. The lifting or lowering of personnel using ASME B30-compliant hoisting equipment is prohibited unless all applicable requirements of this volume have been met.

This new standard is consistent with the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) regulations for Construction that state, in 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*, ASME B30.8, *Floating Cranes and Floating Derricks,* 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.
- 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 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. 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 a 5% reduction in the original wire diameter.
- Any kinking, bird caging, crushing, corrosion, or other damage resulting in distortion of the rope structure.
- Rope that has been in contact with a live power line or has been used as a ground in an electric circuit (eg. welding) may have wires that are fused or annealed and must be removed from service.
- In standing ropes, more than three (3) breaks in one rope lay in sections beyond the end connection or more than two (2) broken wires at an end connection.
- Core deterioration, usually observed as a rapid reduction in rope diameter, is cause for immediate removal of the rope.

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

- Wire ropes wear out. The strength of a wire rope begins to decrease when the rope is put to use and continues to decrease with each use. Wire rope will fail if worn-out, overloaded, misused, damaged or improperly maintained.
- The nominal strength, sometimes called catalog strength, of a wire rope applies only to a new, unused rope.
- The nominal strength of a wire rope should be considered the straight line pull which will actually break a new unused rope. The nominal strength of a wire rope should never be used as its working load.
- Each type of fitting attached to a wire rope has a specific efficiency rating which can reduce the working load of the wire rope assembly or rope system.

- Never overload a wire rope. This means never use the wire rope where the load applied to it is greater than the working load determined by the rope manufacturer.
- Never “shock load” a wire rope. A sudden application of force or load can cause both visible external and internal damage. There is no practical way to estimate the force applied by shock loading a rope. The sudden release of a load can also damage a wire rope.
- Lubricant is applied to the wires and strands of a wire rope when it is manufactured. The lubricant is depleted when the rope is in service and should be replaced periodically. Refer to the *Service Manual* for more information.
- In the U.S.A., regular inspections of the wire rope and keeping of permanent records signed by a qualified person are required by OSHA for almost every wire rope application. The purpose of the inspection is to determine whether or not a wire rope may continue to be safely used on the application. Inspection criteria, including number and location of broken wires, wear and elongation, have been established by OSHA, ANSI, ASME and similar organizations. See the *Service Manual* for inspection procedures.

  When inspecting wire ropes and attachments, keep all parts of your body and clothing away from rotating hoist drums and all rotating sheaves. Never handle the wire rope with bare hands.

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

  - Sheaves that are too small, worn or corrugated cause damage to a wire rope.
  - Broken wires mean a loss in strength.
  - Kinks permanently damage a wire rope and must be avoided.
  - Wire ropes are damaged by knots. Wire rope with knots must never be used.
  - Environmental factors such as corrosive conditions and heat can damage a wire rope.
  - Lack of lubrication can significantly shorten the useful life of a wire rope.
  - Contact with electrical wires and resulting arcing will damage a wire rope.
- An inspection should include verification that none of the specified removal criteria for this usage are met by checking for such things as:
  - Surface wear; nominal and unusual.
  - Broken wires; number and location.
  - Reduction in diameter.
  - Rope stretch (elongation).
  - Integrity of end attachments.
  - Evidence of abuse or contact with another object.
  - Heat damage.
  - Corrosion.

NOTE: A more detailed wire rope inspection procedure is given in the *Service Manual*.

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

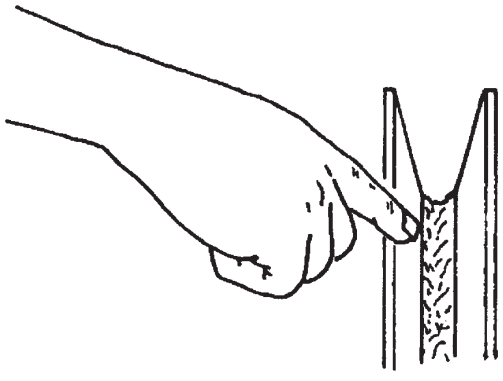
When installing a new rope:

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

When using a wedge socket:

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

Sheaves



Inspect the boom nose and hook block sheaves for proper operation, excessive wear, and damage every 50 hours or

weekly. Inoperable, damaged and/or worn sheaves cause rapid deterioration of wire rope.

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

To attain maximum wire rope life and minimize hook block rotation, it is recommended that even numbers of parts-of-line be used in multiple-part reeving whenever possible.

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

NOTE: The use of cast nylon (polyamide) sheaves will substantially increase the service life of 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.

Do not use the dead end lug on the boom nose for tying down the boom during transport. Damage to the lug and boom can result from usage as a tie down point.

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

Either the hook block may be reeved over the main boom nose or the headache ball may be reeved over the main boom nose or auxiliary boom nose; the other must be removed. If the hook block or headache ball remains reeved on the boom, it must be secured at the tie down on the carrier to prevent swinging.

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

exercised anytime any crane function is being performed while the cable is hooked into the hookblock tie down.

TRAVEL OPERATION

Only the crane operator shall occupy the crane when traveling.

When traveling, the boom should be completely retracted and lowered to the travel position and the turntable pin swing lock 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 operations.

Traveling at high speeds, especially on rough ground, may create a bouncing effect that can result in loss of control. If bouncing occurs, reduce travel speed.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Stay alert at the wheel.

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

Slopes:

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

WORK PRACTICES

Personal Considerations

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

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

Crane Access

WARNING

Fall Hazard!

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

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

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

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

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

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

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

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

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

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

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

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

Job Preparation

Before crane use:

- Barricade the entire area where the crane is working and keep all unnecessary personnel out of the work area.
- Ensure that the crane is properly equipped including access steps, covers, doors, guards, and controls.
- Conduct a visual inspection for cracked welds, damaged components, loose pins/bolts, and wire connections. Any item or component that is found to be loose or damaged (broken, chipped, cracked, worn-through, etc.) must be repaired or replaced. Inspect for evidence of improper maintenance (consult your *Service Manual*).
- Check for proper functioning of all controls and operator aids (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 Manual* when extending or retracting the outriggers. Death or serious injury could result from improper crane set up on outriggers.

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

Working

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

Know the location and function of all machine controls.

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

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

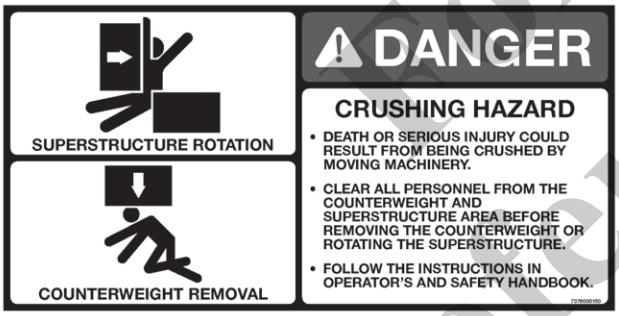
Carbon monoxide fumes from the engine exhaust can cause suffocation in an enclosed area. Good ventilation is very important when operating the crane.

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

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

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

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



Keep unauthorized personnel clear of the working area during operation.

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

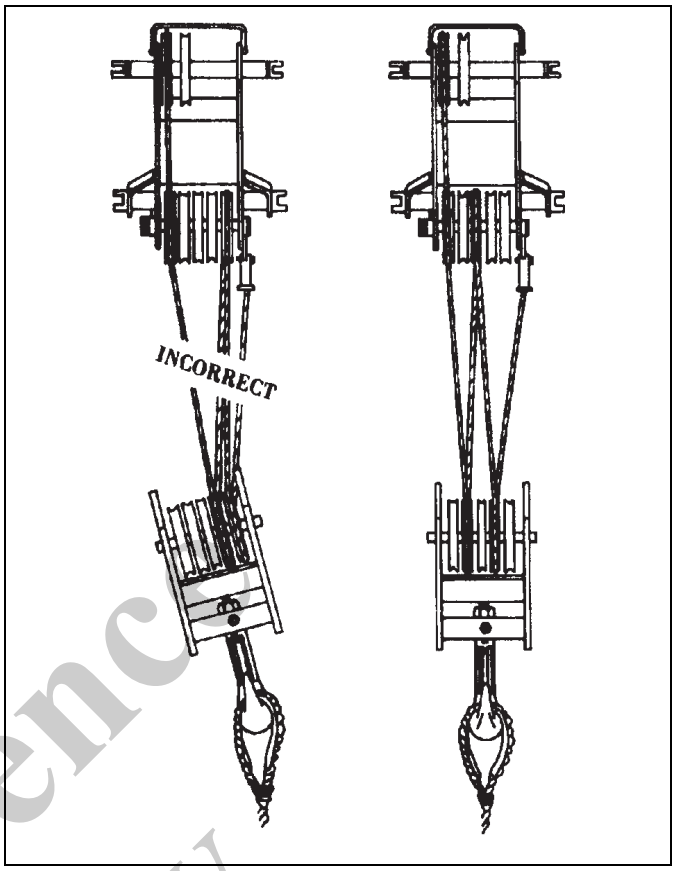
You must always be aware of everything around the crane while lifting or traveling. If you are unable to clearly see in the direction of motion, you must post a look out or signal person before moving the crane or making a lift. Sound the horn to warn personnel

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

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

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

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



Lifting

Use enough parts of line for all lifts and check all lines, slings, and chains for correct attachment. To obtain maximum lifting capacities, the hook block must be set up with enough parts of line. Too few parts of line can result in failure of the wire rope or hoist. **No less than three wraps** of wire rope should remain on the hoist drum. When slings, ties, hooks, etc., are used, make certain they are correctly positioned and secured before raising or lowering the loads.

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

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

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

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

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

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

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

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

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

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

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

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

Stop the hook block from swinging when unhooking a load.

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

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

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

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

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

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

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

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

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

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

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

Hand Signals

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

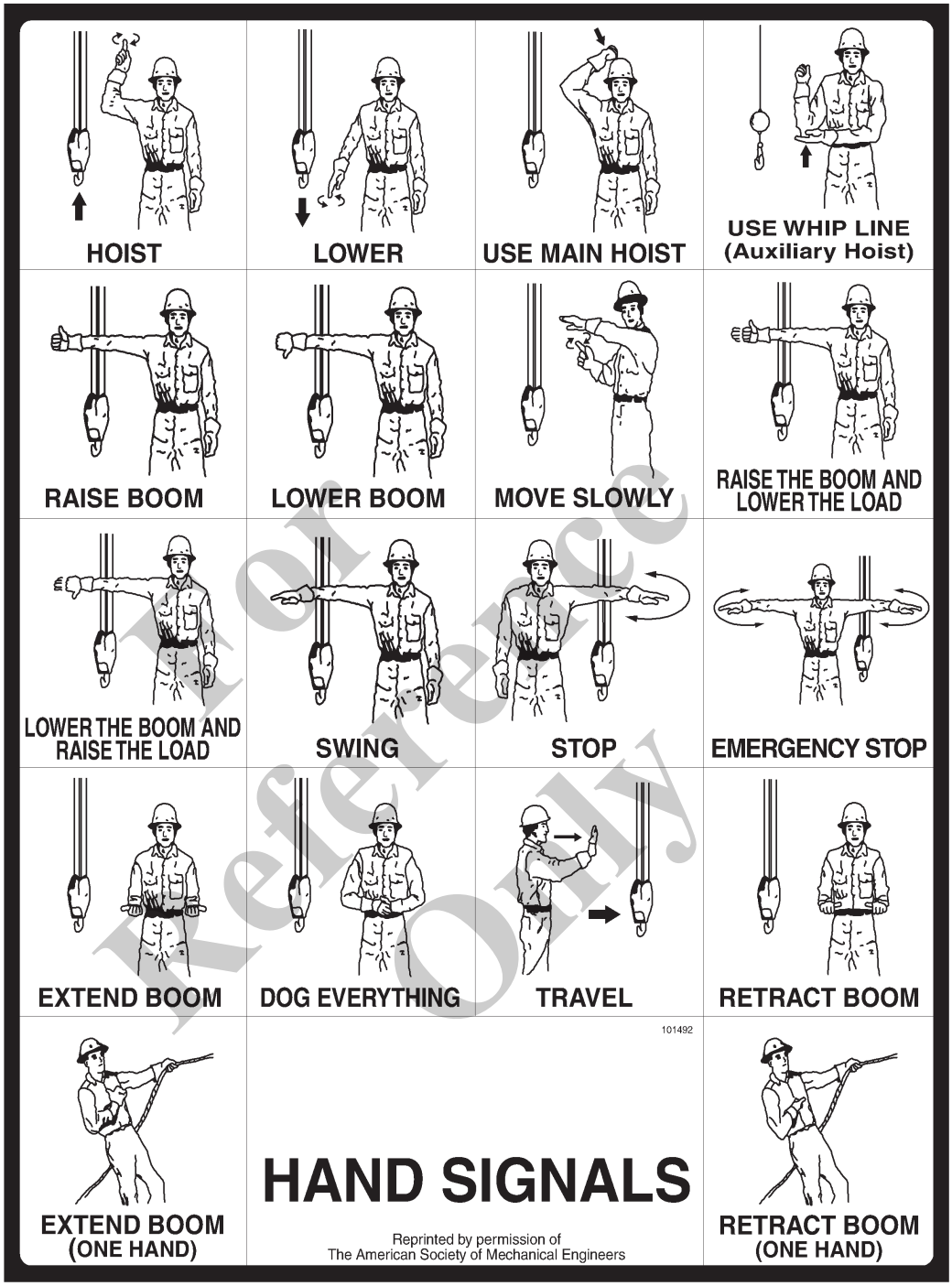
- Working in the vicinity of power lines.
- The crane operator cannot clearly see the load at all times.
- Moving the crane in an area or direction in which the operator cannot clearly see the path of travel.

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

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

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

Obey a signal to stop from anyone.



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.

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 82°C (180°F). Craneblock Working Load Limit is valid between 82°C (180°F) and service temperature given on the identification tag with normal lifting precautions.

Additional lifting precautions are required below the service temperature given on the identification tag because cold temperature begins to affect the 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°C (-40°F), must (be) done at a slow and steady rate to avoid stress spikes common in normal hoisting dynamics.

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

TEMPERATURE EFFECTS ON HYDRAULIC CYLINDERS

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

The change in the length of a cylinder is proportional to the extended length of the cylinder and to the change in temperature of the oil in the cylinder. For example, a cylinder extended 7.6 m (25 ft) in which the oil cools 15.5°C (60°F) would retract approximately 196 mm (7 3/4 in) [see Table 1-2]. A cylinder extended 1.5 m (5 ft) in which the oil cools 15.5°C (60°F) would only retract approximately 38 mm (1 1/2 in). The rate at which the oil cools depends on many factors and will be more noticeable with a larger difference in oil temperature verses the ambient temperature.

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

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

This situation will also occur in reverse. If 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.

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

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

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

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.

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

WARNING

Overload Hazard!

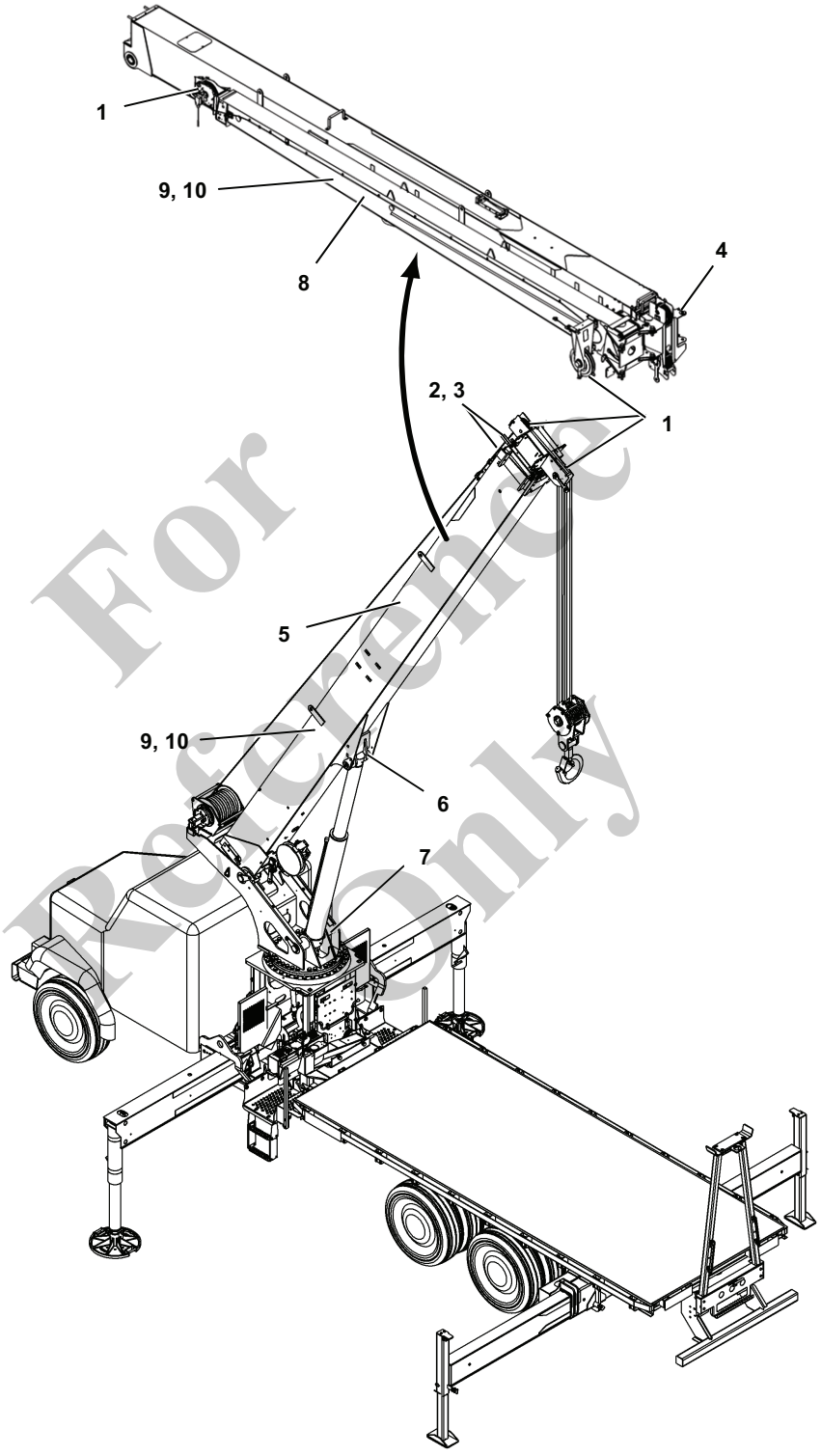
To avoid an accident caused by overload damage to your crane:

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

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

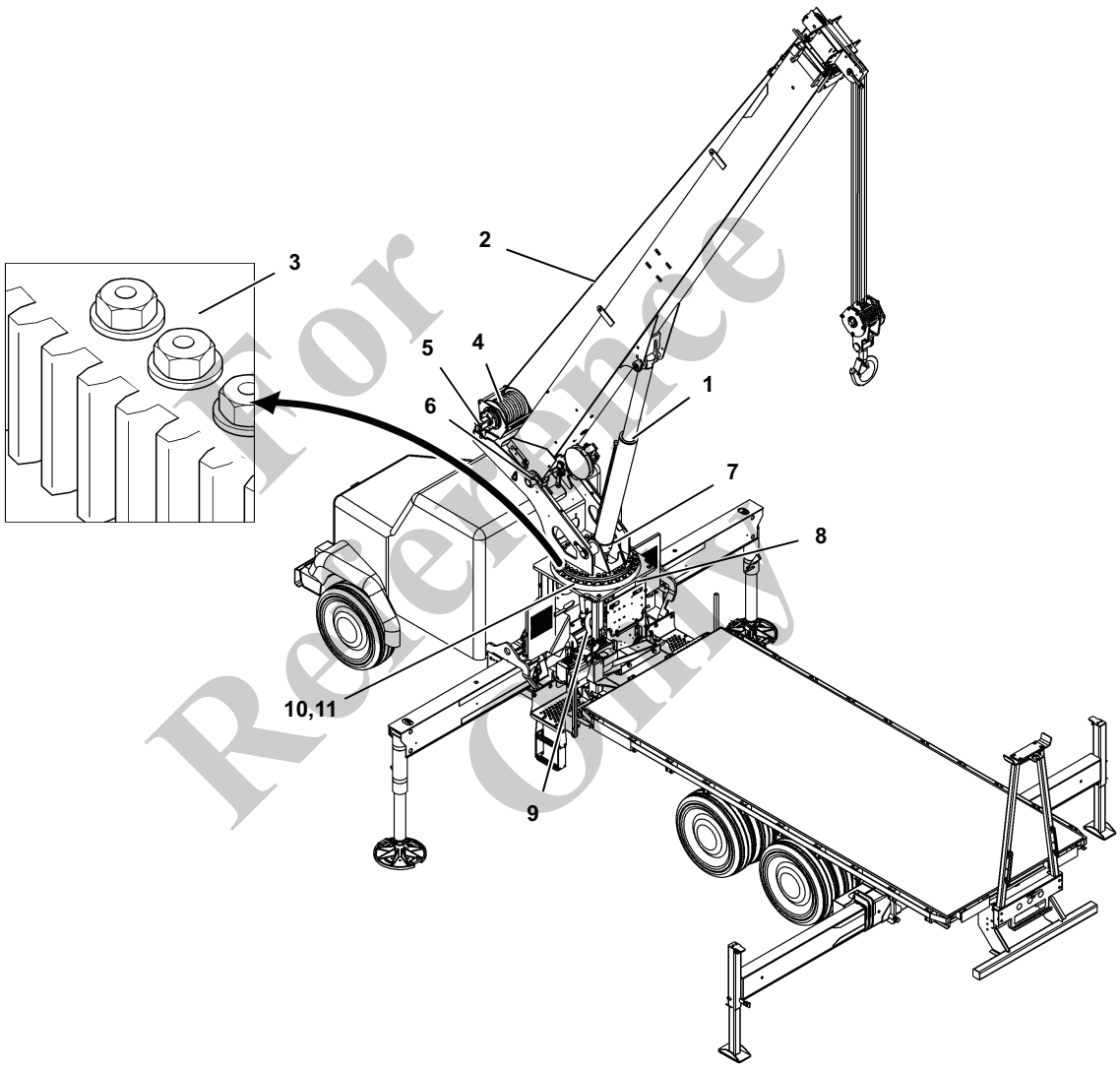
Overload warnings do NOT indicate real time events! Warnings could be sent 24 hours (or more) after the actual event.

Boom Inspection



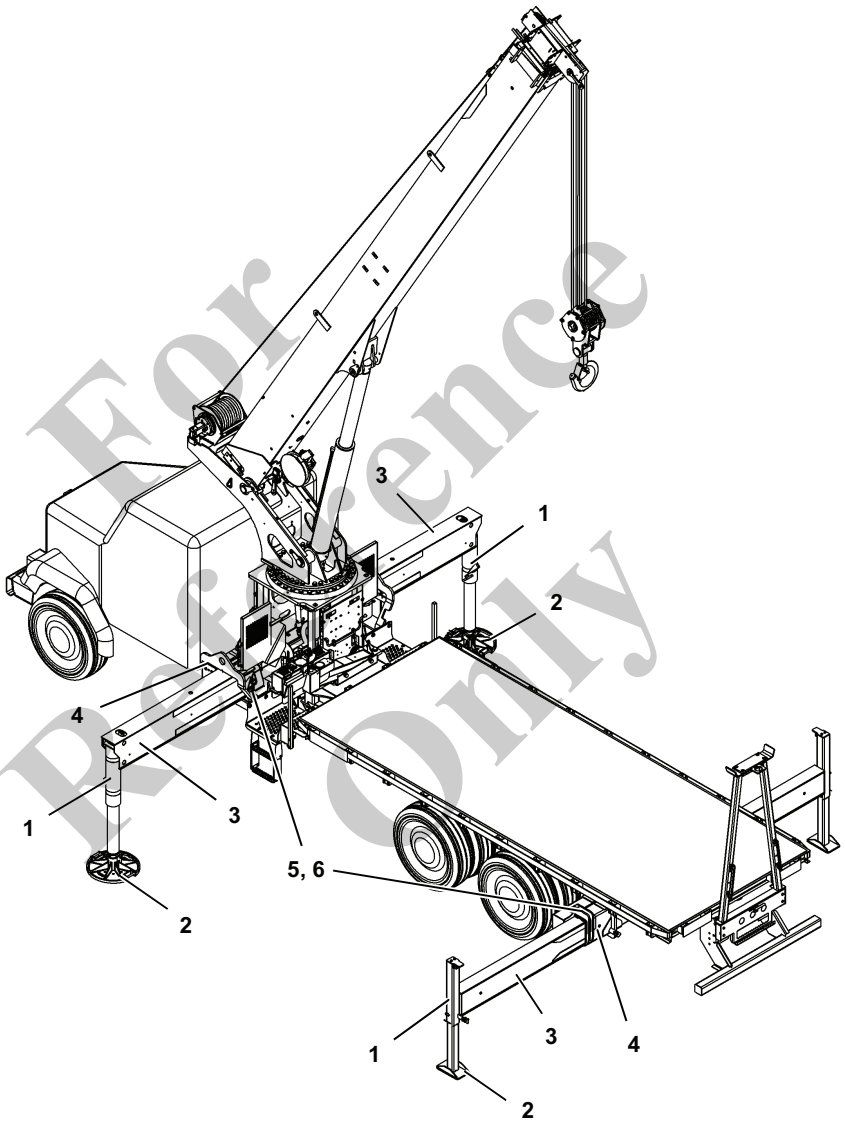
Overload less than 25%			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect for damage.	
Overload from 25% to 49%			
1	Sheaves, Rope Guides	Inspect all for damage.	
2	Collar-Wear Pads, Pad Retainers	Inspect all for damage.	
3	Collar-welds	Inspect all for damage.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

Superstructure Inspection



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

Carrier Inspection



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

SECTION 2
OPERATING CONTROLS

SECTION CONTENTS

TRUCK CAB CONTROLS

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.

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, jacks, 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.

Swing Speed Adjustment – Located on turn motor inside frame. Turn knob in to increase maximum swing speed. Turn knob out to decrease maximum swing speed.

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.

⚠ 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 **UP** to raise the stabilizer legs. Operate the lever to **DOWN** to lower the stabilizer legs.

Stabilizers – In/Out – Operate the lever to **OUT** to move beams out and to **IN** to move beams in.

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

Outriggers – In/Out – Operate the lever to **OUT** to move beams out and to **IN** to move beams in.

Outrigger/Stabilizer Selector – Use in conjunction with stabilizer and outrigger controls to select which cylinders are operational (left side, right side or both). Move switch to the **LEFT** position to operate only the left side stabilizer and outrigger cylinders. Move switch to **RIGHT** position to operate only the right side stabilizer and outrigger cylinders. When switch is in middle position, **BOTH**, the stabilizer and outrigger cylinders on both sides will operate when control levers are activated.

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

Emergency Stop 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 Observe pressure gauge while booming up or down at end of stroke to determine system pressure. **Note: RCL required on cranes with jibs and/or man baskets.**

RCL Display Console – Acts as interface between operation and load moment system. It's used to import operating conditions and display boom and load information. Refer to RCL manual in this owners manual.

RCL CPU – Processes load information to give operator crane capacities and boom information. Refer to RCL manual in this owners manual.

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 line of rotation of the swing bearing to the center of the loadline 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.

Cold Weather Operation

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

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

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

Operation Below -40°C

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

Operation Below -40°F

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

CRANE WARM-UP PROCEDURES

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

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

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, 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.

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 2-3).
2. Once the hydraulic system is warm, operate the unloaded hoist, in both directions, at low speeds several times to prime all hydraulic lines with warm hydraulic oil and to circulate gear lubricant through the planetary gear sets.

Swing Drive and Turntable Bearing

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

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

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

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

Axles

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

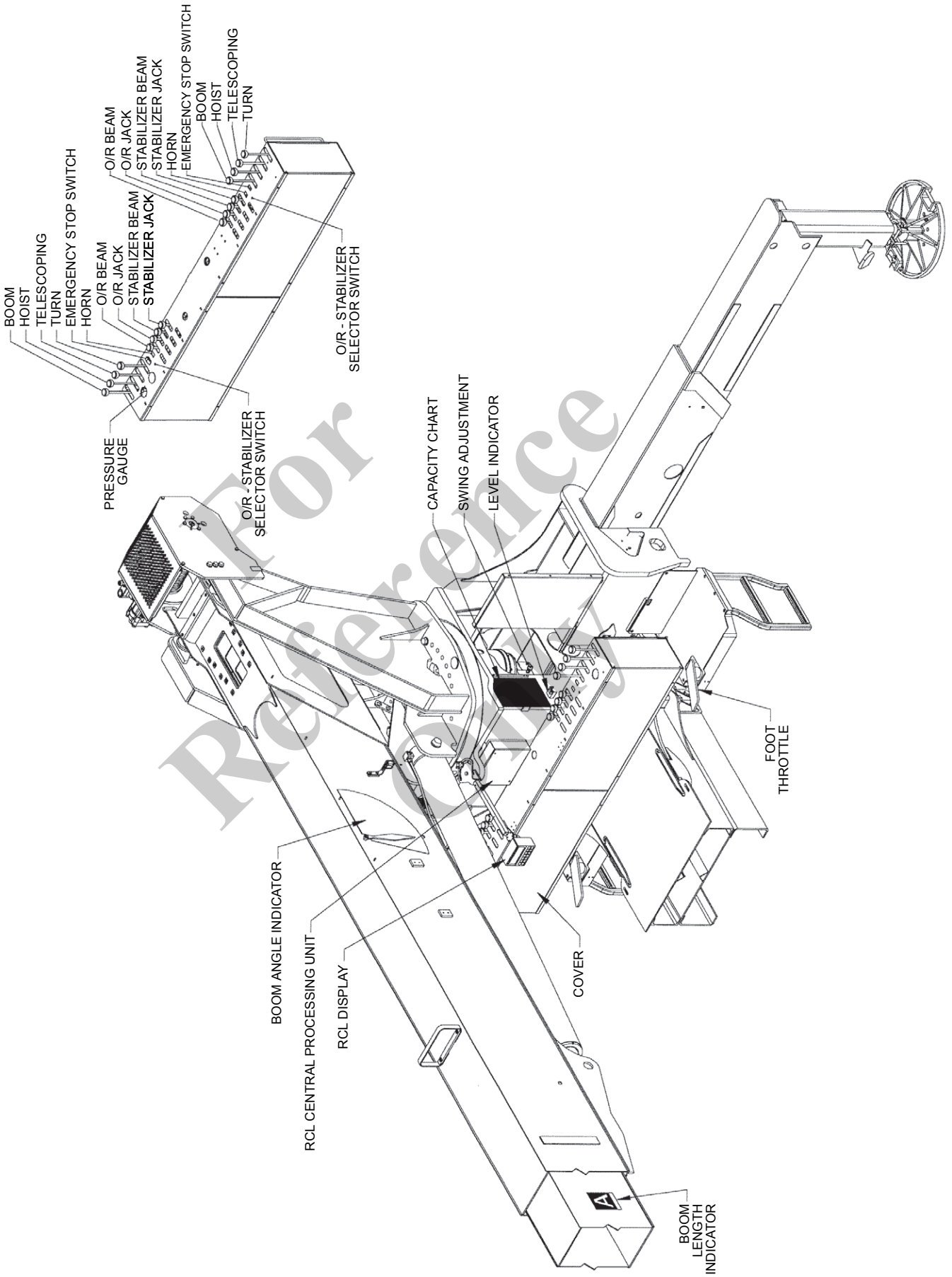
Hydraulic Oil System

Operating Limits and Warm-up Procedures:

- **From 4°C to -10°C (40°F to 15°F):** Crane operation without a load is allowed with medium engine RPM and medium function speed (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.

Crane Nomenclature



Rated Capacity Limiter

General Information

The PAT Rated Capacity Limiter (RCL) DS 160 has been designed to provide the crane operator with the essential information required to enable the machine to be used within its design parameters.

Using various sensing devices, the Rated Capacity Limiter monitors various crane functions and provides the operator with a continuous reading of the crane's capacity. The readings continuously change as the crane moves through the motions needed to make the lift.

The RCL provides the operator with information regarding the length and angle of the boom, working radius, rated load and the total calculated weight being lifted by the crane.

If non permitted conditions are approached, the DS 160 Rated Capacity Limiter will warn the operator by sounding an audible alarm, lighting a warning light and locking out those functions that may aggravate the crane's condition.

**Load Moment: Generally the product of a force and its moment arm; specifically, the product of the load and the load-radius. Used in the determination of the lifting capacity of a crane.*

Warnings

The RCL is an operational aid which alerts a crane operator of approaching overload conditions and also warns of two block conditions which could cause damage to equipment and harm personnel.

The device is not, and shall not, be a substitute for good operator judgment, experience and use of accepted safe crane operating procedures.

The responsibility for the safe operation of the crane shall remain with the crane operator who shall ensure that all instructions supplied are fully understood and observed.

Prior to operating the crane, the operator must carefully and thoroughly read and understand the information in this manual to ensure that he knows the operation and limitations of the indicator and crane.

Proper functioning is dependent upon proper daily inspection and observations of the operating instructions set forth in this manual.

⚠ DANGER

The displays will only aid the operator when the RCL is properly programmed and the proper load capacity chart is selected for the crane configuration being utilized. To prevent property damage or serious bodily injury or death to personnel, ensure the RCL is properly programmed before operating the crane.

System Description

The PAT Rated Capacity Limiter DS 160 consists of a central micro processor unit, operating console, length/ angle sensor, pressure transducers, and anti-two- block switches.

The system operates on the principle of reference/ real comparison. The real value, resulting from the pressure measurement is compared with the reference data, stored in the central processor memory and evaluated in the micro processor. When limits are reached, an overload warning signal is generated at the operator's console. At the same time, the dangerous crane movements, such as hoist up, telescope out and boom down, will be stopped.

The fixed data regarding the crane, such as capacity charts, boom weights, centers of gravity and dimensions are stored in memory chips in the central processor unit. This data is the reference information used to calculate the operating conditions.

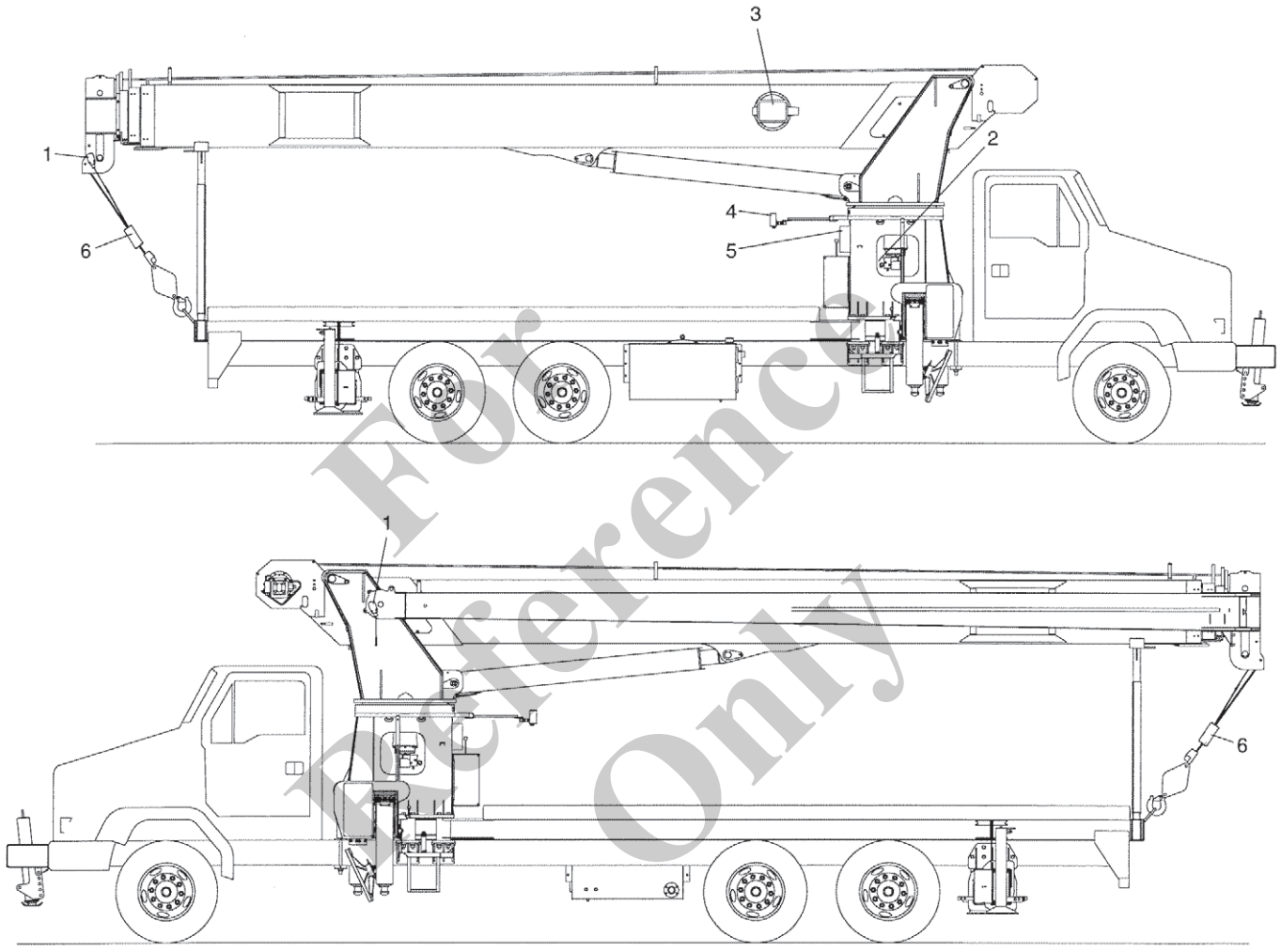
Boom length and boom angle are registered by the length/angle sensor, mounted inside the cable reel which is mounted on the boom. The boom length is measured by the cable reel cable which also serves as an electrical conductor for the anti-two-block switches.

The crane load is measured by pressure transducers attached to the piston and rod side of the lift cylinders.

System Function & Operation

A full PAT operators manual is included in manual. Please refer to it for proper PAT Rated Capacity Limiter operating and set-up procedure.

1. ANTI-TWO-BLOCK SWITCHES
2. PRESSURE TRANSDUCERS
3. LENGTH/ANGLE SENSOR/ANTI-TWO-BLOCK CABLE REEL
4. RCL DISPLAY CONSOLE
5. CENTRAL PROCESSOR UNIT
6. ANTI-TWO-BLOCK WEIGHT



OPERATING PROCEDURES

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 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 “emergency 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 loadline cable for kinks, broken strands or other damage in accordance with instructions in the “Service & 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 RCL and anti-two-block system for proper operation. See RCL Service and Maintenance Procedure.

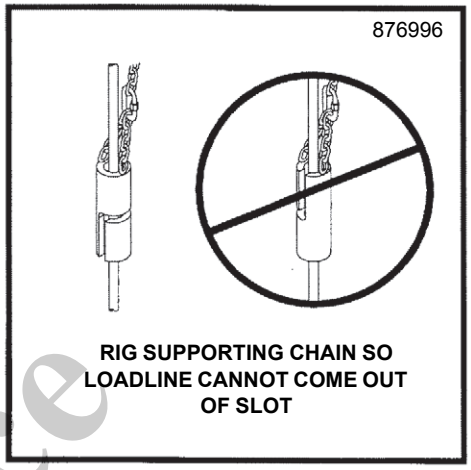
Note: Consult truck manufacturer’s manual for vehicle checks.

RCL Inspection Procedure

Prior to operating the crane, the following electrical connections must be checked to ensure that the system is properly connected for the crane configuration.

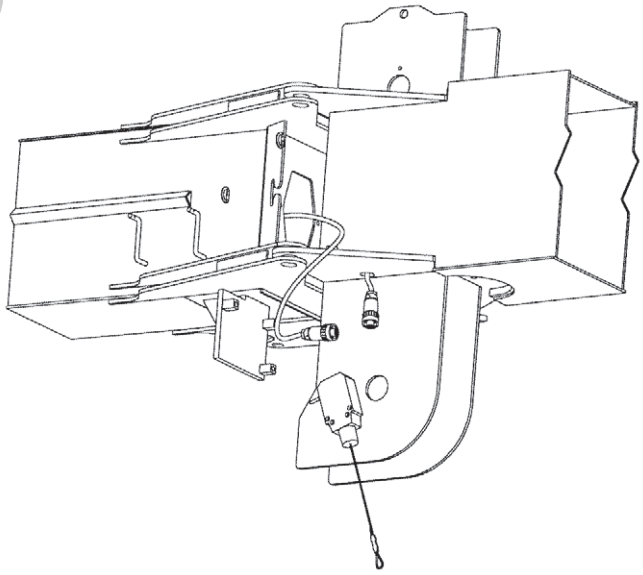
If the crane works only with the boom and without boom extensions (jibs), no additional connections are necessary. Be sure that the weight of the anti-two-block (ATB) switch is properly installed on the hoist load line on the first fall of rope coming off the boom tip.

Proper installation of the ATB weight is as shown in the following picture. Be sure that the wire rope cannot disengage from the weight without disconnecting the link.



RIG SUPPORTING CHAIN SO LOADLINE CANNOT COME OUT OF SLOT

If the crane works with a boom extension (jib), the female connector at the rear of the jib must be plugged into the male connector at the end of the main boom to make the ATB switch at the tip of the jib operational. This will require unplugging the main boom ATB switch. The weight attached to the main boom ATB switch must also be removed and reinstalled on the jib ATB switch. After removal of the weight, the main boom ATB switch must then be locked with the red ATB retainer (which is attached to the switch with a spring clip). The weight must be reattached to the jib ATB switch and installed on the loadline coming off the jib tip.



⚠ DANGER

Failure to reposition the anti-two-block switch weight and properly connect the cord assemblies will prevent the anti-two-block system from functioning properly. No weight shall be on the main boom anti-two-block switch when the boom extension is being used.

Installation of Anti-Two-Block Retainer in Locking Position (see Fig. 1 and 2)

1. Pull the cable out of the switch and bend back parallel to the boom and hold (1)
2. Slide the flag from left side with its slot over the cable between the crimped stop and the switch (2). Push it firmly straight onto the cable guide of the anti-two-block switch (3).
3. Straighten the cable completely into the slot and release the cable (4).

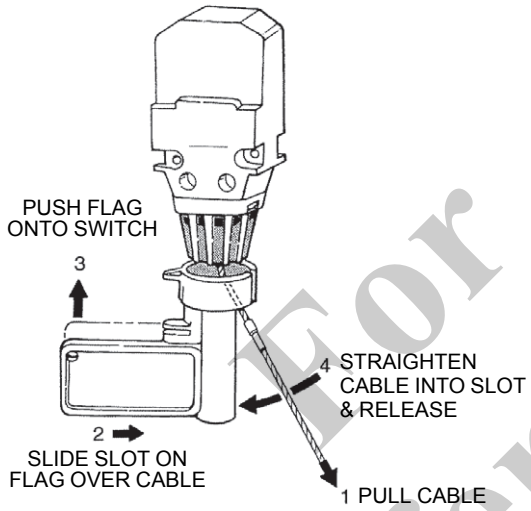


FIGURE 1

SETTING OF ANTI-TWO-BLOCK RETAINER IN LOCKING POSITION

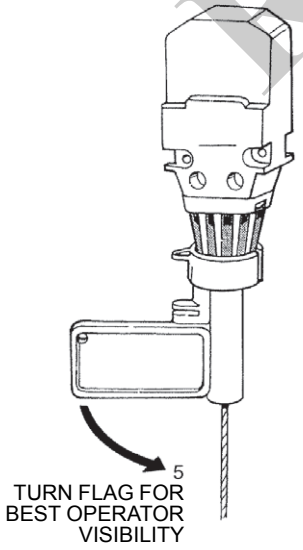


FIGURE 2

RETAINER IN LOCKING POSITION

4. Turn the flag for best visibility for the operator (5).

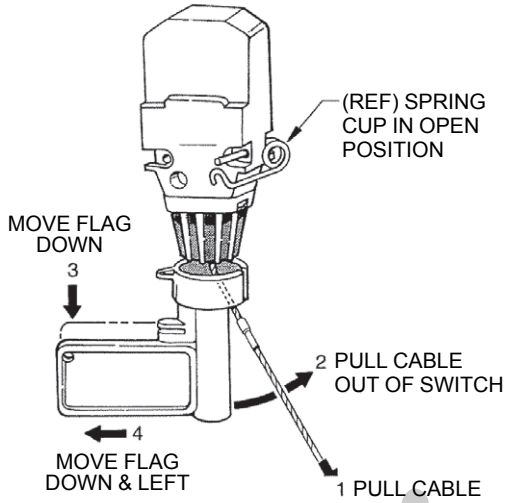


FIGURE 3
REMOVAL OF ANTI-TWO-BLOCK RETAINER

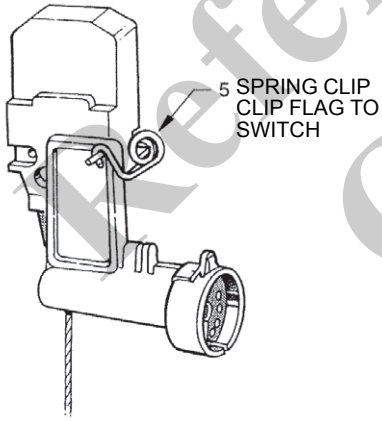


FIGURE 4
RETAINER IN STORAGE POSITION

Removal and Storage of the Anti-Two-Block Retainer Procedure (see Fig. 3 and 4)

1. Pull the cable out of the switch (1) and bend back parallel to the boom and hold (2).
2. Move the flag down (3) and then left (4) to remove it from the anti-two-block switch. Release the cable.
3. For storage, clip the flag to the switch using the provided spring clip (5) attached to the switch.

Pre-Operation Inspection and Calibration Verification

After the electrical connections have been checked to insure that the system is properly connected for the crane configuration, the following checks shall be made:

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.
3. Check the spring-loaded cable reel to be sure it is free to rotate, has tension and the cable is reeled properly.

⚠ 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 RCL system not function properly as indicated by lighting the red warning light, sounding the audible alarm and locking the crane movements, hoist up, telescope out and boom down.

