National Crane NBT40-1 Series

Service Manual

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

SERVICE MANUAL

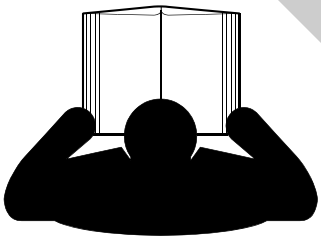
This manual has been prepared for and is considered part of the

NBT40-1 Series Cranes

This Manual is divided into the following sections:

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



⚠DANGER

Untrained operators subject themselves and others to death or serious injury. Do not operate this crane unless:

- You are trained in the safe operation of this crane. **National Crane** 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 the crane.

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SECTION 1
INTRODUCTION

SECTION CONTENTS

GENERAL

This manual has been compiled to assist you in properly operating and maintaining your Model NBT40-1 Series National Crane (see Figure 1-1).The NBT40-1 series includes crane models NBT36-1, NBT40-1and NBT45-1.

Before placing the crane into service, all operators and persons working around the crane must thoroughly read and understand the contents of the Operator's Manual. Before moving a vehicle equipped with a crane, information relating to transporting the vehicle must be read and observed.

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

Information in this manual does not replace federal, state, or local regulations, safety codes, or insurance requirements. For detailed information concerning the operation and maintenance of the RCL system installed on the equipment, see the manufacturer's manual supplied with the equipment. Manufacturers of rated capacity limiters may refer to them in their manuals as a load moment indicator (LMI), a hydraulic capacity alert system (HCAS), National Crane refers to these systems as a rated capacity limiter (RCL) throughout its Operator and Service Manuals.)

The NBT40-1 SERIES has been designed for maximum performance with minimum maintenance. With proper care, years of trouble-free service can be expected.

National Crane and our Distributor Network want to ensure your satisfaction with our products and customer support. Your local distributor is the best equipped and most knowledgeable to assist you for parts, service, and warranty issues. They have the facilities, parts, factory-trained personnel, and information to assist you in a timely manner. We request that you first contact them for assistance. If you feel you need factory assistance, please ask the distributor's service management to coordinate the contact on your behalf.

Supplemental Information

Supplemental Information regarding Safety & Operation, Specifications, Service & Maintenance, Installation, and parts for options such as remote controls, augers, varying control configurations, platforms, grapples, etc. are included in separate manuals. Most optional content is being added to this standard manual such as the platform and remotes. The RCL and optional the hydraulic pressure intensifier are included as separate manuals.

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

A Safety Compact Disc or a USB flashdrive which includes sections on Operation, Service and a Safety Video for National Crane operators and owners is supplied when the equipment is purchased new. Additional copies are available from your local distributor.

New Owner

If you are the new owner of a National crane, please register it with Manitowoc Crane Care so we have the ability to contact you if the need arises. Go to https://www.manitowoccranes.com/home/Parts_Services/ServiceAndSupport/ChangeOfOwnershipForm

Basic Nomenclature

The nomenclature used to describe parts of a National Crane crane are described in Figure 1-2. This nomenclature is used throughout this manual.

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FIGURE 1-1

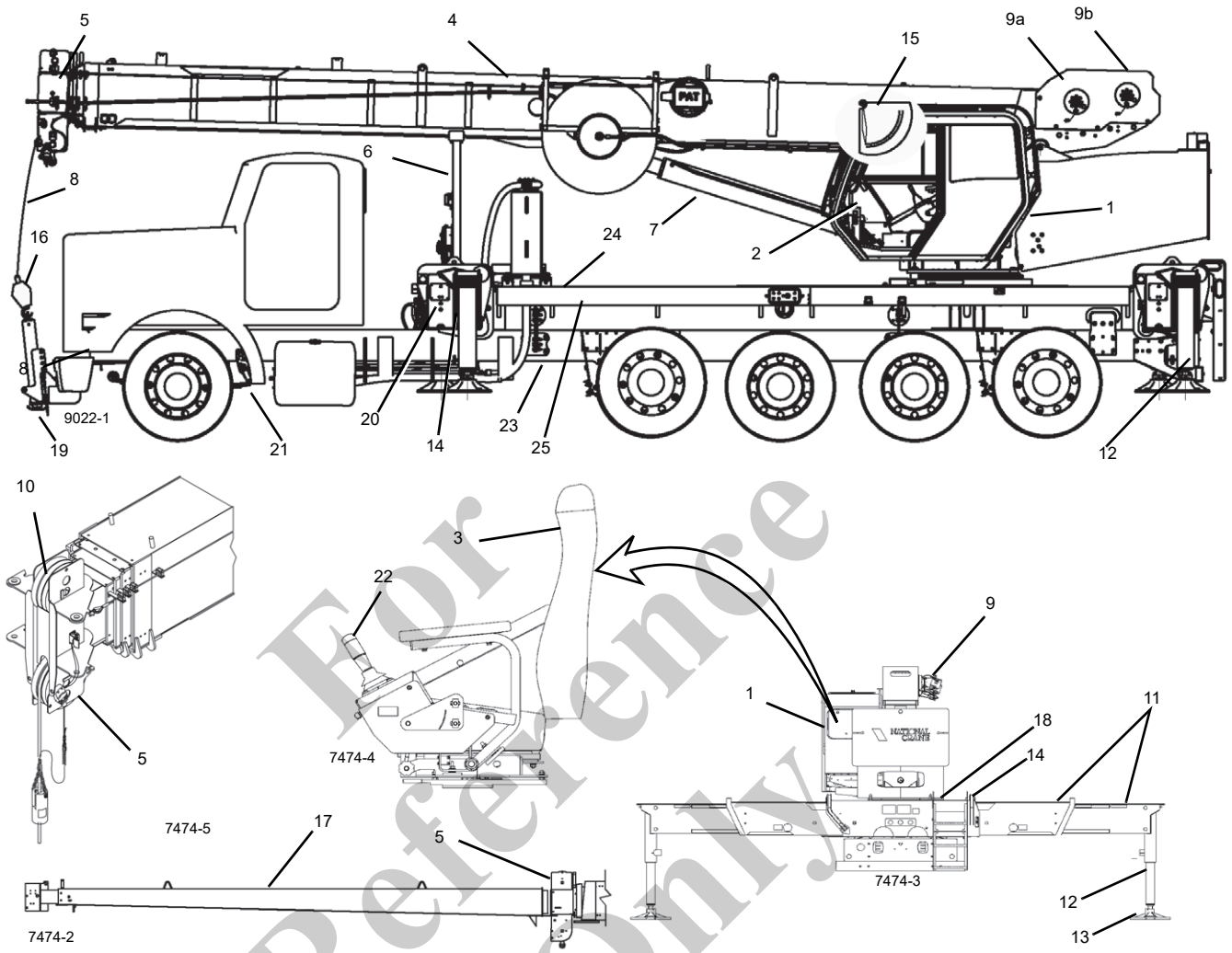


FIGURE 1-2

Item	Component
1	Crane Cab
2	Crane Cab Console
3	Operator's Seat
4	Boom
5	Boom Nose
6	Boom Rest
7	Lift Cylinder
8	Hoist Cable
9	Hoist (9a Auxiliary, 9b Main)
10	Sheave
11	Outrigger Beam
12	Outrigger Jack
13	Outrigger Float

Item	Component
14	Outrigger Box
15	Boom Angle Indicator
16	Downhaul Weight, Hook Block
17	Jib
18	Turret
19	Single Front Outrigger (SFO), Front Outrigger Jack
20	Hydraulic Tank
21	Hydraulic Pump (not shown)
22	Hydraulic Remote Controller (HRC)
23	Truck Frame
24	Truck Bed
25	Torsion Box Frame, T-Box Frame

GENERAL MAINTENANCE

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

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

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

Cleanliness

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

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

Removal and Installation

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

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

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

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

CAUTION

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

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

Disassembly and Assembly

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

Pressing Parts

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

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

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

Locks

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

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

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

Shims

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

Bearings

Antifriction Bearings

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

Double Row, Tapered Roller

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

Heating Bearings

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

Installation

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

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

Preload

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

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

Sleeve Bearings

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

Gaskets

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

Hydraulic Systems

⚠ DANGER

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

Visual Inspection

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

Valves and Manifolds

Inspect valves and manifolds for leaking ports or sections.

Hoses and Fittings

Inspect all hoses and fittings for the following:

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

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

The climate in which the crane operates affects the service life of the hydraulic components. The climate zones are defined in the table on page 1-6. Recommended replacement of hoses is as follows:

- Climate zones A and B with high ambient temperatures and duty cycles after 4,000 to 5,000 hours of service
- Climate zone C after 8,000 hours of service
- Climate zones D and E after 4,000 to 5,000 hours of service

Cleanliness

Contaminants in a hydraulic system affect operation and result in serious damage to the system components.

Keep the System Clean

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

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

Disassemble and assemble hydraulic components on a clean surface.

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

Sealing Elements

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

Hydraulic Lines

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

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

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

Electrical

Batteries

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

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

CAUTION

Disconnect batteries prior to working on the electrical system.

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

Connectors, Harnesses, Wires, and Connectors

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

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

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

The climate in which the crane operates affects the service life of the electrical components. The climate zones are defined in the table on page 1-6. Recommended replacement of harness and cables is as follows:

- Climate zones A and B with high ambient temperatures and duty cycles after 8,000 hours of service
- Climate zone C after 10,000 hours of service
- Climate zones D and E after 10,000 hours of service
- Saltwater conditions after 8,000 hours of service

Table 1-1.Climate Zone Classification

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

Fatigue of Welded Structures

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

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

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

Loctite®

⚠ DANGER

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

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

Application of Medium-Strength Loctite

NOTE: The fastener can be reused, and the adhesive can be reapplied over cured adhesive residue.

The following procedure covers the proper application and curing method for medium-strength Loctite adhesive/sealant (Loctite #243). Clean dirt and oil from the threaded surfaces, both male and female.

Adhesive/Sealant Application

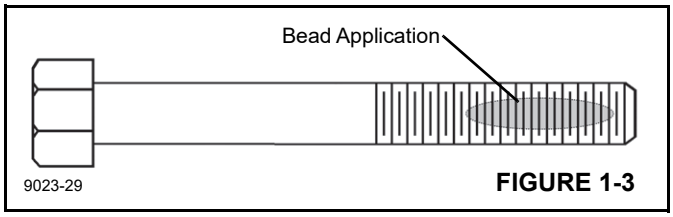


FIGURE 1-3

1. Apply a bead several threads wide in the approximate area of threaded contact (see Figure 1-3).
2. In a blind hole application, apply several drops of adhesive in the bottom of the hole so that the adhesive is forced up when the bolt is installed.
3. After installation, fixturing occurs within five (5) minutes. The 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 of bolts, studs, and nuts being used.

The torque tables are provided by National Crane 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 shall 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 is 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 types of wrenches, even though they might have a pre-set feature, must be pulled at a 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 types, 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 degrees 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.

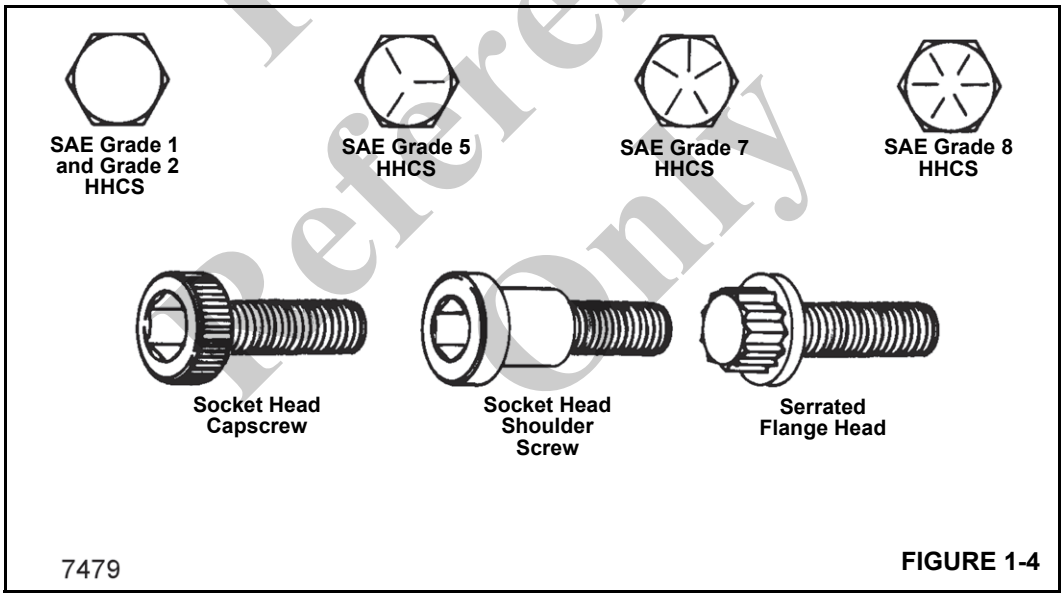


FIGURE 1-4

Table 1-2. Inch Series with Coarse Threads (UNC) – Zinc Flake Coated

Nominal Size, Threads per Inch, and Series Designation	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1/4-20 UNC	5	6.6	6.4	6.2
	8	9.3	9.0	8.8
5/16-18 UNC	5	13.5	13.2	12.8
	8	19.1	18.6	18.1
3/8-16 UNC	5	24.0	23.4	22.8
	8	33.9	33.1	32.2
7/16-14 UNC	5	38.4	37.4	36.5
	8	54.3	52.9	51.5
1/2-13 UNC	5	58.6	57.1	55.7
	8	82.8	80.7	78.6
9/16-12 UNC	5	84.5	82.4	80.3
	8	119.4	116.5	113.5
5/8-11 UNC	5	116.6	113.7	110.8
	8	164.8	160.7	156.6
3/4-10 UNC	5	206.8	201.7	196.5
	8	292.3	284.9	277.6
7/8-9 UNC	5	333.8	325.4	317.1
	8	471.6	459.8	448.0
1-8 UNC	5	500.3	487.8	475.3
	8	707.0	689.3	671.6
1 1/8-7 UNC	5	624.0	608.4	592.8
	8	1,001.4	976.4	951.4
1 1/4-7 UNC	5	880.5	858.5	836.5
	8	1,413.1	1,377.8	1,342.5
1 3/8-6 UNC	5	1,154.5	1,125.6	1,096.7
	8	1,852.8	1,806.5	1,760.2
1 1/2-6 UNC	5	1,532.0	1,493.7	1,455.4
	8	2,458.8	2,397.3	2,335.8

Table 1-3. Inch Series with Fine Threads (UNF) – Zinc Flake Coated

Nominal Size, Threads per Inch, and Series Designation	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1/4-28 UNF	5	7.5	7.3	7.1
	8	10.6	10.4	10.1
5/16-24 UNF	5	15.0	14.6	14.2
	8	21.1	20.6	20.1
3/8-24 UNF	5	27.2	26.5	25.8
	8	38.4	37.5	36.5
7/16-20 UNF	5	42.9	41.8	40.7
	8	60.6	59.1	57.6
1/2-20 UNF	5	66.0	64.4	62.7
	8	93.3	90.9	88.6
9/16-18 UNF	5	94.3	91.9	89.6
	8	133.2	129.9	126.6
5/8-18 UNF	5	132.1	128.8	125.5
	8	186.7	182.0	177.3
3/4-16 UNF	5	231.0	225.2	219.4
	8	326.4	318.2	310.1
7/8-14 UNF	5	367.7	358.5	349.3
	8	519.6	506.6	493.6
1-12 UNF	5	547.4	533.7	520.0
	8	773.5	754.2	734.8
1 1/8-12 UNF	5	700.0	682.5	665.0
	8	1,123.5	1,095.4	1,067.3
1 1/4-12 UNF	5	975.0	950.6	926.2
	8	1,564.8	1,525.7	1,486.5
1 3/8-12 UNF	5	1,314.4	1,281.5	1,248.6
	8	2,109.5	2,056.7	2,004.0
1 1/2-12 UNF	5	1,723.9	1,680.8	1,637.7
	8	2,766.8	2,697.6	2,628.4

Table 1-4. Metric Series with Coarse Threads – Zinc Flake Coated

Nominal Size, Threads per Inch, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M4x0.7	10.9	3.6	3.5	3.4
	12.9	4.2	4.1	4.0
M5x0.8	10.9	7.2	7.0	6.8
	12.9	8.4	8.2	8.0

Nominal Size, Threads per Inch, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M6x1.0	8.8	8.3	8.1	7.9
	10.9	12.2	11.9	11.6
	12.9	14.3	13.9	13.6
M8x1.25	8.8	20.2	19.7	19.2
	10.9	29.6	28.9	28.2
	12.9	34.7	33.8	33.0
M10x1.5	8.8	40.0	39.0	38.0
	10.9	58.7	57.2	55.8
	12.9	68.7	67.0	65.3
M12x1.75	8.8	69.7	68.0	66.2
	10.9	102.4	99.8	97.2
	12.9	119.8	116.8	113.8
M14x2	8.8	111.4	108.6	105.8
	10.9	163.6	159.5	155.4
	12.9	191.5	186.7	181.9
M16x2	8.8	172.8	168.5	164.1
	10.9	253.8	247.4	241.1
	12.9	296.9	289.5	282.1
M18x2.5	8.8	246.2	240.1	233.9
	10.9	350.7	341.9	333.2
	12.9	410.4	400.1	389.9
M20x2.5	8.8	348.0	339.3	330.6
	10.9	495.6	483.2	470.8
	12.9	580.0	565.5	551.0
M22x2.5	8.8	474.4	462.6	450.7
	10.9	675.7	658.8	641.9
	12.9	790.7	770.9	751.2
M24x3	8.8	601.3	586.3	571.3
	10.9	856.4	835.0	813.6
	12.9	1,002.2	977.1	952.1
M27x3	8.8	881.6	859.6	837.5
	10.9	1,255.7	1,224.3	1,192.9
	12.9	1,469.4	1,432.7	1,395.9
M30x3.5	8.8	1,195.3	1,165.5	1,135.6
	10.9	1,702.5	1,659.9	1,617.3
	12.9	1,992.3	1,942.4	1,892.6

Nominal Size, Threads per Inch, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M36x4	8.8	2,089.8	2,037.6	1,985.3
	10.9	2,976.4	2,902.0	2,827.6
	12.9	3,483.0	3,395.9	3,308.9

Table 1-5. Metric Series with Fine Threads – Zinc Flake Coated

Nominal Size, Threads per Inch, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M8x1.0	8.8	21.6	21.1	20.5
	10.9	31.7	30.9	30.1
	12.9	37.1	36.2	35.3
M10x.75	8.8	46.8	45.6	44.4
	10.9	68.7	67.0	65.3
	12.9	80.4	78.4	76.4
M10x1.25	8.8	42.2	41.1	40.1
	10.9	62.0	60.4	58.9
	12.9	72.5	70.7	68.9
M12x1.0	8.8	79.5	77.5	75.5
	10.9	116.7	113.8	110.9
	12.9	136.6	133.2	129.8
M12x1.25	8.8	76.2	74.2	72.3
	10.9	111.8	109.0	106.3
	12.9	130.9	127.6	124.3
M12x1.5	8.8	72.9	71.1	69.2
	10.9	107.1	104.4	101.7
	12.9	125.3	122.1	119.0
M14x1.5	8.8	120.2	117.2	114.2
	10.9	176.5	172.1	167.7
	12.9	206.6	201.4	196.2
M16x1.5	8.8	184.4	179.8	175.2
	10.9	270.9	264.1	257.3
	12.9	317.0	309.1	301.2
M18x1.5	8.8	276.6	269.7	262.8
	10.9	394.0	384.2	374.3
	12.9	461.1	449.6	438.0
M20x1	8.8	405.7	395.5	385.4
	10.9	577.8	563.3	548.9
	12.9	676.1	659.2	642.3

Nominal Size, Threads per Inch, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M20x1.5	8.8	386.0	376.3	366.7
	10.9	549.7	535.9	522.2
	12.9	643.3	627.2	611.1
M22x1.5	8.8	520.8	507.8	494.8
	10.9	741.7	723.2	704.7
	12.9	868.0	846.3	824.6
M24x2	8.8	655.8	639.4	623.0
	10.9	934.0	910.6	887.3
	12.9	1,092.9	1,065.6	1,038.3
M27x2	8.8	951.4	927.6	903.8
	10.9	1,355.0	1,321.1	1,287.2
	12.9	1,585.6	1,546.0	1,506.3
M30x1.5	8.8	1,369.2	1,334.9	1,300.7
	10.9	1,950.0	1,901.3	1,852.5
	12.9	2,281.9	2,224.9	2,167.8
M30x2	8.8	1,324.6	1,291.5	1,258.4
	10.9	1,886.6	1,839.4	1,792.2
	12.9	2,207.7	2,152.5	2,097.3
M33x2	8.8	1,784.5	1,739.9	1,695.3
	10.9	2,541.6	2,478.0	2,414.5
	12.9	2,974.2	2,899.8	2,825.4
M36x2	8.8	2,340.1	2,281.6	2,223.1
	10.9	3,332.8	3,249.5	3,166.2
	12.9	3,900.2	3,802.6	3,705.1

Table 1-6. Metric Series Screws of Stainless Steel A2-70/A4-70 with Coarse Threads

Size	Torque (Nm)
M2.5x0.45	0.4
M3x0.5	0.9
M4x0.7	1.5
M5x0.8	3.1
M6x1	5.3
M8x1.25	13
M10x1.5	27

The torque values shown are for fasteners installed **with lubrication**. When using lubricated fasteners, the torque values result in an 80% utilization of the yield strength.

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

Table 1-7. Inch Series Screws of Stainless Steel 300 (18-8) with Coarse Threads

Size	Torque	
	lb-in	lb-ft
#5-40 (0.125)	6.9	-
#6-32 (0.138)	9	-
#8-32 (0.164)	18	-
#10-24 (0.190)	21	-
1/4-20	68	-
5/16-18	120	10
3/8-16	210	17.5

The torque values shown are for fasteners installed **with lubrication**. When using lubricated fasteners, the torque values result in an 80% utilization of the yield strength.

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

Table 1-8. Inch Series Bearing Bolts – Untreated (black finish)

Nominal Size, Threads per Inch, and Series Designation	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
5/8-11 UNC	8	234	225	216
5/8-18 UNF	8	250	240	230
3/4-10 UNC	8	385	370	355
7/8-9 UNC	8	615	591	567
1-8 UNC	8	929	893	857
1 1/4-7 UNC	8	2,043	1,964	1,885

Table 1-9. Metric Series Bearing Bolts– Untreated (black finish)

Nominal Size, Threads per Inch, and Series Designation	Grade	Torque (Nm)		
		Maximum	Nominal	Minimum
M20X2.5	12.9	756	727	698
M24X3	10.9	1,089	1,047	1,005
M27X3	10.9	1,591	1,530	1,469

Table 1-10 .Inch Series with Coarse Threads (UNC) – Untreated (black finish)

Size	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1/4-20	5	9.0	8.4	7.7
	8	12.5	12	11.5
5/16-18	5	19	18	17
	8	26	25	24
3/8-16	5	32	31	30
	8	48	46	44
7/16-14	5	52	50	48
	8	73	70	67
1/2-13	5	78	75	72
	8	120	115	110
9/16-12	5	114	110	106
	8	161	152	143
5/8-11	5	156	150	144
	8	234	225	216
3/4-10	5	270	259.5	249
	8	385	370	355
7/8-9	5	416	400	384
	8	615	591	567
1-8	5	606	583	560
	8	929	893	857
1 1/8-7	5	813	782	751
	8	1,342	1,288	1,234
1 1/4-7	5	1,141	1,097	1,053
	8	2,043	1,964	1,885
1 3/8-6	5	1,519	1,461	1,403
	8	2,496	2,396	2,296
1 1/2-6	5	2,028	1,946.5	1,865
	8	3,276	3,150	3,024

Table 1-11. Inch Series with Fine Threads (UNF) – Untreated (black finish)

Size	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1/4-28	5	10	9.5	9
	8	14.5	14	13.5
5/16-24	5	21	20	19
	8	26	25	24
3/8-24	5	36	35	34
	8	53	51	49
7/16-20	5	57	55	53
	8	85	82	79
1/2-20	5	88	84.5	81
	8	125	120	115
9/16-18	5	126	121	116
	8	177	170	163
5/8-18	5	182	174.5	167
	8	250	240	230
3/4-16	5	312	299.5	287
	8	425	409	393
7/8-14	5	458	439.5	421
	8	672	646	620
1-12	5	658	632	606
	8	1,009	970	931
1-14 UNS	5	670	644.5	619
	8	945	908.5	872
1 1/8-12	5	882	848	814
	8	1,500	1,440	1,380
1 1/4-12	5	1,251	1,203	1,155
	8	2,092	2,008.5	1,925
1 3/8-12	5	1,704	1,638	1,572
	8	2,833	2,719	2,605
1 1/2-12	5	2,288	2,196.5	2,105
	8	3,640	3,500	3,360

Table 1-12. Metric Series with Coarse Threads – Untreated (black finish)

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M4x0.7	8.8	3.1	2.9	2.8
	10.9	4.5	4.3	4.1
	12.9	5.4	5.2	4.9
M5x0.8	8.8	6.5	6.2	5.9
	10.9	9.2	8.9	8.5
	12.9	11	10.5	10
M6x1	8.8	11	10.5	10
	10.9	16	15	14
	12.9	19	18	17
M8x1.25	8.8	27	26	25
	10.9	38	36.5	35
	12.9	45	43.5	42
M10x1.5	8.8	53	51	49
	10.9	75	72	69
	12.9	89	86	83
M12x1.75	8.8	93	89	85
	10.9	130	125	120
	12.9	156	150	144
M14x2	8.8	148	142	136
	10.9	212	203.5	195
	12.9	248	238	228
M16x2	8.8	230	221	212
	10.9	322	310	298
	12.9	387	372	357
M18x2.5	8.8	319	306.5	294
	10.9	455	436.5	418
	12.9	532	511	490
M20x2.5	8.8	447	430	413
	10.9	629	605	581
	12.9	756	727	698
M22x2.5	8.8	608	585	562
	10.9	856	823	790
	12.9	1029	989	949
M24x3	8.8	774	744	714
	10.9	1,089	1,047	1,005
	12.9	1,306	1,256	1,206

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M27x3	8.8	1,134	1,090	1,046
	10.9	1,591	1,530	1,469
	12.9	1,910	1,836.5	1,763
M30x3.5	8.8	1,538	1,479	1,420
	10.9	2,163	2,080	1,997
	12.9	2,595	2,495	2,395
M36x4	8.8	2,681	2,578.5	2,476
	10.9	3,964	3,812	3,660
	12.9	4,639	4,461	4,283

Table 1-13. Metric Series with Fine Threads – Untreated (black finish)

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M8x1	8.8	29	28	27
	10.9	41	39.5	38
	12.9	49	47	45
M10x0.75	8.8	57	55	53
	10.9	81	78	75
	12.9	96	93	90
M10x1.25	8.8	57	55	53
	10.9	81	78	75
	12.9	96	93	90
M12x1	8.8	101	97.5	94
	10.9	150	144	138
	12.9	175	168	161
M12X1.25	8.8	100	96	92
	10.9	147	141.5	136
	12.9	172	165.5	159
M12x1.5*	8.8	100	96	92
	10.9	140	135	130
	12.9	168	162	156
M14x1.5	8.8	160	153.5	147
	10.9	229	220	211
	12.9	268	257	246
M16x1.5	8.8	248	238.5	229
	10.9	348	335	322
	12.9	418	402	386
M18x1.5	8.8	345	331.5	318
	10.9	491	471	451
	12.9	575	552	529
M20X1	8.8	471	453	435
	10.9	694	667.5	641
	12.9	812	781	750
M20x1.5	8.8	483	464.5	446
	10.9	679	653	627
	12.9	816	785	754
M22x1.5	8.8	657	632	607
	10.9	924	888.5	853
	12.9	1,111	1,068	1,025

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M24x2	8.8	836	803.5	771
	10.9	1,176	1,130.5	1,085
	12.9	1,410	1,356	1,302
M27x2	8.8	1,225	1,171.5	1,130
	10.9	1,718	1,652.5	1,587
	12.9	2,063	1,983.5	1,904
M30x1.5	8.8	1,530	1,471.5	1,413
	10.9	2,253	2,166.5	2,080
	12.9	2,637	2,536	2,435
M30x2	8.8	1,661	1,597.5	1,534
	10.9	2,336	2,246.5	2,157
	12.9	2,800	2,695	2,590
M33x2	8.8	2,141	2,059	1,977
	10.9	3,155	3,034	2,913
	12.9	3,692	3,550.5	3,409
M36x2	8.8	2,795	2,688	2,581
	10.9	4,118	3,960	3,802
	12.9	4,818	4,634	4,450

Weld Studs

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

Table 1-14. Weld Stud Torque Values

Size	Torque
#10	20-lb in
1/4	4-lb ft
5/16	10-lb ft
3/8	14-lb ft
1/2	35-lb ft
5/8	70-lb ft

HOIST CABLE INSPECTION AND MAINTENANCE

Hoist Cable

Cranes may be equipped with synthetic hoist rope or wire rope. Hoist rope may be purchased through Manitowoc Crane Care.

For detailed information concerning synthetic hoist rope, refer to K100™ Synthetic Crane Hoist Line Manual P/N 9828100734 available by contacting Manitowoc Crane Care.

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

Ensure that crane surfaces such as wear pads, sheaves, etc. have not been damaged in a manner that can then damage the synthetic hoist rope.

⚠ WARNING

Worn or Damaged Equipment Hazard!

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

Hoist rope should be inspected frequently. Daily/monthly 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.

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

Keeping Records

A signed and dated report of the hoist rope 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 hoist rope should be replaced.

It is recommended that the hoist 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.

WIRE ROPE

General

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

Environmental Conditions

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

Dynamic Shock Loads

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

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

Lubrication

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

During fabrication, ropes receive lubrication which provides the rope with protection for a reasonable time if stored under proper conditions. After the rope is put into service, periodic

applications of a suitable rope lubricant are required. The wire rope lubricant should have the following characteristics:

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

Remove dirt from the rope before applying lubrication. Use a stiff wire brush and solvent, compressed air, or live steam to clean the rope. Lubricate the rope immediately after cleaning. Methods of lubrication are bath, dripping, pouring, swabbing, painting, or pressure spray (Figure 1-5). Apply the lubricant at the top bend in the rope because at that point the strands are spread and more easily penetrated. Do not lubricate a loaded rope. The service life of wire rope is directly proportional to the amount of lubricant reaching the working parts of the rope.

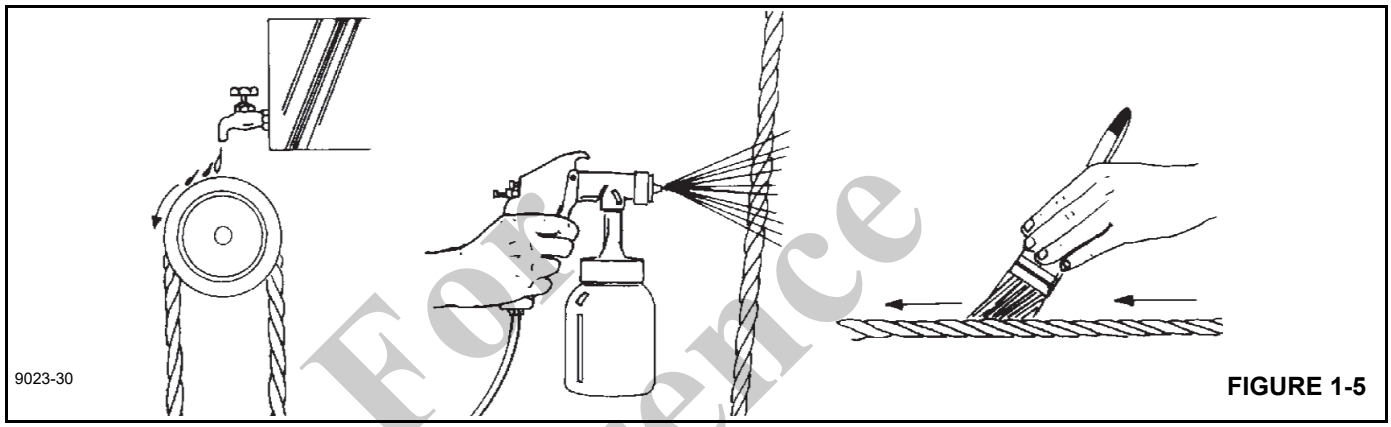


FIGURE 1-5

Recommendations for Servicing Wire Rope

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

Wire Rope Inspection

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

NOTE: Wire rope is available from Manitowoc Crane Care.

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

Daily Inspection

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

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

Monthly Inspections

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

- This inspection must be documented according to OSHA regulations 1926.1412 (e) (3).
- The inspection must monitor any deficiencies that were determined during the annual inspection, to be not presently a safety hazard.

Yearly Inspection

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

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

NOTE: Damaged sheaves or hoist drums can accelerate wear and cause rapid deterioration of the wire rope.

Boom Extension and Retraction Cables

Periodic Inspection

It is recommended that inspection of all boom extension and retraction cables be performed in conjunction with boom lubrication or quarterly. This inspection shall cover all visible areas of the extension and retraction cables of an assembled boom.

NOTE: Note that extending and retracting the boom may be required to access visual inspection holes.

This inspection shall cover the entire length of the extension and retraction cables of a disassembled boom prior to reassembly. Use this inspection to monitor degradation and identify damage that requires wire rope replacement or equipment repair. Inspect the rope using the following guidelines for:

- Reduction of rope diameter below nominal diameter
- Severely corroded or broken wires at end connections
- Severely corroded, cracked, bent, worn, or improperly applied end connections
- Deterioration in areas such as:
  - Sections in contact with saddles, equalizer sheaves, or other sheaves where rope travel is limited
  - Sections of wire rope at or near terminal ends where corroded or broken wires may protrude
  - Sections of wire rope in contact with stationary surfaces where abrasion or chafing may take place as a result of equipment vibration
- Damaged or wobbly boom extension and retraction sheaves which can cause rapid deterioration of wire rope
- Unusual cable sag/stretch

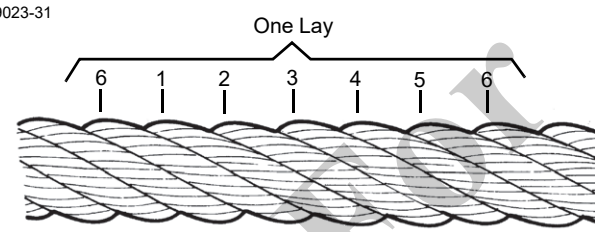
NOTE: Be sure cables used in sets all have an equal tension applied. Repeated need for adjustment of an individual cable is evidence of cable stretch and indicates the need for a more thorough inspection to determine and correct the cause.

Wire Rope Replacement (All Wire Rope)

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

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

- In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay (see Figure 1-6)



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

FIGURE 1-6

- Wear of one-third the original diameter of outside individual wires
- Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure
- Evidence of heat damage
- Reductions from nominal diameter of more than:
  - 1/64 inch for diameters up to and including 5/16 inch
  - 1/32 inch for diameters 3/8 and 1/2 inch inclusive
  - 3/64 inch for diameters 9/16 to 3/4 inch inclusive
  - 1/16 inch for diameters 7/8 to 1-1/8 inches inclusive
  - 3/32 inch for diameters 1/14 to 1-1/2 inches inclusive
- In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection
- National Crane recommends that for cable extended booms, a single damaged wire rope assembly shall require replacement of the complete set of extension cables

NOTE 1: National Crane recommends that boom extension cables be replaced every seven (7) years.

Seizing Wire Rope

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

Method 1

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

The two ends of the annealed wire should be twisted together tightly. Cut off the excess wire and pound the twist flat against the wire rope (see Figure 1-7).

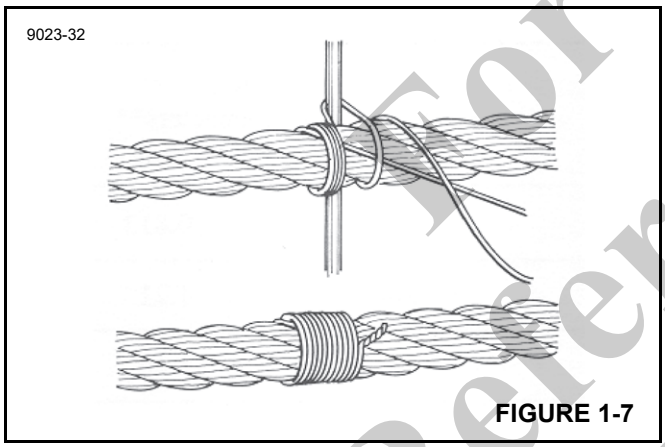


FIGURE 1-7

Method 2

Wind a length of soft annealed wire around the wire rope at least seven times. Twist the two ends together in the center of the seizing. Tighten the seizing by alternately prying and twisting. Cut off both ends of the wire and pound the twist flat against the rope (Figure 1-8).

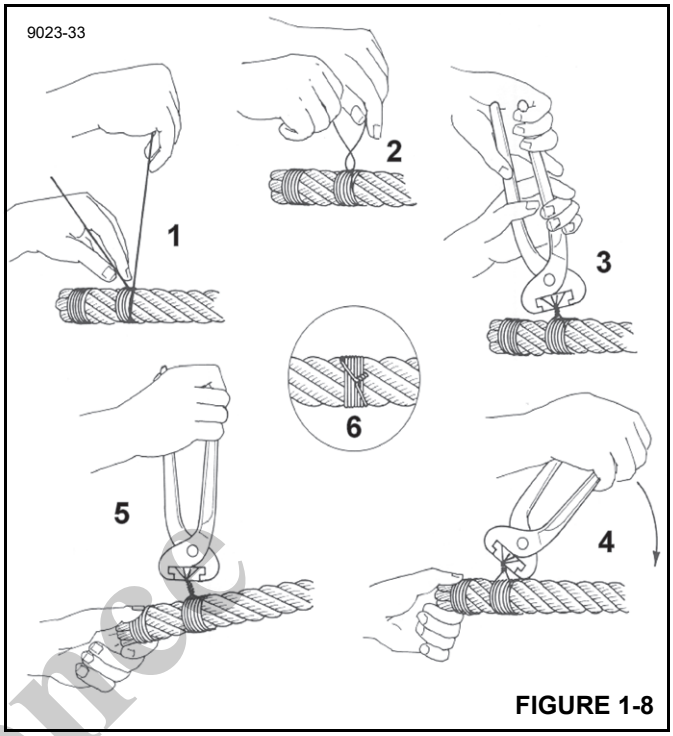


FIGURE 1-8

NOTE: Non-preformed wire rope should have two seizings located on each side of the cut (see Figure 1-9).

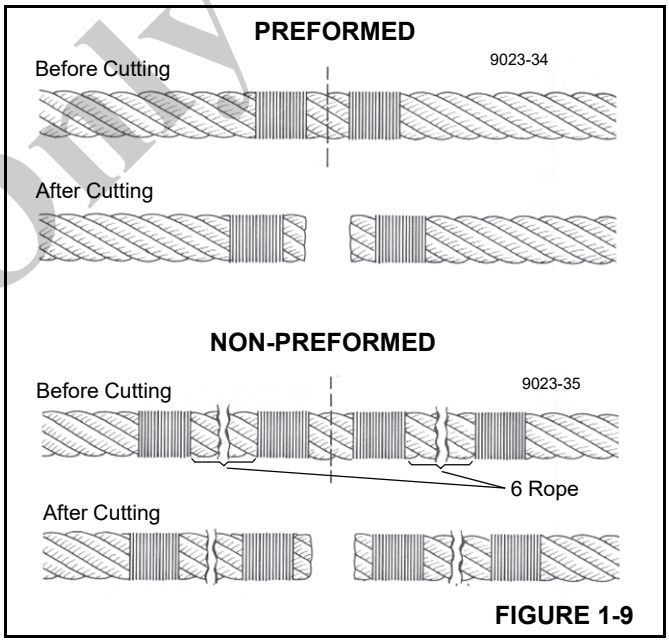


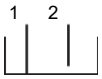
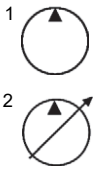
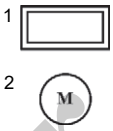
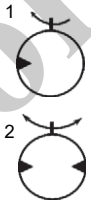
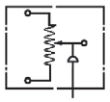
FIGURE 1-9

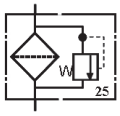
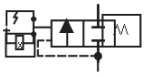
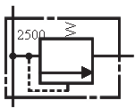
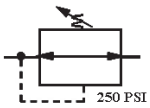
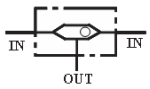
SECTION 2
HYDRAULIC SYSTEM

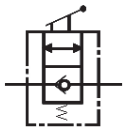
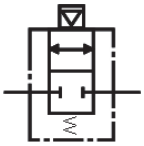
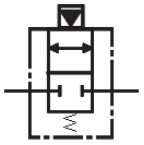
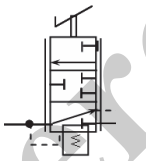
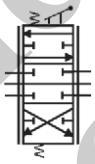
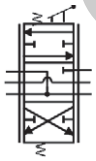
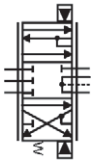
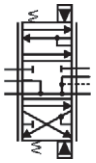
SECTION CONTENTS

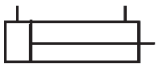
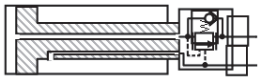
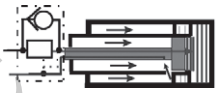
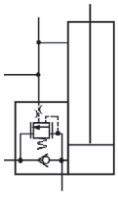
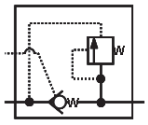
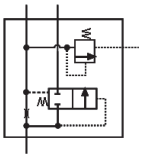
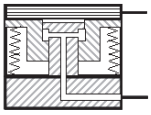
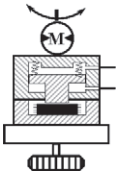
This section describes the hydraulic system, the components which make up the hydraulic system, and the components dependent upon the hydraulic system for their operation. This includes descriptions of the supply pressure and return circuit, pumps, valves, and cylinders. Detailed descriptions and operation of individual hydraulic circuits are discussed within their individual sections as applicable. A chart titled Hydraulic Symbols contains all hydraulic symbols used in the hydraulic schematics contained in this manual.

Table 2-1 Hydraulic Symbols

Description	Symbol
Hydraulic Reservoir - Stores, cools, and cleans machine's hydraulic fluid supply	
Hydraulic Return Lines - Terminated at: (1) below fluid level, (2) above fluid level	
Hydraulic Pump - (1) fixed displacement, (2) variable displacement	
Power Source - Powers hydraulic pump: (1) combustion engine, (2) electric motor	
Hydraulic Motors - (1) unidirectional, (2) bidirectional	
Pump Disconnect - Disconnects pump from power source	
Continuous Line - Supply or return lines	
Connecting Lines - Branch lines connected to main line	
Dashed Line - Pilot pressure	
Dotted Line - Case drain or load sense	
Chain Line - Enclosure of two or more functions contained in one unit	
Pressure Transducer - Hydraulic/ electrical located in lift cylinder circuit for crane's RCL circuit	

Description	Symbol
Filter - Removes contamination from hydraulic fluid	
Filter with Bypass Valve - Bypass valve allows hydraulic fluid to bypass the filter if the filter becomes clogged	
Accumulator - Used to either develop flow or absorb shock	
Check Valve - Creates backpressure	
Orifice - In-line fixed restriction	
Adjustable Orifice - In-line restriction used for control device	
Hydraulic Oil Cooler - Cools hydraulic fluid	
Temperature Switch - Regulates the hydraulic fluid temperature	
Hydraulic Pressure Switch - Senses hydraulic pressure to energize electrical components	
Flow Switch - Illuminates indicator light to indicate a fault	
Relief Valve - Protects system from being overpressurized	
Pressure-Reducing Valve - Regulates maximum pressure	
Shuttle Valve - Used to direct maximum pressure to components	

Description	Symbol
Manually Operated - Valve shifted manually with check to allow flow back to tank	
Pneumatic Operated - Valve shifted by pneumatic device	
Pilot Operated - Valve shifted by pilot pressure	
Electric Operated - Valve shifted by electrical energy	
Brake Valve - Activates swing brake	
Open-Center Cylinder Spool - Directional control valve for hydraulic cylinder function that directs flow back to tank through the open center when in the neutral position	
Open-Center Motor Spool - Directional control valve for hydraulic motor function that directs flow back to tank through the open center when in the neutral position. Allows flow back to tank when the crane is shut down	
Closed-Center Cylinder Spool - Pressure-compensated directional control valve for hydraulic cylinder which directs flow back to tank with an unloader valve cartridge	
Closed-Center Motor Spool - Pressure-compensated directional control valve for motor with open port for flow back to tank. Allows flow back to tank when the crane is shut down	

Description	Symbol
Single-Acting Cylinder - Extended hydraulically and retracted with a spring	
Double-Acting Cylinder - Extended and retracted hydraulically	
Double-Acting Telescope Cylinder - Anchored rod pushes barrel out when check valve is unseated 	
Multi-Stage Telescope Cylinder - Used in multi-section synchronized operations 	
Inverted Outrigger Jack - Extends the barrel down to raise the crane off the ground 	
Holding Valve - Keeps boom lift cylinder from collapse if hydraulic pressure failure occurs (e.g., hose rupture)	
Pilot-Operated Check Valve (with thermal relief) - Requires pilot pressure to unseat the one-way check (nonadjustable)	
Flow Divider Valve - Regulates flow to a selected circuit	
Hoist Brake - Holds load after control is returned to neutral (spring applied and hydraulically released)	
Swing Brake - Spring applied hydraulically brake holds superstructure in place	

MAINTENANCE

General

Before adjustments and repairs begin on a crane, the following precautions must be taken as applicable:

- Place a warning tag in a conspicuous location at the controls stating that the machine requires adjustment or repair before it can be operated.
- Park the crane where it will cause the least interference with other equipment or operations in the area.
- Place all controls at the off position and set the brakes to prevent inadvertent motion.
- Disable all methods used to start the truck's engine.
- Lower the boom to the ground or otherwise secured against dropping.
- Lower the hook block to ground or otherwise secured against dropping.
- Relieve the hydraulic pressure from all hydraulic circuits before loosening or removing hydraulic components.

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

Adjustments and repairs shall be done only by designated personnel who are properly trained. Use only National Crane supplied parts to repair the crane.

Hydraulic System Maintenance Precautions

Contaminants in a hydraulic system affect operation and 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 reassemble 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.

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 systems and crane's electrical system may be damaged by welding on the truck or crane. The following precautions should be taken:

- Disconnect the truck battery cables.
- Attach the welding ground lead as close as possible to the area to be welded.

PARTS REPLACEMENT

Parts found damaged or out of tolerance when maintenance is being performed need to be replaced. Replacement parts may be purchased through Manitowoc Crane Care parts department.

SERVICE

Hydraulic Oil Recommendations

For hydraulic oil specifications, see *Lubrication*, page 8-1.

Draining and Flushing

If a component has been changed because of a failure that might allow metal or abrasive particles to enter the system, all systems must be thoroughly checked, drained, and flushed.

1. Remove the reservoir drain plug. Allow about three minutes after hydraulic oil stops flowing from the drain port for the side walls to drain.
2. Clean and install the reservoir plug and fill the reservoir with a 50/50 mixture of fuel oil and clean hydraulic oil.
3. Cycle the crane through all functions several times. Then return the crane to its stowed position and shut down the engine.

4. Remove the reservoir drain plug and drain the reservoir. Clean and install the drain plug and fill the reservoir with clean hydraulic oil.

CAUTION

Hydraulic oil supply lines must be connected to the cylinders when flushing the system.

NOTE: Connect a drain hose in place of a disconnected return line so that the hydraulic oil can be drained in a container for proper disposal.

5. Disconnect the return line from the lift cylinder and raise the boom to maximum elevation.
6. Connect the cylinder return line and lower the boom to its stowed position. Replenish the reservoir hydraulic oil level as required.
7. Disconnect the return line from an outrigger extension cylinder and fully extend the outrigger.
8. Connect the outrigger return line and retract the outrigger. Replenish the reservoir hydraulic oil level as necessary.
9. Repeat steps 7 and 8 for the remaining outriggers.

CAUTION

When draining the outrigger cylinders, always operate either both front or both rear cylinders together to prevent twisting the crane.

10. Disconnect the return lines from a pair of outrigger jack cylinders and activate the cylinders to their maximum down positions.
11. Connect the return lines and raise the outrigger jack cylinders to the stowed position. Replenish the reservoir hydraulic oil level as necessary.
12. Repeat steps 10 and 11 for the remaining two outrigger cylinders.
13. Disconnect the return line from the telescope cylinder and fully extend the boom.
14. Connect the return line and retract the boom. Replenish the reservoir hydraulic oil level as necessary.
15. Disconnect the return line from the hoist motor and fully hoist up.
16. Connect the return line to the hoist motor and fully hoist down and back up again. Replenish the reservoir hydraulic oil level as necessary.
17. Disconnect one of the lines from the swing motor and drive the motor in the direction it will go.
18. Connect the line to the swing motor, then drive the swing motor in the opposite direction until the boom is centered and forward. Replenish the reservoir hydraulic oil level as necessary.

CAUTION

Hydraulic oils must be of the same specifications or discoloration (milkiness) may occur.

When hydraulic oils are changed, recheck the reservoir hydraulic oil level after brief system operation and add hydraulic oil as required. Ensure the crane is level and in the travel mode of operation when the hydraulic system is being filled. The system must be filled with all cylinders retracted. Fill the reservoir to the full mark on the reservoir sight gauge. After the reservoir is filled, operate all circuits and recheck the reservoir sight gauge. Add hydraulic oil as required.

Removing Air from the Hydraulic System

Air entering the hydraulic oil is normally removed by baffles in the hydraulic reservoir. If a component has been replaced, if the reservoir level is too low, or if a leak develops in the suction line to the pump, air can enter the system. Air can cause noisy operation of the swing and hoist hydraulic motors. Check the level of the hydraulic reservoir first if noisy operation occurs. Inspect for leaks in the suction lines leading to the pumps.

Minute leaks may be hard to locate. If a leak is not readily detectable, use the following way to check for it:

- Seal all normal openings in the hydraulic system and the reservoir. Using a positive means to control the pressure (like a regulator), pressurize the hydraulic system to 13.8 to 27.6 kPa (2 to 4 psi) and inspect all joints and fittings for evidence of leaks. A soap solution applied to the fittings and joints may also prove helpful in detecting minute leaks while the system is pressurized. Remove the pressure, repair any leaks found, and reopen any openings (such as a vent) closed for inspection. Refill the reservoir after completing any repairs or service. Operate all hydraulic circuits several times in both directions.
- This action should return any entrapped air to the reservoir, where it can be removed by the internal baffles.

⚠ DANGER

Locate the machine on a firm supporting surface and position the boom over the front on outriggers when extending the boom at low angles.

- To remove entrapped air from telescope cylinders, lower the boom below the horizontal position and fully telescope the boom in and out several times.
- If the air is still trapped, lower the boom below the horizontal position, extend the telescope cylinders as far

as practical, and allow the boom to remain in this position overnight. This should allow trapped air to find its way to the holding valve so that telescoping the boom IN the next morning should force the air back to the reservoir. Ensure the boom is first telescoped IN (not OUT) in the morning. Telescoping OUT may cause air to be forced back into a cylinder.

DANGER

Extreme care must be used when removing any plugs or restrictions from a hydraulic system suspected to have entrapped air that may be pressurized.

- Trapped air can be removed from cylinders having wet rods by cycling. On certain cylinders, a plugged port is provided on the rod end to bleed off trapped air.

DANGER

Do not attempt to loosen fittings in pressurized lines or while the hydraulic pumps are in operation.

- In the event that trapped air persists, bleed off the air by loosening various clamp and screw types of fittings.
- If the above procedures fail to eliminate trapped air, contact your authorized National Crane distributor.

SYSTEM DESCRIPTION

The hydraulic system is pressure compensated with a closed center. The hydraulic system of the NBT40-1 series cranes consists of the following:

- Hydraulic Pump
- Four-Section Main Control Valve
- RCL Lockout Manifold
- Swing and Air Conditioning Control Valve
- Outrigger Control Manifolds
- Hydraulic Reservoir with Filter
- Hydraulic Remote Controllers (HRC)
- Pilot Manifold
- Radio Remote Manifold (Optional)
- Tool Circuit Manifold (Optional)
- Pressure Intensifier Manifold
- Pump Manifold
- Swing Motor Manifold (w/ Remotes Option)
- Hydraulic Swivel
- Hydraulic Oil Cooler

Hydraulic Pump

The hydraulic pump is mounted directly to the power take-off (PTO) or to the truck chassis. The hydraulic pump is pressure compensated and supplies variable flow to the hydraulic system based on pump shaft speed and system demand through load sense signal pressure.

Directional Control Valve (DCV)

The directional control valve (DCV) is located in the turret and has four sections. The DCV controls the main hoist, auxiliary hoist, lift, and telescope.

- Section one controls the boom up and down and contains the lift workport relief valves to protect the lift cylinder. The boom up relief is a dual stage relief, and the lower setting is used only for aerial lift configuration operation.
- Section two controls the main hoist and contains workport relief valves to protect the main hoist.
- Section three controls the telescope cylinder and contains the workport relief valves to protect the telescope cylinder. The telescope extend and retract reliefs are dual stage reliefs, and the lower setting is used only for areal lift configuration operation.
- Section four controls the auxiliary hoist and contains workport relief valves to protect the auxiliary hoist.

RCL Lockout Manifold

The RCL lockout manifold is located in the turret and disables crane functions when the RCL senses an impending tipping condition. The manifold disables hoist up, boom down, and telescope out. The locked out functions are re-enabled when these conditions are eliminated.

Swing and Air Conditioning Control Valve

The swing and air conditioning valve is located in the turret and controls the swing motor and the air conditioning. The valve limits the maximum flow in both directions and has internal relief valves. The valve has an open center that goes back to tank when the valve is in the neutral position.

Outrigger Control Manifolds

The outrigger control manifolds control the outrigger functions.

Front Outrigger Manifold

The front outrigger manifold is located on the front outrigger box and controls the extend and retract circuits for the front and rear outriggers and the selection of the front outrigger beams and vertical jacks. The front outrigger manifold controls the outrigger component selection for the front outrigger.

Rear Outrigger Control Manifold

The rear outrigger manifold is mounted on the underside of the rear outrigger box. The rear outrigger manifold controls the selection of the rear outrigger components and the selection of the rear outrigger beams and vertical jacks.

Hydraulic Reservoir with Filter

The hydraulic reservoir is attached to the top of the truck frame on a standard length torsion box or to the top of the torsion box for an extended length torsion box (see Figure 2-6). The oil in the hydraulic tank is used to supply the oil to the hydraulic system when the hydraulic cylinders are extended. A filter housing and element is installed in the top of the hydraulic reservoir and filters the return hydraulic oil.

Hydraulic Remote Controllers (HRC)

The crane functions are controlled by hydraulic remote controllers (HRC) on the armrest of the operator's seat. The controllers operate by pilot pressure that is applied to the bonnets on each side of the valve spools to shift the spool in the required direction.

Pilot Manifold

The pilot manifold is located in the turret and controls the enabling of the HRC, enables the hydraulic air conditioning system, releases the spring-applied brake in the swing gearbox, and provides enabling of the aerial lift configuration (optional).

Radio Remote Manifold (optional)

The radio remote manifold is located behind the turret in a separate mounting enclosure. This manifold allows the machine to be operated from a wireless radio remote controller, which provides electrical signals to solenoids in this manifold and, in turn, operates the primary crane and aerial functions.

Tool Circuit Manifold (optional)

The tool circuit manifold is located on the outside rear of the turret near the boom pivot pin. This manifold, when turned on, provides flow and pressure to an auxiliary function through a hydraulic twin-line hose reel mounted to the side of the base boom. This is typically equipped in conjunction with an optional pressure intensifier manifold.

Pressure Intensifier Manifold (optional)

The pressure intensifier manifold is located in the personnel platform and is used in conjunction with the hydraulic tool circuit and hydraulic hose reel options. When enabled, this manifold provides flow to a tool at varying pressures and flows adjusted via the manifold control lever. For more information see Intensifier Manual P/N 9828221048.

Pump Manifold

This manifold is located directly on the axial piston pump and provides a reduced pressure hydraulic circuit for use for the outrigger control manifolds.

Swing Motor Manifold (with Remotes Option)

This manifold is located directly on the swing motor and provides the same free swing operation as the standard swing motor manifold with added capabilities when operating the machine with radio remotes. When remotes are in use, this manifold converts the swing performance into a standard counterbalance valve style swing, requiring no swing brake pedal and no glide-swing-like functionality. When the swing function is activated on the remote controller, the motor begins to rotate. When this lever is returned to neutral, the flow to the swing motor is stopped, and there is no drift or glide-swing performance.

Hydraulic Swivel

The hydraulic swivel is located inside the turret at the center of rotation and provides 360° of continuous rotation in either direction.

Hydraulic Oil Cooler

The hydraulic oil cooler is located in front of the hydraulic reservoir mounted to the boom rest. Heated hydraulic oil returning to the hydraulic tank flows through a bypass valve to the hydraulic oil cooler and returns to the hydraulic tank. The hydraulic oil cooler bypass valve prevents damage to the hydraulic oil cooler if it becomes plugged during operation. An electric fan is mounted to the hydraulic oil cooler and is controlled by a temperature switch installed in the side of the hydraulic oil cooler.

HYDRAULIC VALVES

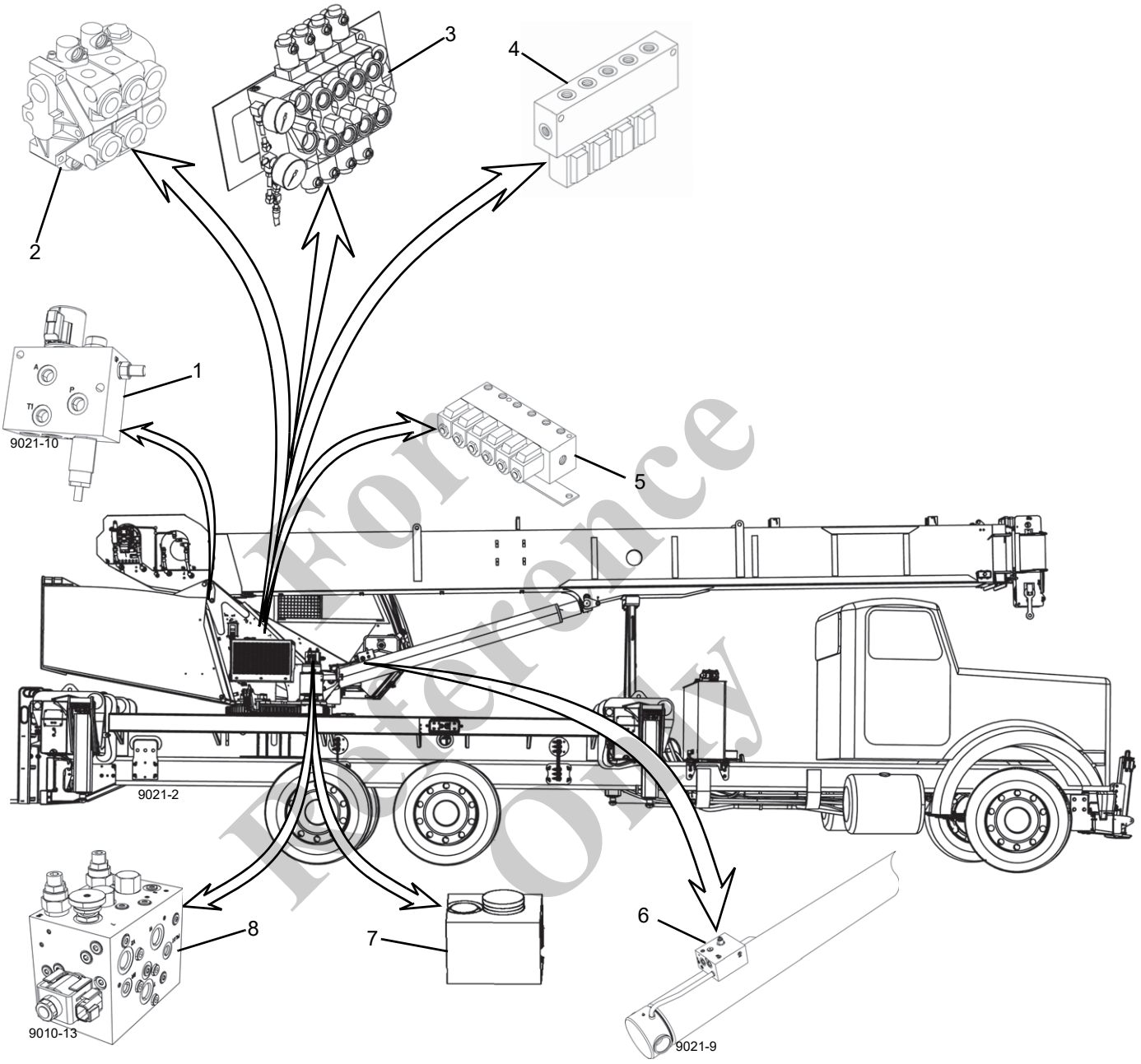
This section provides descriptive information for all the hydraulic valves used on this crane. For a listing of all valves, the circuit they are used in, and their physical location, see Table 2-2. See Figure 2-1 for control valve and manifold locations. The description of each valve given here is for the valve itself. For information on how each valve functions in the individual circuits, see the description and operation procedures of that circuit

Table 2-2 Hydraulic Valves

Valve Name	Circuit Used In	Physical Location
Directional Control Valve	Lift/telescope/hoist(s)	Inside the turret
Hydraulic Remote Controllers	Lift Telescope Main Hoist Swing	Cab seat arm rests (2)
Swing Brake Pedal Valve	Swing	Crane cab floor
Swing Brake Manifold	Swing	Inside turret
Swing Motor Manifold	Swing	On swing motor
Holding Valves	Lift Telescope	Port block on cylinder
Bypass Valve	Return circuit	One in parallel with oil cooler One in parallel with oil filter
Front Outrigger Control Manifold	Outrigger	Front outrigger box
Rear Outrigger Control Manifold	Outrigger	Rear outrigger box
Pilot-Operated Check Valve	Outriggers	Port block of each jack cylinder (4)
Single Front Outrigger Relief Valve	Outrigger	Front center outrigger
Flow Control Valve	Outriggers	Front outrigger box
Telescope Pedal	Optional - with aux. hoist	Cab floor

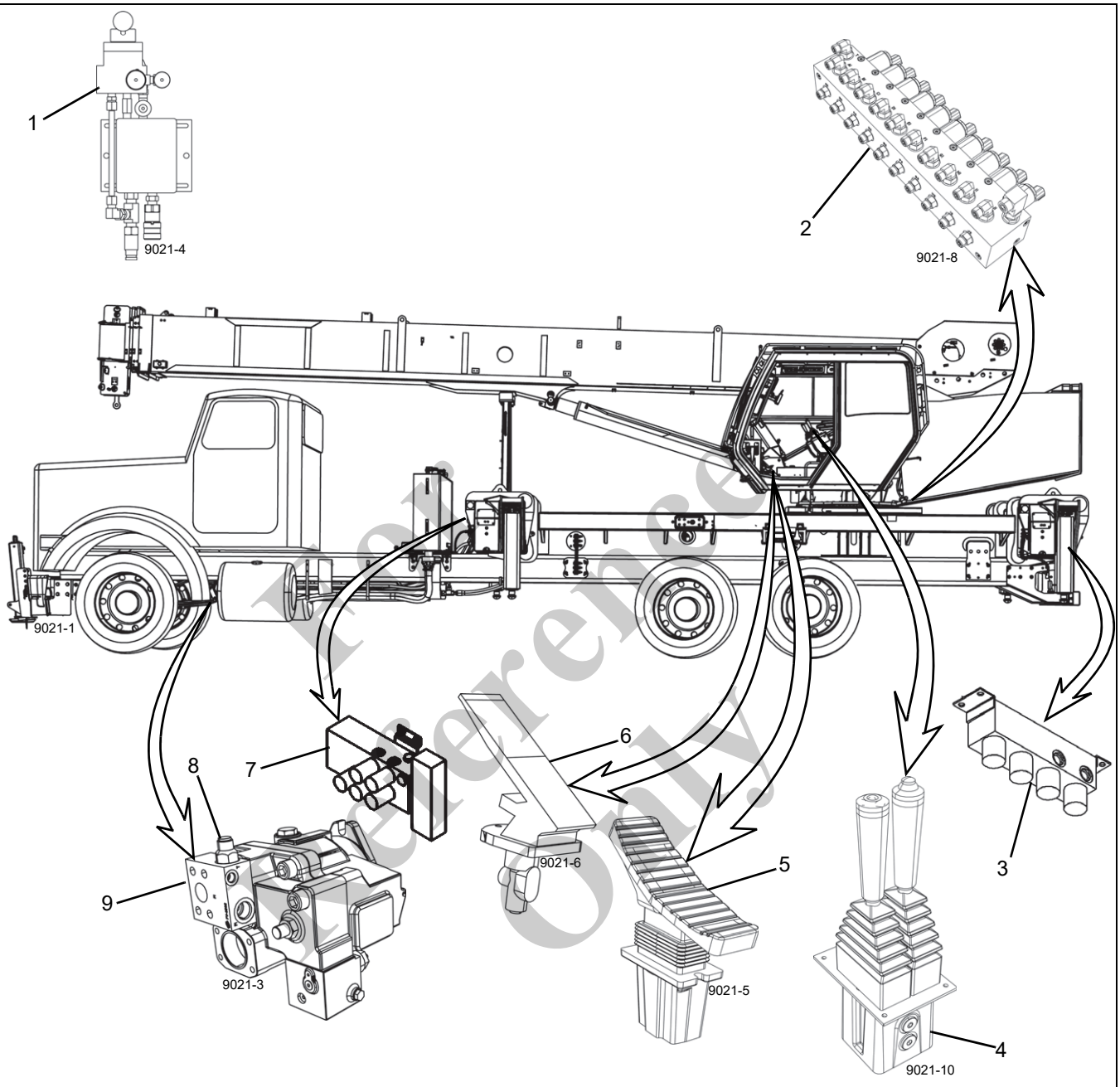
2

.Hydraulic Valve Locations



Item	Component	Item	Component
1	Tool Circuit Manifold	5	RCL Lockout Manifold
2	Swing and Air Conditioner Control Valve	6	Holding Valve
3	Directional Control Valve (DCV)	7	Standard Swing Motor Manifold
4	Pilot Manifold (crane power/AC/swing brake/ aerial)	8	Dual-Mode Swing Motor Manifold (if equipped)

FIGURE 2-1



Item	Component	Item	Component
1	Pressure Intensifier (if equipped, located on aerial lift platform)	6	Swing Brake Valve
2	Remote Controllers (if equipped)	7	Front Outrigger Manifold
3	Rear Outrigger Manifold	8	Outrigger Pressure-Reducing Valve
4	Hydraulic Joystick (X 2)	9	Pump Manifold
5	Telescope Valve (if equipped)		

FIGURE 2-2

Directional Control Valve (with Aux. Hoist) - 4 Section Valve

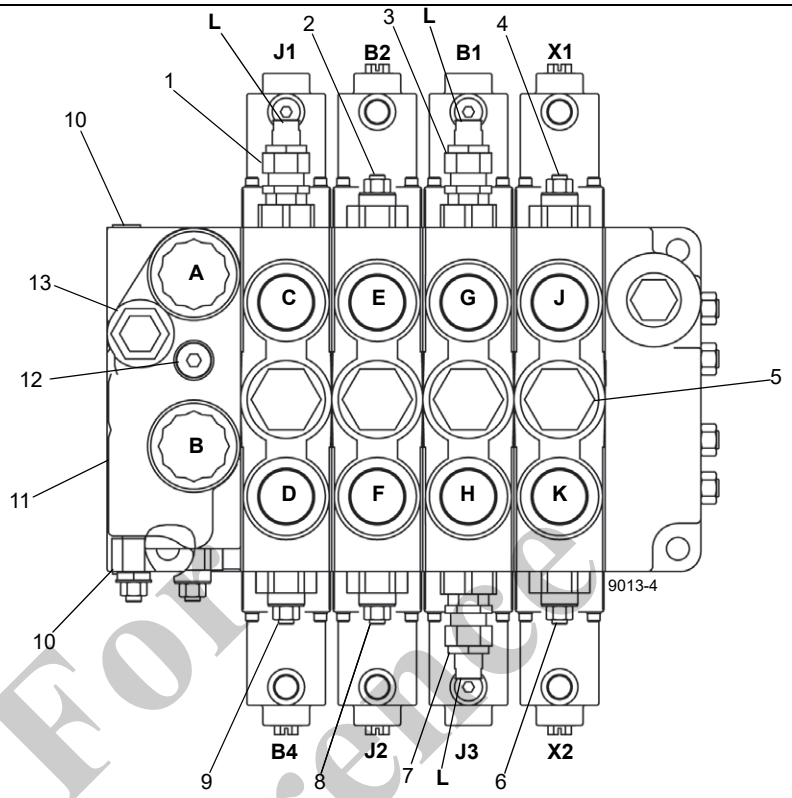


FIGURE 2-3

Directional Control Valve Item Numbers

Item	Description	Item	Description	Item	Description
1	Boom Relief Valve - Up	6	Aux Hoist Relief Valve -	11	Gauge Port
2	Main Hoist Relief Valve - Up	7	Tele Cyl Relief Valve -	12	Load Sense Bleed-Off
3	Tele Cyl Relief Valve - Extend	8	Main Hoist Relief Valve -	13	Standby Pressure
4	Aux Hoist Relief Valve - Raise	9	Boom Relief Valve - Down		
5	Check Valve (four places)	10	Pilot Supply		

Directional Control Valve Port/Hosing

Port	Description	Port	Description	Port	Description
A	Outlet - Swivel Port	H	Tele Cyl - Retract	J1	Plugged
B	Inlet - Swivel Port	J	Main Hoist-Raise	J2	Hose - Dump Valve B2
C	Boom Lift Cylinder - Extend	K	Main Hoist-Down	J3	Plugged
D	Boom Lift Cylinder - Retract	L	2-Stage Relief Valve Pilot	X1	Hose - Dump Valve B5
E	Auxiliary Hoist - Up	B1	Hose - Dump Valve B4	X2	Hose - Dump Valve B6
F	Auxiliary Hoist - Down	B2	Hose - Dump Valve B3		
G	Tele Cyl - Extend	B4	Hose - Dump Valve B1		

Swing Control Valve

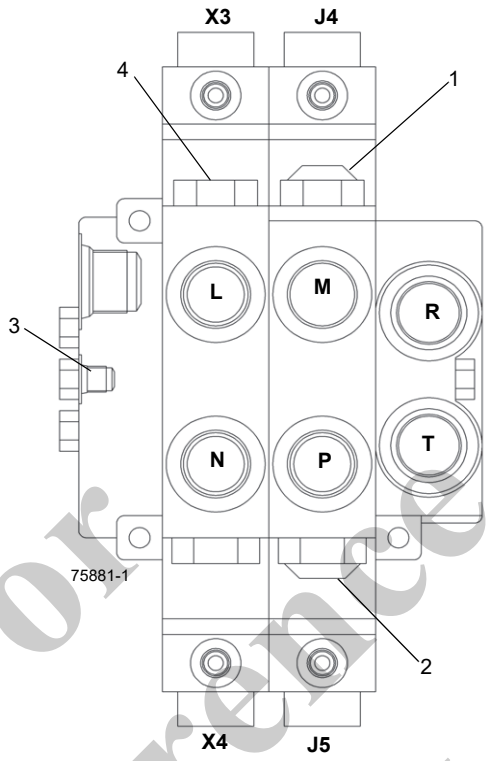


FIGURE 2-4

Swing Control Valve Item List & Port/Hosing

Item	Description	Item	Description	Item/Port	Description
1	Swing Relief Valve - Swing Motor	J5	HRC - Swing 1 (R)	N	Hose - A/C Pressure
2	Swing Relief Valve - Swing	X3	Hose - Return to Tank	P	Hose - Swing Motor
3	Load Sense Port - Swing Motor	X4	Hose - Pilot Manifold A3	R	Outlet - Swivel 4A
4	A/C Relief Valve	L	Hose - A/C Return	T	Inlet - Swivel 3A
J4	HRC - Swing 2 (L)	M	Hose - Swing Motor		

RELIEF VALVE PRESSURE SETTING PROCEDURES

Description

The valves in the hydraulic system must be properly adjusted to protect a component, circuit, or system from overpressurization (relief valves) and ensure the components receive the appropriate pressure and flow.

Maintenance

Relief valves are checked and adjusted by causing a given circuit to reach its prescribed pressure limit (stall). At this point the relief valve opens, returning hydraulic oil to the reservoir. Hydraulic motor circuits can be stalled by preventing rotation of the motor shaft prior to actuating the control valve. Cylinder circuits can be stalled by extending or retracting a cylinder to its limit of travel.

Correct relief valve adjustment is mandatory for proper functioning of a hydraulic circuit. Only qualified technicians using the correct equipment should make pressure adjustments when pressure adjustments are needed.

NOTE: Use an accurate 0 to 345 bar (0 to 5,000 psi) pressure gauge when adjusting relief valves. To adjust a relief valve, turn the adjustment screw (in to increase or out to decrease) until the proper setting is reached.

Release the control lever after taking each reading and while making adjustments. When the proper pressure setting has been attained, tighten the adjustment screw lock nut and recheck the pressure.

It is only necessary to hold hydraulic pressure long enough (usually a few seconds) to gain an accurate reading. Do not overload the hydraulic circuits for long periods of time.

Reservoir oil temperature must be 60°C to 71°C (140°F to 160°F).

CAUTION

Do not overtighten the adjustment screw or lock nut.

Do not hold the relief valve open for more than one minute at a time.

Preparation

- Run the engine until the hydraulic oil temperature reaches a minimum of 49°C to 60°C (120°F to 140°F)
- Shut down the engine

⚠ DANGER

Do not attempt to loosen the fittings in pressurized lines or while the hydraulic pumps are in operation, or personnel injury could result.

Relief Valve Pressure Settings

Valve To Be Set	Pressure Setting	Tolerance	Valve Adjustment Location
Telescope Retract Relief (with aerial lift)	112 bar (1,625 psi)	±7 bar (100 psi)	Main Directional Valve
Telescope Retract Relief (without aerial lift)	155 bar (2,250 psi)	±7 bar (100 psi)	Main Directional Valve
Telescope Extend Relief (with aerial lift)	131 bar (1,900 psi)	±7 bar (100 psi)	Main Directional Valve
Telescope Extend Relief (without aerial lift)	186 bar (2,700 psi)	±7 bar (100 psi)	Main Directional Valve
Pilot Pressure	25.8 bar (375 psi)	±4 bar (50 psi)	Main Directional valve
Outrigger Relief (Flow Control Valve)	207 bar (3,000 psi)	±7 bar (100 psi)	Front Outrigger Box
Boom Up Relief (with aerial lift)	195 bar (2,830 psi)	±7 bar (100 psi)	Main Directional Valve
Boom Up Relief (without aerial lift)	310 bar (4,500 psi)	±7 bar (100 psi)	Main Directional Valve
Boom Down Relief (with or without aerial lift)	76 bar (1,100 psi)	±7 bar (100 psi)	Main Directional Valve
Main/Aux Hoist Raise and Lower	333 bar (4,825 psi)	±2 bar (25 psi)	Main Directional Valve
Air Conditioning Relief	259 bar (3,750 psi)	±7 bar (100 psi)	Main Directional Valve
Swing Valve Relief (CW/CCW)	207 bar (3,000 psi)	±14 bar (200 psi)	Swing Control Valve
Hoist and Auxiliary Hoist Lower Relief	333 bar (4,825 psi)	±2 bar (25 psi)	Main Directional Valve
Front Stabilizer Extend (if equipped)	34 bar (500 psi)	±7 bar (100 psi)	Front Stabilizer
Front Stabilizer Retract (if equipped)	121 bar (1,750 psi)	±7 bar (100 psi)	Front Stabilizer
Tool Circuit Pressure	124 bar (1,800 psi)	±4 bar (50 psi)	Tool Circuit Valve

System Pressure Check

Hoist Up and Hoist Down

See Figure 2-5 for the following procedure.

1. With the engine off, install a pressure check diagnostic quick disconnect (Parker PD240) with gauge onto the test nipple at the GP gauge port of the directional control valve (DCV).
2. Disconnect the two work port tubes (1) at the bulkhead connectors (2) and cap the bulkhead connectors.
3. Start the engine and run at idle. Feather into the hoist raise function until full stroke is achieved and hold in place. Slowly accelerate the engine to full RPM. The reading at GP should be 333 ±2 bar (4,825 ±25 psi). If the pressure is not within specification, adjust the LS relief in to increase pressure or out to decrease pressure until the reading is achieved.
4. Start engine and run at idle. Feather into the hoist lower function until full stroke is achieved and hold in place. Slowly accelerate the engine to full rpm. The reading at GP should be 333 ±2 bar (4,825 ±25 psi). If the pressure is not within specification, adjust the LS relief in to increase pressure or out to decrease pressure until the reading is achieved.
5. Shut down the engine and remove the diagnostic couplers.
6. Remove the caps from the bulkhead connectors and connect the workport tubes to the bulkhead connectors.

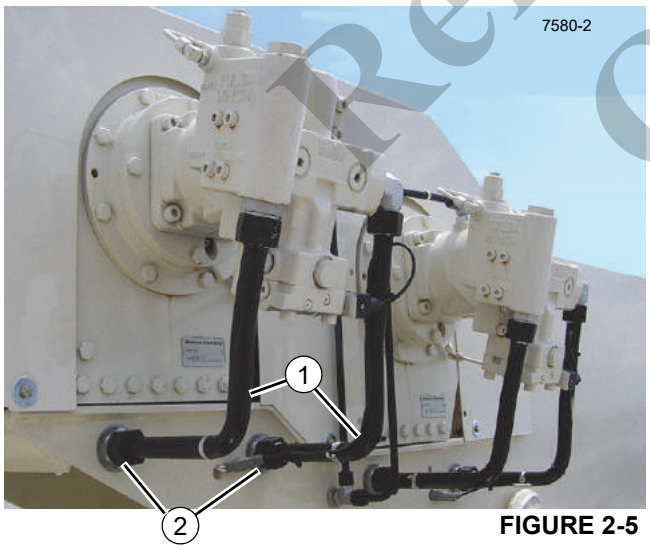


FIGURE 2-5

Boom Lift Up and Boom Lift Down

See Figure 2-3 for the following procedure.

1. With the engine off, install a pressure check diagnostic quick disconnect (Parker PD240) with gauge onto the test nipple at the GP gauge port of the DCV.

NOTE: If the lift cylinder is not attached, make sure the cylinder hoses are capped.

2. Start the engine and run at idle. To check the lift down, feather into the lift down function until full cylinder stroke is achieved and hold in place. Slowly accelerate the engine to full rpm. The reading at GP should be 76 ±7 bar (1,100 ±100 psi). If the pressure is not within specification, adjust the lift down relief in to increase pressure or out to decrease pressure until the reading is achieved.

NOTE: If the machine is not equipped with the aerial lift option, skip step 3.

3. Start the engine and run at idle. To check the lift up with the areal lift option, feather into the lift up function until full cylinder stroke is achieved and hold in place. Slowly accelerate the engine to full rpm. The reading at GP should be 195 ±7 bar (2,830 ±100 psi). If the pressure is not within specification, adjust the lift down relief in to increase pressure or out to decrease pressure until the reading is achieved.
4. Start the engine and run at idle. To check the lift up, feather into the lift up function until full cylinder stroke is achieved and hold in place. Slowly accelerate the engine to full rpm. The reading at GP should be 310±7 bar (4,500 ±100 psi). If the pressure is not within specification, adjust the lift down relief in to increase pressure or out to decrease pressure until the reading is achieved.
5. Shut down the engine and remove the diagnostic couplers.

Telescope In and Telescope Out

See Figure 2-3 for the following procedure.

NOTE: The telescope cylinder hoses can be disconnected and capped for this procedure.

If the aerial lift option is not installed, skip steps 2 and 4.

1. With the engine off, install a pressure check diagnostic quick disconnect (Parker PD240) with gauge onto the test nipple at the GP gauge port of the directional control valve (DCV).
2. Start the engine and run at idle. For cranes equipped with the aerial lift option, select number 2 from the RCL setup screen. Feather into the tele. extend function until full cylinder stroke is achieved and hold in place. Slowly accelerate the engine to full rpm. The reading at GP should be 131 ±7 bar (1,900 ±100 psi). If the pressure is not within specification, adjust the tele. extend two-stage relief in to increase pressure or out to decrease pressure until the reading is achieved.
3. Start the engine and run at idle. For standard crane, select number 1 from the RCL setup screen. Feather into the tele. extend function until full cylinder stroke is achieved and hold in place. Slowly accelerate the engine to full rpm. The reading at GP should be 186 ±7 bar (2,700 ±100 psi). If the pressure is not within specification, adjust the tele. extend two-stage relief in to increase pressure or out to decrease pressure until the reading is achieved.
4. Start the engine and run at idle. For cranes equipped with aerial lift option, select number 2 from the RCL setup screen. Feather into the tele. retract function until full cylinder stroke is achieved and hold in place. Slowly accelerate the engine to full rpm. The reading at GP should be 112 ±7 bar (1,625 ±100 psi). If the relief pressure is not within specification, adjust the tele. extend two-stage relief in to increase pressure or out to decrease pressure until the reading is achieved.
5. Start the engine and run at idle. For standard crane, select number 1 from the RCL setup screen. Feather into the tele. retract function until full cylinder stroke is achieved and hold in place. Slowly accelerate the engine to full rpm. The reading at GP should be 155 ±7 bar (2,250 ±100 psi). If the relief pressure is not within specification, adjust the tele. extend two-stage relief in to increase pressure or out to decrease pressure until the reading is achieved.
6. Shut down the engine and remove the diagnostic couplers.
7. Remove the caps and reconnect the telescope cylinder hoses if they were disconnected.

Outriggers

1. With the engine off, install a pressure check diagnostic quick disconnect (Parker PD240) with gauge onto the test nipple at the GP gauge port of the DCV (see Figure 2-3).
2. Start the engine and run at idle. Press the extend or retract button, then slowly accelerate the engine to full rpm. The reading at GP should be 207 ±7 bar (3,000 ±100 psi). If the relief pressure is not within specification, adjust the outrigger pressure-reducing valve (8, Figure 2-2) in to increase pressure or out to decrease pressure until the reading is achieved.
3. Shut down the engine and remove the diagnostic couplers.

Swing Valve Relief

1. With the engine off, install a pressure check diagnostic quick disconnect (Parker PD240) with gauge onto the test nipple at the GP gauge port of the directional control valve (DCV) (see Figure 2-3).

NOTE: Do not rely on the swing brake to hold the turret in place when checking relief pressures, since the turret may push through the swing brake. Always check pressures by removing and plugging the hydraulic hoses at the swing motor.

2. Remove the hoses from the swing motor, plug both hoses, and cap the swing motor ports.
3. Start the engine and run at idle. Feather into the swing right function until the controller stroke is reached and hold in place. Slowly accelerate the engine to full rpm. The reading at GP should be 207 ±14 bar (3,000 ± 200 psi). If the relief pressure is not within specification, replace the relief valve in the swing/air conditioning valve.
4. Shut down the engine and remove the diagnostic couplers.
5. Replace the swing relief valve(s) in the swing control valve (see Figure 2-4) if the pressure measured is not within specification.

Single Front Outrigger (SFO) (If Equipped)

1. With the engine off, install a pressure check diagnostic quick disconnect (Parker PD240) with gauge onto the test nipple at the GP gauge port of the directional control valve (DCV) (see Figure 2-2).
2. Start the engine and run at idle. Extend the center front stabilizer to the ground and hold the switch in the extend position. Slowly accelerate the engine to full rpm. The reading at GP should be 34 ±7 bar (500 ±100 psi). If the relief pressure is not within specification, replace the relief valve in the SFO valve.

3. Start the engine and run at idle. Retract the SFO until the cylinder is at the end of its stroke and hold the switch in the retract position. Slowly accelerate the engine to full rpm. The reading at GP should be 121 ±7 bar (1,750 ±100 psi). If the relief pressure is not within specification, replace the relief valve in the front stabilizer valve.
4. Shut down the engine and remove the diagnostic couplers.

Hydraulic Reservoir and Filter

See Figure 2-6 for the following procedure.

The hydraulic reservoir (2) is attached to the top of the truck frame on a standard length torsion box or to the top of the torsion box for an extended length torsion box. The all-steel reservoir has an internally mounted full flow hydraulic oil filter and integral baffles that help cool the hydraulic oil and prevent foaming.

Hydraulic oil flows through the suction line at the bottom of the reservoir to the hydraulic pump. Most of the return flow goes through the filter head (5) at the top of the reservoir. The return lines that go directly into the reservoir (instead of through the filter) are the swivel port 1 drain lines from the superstructure, pump case drain, and outrigger return lines.

A magnetized drain plug (11) in the bottom of the reservoir collects metal particles from the hydraulic oil.

A hydraulic oil level gauge (17) is located on the side of the reservoir to indicate hydraulic oil level.

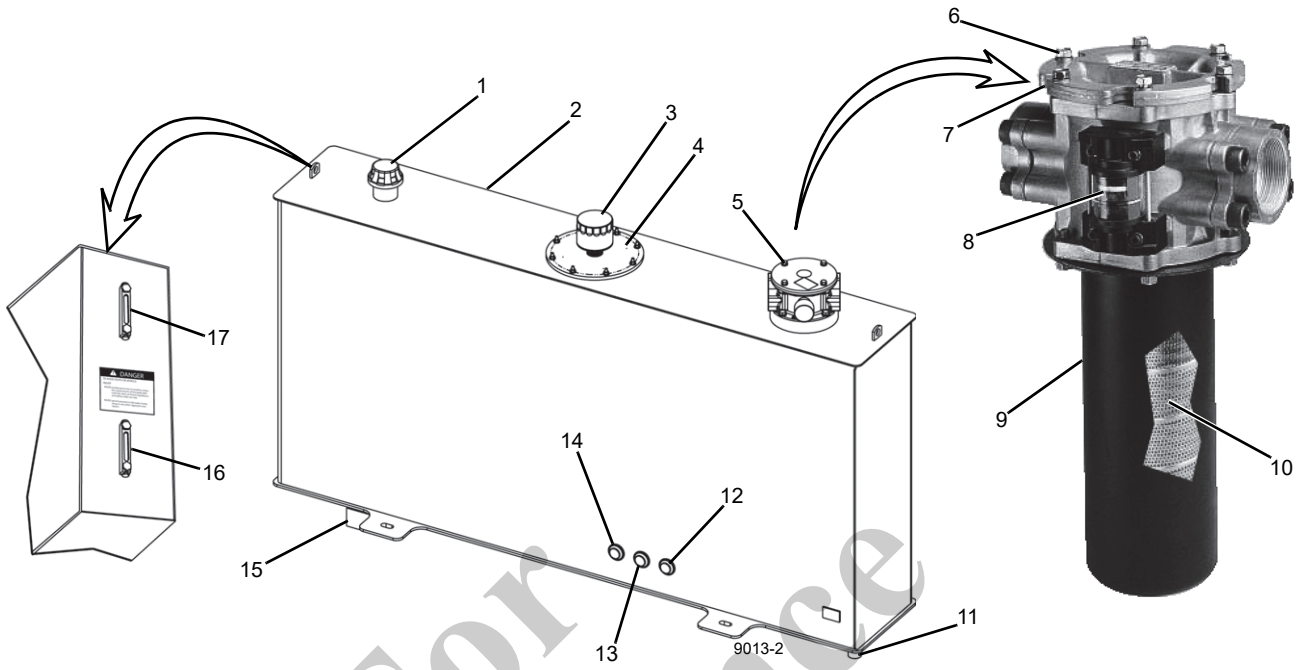
A filler cap on the top left of the reservoir is used when filling the reservoir. The filler cap (7) includes a strainer to catch contaminants and gaskets to prevent leaking.

A breather (3) located in the top center of the hydraulic reservoir allows air to enter or leave the reservoir. The breather must be kept clean to prevent damage to the reservoir.

A large access cover (4) on the top of the reservoir provides access for cleaning. The cover is secured to the top of the reservoir with capscrews and has a gasket to prevent leaking. The access hole can also be used to fill the reservoir after it has been completely drained.

The hydraulic oil filter is located in the reservoir and bolts to the top of the reservoir. The filter housing contains a replaceable filter element (10).

A filter element gauge on the filter head indicates how restricted (clogged) the filter element is. When backpressure caused by a dirty filter element exceeds 103 kPa (15 psi), the filter head's bypass feature allows the hydraulic oil to bypass the filter and flow into the reservoir.



Item	Component
1	Fill Cap
2	Hydraulic Reservoir
3	Breather
4	Access Cover
5	Filter Head
6	Capscrew (qty 6)
7	Filter Cap
8	Filter Element Gauge
9	Filter Bowl

Item	Component
10	Filter Element
11	Magnetized Drain Plug
12	Outrigger Drain
13	Swivel Drain
14	Pump Case Drain
15	Suction to Pump
16	Temperature Gauge
17	Hydraulic Oil Level Gauge

FIGURE 2-6

Hydraulic Filter Replacement

See Figure Figure 2-6 for following steps.

The filter is mounted in the oil reservoir, and is a replaceable element type.

The filter must be serviced with National Crane replacement elements at recommended intervals to ensure the warranty remains in effect.

Element Removal

DANGER

Ensure that the hydraulic system is shut down and the pressure is relieved.

1. Shut down the engine.
2. Remove any dirt from the filter head (5) assembly.
3. Loosen the six capscrews (6) securing the filter cap (7) to the filter head.
4. Twist to unlock and remove the filter cap.
5. Remove the filter element (10) from the filter bowl (9).
6. Ensure the new filter element is correct by comparing their part numbers with the part numbers of the used filter element.
7. Discard the used filter element.

Element Installation

1. Install the new element into the filter bowl (9).
2. Install the filter cap (7) and twist to lock in place.
3. Tighten the six capscrews (6) to secure the filter cap.
4. Activate the hydraulic system and check for leaks. Make repairs as needed.

Hydraulic Oil Cooler

The hydraulic oil cooler (4, Figure 2-7) is located on the boom rest (7). The hydraulic oil cooler return circuit is parallel with the reservoir return circuit (6). The hydraulic oil cooler inlet (2) and return/out (3) circuits run through the bypass block (5) on top of the hydraulic reservoir (1). A 206 kPa (30 psi) check valve in the bypass block regulates flow through the oil cooler. When the hydraulic oil is cold, most of the return oil goes directly to the tank. As the oil warms up and becomes thinner, more oil goes through the cooler.

NOTE: A temperature sensor located in the hydraulic swivel (port 4B) monitors the temperature of the hydraulic oil and illuminates a light on the crane cab console when the temperature reaches 82°C (180°F).

The hydraulic oil cooler fan (9) is controlled by the oil cooler relay (See “VEC Module” on page 3-9) in the vehicle electrical center (VEC) module (10). To access the relay, remove the access panel on the side of the housing. A temperature switch located in the cooling core energizes the fan relay when the hydraulic oil temperature reaches 49°C (120°F). The switch is connected to the hydraulic oil cooler harness (8) at the temperature sensor port.

NOTE: If the temperature sensor in the cooling core fails, the fan runs continuously even when the crane ignition is off.

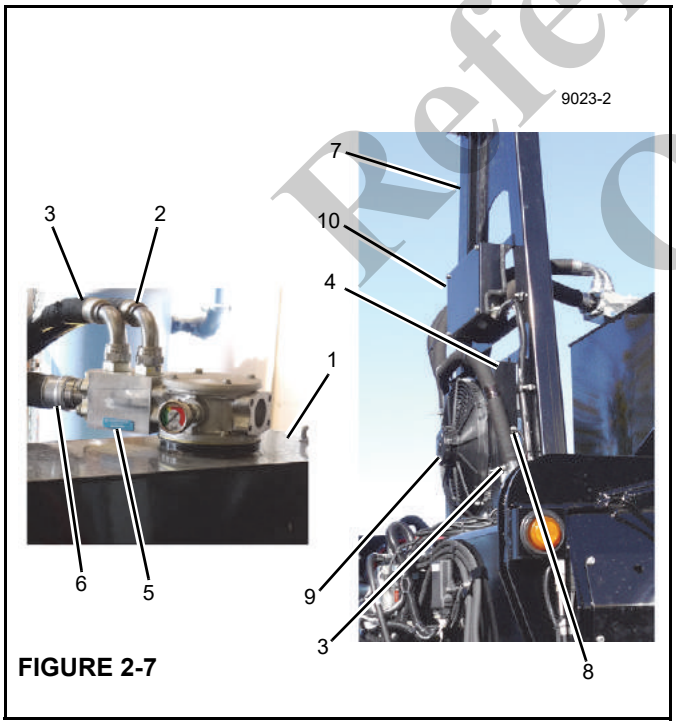


FIGURE 2-7

Item	Component
1	Hydraulic Reservoir
2	Hydraulic Oil Cooler Inlet
3	Hydraulic Oil Cooler Return
4	Hydraulic Oil Cooler
5	Bypass Block
6	Reservoir Return Circuit
7	Boom Rest
8	Hydraulic Oil Cooler Harness
9	Hydraulic Oil Cooler Fan
10	VEC Module

Hydraulic Oil Cooler Service & Maintenance

The hydraulic oil cooler must be kept clean to allow for efficient operation of the cooling system. Frequent washing of the heat exchanger core eliminates 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 eliminates the possibility of end connection failure due to backpressure from cold startup.

If the hydraulic cooling system fails to provide adequate performance, reduced air or oil flow through the heat exchanger is the probable cause. Inspect the cooling fan for proper operation. Any obstructions to air flow need to 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 Valves

Inspection

Inspect the directional valve for visible damage, binding spools, and evidence of leakage. If excessive internal leakage is suspected during operation with a spool in its center position, it is possible that the area between the spool and working section bore of the valve body is worn beyond serviceable limits. If this condition exists, the spool and body must be replaced as an assembly.

Valve Leakage

Dripping hydraulic oil indicates some type of external leakage. The machine should be removed from service for immediate repairs. External leaks sometimes develop at fittings and seals. Spool seals are susceptible since they are subject to wear. Seals may be damaged by temperatures that are too high, or by dirt or paint accumulation on the spool. Damaged seals must be replaced.

A component functioning at reduced efficiency may indicate that the control valve for that component is leaking internally. If preliminary check-out reveals that adequate volume is being supplied to the affected valve bank, relief valves are properly adjusted, and the component is not at fault, check the valve for scored or worn parts. Scoring is usually a sign of contamination (external contamination by dust or internal contamination by debris from deteriorating components or oxidized hydraulic oil). Scored or severely worn valve components must be replaced.

Check valves in the control valve are designed to permit a flow of hydraulic oil in one direction only. If a piece of dirt or rust has worked its way into the check valve and lodges between the poppet and seat, it will keep the valve open and allow a return flow of hydraulic oil. Clean the valve and ensure that the hydraulic system filter is still serviceable.

Binding Spools

Some of the most common causes for stiff spool movement or jammed spool action are system overheating, excessive pressure, contaminated or deteriorated hydraulic oil, or warped mountings. When scorched or deteriorated hydraulic oil or contamination is the cause, flush the system and replenish with clean hydraulic oil. If the spool bores are badly scored or galled, the valve must be removed for servicing.

Warping occurs when mounting plates are not level or become distorted from machine damage. The valve can be shimmed level to correct this problem.

Check the valve for rust. Rust or dirt collecting on the valves can prevent free movement of the spool and keep it from the true center position. Excessive system pressure can create both internal and external leaks in valves that are otherwise sound. Only qualified technicians using the correct equipment should make pressure adjustments when pressure adjustments are needed.

Directional Control Valve (DCV)

Removal

1. Tag and disconnect the hydraulic lines from the directional control valve (DCV).
2. Cap the lines and plug the ports.
3. Loosen and remove the valve mounting bolts and remove the DCV.

Installation

1. Install the DCV to the enclosure.
2. Reinstall the hydraulic lines to the main directional valve as tagged during removal.

Functional Check

1. Start the engine and run it at normal speed.
2. Operate the control levers of the DCV. Check for smooth operation of cylinders and motors.
3. Check the DCV and lines for leakage. Make repairs as needed.

Hydraulic Remote Controllers

The crane functions are controlled by hydraulic remote controllers (HRC) on the armrest of the operator's seat. The controllers operate from pilot pressure, which is generated by the directional control valve. Pilot pressure is applied to a corresponding bonnet in the DCV assembly. When pressure is applied to the bonnet, pilot pressure shifts the valve spool in the requested direction.

Outrigger Manifolds

The outrigger functions are controlled by two manifolds located at the front and rear outrigger boxes. The front manifold contains the extend/retract valve, front outrigger component valves, and optional single front outrigger (SFO) valve. The rear outrigger manifold contains the rear outrigger component valves. The valves are operated by solenoids that are controlled by switches on the outrigger control panels located on the side of the decking. A hand-held outrigger control box is installed in the crane cab.

Holding Valves

Pilot-operated check valves located in the valve block on each cylinder act as holding valves to keep the cylinder from collapse due to hose failure. Do not remove a valve block unless the cylinder is completely retracted. Do not try to repair or set the valve pressure. If a holding valve is suspect, replace it with a new valve.

Swing Gearbox

The standard Glide Swing gearbox is locked in place by an integrally mounted spring-applied disc brake. The swing brake switch is located on the operator seat at the left armrest and is used to activate the swing brake and park the turret in position. Press the switch to activate the swing brake to keep the turret from rotating. A red LED illuminates on the front console of the operator cab when the swing brake switch is applied.

The swing control lever can be used to slow and stop the swing by moving the control lever to the opposite direction of the swing. For example, if the lever is pushed forward for a clockwise swing, pull the lever back to slow and stop the swing.

Crane Function Power Switch

The crane function power switch in the crane cab energizes a solenoid valve on the pilot manifold located in the turret to activate the controllers in the crane cab. The operator must be in the operator's seat with the left armrest lowered for the crane function power switch to be active.

HYDRAULIC PUMP

Description

Hydraulic system pressure is supplied by an axial piston hydraulic pump mounted to the truck power take-off (PTO) or truck chassis.

Removal

If hydraulic 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 hydraulic pump. Cap the lines and plug the ports.
3. Remove the capscrews from the pump rear mounting bracket.
4. Remove the capscrews 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 with the pump drive shaft and slide the pump drive shaft into the coupling.
3. Bolt the pump (1, Figure 2-8) to the PTO with the pump mounting flange.
4. Bolt the pump rear mounting bracket to the truck mounting bracket.

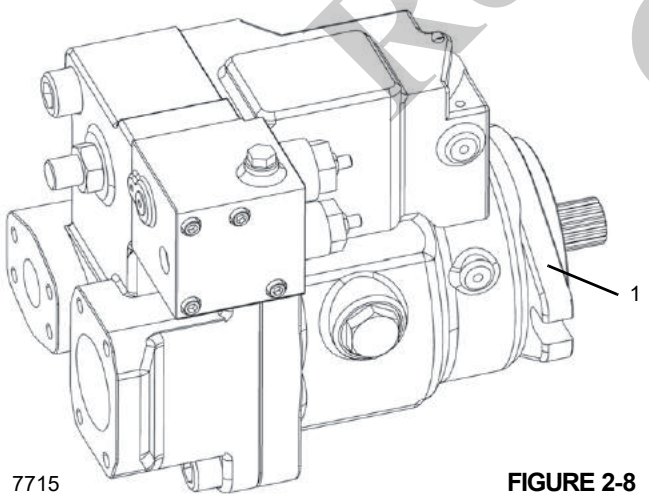


FIGURE 2-8

5. Reconnect the hydraulic lines as noted during removal.
6. See “Pump Startup” on page 2-22 before starting the engine.

Pump Startup

If the hydraulic pump is removed for maintenance or replacement, the following startup procedure should be followed to prevent damage to the hydraulic pump or other components in the hydraulic system.

1. Install the hydraulic pump to the PTO, following the procedures described in the installation section. See *Installation*, page 2-22.
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 hydraulic oil supply shut-off valve at the bottom of the hydraulic reservoir.
4. Pour hydraulic oil into the upper case drain port to fill the hydraulic pump housing with hydraulic oil.
5. Fill the supply line from the pump to the reservoir with hydraulic oil. Check the line for properly tightened fittings, and ensure it is free of restrictions and air leaks.
6. Inspect the case drain line for leaks and restrictions.
7. With the engine off, install a pressure check diagnostic quick disconnect (Parker PD240) with gauge onto the test nipple at the GP gauge port of the directional control valve (DCV) (see Figure 2-3).
8. Start the engine and run at idle. Engage the PTO while observing the pressure gauge. The hydraulic system pressure at idle must be within 51 to 55 bar (750 to 800 psi). If the system pressure does not rise, shut down the engine and take corrective action.
9. If the system pressure is within startup specification, run the engine at idle for 2 to 3 minutes.
10. Operate the system under a light load for 5 to 10 minutes.
11. Check/adjust pump margin pressure; see *Pump Margin Pressure Setting*, page 2-23.
12. Check/adjust maximum pump pressure; see *Maximum Pump Pressure Setting*, page 2-23.
13. Remove pressure gauge. Check the hydraulic oil level in the reservoir and fill if needed.

Table 2-3. Pressure Settings

Pump Margin Pressure	Maximum Pump Pressure	Load Sense Relief Valve Pressure
26 ±4 bar (375 ±50 psi)	345-0+4 bar (5,000 -0+50 psi)	288 ±7 bar (4,175 ±100 psi)

Pump Margin Pressure Setting

1. With the engine off, install a pressure check diagnostic quick disconnect (Parker PD240) with gauge onto the test nipple at the GP gauge port (2) of the directional control valve (DCV) (1). See Figure 2-9.

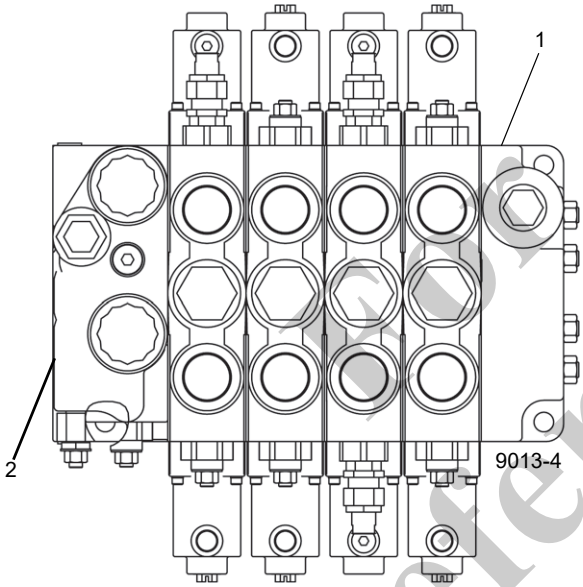


FIGURE 2-9

2. Start the engine and run at idle. Engage the power take-off (PTO). Do not operate any functions.
3. Verify margin pressure is 26 ±4 bar (375 ±50 psi).

   If margin pressure is not correct, adjust the load sense (LS) adjusting screw (2, Figure 2-10) at the pump. Turn the screw clockwise to increase the setting. Each turn gains 19 bar (275 psi). Tighten the lock nut to 16.2 Nm (12 lb-ft) to secure the setting.

Maximum Pump Pressure Setting

With the engine off, install a pressure check diagnostic quick disconnect (Parker PD240) with gauge onto the test nipple at the GP gauge port of the directional control valve (DCV) (see Figure 2-9).

Crane Preparation

1. Start the engine and run at idle. Engage the power take-off (PTO).
2. Raise the boom to its maximum elevation or cap both boom hoses. Activate the boom up to increase the pump pressure to the maximum setting.

Adjust Maximum Pressure

1. Verify the maximum pump pressure is at the correct settings (see Table 2-3).
2. If the maximum pressure is incorrect, adjust the pressure-compensating (PC) adjusting screw.
3. Loosen the lock nut and turn the PC adjustment screw (1, Figure 2-10) clockwise to increase the setting. Each turn gains 100 bar (1,450 psi). Tighten the lock nut to 16.2 Nm (12 lb-ft) to secure setting.
4. Reset the LSRV setting (see Load Sense Relief Valve Pressure Setting).

Load Sense Relief Valve Pressure Setting

NOTE: Perform this procedure after setting the pump's maximum pressure setting or checking the load sense relief valve (LSRV) setting.

Method 1

Leave the main hoist up/down hoses connected to the motor. Remove and cap the main hoist brake line at the hoist down block on the hoist. Activate the hoist down function to develop pressure.

Method 2

Disconnect and cap and plug the main hoist up/down hoses. Activate the hoist up and down function to develop pressure.

Set the LSRV Pressure

1. Start the engine and run at idle. Engage the PTO.
2. Use method 1 or 2 and hold the joystick controller. Verify the LSRV pressure is at the correct setting (see Table 2-3).
3. If the LSRV pressure is not correct, adjust the LSRV adjusting screw. Loosen the lock nut and adjust the setting. Turn the PC adjustment screw (1, Figure 2-10) clockwise to increase the setting. Each turn gains 59 bar (850 psi). Tighten the lock nut to 5.4 Nm (4 lb-ft) to secure the setting.

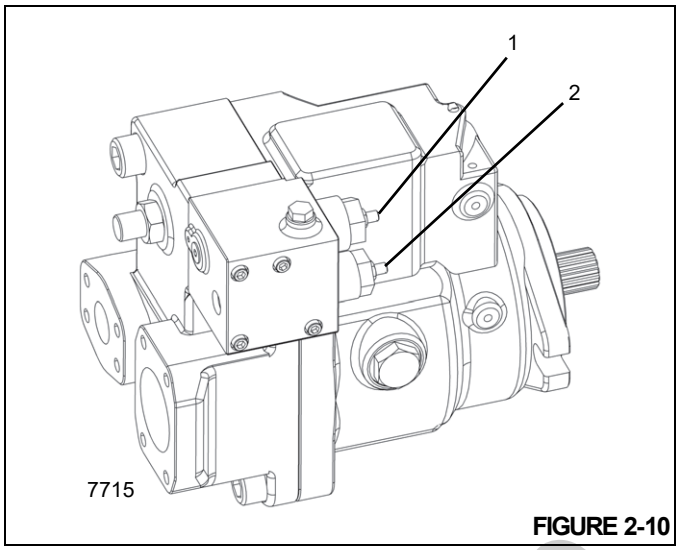


FIGURE 2-10

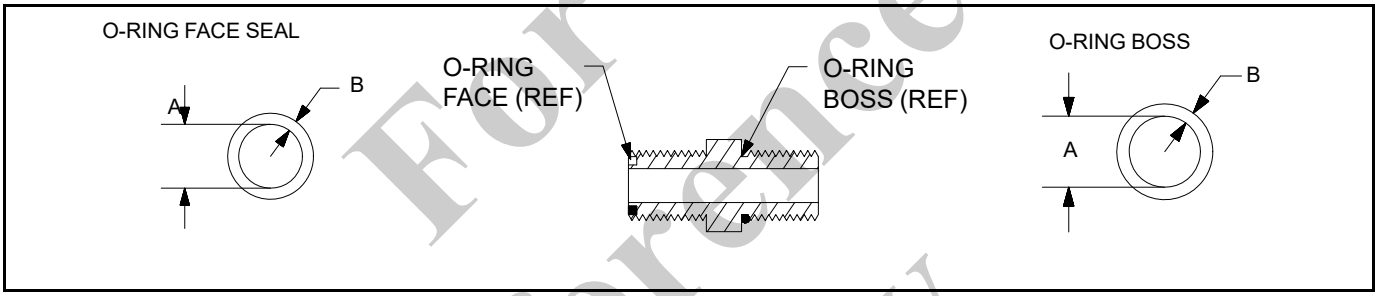


Table 2-4

O-RING FACE SEAL			FITTING SIZE		O-RING BOSS		
THREAD SIZE	B inches (mm)	A inches (mm)	TUBE O. D.	MFGR'S SIZE CODE	A inches (mm)	B inches (mm)	THREAD SIZE
9/16-18	0.07 (1.78)	0.301 (7.64)	0.250	4	0.351 (8.92)	0.072 (1.83)	7/16-20
11/16-16	0.07 (1.78)	0.364 (9.24)	0.375	6	0.458 (11.63)	0.078 (1.98)	9/16-18
13/16-16	0.07 (1.78)	0.489 (12.42)	0.500	8	0.644 (16.36)	0.087 (2.21)	3/4-16
1-14	0.07 (1.78)	0.614 (15.60)	0.625	10	0.755 (19.18)	0.097 (2.46)	7/8-14
1 3/16-12	0.07 (1.78)	0.739 (18.77)	0.750	12	0.924 (23.47)	0.116 (2.95)	1 1/16-12
1 7/16-12	0.07 (1.78)	0.926 (23.52)	1.000	16	1.171 (29.74)	0.116 (2.95)	1 5/16-12
1 11/16-12	0.07 (1.78)	1.176 (29.87)	1.250	20	1.475 (37.46)	0.118 (3.00)	1 5/8-12
2-12	0.07 (1.78)	1.489 (37.82)	1.500	24	1.720 (43.69)	0.118 (3.00)	1 7/8-12
NOTE: Contact your National Crane distributor or Manitowoc Crane Care for O-ring boss seal kits.							

TROUBLESHOOTING

The following chart lists malfunctions which may occur during equipment operation, the possible cause, and the possible solution. These are not all inclusive but are designed to help isolate the problem and should be checked before calling Manitowoc Crane Care.

Table 2-5. Troubleshooting

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
No hydraulic oil flows in any system.	Low hydraulic oil level	Fill reservoir.
	Reservoir-to-pump suction lines broken or restricted. Air entering at suction lines. Pump not priming.	Check that all connections are tight and there are no cracks. Clean, tighten, repair, or replace parts as necessary.
	Pump shaft sheared or disengaged	If drive shaft is damaged or sheared, remove and repair or replace as necessary
	Internal contamination	Drain, flush with recommended oil mixture, then drain and refill system with recommended hydraulic oil.
System is slow to respond.	Low hydraulic oil level.	Fill reservoir.
	Hydraulic oil temperature too high (thin oil) or too low (thick oil).	If the temperature is too high, check the cooler circuit. If the temperature is too low, warm up system.
	Faulty pump.	Repair or replace pump.
Pump noise accompanied by hydraulic oil foaming in reservoir.	Low hydraulic oil level.	Fill reservoir.
	Excessive engine speed.	Regulate engine speed.
	Air entering at suction line.	Check that all line connections are tight. Tighten, repair, or replace as needed.
Excessive pressure buildup.	Circuit relief valve malfunction or set too high.	Pressure check circuit relief and adjust or replace relief valve.
	Restricted pump-to-control valve supply line.	Clean, repair, or replace line as necessary.
Specific hydraulic system (lift, hoist, telescope, swing) not working.	Leak in system.	Repair leak.
	Faulty directional control valve (DCV)	Replace valve.
	Troubleshoot circuit with schematic.	Poorly adjusted control in circuit. Adjust hydraulic component.
	Faulty hydraulic cylinder, motor, or valve.	Replace faulty component.
No response to control.	Crane function power switch off.	Turn crane function power switch on.
	Load too heavy.	Check Capacity Chart.
	RCL inoperative.	Ensure RCL is programmed properly and anti-two block/overload solenoids are powered.
	Power take-off (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.
	Hydraulic controllers inoperative.	Check for pilot pressure at main valve bonnets.
	Mesh screen in crane manifold clogged (pilot circuit).	Remove and clean or replace screen.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
Poor hydraulic system performance.	Pump not operating at proper speed or displacement.	Check PTO ratio, pump size, and engine speed for proper oil flow.
	Low hydraulic fluid supply.	Check and fill as required.
	Relief valve sticking.	Remove and clean.
	Relief setting too low.	Readjust to proper setting.
	Worn pump, motor, or cylinder.	Replace worn components.
	Plugged filter.	Change filter.
Poor hydraulic system performance (continued).	Valve spools not fully open.	Pilot pressure at valve bonnets should be 7 to 24 bar (100 to 350 psi) 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.
Swing moves erratic or loosely (Glide Swing system).	Loose swing bearing.	Tighten bearing mounting capscrews.
	Loose swing gearbox mounting capscrews.	Tighten capscrews.
	Worn gears or bearing.	Replace worn parts or adjust gearbox spacing.
	Operator control of lever too erratic.	Operate controls smoothly.
	Park brake not releasing.	Check pressure in brake release line. Must be 21 to 34 bar (300 to 500 psi).
	Dynamic brake not properly applying.	Check dynamic brake pressure. Must modulate between 0 to 34 bar (0 to 500 psi).
Swing does not function (Glide Swing system).	Attempting to swing up too much of incline.	Level machine.
	Turn circuit relief valves sticking.	Clean and check circuit pressure.
	Swing bearing drag.	Lubricate thoroughly as upper is rotated.
	Swing brake on.	Select swing brake control switch on and check swing brake release pressure at 20 to 34 bar (300 to 500 psi).
	Swing speed adjustment set too low.	Adjust valve on turn motor.
Swing moves erratic or loosely (standard system).	Brake not holding properly.	Check for no pressure in brake pilot line when turn is in neutral.
		Replace worn brake parts or shim brake to proper torque.
	Brake releasing at wrong time or erratically.	Bleed air from brake with bleed screw on side of brake.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
Swing does not function (Standard System).	Attempting to swing up too much of incline.	Level machine.
	Turn circuit relief valves sticking.	Clean and check circuit pressure.
	Swing bearing drag.	Lubricate thoroughly as rotating boom.
	Brake not releasing properly.	Check for a minimum of 14 bar (200 psi) brake pilot pressure. Clean pilot line or adjust motor counterbalance valves.
	Swing speed adjustment set too low.	Adjust or clean brake for proper release.
		Adjust valve on turn motor.
Excessive noise during operation.	Low oil temperature.	Allow unit to warm up.
	Low hydraulic oil supply.	Check and fill with crane in travel position.
	Suction line kinked, collapsed, or blocked.	Clear blockage.
	Hydraulic oil too thick.	Warm oil or use oil more applicable to environment.
	Plugged suction strainers.	Remove from tank and clean.
	Relief valve chattering.	Dirt in relief valve or damaged relief.
	Swing brake dragging.	Bleed air from brake line at fitting on brake housing.
	Hydraulic tubing vibration.	Check for loose tubing.
	Tank breather plugged.	Clean breather.
Cylinders drift.	Worn or damaged piston seals.	Replace as required.
	Air in hydraulic oil.	Cycle operate crane cylinder to remove air.
	Loose holding valve.	Tighten valve.
	Dirt in holding or check valve.	Clean valve.
Hoist will not lift or hold load.	Load too heavy.	Check load and change to Lo-speed/Hi-pull or applicable multipart reeving.
	Hoist or boom overloaded causing RCL shutdown.	Reduce load or reeve hoist properly for shutdown load lifting.
	Relief valve setting too low.	Check and adjust if required.
	Motor worn.	Replace motor.
	Sprag clutch defective.	Clean or replace sprag clutch.
	Load block too close to boom tip, two-block system shut down.	Lower load or retract boom. Check two-block system, repair if defective.
	Brake worn out.	Repair or replace brake.
	Anti-two-block system defective.	Repair anti-two-block system.
Hoist gearbox heats.	Gearbox grease low.	Check and fill as required.
	Duty cycle too high.	Reduce cycle time or speed of engine.
Truck engine will not start from crane cab.	Truck ignition switch on.	Turn truck ignition off.
		Check all other normal motor vehicle systems as outlined by normal practice.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
Boom chatters during extension/retraction or doesn't proportion properly.	Boom sections need lubrication.	Use dry lubricant or replace lube plugs in wear pads.
	Wear pads not shimmed correctly.	Re-shim as described in boom assembly section.
	Boom hot from high extend duty cycle.	Slow duty cycle to cool boom and pads.
	Worn wear pads.	Replace pads.
	Cylinder came out of lock.	Disassemble and reinstall keepers.
	Extension cables out of adjustment.	Readjust cables and tension properly.
	Extend or retract cables broken.	Disassemble and inspect and replace cables.
Boom will not extend.	Cables not attached correctly.	Reconnect, replace, and/or adjust cables.
	Anti-two-block system shut down.	Lower hook, and extend load.
	Defective anti-two-block system.	Check anti-two-block system; repair if defective.
	Overload causing RCL shutdown.	Reduce load or radius until RCL resets and resume operation.
	Insufficient oil flow or pressure to extend cylinder.	Check oil flow, repair if not to specification.
Turn pulsates for a few seconds.	Accelerating swing too rapidly.	Move joystick slowly and smoothly to start and stop swing.
Turn pulsates continuously and is slow.	Low pilot circuit pressure.	Check and adjust pilot pressure to 34 bar (500 psi).
Turn will not start smoothly or increases/decreases speed drastically near full joystick throw.	Improper or defective valve spool springs or burrs on valve spool.	Swing should start to rotate at 7 to 10 bar (100 to 140 psi) and be at full speed at 21 to 24 bar (300 to 350 psi). Check for free movement of spool in valve body, hone spool if required. Replace spool spring pack if necessary.
Turn moves erratically in one quadrant.	Machine out of level or windy conditions.	Level machine. Operate slowly and carefully in the wind.

SECTION 3
ELECTRICAL SYSTEM

SECTION CONTENTS

DESCRIPTION

The truck electrical system is a standard 12-volt DC automotive type and supplies power to all crane functions. The wire harness is routed through the truck frame and contains the wiring interface between the truck and the crane, including the electrical outrigger controls.

Jump Starting Hazard

Do not attempt to jump start the crane.

CAUTION

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

This crane has multiple computer systems (crane control, RCL, engine and transmission control) that are highly susceptible to voltage/amperage surges in the electrical system.

The batteries should be completely disconnected from the crane electrical system and charged using a battery charger of appropriate voltage level or replace the batteries with fully charged batteries. Refer to *Charging the Batteries*, page 3-1.

Charging the Batteries

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

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

MAINTENANCE

General

Electrical system maintenance includes troubleshooting and replacement of damaged components. Observe standard wiring practices when replacing components.

⚠ DANGER

When metal jewelry, rings, or watches come in contact with live circuits, serious burns can result. Remove all metal jewelry, rings, and watches before working on live circuits.

Dielectric Grease

Dielectric grease was applied to the following connections at the factory when the crane was assembled. When servicing electrical connections, dielectric grease must be re-applied to these connections.

- All Deutsch Connectors
- All Valve Solenoid connections on Hydraulic valves and Transmissions
- All Harness Connections
- RCL Module Connections (except M12 and M8 connectors)

Excluded Connections

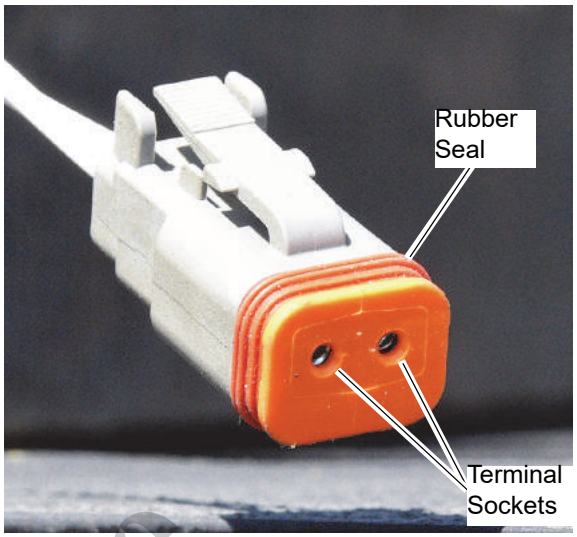
Do not apply dielectric grease to the following connections:

- All Connections Inside the Cab
- M12 and M8 Connectors
- Pin-type Contacts

Applying Dielectric Grease to an Electrical Connector

Use the following procedure to apply dielectric grease to an electrical connection. Grease should be applied immediately prior to securing the connector. Ensure that grease is applied to all terminal sockets (Figure 3-1).

1. Check the connection for moisture before application of the grease. If moisture is found, clean or replace the connector as necessary.
2. Screw a tip or trigger assembly on to the can of dielectric grease if necessary.
3. Apply the grease onto socket (female) contacts.



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Example. For illustration purposes only. Your connector may differ.

FIGURE 3-1

4. Use a clean towel to remove excess grease from the surface of the connector, and wipe grease into the terminal sockets (Figure 3-1).
5. Ensure grease is applied to each terminal socket. The towel with excess grease can be used to fill empty terminal sockets (Figure 3-1).
6. Ensure grease is applied to the entire surface of the connector's rubber seal (Figure 3-1).

NOTE: Do not allow grease to come in contact with any painted surface, or any other components.

7. If clean up is necessary, contact cleaner or petroleum distillates can be used.
8. Secure the connector when complete.

General Troubleshooting

Make voltage checks at terminations when components are installed and operating. Make continuity checks when components are isolated or removed. Troubleshoot per the following guidelines:

1. Use reported symptoms to identify a problem or a suspect component.
2. Use a multimeter to test for circuit continuity if you suspect an open circuit or for voltage if you suspect a power problem. Check the electrical schematic for the most accurate wiring information.
3. Replace faulty components and wiring.
4. Test the repaired circuit and verify that the circuit works properly.

Connector Troubleshooting

The cause of an electrical problem may be a loose or corroded connection in a connector. Check the connectors to ensure that the pins and sockets are properly seated and engaged. If the pins and sockets show any signs of corrosion, use a good quality electrical contact cleaner or fine sandpaper to clean them. When the pins or sockets show signs of arcing or burning, it may be necessary to replace them.

Damaged connectors need to be cut off the wire, and this may make the wire too short for the new connector to make proper contact. The wire needs to have some slack after the connector is put together. Splice a wire of the same size to the cut wire. Use solder to ensure a good connection and shrink tube to insulate the splice. Crimp the new connector on the spliced wire.

Tooling for Troubleshooting

To effectively troubleshoot the outrigger monitoring system (OMS) and A92.2 option (if equipped), you need a Windows-based personal computer, HED service software, CAN-Link service software, and the diagnostic cable. Contact Manitowoc Crane Care for more information.

Manitowoc Crane Care recommends you have as part of your service tool kit inventory the Orchestra (CAN-Link) service tool kit for the NBT40-1. This software will allow you to see in real time the status of all input and output signals on the system and detect any input or output errors. The Orchestra (CAN-Link) service software and hardware are available through Manitowoc Crane Care to those service technicians who have successfully completed the Orchestra level training course.

Troubleshooting the Electrical Swivel

Many crane component electrical troubles can be traced to the electrical swivel. Troubles common to the swivel are improper mounting, foreign material between the brushes and slip rings, worn brushes, improper spring tension on the brush assembly, and loose setscrews on the slip ring assembly. See the electrical schematic and wiring diagram for slip ring connections and amperages.

Ignition Switch

There are two ignition switches on the crane. One is in the truck cab, and the other one is on the crane cab console. Only one ignition switch at a time can be energized.

NOTE: If one ignition switch does not engage the truck starter, check and make sure the other ignition switch is OFF.

When the crane ignition switch at the operator's station is set to RUN and the PTO is engaged, the throttle pedal in the operator's station overrides the truck cab throttle, the RCL system is powered, and the crane functions can be activated. The lower outrigger controls are disabled when the crane function power switch is ON.

RCL SYSTEM DESCRIPTION

The rated capacity limiter (RCL) monitors crane operation and alerts the operator of stability or structural limits based on the load chart. The crane functions that can worsen the condition (hoist up, boom down, and telescope out) are disabled.

The RCL override key switch is located behind the operator's seat (see Figure 3-3). Turn the key switch on to override the RCL. The RCL has unswitched power supplied by the truck battery to allow the RCL to retain system and user settings.

NOTE: Consult the RCL manual in the event of an RCL malfunction.

RCL and A2B System Description

The anti-two-block (A2B) system is part of the RCL system that helps prevent damage to the hoist cable by sensing when the overhaul ball, hook block, or wire rope becket is near the boom tip and disables the functions that cause a two-block condition.

Normal function is restored by hoisting down or retracting the boom until the A2B weight is suspended freely.

WARNING

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

The boom A2B/RCL cable (1, Figure 3-2) runs from the A2B reel (2) through the boom and to the A2B switch assembly

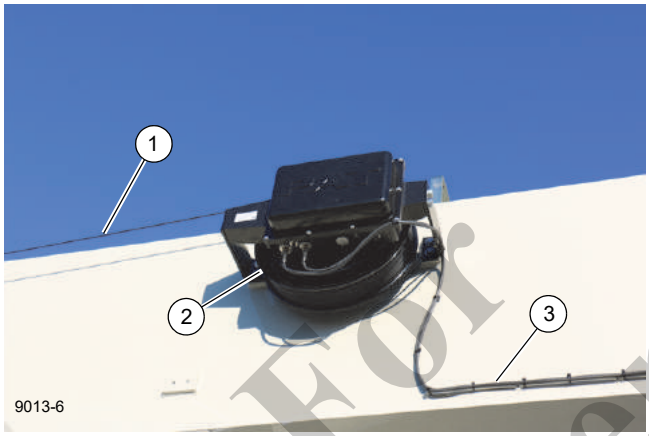
(4). The A2B switch assembly cable is attached to the anti-two-block weight (5).

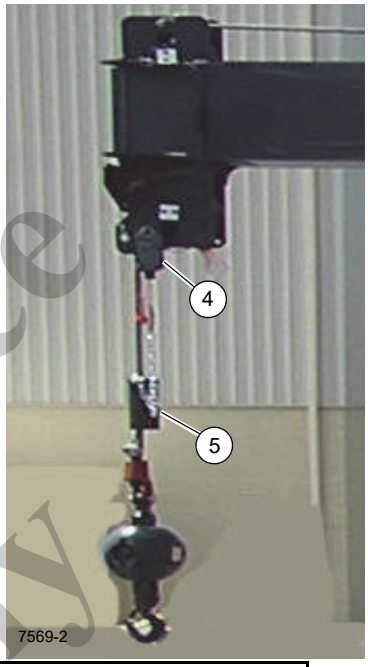
The RCL cable (3, Figure 3-2) runs from the bottom of the reel (2) to the end of the boom, then splits, with one cable (CAN cable) routed to the CAN junction block. A second cable routes from the RCL reel to the superstructure wire harness and transmits signals from the aerial lift foot switch (if equipped).

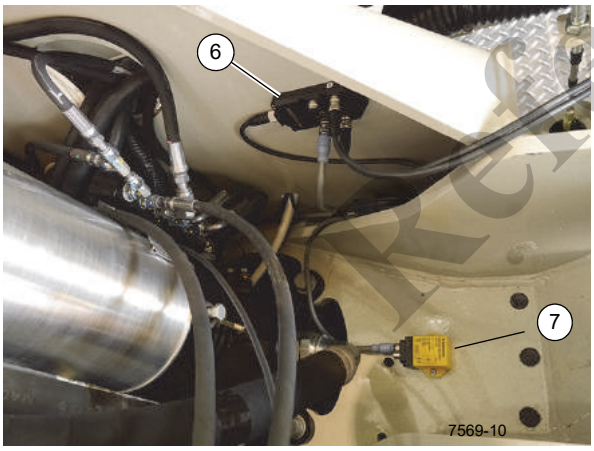
NOTE: The slew encoder is on the CAN cable and internal to the electrical slip ring.

The two lift cylinder pressure transducers are integral to the lift cylinder, and CAN cables are routed from each sensor to the CAN junction block (6) located inside the turret.

To replace the A2B/RCL cable (1) or the entire reel (2), disconnect the cable at the A2B switch (4) and the electrical cable connections at the reel. Then, remove the length cable or the reel for service.







Item	Description
1	A2B/RCL Cable
2	Reel
3	RCL Cable
4	Anti-Two-Block (A2B) Switch
5	Anti-Two-Block (A2B) Weight
6	CAN Junction Block
7	Level Sensor (Aerial Lift option)

FIGURE 3-2

FUSE AND RELAY PANEL

The cab and superstructure fuse and relay panel (1, Figure 3-3) is located behind the operator's seat. Remove the two screws that secure the access panel to gain access to the rear of the fuse blocks, relays, and interface connectors.

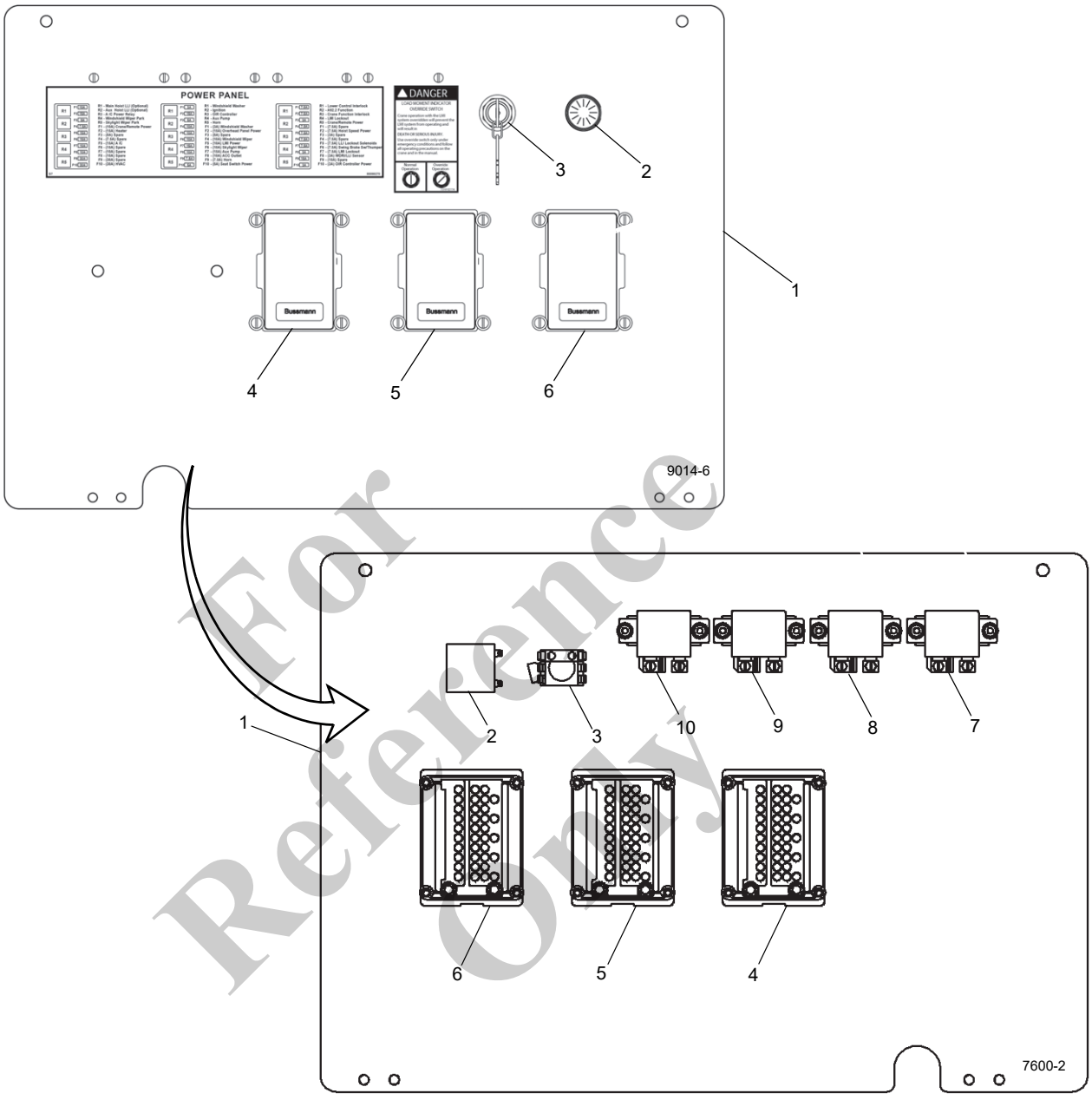


FIGURE 3-3

Item	Component	Item	Component
1	Fuse and Relay Panel	6	Fuse Box #1
2	Buzzer, 3rd wrap indicator	7	ACC Relay
3	RCL Bypass Key Switch	8	Crane Relay
4	Fuse Box #3	9	Remotes Relay
5	Fuse Box #2	10	HVAC Relay

Micro Relay Fuse Box 1

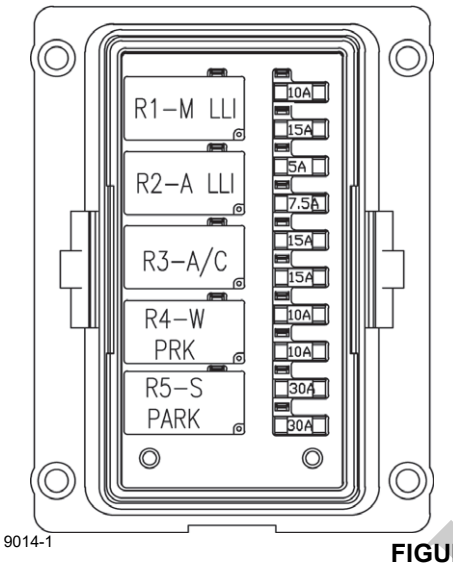


FIGURE 3-4

Micro Relay Fuse Box 2

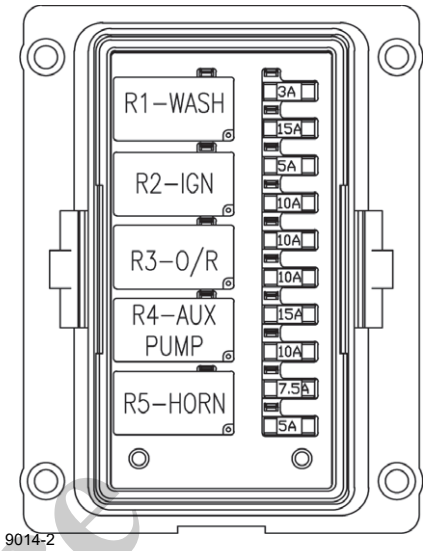


FIGURE 3-5

Micro Relay Fuse Box 1

Micro relay fuse block 1 (6, Figure 3-3) is located on the left side of the fuse relay panel and contains the following components. See Figure 3-4.

- R1 - Auxiliary Hoist 3rd Wrap Indicator (Optional)
- R2 - Main Hoist 3rd Wrap Indicator (Optional)
- R3 - Air Conditioner Power Relay
- R4 - Windshield Wiper Park Relay
- R5 - Skylight Wiper Park Relay
- F1- Spare - Crane/Remote Power Relay - 10 amp
- F2 - Diesel Heater Circuit - 15 amp
- F3 - Spare - 5 amp
- F4 - Spare - 7.5 amp
- F5 - Air Conditioning Power Relay - 15 amp
- F6 - Spare - 15 amp
- F7 - Spare - 10 amp
- F8 - Spare - 10 amp
- F9 - Spare - 30 amp
- F10 - HVAC Power - 30 amp

Micro Relay Fuse Box 2

Micro relay fuse block 2 (5, Figure 3-3) is located in the middle of the fuse relay panel and contains the following components. See Figure 3-5.

- R1 - Windshield Washer Relay
- R2 - Ignition Relay
- R3 - OIR Controller Relay
- R4 - Auxiliary Pump Relay
- R5 - Horn Relay
- F1- Windshield Washer Relay - 3 amp
- F2 - Overhead Panel Power - 15 amp
- F3 - Spare - 5 amp
- F4 - Windshield Wiper - 10 amp
- F5 - LMI Power -10 amp
- F6 - Skylight Wiper - 10 amp
- F7 - Auxiliary Pump- 15 amp
- F8 - Accessory Outlet - 10 amp
- F9 - Horn - 7.5 amp
- F10 - Seat Switch Power - 5 amp

Micro Relay Fuse Box 3

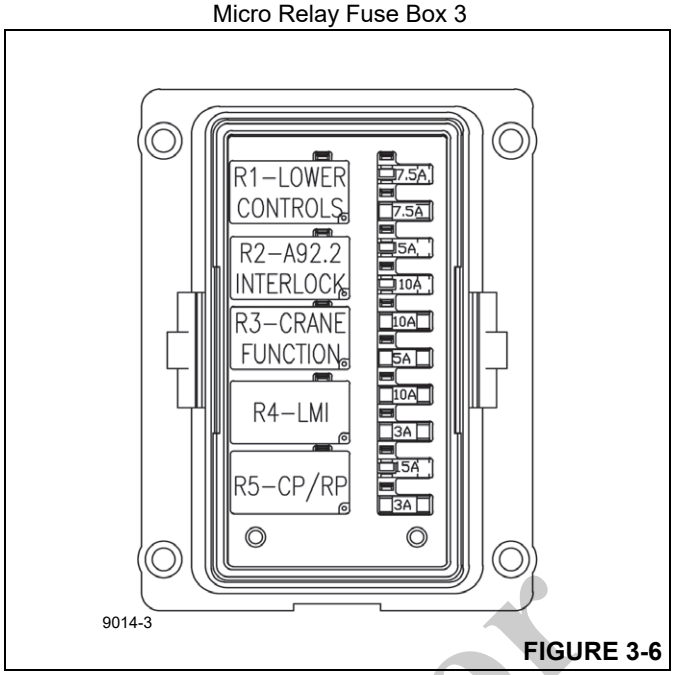


FIGURE 3-6

Micro Relay Fuse Box 3

Micro relay fuse block 3 (4, Figure 3-3) is located on the right side of the fuse relay panel and contains the following components. See Figure 3-6.

- R1 - Lower Control Interlock Relay
- R2 - A92.2 Interlock Relay
- R3 - Crane Function Interlock Relay
- R4 - LMI Lockout Relay
- R5 - Crane Power and Remote Power Relay
- F1 - Spare - 7.5 amp
- F2 - Hoist Speed Power - 7.5 amp
- F3 - Spare - 5 amp
- F4 - Spare - 10 amp
- F5 - 3rd wrap indicator Lockout Solenoids - 10 amp
- F6 - Swing Brake Switch, Hoist Thumper - 5 amp
- F7 - LMI Lockout - 10 amp
- F8 - WDR/3rd wrap indicator Sensor - 3 amp
- F9 - Spare - 15 amp
- F10 - OIR Controller Power - 3 amp

Micro Relay Fuse Box 4

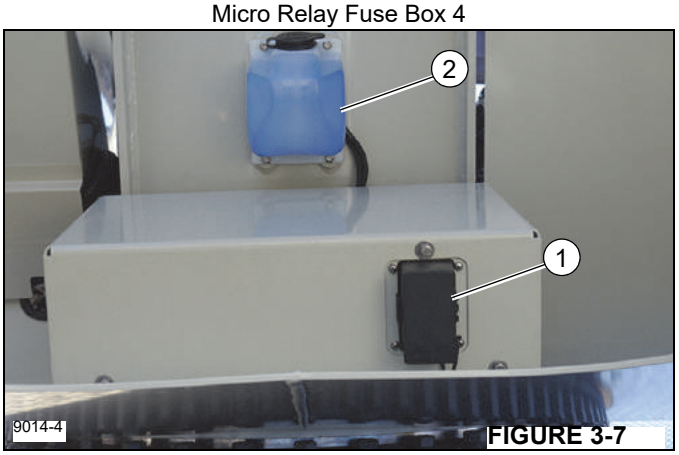


FIGURE 3-7

Micro Relay Fuse Box 4

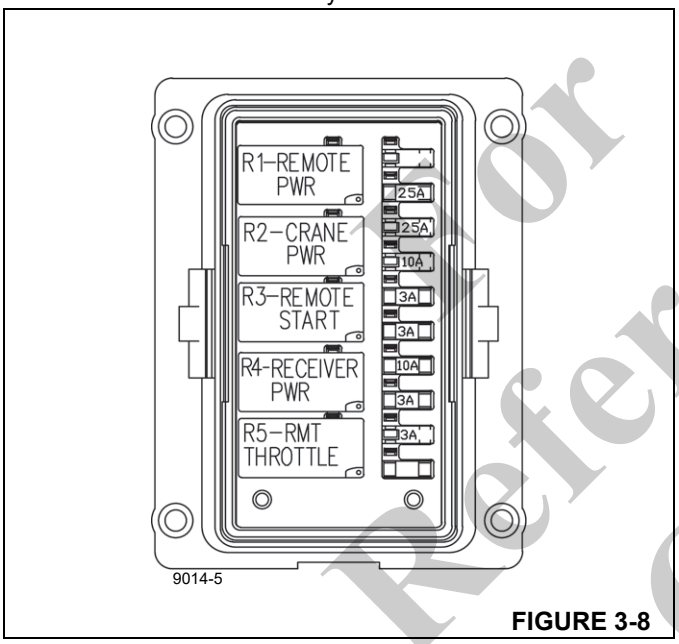


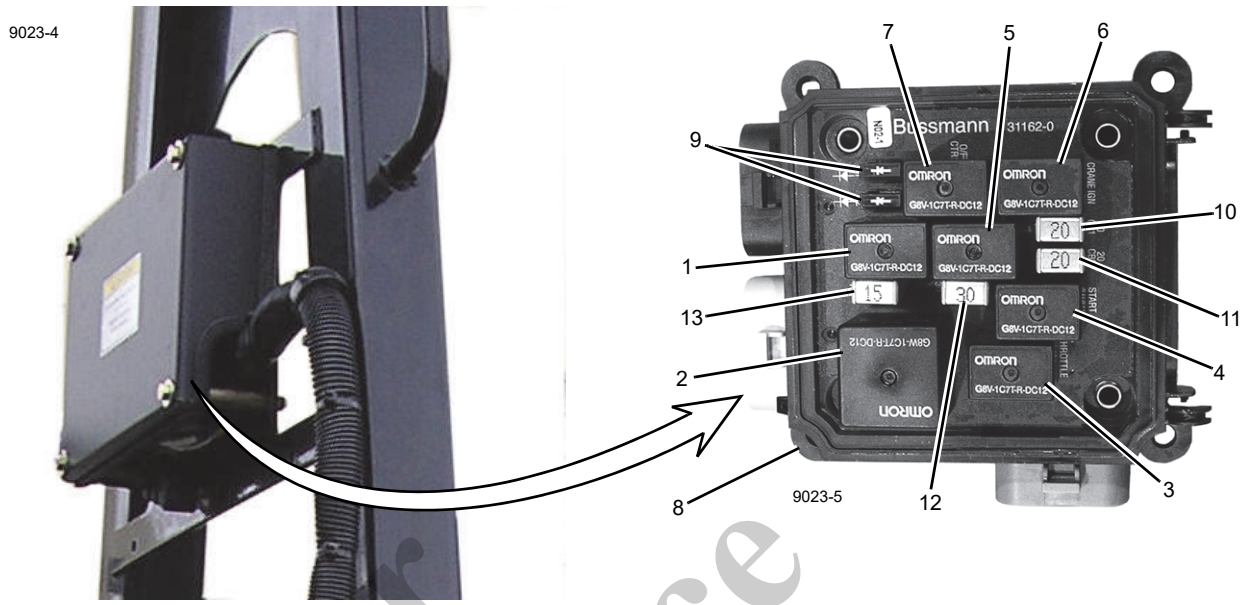
FIGURE 3-8

Micro Relay Fuse Box 4

Micro relay fuse block 4 (1, Figure 3-7) is located at the rear of the crane, below the counterweight and windshield wash reservoir (2) and is installed with the radio remote option.

Micro relay fuse box 4 contains the following components. See Figure 3-8.

- R1 - Remote Power Relay
- R2 - Crane Power Relay
- R3 - Remote Start Relay
- R4 - Receiver Power Relay
- R5 - Remote Throttle Relay
- F1 - Not Used
- F2 - Spare - 25 amp
- F3 - Crane Power - 25 amp
- F4 - Spare - 10 amp
- F5 - Spare - 3 amp
- F6 - Spare - 3 amp
- F7 - Spare - 10 amp
- F8 - Swing Manifold Dual-Mode - 3 amp
- F9 - Remote Throttle
- F10 - Not Used



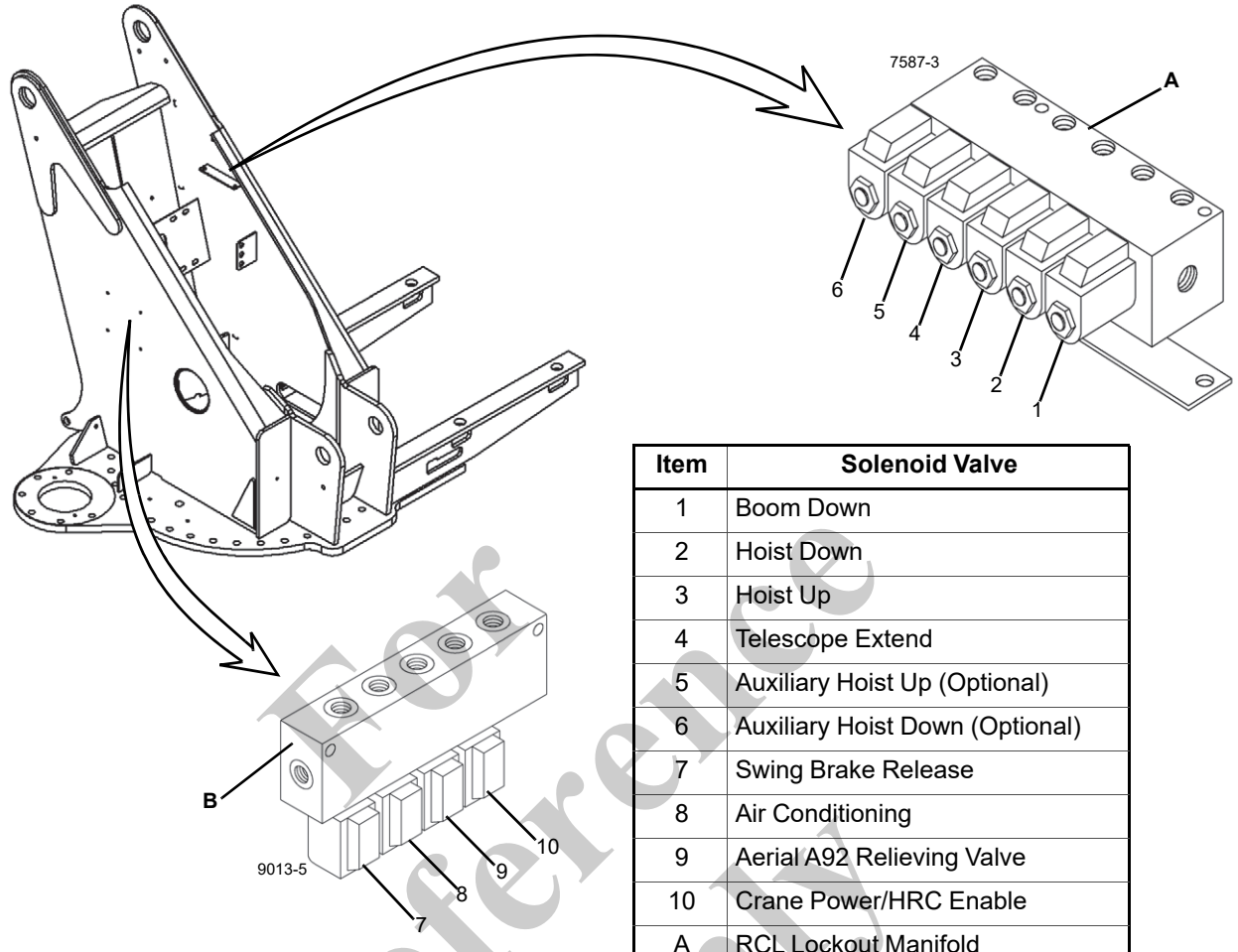
Item	Component	Item	Component
1	Truck Ignition Relay	8	Vehicle Electrical Center (VEC)
2	Oil Cooler Relay	9	Diode (2 used)
3	Not Used	10	Circuit Breaker 1 (CB1) - 20 Amp
4	Engine Start Relay	11	Circuit Breaker 2 (CB2) - 20 Amp
5	Not Used	12	Circuit Breaker 3 (CB3) - 30 Amp
6	Crane Ignition Relay	13	Circuit Breaker 4 (CB4) - 15 Amp
7	Outrigger Control Relay		

FIGURE 3-9

VEC MODULE

The vehicle electrical center (VEC) module (8, Figure 3-9) is located in an enclosure on the boom rest above the front outrigger manifold. The VEC module contains the following relays and circuit breakers:

- The truck ignition relay (1) disables the truck ignition when there is not a crane ignition signal or when either of the lower emergency stop switches are depressed. The truck ignition circuit is protected from overload by circuit breaker 1 (10).
- Oil cooler relay (2) powers the oil cooler fan when the oil temperature switch closes. The oil cooler circuit is protected from overload by circuit breaker 2 (11).
- The engine start relay (4) energizes the engine starter circuit from the crane cab ignition or radio remote. The engine start circuit is protected from overload by circuit breaker 1 (10).
- The crane ignition relay (6) disables the crane ignition switch when the truck is running. The crane ignition circuit is protected from overload by circuit breaker 1 (10).
- The outrigger control relay (7) provides power for ground level outrigger control. When the crane function power switch is energized, the ground level outrigger control is disabled. The outrigger control circuit is protected from overload by circuit breaker 2 (11).
- Two relays (3 and 5) are not used.



Item	Solenoid Valve
1	Boom Down
2	Hoist Down
3	Hoist Up
4	Telescope Extend
5	Auxiliary Hoist Up (Optional)
6	Auxiliary Hoist Down (Optional)
7	Swing Brake Release
8	Air Conditioning
9	Aerial A92 Relieving Valve
10	Crane Power/HRC Enable
A	RCL Lockout Manifold
B	Pilot Manifold

FIGURE 3-10

CRANE MANIFOLD SOLENOIDS

The RCL and A2B solenoids are located on the six-section RCL lockout manifold (A, Figure 3-10). The RCL and A2B solenoids disable crane operations that can worsen an impending tipping or two-block condition. The operations listed below are disabled when the solenoids are de-energized.

- Main Hoist Up
- Boom Telescope Cylinder — Extend the Boom
- Auxiliary Hoist Up (optional)
- Lift Cylinder Retract — Boom Down

The crane manifold solenoids are located on the pilot manifold valve (B, Figure 3-10) and provide for the following operations.

- Crane Function Power — enables all crane functions when energized (when functions are not locked out by the RCL).
- Air Conditioner — runs the air conditioner compressor when energized.
- Swing Brake — applies pressure to release the swing gearbox parking brake when energized.
- Aerial A92 Relieving Valve — provides reduced pressure functions for boom up, telescope extend, and telescope retract for aerial lift functionality when de-energized. Provides full pressure functionality when energized for crane operation.

Before replacing a relay or solenoid, check the connector for corrosion. Clean the connector with fine sand paper and lubricate with electrolytic grease. Do not use a non-electrolytic grease. Non-electrolytic grease insulates the connection and prevents relay operation.