Check the anti-two-block alarm light and the audible alarm 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 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 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 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.

⚠ DANGER

If the light and audible alarm do not function as described and the crane movements are not stopped, the system is not working properly.

- If the crane is equipped with a boom extension that is deployed and rigged for work, repeat the test procedure for the boom extension anti-two-block switch.
- Check that the display of the main boom length agrees with the actual boom length.
- Check that the display of the main boom angle agrees with the actual boom angles.
- Check that the display of the operating radius of the crane agrees with the actual radius.
- Check the load display by lifting a load of known weight. The accuracy of the load indication shall be within the tolerance of SAE J159.

Operation

After being properly checked, the RCL is operational. The operator shall be thoroughly familiar with all controls of the RCL and he shall properly set the reeving input before operating the crane. The proper function of the system shall be checked by lifting a load of known weight and comparing the load to the information displayed on the RCL.

Rated loads include the weight of the hook block, slings, and auxiliary load handling devices. Their combined weights shall be subtracted from the listed load capacities as stated on the load capacity chart to obtain the net load to be lifted.

⚠ DANGER

If any of the displays reflect a deviation between displayed and actual values, an authorized PAT service representative shall be called for repair of the system or reverification of the crane's RCL calibration.

⚠ DANGER

Any structural modifications or changes to the crane shall require reverification of the crane's RCL calibration.

⚠ DANGER

The RCL will warn the operator when hoist and loadline overload occurs but will allow the boom up function to continue to operate. Booming up a hoist and loadline overload in areas where the boom capacity exceeds the loadline capacity can cause serious damage to the hoist and loadline. Always reeve the loadline properly for the load to be lifted.

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 leg comes down on 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. Wheel chocks may be required under certain conditions.
2. Engage PTO by using one of the methods outlined earlier in Truck Cab Controls section.
3. Bring the hydraulic system up to operating temperature (oil reservoir warm to the touch) by allowing the system to operate with all controls in neutral.

Crane Set Up

⚠ DANGER

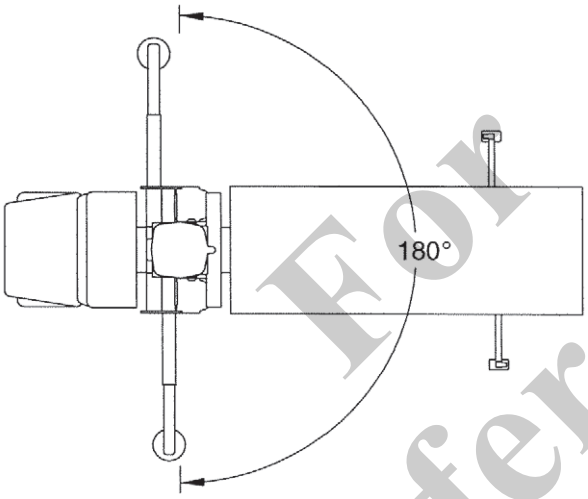
Do not operate the boom until all outriggers are extended and set providing firm support.

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 70,000 lb (31 750 kg) [156 psi (1,07 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

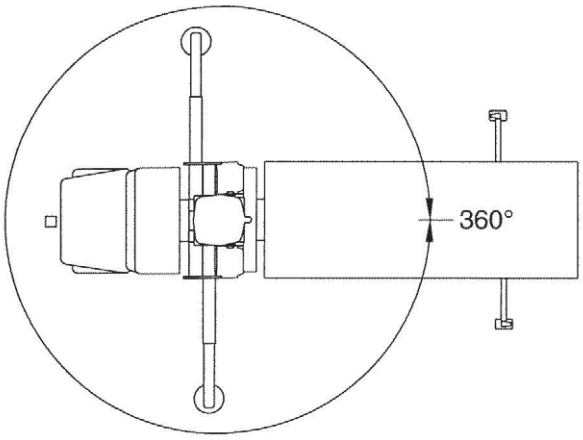


Inspect oil level gauge and contaminated oil filter gauge with oil at operating temperature and boom and outriggers stowed. Add oil if low, change filters if gauge indicates dirty.

Remove outrigger pads from their carrying brackets and install them on the outrigger legs. Be sure they are properly secured in place.

Extend the two main outrigger beams to either the mid span or full span width as indicated by the decals on the beams and lower the stabilizer legs until the front truck tires clear the ground. Level the truck from side to side while observing the level indicator at either control station. If using mid span outrigger, engage manual mid span over-center locks. Then extend and lower the 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 Jack



A front jack is required when loads are to be lifted over the front of the vehicle. (Except with a Rear Mount Configuration). Inspect oil level gauge and contaminated oil filter gauge with oil at operating temperature and boom and outriggers stowed. Add oil if low, change filters if gauge indicates dirty.

Remove outrigger pads from their carrying brackets and install them on the outrigger legs. Be sure they are properly secured in place. Extend the two main outrigger beams to either the mid span or full span width as indicated by the decals on the beams and lower the stabilizer legs until the front truck tires clear the ground. Level the truck from side to side while observing the level indicator at either control station. If using mid span outrigger, engage manual mid span over-center locks. 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. After the crane is leveled side-to-side and front-to-back, extend the front jack until firm contact is made with the ground. Always keep the load as close to the ground as possible.

⚠ DANGER

Rear stabilizers must be fully extended for both full and mid span outrigger operation.

⚠ 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.

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

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

Operation

The Outrigger Monitoring System (OMS) is standard equipment on cranes sold in North America and optional equipment on cranes sold outside of North America. The OMS aids the operator in ensuring that the crane is properly setup on outriggers and jacks. The OMS utilizes one sensor in each outrigger and one sensor in each horizontally extending stabilizer to identify when each jack is fully extended and an outrigger beam is positioned to one of the two pre-defined locations, including mid-extend fully extended position in which they provide maximum stability.

The OMS utilizes an LED indicator to communicate to the operator the position of the outriggers. The Outrigger Status Indicator (1, (Figure 3)) is a bi-color LED located at each control station.

When power is on and both stabilizers beams are fully extended and both outriggers beams are at the mid-extend position, the Outrigger Status Indicator flashes green, indicating a lift can be made using the capacities from the mid-extend outrigger load chart.

When power is on and both stabilizers beams are fully extended and one outrigger beam is at the mid-extend position and the other is fully extended, the Outrigger Status Indicator flashes green, indicating a lift can be made using capacities from the mid-extend outrigger load chart.

If power is on and both stabilizers beams are fully extended and both outriggers beams are at the fully extended position, the Outrigger Status Indicator illuminates constant green, indicating a lift can be made using capacities from the full-extend outrigger load chart. If power is on and one or more stabilizer beams are not fully extended, or one or more outriggers are at a position other than the mid-extend or fully extended positions, the Outrigger Status Indicator flashes red, indicating a lift should not be made. If the Outrigger Status Indicator illuminates constant red, there is a fault in the OMS.

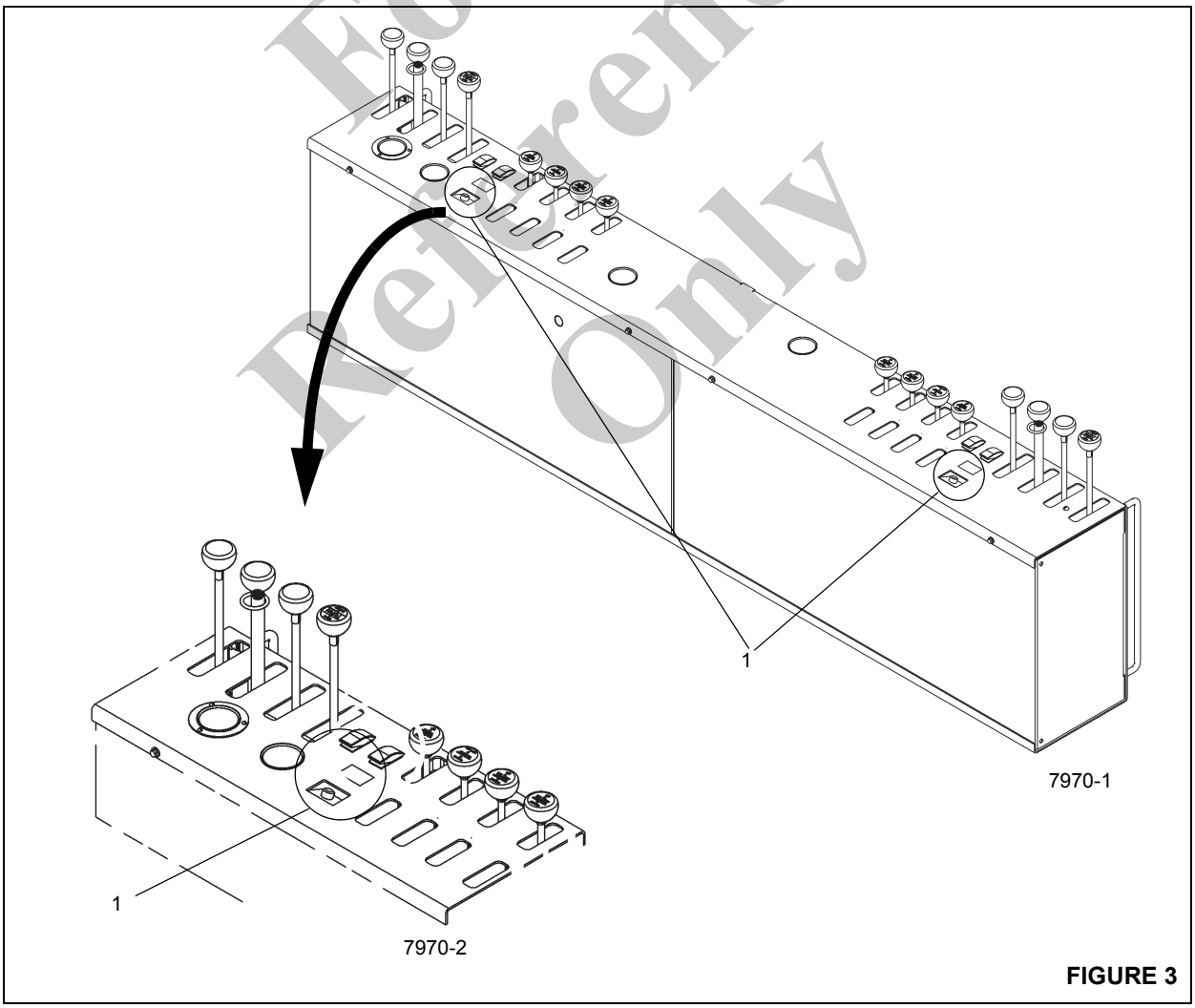


FIGURE 3

Maintenance

Outrigger Cylinder Length Sensor

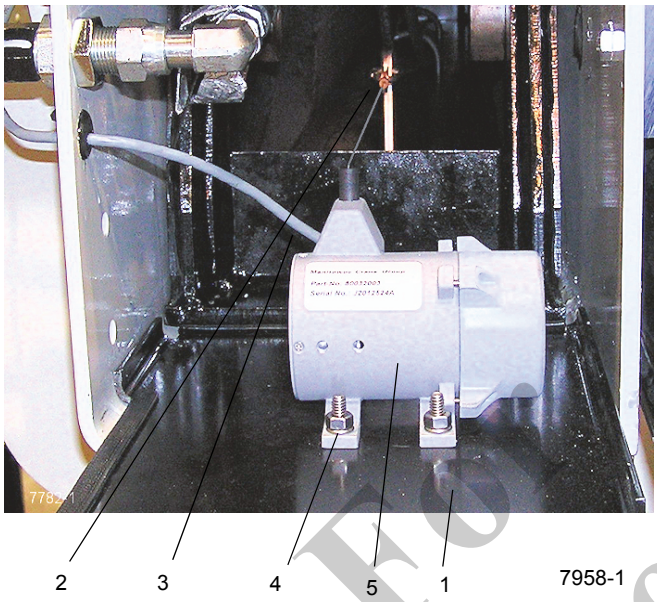


FIGURE 4

Remove

1. Fully retract outriggers.
2. Remove outrigger box cover bracket (1, (Figure 4)).
3. Disconnect spring clip (2, (Figure 4)) from its attaching point on outrigger beam.
4. Disconnect electrical connector (3, (Figure 4)) at string potentiometer.
5. Remove screws securing string potentiometer, (4, (Figure 4)).
6. Remove string potentiometer (5, (Figure 4)).

Install

1. Fully retract outriggers.
2. Using screws (4, (Figure 4)) mount the string potentiometer to the outrigger box cover bracket.
3. Connect electrical connector (3, (Figure 4)) to string potentiometer.
4. Attach spring clip (2, (Figure 4)) to attaching point on outrigger beam.
5. Calibrate sensor; refer to *Calibrate*, page 15.

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 distributor for further assistance.

Stabilizer Proximity Switch (version 1)

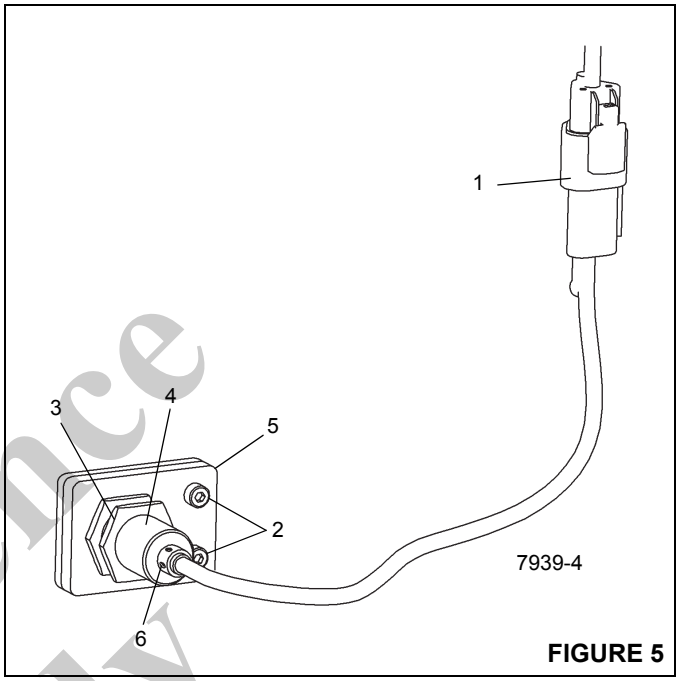


FIGURE 5

Remove

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

Install

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

Stabilizer Proximity Switch (version 2)

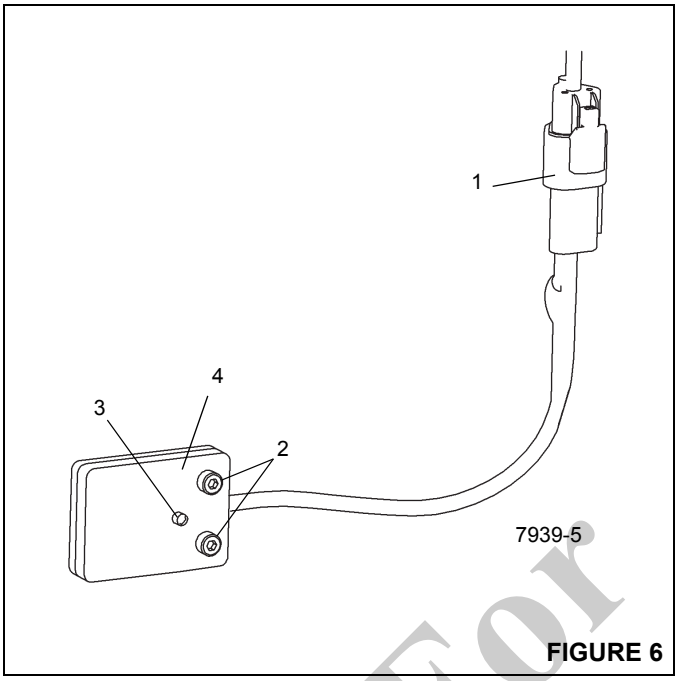


FIGURE 6

Remove

1. Disconnect electrical connector (1, (Figure 6)) at switch.
2. Remove the two screws (2, (Figure 6)) securing the switch (4) to the stabilizer box; remove switch.

Install

1. Fully extend stabilizer beam (horizontally).
2. Using two screws (2, (Figure 6)) secure the switch (4) to stabilizer box.
3. Connect electrical connector (1, (Figure 6)) to switch.
4. With power on and stabilizer beam fully extended, ensure LED (3, (Figure 6)) on proximity switch illuminates; retract stabilizer beam and ensure LED is not illuminated.

Before Making the Lift

1. Unspool loadline and free load block from it's stowed position.
2. 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.
3. 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.
4. Check the operating area for electric power lines.

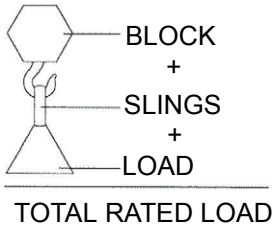
RCL Set Up and Programming Procedure

The DS-160 operators manual located in this book contains instruction for proper setup and operation of the RCL system.

⚠ DANGER

The correct setting is of utmost importance for the proper functioning of the system and the crane. Therefore, only operators who are thoroughly familiar with the crane's load charts and the operation of the system should execute the setting of the system according the operating configuration of the crane.

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 will be done automatically but use of a dynamometer and tape measure is recommended periodically to verify RCL accurately.

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 nonshaded areas. The stability or non shaded areas represent a stability tipping factor of 85% when:

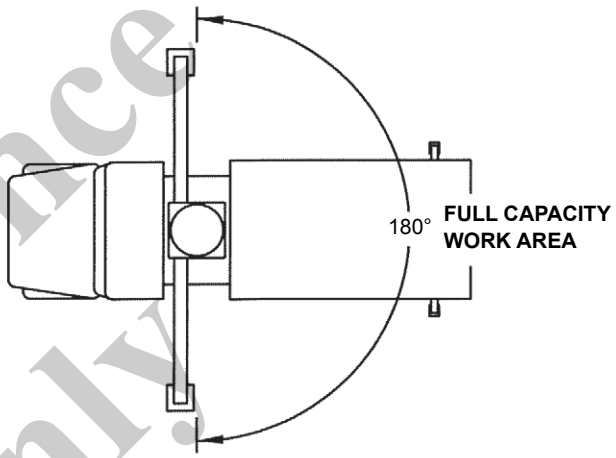
1. All outriggers are extended with positive contact on firm, level surface, the tires are free of the ground and the machine is level within 1°.
2. The proper amount of counterweight has been installed, if required.
3. The unit is mounted in accordance with factory instructions on a vehicle with proper 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. The load to be handle does not exceed the maximum capacity at the boom length and loaded radius.

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

Series 1400H Load Chart - Full Span Outriggers

The load chart for a Series 1400H with a 30 ft to 100 ft boom with a 30 ft to 54 ft jib and with outriggers extended to full span is shown in Figure A. To the right of the range diagram the outriggers are shown at full span. Below this pictorial, all maximum rated loads are shown in columns based on boom length (30 ft, 44 ft, 58 ft, 72 ft, 86 ft and 100 ft) and on load radius (6 ft, 8 ft, 10 ft, 12 ft, etc.) Loaded boom angles for each load at each radius are also listed directly to the left of the load. Boom length is measured from the pivot pin point at the base of the main boom to the tip of the sheave case on the last boom section. Fully retracted this boom is 30.16 ft (9,19 m) long and fully extended it is 100 ft (30,48 m) long. The boom length is 0.5 ft (0,15 m) shorter if the loadline is reeved for multipart operation. Decals on each side of the second stage boom show the boom lengths as listed above when the hash mark at the bottom of the decal is completely exposed from the first stage boom. An angle indicator is located on the side of the boom near the operators station. The boom length decals and the angle indicator can be used to verify the boom length, boom angle information shown on the “rated capacity limiter” (RCL) in the operators station. The load radius is listed in a column at the left side of the rating chart. Load radius is the horizontal distance from the centerline of rotation of the swing bearing to the center of the loadline when the load is suspended. Lifting a load will cause the radius to increase due to boom deflection, oil compression in the lift cylinder and outrigger and subbase deflection, therefore the boom must be raised slightly when lifting maximum loads in order to maintain the correct radius. When lifting maximum loads, always operate the crane slowly and smoothly or the RCL will stop operation prematurely due to pressure spikes in the lift cylinder. Load ratings shown assume the jib is stowed on the first section boom. The chart “ADD TO CAPACITIES WHEN NO JIB STOWED” in Figure A below the load ratings, shows the amount the rated load can be increased for a given boom length when no jib is stowed on the side of the boom. The RCL automatically compensates for this when set to the proper mode.

In order to lift loads over the front of the vehicle an optional front jack is required. If a working area diagram decal as shown below is present, the crane is not equipped with an optional front jack and loads can only be lifted in a circular arc about the centerline of rotation as shown on the working area diagram. (Except if equipped with a Rear Mount Configuration).



WORK AREA DIAGRAM

The shaded areas of the load chart are structurally limited loads. The non shaded areas are loads which are limited by stability.

The range diagram in the upper left corner shows the operating radius and height of the unloaded boom and/or jib. It should be used as a guide to position the unloaded boom tip or jib tip over the load and to determine approximate height to which the load can be lifted.

The stability limit line at the right hand side of the range chart shows the maximum radius to which the unloaded boom with suspended 180 lb hook block may be extended when operating anywhere within the safe working area of the crane. Attempting to extend the boom or jib tip beyond these lines can cause tipping to occur with no load on the hook block.

A hoist data chart is shown at the bottom of Figure A. Loads which weigh more than the hoist single part rated line pull must be multi-part reeved so the hoist system is not overloaded. The RCL will limit the maximum allowable load to the lower value of either the maximum capacity of the crane or the maximum capacity of the hoist reeving system.

This chart gives the correct reeving for all loads listed on the load chart.

⚠ DANGER

The RCL will warn the operator when hoist and loadline overload occurs but will allow the boom up function to continue to operate. Booming up a hoist and loadline overload in areas where the boom capacity exceeds the loadline capacity can cause serious damage to the hoist and loadline. Always reeve the loadline properly for the load to be lifted.

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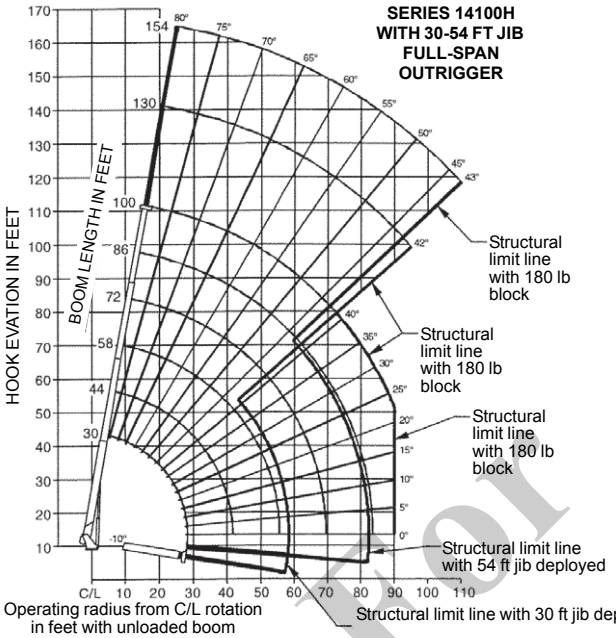
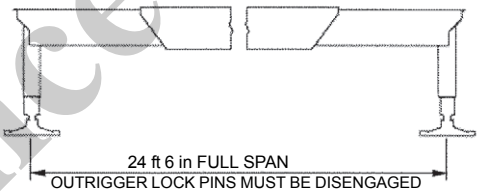


RCL OPERATING CODE	
OPERATING MODE	
01	Main Boom - No Jib Stowed
02	Main Boom - Jib Stowed
03	30 ft Tele Jib
04	54 ft Tele Jib
11	Man Basket on Main Boom
12	Man Basket on 30 ft Tele Jib
13	Man Basket on 54 ft Tele Jib

NOTE:

9. Operate with jib by radius when main boom is fully extended, if necessary increase boom angle to maintain loaded radius.
10. Operate with jib by boom angle when main boom is not fully extended. Do not exceed rated jib capacities at any reduced boom lengths.
11. Capacities do not exceed 85% stability.
12. Shaded areas are structurally limited capacities.
13. Handling of personnel is only permitted with full span outriggers.
14. All capacities in pounds, angles in degrees, radii in feet.
15. Loaded boom angles are given as reference only.



LOAD RATINGS

LOAD RADIUS (ft)	LOADED BOOM ANGLE	30 ft BOOM (lb)	LOADED BOOM ANGLE	A 44 ft BOOM (lb)	LOADED BOOM ANGLE	B 58 ft BOOM (lb)	LOADED BOOM ANGLE	C 72 ft BOOM (lb)	LOADED BOOM ANGLE	D 86 ft BOOM (lb)	LOADED BOOM ANGLE	100 ft BOOM (lb)
6	79.1	66,000										
8	74.9	49,200										
10	70.6	42,200	77.2	37,900								
12	66.3	38,600	74.9	33,400	79.2	29,550						
14	61.7	34,200	72.1	29,400	77.1	26,550	80	23,050				
16	56.8	30,350	69.2	26,900	75.1	24,550	78.6	21,050				
20	46	23,550	63.3	21,400	70.8	19,250	75.3	18,050	78.4	16,800	80	11,600
25	27.4	16,700	55.2	17,400	65.3	16,050	71	14,650	74.9	13,700	77.3	10,950
30			46.1	13,900	59.5	13,550	66.7	12,550	71.3	11,450	74.5	10,550
35			35	10,350	53.1	10,650	61.9	10,550	67.7	9,900	71.8	9,150
40			20	8,000	46.8	8,250	57.6	8,400	64.3	8,550	68.4	8,050
45					38.8	6,500	52.4	6,650	60.1	6,750	65.3	6,850
50					29	5,150	46.7	5,300	55.9	5,400	61.9	5,500
55					12.3	4,150	40.4	4,250	51.5	4,400	58.3	4,450
60							33.2	3,400	46.7	3,550	54.6	3,600
65							23.8	2,750	41.5	2,850	50.7	2,900
70									35.7	2,250	46.6	2,300
75									28.8	1,750	42.2	1,800
80									19.6	1,350	37.3	1,400
85											31.8	1,050
90											25.2	700
	0	11,400	0	7,300	0	4,000	0	1,850	0	900		
ADD TO CAPACITIES WHEN NO JIB STOWED (lb)		800		600		450		350		300		250

LOAD RADIUS (ft)	LOADED BOOM ANGLE	30 ft JIB (lb)	LOADED BOOM ANGLE	54 ft JIB (lb)
30	78.4	5,500		
35	76.5	5,450	78.5	2,650
40	74.6	5,400	76.9	2,600
45	72.4	5,100	75.2	2,500
50	70.1	4,600	73.4	2,400
55	67.8	4,250	71.6	2,300
60	65.5	3,900	69.8	2,200
65	62.7	3,200	67.9	2,100
70	59.9	2,600	66	2,000
75	57.1	2,050	64	1,850
80	54.1	1,650	61.8	1,750
85	51.1	1,250	59.6	1,600
90	47.9	950	57.4	1,500
95	44.5	650	54.8	1,200
100			52.2	950
105			49.4	700
110			46.6	500

LOADLINE EQUIPMENT DEDUCT

Downhaul weight ..... 180 lb
One sheave block ..... 375 lb
Two sheave block ..... 640 lb
Three sheave block ... 870 lb
Four sheave block ..... 970 lb

1 PART LINE	2 PART LINE	3 PART LINE	4 PART LINE	5 PART LINE	6 PART LINE	7 PART LINE	8 PART LINE	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 5/8 inch diameter rotation resistant cable with 45,400 lb breaking strength on this machine. • Maximum capacity with “burst of speed” is 4,400 lb.
MAX. PULL 9,000 lb	MAX. PULL 18,000 lb	MAX. PULL 27,000 lb	MAX. PULL 36,000 lb	MAX. PULL 45,000 lb	MAX. PULL 54,000 lb	MAX. PULL 63,000 lb	MAX. PULL 66,000 lb	

FIGURE A

The 54 foot jib load chart is shown to the right of the boom load chart in Figure A. The maximum loads listed are based on radius when the boom is fully extended and on boom angle when the boom is not fully extended. The rated jib capacities remain the same at the same angle whether the boom is fully extended, partially extended or retracted.

The structural limit line with the jib deployed is shown in the Range Diagram. The boom must be within 1.5 ft of full retraction to lower the 54 ft jib below 43° and 30 ft jib below 42° down to -10°.

Series 1400H Load Chart - Mid Span Outriggers

The load chart for the Series 1400H with 30 to 100 ft boom with 30 ft to 54 ft jib stowed and with the outriggers extended to mid span (18 ft-6 in) is shown in Figure B. To the right of the Range Diagram the outriggers are shown at their mid span length with the mid span decals aligned with the outer ends of the intermediate beams. Four over center lock pins are provided on the outer outrigger boxes to lock the extendible beams at mid span when the pins are rotated 180 degrees from the full span position. The four over center outrigger mid span locks must be engaged when lifting with outriggers at mid span length.

The mid span outriggers and the corresponding mid span chart are intended for use in confined areas where it is not possible to fully extend the outriggers. As can be seen by comparing the two load charts and range diagrams, the capacities of the machine are reduced substantially due to lack of stability at lower boom angles but has the same capacity as the full span outrigger chart at higher boom angles.

To bring the RCL into operation with the reduced span load chart simply select the correct operating mode from the load chart. The RCL will become operational with a reduced span load chart for the main boom or for the jib as shown in Figure B.

The reduced span range chart shown in Figure B will also become operational when the reduced span outrigger operating mode is selected. This range chart will limit the radius at which the boom or jib will operate due to the reduced stability associated with the narrow span outriggers.

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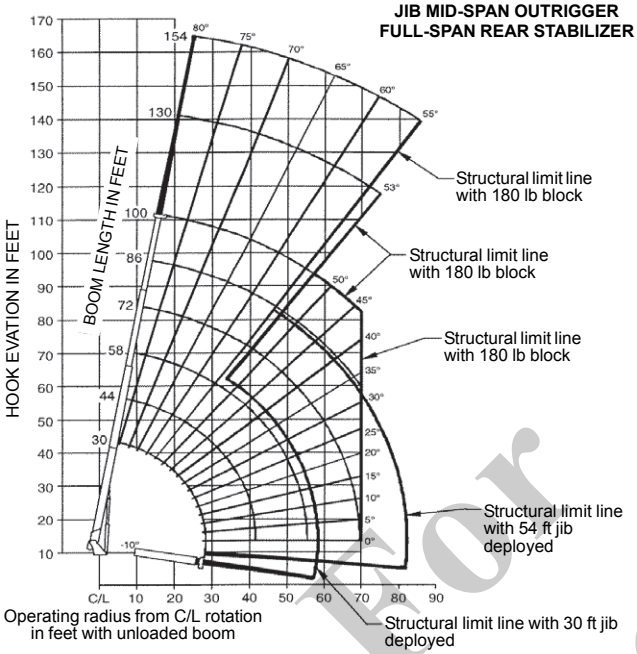
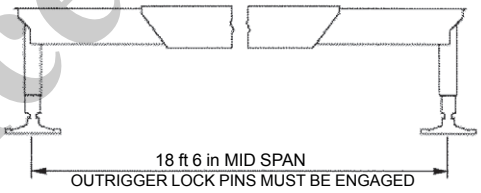
SERIES 14100H WITH 30-54 FT JIB MID-SPAN OUTRIGGER FULL-SPAN REAR STABILIZER



RCL OPERATING CODE	
OPERATING MODE	
21	Main Boom - No Jib Stowed
22	Main Boom - Jib Stowed
23	30 ft Tele Jib
24	54 ft Tele Jib

NOTE:

16. Operate with jib by radius when main boom is fully extended, if necessary increase boom angle to maintain loaded radius.
17. Operate with jib by boom angle when main boom is not fully extended. Do not exceed rated jib capacities at any reduced boom lengths.
18. Capacities do not exceed stability based on ISO 4305-1991.
19. Shaded areas are structurally limited capacities.
20. Handling of personnel is only permitted with full span outriggers.
21. All capacities in pounds, angles in degrees, radii in feet.
22. Loaded boom angles are given as reference only.



LOAD RATINGS

LOAD RADIUS (FT)	LOADED BOOM ANGLE	30 ft BOOM (lb)	LOADED BOOM ANGLE	A 44 ft BOOM (lb)	LOADED BOOM ANGLE	B 58 ft BOOM (lb)	LOADED BOOM ANGLE	C 72 ft BOOM (lb)	LOADED BOOM ANGLE	D 86 ft BOOM (lb)	LOADED BOOM ANGLE	100 ft BOOM (lb)
6	79.1	58,600										
8	74.9	49,200										
10	70.6	42,200	77.2	37,900								
12	66.3	38,600	74.9	33,400	79.2	29,550						
14	61.7	34,200	72.1	29,400	77.1	26,550	80.2	23,050				
16	56.8	30,350	69.2	26,900	75.1	24,550	78.6	21,050				
20	45.9	19,650	63.2	20,400	70.8	19,250	75.3	18,050	78.4	16,800	80	11,600
25	27.4	12,450	54.9	13,150	65.1	13,450	70.9	13,600	74.9	13,700	77.3	10,950
30			45.8	9,150	59.5	9,450	66.3	9,550	71.1	9,700	74.2	9,850
35			35.7	6,550	53	6,850	62	7,000	67.5	7,100	71.4	7,250
40			19.4	4,850	46.6	5,150	57.1	5,300	63.6	5,400	68	5,450
45					38.7	3,850	51.9	4,000	59.5	4,100	64.6	4,150
50					28.8	2,850	46.2	3,000	55.3	3,100	61.1	3,150
55					12	2,050	40	2,200	50.9	2,300	57.6	2,350
60							32.7	1,550	46.1	1,650	53.9	1,700
65							23.4	1,050	41	1,150	50.1	1,200
70									35.2	700	46	750
	0	10,000	0	4,650	0	1,850	0	850				
	ADD TO CAPACITIES WHEN NO JIB STOWED (lb)	800		600		450		350		300		250

LOAD RADIUS (ft)	LOADED BOOM ANGLE	30 ft JIB (lb)	LOADED BOOM ANGLE	54 ft JIB (lb)
30	78.4	5,500		
35	76.5	5,450	78.5	2,650
40	74.6	5,400	76.9	2,600
45	72.1	4,450	75.2	2,500
50	69.5	3,450	73.4	2,400
55	66.8	2,650	71.6	2,300
60	64.2	1,950	69.8	2,200
65	61.5	1,400	67.9	2,050
70	58.7	950	65.5	1,600
75	55.8	600	63	1,200
80			60.6	850
85			58.1	550

LOADLINE EQUIPMENT DEDUCT

Downhaul weight ..... 180 lb
One sheave block ..... 375 lb
Two sheave block ..... 640 lb
Three sheave block ... 870 lb
Four sheave block ..... 970 lb

1 PART LINE	2 PART LINE	3 PART LINE	4 PART LINE	5 PART LINE	6 PART LINE	7 PART LINE	8 PART LINE	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 5/8 inch diameter rotation resistant cable with 45,400 lb breaking strength on this machine. • Maximum capacity with “burst of speed” is 4,400 lb.
MAX. PULL 9,000 lb	MAX. PULL 18,000 lb	MAX. PULL 27,000 lb	MAX. PULL 36,000 lb	MAX. PULL 45,000 lb	MAX. PULL 54,000 lb	MAX. PULL 63,000 lb	MAX. PULL 66,000 lb	

FIGURE B

General Rules When Operating the Hoist

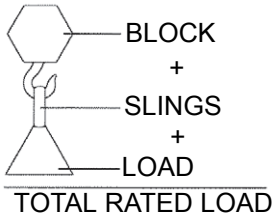
1. Always operate the hoist control as if the anti-two-block is not operational. Payout the loadline while extending the boom and reduce hoist speed and maintain safe clearance at the boom tip when hoisting up. Do not rely on anti-two-block system to eliminate two blocking. Use the system as a backup to safe operation.
2. Make certain the hoist cable is not twisted or kinked and that cable is properly seated on the drum and in the sheaves.
3. Before lifting a load, always make certain that three full wraps of rope will remain on the drum at all times throughout the lift.
4. 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.
5. Do not drag loads in any direction with the hoist.
6. Never attempt to lift loads which are not loose and free, i.e. frozen down material or poles out of ground.
7. 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. Start and stop load movement slowly and smoothly especially when operating on high speed mode with multi-part reeving to avoid bird caging the load line on the hoist drum.

Lifting the Load

After the vehicle and crane have been properly set up as close to the work as possible, 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.

The following procedure is a typical method which should be used to determine the crane's ability to handle a load.

1. Determine the weight of the load and load handling equipment. Use a dynamometer whenever load weight is in question and be sure to include weight of blocks and slings as part of load weight.



2. Refer to the hoist data chart for correct loadline reeving. Hoist capacity and crane capacity are separate. Be sure hoist is properly reeved for the load to be lifted.

⚠ DANGER

The RCL will warn the operator when hoist and loadline overload occurs but will allow the boom up function to continue to operate. Booming up a hoist and loadline overload in areas where the boom capacity exceeds the loadline capacity can cause serious damage to the hoist and loadline. Always reeve the loadline properly for the load to be lifted.

3. Determine the furthest radius from centerline of rotation and greatest height that the load will have to be handled. Crane maximum rated loads decrease as radius and height increase. Determining the furthest distance and height a load will have to be handled at will determine what maximum loads can be handled. Moving the crane hook block to the furthest load-setting point, reading boom length and boom angle from the RCL, then referring to the range chart will give an approximation of the load radius and height.
4. Refer to the load chart or RCL to determine that the load is within the rated capacity of the crane for the approximate radius and height. By knowing boom length, approximate radius and load weight, a glance at the load chart will tell you if you are within rated capacity of the machine. If load and radius are close to maximum, measure the radius to determine the exact distance from center line of rotation to load-setting point. Remember when working between listed radii or boom lengths, use the smallest rated capacity.

5. Check the environmental factors before lifting. After you have determined that the load is within safe crane capacity, you must check wind, crane level, outrigger footing, or any other factors which could make handling a maximum rated load dangerous because of adverse conditions.
6. After determining that the load is safe to lift, turn, extend, retract or boom up or down until boom tip is directly over the load. Lower loadline and attach load. Tighten loadline slightly, then boom up to raise load off the ground. This will prevent the load from swinging out to a greater radius. Control load by use of a non-conductive tag line.
7. 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 equipment. This is especially true when handling maximum rated 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.

Shut Down and Preparation for Road Travel

CAUTION

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

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

CAUTION

Machine Damage Hazard!

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

Fully retract the outrigger stabilizers and properly store the floats.

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

WARNING

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

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

2. Retract and place the boom in boom rest.
3. Ensure the center front jack is fully retracted, if equipped.
4. Ensure the outrigger beams and stabilizers are fully retracted with the floats properly stowed.

CAUTION

Outrigger beams must be pinned for travel.

If not pinned, outrigger beams may drift out during travel.

5. Engage the mechanical travel lock at each outrigger beam.
6. Engage the swing brake.
7. Engage the swing lock.
8. Either the hook block may be reeved over the main boom nose or the headache ball may be reeved over the main boom nose or auxiliary boom nose; the other must be removed and stowed securely before travelling. If the hook block or headache ball remains reeved on the boom, it must be secured at the tie down on the carrier provided for that purpose.
9. Secure the hook block and A2B weight:
   a. Slowly hoist up until there is a slight tension on the hoist cable. It may be necessary to override the A2B function to tension the cable.
   b. The the A2B weight needs to be resting on the wedge socket so that there is slack in the anti-two-block-chain.

NOTE: There needs to be enough slack in the A2B chain so that the A2B switch does not switch between open and close during travel.

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

10. Turn off the ignition and all other switches in the crane cab.
11. Close and/or secure all windows and doors.

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

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

14. Ensure tires are properly inflated.

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

16. Release the park brake before moving truck.

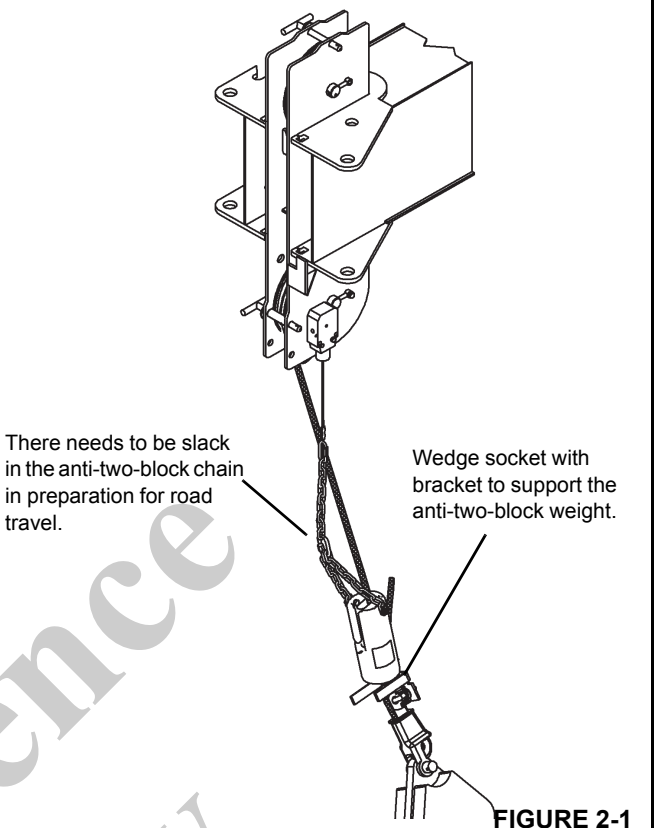
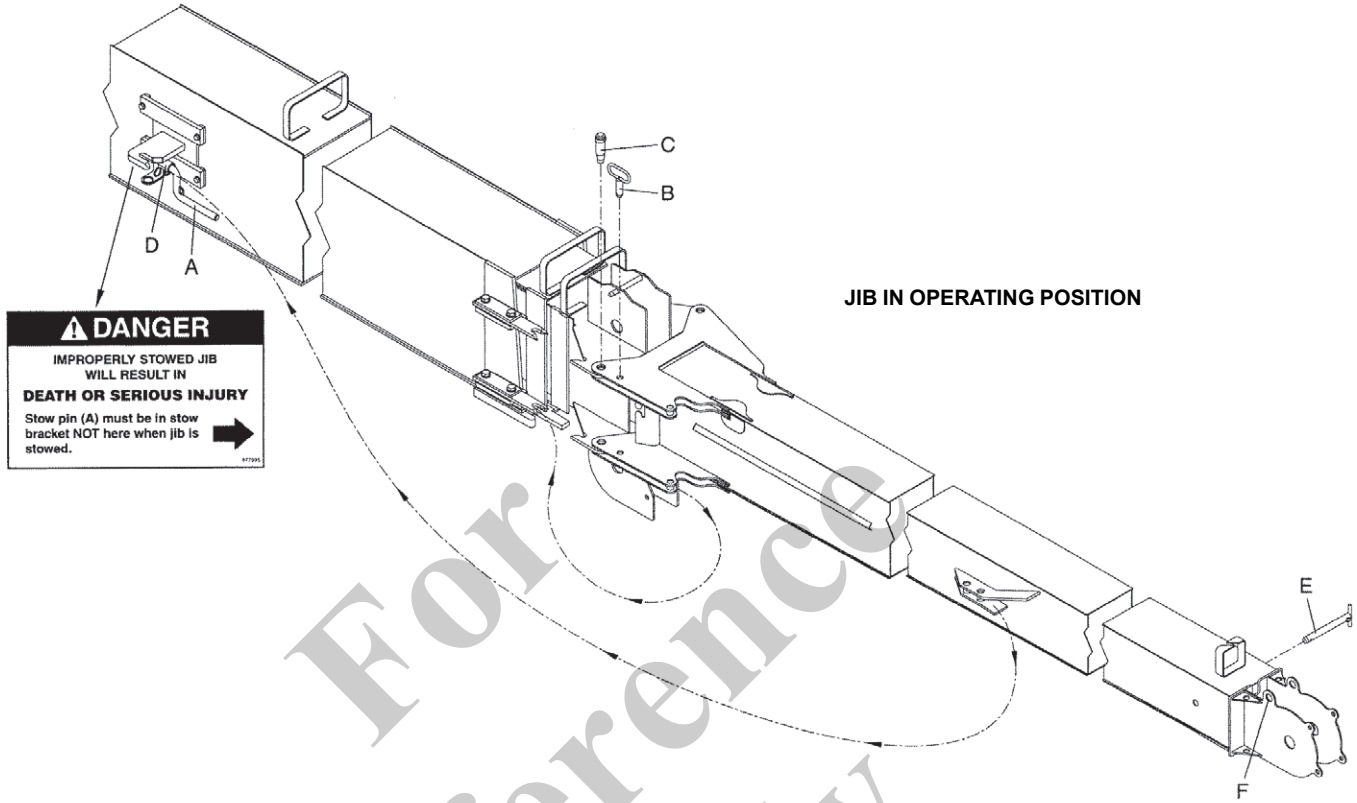
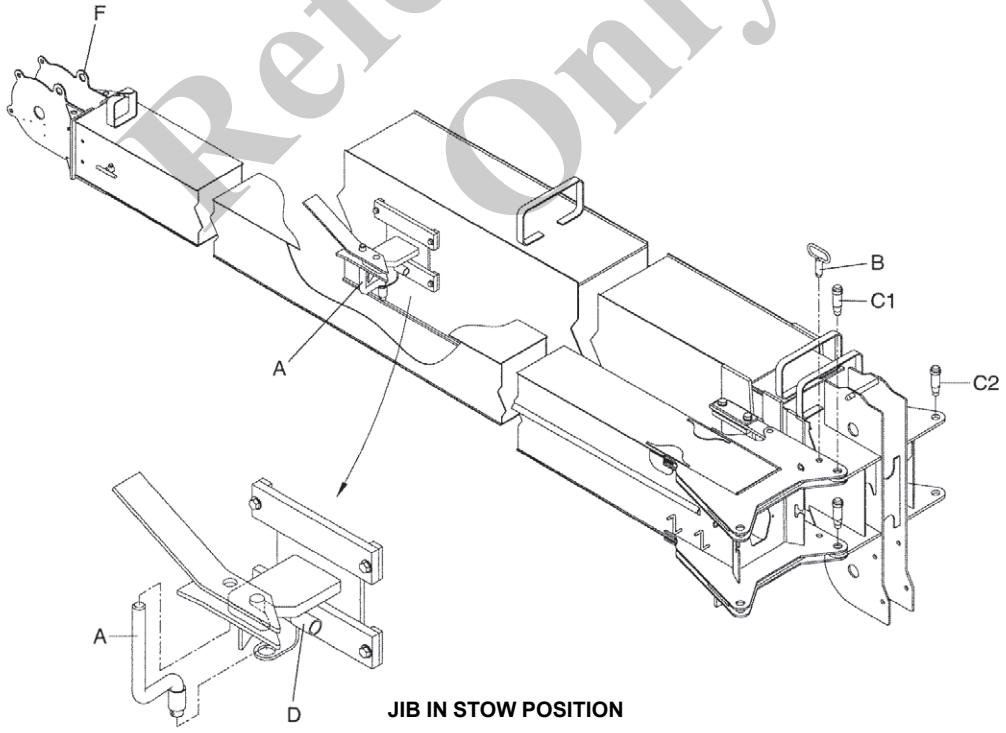


FIGURE 2-1

JIB SAFETY AND OPERATION



JIB IN OPERATING POSITION



JIB IN STOW POSITION

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 jib swing pin B, may allow jib to fall off.

   b. Extending boom with jib stowed and failure to remove swing pins, 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 jib swing 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 jib swing 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 1st section jib when pin, E, is removed. Keep personnel clear of area.

SIDE FOLDING-SWING AROUND JIB OPERATION

Deployment Procedure

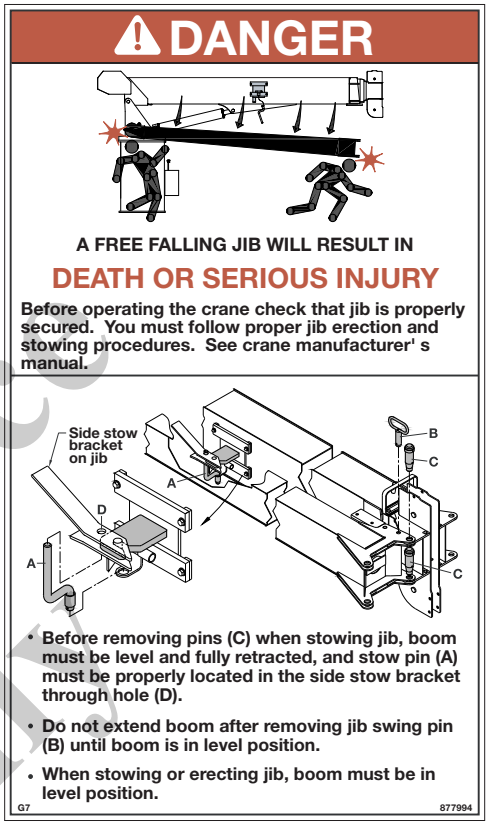
NOTE: When lowering the boom below horizontal, two persons may be required. With the telescope control in neutral, the boom may creep out when below horizontal.

4. Using boom telescope function, fully retract boom.
5. Using lift function, lower boom to allow for easier access to jib deployment pins C1 and C2.
6. 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.
7. Locate the stowed position of pins C2. If in jib attachment holes or boom sheave case jib holes, remove pins from storage location.
8. Remove jib swing Pin B from top ear of jib.
9. Remove stow Pin From ramp/side stow bracket assembly on jib and stow in Stow Loop D and install spring clip.
10. Attach tag line to sheave case end of jib.
11. Using lift function, raise boom to a horizontal position.
12. Using telescope function, slowly extend boom approximately one foot. This procedure will pull the jib out of the side stow bracket.

⚠ CAUTION

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

13. Using tag line, swing jib into deployed position.
14. 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.
15. Pivot jib into place, visually aligning the upper C2 pin holes. Install upper C2 pin and spring clip. A slight hammer strike may be necessary to install pins. Always use proper eye protection during this step.
16. Using jib jack, position jib so that lower C2 pin holes are in alignment and install lower C2 pin and spring clip.
17. 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.
18. Route loadline over jib sheave and install keeper. Install line block to end of loadline.
19. Remove anti-two-block switch and weight/chain assembly and install on jib tip. Be certain to use keeper provided with switch.
20. 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.
21. Install jib swing pin B and spring clip into jib ears.
22. 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 E and spring clip.
23. Make ATB cord connections as required.



Stowing Procedure

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.

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 E 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 boom tip. Move 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 ft (0,3 m).
11. Using tag line attached to jib sheave case, slowly swing jib into stow position (parallel with 1st 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 jib swing pin B with spring clip through jib ear and boom sheave case holes. This pin will keep the jib assembly in proper alignment with the 1st section boom. Jib swing 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/side stow 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 side stow bracket and the boom hook completely upon full retraction of the boom.
14. Install stow pin A with spring clip into the ramp/ side stow 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.

⚠ DANGER

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 proper 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:

- **Side 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 30 ft jib weight is 850 lb (385 kg) at 157 in (398 cm) from mounting pin holes. The 54 ft jib weight is 1450 lb (657 kg) at 167 in (424 cm) when retracted 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 -10 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.

JIB JACK

Operation

The jib pin alignment device consists of a hydraulic jack mounted horizontally on the underside of the jib. A handle for the jack is provided and is installed above the jack on the side of the jib.

The purpose of the jib pin alignment device is to aid in installing the fourth or “last” jib pin when setting up a jib. This device has been designed to line up the bottom jib pin hole on the left side of the crane.

To use the device, follow the proper procedure outlined in the Owner's Manual to install both jib pins on the right side of crane and the top pin on the left side. Next remove jack handle and using the flattened end, close jack release valve by turning handle clockwise until it is firmly closed. Insert the round end of the handle into the handle sleeve and pump jack until ram contacts boom sheave case. Continue to pump slowly until jib pin hole is exactly aligned with hole in boom ear. At this time the final jib pin can be easily tapped into position.

If hole alignment is “over shot” due to jacking too far, the jack can simply be relieved and the process repeated. To relieve the jack, use the flattened end of jack handle to slowly turn relief valve counter clockwise no more than one full turn.

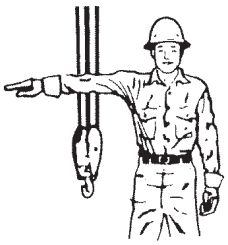
After all jib pins are installed, relieve jack. The jib pin alignment device is also useful when removing the “fourth” pin. Use the jib jack to relieve jib weight induced pressure on the “fourth” pin and it will be much easier to remove.

Once the jib has been erected or stowed, it is important that the jack handle be properly placed back on its stowage hooks and that the cotter key be properly placed in the stowage hook to retain the handle on the hook.

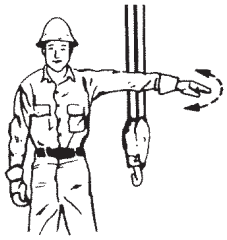
Important: Avoid “shock loads” created by quickly opening and closing the release while jack is under load. This may result in overloading of the hydraulic circuit and possible damage to the jack.

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

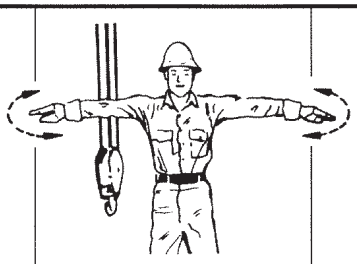
STANDARD HAND SIGNALS FOR CONTROLLING CRANE OPERATIONS



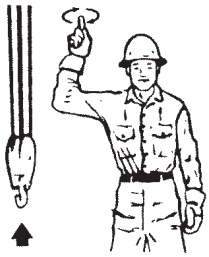
SWING. Arm extended, point with finger in direction of swing of boom.



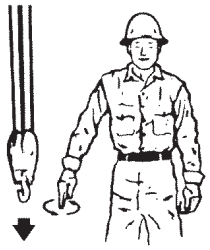
STOP. Arm extended, palm down, move arm back and forth horizontally.



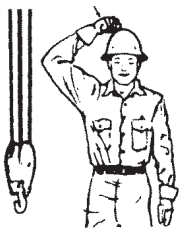
EMERGENCY STOP. Both arms extended, palms down, move arms back and forth horizontally.



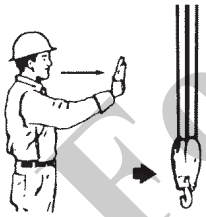
HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.



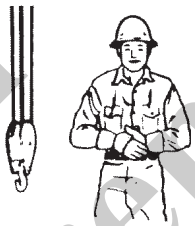
LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circle.



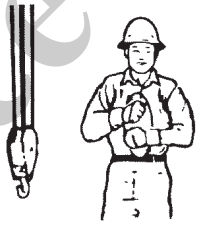
USE MAIN HOIST. Tap fist on head; then use regular signals.



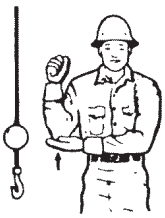
TRAVEL. Arm extended forward, hand open and slightly raised, making pushing motion in direction of travel.



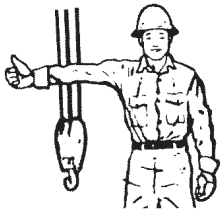
DOG EVERYTHING. Clasp hands in front of body.



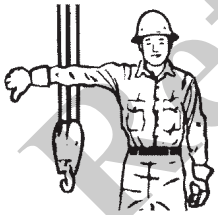
TRAVEL (Both Tracks). Use both fists in front of body, making a circular motion about each other, indicating direction of travel, forward or backward. (For land cranes only.)



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

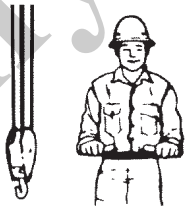


RAISE BOOM. Arm extended, fingers closed, thumb pointing upward.

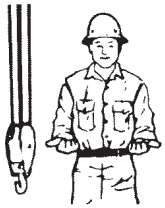


LOWER BOOM. Arm extended, fingers closed, thumb pointing downward.

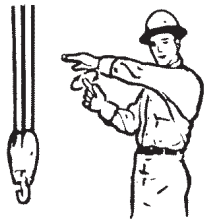
TRAVEL (One Track). Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body. (For land cranes only)



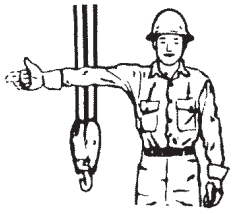
RETRACT BOOM (Telescoping Booms). Both fists in front of body with thumbs pointing toward each other.



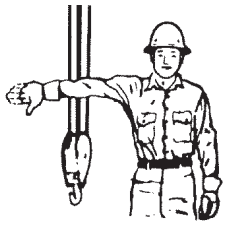
EXTEND BOOM (Telescoping Booms). Both fists in front of body with thumbs pointing outward.



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 example.)



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

OIL COOLER

Specifications

Fan RPM 2000
SCFM ..... 1900 (54,000 LPM)
Voltage ..... 12 VDC (Nom.)
Stall Max. Amp Draw ..... 75 A
Operating Amp Draw..... 18 A
Temperature Switch..... 140°F (60°C)

Oil flow through heat exchanger at 180°F (82 C) oil is 30 to 50 gpm (113 to 189 lpm) variable with pump and engine rpm.

Maximum operating oil temperature 210°F (99°C)

Operation

The oil cooler system consists of a 15 psi (1 bar) relief valve and a self-contained heat exchanger in parallel with the relief valve in the hydraulic system return line.

After the truck has been started and PTO engaged, oil flow will be determined by oil viscosity. During cold weather operation, most of the return oil will flow over the 15 psi (1 bar) relief valve because of cold oil in the heat exchanger. As the hydraulic oil heats up with crane operation, oil flow through the heat exchanger will increase and pressure through the exchanger will decrease due to thinner (less viscous) oil.

When the oil temperature heats up to approximately 140°F (60°C), the electric cooling fan will automatically be switched on and the hydraulic oil will be maintained at an acceptable operating temperature [under 210°F (99°C)]. The operating temperature will vary depending on ambient air temperature and duty cycle. To cool the oil in the reservoir rapidly, the operator may retract then extend the telescope and/or lift cylinder in order to exchange cool oil in the cylinders with the hot oil in the reservoir. Consult Service and Maintenance Section for inspection and cleaning requirements.

SECTION 3
MAINTENANCE

SECTION CONTENTS

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 mis-adjustment.
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 RCL and anti-two-block system to include switch, weight and chain at boom tip (and jib tip if equipped), power cords and reel on main boom and display console at operators station showing boom length, angle, radius and load status. Cycle slowly to check for proper operation.
18. Presence and proper operation of load hook safety latch.
19. Swing system for proper operation of dynamic and park brakes.
20. All drain holes at rear of first section boom are clear of all obstructions.
21. All fasteners retaining loadline centering block are in place and tight.

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.
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 percent 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. Un-spool 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/stabilizer 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. Crane to truck frame mounting bolts for proper torque (see Torque Chart).
14. Rotation bearing and gearbox mount bolts for proper torque (see Torque Chart).

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 3,000 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.

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 take-off.
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.

HOIST CABLE INSPECTION AND MAINTENANCE

⚠ WARNING

Worn or Damaged Equipment Hazard!

Never use a worn or damaged wire rope. Death or serious injury could result from using worn or damaged wire rope.

Wire rope should be inspected frequently/daily and periodically/yearly in accordance with the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies. Recommended inspection intervals may vary from machine to machine and may vary based on environmental conditions, frequency of lifts, and exposure to shock loads. The inspection time intervals may also be predetermined by state and local regulatory agencies.

NOTE: Wire rope may be purchased through Manitowoc Crane Care.

Any deterioration observed in the wire rope should be noted in the equipment inspection log and an assessment concerning wire rope replacement should be made by a qualified person.

Keeping Records

A signed and dated report of the wire rope's condition at each periodic inspection must be kept on file at all times. The report must cover all inspection points listed in this section. The information in the records can then be used to establish data which can be used to determine when a wire rope should be replaced.

It is recommended that the wire rope inspection program include reports on the examination of wire rope removed from service. This information can be used to establish a relationship between visual inspection and the rope's actual internal condition at the time of removal from service.

Environmental Conditions

The life expectancy of wire rope may vary due to the degree of environmental hostility and other conditions to which these mechanical devices are subjected. Variation in temperature, continuous excessive moisture levels, exposure to corrosive chemicals or vapors or subjecting the wire rope to abrasive material may shorten normal wire rope life. Frequent/ periodic inspections and maintenance of wire rope is recommended for preventing premature wear and to insure long-term satisfactory performance.

Dynamic Shock Loads

Subjecting wire rope to abnormal loads beyond the endurance limit will shorten the wire rope life expectancy. Examples of this type of loading are listed below.

- High velocity movement, for example; hoisting or swinging of a load followed by abrupt stops.
- Suspending loads while traveling over irregular surfaces such as railroad tracks, potholes, and rough terrain.
- Lifting a load that is beyond the rated capacity of the lifting mechanism, such as overloading.

Precautions and Recommendations During Inspection

- Always use safety glasses for eye protection.
- Wear protective clothing, gloves, and safety shoes as appropriate.
- Measure the rope's diameter across crowns of the strands when determining if rope has become damaged, refer to Figure 3-1.

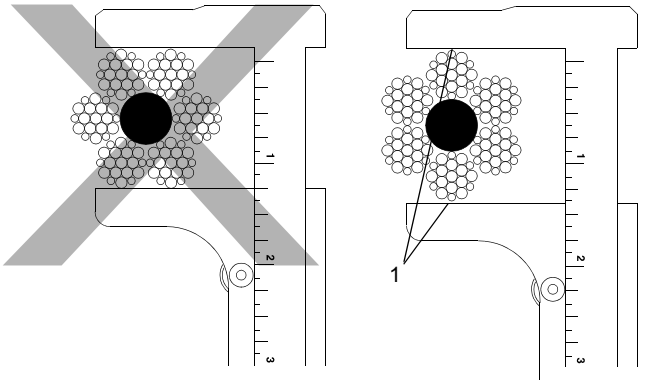


FIGURE 3-1

Inspection

All hoist cable in service needs to be inspected on a daily, monthly, and quarterly basis. Cable which has been idle for a period of a month or more must be given a thorough inspection before it is placed in service. These inspections should cover all types of deterioration including:

- Distortion such as kinking, crushing, un-stranding, bird caging, main strand displacement or core protrusion.
- Loss of cable diameter in a short cable length or unevenness of outer strands indicates the cable needs to be replaced.
- Significant corrosion.
- Broken or cut strands.
- Number, distribution and type of visible broken wires.
- Core failure in rotation resistant ropes.
- Prior electrical contact with a power line or other electric arc damage.
- Significantly corroded, cracked, bent, or worn end connections.

Only inspect the outer surface of a cable. Never attempt to open the cable.

Pay particular attention to areas of the rope where wear and other damage is likely to occur:

- Pick-up Points: Sections of wire rope that are repeatedly stressed during each lift, such as those sections in contact with sheaves.
- End Attachments: The point where a fitting is attached to the wire rope or the point where the wire rope is attached to the hoist drum.
- Abuse Points: The point where the wire rope is subjected to abnormal scuffing and scraping.

Daily Inspections

All cable in continuous service must be inspected at the beginning of each work day. Inspect the eye end and length of cable that is used in daily operation. The end should be inspected for abrasion, corrosion, broken wires, and loose or broken servings. Inspect the remainder of the cable length used for daily operations for points showing kinks, sharp bends, or any other evidences of damage or excessive wear.

Monthly Inspections

Inspect the eye end and length of cable normally used in daily operations. Examine the rest of the cable for kinked, crushed or otherwise damaged points.

Periodic Inspections

Wire rope should be inspected periodically/annually, or at a shorter time interval, if necessitated by environmental or other adverse conditions, and shall cover the entire length of the wire rope. Periodic inspection should include all previous items listed under *Inspection*, plus the following:

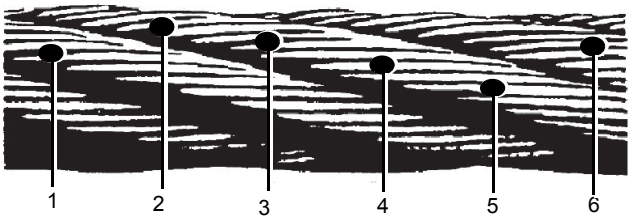
- Inspect for severely corroded or broken wires at end connections.
- Inspect wire rope in areas subjected to rapid deterioration such as:
  - Sections in contact with saddles, equalizer sheaves, or other sheaves where wire rope travel is limited.
  - Sections of wire rope at or near terminal ends where corroded or broken wires may protrude.
- Inspect boom nose sheaves, hook block sheaves, boom extension/extension 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.

Inspect the eye end of the cable for greater wear than the rest of the cable. If the cable is in good condition, reverse the cable on the drum so that the wear is equalized along the total length of the cable.

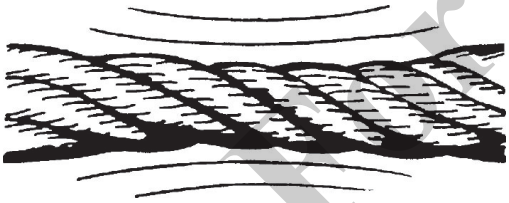
Wire Rope Replacement

It is difficult to determine the exact time for replacement of wire rope (hoist cable) since many variable factors are involved. Proper determination of the condition of a rope depends upon the judgment of an experienced person. The following reasons are sufficient for consideration of rope replacement:

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



- In rotation resistant ropes: two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters
- Wear of one-third the original diameter of outside individual wires. Worn rope, usually indicated by flat spots on the outer wires is unsafe for further use when less than two-thirds the thickness of the outer wire remains.
- Necking down of the rope indicates core failure.



- Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.
- Evidence of heat damage.
- Reductions from nominal diameter of more than 5%:
  - 0.0156 in (.4 mm) for rope diameters to 0.313 in (8 mm)
  - 0.031 (.8 mm) for rope diameters 0.375 in (9.5 mm) to 0.50 in (12.7 mm)
  - 0.047 in (1.2 mm) for rope diameters 0.561 in (14.3 mm) to 0.75 in (19.1 mm)
  - 0.063 (1.6 mm) for rope diameters 0.875 in (22.2 mm) to 1.125 in (28.6 mm).
- 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.
- n 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.

Care of Wire Rope

Handle wire rope with care to prevent damage to the individual wires which affect the overall strength and performance of the rope. Do not allow the formation of kinks, because this displaces the strands of wire from their original position and relation to each other causing severe bending and unequal tensions in the strands. This distortion and wire displacement cannot be corrected even under high tension and a permanent weak point remains in the rope. Displaced or raised wires indicate a previous kink, but does not show the damaged condition of the inner rope wires.

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

Do not use worn sheaves or sheaves with flat grooves because they do not provide sufficient support to prevent the distortion and flattening of the rope. Sheaves with nicked or broken flanges can cut or otherwise damage the rope.

An even distribution of rope coils over the hoist drum is essential to smooth operation. This prevents the rope from cutting down through or crushing other coils on the drum resulting in damage to and difficulty in unwinding the rope.

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.

Standard

5/8 in Dia. Wire Rope	Rotation Resistant
(Main and Auxiliary Hoist)	Nominal Breaking
	Strength 22.7 tons

Optional

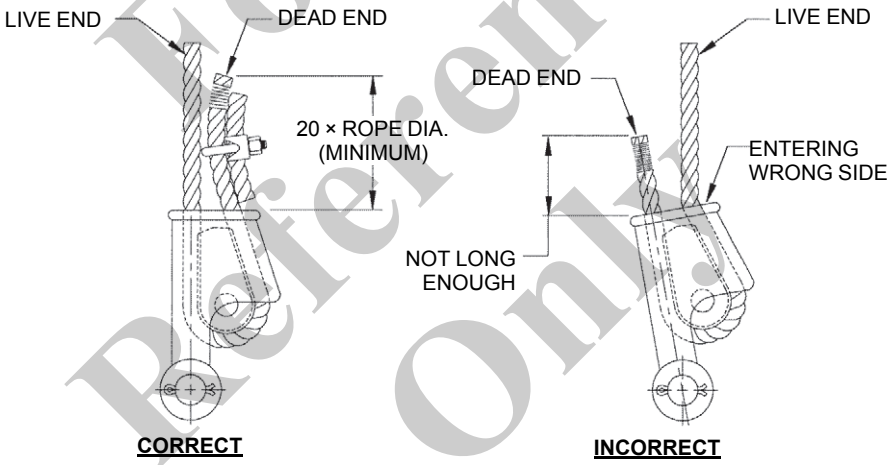
5/8 in Dia. Wire Rope	6x25 General purpose
(Main and Auxiliary Hoist)	Nominal Breaking
	Strength 20.6 tons

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

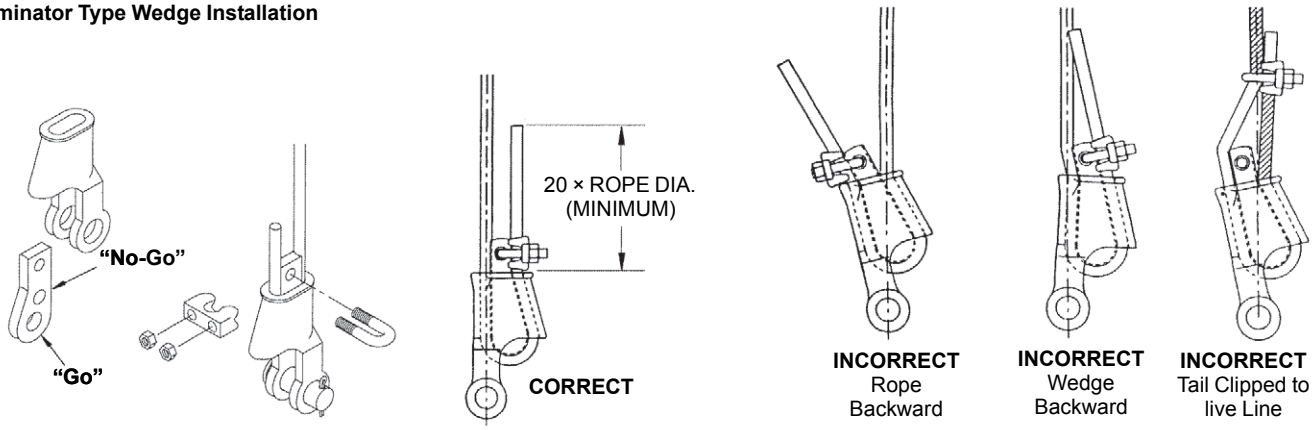
lifting ropes. High strength, rotation resistant is preferred and furnished standard by National Crane. This rope eliminates single part line load spin. It also eliminates load block spin up when multi-part reeving is used which results in prolonged rope life.

Wire Rope Installation

1. Unspool approximately 40 ft (12 m) of cable and route the cable through the boom cable guides block at the front of the boom back to the hoist. 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 with 5/8 in diameter wire rope. Remove the top pin from the sheave case and lay the cable over the right sheave as viewed from sheave case. Replace pin and spring clip. Start truck from crane cab with PTO engaged. Program RCL and turn crane power switch on. With crane outriggers extended and set, unspool the remainder of the cable [approximately 350 ft (100 m)] out from the truck being sure the cable is straight and without kinks. Attach wedge socket as shown in the Loadline Section. Torque cable clamp (clip) to 95 lb-ft (128 Nm). This torque must be rechecked after initial operation of crane. Be sure cable clamp is attached to the free end of the cable only. Special care should be taken to reeve the cable through the wedge socket as shown in following figure.
2. Spool the loadline onto the hoist drum while maintaining approximately 500 lb (226 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). Verify that the first wrap of cable is properly seated in the grooves of the hoist drum. 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 second, third and fourth layers will wrap smoothly guided by the first layer wrapping. After cable is completely wrapped on drum, remove lower pin and retain cable in right sheave as viewed from sheave case.



Terminator Type Wedge Installation



Rope Size (inch)	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/8	1-1/4
*Torque lb-ft	45	65	65	95	95	130	225	225	225	360
* 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.

INSTALLING CABLE ON THE HOIST

CAUTION

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

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

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

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

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

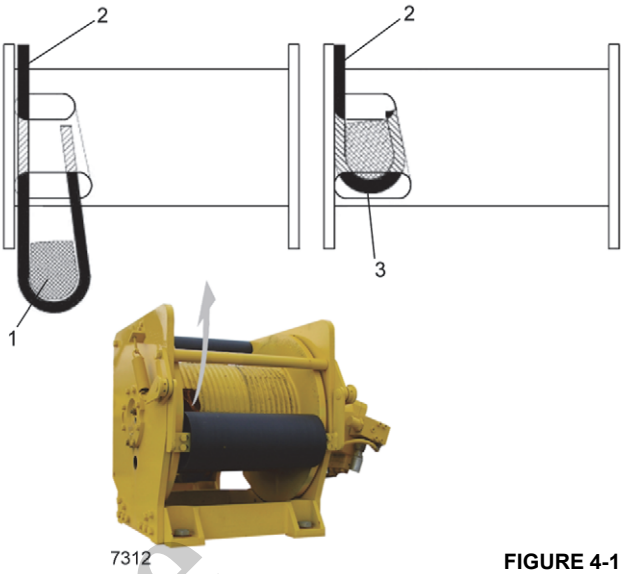


FIGURE 4-1

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

NOTE: If the wedge does not seat securely in the slot, carefully tap (3) the top of the wedge with a mallet.

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

SECTION 4
LUBRICATION

SECTION CONTENTS

GENERAL

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

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

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.

Lubricants

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

Arctic Lubricants and Conditions

Temperatures Below -9°C (15°F)

Regions with ambient temperatures below -9°C (15°F) are considered arctic. In general, petroleum based fluids developed especially for low temperature service may be used with satisfactory results in these temperatures. However, certain fluids, such as halogenated hydrocarbons, nitro hydrocarbons, and phosphate ester hydraulic fluids, may not be compatible with hydraulic system seals and wear bands. Therefore, always check with an authorized Manitowoc distributor or Manitowoc Crane Care if in doubt of the suitability of a specific fluid or lubricant.

When operating in cold weather and regardless of the oil viscosity of the crane's lubricants, always follow the cold weather start-up and operating procedures described in the *Operator Manual* to ensure adequate lubrication during system warm-up and proper operation of all crane functions.

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 C (F)
75W	-40°C (-40°F)
80W	-2°C (-15°F)
85	-12°C (+10°F)
90	-7°C (+20°F)
140	+5°C (+40°F)
250	+10°C (+50°F)

Open Gear Lubricant

This is a special high-graphite adhesive lubricant that helps to eliminate fretting corrosion, is water resistant, and forms a dry lubrication film which does not attract dust. Lubricant meets NLGI Class 1-2 specifications.

Low Temperature Grease

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

Anti-wear Additives

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

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.

CAUTION

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

NOTE: When operating the crane in temperatures -9°C (15°F) and below, follow the procedures in the section titled "Cold Weather Operation" on page 20.

Standard Hydraulic Oil

Temperature Above -9°C (15°F)

The factory fill standard hydraulic oil is SAE grade 10W-20 Hydraulic Oil. This fluid is acceptable for operating temperatures above -9°C (15°F).

NOTE: On units equipped with self-leveling platforms, low temperature service oils are necessary to provide proper boom functions at temperatures below -9°C (15°F).

CAUTION

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

Arctic Hydraulic Oil

Temperature Down to -9°C (15°F) to -29°C (-20°F)

For colder operating conditions, the standard fluid may be replaced with a petroleum based fluid developed especially for colder environments.

Temperature Down to -40°C (-40°F) and Below

Petroleum based fluids developed especially for low temperature service may be used with satisfactory results. However, certain fluids, such as hologenated hydrocarbons, nitro hydrocabons and phosphate ester hydraulic fluids might not be compatible with hydraulic system seals and

wear bands. Arctic hydraulic oil is not recommended for service in ambient temperatures above 0°C (32°F).

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

NOTE: All fluids and lubricants may be purchased by contacting the Manitowoc Crane Care Parts Department.

Hydraulic Oil Inspection

Environmental and other conditions can dramatically affect the condition of hydraulic oil and filters. Therefore, specific intervals for servicing/changing hydraulic oil, filters and hydraulic tank breathers cannot be set. However, it is imperative for the continued satisfactory performance that inspections be performed on the basis of how and where each crane is used. Air borne and ingested contaminants can significantly reduce the life of oil and the condition of hydraulic oil filters and tank breathers.

Under normal operating conditions, it is recommended that hydraulic oil, filter and breathers be inspected at least every three to six months and more frequently for severe operating conditions. The inspections should be for air borne and/or ingested particles and water that deteriorate and contaminate the oil. For example, if oil appears “milky” or no longer has a transparent clear to amber color. The return filter by-pass indicator should be observed daily to determine if contaminant content is high. If the indicator reaches the red zone or indicates a by-pass condition, the hydraulic oil must be sampled. The hydraulic tank breather should also be inspected to assure that it is not restricting air flow into and out of the reservoir.

To inspect the hydraulic oil, fill a small glass container with a sample of the reservoir oil and another glass container with fresh oil. Let the samples stand, undisturbed, for one or two hours. Then, compare the samples. If the reservoir oil is heavily contaminated with water, the sample will appear “milky” with only a small layer of transparent oil on top. If the “milky” appearance is due to air foaming, it will dissipate and the oil should closely match the fresh oil. Remember, replacement oil must meet ISO 17/14 or better cleanliness level and must meet John Deere Standard JDM J20c. Contact your National Crane distributor or Manitowoc Crane Care if you have any questions.

Surface Protection for Cylinder Rods

Steel cylinder rods include a thin layer of chrome plating on their surfaces to protect them from corroding. However, chrome plating inherently has cracks in its structure which can allow moisture to corrode the underlying steel. At typical ambient temperatures, hydraulic oil is too thick to penetrate these cracks. Normal machine operating temperatures will allow hydraulic oil to warm sufficiently to penetrate these cracks and if machines are operated daily, protect the rods. Machines that are stored, transported, or used in a corrosive environment (high moisture, rain, snow, or coastline conditions) need to have the exposed rods protected more frequently by applying a protectant. Unless the machine is operated daily, exposed rod surfaces will corrode. Some cylinders will have rods exposed even when completely retracted. Assume all cylinders have exposed rods, as corrosion on the end of the rod can ruin the cylinder.

It is recommended that all exposed cylinder rods be protected using Boeshield® T-9 Premium Metal Protectant. Manitowoc Crane Care has Boeshield T-9 Premium Metal Protectant available in 12 oz. cans that can be ordered through the Parts Department.

NOTE: Cylinder operation and inclement weather will remove the Boeshield protectant. Inspect machines once a week and reapply Boeshield to unprotected rods.

The following sections describe the lubrication points and gives the lube type, lube interval, lube amount, and application of each. Each lubrication point is numbered, and this number corresponds to the index number shown on the Lubrication Points (See “Lubrication Points” on page 4-5). Lube description and symbols are found in tables below.

LUBRICATION

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

⚠ DANGER

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

CAUTION

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

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

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

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

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

CAUTION

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

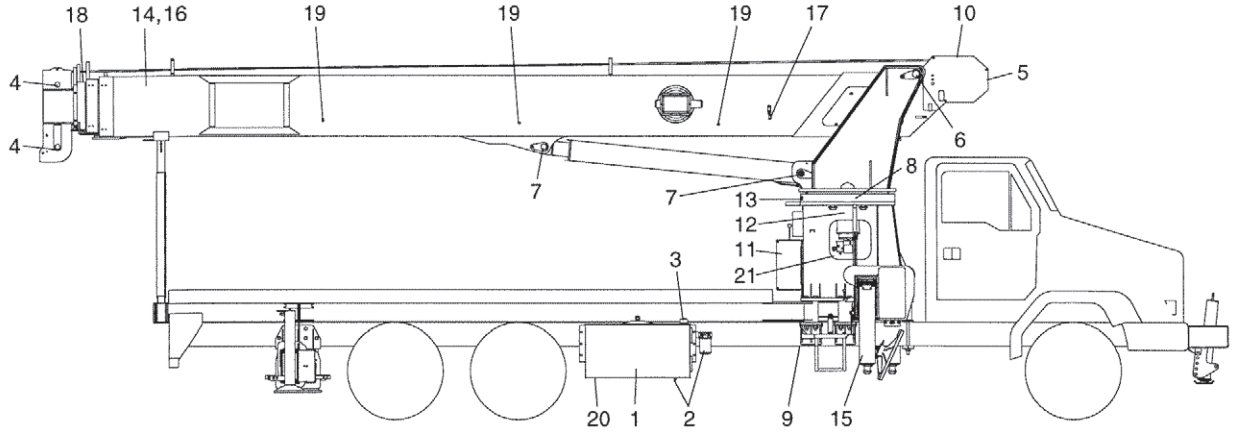
NOTE:

The following describe the lubrication points and gives the lube type, lube interval, lube amount, and application of each. Each lubrication point is numbered, and this number corresponds to the index number shown on the Lubrication Points (“Lubrication Points” on page 5). Lube description and symbols are found below in Table 4-1.

Table 4-1

Symbol	Description	Manitowoc Lube Specification	
		Standard	Cold Weather - 40°C (-40°F)
AFC	Antifreeze/Coolant (for Cab Heater)	6829101130	6829104212
EP-MPG	Extreme Pressure Multipurpose Grease	6829003477	6829104275
GL-5	GL-5 Gear Lubricant	6829012964	6829014058
HYDO	Hydraulic Oil	6829006444	6829006993
EP-OGL	Open Gear Lubricant, CEPLATTYN 300 Spray, NLGI Grade 1-2	6829102971	6829102971
AGMA EP-4	Extreme Pressure Gear Lubricant.	6829100213	6829103636
WRL	Wire Rope Lubricant	6829015236	6829010993
EO-20W-20	Engine Oil (Light non-EP Oil), Mil-L-46152	6829005570	-
TES 295	TES295 Compliant Fluid	-	6829101690
NOTE: Cold weather lubricants are not sufficient for temperatures below 40° C (-40° F). Use hydraulic tank heaters and insulate where appropriate.			

Lubrication Points



APPLICATION	RECOMMENDED LUBRICANT	PROCEDURE	FREQUENCY
1. Hydraulic Oil Reservoir	Hydraulic Oil	Check Fill Change	Weekly As Required 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, Block - 1, Rooster Sheave - 1	Chassis Grease	Grease Gun	Weekly
5. Load line - 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	Weekly
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	Weekly Semi-Annually
10. Hoist Drive *(See Hoist Service Manual in this section for Oil Checking & Changing Procedures)*	Refer to Hoist Manual for Oil Recommendation on Hoist	Change Check & Fill Change	After first 100 Operating Hours 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	Open Gear Lube	Grease Gun	Monthly
14. Boom Extension	Low Temp. Chassis Grease or Never - Seize or Dry Film Lubricant	Brush, Roller or Grease Gun Spray Can	Monthly or As Required As Required
15. Outrigger Beams, Bottom, Sides	Low Temp. Chassis Grease or Dry Film Lubricant	Brush or Roller Spray Can	Monthly or As Required
16. Boom Extend/Retract Cables	Open Gear Lube	Brush or Spray	Anytime Boom is Disassembled or 3 Years
17. Wire or Hose Rollers	SAE-10W	Oil Can	Quarterly
18. Extend Sheaves	Chassis Grease #200S Silver Streak Special Multi-Lube (light)	Grease Gun w/ Nozzle tip. See Boom Maintenance Section	Weekly

19. Retract Sheaves Extend boom until retract sheave grease holes are visible through access holes along side of boom.	Chassis Grease #200S Silver Streak Special Multi-Lube (light)	Grease Gun w/ Nozzle tip. See Boom Maintenance Section	Weekly
20. Diffuser, Strainer		Clean	Semi-Annually with oil change
21. Optional Continuous Rot. Swivel	Chassis Grease	Grease Gun	Monthly
22. Boom Top Wear Pads	Chassis Grease	See Boom Wear Pad Lubrication in this section	

BOOM LUBRICATION

This crane boom is painted with an exclusive highly wear resistant/lubricating enhanced polymer coating. This coating was formulated and tested specifically for use on crane boom and outrigger extension sections. It has shown excellent long lasting durability and good smooth boom operation without use of boom lubrication during field and laboratory testing conducted by National Crane. However, we do not represent this as a life time coating system which never needs lubrication.

Greasing these boom sections with chassis grease will not harm the paint. Grease may improve the extension system performance. Please inform us if you find it necessary to grease the boom sections.

Since field tests cannot simulate every condition, we are interested in how this coating performs in your application without lubrication. Your comments about your experience with this system would be appreciated. Please contact National Crane Product Support Service at telephone 402-786-6300 or FAX 402-786-6379.

INNER BOOM PAD LUBRICATION

Outriggers and stabilizers should be fully deployed with crane set up on a level surface during the boom pad lubrication process.

WARNING

Fall Hazard!

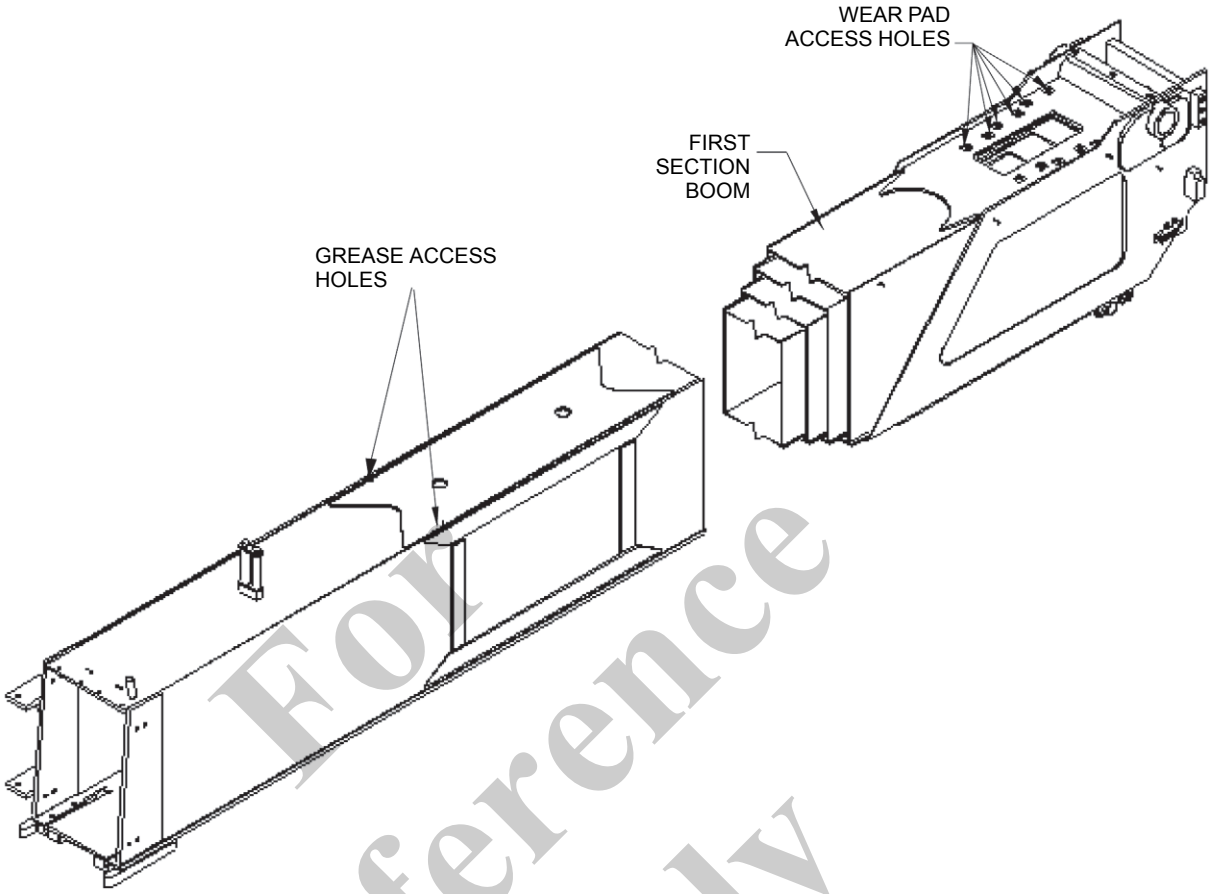
Do not, under any circumstances, work at an elevated height without using proper fall protection as required by local, state or federal regulations.

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 plate.
2. With boom over rear of truck, fully extend boom and then lower to the lowest angle possible. It may be necessary to first turn boom slightly to miss boom rest. The upper rear pad retention pockets will be under the 1/4 in (6,35 mm) grease access holes in the butterfly plates on the top of the boom sections.
3. Using a 1/4 in (6,35 mm) 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.

Side and Bottom Boom Wear Pad Lubrication

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers.
2. Lower the boom to horizontal.
3. Fully extend the boom and apply grease to the side and bottom of the 2nd, 3rd, and 4th sections with a brush.
4. Raise the boom to 75° and retract the boom.
5. Extend and retract the boom several times until the grease is evenly spread.
6. Repeat as necessary.



Outrigger Beam Lubrication

DANGER

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

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers. Refer to (Figure 4-1.)
2. Apply grease to all wear pads and contact surfaces at the side and bottom of all beam sections and lower surface of the stabilizer/jacks with a suitable brush or putty knife.
3. Extend and retract the outriggers several times until the grease is evenly spread.
4. Repeat as necessary.

8352-2 **FIGURE 4-1**

Hoist Brake Oil

DANGER

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

Check Hoist Brake Oil

To check the hoist brake oil, remove the inspection plug (Figure 4-2) and visually inspect the oil level. The fluid should be visible within the bottom of the inspection hole. If more fluid is needed, add through the brake oil vent and fill plug hole.

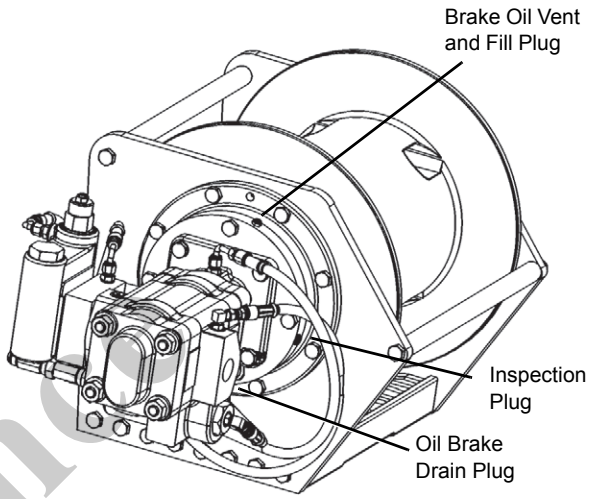
Drain /Add New Hoist Brake Oil

To drain and add new oil, remove the drain plug (Figure 4-2), inspection plug and vent plug and drain the brake oil. Reinstall drain plug and add fluid at the brake oil vent hole until oil is at the top level of the inspection hole. Install the inspection plug and the oil vent and fill plug. See“Lubrication” on page 3.

NOTE: Brake lubricants are satisfactory for operation in temperatures from -23° C to 66° C (-10° F to +150° F). For operation outside this range, contact Manitowoc Crane Care for recommendations.

DANGER

Do not use EP type gear lubes in the brake section. This may prevent proper operation and cause the load to fall resulting in serious injury or death.



7142 **FIGURE 4-2**

Hoist Gearbox Oil

Check hoist gearbox oil level:

- Rotate the drum until the oil fill/level plug (Figure 4-3) is visible in the inspection hole.
- Remove the fill/level plug and visually inspect the oil level. The oil should be level with the bottom of the inspection hole. Add oil as required and reinstall oil fill/level plug.
- To drain and add new oil, remove the vent plug (Figure 4-3) and then screw a 1” pipe into the drain plug hole to allow the oil to drain. Remove the drain plug with a hex head socket and drain hydraulic oil. Remove the 1” drain pipe and install drain plug.

Fill hoist gearbox with oil.

- To fill with oil, rotate the drum so the oil fill/level port (Figure 4-3) is visible through the upper hole. Install a 1” pipe with elbow into the fill hole to assist in adding oil. Remove oil fill/level plug with a hex socket and fill gear box with gear lube oil. See“Lubrication” on page 3.