Problem	Cause	Solution
RCL/A2B interlock solenoid fails to energize.	Fuse F7 open	Check fuse F7 in the micro relay fuse box 2 for continuity. Replace if defective.
	Faulty RCL/A2B override switches	Check RCL override switches for correct operation.
	Faulty RCL/A2B interlock relay	Test the RCL interlock relay (R4 in micro relay fuse box 3) terminal B10 (wire 12) for battery voltage. If battery voltage is present, test relay for ground continuity at terminal D9 (wire 51). If ground connection is OK, replace relay.
	Faulty crane function switch	Check for battery voltage on pin 2 (wire 41) of the crane function switch while sitting in the operator seat. If battery voltage is present, check for battery voltage at pin 4 (wire 12) of the crane function switch. If battery voltage is not present, replace the crane function switch.
	Faulty RCL/A2B solenoid	Check solenoid for continuity. Replace if defective.
3rd Wrap Indicator relay fails to energize.	Fuse F3 open	Check fuse F3 in micro relay fuse box 4 for continuity. Replace if defective.
	Fuse F5 open	Check fuse F5 in micro relay fuse box 3 for continuity. Replace if defective.
	Feed fuse open	Check the 80 amp feed fuse at the power point for continuity. Replace if defective.
	Faulty 3rd wrap indicator relay	Test the 3rd wrap relay (R1 in micro relay fuse box 1) socket for battery voltage at pin B2 (wire 820). If battery voltage is present, test 3rd wrap indicator relay socket pin D1 (wire 824) for continuity to 3rd wrap indicator switch connector pin 5. If wire is OK, check 3rd wrap indicator switch for operation. If 3rd wrap indicator switch is OK, replace the 3rd wrap indicator relay.
	Faulty 3rd wrap indicator switch	Check 3rd wrap indicator switch for correct operation. Replace if defective.
	Faulty RCL/A2B solenoid	Check solenoid for continuity. Replace if defective.
Crane/remote relay fails to energize.	Fuse F10 in micro fuse block	Check fuse F10 in micro relay fuse box 2 for continuity. Replace if defective.
	Faulty crane function switch	Check for battery voltage on pin 2 (wire 41) of the crane function switch while sitting in the operator seat. If battery voltage is present on pin 2 (wire 41), check for battery voltage at pin 4 (wire 12) of the crane function switch. If battery voltage is not present at pin 4 (wire 12), replace crane power switch.
	Faulty crane/remote relay	Test crane/remote relay (R5 in micro relay fuse box 3) terminal B10 (wire 12) for battery voltage. If battery voltage is present, test relay for ground continuity at terminal D9 (wire 51). If ground connection is OK, replace relay.

OUTRIGGER MANIFOLDS

There are two outrigger manifolds located on the carrier frame. The front outrigger manifold is mounted at the center of the front outrigger box (Figure 3-11), and the rear outrigger manifold is mounted at the center of the rear of the truck under the T-box (Figure 3-12).

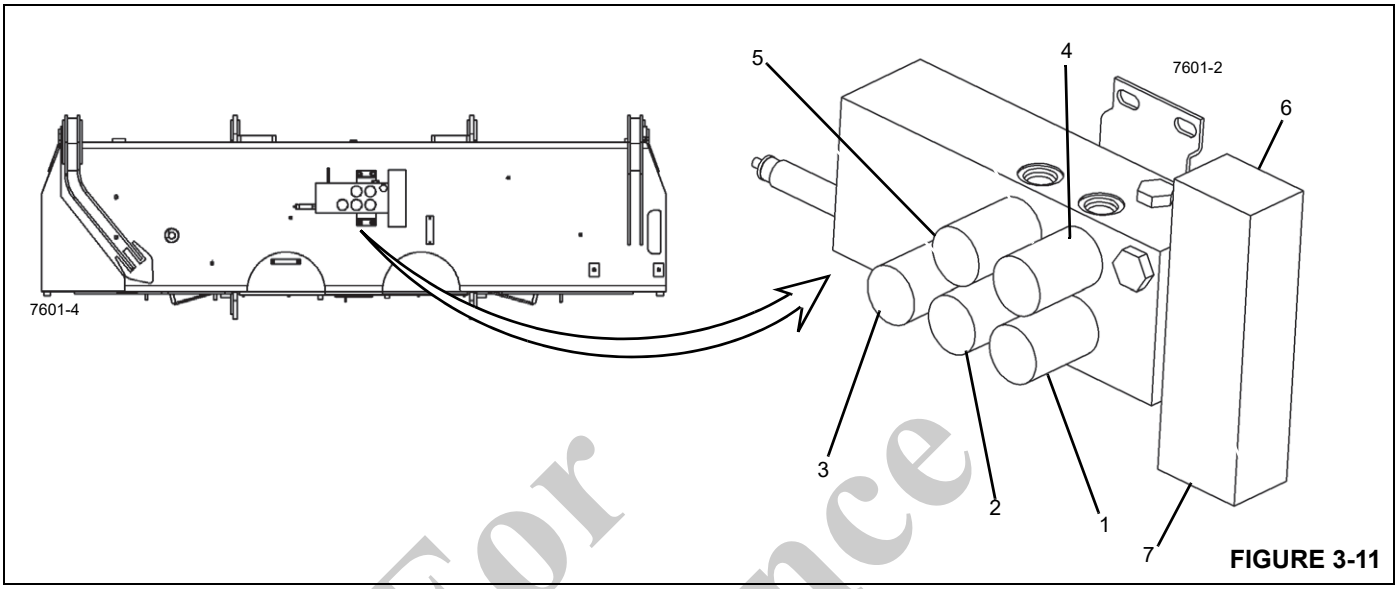


FIGURE 3-11

Item	Description	Item	Description
1	Driver Side Outrigger Jack Solenoid	5	Passenger Side Outrigger Jack Solenoid
2	Driver Side Outrigger Beam Solenoid	6	Outrigger Extend Solenoid
3	Single Front Outrigger (SFO) Solenoid	7	Outrigger Retract Solenoid
4	Passenger Side Outrigger Beam Solenoid		

Front Outrigger Manifold

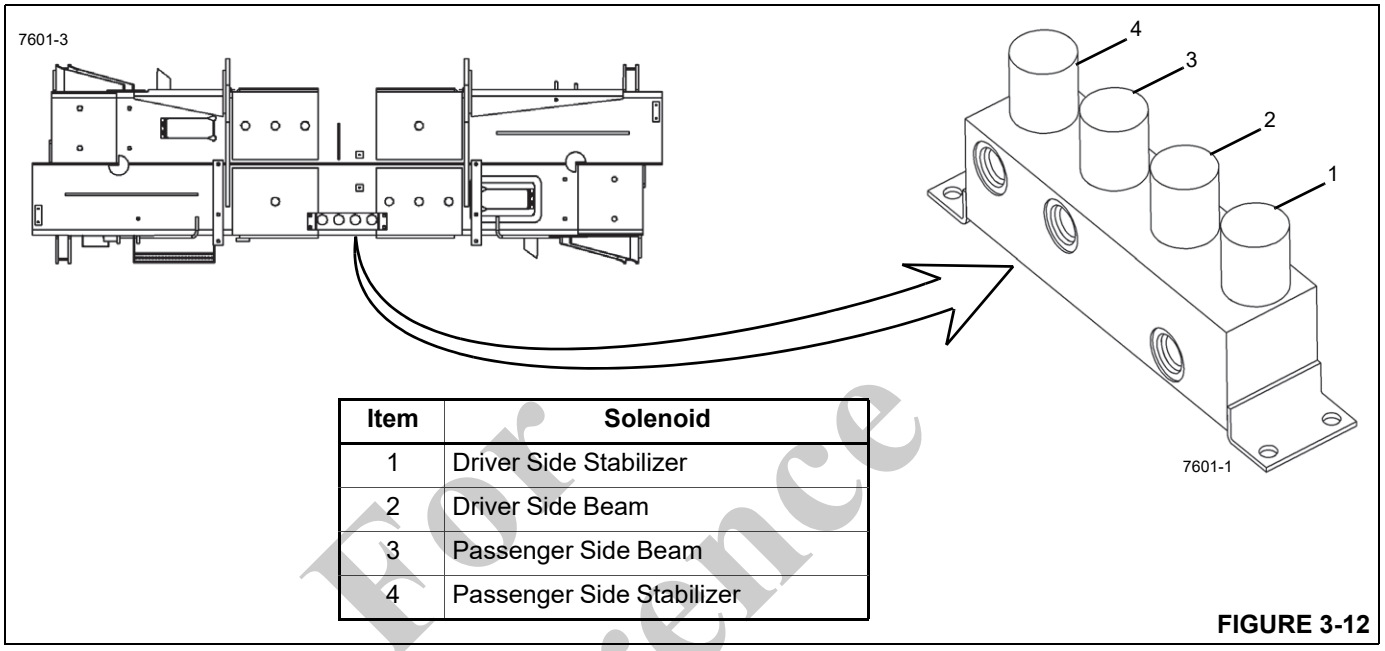
The solenoids on the front outrigger manifold control the selection of the front outrigger components, the single front outrigger (SFO), the extend and retract functions of all outrigger components, and the hydraulic flow to the outrigger hydraulic circuit.

The solenoids on the front outrigger manifold provide the following functions:

- The SFO (Figure 3-11) solenoid extends or retracts the SFO when energized. Anytime the retract switch on the outrigger control is depressed, the SFO is first up.
- The component solenoids (2 through 5) control the front outrigger components. See Figure 3-11 for solenoid identification.
- The extend (6) and retract (7) solenoids control the extend and retract functions for all outrigger components on both front and rear outriggers.

Rear Outrigger Manifold

The solenoids on the rear outrigger manifold control the selection of the rear outrigger components. See Figure 3-12 (1 through 4) for solenoid identification.



Item	Solenoid
1	Driver Side Stabilizer
2	Driver Side Beam
3	Passenger Side Beam
4	Passenger Side Stabilizer

FIGURE 3-12

HYDRAULIC OIL COOLER

The hydraulic oil cooler (3, Figure 3-13) is mounted on the boom rest. An electric fan in the cooler housing circulates air through the cooling core when the hydraulic oil reaches 49°C (120°F).

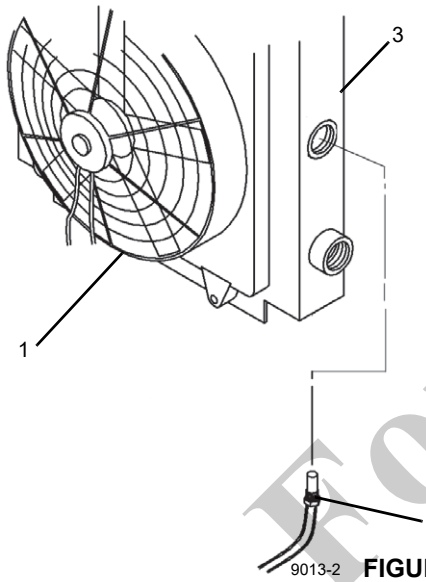


FIGURE 3-13

Not all return flow is routed through the oil cooler. A 2 bar (30 psi) check valve limits the flow through the cooler. Since hydraulic oil is thicker when it is cold, less oil is routed through the cooler when it is cold than when it is hot.

The cooler electrical system is made up of the electric fan (1, Figure 3-13), temperature sensor (2), and fan relay.

The temperature sensor (2) is located in the cooling core and energizes the fan relay when the hydraulic oil reaches 49°C (120°F). The fan relay is in the VEC module (Figure 3-9) and turns the fan on when energized. If the fan does not run when the hydraulic oil is hot, check the temperature sensor, oil cooler relay (2, Figure 3-9), and fan motor.

NOTE: The fan runs constantly if the sensor fails.

HYDRAULIC TEMPERATURE SENSOR WARNING LIGHT

A warning light on the crane cab console is illuminated when the hydraulic oil has exceeded the maximum recommended temperature. A sensor in the hydraulic swivel port number 4 monitors the temperature of the return oil and turns the light on when the hydraulic oil reaches 82°C (180°F). If the light fails to illuminate, check the light and the temperature sensor in swivel port number 4.

OUTRIGGER MONITORING SYSTEM (OMS)

For more information on the outrigger monitoring system. See “Outrigger Monitoring System (OMS)” on page 7-9.

OUTRIGGER JACK MONITORING SYSTEM (OPTIONAL)

For more information on the outrigger jack monitoring system. See “Outrigger Jack Monitoring System (optional)” on page 7-9.

SECTION 4
BOOM MAINTENANCE

SECTION CONTENTS

4

FOUR-SECTION BOOM

See Figure 4-1 for reference.

A two-stage, rod-fed, double-acting cylinder is attached to and supports the base, TEL #1, and TEL #2 boom sections.

The 2/3/4 extend cables are attached to the rear of the TEL #1 boom section, which is reeved around sheaves at the front of the TEL #2 boom section, then attaches to the rear, and supports the TEL #3 boom section.

The 4/3/2 retract cables are attached to the rear of the TEL #3 boom section, which is reeved around sheaves at the rear of the TEL #2 boom section, then attach to the front of the TEL #1 boom section.

The 1/2/3 extend cables are attached to the rear of the Base boom section, which is reeved around sheaves at the front of the TEL #1 boom section then attaches to the rear of the TEL #2 boom section.

The 3/2/1 retract cables are attached to the rear of the TEL #2 boom section, which is reeved around sheaves at the rear of the TEL #1 boom section, then attaches to the front of the base boom section.

The 3/2/1 retract cables directly oppose the 1/2/3 extend cables to ensure that the TEL #1 and TEL #2 boom sections 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 TEL #2 and TEL #3 boom sections extend and retract equally at all times.

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 the retract pressure is returned to neutral.

Hydraulic extend cylinder construction determines which extendable section is controlled first or second. The extend sections will need to be adjusted utilizing cable adjustment.

A single-stage cylinder controls the first extendable section.

A dual-stage cylinder controls the second extendable section.

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

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

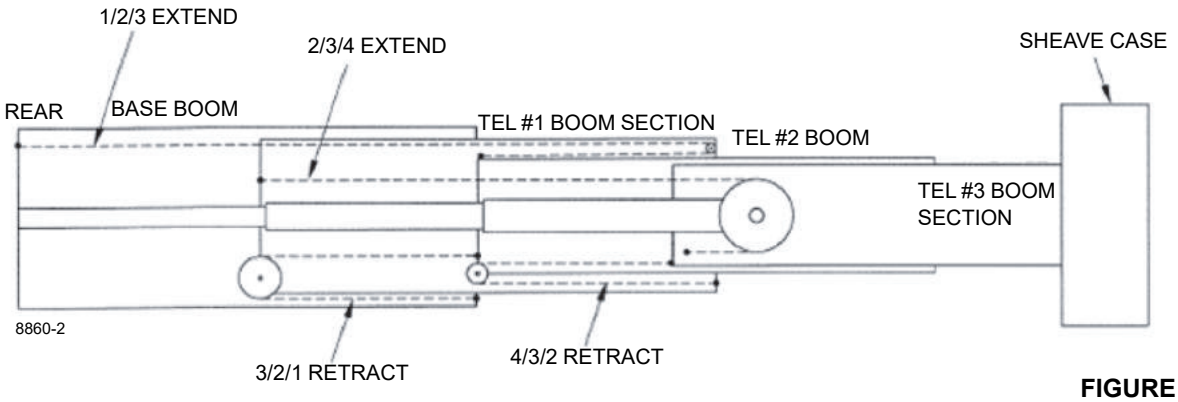


FIGURE 4-1

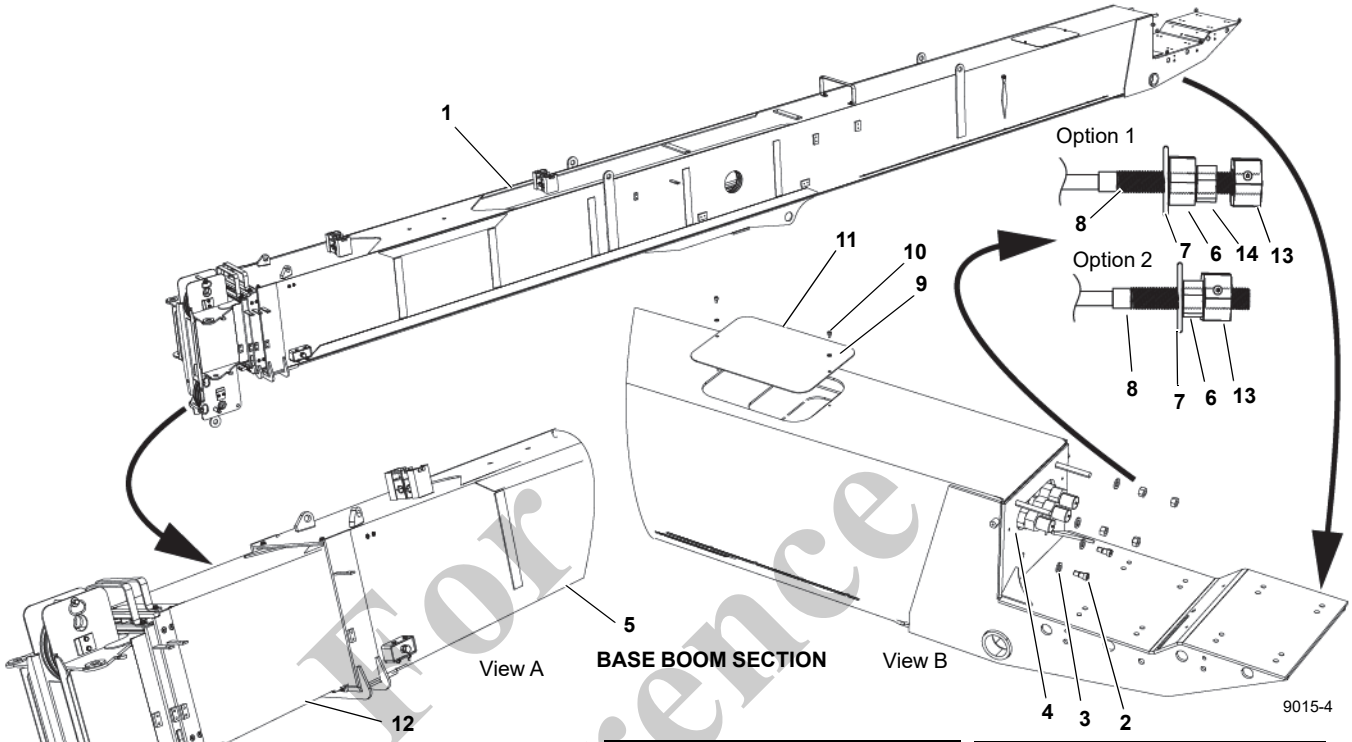
See Figure 4-1, Figure 4-9, and Figure 4-13 for boom removal, disassembly, assembly, and cable tensioning.

Boom Removal

For boom weight, see “Specifications” in Section 9 of this manual.

1. Extend and set the crane outriggers and single front outrigger (SFO). The boom must be completely retracted and stowed in the boom rest over the front of the truck.
2. If equipped, remove the swing around the jib according to procedures outlined in Section 6, Equipment Setup of the Operator Manual.
3. Remove the hook block or downhaul weight, wind up the rope on the hoist drum, and stow the wedge socket becket on the pegs provided on the base boom section. Shut down the truck engine.
4. Attach a lifting device to the counterweight to provide even weight distribution and raise the counterweight until the weight is removed from the boom pivot pin. Remove the counterweight retaining hardware from the boom pivot pin and lower the counterweight until it rests on the rear outrigger box.
5. Attach a lifting device to the rod end of the lift cylinder, and remove the boom lift cylinder pin keeper and pin from the bottom of the base boom section. Lower the lift cylinder rod end to the deck.
6. Tag and disconnect the extend cylinder lines and the hoist hydraulic and electric lines. Cap and plug all openings. Unplug the anti-two-block/RCL cord from the receptacle in the turret.
7. Tag and disconnect all hoist hydraulic lines. Cap and plug all openings. The hoist may be removed at this point, but it is not necessary. See “Hoist Removal” on page 5-2.
8. Attach a lifting device to provide even weight distribution and raise the boom until weight is removed from the boom pivot pin. Remove the boom pivot pin keeper and boom pivot pin. Lift the boom free of the turret.
9. If maintenance is required, see “Additional Maintenance (Disassembled Boom)” on page 10.

Four-Section Boom Disassembly



Item	Description
1	Base Boom Section
2	Capscrew
3	Washer
4	Rear
5	Front

Item	Description
6	Nut (Adjustment)
7	Washer
8	1/2/3 Extend Cables
9	Washer
10	Capscrew

Item	Description
11	Inspection Cover
12	TEL #1 Boom Section
13	Nut (Positive Lock)
14	Nut (Torqued)

FIGURE 4-2

For reference, the front is the sheave case end (View A), and the rear is the hoist mount end (View B). Left and right are viewed from the rear to the front. See Figure 4-2 for the following procedure.

NOTE: All wear pads must be tagged, inspected, and reassembled exactly as they have been removed unless doing a complete overhaul.

Steps 1 through 3 apply to a boom that is to be disassembled with the base boom section and jib (if equipped) left on the crane. All other steps apply to the boom being removed from the crane. See “Boom Removal” on page 4-2.

1. Extend and set the outriggers and single front outrigger (SFO).
2. Completely retract the boom and place it in a horizontal position.
3. Tag and disconnect the hydraulic lines to the telescope cylinder. Cap and plug all lines and openings.
4. Remove the capscrews (2, View B) and washers (3) that anchor the base boom section extend cylinder rod to the rear (4) of the Base boom section (1). Repeat for the other side.
5. Mark the location of the nuts (6,13, and 14) (if equipped) and washer (7) that secure the 1/2/3 extend cables (8) to the rear (4) of the base boom section (1). Remove the nuts, and washers from the 1/2/3 extend cables at the rear of the base boom section. Mark and tag the cables while leaving the cable ends draped inside the boom.
6. Remove the capscrews (10, View A), washer (9), and inspection cover (11) from the top rear of the base boom section (1).
7. Attach a sling or chain to the front of the TEL #1 boom section (12, View A) and pull out the TEL #1 boom section (with the TEL #2 and TEL #3 boom sections) approximately one foot or until the inspection hole on all the boom sections align to the top wear pad assemblies for all the boom sections.

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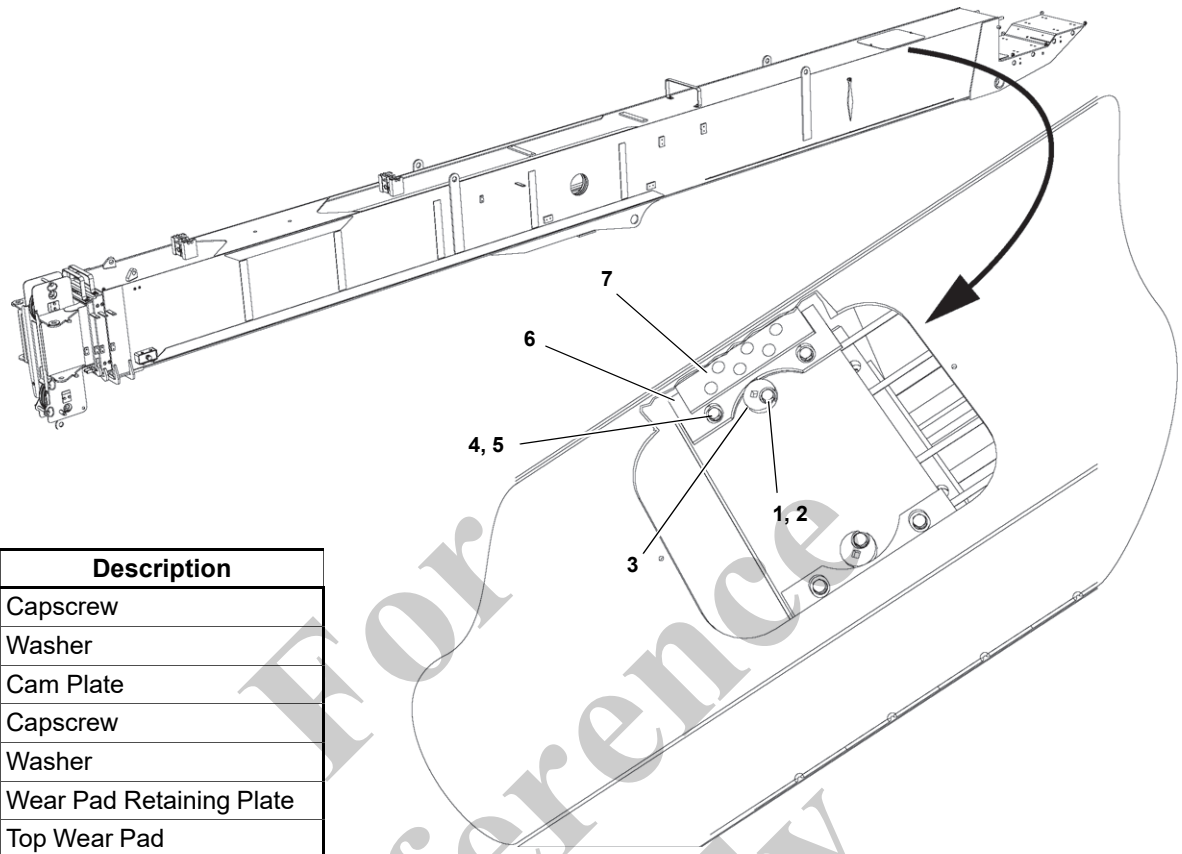


Item	Description
1	Capscrew
2	Washer
3	Cam Plate
4	Capscrew
5	Washer
6	Wear Pad Retaining Plate
7	Top Wear Pad

FIGURE 4-3

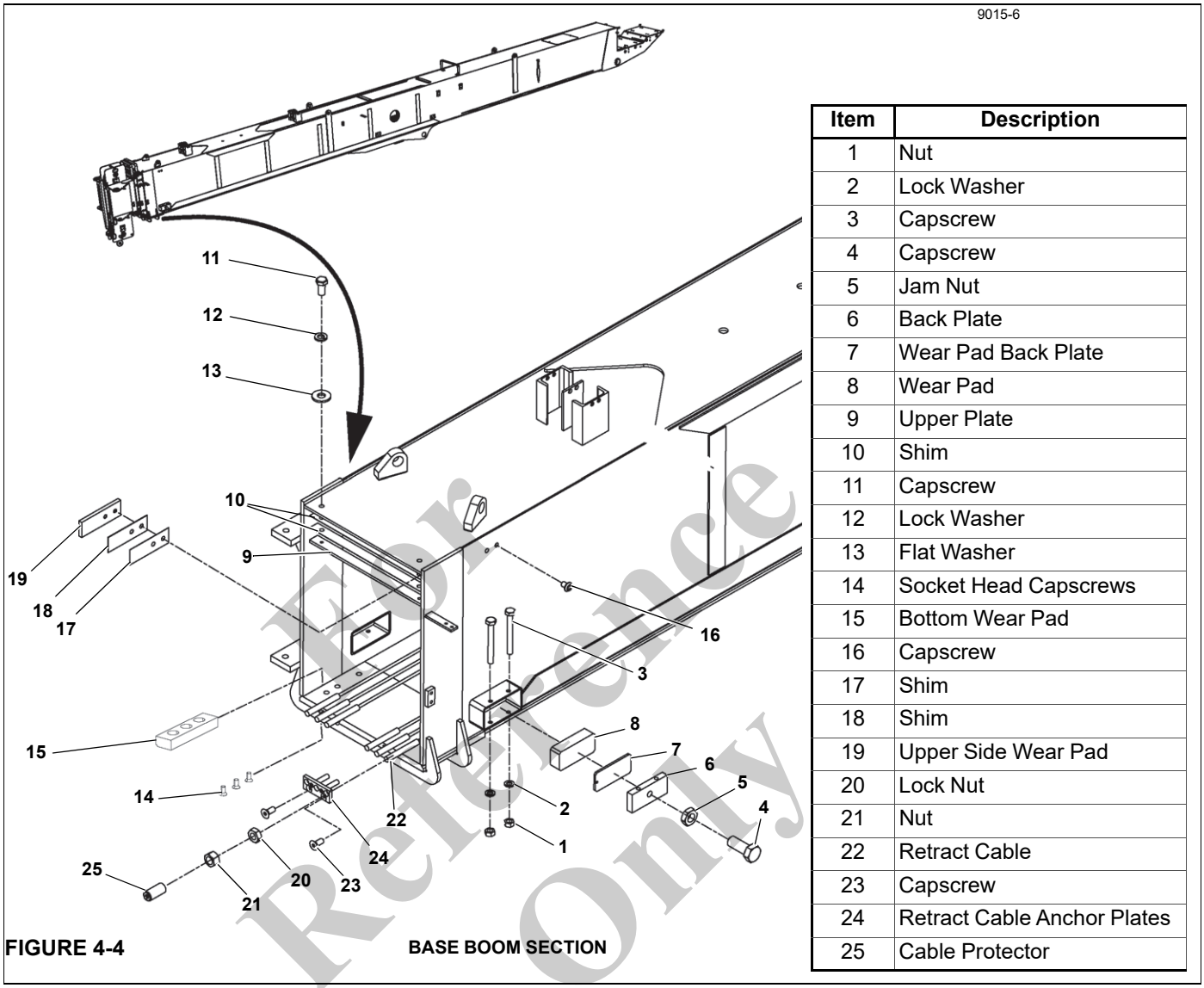
See Figure 4-3 for the following steps.

NOTE: All top wear pads must be tagged, inspected, and reassembled exactly as they have been removed.

8. Remove the capscrew (1), washer (2), and cam plate (3) from the TEL #1 boom section.

9. Remove the capscrews (4), washers (5), and wear pad retaining plate (6).

10. Remove the top wear pad (7) from the top of each boom section. Repeat for the other side and for the remaining boom sections being removed.



Item	Description
1	Nut
2	Lock Washer
3	Capscrew
4	Capscrew
5	Jam Nut
6	Back Plate
7	Wear Pad Back Plate
8	Wear Pad
9	Upper Plate
10	Shim
11	Capscrew
12	Lock Washer
13	Flat Washer
14	Socket Head Capscrews
15	Bottom Wear Pad
16	Capscrew
17	Shim
18	Shim
19	Upper Side Wear Pad
20	Lock Nut
21	Nut
22	Retract Cable
23	Capscrew
24	Retract Cable Anchor Plates
25	Cable Protector

FIGURE 4-4 **BASE BOOM SECTION**

See Figure 4-4 for the following steps.

11. Remove and tag the attaching nut (1), lock washer (2), and capscrew (3) on the front of the base boom section. Loosen the wear pad adjustment jam nut (5) and capscrew (4). Tag and remove wear pads (8), back plates (6), and wear pad back plates (7).

12. Remove capscrew (11), lock washer (12), and flat washer (13). Tag and remove the upper plate (9) and shims (10) from the front of the base boom section.

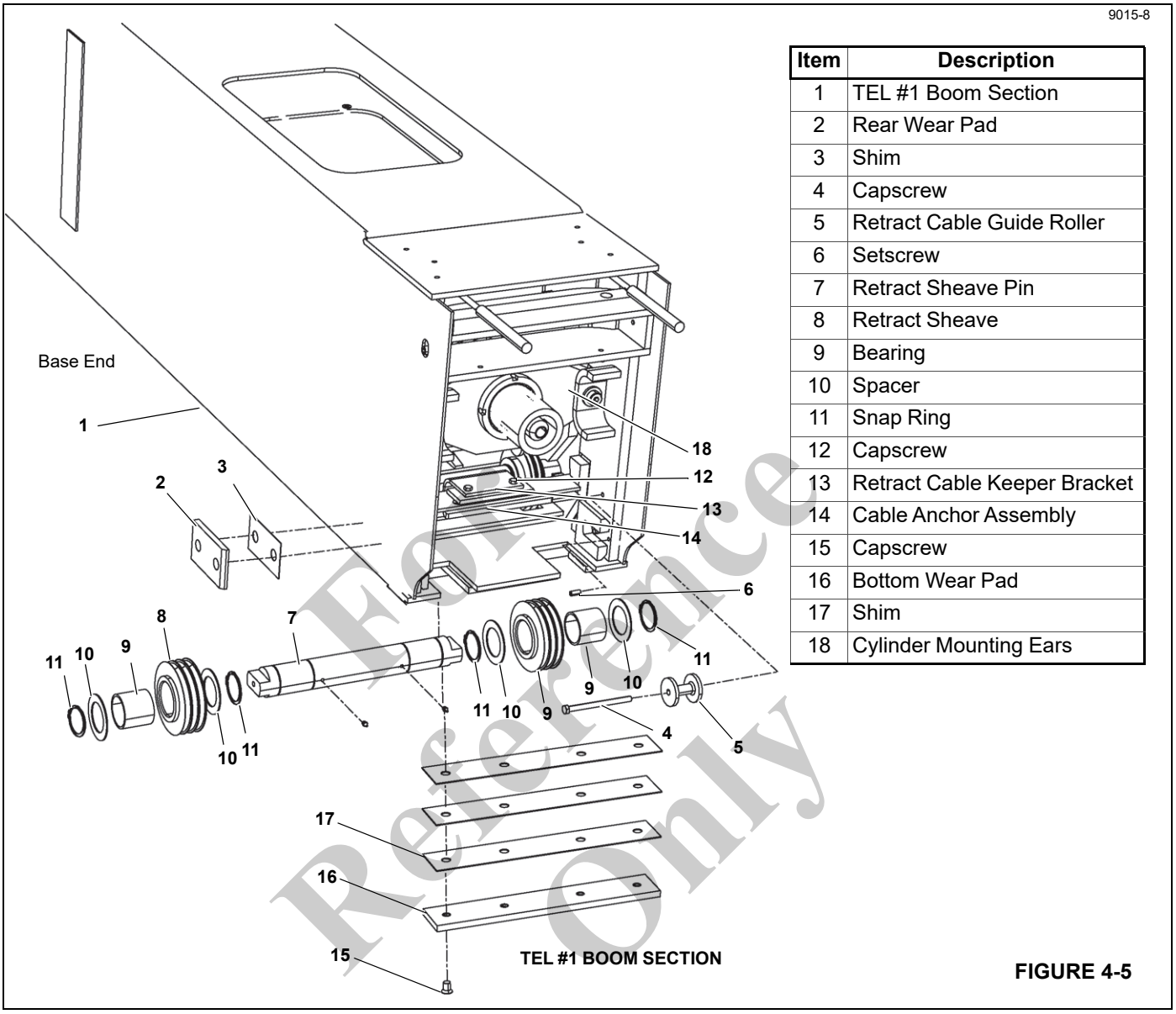
13. Remove capscrews (16) from the side of the base boom section. Tag and remove the two upper side wear pads (19) and shims (17 and 18) from the front of the base boom section.

14. Remove the cable protector (25) and loosen the cable adjusting lock nut (20) and nut (21) on the lower front 3/2/1 retract cables (22). Remove the four capscrews (23) that retain the 3/2/1 retract cable anchor plates (24) to the bottom front of the base boom section.

15. Pull the retract cable anchors out and keep the retract cables taut while pulling the TEL #1 (with TEL #2 and TEL #3) boom section out of the base boom section. Partially pull the TEL #1 boom section from the boom assembly until the front of the boom can be raised enough to remove and tag the bottom wear pads (15) and socket head capscrews (14) from the bottom front of the base boom section. Support the rear end of the TEL #1 boom section as it exits the base boom section.

16. Place the TEL #1 (with TEL #2 and TEL #3) boom section on a suitable horizontal surface.

NOTE: Use caution not to pinch or crush the retract cables while lifting or supporting the TEL #1 boom section.



Item	Description
1	TEL #1 Boom Section
2	Rear Wear Pad
3	Shim
4	Capscrew
5	Retract Cable Guide Roller
6	Setscrew
7	Retract Sheave Pin
8	Retract Sheave
9	Bearing
10	Spacer
11	Snap Ring
12	Capscrew
13	Retract Cable Keeper Bracket
14	Cable Anchor Assembly
15	Capscrew
16	Bottom Wear Pad
17	Shim
18	Cylinder Mounting Ears

FIGURE 4-5

See Figure 4-5 for the following steps.

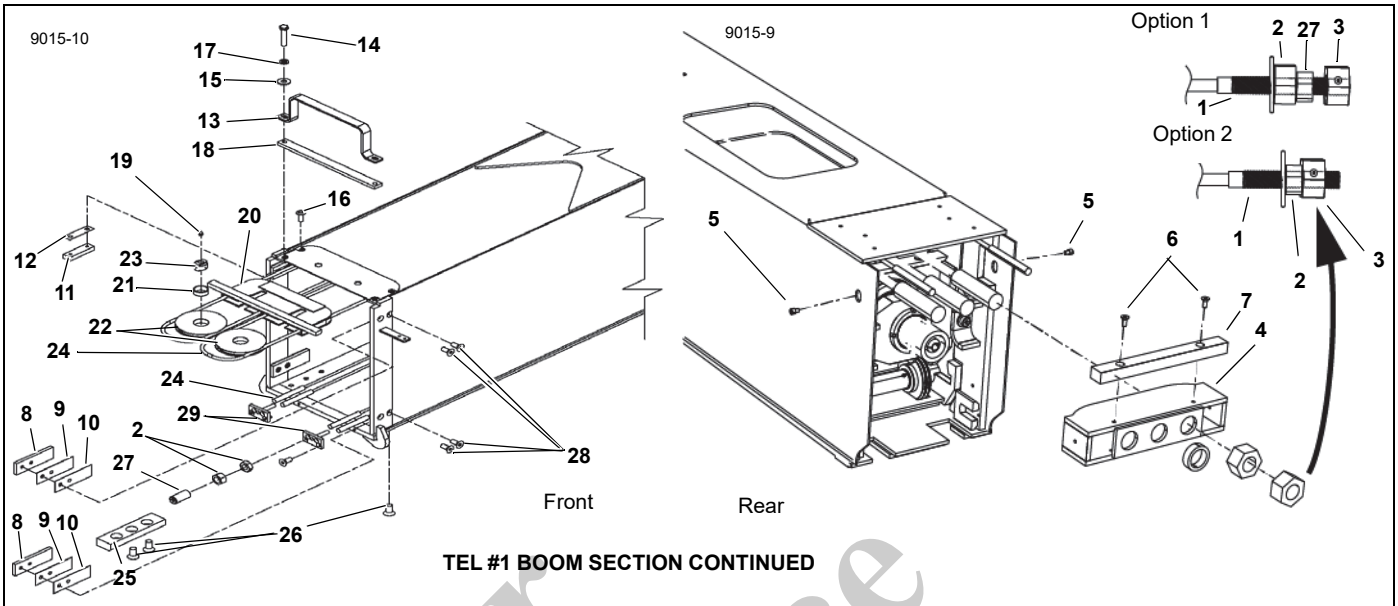
17. Tag and remove the rear wear pads (2) and shims (3) from the rear of the TEL #1 boom section (1), if replacing.

18. Remove the capscrew (4) and the retract cable guide roller (5) from each side of the bottom rear of the TEL #1 boom section.

19. Remove the setscrews (6) that retain the retract sheave pin (7). Pull the retract sheave pin with the retract sheaves (8), bearing (9), spacers (10), and snap rings (11) back and out of its slot at the rear of the TEL #1 boom section. Smooth out any burrs that may be present on the flat ends of the pin to eliminate sheave bearing damage when the sheaves are removed from the pin.

20. Tag and remove the four capscrews (15), bottom wear pad (16), and shims (17), if replacing.

21. Remove the two capscrews (12), retract cable keeper bracket (13), and cable anchor assembly (14) from the lower rear of the TEL #2 boom section. Store the 3/2/1 retract cables, which are now free, in an area where they will not be damaged during further boom disassembly.



TEL #1 BOOM SECTION CONTINUED

Item	Description
1	2/3/4 Extend Cables
2	Nut (Adjustment)
3	Nut (Positive Lock)
4	Cable Anchor Assembly
5	Socket Head Screw
6	Flathead Screw
7	Wear Pad
8	Wear Pad
9	Shim
10	Shim

Item	Description
11	Steel Pad
12	Shim
13	Cable Guide
14	Capscrew
15	Flat Washer
16	Capscrew
17	Lock Washer
18	Wear Pad
19	Grease Fitting
20	Sheave Anchor Assembly

Item	Description
21	Bearing
22	Sheave
23	Pin
24	Cable Assembly
25	Wear Pad
26	Capscrew
27	Nut (Torqued)
28	Cap Screw
29	Plate Assembly

FIGURE 4-6

See Figure 4-6 for the following steps.

22. Mark the location of the nuts (2, 3 and 27) (if equipped) that secure the 2/3/4 extend cables (1) to the rear of the TEL #1 boom section. Remove the socket head screws (5), nuts, and cable anchor assembly (4) from the top/rear of the TEL #1 boom section.

23. Remove the flathead screws (6) that retain the wear pad (7) to the cable anchor assembly (4) attached to the top rear of the TEL #1 boom section.

24. Attach a sling or chain to the front of the TEL #2 boom section and pull the TEL #2 boom section (with the TEL #3 section) out approximately one foot. Remove and tag the capscrews (28) and the upper and lower side wear pads (8) with shims (9 and 10) from the front of the TEL #1 boom section.

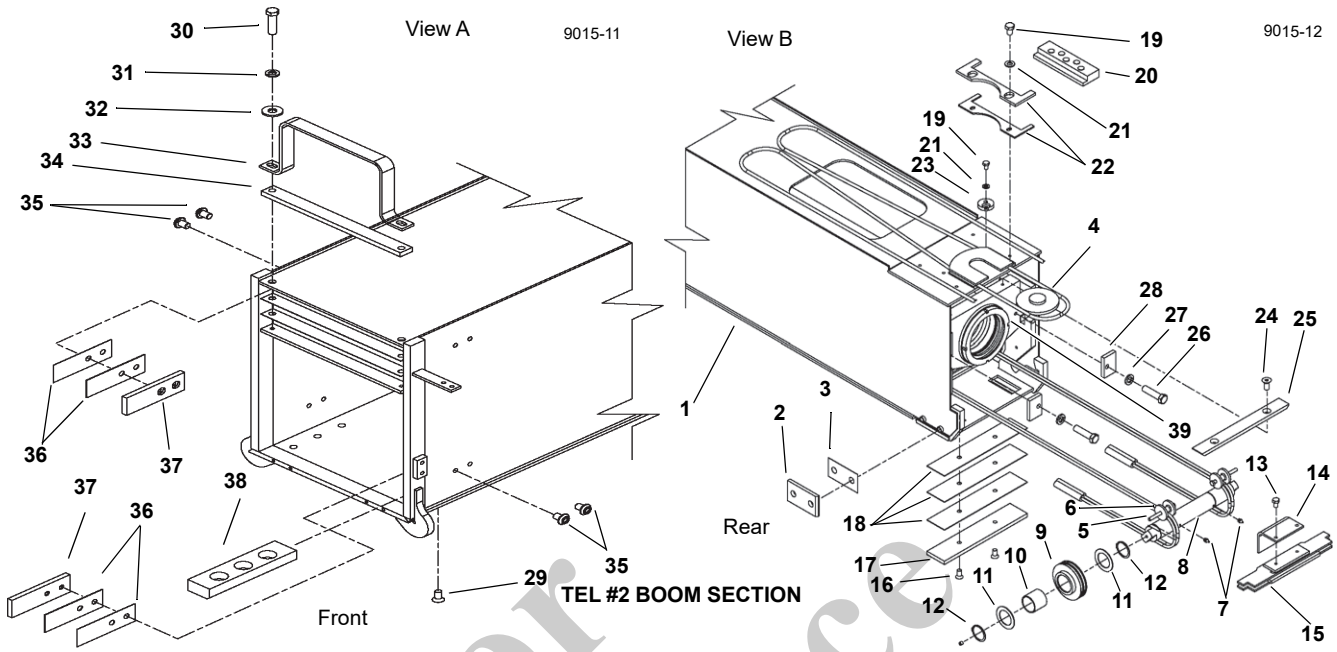
25. Remove and tag the two top inner steel pads (11) and shims (12) from the front of the TEL #1 boom section.

26. Remove and tag the cable guide (13), hardware (14-17), and wear pad (18) located on the top of the front of the TEL #1 boom section.

27. Slide the sheave anchor assembly (20) out from the front of the TEL #1 boom section. Remove the bearings (21), sheaves (22), grease fittings (19), and pins (23) out from the sheave anchor assembly and allow the plate assembly (29) and cable assembly (24) to rest on the top of the TEL #2 boom section.

28. Raise the front of the boom and remove the cap screws (26) and wear pads (25) from between the bottom front of the TEL #1 and TEL #2 boom sections. Pull the retract cable anchors out and keep the retract cables taut while pulling the TEL #2 and TEL #3 boom sections out of the TEL #1 boom section.

29. Place the TEL #2 and TEL #3 boom sections on a suitable horizontal surface.



Item	Description
1	Boom Section Rear
2	Wear Pads
3	Shim
4	Sheave
5	Capscrew
6	Cable Guide Roller
7	Grease Fitting
8	Sheave Pin
9	Sheave
10	Bearing
11	Spacer
12	Snap Ring
13	Capscrew

Item	Description
14	Cable Keeper Bracket
15	Cable Keeper
16	Capscrew
17	Wear Pad
18	Shim
19	Capscrew
20	Top Wear Pad
21	Flat Washer
22	Wear Pad Retaining Plate
23	Cam Plate
24	Capscrew
25	Wear Pad
26	Capscrew

Item	Description
27	Lock Washer
28	Keeper
29	Capscrew
30	Capscrew
31	Lock Washer
32	Flat Washer
33	Cable Guide
34	Wear Pad
35	Capscrew
36	Shim
37	Wear Pad
38	Wear Pad
39	Cylinder Mounting Ears

FIGURE 4-7

NOTE: Use caution not to pinch or crush the retract cables while lifting or supporting the TEL #2 boom section.

30. Remove the 1/2/3 extend cable from the resting position on the top of the TEL #2 boom section rear. Slide the sheave (4) toward the rear of the boom and remove it.

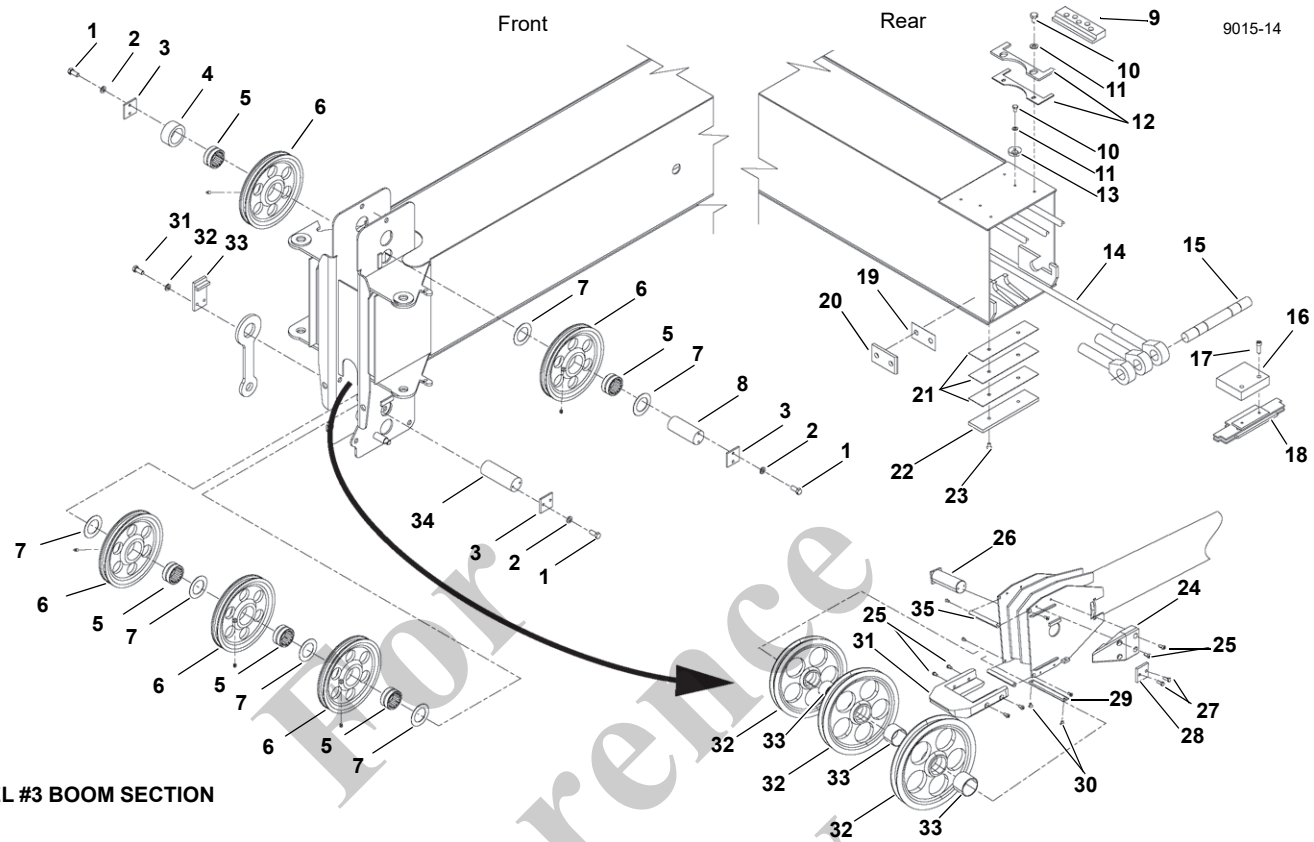
31. Tag and remove the rear wear pads (2) and shims (3) from the rear of the boom section. Tag and remove the capscrews (16), bottom wear pad (17), and shims (18). Tag and remove the cap screws (19), top wear pad (20), flat washer (21), wear pad retaining plates (22), and cam plate (23).

32. Remove the capscrew (5) and the retract cable guide roller (6) from each side of the bottom rear of the boom section. Remove the cap screws (13), cable keeper bracket (14), and cable keeper (15).

33. Remove the sheave pin (8) with the sheaves (9), grease fittings (7), bearing (10), spacers (11), and snap rings (12) assembled back and out of its slot at the rear of the boom section. Smooth out any burrs that may be present on the flat ends of the pin to eliminate sheave bearing damage when sheaves are removed from the pin.

34. Tag and remove the capscrews (29, 30, and 35), washers (31 and 32), cable guide (33), wear pads (34, 37, and 38), and shim (36).

35. Remove the two capscrews (26), lock washers (27), and keepers (28) from the cylinder.



Item	Description
1	Capscrew
2	Lock Washer
3	Keeper
4	Spacer
5	Bearing
6	Loadline Sheave
7	Spacer
8	Sheave Pin
9	Wear Pads
10	Capscrew
11	Washer
12	Wear Pad Plate

Item	Description
13	Cam Plate
14	Cable
15	Pin
16	Wear Pad
17	Capscrew
18	Retract Anchor
19	Shim
20	Wear Pad
21	Shim
22	Wear Pad
23	Capscrew
24	Wear Pad

Item	Description
25	Capscrew
26	Sheave Pin
27	Capscrew
28	Keeper
29	Plate
30	Capscrew
31	Wear Pads
32	Sheaves
33	Bearing
34	Sheave Pin
35	Rod

FIGURE 4-8

36. Attach a sling to the rear of the extend cylinder and pull it out of the TEL #2 boom section approximately one foot, keeping the 2/3/4 extend cables taut. Raise the extend cylinder approximately 127 mm (5 in).

37. Push the 4/3/2 retract anchor (18) forward out of its slot in the bottom rear of the TEL #3 boom section and remove from the TEL #3 boom section with the wear pad (16) attached. Remove the 4/3/2 retract cables from the 4/3/2 retract anchor (18) and store in an area where they will not be damaged during further boom disassembly.

38. Pull the pin (15) with the cables (14) as an assembly out of the slot in the bottom rear of the TEL #3 boom section and drape out of the rear of the TEL #2 boom section.

39. Lower the cylinder to the original position. Attach a sling or chain to the front of the TEL #3 boom section and pull the TEL #3 boom section out of the TEL #2 boom section approximately one foot. Remove the extend cylinder from the boom, keeping the 2/3/4 extend cables (14) taut.

40. Remove the capscrews (30), rods (35), and plate (29) from the cylinder sheave case front. Remove the sheaves (32) and bearings (33) from the extend cylinder by removing the two capscrews (27) and keeper (28) from the sheave pin (26) and lightly tapping the pin while removing the sheaves from the front of the extend cylinder.

41. Remove the 2/3/4 extend cables (14) from the pin (15) and store the cables and extend cylinder in an area where they will not be damaged during further boom disassembly.

42. Place the TEL #3 boom section on a suitable horizontal surface. Take care not to pinch or crush the retract and extend cables while lifting or supporting the TEL #3 boom section.

43. Tag and remove the capscrews (23), wear pads (22), and shims (21) from the rear of the TEL #3 boom section. Tag and remove the capscrews (10, 17, and 25), washers (11), shims (19), wear pad plates (12), cam plates (13), and wear pads (9, 16, 20, 24, and 31).

44. Remove the loadline sheaves (6) by removing the capscrews (1), lock washers (2), keeper (3), bearings (5), and spacers (4 and 7) from the sheave pins (8 and 34). Remove the sheave pins by lightly tapping the pin while removing the sheaves and spacers until all the sheaves are removed from the boom front.

Additional Maintenance (Disassembled Boom)

1. Clean all the 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 cutting of the inner liner material. If the installed bearing diameter is 0.38 mm (0.015 in) larger than the pin diameter, the bearing must be replaced. Any cut or gouge that causes the bearing liner to lose strands is a cause for bearing replacement.

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

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

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

7. Inspect all wear pads for gouges or uneven wear on the surface area. Replace if any damage is evident. Replace all lubricating plugs in all wear pads as necessary.

8. Apply multipurpose grease (MPG) to all wear pad surfaces.

Boom Assembly

NOTE: Tighten all hardware to their specified torque value. See “Fasteners and Torque Values” on page 1-7.

Apply medium-strength thread locking adhesive/sealant using Loctite® type 243 according to Loctite recommendations to all hardware and torque.

Do not use Loctite® on any cable threaded ends. Always use the jam nuts and/or lock nuts provided.

Install the cables in their natural untwisted condition. Do not twist the cables. Twisting of the cables will result in damage or failure of cable. When initially assembling the threaded ends of the cables, thread the first nut on past the flat so adjustment can be made later.

Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

NOTE: *The front is the sheave case end, the rear is the hoist mount end, and the left and right are viewed from rear to front.*

TEL #3 Boom Section Assembly

See Figure 4-8 for the following procedure.

1. Assemble the upper loadline sheaves (6) and bearings (5) into the sheave case of the TEL #3 boom section.

a. Install the sheave pin (8) in the left side of the upper sheave case.

NOTE: Install the small spacers (7) between the sheaves and between the sheaves and the side plates.

b. Install the small spacer (7).

c. Install the bearing (5) and loadline sheave (6) near the sheave case side plates with the grease fitting facing the side plate to allow for greasing.

d. Install the spacer (4).

e. Install the center bearing (5) and loadline sheave (6) with the grease fitting facing either side.

f. Install the top bearing (5) and loadline sheave (6) to the left-hand side of the boom with the spacer (7) to the right-hand side.

g. Install the keepers (3) to both sides of the sheave case using the capscrew (1) and lock washer (2). Tighten the bolt to specification. See “Fasteners and Torque Values” on page 1-7.

2. Assemble the lower loadline sheaves (6) and bearings (5) into the sheave case TEL #3 boom section.

a. Install the sheave pin (34) in the left side of the sheave case.

NOTE: Install spacers between the sheaves and between the side plates.

b. Install the spacer (7).

c. Install the sheaves (6) and bearings (5) nearest the sheave case side plates with the grease fitting facing the side plate to allow for greasing.

d. Install the small spacer (7).

e. Install the center sheaves (6) with the grease fitting facing either side.

f. Install the sheaves (6) to the right-hand side of the boom.

g. Install the spacer (7).

h. Install the link to the outside of the sheave case.

i. Install the keepers (3) to the right side of the sheave case using the capscrew (1) and lock washer (2).

j. Install the keepers (3) to the left side of the sheave case using the capscrew (1) and lock washer (2).

k. Install the tube in the lower forward sheave case.

l. Install the hitch pins in the sheave case.

3. Install the bottom rear wear pad (22), shims (21), and capscrew (23) to the rear of the TEL #3 boom section.

4. Install the two side wear pads (20) and shims (19) on the rear of the TEL #3 boom section. Shim according to calibration instructions in this section or as the pads were originally removed and tagged.

5. Install the two top wear pad mounting plates (12), wear pads (9), capscrew (10), and washer (11) onto the rear of the TEL #3 boom section.

6. Install the adjustment cam plate (13), capscrews (10), and washers (11).

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

7. Raise and support the TEL #3 boom section in the front of the TEL #2 boom section.

TEL #3 and TEL #2 Boom Section

See Figure 4-7 for the following steps.

NOTE: Be careful not to damage cables.

1. Install the TEL #3 boom section into the TEL #2 boom section approximately fifteen feet.

2. Rotate the cam (23) until the gap is eliminated between the wear pad (20) and the boom section, keeping the boom sections centered for proper boom alignment.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

3. Raise the TEL #3 boom section against the top of the TEL #2 boom section and install the wear pads (17) with the capscrews (29) into the bottom front of the TEL #2 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

4. Lower the TEL #3 boom section onto the wear pads in the TEL #2 boom section. Push the TEL #3 boom section into the TEL #2 boom section, leaving approximately four feet of the TEL #3 boom section out of the TEL #2 boom section.

5. Install the lower side wear pads (37) with shims (36) on the front inside of the TEL #2 boom section, securing it with capscrews (35).

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

6. Install the upper side wear pads (37) with shims (36) on the front inside of the TEL #2 boom section, securing it with capscrews (35).

NOTE: It may be necessary to support the components with a bar or tool that extends inside the boom section to aid in positioning components during assembly.

7. Install the top wear pads, shims, cable guide (33), wear pad (34), and related hardware (30—32) to the top front of the TEL #2 boom section. Shim according to calibration instructions “Boom Calibration” on page 45.

8. Push the TEL #3 boom section completely into the TEL #2 boom section. Scribe a mark in the front of the TEL #3 boom section in front of the side wear pad on the TEL #2 section for retract sequencing.

9. Pull the TEL #3 boom section out of the TEL #2 boom section approximately one foot.

See Figure 4-8 for the following steps.

10. Assemble and install the extend cylinder assembly.

a. Install the bearings (5) into the 2/3/4 extend cylinder sheaves (6).

b. Coat the bearings with multi-purpose grease and install the 2/3/4 extend sheaves into the extend cylinder.

c. Install the sheave pin (26) through the cylinder sheave case securing it with the keeper plate (28) and two capscrews (27).

d. Install the two wear pads (24 and 31) on each side of the front of the extend cylinder with capscrews (25).

11. Reeve the 2/3/4 extend cables (14) over the sheaves (32) at the front of the telescope cylinder assembly, routing the cables behind the cylinder in the correct order.

NOTE: Mark the cable ends to maintain the proper sequence during assembly to avoid crossing the cables.

12. Install the upper and lower rods (35) with capscrews to the bottom of the extend cylinder sheave case. Install the cable retaining plate (29) and capscrews (30) to the bottom of the extend cylinder sheave case.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

13. Install the extend cylinder into the rear of the TEL #3 boom section, leaving approximately two feet extended. Push the TEL #3 boom section completely into the TEL #2 boom section and raise the extend cylinder to the top of the TEL #2 boom section.

14. Assemble and install the 4/3/2 retract-2/3/4 extend pin (15) into the anchor plate at the bottom rear of the TEL #3 boom section

a. Assemble three extend cables (14) on the 4/3/2 retract-2/3/4 extend pin (15).

b. Install the shaft assembly into the retainer at the rear of the TEL #3 boom section.

15. Lower the extend cylinder and push it into the TEL #2 boom section while keeping cables taunt to approximately one foot behind the cylinder anchors in the TEL #2 boom section. Raise the rear of the extend cylinder to the top of the TEL #2 boom section.

16. Install the wear pad (16) with capscrews (17) at the rear of the fourth boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

17. Route the two 4/3/2 retract cables evenly centered around the retract anchor (18). Route the threaded ends of the 4/3/2 retract cables down through the opening in the rear of the TEL #2 boom section and pull the threaded ends of the 4/3/2 retract cables toward the front of the TEL #2 boom section. Install the 4/3/2 retract anchor (18) into the anchor plates at the rear of the TEL #3 boom section.

See Figure 4-7 for the following steps.

18. Assemble and install the 4/3/2 retract-1/2/3 extend pin (8) into the anchor plate at the bottom rear of the TEL #2 boom section.

a. Install one snap ring (12) and one spacer (11) onto the inside grooves of the pin.

b. Install the bushing (10) into the sheave (9), brush the bushing with chassis grease, and install it on both ends of the pin.

c. Install the remaining spacer (11) and snap ring (12) to the pin.

d. Loop the 4/3/2 retract cables around the sheaves (9) and pin (8).

e. Install the plugs in the ends of the pin (8).

f. Install the assembled pin into the retainer at the rear of the TEL #2 boom section.

g. Install the grease fittings (7) toward the rear of the boom section.

h. Apply multipurpose grease (MPG) to grease fittings.

19. Install the retract cable guides (6) with capscrews (5) into the rear of the TEL #2 boom section.

NOTE: Use caution when moving the extend cylinder to avoid damage to the cable guides (6).

20. Lower the extend cylinder on the wear pad (16 Figure 4-8).

TEL #2 and TEL #1 Boom Section

See Figure 4-7 for the following steps.

1. Install the two top wear pad retaining plates (22), wear pads (20), capscrews (19), and flat washers (21) onto the rear of the TEL #2 boom section (1).

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

2. Install the adjustment cam plate (23), capscrews (19), and flat washers (21).

3. Rotate the cam (23) until the gap is eliminated between the wear pads (20) and the boom section, keeping the sections centered for proper boom alignment.

4. Install the bottom wear pad (17) and shims (18) with capscrews (16) onto the rear of the TEL #2 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

5. Install the two side wear pads (2) and shims (3) onto the pins at the rear of the TEL #2 boom section. Shim according to calibration instructions in “Boom Calibration” on page 45.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

6. Stretch out the 1/2/3 sync extend cable then bring the threaded ends back together to form a loop and find the center of the cable’s length.

a. Slide this center loop from front to back through the cable anchor slot at the top rear of the TEL #2 boom section.

b. Slide the keeper sheave (4) into this slot from back to front so the raised portion of the sheave slides the into slot of the cable anchor plate.

c. Pull this loop of cable forward to lock the 1/2/3 sync extend cable to the TEL #2 boom section.

See Figure 4-6 for the following steps.

d. Place the sheave anchor assembly (20) on the top front of the TEL #2 boom section with its top bar up and forward.

e. Loop both threaded ends of the sync extend cable toward the back of the boom to form two loops, left and right, at the front of the boom. Slide the left and right loops into the left and right sides of the sheave anchor assembly.

f. Install the bearings (21) in the sheaves.

g. Brush the assembly with chassis grease.

h. Install the pins (23) into the sheaves (22).

NOTE: Make sure the grease feed holes are facing the back of the boom.

i. Slide the pins (with sheaves) into the slots in front of the sheave anchor assembly (20). Fold back and position the assembled sheave anchor assembly on top of the boom sections during assembly of the next boom section.

j. Route and pull the threaded ends of the sync extend cable (24) toward the rear of the boom and loop it over the rear of the boom.

NOTE: Make sure that the TEL #1 section extend cylinder ears are horizontal.

7. Raise and support the TEL #2 and TEL #3 boom sections and install them in the TEL #1 boom section approximately fifteen feet.

NOTE: Keep the 3/2/1 retract cables taut, not crossing cables and keeping all cables clear of pinch points created by slings and bottom pads.

8. Raise the TEL #2 and TEL #3 boom sections against the top of the TEL #1 boom section and install the wear pads (25) with capscrews (26) into the bottom front of the TEL #1 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

a. Lower the TEL #2 and TEL #3 boom sections onto the wear pads (25) in the TEL #1 boom section.

b. Push the TEL #2 and TEL #3 boom sections into the TEL #1 boom section, leaving approximately four feet of the TEL #2 and TEL #3 boom sections out of the TEL #1 boom section.

9. Assemble the 4/3/2 retract cable keeper plate assemblies (29) with capscrews (26) onto the 4/3/2 retract cables (24). Install the double nuts (2) just past the flats on the 4/3/2 retract cables and assemble at the bottom front of the TEL #1 boom section.

NOTE: Do not twist the cables. Twisting the cables will result in damage or failure of the cable. When initially assembling the threaded ends of the cables, thread the first nut on past the flat so adjustment can be made later.

10. Install the lower side wear pads (8) and shims (9 and 10) with capscrews (28) on the lower front insides of the TEL #1 boom section.

11. Install the upper side wear pads (8) and shims (9 and 10) with capscrews (28) on the upper front insides of the TEL #1 boom section.

NOTE: It may be necessary to support the components with a bar or tool that extends inside the boom section to aid in positioning components during assembly.

Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

12. Slide the previously assembled 1/2/3 extend cable sheave anchor assembly (20), which is on the top front of the TEL #2 boom section, into position in the TEL #1 boom section and secure with capscrews (16).

13. Install the grease fittings (19) into the pins (23).

14. Install the wear pad (11) with shims (12) on the inside top front of the TEL #1 boom section. Install the wear pad (18) and cable guide (13) with related hardware (14,15, and 17) on the top front of the TEL #1 boom section. Shim according to calibration instructions in “Boom Calibration” on page 45.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

15. Push the TEL #2 and TEL #3 boom sections into the TEL #1 boom section until it bottoms out against the TEL #1 section cylinder ears. Apply Loctite and install the capscrews and washers (2 and 3, Figure 4-2) to retain the TEL #1 section of the cylinder in the rear of the TEL #1 boom section.

See Figure 4-7 for the following steps.

16. Install the cable wear pad (25) with capscrews (24) on the top of the extend cylinder barrel.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

17. Install the extend cylinder into the slots at the rear of the TEL #2 boom section. Install the keepers (28), capscrews (26), and lock washers (27) with Loctite applied to the capscrews in the TEL #1 section cylinder in the TEL #1 boom section.

See Figure 4-6 for the following steps.

18. Install the wear pad (7) on top of the 2/3/4 extend cable anchor assembly (4), then install the 2/3/4 extend cable anchor assembly in the slots of the rear of the TEL #1 boom section while guiding the 2/3/4 extend cables (24) into the anchor assembly (4). Install nuts (2, 3, and 27) on the threaded ends of the 2/3/4 extend cables (spacer is used on center cable only).

NOTE: Do not twist the cables. Twisting the cables will result in damage or failure of the cable. When initially assembling threaded ends of cables, thread the first nut on past the flat washer so adjustment can be made later.

19. Lock the cable anchor assembly (4) in place with the flathead screws (6) through the top and back side plates with the socket head screw (5) on the TEL #1 boom section. Be sure 1/2/3 sync extend cables (24) are routed over the top of the 2/3/4 extend cable anchor.

See Figure 4-7 for the following step.

20. Route three 3/2/1 retract cables around the 3/2/1 retract cable keeper (15) and install them on the mounting bracket (14) with the capscrew (13) onto the3/2/1 retract cable anchor with 3/2/1 retract cables draped out behind the boom.

See Figure 4-5 for the following steps.

21. Assemble the pin (7) and install it into the bottom rear of the TEL #1 boom section.

- **a.** Install one snap ring (11) and one spacer (10) inside each sheave.
- **b.** Install the bearing (9) into the sheave (8) brush the bearing with multipurpose grease (MPG), and install it on both ends of the pin.
- **c.** Install the remaining washers and snap rings on pin.
- **d.** Loop the 3/2/1 retract cables around the sheaves (8) and pin (7) assembly.
- **e.** Install the plugs in the ends of the pin (7).

22. Install the assembly into the rear of the TEL #1 boom section.

- **a.** Install the assembled pin into the anchor plates at the rear of the TEL #1 boom section, pulling the threaded ends of 3/2/1 retract cables toward the front of the boom.
- **b.** Install the setscrews (6) behind the pin into rear of the TEL #1 boom section (1).
- **c.** Install the grease fittings toward the rear of the boom.
- **d.** Apply multipurpose grease (MPG) to the grease fittings.

23. Install the retract cable guides (5) and capscrews (4) into the rear of the TEL #1 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

24. Route the 3/2/1 retract cables between the bottom of the TEL #1 boom section and the bottom pad shims.

25. Install two side wear pads (2) and shims (3) onto the rear of the TEL #1 boom section. Shim according to calibration instructions in “Boom Calibration” on page 45.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

See Figure 4-3 for the following steps.

26. Install the two top wear pad retaining plates (6), wear pads (7), capscrews (4), and washers (5) onto the rear of the TEL #1 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

27. Install the adjustment cam plate (3), capscrews (4), and flat washers (5).

TEL #1 and Base Boom Section

See Figure 4-5 for the following steps.

1. Install the bottom wear pad (16), shims (17), and capscrews (15) onto the rear of the TEL #1 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

2. Install the two side wear pads (2) and shims (3) onto the rear of the TEL #1 boom section. Shim according to calibration instructions in “Boom Calibration” on page 45.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

3. Rotate the base section cylinder shaft so the counterbalance valve is directly below the cylinder shaft centerline.

4. Raise and support TEL #1, TEL #2, and TEL #3 boom sections and install them into the base boom section approximately fifteen feet.

NOTE: Keep the 3/2/1 retract cables taut, do not allow the cables to cross, and keep all cables clear of pinch points created by slings and bottom pads.

See Figure 4-4 for the following steps.

5. Raise the TEL #1, TEL #2, and TEL #3 boom sections against the top of the base boom section and install the wear pads (15) and capscrews (14) into the bottom front of the base boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

6. Lower TEL #1, TEL #2, and TEL #3 boom sections onto the wear pads in the base boom section. Push the TEL #1, TEL #2, and TEL #3 boom sections into the base boom section, leaving approximately four feet of the TEL #1, TEL #2, and TEL #3 boom sections sticking out of the base boom section.

7. Assemble the 3/2/1 retract cable anchor plates (24) with capscrews (23) onto 3/2/1 retract cables. Install nuts (20 and 21) just beyond the flats on 1/2/3 retract cables (22) and assemble at the bottom front of base boom section. Take care not to cross cables.

NOTE: Do not twist the cables. Twisting the cables will result in damage or failure of the cable. When initially assembling threaded ends of cables, thread the first nut on past the flats so adjustment can be made later.

8. Install the side wear pads (8), wear pad back plates (7), and back plates (6).

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

9. Install the adjusting capscrew (4) and jam nut (5) in the back plates of the base boom section. Install the wear pad retaining hardware (1—3) in the back plates.

NOTE: It may be necessary to support the components with a bar or tool that extends inside the boom section to aid in positioning components during assembly.

Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

10. Install the upper plate (9), shims (10), and hardware (11—13) at the front of the base boom section. Apply Loctite to the capscrews. Shim according to calibration instructions in see “Boom Calibration” on page 45.

See Figure 4-3 for the following steps.

11. Push the TEL #1, TEL #2, and TEL #3 boom sections in until all the cam plates (3) are accessible through the top access hole in the base, TEL #1, and TEL #2 boom sections, while keeping the 3/2/1 retract cables taut.

12. Rotate the cam plates (3) until the gap is eliminated between the wear pads and the boom section. Make sure that the boom sections remain centered for proper boom alignment. Tighten the capscrews (1).

13. Repeat step 12 for all wear pad adjustments.

See Figure 4-2 for the following steps.

14. Attach the base section cylinder rod to the base section hoist mount with washers (3) and capscrews (2). Apply Loctite and tighten to specification. See “Fasteners and Torque Values” on page 1-7.

NOTE: It is important in this step to have the nuts (20 and 21, Figure 4-4) loose on the 3/2/1 retract cables (22, Figure 4-4) at the bottom front of the base boom section.

15. Install the 1/2/3 sync extend cables (8) into the holes at the rear of the base boom section and install the washers (7) and nuts (6, 13, and 14) (if equipped) just beyond the flats. For proper nut configuration options. See “Cable Retention” on page 4-18

NOTE: Do not twist the cables. Twisting the cables will result in damage or failure of the cable. When initially assembling threaded ends of cables, thread the first nut on past the flat so adjustment can be made later.

16. Tighten the cables. See “Tensioning Setup Procedure” on page 4-17.

17. Install all protective caps on the threaded cable ends.

18. Extend the boom and align all boom sections as needed.

19. Install the inspection cover (11) with the hardware (9 and 10) to the top rear of the base boom section.

20. Extend and set the outriggers and single front outrigger (SFO).

21. Install the boom to the crane. See “Boom Assembly” on page 4-10.

22. Connect the hydraulic lines to the telescope cylinder as noted during removal.

23. Test the boom extend and retract for proper operation.

Four-Section Cable Tensioning

After boom assembly or if the interior proportioning cables appear loose, cable tensioning may be necessary.

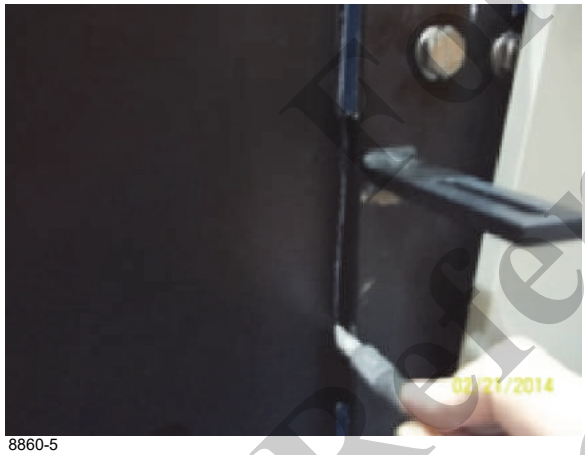
Tensioning Setup Procedure

NOTE: Cable tensioning must be done with the boom in the horizontal position.

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

Ensure that the boom is completely assembled and fully retracted.

1. Mark the front of each section with a chalk line as indicated in Figure 4-9.
2. Extend and retract the boom several times to establish the working state of the cables.
3. Extend the boom so that the scribed lines are exposed by approximately 305 mm (12 in).
4. Measure the extension gaps between each boom section and the scribed line and note the values.
5. Retract the boom so that the scribed lines are exposed by approximately 152 mm (6 in).
6. Measure the retraction gaps between each boom section and the scribed line and note the values.
7. Extend and retract the boom a few times and then repeat measuring the extension gaps.
8. Adjust all corresponding cables. See “Cable Tightening Sequence” on page 4-17.



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8860-6

FIGURE 4-9

Cable Tightening Sequence

Cables must be tightened in the following order:

1. 3/2/1 retract cables
2. 1/2/3 extend (synchronizing) cables
3. 2/3/4 extend cables
4. 4/3/2 retract cables

The boom must be in horizontal position when adjusting cable tension. Fully retract the boom to ensure that the sections are bottomed out on the section stops. Make sure that all the sections are fully bottomed out and do not spring back. See “Tensioning Setup Procedure” on page 4-17.

3/2/1 and 1/2/3 Cable Balancing

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

If the extension gap between the first and second section is less than the extension gap between the second and third sections, complete the following steps.

2. Tighten the 3/2/1 retract cable located at the front bottom of the rear section the difference in the extension gap measurements.
3. Extend and retract the boom a few times and then repeat the measurement of the extension gaps.

The second section should have moved out.

4. Continue tightening until the extension gap between the first and second sections and the extension gap between the second and third sections are equal.

If the third section starts to go out with the second section when tightening the 3/2/1 retract cable, the 1/2/3 synchronizing cable located at the top back of the rear section may need to be loosened.

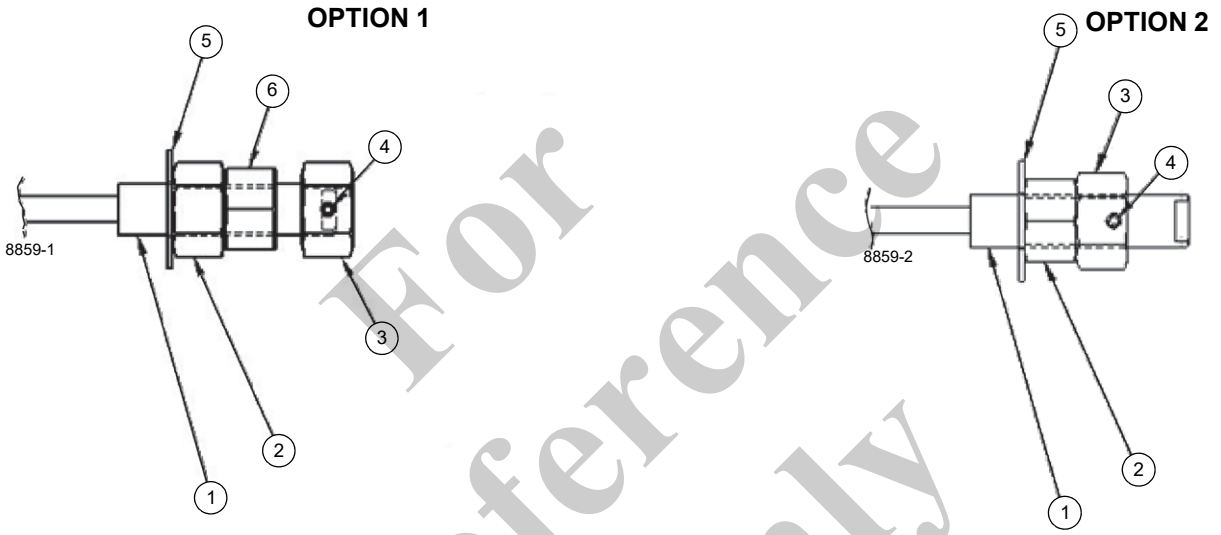
Retraction

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

If the retraction gap between the first and second sections is greater than the retraction gap between the second and third sections complete the following steps:

2. Tighten the 1/2/3 synchronizing cable located at the back of the rear section the difference in the retraction gap measurements.
3. Extend and retract the boom a few times and then remeasure the retraction gaps.
4. Continue tightening until the retraction gap between the first and second sections and the retraction gap between the second and third sections are equal.
5. Tighten the extend cables to 61.01 Nm (45 ft-lb). Tighten the 3/2/1 retract cables to 8.13 Nm (6 ft-lb). Tighten the 1/2/3 extend cable to 29.83 Nm (22 ft-lb).
6. Cycle the boom through a complete extend and retract cycle. Make sure all cables are properly tightened and that all sections retract completely.