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

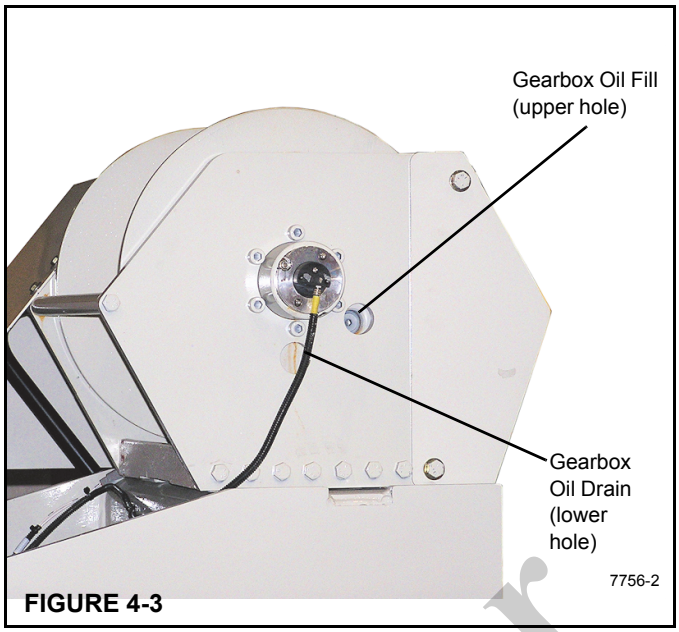


FIGURE 4-3

Swing Gearbox and Brake Oil

Check Swing Gearbox oil level:

The oil in the gearbox and brake sections is recommended to be changed after first 50 hours of operation and every 1000 hours or 6 months of usage.

1. Examine the used oil for signs of significant metal deposits.
2. Fill the swing gearbox with the appropriate amount and type of oil and then replace plug and vent. *See "Lubrication" on page 3 of this manual.*

Gearbox oil level inspection is achieved by removing the gearbox fill/vent plug and visually inspecting the oil level. Maximum oil level is to be 1" below the port for this gearbox with of gear lube oil.

Hydraulic Oil Reservoir Level

The hydraulic oil reservoir has a sight gauge and decal located on the side of the reservoir (Figure 4-4). The oil in the hydraulic reservoir is sufficient when the level is between the upper and lower marks on the decal with the crane parked on a level surface in the transport position and the oil cold.

If the oil level is too low, add the recommended hydraulic oil until the oil level is even with the upper mark. If the oil level is high, drain oil until the oil level is even with the upper mark.

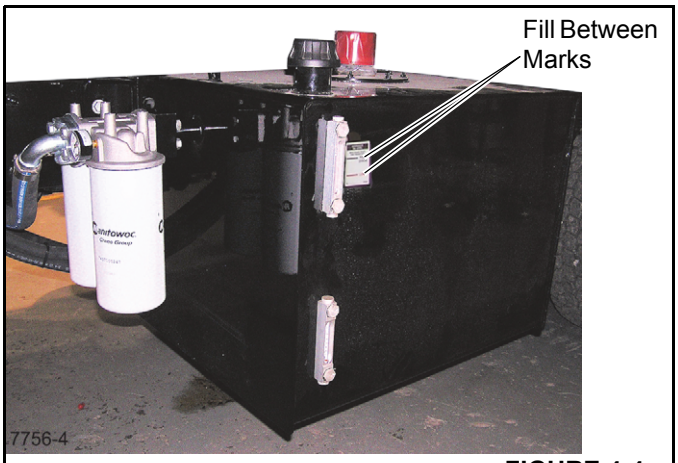


FIGURE 4-4

WIRE ROPE LUBRICATION

Wire rope is lubricated during manufacture and the lubricant applied does not last the life of the rope. The wire rope must be lubricated as part of a regularly scheduled maintenance program. The lubricant applied must be compatible with the original lubricant and not hinder visual inspection of the rope. Consult the rope manufacturer for proper lubricant. The sections of rope which are located over sheaves or otherwise hidden during inspection and maintenance procedures require special attention.

The object of rope lubrication is to reduce internal friction and to prevent corrosion. The type and amount of lubrication applied during manufacture depends on the rope size, type, and anticipated use. This lubrication provides the finished rope with protection for a reasonable time if the rope is stored under proper conditions. When the rope is put into service, periodic applications of a suitable rope lubricant are necessary. Characteristics of a good wire rope lubricant are that it should be:

- free from acids and alkalis.
- have sufficient adhesive strength to remain on the rope.
- of a viscosity capable of penetrating the interstices between wires and strands.
- not be soluble in the medium surrounding it under the actual operating conditions (i.e. Water).
- have a high film strength.
- resistant to oxidation.

Before applying lubrication, accumulations of dirt or other abrasive material should be removed from the rope. Clean with a stiff wire brush and solvent, compressed air, or live steam. Lubricate the rope immediately after the rope is cleaned. Techniques that can be used include:

- bath

- dripping
- pouring
- swabbing
- painting
- pressure spray

Whenever possible, the lubricant should be applied at the top of a bend in the rope, because at that point the strands are spread by bending and are more easily penetrated. There should be no load on the rope while it is being lubricated. The service life of wire rope is directly proportional to the effectiveness of the method used and amount of lubricant that reaches the working parts of the rope.

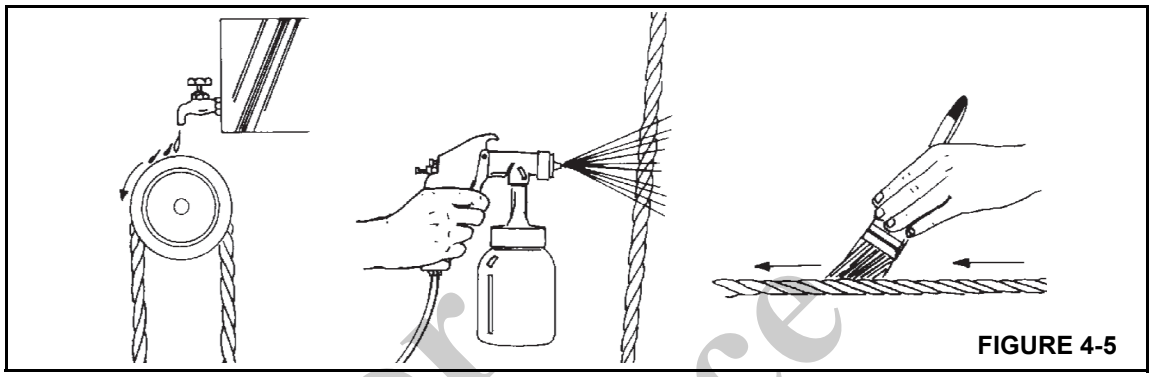


FIGURE 4-5

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 Crane 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 cleanings if the crane is operated:

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

Cleaning Procedures

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

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

CAUTION

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

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

- 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

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. 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 oz 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.

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.

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

Item	Description
8	O/R Hose Connections
9	Valve Bank, Hose Connections
10	Hose Connections
11	Entire underside of unit
12	Hook Block/Headache Ball
13	Pins, Clips for Optional Jib
14	Hanger Hardware for Optional Jib
15	Turntable Bearing Fasteners
16	Power Train Hardware

SECTION 5
SERVICE

SECTION CONTENTS

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 overlooked.
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 reusable fittings, the hose curvature must be taken into consideration when assembling and positioning the angled stem.

Fatigue of Welded Structures

Experience has shown that highly stressed welded structures when repeatedly subjected to varying stresses caused by twisting, shock, bending, and intentional and/or unintentional overloads, often become subject to weld cracking which may be attributed to fatigue of the welded joint. This condition is not uncommon in construction equipment.

Equipment should be periodically inspected for evidence of weld fatigue. The frequency of these inspections should increase with the age of the equipment and the severity of the application.The following are known high stress areas applicable to Grove machines, and a visual inspection of these areas should be made part of an owner's planned preventive maintenance program:

- Telescopic Boom: wear pad retaining structures, hydraulic cylinder attaching points, boom pivot shaft retaining structures.
- Outrigger pads, beams, boxes and attachment structures.
- Main frame: generally in the area of doubler plates and crossmembers; at the junction of front and rear frame members on truck cranes.
- Turntable bearing connection—where bearing is welded to the crane superstructure or chassis.
- Counterweight support structures.
- Chassis axle and suspension mounting structures.
- 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 thorough visual inspection of all weldments is good practice.

Anyone requiring more detailed inspection instructions and/or repair procedures may request same by contacting your local Manitowoc distributor.

Loctite

⚠ CAUTION

Skin and/or Eye Hazard!

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

Always follow the directions on the Loctite® container, as not all Loctite® types are suitable for all applications.Various types of Loctite® are specified throughout the Service Manual. The following types of Loctite® brand adhesives are available from the Parts Department of the local Manitowoc distributor.

Application of Medium Strength Loctite®

NOTE: The fastener may be re-used; the adhesive may be re-applied over cured adhesive residue.

The following procedure covers the proper application and curing method for medium strength Loctite® adhesive/sealant (Loctite® #243).

NOTE: Ensure the threaded surface, both male and female, is clean of contaminants and free of dirt and oil. Adhesive/Sealant Application

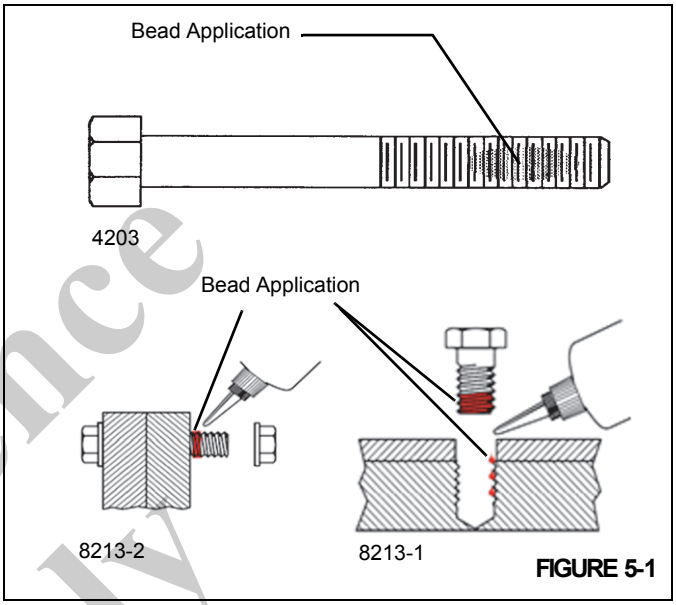


FIGURE 5-1

1. Apply a bead perpendicular to the thread, several threads wide, in the approximate area of threaded engagement (see Figure 1-1).
2. In a blind hole application, a bead of several drops of adhesive should be applied into the bottom of the hole to be hydraulically forced up during engagement.

After application and engagement of mated threads, fixturing will occur within five (5) minutes. Time required to achieve full strength is 24 hours.

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.

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.

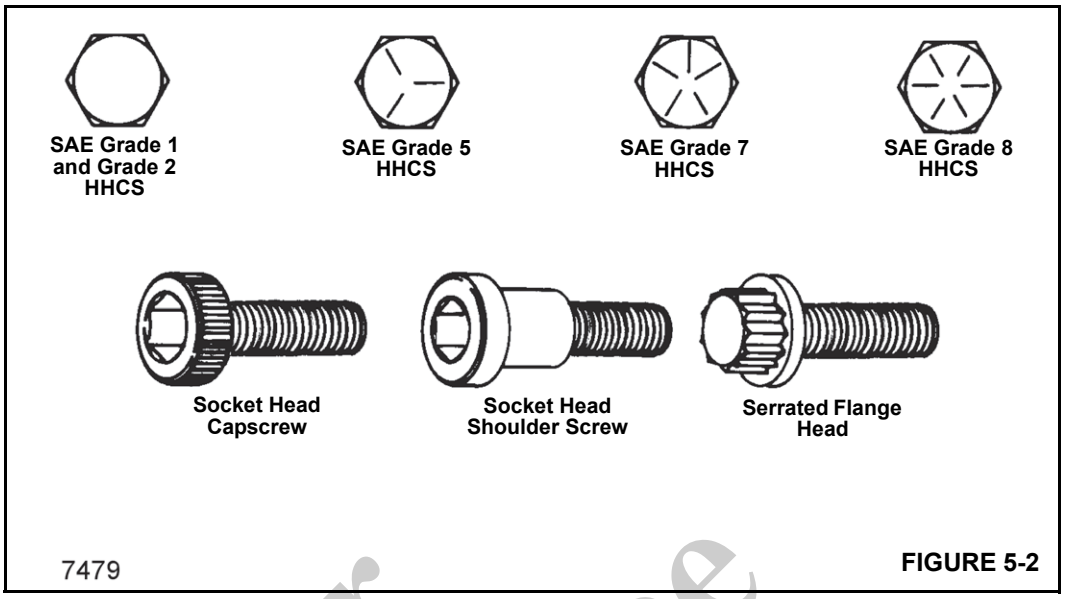


FIGURE 5-2

Table 5-1: UNC (Coarse) Thread: Torque Values for Zinc-Flake Coated and Untreated Fasteners

		Bolt Diameter - Inches												
		Torque Values (lb-ft, 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 7.7	19 17	32 30	52 48	78 72	114 106	156 144	270 249	416 384	606 560	813 751	1141 1053	2028 1865
	8	12.5 11.5	26 24	48 44	73 67	120 110	161 143	234 216	385 355	615 567	929 857	1342 1234	2043 1885	3276 3024

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

Table 5-2: UNF (Fine) Thread: Torque Values for Zinc-Flake Coated and Untreated Fasteners

		Bolt Diameter - Inches												
		Torque Values (lb-ft, 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 9	21 19	36 34	57 53	88 81	126 116	182 167	312 287	458 421	658 606	882 814	1251 1155	2288 2105
	8	14.5 13.5	26 24	53 49	85 79	125 115	177 163	250 230	425 393	672 620	1009 931	1500 1380	2092 1925	3640 3360

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

Table 5-3: Metric Fasteners, Coarse Thread, Zinc-Flake Coating

Bolt Diameter - Metric

Torque Values (Nm)

Class	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 5-4: Metric Fasteners, Coarse Thread, Untreated

Bolt Diameter - Metric

Torque Values (Nm, Maximum/Minimum)

Class	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 2,8	6,5 5,9	11 10	19 17	27 25	53 49	93 85	148 136	230 212	319 294	447 413	608 562	774 714	1134 1046	1538 1420
10.9	4,5 4,1	9,2 8,5	16 14	26 24	38 35	75 69	130 120	212 195	322 298	455 418	629 581	856 790	1089 1005	1591 1469	2163 1997
12.9	5,4 4,9	11 10	19 17	31 28	45 42	89 83	156 144	248 228	387 357	532 490	756 698	1029 949	1306 1206	1910 1763	2595 2395

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

Bolt Diameter - Metric

Torque Values (Nm)

Class	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 5-6: Metric Fasteners, Fine Thread, Untreated

Bolt Diameter - Metric

Torque Values (Nm, Maximum/Minimum)

Class	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 27	57 53	57 53	100 92	160 147	248 229	345 318	483 446	657 607	836 771	1225 1130	1661 1534	— —	— —
10.9	41 38	81 75	81 75	1140 130	229 211	348 322	491 451	679 627	924 853	1176 1085	1718 1587	2336 2157	— —	— —
12.9	49 45	96 90	96 90	168 156	268 246	418 386	575 529	816 754	1111 1025	1410 1302	2063 1904	2800 2590	— —	— —

Table 5-7: UNC (Coarse) 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 5-8: Metric Coarse 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 5-9: 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

T-2-4

Label Parts When Disassembling

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

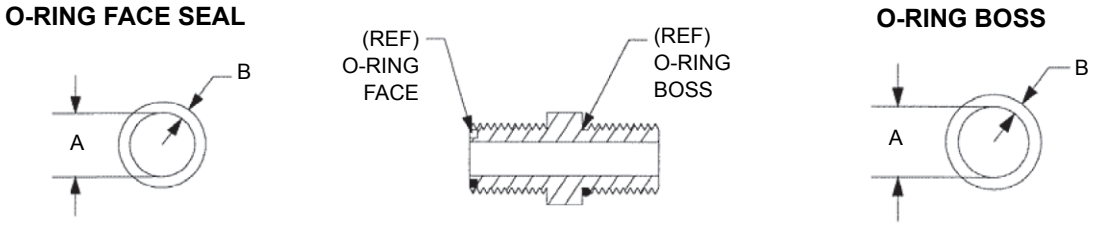
When shims are removed, tie them together and identify them as to location. Keep shims clean and flat until they are reinstalled.

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.

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. (mm)	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)	0.250 (6,35)	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)	0.375 (9,53)	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)	0.500 (12.,70)	8	0.644 (16.36)	0.087 (2.21)	3/4-16	888415*
**897066	1-14	0.07 (1,78)	0.614 (15,60)	0.625 (15,88)	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)	0.750 (19,05)	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 (25,40)	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 (31,75)	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 (38,10)	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)

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	• RCL power switch in truck cab off.	• Turn RCL power switch on.
	• Load too heavy.	• Check Capacity Chart.
	• RCL inoperative.	• Insure RCL is programmed properly and Anti Two Block/Overload solenoids are powered.
	• 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 or replace.
Poor hydraulic system performance	• Pump not operating at proper speed or proper displacement.	• Check PTO ratio, pump size and engine speed for proper oil flow (see pump manual).
	• 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.
	• Plugged diffuser.	• Remove from tank and clean.
	• Boom holding valves out of adjustment or dirty.	• Adjust or clean as required.
	• Hydraulic oil too cold.	• Warm oil or use less viscous oil.
	• Line restricted.	• Check lines; clean and repair as necessary.
	• Plugged suction strainers.	• Remove strainers from tank and clean.
	• Internal valve crack.	• Replace valve.
	• Load too heavy.	• Check Capacity Chart and reduce load.
	• Oil temperature too high.	• Reduce engine RPM or slow cycle time to cool oil. Add oil cooler option if not equipped.

TROUBLE DIAGNOSIS (continued)

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
Turn moves erratic or loosely	• Loose turntable bearing. • Loose swing gearbox mounting bolts. • Worn gears or bearing. • Operator control of lever too erratic. • Motor counterbalance valves dirty or not set properly. • Brake not holding properly. • Brake releasing at wrong time or erratically.	• Torque bearing mounting bolts. • Tighten bolts. • Replace worn parts or adjust gearbox spacing. • Operate controls smoothly. • Clean or replace counterbalance valves not set at 600 psi. • Check for no pressure in brake pilot line when turn is in neutral. • Replace worn brake parts or shim brake to proper torque. • Bleed air from brake with bleed screw on side of brake.
Turn will not function	• Attempting to swing up too much of incline. • Turn circuit relief valves sticking. • Turntable bearing drag. • Brake not releasing properly. • Swing speed adjustment set too low.	• Level machine. • Clean and check circuit pressure. • Lubricate thoroughly as rotating boom. • Check for 200 + psi (1,4 MPa) brake pilot pressure. Clean pilot line or adjust motor counterbalance valves. • Adjust or clean brake for proper release. • Adjust valve on turn motor.
Excessive noise during operation	• Low oil temperature. • Low hydraulic oil supply. • Suction line kinked, collapsed or blocked. • Hydraulic oil too thick. • Plugged suction strainers. • Relief valve chattering. • Swing brake dragging. • Hydraulic tubing vibration. • Tank breather plugged.	• Allow unit to warm up. • Check and fill with crane in travel position. • Clear blockage. • Warm oil or use oil more applicable to environment. • Remove from tank and clean. • Dirt in relief valve or damaged relief. • Bleed air from brake line at fitting on brake housing. • Check for loose tubing. • Clean breather.
Cylinders drift	• Worn or damaged piston seals. • Air in hydraulic oil. • Loose holding valve. • Dirt in holding or check valve.	• Replace as required. • Cycle operate crane cylinder to remove air. • Tighten valve. • Clean valve.

TROUBLE DIAGNOSIS (continued)

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
Hoist will not lift or hold load	• Load too heavy. • Hoist or boom overloaded causing RCL shutdown. • Relief valve setting too low. • Motor worn. • Sprag clutch defective. • Load block too close to boom tip, two-block system shut down. • Brake worn out. • Anti-two-block system defective.	• Check load and change to Lo-speed/Hi-pull or applicable multipart reeving. • Reduce load or reeve hoist properly for load lifting. • Check and adjust if required. • Replace motor. • Clean or replace Sprag clutch. • Lower load or retract boom. Check two-block system, repair if defective. • Repair or replace brake. • Repair anti-two-block system.
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	• Emergency stop switch on crane console in “STOP” position.	• Reset kill switch to operating position. • 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. • Boom hot from high extend duty cycle. • Worn wear pads. • Cylinder came out of lock. • Extension cables out of adjustment. • Extend or retract cables broken.	• Use dry lubricant or replace lube plugs in wear pads. • Reshim as described in boom assembly section. • Slow duty cycle to cool boom and pads. • Replace pads. • Disassemble and reinstall keepers. • Readjust cables and tension properly. • Disassemble and inspect and replace cables.
Boom will not extend	• Cables not attached correctly. • Anti-two-block system shut down. • Defective anti-two-block system. • Overload causing RCL shutdown. • Insufficient oil flow or pressure to extend cylinder.	• Reconnect, replace and/or adjust cables. • Lower hook, and extend load. • Check anti-two-block system; repair if defective. • Reduce load or radius till RCL resets and resume operation. • Check oil flow, repair if not to specification.

Manitowoc
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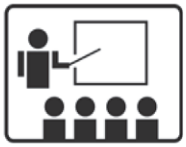
Technical Publications


Field Service


Parts


Factory Service


Training

NATIONAL CRANE

NOTICE TO USERS OF THIS MANUAL:

The most current Schematics available at time of the printing will be found at the back of the Servicing information of this manual.

RCL SERVICE AND MAINTENANCE

Daily maintenance of the rated capacity limiter consists of inspecting:

1. The electrical wiring connecting the various parts of the system. If electrical wiring is damaged, it shall be replaced immediately.
2. If the insulation is worn on the length sensor cable or cable guides are damaged, these parts shall be replaced.
3. Check the anti-two-block limit switches for freedom of movement.
4. The cable reel shall be under tension to operate properly.
5. Check the pressure transducers at the lift cylinder and the connecting hoses for oil leakage.

Other than correcting the problems identified in the Malfunctions Table and replacing faulty mechanical parts and cables, no other repairs shall be performed by nonexpert personnel.

Operating Errors

Malfunctions in the system which are caused by range exceedings or operating errors by the crane operator himself are indicated on the display together with an explanation. These error codes are E01, E02, E03, E04 and E05 and they can normally be eliminated by the crane operator himself. Refer to PAT manual in the book for more detail on error codes.

ANTI-TWO-BLOCK WIRE WITH EXTERNAL REEL

Operation

Boom is equipped with an anti-two-block utilizing a reel on the outside of the boom. As the boom extends, the wire pays off of the reel and is routed through a sheave on the hoist end of the boom. The wire is then routed through roller guides attached at the hoist end of the 2nd, 3rd and 4th of the 4 section boom or 2nd, 3rd, 4th and extend cylinder of the 5 section boom. A switch at the sheave case on the last boom section controls switching of the signal.

Maintenance

In the event of a break in continuity of the anti-two-block wire, the hydraulic portion of the system will be disabled and make certain crane functions inoperative. Before replacement of the wire, check for continuity loss at the anti-two-block switch, connector damage or corrosion, and overall system condition. Due to the environmental exposure of the system, a thorough check of the circuit should be performed. If the wire on the reel is determined to be faulty, replace the wire.

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 method pulls the replacement wire through the boom using the defective wire as the installation tool.

Special tools and equipment

- Two end-to-end electrical butt connectors
- 40 ft (12,2 m) flexible wire or light cord

1. Retract boom completely.
2. Unplug electrical connector at sheave case end of boom.
3. Remove electrical connector from the anti-two-block wire running to the reel.
4. Remove the capscrew, washers and nut, anchoring the anti-two-block wire at the sheave case end of the last section.
5. Pull the wire about 2 ft (0,6 m) out the sheave case end of the boom.
6. Cut the thimble off of the wire.
7. Attach the 40 ft (12,2 m) length of flexible wire or light cord to the end of the anti-two-block wire using the end-to-end electrical butt connector.
8. Let the spring tension on the reel slowly pull the wire or cord back through the boom.
9. Remove old wire from reel and replace with new anti-two-block wire.
10. Route the new wire through the sheave at the hoist end of the boom and attach the end of the anti-two-block wire to the end of the wire routed through the boom using the second end-to-end butt connector.
11. Draw all of the light cord or flexible wire through the boom plus an additional length of anti-two-block wire long enough to install the first thimble for the sheave case end of the boom. Install thimble per instructions.
12. Attach thimble end to capscrew anchor point in sheave case.
13. Tension extendable length of cable at anti-two-block reel by wrapping cable around reel until proper tension is achieved.
14. Attach the electrical connector and connect to the switch.
15. Slowly operate the boom to make sure that the anti-two-block wire runs freely in the boom and that the cable reel runs properly.

16. Test the anti-two-block circuit for proper operation and hydraulic circuit cut out.

Alternative #2

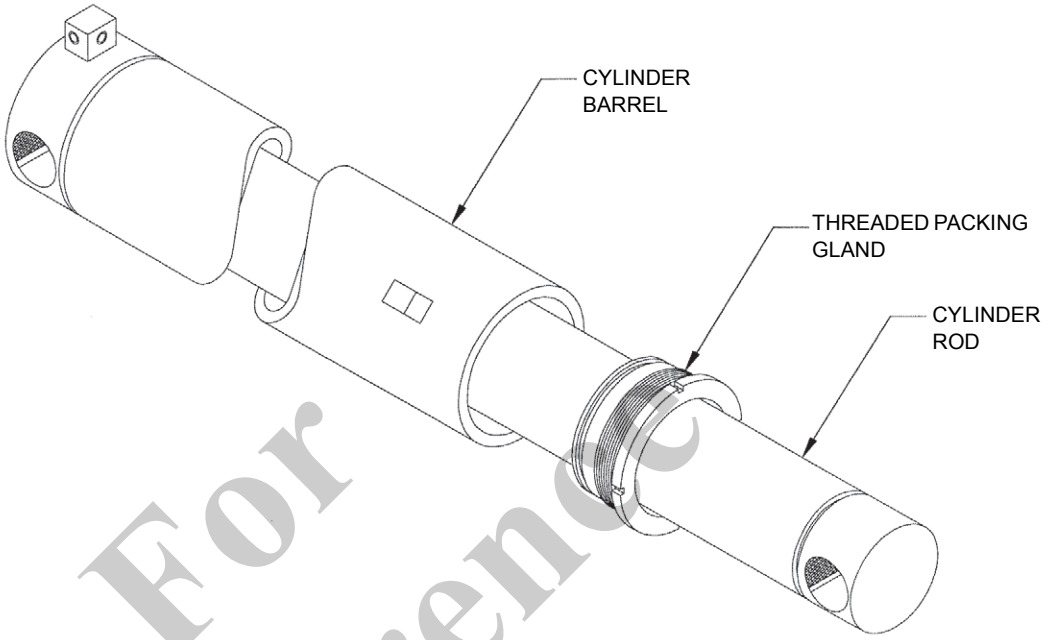
This method requires pushing a long rod through the boom to pull the new anti-two-block wire through the boom. This method is required in the event the anti-two-block wire is severed.

Special tools and equipment:

- Electrical tape
- Rod or electrical conduit 30 ft (9,1 m)

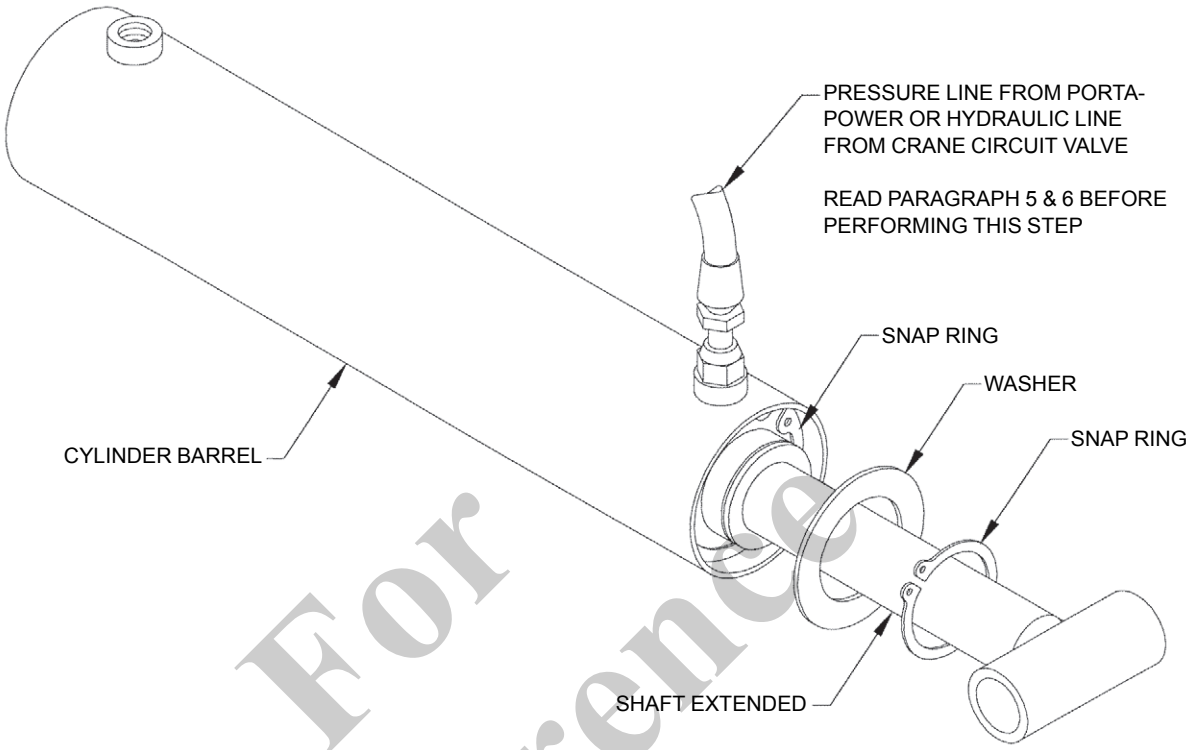
1. Retract boom completely.
2. Unplug electrical connector at sheave case end of boom.
3. Remove electrical connector from the anti-two-block wire running to the reel.
4. Remove the capscrew, washers and nut, anchoring the anti-two-block wire at the sheave case end of the last section.
5. Insert the rod or conduit into the sheave case end of the boom and push through the full length of the boom. On the five section boom the rod or conduit must be routed thru the guide loop on the extend cylinder sheave case. This can be verified by looking inside the fully retracted boom, viewed from the sheave case end.
6. At the hoist end of the boom, the rod or conduit will be below the roller guides at the backs of the extending sections.
7. Lift the rod or conduit and pull it out the back end of the boom about 1 ft (0,3 m).
8. Install the new anti-two-block wire on the reel.
9. Route the new wire through the sheave case at the hoist end of the boom and through the roller guides on the back end of each extending section.
10. Pull the anti-two-block wire out the hoist mount end of the boom and tape securely to the rod or electrical conduit. This will still leave the anti-two-block wire routed through the roller guides.
11. Draw the rod or electrical conduit plus an additional length of anti-two-block wire long enough to install the thimble from the sheave case end of the boom. Install thimble per instructions out of the sheave case end of the boom.
12. Attach the thimble to the capscrew retainer anchor in the sheave case.
13. Allow the reel to retract the thimbles into the boom.
14. Attach the electrical connector and connect to the switch.
15. Slowly operate the boom to make sure that the anti-two-block wire runs freely in the boom and that the cable reel runs properly.
16. Test the anti-two-block circuit for proper operation and hydraulic circuit cut out.

SINGLE STAGE CYLINDER DISASSEMBLY AND REPAIR



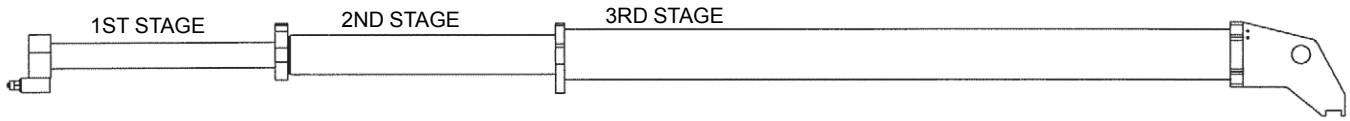
1. Retract cylinder shaft with oil from the hydraulic system until about 12 in (30 cm) of shaft is extended. The barrel must be filled with oil to prevent a compressed air chamber being formed which could result in injury at disassembly.
2. Disconnect cylinder from machine. Cap all hydraulic connections.
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 spanner wrench (listed on the cylinder parts page breakdown), loosen packing gland and completely unscrew from barrel assembly.
5. Remove the shaft and piston assembly by hand.
6. Using a hex key wrench remove one or two set-screws in the piston.
7. Using the proper size spanner wrench (listed on the parts page breakdown), loosen and completely unthread piston from rod assembly.
8. Wipe and inspect cylinder barrel for internal damage.
9. Wipe and inspect cylinder rod assembly for damage.
10. Inspect all threaded components for damage to threads.
11. Replace cylinder packing parts as required. Soaking the U-cups in warm oil [140°F (60°C)] will aid installation. Refer to parts pages for replacement packing kit part number.
12. Reinstall packing gland onto rod assembly.
13. Install O-rings and backups on inner diameter of piston and thread onto rod assembly until snug. Using spanner, tighten piston.
14. On most threaded pistons, two setscrews are utilized to lock each other in place. Apply Loctite 243 to setscrews and torque each setscrew.
15. Reinstall rod assembly with packing gland into barrel assembly and tighten packing gland until within 0.25 in (0,63 cm) of engaged.
16. Apply a band of Loctite 518 to outer threads on packing gland and complete installation.
17. Using a spanner wrench, torque packing gland.
18. If cylinder utilizes an external setscrew to lock the packing gland in place, apply Loctite 243 and torque.

SINGLE STAGE 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.

MULTI-STAGE EXTEND CYLINDER DISASSEMBLY AND REPAIR



Cylinder Disassembly

1. After cylinder has been disassembled from boom, place on supports and place drain pan under holding valve.
2. Using hydraulic power (porta power or crane circuit) extend cylinder sections approximately 24 in (60 cm). If stages do not move equally, retain the moving stage to allow for equal extension of cylinder. Remove the holding valve from the 1st stage butt plate and drain oil.
3. Using a special drive tool, drive the packing gland into the 3rd stage barrel assembly to expose the round cross section retaining ring. Then use a small needle nose locking plier 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. Remove the 2nd/1st stage cylinder assembly from the 3rd stage barrel assembly and place on supports. Caution must be exercised in the support and removal of 2nd/1st stage cylinder assembly as damage to the chrome surface will necessitate replacement.
6. Using a special drive tool, drive the packing gland into the 2nd stage barrel assembly to expose the round cross section retaining ring. Then use a small needle nose locking plier 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.
7. Debur ring groove edge. Failure to do so will damage packing gland and or barrel assembly when packing gland is removed. Using a 3/16 in hex key wrench, remove the locking setscrews from the 2nd stage cylinder shaft piston. Using the proper size spanner wrench, loosen and completely unscrew piston from the 2nd stage cylinder shaft assembly. Remove nut washer and piston from 1st stage cylinder shaft assembly. Remove stop tubes from the 1st and 2nd stage cylinder shaft assemblies.
8. Wipe and inspect all cylinder internal and external surfaces for damage. Wipe and inspect all threaded components for damage to threads.
9. Inspect wear pads on the 3rd stage barrel sheave case assembly. Replace as required.
10. Ensure that the O-ring seal area of the packing gland bores on both the 2nd stage cylinder assembly and the 3rd stage barrel assembly are smooth and free of nicks and lubricate to eliminate damage to the packing gland O-ring during reassembly.

Cylinder Reassembly

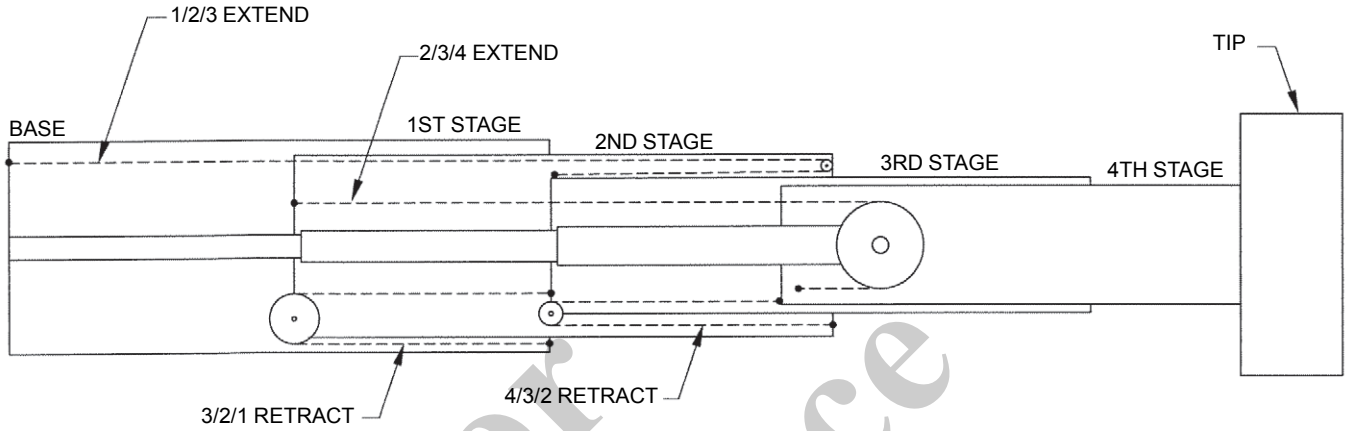
1. Replace cylinder packing parts as required on 1st stage cylinder assembly. Refer to parts pages for replacement packing kit part number. Warming the U-cup seals in 140°F (60°C) oil will allow for easier assembly.
2. Reinstall packing gland retaining ring and stop tube onto 1st stage cylinder shaft assembly.
3. Reinstall piston and related components. Torque retaining nut to specification.
4. Insert 1st stage into 2nd stage, grease on piston seals will aid installation, install packing gland and round retaining ring into 2nd stage.
5. Replace cylinder packing parts as required on 2nd stage cylinder assembly. Refer to parts pages for replacement packing kit part number.
6. Reinstall packing gland, retaining ring and stop tube onto 2nd stage cylinder shaft assembly.
7. Install O-ring and backup rings on inner diameter of 2nd stage piston and thread onto 2nd stage cylinder shaft assembly until snug making certain piston counter bore is seated over shaft assembly properly. Take care not to damage the O-ring while installing piston. Using the proper size spanner wrench, tighten piston onto 2nd stage cylinder shaft assembly to specification.
8. Install setscrew into piston using Loctite Type 243 according to Loctite recommendations and torque. Loctite and install second setscrew on top of first setscrew and torque.
9. Reinstall 2nd stage cylinder assembly with piston stop tube and packing gland into 3rd stage barrel assembly to within 24 in (60 cm) of fully assembled.

Torque Specifications

5 section	2nd stage piston	600 lb-ft (813 Nm)
	1st stage nut	300 lb-ft (407 Nm)
4 section	2nd stage piston	200 lb-ft (271 Nm)
	1st stage nut	300 lb-ft (407 Nm)
Setscrew		8 lb-ft (11 Nm)

FOUR SECTION BOOM

The boom service and maintenance section of this manual includes both the four and five section boom information. Use appropriate information for your particular boom length.



A rod-fed, two-stage double-acting cylinder, attached to the 1st, 2nd and 3rd boom sections, supports and propels the 2nd and 3rd boom sections. The extend cables attach to the base end of the 2nd boom section, are reeved around sheaves attached to the cylinder, and attach to the base end of the 4th boom section, therefore providing support and extension of the 4th boom section. The 3rd section retract cables attach to the tip end of the 1st 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. The 4th section retract cables attach to the tip end of the 2nd boom section, are reeved around sheaves attached to the 3rd boom section, and attach to the base end of the 4th boom section, therefore providing retraction of the 4th boom section. A proportioning cable attached to the rear of the 1st section, reeved around a sheave at the tip of the 2nd section, and anchored to the rear of the 3rd section maintain proper cylinder extension proportion, therefore maintaining equal boom section proportion Detailed service and maintenance is required to insure smooth and proper operation.

FOUR 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 Department to obtain this nozzle tip (NCC PN 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 and 3rd section and the extend cable sheave attached to the bottom of the top plate of the second section at the sheave case end of the boom, are accomplished as follows:

1. Extend boom 78 in (198 cm) per section or 19.50 ft (594 cm) for a four section boom.
2. Visually check alignment between the grease access holes for the retract sheaves, when the holes align, the end of the extend cable sheave pin will be accessible thru a hole in the 3rd section side plate for lubrication.
3. Grease all pins accessible at this boom length location with nozzle grease gun fitting.
4. The extend cable sheave located on the bottom of the top plate of the 2nd section at the sheave case end of the boom can be accessed at any boom length for lubrication.

Four 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, the third section should be bottomed on the thick vertical side plates welded to the inside of the second section, the fourth section should be bottomed on the thick vertical side plates welded to the inside of the third 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. After proper section position has been established, a scribe mark on all the sections at the boom tip end to identify proper section position relative to each other may be helpful during the tensioning process.
4. Torque 4/3/2 retract cables to 7 lb-ft (9,5 Nm). Cable adjustment point is located at the sheave case end of the boom, on the bottom of the 2nd section. Use the flats at the front of the cable ends to keep the cables from turning while torquing retainer nuts.
5. Torque large extend cables to 22 lb-ft (29,8 Nm). Cable adjustment point is located at the rear of the boom on the cable anchor located in the rear of the 2nd section.
6. Torque 3/2/1 retract cables to 9 lb-ft (12,2 Nm) 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.
7. Torque 1/2/3 extend cable to 9 lb-ft (12,2 Nm) Cable adjustment point is located at rear of boom, on the hoist crossbar spanning the 1st section.
8. Repeat steps 4, 5, 6, and 7, torquing the 4/3/2 retract cables to 14 lb-ft (19 Nm). Torque the large extend cables to 45 lb-ft (61 Nm). The 3/2/1 retract cables to 18 b-ft (24 Nm) and the 1/2/3 extend cable to 18 lb-ft (24 Nm)
9. Cycle the boom fully, check that all cables are torqued properly and that all sections are retracted completely, utilizing scribe marks or bottoming position of boom sections then add jam nuts to all cables. All threaded cable ends must be equipped with retainer nuts and jam nuts.

FOUR SECTION BOOM SERVICE

Boom Removal

Boom Length	Boom Weight	CG from pivot point
14100H	11,475 lb (5205 kg)	160 in (406 cm)

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 downhaul 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. Unplug anti-two-block/RCL cord from receptacle in turret.
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

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 Four Section 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 all outriggers and SFO if equipped.
2. Fully retract the boom and place in a horizontal position.
3. Hoist removal optional.

Boom Disassembly

1. Gaining access through rear of boom, loosen capscrews retaining the keeper plates holding the extend cable anchor and retract cables in the rear of the 3rd section, remove keeper plates.
2. Extend boom 24 in (60 cm). Loosen and remove the nuts which secure the extend cables to the cable anchor plate. Tag and disconnect hydraulic lines to the extend cylinder.
3. Drape extend cables 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-4th assembly at the front with an appropriate lifting method. Raise the 2nd-3rd-4th assembly inside the 1st section to allow for front bottom pad removal. Remove bottom wear pads.
8. With the 2nd-3rd-4th assembly supported, slide assembly out of the 1st. Relocation of the sling point on the 2nd-3rd-4th 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-4th 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 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 six 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. Remove retract cables.
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 4th 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 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 4th section and pull the extend cable anchor out from its retaining pocket on the bottom of the 4th section. A slight angle applied to the anchor as it's being pulled to the rear will permit easier removal through the 2nd and 3rd sections.

18. Remove the extend cylinder from the boom. Do not allow the sheaves to fall off the pin on the end of the extend cylinder. Remove extend cables. Place cylinder and cables in suitable area to prevent possible damage.

19. Loosen and remove two capscrews, cable guide, wear pad and spacer bar from the front top of the second section.

20. Loosen and remove four capscrews attaching the bottom pad plate to the second section. Slightly lift third section, and remove pad plate.

21. 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.

22. Loosen and remove two capscrews, cable guide wear pad and spacer bar from the front top of the third section.

23. Loosen and remove four capscrews attaching the bottom pad plate to the third section. Slightly lift fourth section, and remove pad plate.

24. Slide fourth section out of second section. Removal of side pads is optional, as the side pads have adequate clearance for the boom disassembly. If removal of the side pads is required. Tag all shims, pads and corresponding locations for proper reassembly.

25. Loosen and remove all remaining capscrews and wear pads from sections.

Additional Maintenance, Disassembled Boom

1. Clean all boom sections and inspect for wear, dents, bent or crooked 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 inner liner material. If installed bearing diameter is 0.015 in (0,38 mm) larger than pin diameter, bearing must be replaced. Any cut or gouge which causes the bearing liner to lose strands is cause for bearing replacement.

4. Clean and inspect all cable assemblies according to wire rope inspection procedures in this section. Pay particular attention to any wire breakage at the end connections. Replace cable assemblies as required. Lubricate all cable assemblies as required. Lubricate all cable assemblies before reinstalling them in 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 all zerks and grease paths in pins to ensure proper grease flow. Clean and replace as required.

7. Replace all lubricating plugs in all wear pads.

FOUR 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 4th 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 4th section. Using Loctite 243 blue, Loctite all wear pad mounting capscrews.
3. Install 4th section boom into 3rd section. Slide together approximately 5 ft (150 cm).
4. Assemble bottom front wear pads for 3rd section and Teflon plugs. Attach pads to pad plate.
5. Using appropriate lifting device, lift 4th section to allow for wear pad/pad plate installation in front of 3rd. Install wear pad/pad plate assembly. Slide sections together within 12 in (30 cm) of full retraction.
6. Install cable guide and upper spacer to front of 3rd section
7. Install front side wear pads with appropriate shims, between 4th and 3rd 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. Slide boom sections completely together.
8. Assemble top rear wear pads to the top of the 4th boom section with the cam plates and install through the hoist mount end of the boom. Install capscrew through holes in outer boom sections.

   The wear pads on each side at the top/rear of the boom can be adjusted over a range of 3/16 in (4,8 mm) by rotating, end for end, the wear pad and plate or the wear pads and plate independently. This is possible because the holes in these parts are offset from the center. The hole are 0.06 in (1,5 mm) off center in the plate and 0.03 in (0,8 mm) off center in the wear pad. Various combinations of rotation of these parts allow the adjustment.
9. Uncoil 4/3/2 retract cable assemblies, and insert button end into anchors in back of the 4th section. Place uncoiled cable in area that will minimize the potential for damage.
10. Uncoil 3/2/1 retract cable assemblies, and insert button end into cable anchor pockets in back of the 3rd section. Place uncoiled cable in area that will minimize the potential for damage. Assemble retract sheaves and retract sheave pins in rear of 3rd section. Coat surfaces of bearings and keeper plates with grease before assembly.
11. Place retract cables anchored to 4th over the top of the retract sheaves on the 3rd. Install keeper capscrew above sheave to hold retract cables in place.
12. Reeve cables over retract sheave and install keeper/ wear pad to bottom rear of 3rd section. This pad acts as a side pad, bottom pad, and a cable retainer. Loctite rear wear pad hardware on bottom of 3rd section with Loctite 243 blue. Loctite all wear pad mounting capscrews.
13. Loop the 1/2/3 extend cable in half and place it on the top of the 3rd section, with the loop end towards the sheave case end and the threaded and button end towards the rear of the section.
14. Install clamp plate and capscrews with the button end of the cable installed in the anchor slot on the rear top of the 3rd section.
15. Place sheave pin and sheave for the 1/2/3 extend cable in position on the sheave case end of the boom, inside the loop of cable
16. Install 3rd and 4th section boom assembly into 2nd section. Slide together approximately 5 ft (150 cm). Use caution as retract cables and upper extend cable attached to the 4th-3rd section assembly slide into the 2nd section to prevent damage or crossing of cables.
17. Assemble bottom front wear pads for 2nd section and Teflon plugs. Attach pads to pad plate.
18. Using appropriate lifting device, lift 3rd and 4th section assembly to allow for wear pad/pad plate installation in front of 2nd. Install wear pad/pad plate assembly. Slide sections together within 12 in (30 cm) of full retraction.
19. Install cable guide and spacer to top of 2nd section
20. 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. Slide sections fully together
21. Assemble top rear wear pads to the top of the 3rd boom section with the cam plates and install through the hoist mount end of the boom. Install capscrew through holes in outer boom sections.

    The wear pads on each side at the top/rear of the boom can be adjusted over a range of 3/16 in (4,8 mm) by rotating, end for end, the wear pad and plate or the wear pads and plate independently. This is possible because the holes in these parts are offset from the center. The hole are 0.06 in (1,5 mm) off center in the plate and 0.03

in (0,8mm) off center in the wear pad. Various combinations of rotation of these parts allow the adjustment.plates function as rear side clearance adjustment.

22. Position sheave and sheave pin located in cable loop on top of 3rd to allow capscrew installation, through top plate of 2nd. Install capscrews and torque to specification, clamping sheave pin and sheave to the bottom of the 2nd section top plate.

23. Assemble retract sheaves, retract sheave pins and cable keeper plates in rear of 2nd section. Coat surfaces of bearings with grease before assembly.

24. Place retract cables anchored to 3rd over top of retract sheaves attached to rear of 2nd. Install keeper capscrew above sheave to hold retract cables in place.

25. 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.

26. Assemble exterior extend cylinder components. Install and center sheave pin sheave case end of extend cylinder. Install bearings into extend cable sheaves. Coat surface of bearings with grease and assemble extend sheaves on sheave pin.

27. Wrap approximately 10 ft (300 cm) of each 7/8 in (22.22 mm) diameter 2/3/4 extend cable around extend sheaves and install 4th section extend cable anchor around cables at button end. Do not tighten capscrews clamping anchor together completely. These capscrews if tightened completely will not allow cable anchor to install into 4th section.

28. 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.

29. Slide extend cylinder/extend cables into 2nd-3rd-4th boom assembly enough to assemble extend cable anchor into bottom rear of 4th section. Be aware of extend cable location when inserting cylinder into boom sections, inadvertent crushing or other damage to cables will warrant replacement.

30. Tighten capscrews clamping extend cable anchor together. This will also lock anchor in place in the anchor cutouts in the 4th section.

31. Visually verify that the extend cables are properly routed on their sheaves and continue to slide with the extend cylinder and cables into the boom sections. Keep extend cables supported and slightly tensioned during insertion of cylinder to maintain proper cable placement.

32. As the extend cylinder nears complete insertion into the 2nd-3rd-4th section assembly, adjust the height of the cylinder to allow the cylinder anchor collars to access the cylinder keeper cutouts in the doubler plates on the sides of the 2nd and 3rd sections.

33. Drop the cylinder down into the vertical cutouts in the doubler plates on the sides of the 2nd and 3rd sections. Cylinder length or boom section placement may have to be adjusted to allow cylinder collars to drop into their proper position.

34. Install lock bar and capscrews to the extend cylinder collar in the 3rd section.

35. Install large extend cable anchor into anchor cutouts in the doubler plates in the rear of the 2nd by routing the 7/ 8 in (22,22 mm) extend cables through the anchor and the small 7/16 in (11,11 mm) cable over the anchor. Slide anchor fully into cutout.

36. Install keeper plates and hardware. This keeper plate retains both the horizontal movement of the extend anchor and the vertical movement of the extend cylinder.

37. Install 2nd-3rd-4th section boom assembly into 1st section boom, use caution when sliding sections together, 3rd retract cables must maintain their position to prevent damage, do not let boom rest on cables. Damage will result.

38. Assemble bottom front wear pads for 1st section and Teflon plugs.

39. Using appropriate lifting device, lift 2nd-3rd-4th section assembly to allow for wear pad installation in front of 1st. Install wear pads. Slide sections together within 12 in (30 cm) of full retraction.

40. Install upper spacer to front of 1st section.

41. Install front side wear pads with appropriate shims between 2nd and 1st 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.

42. Push boom together until extend cylinder butt plate makes contact with the rear cylinder anchor plates in the rear of the 1st section. Install spacers, washers and capscrews, attaching cylinder to 1st section boom. If cylinder is misaligned with anchor points, cylinder butt plate can be rotated to achieve proper alignment (holding valve up, parallel with boom top plate).

43. Assemble top rear wear pads to the top of the 2nd boom section with the cam plates and install through the hoist mount end of the boom. Install capscrew through holes in outer boom sections.

The wear pads on each side at the top/rear of the boom can be adjusted over a range of 3/16 in (4,8 mm) by rotating, end for end, the wear pad and plate or the wear pads and plate independently. This is possible because

the holes in these parts are offset from the center. The hole are 0.06 in (1,5 mm) off center in the plate and 0.03 in (0,8 mm) off center in the wear pad. Various combinations of rotation of these parts allow the adjustment.

44. Install thick hoist attachment bar through hoist mount. This bar anchors the 7/16 in (11,11 mm) extend cable and serves as the upper hoist attachment point. Hold this bar up in its slot with a spacer on each side. This will facilitate easier assembly.

45. Install the threaded end of the 7/16 in (11,11 mm) extend cable through hole in center of the hoist attachment bar.

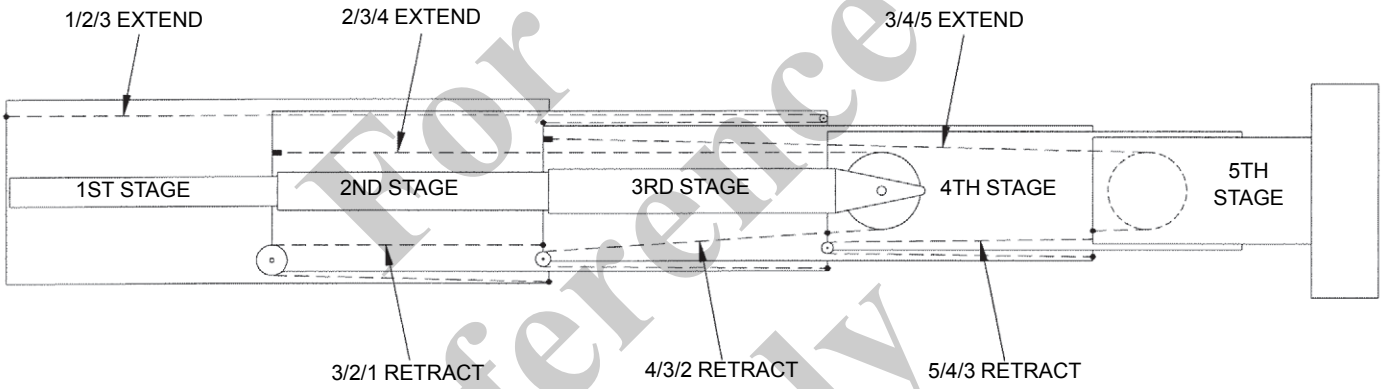
46. Slightly tighten all cables. Cycle boom slowly to assure proper operation before torquing cables. Refer to the “Four Section Cable Tensioning” section to properly torque the cables in the extend system. Cables must be torqued to proper specifications for proper boom operation.

47. Install hoist and anti-two block system.

FIVE SECTION BOOM

A two-stage, rod fed, double-acting cylinder is attached to and supports the 1st, 2nd and 3rd stage boom sections. The 3/4/5 extend cables attach to the base of the 3rd stage boom, are reeved around sheaves at the tip of the 4th stage boom and attach to the base and support the 5th stage boom. The 5/4/3 retract cables are attached to the base of the 5th stage boom, are reeved around sheaves at the base of the 4th stage boom and attach to the tip of the 3rd stage boom. The 2/3/4 extend cables attach to the base of the 2nd stage boom, are reeved around sheaves at the tip of the 3rd stage cylinder and attach to the base and support the 4th stage boom. The 4/3/2 retract cables are attached to the base of the 4th stage boom, are reeved around sheaves at the base of the 3rd stage boom and attach to the tip of the 2nd stage boom. The 11213 extend cables attach to the base of the 1st stage boom, are reeved around sheaves at the tip of the 2nd stage boom and attach to the base of the 3rd stage boom. The 3/2/1 retract cables attach to the base of the 3rd stage boom, are reeved around sheaves at the base of the 2nd stage boom and attach to the tip of the 1st stage boom.

The 3/2/1 retract cables directly oppose the 1/2/3 extend cables to ensure that the 2nd and 3rd stage booms extend and retract equally at all times. The 4/3/ 2 retract cables directly oppose the 2/3/4 extend cables to ensure that the 3rd and 4th stage booms extend and retract equally at all times. The 5/4/3 retract cables directly oppose the 3/4/5 extend cables to ensure that the 4th and 5th stage booms extend and retract equally at all times.



FIVE SECTION BOOM SERVICE

Boom Removal

Boom Length	Boom Weight	CG from pivot point
14127H	14,160 lb (6423 kg)	168 in (427 cm)

1. Extend and set machine outriggers. Boom must be completely retracted and stowed in boom rest.
2. If equipped, remove swing around jib according to procedures outlined in the “Safety and Operation” section.
3. Remove hook block or downhaul weight, wind up rope on hoist drum and stow wedge socket becket 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 1st section boom. Lower lift cylinder rod end to the deck.
5. Tag and disconnect extend cylinder lines and hoist hydraulic and electric lines. Cap all openings. Unplug anti-two-block/RCL cord from receptacle in turret.
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.

FIVE 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 Department to obtain this nozzle tip (NCC PN 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.

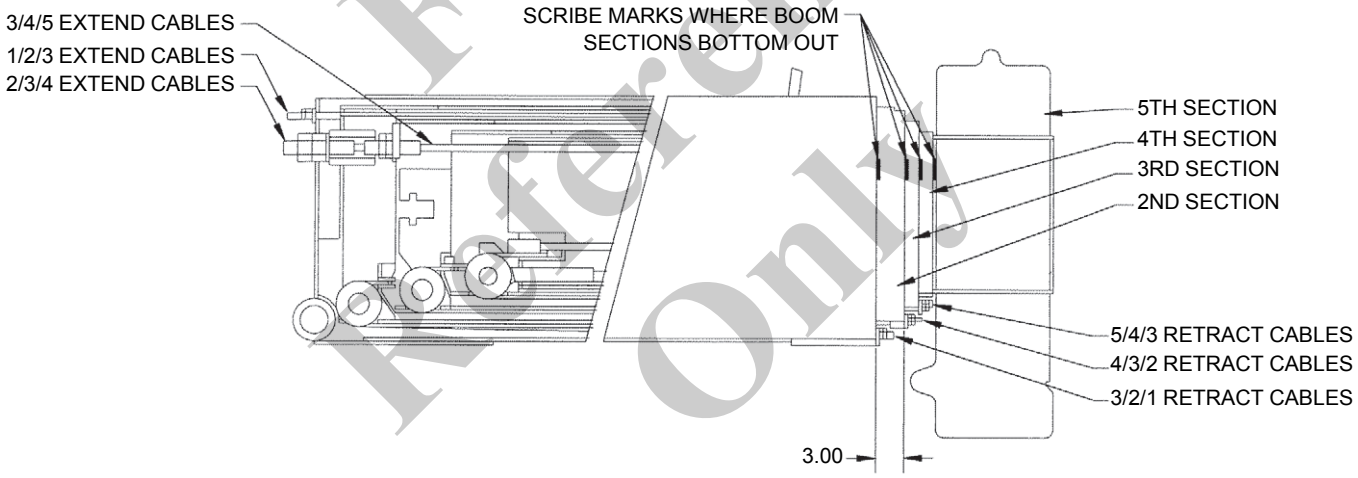
Lubrication of the extend cable sheaves located on the boom tip end of the extend cylinder, and the retract cable sheaves located on the inside rear of the 2nd and 3rd section and the extend cable sheave attached to the bottom of the top plate of the second section at the sheave case end of the boom, are accomplished as follows:

1. Extend boom 78 in (198 cm) per section 26 ft (792 cm) for a five section boom.
2. Visually check alignment between the grease access holes for the retract sheaves, when the holes align, the end of the extend cable sheave pin will be accessible thru a hole in the 3rd section side plate for lubrication.
3. Grease all pins accessible at this boom length location with nozzle grease gun fitting.
4. The extend cable sheave located on the bottom of the top plate of the 2nd section at the sheave case end of the boom can be accessed at any boom length for lubrication.

FIVE 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. Proceed as follows:

1. Cycle boom approximately 8 ft (243 cm) out and in a few times [2 ft (60 cm) per section].
2. Fully retract boom. At full retraction the base of the 2nd section boom bottoms out in the base of the 1st section boom, the base of the 3st section boom bottoms out in the base of the 2nd section, the base of the 4th section boom bottoms out in the base of the 3st section boom and the base of the 5th section boom bottoms out in the base of the 4th section boom. Marks should be scribed on the side plates along the front edge of each upper wear pad indicating where each section bottoms out. This will aid the mechanic during the cable tensioning procedure. When the cables are torqued (tensioned) properly, the boom sections should extend/retract proportionally and bottom out at the same time during retract.
3. Tighten the 5/4/3 retract, 3/4/5 extend, 4/3/2 retract, 2/3/4 extend, 3/2/1 retract and 1/2/3 extend cables (in order listed) to remove slack from the cables and to achieve proper sequencing of bottoming out base of booms. To reach the 3/4/ 5 extend cables boom must be extended out approximately 18 in (45 cm), 4.50 in (11,43 cm) per stage and tightened through openings in the 1st and 2nd section booms.)
4. Torque the 5/4/3 retract cables to 6 lb-ft (8,13 Nm) each. Use the flats at the front of the cable ends to keep the cables from rotating while torquing. These cables are located at the bottom tip of the 3st section boom.
5. Torque the 3/4/5 extend cables to 15 lb-ft (20,37 Nm) each. These cables are located at the top base of the 3st stage boom. (Reference Step #3 for access to the 3/4/5 extend cables.)
6. Torque the 4/3/2 retract cables to 7 lb-ft (9,5 Nm). Use the flats at the front of the cable ends to keep the cables from rotating while torquing. These cables are located at the bottom tip of the 2nd section boom.



7. Torque the 2/3/4 extend cables to 20 lb-ft (27 Nm) each. These cables are located at the top base of the 2nd section boom. (Reference step #3 for access to the 2/3/4 extend cables.)
8. Torque the 3/2/1 retract cables to 9 lb-ft (12 Nm). Use the flats at the front of the cable ends to keep the cables from rotating while torquing. These cables are located at the bottom tip of the 1st section boom.
9. Torque the 1/2/3 extend cables to 7 lb-ft (9,5 Nm) each. These cables are located at the top of the 1st section boom hoist bar.
10. Check to ensure that boom sections are all bottoming out simultaneously as in Step 2. If not, proceed as follows:
    a. If the second section is bottoming out first, equally loosen the 1/2/3 extend cables and tighten the 3/2/1 retract cables. This will cause the second section boom to bottom later but will also cause the third, fourth and fifth sections to bottom out sooner.
    b. If the third section is bottoming out first, equally loosen the 3/2/1 retract cables and tighten the 1/2/3 extend cables. This will cause the third, fourth and fifth sections to bottom later and the second section boom to bottom sooner.
    c. If the fourth section is bottoming out first, equally loosen the 4/3/2 retract cables and tighten the 2/3/4 extend cables. This will cause the fourth and fifth sections to bottom out later and the second and third sections to bottom out sooner.

d. If the fifth section is bottoming out first, equally loosen the 5/4/3 retract cables and tighten the 3/4/5 extend cables. This will cause the fifth section to bottom out later and the second, third and fourth sections to bottom out sooner.

11. Cycle the boom a few feet out and in. Check to ensure that all sections are bottoming out simultaneously. Repeat step 10 as required.

12. Repeat Steps 4 through 9. Torque the 5/4/3 retract cables to 12 lb-ft (16,26 Nm). Torque the 3/4/5 extend cables to 30 lb-ft (40 Nm). Torque the 4/3/2 retract cables to 14 lb-ft (19 Nm). Torque the 2/3/4 extend cables to 45 lb-ft (61 Nm). Torque the 3/2/1 retract cables to 18 lb-ft (24 Nm). Torque the 1/2/3 extend cables to 14 lb-ft (19 Nm).

13. Cycle boom fully, check that all cables are torqued properly and that all sections are bottoming out simultaneously. Repeat step 10 as required then add locknuts to all cables. Each threaded cable end must have two nuts locked together.

FIVE SECTION BOOM DISASSEMBLY

For reference, front is sheave case end, rear (base) is hoist mount end, left and right are viewed from rear to front.

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

Steps 1 thru 3 apply to a boom that is to be disassembled with the 1st section and jib (if equipped) left on crane. If the boom is to be unpinned from the turret of the crane structure, refer to the Five Section Boom Removal procedure section in this book.

1. Extend and set all outriggers.
2. Fully retract boom and place it in a horizontal position.
3. Tag and disconnect the hydraulic lines to the telescope cylinder. Cap all lines and fittings.
4. Loosen and remove the fasteners attaching the extend cylinder butt plate to the base of the 1st section boom.
5. Mark the location of the hex nuts which secure the 1/2/3 extend cables to the hoist bar. Remove hex nuts and washers from 1/2/3 extend cables, Leave the cable ends draped inside the boom.
6. Attach a sling or chain to the front of the 2nd section boom, pull the 2nd-3rd-4th-5th assembly out of the 1st section approx 12 in (30 cm). Remove front upper spacer bar from 1st section. Remove and tag the four side wear pads and shims from the front of the 1st section. Suspend 2nd-3rd-4th-5th assembly off of bottom pads.
7. Remove four capscrews which retain the lower front pad plate to the 1st section. Remove pad plate. Remove upper back wear pads and cam plates from 2nd section. Pull the retract cables out and keep retract cables taunt while pulling the 2nd-3rd-4th-5th assembly out of the 1st section. Support the base end of the 2nd as it exits the 1st stage boom.
8. Place 2nd-3rd-4th-5th on a suitable horizontal surface. Take care not to damage the retract cables while lifting or supporting the 2nd-3rd-4th-5th assembly.
9. Remove lower L-pads , retract cables, and retract cable retaining capscrews from rear of 2nd section. Remove retract cable retaining plates from the rear of the 3rd section, Remove 3/2/1 retract cables from anchor pocket in 3rd section.
10. Remove retaining capscrews from cylinder anchor channels in the rear of the 2nd section. Remove upper top wear pads and cam plates from upper rear of the 3rd section.
11. Remove cable guide and upper spacer bar/cable retainers from the front top of the 2nd section. Attach a sling or chain to the tip of the 3rd section boom and pull the 3rd-4th-5th assembly out of the 2nd approximately 12 in (30 cm). Suspend the 3rd section off of the lower wear pads.
12. Remove capscrews retaining 1/2/3 extend sheaves to the top plate of the 2nd section, this will allow the sheaves, pins, and extend cables to lay on the top plate of the 3rd section.
13. Remove four capscrews which retain the lower front pad plate to the 2nd section. Remove pad plate. Remove and tag four side wear pads with shims from front of 2nd section. Pull the retract cables out and keep retract cables taunt while pulling the 3rd-4th-5th assembly out of the 2nd section. Support the base end of the 3rd as it exits the 2nd section boom.
14. Place 3rd-4th-5th assembly on a suitable horizontal surface. Take care not to damage the retract cables while lifting or supporting the 3rd-4th-5th assembly. Remove 1/2/3 extend cables from the top of the 3rd section by removing the anchor plates and capscrews at the rear of the section, place cables in a area to avoid damage.
15. Remove lower L-pads, retract cables, and retract cable retaining capscrews from rear of 3rd section. Remove retract cable retaining plates from the rear of the 4th section, Remove 4/3/2 retract cables from the anchor pocket in the 4th section.
16. Remove lock bar and hardware from extend cylinder collar anchor pocket in the 3rd section. Lifting the butt plate end of the cylinder up will disengage the cylinder from its anchor pockets in the 3rd section. Slowly pull cylinder out of the 3/4/5 assembly. Keep 2/3/4 extend cables taunt and in position to avoid damage as cylinder exits boom assembly. Remove 2/3/4 extend cable anchor in the 4th section as the end of the cylinder nears the anchor position.
17. Place cylinder assembly on suitable horizontal surface. Take care not to damage the extend cables while lifting or supporting the cylinder assembly. The cables can be disassembled from the cylinder at this time by removing the tapered wear pads on the front of the cylinder assembly and routing the cables thru the access opening made by removing the pad. After tapered pads are removed use caution as the sheave pin and sheaves can move forward from the lock position into the assembly position.
18. Remove cable guide and upper spacer bar from the front top of the 3rd section. Loosen and remove hex nuts from threaded ends of 5/4/3 extend cables at rear of 3rd section. Remove top rear wear pads and cam plates from top of 4th section.
19. Attach a sling or chain to front of the 4th section boom and pull the 4th-5th assembly out of the 3st approx. 12 in

(30 cm). Suspend the 4th section off of the lower wear pads.

20. Remove 4 capscrews which retain the lower front pad plate to the 3rd section. Remove pad plate. Remove and tag four side wear pads with shims from the front of the 3rd section. Pull the retract cables out and keep retract cables taunt while pulling the 4th-5th assembly out of the 3rd section. Support the base end of the 4th as it exits the 3rd section boom.

21. Place 4th-5th assembly on a suitable horizontal surface. Take care not to damage the retract cables while lifting or supporting the 4/5 assembly.

22. Remove lower L-pads, retract cables, and retract cable keeper from rear of 4th section, coil 5/4/3 retract cables inside of 5th section. Remove upper top wear pads and cam plates from upper rear of 5th section.

23. Remove cable guide and upper spacer bar from the front of the 4th section. Remove side wear/ cable retainer pads from front of 4th section, leave 3/4/5 extend sheaves and 3/4/5 extend cables in place.

24. Attach sling or chain to the front of the 5th section boom and pull the 5th section out of the 4th until there is approx. 36 in (90 cm) of the 5th still inserted in the 4th, use caution to keep 3/4/5 extend cables from damage as boom sections slide apart, if possible keep tension on 3/ 4/ 5 extend cables from the base end of the 4th boom section during this procedure.

25. Lift 5th section off the lower pads and remove pads and hardware. Remove 3/4/5 extend sheaves and hardware.

26. Slide 5th section completely out of 4th. Support the base end of the 5th as it exits the 4th section boom. Place 5th section boom on a suitable horizontal surface.

27. Remove cable retainers and hardware from side anchor locations on the 5th section. Remove 3/ 4/5 extend and 5/4/3 retract cables from anchor points in the side of the 5th section, place in suitable area to avoid damage.

28. Remove loadline sheaves by removing retainers and lightly tapping on sheave pin while removing sheaves and spacers until all sheaves are removed from boom sheave case.

Additional Maintenance, Disassembled Boom

1. Clean all boom sections and inspect for wear, dents, bent or crooked 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 inner liner material. If installed bearing diameter is 0.015 in (0,38 mm) larger than pin diameter, bearing must be replaced. Any cut or gouge which causes the bearing liner to lose strands is cause for bearing replacement.

4. Clean and inspect all cable assemblies according to wire rope inspection procedures in this section. Pay particular attention to any wire breakage at the end connections. Replace cable assemblies as required. Lubricate all cable assemblies as required. Lubricate all cable assemblies before reinstalling them in boom.

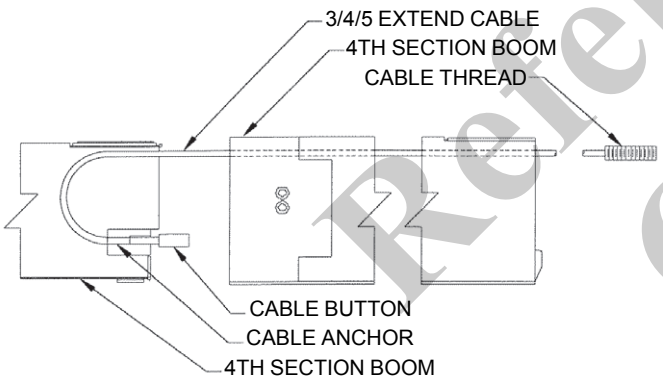
5. Inspect all sheave pins for nicks, gouges or pitting due to rust in the bearing surface area. Replace if any damage is evident.

6. Inspect all zerks and grease paths in pins to ensure proper grease flow. Clean and replace as required.

7. Replace all lubricating plugs in all wear pads.

FIVE SECTION BOOM ASSEMBLY

1. Assemble sheaves into 5th section sheavecase. Top sheave is to be installed to the left hand side of the boom with the spacers to the right hand side.
2. Attach rear wear pads to the bottom of the 5th section. Using loctite 243 blue, Loctite all wear pad mounting capscrews,
3. Position 5th section boom in front of the 4th section boom ready to slide together. Route 3/4/5 extend cables thru 4th section boom, with the threaded end of the cable at the rear of the 4th section and the button end out the front, loop the front button end of the 3/4/5 cable beyond it's anchor point on the 5th section and install button end into 5th section boom.
4. Install 5/4/3 retract cable button end into anchor point in 5th section and install keeper plate and capscrews, keeper plate will lock both the extend and retract cables in place. Coil 5/4/3 retract cables temporarily into 5th section
5. Install 5th section into 4th section approximately 3 ft (100 cm). Take care not to damage 3/4/5 extend cables. They should be laying on the extended lip of the bottom plate of the 5th section.



6. Install 3/4/5 extend sheave pins and bearings into the 3/4/5 extend sheaves. Install wear plugs into the holes on each side of the extend sheaves. Loop 3/4/5 extend cables around the 3/4/5 extend sheaves and slide the sheaves between the 4th and 5th boom sections, make certain the grease hole in the pin is orientated correctly before attaching pin to 4th section.Install countersunk capscrews attaching 3/4/5 extend sheave pins to 4th section.
7. Raise the 5th section against the top of the 4th, and install the bottom wear pads between the 4th and 5th, lower 5th section onto pads.
8. Install side wear pads with appropriate shims on front inside of the 4th section boom, Install upper spacer bar and cable guide with wear pad and related hardware on the top of the 4th section. Shim according to calibration instructions, or as pads were originally removed and tagged.
9. Push the 5th section completely inside the 4th section until it bottoms out on the doubler plates in the rear of the 4th, keep 3/4/5 extend cables tight when installing section. A scribe mark on the 5th at full retraction will aid in cable tensioning for proper boom sequence later.
10. Uncoil 5/4/3 retract cables out of 5th section, assemble 4th section retract sheaves and pins into the inside of the 4th section rear, using proper hardware and Loctite 243, reeve cable over sheave installing upper keeper capscrew and lower rear pad, this pad serves as a cable keeper, lower pad and side pad for the rear of the section.
11. Install 4/3/2 retract cable button end into anchor point in 4th section and install keeper plate and capscrews. This keeper plate is installed temporarily to keep the button ends in place during this phase of the assembly, it will need to come back out during cylinder and 2/3/4 extend cable installation. Coil 4/3/2 retract cables temporarily into 5th section
12. Assemble top rear wear pads with the cam plates to the top of the 5th section. The wear pad on each side of the top/rear of the boom can be adjusted over a range of 3/16 in (4,8 mm) by rotating, end for end, the wear pad and plate or the wear pads and plate independently. This is possible because the holes in these parts are offset from the center. The holes are 0.06 in (1,5 mm) off center in the plate and 0.03 in (0,8 mm) off center in the wear pad, Various combinations of rotation of these parts allow this adjustment.
13. Pull threaded ends of 5/4/3 retract cable, now under the 4th section, towards front of boom.
14. Position 4th-5th section in front of 3rd section, ready for assembly. Route 5/4/3 retract cables to allow easy cable movement as the sections slide together.
15. Slide 4th-5th section into 3rd boom section approximately 36 in (90 cm) keep 4th-5th sections suspended to avoid damage to 5/4/3 retract cables.
16. Assemble bottom wear pads on 3rd section pad plate, raise 4th-5th section high enough in 3rd to allow plate with pads to slide between the sections, place retract cables in the grooves in the bottom pad plate, as boom sections are slid together, retract cables will pull thru these grooves, use appropriate hardware and fasten pad plate to the bottom plate of the 3rd section.

17. Install a nut on the threaded ends of the 5/4/3 retract cables, to keep the cable ends from pulling thru the anchor as the sections are pushed together.

18. Push the 4th-5th section inside the 3rd section, until it is within 36 in (90 cm) of full insertion.

19. Install side wear pads with appropriate shims on front inside of the 3rd section boom. Install upper spacer bar and cable guide with wear pad and related hardware on the top to the 3rd section. Shim according to calibration instructions, or as pads were originally removed and tagged.

20. Slide 4th-5th section inside 3rd until the end of the 4th section hits against the doubler bars in the 3rd section. Use caution as the 5/4/3 retract cable threaded end gets close to the grooves in the lower front pad plate, adjust as necessary to allow proper placement. A scribe mark on the 4th section at full retraction will aid in cable tensioning for proper boom sequence later.

21. Assemble top rear wear pads with the cam plates to the top of the 4th section. See step #11 for pad installation detail.

22. Uncoil 4/3/2 retract cables out of the 5th section, assemble 3rd section retract sheaves and pins into the inside of the 3rd section rear, using proper hardware and loctite 243, reeve cable over sheave installing upper keeper capscrew and lower rear pad, this pad serves as a cable keeper, lower pad and side pad for the rear of the section.

23. Pull threaded end of 4/3/2 retract cables, now under the 3rd section, towards front of boom.

24. Assembly step 22 completes the 5/4/3 boom section stage, at this point the Hydraulic extension cylinder and related cables and components are inserted into the 3rd-4th-5th section assembly starting with step 24

25. Support extension cylinder in a workable location and install the 3 extend sheaves in the sheave case end of the cylinder, orientate the pin so that the bearing grease holes are on the unloaded side of the pin (towards cylinder butt plate). Slide pin in thru round area of keyway shaped slot, installing sheaves one at a time, as the pin is slide thru the sheave case. Align slots in pin with square keyway side plate cutouts and push pin/ sheaves rearward (towards cylinder butt plate) into slot.

26. Install 3 2/3/4 extend cables over sheaves by placing button end thru opening between the sheave and the front double tapered plate on the cylinder. After the cables are in place, install the plastic tapered cylinder pads on the top and bottom shelves of the cylinder sheave case, these pads when secured in place act as cable retainers as well as wear pads, again apply loctite and jam nuts in these locations.

27. Pull the 3 button ends thru the extend cylinder sheave case until there is enough slack to install the 2/3/4 extend cable anchor, install cable anchor on extend cables, keep capscrews clamping the two halves of the anchor together just tight enough to not let the cables escape from their positions, this will allow easier assembly into the 4th section anchor point.

28. Drape 2/3/4 extend cables that come off the top of the sheaves in an area to avoid damage, preferably on the top of the extend cylinder, this will put them in their approximate location as the cylinder is installed into the 5th/4th/3rd boom assembly.

29. Slide extend cylinder into the 3rd-4th-5th boom assembly approximately 36 inches (90cm) Raise cylinder up at an angle slightly to allow easier access to the 2/3/4 extend cable anchor in the rear of the 4th section. Install 2/3/4 extend cable anchor and cable ends into the anchor point. Install keeper plates over the retract cable ends, these keepers are shaped to retain the 2/3/4 anchor as well as the retract cable ends. Tighten capscrews holding the two halves of the 2/3/4 anchor assembly together.

30. Lower extend cylinder to a position parallel with the 3rd-4th-5th boom assembly and slowly push the cylinder into the 3rd-4th-5th boom assembly until the cylinder collar makes contact with the 3rd section rear vertical doubler plates. Monitor 2/3/4 extend cable location as cylinder slides into boom sections to avoid damaging cables.

31. Raise extend cylinder up to allow cylinder collar to slide thru and align with the anchor pocket on the back of the 3rd, lower cylinder, collar will move down into cylinder anchor pocket, if properly positioned over pocket. Assemble lock bar and proper hardware to the cylinder collar, this will retain the cylinder into the anchor pocket.

32. Attach button end of 1/2/3 small extend cables into anchor point on the rear top plate of the 3rd section, a thin plate on the bottom and a thicker anchor plate on the top of the 3rd section top are required for proper cable retention, assemble with proper hardware and Loctite 243.

33. Lay 1/2/3 extend cables on the top of the 3rd section with the proper sheaves and pins that eventually will attach to the top plate of the 2nd section. Arrange cables per illustration (see figure 1).

34. The 3rd-4th-5th and cylinder assembly is now ready to assemble into the 2nd section boom.

35. Slide 3rd-4th-5th and cylinder assembly into the 2nd section boom approx. 36 in (90 cm) keep the 3rd-4th-5th and cylinder assembly suspended to avoid damage to the 4/3/2 retract cables.

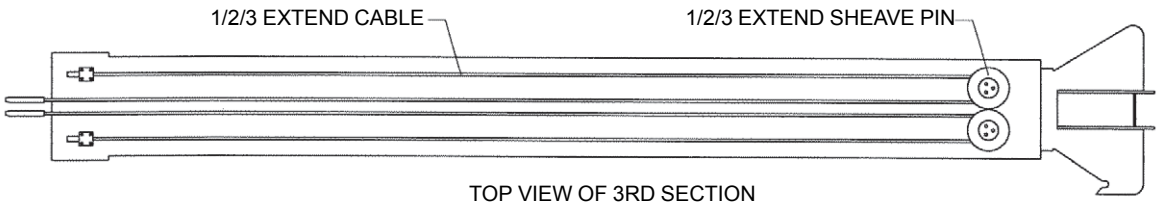


FIGURE 1

36. Assemble bottom wear pads on 2nd section pad plate, raise the 3rd-4th-5th and cylinder assembly high enough in the 2nd to allow pad plate with pads to slide between the sections, place retract cables in the grooves in the bottom pad plate, as the boom sections are slide together, retract cables will pull thru these grooves, use appropriate hardware and fasten the pad plate to the bottom of the 2nd section.

37. Install a nut on the threaded ends of the 4/3/2 retract cables, to keep the cable ends from pulling thru the anchor as the sections are pushed together.

38. Push the 3rd-4th-5th and cylinder assembly inside the 2nd section, until it is within 36 in (90 cm) of full insertion.

39. Install side wear pads with appropriate shims on front inside of the 2nd section, shim according to calibration instructions, or as pads were originally removed and tagged. Assemble 1/2/3 extend cable sheaves and pins with the appropriate hardware to the 2nd section top plate, assemble cable keeper/spacer bar plates to 2nd section, install cable guide and wear pad to the top of the 2nd section.

40. Slide the 3rd-4th-5th and cylinder assembly into the 2nd section until the extend cylinder collar bottoms out in its anchor pocket in the rear of the 2nd section or the 3rd section side plates bottom out on the doubler plates on the rear of the 2nd section. Use caution as the 4/3/2 Retract cable threaded ends get close to the grooves in the lower front pad plate, adjust as necessary to allow proper placement

41. Cylinder length adjustment may be necessary to properly position cylinder collar in the anchor pocket with the 3rd section side plates bottoming out on the doublers in the rear of the 2nd. A hydraulic power source may have to be utilized to adjust the cylinder length. Install appropriate hardware fastening the extend cylinder collar to the cylinder mounting channels in the rear of the 2nd section boom. Ascribe mark on the 3rd section at full retraction will aid in cable tensioning for proper boom sequence later.

42. Assemble top rear wear pads with the cam plates to the top of the 3rd section. See step #11 for pad installation detail.

43. Assemble 3/2/1 Retract cable button ends into anchors points in the rear of the 3rd section. Install keeper plates and capscrews. Assemble with loctite 243.

44. Assemble 2nd section retract sheaves and pins into the inside of the 2nd section using proper hardware and Loctite 243, reeve 3/2/1 retract cables, anchored to 3rd, over sheaves attached to 2nd section and install upper keeper capscrew and lower rear pad, this pad serves as a cable keeper, lower pad and side pad for the rear of the section.

45. Pull threaded ends of 3/2/1 retract cables, now under the 2nd section, towards the front of the boom.

46. Suspend assembled boom sections, position of extend cylinder butt plate is holding valve down, rotate rod assembly to achieve proper orientation, place retract cables to avoid damage, and slide assembled boom sections into the 1st section approximately 36 in (90 cm). Keep boom assembly suspended to avoid damage to the retract cable.

47. Assemble bottom wear pads on 2nd section pad plate, raise the 2nd-3rd-4th-5th and cylinder assembly high enough in 1st to allow plate with pads to slide between the sections, place retract cables in the grooves in the bottom pad plate, as the boom sections are slid together, retract cables will pull thru these grooves, use appropriate hardware and fasten pad plate to the bottom plate of the 1st section.

48. Install a nut on the threaded ends of the 3/2/1 retract cables, to keep the cable ends from pulling thru the anchor as the sections are pushed together.

49. Push the 2nd-3rd-4th-5th and cylinder assembly inside the 1st section, until it is within 36 in (90 cm) of full insertion.

50. Install side wear pads with appropriate shims on the front inside of the 1st section. Install upper spacer bar

with appropriate hardware to the inside top of the 1st. Shim according to calibration instructions, or as pads were originally removed and tagged.

51. Slide the 2nd-3rd-4th-5th and cylinder assembly into the 1st section until the extend cylinder butt plate contacts the back plate of the hoist mount. Use caution as the holding valve nears the hoist mount back plate, the holding valve to back plate clearance requires the butt plate to be level, with the holding valve down. Use caution as the 3/2/1 retract cable threaded ends get close to the grooves in the lower front pad plate, adjust as necessary to allow proper placement.

52. Install proper hardware retaining extend cylinder butt plate to the 1st section hoist mount.

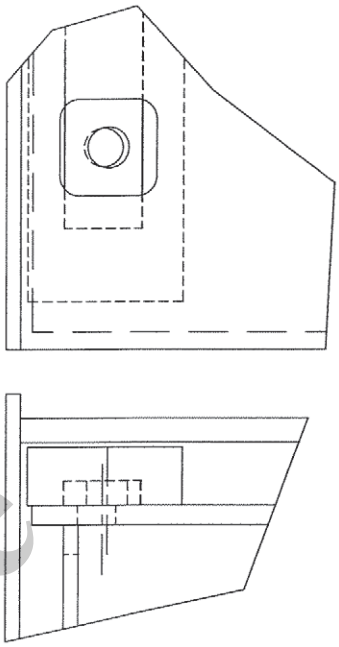
53. Assemble top rear wear pads with the cam plates to the top of the 2nd section. See step #11 for pad installation detail.

54. Install cable guides, angle pendulum, hoist and anti-two block system, see anti-two block system description and installation instructions.

Top/Rear Side Pad Adjustment

With the boom fully retracted, locate the inner boom section horizontally in the outer boom section it is riding in. A pry bar can be used to manipulate the side to side position of the section, however it is often difficult to pry the very most inner sections over. To assist in this process a keyhole slot is provided in the side plate of the first section to allow access to the 4th and 5th sections (on the five section boom configuration only). Insert the head of a capscrew into this slot and pull it into the slot opening in the boom section side plate you want to move. Install a large washer and nut on the capscrew, creating a clamp between the 1st section and the section requiring adjustment. Tighten capscrew to pull inner section over to a position that centers it within the section it is riding in.

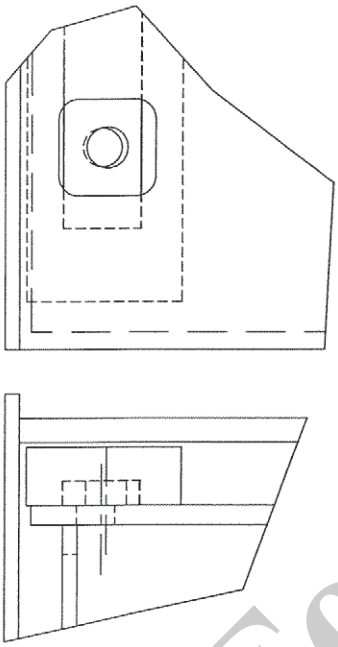
Extended boom straightness is critical for proper boom operation, The extended boom straightness required is a deviation of 0.50 in (13 mm) or less from the theoretical centerline of the boom. A string line from the center of the hoist to the middle of the sheave case on the last section will provide a theoretical center line. The top rear pads should be adjusted accordingly to provide proper clearances to achieve a straight extended boom.



Needs adjustment. The capscrews can not be installed and there is a gap between the wear pad and side plate of the larger boom section.

Assemble the top/rear wear pads and plates. The top/rear wear pads on this boom are adjustable to account for lateral tolerances that occur during the manufacturing process of the boom sections. The wear pad on each side at the top/rear of the boom can be adjusted over a range of 3/16 in (4,8 mm) by rotating, end for end, the wear pad and plate or the wear pads and plate independently. This is possible because the holes in these parts are offset from the center. The holes are 0.06 in (1,6 mm) off center in the plate and 0.03 in (0,8 mm) off center in the wear pad. Various combinations of rotation of these parts allow the adjustment.

Once the boom section has been centered within the section it is riding in, the wear pad and plate combinations can be inserted into the space between the boom sections and aligned over the holes in the sections. If the holes in the plate are not centered over the holes in the sections, the wear pads and plates have to be removed and adjusted either towards or away from the side plate of the next larger section until the holes will align. When properly aligned the wear pad should be tight against the side plate of the outer boom section and the extended boom should be straight to previously mentioned specifications.



Properly aligned and adjusted wear pad. The holes in the cam plate are concentric with the threaded holes in the smaller boom section and the wear pad is tight against the side plate of the larger boom section.

When wear pads are properly aligned and adjusted, install capscrew and torque to 75 lb-ft (100 Nm).

Four and Five 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 of an inch (4,8 mm) from the original pad thickness, top rear pad thickness 0.75 in (19 mm), bottom front 1st section 1 in (25 mm), bottom front 2nd and 3rd section 0.44 in (13 mm). Uneven pad wear of 3/32 in (2 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

Pad maintenance on the four or five section can be made easier by removal of the hoist and or removal of the hoist mounting bar spanning the end of the 1st section. Additional clearance can be achieved on the four section by loosening the large extend cables and removing the extend cable anchor located in the 2nd section.

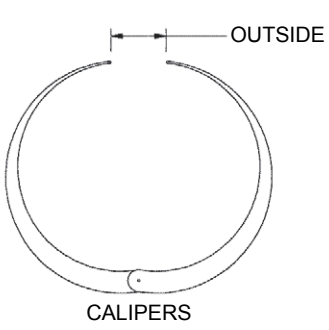
1. Retract boom completely.
2. Remove capscrews through access holes on top rear of sections.
3. Remove wear pads, shims, and cam plates from the rear of the boom through open hoist mount end.
4. Note all pad locations and tag accordingly.
5. Inspect pads for wear using previously mentioned inspection criteria.
6. Install new pads through hoist mount end of boom. See top pad adjustment procedure for proper pad and section position.
7. Torque retainer capscrews to 75 lb-ft (100 Nm) Failure to properly torque capscrews will cause loss of preload, allowing pad cam to rotate and cause excessive side clearance between sections.

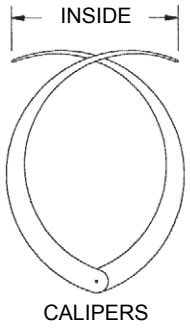
Front Bottom Pad Replacement

1. Extend boom approximately 4 ft (120 cm) out.
2. Remove cable guides and upper spacer bars from front of boom sections
3. Loosen and remove hex nuts on retract cables on the front of the 1st and 2nd sections
4. Using an appropriate lifting device, sling around the 4th or 5th depending on configuration section boom and lift it up until weight is removed from the bottom pads in the front of the interior sections.
5. Loosen and remove the capscrews holding the pad doubler plates in the front of the sections. Remove plates. Remove pads from these plates. Note all pad locations and tag accordingly.
6. Inspect pads for wear using previously mentioned inspection criteria.

Install new pads with Teflon inserts on plates or boom sections. Reassemble plates in boom in proper locations.