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



Item	Description
1	Threaded Cable End
2	Nut (Adjustment)
3	Nut (Positive Lock)

Item	Description
4	Setscrew
5	Washer
6	Nut (Torqued)

FIGURE 4-10

Cable Retention

To retain the cables the nut configuration will be first nut (adjustment) and second nut (torqued). see Figure 4-10.

NOTE: Use Option 2 only when space constraints inhibit the use of Option 1 (see Figure 4-10).

When tightening or loosening the first nut (2) on the cables, secure the 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, install and tighten the second nut (6) on all retract and extend cables.

Hand tighten the second nut until it comes in contact with the back of the first nut.

Hold the first nut (2) stationary and use a torque wrench to tighten the second nut (6) against the first nut. See “Torque Values for Second Lock Nut” on page 4-19.

Install the third nut (3) on each of the extend cables. The retract cables do not require the third nut.

Hand tighten the third nut until the tapped hole for the setscrew is tangent to the end face of the wrench flat.

Install the set-screw into the third nut (3) and tighten.

Use Option 2 only when space constraints inhibit the use of Option 1 (see Figure 4-10).

Torque Values for Second Lock Nut

Table 4-1

Inch Series with Coarse Threads (UNC)			
Cable End Thread Size	Minimum Nut Strength GRADE	Nut Type	Torque
1/2-13	SAE 2	Hex Jam (HALF)	16 Nm (12 ft-lb)
5/8-11	SAE 2	Hex Jam (HALF)	42 Nm (31 ft-lb)
3/4-10	SAE 2	Hex Jam (HALF)	64 Nm (47 ft-lb)
7/8-9	SAE 2	Hex Jam (HALF)	85 Nm (63 ft-lb)
1-8	SAE 2	Hex Jam (HALF)	270 Nm (199 ft-lb)
1 1/4-7	SAE 2	Hex Jam (HALF)	275 Nm (203 ft-lb)
1 1/2-6	SAE 5	Hex Jam (FULL)	339 Nm (250 ft-lb)
1 3/4-5	ASTM B	Hex Jam (FULL)	339 Nm (250 ft-lb)
Metric Series with Coarse Threads			
Cable End Thread Size	Minimum Nut Property Class	Nut Type	TORQUE Nm (ft lb)
M16x2	5	Hex Jam (THIN)	26 Nm (19 ft-lb)
M20x2.5	5	Hex Jam (THIN)	66 Nm (49 ft-lb)

Four-Section Top and Bottom Pad Replacement (Assembled Boom)

Inspect the top and bottom wear pads periodically for signs of abrasion or excessive wear.

Excessive wear is wear that is in excess of 4.76 mm (0.188 in) from the original thickness.

The base, TEL #1, and TEL #2 boom section bottom pads at the front end are 31.8 mm (1.25 in) thick. The TEL #1 and TEL #2 section top pads are 28.6 mm (1.125 in) thick. The TEL #3 section top pads are 11.6 mm (0.45 in) thick.
Uneven wear pattern such as the outside edge of the pad worn in excess of 1.59 mm (0.0625 in) more than the inside edge of the pad. If any of these conditions are found, the top and bottom pads may be replaced without disassembly of the boom.

If the boom extension operates erratically or during replacement of top and bottom pads, it is recommended that the lubricating plugs in the wear pads also be replaced with new plugs. New lubricating plugs initially extend 2.38 mm (0.0938 in) above the pad surface and will wipe a long-lasting coating of lubricant onto the boom sliding surface.

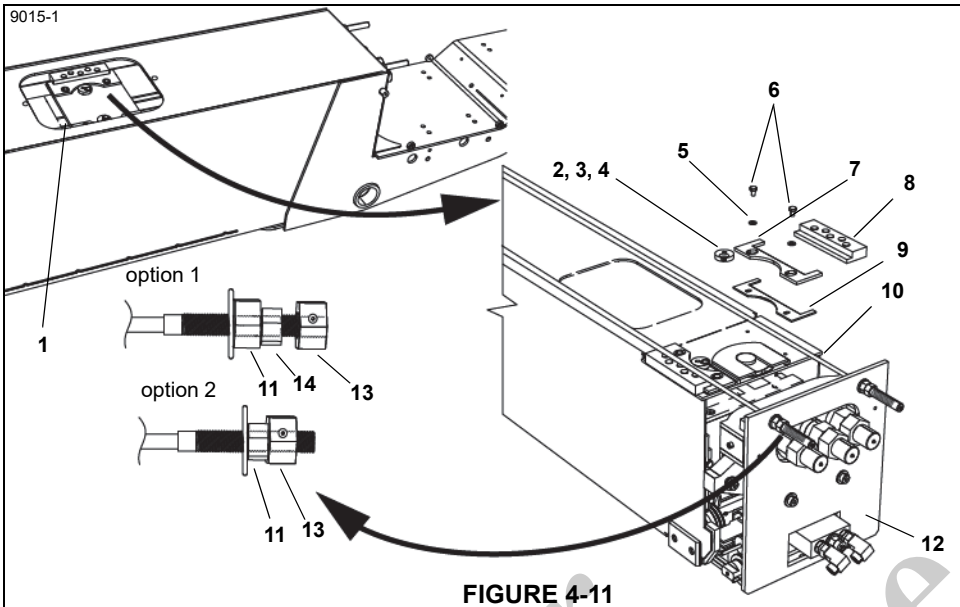


FIGURE 4-11

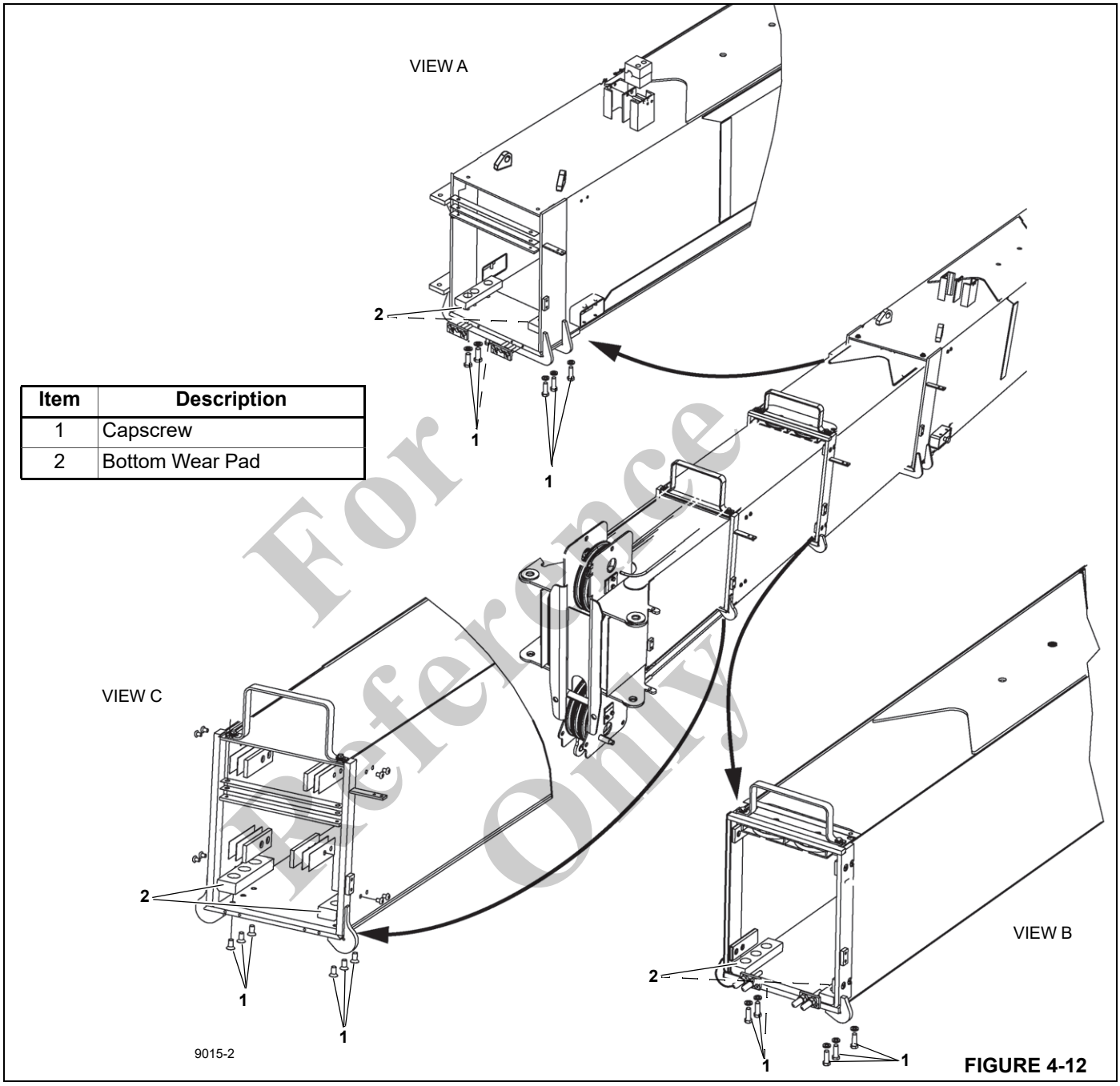
Item	Description
1	Inspection Hole
2	Capscrew
3	Washer
4	Cam Plate
5	Washer
6	Capscrew
7	Wear Pad Retaining Plate
8	Top Wear Pad
9	Shim
10	1/2/3 Extend Cable
11	Nut (Adjustment)
12	Back Plate
13	Nut (Positive Lock)
14	Nut (Torqued)

SeeFigure 4-11for the following steps.

NOTE: All top wear pads must be tagged, inspected, and reassembled exactly as they were removed unless doing a complete overhaul.

1. Remove the inspection cover from the rear of the base section boom.
2. Retract the boom completely, then extend the boom approximately 343 mm (13.50 in) or 114 mm (4.50 in) per section so that the top wear pads on the TEL #2 boom section are visible through the inspection hole (1) of the base and TEL #1 boom sections.
3. Remove the capscrew (2), washer (3), and cam plate (4) from the TEL #2 boom section.
4. Remove the capscrews (6), washers (5), wear pad retaining plates (7), and shims (9) from the TEL #2 boom section. Remove the top wear pads (8) from the TEL #2 boom section. Mark the wear pad retaining plates so they can be reinstalled exactly as they were removed.
5. Mark the location of the nuts (11,13, and 14) (if equipped). Loosen and remove the 1/2/3 extend cables (10) from the mounting holes at the back plate (12) of the base boom section. Tie the 1/2/3 extend cables with approximately 610 mm (24 in) of wire and allow them to slack into the base boom section, removing the cables from the notch in the TEL #2 boom section pads.
6. Replace the TEL #2 boom section top wear pads and install the wear pad retaining plates exactly as removed from the top plate of the TEL #2 boom section. Apply Loctite to all flathead mounting screws.
7. If necessary, reinstall the 1/2/3 extend cables into the rear of the base boom section and reinstall the nuts that secure these cables to their original location previously marked on the threaded cable ends.
8. Extend the boom approximately 800 mm (31.5 in) or 265 mm (10.44 in) per section, so that the top wear pads on the TEL #1 boom section are visible through the inspection hole in the top plate of the base boom section.
9. Remove the capscrews from the TEL #1 boom section wear pad retaining plates and slide the wear pad retaining plates toward the center of the boom. Mark these retaining plates so they can be installed exactly as removed. Remove the TEL #1 boom section top wear pads.
10. Replace the TEL #1 boom section top wear pads and install the wear pad retaining plates onto the top plate of the TEL #1 boom section exactly as removed. Apply Loctite to all flathead mounting screws.
11. Extend the boom approximately 12.4 m (40.7 ft) or 4 m (13.5 ft) per section, so that the rear of the TEL #3 boom section passes the hole in the side plate of the TEL #2 boom section. Raise the front of the TEL #3 boom section to relieve pressure on the wear pads on the top rear of the TEL #3 boom section.
12. Remove the capscrews from the bottom of the top plate on the rear of the TEL #3 boom section that attaches the wear pad retaining plates to the TEL #3 boom section.
13. Slide the wear pad retaining plates and top wear pads toward the rear of the boom and remove. Mark the wear pad retaining plates so they can be installed exactly as they were removed.
14. Replace the TEL #3 boom section top wear pads and install the wear pad retaining plates exactly as removed onto the top plate of the TEL #3 boom section. Apply Loctite to all flathead mounting screws.

Bottom Wear Pad Replacement



Item	Description
1	Capscrew
2	Bottom Wear Pad

FIGURE 4-12

See Figure 4-12 for the following steps.

1. Lower the boom until the boom lift cylinder is bottomed out, and extend the boom approximately 18 m (6 ft) or 0.6 m (2 ft) per section.
2. Raise the front of the TEL #3 boom section until the weight is removed from the bottom pads in the TEL #2, TEL #1, and base boom sections.
3. Remove the capscrews (1, View A and B) (three in each pad) that retain the TEL #1 and base boom section bottom wear pads (2, View A and B) and remove the bottom wear pads. Install new bottom wear pads. Apply Loctite and install the capscrews securely.
4. Remove the capscrews (1, View C) (three in each pad) that retain the TEL #2 boom section bottom wear pads (2) and remove the bottom wear pads. Install new bottom wear pads. Apply Loctite and install the capscrews securely.

‘FIVE-SECTION BOOM

See Figure 4-13 for the following information.

A two-section, rod fed, double-acting cylinder is attached to and supports the base, TEL #1, and TEL #2 boom sections.

The 3/4/5 extend cables attach to the rear of the TEL #2 boom section, are reeved around the sheaves at the front of the TEL #3 boom section, and attach to the rear and support the TEL #4 boom section.

The 5/4/3 retract cables are attached to the rear of the TEL #4 boom section, are reeved around the sheaves at the rear of the TEL #3 boom section, and attach to the front of the TEL #2 boom section.

The 2/3/4 extend cables attach to the rear of the TEL #1 boom section, are reeved around the sheaves at the front of the TEL #2 section cylinder, and attach to the rear and support the TEL #3 boom section. The 4/3/2 retract cables are attached to the rear of the TEL #3 boom section, are reeved around the sheaves at the rear of the TEL #2 boom section, and attach to the front of the TEL #1 boom section.

The 1/2/3 extend cables attach to the rear of the base boom section, are reeved around the sheaves at the front of the TEL #1 boom section, and attach to the rear of the TEL #2 boom section.

The 3/2/1 retract cables attach to the rear of the TEL #2 boom section, are reeved around the sheaves at the rear of the TEL #1 boom section, and attach to the front of the base boom section.

The 3/2/1 retract cables directly oppose the 1/2/3 extend cables to ensure that the TEL #1 and TEL #2 boom sections 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 TEL #2 and TEL #3 boom sections 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 TEL #3 and TEL #4 boom sections extend and retract equally at all times.

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

Hydraulic extend cylinder construction dictates which extendable section will be the driver that the other extend sections are adjusted to.

A single-section cylinder will control the first extendable section.

A dual-section cylinder will control the second extendable section.

NOTE: Timing sequence of cables depends on the number of sections and the extend cylinder construction.

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

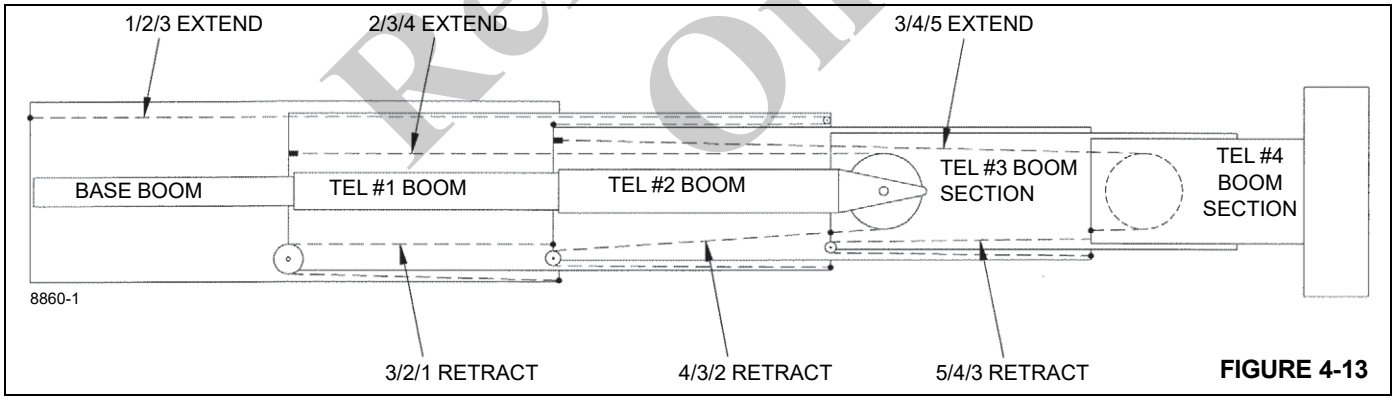


FIGURE 4-13

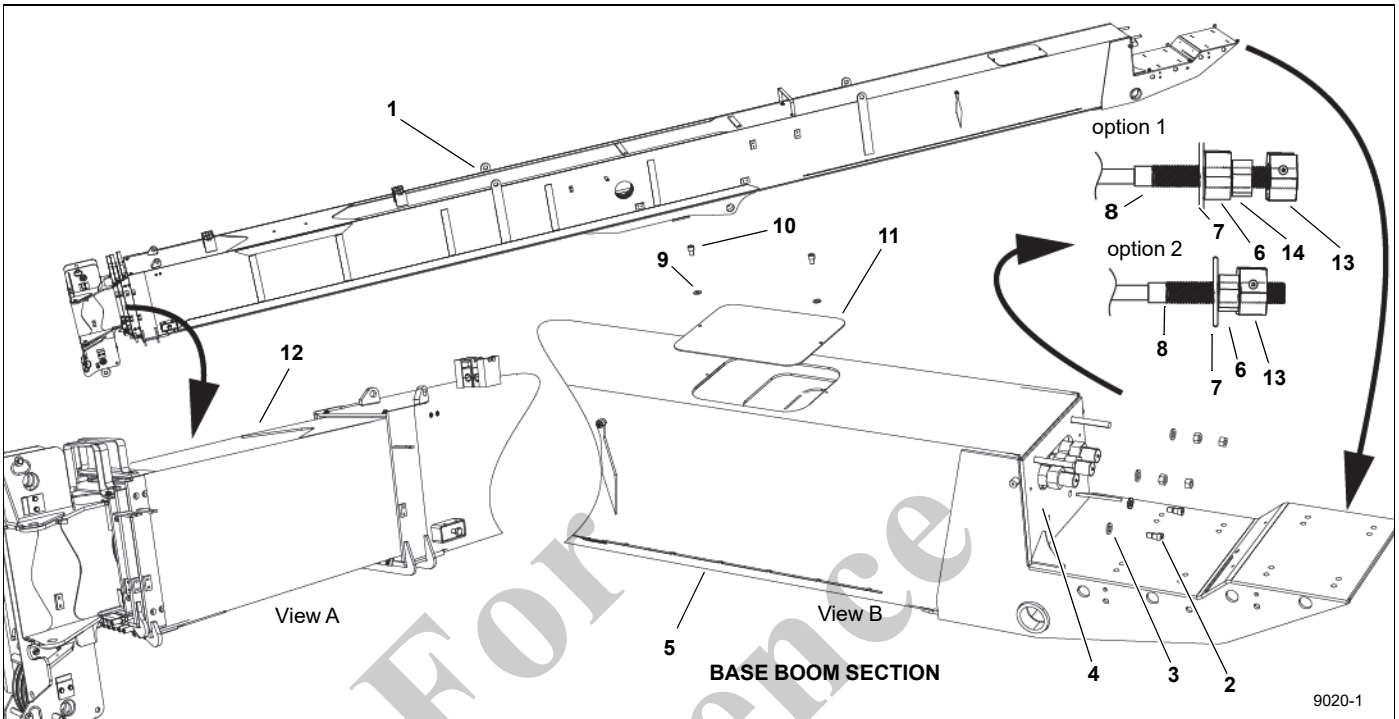
Boom Removal

See Figure 4-13, Figure 4-21, Figure 4-18, Figure 4-20, and Figure 4-21 for Boom Removal, Disassembly, Assembly and Cable Tensioning.

For boom weight, see “Specifications” in Section 9 of this manual.

1. Extend and set the machine outriggers and optional single front outrigger (SFO) (if equipped). The boom must be completely retracted and stowed in the boom rest over the front of the truck.
2. If equipped, remove the swing around the jib according to the procedures outlined in Section 6 of the Operator’s Manual.
3. Remove the hook block or downhaul weight and wind up the rope on the hoist drum. Turn off the engine.
4. Attach a lifting device to the counterweight to provide even weight distribution. Raise the counterweight until the weight is removed from the boom pivot pin. Remove the counterweight retaining hardware from the boom pivot pin and lower the counterweight until it rests on the rear outrigger box.
5. Attach a lifting device to the rod end of the lift cylinder, and remove the boom lift cylinder pin keeper and pin from the bottom of the base boom section. Lower the lift cylinder rod end to the deck.
6. Tag and disconnect the extend cylinder lines, hoist hydraulic lines, and electric cables. Cap and plug all openings. Unplug the anti-two-block/RCL cable from the receptacle in the turret.
7. Disconnect and cap all hoist hydraulic lines and openings from the hoist. The hoist may be removed at this point, but it is not necessary. See “Hoist Removal” on page 5-2.
8. Attach a lifting device to provide even weight distribution and raise the boom until the weight is removed from the boom pivot pin. Remove the boom pivot pin keeper and boom pivot pin. Lift the boom free of the turret.

Five-Section Boom Disassembly



Item	Description
1	Base Boom Section
2	Capscrew
3	Washer
4	Rear
5	Front

Item	Description
6	Nut (Adjustment)
7	Washer
8	1/2/3 Extend Cables
9	Washer
10	Capscrew

Item	Description
11	Inspection Cover
12	TEL #1 Boom Section
13	Nut (Positive Lock)
14	Nut (Torqued)

FIGURE 4-14

See Figure 4-14 for the following procedure.

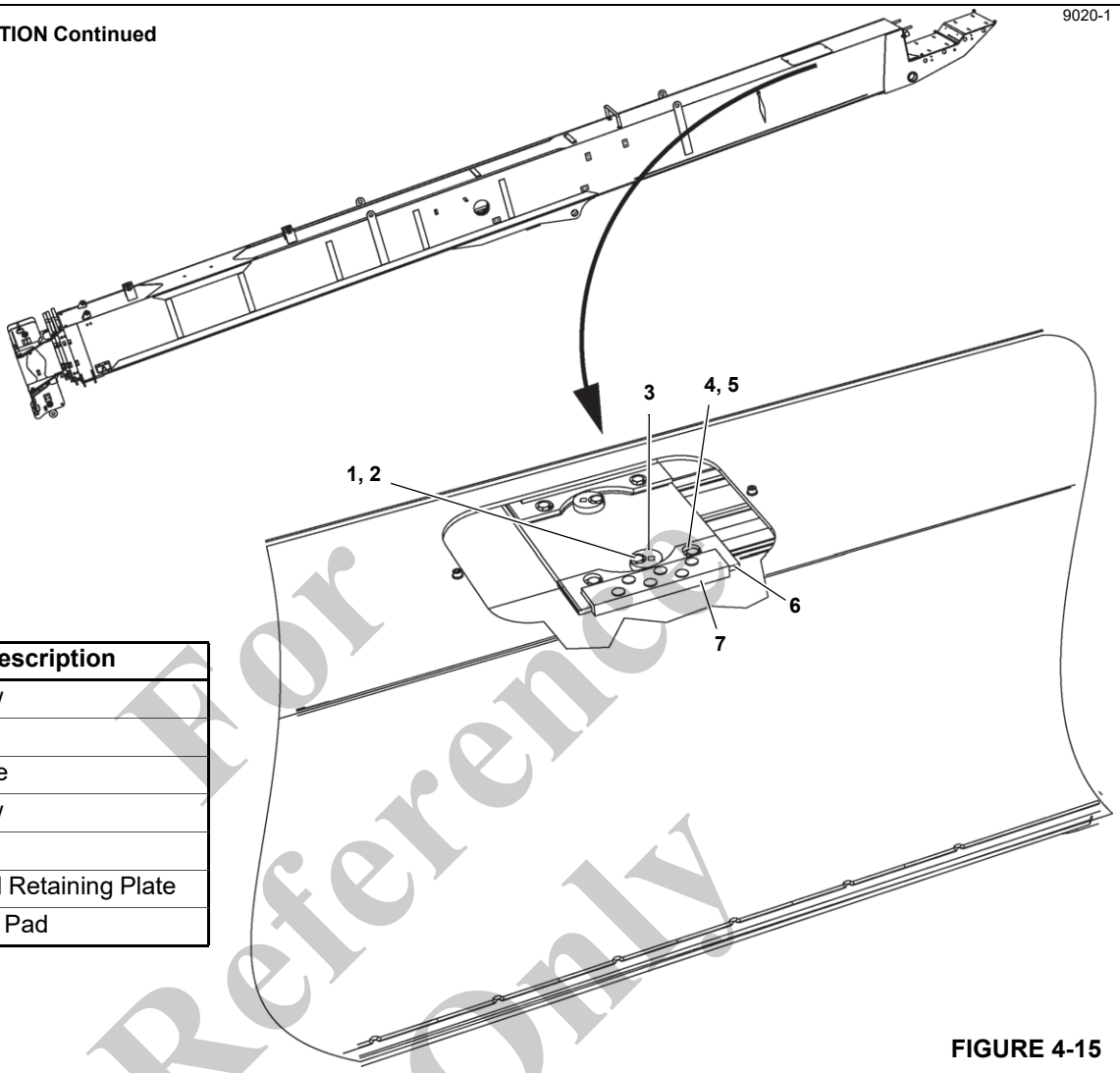
For reference, the front (View A) is the sheave case end, the rear (base) (View B) is the hoist mount end, and left and right are viewed from rear to front.

NOTE: All wear pads must be tagged, inspected, and reassembled exactly as they have been removed unless doing a complete overhaul.

Steps 1 through 3 apply to a boom that is to be disassembled with the base section and jib (if equipped) left on the crane. all other steps apply to the boom being removed from the crane (See “Boom Removal” on page 4-2).

1. Extend and set the machine outriggers and optional single front outrigger (SFO) (if equipped).
2. Completely retract the boom and place it in a horizontal position.
3. Tag and disconnect the hydraulic lines to the telescope cylinder. Cap and plug all lines and openings.
4. Remove the capscrews (2) and washers (3) that anchor the base section extend cylinder rod to the rear (4) of the base boom section (1). Repeat for the other side.
5. Mark the location of the nuts (6, 13, and 14) (if equipped) and washer (7) that secure the 1/2/3 extend cables (8) to the rear (4) of the base boom section (1). Remove the nuts and washers from the 1/2/3 extend cables at the rear of the base boom section. Mark and tag the cables while leaving the cable ends draped inside the boom.
6. Remove the capscrews (10) and flat washers (9) and remove the inspection cover (11) from the top rear of the base boom section (1).
7. Attach a sling or chain to the front of the TEL #1 boom section (12) and pull out the TEL #1 boom section (with the TEL #2, TEL #3, and TEL #4 boom sections) approximately 304 mm (12 in). Remove and tag four side wear pads with shims and one top wear pad with shims from the front of the base boom section.

BASE BOOM SECTION Continued



Item	Description
1	Capscrew
2	Washer
3	Cam Plate
4	Capscrew
5	Washer
6	Wear Pad Retaining Plate
7	Top Wear Pad

FIGURE 4-15

NOTE: All top wear pads must be tagged, inspected, and reassembled exactly as they have been removed.

8. Remove the capscrew (1), washer (2), and cam plate (3) from the TEL #1 boom section.

9. Remove the capscrews (4) and washers (5) and remove the wear pad retaining plate (6).

10. Remove the top wear pad (7) from the top of the boom section. Repeat for the other side and the remaining boom sections being removed.

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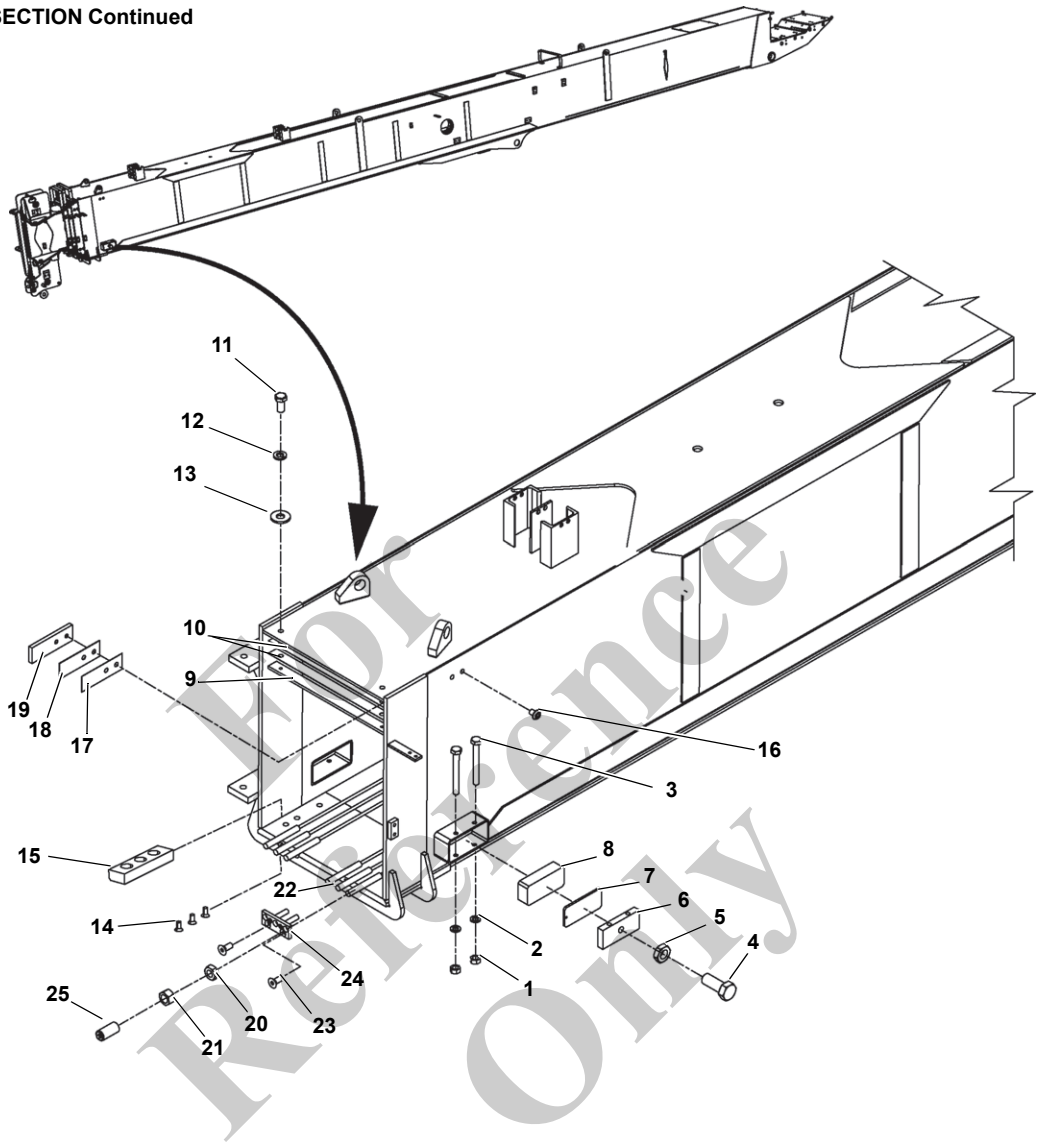
BASE BOOM SECTION Continued



Item	Description
1	Nut
2	Lock Washer
3	Capscrew
4	Capscrew
5	Jam Nut
6	Back Plate
7	Wear Pad Back Plate
8	Wear Pad
9	Upper Plate

Item	Description
10	Shim
11	Capscrew
12	Lock Washer
13	Flat Washer
14	Socket Head Capscrews
15	Bottom Wear Pad
16	Capscrew
17	Shim

Item	Description
18	Shim
19	Upper Side Wear Pad
20	Lock Nut
21	Nut
22	3/2/1 Retract Cable
23	Capscrew
24	Retract Cable Anchor Plates
25	Cable Protector

FIGURE 4-16

See Figure 4-16 for the following steps.

11. Remove and tag the nut (1), lock washer (2), and capscrew (3) on the front end of the base boom section (see Figure 4-16). Loosen the wear pad adjustment jam nut (5) and capscrew (4). Tag and remove the wear pad (8), back plates (6), and wear pad back plates (7).

12. Remove the capscrew (11), lock washer (12), and flat washer (13). Tag and remove the upper plate (9) and shims (10) from the front of the base boom section.

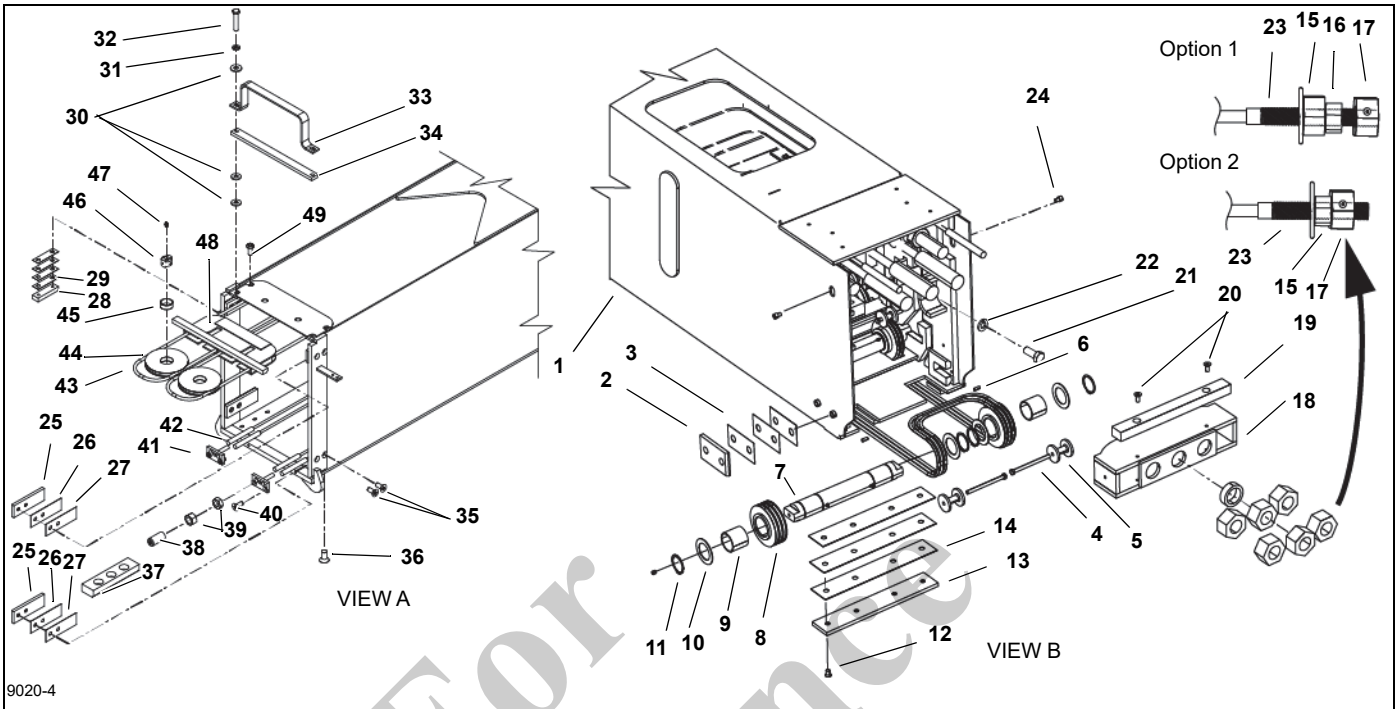
13. Remove the capscrews (16) from the side of the base boom section. Tag and remove the two upper side wear pads (19) and shims (17 and 18) from the front of the base boom section.

14. Remove the cable protector (25) and loosen the cable adjusting lock nut (20) and nut (21) on the lower front 3/2/1 retract cables (22). Remove the four capscrews (23) that retain the 3/2/1 retract cable anchor plates (24) to the bottom front of the base boom section.

15. Pull the retract cable anchors out and keep the retract cables taut while pulling the TEL #1 (with TEL #2 and TEL #3) boom section out of the base boom section. Partially pull the TEL #1 boom section from the boom assembly until the front of the boom can be raised enough to remove and tag the bottom wear pads (15) and socket head capscrews (14) from the bottom front of the base boom section. Support the rear end of the TEL #1 boom section as it exits the base boom section.

16. Place the TEL #1 (with TEL #2, TEL #3, and TEL #4) boom section on a suitable horizontal surface.

NOTE: Use caution not to pinch or crush the retract cables while lifting or supporting the TEL #1 boom section.



TEL #1 BOOM SECTION

Item	Description
1	TEL #1 Boom Section
2	Rear Wear Pad
3	Shim
4	Capscrew
5	Guide Roller
6	Setscrew
7	Retract Sheave Pin
8	Retract Sheave
9	Bearing
10	Spacer
11	Snap Ring
12	Capscrew
13	Bottom Wear Pad
14	Shim
15	Nut (Adjustment)
16	Nut (Torqued)
17	Nut (Positive Lock)

Item	Description
18	Cable Anchor
19	Wear Pad
20	Flathead Screw
21	Capscrew
22	Flat Washer
23	Extend Cable
24	Socket Head Screw
25	Wear Pad
26	Shim
27	Shim
28	Steel Pad
29	Shim
30	Flat Washer
31	Lock Washer
32	Capscrew
33	Cable Guide

Item	Description
34	Wear Pad
35	Capscrew
36	Capscrew
37	Wear Pad
38	Cable Protector
39	Nut
40	Capscrew
41	Plate Assembly
42	Cable Assembly
43	Cable Assembly
44	Sheave
45	Bearing
46	Pin
47	Grease Fitting
48	Sheave Anchor Assembly
49	Capscrew

FIGURE 4-17

See Figure 4-17 for the following steps.

17. Remove the capscrew (4) and guide roller (5) from each side of the bottom rear of the TEL #1 boom section (1).

18. Remove the two setscrews (6) that retain the 3/2/1 retract sheave pin (7). Remove the retract sheave pin assembly. Remove the retract sheaves (8), bearings (9), spacers (10), and snap rings (11) as an assembly from its slot at the rear of the TEL #1 boom section. Smooth out any burrs that may be present on the flat ends of the pin to eliminate sheave bearing damage when the sheaves are removed from the pin.

19. Remove the two socket head screws (24) and two socket flathead screws (20) that retain the wear pad (19) to the cable anchor (18) attached to the top rear of the TEL #1 boom section (1).

20. Mark the location of the nuts (15—17) (if equipped) that secure the 2/3/4 extend cables (23) to the rear of TEL #1 boom section. Remove the nuts and cable anchor (18) from the top/rear of the TEL #1 boom section.

21. Remove the capscrew (21) with flat washers (22) from the extend cylinder anchor brackets as part of the center rear of the TEL #1 boom section.

22. Attach a sling or chain to the front of the TEL #2 boom section and pull the TEL #2 boom section (with the TEL #3 and TEL #4 sections) out approximately one foot. Remove and tag the upper and lower side wear pads (25) and shims (26 and 27) from the front of TEL #1 boom section. Remove and tag the two top inner steel pads (28) and shim (29) from the front of the TEL #1 boom section.

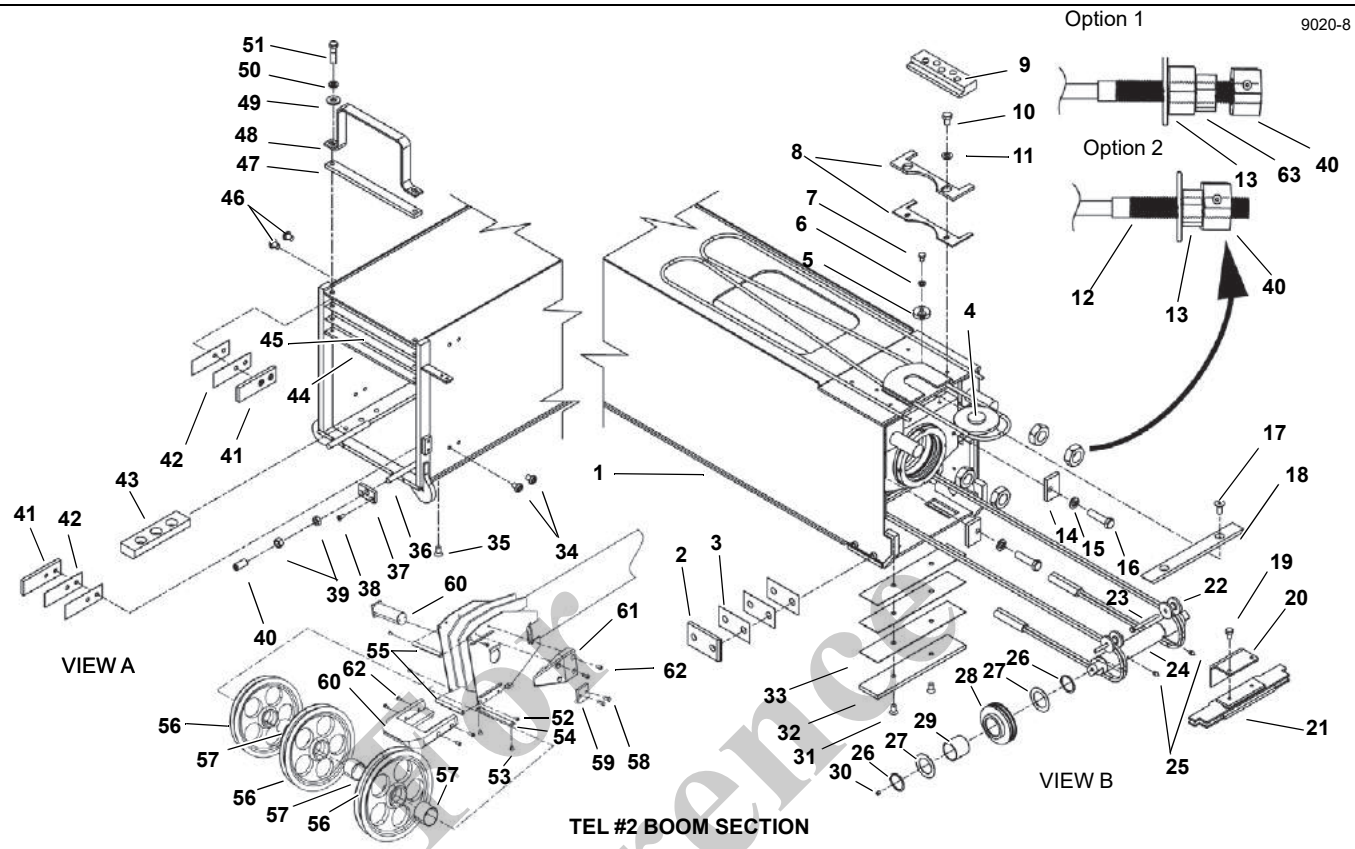
23. Remove and tag the cable guide (33) and hardware (30—32 and 34) located on the top front of the TEL #1 boom section.

24. Slide the 1/2/3 extend cable sheave anchor assembly (44—48) out from the top front of the TEL #1 boom section and allow the sheave case assembly and cables (43) to rest on the top of the TEL #2 boom section. Push the two sheaves at the front of the TEL #1 boom section forward and remove them from the 1/2/3 extend cable sheave anchor assembly (48) and sheaves (44) previously removed and stored at the front of the TEL #2 boom section. The cable loops may now be pulled back out of the sheave case, and the 1/2/3 extend cable is free. Smooth out any burrs that may be present on the flat ends of the pins to eliminate sheave bearing damage and if necessary to remove the pins from the top sheaves.

25. Remove the cable protectors (38). Loosen the adjustment nuts (39) from the retract cable (42). Remove the capscrews (40) that retain the 4/3/2 retract cable anchor plate assembly (41) to the bottom front of the TEL #1 boom section.

26. Raise the front of the boom and remove the wear pads (37) from between the bottom front of the TEL #1 boom section. Pull the retract cable anchors out and keep the retract cables taut while pulling the TEL #2, TEL #3, and TEL #4 boom sections out of the TEL #1 boom section.

27. Place the TEL #2, TEL #3, and TEL #4 boom sections on a suitable horizontal surface.



TEL #2 BOOM SECTION

Item	Description
1	Boom Section Rear
2	Wear Pad
3	Shim
4	Sheave
5	Cam Plate
6	Flat Washer
7	Capscrew
8	Wear Pad Retaining Plate
9	Top Wear Pad
10	Capscrew
11	Flat Washer
12	Cable
13	Nut (Adjustment)
14	Keeper
15	Lock Washer
16	Capscrew
17	Capscrew
18	Wear Pad
19	Capscrew
20	Cable Keeper Bracket
21	Cable Keeper

Item	Description
22	Guide Roller
23	Capscrew
24	Sheave Pin
25	Grease Fitting
26	Snap Ring
27	Spacer
28	Sheave
29	Bearing
30	Plug
31	Capscrew
32	Wear Pad
33	Shim
34	Capscrew
35	Capscrew
36	Cable Assembly
37	Keeper
38	Capscrew
39	Nut
40	Nut (Positive Lock)
41	Wear Pad
42	Shim

Item	Description
43	Wear Pad
44	Wear Pad
45	Shim
46	Capscrew
47	Wear Pad
48	Cable Guide
49	Flat Washer
50	Lock Washer
51	Capscrew
52	Capscrew
53	Capscrew
54	Plate
55	Rod
56	Sheave
57	Bearing
58	Capscrew
59	Keeper
60	Sheave Pin
61	Wear Pad
62	Capscrew
63	Nut (Torqued)

FIGURE 4-18

See Figure 4-18 for the following steps.

28. Remove the capscrews (19), retract cable keeper bracket (20), and cable keeper (21) from the lower rear of the TEL #2 boom section. Store the 3/2/1 retract cables, which are now free, in an area where they will not be damaged during further boom disassembly.

NOTE: Use caution not to pinch or crush retract cables while lifting or supporting the TEL #2 boom section.

29. Tag and remove the wear pads (2) and shims (3) from the rear of the TEL #2 boom section (1).

30. Remove the 1/2/3 extend cable from the top of the TEL #2 boom section. Slide the top center rear sheave (4) toward the rear of the boom section and remove. Pull the cable loop forward and remove it from the sheave keeper. The cable is now free at the rear of the boom.

31. Loosen and remove the two capscrews (17) retaining the wear pad (18) to the top rear of the TEL #2 boom section. Loosen and remove the two capscrews (16), lockwashers (15), and keepers (14) that anchor the extend cylinder at the center rear of the TEL #2 boom section. Attach a sling to the rear of the extend cylinder and pull the extend cylinder out of the TEL #2 boom section approximately one foot, keeping the 2/3/4 extend cables taut. Raise and support the extend cylinder approximately five inches.

NOTE: Avoid damage to the retract cable guide roller (22) when lifting the cylinder.

32. Remove the capscrews (23) and retract cable guide roller (22) from each side of the bottom rear of the TEL #2 boom section. Pull the retract sheave pin (24) with the sheaves as an assembly (25—30) back and out of its slot at the bottom rear of the TEL #2 boom section. Smooth out any burrs that may be present on flat ends of the pin to eliminate sheave bearing damage if sheaves are removed from the pin. Stow the cable out of the way to avoid damage.

33. Push the 4/3/2 retract anchor (19, Figure 4-19) forward out of its slot in the bottom rear of the TEL #3 boom section and remove it from the TEL #3 boom section with the wear pad (18) attached. Remove the 4/3/2 retract cables from the anchor and store in an area where they will not be damaged during further boom disassembly.

34. Mark the location of the nuts (39) that secure the 5/4/3 retract cables (36) to the front of the TEL #2 boom section. Loosen the nuts and remove the keeper (37) and capscrew (38) to the end of the cable thread.

SeeFigure 4-19 for the following steps.

35. Remove the capscrews (16) and the guide rollers (15) from each side of the bottom rear of the TEL #3 boom section.

36. Remove the 5/4/3 retract cable anchor capscrews (10, Figure 4-20) from the inside rear of the TEL #4 boom section. Remove the 5/4/3 retract cables (36, Figure 4-18) from the anchor plate in the bottom rear of the TEL #4 boom section and drape outside of rear end of the TEL #2 boom section.

See Figure 4-19 for the following steps.

37. Pull the pin (20) with the sheaves (23) and cables as an assembly from the slot, located in the rear of the TEL #3 boom section. Allow the assembly to hang from the rear of the TEL #2 boom section to remove and tag the sheaves and cables from the pin.

38. Lower the cylinder to its original position. Attach a sling or chain to the front of the TEL #4 boom section and pull the TEL #4 boom section out of the TEL #3 boom section approximately one foot. Remove the extend cylinder from the boom, keeping the 2/3/4 extend cables taut.

See Figure 4-18 for following steps.

39. Remove the capscrews (62) and the wear pads (61) from the sheave case of the extend cylinder.

40. Remove the capscrews (52 and 53), rods (55), and plate (54) from the sheave case. Remove the sheaves (56) from the sheave case by removing the two capscrews (58) and keeper (59) from the sheave pin (60). Lightly tap the pin out while removing the sheaves from the front of the sheave case.

41. Remove the 2/3/4 extend cables from the pin (20, Figure 4-19) and store the cables and extend cylinder in an area where they will not be damaged during further boom disassembly.

42. Remove the nuts (13, 40, and 63) (if equipped) that retain the 3/4/5 extend cables (12) to the top rear end of the TEL #2 boom section. Push the TEL #4 boom section back into the TEL #3 boom section. Install the pin back into the slot in the bottom rear end of the TEL #3 boom section. Install the 5/4/3 retract cables (36) into the anchor plates at the bottom rear end of the TEL #4 boom section.

43. Attach a sling or chain to the front of the TEL #3 boom section and pull out (with the TEL #4 boom section) approximately two feet. Remove and tag the upper and lower side wear pads (41) and shims (42).

44. Remove the top wear pad (44), shims (45), cable guide (48), and wear pad (47) with related hardware (49—51) on the top front of the TEL #2 boom section (1).

45. Remove the four capscrews (38) that retain the 5/4/3 retract cable keeper (37) to the bottom front of the TEL #2 boom section. Remove the wear pads (43) from the bottom front of the TEL #2 boom section. Pull the retract cable anchors out and keep the retract cables taut while pulling the TEL #3 boom section (with the TEL #4 boom section) out of the TEL #2 boom section.

46. Place the TEL #3 and TEL #4 boom sections on a suitable horizontal surface.

NOTE: Use caution not to pinch or crush the retract cables while lifting or supporting the TEL #3 boom section.

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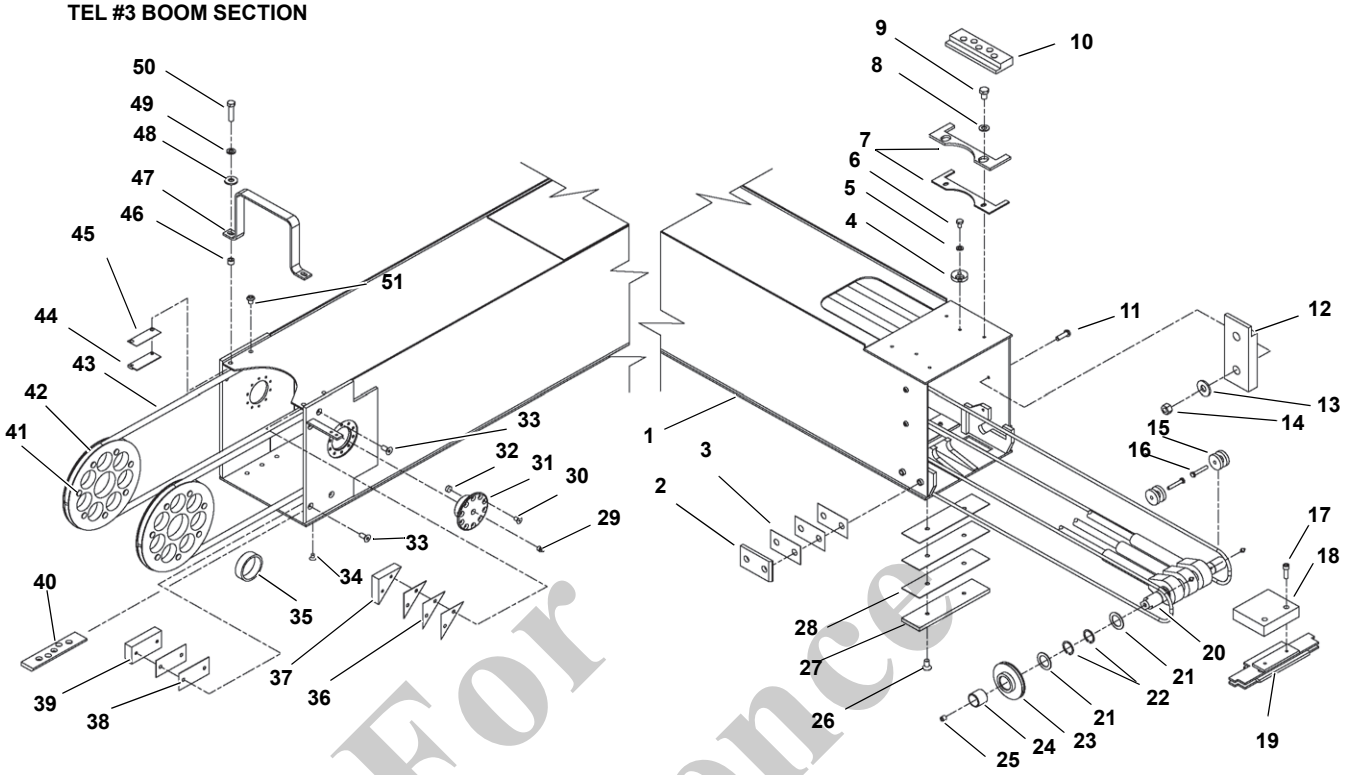
TEL #3 BOOM SECTION



Item	Description
1	Boom Section Rear
2	Wear Pad
3	Shim
4	Cam Plate
5	Flat Washer
6	Capscrew
7	Wear Pad Retaining Plate
8	Flat Washer
9	Capscrew
10	Wear Pad
11	Capscrew
12	Wear Pad
13	Flat Washer
14	Nut
15	Guide Roller
16	Capscrew
17	Capscrew

Item	Description
18	Wear Pad
19	Cable Anchor Assembly
20	Sheave Pin
21	Flat Washer
22	Snap Ring
23	Sheave
24	Bearing
25	Plug
26	Capscrew
27	Wear Pad
28	Shim
29	Grease Fitting
30	Capscrew
31	Sheave Pin
32	Plug
33	Capscrew
34	Capscrew

Item	Description
35	Bearing
36	Shim
37	Wear Pad
38	Shim
39	Wear Pad
40	Wear Pad Assembly
41	Plug
42	Sheave
43	Cable
44	Steel Wear Pad
45	Shim
46	Washer
47	Cable Guide
48	Flat Washer
49	Lock Washer
50	Capscrew
51	Capscrew

FIGURE 4-19

See Figure 4-19 for the following steps.

47. If necessary, tag and remove the side wear pads (2) and shims (3) and the bottom wear pads (27), shims (28), and capscrews (26) from the rear of the TEL #3 boom section.

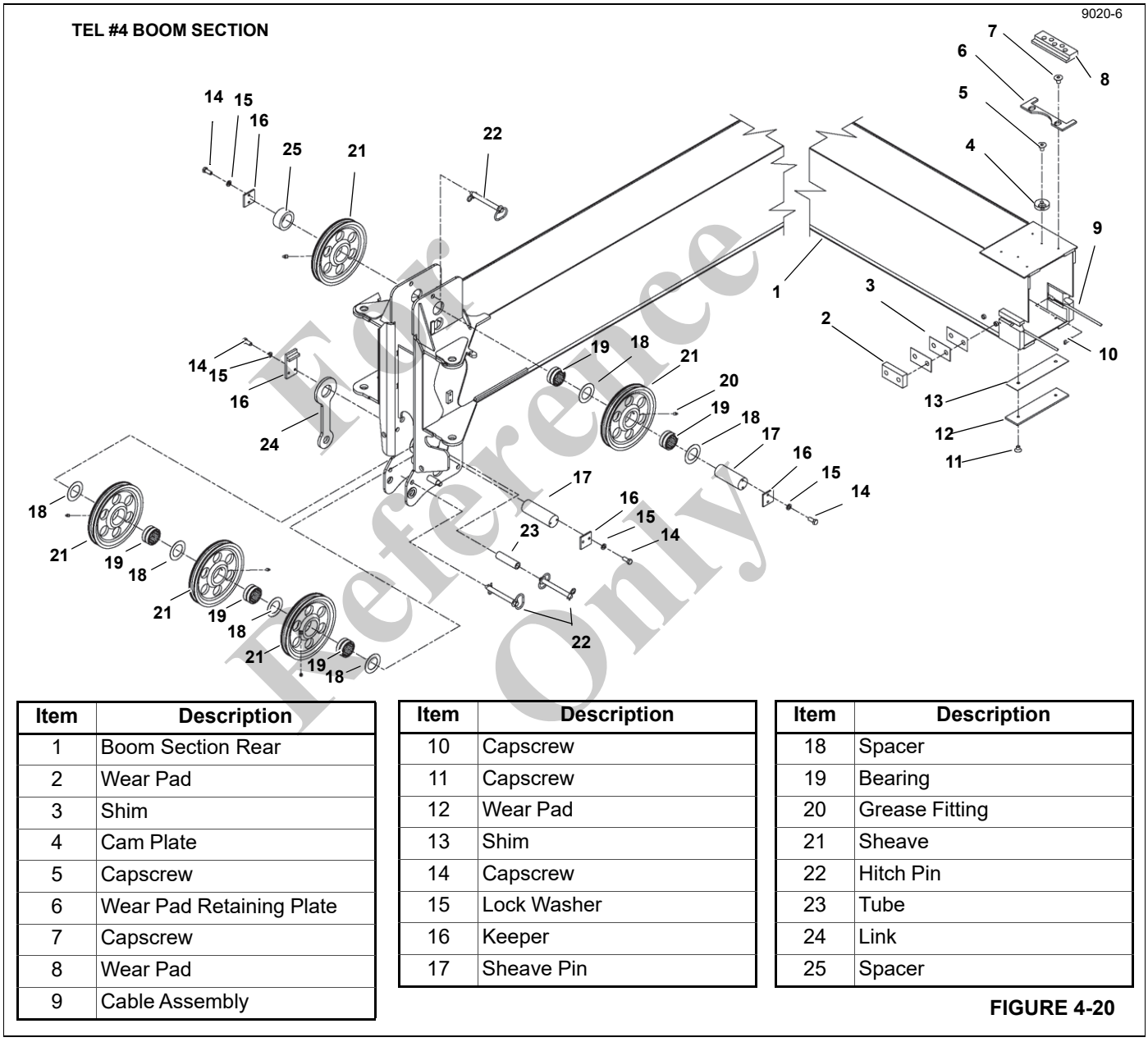
48. Remove the sheave pin (20) from the bottom rear of the TEL #3 boom section by removing the pin from the cables. Remove the cables (9, Figure 4-20) from the anchor plates at the bottom rear of the TEL #4 boom section and store them in an area where they will not be damaged during further boom disassembly.

49. Attach a sling or chain to the front of the TEL #4 boom section and pull the TEL #4 boom section out approximately six feet. Remove and tag the lower side wear pads (39), shims (38), top wear pads (37), and shims (36) from the front of the TEL #3 boom section.

50. Remove the two capscrews (11), washers (13), and nuts (14) from the 3/4/5 extend cable wear pads (12) at the rear of the TEL #3 boom section.

51. Remove the grease fittings (29) from the sheave pin (31) at the front of the TEL #3 boom section. Remove the ten capscrews (30) that secure the sheave pins (31) to the TEL #4 boom section side plates and remove the sheaves (42).

52. Raise the front of the TEL #3 boom section and remove the wear pads (40) from the TEL #3 boom section. Pull the TEL #4 boom section out of the TEL #3 boom section while keeping the extend cables taut.



Item	Description
1	Boom Section Rear
2	Wear Pad
3	Shim
4	Cam Plate
5	Capscrew
6	Wear Pad Retaining Plate
7	Capscrew
8	Wear Pad
9	Cable Assembly

Item	Description
10	Capscrew
11	Capscrew
12	Wear Pad
13	Shim
14	Capscrew
15	Lock Washer
16	Keeper
17	Sheave Pin

Item	Description
18	Spacer
19	Bearing
20	Grease Fitting
21	Sheave
22	Hitch Pin
23	Tube
24	Link
25	Spacer

FIGURE 4-20

53. Place the TEL #4 boom section on a suitable horizontal surface. Take care not to pinch or crush the extend cables while lifting or supporting the TEL #4 boom section. If necessary, tag and remove the wear pads and shims from the rear of the TEL #4 boom section.

54. Remove the 3/4/5 extend cables from the anchor plates at the rear of the TEL #4 boom section and store in an area where they will not be damaged during further boom disassembly.

55. Remove the sheaves (21) by removing the capscrews (14), lock washers (15), and keeper (16) from the sheave pin (17) by lightly tapping the pin out while removing the sheaves and spacers.

Additional Maintenance (Disassembled Boom)

1. Clean all boom sections and inspect for wear, dents, bent or crooked boom sections, gouged metal, broken welds and any abnormal conditions. Repair or replace as necessary.
2. Inspect all sheaves for excessive groove wear and abnormal rim wear. Replace as necessary.
3. Inspect all sheave bearings for excessive wear or cutting of the inner liner material. If the installed bearing diameter is 0.38 mm (0.015 in) larger than the pin diameter, the bearing must be replaced. Any cuts or gouges that cause the bearing liner to lose material 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 the cable assemblies as required. Lubricate all cable assemblies as required. Lubricate all cable assemblies before reinstalling them in the boom.
5. Inspect all sheave pins for nicks, gouges, or pitting due to rust in the bearing surface area. Replace if any damage is evident.
6. Inspect all grease fittings and grease paths in the pins to ensure proper grease flow. Clean and replace as necessary.
7. Replace all lubricating plugs in all wear pads as necessary.
8. Apply multipurpose grease (MPG) to all wear pad surfaces.

Five-Section Boom Assembly

See Figure 4-1 for the following notes.

NOTE: Torque all hardware to their specified torque value. See “Fasteners and Torque Values” on page 1-7.

NOTE: Apply medium-strength thread locking adhesive/sealant using Loctite™ type 243 (according to Loctite recommendations) to all hardware and torque.

NOTE: Do not use Loctite on any cable threaded ends. Always use the jam nuts and/or nuts provided.

NOTE: Install cables in their natural untwisted condition. Do not twist cables. Twisting cable will result in damage or failure of the cable. When initially assembling threaded ends of cables, thread the first nut on past the flat so adjustment can be made later.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

NOTE: *For reference, the front of the boom is the sheave case end, rear is hoist mount end, and the left and right are viewed from rear to front.*

TEL #4 Boom Section

See Figure 4-20 for the following steps.

1. Assemble the upper loadline sheaves (21) and bearings (19) into the TEL #4 boom section sheave case.
   a. Install the sheave pin (17) in the left side of the upper sheave case.

NOTE: Install the spacers (18) between the sheaves and between the sheaves and the side plates.

   b. Install the small spacer (18).
   c. Install the sheaves (21) near the sheave case side plates with the grease fitting (20) facing the side plate to allow for greasing.
   d. Install the small spacer (18).
   e. Install the center sheaves (21) with the grease fitting (20) facing either side.
   f. Install the top sheaves (21) to the left side of the boom with the spacer (25) to the right side.
   g. Install the keeper (16) to both sides of the sheave case using the capscrews (14) and washers (15).
2. Assemble the lower loadline sheaves (21) and bearings (19) into the TEL #4 section sheave case.
   a. Install the sheave pin (17) in the left side of the sheave case.

NOTE: Install the spacers (18) between the sheaves and between the sheaves and the side plates.

   b. Install the small spacer (18).
   c. Install the sheaves (21) near the sheave case side plates with the grease fitting (20) facing the side plate to allow for greasing.
   d. Install the small spacer (18).
   e. Install the center sheaves (21) with the grease fitting facing either side.
   f. Install the sheaves (21) to the right side of the boom.
   g. Install the spacer (18).
   h. Install the link (24) to the outside of the sheave case.
   i. Install the keeper (16) to the right side of the sheave case using the capscrews (14) and washers (15).
   j. Install keeper (16) to left side of the sheave case using capscrews (14) and washers (15).
   k. Install the tube (23) in the lower forward sheave case.
   l. Install the three hitch pins (22) into the sheave case.

3. Install the bottom rear wear pads (12), shims (13), and capscrews (11) to the rear of the TEL #4 boom section (1).

4. Install the two side wear pads (2) and shims (3) onto the rear of the TEL #4 boom section (1). Shim according to calibration instructions in this section or as wear pads were originally removed and tagged. See “Boom Calibration” on page 45

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

See Figure 4-19 for the following step.

5. Raise and support the TEL #4 boom section (1) in front of the TEL #3 boom section.

   a. Route the threaded end of 3/4/5 extend cables (43) through the front of the TEL #3 boom section (1) and out the rear of the TEL #3 boom section.

   b. Loop the button end of the 3/4/5 extend cables (43) back beyond the cable anchor on the TEL #4 boom section and install the button end of the 3/4/5 extend cables into the outer side anchor plates at the rear of the TEL #4 boom section and pull taut.

TEL #4 and TEL #3 Boom Section

See Figure 4-21 for the following step.

1. Install the TEL #4 boom section into the TEL #3 boom section approximately five feet.

NOTE: Take care not to damage 3/4/5 extend cables.

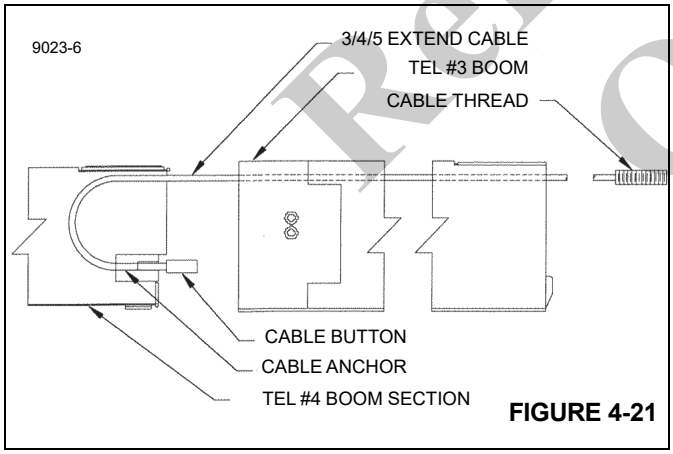


FIGURE 4-21

See Figure 4-19 for the following steps.

2. Raise the TEL #4 boom section against the top of the TEL #3 boom section and install the wear pads (40), and capscrews (34) to the bottom front of the TEL #3 boom section and lube.

3. Lower the TEL #4 boom section onto the wear pads in the TEL #3 boom section.

4. Install the 3/4/5 extend sheave assembly (42) inside the front of the TEL #3 boom section.

   a. Install the bearing assembly (35) in the sheave (42).

   b. Install the wear plugs (32) into the small holes of each sheave (42).

   c. Loop the 3/4/5 extend cables (43) around the 3/4/5 extend sheaves (42) and install the sheaves into the TEL #3 boom section.

NOTE: Do not twist the cables. Twisting the cables will result in damage or failure of the cable. When initially assembling the threaded ends of the cables, thread the first nut on past the flat so adjustment can be made later.

   d. Install the sheave pins (31) and plugs (32) into the recessed holes in the sides of the front of the TEL #3 boom section.

   e. Install the ten retaining capscrews (30) into the 3/4/5 extend sheave pins (31) and tighten. See “Fasteners and Torque Values” on page 1-7.

   f. Install the grease fittings (29) into the 3/4/5 extend sheave pins (31) and apply multipurpose grease (MPG) to the grease fitting.

5. Install the side wear pads (39), shims (38), and capscrews (33) into the inside front of the TEL #3 boom section.

6. Install the cable guide assembly (47) on the top of the TEL #3 boom section.

   a. Install the upper steel wear pad (44) and shims (45) between the TEL #3 boom section and the top of the TEL #4 boom section.

   b. Install the capscrew (51) in the rear holes only.

   c. Install the cable guide (47) to the outside front of the TEL #3 boom section and install the capscrews (50), lock washer (49), and flat washer (48) to the top front of the TEL #3 boom section.

NOTE: Shim according to calibration instructions in this section or as pads were originally removed and tagged.

   d. Push the TEL #4 boom section completely into the TEL #3 boom section while keeping the 3/4/5 extend cables taut.

   e. Make a mark in the front of the TEL #4 boom section in front of the side wear pads on the TEL #3 boom section, for retract sequencing.

7. Install the 3/4/5 extend cable retaining pads (12) with the flanged lip facing upward toward the inside of the rear of the TEL #3 boom section in order to support the cable.

8. Install the upper capscrew (11), washer (13), and nut (14) only. Swing the wear pad (12) and position the 3/4/5 extend cables between the opening of the cable retaining pad and the side plate and with the threaded end of the 3/4/5 extend cable routed beyond the rear of the TEL #3 boom section. Swing the wear pad (12) into place and install the lower capscrew (11), washer (13), and nut (14) and tighten both capscrews. (See “Fasteners and Torque Values” on page 1-7.)

See Figure 4-20 for following steps

9. Push the threaded end of the 5/4/3 retract cable (9) through the sheave opening in the bottom rear end of the TEL #3 boom section and pull the 5/4/3 retract cables threaded ends toward the front of the boom.

10. Install the button end of the 5/4/3 retract cable (9) into the cable anchor on the inside rear end of the TEL #4 boom section.

11. Install the cable retaining capscrew (10) to secure the cable.

See Figure 4-19 for the following steps.

12. Temporarily install the retract-2/3/4 extend pin (20) assembly with sheaves (23) at the bottom rear of the TEL #4 boom section to aid in positioning cables when assembling the next section.

13. Extend the TEL #4 section approximately one foot to install the top wear pads through the opening on top of the boom at the rear of the TEL #3 section.

14. Install the two top wear pad retaining plates (7), top wear pads (10), adjustment cam plate (4), capscrews (9), and flat washers (8).

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

15. Rotate the cam (4) until the gap is eliminated between the wear pad and boom section, keeping sections centered for proper boom alignment.

TEL #3 and TEL #2 Boom Section

SeeFigure 4-19 for the following steps.

1. Install the bottom wear pad (27), shims (28), and capscrews (26) onto the rear of the TEL #3 boom section (4).

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

2. Install the two side wear pads (2) and shims (3) onto pins at the rear of the TEL #3 boom section. Shim according to the calibration instructions in this section or as the pads were originally removed and tagged.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

3. Raise and support the TEL #3 TEL #4 boom sections and install them into the TEL #2 boom section approximately fifteen feet.

NOTE: Keep the 5/4/3 retract cables taut, not crossing cables and keeping all cables clear of pinch points created by slings and bottom pads.

See Figure 4-18 for the following steps.

4. Raise the TEL #3 and TEL #4 boom sections against the top of the TEL #2 boom section and install the wear pads (43), and capscrew (35) into the bottom front of the TEL #2 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

5. Lower the TEL #3 and TEL #4 boom sections onto the wear pads in the TEL #2 boom section. Push the TEL #3 and TEL #4 boom sections into the TEL #2 boom section, leaving approximately four feet of the TEL #3 and TEL #4 boom sections out of the TEL #2 boom section.

6. Install the keeper (37) onto the 5/4/3 retract cables. Install the nuts (39) just past the wrench flats at the threaded end of the retract cables, assemble them at the bottom front of the TEL #2 boom section, and secure them with the capscrews (38).

7. Install the lower side wear pads (41) and shims (42) on the front inside of the TEL #2 boom section and secure with capscrews (34).

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

8. Install the upper side wear pads (41) and shims (42) on the front inside of the TEL #2 boom section and secure with capscrews (34).

NOTE: It may be necessary to support the components with a bar or tool that extends inside the boom section to aid in positioning the components during assembly.

9. Install the top wear pad (44), shims (45), cable guide (48), wear pad (47), and related hardware (49—51) on the top front of the TEL #2 boom section. Shim according to the calibration instructions in this section or as the pads were originally removed and tagged.

10. Push the TEL #3 and TEL #4 boom sections completely into the TEL #2 boom section and make a mark on the front of the TEL #3 boom section in the front of the side wear pad on the TEL #2 boom section for retract sequencing. Keep the 3/4/5 extend cables and the 5/4/3 retract cables taut while guiding the 3/4/5 extend cables into the anchor plates at the upper rear of the TEL #2 boom section. Thread the nuts (13, 40, and 63) (if equipped) onto the 3/4/5 extend cables just past the wrench flats.

NOTE: Install cables in their natural untwisted condition. Do not twist the cables. Twisting the cables will result in damage or failure of the cable. When initially assembling the threaded ends of the cables, thread the first nut on past the flat so adjustment can be made later.

11. Remove the previously assembled 5/4/3 retract cables from the plate at the bottom rear of the TEL #4 boom section and loop the cables back away from the rear of the boom.

12. Pull the TEL #4 boom section out of the TEL #3 boom section approximately 12 inches.

13. Assemble and install the hydraulic cylinder.

- **a.** Install the bearings (57) into the sheaves (56).
- **b.** Coat the bearings with multi-purpose grease and install the sheaves onto the extend cylinder.
- **c.** Install the pin assembly (60) through the cylinder sheave case, securing it with the keeper (59) and capscrews (58).
- **d.** Install two wear pads (61) to each side, in front of the extend cylinder with the capscrew (62).

14. Reeve 2/3/4 extend cables over the sheaves (56) at the front of the hydraulic cylinder assembly, routing the cables behind the hydraulic cylinder in the correct order.

NOTE: Mark the cable ends to maintain the correct sequence during assembly to prevent crossing the cables.

15. Install the rods (55) and capscrews (52). Install the plate (54) and capscrews (53) to the bottom of the sheave case.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

16. Install the hydraulic cylinder into the rear of the TEL #4 boom section leaving approximately two feet of the hydraulic cylinder exposed. Push the TEL #4 boom section completely into the TEL #3 boom section and raise the hydraulic cylinder to the top of the TEL #2 boom section.

See Figure 4-19 for the following steps.

17. Assemble and install the sheave pin (20) assembly into the anchor plate at the bottom rear of the TEL #3 boom section (1).