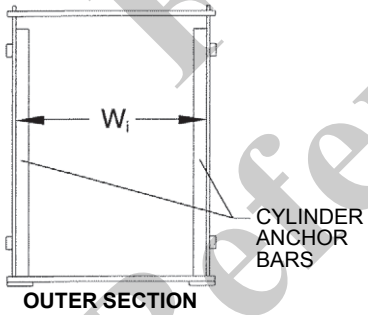
INNER WEAR PAD CALIBRATION



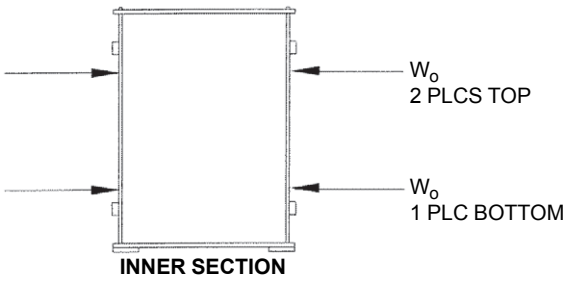


INNER SIDE PADS

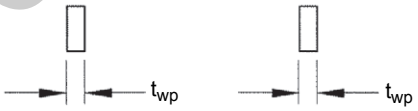
1. With a pair of inside/outside calipers, measure the inside width of the outer section (W_i) at the front and back of the boom and record the smallest measurement. If the section has cylinder anchor bars, take a measurement directly in front of these bars.



2. With the inside/outside calipers, measure the outside width of the inner section (W_o) at each side pad location. Record the largest measurement.



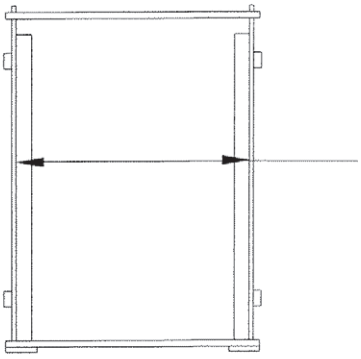
3. Measure the thickness of the wear pads and record (t_{wp}).



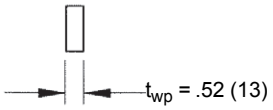
4. Subtract the largest outside width (W_o) of the inner section and the thickness of the two pads (t wp) from the inside width of the outer section (W_i). Add shims as required [each shim is 0.03 in (0,8 mm) thick] to tighten the pads so that there is 0.03 - 0.09 in (0,8 - 2,3 mm) clearance between 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.

EXAMPLE

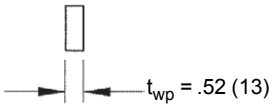
NOTE: All measurements are in inches (mm).

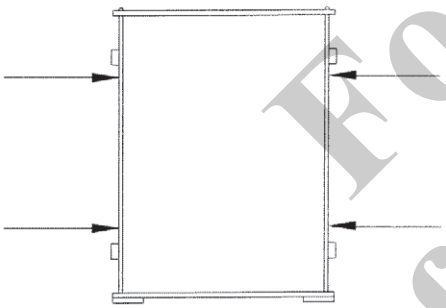


W_i = 12.12 (308) at front
12.06 (306) at back
near cylinder
anchor bars



THIRD SECTION





W_o = 10.94 (278) at top rear pad location

W_o = 11.00 (279) at top forward pad location

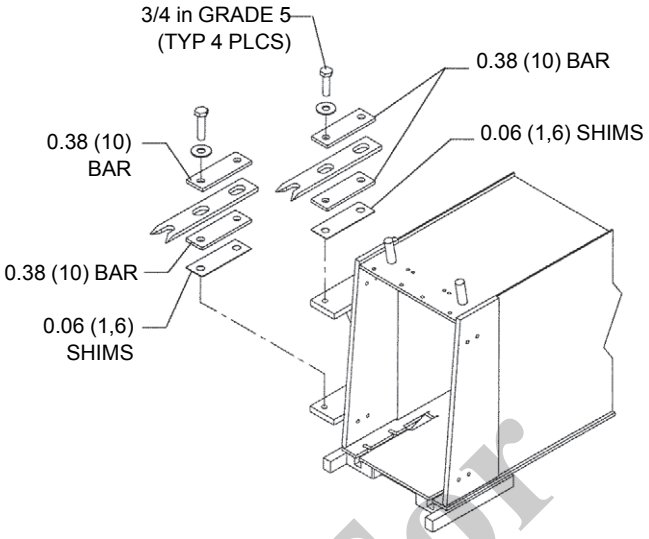
W_o = 10.94 (278) at bottom rear pad location

FOURTH SECTION

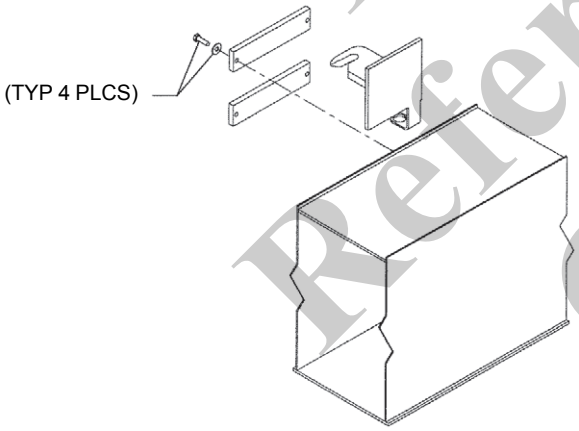
		TOP REAR		BOTTOM REAR	
W_i	=	12.06	(306)	12.06	(306)
$-W_o$	=	–10.94	–(278)	–10.94	–(278)
$-t_{wp}$	=	–0.52	–(13)	–0.52	–(13)
$-t_{wp}$	=	–0.52	–(13)	–0.52	–(13)
Clearance before shims	=	0.08	(2)	0.08	(2)
Left side shim	=	–0.03	–(0.8)	–0.03	–(0.8)
Final clearance	=	**0.05**	**(1,2)**	**0.05**	**(1,2)**

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).**

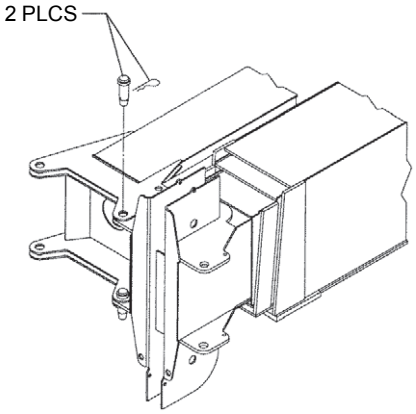


2. Loosely bolt the hook assembly to the side of the first boom section.

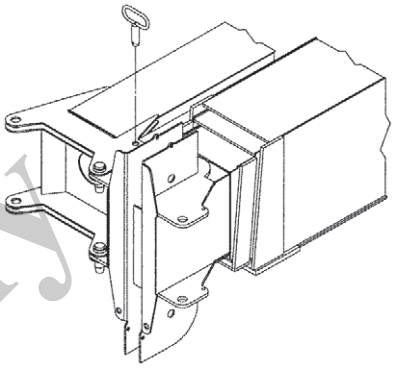


3. Extend the boom approximately one foot (300 mm).

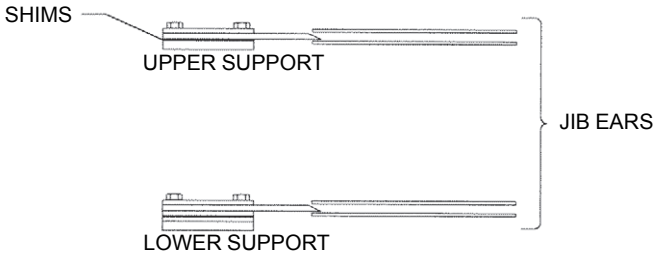
4. Using an overhead hoist, lift the jib assembly and align and pin the jib to the boom sheave head.



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).

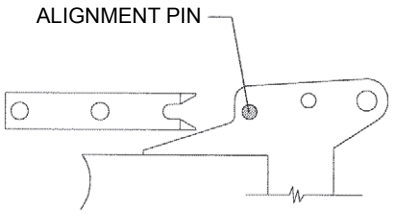


6. Slowly retract the boom until the jib ears are within 0.50 in (13 mm) of the ear assemblies on the first section. Observe the vertical alignment of the jib ears and ear assemblies and add or remove shims until the jib is supported by the jib ears. The jib will typically rest only on the upper support.

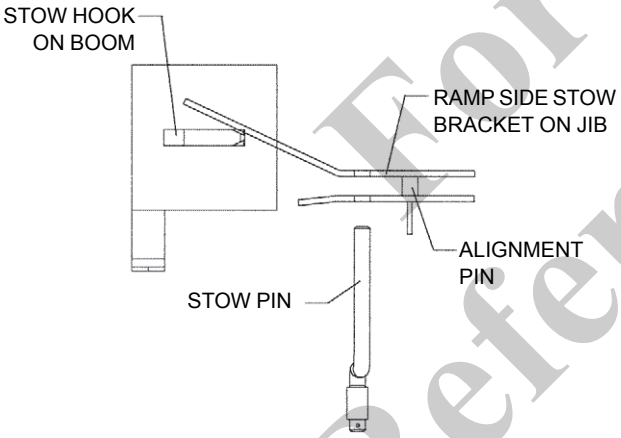


7. Observe the horizontal alignment of the slot in the ear assemblies and the alignment pin in the jib. Horizontal

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.



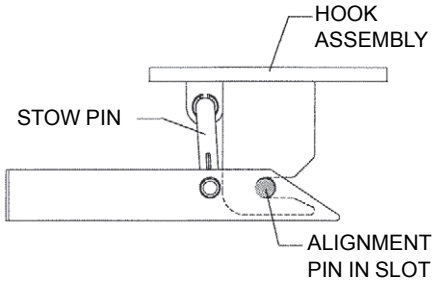
8. Retract the boom slowly. Observe the stow hook and side stow bracket assembly alignment as the boom is retracted.

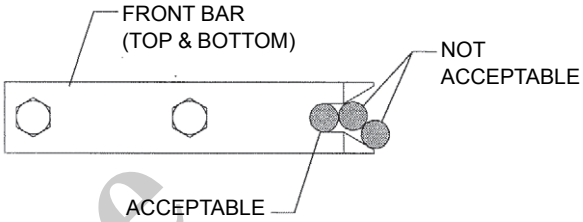


⚠ CAUTION

Make sure the ramp side stow bracket slides up the stow hook and does not hit the end of the ramp.

9. When the boom is fully retracted, the jib must be bottomed out securely in the ear assemblies.

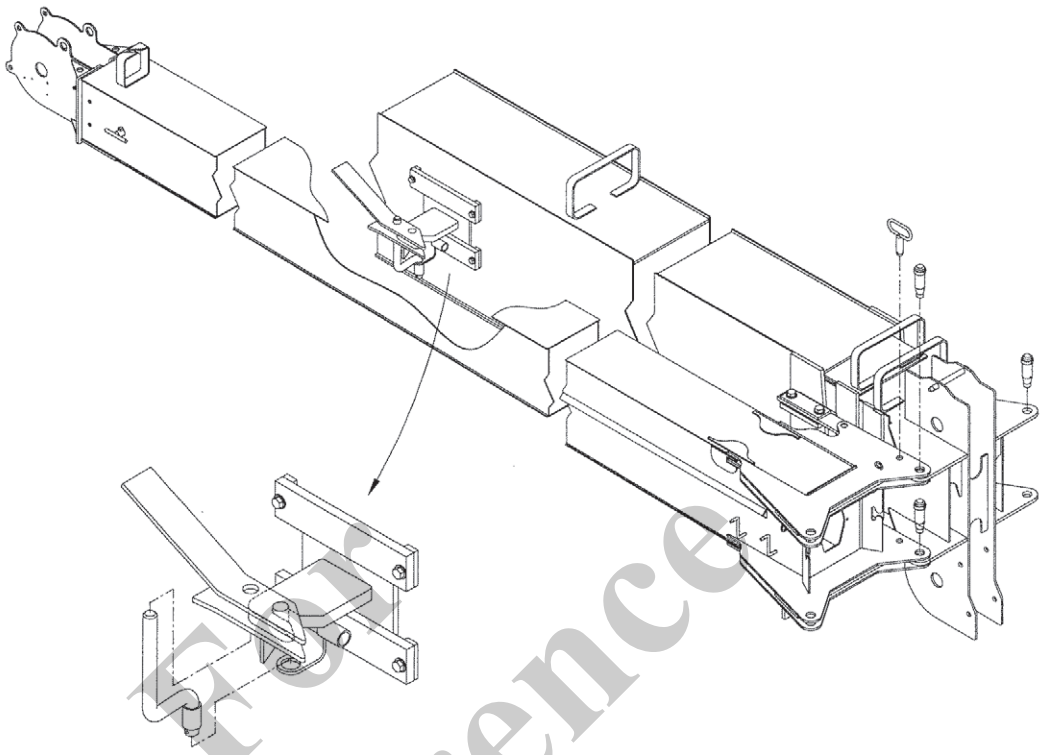




If the alignment pins are not aligned properly, the hook assembly and front bars will have to be positioned as shown so the jib cannot slide forward or backward as the boom is elevated.

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.



JIB JACK SERVICE & MAINTENANCE

Important: Use only a good grade hydraulic jack oil, transmission oil, or turbine oil. Avoid mixing types of oil. Do not use brake fluid, alcohol, glycerin, detergent motor oil, or dirty oil. Improper fluid can cause serious internal damage to the jack rendering it inoperative.

Adding Oil

1. With saddle fully lowered and piston depressed, set jack in its upright level position and remove oil filler plug.
2. Fill until oil is level with filler plug hole.

Changing Oil

1. For best performance and longest life, replace the complete oil supply at least once a year.
2. To drain the oil, remove the filler plug.
3. Lay the jack on its side and allow the oil to run out into suitable drain pin. The oil will run slowly because air must enter as oil drains out.
4. Be careful to prevent dirt or foreign matter from entering the system.
5. Replace with proper oil as described above.

Lubrication

Add proper lubrication oil to all pivoting sections every three months.

Rust Prevention

Check ram every three months for any sign of rust or corrosion. Clean as needed and wipe with an oil saturated cloth.

Note: When not in use, always leave the saddle and ram all the way down.

Troubleshooting

Symptom	Possible Cause(s)	Corrective Action
Will not lift load	1. No oil in system 2. Release valve not closed	1. Add oil to reservoir tank through oil filler hole 2. Turn handle clockwise tightly
Will lift load only part way	Oil level low	Add oil to reservoir tank through oil filler hole
Will lift load but will not hold	1. The following valve or valves leaking: a. Suction valve b. Delivery valve c. Release valve 2. Packings worn out or defective	1. Replace jack 2. Replace jack
Jack will not lower	Release valve stuck, probably dirt or foreign matter	Transfer load then replace dirty oil, flush oil reservoir with kerosene
Poor lifting	1. Dirty oil 2. Air in hydraulic system	1. Change hydraulic oil 2. Purge air from system
Poor pumping action	Oil seal for pump unit worn out or defective	Replace jack

OIL COOLER SERVICE & MAINTENANCE (OPTIONAL)

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 airflow 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.

HYDRAULIC SYSTEM

The hydraulic system of this machine is an open center type, consisting of a fixed displacement three section high pressure pump which supplies oil to a two inlet main control valve and a one inlet turn/outrigger/ stabilizer control valve.

The hydraulic oil is supplied by a truck mounted oil reservoir and is equipped with replaceable canister type return oil filters. The truck power take off driven hydraulic pump is sized to supply 32 gpm (121 lpm) to the hoist circuit, 32 gpm (121 lpm) to the boom lift and telescope circuits, and 16 gpm (61 lpm) to the turn and outrigger circuits at 2,000 rpm pump/pto shaft speed. Higher pump speeds may result in excessive heat generation in the hydraulic system. The pump rotation direction is reversible. Consult pump manual for changing rotation direction if necessary to match PTO output direction.

The main control valve is equipped with two inlet sections and one mid-outlet section. One inlet supplies oil from the front (shaft end) section of the pump to the hoist function(s). The other inlet section distributes flow from the middle pump section to the boom and telescope functions. Return oil is routed thru various outlet ports on the main control valve. The main control valve contains inlet section relief valves or port reliefs which limit pressure in the hydraulic system to acceptable levels and control crane movements. See specification section for proper pressure settings.

The turn, outrigger and stabilizer functions are controlled by a separate control valve. Oil from the rear section of the pump is routed to the main inlet of the valve. The control valve contains inlet section relief valves which limit pressure in the hydraulic system to acceptable levels and control crane movements. See specification section for proper pressure settings.

The crane hydraulic system includes a rated capacity limiter (RCL) system. This system monitors lift cylinder pressure. As the pressure in the lift cylinder approaches a maximum predetermined level, which can be monitored on the RCL display console, a signal is sent to a solenoid which dumps oil flowing to 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.

See “Specifications” section for system pressures and flows.

SERVICING THE MAIN CONTROL VALVE

Disassembly And Reassembly Of Control Valves To Replace Seals

1. Before disassembly, it is suggested that each valve section be marked numerically to avoid incorrect stacking when reassembled.
2. Remove four assembly stud nuts from the end section with a 17 mm open end wrench or 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 and washers with all assembly studs. No lock washers! All studs are stress-proof material and should be replaced only with original equipment replacement parts.

5. Thoroughly clean O-ring counter bores.
6. Replace the nine O-rings in between each section. O-rings are metric (3 pieces 17,86 x 2,62 mm, 2 pieces 12,37 x 2,62 mm, 4 pieces 5,28 x 1,78 mm).
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 the assembly studs, replace stud nuts and tighten evenly in two steps. Initially tighten all studs to 11 lb-ft (15 Nm), and then tighten all studs to 20 lb-ft (27 Nm).

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

1. Remove both capscrews and bonnet from spring end of spool.
2. Carefully remove the compressed spring package and spool (one side only).
3. Remove both capscrews from bracket on linkage end of spool seal counterbores.
4. Remove spool seals and thoroughly clean spool seal counter bores.
5. Pull seal retainer cup out of spring end of spool.
6. Remove O-rings, clean cup, and install new O-rings.
7. Lightly oil new spool seals and install in counterbores.
8. Reinstall all components in the same order as they were removed.
9. Torque spring spacing screw and capscrews to 50 lb-in (6 Nm).

Adjusting the Relief Valve Pressure Settings

The control valves supplied with this crane are equipped with adjustable relief valves. After time of use, it may be necessary to make some adjustment in pressure because of spring weakening, etc. See the “Specifications” section for correct pressure setting.

Important: If the machine does not perform properly first consult the trouble diagnosis chart in this section.

Do not adjust any relief valve setting without first checking the current setting with a pressure gauge.

Never adjust any relief valve setting above its specified setting as this could allow the machine to operate in such a manner as to endanger personal safety.

⚠ CAUTION

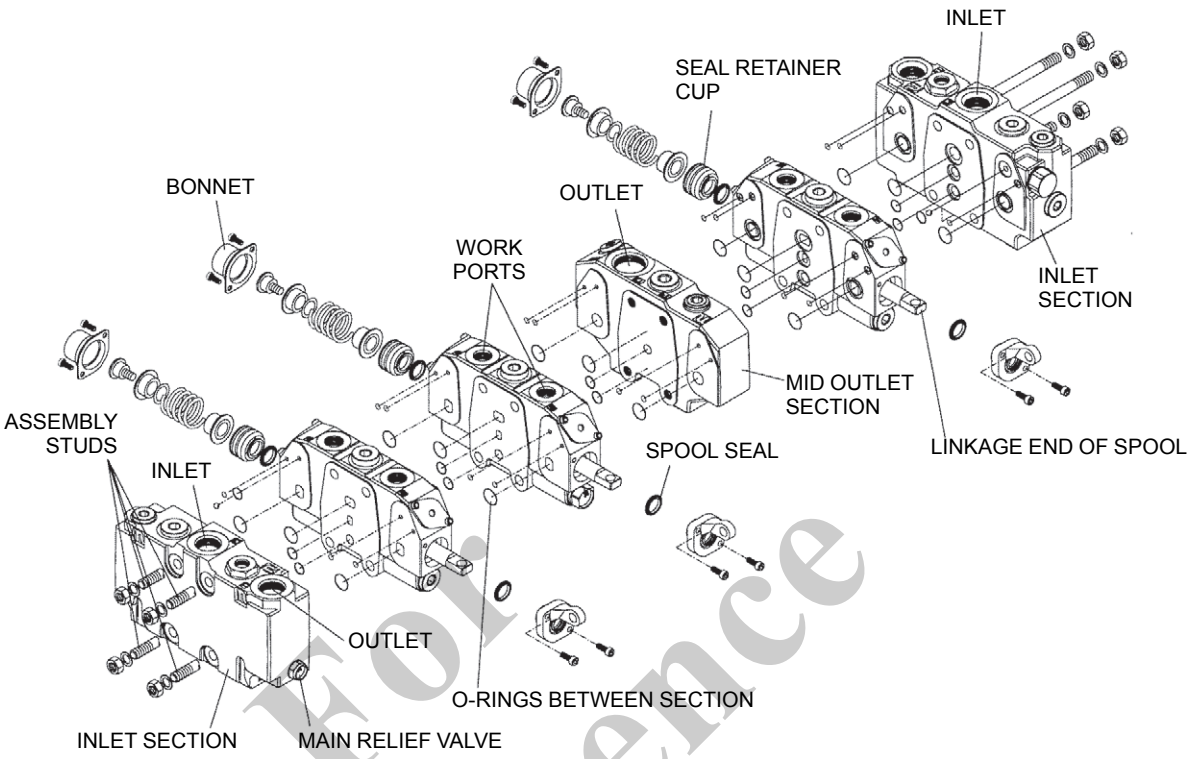
If the machine does not perform properly at these pressures, the problem is not the relief valve and no attempt should be made to readjust the setting. If the relief valves are set to higher pressures than those specified, the warranty on the machine is void. Also the machine could operate in a manner such as to endanger personal safety.

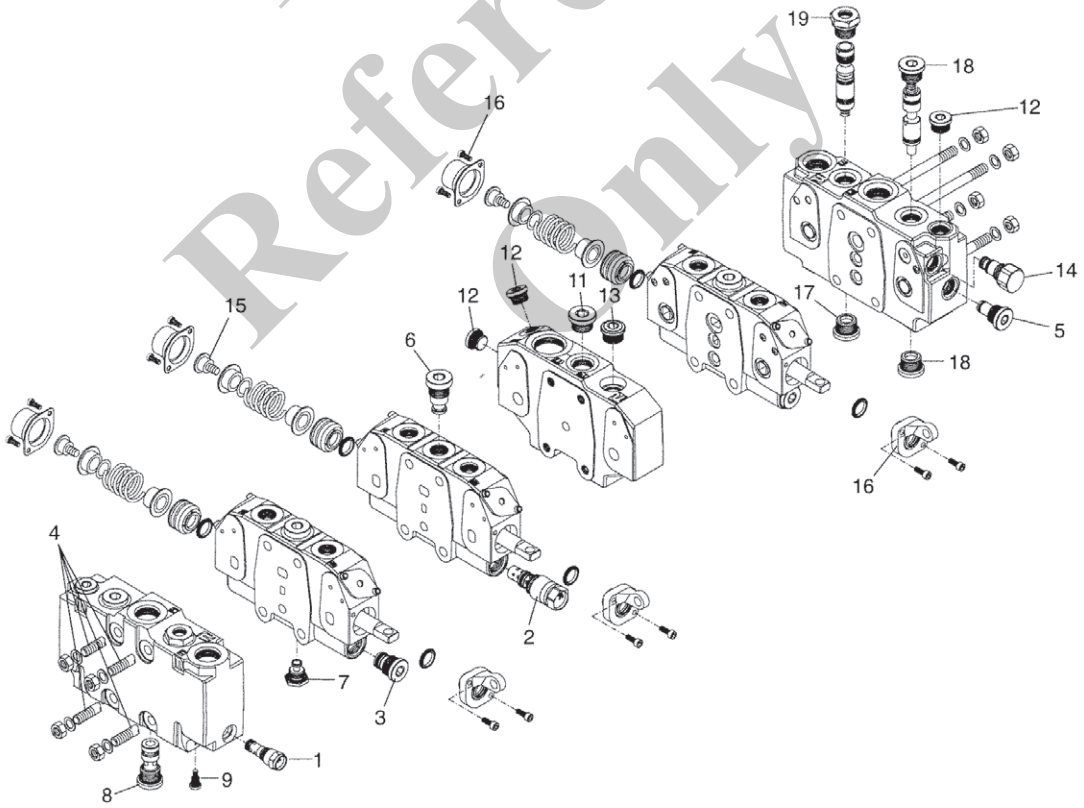
Adjustment of port relief, on individual work sections of the control valve, or main relief, on inlet section of the control valve:

1. Remove seal disc in top of port relief.
2. Clean grease out of port relief cavity.
3. Turn adjustment screw in for increased pressure or back adjustment screw out for decreased pressure setting.
4. Fill port relief cavity with grease.
5. Install seal disc, replace with new disc if necessary. ***Never set pressure above recommendations.***

Tightening Torques (maximums)

1. Main Relief Valve .....30 lb-ft (41 Nm)
2. Port Relief Valve.....35 lb-ft (47 Nm)
3. Port Relief Cavity Plug .....35 lb-ft (47 Nm)
4. Assembly Studs-initial torque..... 11 lb-ft (15 Nm)
   Final torque .....20 lb-ft (27 Nm)
5. Cavity Plug.....30 lb-ft (41 Nm)
6. Standard Check Valve.....50 lb-ft (68 Nm)
7. Check Valve .....30 lb-ft (41 Nm)
8. Metering Orifice.....50 lb-ft (68 Nm)
9. Damp/Check Valve Cartridge..... 8 lb-ft (11 Nm)
10. Steel Plugs (SAE#12) .....60 lb-ft (81 Nm)
11. Steel Plugs (SAE#10) .....50 lb-ft (68 Nm)
12. Steel Plugs (SAE #8).....40 lb-ft (54 Nm)
13. Cavity Plug.....35 lb-ft (47 Nm)
14. Pressure Reducing Valve Cavity Plug .....30 lb-ft (41 Nm)
15. Spool Control Spring .....50 lb-in (6 Nm)
16. Hydraulic Cap Capscrews.....50 lb-in (6 Nm)
17. By-Pass Unit .....50 lb-ft (68 Nm)
18. Hi/Lo Flow Unit.....50 lb-ft (68 Nm)
19. Pressure Gauge Port .....50 lb-ft (68 Nm)





SERVICING THE OUTRIGGER, STABILIZER AND TURN CONTROL VALVE

Before servicing the control valve, please familiarize yourself with the valve, plumbing components, mounting area and environment. Only work on the valve in an environment free from contamination so that the stipulated contamination level of oil is not exceeded. All valve connections and plumbing components must be plugged until connections are made.

Replacing Spool Seals

1. Remove both capscrews and bonnet from spring end of spool.
2. Carefully remove the compressed spring package and spool (one side only).
3. Remove both capscrews from bracket on linkage end of spool and remove bracket.
4. Remove spool seals and thoroughly clean spool seal counterbores.
5. Lightly oil new spool seals and install in counterbores.
6. Reinstall all components in the same order as they were removed.
7. Torque spring spacing screw and capscrews to 50 lb-in (6 Nm maximum.

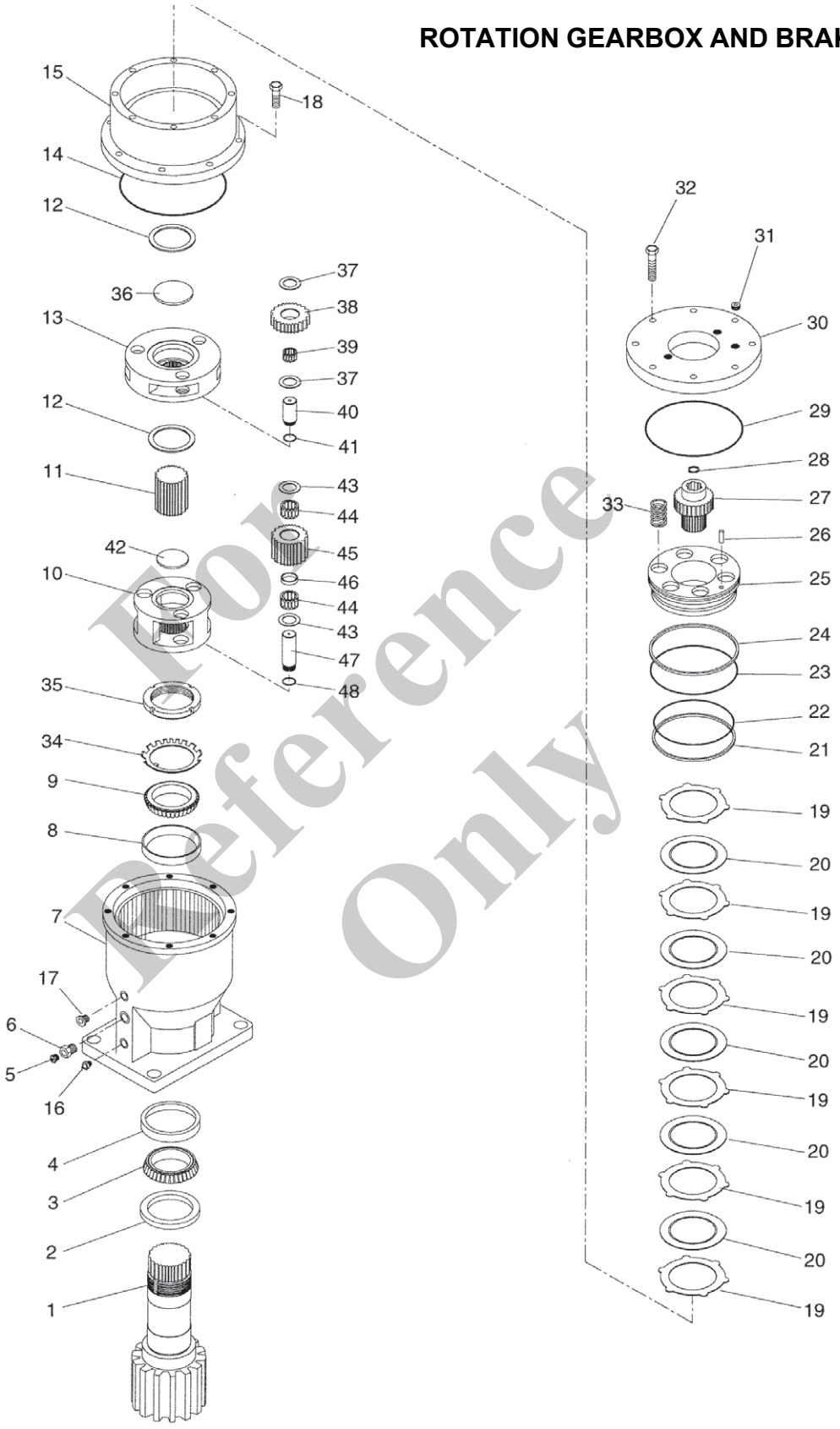
Replacing Section Seals

1. Remove the tie rods with a 17 mm open wrench or socket and pull the sections a part.
2. Thoroughly clean O-ring surfaces on each section. Replace section seals with the proper O-rings for tank gallery and Quad-rings for the pressure channels.
3. Reinstall the sections in same order as they where removed. Tighten tie-rods in two steps. Torque all three rods to 11 lb-ft (15 Nm then torque all three rods to 20 lb-ft (27 Nm).

Tightening Torques (maximums)

1. Main Studs - Initial Torque ..... 11 lb-ft (15 Nm)
   Final Torque ..... 20 lb-ft (27 Nm)
2. Main Relief Valve ..... 35 lb-ft (47 Nm)
3. Anti Cavitation Valve ..... 40 lb-ft (54 Nm)
4. Bonnet and Bracket ..... 50 lb-in (6 Nm)
5. Steel Plugs (SAE #10)..... 50 lb-ft (68 Nm)

ROTATION GEARBOX AND BRAKE



SWING DRIVE SERVICE

Lubrication and Maintenance

Manufacturer recommends changing oil after first 50 hours of operation. Oil should be changed at 500-hour intervals thereafter. All gearboxes require GL-5 grade EP 80/90 gear oil for lubrication. Some units may be equipped with a grease fitting for lubrication of the output shaft bearings (pinion up applications). The shaft bearings should be greased sparingly at every 50 operating hours with a lithium or GP bearing lube. In pinion down applications, gearbox oil will lubricate Shaft bearings.

Oil Capacities:

70 oz (9,64 kg)

Disassembly Procedure

1. Remove drive from vehicle and drain gearbox lubricant by removing the drain plug (**31**).
2. Remove the motor from the motor adapter (**30**).
3. Remove the brake assembly from the gear housing assembly (**7**) by removing eight sockethead capscrews (**18**).

NOTE: Notice the position of the brake port in conjunction with the drain and fill holes in the housing for reassembly.

4. Separate the motor adapter (**30**) from the brake housing (**15**) by removing eight capscrews (**32**).

NOTE: Notice the position of the motor mounting hole in relation to the brake release port for re-assembly.

⚠ CAUTION

The motor adapter is spring-loaded and the capscrews should be loosened in a sequence that will allow an even load distribution on the motor adapter.

5. Inspect the motor adapter O-ring (**29**) for damage. Replace if necessary.
6. Remove the six springs (**33**), piston (**25**), and brake driver (**27**) from brake housing (**15**).

NOTE: Notice the position of the dowel-pin hole in piston with respect to the brake release port for re-assembly.

NOTE: A port-a-power can be used to assist in the removal of piston by slowly pressurizing the brake release port until piston clears the top of housing (**15**). Remove stator plates (**19**) and friction discs (**20**) from the brake housing (**15**). Inspect stator plates for excessive grooving or burn spots. Also, inspect friction discs for wear. Replace as required. *(Ref. Fig. 1)*

7. Remove stator plates (**19**) and friction discs (**20**) from the brake housing (**15**). Inspect stator plates for excessive grooving or burn spots. Also, inspect friction discs for wear. Replace as required. *(Ref. Fig 1)*.

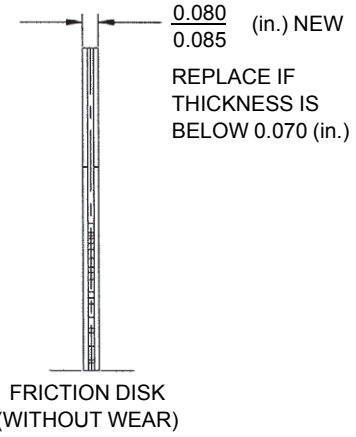


FIGURE 6

8. Inspect the piston O-rings (**22** & **23**) and the back-up rings (**21** & **24**) for damage, replace if necessary. *(Ref. Fig. 2)*

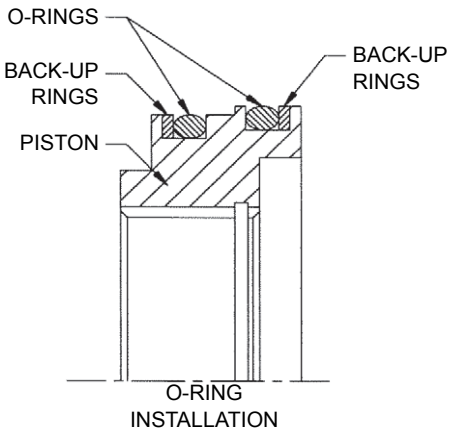


FIGURE 7

9. If applicable remove 2nd piston (**36**) from the brake housing (**15**), inspect O-rings (**37** & **38**) and back-up rings (**39** & **40**) for damage, replace if necessary. *(Ref. Fig. 2)* Inspect bearing (**41**) in brake housing (**15**) replace if necessary.

10. Remove race (**12**) from input planet set (**13**).

11. Remove input planet set (**13**) from gear housing (**7**) by pulling straight up and out of the housing.

12. Remove retaining ring (**41**), press out the planet pins (**40**), remove the planet gear (**38**), and needle bearings (**39**), inspect for unusual wear. Replace as required.

13. Remove race (**12**) from output planet set (**10**).

14. Remove the output sun gear (**11**), from the output planet carrier (**10**). Lift the output planet set out of the housing (**7**).

15. Remove the retaining ring (**48**). Press out the planet pins (**47**); remove the planet gear (**45**) and needle bearings (**44**). Inspect for unusual wear. Replace as required.

16. Remove bearing lock nut (**35**) and lock washer (**34**).

17. Remove the pinion shaft (**1**) from the housing (**7**) inspect the pinion shaft, seal, and bearing for wear and replace if necessary. Remove the inboard bearing (**9**) and inspect for wear.

18. Remove outboard seal (**2**) and bearing (**3**) Inspect for wear and replace if necessary.

ASSEMBLY PROCEDURE

1. Press the inboard and outboard bearing cup (4 & 8) into the gear housing (7) if replaced.

2. Grease pack the bearing cones (9 & 3) with EP-2 before installation.

3. Install the outboard cone (**3**) into the outboard cup (**4**). Press the seal (**2**) into the gear housing (**7**) from the outboard side.

4. Slide the output pinion (**1**) into the housing (**7**) from the outside.

5. Install the inboard bearing cone (**9**).

6. Apply Loc-Tite to pinion shaft and locknut.

7. Install the bearing lockwasher (**34**) then the bearing locknut (**35**). Torque locknut to 50 lb-ft Loosen and rotate pinion 90 degrees, re-torque locknut to 50 lb-ft (repeat this process 4 times) then re-tighten locknut to 20 lb-ft If the locknut is between tabs on the lockwasher always tighten until tabs align with slots in locknut. Secure locknut by bending tabs on lockwasher so that it engages locknut to prevent locknut from backing off.

NOTE: Install a 5/8-11 bolt into the end of the pinion shaft on the outboard side and check the rolling torque. Preload of the bearing torque should be 50-75 In. Lbs.

8. Install the output carrier (**10**) into the gear housing (**7**). Install sun gear (**11**) and then the race (**12**) into output carrier (**10**).

9. Install the input carrier section (**13**) with race (**12**).

10. Assemble the brake section by first installing the O-ring (**14**) on the brake housing (**15**). Install eight capscrews (**18**) to the brake housing (**15**) and torque to 10 lb-ft.

NOTE: Notice the position of the brake port in conjunction with the drain and fill holes in the housing.

11. If applicable install piston (**36**) into brake housing (**15**).

NOTE: Apply a slight flim of oil on the O-rings and back-up rings before installation.

12. Insert the brake driver (**27**) into the assembled brake housing (**15**).

13. Install the stator plates (**19**) and friction disks (**20**) starting with one stator plate and alternating between friction disk and stator plate until six stator plates and five friction disks are used.

NOTE: Soak friction disk in EP-90 oil before installation.

14. Carefully press the assembled piston (**25**) into the brake housing (**15**), taking care not to damage the O-rings.

NOTE: Notice the position of the dowel pin hole in piston with the brake release port for correct assembly.

15. Install six springs (**33**) into the holes in the piston (**25**).

16. Mount the motor adapter (**30**) to the brake housing (**15**) with eight capscrews (**32**) checking to make sure the roll pin (**26**) is in line with the dowel hole in piston (**25**).

NOTE: Notice the position of the motor mounting hole in relation to the brake release port for correct re-assembly.

17. Mount the motor to the adapter (**30**).

18. Fill the gearbox to desired level with EP-90 gear lube.

OUTRIGGER DISASSEMBLY

Outrigger wear pads and shims have been calibrated. Positioning of all wear pads and shims must be noted for reassembly. If location of shims are unknown or if outrigger sections are replaced, recalibration will be necessary.

1. Remove the outrigger floats from the jack leg and store.
2. Remove the retaining capscrews attaching the end cover to the extend cylinder, remove end cover.
3. Remove feed tubes from extend cylinder holding valve and bulkhead fittings thru access opening after removing end cover
4. Remove holding valve to allow cylinder rod movement. Lift cylinder out of anchor pockets in main outrigger box section with prybar, push cylinder buttplate forward to keep buttplate from falling back into anchor pocket.
5. Remove and tag top wear pads and shims from the main outrigger box section. Raise the 1st/ 2nd section outriggers against the main outrigger box section. Remove and tag the bottom wear pad and shims from the main outrigger box section.
6. Mark the position and remove the retaining nuts which anchor the proportioning cables to the bottom tip of the main outrigger box section. Route cables back thru anchor plate and pull ends out between the main box and the 1st/2nd outrigger assembly
7. Pull the 1st/2nd section outrigger assembly out of the main outrigger box section. Insure that the intermediate lock is disabled. Keep the proportioning cables taut to avoid pinching or damaging the cables during this operation.
8. Place the 1st/2nd assembly on a suitable horizontal surface. Take care not to pinch or crush the proportioning cables while lifting or supporting the assembly.
9. Using hoist, lift extend cylinder out of anchor pockets in the 1st section outrigger, and suspend to allow for easy access to internal components.
10. Remove snaprings from dual cable sheave pin in the rear of the 1st section. Remove pin and sheave from section. Route cables back thru opening in the bottom plate of the 2nd section after sheave removal.
11. Remove the hoses that route oil to the vertical cylinder at the bulkhead fittings at the rear of the 2nd section. Remove capscrews clamping the cable anchor together at the rear of the 2nd section. Remove cable anchor assembly.
12. Pull extend cylinder out of the 1st/2nd section assembly. Take care not to pinch or crush hoses or cables during cylinder removal. Use caution as cylinder is fully removed from 2nd section, loose parts such as the hose sheaves can fall off the pin and be damaged.
13. Place cylinder on a suitable horizontal surface, remove cable sheaves and hose sheaves, remove pin.
14. Mark retaining nut positions on proportioning cables and remove cables from cylinder butt plate, place cables in location to avoid damage.
15. Remove and tag side wear pads and shims from the inner front of the 1st section outrigger. Raise the 2nd section outrigger against the top pad of the 1st section outrigger. Remove and tag the bottom wear pad between the 1st and 2nd outrigger.
16. Pull the 2nd section outrigger out of the 1st section and place on a suitable horizontal surface. If necessary remove and tag wear pads and shims from the 2nd section outrigger.
17. Disassemble the hydraulic feed tubes from the outrigger jack cylinder holding valve, and remove the tubes from the 2nd section outrigger.
18. Properly support the outrigger jack cylinder from the bottom with a floor jack or hoist and remove the holding valve and O'rings from the outrigger jack cylinder.
19. Remove the capscrews retaining the lock plate on the jack cylinder, remove lock plate. With the cylinder supported, slide the retainer plate out from under the cylinder rod butt plate, lower cylinder out of vertical outrigger tube, use caution and proper support during this step.

⚠ CAUTION

When the retainer plate is removed, cylinder is free to drop out of leg assembly.

20. Remove wear rings installed in grooves of lower cylinder support legs.

OUTRIGGER ASSEMBLY

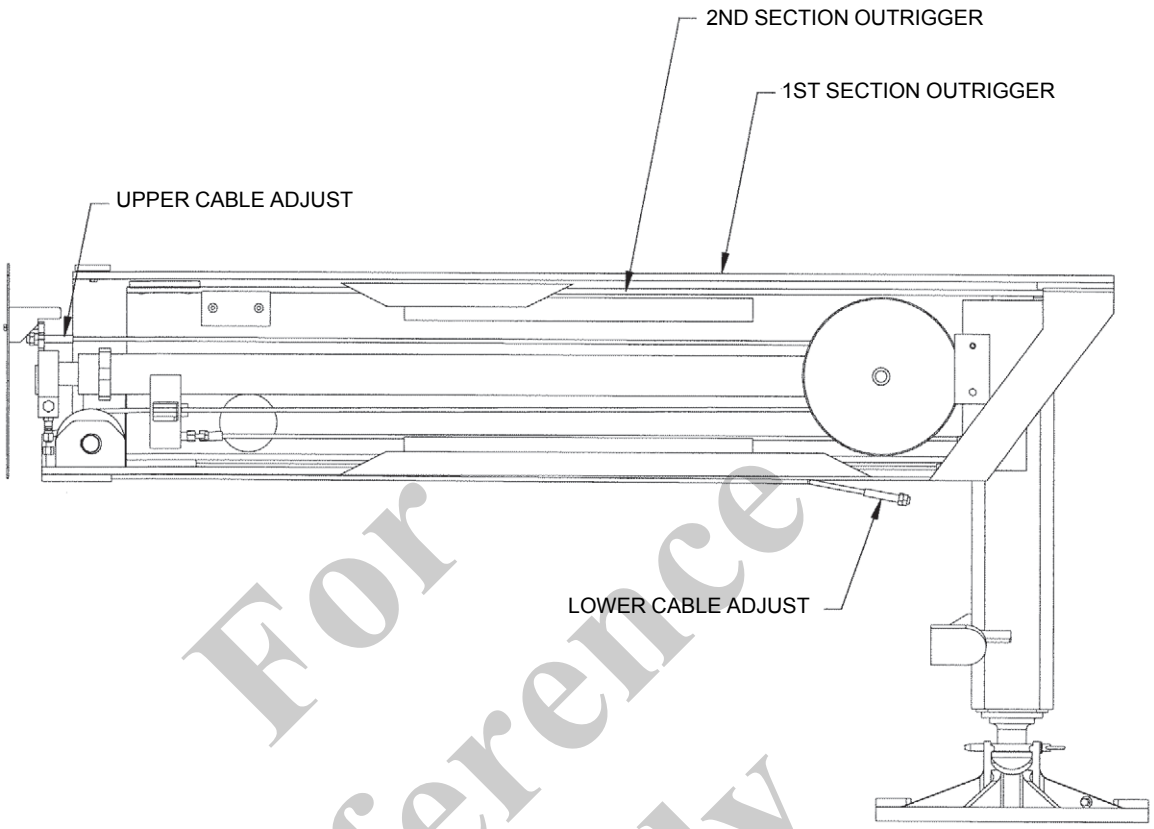
Note: Do not use loctite on any threaded cable ends. Always use the jam nuts and or nuts provided. When initially assembling threaded ends of cables, thread the first nut on past the flat so adjustment can be made later.

With the exception of threaded cable ends, Loctite must be applied to all fasteners and all fasteners must be tightened to the proper torque.

Outrigger wear pads and shims have been calibrated. All shims must be reassembled for proper outrigger operation. If locations of shims are unknown or if outrigger sections are replaced, recalibration will be necessary.