- **a.** Install the three cables on the sheave pin (20).
- **b.** Install one washer (21) and one snap ring (22) on each side of the outer cables.
- **c.** Install one snap ring (22) and one washer (21) on the inside of each sheave.
- **d.** Install a bearing (24) into both sheaves (23) and brush with chassis grease. Install the sheaves on both ends of the sheave pin.
- **e.** Loop the 5/4/3 retract cables around the sheaves and sheave pin assembly.
- **f.** Install the plugs (25) into both ends of the sheave pin.
- **g.** Install the pin assembly into the retainer at the rear of the TEL #3 boom section and install the button end of the 5/4/3 retract cables into the anchor plate at the bottom rear of the TEL #4 boom section.

See Figure 4-20 for the following steps.

- **h.** Install the cable retaining capscrew (10) into the threaded hole in cable retainer block at back bottom of the TEL #4 boom section.
- **i.** Install the grease fittings (20) toward the rear of the boom.
- **j.** Apply multipurpose grease (MPG) to the grease fittings.

See Figure 4-19 for the following steps.

18. Install the retract cable guides (15) and capscrew (16) into the rear of the TEL #3 boom section.

NOTE: Use caution when moving the cylinder to avoid damage to the cable guides.

19. Lower the hydraulic cylinder and push it into the TEL #2 boom section, keeping cables taut to approximately one foot behind the hydraulic cylinder anchors in the TEL #2 boom section. Raise the rear of the hydraulic cylinder to the top of the TEL #2 boom section.

20. Install wear pads (18) and capscrews (17) at the rear of the TEL #3 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

21. Route the two 4/3/2 retract cables evenly centered around the 4/3/2 retract cable keeper (19). Route the threaded ends of the 4/3/2 retract cables down through the opening in the rear of the TEL #2 boom section and pull the threaded ends of the 4/3/2 retract cables toward the front of the boom. Install the 4/3/2 cable anchor assembly (19) into the anchor plates at the rear of the TEL #3 boom section.

22. Install the guide rollers (15) and capscrews (16) into the rear of the TEL #2 boom section.

NOTE: Use caution when moving the cylinder to avoid damage to cable guides.

23. Lower the extend cylinder onto the wear pad (18).

TEL #2 and TEL #1 Boom Section

See Figure 4-18 for the following steps.

1. Install the two top wear pad retaining plates (8), wear pads (9), capscrews (10), and flat washers (11) onto the rear of the TEL #2 boom section (1).

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

2. Install the adjustment cam plate (5), capscrews (7), and flat washers (6).
3. Rotate the cam plate (5) until the gap is eliminated between the wear pad and the boom section, keeping sections centered for proper boom alignment.
4. Install the bottom wear pad (32), shims (33), and capscrews (31) onto the rear of the TEL #2 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

5. Install the two side wear pads (2) and shims (3) onto the rear of the TEL #2 boom section. Shim according to the calibration instructions in see “Boom Calibration” on page 45.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

See Figure 4-17 for the following steps.

6. Stretch out the extend cable (43), then bring the threaded ends back together to form a loop and find the center of the cable length.
   a. Slide this center loop from front to back through the cable anchor slot at top rear of the TEL #2 boom section.

See Figure 4-18 for the following steps.

   b. Slide the sheave (4) into this slot from back to front so the raised portion of the sheave slides into the slot of the cable anchor plate.
   c. Pull this loop of cable forward to lock the extend cable to the TEL #2 boom section.

See Figure 4-17 for the following steps.

   d. Place the sheave anchor assembly (48) on the top front of the TEL #2 boom section with its top bar up and forward.
   e. Loop both threaded ends of the extend cable (43) toward the back of the boom to form two loops, left and right, located at the front of the boom. Slide the left and right loops into the left and right sides of the sheave case assembly.
   f. Install the bearings (45) into the sheaves (44).
   g. Brush with chassis grease.
   h. Install the flattened end pins (46) into the sheaves.

NOTE: Make sure the grease fittings face the back of the boom.

   i. Slide the pin assembly into the slots in the front of the sheave case assembly (48). Fold back and position the assembled sheave case on the top of the boom sections when assembling of the next boom section.
   j. Route and pull the threaded ends of the sync extend cable toward the rear of the boom and loop them over the rear of the boom.

NOTE: Make sure the TEL #1 boom section cylinder ears are horizontal.

7. Raise and support the TEL #2, TEL #3, and TEL #4 boom sections and install them into the TEL #1 boom section approximately fifteen feet.

NOTE: Keep the 4/3/2 retract cables taut, do not cross the cables, and keep all cables clear of pinch points created by slings and bottom pads.

8. Raise the TEL #2, TEL #3, and TEL #4 boom sections against the top of the TEL #1 boom section and install the wear pads (37) and capscrews (36) into the bottom front of the TEL #1 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

   a. Lower the TEL #2, TEL #3, and TEL #4 boom sections onto the wear pads in the TEL #1 boom section.
   b. Move the TEL #2, TEL #3, and TEL #4 boom sections into the TEL #1 boom section until approximately four feet of the TEL #2 boom section is out of the TEL #1 boom section.

9. Assemble the 4/3/2 retract cable keeper plate assemblies (41) and capscrews (35) onto the 4/3/2 retract cables. Install the two nuts (39) just past the wrench flats on the 4/3/2 retract cables and assemble them at the bottom front of the TEL #1 boom section.

NOTE: Take care not to cross cables. Do not twist the cables. Twisting the cables will result in damage or failure of the cable. When initially assembling the threaded ends of the cables, thread the first nut on past the wrench flats so adjustment can be made later.

10. Install the lower side wear pads (25), shims (26 and 27), and capscrews (35) on the front inside of the TEL #1 boom section.
11. Install the upper wear pad assembly (25), shims (26 and 27), and capscrews (35) at the upper front of the TEL #1 boom section.

NOTE: It may be necessary to support the components with a bar or tool that extends inside the boom section to aid in positioning the components during assembly.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

12. Slide the previously assembled 1/2/3 extend cable sheave anchor assembly into position in the TEL #1 boom section.

13. Install the grease fittings (47) into the 1/2/3 extend sheave pins (46).

14. Install the wear pads (28) and shims (29) on inside top front of TEL #1 boom section. Install the wear pad (34), cable guide (33), and related hardware (30—32) on the top front of the TEL #1 boom section. Shim according to the calibration instructions in this section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

15. Push the TEL #2, TEL #3, and TEL #4 boom sections into the TEL #1 boom section until it bottoms out against cylinder ears. Install the capscrew (21) and flat washer (22) with Loctite to retain the TEL #1 section cylinder in the TEL #1 boom section.

See Figure 4-18 for the following steps.

16. Install the cable wear pad (18) with capscrew (17) on the top of the hydraulic cylinder barrel.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

17. Install the hydraulic cylinder into the slots at the rear of the TEL #2 boom section. Install the keepers (14), capscrew (16), and lock washers (15) with Loctite to retain the TEL #1 section cylinder in the TEL #1 boom section.

See Figure 4-17 for the following steps.

18. Install the wear pad (19) on top of the cable anchor assembly (18), then install the 2/3/4 extend cable anchor assembly in the slots at the rear of the TEL #1 boom section while guiding the 2/3/4 extend cables into the cable anchor assembly. Install the nuts (15—17) (if equipped) as they were removed from the threaded ends of the 2/3/4 extend cables.

NOTE: Do not twist the cables. Twisting the cables will result in damage or failure of the cable. When initially assembling the threaded ends of the cables, thread the first nut on past the wrench flats so adjustment can be made later.

19. Lock the cable anchor assembly (18) in place with the socket head screw (24) through the top back side plates of the TEL #1 boom section. Be sure the 1/2/3 sync extend cables (43) are threaded over the top of the 2/3/4 extend cable anchor.

See Figure 4-18 for the following steps.

20. Route three 3/2/1 retract cables around the 3/2/1 retract cable keeper (21) and install them on the cable keeper bracket (20) with capscrew (19) onto the 3/2/1 retract cable anchor with the 3/2/1 retract cables draped out behind the boom.

21. Assemble and install the pin (24) into the anchor plate at the bottom rear of the TEL #1 boom section.

- **a.** Install a snap ring (26) on the inside groove of the sheave pin (24). Repeat this step for the other inside groove of the pin.
- **b.** Install a spacer (27) to both sides of the pin.
- **c.** Install the bearing (29) into the sheaves (28), brush it with multipurpose grease (MPG), and install one sheave on each end of the pin.
- **d.** Install the spacers (27) to the outsides of the sheaves on the pin.
- **e.** Install the snap ring (26) to the outside of the washers in the outside groove of the pin.
- **f.** Install the plug (30) in the end of the sheave pin (24).
- **g.** Loop the 3/2/1 retract cables around three groove sheaves (28) and the retract sheave pin (24) assembly.

See Figure 4-17 for the following steps.

22. Install the 3/2/1 retract pin keeper setscrews (6) behind the retract sheave pin (7) into the rear of the TEL #1 boom section.

23. Install the grease fittings toward the rear of the boom.

24. Apply multipurpose grease (MPG) to the grease fittings.

25. Install the guide rollers (5), and capscrews (4) into the rear of the TEL #1 boom section.

26. Install the bottom wear pad (13), shims (14), and capscrew (12) onto the rear of the TEL #1 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

27. Route the 3/2/1 retract cables between the bottom of the TEL #1 boom section and the bottom pad shims.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

See Figure 4-15 for the following steps.

28. Install the two top wear pad retaining plates (6), top wear pads (7), capscrews (4), and washers (5) onto the rear of the TEL #1 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

29. Install the cam plate (3), capscrews (1), and washers (2).

TEL #1 and Base Boom Section

See Figure 4-17 for the following steps.

1. Install the bottom wear pad (13), shims (14), and capscrews (12) onto the rear of the TEL #1 boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

2. Install the two side wear pads (2) and shims (3) onto the rear of the TEL #1 boom section. Shim according to the calibration instructions in “Boom Calibration” on page 45.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

3. Rotate the Base section cylinder shaft so the counterbalance valve is directly below the shaft centerline.

4. Raise and support the TEL #1, TEL #2, TEL #3, and TEL #4 boom sections and install them into the base boom section approximately fifteen feet. Take care to keep the 3/2/1 retract cables taut, keeping the cables from crossing, and clear of the pinch points created by the slings and bottom pads.

See Figure 4-16 for the following steps.

5. Raise the TEL #1, TEL #2, TEL #3, and TEL #4 boom sections against the top of the base boom section and install the bottom wear pads (15), socket head capscrews (14), and lock washers (12) into the bottom front of the base boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

6. Lower the TEL #1, TEL #2, TEL #3, and TEL #4 boom sections onto the wear pads in the base boom section. Push TEL #1, TEL #2, TEL #3, and TEL #4 boom sections into the base boom section, leaving approximately four feet of the TEL #1 boom section sticking out of the base boom section.

7. Assemble the 3/2/1 retract cable anchor plates (24) with capscrew (23) onto the 3/2/1 retract cables, the double nut (20 and 21) just beyond the flat on 1/2/3 retract cables and assemble at the bottom front of the base boom section. Take care not to cross the cables.

NOTE: Do not twist the cables. Twisting the cables will result in damage or failure of the cable. When initially assembling the threaded ends of the cables, thread the first nut on past the wrench flats so adjustment can be made later.

8. Install the side wear pads (8), wear pad backup plates (7), and back plates (6) to both sides of the base boom section.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

9. Install the capscrew (4) and jam nut (5) on the lower front side of the base boom section. Install the wear pad retaining hardware (1—3) in the wear pad pocket.

10. Install the upper wear pad assembly (19), shims (17 and 18), and capscrew (16) at the upper front of the base boom section.

NOTE: It may be necessary to support the components with a bar or tool that extends inside the boom section to aid in positioning the components during assembly.

NOTE: Apply multipurpose grease (MPG) to all wear pads and contact surfaces.

11. Install the upper plate (9), shims (10), and hardware (11—13) at the front of the base boom section, with Loctite applied to the capscrews. Shim according to the calibration instructions in this section.

12. Push the TEL #1, TEL #2, TEL #3, and TEL #4 boom sections in, while keeping the 3/2/1 retract cables taut, completely into the base boom section or until the top wear pad aligns with the top access hole in the base boom section.

See Figure 4-15 for the following step.

13. Rotate the cam (3) until the gap is eliminated between the wear pads and boom section that keep the sections centered for proper boom alignment. Tighten the clamping hardware.

See Figure 4-14 for the following steps.

14. Install the base section cylinder rod to the base boom section hydraulic cylinder mount with washers (3) and capscrew (2) with Loctite applied and tighten to specification.

NOTE: It is important in this step to have the nuts loose on the 3/2/1 retract cables at the bottom front of the base boom section.

15. Install the 1/2/3 sync extend cables into the holes at the rear of the base boom section, and install the washers (7) and nuts (6, 13, and14) just beyond the flats. For proper nut configuration options, see “Cable Retention” on page 18

NOTE: Do not twist the cables. Twisting the cables will result in damage or failure of the cable. When initially assembling the threaded ends of the cables, thread the first nut on past the wrench flats so adjustment can be made later.

16. Tighten the cables per the five-section cable tensioning procedure. See “Five-Section Cable Tensioning” on page 41.
17. Install all protective caps on the threaded cable ends.
18. Install the cable guide, washer, and nut to the mounting studs at the center top of the base boom section.
19. Extend the boom and align all boom sections according to the boom alignment procedure.
20. Install the inspection cover (11) with hardware (9 and 10) to the top rear of the base boom section.
21. Install the pendulum, bearing, flat washer, and nut to the left side of the base boom section.

Five-Section Cable Tensioning

After boom reassembly or from time to time if the interior proportioning cables appear loose, cable tensioning may be required.

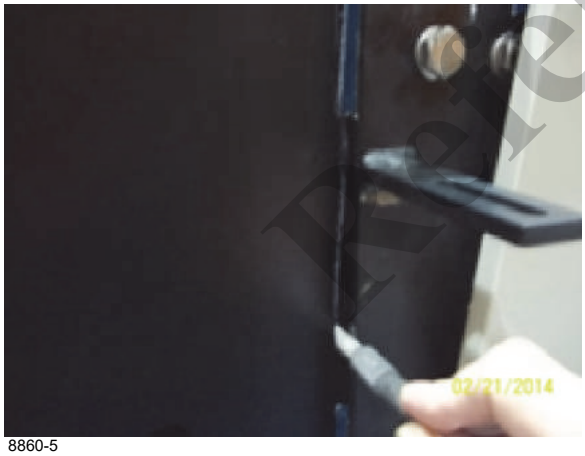
Tensioning Setup Procedure

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

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

Ensure the boom is completely assembled and fully retracted.

1. Mark the front of each section with a chalk line as indicated in Figure 4-22.
2. Extend and retract the boom several times to establish the working state of the cables.
3. Extend the boom so the scribed lines are exposed by approximately 12 inches.
4. Measure the extension gaps between each boom section and scribed line and note the values.
5. Retract the boom so that the scribed lines are exposed by approximately six inches.
6. Measure the retraction gaps between each boom section and scribed lines and note the values.
7. Extend and retract the boom a few times and then repeat measuring the extension gaps.
8. Adjust all corresponding cables according to the cable tightening sequence instructions. See “Cable Tightening Sequence” on page 41.



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8860-6

FIGURE 4-22

NOTE: When adjusting the cable, hold the cable end and turn the nut. Do not turn the cable. Turning the cable while adjusting may result in damage or failure of the cable.

Cable Tightening Sequence

The boom must be in the horizontal position when adjusting the cable tension (see Figure 4-22). Retract the boom fully, ensuring that the sections are bottomed out on the section stops and do not spring back. (See Tensioning Setup Procedure)

3/2/1 and 1/2/3 Cable Balancing

Extension

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

   If the extension gap between the first and second section is less than the extension gap between the second and third section.
2. Tighten the 3/2/1 retract cable, located at the front bottom of the rear section, the difference in the extension gap measurements.

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

NOTE: The second section should have moved out.

4. Tighten until the extension gap between the first and second sections and the extension gap between the second and third sections are equal.

   If, when tightening the 3/2/1 retract cable, the third section starts to go out with the second section, the 1/2/3 synchronizing cable located at the top back of the rear section may need to be loosened.

Retraction

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

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

2. Tighten the 1/2/3 synchronizing cable located at the back of the rear section the difference in the retraction gap measurements.

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

NOTE: The third section should have moved out.

4. Tighten until the retraction gap between the first and second sections and the retraction gap between the second and the third sections are equal.

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

2/3/4 and 4/3/2 Cable Balancing

Extension

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

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

2. Tighten the 2/3/4 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.

NOTE: The fourth section should have moved out.

4. Continue tightening until the extension gap between the third and fourth sections is equal to the extension gap between the second and third sections.

Retraction

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

   If the retraction gap is greater between the third and fourth sections than the retraction gap between the second and third sections.

2. Tighten the 4/3/2 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.

NOTE: The fourth section should have moved in.

4. Tighten until the retraction gap between the third and fourth sections is equal to the retraction gap between the second and third sections.

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

3/4/5 and 5/4/3 cable balancing

Extension

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

   If the extension gap between the fourth and fifth sections is less than the extension gap between the third and fourth sections.

2. Tighten the 3/4/5 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.

NOTE: The fifth section should move outward.

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

Retraction

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

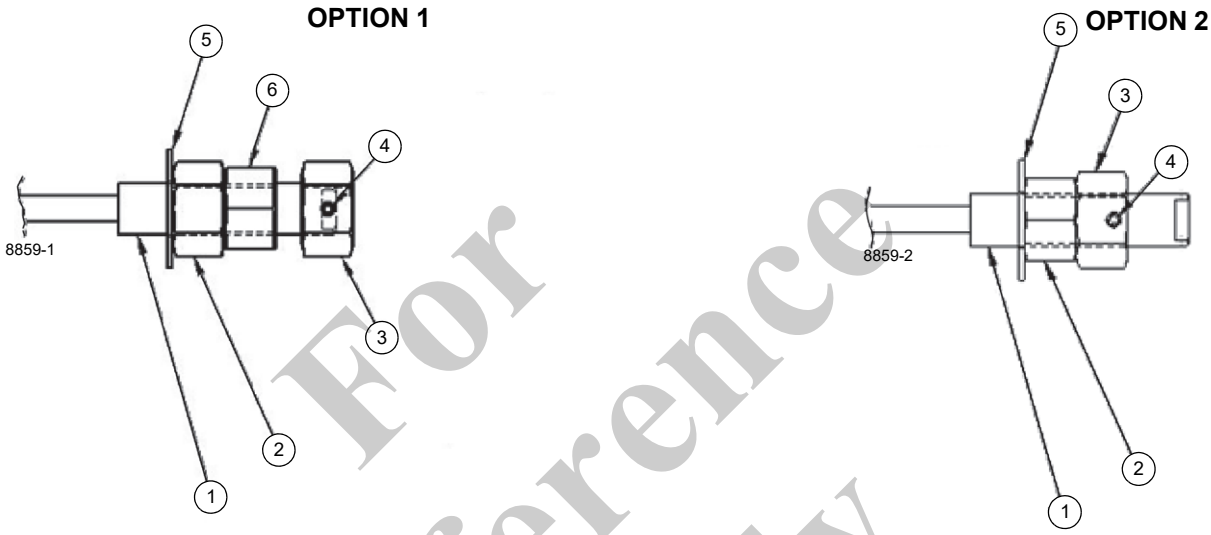
If the retraction gap is greater between the fourth and fifth section than the retraction gap between the third and fourth section:

2. Tighten the 5/4/3 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. Continue 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 all the boom sections should extend and retract equally and bottom out against the stops simultaneously.



Item	Description
1	Threaded Cable End
2	Nut (Adjustment)
3	Nut (Positive Lock)

Item	Description
4	Setscrew
5	Washer
6	Nut (Torqued)

FIGURE 4-23

Cable Retention

Nut configuration will be first nut (adjustment) and second nut (torqued) (see Figure 4-23).

NOTE: Use Option 2 only when space constraints inhibit the use of Option 1 (see Figure 4-23).

When tightening or loosening the first nut (2) on the cables, secure the 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 nut (6) must be installed and tightened 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 nut (2) stationary and use a torque wrench to tighten the second nut (6) against the first nut. See “Torque Values for Second Nut” on page 4-44.

The third nut (3) should be installed on each of the extend cables. The retract cables do not require the third nut.

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

Install setscrew into the third nut (3) and tighten.

Torque Values for Second Nut

Table 4-2

Inch Series with Coarse Threads (UNC)			
Cable End Thread Size	Minimum Nut Strength GRADE	Nut Type	TORQUE Nm (ft lb)
1/2-13	SAE 2	Hex Jam (HALF)	16 Nm (12 ft-lb)
5/8-11	SAE 2	Hex Jam (HALF)	42 Nm (31 ft-lb)
3/4-10	SAE 2	Hex Jam (HALF)	64 Nm (47 ft-lb)
7/8-9	SAE 2	Hex Jam (HALF)	85 Nm (63 ft-lb)
1-8	SAE 2	Hex Jam (HALF)	270 Nm (199 ft-lb)
1 1/4-7	SAE 2	Hex Jam (HALF)	275 Nm (203 ft-lb)
1 1/2-6	SAE 5	Hex Jam (FULL)	339 Nm (250 ft-lb)
1 3/4-5	ASTM B	Hex Jam (FULL)	339 Nm (250 ft-lb)
Metric Series with Coarse Threads			
Cable End Thread Size	Minimum Nut Property Class	Nut Type	TORQUE Nm (ft lb)
M16x2	5	Hex Jam (THIN)	26 Nm (19 ft-lb)
M20x2.5	5	Hex Jam (THIN)	66 Nm (49 ft-lb)

Five-Section Top and Bottom Pad Replacement (Assembled Boom)

Inspect the top and bottom wear pads periodically for signs of abrasion or excessive wear.

Excessive wear is wear in excess of 4.78 mm (3/16 in) from the original thickness. base, TEL #1 and TEL #2 section bottom pads are 29.8 mm (1.17 in) thick; TEL #3 section bottom pads are 11.6 mm (0.45 in) thick; TEL #1, TEL #3, and TEL #4 section top pads are 11.6 mm (0.45 in) thick; TEL #2 section top pads are 25.4 mm (1.0 in) thick. When the pads show uneven wear such as the outside edge of the pad worn in excess of 1.59 mm (0.0625 in) deeper than the inside edge of the pad. If any of these conditions are found, the top and bottom pads may be replaced without disassembly of the boom.

Also, if the boom extension operates erratically or during replacement of top and bottom pads, it is recommended that the lubricating plugs in the wear pads also be replaced with new plugs. These new lube plugs initially extend 1.5 mm (0.06 in) above the pad surface and will wipe a long-lasting coating of lubricant onto the boom sliding surface.

Top Pad Replacement

NOTE: All wear pads must be tagged, inspected, and reassembled exactly as they have been removed unless doing a complete overhaul.

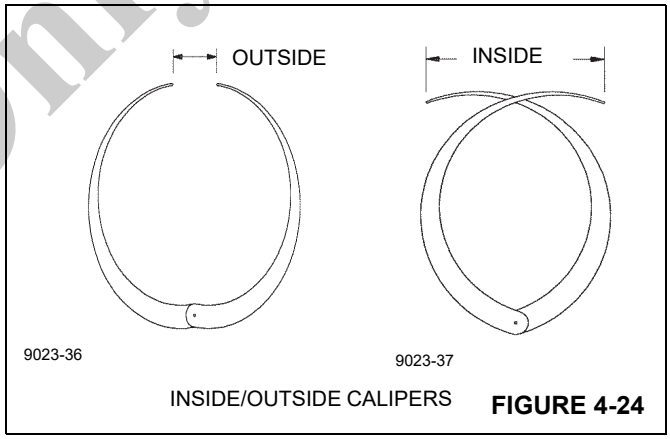
1. Retract the boom completely, then extend the boom approximately (17.75 in) (4.44 in per section) so that the upper wear pads on the TEL #2 boom section are visible through the holes in the top plates of the base and TEL #1 boom sections.
2. Remove the capscrews from the top rear of the TEL #2 boom section wear pad retaining plates and remove the wear pad retaining plates from the TEL #2 boom section. Mark the retaining plates so they can be installed exactly as they were removed. Remove the TEL #2 boom section wear pads.
3. If necessary, mark the location of the nuts and loosen the 1/2/3 extend cables, and remove them from the mounting holes at the rear of the base boom section. Tie the 1/2/3 extend cables with approximately two feet of wire and allow them to slack into the base boom section, removing the cables from the notch in TEL #2 boom section pads.
4. Replace the TEL #2 boom section wear pads and install the wear pad retaining plates onto the top plate of the TEL #2 boom section. Apply Loctite to all flathead mounting screws.
5. If necessary, install the 1/2/3 extend cables into the rear of the base boom section and install the nuts that secure these cables to their original location previously marked on the threaded cable ends.

6. Extend the boom approximately (41.75 in) (10.44 in per section) so that the upper wear pads on the TEL #1 boom section are visible through the hole in the top plate of the base boom section.
7. Remove the capscrews from the top rear of the TEL #1 boom section wear pad retaining plates and slide the wear pad retaining plates toward the center of the boom. Mark these retaining plates so they can be installed exactly as removed. Remove the TEL #1 boom section wear pads.
8. Replace the TEL #1 boom section wear pads and install the wear pad retaining plates onto the top plate of the TEL #1 boom section exactly as removed. Apply Loctite to all flathead mounting screws.
9. Extend the boom approximately 16.5 m (54.25 ft) so that the rear of the TEL #3 boom section passes the hole in the side plate of the TEL #2 boom section and so that the rear of the TEL #4 boom section passes the hole in the side plate of the TEL #3 boom section. Raise the front of the TEL #3 and TEL #4 boom sections to relieve pressure on the wear pads on the top rear of the TEL #3 and TEL #4 boom sections.
10. Remove the countersunk capscrews from the bottom of the top plate on the rear of the TEL #3 boom section that attaches the wear pad retaining plates to the TEL #3 boom section.
11. Slide the wear pad retaining plates and wear pads toward the rear of the boom and remove them. Mark the wear pad retaining plates so they can be installed exactly as removed.
12. Replace the TEL #3 boom section wear pads and install the wear pad retaining plates exactly as removed onto the top plate of the TEL #3 boom section. Apply Loctite to all flathead mounting screws.
13. Remove the countersunk capscrews from the bottom of the top plate on the rear of the TEL #4 boom section that attaches the wear pad retaining plates to the TEL #4 boom section.
14. Slide the wear pad retaining plates and wear pads toward the rear of the boom and remove them. Mark the wear pad retaining plates so they can be installed exactly as removed.
15. Replace the TEL #4 boom section wear pads and install the wear pad retaining plates exactly as removed onto the top plate of the TEL #4 boom section. Apply Loctite to all flathead mounting screws. Retract the boom completely.

Bottom Pad Replacement

1. Lower the boom until the boom lift cylinder is bottomed out and extend the boom out approximately eight feet.
2. Raise the front of the TEL #4 boom section until the weight is removed from the bottom pads in the TEL #3, TEL #2, TEL #1 and base boom sections.
3. Remove the capscrews (two in each pad) that retain the TEL #3, TEL #1, and base boom section bottom wear pads and remove and replace the pads. Install the capscrews, apply Loctite, and tighten them to the proper torque.
4. Mark the location of the nuts that retain the 5/4/3 retract cables to the bottom front of the TEL #2 boom section. Loosen (to remove tension) the nuts on the 5/4/3 retract cables. Remove the capscrews from the 5/4/3 retract cable retainers and move the retainers and cables toward the center of the boom.
5. Remove the capscrews (two in each pad) that retain the TEL #2 boom section's bottom wear pads and remove and replace the pads. Install the capscrews, apply Loctite, and tighten them to the proper torque.
6. Install the 5/4/3 retract cable retainers and 5/4/3 retract cables into the bottom front of the TEL #2 torque. Tighten the 5/4/3 retract cables to their original location previously marked on the threaded cable ends.

BOOM CALIBRATION



INSIDE/OUTSIDE CALIPERS **FIGURE 4-24**

Top and Rear Wear Pads

1. With a pair of inside/outside calipers, measure the inside width of the outer section (W_i) within 50 mm (2 in) of the top plate 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 those bars.

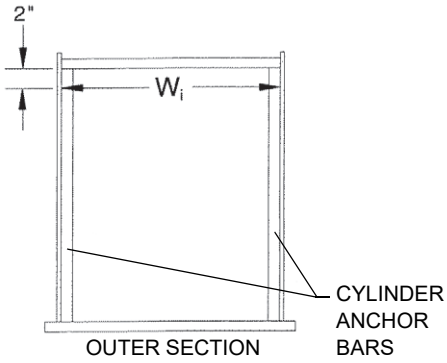


FIGURE 4-25

2. The top rear wear pads also act as the top side pads. These pads are anchored in place by means of offset retainers that are bolted onto the inner boom top plates. Two different offset retainers are utilized, one stamped 0.53 and the other stamped 0.59. These numbers correspond to the distance that the mounting holes are placed off the centerline of the part. Use a combination of 0.53 and 0.50 wear pad retainers on the upper inner section to obtain a 0 mm to 1.5 mm (0.00 in to 0.06 in) clearance between these wear pads (W_o) and inside width (W_i) of the outer section. Stamp the wear pad retainers with R (right) or L (left) and with 2, 3, 4, or 5 (boom section) in position as shown. Stamp the top plate of the boom sections with R or L corresponding to and in the same general location as the stamp on the wear pad mounting plates as shown.

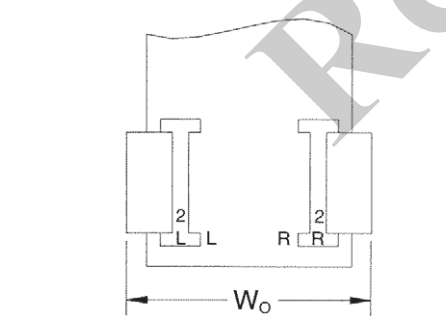


FIGURE 4-26

Inner Side Wear 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 within 76.2 mm (3 in) of the bottom plate and record the smallest measurement. If the section has cylinder anchor bars, take a measurement directly in front of these bars.

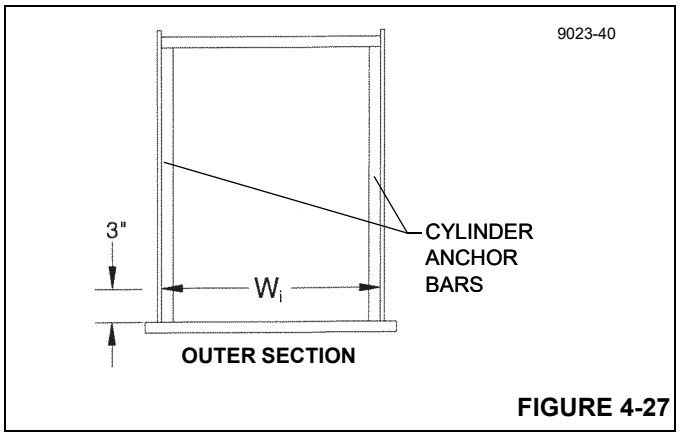


FIGURE 4-27

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

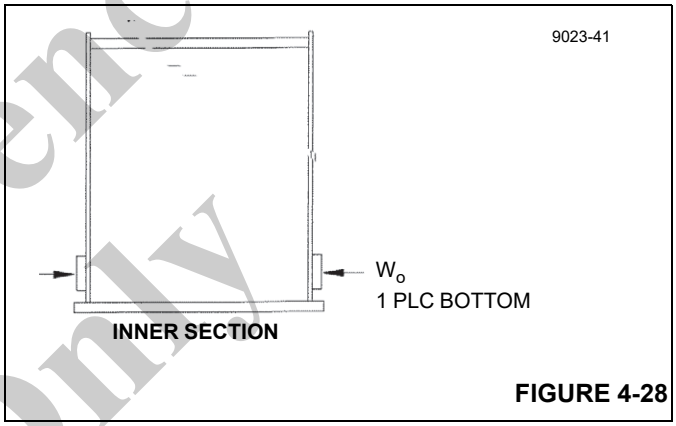


FIGURE 4-28

3. Measure and record the thickness of the wear pads (twp).

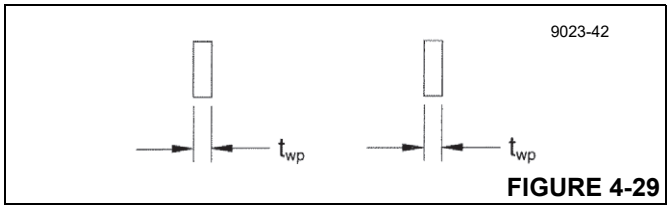


FIGURE 4-29

4. Subtract the outside width (W_o) of the inner section and the thickness of the two wear pads (twp) from the inside width of the outer section (W_i). Add shims as required (each shim is 0.03 thick) to tighten the pads so that there is 0 mm to 1.5 mm (0.00 in to 0.06 in) clearance between the inner boom rear bottom wear pads and the most narrow part of the outer boom when shims are installed.

Rear, Bottom Wear Pads

1. With a tape measure, measure the inside height of the outer section (H_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.

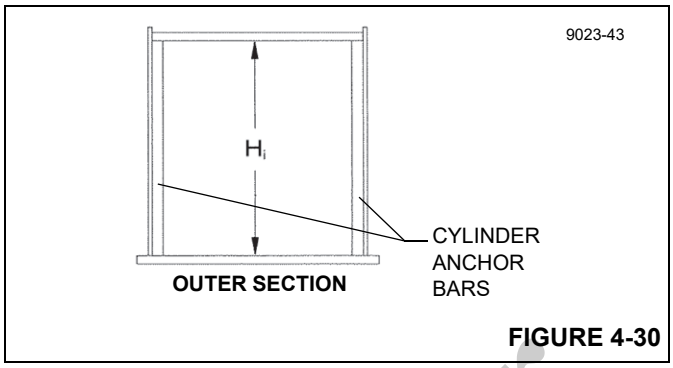


FIGURE 4-30

2. With the tape measure, measure the outside height of the inner section (H_o) at the bottom, rear pad locations. Record the largest measurement.

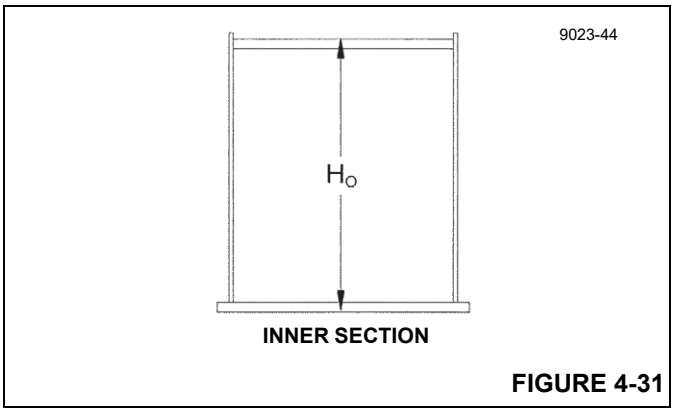


FIGURE 4-31

3. Measure and record the thickness of the top wear pads (twp).

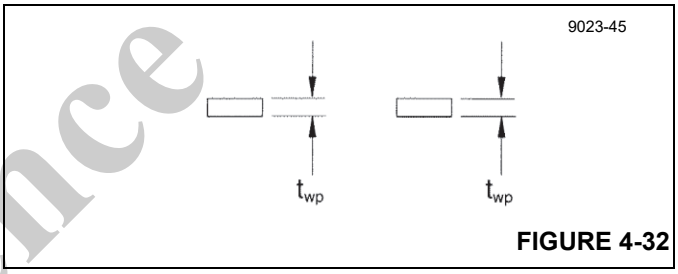


FIGURE 4-32

4. Subtract the largest outside height (H_o) of the inner section and the thickness of the top pad and lower pad (twp) from the inside height of the outer section (H_i). Add shims as required (each shim is 0.06 in thick) to tighten the pads so that there is 1.5 mm to 3 mm (0.06 in to 0.12 in) clearance between the widest part of the inner boom and the most narrow part of the outer boom when shims and pads are installed.

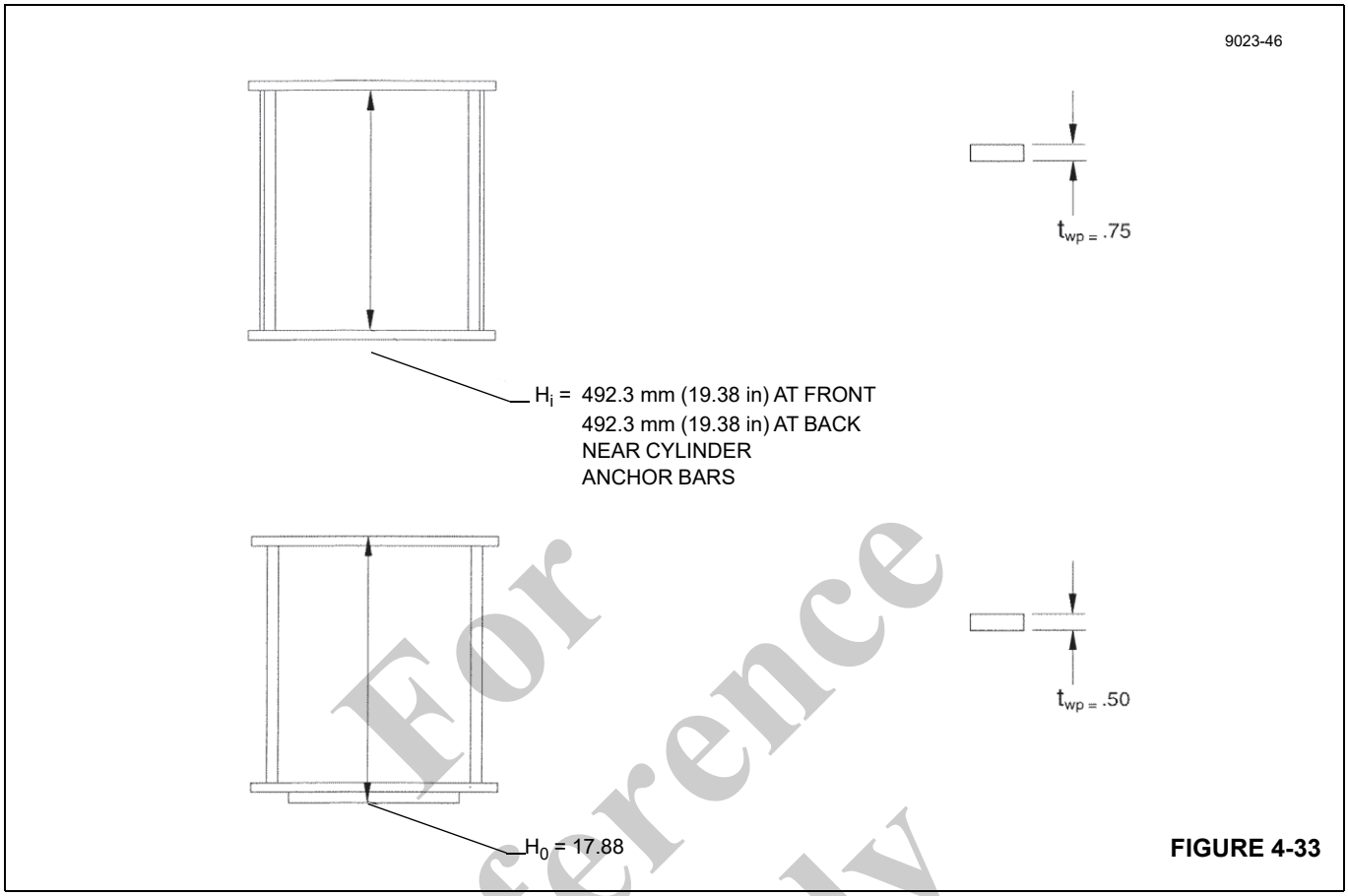


FIGURE 4-33

H_i	=	19.38
$-H_o$	=	-17.88
-twp	=	- 0.75
-twp	=	- 0.50
Clearance	=	0.25
Bottom shims	=	- 0.19
Final Clearance	**=**	**0.06**

HYDRAULIC CYLINDER

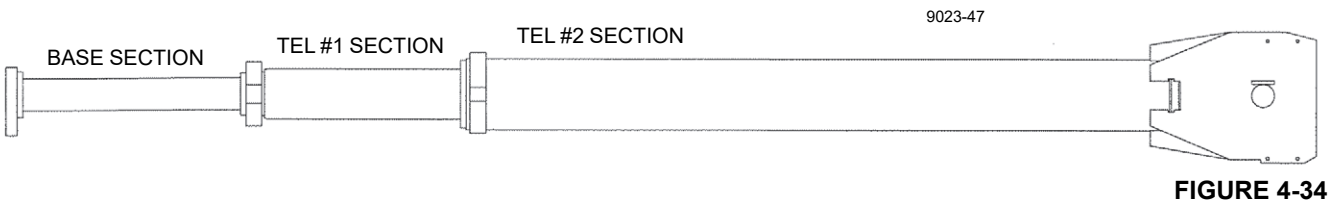


FIGURE 4-34

1. After the hydraulic cylinder has been disassembled from the boom, place the hydraulic cylinder on supports and place the drain pan under the holding valve.

2. Using hydraulic power (porta power or crane circuit) extend the hydraulic cylinder sections approximately 609.6 mm (24 in). If the sections do not move equally, retain the moving section to allow for equal extension of cylinder. Remove the holding valve from the base section butt plate and drain the oil.
3. Using the proper size spanner wrench (listed on the cylinder parts page break down), loosen the packing gland and completely unscrew it from the TEL #2 section barrel assembly.
4. Remove the TEL #1 and Base section cylinder assembly from the TEL #2 section barrel assembly and place it on the supports. Caution must be exercised in the support and removal of the TEL #1 and base section cylinder assembly as damage to the chrome surface will necessitate replacement.
5. Using the proper size spanner wrench (listed on the cylinder parts page break down), loosen the packing gland and completely unscrew it from the TEL #1 section cylinder assembly.
6. Remove the base section cylinder assembly from the TEL #1 section cylinder assembly and place it on the supports. Caution must be exercised in the support and removal of the base section cylinder assembly as damage to the chrome surfaces will necessitate replacement.
7. Using a 3/16 in allen wrench, remove the locking setscrews from the base section cylinder shaft piston and from the TEL #1 section cylinder shaft piston. Using the proper size spanner wrench, loosen and completely unscrew the pistons from the base and TEL #1 section cylinder shaft assemblies. Remove the stop tubes from the base and TEL #1 section 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 the wear pads on the TEL #2 section barrel sheave case assembly. Replace as required.
10. Ensure that the O-ring seal area of the packing gland bores on both the TEL #1 section cylinder assembly and the TEL #2 section barrel assembly are smooth and free of nicks. Lubricate the packing gland O-ring to prevent damage during assembly.

Cylinder Reassembly

1. Replace the cylinder packing parts as required on the base section cylinder assembly. See the parts pages for the replacement packing kit part number. Warming the U-cup seals in 60°C (140°F) oil will allow for easier assembly.
2. Install the packing gland and stop tube onto the base section cylinder shaft assembly.
3. Install the O-ring and backup rings on the inner diameter of the base section piston and thread onto the base section cylinder shaft assembly until snug, making certain that the piston counterbore is seated over the shaft assembly properly. Take care not to damage the O-ring while installing the piston. Using the proper size spanner wrench tighten the piston onto the base section cylinder shaft assembly to 813 Nm (600 lb-ft).
4. Install the setscrew into the piston using Loctite™ Type 243 according to Loctite recommendations and torque it to 8 lb-ft. Loctite and install the second setscrew on top of the first setscrew and torque to 10.8 Nm (8 lb-ft).
5. Replace the cylinder packing parts as required on the TEL #1 section cylinder assembly. See the parts pages for the replacement packing kit part number.
6. Install the packing gland and stop tube onto the TEL #1 section cylinder shaft assembly.
7. Install the O-ring and backup rings on the inner diameter of the TEL #1 section piston and thread onto the TEL #1 section cylinder shaft assembly until snug, making certain that the piston counterbore is seated over the shaft assembly properly. Take care not to damage the O-ring while installing the piston. Using the proper size spanner wrench, tighten piston onto the TEL #1 section cylinder shaft assembly to 813 Nm (600 lb-ft).
8. Install the setscrew into the piston using Loctite Type 243 according to Loctite recommendations and torque the setscrew to 10.8 Nm (8 lb-ft). Loctite™ and install the second setscrew on top of the first setscrew and torque to 8 lb-ft.
9. Install the TEL #1 section cylinder assembly with the piston stop tube and packing gland into the TEL #2 section barrel assembly to within 609 mm (24 in) of fully assembled. Carefully start packing the gland into the TEL #2 section barrel and tighten to within 1/4 in of snug. Using the proper size spanner wrench, torque the packing gland to 813 Nm (600 lb-ft).
10. Apply a 4.77 mm (3/16 in) wide band of Loctite 518 to the outer threads of the packing gland and complete installation.
11. Install the base section shaft assembly with the piston, stop tube, and packing gland into the TEL #1 section cylinder assembly to within 609 mm (24 in) of fully assembled. Carefully start the packing gland into the TEL #1 section and tighten to within 1/4 in of snug.
12. Apply a 4.77 mm (3/16 in) wide band of Loctite™ 518 to the outer threads of packing gland and complete the installation. Using the proper size spanner wrench, torque the packing gland to 813 Nm (600 lb-ft).
13. Install the holding valve onto the base section shaft butt plate. Cycle test the cylinder to ensure leak-proof operation. Apply oil to the base section shaft assembly through the holding valve. Support the TEL #1 and the TEL #2 sections as they extend and retract.

JIB BOOM

Jib Stowage Bracket Adjustment

It is extremely important for the safety of the crane operator and all others working near the crane that the jib boom extension be properly secured to the jib stowage bracket (Figure 4-39) and to the boom nose of the main boom.

Use the following procedure to make adjustments to the jib stowage bracket.

Before beginning this procedure read and understand the following DANGER decal (Figure 4-35). Also review and understand Section 4 in the Operator's Manual for jib safety, stowing, and deployment instructions.

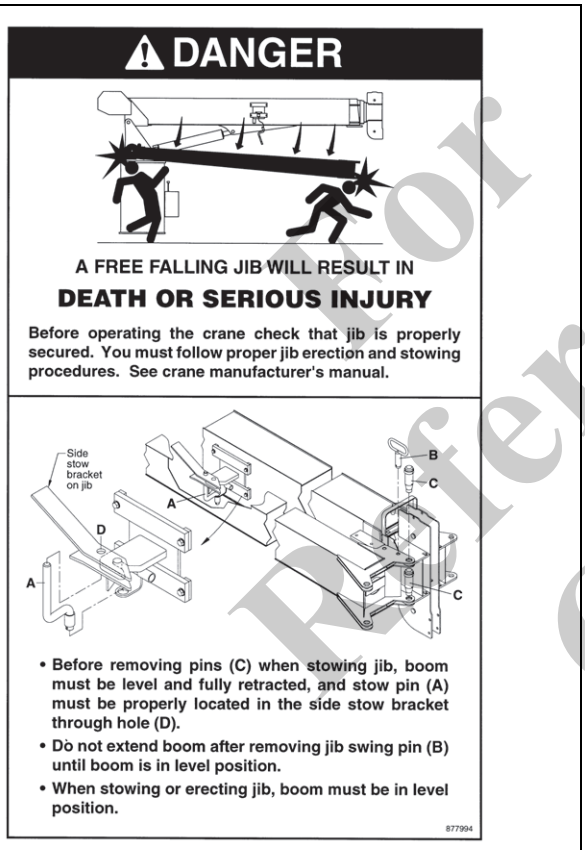


FIGURE 4-35

1. Loosely bolt the two ear assemblies with shims and bars as shown in Figure 4-36 to the side of the first boom section.

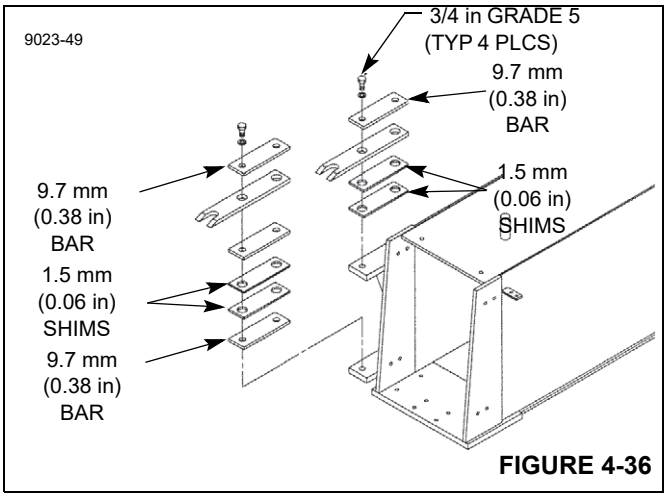


FIGURE 4-36

2. Loosely bolt the hook assembly to the side of the first boom section (Figure 4-37).

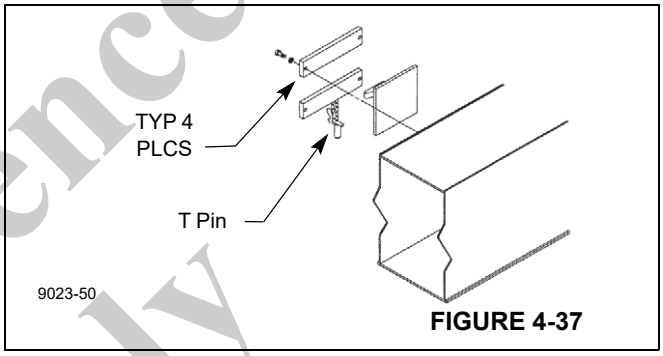


FIGURE 4-37

3. Extend the boom approximately one foot.
4. Using an overhead hoist, lift the jib assembly and align and pin the jib to the boom sheave head (Figure 4-38).

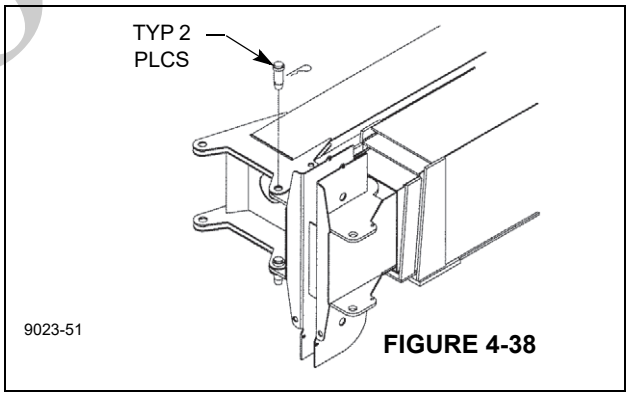


FIGURE 4-38

5. With the jib pinned to the sheave head, swing the jib parallel to the boom and secure the jib to the jib stowage bracket (Figure 4-39).

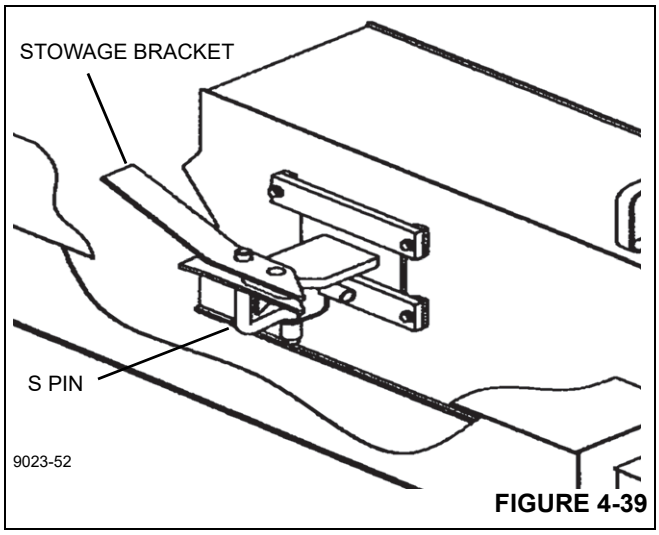


FIGURE 4-39

6. Slowly retract the boom until the jib ears are within 12.7 mm (0.50 in) of the ear assemblies on the first boom 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 (Figure 4-40).

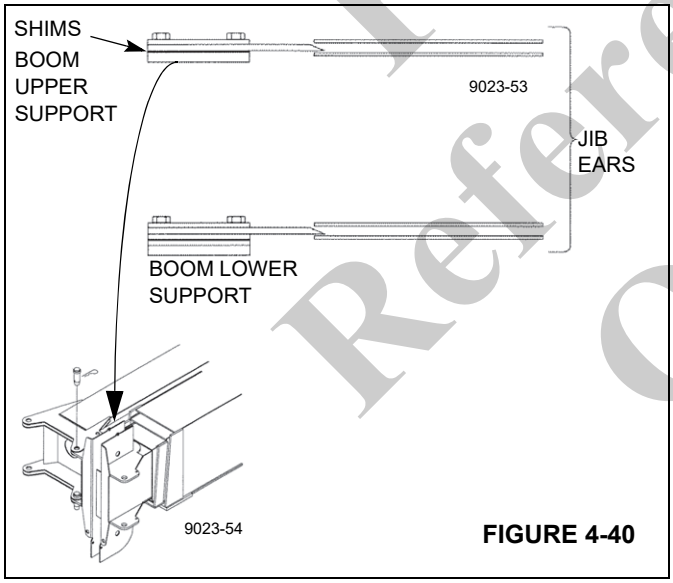


FIGURE 4-40

7. Observe the horizontal alignment of the slot in the ear assemblies and the stow pin in the jib. Horizontal adjustment of the stow ears is provided by oversize bolt holes in the stow ear. Move the ears in or out to achieve proper alignment. Position the top ear so it holds the top of the jib in toward the boom and the bottom ear so that it holds the bottom of the jib away from the bottom of the boom, see Figure 4-41.

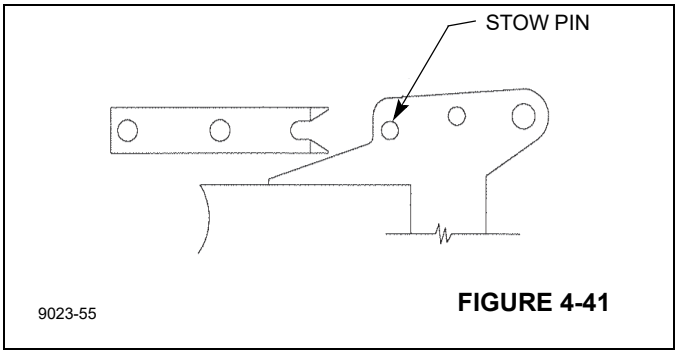


FIGURE 4-41

8. Retract the boom slowly. Observe the stow hook and lock assembly alignment as the boom is retracted (Figure 4-42).

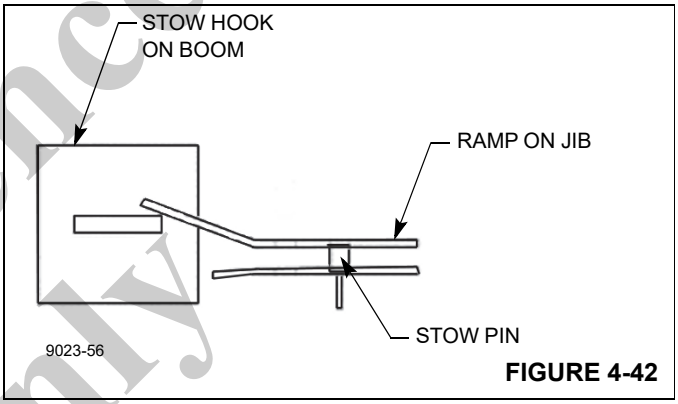


FIGURE 4-42

CAUTION

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

9. When the boom is fully retracted, the jib stow pins must be bottomed out securely in the ear assemblies (Figure 4-43).

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

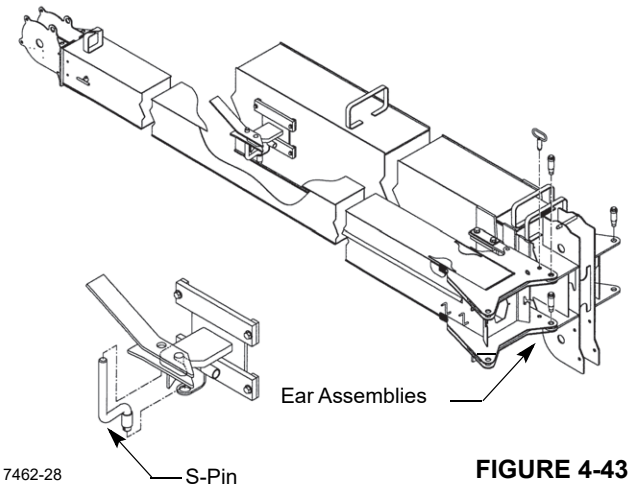


FIGURE 4-43

10. Try to remove the jib pins. If the pins are too tight, the stow hook assembly or front bars will need to be adjusted.
11. Torque all capscrews to their specified torque values (see table in Service and Maintenance Section). Install the stow pin in the lock assembly and remove the jib pins.
12. Extend and retract the boom to ensure proper alignment of the jib pins.
13. Install the jib pins and remove the stow pins.
14. Extend and retract the boom and jib to ensure proper alignment of the jib stow brackets.
15. Install the jib stow pins and remove the jib pins. Always save the shims to allow future adjustment of the jib stow if required.

Jib Jack Service and 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.

See Figure 4-44 for following procedures.

Remove the jack (1) from the jib boom (2) by removing three capscrews and flatwashers (3).

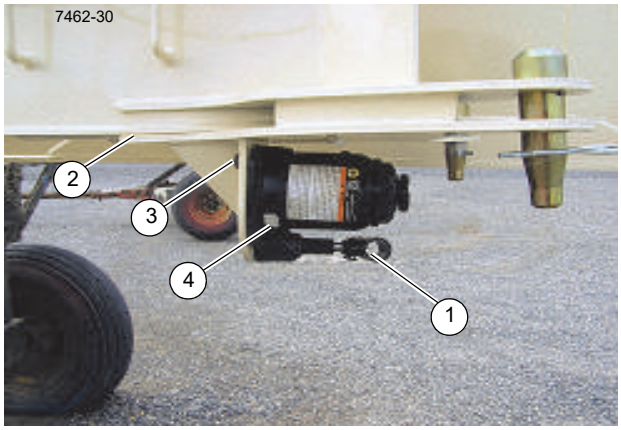


FIGURE 4-44

Adding Oil

1. With the saddle fully lowered and the piston depressed, set jack in its upright level position and remove oil filler plug. (4).
2. Fill the jack until oil is level with the filler plug hole.

Changing Oil

1. For the best performance and longest life, replace the complete oil supply at least once per year.
2. To drain the oil, remove the filler plug (4).
3. Lay the jack on its side and allow the oil to run out into a 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 recommended by manufacture of the jack.

Lubrication

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

Rust Prevention

Check the 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.

Table 4-3.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 partway.	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	1. Transfer load then replace dirty oil. 2. Flush oil reservoir with kerosene.
Poor lifting	1. Dirty oil 2. Air in the 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

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SECTION 5
HOIST

SECTION CONTENTS

DESCRIPTION

The NBT40-1 hoist is composed of a motor control valve, a selectable displacement (two-speed) hydraulic motor, a multiple-disc brake, and a pair of planetary gear sets.

The multiple-disc brake is spring applied and hydraulically released through a port in the brake housing. An overrunning clutch allows the hoist to be raised without releasing the brake while at the same time holding the load until there is sufficient pressure to release the brake when hoisting down.

Figure 5-1 shows both the main and auxiliary hoist, hoist cover, and hydraulic motor. Some NBT40-1 models are configured with only a main hoist, and some models with both the main and auxiliary hoists.

The following removal, installation, disassembly, assembly, and adjustments procedures in this section apply to both the main and auxiliary hoist.

MAINTENANCE

Inspect the hoist daily for oil leaks, loose bolts, and worn hoist cable (see Section 8). Inspect the hoist from the deck of the crane. Do not stand on the turret.

⚠ DANGER

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

Warm-Up Procedure

A warm-up procedure is recommended at each startup and is essential if ambient temperature is below 4°C (40°F). Run the crane at idle with the hoist control lever in neutral and allow sufficient time for the hydraulic system to warm up. Operate the hoist at low speeds, forward and reverse, several times to prime all lines with warm hydraulic oil and circulate lubricant through the planetary gear sets.

Hoist Removal

CAUTION

The combined weight of the hoist and 137 m (450 ft) of wire rope is approximately 467 kg (1,030 lb).

The following removal procedure applies to both the main and auxiliary hoists. See Figure 5-1 for the following procedure.

1. Remove the hoist cover (1) and attaching hardware (2 and 3).
2. Remove the cable (8) from the hoist drum.
3. Tag and disconnect the hoist hydraulic tubes and hoses (17, 18, and 23). Cap and plug all hydraulic openings.
4. Attach a lifting device to the hoist (4 or 7).

   Apply tension on the lifting device cable to prevent the hoist from falling when its hardware is removed.
5. Remove the hoist mounting bolts, washers, and nuts (5, 6, 12, and 13) from the hoist.
6. Remove the hoist (4 or 7) from the crane with the lifting device.

Hydraulic Hoses

Inspect the hoist hydraulic tubes and hoses (17, 18, and 23) for cracks or damage that may cause leaks. Replace hoses as needed.

Hoist Installation

The following installation procedure applies to both the main and auxiliary hoists. See Figure 5-1 for the following procedure.

1. Attach a lifting device to the hoist (4 or 7).
2. Lift the hoist with a lifting device onto the turret.
3. Install the mounting bolts, washers, and nuts (5, 6, 12, and 13).
4. Remove the lifting device from the hoist.
5. Install the hydraulic tubes and hoses (17, 18, and 23) per removal tags.

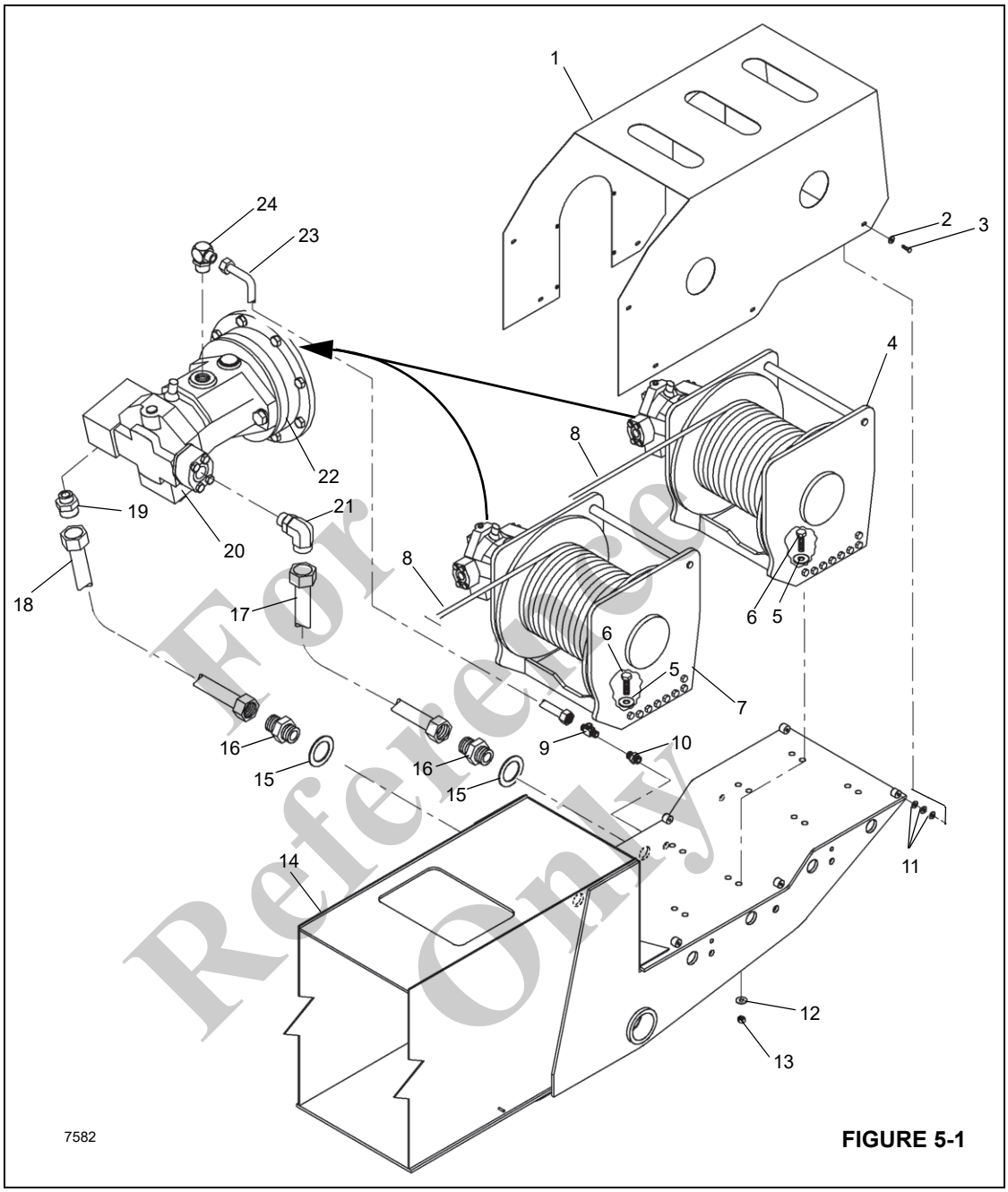


FIGURE 5-1

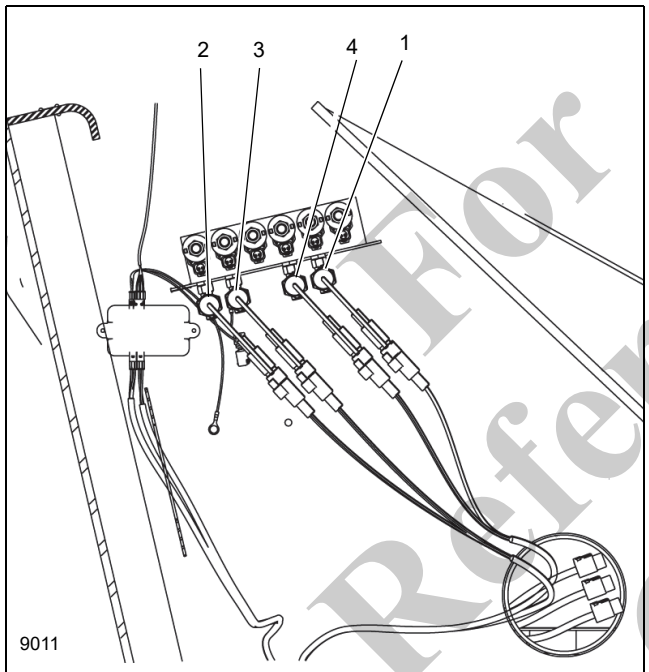
Item	Component	Item	Component	Item	Component
1	Cover	9	Elbow	17	Tube, Lower
2	Flatwasher	10	Union	18	Tube, Raise
3	HHCS	11	Washer	19	Adapter
4	Main Hoist	12	Washer	20	Motor
5	Washer (8 places)	13	Nut	21	Elbow, 90
6	HHCS (8 places) 5/8-11UNC	14	Boom	22	Brake
7	Auxiliary Hoist	15	Washer	23	Case Drain Hose
8	Cable, 5/8	16	Union	24	Elbow, 90

Hoist Rotation Indicator (HRI) System

The HRI system consists of an LED display that indicates the direction the hoist(s) are rotating, pressure switches that monitor hydraulic pilot pressure, and a control module mounted in the cab. The HRI system also provides the operator with a touch indication of drum rotation so he will know if and at what speed the hoist drum is rotating, even under the most distracting conditions. (See “Drum Rotation Indicator” on page 5-5).

Pressure Switches

The pressure switches are located on the main control valve (see Figure 5-2). The switch contacts close at 5.17 bar (75 psi).



Item	Description
1	Main Hoist Down Switch
2	Auxiliary Hoist Down Switch
3	Auxiliary Hoist Up Switch
4	Main Hoist Up Switch

FIGURE 5-2

HRI Display

The HRI display (1, Figure 5-3) is located in the front overhead panel.

To replace the display, remove the overhead panel. Disconnect the electrical connector and pry the display off of the panel. Clean the panel where the display was affixed with isopropyl alcohol, remove the paper from the adhesive back of the new display, and stick it into the panel. Connect the wires to the display. Replace the panel and secure with the hardware.

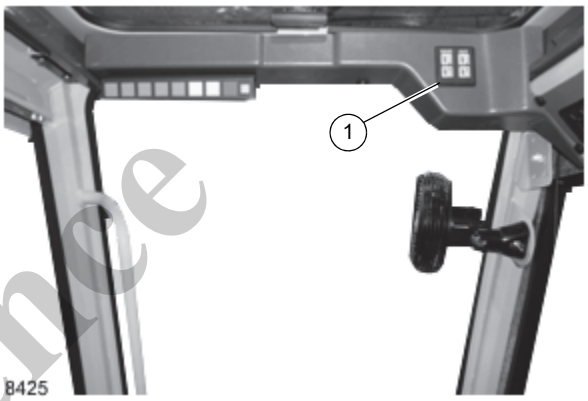


FIGURE 5-3

HRI Control Module

The HRI control module (1, Figure 5-4) is located in the fuse and relay panel behind the driver’s seat in the cab.

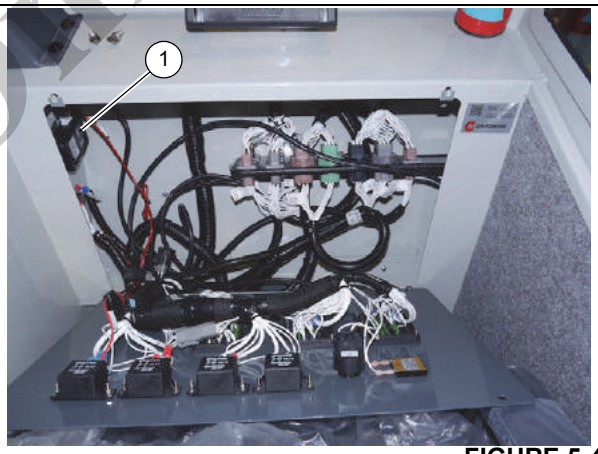
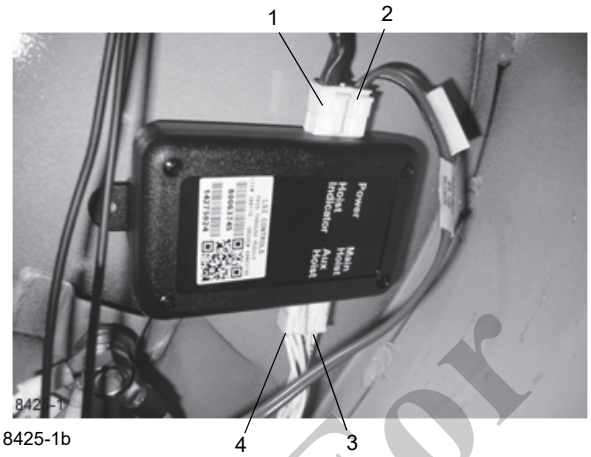


FIGURE 5-4

To replace the control module, tag and disconnect the wires from the module (see Figure 5-5). The module is mounted to the bulkhead using double-sided adhesive tape. To remove the module, pry it off the bulkhead. Remove any residual tape from the bulkhead. Secure the replacement module to the bulkhead with the foam tape. Connect the wires as tagged during removal.



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Item	Description
1	To LED Indicator
2	Power and Ground
3	Main Hoist Pressure Switches
4	Auxiliary Hoist Pressure Switches

FIGURE 5-5

DRUM ROTATION INDICATOR

The Drum Rotation Indicator (DRI) and 3rd Wrap Indicator are integrated into one Hoist Monitoring System (HMS) located on the left side of the hoist and transmits a rotation signal to a solenoid (thumb thumper) located in the hoist control lever on the operator's seat.

The DRI transducer and integral 3rd Wrap Indicator is programmed to notify the operator when there are three wraps of wire or synthetic rope left on the hoist drum.

The HMS is available with two systems, Series, "A" and Series "B". The HMS is available with a CAN J1939, (Series "B"), allowing the device to interface with the Rated Capacity Indicator (RCL) system.

Series "A" units can be distinguished by a single cable connection on the HMS, located on the left side of the hoist. Series "B" units have a second connection (CAN J1939) along with an integrated protection circuitry, acting as a circuit breaker, on the 3rd wrap indicator and DRI (Thumper) outputs.

Removal

1. Loosen the collar on the connector and unplug the DRI cable (1, Figure 5-6).
2. Remove the two retaining screws (2).
3. Remove the DRI unit from the hoist.
4. Loosen set screw and remove shaft assembly from 3rd wrap indicator.

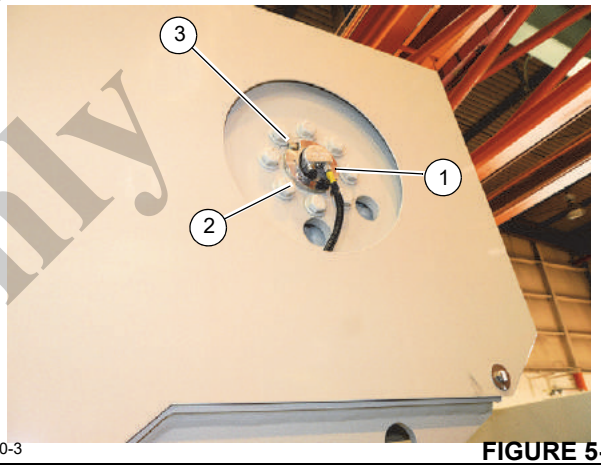

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FIGURE 5-6

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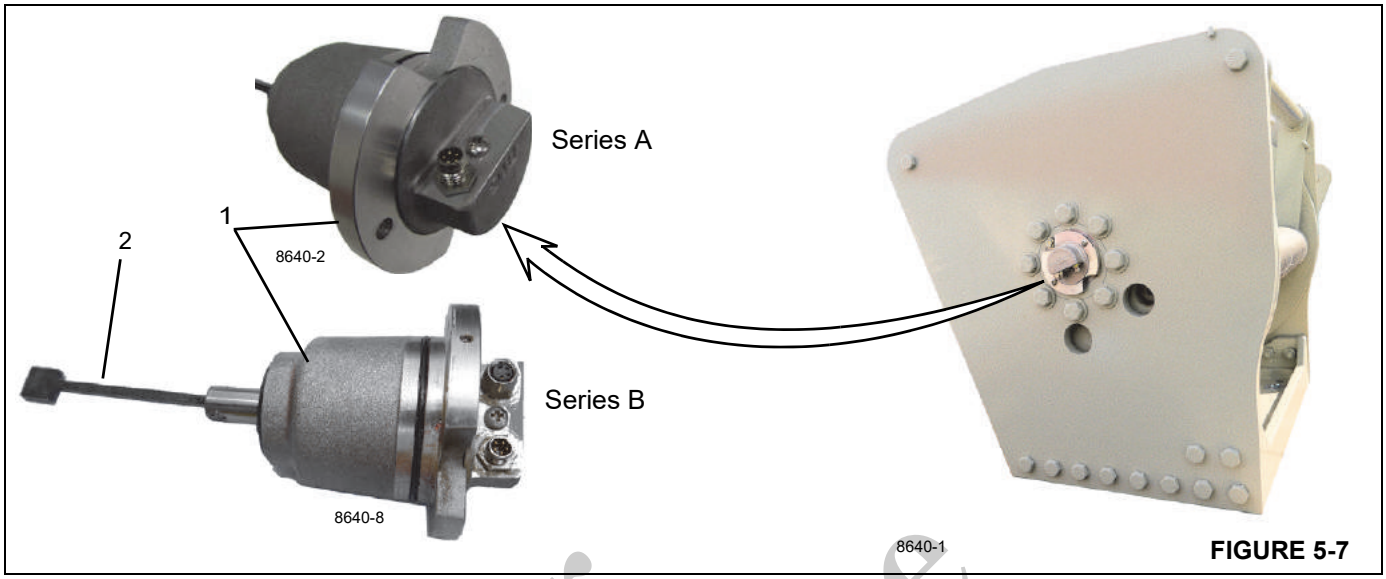


FIGURE 5-7

Installation

To install the DRI, use the following procedure:

1. Install shaft assembly into 3rd wrap indicator.
2. Apply silicone sealant on the setscrew to prevent oil getting into electronics.
3. Tighten setscrew.
4. Insert the DRI into the drum. Rotate the DRI (1, Figure 5-7) so that the DRI shaft (2) engages the drive inside the drum.
5. Push the DRI into the drum so that the notch is lined up with the breather (3, Figure 5-6).
6. Secure the DRI with the retaining screws (2, Figure 5-6).
7. Loosen the set screw (1, Figure 5-8) on the side of the DRI flange.
8. Using the spanner wrench holes (2, Figure 5-8) rotate the DRI so that the connector (3) is pointed down.
9. Tighten the set screw (1, Figure 5-8) after the DRI is positioned as desired.
10. Plug in the DRI cable and tighten the collar to secure the connector.

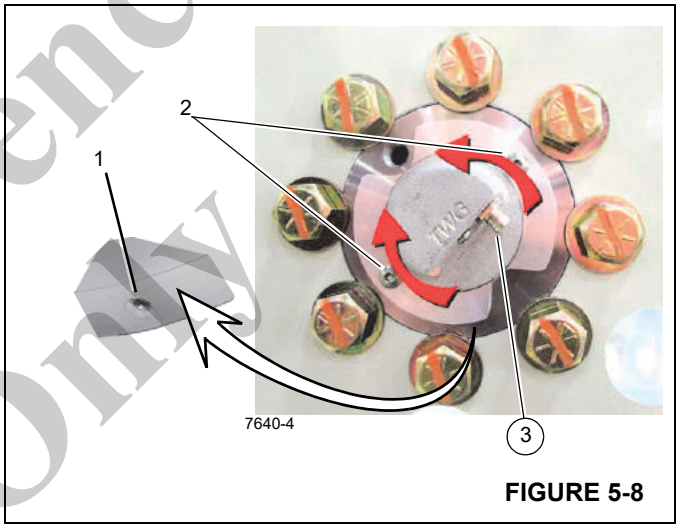


FIGURE 5-8

Programming the 3rd Wrap Indicator

The 3rd Wrap indicator needs to be programmed to alert the operator when the cable is down to the third wrap of wire or synthetic hoist rope. To program the 3rd Wrap indicator you need to:

1. Run the hoist to the first set point, third wrap of wire or synthetic rope. This deactivates the alarm output.
2. Remove power from the 3rd wrap indicator by disconnecting the DRI cable (2, Figure 5-9).
3. Remove the sealed Hoist Monitoring System (HMS) programming button cover screw (1, Figure 5-9) on the DRI.
4. Push and gently hold the programming button (3, Figure 5-9) and return power to the 3rd wrap indicator by reconnecting the DRI cable.

NOTE: Use an Allen Wrench or other small tool with a flat, blunt end approximately 1.5mm or (1/16") in width and at least 76 mm (3") in length. Use of a pointed or sharp tool can cause faulty setting or damage to the HMS. Excess force can damage the HMS operation.

5. Hold the programming button for at least 2 seconds, but less than 15 seconds, after power is applied and release.

NOTE: Holding the button for longer than 15 seconds puts the HMS into Shipping Mode for Series A units.(See Figure 5-9). See Shipping Mode for more information.

6. Run the winch to the second set point.

NOTE: It is recommended to transition to the second layer as the second set point.

7. Gently press and hold the programming button for 1-2 seconds, then release.

8. Replace the 3rd wrap indicator/HMS programming screw. Tighten to 7 in-lbs.

NOTE: Failure to replace the programming screw (1, Figure 5-9) could effect the operation of the 3rd wrap indicator.

9. The 3rd wrap indicator setup routine is complete.

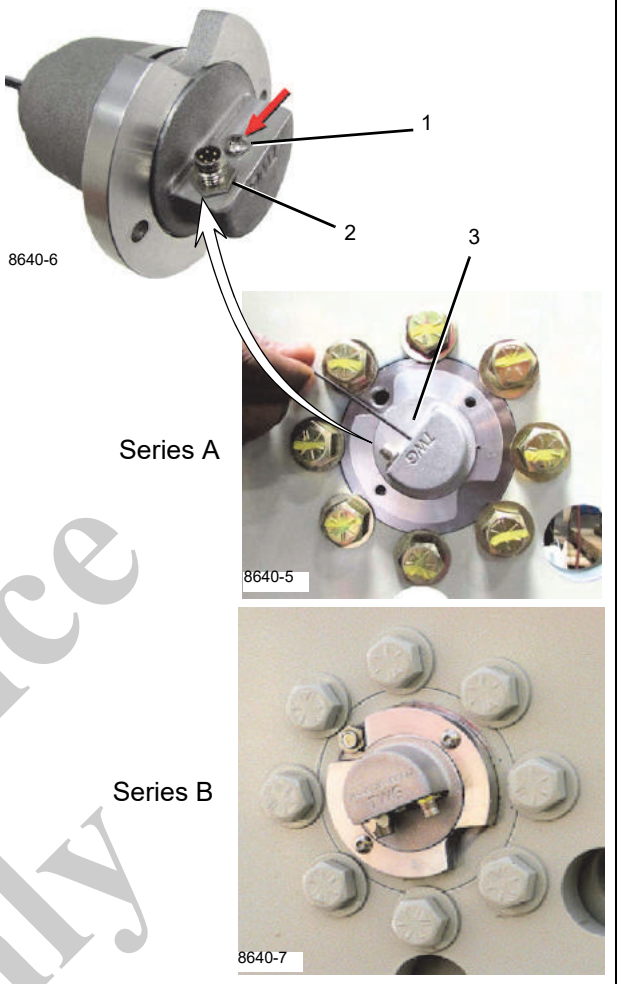


FIGURE 5-9

Shipping Mode (Series A Only)

If the programming button is held down for more than 15 seconds, the HMS will enter "Shipping Mode (Series A Only)." The HMS rapidly pulses the "Warning" output indicating the HMS is entering or exiting "Shipping Mode." While in "Shipping Mode", the HMS will pulse the "Warning" output two times with a 30 second pause.

Shipping Mode allows the OEM to set the set points on the cable before shipping to a job site. This prevents the need to recalibrate the set points when the winch is installed on the machine.

NOTE: The drum rotation indication, commonly a thumper handle, remains operational while the HMS is in shipping mode.

To use Shipping Mode:

1. Install the wire rope on the drum. Refer to the appropriate winch manual for more information.
2. See See “Programming the 3rd Wrap Indicator” on page 5-6 to set the end points.
3. Remove the programming button cover screw (1, Figure 5-9).
4. Press and gently hold the programming button for at least 15 seconds. The HMS rapidly pulses the “Warning” output to confirm the HMS has entered Shipping Mode. The set points remain saved in the HMS.

NOTE: Excess force can damage the programming button and affect 3rd wrap indicator/HMS operation.

5. This allows the winch to rotate without the count or set points being disturbed.
6. When the winch is installed on the machine and the wire rope is installed to the same length as the original setup, press and hold the programming button for more than 15 seconds. The HMS rapidly pulses the "Warning" output to confirm the HMS is no longer in Shipping Mode.
7. The HMS is now ready for use.

TROUBLESHOOTING

For Series “A”

Check the in-line fuse used to protect the thumper line.

Series “B” Circuit Breaker Reset Instructions

Series “B”, units have integrated protection circuitry, acting as a circuit breaker on 3rd wrap indicator and DRI outputs. If circuit breaker trips, remove power (turn OFF key switch or disconnect cable) and inspect load devices, (Thumper handles).

HOIST REPAIR

Disassembly

Refer to Figure 5-10 and the Hoist Parts List on page 5-11 to aid in disassembly of the hoist.

1. Drain the oil from the gearbox and brake sections using the instructions in the Operator’s Manual.
2. Stand the hoist on its end with the motor pointing up.
3. Disconnect the tubing (22) connected to the brake housing (21). Remove the motor (42) from the hoist by removing four capscrews (47). See “Motor” on page 5-13 for motor and counterbalance valve disassembly.
4. Remove the brake subassembly from the hoist by removing eight capscrews (9) holding the brake housing to the side plate (27). Reinstall two of these capscrews into the two extra tapped holes and tighten them evenly until the brake housing comes loose from the side plate. See “Brake” on page 5-12 for brake repair.
5. Remove the side plate (27) by removing twelve capscrews (1, 57, and 87) and two nuts (58).
6. Remove the retaining ring (52). Lift the ring gear (25) out of the drum (5). Remove the five pins (51) as the ring gear is lifted out. Inspect the gear teeth in the ring gear for excessive wear and replace if necessary. Inspect the ball bearing (28) for signs of pitting or spalling and, if necessary, replace the ball bearing and oil seal (7-6).
7. Remove the thrust washer (6) and input sun gear (8) from the input planet gearset (36). Inspect for damage and replace if needed.
8. Remove the input planet gearset (36) from the drum (5). Inspect the gearset for damage.
9. Remove the thrust washer (6) and output sun gear (16). Inspect for damage and replace if needed.
10. Remove the output planet gearset (4) from the drum (5). Inspect the output planet gearset for wear and repair as needed. See “Planetary Set” on page 5-13 for disassembly and repair.
11. Remove the drum (5) by lifting straight up and off the output shaft (32). Inspect the ball bearing (28) for signs of spalling or pitting and, if necessary, replace the ball bearing and oil seal (7-6).
12. Inspect the retaining ring (35) on the output shaft (32) to ensure that it is still in the groove and is not bent. Replace if necessary.
13. Inspect the output shaft (32) for wear or damage and, if necessary, remove it from the side plate (29) by removing eight capscrews (88).

Assembly

See Figure 5-10 and the Hoist Parts List on page 5-11 to aid in assembly of the hoist.

1. Thoroughly clean all parts. Replace those that show wear or damage.
2. Inspect the drum (5) for structural integrity and the gear teeth for excessive wear, then replace if necessary.
3. Attach the output shaft (32) to the side plate (29) with eight capscrews (88), making sure the breather (30) is oriented properly, then tighten them to specification. See “Fasteners and Torque Values” on page 1-7.
4. Install the retaining ring (35) onto the output shaft (32).

5. Attach the base (56), and support rod (2) to the side plate (29) with twelve capscrews (1, 57, and 87) and two nuts (58). Tighten to specification (see “Fasteners and Torque Values” on page 1-7).
6. If necessary, install a new ball bearing (28) and oil seal (7-6) into the drum.
7. Lay the unit down so that the support rod (2) and base (56) are pointing up. Set the drum (5) onto the output shaft (32). Use care not to damage the oil seal (7-6) while seating the drum on the ball bearing (28).
8. Install the output planet gearset (4) into the drum (5), making sure it is installed correctly onto the output shaft (32).
9. Apply a light coating of grease on the thrust washer (6) to keep it in place. Install the thrust washer into the output planet gearset (4), and insert the output sun gear (16). The slot in the sun gear must be installed facing the output shaft (32).
10. Install the input planet gearset (36) into the drum (5), making sure it is installed correctly onto the output sun gear (16).
11. Apply a light coating of grease on the thrust washer (6) to keep it in place and install the input planet gearset (36). Insert the input sun gear (8).
12. Install a new O-ring (7-4) and, if necessary, a new ball bearing (28) and oil seal (7-6) into the ring gear (25). Apply a light coating of grease to the O-ring and seal and install the ring gear into the drum, making sure the pin holes are lined up.
13. Install five pins (51) between the ring gear (25) and the drum (5).
14. Install the retaining ring (52) into the drum.
15. Position the side plate (27) on top of the base (56) and support rod (2). Attach the side plate with twelve capscrews (1, 57, and 87) and two nuts (58). Tighten to specification (see “Fasteners and Torque Values” on page 1-7).
16. Install the brake subassembly into the side plate (27), making sure that the pilot of the brake housing aligns with the ball bearing (28) and oil seal (7-6) in the ring gear (25) and that the holes for the motor are in the correct orientation.

NOTE: Make sure that the level and vent plugs in the cover are properly oriented.

17. Install eight capscrews (88) and tighten them to specification (see “Fasteners and Torque Values” on page 1-7).
18. Install a new O-ring (7-5) on the face of the motor and re-install the motor (42). Install four capscrews (47) and tighten them to specification (see “Fasteners and Torque Values” on page 1-7).
19. Reconnect the tubing (22) to the brake housing (21).
20. Fill both the gearbox and the brake section with the proper amount and type of lubricants as instructed in “Recommended Oil” (see “Hoist Brake Oil” on page 8-8).

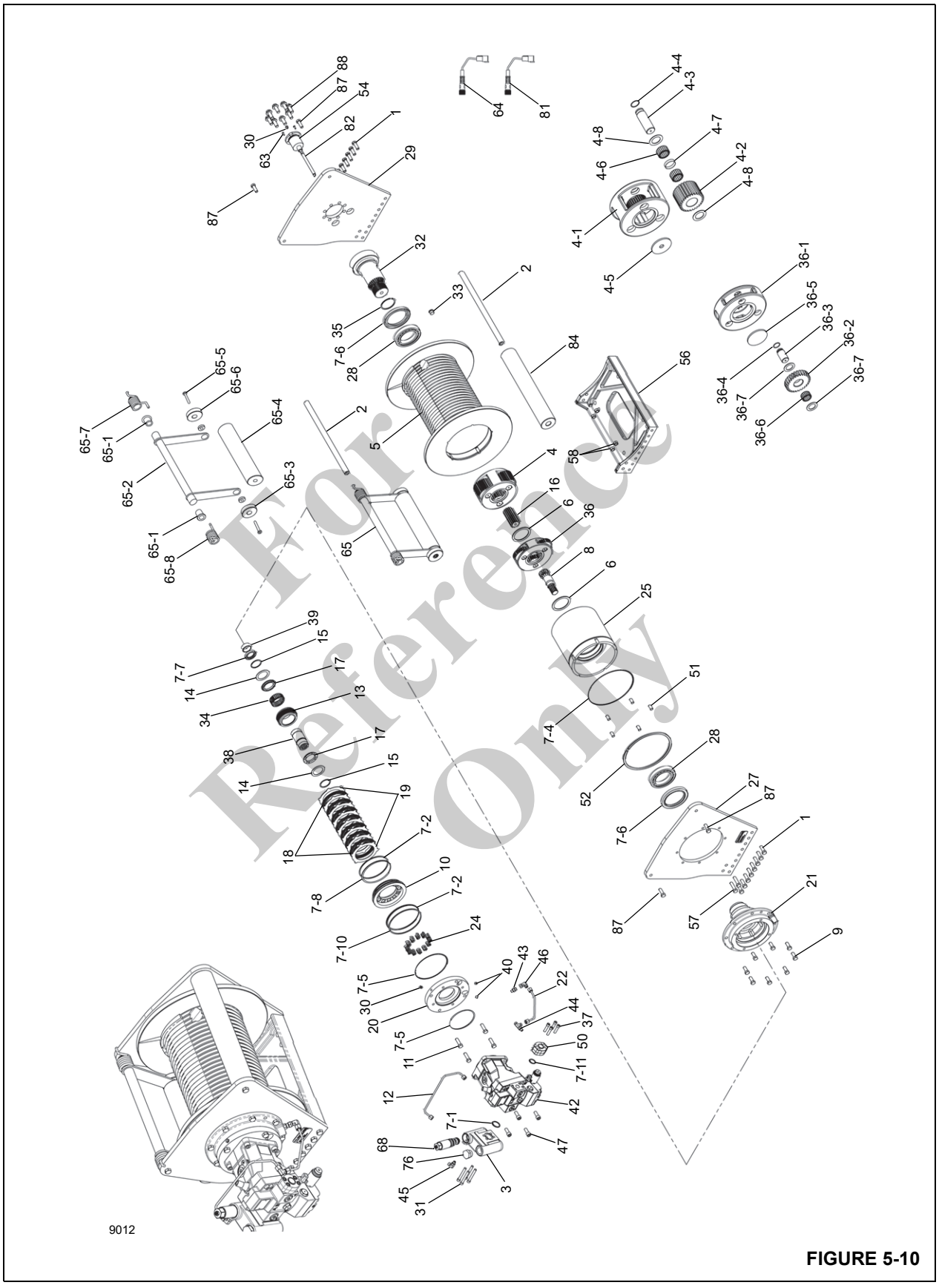


FIGURE 5-10

Hoist Parts List

Item	Qty	Description	Item	Qty	Description	Item	Qty	Description
1	16	Capscrew	15	2	Retaining Ring	43	1	Straight Adapter
2	2	Support Rod	16	1	Output Sun Gear	44	1	Tee Fitting
3	1	Counterbalance Block	17	2	Thrust Bushing	45	1	90 deg Adapter
4	1	Output Planet Gearset	18	7	Friction Disk	46	1	90 deg Adapter
4-1	1	Carrier	19	8	Stator Plate	47	4	Capscrew
4-2	3	Planet Gear	20	1	Brake Cover	50	1	Flange
4-3	3	Planet Pin	21	1	Brake Housing	51	1	Pin
4-4	3	Retaining Ring	22	1	Tubing	52	5	Retaining Ring
4-5	1	Plate	24	12	Brake Spring	54	1	HMS Unit
4-6	6	Bearing	25	1	Ring Gear	56	1	Base
4-7	3	Spacer	27	1	Side Plate	57	4	Capscrew
4-8	6	Race	28	2	Ball Bearing	58	4	Nut
5	1	Drum	29	1	Sideplate	63	2	Screw
6	2	Thrust Washer	30	2	Breather	64	2	Cordset
7	1	Seal Kit	31	4	Capscrew	65	1	Cable Packer
7-1	1	O-ring	32	1	Output Shaft	65-1	2	Bearing
7-2	2	O-ring	33	1	Plug	65-2	2	Arm
7-3	1	O-ring	34	1	Clutch	65-3	1	Roller
7-4	1	O-ring	35	1	Retaining ring	65-4	1	Roller
7-5	1	O-ring	36	1	Input Planet Gearset	65-5	2	Capscrew
7-6	2	Oil Seal	36-1	1	Carrier	65-6	2	Ball Bearing
7-7	1	Oil Seal	36-2	3	Planet Gear	65-7	1	Spring, LH
7-8	1	O-ring	36-3	3	Planet Pin	65-8	1	Spring RH
7-9	1	O-ring	36-4	3	Retaining Ring	68	1	Counterbalance Valve
7-10	1	O-ring	36-5	1	Plate	76	1	Plug
7-11	1	O-ring	36-6	3	Needle Bearing	81	1	Cordset, DRI/3rd wrap
8	1	Input Sun Gear	36-7	6	Fitting, Str Adapter	82	1	DRI/3rd wrap indicator
9	8	Capscrew	37	4	Capscrew	84	1	Roller
10	1	Brake Piston	38	1	Input Driver	85	2	Bushing
11	4	Capscrew	39*	1	Bushing	86	1	Connector
12	1	Tubing	40	1	Pipe Plug	87	4	Capscrew
13	1	Brake Driver	42	1	Motor	88	8	Capscrew
14	2	Race						

Brake

See Figure 5-10 and the Hoist Parts List on page 5-11 for the following brake service steps.

1. Evenly remove the four capscrews (11) holding the brake cover (20) in place. Spring pressure will raise the cover as the capscrews are loosened. Remove the cover from the brake housing.
2. Remove the brake springs (24) from the brake piston (10) and check the free height. Each spring should measure at least 30.5 mm (1.20 in) with no force on them.
3. Remove the brake piston (10) by installing two lengths of 3/8”-16NC threaded rod in the bottom of two spring pockets. Using jam nuts, screw in the all-thread pieces evenly until the piston is clear of the housing. An alternate way of removing the piston is to use a portable power unit or shop air to slowly pressurize the brake cavity until the piston is out of the bore.
4. Remove the brake driver/clutch assembly (13—14, 15, 17, 34, and 38) from the brake housing (21).
5. Remove the stator plates (19) and friction disks (18) from the brake housing and check them for excessive wear, then replace if necessary. Check the top stator plate for scoring caused by the removal tools and polish if necessary. Friction discs should measure no less than 1.40 mm (0.055 in) thick, and stator plates should measure no less than 1.63 mm (0.064 in) thick.
6. If necessary, with a hook wire or pry bar, remove the oil seal (7-7) from the brake housing.
7. Examine the bushing (39) in the brake housing for wear and, if worn, replace it.
8. If the brake housing (21) is removed from the hoist, examine the journal on the brake housing where the seal (7-6) runs for wear. If severely worn, replace the brake housing.
9. Carefully disassemble the brake driver/clutch and note the side in which the markings on the clutch (34) are facing. The clutch assembly must be reassembled with the markings facing the proper direction in order for the hoist to function properly. Inspect the surface on the input and brake drivers (13 and 38) where the clutch (34) runs. If there is any pitting or spalling on the drivers, both it and the clutch must be replaced.
10. Reassemble the driver/clutch assembly, making sure that the clutch is installed properly.
11. Install a new oil seal (7-7) into the brake housing. If the brake housing is removed from the hoist, temporarily install the input sun gear (8) into the brake housing and slide the driver/clutch assembly onto the sun gear spline.
12. Install the stator plates (19) and friction disks (18) into the brake housing, starting with a stator and alternating friction discs and stator plates.

NOTE: There is one more stator plate than friction disc. When assembled correctly, a stator plate will be on top.

13. After installation, check the brake stack-up to make sure that the dimensions are within the tolerance shown in Figure 5-11. If your measurement is greater than shown, either some friction disks and stator plates have been left out, or the friction discs are worn beyond acceptable tolerances. If your measurement is less than shown, too many plates or discs have been inserted or they are not seated properly.
14. Coat the new O-rings and backup rings (7-2, and 7-7—7-9) with light oil and install onto the piston (10). See Figure 5-11 for proper O-ring/backup ring installation.

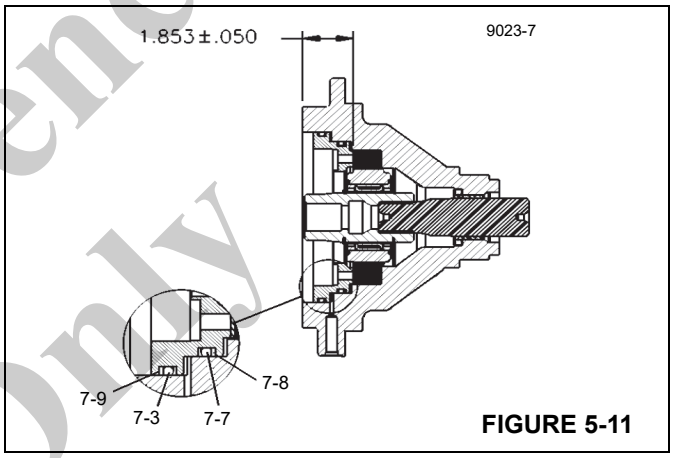


FIGURE 5-11

15. Carefully install the piston (10) into the brake housing (21) and gently tap it down until it is seated.
16. Install the springs (24) into the spring pockets of the piston. If working in a horizontal position, coat the bottom of each spring with chassis lube to keep it in position.
17. Coat the new o-ring (7-3) with light oil and install it into the groove on the brake cover (20).
18. Install the cover (20) onto the brake housing (21) and draw it down evenly, alternating between opposite capscrews. Make sure that the cover is aligned properly with the brake housing in order to correctly orient the motor and vent/drain plugs.
19. Check the brake release with a portable hydraulic pump. Full release should be obtained at 24 bar ±2.4 (225 psi ±35).

Planetary Set

See Figure 5-10 and the Hoist Parts List on page 5-11 for the following procedure.

1. Remove the spiral retaining rings (4-4 and 36-4) from the planet pins.
2. Remove the pins (4-3 and 36-3) from the carrier by carefully tapping them out.
3. Remove the planet gears, thrust washers, and bearings from the carriers.
4. Inspect the pins, bearings, and gear bores for evidence of wear and replace if necessary.
5. On output planet sets, note that two bearings (4-6) with a spacer (4-7) between them are used.
6. Before reassembly, be sure to insert the round plates (4-5 and 36-5) into the carriers.
7. To reassemble, be careful to line up the planet pins with the thrust washers and bearings and then press the knurled part of the pin into the carrier.

CAUTION!

If the pins are not lined up properly, the thrust washers can be shattered during the pressing operation.

Motor

See Figure 5-12 and the Hoist Parts List on page 5-11 for the following procedure.

1. Remove and tag lines.
2. Remove the counterbalance block (1) from the motor assembly (42, Figure 5-10) by removing four capscrews (2).
3. Remove the counterbalance valve (3) from the counterbalance block (1) and inspect the small metering hole located on the side of the cartridge valve to make sure it is not obstructed. Also inspect the O-rings to ensure that they are not cut or flattened.

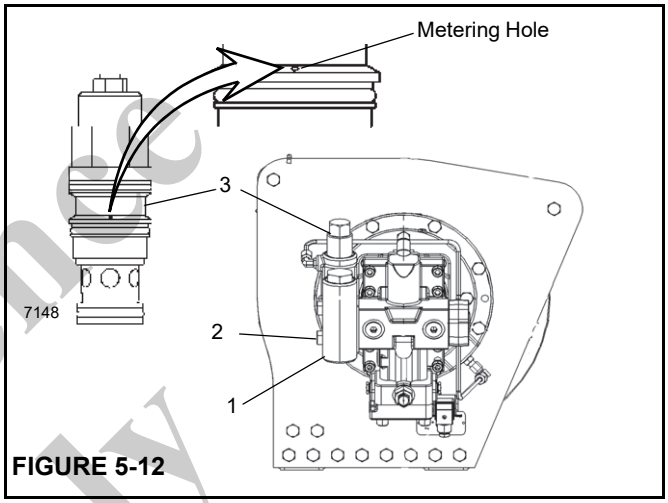


FIGURE 5-12

4. Motors and cartridge valves are not serviceable in the field. Return them to an authorized distributor for service.

TROUBLESHOOTING

Problem	Cause	Solution
The hoist does not hold the load.	Excessive back pressure in the system.	Check the system for restrictions and reduce the back pressure.
	Brake discs are worn out.	Replace brake discs.
	Hoist clutch is slipping.	Inspect the clutch and driver for wear and replace worn parts.
The hoist does not raise the load it should.	Relief valve setting may be too low to allow proper lifting.	Increase relief valve pressure setting.
	Load being lifted may be more than the hoist's rating.	Reduce the load or re-rig to increase mechanical advantage.
The hoist does not lower the load.	The brake valve was improperly hooked up after being disconnected.	Check plumbing and connect lines properly.
	The cartridge in the brake valve may have a plugged metering hole.	Remove the cartridge and clean it if necessary.
Oil leaks from the vent on the motor side of the hoist.	The motor shaft seal may have failed.	Replace this seal and reduce back pressure if that caused the shaft seal to fail.
	Brake piston seals may have failed.	Service the brake section and replace worn parts.

SECTION 6
SWING

SECTION CONTENTS

DESCRIPTION

The purpose of the swing system is to allow the crane turret to rotate atop the carrier frame. The NBT40-1 swing system provides full 360° rotation in both directions and is equipped with free swing capabilities. With glide-swing, the swing brake switch is in the OFF position, and the turret swings freely after the SWING control lever is released and coasts to a stop.

NOTE: When equipped with a radio remote control, the swing brake is automatically applied whenever the swing control lever is in the neutral position.

The swing system consists of a hydraulic remote controller, directional control valve, swing drive gearbox, swing motor, swing brake, swing brake pedal, and house lock. The swing control lever is used to slow and stop the swing by moving the control lever to the opposite direction of the swing. The swing brake pedal is used to keep the turret parked in position.

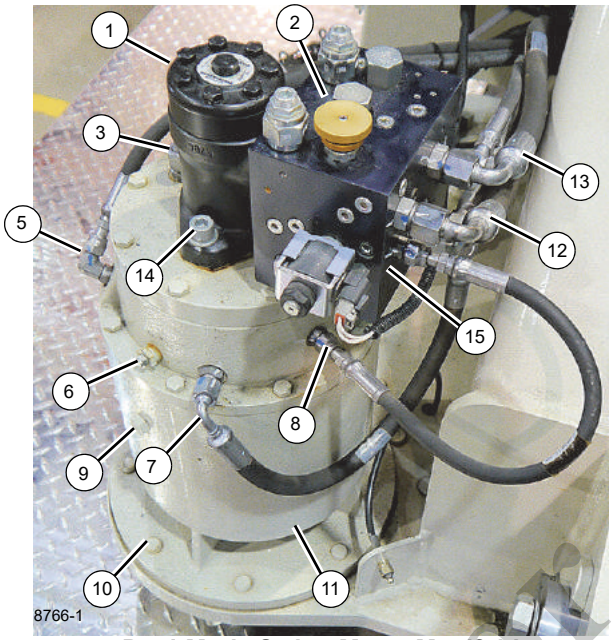
The house lock is used to lock the turret in place for transport.

THEORY OF OPERATION

Swing Drive

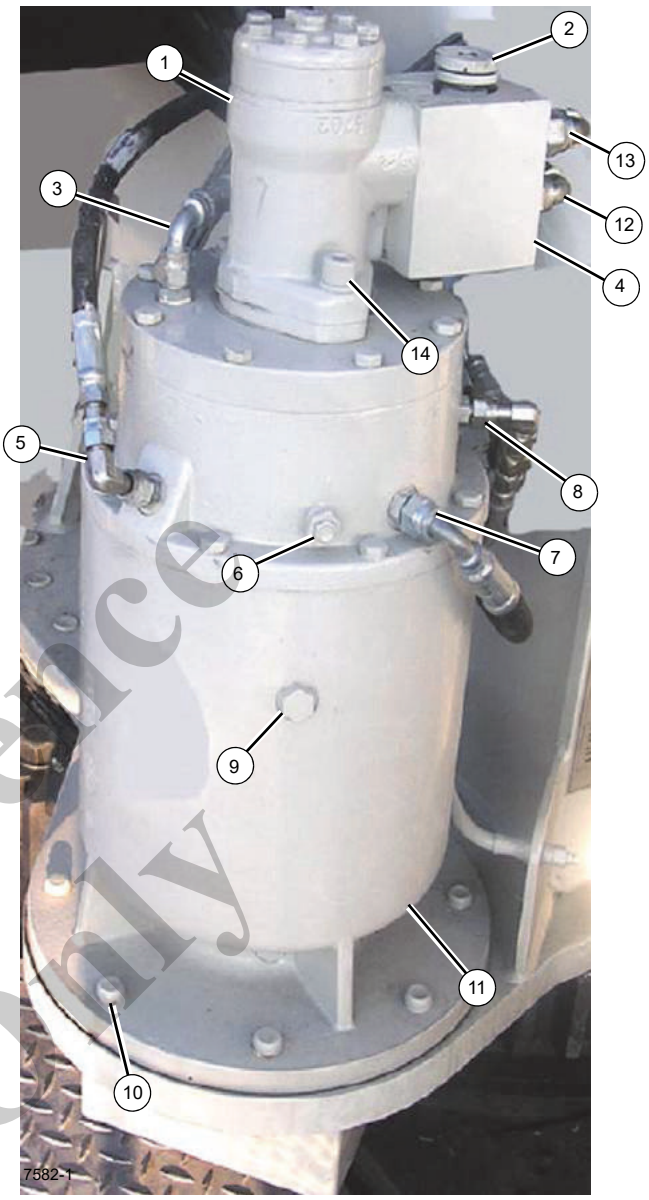
The hydraulic power for the swing drive (Figure 6-1) is supplied by the power take-off (PTO) driven hydraulic pump. Oil flows from the pump, through swivel port #3, to the main control valve.

When the hydraulic remote control is positioned to select right or left swing, hydraulic oil flows through the control valve and is directed to the swing motor (1, Figure 6-1). If the swing brake switch is in the OFF position, the turret rotates in the desired direction. Shifting the control to neutral allows the turret to coast to a stop. Shifting the control to the opposite directions powers the turret to a stop. Depressing the swing brake pedal holds the turret in position. If the swing brake switch is in the ON position and the crane is equipped with the dual-mode swing motor manifold (15), the swing brake is released when pressurized hydraulic oil enters the dual-mode swing motor manifold.



Dual-Mode Swing Motor Manifold

Item	Description
1	Swing Motor
2	Adjustable Speed Valve
3	Brake Coolant Out
4	Standard Swing Motor Manifold
5	Service Brake Apply
6	Breather
7	Brake Coolant In
8	Parking Brake Release
9	Fill
10	Screw & Flatwasher, 3/4 in
11	Gearbox
12	Control Clockwise
13	Control Counterclockwise
14	Screw & Lockwasher, 1/2 in
15	Dual-mode Swing Motor



Standard Swing Motor Manifold

FIGURE 6-1

Swing Brake

Spring pressure in the swing brake chamber applies the swing brake while at rest. The swing brake is controlled by the swing brake release solenoid on the pilot manifold. When the swing brake switch is positioned to OFF, pressure is directed from the pilot manifold to the brake release port and overcomes the brake spring pressure, releasing the swing brake. When the swing brake switch is in the ON position, no hydraulic pressure is present at the brake release port, and spring pressure applies the swing brake.

When the standard swing motor manifold (4, Figure 6-1) is installed, it provides glide-swing operation. This allows the use of the swing brake pedal to control braking. Hydraulic pressure for the swing brake is supplied by the pilot manifold and is controlled by the swing brake valve. The swing brake must be released before attempting to swing the crane.

When the crane is equipped with radio remotes or the aerial lift option, the larger dual-mode swing motor manifold (15) is installed. The dual-mode swing motor manifold controls the release of the swing brake. The dual-mode swing motor manifold is used for remote or aerial operation and can switch between glide-swing and counterbalance operation using a solenoid valve. When in crane mode, the operation is glide-swing. When in aerial mode, the glide-swing feature is disabled and the dual-mode manifold functions as a counterbalance swing operation.

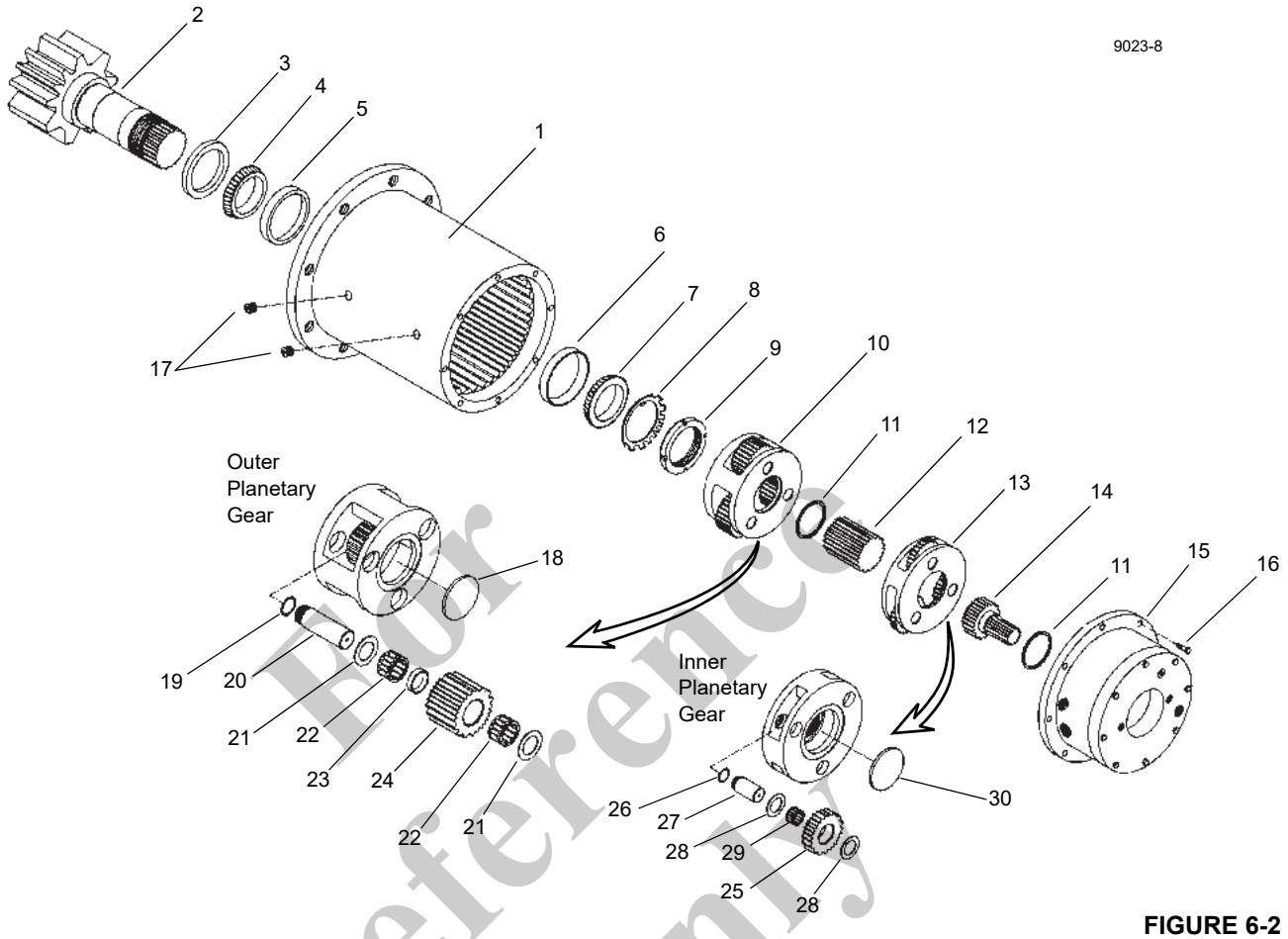


FIGURE 6-2

Item	Component	Item	Component
1	Gear Housing	16	Capscrew (qty 8)
2	Output Shaft	17	Drain Plug (qty 2)
3	Oil Seal	18	Plate
4	Lower Bearing	19	Retaining Washer
5	Lower Bearing Race	20	Output Planetary Pin
6	Upper Bearing Race	21	Washer
7	Upper Bearing	22	Needle Bearing
8	Lock Washer	23	Spacer
9	Lock Nut	24	Output Planetary Gear
10	Output Planetary Assembly	25	Input Planetary Gear
11	Thrust Washer	26	Retaining Washer
12	Output Sun Gear	27	Input Planetary Pin
13	Input Planetary Assembly	28	Washer
14	Input Sun Gear	29	Needle Bearing
15	Brake Assembly	30	Plate

SWING GEARBOX AND BRAKE

The swing drive is a double planetary gear reducer with an integral brake. The planetary gear reducer is designed for long life in heavy-duty applications such as crane rotation. The swing gearbox incorporates tapered roller bearings on the output shaft and heavy-duty bearings in the planet gears.

NOTE: Swing motor and cartridge valves are not serviceable in the field. Return them to an authorized distributor for service.

Removal and Installation

See Figure 6-1 for the following procedures.

Removal

1. Tag and note the location of all hydraulic hoses and swing gearbox ports. Remove all hoses from the swing gearbox and plug open hoses and ports.
2. Attach a lifting device capable of lifting approximately 125 kg (275 lb) to the swing gearbox (11). Apply tension to the lifting cable.
3. Remove the six capscrews and flatwashers (10) that secure the swing gearbox to the turret. Lift the swing gearbox from the turret.
4. Remove two socket head capscrews and two lock washers (14) that secure the hydraulic motor (1) to the swing gearbox (11) and remove the hydraulic motor.

Installation

1. Secure the hydraulic motor (1) to the swing gearbox (11) with two screws and two lock washers (14).
2. Using a lifting device, position the swing gearbox (11) onto the turret. Secure the swing gearbox (11) to the turret with six capscrews and flatwashers (10).
3. Connect hydraulic hoses to the swing gearbox and hydraulic motor.

Disassembly and Assembly Instructions

If the swing drive needs repair, see Figure 6-2 for the disassembly and assembly procedure.

NOTE: The swing gearbox assembled with the hydraulic motor, swing brake, and control valve weighs 125 kg (275 lb).

Tools Required

- Scribe or small punch
- Oil drain pan
- Eye-bolt (1/4 in)
- Retaining ring pliers
- Gear puller
- Ratchet wrench (1/2 in drive)
- 9/16 in socket (1/2 in drive)
- Socket for pinion nut (Whittet-Higgins P/N BAS-14)
- Soft hammer (brass or plastic)
- Press
- Drift rod (1/4 in to 3/8 in diameter)
- 1/2 in drive torque wrench capable of 135 Nm (100 ft lb)

Parts Required to Rebuild

- Seals
- O-rings
- Back-up rings
- Parts to replace damaged or worn parts
- Lock nut (9, Figure 6-2) and lock washer (8)

Disassembly

See Figure 6-2 for the following procedure.

1. With a scribe or small punch, make a set of marks on the brake assembly (15) flange and the top edge of the gear housing (1) to aid in reassembly.
2. Remove both drain plugs (17) and drain the oil from the unit. Drainage is facilitated when the oil is warm.
3. Remove the eight capscrews (16) holding the brake assembly (15) onto the gear housing (1).
4. Lift the brake assembly (15) off the swing gearbox. If necessary, screw the hydraulic motor capscrews into the brake assembly for use as handles.
5. Remove the thrust washer (11) and input sun gear (14) from the input planetary assembly.
6. Install three 1/4 in eyebolts into the three planet pins of the input planetary assembly (13), and with a small chain pull the input planetary assembly from the gear housing.
7. Remove the output sun gear (12) and thrust washer (11) from the output planetary assembly (10).
8. Using the eye-bolt/chain method outlined in step 6, remove the output planetary assembly (10) from the gear housing.
9. To remove the output shaft (2) from the gear housing (1), bend the tab on the lock washer (8) out of the slot in the lock nut (9). Loosen and remove the lock nut from the output shaft.

CAUTION

The lock nut is no longer retaining the output shaft. Care should be taken when moving the gear housing because the output shaft can fall out.

10. Output shaft removal. Place the gear housing (1) on a plate or table with a hole that allows the output shaft (2) to extend through the hole. Press the output shaft out of the bottom of the case by applying a minimal load to the threaded end of the output shaft until it passes through the upper shaft bearing (6 and 7).

The unit is now disassembled into groups of parts. The area(s) requiring repair should be identified by thorough inspection of the parts after they have been washed in solvent. See the appropriate group repair section.

Input Planetary Repair

See Figure 6-2 for the following procedure.

1. Remove the retaining washers (26) from the planetary pins.

2. Use a press to remove the planetary pins (27) from the carrier. Support the input planetary assembly (13) to remove the planetary pins.

3. Slide the planetary gears (25) and washers (28) out of the input planetary assembly.

4. Remove the plate (30) from the input planetary assembly.

5. If needle bearings (29) must be replaced, they may now be removed out of the input planetary gears (25).

6. Rebuild the input gear set in reverse order using any required new parts.

7. Before reassembly, be sure to insert the plate (30) into the input planetary assembly.

8. To reassemble, be careful to line up the planetary pins (27) with the washers (28) and the needle bearings (29) and then press the knurled part of the planetary pin (27) into the input planetary assembly (13). If the planetary pins (27) are not lined up properly, the washers (28) can be shattered during the pressing process. Reinstall the retaining washers (26) onto the planetary pins.

Output Planetary Repair

See Figure 6-2 for the following procedure.

Repair for the output planetary gear set is the same as the input planetary gear set with one exception: the output planetary gear set has two needle bearings (22) per planetary pin (20) with a spacer (23) between the bearings.

Shaft Repair

See Figure 6-2 for the following procedure.

1. The lower bearing (4) may be removed from the output shaft (2) using a gear puller.

2. Remove the old seal (3) and discard. Grease pack the lower bearing (4) with lithium grease or EP and install it into the bearing race (5) in the gear housing (1). The old bearing (4) may be reused only if it was removed to replace the seal and was not the cause of the seal failure. Use a press fixture or a hammer and a large flat-ended bar or rod to press the new oil seal into the gear housing (1) until the oil seal is flush.

NOTE: If the bearing (4) is replaced, the bearing race (5) must also be replaced.

3. Install the output shaft (2) into the gear housing (1). Be careful not to damage the seal (3) in the gear housing.

Case Assembly Repair

See Figure 6-2 for the following procedure.

1. Remove the bearing race (6) and replace it if required.

2. Clean all foreign material from the case.

Unit Assembly

See Figure 6-2 for the following procedure.

1. Place the gear housing (1) on a table with the gear end of the output shaft (2) on the table surface.

CAUTION

The output shaft and case are not retained together at this point. Move the unit so that the output shaft and gear do not separate.

2. Hold the gear of the output shaft (2) and rotate the gear housing (1) to be sure it moves freely. The slight resistance is due to seal load on the output shaft (2).

3. Grease pack the upper bearing (7) with lithium grease or EP lubricant. Slide the upper bearing over the threaded end of the output shaft (2) with the small end down. Press the upper bearing on slowly until it is seated.

Hold the output shaft and rotate the gear housing when installing the upper bearing. The bearing is seated when all rollers are rotating evenly.

NOTE: If the upper bearing is replaced, the bearing race (6) must also be replaced.

4. Slide the lock washer (8) down the threaded end of the output shaft (2) until it reaches the end of the bearing (7).

5. Thread the lock nut (9) down the threads of the output shaft (2) and tighten until it is snug.

6. Set the bearing preload by tightening the lock nut (9) onto the output shaft (2) to a torque of 135 Nm (100 ft lb). Proper bearing preload is determined by the rolling torque method. This method involves increasing press load on the bearings (4 and 7) until drag or rolling resistance of 8.4 Nm to 9.6 Nm (75 in-lb to 85 in-lb) is achieved when rotating the case.

   This includes bearing as well as seal drag. The torque is equal to a force of 8.4 Nm to 9.6 Nm (75 in-lb to 85 in-lb) on a capscrew screwed into one of the brake assembly mounting holes to rotate the case. Bend the tang of the lock washer (8) into place on the lock nut (9).

7. Place the gear housing (1) on a table with the gear end of the output shaft (2) on the table surface.

8. Lower the output planetary assembly (10) into the gear housing until the planetary gears engage the teeth in the gear housing. Lower the output planetary assembly until the planetary gears engage the teeth on the output shaft. Rotate the output planetary assembly or the output shaft until the output planetary assembly slides down to allow full contact between the two sets of gear teeth.

9. Firmly hold the pinion end of the output shaft and slowly rotate the gearbox assembly to ensure the free rotation of the installed gear sets.

10. Install the thrust washer (11) and the output sun gear (12) in the end of the output planetary assembly (10).

11. Lower the input planetary assembly (13) into the gear housing (1) until the planetary gears engage the teeth on the input end of the output sun gear (12).

12. Rotate the input planetary assembly (13) or the output shaft until the input planetary assembly slides down to allow full contact between the two sets of gear teeth.

13. Firmly hold the pinion end of the output shaft (2) and slowly rotate the gearbox assembly to ensure free rotation of installed planetary assembly.

14. Install the thrust washer (11) and the input sun gear (14) into the input planetary assembly (13).

15. Lubricate a new O-ring (1, Figure 6-3) and install it in the groove in the top of the gear housing (1).

16. Place the brake assembly (15) onto the top of the gear housing (1). The marks made during the disassembly process will aid in properly lining up the brake assembly on the gear housing (1).

17. Install the eight capscrews (16) in the brake assembly (15) and torque them to 40 Nm (30 ft-lb).

18. Apply pipe sealant on one of the drain plugs (17) and install the plug in the lower hole of the gear housing (1).

19. Fill the gear housing with 3.8 L (1 gal) of EP 80-90 gear grease.

20. Apply pipe sealant on the other drain plug and install the plug in the top hole of the gear housing.

SWING BRAKE

The swing brake is manufactured for two specific types of holding torque requirements: park mode and swing glide. The swing brake remains in park mode until oil pressure is applied to the brake piston chamber in the brake assembly. As the oil pressure increases, the spring force keeping the brake applied is overcome and the brake is released. Once the brake is released, the crane is free to rotate. Crane rotation is also controlled by applying pressure to the dynamic brake piston, which reapplies pressure to the brake discs.

Disassembly

See Figure 6-3 for the following procedure.

1. With a scribe or punch, make a pair of marks on the edge of the brake cover (22) and the top of the brake housing (2) to aid in reassembly.

2. Remove the hydraulic motor from the brake assembly.

3. Alternately loosen the eight capscrews (23) one turn at a time until the internal spring force is relieved.

⚠ DANGER

Do not clamp or otherwise restrain the cover while removing the capscrews because the brake is under high compressive spring load.

4. Lift and remove the brake cover from the brake housing.

5. Remove the brake springs (20) from the brake assembly.

6. Apply low hydraulic pressure (138 kPa [20 psi]) to the brake release port while holding one hand on top of the brake piston (19). The pressure will force the brake piston out of the brake housing.

7. Remove the friction discs (14) and the stator plates (13) from the brake housing.

NOTE: Record the order in which the friction discs are removed because they must be reinstalled in the same order.

8. Remove the brake driver (11) from the brake housing.

9. If necessary, remove the two retaining rings (10 and 12) from the inside of the brake driver.

10. Apply low hydraulic pressure (138 kPa [20 psi]) to the dynamic brake port to push the dynamic brake piston (9) out of the brake housing.

11. Remove the bearing (4) and the oil seal (3) from the brake housing.

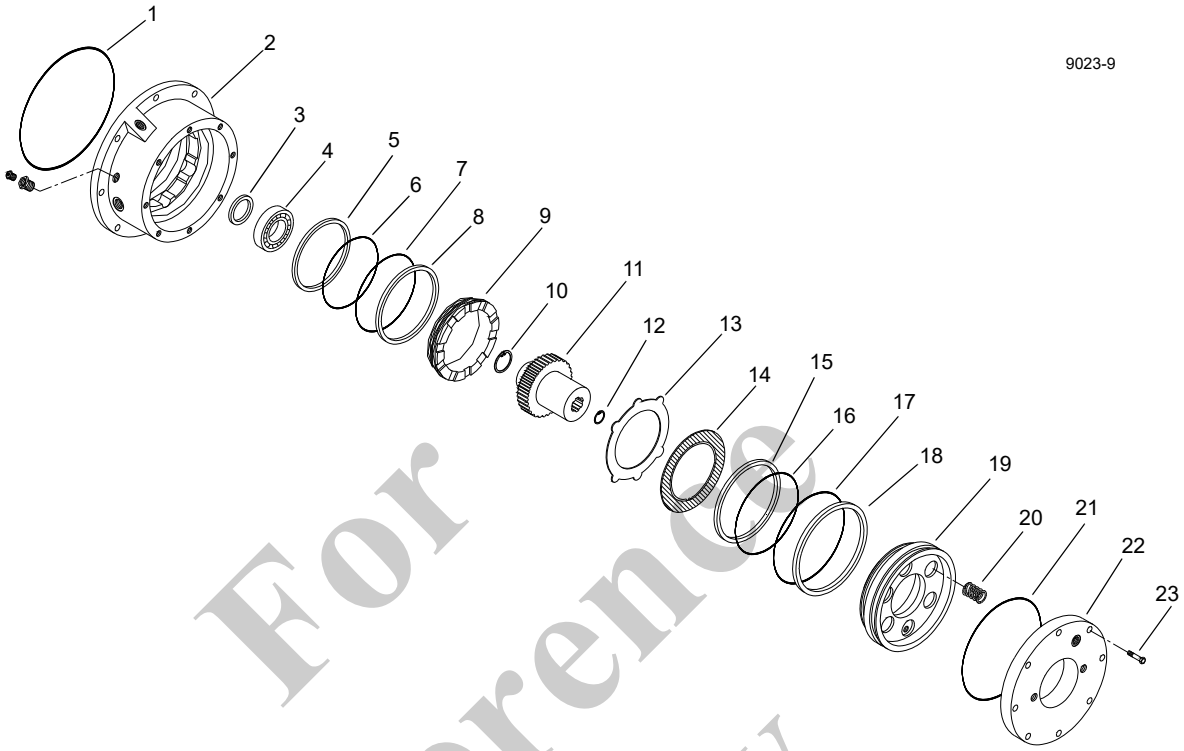


FIGURE 6-3

Item	Component	Item	Component
1	O-ring	13	Stator Plate (qty 6)
2	Brake Housing	14	Friction Disc (qty 4)
3	Oil Seal	15	Back-up Ring
4	Bearing	16	O-ring
5	Back-up Ring	17	O-ring
6	O-ring	18	Back-up Ring
7	O-ring	19	Park Brake Piston
8	Back-up Ring	20	Brake Spring (qty 6)
9	Dynamic Brake Piston	21	O-ring
10	Retaining Ring	22	Brake Cover
11	Brake Driver	23	Capscrew (qty 8)
12	Retaining Ring		

Assembly

See Figure 6-3 for the following procedure.

Assembly is in reverse order of disassembly with the following additional instructions.

1. Lubricate the sealing lip of the oil seal (3) with the same type of hydraulic oil that the crane uses. Press the oil seal into the brake housing (2) with the open side of the seal facing the hydraulic motor end of the brake assembly. Install the bearing (4) into the brake housing.
2. If replacing the dynamic brake O-rings (6 and 7), make sure to install the O-rings and back-up rings (5 and 8) in the same order in which they were removed. Lubricate with hydraulic oil to aid in assembly.
3. Gently slide the dynamic brake piston (9) into the brake housing. Press down on the piston with the heel of both hands to squeeze the O-rings into the housing. Push the piston completely down into the housing.
4. Install the brake driver (11) into the brake housing by pushing down until the bearing shoulder on the driver is seated against the bearing. Make sure that the retaining rings (10 and 12) are installed in the driver.
5. Install the stator plates (13) and friction discs (14) into the brake housing in the exact same order that they were removed. Note that two stator plates are stacked together in the center of the stack. Be careful not to contaminate the friction surfaces with dirt, grease, or fluid media other than what is specified for your brake.

NOTE: If installing new friction discs, soak all discs in hydraulic oil for approximately 10 minutes before installation.

6. Pour hydraulic oil into the brake housing (2) until it is level with the top of the brake discs and stator plates.
7. If replacing the brake piston O-rings (16 and 17), make sure to reinstall the O-rings and back-up rings (15 and 18) in the same order in which they were removed. Lubricate O-rings and back-up rings with hydraulic oil to aid in their assembly.
8. Gently slide the park brake piston (19) into the brake housing. Press down on the brake piston using the heel of both hands. This will squeeze the O-rings into the case and set the brake piston against the stator plates.
9. Insert the brake springs (20) into the brake piston.
10. Lubricate the O-ring (21) with hydraulic oil and install on the brake cover (22).
11. Carefully set the brake cover on top of the piston springs so they remain upright on the brake piston.
12. Start the eight capscrews (23) into the brake housing by hand. Alternately tighten the capscrews one turn at a time until the cover is tight against the brake housing. Tighten the capscrews to a torque of 41 Nm to 47 Nm (30 ft-lb to 35 ft-lb).

SWING BEARING

Description

The swing bearing is an anti-friction roller bearing that mates the turret to the carrier. The bearing inner race is bolted to the turret and the outer race is bolted to the carrier. The inner race contains four grease fittings for lubrication of the bearing. The outer race incorporates gear teeth that mesh with the pinion gear of the swing gearbox to provide rotation.

MAINTENANCE

General

The swing bearing is the most critical maintenance point of the crane. It is here, at the centerline of rotation, that the stresses of loads are concentrated. In addition, the bearing provides the only attachment between the turret and carrier. Therefore, proper care of the bearing and periodic maintenance of the turret-to-bearing capscrews is required to ensure safe and efficient operation.

TORQUING SWING BEARING CAPSCREWS

General

⚠ DANGER

It is mandatory that swing bearing and T-box attaching bolts be inspected and re-torqued after the first 300 hours of crane operation and every 500 hours thereafter. The bolts may loosen and cause the crane to separate from the carrier, which will result in damage to the crane and possible injury or death to personnel.

Maintaining the proper torque value for capscrews is extremely important for structural strength, performance, and reliability of the crane. Variations in torque can cause distortion, binding, or complete separation of the turret from the carrier.

CAUTION

Repeated re-torquing may cause bolts to stretch. If bolts keep working loose, they must be replaced with new bolts of the proper grade and size.

Proper identification of capscrew grade is important. When marked as a high-strength capscrew (grade 8), the technician must be aware of capscrew classifications and that he is installing a high-strength, heat-treated, tempered component, and the capscrew must be installed according to specification. Special attention should be given to the

existence of lubricant and plating that will cause variation from dry torque values. When a high-strength capscrew is removed, or untorqued, the capscrew must be replaced with a new capscrew of the same classification. Torque the capscrews to recommended values, refer to *Fasteners and Torque Values*, page 1-7.

NOTE: Zinc flake coated bearing bolt heads are stamped with the suffix "ZF" as a visual identifier.

Know your torque wrench! Flexible beam type wrenches, even though they might have a pre-set feature, must be pulled at a 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 torque 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 re-calibrated. When using a torque wrench, any erratic or jerking motion can result in the application of excessive or improper torque. **Always** use a slow and even movement and **stop** when the predetermined value has been reached.

If it is reported by the crane operator or suspected that the crane has been overloaded beyond the capacities specified above the bold line on the crane's capacity chart, then all swing bearing capscrews must be inspected and re-torqued to specifications.

Tighten the swing bearing capscrews to the torque according to the procedures outlined in this section.

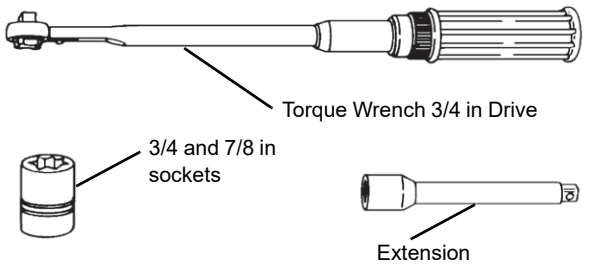


FIGURE 6-4 9023-10

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 capscrew.
- 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.

Swing Bearing Capscrews

The inner race of the swing bearing is secured to the turret by 36 capscrews (Figure 6-5). The outer race of the bearing is secured to the carrier frame by 36 capscrews (Figure 6-5).

Tools Required

A complete set of special tools are required to torque the swing bearing capscrews (see Figure 6-4).

Inner Race Tightening Procedure

See Figure 6-5 for the following procedure.

The inner race capscrews (1—36) can be accessed through the access holes underneath the bed (1, Figure 6-6).

Table 6-1 Inner Race Capscrew Torque

	Inner Race Capscrew Torque
First Pass Torque	637 Nm ±27 Nm (470 lb-ft ± 20 lb ft)
Final Pass Torque	1,161.9 Nm to 1,259.6 Nm (857 ft-lb to 929 ft-lb)

1. Extend and set the outriggers and fully elevate the boom.
2. For the first pass, tighten the inner race swing bearing capscrews shown in Figure 6-5 to the torque shown in Table 6-1. Use a socket, torque multiplier, backlash adapter, necessary extensions, and a torque wrench.
3. For the final pass, starting with the first capscrew (1), tighten the inner race capscrews sequentially in a clockwise direction to the torque shown in Table 6-1, using the same tools as in step 2.

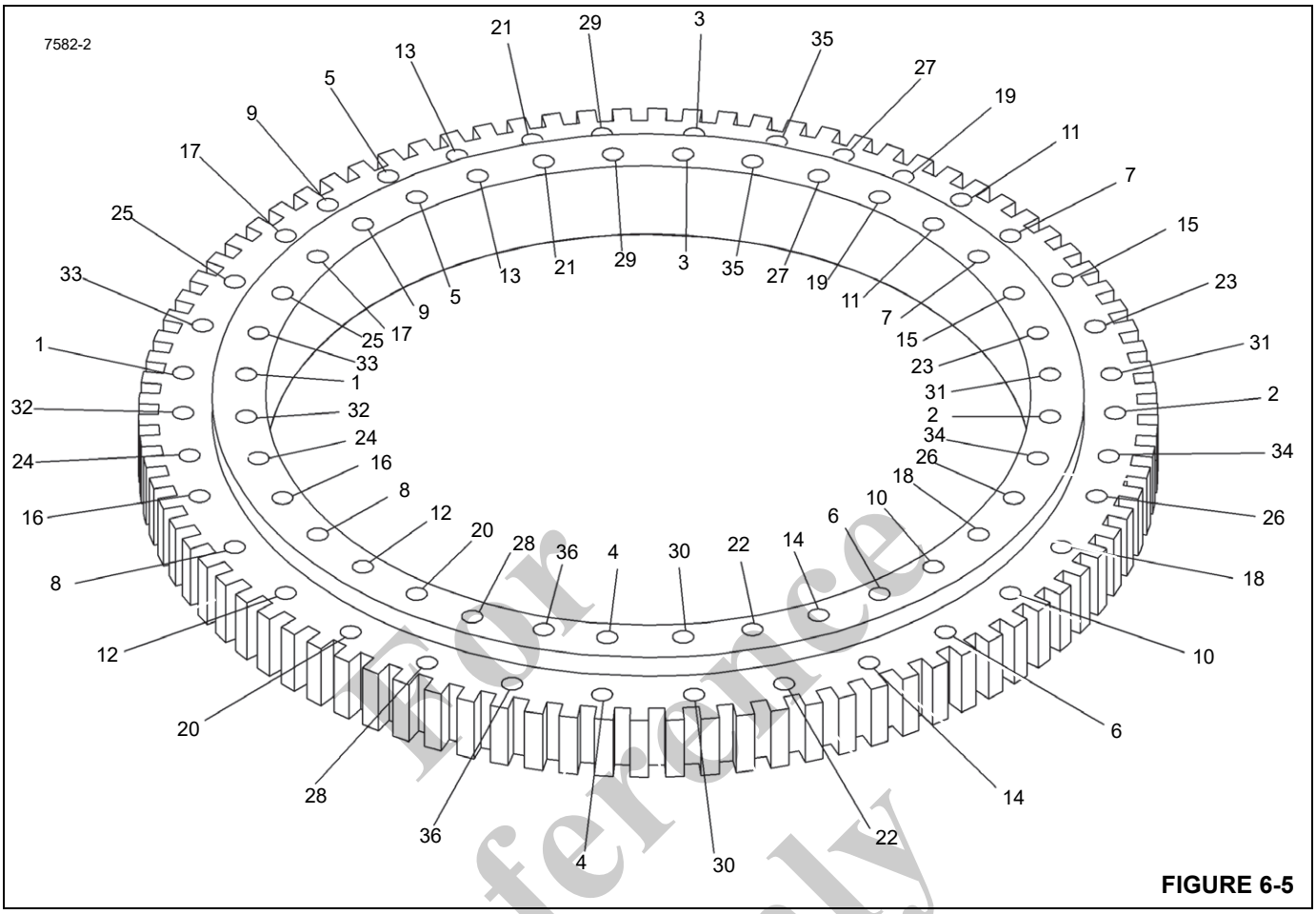


FIGURE 6-5

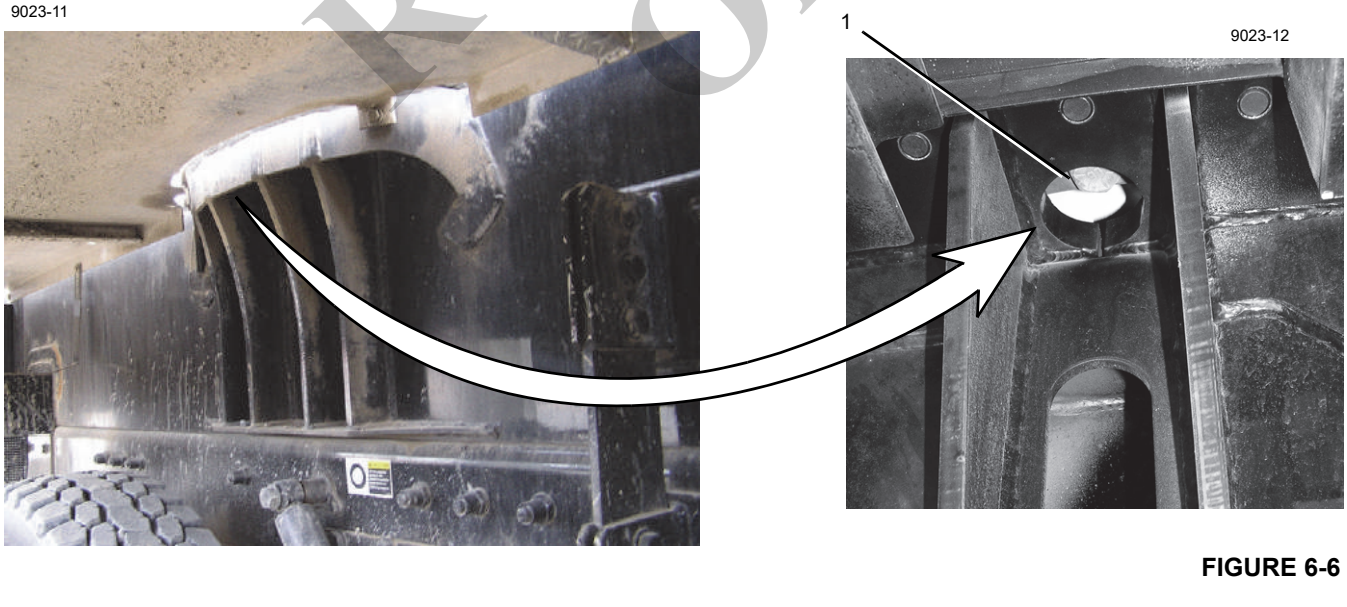


FIGURE 6-6

Outer Race Tightening Procedure

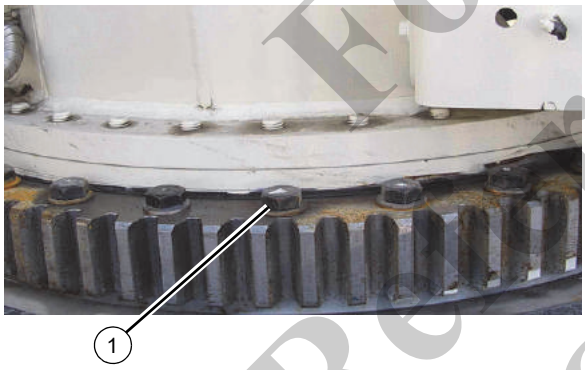
The outer race capscrews (1, Figure 6-7) are located on top of the bearing.

Table 6-2. Outer Race Capscrew Torque

First Pass Torque	637 Nm ±27 Nm (470 ft-lb ± 20 ft-lb)
Final Pass Torque	846 to 916 Nm (624 ft-lb to 676 ft-lb)

See Figure 6-5 for the following procedure.

4. Extend and set the outriggers and fully elevate the boom.
5. For the first pass, tighten the outer race swing bearing capscrews shown in Figure 6-5 to the torque shown in Table 6-2. Use a socket, torque multiplier, backlash adapter, necessary extensions, and torque wrench.
6. For the final pass, starting with the first capscrew (1), tighten the outer race capscrews sequentially in a clockwise direction to the torque shown in Table 6-2, using the same tools as in step 2.



9023-13 **FIGURE 6-7**

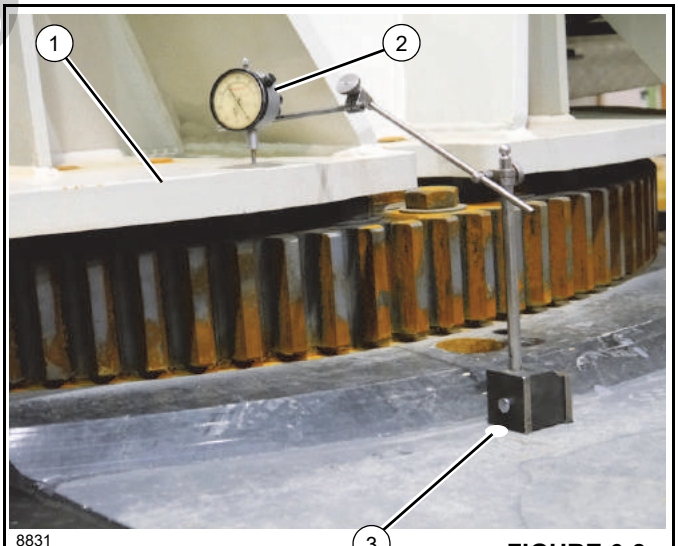
BEARING CLEARANCE

If a swing bearing exhibits the following symptoms, it may have reached the end of its useful life.

- Metal particles in the grease
- Increased drive power required
- Noise
- Rough operation
- Acceleration in the increase of normal wear in bearing clearance

Measure the internal clearance of the swing bearing to determine if it needs to be replaced. (See National Crane Technical Support Information TSI #10.)

1. Place the boom over the front and set the outriggers.
2. Put a dial indicator (2, Figure 6-8) opposite the boom on the torsion box frame (3).
3. Place the dial on the top of the turret bearing plate (1, Figure 6-8).
4. Power the boom down onto the boom rest.
5. Set the dial indicator at zero.
6. Raise the boom about 76 mm (3 in) above the boom rest.
7. Record the deflection indicated on the dial.
8. Repeat steps 4 through 7 three times and average the readings.
9. If the average is greater than 2.2 mm (0.090 in), replace the bearing.
10. If the average is less than 2.2 mm (0.090 in), repeat the measurement at every 45° around the total working area of the crane (see Figure 6-9).
    a. Measure the deflection at positions 2, 3, 7, and 8 for 180° rotation and at positions 2 and 8 for 360° rotation.
    b. Use another crane to support the end of the boom when the boom is powered down.
    c. Locate the dial indicator opposite the boom.
    d. Set the dial indicator to zero.
    e. Raise the boom about 76 mm (3 in).
    f. Record the reading on the dial indicator.
    g. Repeat steps d through f three times.
    h. Average the readings.
    i. If the averages are greater than 2.2 mm (0.090 in) at any position, replace the bearing.



8831 **FIGURE 6-8**

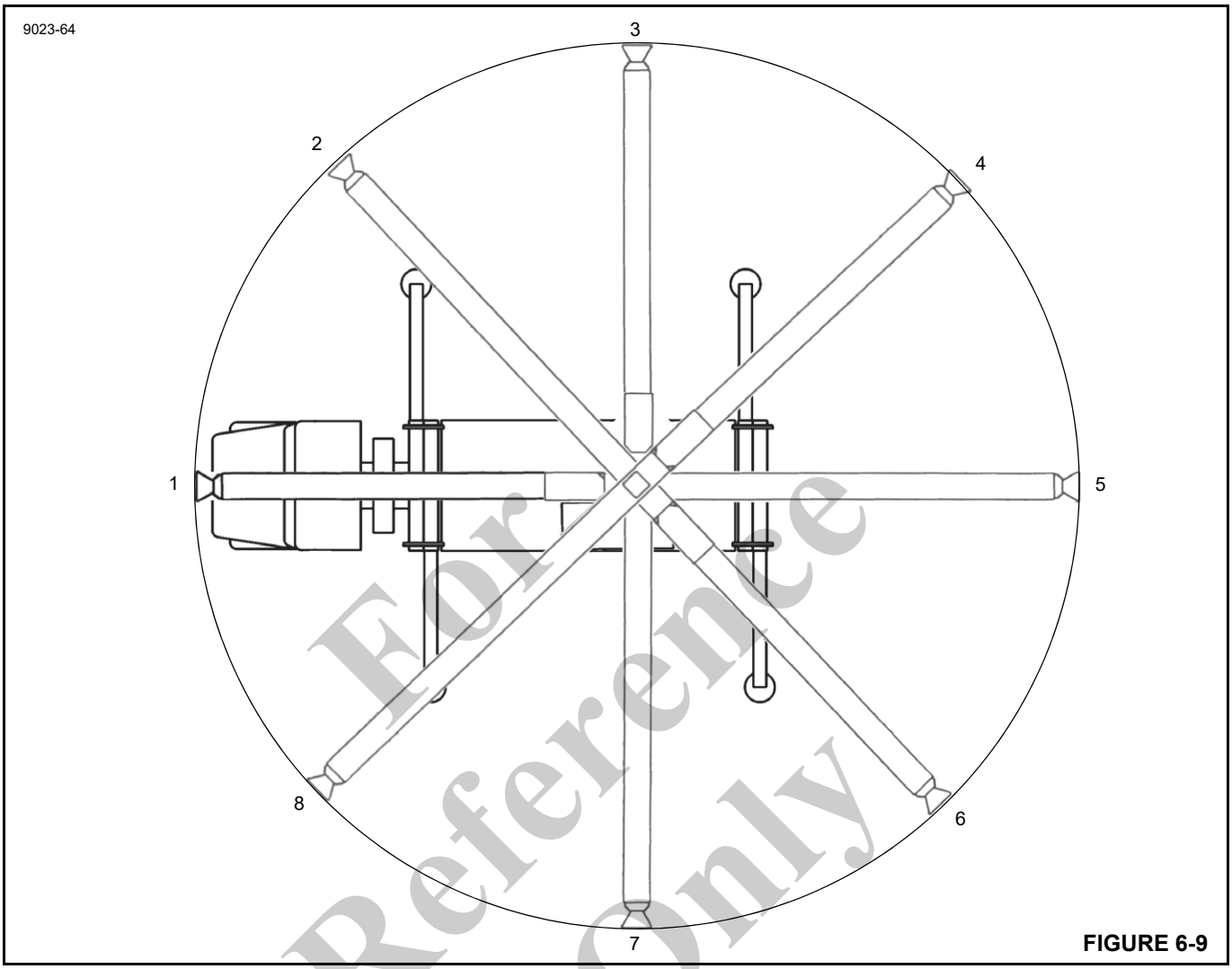


FIGURE 6-9

BEARING REPLACEMENT

Removal

1. Fully extend and set the outriggers enough to take up the slack in the pads.

NOTE: Do not raise the machine on the outriggers.

2. Rotate the boom to about 20° off the front position so that the boom is clear of the truck cab.

NOTE: The lift cylinder pins need to be accessible from the truck deck.

3. Mark the position of the swing motor. The capscrews underneath the swing motor need to be removed before any other bearing capscrews are removed.

4. Rotate the boom back to the front and remove the turntable capscrews between the marks.

5. Slowly rotate the boom back to 20° off the front position.

6. Elevate the boom slightly and shut down the engine.

7. Tag and disconnect the battery cables.

8. Remove the boom and lift cylinder, following the procedures outlined in Section 4 of this manual.

9. Tag and disconnect the hydraulic lines from the carrier side of the swivel. Cap and plug all lines and openings.

10. Disconnect the wiring harness connectors from the carrier side of the swivel.

11. Coil the wiring harness and secure it to the swivel to prevent damage to the harness during turret removal.

NOTE: The swivel is removed with the turret.

12. Attach a suitable lifting device to the turret. Remove any slack in the sling. Do not pull up on the turret.

DANGER

Ensure the lifting device is capable of supporting the boom assembly.

13. Remove the remaining capscrews and washers that secure the swing bearing outer race to the carrier.

DANGER

Ensure the blocking material can support the turret.

14. Carefully lift the turret and set it on blocking that will not allow the turret to tilt or shift. Leave the lifting device attached.

NOTE: If the current bearing is to be reinstalled, mark the position of the swing bearing on the turret before removal.

15. Remove the 36 capscrews from the inner race of the swing bearing.

16. Lift the turret off the swing bearing and set it on the blocking.

NOTE: The swing bearing weighs about 284 kg (625 lb).

Check the bearing teeth for chipping or cracking. If any evidence of these is found, replace the bearing. Ensure the capscrew holes are free of dirt, oil, and foreign material.

Installation

DANGER

Do not reuse the swing bearing bolts. The swing bearing is torqued to the applied torque of the grade 8 and L9 bolts. Using new bolts ensures proper torque and bolt strength for securing the swing bearing and turret to the carrier.

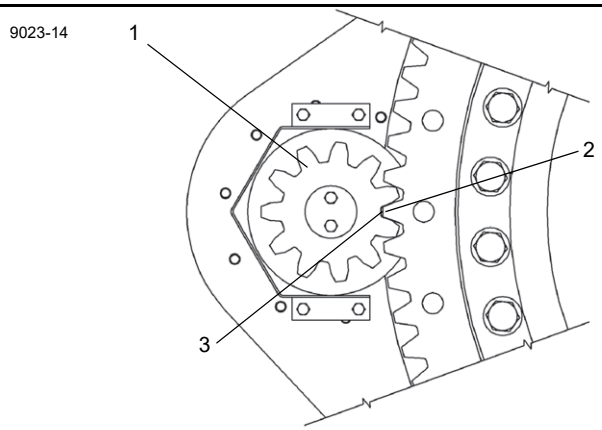
NOTE: If the current bearing is reinstalled, align the marked teeth on the swing drive pinion shaft with the marked teeth on the bearing.