1. Install hydraulic feed tubes into the 2nd section outrigger.
2. Install wear rings into outrigger leg. Assemble outrigger jack cylinder into the 2nd section outrigger leg, install the retainer plate by sliding the plate under the jack cylinder butt plate. Install lock plate and capscrews.
3. Install holding valve on jack cylinder, use caution to get proper O'ring placement. Install hydraulic fittings onto holding valve, attach feed tubes.
4. Install wear pads and shims to 2nd section outrigger. With 1st section outrigger on suitable horizontal surface, assemble 2nd section into 1st section, slide in until 2nd section stops.
5. Install side wear pads and shims between 2nd and 1st outrigger sections. Raise the 2nd section and install the bottom front wear pads and shims.
6. Assemble proportioning cable sheave with pin and hose sheaves onto extend cylinder. Reeve cables and hoses over appropriate sheaves and drape excess in area to avoid damage.
7. Insert extend cylinder into 1st/2nd outrigger assembly, use caution, avoid pinching cables and hoses during this operation. Roll cylinder into section on hose sheaves and lift cylinder up to allow cable anchor access.
8. Install bulkhead fittings in anchor plate assembly, attach jack cylinder hoses.
9. Assemble proportioning cable button into cable anchor and install anchor in 2nd section outrigger. Assemble jack cylinder feed tubes to bulkheads on anchor.
10. Route cables thru sheave hole on bottom of 2nd outrigger section, reeve cables around dual sheave and install sheave, pin and snaprings
11. Lower cylinder, allowing cylinder anchor collar to engage into U shaped anchor points on the side plates of the 1st outrigger section.
12. With 1st/2nd section assembly on suitable horizontal surface, install appropriate wear pads and shims.
13. Attach cables, bulkhead fittings and hoses to cylinder buttplate for ease of assembly and to avoid damage during assembly of 1st/2nd section into outrigger box, depending on cylinder position this may or may not be possible, adjust cylinder length to allow assembly.
14. Slide 1st/2nd section assembly into outrigger box, use caution not to damage the cables sliding in under the 1st section. Section assembly may have to be lifted to install cable ends into the anchor points in the outrigger box. Guide cable ends between main outrigger section and 1st/2nd assembly and back thru anchor points. Install anchor hex nuts in previously marked positions.
15. Push the 1st/2nd outrigger assembly into the main outrigger box, when the butt plate of the extend cylinder reaches the anchor points, Lift the cylinder with a hoist or prybar and drop into the U shaped anchor points on the inside of the main outrigger box.
16. Install holding valve on extend cylinder if removed, reassemble hydraulic feed tubes and bulkheads.
17. Install side and bottom wear pads and appropriate shims. Install cylinder keeper plate/ end cover, and reinstall outrigger floats.

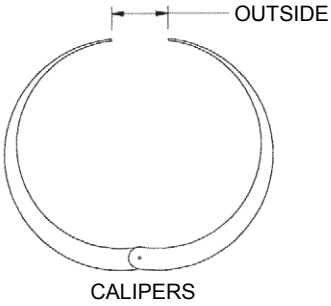
OUTRIGGER CABLE TENSIONING

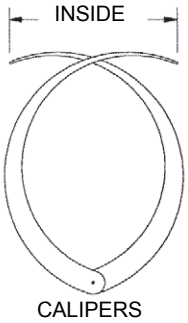


1. With outriggers assembled and operational, cycle the outriggers and front stabilizer through full stroke out and down then up and in for five complete cycles to remove air in cylinders.
2. Fully retract outriggers. At full retraction, the base of the 1st section outrigger bottoms out in the base of the main outrigger and the base of the 2nd section outrigger bottoms out against the sheave cable anchor plates in the base of the 1st section outrigger. This may be viewed through the hole in the main outrigger.
3. If the 1st section outrigger does not bottom out in the main outrigger, loosen the upper cable adjustment. If the 2nd section outrigger does not bottom out in the 1st section outrigger, loosen the lower cable adjustment. After cables have been adjusted to allow full retraction of sections, torque cables to 30-35 lb-ft (40-47 Nm) by first tensioning the lower cable adjustments, then the upper

OUTRIGGER CALIBRATION

NOTE: All measurements are in inches (mm)

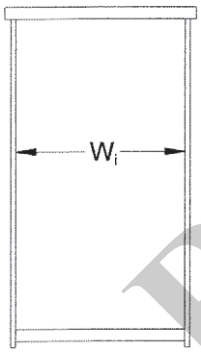




Side Pads

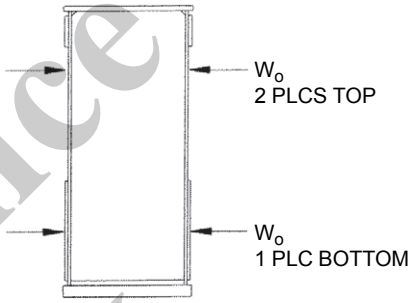
1. With a pair of inside/outside calipers, measure the inside width of the outer section outrigger (W_i) at the front pad location and three feet back from the front of the section and record the smallest measurement.

Note: Method of calibration is the same for the 1st or 2nd section outrigger.



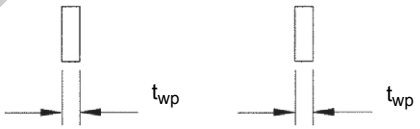
OUTER SECTION

2. With the inside/outside calipers, measure the outside width of the appropriate inner section (W_o) at the rear of the section and three feet from the rear. Record the largest measurement.



INNER SECTION

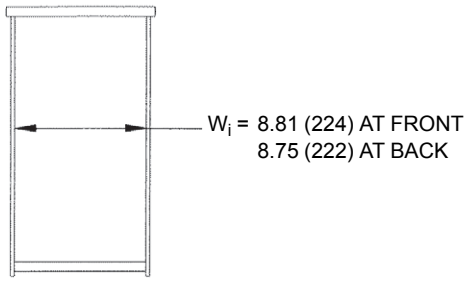
3. Measure the thickness of the wear pads and record (t_{wp}).



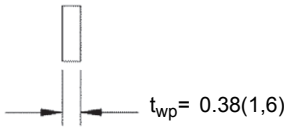
4. Subtract the largest outside width (W_o) of the inner section and the thickness of the two pads (t_{wp}) from the inside width of the outer section (W_i). Add shims as required [each shim is 0.03 (0,8) or 0.06 (1,6) thick] to tighten the pads so that there is 0.00 - 0.06 (0,00 - 1,6 clearance between the widest part of the inner outrigger section and the most narrow part of the outer outrigger section when shims and pads are installed. See example.

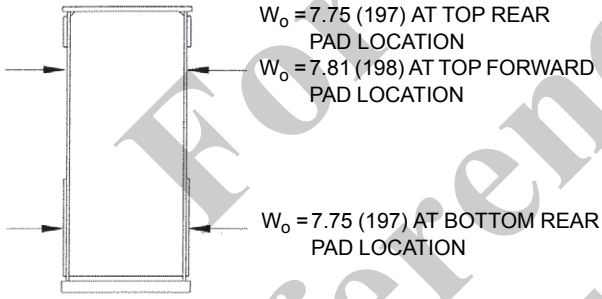
5. Repeat procedure when installing 1st/2nd outriggers into outrigger boxes subbase.

EXAMPLE

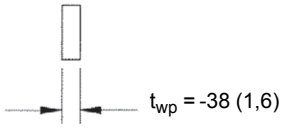


1ST SECTION





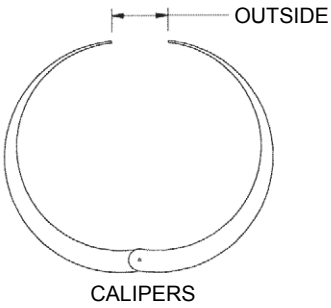
2ND SECTION

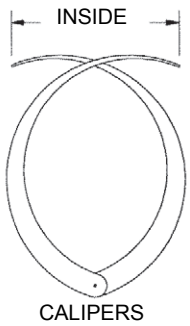


W_i	=	8.75	(222)
$-W_o$	=	-7.81	(198)
$-t_{wp}$	=	-0.38	(9,6)
$-t_{wp}$	=	-0.38	(9,6)
Clearance	=	0.18	(4,8)
Left side shim	=	-0.06	(1,6)
Right side shim	=	-0.06	(1,6)
		0.06	(1,6)

Outrigger Calibration (continued)

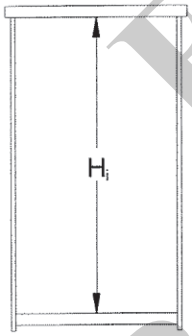
NOTE: All measurements are in inches (mm)





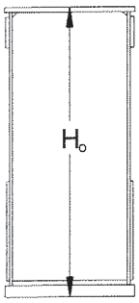
Top and Bottom Pads

1. With a pair of inside/outside calipers, measure the inside height of the outer section (H_i) three feet from the front of the section and record.



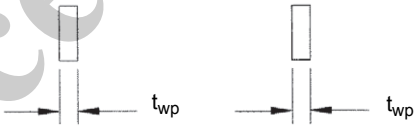
OUTER SECTION

2. With the inside/outside calipers, measure the outside height of the inner section (H_o) at the rear of the section from the top plate to the bottom of the bottom pads and record.



INNER SECTION

3. Measure the thickness of the top wear pads that attach to the inner section and record (t_{wp}).



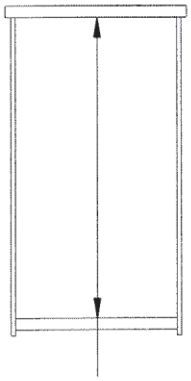
4. Subtract the outside height (H_0) of the inner section and the thickness of the top pads (t_{wp}) from the inside height (H_i)of the outer section. Add shims as required [each shim is 0.03 or 0.06 (0,8 or 1,6) thick] to tighten the pads so that there is 0.03 - 0.06 (0,8 -1,6) clearance between the widest part of the inner outrigger and the most narrow part of the outer outrigger when shims and pads are installed. See example.

5. Install the inner outrigger section into the outer outrigger section. Nominal front bottom pad and shim thickness should allow the inner outrigger section to extend parallel with the outer outrigger section. If adjustment is necessary, raise the inner section outrigger up and adjust the lower front shims to level the outrigger section extension. Shim the top front wear pads as required to provide 0,03 - 0,09 (0,8 - 2,4) total section clearance.

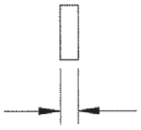
6. Repeat procedure when installing 1st/2nd outriggers into outrigger boxes on subbase.

EXAMPLE

1ST SECTION

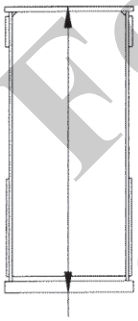


H_i = 16.19 (411)



t_{wp}= 0.50 (12,7)

2ND SECTION



H_0 = 14.88 (378)

H_i	=	16.19	(411)
$-H_o$	=	-14.88	(378)
$-t_{wp}$	=	-0.50	(12.7)
$-t_{wp}$	=	-0.50	(12.7)
Clearance	=	0.12	(3.2)
Shims	=	-0.19	(4.4)

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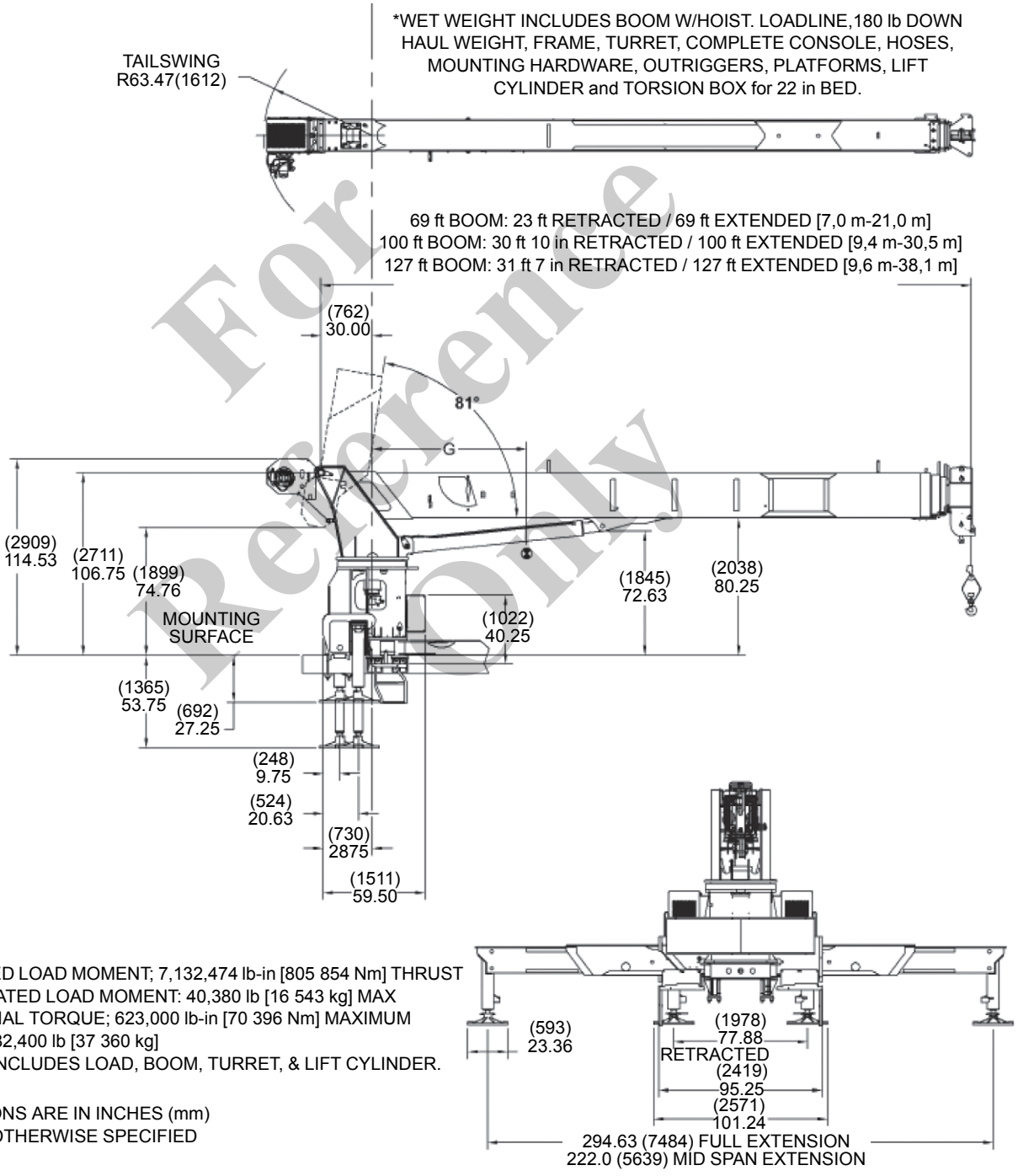
SECTION 6
SPECIFICATIONS

(DIMENSION SPECIFICATIONS)

	RETRACTED	EXTENDED	G	WET / WT*
SERIES	LENGTH	LENGTH	Inches (cm)	lb (kg)
1469H	23 ft	69'	60.2 in (153)	22,448 (10 182)
14100H	30 ft 10 in	100'	82.7 in (210)	25,631 (11 626)
14127H	31 ft 7 in	127'	90.4 in (230)	28,371 (12 869)

*WET WEIGHT INCLUDES BOOM W/HOIST. LOADLINE,180 lb DOWN HAUL WEIGHT, FRAME, TURRET, COMPLETE CONSOLE, HOSES, MOUNTING HARDWARE, OUTRIGGERS, PLATFORMS, LIFT CYLINDER and TORSION BOX for 22 in BED.



NOTES:
MAX RATED LOAD MOMENT; 7,132,474 lb-in [805 854 Nm] THRUST AT MAX RATED LOAD MOMENT: 40,380 lb [16 543 kg] MAX ROTATIONAL TORQUE; 623,000 lb-in [70 396 Nm] MAXIMUM THRUST: 82,400 lb [37 360 kg]
THRUST INCLUDES LOAD, BOOM, TURRET, & LIFT CYLINDER.

DIMENSIONS ARE IN INCHES (mm)
UNLESS OTHERWISE SPECIFIED

Pump Flow

Hoist System	32 gpm (121 lpm)
Boom and Telescope System	32 gpm (121 lpm)
Turn and Outrigger System	16 gpm (61 lpm)

System Pressure

Hoist Up and Down	4000 psi +100/-0 psi (27,6 MPa)
Boom Up and Down	4000 psi +100/-0 psi (27,6 MPa)
Telescope Out	2700 psi +100/-0 psi (18,6 MPa)*
Telescope In	2200 psi +100/-0 psi (15,2 MPa)*
Turn Left and Right	3000 psi +100/-0 psi (20,7 MPa)
Outriggers	3000 psi +100/-0 psi (20,7 MPa)
Stabilizers	3000 psi +100/-0 psi (20,7 MPa)

Reservoir Capacity 103.3 gal (391 l)

System Capacity 164 gal (621 l)

Filtration 10 Micron Return

Flow rates listed are at free flow condition (approx. 100 psi/1 MPa)

Crane Performance

Rotation, 360°	35 seconds + 5 seconds (1.70 rpm)**
Boom Up (-10° to 80°)	34 seconds + 5 seconds
Boom Down (80° to -10°)	34 seconds + 5 seconds
Boom Extend/Retract	
(31-100 ft Four Section)	Extend - 125 sec. + 15 sec. (33 ft/min) (10,1 m/min) Retract - 140 sec. + 15 sec. (30 ft/min) (9,1 m/min)
(32-127 ft Five Section)	Extend - 135 sec. + 15 sec. (42 ft/min) (12,8 m/min) Retract - 155 sec. + 15 sec. (37 ft/min) (11,3 m/min)

Hoist Performance

Wire Rope

Standard	375 ft (114 m) of Ø 5/8 in (15,9 mm) Rotation Resistant Nominal Breaking Strength 45,400 lb (202 kN)
Optional	375 ft (114 m) of Ø 5/8 in (15,9 mm) 6 x 25 IWRC Nominal Breaking Strength 41,200 lb (183 kN)

Speed and Pull

	Low Speed/High Pull				High Speed/LowPull				Rope Capacity	
Layer	(fpm)	(mpm)	(lb)	(kg)	(fpm)	(mpm)	(lb)	(kg)	(ft)	(m)
1	128	39	12,100	5488	255	78	5,800	2631	79	24
2	141	43	10,800	4899	283	80	5,200	2359	167	51
3	156	47	9,900	4491	311	95	4,800	2177	265	81
4	170	52	9,000	4082	340	103	4,400	1996	371	113

* Work port relief settings based on 32 gpm with pressure gauge at work port.

** Swing speed based on adjustment knob in closed position.

SECTION 7
INSTALLATION

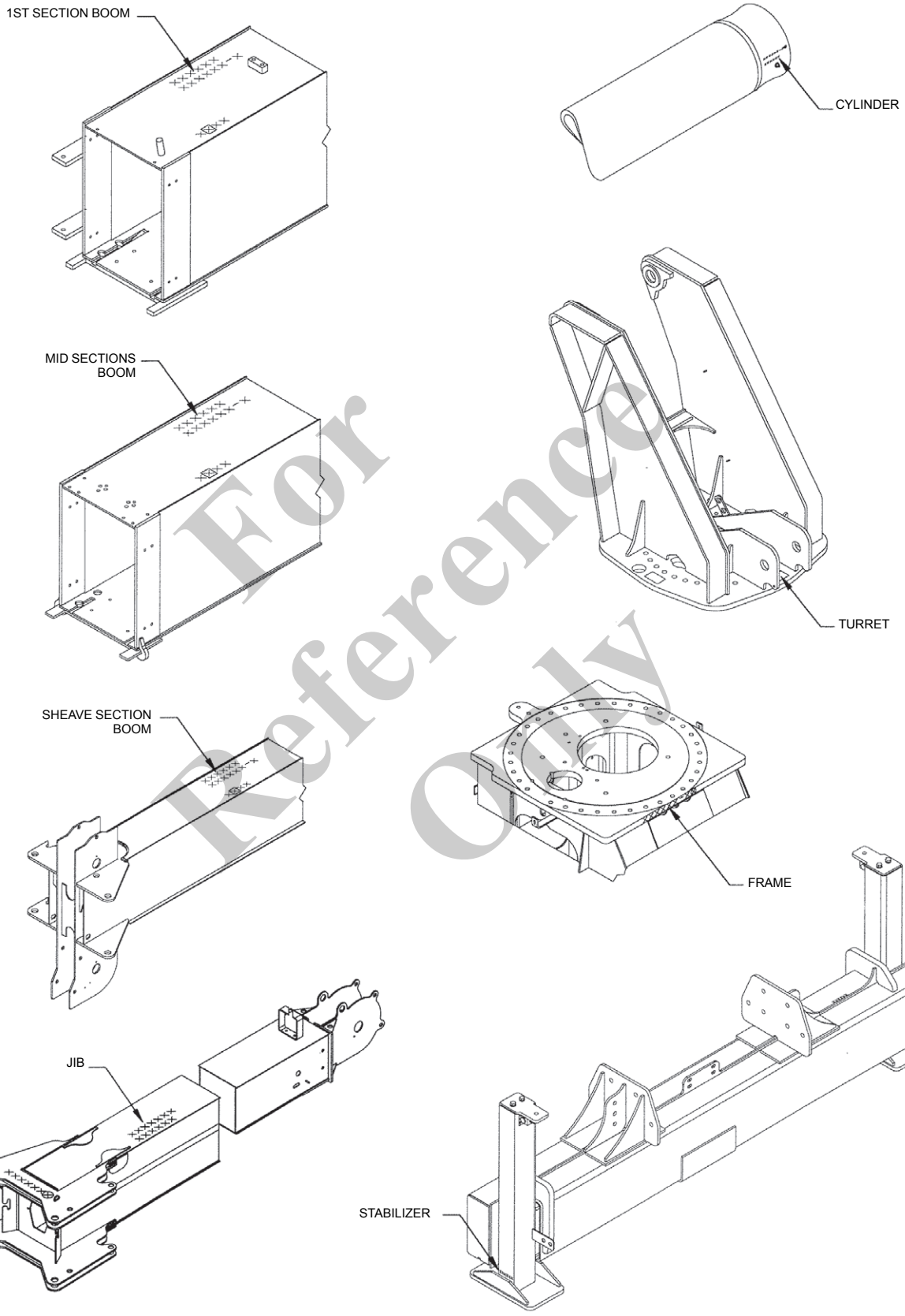
SECTION CONTENTS

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, 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 gas and men in the truck cab.

National cranes should meet ASME/ANSI B30.5 (latest) when completed as cranes and ASME/ANSI B30.23 (latest) when completed as a personnel lifting system. 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.

TYPICAL LOCATIONS / SERIAL NUMBER IDENTIFICATION



MINIMUM TRUCK REQUIREMENTS

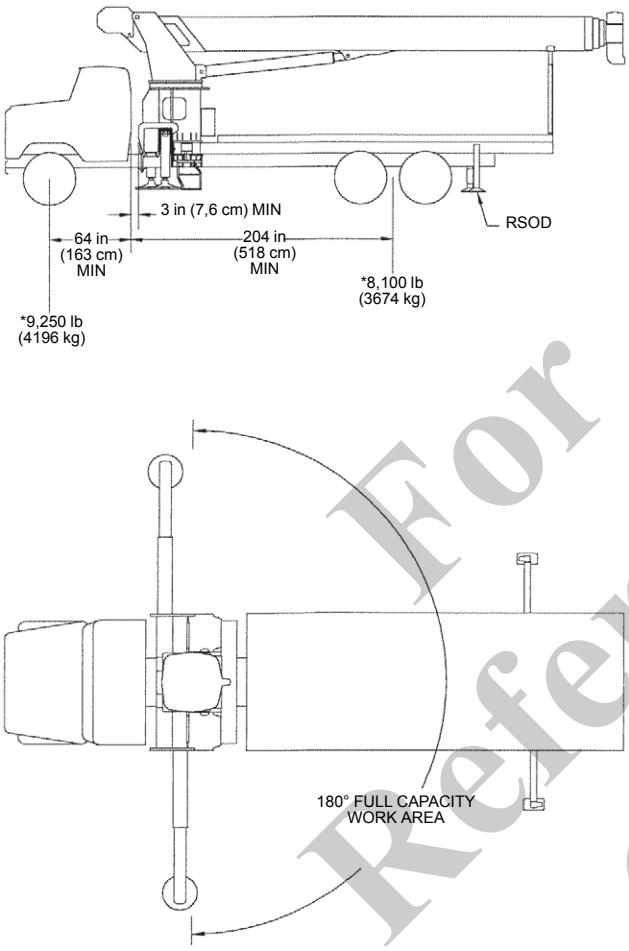
Many factors must be considered in the selection of a proper truck for a 1400H series crane. Items which must be considered are:

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 (WB), Cab-to-Trunnion (CT) and Bare Chassis Weight.** The wheelbase, CT and chassis weights shown are required so the basic 1400H can be legally driven in all states and meet stability requirements. The dimensions given assume the sub-base is installed properly behind the truck cab. If exhaust stacks, transmission protrusions, etc. do not allow a close installation to the cab, the WB and CT dimensions must be increased. Refer to the Mounting Configuration pages for additional information.
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 optional front stabilizer 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.** The chassis must be equipped with a switch that prevents operation of the engine starter when the transmission is in gear.

TRUCK REQUIREMENTS

Configuration 1 - 14127H

This configuration allows full capacity in a 180° working area over the rear of the truck.

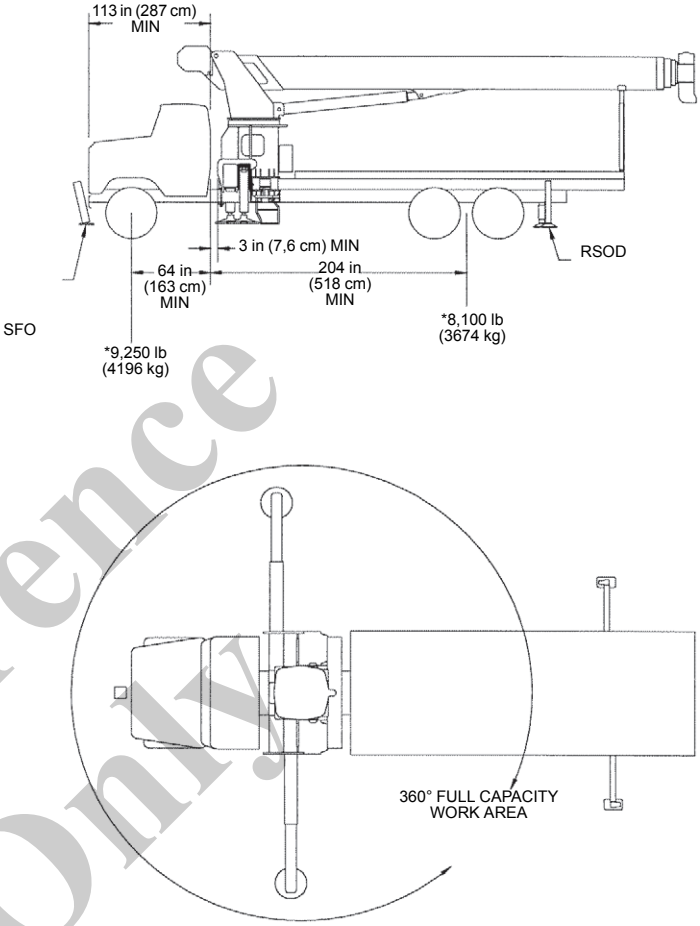


Requires 20,000 lb (9072 kg) GAWRF, 40,000 lb (18 144 kg) GAWRR, 60,000 lb (27 215 kg) GVWR, RSOD rear stabilizers and sub-base. Full capacity work area is rear 180° of vehicle from outrigger to outrigger. Truck frame must have or be capable of being reinforced to 30.0 in^3 S.M. (492 cm^3) and 3,300,000 lb-in (372 850 Nm) RBM under the crane, spring hanger to spring hanger.

***Bare chassis weight.**

Configuration 2 - 14127H

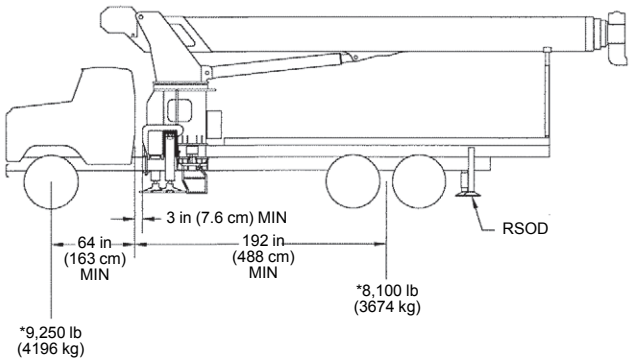
This mount requires front stabilizer for full capacity 360° around the truck. Front stabilizer gives the machine a solid base helping the operator control loads.

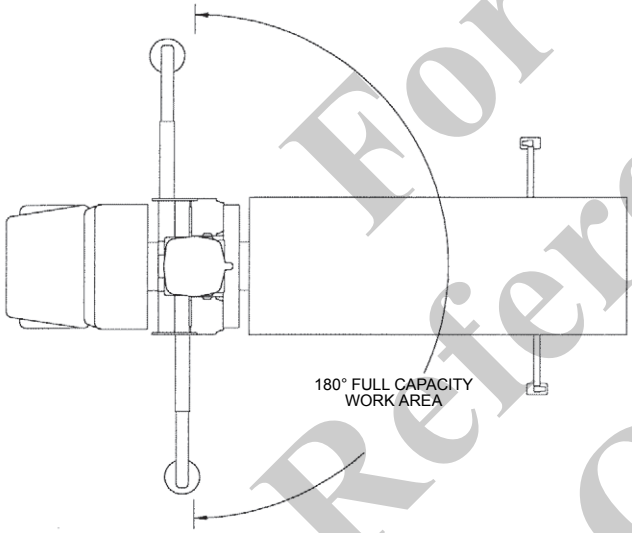


Requires 20,000 lb (9072 kg) GAWRF, 40,000 lb (18 144 kg) GAWRR, 60,000 lb (27 215 kg) GVWR, sub-base, SFO and RSOD rear stabilizers. Truck must have 30.0 in^3 (492 cm^3) section modulus and 3,300,000 lb-in (372 850 Nm) RBM or be capable of being reinforced to this strength under the crane frame through to the front suspension. Normally a tapered frame cannot be reinforced to this requirement. Additional truck frame requirements must be met from the crane frame through the front suspension to the SFO attachment point (See “Truck Frame and Mounting Bolt Requirements for Front Stabilizer” in this section).

Configuration 3 - 14100H

This configuration allows full capacity in a 180° working area over the rear of the truck.



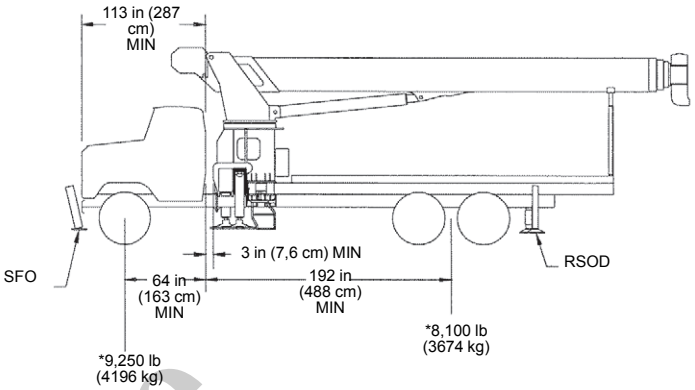


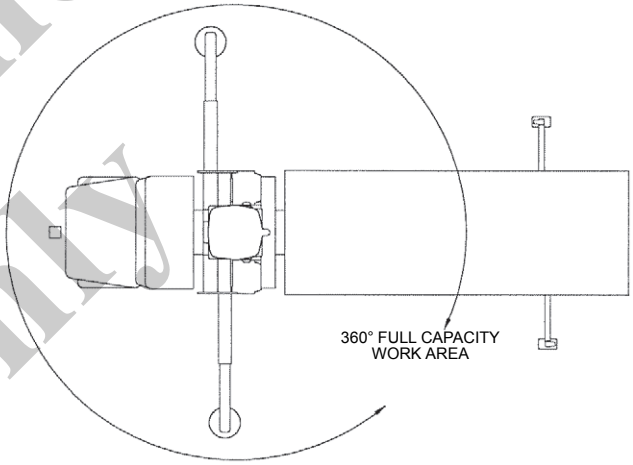
Requires 20,000 lb (9072 kg) GAWRF, 40,000 lb (18 144 kg) GAWRR, 60,000 lb (27 215 kg) GVWR, RSOD rear stabilizers and sub-base. Full capacity work area is rear 180° of vehicle from outrigger to outrigger. Truck frame must have or be capable of being reinforced to 30.0 in^3 S.M. (492 cm^3) and 3,300,000 lb-in (372 850 Nm) RBM under the crane, spring hanger to spring hanger.

***Bare chassis weight.**

Configuration 4 - 14100H

This mount requires front stabilizer for full capacity 360° around the truck. Front stabilizer gives the machine a solid base helping the operator control loads.





Requires 20,000 lb (9072 kg) GAWRF, 40,000 lb (18 144 kg) GAWRR, 60,000 lb (27 215 kg) GVWR, sub-base, SFO and RSOD rear stabilizers. Truck must have 30.0 in^3 (492 cm^3) section modulus and 3,300,000 lb-in (372 850 Nm) RBM or be capable of being reinforced to this strength under the crane frame through to the front suspension. Normally a tapered frame cannot be reinforced to this requirement. Additional truck frame requirements must be met from the crane frame through the front suspension to the SFO attachment point (See “Truck Frame and Mounting Bolt Requirements for Front Stabilizer” in this section).

***Bare chassis weight.**

PTO HORSEPOWER REQUIREMENTS

A three pump hydraulic system is furnished with this crane. The unit is equipped with a three section pump that will supply 32 gpm (121 lpm) to the hoist, 32 gpm (121 lpm) to the boom and telescope and 16 gpm (61 lpm) to the turn and outriggers circuit. To provide these flows, the pump shaft must turn at the proper rpm as shown below. The PTO requirement is a torque rating of at least 400 lb-ft (542 Nm) or 85 HP (63 kW) per 1000 rpm of PTO shaft speed.

PUMP VENDOR	rpm
CASAPPA	1800
DENISON	2000
HALDEX	2200

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. #200S Silver Streak Special Multi-Lube (Medium) should be applied to the shaft during original installation and reapplied to the shaft or zerk provided on PTO housing shaft semi-annually thereafter.

PTO Ratio

Pump shaft speed is determined by truck engine rpm and PTO ratio:

Pump Shaft Speed =

Truck Engine rpm X PTO Ratio

The following PTO ratio - engine speed combinations will provide the proper rpm pump shaft speed which is the recommended maximum speed for the 1400H pump:

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 and flow requirements.

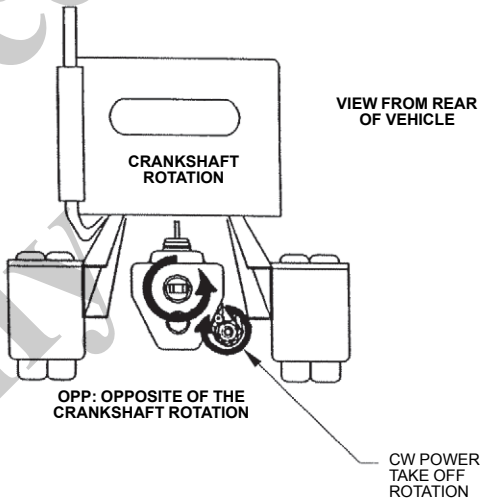
ENGINE SPEED (rpm)		PTO RATIO		
		1800 rpm PUMP	2000 rpm PUMP	2200 rpm PUMP
Gasoline Engine **Optimum** Speed Range	2900	62%	69%	76%
	2800	64%	71%	79%
	2600	69%	77%	85%
	2400	75%	83%	91%
	2200	82%	91%	100%
	2000	90%	100%	110%
Diesel Engine **Optimum** Speed Range	1800	100%	111%	122%
	1600	113%	125%	138%
	1500	120%	133%	147%
	1400	129%	143%	157%

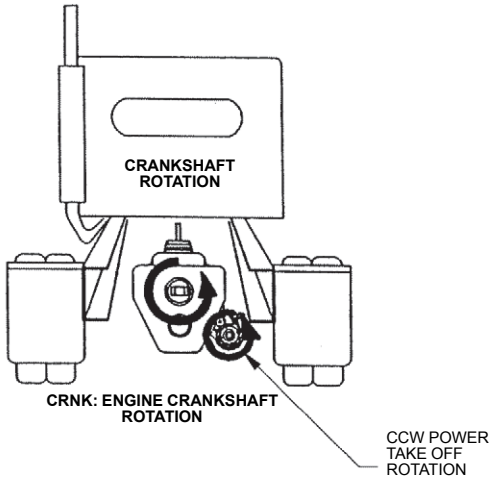
Pump Rotation

It is imperative that the three section hydraulic pump installed in a 1400H application be the correct pump rotation configuration for the truck drive train/power take off rotation direction. Make certain which direction the power take off output shaft rotates before selecting a clockwise (cw) or counter-clockwise (ccw) rotation hydraulic pump. Either cw or ccw rotation pumps are available, and are marked clearly with a directional arrow on the pump housing.

Do not attempt to turn pump in the opposite direction of the indicating arrow on the pump housing. Pump failure will result.

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.





HYDRAULIC PUMP

Description

The hydraulic system pressure is supplied by a gear hydraulic pump mounted on the truck power take off (PTO).

Removal

If pump replacement is required, the hydraulic fluid should also be replaced to avoid possible contamination.

1. Drain the hydraulic tank.
2. Tag and disconnect the hydraulic lines from the pump.
3. Remove the bolts from the pump rear mounting bracket.
4. Remove the bolts from the pump mounting flange and slide the pump out of the PTO drive coupling.

Installation

1. Lubricate the splines on the pump and PTO drive shaft coupling with heavy lithium grease.
2. Line up the splines on the PTO drive shaft coupling up with the pump drive shaft and slide the pump drive shaft into the coupling.
3. Bolt the pump to the PTO with the pump mounting flange.
4. Bolt the pump rear mounting bracket to the truck mounting bracket.

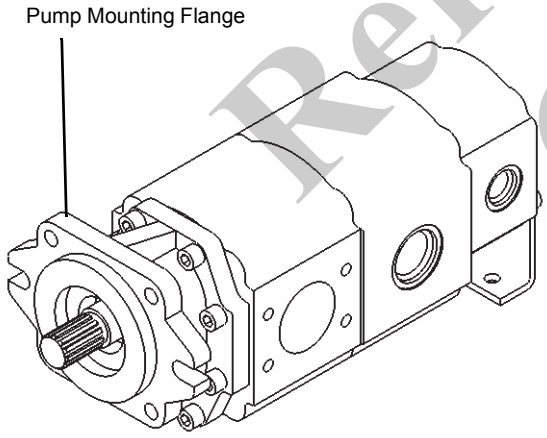


FIGURE 7-1

5. Reconnect the hydraulic lines as per removal tags.
6. Fill the hydraulic tank to the full mark with hydraulic oil.
7. Start the truck engine at idle and engage the PTO.
8. Let the truck idle until the system is pressurized to make sure that the hydraulic oil has replenished the system and that the system is not sucking air.
9. Check all crane functions.

Initial Pump Installation

For initial pump installation, use the following procedure:

1. The hydraulic pump has integral mounting flanges and can be bolted directly to the PTO. Be sure adequate clearance exists for this type of pump mount.
2. If the pump is powered through a drive line, a pump mount must be installed or bolt the pump to an existing frame cross member.
3. A mounting bracket needs to be installed so that the rear mounting bracket on the pump can be secured.
4. Be sure the drive line is sized to safely carry the maximum pump horsepower requirements (189 hp (140.9 kw) at 1800 rpm).
5. Do not locate the pump more than 107 cm (42 inches) from the PTO. Do not exceed a 7° drive line angle and the U-joints on both ends of the drive shaft must be parallel with each other.
6. Plan the location of the pump mount and drive line for adaquate clearance between the pump and truck drive shaft or exhaust system.
7. Position the pump so that hydraulic lines can be connected without sharp bends especially the large suction line from the reservoir.
8. For drive line installation, install the pump mount to the truck frame.
9. Lubricate the splines on the pump shaft and drive coupling with heavy lithium grease.
10. Bolt the pump mounting flange to the PTO or to the pump mount on the truck.
11. Torque the mounting flange nuts.
12. Bolt the pump rear mounting bracket to the truck mounting bracket.

NOTE: O-ring boss fittings are used for sealing hydraulic line connections. Make sure the O-ring is in its grove before tightening.

13. Remove the dust covers from the pump inlet and outlet ports and install the hydraulic fittings and lines.
14. Fill the reservoir with the proper hydraulic fluid to the high-level mark on the reservoir sight gage.
15. Start up the pump following procedures described under “Pump Start-up” on page 7.

Pump Start-up

If the pump is removed for maintenance or replacement the following startup procedure should be followed to prevent

damage to the pump or other components in the hydraulic system.

1. Install pump on PTO following procedures described under “Initial Pump Installation” on page 7.
2. Fill the reservoir with hydraulic oil.

CAUTION

The supply line shut-off valve must be open to allow flow to the pump to prevent pump damage.

3. Open the shut-off valve on the hydraulic line from the reservoir to the pump.
4. Fill the pump housing with hydraulic fluid. Pour the oil directly into the upper most case drain port.
5. Fill the inlet lines from the pump to the reservoir with hydraulic oil. Fill all outlet lines from each pump section with hydraulic oil and reconnect hoses.

NOTE: This can be done before pump installation. Simply remove the cap on the outlet of pump and fill with oil. Reinstall cap and install pump.

6. Check the lines for properly tightened fittings, and be certain it is free of restrictions and air leaks. Inspect the case drain line for leaks and restrictions.
7. Install a gauge at the pump pressure gauge port on the Main Directional Control Valve Manifold.
8. Start the and idle the engine with PTO engaged while monitoring the pressure gauge for two or three minutes. Do not operate any hydraulic levers.
9. Check the temperature of pump by carefully laying hand on the pump sections.

CAUTION

Pump could be extremely hot and could result in serious injury.

10. All pumps should be the same temperature. It depends on the pressure drop across the circuits which could vary. If the pump does not build up pressure to 13 to 34 bar (200 to 500 psi), shut down the engine and take corrective action.
11. If pump makes excessive noise it is probably sucking air into the inlet keeping the pump from priming. If this occurs, stop engine and inspect all connections of suction hose.
12. Operate the system under a light load for 5 to 10

NOTE: Pay attention to the service brake charge pump on cranes with the dual accumulating charging valve for hydraulic service brakes. If the dual accumulator charge is set to high the pump will push all the flow across an integral relief valve that dumps the heated flow back into the inlet pump. This will cause overheating of pump section above the hydraulic reservoir temperature. If this occurs stop the engine and adjust the dual accumulator charging valve, located in the tank port or turn CCW to lower the pressure.

13. Re-start the engine and check for the dual accumulator charge valve to cycle on and off with a one to two second charge cycle.
14. Increase rpm to 1500-1800 for 1-2 minutes with no functions actuated. and recheck.
15. Incrementally increase throttle to full rpm and cycle the functions supplied by pump.

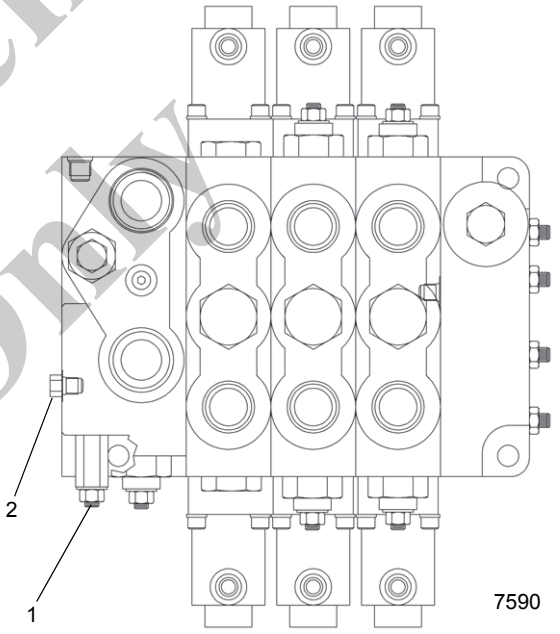


FIGURE 7-2

TRUCK FRAME STRENGTH

In order for a truck frame to be suitable for accepting a Series 1400H 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 mount, 180° stability, the Series 1400H crane requires a minimum of 3,300,000 lb-in (372 850 Nm) RBM and 30.0 in^3 (492 cm^3) S.M. under the crane frame between the front and rear springs with 1,980,000 lb-in (223 710 Nm) RBM and 18 in^3 (295 cm^3) S.M. through suspension to rear stabilizers on each truck frame rail. For 360° stability the truck frame must have a 30.0 in^3 (492 cm^3) section modulus [3,300,000 lb-in (372 850 Nm) RBM] minimum under the crane frame, 18 in^3 (295 cm^3) section modulus [1,980,000 lb-in (223 710 Nm) RBM] at the front spring rear hanger, 12 in^3 (197 cm^3) section modulus [1,320,000 lb-in (149 140 Nm) RBM] through the front spring and 3 in^3 (49 cm^3) section modulus [330,000 lb-in (37 284 Nm) RBM] at the stabilizer attachment point on each truck frame rail. Listed below is a table showing the commonly used truck frame and reinforcing materials and the section modulus required for each material to ensure adequate strength and rigidity. In all cases, the minimum requirements for section modulus and RBM must be met.

	Truck Frame or Reinforcing Material	Min. Section Modulus Under Crane	Min. Section Modulus Thru Rear Suspension	RBM Under Crane	RBM Thru Suspension
180° Stability	110,000 psi (758 MPa)	30.0 in^3 (492 cm^3)	18.0 in^3 (295 cm^3)	3,300,000 lb-in (372 850 Nm)	1,980,000 lb-in (223 710 Nm)
360° Stability	110,000 psi (758 MPa)	30.0 in^3 (492 cm^3)	13.0 in^3 (295 cm^3)	3,300,000 lb-in (372 850 Nm)	1,980,000 lb-in (223 710 Nm)

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.