1. Using an appropriate lifting device, set the turret on the swing bearing. If the same bearing is being used, position it as marked prior to removal.

2. Install 36 new capscrews and washers, securing the swing bearing to the turret. Tighten the capscrews. See “Inner Race Tightening Procedure” on page 6-9.

3. Using an appropriate lifting device, align the turret over the carrier in the same position that it was before removal.

4. Carefully lower the turret into position on the bearing plate. Be careful not to damage the swivel assembly.



Item	Description
1	Pinion Gear
2	High Point
3	Shim

FIGURE 6-10

5. Install the capscrews and washers that are not covered by the swing motor. Tighten and torque the capscrews. See “Outer Race Tightening Procedure” on page 6-11 and Figure 6-5.

NOTE: If a new bearing is installed, a new pinion gear (1, Figure 6-10) must also be used. Align the high point (maximum eccentricity) (2) on the bearing with the high point on the new pinion gear.

6. Install the swing drive pinion so that the high point (maximum eccentricity) aligns with the turret bearing high point. Check the backlash with a 0.203 mm (0.008 in) shim (3, Figure 6-10). If the pinion must be moved to achieve proper backlash, contact your local distributor.

7. Connect the swivel wiring harness connectors to the carrier receptacles.

8. Connect the hydraulic lines as per removal tags.

9. Install the boom and lift cylinder following the procedures outlined in Section 4 of this manual.

10. Reconnect the batteries.

11. Carefully swing the turret so that the capscrew holes that were covered by the swing motor are accessible.

12. Install the remaining swing bearing capscrews.Tighten and torque the capscrews. See “Outer Race Tightening Procedure” on page 6-11 and Figure 6-5.

13. See “Slew Potentiometer Adjustment” on page 6-14 to check the slew potentiometer in the electrical swivel for proper orientation.

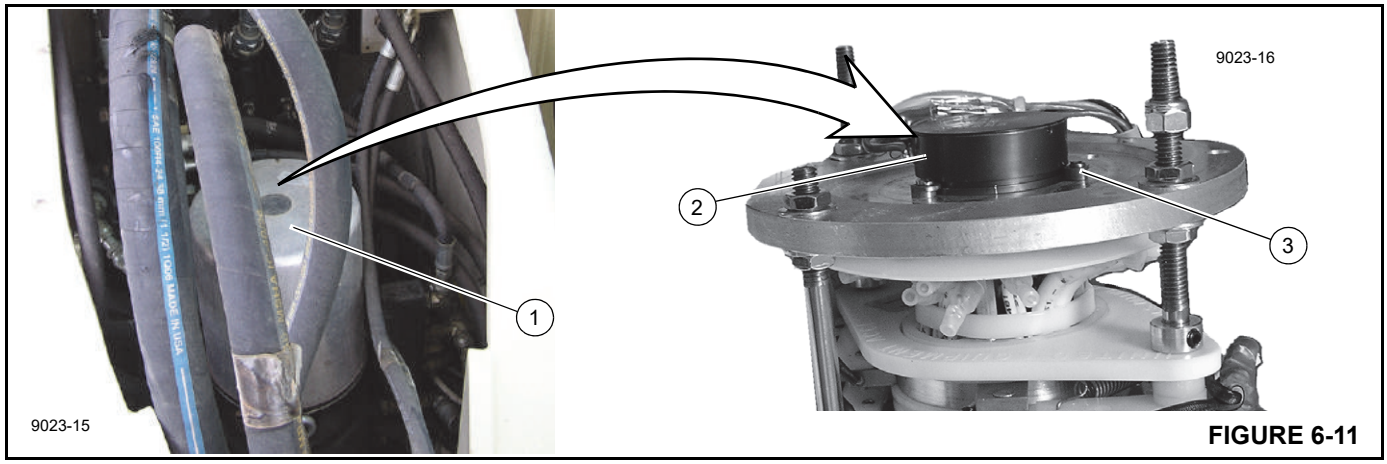


FIGURE 6-11

Slew Potentiometer Adjustment

See Figure 6-11 for the following procedure.

The slew potentiometer is a component of the hydraulic and electric swivel assembly, which is mounted inside the superstructure turret. The top part of the swivel assembly is the electrical swivel section (1) and contains the slew potentiometer (2).

1. Remove the cover from the electrical swivel section (1).
2. Using the cab controls, rotate the turret over the front and set the swing brake.
3. Set the RCL console to read the slewing angle as follows:
   a. Complete the RCL console setup according to the crane's current operating configuration.See the Rated Capacity Limiter (RCL) manual for detailed instructions.
   b. Press the RCL button.
   c. Press the OK button.
   d. Toggle down to SLEW and press the OK button to display the slew angle work area definition limits.
4. Release the swing brake and swing the turret to approximately 10° to the right (clockwise) and stop. Slowly swing the turret back to center and stop. Set the swing brake.

NOTE: If the turret swings past the center position, step 4 must be repeated.

5. Loosen the three screws (3) that secure the slew potentiometer to the mounting plate.
6. Rotate the body of the slew potentiometer (2) until the slew angle indicates 0.6° ±0.1°.
7. Tighten the three screws (3) to secure the slew potentiometer to the mounting plate. Install the electrical swivel cover.
8. Release the swing brake and swing the turret to approximately 10° to the left (counterclockwise) and stop. Slowly swing the turret back to center and stop. Set the swing brake.

NOTE: If the turret swings past the center position, step 8 must be repeated.

9. If the angle indicated on the console does not exceed ±1.0°, proceed to step 10. If the indicated angle exceeds ±1.0°, return to step 4.
10. Release the swing brake and swing the turret approximately 10° to the right (clockwise) and stop. Slowly swing the turret back to center and stop. Set the swing brake.

NOTE: If the turret swings past the center position, step 10 must be repeated.

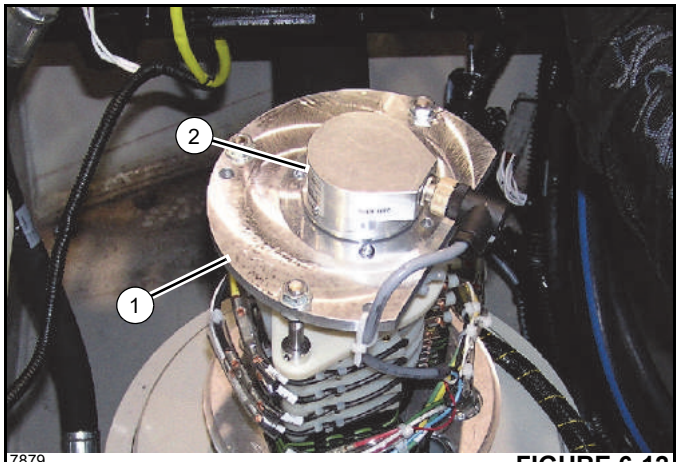
11. If the angle indicated on the console does not exceed ±1.0°, proceed to step 12. If the indicated angle exceeds ±1.0°, return to step 4.
12. Release the swing brake and swing the turret approximately 10° to the left (counterclockwise) and stop. Slowly swing the turret back to center and stop. Set the swing brake.
13. Tighten the screws and reinstall the cover on the electrical swivel section (1).

Slew Sensor Calibration

The following procedure is for cranes equipped with the A92.2 option.

The slew sensor is a component of the hydraulic and electric swivel assembly, which is mounted inside of the superstructure turret (1, Figure 6-11). The top part of the

swivel assembly is the electrical swivel section (1, Figure 6-12) and contains the slew sensor (2, Figure 6-12).



7879 **FIGURE 6-12**

NOTE: Slew sensor calibration requires Orchestra software (version 2.4.7 or later), Windows-based PC, and diagnostic cable 80009992. See “Tooling for Troubleshooting” on page 3-3 for more information.

9014-7 **FIGURE 6-13**

1. Connect the diagnostic cable 80009992 to a USB port on the PC. Connect the other end to the diagnostic connector located on the right side behind the right side outrigger control panel (Figure 6-13).
2. Open the Start Menu on the PC and go to All Programs>Orchestra>Orchestra 2.4.7 (or later).
3. When the Orchestra window opens, select the Conductor tab.
4. In Conductor, choose the appropriate connection from the drop-down menu and click on the Connect button in the upper left corner.
5. Once connected, a prompt will appear to select an IOC file. Select Choose File to open an explorer window and browse to the IOC file that matches the current software version. Select Open to load the IOC file.
6. In the password field, type Manitowoc1 and select Load.
7. Expand the View drop-down menu to the left of the screen and select EEPROMs from the list of windows under it.
8. In the EEPROMs window, locate the EE_Slew_Angle_Center EEPROM.
9. In the Variables window, locate the V_CurrentSwingAng_Deg variable.

NOTE: When adjusting the EEPROM value, add or subtract the current value multiplied by 100 to the current EEPROM value. For example, if the value for the variable was 25°, 2500 would be added to the current EEPROM value.

10. While observing the V_CurrentSwingAng_Deg variable, adjust the EE_Slew_Angle_Center EEPROM value until the V_CurrentSwingAng_Deg variable shows 0°.
11. When the EEPROM value is set correctly, save the values by selecting Save All under the Save drop-down menu at the top of the EEPROM window.
12. Export the EEPROM data for Manitowoc Crane Care and/or dealer records.
13. Disconnect the diagnostic cable 80009992 from the PC and the diagnostic connector.

Testing

Activate the crane and check for proper function.

SWING LOCK

The swing 360° lock holds the turret in place, preventing any type of movement in either a counterclockwise or clockwise direction.

This is a mechanical lock, which is engaged and disengaged by a cable assembly connected to the swing lock foot pedal located in the operator's cab.

Pressing the pedal down allows the lock to engage the swing bearing ring gear. Releasing the pedal disengages the lock from the bearing ring gear.

Removal

See Figure 6-14 for the following procedures.

1. Release the swing lock foot pedal and make sure the swing lock is disengaged from the swing bearing ring gear (15).
2. Remove the clevis pin (1), cotter pin (2), and washer (3) that secure the cable (4) to the swing lock (5).
3. Remove the shim (6), capscrews (7), and lock washers (8).
4. Remove four capscrews (9), bushings (10), and flat washers (11) and remove the swing lock (5) from the turret.
5. Remove the two springs (12) from the swing lock. Inspect the springs for wear or damage. Replace springs as needed.
6. Inspect the swing lock assembly for wear or damage. Replace parts as needed.

Installation

See Figure 6-14 for the following procedures.

1. Position the swing lock (5) onto the turret and secure it with four capscrews (9), bushings (10), and flat washers (11).
2. Place a shim (6) on top of the swing lock mounting block and secure with capscrews (7) and lock washers (8).

NOTE: Use shims to eliminate all side-to-side movement between the swing lock (5) and the swing lock mounting blocks welded to the turret.

3. Attach the cable (4) to the swing lock (5) with the clevis pin (1), cotter pin (2), and washer (3).
4. Adjust the cable (4) using the following procedure.
   a. Engage the swing lock assembly with the swing bearing gear ring so that maximum tooth engagement is achieved.
   b. Figure 6-14 shows a side view (A) of the swing lock engaged with the swing bearing ring gear (15).

      When the swing lock is disengaged, the clearance between the swing bearing ring gear (15) and the swing lock is 14.5 mm (0.57 in). This will allow the swing bearing to rotate freely and provide maximum engagement when the swing lock is applied.
   c. Adjust the stop capscrew (13) until the head of the capscrew comes in contact with the link on the swing lock assembly. Securely tighten the lock nut (14).
   d. Adjust the cable so that the cable pulls the link tightly against the stop capscrew (13) when the foot pedal control is fully engaged.
   e. Attach the springs (12) and operate the foot pedal control lever several times to verify that the lock engages and disengages from the bearing ring gear (15) properly. Adjust the cable as required.
5. Tighten the swing lock capscrews (9). See "Fasteners and Torque Values" on page 1-7.

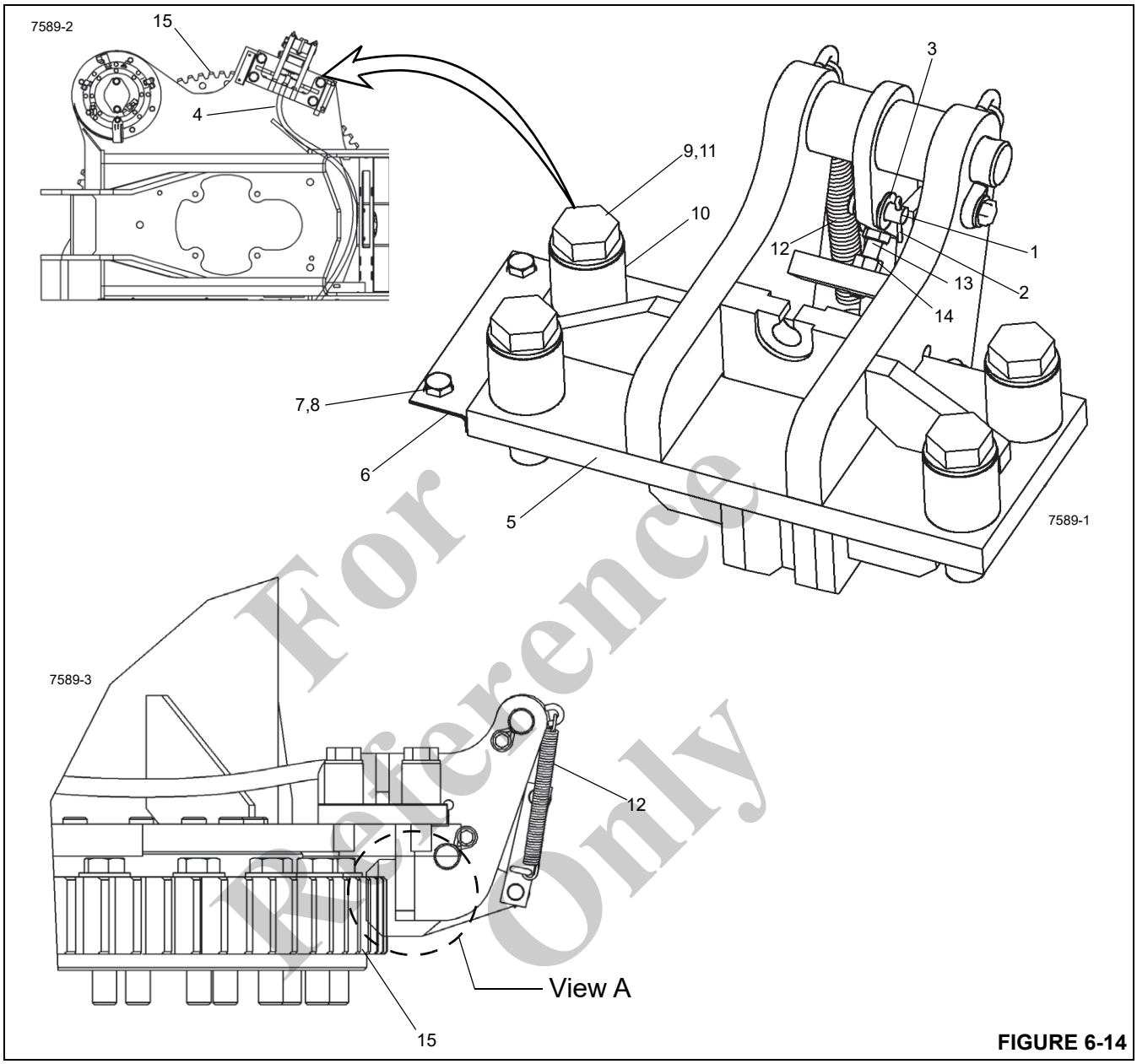


FIGURE 6-14

Item	Description	Item	Description
1	Clevis Pin	9	Capscrew (qty 4)
2	Cotter Pin	10	Bushing (qty 4)
3	Washer	11	Flat Washer (qty 4)
4	Cable	12	Spring (qty 2)
5	Swing Lock	13	Stop Capscrew
6	Shim	14	Lock Nut
7	Capscrew (qty 2)	15	Swing Bearing Ring Gear
8	Lock Washer (qty 2)		

HOUSE LOCK

The house lock holds the turret in place, preventing any type of movement in either a counterclockwise or clockwise direction when the crane is in transit.

This is a mechanical lock, which is engaged and disengaged by a push-pull cable assembly located in the operator's cab.

Pushing the house lock cable handle in allows the house lock pin to engage the lock hole in the torsion box. Pulling the house lock cable handle out pulls the house lock pin out of the lock hole in the torsion box. Twisting the house lock cable handle 90° in either direction locks the position of the house lock pin.

Removal

See Figure 6-15 for the following procedure.

NOTE: Secure the house lock pin (1) to prevent it from falling into the torsion box lock hole.

Note the routing of the house lock cable during removal to aid in installation.

1. Remove the cotter pin (not shown) from the clevis pin (not shown) and remove the clevis pin from the yoke (2).
2. Loosen the house lock cable lock nuts (3) that secure the house lock cable (4) to the house lock bracket (5) and remove the house lock cable from the house lock bracket.
3. Remove the lock nut (6) from behind the cab bracket (7) and pull the house lock cable through the cab bracket.

Installation

See Figure 6-15 for the following procedure.

1. Insert the house lock cable (4) through the cab bracket (7). Install and securely tighten the lock nut (6). Route the house lock cable through the cab the same way as noted during removal.
2. Insert the house lock cable into the house lock bracket (5) and securely tighten the lock nuts (3).
3. Align the yoke (2) with the hole in the house lock pin (1) and install the clevis pin (not shown).
4. Install a new cotter pin (not shown) into the clevis pin.

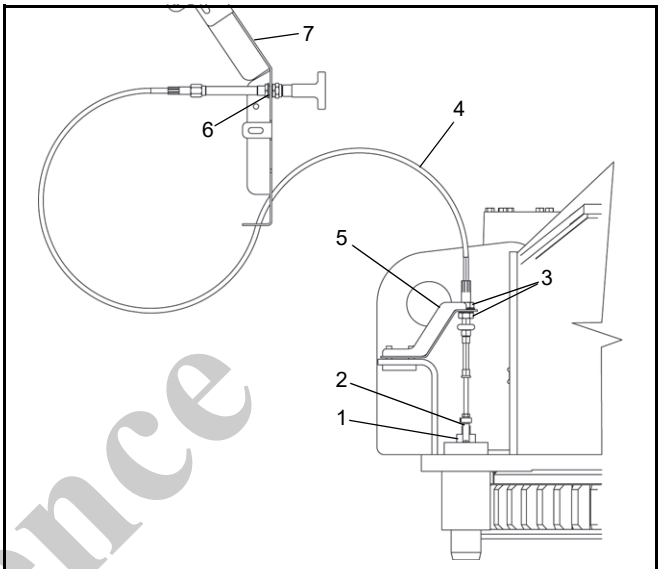


FIGURE 6-15

Item	Description
1	House Lock Pin
2	Yoke
3	House Lock Cable Lock Nut (qty 2)
4	House Lock Cable
5	House Lock Bracket
6	Lock Nut
7	Cab Bracket

SECTION 7
OUTRIGGERS

SECTION CONTENTS

DESCRIPTION

The two-section outriggers are used to provide stability for the crane when the crane is in use. The outriggers can be used in the fully retracted position, mid-extended position, or fully extended position.

When the outrigger extension is activated, it extends or retracts the outrigger beam and/or stabilizer cylinders. The outrigger beams can be extended to the mid-extended position by rotating the lock pin into the lock position. When an outrigger beam reaches the mid-extended position, a spring-loaded lock pin is automatically inserted into the outrigger beam to secure it in place. Internal cables and a hydraulic cylinder extend and retract the two-section outrigger beams.

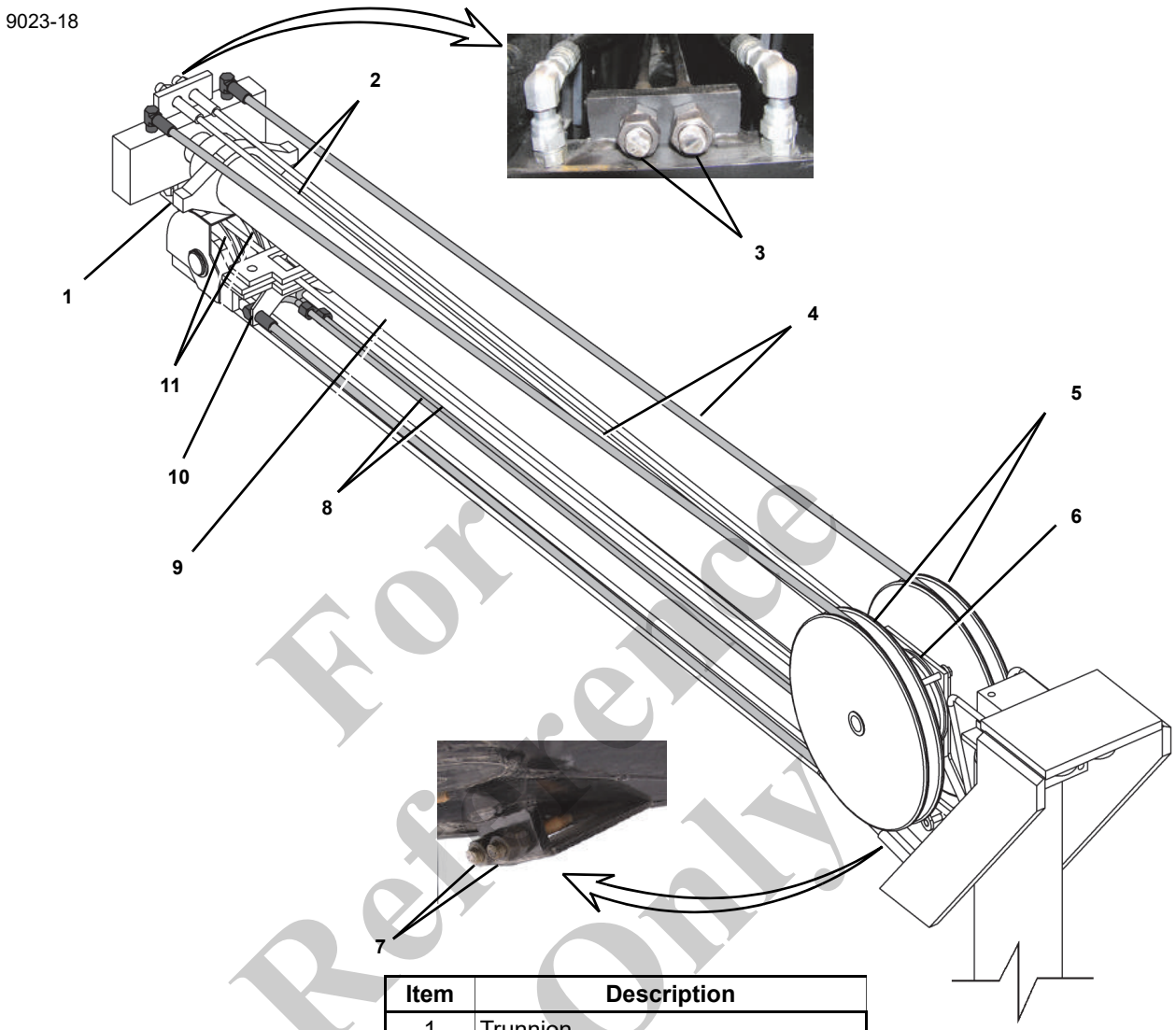
OUTRIGGER BEAM ASSEMBLY

The outrigger beam assembly consists of the following:

- Midbeam
- Outer jackbeam
- Stabilizer cylinders
- Required hoses and mounting hardware
- Extend and retract cables and sheaves

Item	Description
1	Top Cable Adjustment
2	Outer-Jackbeam
3	Midbeam
4	Outrigger Box
5	Lock Pin
6	Bottom Cable Adjustment
7	Outrigger Float
8	Stabilizer
9	Extend Cylinder Anchor Capscrew
10	Hydraulic Line

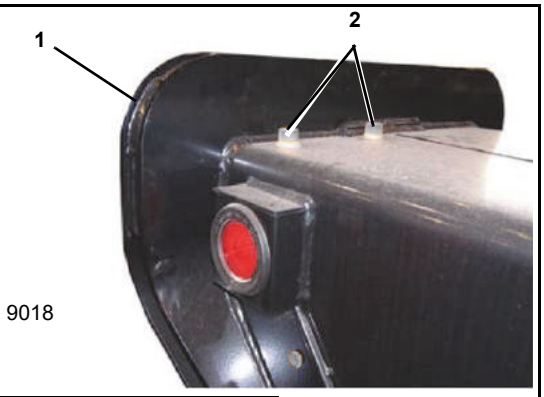
FIGURE 7-1



Item	Description
1	Trunnion
2	Extend/Retract Cable
3	Top Cable Adjustment
4	Hydraulic Hoses
5	Hydraulic Hose Sheaves on the nose of the Extend Cylinder
6	Cable sheaves on the Nose of the Extend Cylinder
7	Bottom Cable Adjustment
8	Hydraulic Tubes To Stabilizer Cylinder
9	Extend Cylinder
10	Anchor Bracket
11	Cable Sheaves on Outer Jackbeam

FIGURE 7-2

Removal



Item	Description
1	Outrigger Box
2	Wear Pad Capscrew

FIGURE 7-3

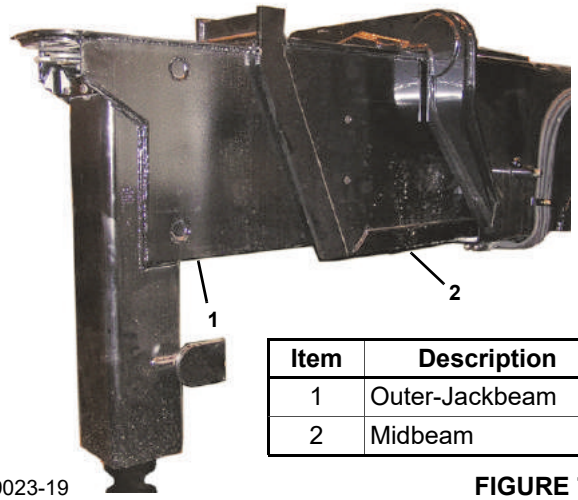
1. Make sure the stabilizer (1,Figure 7-1) is fully retracted and the outrigger float (7,Figure 7-1) removed.
2. Disconnect and remove the outrigger monitoring system (OMS) potentiometer. See “Outrigger Monitoring System (OMS)” on page 7-9.
3. On the stabilizer end, tag and remove the top wear pads and shims from the outrigger beam.

NOTE: The outrigger wear pads and shims are adjusted at the factory. Tag the shims and wear pads during removal to ensure proper installation.

4. Extend the outrigger beam slightly so that a lifting strap (Figure 7-4) can be attached to the outrigger beam.

NOTE: To prevent nicks and gouges to the bottom of the outrigger beam, do not attach chains to the outrigger beam.

5. Remove the hydraulic lines (10, Figure 7-1) from the base of the extend cylinder.



Item	Description
1	Outer-Jackbeam
2	Midbeam

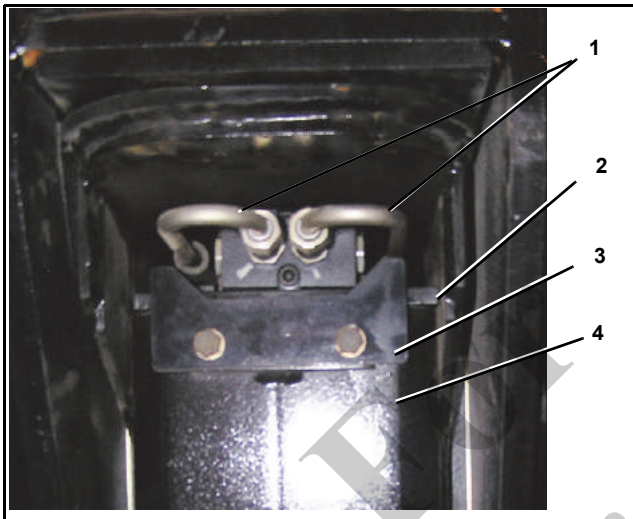
FIGURE 7-4

6. Remove the holding valve to allow extend cylinder rod movement.
7. Raise the midbeam and outer jackbeam assembly against the outrigger box. Remove and tag the bottom wear pad and shims from the outrigger box.
8. Mark the position and remove the retaining nuts from the proportioning cable stops at the bottom of the outrigger box.
9. Route the cables back through the anchor plate and pull the ends out between the outrigger box and the midbeam and outer-jackbeam assembly.
10. Pull the midbeam and outer-jackbeam assembly out of the outrigger box. Insure that the lock pin is disabled. Keep the proportioning cables taut to avoid pinching or damaging the cables during removal.
11. Place the midbeam and outer-jackbeam assembly on adequate blocking. Do not pinch or crush the proportioning cables while lifting or supporting the assembly.
12. Lift the extend cylinder trunnion out of anchor pockets in the mid-section beam (Figure 7-2).
13. Remove the snap rings from the shaft in the rear of the midbeam. Remove the shaft and sheaves from the beam. Route the cables back through the opening in the bottom plate of the outer jackbeam after sheave removal.
14. Disconnect the internal hydraulic hoses from the anchor brackets at the rear of the outer jackbeam (Figure 7-2).
15. Remove the capscrews that clamp the cable anchor together at the rear of the outer jackbeam and remove the cable anchor assembly.
16. Pull the extend cylinder out of the midbeam and outer-jackbeam assembly.

NOTE: Take care not to pinch or crush hoses or cables during extend cylinder removal. Use caution as the cylinder is removed from the outer beam because loose parts such as the hose sheaves can fall off the shaft and be damaged.

17. Place the cylinder on a suitable horizontal surface and remove the hoses, cable sheaves, hose reels, and shaft.
18. Mark the retaining nut positions on proportioning cables and remove the cables from the cylinder butt plate. Place the cables in a safe location to avoid damage.
19. Remove and tag the side wear pads and shims from the front of the midbeam.
20. Raise the outer jackbeam outrigger against the top pad of the mid beam outrigger. Remove and tag the bottom wear pad between the mid beam and outer jackbeam.

21. Pull the outer jackbeam out of the midbeam and place it on adequate blocking. If necessary, remove and tag the wear pads and shims from the outer jackbeam.
22. Disconnect and remove the hydraulic tubes from the stabilizer cylinder.
23. Properly support the stabilizer cylinder from the bottom with a floor jack or hoist and remove the holding valve and O-rings.



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Item	Description
1	Hydraulic Line
2	Retainer Plate
3	Lock Plate
4	Stabilizer Tube

FIGURE 7-5

24. Remove the capscrews and lock plate from the stabilizer tube.
25. With the cylinder supported, slide the retainer plate out from under the cylinder butt plate.
26. Lower the cylinder out of the stabilizer tube.
27. Remove the wear rings installed in the grooves of the lower cylinder support legs.

Assembly

NOTE: When assembling the outriggers do the following:

- Always use the jam nuts and thread the first nut on past the flat so adjustment can be made later.
- Do not use Loctite on any threaded cable ends.
- Use Loctite on all other capscrews.
- Reassemble wear pads as per removal tags. If new wear pads are used, readjust the pads and shims.

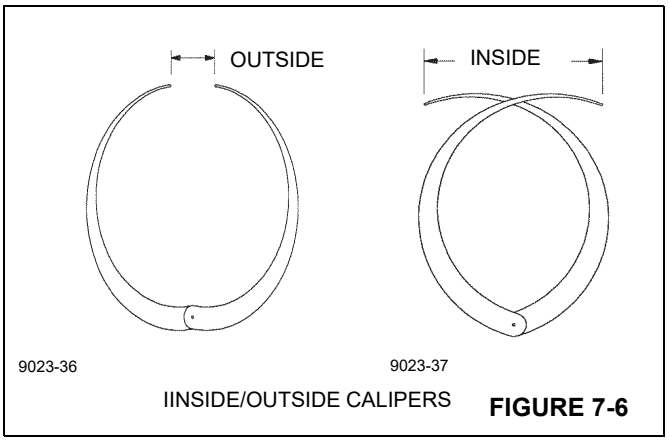
1. Install the stabilizer hydraulic tubes in the outer beam.
2. Install wear rings into the stabilizer leg.
3. Insert the stabilizer cylinder into the stabilizer tube.
4. Slide the retainer plate under the stabilizer cylinder butt end.
5. Install the lock plate and capscrews (3, Figure 7-5).
6. Install the holding valve on the stabilizer cylinder.
7. Install the hydraulic fittings and tubes on the holding valve.
8. Install the wear pads and shims to the outer-jackbeam.
9. Place the midbeam section on adequate blocking and slide the outer jackbeam into the mid jackbeam until the outer jackbeam stops.
10. Install the side wear pads and shims between the outer jackbeam and midbeam. Raise the outer jackbeam and install the bottom front wear pads and shims.
11. Assemble the proportioning cable sheave with the shaft and hose reels onto the extend cylinder. Install the cables and hoses and drape the excess in an area to avoid damage.
12. Insert the extend cylinder into the midbeam and outer jackbeam assembly. Use caution to avoid pinching the cables and hoses.
13. Lift the cylinder to allow cable anchor access and install the fittings in the anchor plate assembly. Attach stabilizer cylinder hoses.
14. Assemble the proportioning cable stop into the cable anchor and install the anchor in the outer jackbeam.
15. Attach the fittings for the stabilizer cylinder hydraulic tubes to the cable anchor.
16. Route the cables through the sheave hole on the bottom of the outer jackbeam. Reeve the cables around the dual sheave and install the sheave, shaft, and snap rings.
17. Lower the cylinder trunnion into the pocket on the midbeam.
18. With the midbeam and outer jackbeam assembly on adequate blocking, install the wear pads and shims.
19. Attach the cables, fittings, and hoses to the cylinder butt plate. The cylinder length may need to be adjusted to allow assembly.
20. Slide the midbeam and outer jackbeam assembly into the outrigger box. Use caution not to damage the cables sliding in under the midbeam. The midbeam and outer jackbeam assembly may need to be lifted to install the cable ends into the anchor points in the bottom of the outrigger box. Guide the cable ends between the outrigger box and the midbeam and outer jackbeam assembly back through the anchor points. Install anchor hex nuts in previously marked positions.

21. Push the midbeam and outer-jackbeam assembly into the main outrigger box until the butt plate of the extend cylinder reaches the end of the outrigger box. Bolt the butt end of the extend cylinder to the end of the outrigger box.
22. Install the hydraulic lines and holding valve on the extend cylinder.
23. Install the side and bottom wear pads and shims.
24. Install and connect the outrigger monitoring system (OMS) potentiometer. See “Outrigger Monitoring System (OMS)” on page 7-9.

CABLE TENSIONING

1. With the outriggers assembled, cycle the outriggers and front stabilizer through full extension and retraction for five complete cycles to remove air in cylinders.
2. Fully retract the outriggers.
3. Look through the hole in the end of the outrigger box to determine the outrigger beam position. At full retraction:
   a. The base of the midbeam bottoms out in the base of the outrigger box.
   b. The base of the outer jackbeam section beam bottoms out against the sheave cable anchor plates in the base of the midbeam section outrigger.
4. If the outrigger beams do not bottom out as described above:
   a. Loosen the upper cable adjustment if the midbeam section beam does not bottom out in the outrigger box.
   b. Loosen the lower cable adjustment if the outer-jackbeam section beam does not bottom out in the midbeam section beam.
5. After the cables have been loosened to allow full retraction, tighten the cables to a torque of 40 to 47 Nm (30 to 35 ft-lb) by:
   a. Tightening the lower cables.
   b. Tightening the upper cables to equal the lower cables.
6. Check the outriggers for proper proportioning when extended and proper position when retracted.

OUTRIGGER CALIBRATION

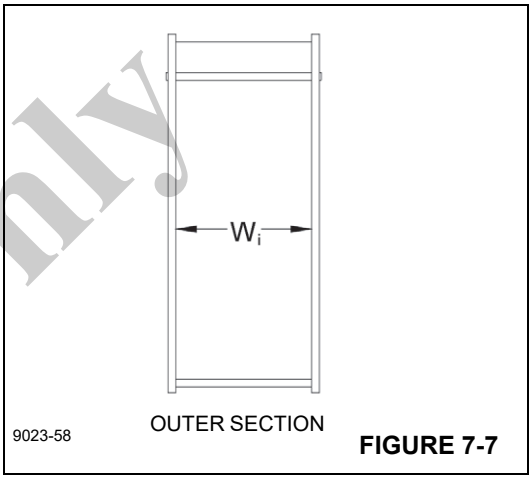


IINSIDE/OUTSIDE CALIPERS **FIGURE 7-6**

Side Pads

1. With a pair of inside/outside calipers, measure the inside width of the outer section outrigger (Wi, Figure 7-7) at the front pad location and three feet back from the front of the section and record the smallest measurement.

NOTE: The method of calibration is the same for both sections of the outrigger.



OUTER SECTION **FIGURE 7-7**

2. With the inside/outside calipers, measure the outside width of the appropriate inner section (W_0, Figure 7-8) at the rear of the section and three feet from the rear. Record the largest measurement.

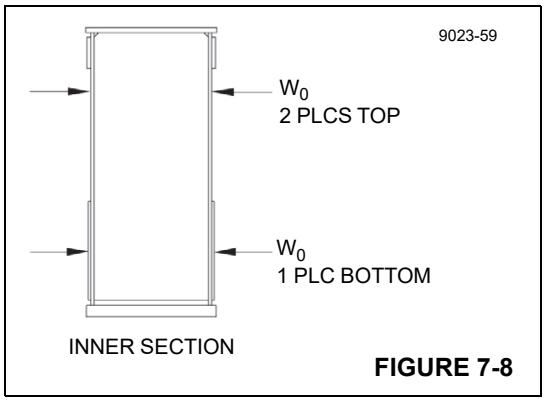


FIGURE 7-8

3. Measure and record the thickness of the wear pads ($t_{wp,}$ Figure 7-9).

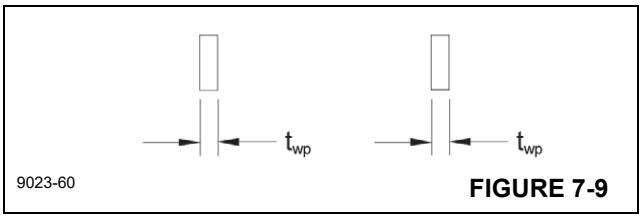


FIGURE 7-9

4. Subtract the largest outside width ($W_{0,}$ Figure 7-8) of the inner section and the thickness of the two pads ($t_{wp,}$ Figure 7-9) from the inside width of the outer section ($W_{i,}$ Figure 7-7). Add shims as required (each shim is 0.8 mm or 1.5 mm [0.03 in or 0.06 in] thick) to tighten the pads so that there is 0 to 1.5 mm (0.00 in to 0.06 in) 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 Figure 7-10 and Table 7-1 for examples.
5. Repeat the procedure when installing the midbeam and outer jackbeam into the outrigger boxes on the sub-base.

EXAMPLE

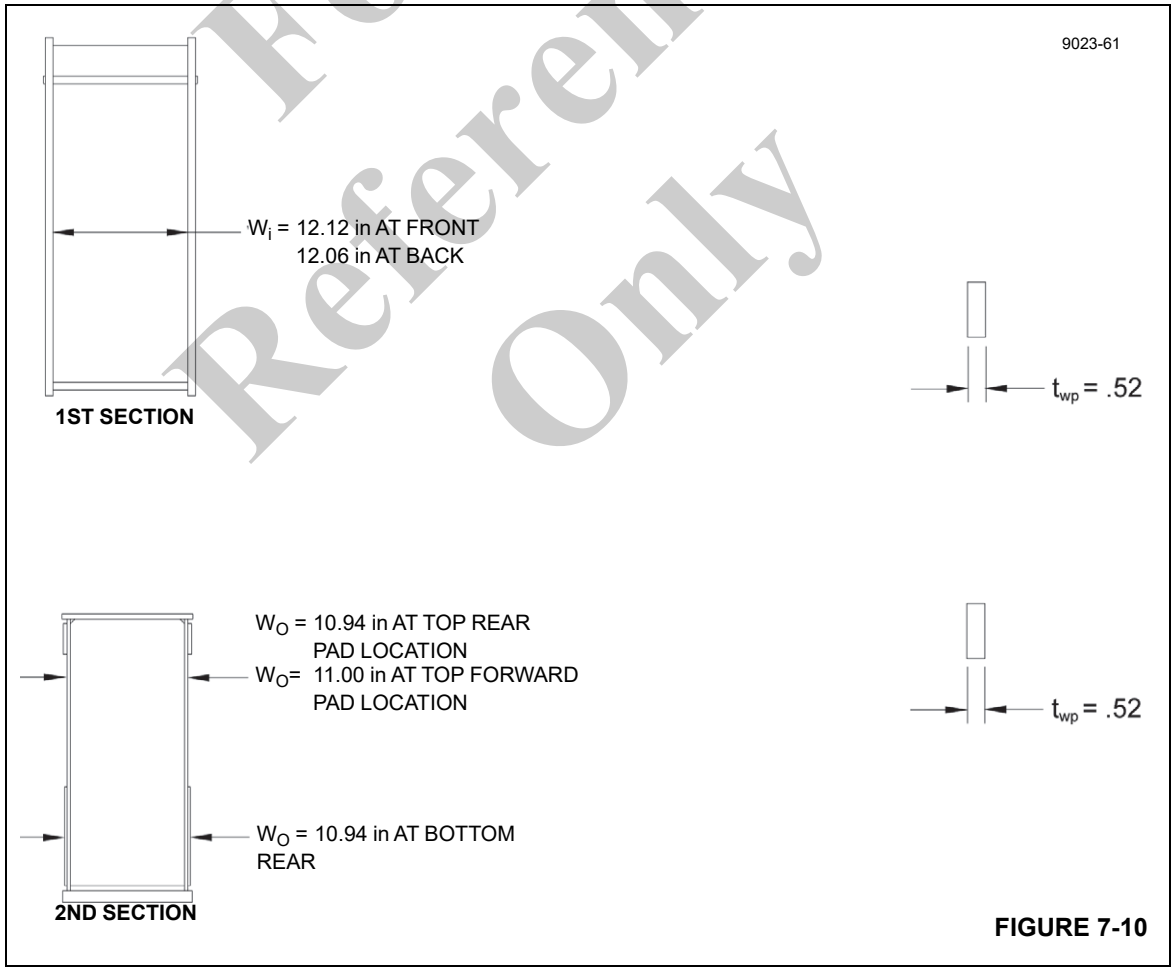


FIGURE 7-10

7

Table 7-1. Side Wear Pad Clearance

Dimension	mm	(in)
W_i (inside width, smallest)	306.3	12.06
$-W_o$ (outside width, largest)	279.4	11
$-t_{wp}$ (side wear pad thickness, total)	26.4	1.04
Clearance = $W_i - W_o - t_{wp}$	0.5	0.02
Side Clearance Specification	0 to 1.5	0 to 0.06

Top and Bottom Pads

1. With a pair of inside/outside calipers, measure and record the inside height of the outer section (Hi, Figure 7-11) three feet from the front of the section.

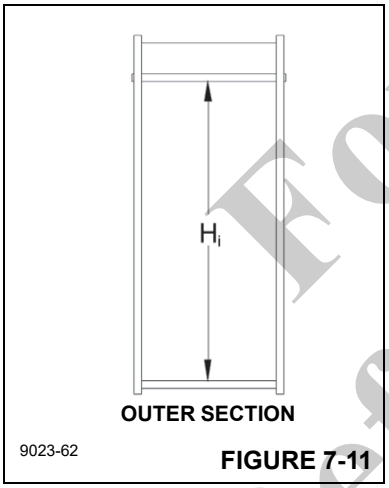


FIGURE 7-11

2. With the inside/outside calipers, measure and record the outside height of the inner section (Ho, Figure 7-12) at the rear of the section from the top plate to the bottom of the bottom pads.

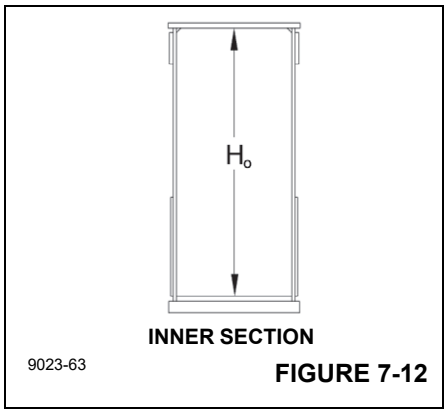


FIGURE 7-12

3. Measure and record the thickness of the top wear pads that attach to the inner section ($t_{wp,}$ Figure 7-13).

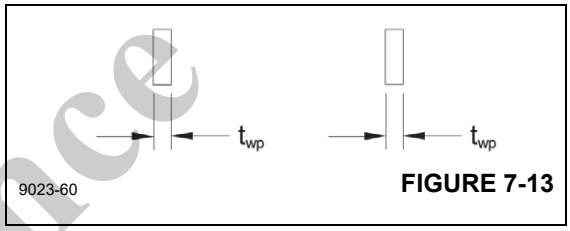


FIGURE 7-13

4. Subtract the outside height ($H_{o,}$ Figure 7-12) of the inner section and the thickness of the top pads ($t_{wp,}$ Figure 7-13) from the inside height ($H_{i,}$ Figure 7-11) of the outer section. Add shims as required (each shim is 0.8 mm or 1.5 mm [0.03 in or 0.06 in] thick) to tighten the pads so that there is 0.08 mm to 0.15 mm (0.003 in to 0.006 in) clearance between the widest part of the inner outrigger and the most narrow part of the outer outrigger when shims and pads are installed.

5. Install the inner outrigger section into the outer outrigger section. The nominal front bottom pad and shim thickness 19 mm (0.75 in), which 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 0.8 mm or 1.5 mm (0.03 in to 0.09 in) total section clearance.

6. Repeat this procedure when installing the midbeam and outer jackbeam outriggers into the outrigger boxes on the sub-base.

OUTRIGGER MONITORING SYSTEM (OMS)

The OMS aids the operator in accurately programming the rated capacity limiter (RCL) by automatically identifying the position of each outrigger beam. The OMS uses four string potentiometers, with one string potentiometer (1, Figure 7-14) mounted in each outrigger beam. The information is used to identify if an outrigger beam is positioned in one of three predefined positions, including fully retracted, mid-extended, and fully extended.

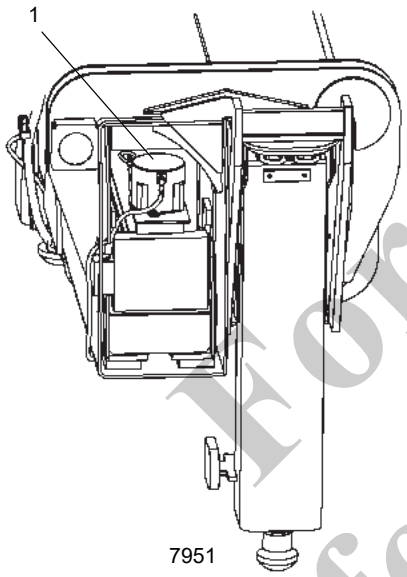


FIGURE 7-14

String Potentiometer

Remove

1. Fully retract the outrigger beam.
2. Remove the capscrews from the outrigger box cover and remove the outrigger box cover from the outrigger box.
3. Disconnect the spring clip from the attaching point on the outrigger beam.
4. Disconnect the electrical connector at the string potentiometer.
5. Remove the capscrews that secure the string potentiometer to the outrigger box cover.
6. Remove the string potentiometer from the outrigger box cover.

Install

1. Fully retract the outrigger beam.
2. Install the string potentiometer to the outrigger box cover and reinstall the capscrews. Securely tighten the capscrews.
3. Connect the electrical connector to the string potentiometer.
4. Connect the spring clip to the attaching point on the outrigger beam.
5. Install the outrigger box cover onto the outrigger box. Securely tighten the capscrews.
6. Calibrate the string potentiometer. See “Calibrate” on page 7-9.

Calibrate

Calibrating the string potentiometers is done through the crane's rated capacity limiter (RCL). Refer to the *Rated Capacity Limiter Operator's Manual* for detailed calibration instructions.

OUTRIGGER JACK MONITORING SYSTEM (OPTIONAL)

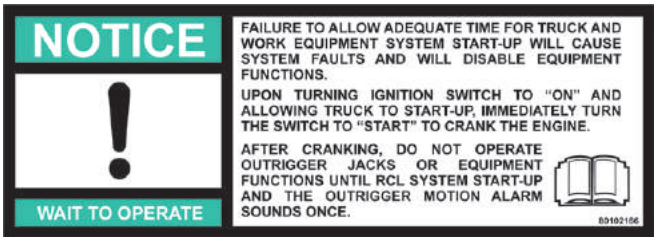
The outrigger jack monitoring system works in conjunction with the standard outrigger monitoring system (OMS) and senses the location of each outrigger beam, the position of each vertical jack, that the boom is stowed in the boom rest, the truck chassis park brake is set, and the levelness of the outriggers to permit operation within the allowable level specification.

This system comprises several sensors and modules located throughout the machine:

- Outrigger string potentiometers used in the standard outrigger monitoring system (OMS)
- Aerial lift interlock module located inside the torsion box near the passenger side outrigger controllers (see Figure 6-13)
- Three-axis inclinometer located in the crane turret (see Figure 6-11)
- Slew position sensor (2 Figure 6-12) located internal to the electrical slip ring.
- Truck chassis parking brake switch located on the truck chassis (J1939 CAN) interface
- Outrigger motion alarm (OMA) located at the rear of the machine (7, Figure 9-21)
- Boom angle sensor located internal to the RCL system length and angle cable reel (2, Figure 3-2)

Startup

Upon turning the operator cab key switch to the ignition position, the outrigger jack monitoring system begins to sense the configuration of the machine. The truck engine must be started within approximately 30 seconds of ignition position in order for all sensors to be powered up and communicating with the aerial lift interlock module.



9023-1 **FIGURE 7-15**

When the engine is running, the outrigger functions must not be operated until the RCL system has powered up and is ready to be configured. The outrigger motion alarm will sound once to indicate the system is operational. During this time, all boom functions are disabled until the outriggers are properly set up within specifications.

Outrigger Setup

The outriggers can be set up and leveled per operating instructions, and the RCL can be configured to match the actual configuration of the machine. The outrigger jack monitoring system will not allow operation of any crane functions until:

1. The outrigger jacks are extended.
2. The boom is in the boom rest.
3. The outriggers are leveled.

If operation is allowed, the outrigger motion alarm will activate and sound two low pitch tones followed by a single higher tone indicating the boom functions are permissible for operation.

During Operation

Once boom functions are permitted, the boom functions operate normally as per operating instructions. The outrigger jack monitoring system monitors the real-time status of the level sensor during operation and allows full range of operation. If the sensor indicates that the machine is not level according to the specifications, the outrigger motion alarm (OMA) will sound, indicating an out of level condition. When this alarm sounds, all boom functions remain operational to allow the operator to level the machine by returning the boom to the boom rest and leveling the machine again.

Troubleshooting

There are several software settings, called EEPROM's, that must be calibrated upon initial set up of the outrigger jack monitoring system. These are setup at the factory and typically do not require adjustments. If any sensors are missing, have been recently replaced, or are not working properly, this could result in boom functions being disabled. The sensors and software settings related to these sensors include:

1. Outrigger string potentiometers (qty 4)
2. Aerial lift interlock module located inside the torsion box near the passenger side outrigger controllers (see Figure 6-13).
3. Three-axis inclinometer located in the crane turret (see Figure 6-11).
4. Slew sensor (2, Figure 6-12). located internal to the electrical slip ring
5. Truck chassis parking brake switch located on the truck chassis (J1939 CAN) interface.
6. Boom angle sensor located internal to the RCL system length and angle cable reel (2, Figure 3-2).

If diagnostics or changes to these software settings are required, you need a Windows based personal computer, HED service software, CAN-Link service software, and the diagnostic cable. For more information *Tooling for Troubleshooting*, page 3-3.

SECTION 8
LUBRICATION

SECTION CONTENTS

GENERAL

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

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

Arctic Conditions Below -9°C (15°F)

In general, petroleum-based fluids developed especially for low-temperature service may be used with satisfactory results. However, certain fluids, such as halogenated hydrocarbons, nitro hydrocarbons, and phosphate ester hydraulic fluids, might not be compatible with hydraulic system seals and wear bands. 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.

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

Chassis Grease

CAUTION

Do not use air pressure devices to apply chassis grease otherwise damage to sealed fittings may result.

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

CAUTION

The multipurpose grease installed during manufacture is of a lithium base. Use of a non-compatible grease could result in damage to equipment.

Low Temperature Grease

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

Multipurpose Extreme-Pressure 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
75W	-40°C (-40°F)
80W	-26°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.

Antifreeze/Coolant (for Cab Heater)

The standard antifreeze/coolant filled from the factory is intended to provide protection against freeze-up down to -36°C (-34°F) and boil-over up to 129°C (265°F) using a 15 psi pressure cap.

Anti-wear Additives

Excessive wear in the system may cause a loss in volumetric efficiency and 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 of -9°C (15°F) and below, follow the procedures in See “Arctic Conditions Below -9°C (15°F)” on page 8-1.

Standard Hydraulic Oil

Temperature Above -9°C (15°F)

The factory fill standard hydraulic oil is ISO grade 46/68 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 temperatures below 0°C (32°F) 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. Airborne 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, filters, and breathers be inspected at least every three to six months and more frequently for severe operating conditions. The inspections should be for airborne 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 bypass 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 ensure 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.

LUBRICATION

A regular frequency of lubrication must be established based on component operating time. The most efficient method of keeping track of lubrication 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 of 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.

NOTE: The following table describes the lubrication points and gives the lubricant type, lubricant interval, lubricant amount, and application of each. Each lubrication point is numbered, and this number corresponds to the index number shown on Figure 8-1. Lube description and symbols are listed in Table 8-1, page 8-4.

Table 8-1

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

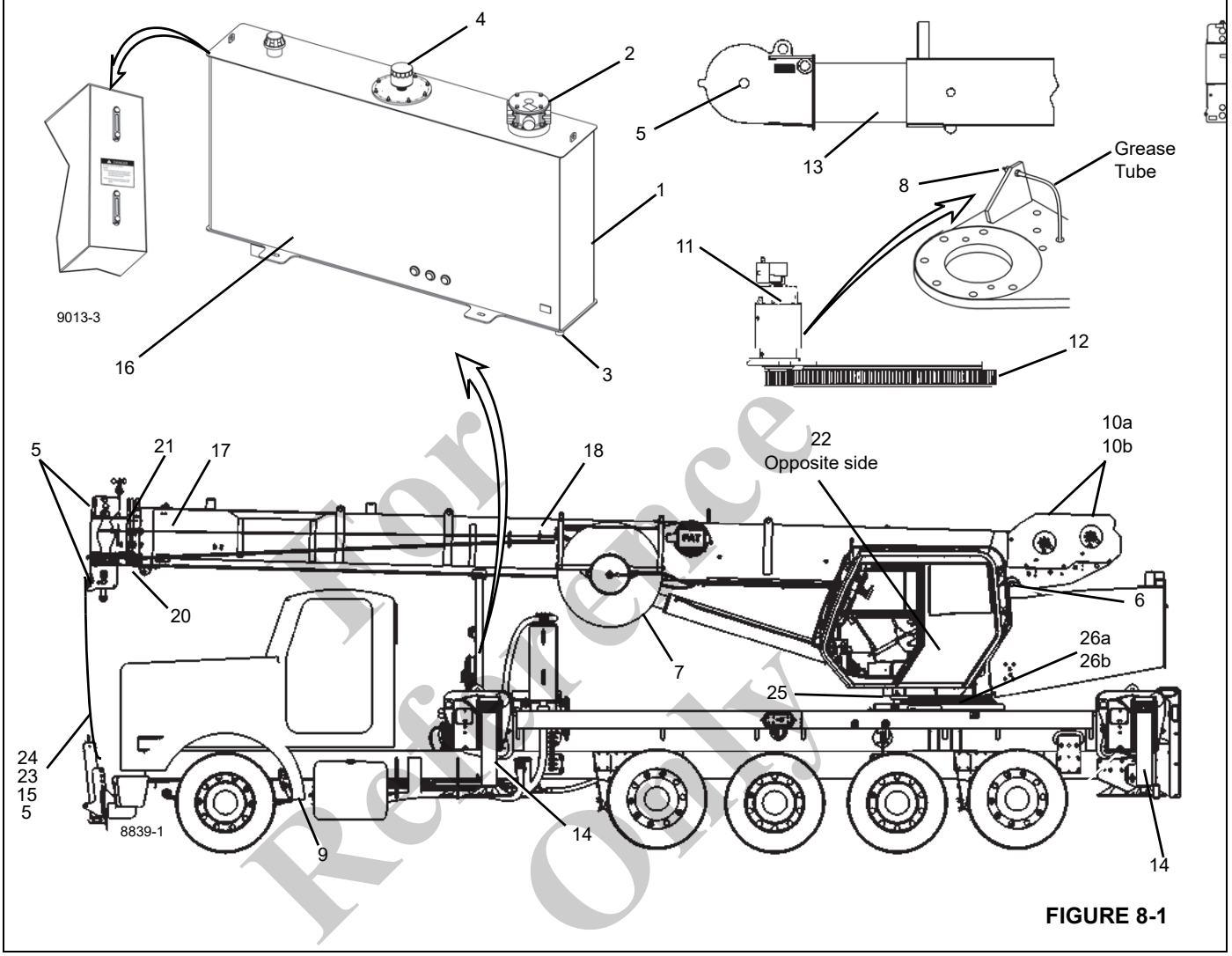


FIGURE 8-1

Item	Application	Recommended Lubricant	Procedure	Frequency
1	Hydraulic Oil Reservoir	Hydraulic Oil	Change/Check and Fill	Weekly as Required Semi-Annually
2	Oil Filter, Hydraulic Oil Reservoir		Change or Clean	After First 40 Hrs. As indicated by Gauge Thereafter.
3	Magnetic Plug, Hydraulic Oil Reservoir		Clean	At Oil Filter Service Interval
4	Breather, Hydraulic Oil Reservoir		Clean	Monthly
5	Sheave Pins: Boom Nose (qty 5), Jib (qty 1), Hook Block (qty 1), Aux Boom Nose (qty 1)	EP-MPG	Grease gun	Weekly
6	Boom Pivot Pin	EP-MPG	Grease Gun	Monthly
7	Lift Cylinder Pins (qty 2)	EP-MPG	Grease Gun	Monthly
8	Turntable Bearing	EP-MPG	Grease Gun	Weekly

Item	Application	Recommended Lubricant	Procedure	Frequency
9	Pump Drive U-Joint (qty 2) (if equipped) or Pump Spline Shaft (direct mount)	Chassis Grease #200S Silver Streak Special Multi-Lube (light)	Grease Gun or Direct Apply when Disassembled	After First 100 Operating Hours Weekly Semi-Annually
10a	Main and Auxiliary Hoist Gearbox	GL-5	Check and fill Change	Check and fill: As part of daily crane inspection, check the gearbox for visible leaks. Change: Every 1000 hours or 6 months of use.
10b	Hoist Brake	EO-20W-20 or TES295	Check and fill Change	Check and fill: As part of daily crane inspection, check the gearbox for visible leaks. Change: Every 1000 hours or 6 months of use.
11	Swing Drive Gearbox	GL-5	Check and fill Change	Check and Fill: As part of daily crane inspection, check the gearbox for visible leaks. Change: After first 50 hours and every 500 hours of use thereafter.
12	Swing Gear Teeth	EP-OGL	Spray Can	Monthly
13	Boom Jib	EP-MPG	Brush, Roller, or Grease Gun	Monthly or as Required
14	Outrigger Beams, Bottom, Sides	EP-MPG	Brush or Roller	Monthly or as Required
15	Wire Rope	EP-OGL	Brush or Spray	Semi-Annually
16	Diffuser Strainer, Hydraulic Oil Reservoir		Clean	Semi-Annually with Oil Change
17a	Extend Sheaves: TEL #1 Section 127 Ft and 142 Ft Booms Each Side	Chassis Grease #200S Silver Streak Special Multi-Lube (light)	Grease Gun	Weekly
17b	Extend Sheaves: TEL #3 Section 127 ft and 142 ft Booms, Each Side	Chassis Grease #200S Silver Streak Special Multi-Lube (light)	Grease Gun	Weekly
18	Retract Sheaves Extend boom until retract sheave zerks are visible through access holes at center of boom.	Chassis Grease #200S Silver Streak Special Multi-Lube (light)	Grease Gun	Weekly
19	Wire Rope Jib Extension Cables (not shown)	WRL	Spray or Brush	Anytime Boom is Disassembled or 5 Years
20	Boom Wear Pads	EP-MPG	See Boom Lubrication	Monthly or as Required
21	Wire or Hose Rollers	SAE 10	Oil Can	Quarterly
22	Cab Heater Reservoir	AFC	Check/Fill Drain	Weekly/as Required Semi-Annually
23	Hook Block Swivel Bearing	EP-MPG	Grease Gun	Monthly

Item	Application	Recommended Lubricant	Procedure	Frequency
24	Hook Block Sheaves	EP-MPG	Grease Gun	Monthly
25	Turntable Swing Lock Pin	EP-MPG	Spray	Monthly
26a	Air Conditioning	Polyalkylene (PAG) Oil	Check and fill w/ 4 ounces above 6 ounces in compressor.	Anytime A/C Is Disconnected or Serviced
26b	Air Conditioning Refrigerant	R-134a	2 lb	Anytime A/C Is Disconnected, Serviced, or as Needed
NOTE: Lubricate items more frequently than interval indicated in table if environmental conditions and/or operating conditions necessitate.				

Internal Cable Sheave 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.

Lubrication of the extend and retract sheaves is as follows.

1. Locate the fittings as listed in Table 8-1.
2. Lubricate the pins until a small amount of grease extrudes from the pin.

Side and Bottom Boom Wear Pad 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.

The 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 all wear pad contact surfaces at the side and bottom of all boom sections with a brush or putty knife.
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.

Top Boom Wear Pad 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.

The recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers.
2. Lower the boom to horizontal.
3. Remove the access plate at the top rear of the base section.
4. Extend the boom until the wear pads are centered in the access opening, and apply grease to all wear pads and contact surfaces at the top of all boom sections with a grease gun or a brush.
5. Raise the boom to 75°.
6. Extend and retract the boom several times until the grease is evenly spread.
7. 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.

The recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers. See Figure 8-2.
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.

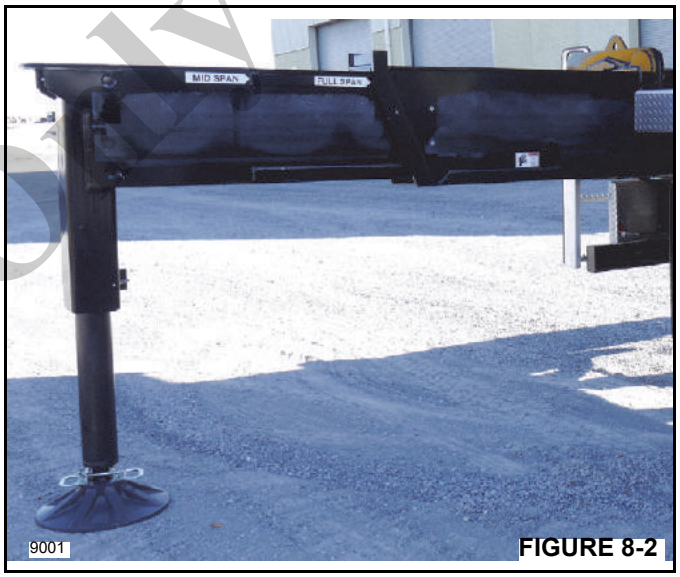


FIGURE 8-2

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 (2, Figure 8-3) and visually inspect the oil level. The oil should be visible within the bottom of the inspection hole. If more oil is needed, add through the oil vent/fill plug (1) hole until oil is at the bottom level of the inspection hole.

Drain/Add New Hoist Brake Oil

To drain and add new oil:

1. Remove the drain plug (3, Figure 8-3), inspection plug (2), and oil vent/fill plug (1).
2. Drain the brake oil.
3. Reinstall the drain plug (3) and add oil at the brake oil vent hole (1) until oil is at the bottom level of the inspection hole (2). The hoist brake fill capacity is 0.23 L (.25 qt).
4. Install the inspection plug (2) and the oil vent/fill plug (1).

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.

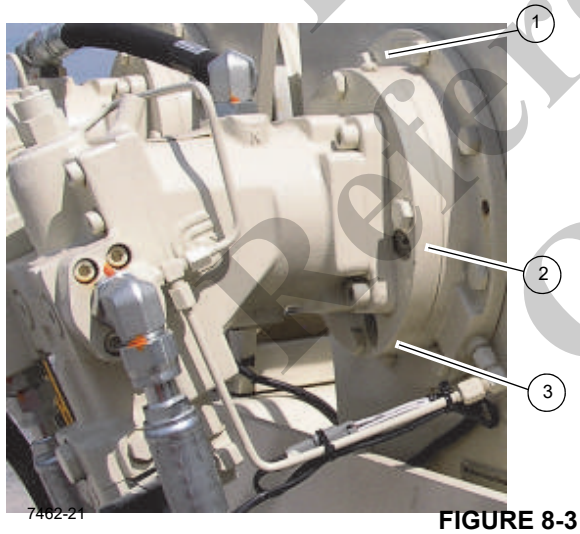


FIGURE 8-3

DANGER

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

Hoist Gearbox Oil

Check Hoist Gearbox Oil Level

1. Rotate the drum until the oil fill/level plug (1, Figure 8-4) is visible in the inspection hole.
2. Remove the fill/level plug (1) and visually inspect the oil level. The oil should be level with the bottom of the inspection/fill hole. If more oil is needed, add oil. (See Figure 8-3).
3. Install the fill/level plug (1).

Fill Hoist Gearbox with Oil

1. To fill with oil, rotate the drum so the gearbox fill/level plug (1, Figure 8-4) is visible through the upper hole.
2. Remove the fill/level plug (1) with a hex socket.
3. Install a 1 in pipe with elbow into the fill hole (1) to assist with adding oil.
4. Remove the vent plug (3) to assist with adding the oil.
5. Fill the gear box with 3.3 L (3.50 qt) of oil or until the oil is at the bottom level of the inspection hole with gear lube oil. (See Figure 8-4.)

Drain and Fill Hoist Gearbox with Oil

1. To drain and add new oil, remove the vent plug (3, Figure 8-4) to assist with draining the oil.
2. Remove the fill/level plug (1) with a hex socket.
3. Remove the drain plug (2) with a hex head socket.
4. Screw a 1 in pipe into the drain plug hole to assist with draining the oil.
5. Drain the oil.
6. Remove the 1in drain pipe.
7. Install the oil drain plug (2).
8. Install a 1 in pipe with elbow into the fill hole (1) to assist with adding oil.
9. Fill the gear box with 3.3 L (3.50 qt) of oil or until oil is at the bottom level of the inspection hole with gear lube oil. (See Figure 8-4).
10. Remove the 1 in fill pipe.
11. Install the fill/level plug (1).
12. Install the vent plug (3).

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.

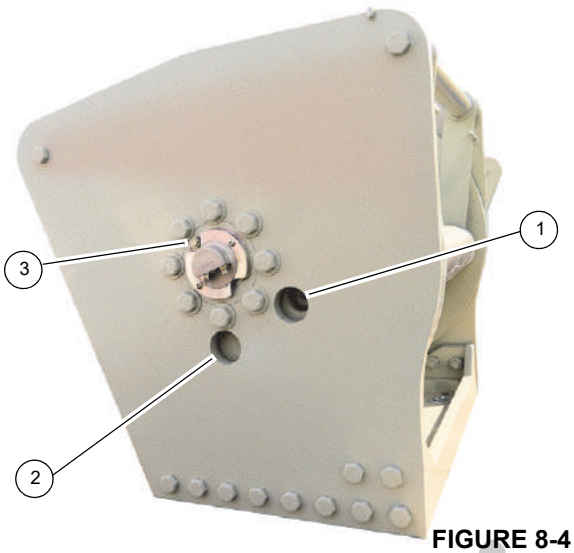


FIGURE 8-4

Swing Gearbox and Brake Oil

Check Swing Gearbox Oil Level

See Lubrication Points for lubrication type and maintenance frequency. Gearbox oil is drained by removing the drain plug and removing the fill/vent plug for ease of draining (see *Figure 8-5)*.

1. Examine the used oil for signs of significant metal deposits and then dispose of it in a proper manner.
2. Replace the drain plug.
3. Fill the swing gearbox with the appropriate amount and type of oil and replace the fill/vent plug. *See "Lubrication" on page 8-3.*

The gearbox oil level can be inspected by removing the gearbox fill/vent plug and visually inspecting the oil level. Maximum oil level is to be 1 inch below the port for this gearbox with 3.3 L (3.50 qt) of gear lube oil.

Gearbox lubricants are satisfactory for standard operation in temperatures from -23°C to 82°C (-10°F to +180°F). For operation outside this range, contact Manitowoc Crane Care for recommendations.

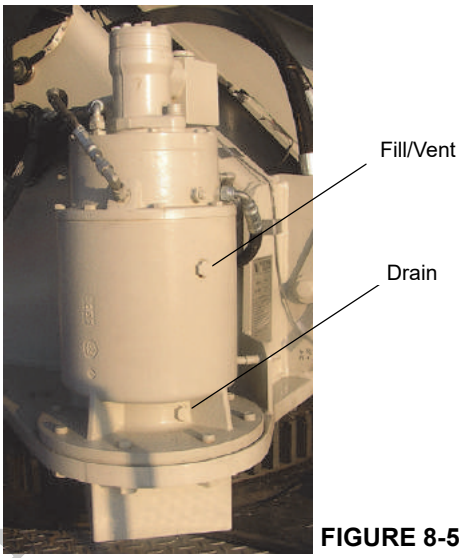


FIGURE 8-5

Hydraulic Oil Reservoir Level

The hydraulic oil reservoir has a sight gauge (see Figure 8-6) located on the side of the reservoir. The oil in the hydraulic reservoir is sufficient when the level is between the high and low marks on the sight gauge with the crane parked on a level surface in the transport position and when the oil is 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 too high, drain the oil until the oil level is even with the upper mark.

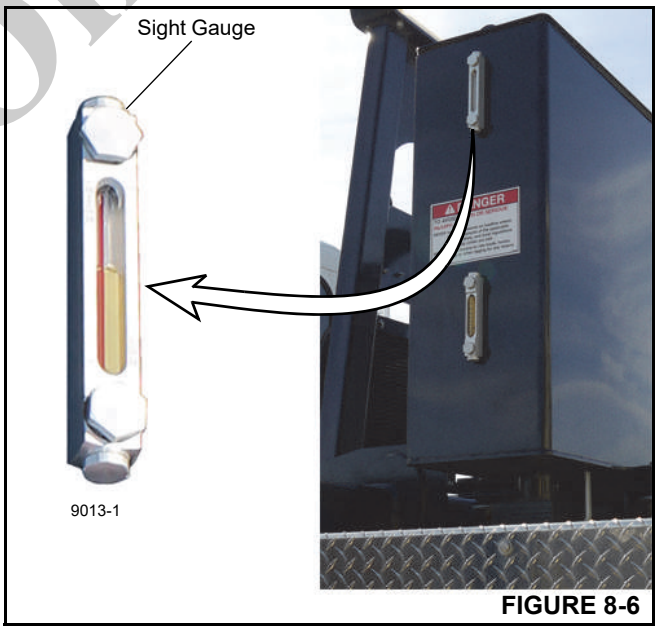


FIGURE 8-6

AIR CONDITIONING

When servicing the air conditioner, evacuate the system prior to disconnecting any components connected to the pressurized system. See “Air Conditioner” on page 9-38 for more information.

After servicing, ensure the air conditioning system is recharged with the specified refrigerant and lubricating oil types listed on Figure 8-1.

WIRE ROPE LUBRICATION

Wire rope is lubricated during manufacturing, 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 the proper lubricant. The sections of rope which are located over sheaves or otherwise hidden during inspection and maintenance procedures require special attention.

The purpose of rope lubrication are to reduce internal friction and to prevent corrosion. The type and amount of lubrication applied during manufacturing 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. A good wire rope lubricant should:

- Be free from acids and alkalies
- Have sufficient adhesive strength to remain on the rope
- Be of a viscosity capable of penetrating the interstices between wires and strands
- Not be soluble in the medium surrounding it under the actual operating conditions (e.g., water)
- Have a high film strength
- Be resistant to oxidation

Before applying lubrication, accumulation 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.

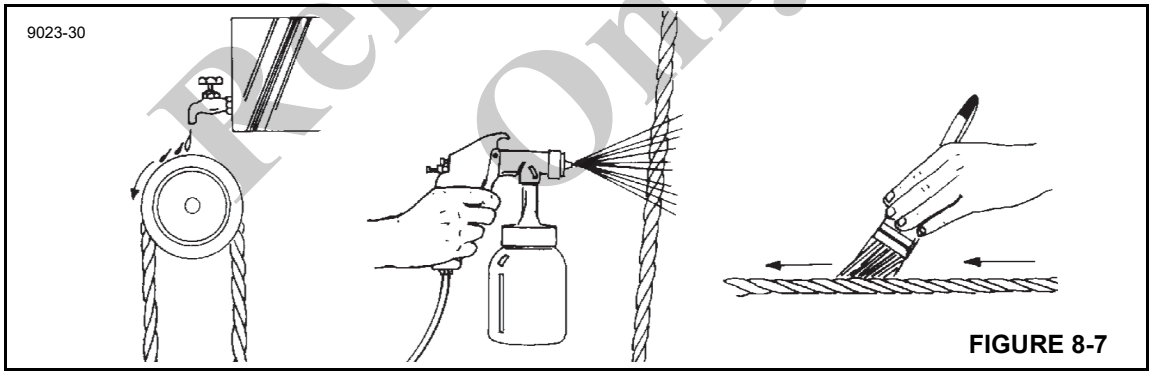


FIGURE 8-7

8

CARWELL® RUST INHIBITOR

Protecting Cranes from Rusting

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

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

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

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

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

This treatment works in various ways:

- It eliminates the moisture containing salt, dirt and other pollutants by lifting and removing them from the metal surface
- The film creates a barrier to repel further moisture from coming in contact with the metal
- It penetrates crevices

In addition to the factory-applied treatment, 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, caused by minor incidents or moving components
- Damage caused by personal abuse, such as using the decks to transport rigging gear, tools, or cribbing
- Exposure to harsh environmental hazards such as alkaline, acids, or other chemicals that can attack the crane's paint finish.

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

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

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

Cleaning Procedures

⚠ DANGER

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

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

- High pressure water or steam is effective for cleaning the crane's undercarriage and wheel housings. Keeping these areas clean will not only help retard the effects of

corrosion, but will also improve the ability to identify potential issues before they grow into larger problems.

CAUTION

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

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

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

Inspection and Repair

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

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

CAUTION

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

For scratches and marks in highly visible areas:

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

Application

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

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

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

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

NOTE: The unit must be completely dry before applying treatment.

- Do not allow product to puddle or build up on weather stripping, rubber gaskets, etc. The unit should not have puddles or runs evident anywhere.
- To ensure proper coverage of treatment, the product needs to be fogged on the unit.
- Use of pressure pots to apply the treatment to the unit being processed is recommended.
- Carwell® treatment is available in 16-ounce spray bottles from Manitowoc Crane Care (order part number 8898904099).