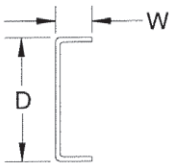


TABLE A

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)

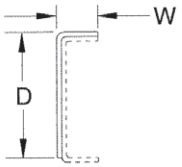


TABLE B

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)
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)
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)
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)
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)

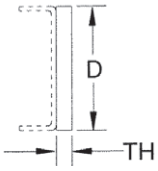


TABLE C

Section Modulus in^3 (cm^3)

D in. (mm) \ W 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)

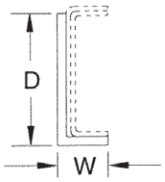


TABLE D

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)

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 and crane's LMI 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.

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 (61 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. Direct mount pumps require lubrication of the spline shaft coupling. See “Service and Maintenance” Section for lubrication information. 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 (if used) securely to frame. Attach pump to pump mounting plate or to PTO using capscrews provided. Install the support bar at the rear of the pump and bolt or weld the upper end to a crossmember if the pump is mounted with a drive line or install the support bar to a transmission bolt if the pump is direct mounted to the PTO.

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.

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. An arrow is cast into the rear pump housing to identify rotation. 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 Extension

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 110,000 psi (758 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.

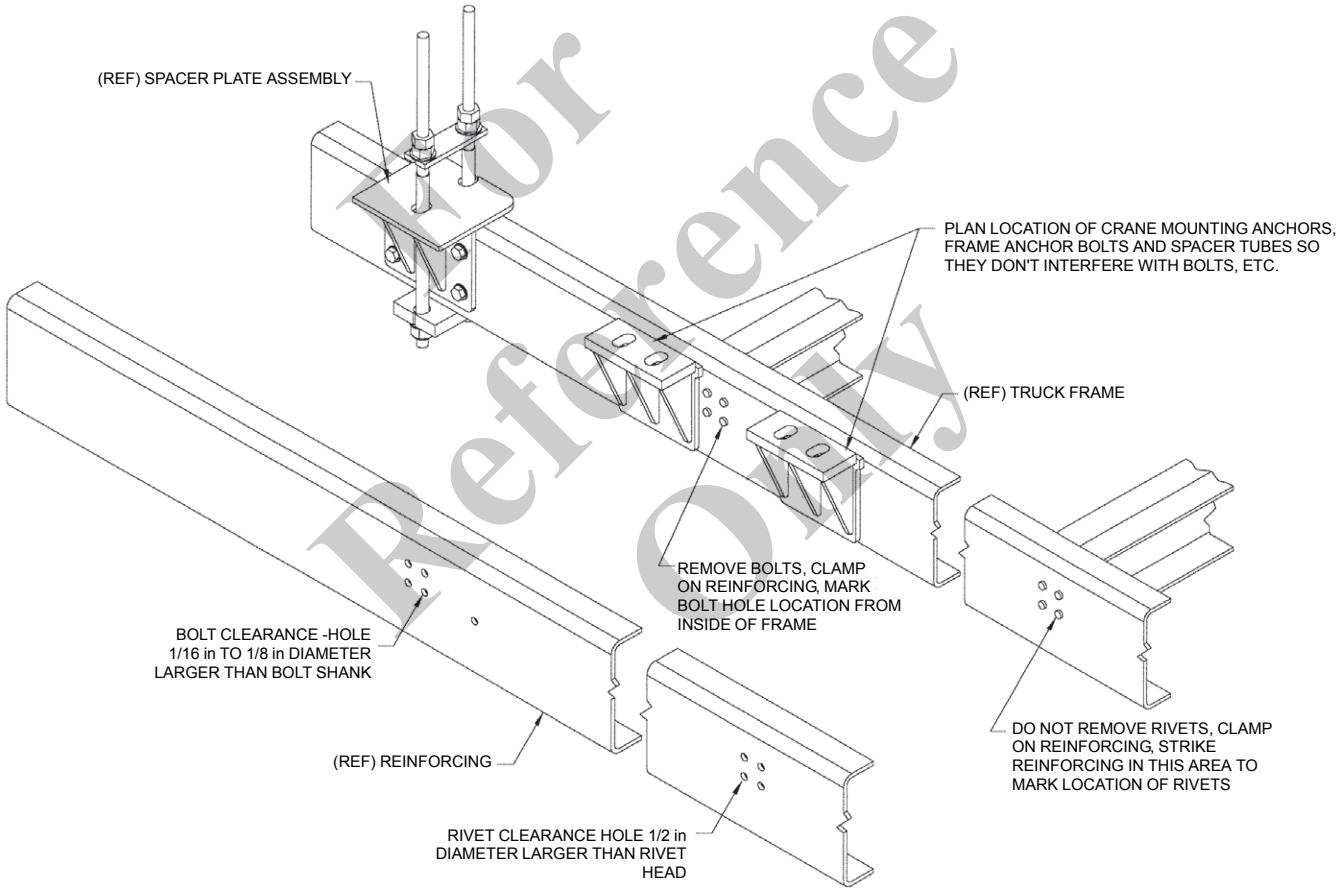


FIGURE A

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 cross member 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 in diameter, Grade 8 bolts, drill holes to 39/64 in diameter, drive fit bolts and torque according to Torque Chart in Maintenance Section.

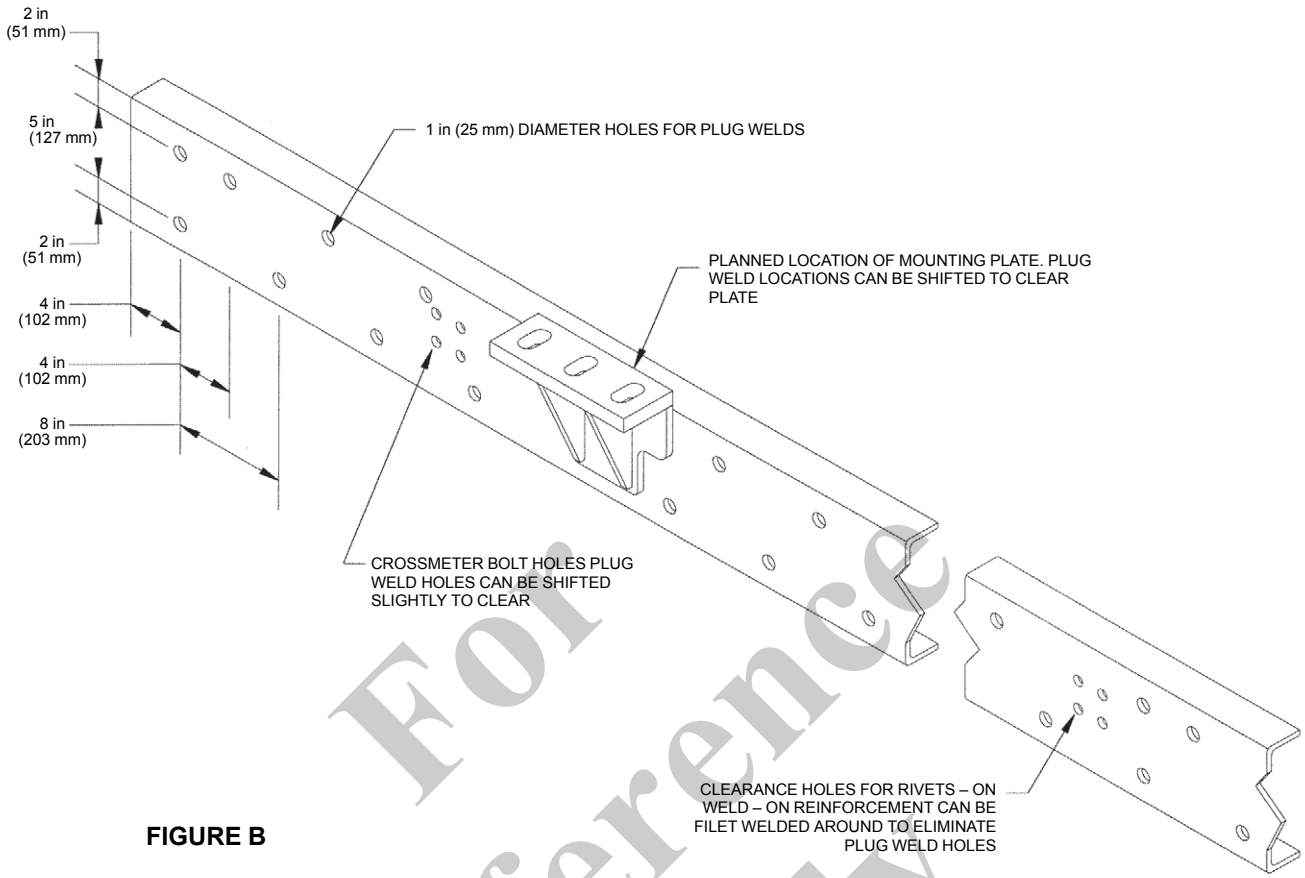


FIGURE B

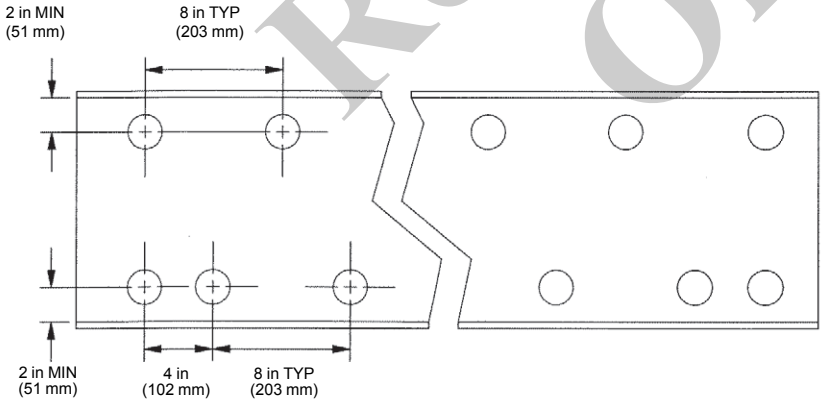


FIGURE C

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.

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.

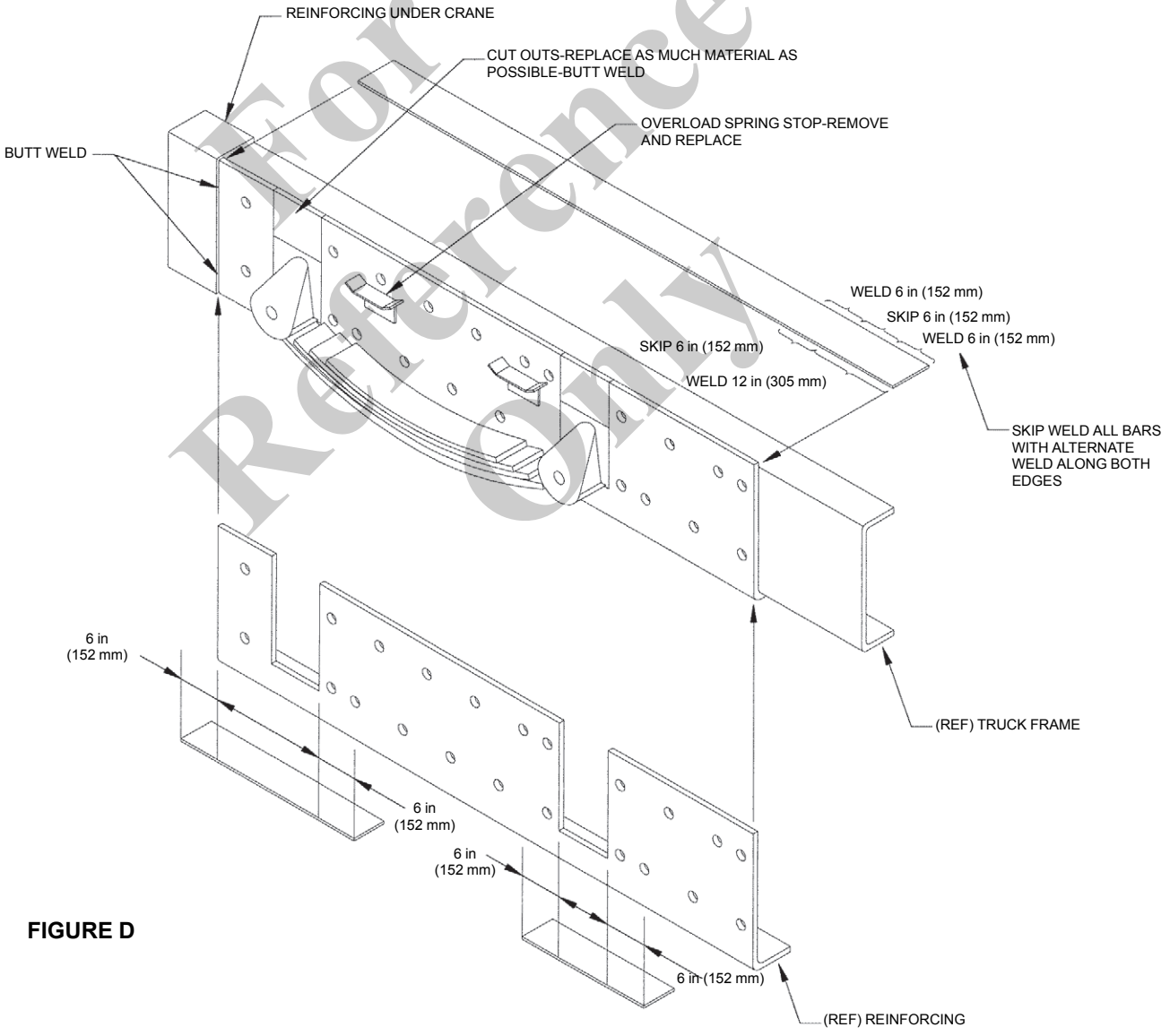


FIGURE D

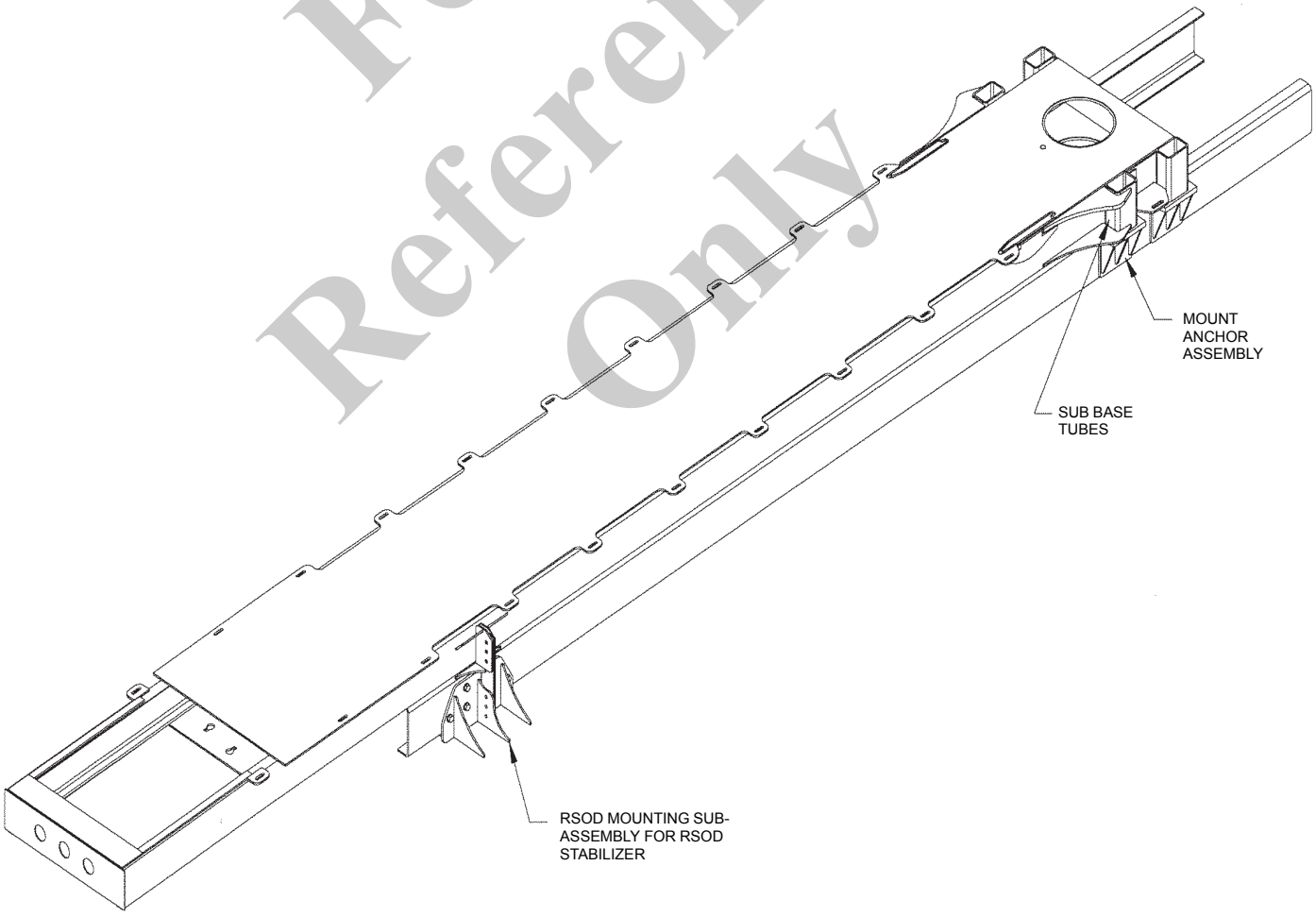
AFTER FRAME MODIFICATION

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.

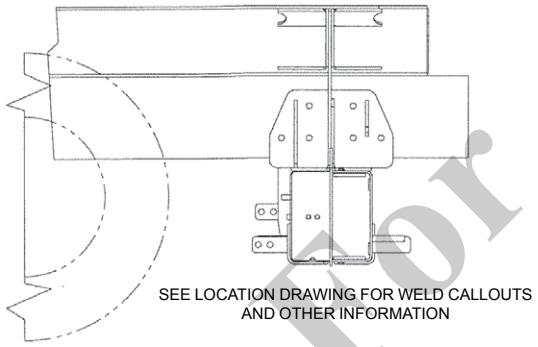
Length of after frame (AF) may have to be modified for crane installation. If AF is too long, cut off excess and remove any crossmembers from back of truck frame. If AF is too short, the frame will have to be lengthened. Use channels fabricated from 110,000 psi (758 MPa) yield material that are the same 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. The top and bottom subbase reinforcing plates must extend past the RSOD mounting sub-assembly. If this is not achievable, due to a long cab to tandem (CT) dimension or special mounting configuration, contact the factory before proceeding.
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, clamp them together to remove gaps.
4. Making certain that subbase is tight against truck frame and mount anchor assemblies are tight against bottom of subbase tubes, 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 RSOD stabilizers retracted, determine the distance from the top of the stabilizer frame cross tube to ground level that will give you approximately 11 in (28 cm) of ground clearance to the bottom of the stabilizer foot. This will give approximately 14 in (35 cm) of stabilizer penetration. Before final mounting the RSOD brackets make sure that the tops of the stabilizer vertical cylinder are below the top of the torsion box. 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 RSOD mounting sub-assembly approximately 12 in (30 cm) behind the rear tires. Check for truck frame bolt or rivet interference. Cut clearance holes for rivet heads. Mark and drill six 3/4 in diameter bolt holes as specified through RSOD mounting sub-assemblies and truck frame and install six 3/4 in diameter Grade 8 bolts, washers and nuts per side. Tighten to proper torque.



6. Loosely assemble flex plate and two anchor ears as shown. Locate flex plate anchor ears to torsion box and RSOD anchor plate as specified and tack in place. If proper ground clearance cannot be obtained, see location drawing for further instructions. Cut flex plate to length specified. Use holes in RSOD mounting sub-assembly as a template to mark and drill three holes in flex plate. Remove flex plate and weld (E70) ears to torsion box and anchor plate as specified. Install flex plate with six 5/8 in diameter Grade 8 bolts, washers and nuts. Tighten to proper torque. Repeat flex plate installation procedure on other side. Raise and locate the RSOD frame to the RSOD mounting sub-assembly and weld (E70).



7. Cut and install the spacer tubes so they fit snugly between the truck frame flanges. If the truck frame tapers at the crane mounting location, the crane will have to be relocated to an area of straight frame or the truck frame will have to be reinforced to eliminate the height taper. Special spacers will be required to prevent crushing of this reinforcement. If the crane is being mounted on a truck with a double channel frame, the gap between inner and outer channel must be shimmed to prevent the channel from collapsing.

8. Set the crane frame on the truck frame and sub-base. Make sure the plate spacer is installed between the crane frame and truck frame. Install the 1-1/8 in Grade 8 mounting bolts to bolt the crane frame to the mounting anchors through the tubes in the subbase. Tighten mounting bolts to the proper torque.

9. Assemble the mounting studs and plates as shown in the parts pages. It is very important that the spacer plate assembly that goes between the crane frame and top of truck frame rail be positioned tight against the side of the truck frame rail. **Note that this spacer plate assembly should be bolted to truck frame only after mounting studs have been torqued**. Be sure to maintain a constant clearance between the truck frame and the outer stud, top to bottom. Run bottom nut onto the stud threads until one thread sticks out of the nut. Install the studs onto the crane frame as shown. Install 1st nut on the top and tighten. Install the 2nd nut on top and tighten the two nuts until they are locked. Torque bottom nut to 1280 +/- lb-ft To keep the stud from turning use a wrench to hold the top nut.

Note: Do not use a cutting torch to shorten the mounting studs. If studs must be shortened, they must be cut off with a saw. Do not allow the nuts to bottom out on the stud. Make allowances for threads during torquing. After mounting studs have been torqued and it has been verified that spacer plate assemblies are still tight against side of truck frame rail, drill four 3/4 in diameter holes at each spacer plate assembly using the small holes in the plates as pilot holes. Install 3/4 in diameter Grade 8 bolts, washer and nuts and tighten to proper torque.

10. Find a location for and install hydraulic oil reservoir and oil cooler. See location drawing for location details. Mounting brackets may be bolted to the truck frame. Before placing reservoir in service, remove cleanout cover and inspect to ensure proper installation of diffuser. Connect 1/2 in winch drain line to coupling in back side of reservoir and 3 in suction line from pump before filling with oil.

11. Route and install fittings and return hoses from crane frame to reservoir filter.

12. Route and install fittings and pressure hoses from crane frame to pump.

13. Install the main frame outriggers as instructed in the Service and Maintenance section of this manual.

14. Install operator platforms according to the platform group parts pages.

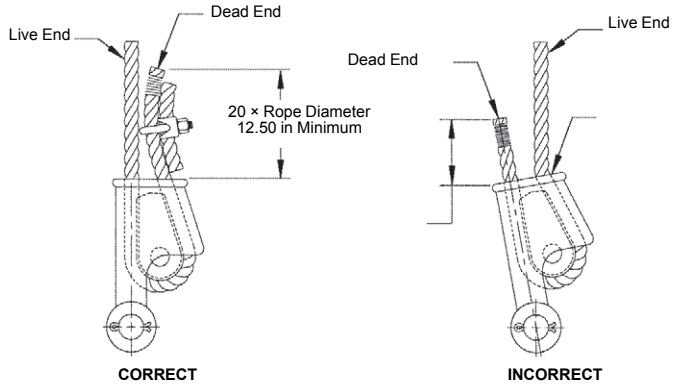
15. **Important: Before attempting to assemble the boom and lift cylinder to the frame, see "Hose Routing" page in "Controls & Hydraulics" Section and "Pin Bearing Inspection and Installation" and "Anti-Two-Block System Installation" pages in this section. Before connecting hoses, boom must be opposite (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. Install snap ring to end of boom pivot pin. Grease the three pin joints with gun grease and operate the boom and lift cylinder through several complete cycles before placing machine in operation.

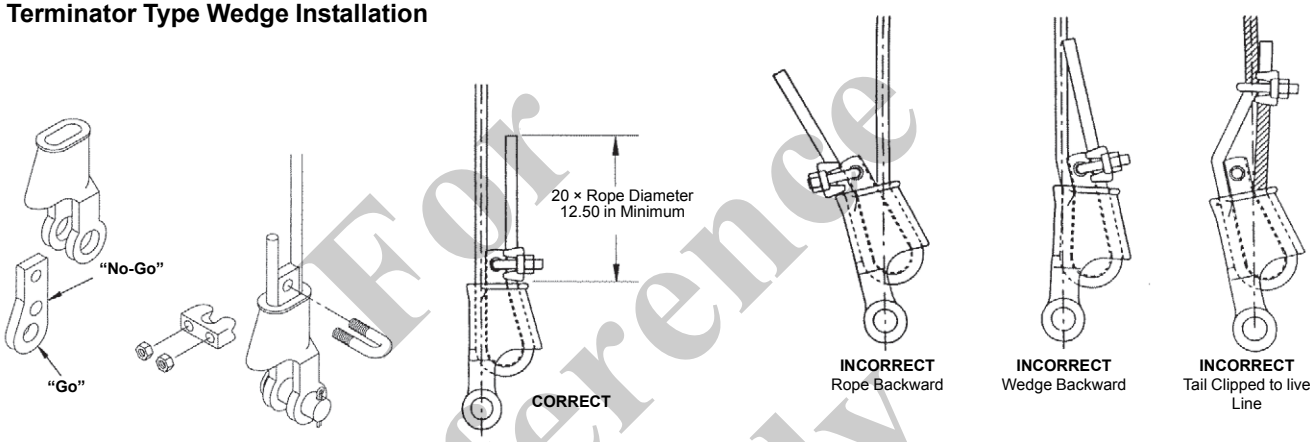
16. Route the telescope hoses as shown in the parts pages. Connect the telescope cylinder connections at the back of the boom.

17. Route the hoist drain hose through the turret and connect to the hoist.

18.



Terminator Type Wedge Installation



Rope Size (inches)	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/8	1-1/4
*Torque lb-ft (Nm)	45 (61)	65 (88)	65 (88)	95 (128.8)	95 (128.8)	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 L

19. Un-spool 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.

20. Install one end of the load line 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 with 5/8 in diameter wire rope.

21. 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.

22. 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 Load line Section. Torque cable clamp (clip) to 95 lb-ft (128,8 Nm). 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 line block, omit downhaul weight and assemble as shown in loadline section of parts pages. Special care should be taken to reeve the cable through the wedge socket as shown in figure L.

23. Spool the loadline 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). The loadline should wrap tightly in the grooves that are cast into the bare drum.

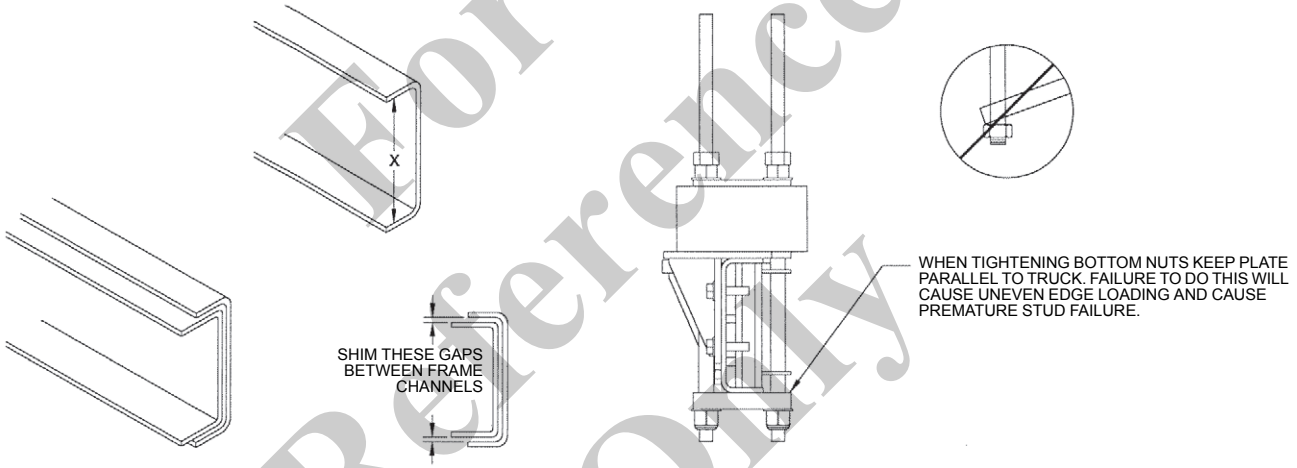
24. Continue winding the cable on the second, third and fourth layer of the drum. Keep the cable paying in straight to the boom to avoid side loading the boom. The layers will wrap smoothly guided by the first layer wrapping.

25. After cable is completely wrapped on drum, replace remaining cable keeper bolts on the sheave case.

26. 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.

27. 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.

28. After installation, check all oil and lubricant levels and lubricate unit according to Lubrication Chart in Service and Maintenance Section.



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.

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.

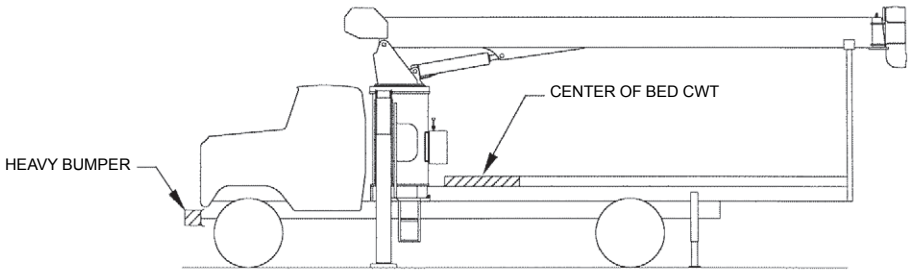
Installation

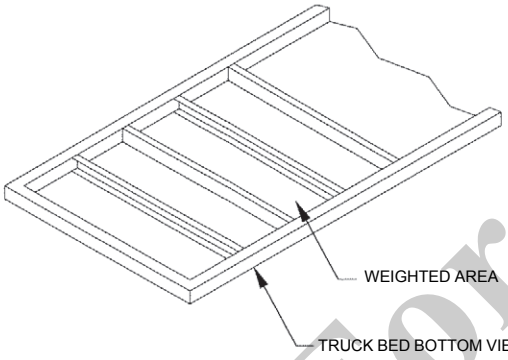
1. Two bearings are to be installed in the boom pivot trunnion located directly below the hoist and the remaining four bearings are to be installed in the lift cylinder, two at each side of the rod end of the cylinder and two at each side of the butt end of the cylinder.
2. The bearings should be started 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 counter bored 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.

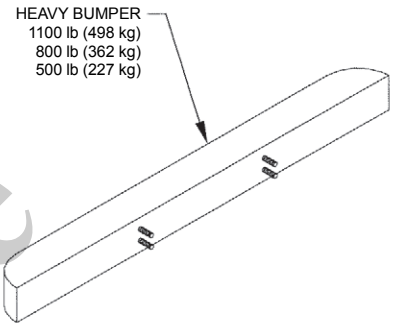
COUNTERWEIGHTING

1. Refer to “Truck Requirements” pages in this section. The amount of counterweight and its location is dependent upon the weight of the truck and all permanently attached equipment. Permanently attached equipment which can be considered as counterweight includes reinforcing, PTO's and pumps, tool boxes, auxiliary hoists, etc. The torsion resisting subbase is 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. This crane is stable to 85% tipping factor at full outrigger span.
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. These loads are not shaded on the load rating chart.
3. This crane is stable to a variable stability factor with the outriggers set at mid-span. This factor is based on an International Standards Organization (ISO) formula which uses an 80% stability factor and also factors in dynamic loads due to boom weight. If the crane is stable to the 85% stability factor as outlined in #2, it will meet the mid-span stability factors as outlined in the ISO reduced span formula.
4. 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 “Truck Requirements” pages to determine the amount and location of counterweight required.

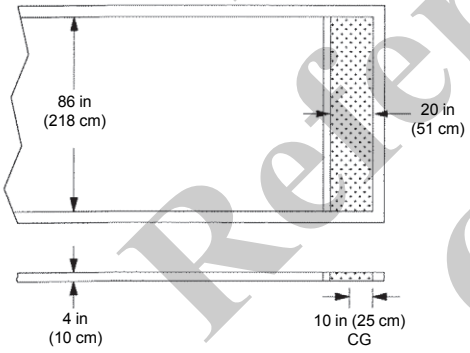
COUNTERWEIGHTING METHODS FOR STABILITY AROUND THE REAR 180°



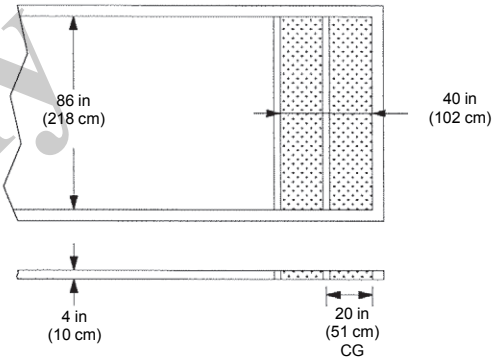




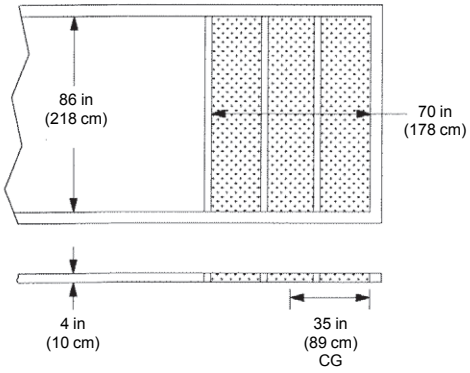
BED COUNTERWEIGHTING FOR
500 lb (230 kg)



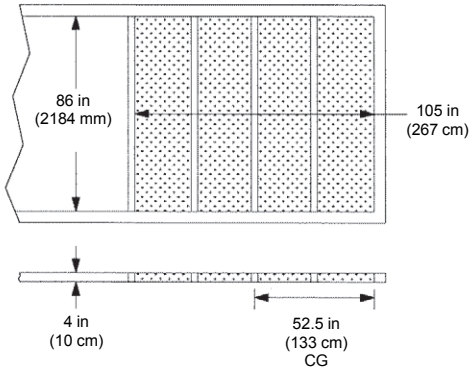
BED COUNTERWEIGHTING FOR
1150 lb (520 kg)



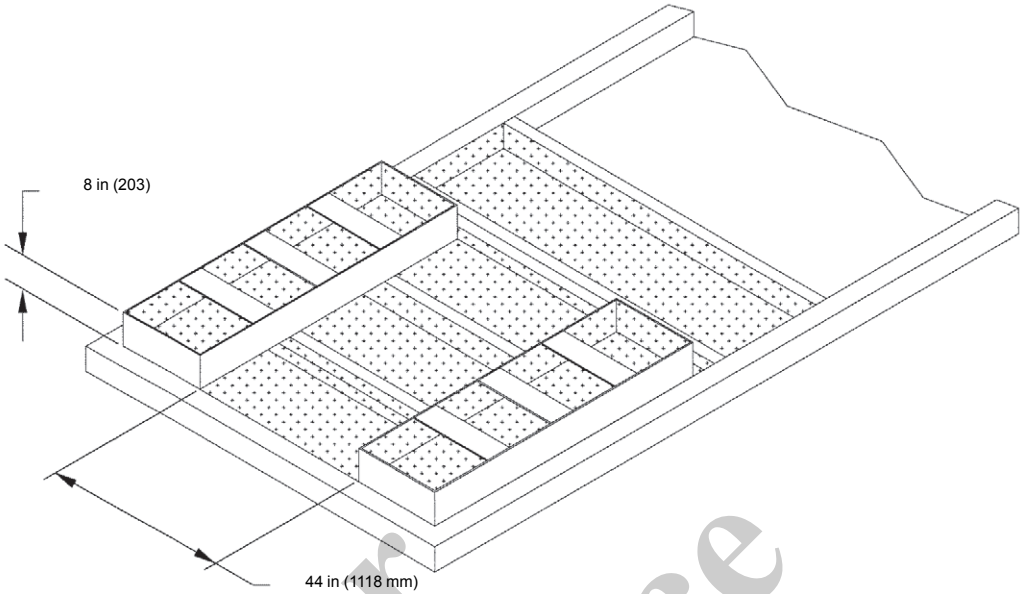
BED COUNTERWEIGHTING FOR
2000 lb (910 kg)



BED COUNTERWEIGHTING FOR
3000 lb (1360 kg)



NOTE: SHADED AREAS INDICATE CONCRETE



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.

ANTI-TWO-BLOCK LOAD MOMENT INDICATOR INSTALLATION AND FUNCTION VERIFICATION

1. 1400H model cranes equipped with DS160 LMI systems have the LMI reel length cable routed inside the boom. The cable has been installed and pre-tensioned at the factory. If cable tension adjustment is required, rotate the reel counterclockwise (in the direction of payout) and wrap the length cable back onto the reel. Length transducer must be zeroed after doing this (see step 10). Disconnect the length cable at the boom tip and rotate the length cable clockwise to remove twist.

⚠ DANGER

Do not allow reel to unwind uncontrolled. The signal cable will be damaged.

2. Insert cord plug from the boom cable reel into the mating connector located in the frame coming from the CPU. (See Illustrated Parts Pages.) Check cable routing to ensure cable is unobstructed through complete range of boom angle and rotation. Secure excess cable as needed using nylon ties.

3. Install ATB weight assembly around load line and attach to switch at boom tip. The length of chain used to attach the weight can be adjusted to permit maximum crane working height and allow securing the boom with the loadline in the transport position. Extra chain should be retained for use if additional load line rigging attachments are added.

4. Route hydraulic hoses from transducers inside frame to the lift cylinder. Connect hose with the small 90° drop to swivel on holding valve located at base of lift cylinder (piston side). Connect hose with larger 90° drop to tee located at base of lift cylinder (rod side).

5. Bleed air from hydraulic hoses connecting to transducers. Operate crane slowly while following this procedure. It is not required to lift boom from boom rest during bleeding procedure. With boom in boom rest, loosen bleeder on bulkhead fitting piston side transducer and install clear plastic hose and route to catch pan. Slowly actuate boom up lever generating flow and permitting air to escape and when ai r ceases to escape tighten bleeder. With boom still in boom rest loosen bleeder on bulkhead fitting rod side transducer and install clear plastic hose and route to catch pan. Slowly actuate boom down lever generating flow and permitting air to escape and when air ceases to escape tighten bleeder.

6. Route the two conductor cord to a convenient location in the truck cab. Install the LMI power switch and indicator light. A mounting plate is provided or the switch and light may be installed in the dash. Install the label decals adjacent to the switch. Refer to illustrated parts section for item numbers and decal placement.

7. To ensure LMI calibration is correct, the serial numbers of the frame, boom, and lift cylinder must match. If they do not, the system will not work properly. If serial numbers do not match, contact National Crane immediately.

8. The components of this system are pre-calibrated, however, there is an initial setup that needs to take place to ensure proper communication between the sensors and the processor. If the system has not yet been set up, the maintenance screen will appear when the LMI system is powered up. The maintenance screen will have the options CALIBRATE SENSORS, SENSOR OUTPUTS & EXIT.

9. The pressure transducers have been zeroed at the factory. This step is only required if replacing or changing the pressure transducers. Support boom and release pressure from lift cylinder. Remove hoses from pressure transducers.

⚠ DANGER

Ensure there is no pressure in the hydraulic lines when disconnecting the hoses from pressure transducers.

Using the UP & DOWN keys to scroll, select “PIS” or “ROD” and press “OK”. The screen will read BOOM DOWN COMPLETELY AND DISCONNECT HYDR, OK, & EXIT. Press “OK” button to zero the selected pressure transducer. The rod and piston side pressure transducers must be zeroed individually; therefore you must complete this procedure for both piston and rod side pressure transducers.

Press “EXIT” to leave calibration or select “CALIBRATE SENSORS” to calibrate another sensor.

After zeroing both pressure transducers, reconnect the hydraulic lines to the pressure transducers. Operate the lift cylinder in both directions, then support the boom and bleed any air from the hydraulic lines (using procedure in step 5).

10. Remove cable reel cover. Fully retract main boom. Confirm length sensor is set by rotating center screw in large gear counterclockwise to a soft stop.

11. After selecting “CALIBRATE SENSORS” select “ANG” to begin angle sensor calibration. Using a calibrated inclinometer (measures to within 0.1°, Example: SMARTTOOL DIGITAL LEVEL) adjust boom angle to 0° (range -0.5° - +0.5°) and mechanically adjust the angle

sensor so that the system reads the angle to ±0.0° of the measured angle. Press “OK” when the sensor is mechanically set, this confirms the mechanical adjustment.

The display should now read BOOM TO 40.0 DEG, XX.X DEG, EXIT. Raise boom to approx. 40° (range 35° to 45°). When the boom angle is within the calibration range, the screen will add “CHANGE” & “OK” text. Measure the boom angle with the inclinometer. Compare this with the displayed angle and select “CHANGE” and press “OK”. Use the “UP” & “DOWN” arrow buttons to adjust the displayed angle to match the measured angle. Once the display shows the correct angle press “OK”.

The display will now define a mid correction angle, 65 DEG. Raise boom to approx. 65° and repeat above steps.

The display will then define a high correction angle, 75 DEG. Raise boom to approx. 75° and repeat above steps.

After pressing “OK” the system will request the angle sensor calibration be saved. Select “YES” then press “OK” to confirm calibration.

Press “EXIT” to leave calibration or select “CALIBRATE SENSORS” to calibrate another sensor.

12. After selecting “CALIBRATE SENSORS” select “LEN” to begin length sensor calibration. Screen will read FULLY RETRACT MAIN BOOM XX.X ft., OK & EXIT. Refer to load chart and elevate the boom to an angle that allows boom to be fully extended. Verify the retracted boom length is correct and press “OK”. The screen will now read FULLY EXTENDED MAINBOOM XX.X ft. OK & EXIT. Fully extend the main boom and press “OK”. NOTE: The LMI system measures boom length from the pivot pin to the center of the boom tip sheave. This varies slightly from length indicated on Load Chart (see table below).

After pressing “OK”, the system will request the length sensor calibration be saved. Selected “YES” then press “OK” to confirm calibration.

Press “EXIT” to leave calibration.

Verify length and angle indication are accurate and replace cable reel cover.

13. Load indicating accuracy is verified by lifting known loads. Select one or more known test loads that will load the crane to full capacity, preferably a load that can fully load the crane at more than one rated boom length. The test loads including blocks, slings, etc. are to be known accurate within ±1%.

Starting with a rated boom length and a short radius (high boom angle), lift a load that is somewhat lower than rated capacity at this condition. Increase the radius slowly by decreasing the boom angle until the limit signal is activated. Measure and record radius along with the test load. Complete this for each test condition. If you have selected a test load that is within the crane's capacity at the next longer rated boom length (closer load radius at higher boom angle), you can reposition the same test load for an additional test condition. A minimum of four tests with one or more at full boom extension are recommended.

For each test condition, refer to the Load Capacity Chart and determine the rated load for the measured radius condition. If the measured radius is between those listed on the Capacity Chart, the rated load (for this test work only) shall be determined by linear interpolation.

The load indicating accuracy is determined by this formula:

TEST LOAD/RATED LOAD x 100 = % of Rated Load

The actual test load which activates the limit signal is not to be less than 90% of the rated load nor more than 100% of the rated load for the corresponding actual load radius.

MODEL	CAP. CHART RETRACT	CAP. CHART EXTEND	LMI RETRACT	LMI EXTEND
14100H 14127H	30 ft 31 ft	100 ft 127 ft	30.3 ft 31.1 ft	99.6 ft 126.7 ft
The LMI system measures boom length from the pivot pin to the center of the boom tip sheave. This varies slightly from length indicated on Load Chart.				

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 2000 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 near the top of the sight gage.
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 re-torqued 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.

The load line 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 1 st 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.

STABILITY CHECK

The bare 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. Using the following as an example only:

1. Test the unit for stability on a firm level surface.
2. A Series 1400H crane requires RSOD 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 at the specified boom extension and radius listed in the example below.

Model	Boom Length	Loaded Radius	Add to Rated Load When Jib Stowed
14127H	127 ft (38,7 m)	90 ft (27,4 m)	83 lb (37,6 kg)
	51 ft (15,5 m)	40 ft (12,2 m)	217 lb (98,4 kg)
14100H	100 ft (30,5 m)	85 ft (25,9 m)	201 lb (91,2 kg)
	44 ft (13,4 m)	40 ft (12,2 m)	430 lb (195,0 kg)
1469H	69 ft (21 m)	65 ft (19.8 m)	N/A
	34 ft (10.4 m)	30 ft (9.1 m)	

⚠ DANGER

Stability test conditions represents overloads at crâne positions where boom weight and CG location make up a large portion of the overturning moment. Great care should be taken to control boom position and keep hook load close to the ground. Test loads should not be allowed to swing out past rated radius. If overturning caused by the load is allowed to start, and boom angle gets too low, boom weight may cause the unit to upset.

The stability test load will be 1.18 times the load chosen from the load rating area of the capacity chart.

Example 1: 14100H without 54 ft Jib Stowed

Boom Length: 100 ft (30,5 m)
Loaded Radius: 85 ft (25,9 m)
Test Load for Stability with no Jib Stowed:
*1050 lb (476 kg) + 250 lb (113 kg) = 1300 lb (590 kg)
Stability Test Load: 1.176 x 1300 lb (590 kg) = 1529 lb (694 kg)

(Includes weights of slings and downhaul blocks.)

* Note: The 1050 lb (476 kg) capacity from the load ratings area of the capacity chart is for the 14100H with a 54 ft jib stowed on the side of the first section boom. From the “ADD TO CAPACITIES WHEN NO JIB STOWED” area under the load ratings chart 250 lb (113 kg) is added to the 1050 lb (476 kg) rated load.

Example 2: 14127H with 31 ft Jib Stowed

Boom Length: 51 ft (15,5 m)
Loaded Radius: 40 ft (12,2 m)
Load Rating with Jib Stowed:
*8100 lb (3674 kg)
Add to Rated Load for Stability Test when Jib Stowed:
217 lb (98 kg)
Total Load for Stability Test:
8100 lb (3674 kg) + 217 lb (98 kg) = 8317 lb (3772 kg)
Stability Test Load with 311 ft Jib Stowed:
1.176 x 8317 lb (3772 kg) = 9781 lb (4437 kg)

(Includes weights of slings and downhaul blocks.)

* Note: Capacity from the load ratings area of the capacity chart.

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 specified 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 in 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. Do not attempt

to lift loads around the front of the truck unless the unit is equipped with a front stabilizer.

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 1.176 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.

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ALPHABETICAL INDEX