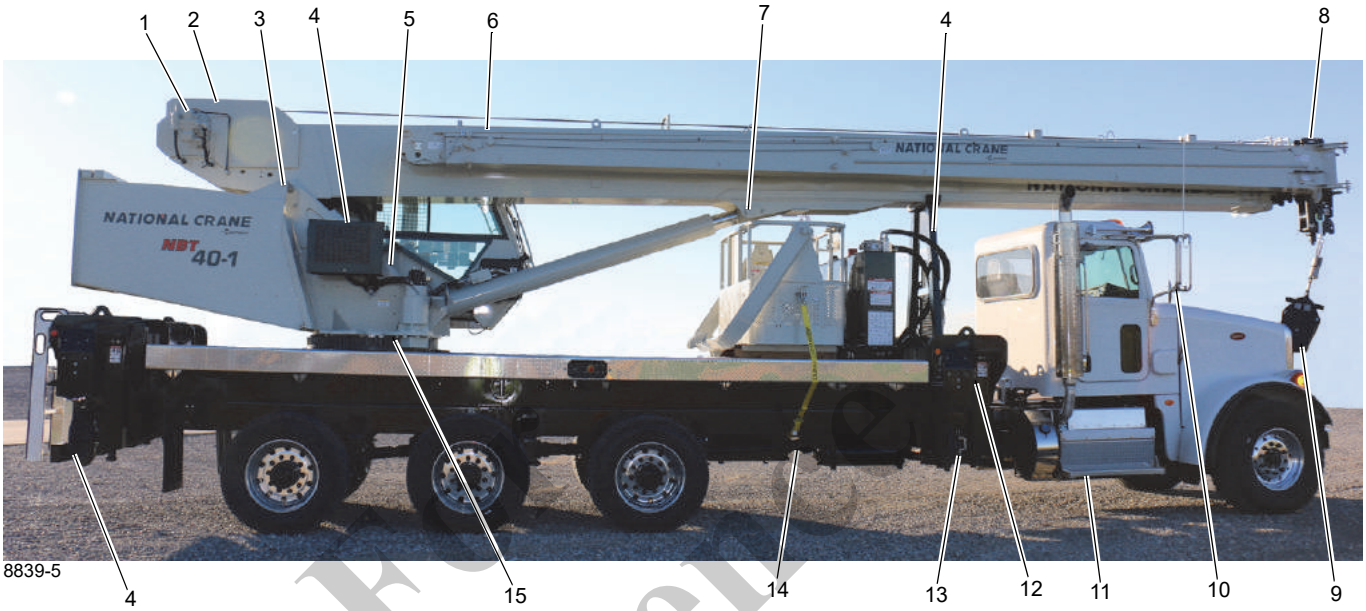
- After application of the treatment is complete, wash or clean film residue from lights, windshield, grab handles, ladders/steps and all access areas to the crane, as necessary.

Please contact Manitowoc Crane Care if you have any questions.

Areas of Application

See Figure 8-8 for the following information.

- 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, drive lines, transmission, slew ring fasteners, and all interior surfaces of the frame.
- Frame application areas are: hose ends and fittings, all unpainted fasteners and hardware, all bare metal surfaces, outrigger pads, and back-up alarm hardware.
- Superstructure applications are: hose end and fittings, wire rope on hoist roller tensioning springs on hoists, all unpainted fasteners and hardware, valves, slew ring fasteners, and all bare metal surfaces.
- Boom applications areas are: pivot pins, hose end and fittings, jib pins and shafts, all bare metal surfaces, downhaul weight pins/ hook block pins, and fasteners.
- All hardware, clips, pins, and hose connections that are not painted will have treatment applied.



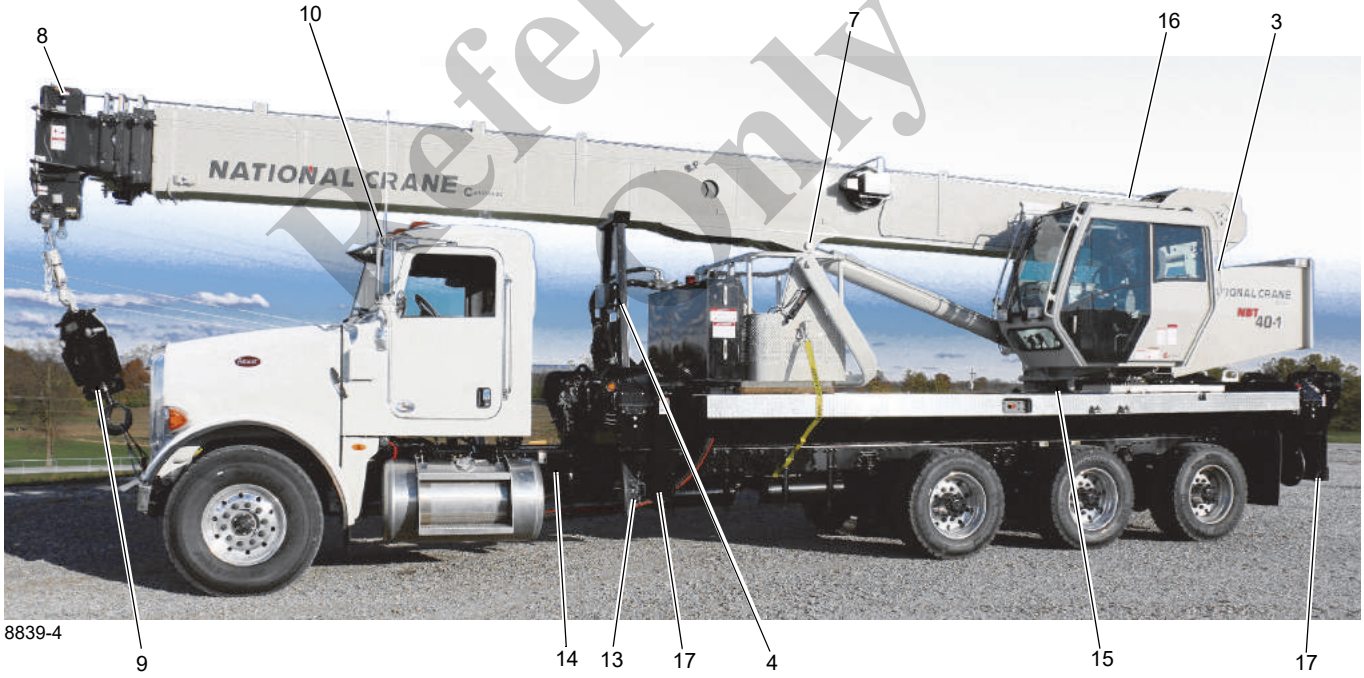


FIGURE 8-8

8

Item	Description
1	Hoist Plumbing Connections
2	Tension Spring
3	Counterweight Pins
4	Boom Rest
5	Valvebank, Hose Connections Inside Turntable
6	Boom Extension Hardware (optional)
7	Pivot Shaft
8	Boom Nose Pins, Clips
9	Downhaul Weight/Hook Block
10	Mirror Mounting Hardware
11	Powertrain Hardware
12	O/R Hose Connections
13	O/R Pins, Clips
14	Entire Underside of Unit
15	Turntable Bearing Fasteners
16	Wire Rope
17	Outrigger Beam Hardware

SECTION 9
CRANE INSTALLATION

SECTION CONTENTS

GENERAL

This section provides information for proper mounting and initial checkout of the crane. Improper mounting can result in damage to the truck frame, drive train, and hydraulic pump, and cause crane instability. The 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 and overhang.

The final manufacturer of the vehicle must certify that the axle ratings have not been exceeded with all permanently attached equipment including a full load of fuel and men (at 90 kg [200 lb] each].

National Cranes must meet ASME/ANSI B30.5 (latest) when completed as cranes and ASME/ANSI B30.23 (latest) when completed as a personnel lifting system. When equipped with the dual-rating option from the factory, the equipment is compliant with ASME B30.5 (latest) and ANSI/SAIA A92.2 (latest). These standards require welds to meet AWS D14.3 or AWS D1.1 respectively. Any work done in mounting must be done in compliance with these codes.

MINIMUM TRUCK REQUIREMENTS

Many factors must be considered in the selection of a proper truck for a NBT40-1 series crane. The following items must be considered.

- **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.
- **Wheelbase (WB), Cab-to-Trunnion (CT) and Bare Chassis Weight**
  - Mounting Configuration
  - Boom Length
  - Bed Length

  The wheelbase (WB), cab-to-trunnion (CT), and chassis weights shown meet technical axle ratings and 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. See the mounting configuration pages for additional information.
- **Axle Weight Limits—**Individual states vary on the permissible loads that a three-axle or four-axle truck may carry on state highways. Some states allow 11,340 kg (25,000 lb) on the steering axle and 20,412 kg (45,000 lb) on the tandem axle if the unit is designated as a truck-mounted crane.

  All states must use the federal bridge law requirements for trucks operating on the interstate highway system. The federal bridge law formula must be used to determine allowable axle weights for every individual axle and axle group.
- **Truck Frame—**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 AF section modulus (SM) and resistance to bending moment (RBM) so that reinforcing is not required. The single front outrigger (SFO) is used for a 360-degree working area around the truck. The frame under the cab through the front suspension must have the minimum SM and RBM because reinforcing through the front suspension is often difficult because of engine, radiator mounts, and steering mechanics. See Minimum Truck Requirements and Truck Frame Strength pages for the necessary SM and resistance to RBM values.
- **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 Requirements pages for more information. A conventional cab truck should be used for standard crane mounts.
- **Neutral Start Switch—**The chassis must be equipped with a switch that prevents operation of the engine starter when the transmission is in gear.
- **Serial Number Identification—**Figure 9-1 shows the typical serial number locations for the main components of the crane. Verify that the serial numbers on the major components match the serial number located on the sub-base. If any of the serial numbers do not match, contact the factory before proceeding. Matching serial numbers ensures that accurate information is recorded.

Typical Serial Number Location

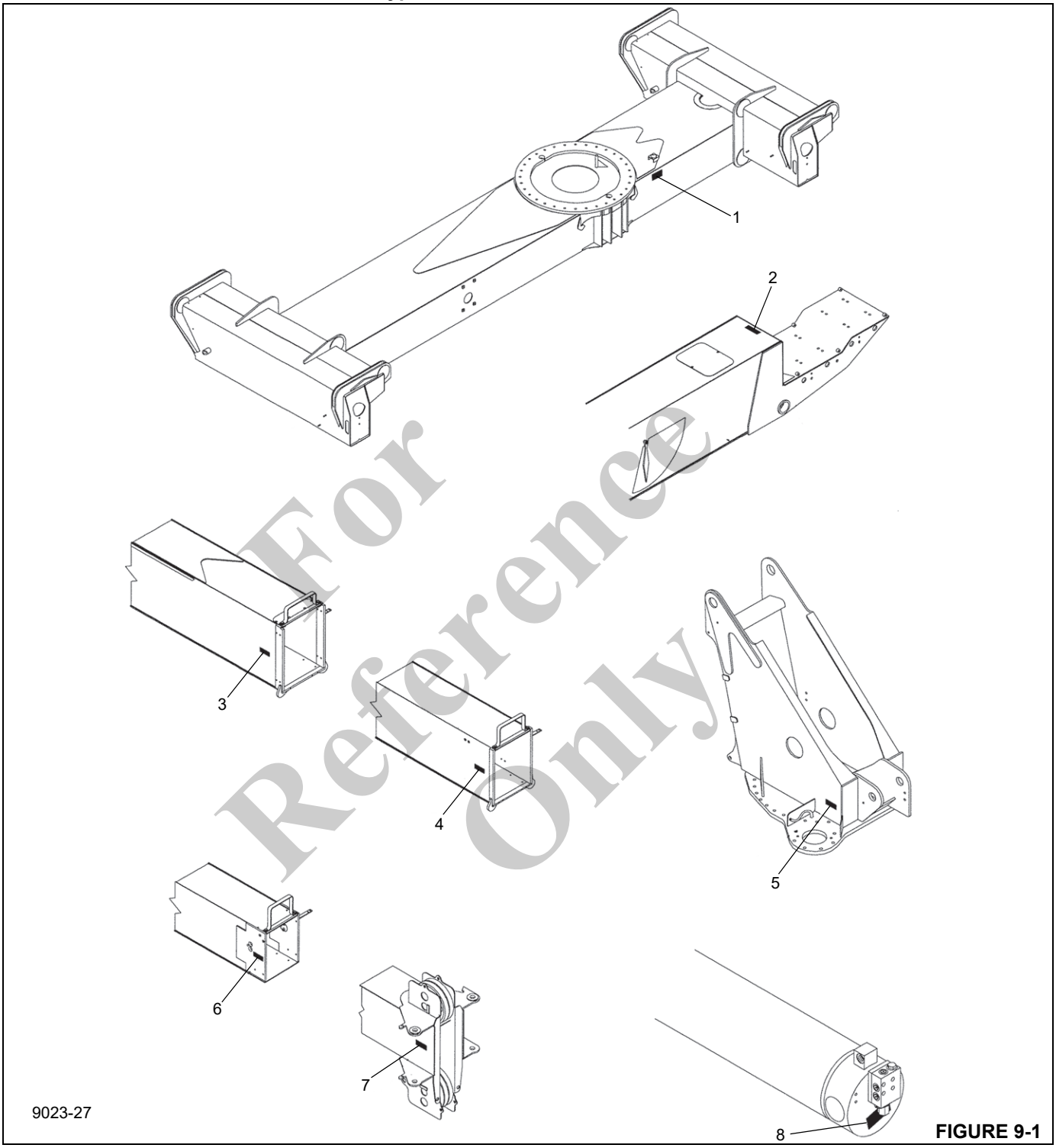


FIGURE 9-1

Item	Description	Item	Description
1	Sub-base	5	Turret
2	Base Boom Section	6	TEL #3 Boom Section
3	TEL #1 Boom Section	7	TEL #4 Boom Section
4	TEL #2 Boom Section	8	Lift Cylinder

MOUNTING CONFIGURATIONS

NBT36-1 Configuration — Standard Torsion Box and 103 ft Boom

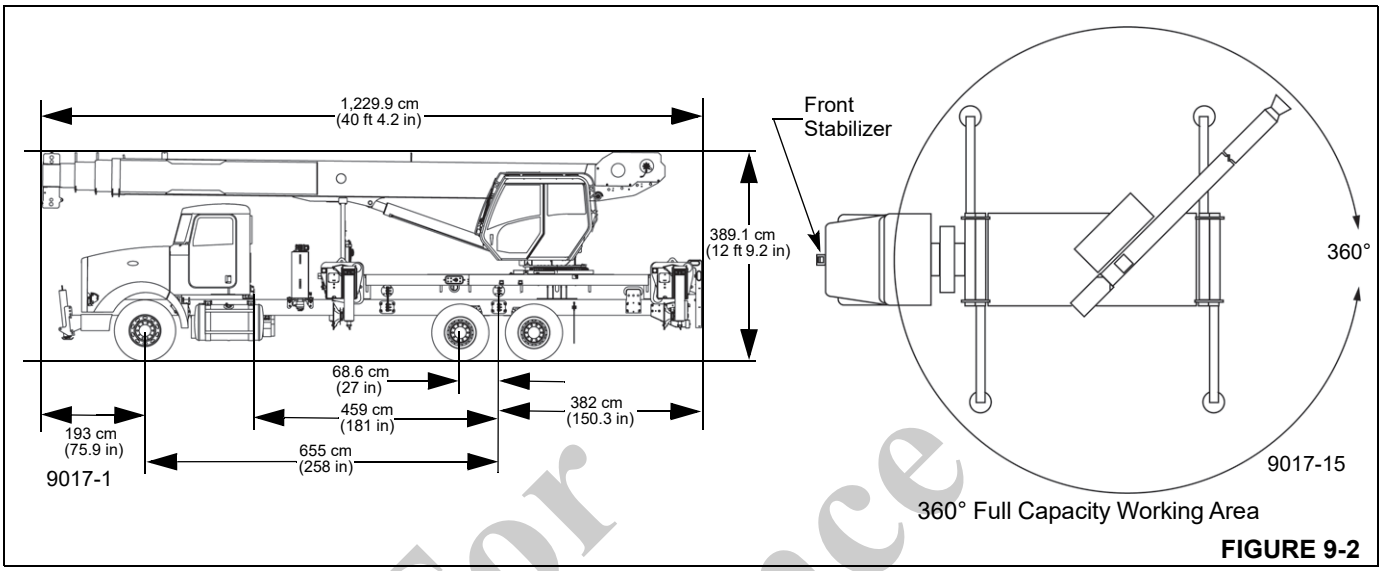


FIGURE 9-2

The mounting configuration for crane with a 103 ft boom and standard torsion box shown in Figure 9-2 is based on an 85% stability factor.

The complete unit must be installed on the truck in accordance with factory requirements. Installation must be tested to determine actual stability and counterweight requirements since individual truck chassis vary. Contact National Crane for details.

NOTE: If bare truck weights are not met, counterweights will be required.

Truck and crane mounting requirements:

- Working area 360°
- Gross Axle Weight Rating (GAWR), Front 9,072 kg (20,000 lb)
- Gross Axle Weight Rating (GAWR), Rear 20,865 kg (46,000 lb)
- Gross Vehicle Weight Rating (GVWR) 29,937 kg (66,000 lb)
- Wheelbase (WB) 655 cm (258 in)
- Cab to Trunnion (CT) 459 cm (181 in)
- After-Frame (AF) 305 cm (120 in) (min)
- Frame Strength 785 MPa (110,000 psi)
- Frame Section Modulus (SM), Front Axle to End of After-Frame (AF) 426 cm^3 (30.0 in^3)
- Bare Truck Weight, Front 4,853 kg (10,700 lb)
- Bare Truck Weight, Rear 3,864 kg (8,520 lb)
- Estimated Final Average Weight
  - 24,460 kg (53,924 lb)
  - 2/3 Sheave Block
  - Aluminum Decking and Ladders
  - 100 gal Fuel and Two People in Cab
  - Add 858 kg (1,891 lb) for 31/55 ft Jib, 637 kg (1,405 lb) for Aux. Hoist with Rooster Sheave and Downhaul Weight.

Figure 9-2 shows the 360-degree working area that is achieved with the front stabilizer (standard on the NBT36-1) and AWMCWT option. Extended front rails are required for SFO installation unless application without extended rails has been approved by National Crane. See “Truck Frame Strength” section for the truck frame strength required for the mounting crane and front stabilizer.

The gross vehicle weight rating (GVWR) is dependent on all components of the vehicle (axles, tires, springs, frame, etc.) meeting manufacturers' recommendations. Always specify the GVWR when purchasing trucks.

Diesel engines require a variable-speed governor and an energize-to-run fuel solenoid for smooth crane operation. Electronic fuel injection and a transmission neutral safety interlock switch are required.

NOTE: Specifications are based on bare truck weights prior to the installation of the crane assembly for 85% stability.

NBT36-1 Configuration — Standard Torsion Box and 127 ft Boom

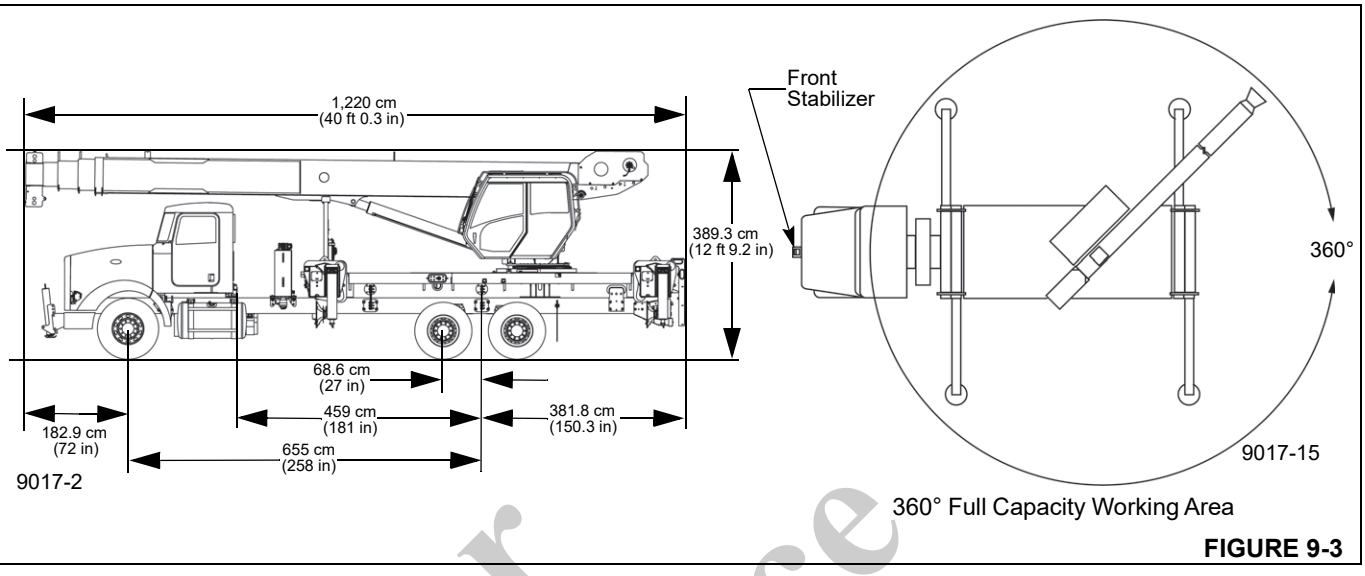


FIGURE 9-3

The mounting configuration for crane with a 127 ft boom and standard torsion box shown in Figure 9-3 is based on an 85% stability factor.

The complete unit must be installed on the truck in accordance with factory requirements. Installation must be tested to determine actual stability and counterweight requirements since individual truck chassis vary. Contact National Crane for details.

NOTE: If bare truck weights are not met, counterweights will be required.

Truck and crane mounting requirements:

- Working area 360°
- Gross Axle Weight Rating (GAWR), Front 9,072 kg (20,000 lb)
- Gross Axle Weight Rating (GAWR), Rear 20,865 kg (46,000 lb)
- Gross Vehicle Weight Rating 66,000 lb
- Wheelbase (WB) 655 cm (258 in)
- Cab to Trunnion (CT) 459 cm (181 in)
- After-Frame (AF) 305 cm (120 in) (min)
- Frame Strength 785 MPa (110,000 psi)
- Frame Section Modulus (SM), Front Axle to End of After-Frame (AF) 426 cm^3 (30.0 in^3)
- Bare Truck Weight, Front 4,853 kg (10,700 lb)
- Bare Truck Weight, Rear 3,864 kg (8,520 lb)
- Estimated Final Average Weight
  - 24,691 kg (54,434 lb)
  - 2/3 Sheave Block
  - Aluminum Decking and Ladders
  - 100 gal Fuel and Two People in Cab
  - Add 858 kg (1,891 lb) for 31/55 ft Jib, 637 kg (1,405 lb) for Aux. Hoist with Rooster Sheave and Downhaul Weight.

Figure 9-3 shows the 360-degree working area that is achieved with the front stabilizer (standard on the NBT36-1). Extended front rails are required for SFO installation unless application without extended rails has been approved by National Crane. See “Truck Frame Strength” section for the truck frame strength required for the mounting crane and front stabilizer.

The gross vehicle weight rating (GVWR) is dependent on all components of the vehicle (axles, tires, springs, frame, etc.) meeting manufacturers' recommendations. Always specify the GVWR when purchasing trucks.

Diesel engines require a variable-speed governor and an energize-to-run fuel solenoid for smooth crane operation. Electronic fuel injection and a transmission neutral safety interlock switch are required.

NOTE: Specifications are based on bare truck weights prior to the installation of the crane assembly for 85% stability.

NBT40-1 Configuration — Standard Torsion Box and 103 ft Boom

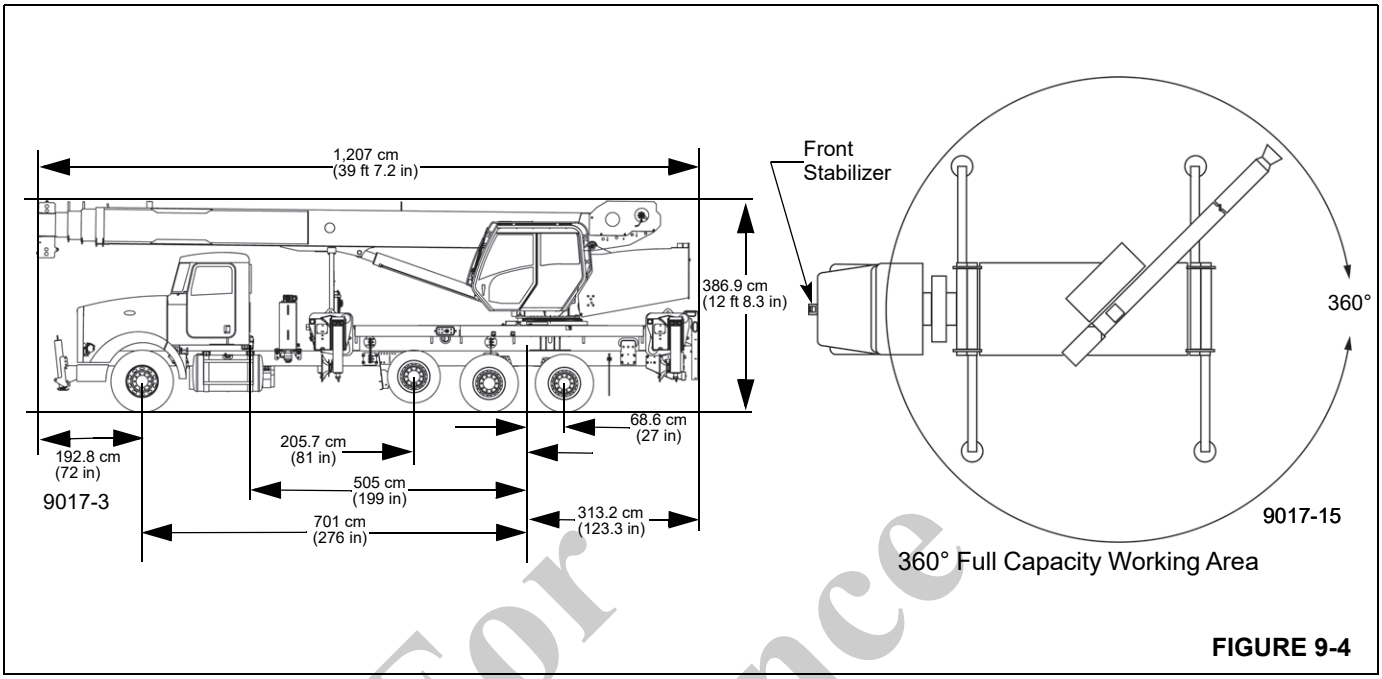


FIGURE 9-4

The mounting configuration for crane with a 103 ft boom, standard torsion box, and pusher axle as shown in Figure 9-4 is based on an 85% stability factor.

The complete unit must be installed on the truck in accordance with factory requirements. Installation must be tested to determine actual stability and counterweight requirements since individual truck chassis vary. Contact National Crane for details.

NOTE: If bare truck weights are not met, counterweight will be required.

Truck and crane mounting requirements:

- Working Area 360°
- Gross Axle Weight Rating (GAWR), Front 9,072 kg (20,000 lb)
- Gross Axle Weight Rating (GAWR), Rear 20,865 kg (46,000 lb)
- Gross Vehicle Weight Rating (GVWR) 29,937 kg (66,000 lb)
- Gross Pusher Axle Weight Rating 5,987 kg (13,200 lb) (min)
- Wheelbase (WB) 701 cm (276 in)
- Cab to Trunnion (CT) 505 cm (199 in)
- Pusher Axle Location From Front Axle 495 cm (195 in)
- Frame Section Modulus (SM), Front Axle to End of AF 426 cm^3 (30 in^3)
- After-Frame (AF) 241 cm (95 in) (min)
- Frame Strength 785 MPa (110,000 psi)
- Bare Truck Weight, Front 4,780 kg (10,540 lb)
- Bare Truck Weight, Rear: 4,545 kg (10,020 lb)
- Estimated Final Weight with the Following Machine Configuration

  NBT40-1 (Wet) - 25,670 kg (56,592 lb)
  - 2/3 Sheave Block
  - Aluminum Decking and Ladders
  - 100 gal Fuel and Two Men in Cab
  - Add 858 kg (1,891lb) for 31/55 ft Jib, 637 kg (1,405 lb) for Aux. Hoist with Rooster Sheave and Downhaul Weight

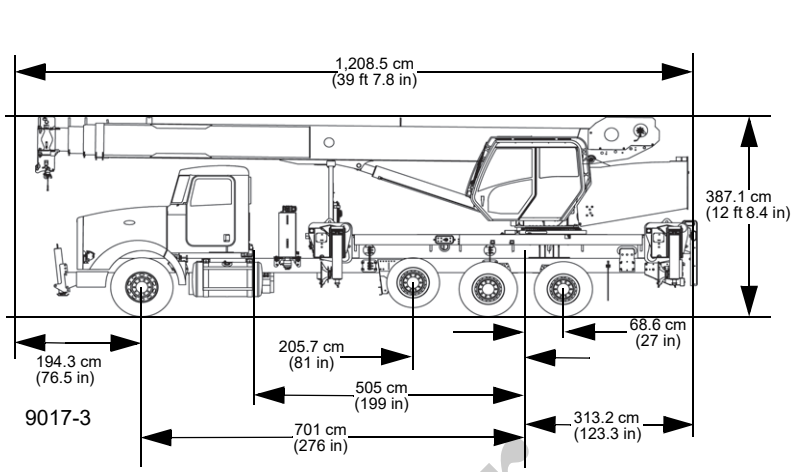
Figure 9-4 shows the 360-degree working area that can be achieved with the front stabilizer (standard on the Series NBT40-1). The front stabilizer is essential when extending the boom and lifting loads over the front of the truck. See “Truck Frame Strength” on page 9-15 for the truck frame strength required for the mounting crane and front stabilizer.

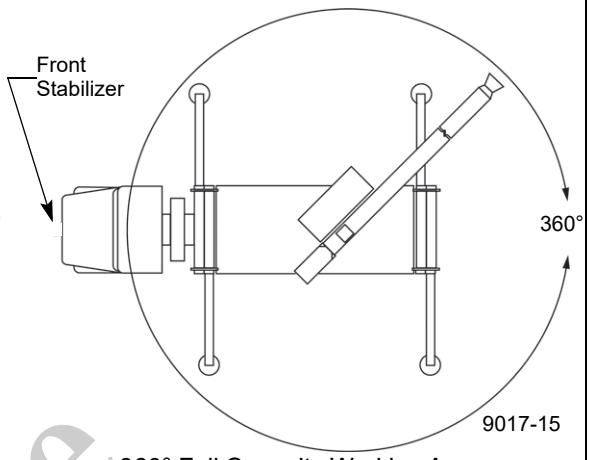
The gross vehicle weight rating (GVWR) is dependent on all components of the vehicle (axles, tires, springs, frame, etc.) meeting manufacturers' recommendations; always specify GVWR when purchasing trucks.

Diesel engines require a variable-speed governor and an energize-to-run fuel solenoid for smooth crane operation. Electronic fuel injection and a transmission neutral safety interlock switch are required.

NOTE: Specifications are based on bare truck weights prior to the installation of the crane assembly for 85% stability.

NBT40-1 Configuration — Standard Torsion Box and 127 ft Boom





360° Full Capacity Working Area

FIGURE 9-5

The mounting configuration for the crane with a 127 ft boom, standard torsion box, and pusher axle as shown in Figure 9-5 is based on an 85% stability factor.

The complete unit must be installed on the truck in accordance with factory requirements. Installation must be tested to determine actual stability and counterweight requirements since individual truck chassis vary. Contact National Crane for details.

NOTE: If bare truck weights are not met, counterweights will be required.

Truck and crane mounting requirements:

- Working area 360°
- Gross Axle Weight Rating (GAWR), Front 9,072 kg (20,000 lb)
- Gross Axle Weight Rating (GAWR), Rear 20,865 kg (46,000 lb)
- Gross Vehicle Weight Rating 29,937 kg (66,000 lb)
- Pusher Axle Weight Rating: 5,987 kg (13,200 lb)
- Wheelbase 701 cm (276 in)
- Cab to Trunnion (CT) 505 cm (199 in)
- Pusher Axle Location from Front Axle 495 cm (195 in)
- Frame Section Modulus (SM), Front Axle to End of AF 426 cm^3 (30 in^3)
- After-Frame (AF) 241 cm (95 in) (min)
- Frame Strength 785 MPa (110,000 psi)
- Bare Truck Weight, Front 4,780 kg (10,540 lb)
- Bare Truck Weight, Rear 4,545 kg (10,020 lb)
- Estimated Final Weight with the Following Machine Configuration

  NBT40-1 (Wet) - 26,264 kg (57,902 lb)

  - 2/3 Sheave Block
  - Aluminum Decking and Ladders
  - 100 gal Fuel and Two People in Cab
  - Add 858 kg (1,891 lb) for 31/55 ft Jib, 637 kg (1,405 lb) for Aux. Hoist with Rooster Sheave and Downhaul Weight.

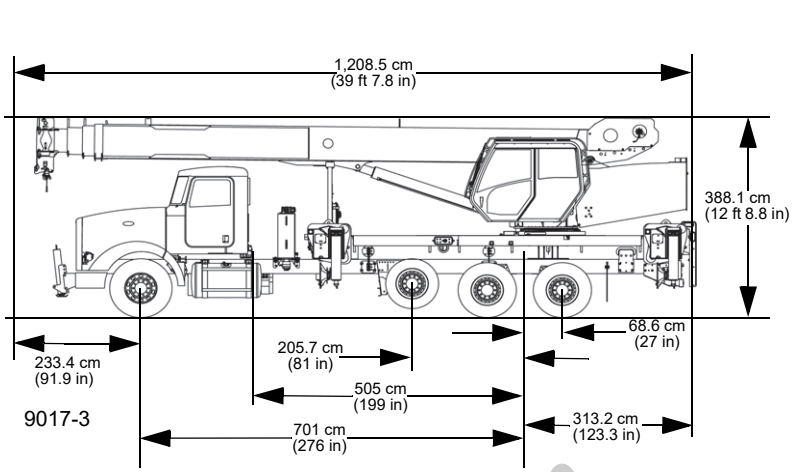
Figure 9-5 shows the 360-degree working area that can be achieved with the front stabilizer (standard on the Series NBT40-1). The front stabilizer is essential when extending the boom and lifting loads over the front of the truck. See “Truck Frame Strength” on page 9-15 for the truck frame strength required for the mounting crane and front stabilizer.

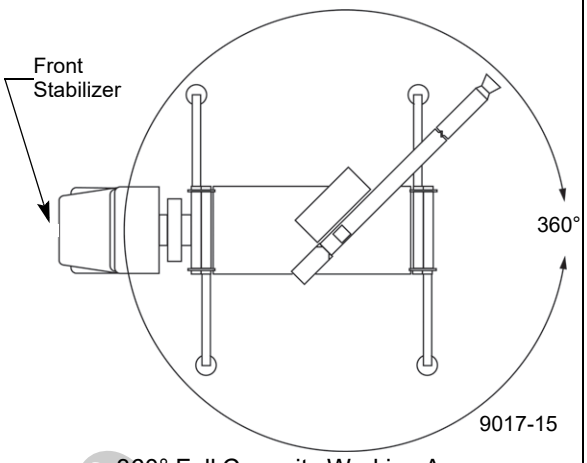
The gross vehicle weight rating (GVWR) is dependent on all components of the vehicle (axles, tires, springs, frame, etc.) meeting manufacturers' recommendations. Always specify the GVWR when purchasing trucks.

Diesel engines require a variable-speed governor and an energize-to-run fuel solenoid for smooth crane operation. Electronic fuel injection and a transmission neutral safety interlock switch are required.

NOTE: Specifications are based on bare truck weights prior to the installation of the crane assembly for 85% stability.

NBT40-1 Configuration — Standard Torsion Box and 142 ft Boom





360° Full Capacity Working Area

FIGURE 9-6

The mounting configuration for a crane with a 142 ft boom, standard torsion box, and pusher axle as shown in Figure 9-5 is based on an 85% stability factor.

The complete unit must be installed on the truck in accordance with factory requirements. Installation must be tested to determine actual stability and counterweight requirements since individual truck chassis vary. Contact National Crane for details.

NOTE: If bare truck weights are not met, counterweights will be required.

Truck and crane mounting requirements:

- Working area 360°
- Gross Axle Weight Rating (GAWR), Front 9,072 kg (20,000 lb)
- Gross Axle Weight Rating (GAWR), Rear 20,865 kg (46,000 lb)
- Gross Vehicle Weight Rating 29,937 kg (66,000 lb)
- Pusher Axle Weight Rating: 5,987 kg (13,200 lb)
- Wheelbase 701 cm (276 in)
- Cab to Trunnion (CT) 505 cm (199 in)
- Pusher Axle Location from Front Axle 495 cm (195 in)
- Frame Section Modulus (SM), Front Axle to End of AF 426 cm^3 (30 in^3)
- After-Frame (AF) 241 cm (95 in) (min)
- Frame Strength 785 MPa (110,000 psi)
- Bare Truck Weight, Front 4,780 kg (10,540 lb)
- Bare Truck Weight, Rear 4,545 kg (10,020 lb)
- Estimated Final Weight with the Following Machine Configuration.

  NBT40-1 (Wet) - 26,851 kg (59,197 lb)

  - 2/3 Sheave Block
  - Aluminum Decking and Ladders
  - 100 gal Fuel and Two People in Cab
  - Add 858 kg (1,891 lb) for 31/55 ft Jib, 637 kg (1,405 lb) for Aux. Hoist with Rooster Sheave and Downhaul Weight.

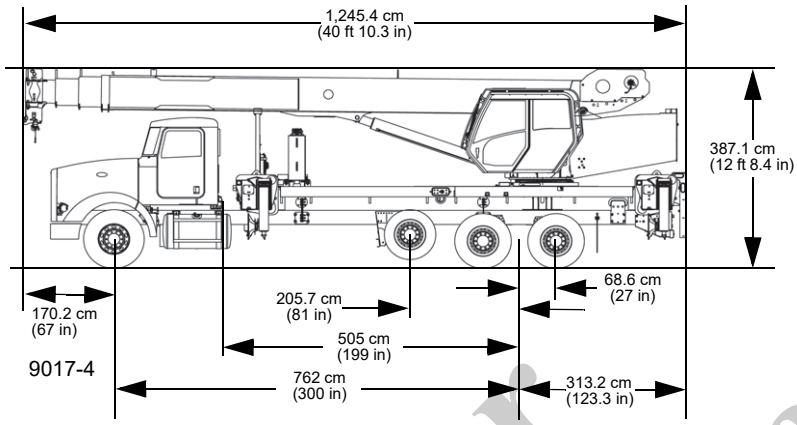
Figure 9-5 shows the 360-degree working area that can be achieved with the front stabilizer (standard on the Series NBT40-1). The front stabilizer is essential when extending the boom and lifting loads over the front of the truck. See “Truck Frame Strength” on page 9-15 for the truck frame strength required for the mounting crane and front stabilizer.

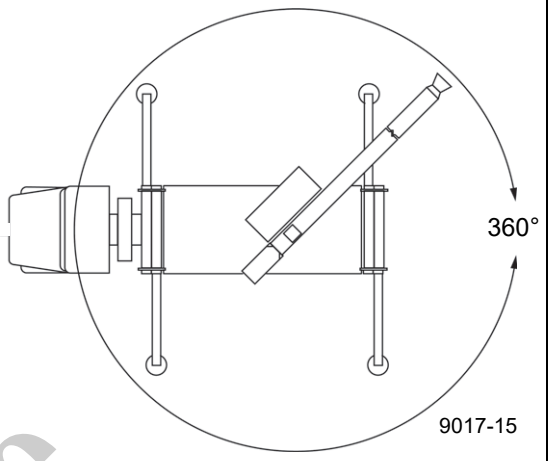
The gross vehicle weight rating (GVWR) is dependent on all components of the vehicle (axles, tires, springs, frame, etc.) meeting manufacturers' recommendations. Always specify the GVWR when purchasing trucks.

Diesel engines require a variable-speed governor and an energize-to-run fuel solenoid for smooth crane operation. Electronic fuel injection and a transmission neutral safety interlock switch are required.

NOTE: Specifications are based on bare truck weights prior to the installation of the crane assembly for 85% stability.

NBT40-1 Configuration — Extended Torsion Box and 127 ft Boom





360° Full Capacity Working Area

FIGURE 9-7

The mounting configuration for a crane with a 127 ft boom, extended torsion box, and pusher axle as shown in Figure 9-7 is based on an 85% stability factor.

The complete unit must be installed on the truck in accordance with factory requirements. Installation must be tested to determine actual stability and counterweight requirements since individual truck chassis vary. Contact National Crane for details.

NOTE: If bare truck weights are not met, counterweights will be required.

Truck and crane mounting requirements:

- Working area 360°
- Gross Axle Weight Rating (GAWR), Front 9,072 kg (20,000 lb)
- Gross Axle Weight Rating (GAWR), Rear 20,865 kg (46,000 lb)
- Gross Vehicle Weight Rating 29,937 kg (66,000 lb)
- Pusher Axle Weight Rating 5,987 kg (13,200 lb)
- Wheelbase (WB) 762 cm (300 in)
- Cab to Trunnion (CT) 505 cm (199 in)
- Pusher Axle Location from Front Axle 556.2 cm (219 in)
- Frame Section Modulus (SM), Front Axle to End of (AF) 426 cm^3 (27.5 in^3)
- After-Frame (AF) 241 cm (95 in) (min)
- Frame Strength 785 MPa (110,000 psi)
- Bare Truck Weight, Front 4,762 kg (10,500 lb)
- Bare truck weight, rear 5,685 kg (10,330 lb)

NOTE: The RC1000 add-on rotating counterweight may be required for stability on the NBT40-1, depending on configuration.

- Estimated Final Weight with the following machine configuration.

  NBT40-1 (Wet) - 27,256 kg (60,088 lb)

  - 2/3 Sheave Block
  - Aluminum Decks and Ladders
  - 100 gal Fuel and Two People in Cab
  - Add 858 kg (1,891 lb) for 31/55 ft Jib, 637 kg (1,405 lb) for Aux. Hoist with Rooster Sheave and Downhaul Weight.

NOTE: This configuration shows the 360 degree working area achieved with the EXTB torsion box and RC1000 options

Figure 9-7 shows the 360-degree working area. See “Truck Frame Strength” on page 9-15 for the truck frame strength required for the mounting crane.

The gross vehicle weight rating (GVWR) is dependent on all components of the vehicle (axles, tires, springs, frame, etc.) meeting manufacturers' recommendations. Always specify the GVWR when purchasing trucks.

Diesel engines require a variable-speed governor and an energize-to-run fuel solenoid for smooth crane operation. Electronic fuel injection and a transmission neutral safety interlock switch are required.

NBT40-1 Configuration — Extended Torsion Box and 142 ft Boom

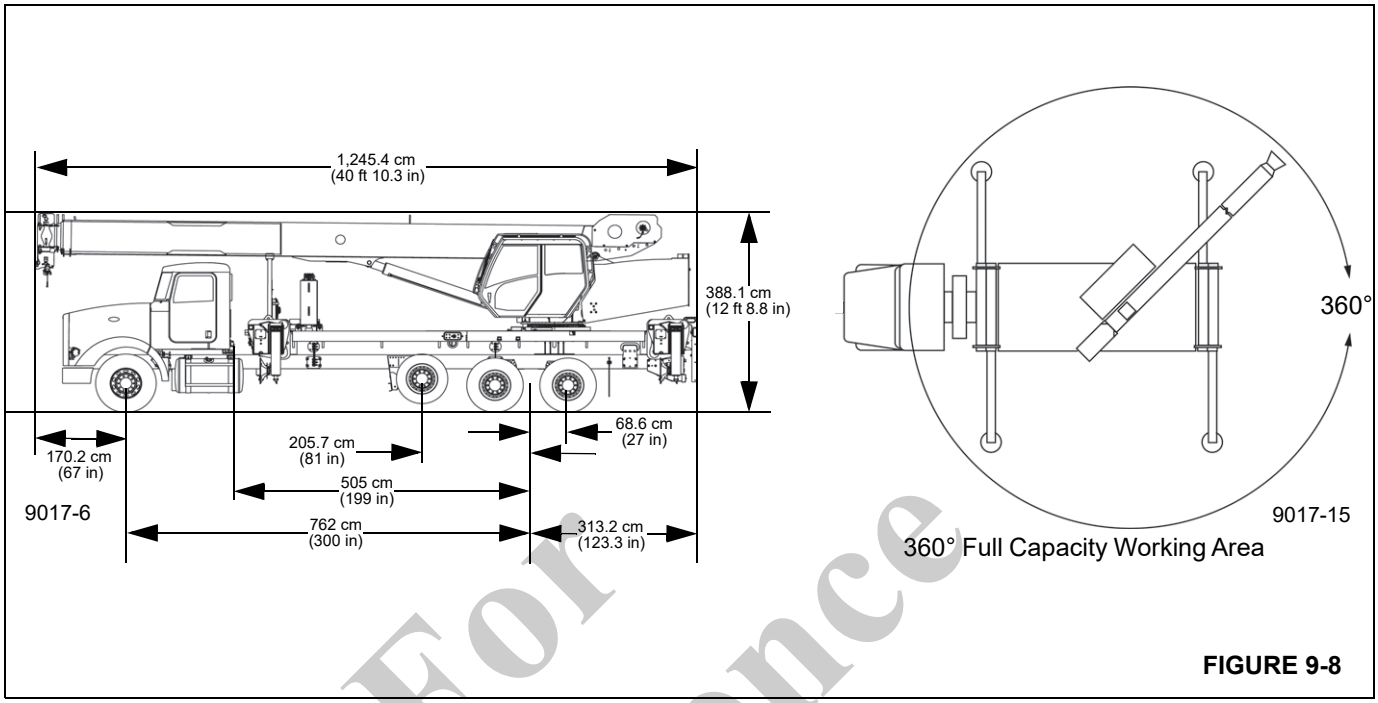


FIGURE 9-8

The mounting configuration for a crane with a 142 ft boom, extended torsion box, and pusher axle as shown in Figure 9-8 is based on an 85% stability factor.

The complete unit must be installed on the truck in accordance with factory requirements. Installation must be tested to determine actual stability and counterweight requirements since individual truck chassis vary. Contact National Crane for details.

NOTE: If bare truck weights are not met, counterweights will be required.

Truck and crane mounting requirements:

- Working area 360°
- Gross Axle Weight Rating (GAWR), Front 9,072 kg (20,000 lb)
- Gross Axle Weight Rating (GAWR), Rear 20,865 kg (46,000 lb)
- Gross Vehicle Weight Rating 29,937 kg (66,000 lb)
- Pusher Axle Weight Rating 5,987 kg (13,200 lb)
- Wheelbase (WB) 762 cm (300 in)
- Cab to Trunnion (CT) 566 cm (223 in)
- Pusher Axle Location from Front Axle 556.2 cm (219 in)
- Frame Section Modulus (SM), Front Axle to End of AF 426 cm^3 (30 in^3)
- After-Frame (AF) 241 cm (95 in) (min)
- Frame Strength 785 MPa (110,000 psi)
- Bare Truck Weight, Front 4,762 kg (10,500 lb)
- Bare Truck Weight, Rear 5,685 kg (10,330 lb)
- Estimated Final Weight with the Following Machine Configuration:

  NBT40-1 - 27,351 (60,298 lb)

  - 2/3 Sheave Block
  - Aluminum Decks and Ladders
  - 100 gal Fuel and Two People in Cab
  - Add 858 kg (1,891 lb) for 31/55 ft Jib, 637 kg (1,405 lb) for Aux. Hoist with Rooster Sheave and Downhaul Weight.

Figure 9-8 shows the 360-degree working area. See “Truck Frame Strength” on page 9-15 for the truck frame strength required for the mounting crane.

The gross vehicle weight rating (GVWR) is dependent on all components of the vehicle (axles, tires, springs, frame, etc.) meeting manufacturers' recommendations. Always specify the GVWR when purchasing trucks.

Diesel engines require a variable-speed governor and an energize-to-run fuel solenoid for smooth crane operation. Electronic fuel injection and a transmission neutral safety interlock switch are required.

NOTE: Specifications are based on bare truck weights prior to the installation of the crane assembly for 85% stability.

NBT45-1 Configuration — Extended Torsion Box and 127 ft Boom

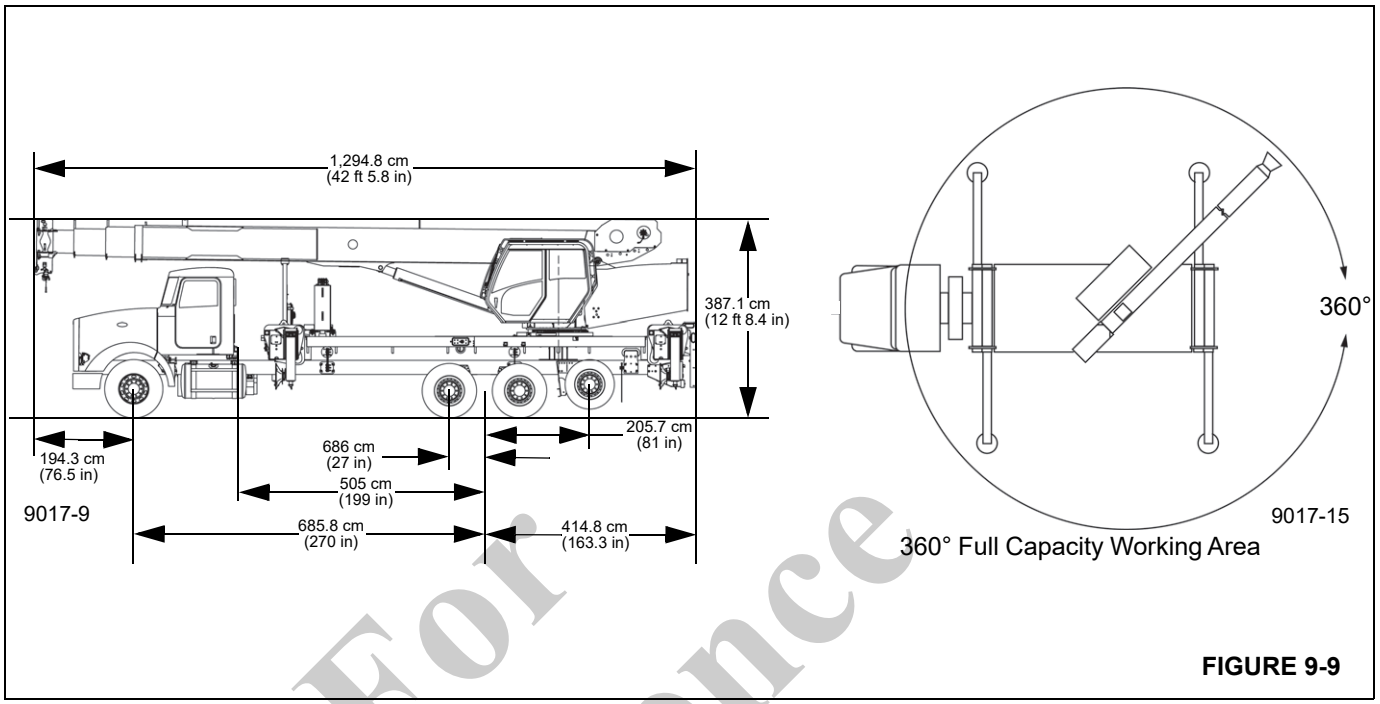


FIGURE 9-9

The mounting configuration for a crane with a 127 ft boom, extended torsion box, and tag axle as shown in Figure 9-9 is based on an 85% stability factor.

The complete unit must be installed on the truck in accordance with factory requirements. Installation must be tested to determine actual stability and counterweight requirements since individual truck chassis vary. Contact National Crane for details.

NOTE: If bare truck weights are not met, counterweights will be required.

Truck and crane mounting requirements:

- Working area 360°
- Gross Axle Weight Rating (GAWR), Front 9,072 kg (20,000 lb)
- Gross Axle Weight Rating (GAWR), Rear 20,865 kg (46,000 lb)
- Gross Vehicle Weight Rating 29,937 kg (66,000 lb)
- Tag Axle Weight Rating 5,987 kg (13,200 lb)
- Cab to Trunnion (CT) 490 cm (193 in)
- Wheelbase (WB) 685 cm (270 in)
- Tag Axle Location from Front Axle 891.5 cm (351 in)
- Frame Section Modulus (SM), Front Axle to End of AF 426 cm^3 (30 in^3)
- Frame Strength 785 MPa (110,000 psi)
- After-Frame (AF) 343 cm (135 in)
- Bare Truck Weight, Front 4,436 kg (9,780 lb)
- Bare Truck Weight, Rear 5,012 kg (11,050 lb)
- Estimated Final Weight with the Following Machine Configuration:

  NBT45-1 -28,265 kg (62,313 lb)

  - 2/3 Sheave Block
  - Aluminum Decks and Ladders
  - 100 gal Fuel and Two People in Cab
  - Add 858 kg (1,891 lb) for 31/55 ft Jib, 637 kg (1,405 lb) for Aux. Hoist with Rooster Sheave and Downhaul Weight.

Figure 9-9 shows the 360-degree working area. See “Truck Frame Strength” on page 9-15 for the truck frame strength required for the mounting crane.

The gross vehicle weight rating (GVWR) is dependent on all components of the vehicle (axles, tires, springs, frame, etc.) meeting manufacturers' recommendations. Always specify the GVWR when purchasing trucks.

Diesel engines require a variable-speed governor and an energize-to-run fuel solenoid for smooth crane operation. Electronic fuel injection and a transmission neutral safety interlock switch are required.

NOTE: This configuration shows the 360-degree working area achieved with the EXTB torsion box.

NBT45-1 Configuration — Extended Torsion Box and 142 ft Boom

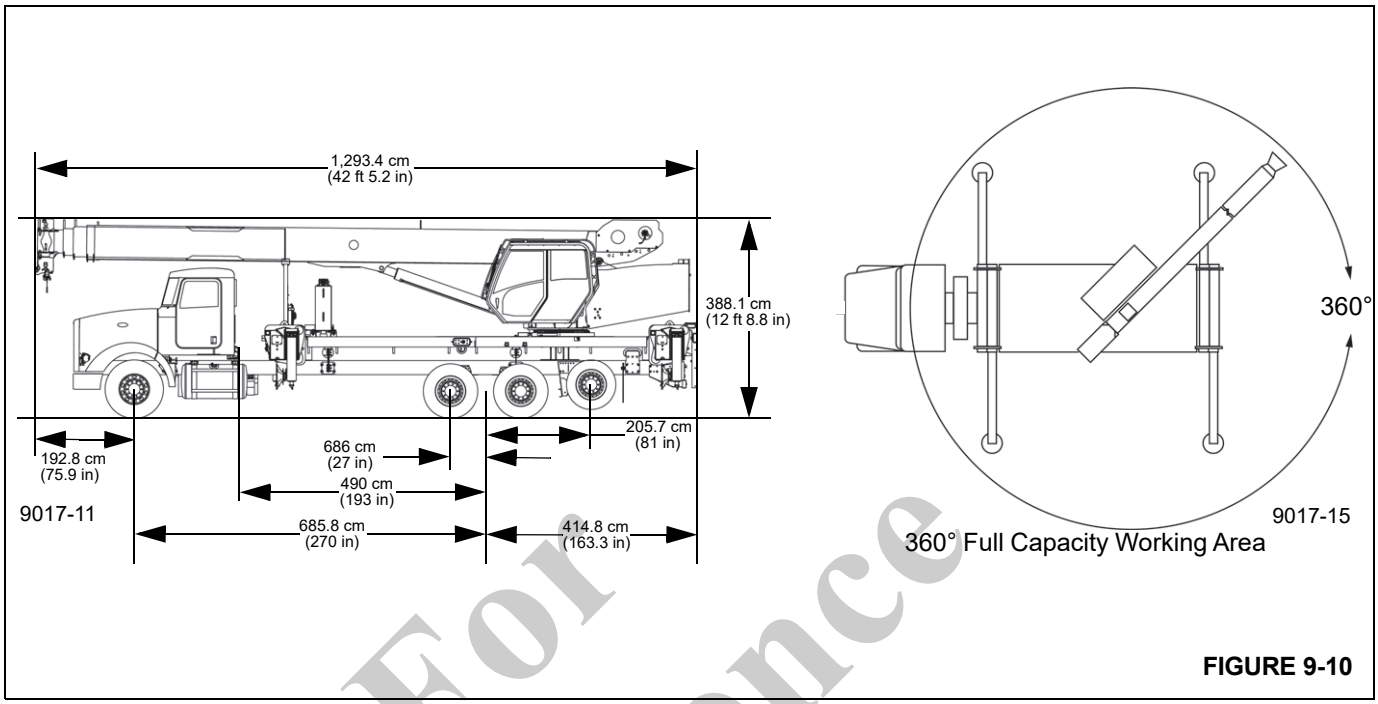


FIGURE 9-10

The mounting configuration for a crane with a 142 ft boom, extended torsion box, and tag axle as shown in Figure 9-10 is based on an 85% stability factor.

The complete unit must be installed on the truck in accordance with factory requirements, and a test performed to determine actual stability and counterweight requirements, since individual truck chassis vary.

NOTE: If bare truck weights are not met, counterweights will be required.

Truck and crane mounting requirements:

- Working area 360°
- Gross Axle Weight Rating (GAWR), Front 9,072 kg (20,000 lb)
- Gross Axle Weight Rating (GAWR), Rear 20,865 kg (46,000 lb)
- Gross Vehicle Weight Rating 29,937 kg (66,000 lb)
- Tag Axle Weight Rating 5,987 kg (13,200 lb)
- Wheelbase (WB) 685 cm (270 in)
- Cab to Trunnion (CT) 490 cm (193 in)
- Tag Axle Location from Front Axle 331 in
- Frame Strength 785 MPa (110,000 psi)
- Frame Section Modulus (SM), Front Axle to End of AF 426 cm^3 (30 in^3)
- After-Frame (AF) 343 cm (135 in) (min)
- Bare Truck Weight, Front 4,436 kg (9,780 lb)
- Bare Truck Weight, Rear 5,012 kg (11,050 lb)
- Estimated Final Weight with the Following Machine Configuration:

  NBT45-1 - 28,852 kg (63,608 lb)

  - 2/3 Sheave Block
  - Aluminum Decks and Ladders
  - 100 gal Fuel and Two People in Cab
  - Add 858 kg (1,891 lb) for 31/55 ft Jib, 637kg (1,405 lb) for Aux. Hoist with Rooster Sheave and Downhaul Weight.

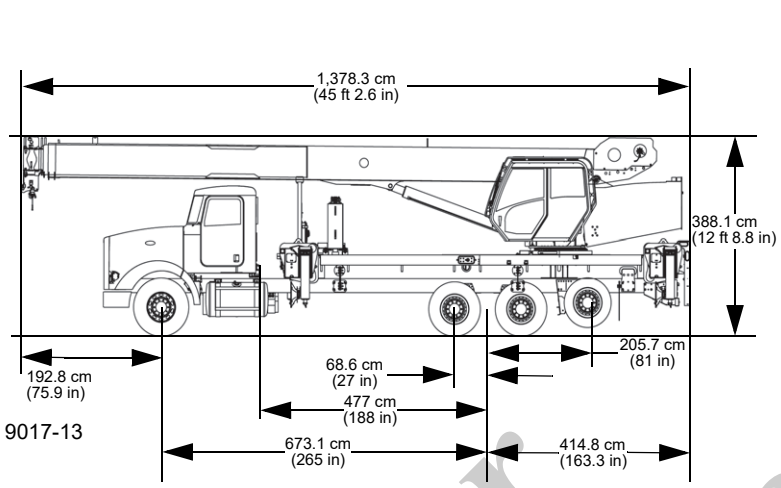
Figure 9-10 shows the 360-degree working area. See “Truck Frame Strength” on page 9-15 for the truck frame strength required for the mounting crane.

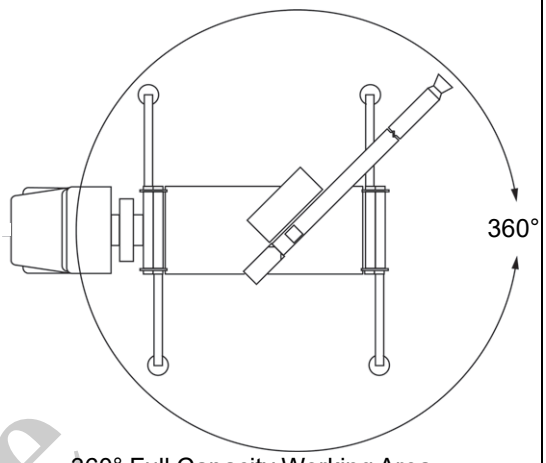
The gross vehicle weight rating (GVWR) is dependent on all components of the vehicle (axles, tires, springs, frame, etc.) meeting manufacturers' recommendations. Always specify the GVWR when purchasing trucks.

Diesel engines require a variable-speed governor and an energize-to-run fuel solenoid for smooth crane operation. Electronic fuel injection and a transmission neutral safety interlock switch are required.

NOTE: This configuration shows the 360-degree working area achieved with the EXTB torsion box option.

NBT45-1 Configuration — Extended Torsion Box and 161 ft Boom





360° Full Capacity Working Area

FIGURE 9-11

The mounting configuration for a crane with a 161 ft boom, extended torsion box, and tag axle is shown in Figure 9-11.

The complete unit must be installed on the truck in accordance with factory requirements. Installation must be tested to determine actual stability and counterweight requirements since individual truck chassis vary. Contact National Crane for details.

NOTE: If bare truck weights are not met, counterweights will be required.

Truck and crane mounting requirements:

- Working area 360°
- Gross Axle Weight Rating (GAWR), Front 9,072 kg (20,000 lb)
- Gross Axle Weight Rating (GAWR), Rear 20,865 kg (46,000 lb)
- Gross Vehicle Weight Rating 29,937 kg (66,000 lb)
- Gross Tag Axle Rating 5,987 kg (13,200 lb)
- Wheelbase (WB) 673 cm (265 in)
- Cab to Trunnion (CT) 477 cm (188 in)
- Tag Axle Location from Front Axle 878.8 cm (346 in)
- Frame Section Modulus (SM), Front Axle to End of AF 426 cm^3 (30 in^3)
- After-Frame (AF) 343 cm (135 in) (min)
- Bare Truck Weight, Front 4,336 kg (9,560 lb)
- Bare Truck Weight, Rear 4,990 kg (11,000 lb)
- Estimated Final Weight with the Following Machine Configuration:

  NBT45-1 - 29,208 kg (64,392 lb)

  - 2/3 Sheave Block
  - Aluminum Decks and Ladders
  - 100 gal Fuel and Two People in Cab
  - Add 858 kg (1,891 lb) for 31/55 ft Jib, 637 kg (1,405 lb) for Aux. Hoist with Rooster Sheave and Downhaul Weight.

Figure 9-11 shows the 360-degree working area. See “Truck Frame Strength” on page 9-15 for the truck frame strength required for the mounting crane.

The gross vehicle weight rating (GVWR) is dependent on all components of the vehicle (axles, tires, springs, frame, etc.) meeting manufacturers' recommendations. Always specify the GVWR when purchasing trucks.

Diesel engines require a variable-speed governor and an energize-to-run fuel solenoid for smooth crane operation. Electronic fuel injection and a transmission neutral safety interlock switch are required.

NOTE: This configuration shows the 360-degree working area achieved with the EXTB torsion box option.

PTO REQUIREMENTS

Horsepower

The PTO must meet the minimum requirements shown in hydraulic specifications. See “Specifications” on page 9-38.

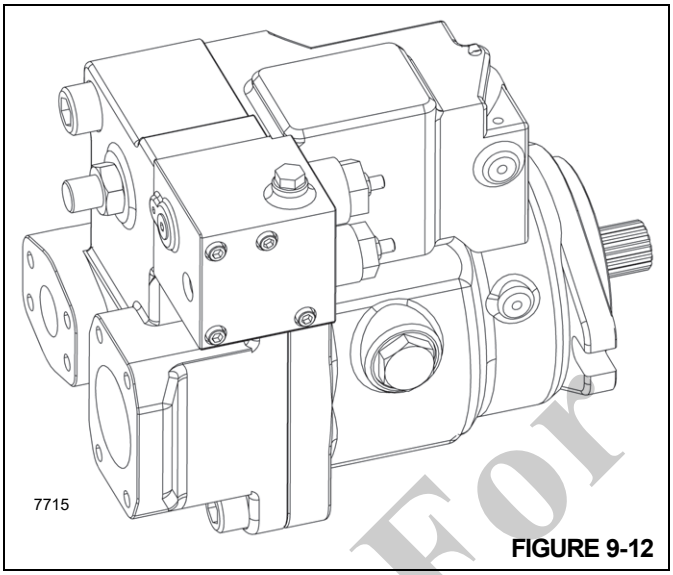


FIGURE 9-12

Direct PTO Mount

Most pump installations can be mounted directly to the PTO using adapter assemblies available from the PTO supplier. If the pump is mounted to the PTO, its weight must be supported by a strap between the pump and the transmission. The splined shaft coupling in a direct mount pump installation requires lubrication. A special multi-lube (#200S Silver Streak) is applied to the shaft during original installation and should be reapplied to the shaft on the PTO semi-annually thereafter.

PTO Ratio

Hydraulic pump shaft speed is determined by multiplying the truck engine rpm by the PTO ratio:

- Pump Shaft Speed = Truck Engine rpm x PTO Ratio
- For example: 2,000 x 1.10 = 2,200

The following PTO ratio and engine speed combinations provide the proper pump shaft speed, which is the recommended maximum rpm for the NBT40-1 hydraulic pump.

The engine must be operated within a specific rpm range to ensure the horsepower and torque developed is adequate to run the hydraulic pump under pressure to provide the required flow.

Select as slow as an engine speed as possible to reduce fuel usage, while ensuring PTO ratio does not exceed engine torque capacity especially at low engine speeds.

Table 9-1

Engine Optimum Speed Range (RPM)	PTO Ratio - 2200 RPM Pump
2,000	110%
1,800	122%
1,600	138%
1,500	147%

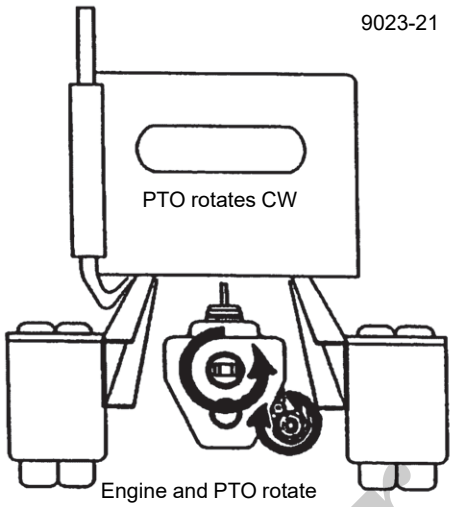
Pump Rotation

The hydraulic pump must be installed so that the pump rotates the same direction as the arrow on the pump housing. Make sure which direction the PTO 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.

CAUTION

Rotating the pump in the wrong direction damages the hydraulic pump.

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 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 CCW direction when viewed from the rear of the truck.



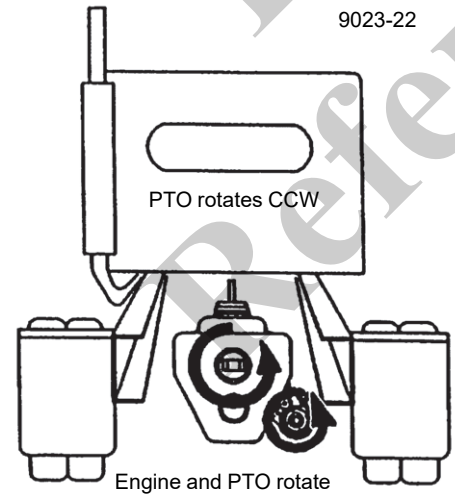


FIGURE 9-13

TRUCK FRAME STRENGTH

For a truck frame to be suitable for a NBT40-1 series crane, the truck frame must:

- Be rigid enough to allow excessive boom movement due to truck frame deflection when lifting over the front of the unit
- Be strong enough to resist the loading induced by the crane
- Not permanently bend or deform

The section modulus (SM), which determines the rigidity of the frame, is a measurement of the cross-sectional area of the truck frame. Resistance to bending moment (RBM) is a measurement of strength and is determined by multiplying the SM of each frame rail by the yield strength of the rail material.

The NBT40-1 series cranes require a minimum of 372,850 Nm (3,300,000 in-lb) RBM and 426 cm^3 (30 in^3) SM from the rear of the truck frame to the front of the front outrigger boxes.

The truck frame strength required from the front of the outrigger boxes to the single front outrigger (SFO) attachment point is variable and is listed in the table below.

Most truck frames have reduced section properties through the front suspension due to truck frame cut-outs or because outer channel reinforcement stops short of the front suspension. In these cases it is imperative that the truck frame is measured and the SM is calculated and compared to the table below to ensure adequate strength exists for front stabilizer loading.

The distances listed in Table 9-2 are shown in Figure 9-14.

Table 9-2

Distance From SFO Attachment cm (In)		Section Modulus (SM) Per Rail cm^3 (in^3)	
0 - 30	(0 - 12)	44	(2.7)
30 - 61	(12 - 24)	90	(5.5)
61 - 91	(24 - 36)	134	(8.2)
91 - 121	(36 - 48)	180	(11.0)
121 - 152	(48 - 60)	224	(13.7)
152 - 182	(60 - 72)	270	(16.5)
182 - 213	(72 - 84)	315	(19.2)
213 - 243	(84 - 96)	359	(21.9)
243 - 274	(96 - 108)	405	(24.7)
274 - 304	(108 - 120)	449	(27.4)
304 +	(120 +)	492	(30.0)

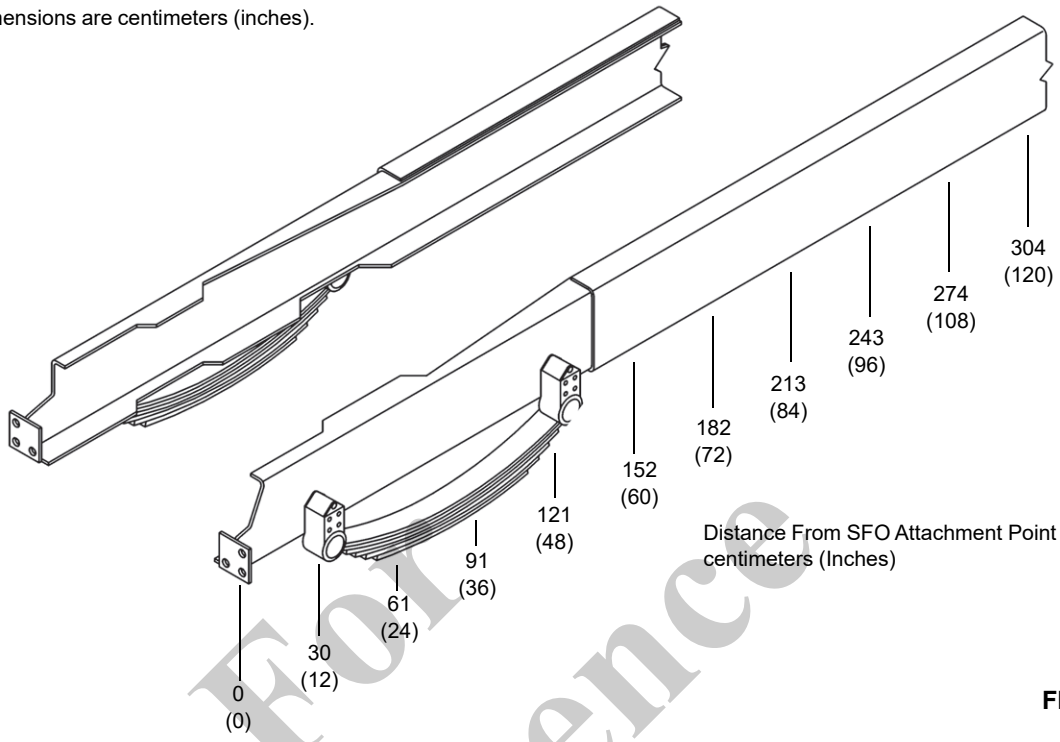


FIGURE 9-14

SECTION MODULUS TABLES

The following tables (A, B, C, and D) determine the section modulus (SM) of the truck frame. Measure the truck frame and check the tables to be sure that the truck factory listed SM is correct.

- **Channel (Table A on page 17)—**Table A provides the SM 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 SM from that particular channel.

  If the SM of the channel does not meet the requirements, the channel should be reinforced in the most applicable following method.

- **Channel Reinforcement (Table A on page 17)**—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 SM of the needed channel is obtained from Table A and should be added to the section modulus obtained from the truck frame. Add this to the section modulus of the channel obtained from Table A.

- **Angle Reinforcement (Table B on page 18)**—If the truck is reinforced with an angle, see 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.

- **Fish Plate Reinforcement (Table C on page 19)**—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.

- **Angle under Reinforcement (Table D on page 19)**—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 should be flush with the edges of the frame.

Welding - Two rows of 1 in (25.4 mm) diameter plug welds should be placed in a staggered pattern of the web. The rows should 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.

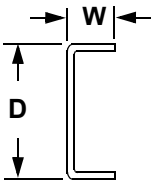


TABLE A
Section Modulus cm^3 (in^3)

Thickness 4.76 mm (3/16 in)					
D mm (in)	W mm (in)				
	64 (2.5)	76 (3)	89 (3.5)	102 (4)	
203 (8)	87 (5.3)	98 (6.0)	110 (6.7)	123 (7.5)	cm^3 (in^3)
229 (9)	103 (6.3)	116 (7.1)	130 (7.9)	143 (8.7)	
254 (10)	120 (7.3)	134 (8.2)	149 (9.1)	164 (10.0)	
279 (11)	138 (8.4)	154 (9.4)	170 (10.4)	187 (11.4)	
305 (12)	156 (9.5)	174 (10.6)	192 (11.7)	210 (12.8)	
330 (13)	177 (10.8)	195 (11.9)	215 (13.1)	234 (14.3)	
356 (14)	197 (12.0)	218 (13.3)	239 (14.6)	261 (15.9)	
381 (15)	220 (13.4)	241 (14.7)	264 (16.1)	287 (17.5)	

Thickness 6.35 mm (1/4 in)					
D mm (in)	W mm (in)				
	64 (2.5)	76 (3)	89 (3.5)	102 (4)	
203 (8)	6.9 (113)	7.8 (128)	8.8 (144)	9.7 (159)	cm^3 (in^3)
229 (9)	8.2 (134)	9.2 (151)	10.3 (169)	11.4 (187)	
254 (10)	9.5 (156)	10.7 (175)	11.9 (195)	13.1 (215)	
279 (11)	11.0 (180)	12.3 (202)	13.6 (223)	14.9 (244)	
305 (12)	12.5 (205)	13.9 (228)	15.3 (251)	16.8 (275)	
330 (13)	14.1 (231)	15.6 (256)	17.2 (282)	18.8 (308)	
356 (14)	15.8 (259)	17.5 (287)	19.1 (313)	20.8 (341)	
381 (15)	17.5 (287)	19.3 (316)	21.2 (348)	23.0 (377)	

Thickness 7.9 mm (5/16 in)					
D mm (in)	W mm (in)				
	64 (2.5)	76 (3)	89 (3.5)	102 (4)	
203 (8)	138 (8.4)	156 (9.5)	175 (10.7)	195 (11.9)	cm^3 (in^3)
229 (9)	164 (10.0)	185 (11.3)	206 (12.6)	228 (13.9)	
254 (10)	190 (11.6)	215 (13.1)	239 (14.6)	262 (16.0)	
279 (11)	220 (13.4)	246 (15.0)	272 (16.6)	300 (18.3)	
305 (12)	251 (15.3)	280 (17.1)	308 (18.8)	338 (20.6)	
330 (13)	284 (17.3)	315 (19.2)	346 (21.1)	379 (23.1)	
356 (14)	318 (19.4)	351 (21.4)	385 (23.5)	420 (25.6)	
381 (15)	354 (21.6)	390 (23.8)	426 (26.0)	464 (28.3)	

Thickness 9.5 mm (3/8 in)					
D mm (in)	W mm (in)				
	64 (2.5)	76 (3)	89 (3.5)	102 (4)	
203 (8)	161 (9.8)	184 (11.2)	205 (12.5)	228 (13.9)	cm^3 (in^3)
229 (9)	192 (11.7)	216 (13.2)	243 (14.8)	267 (16.3)	
254 (10)	223 (13.6)	252 (15.4)	280 (17.1)	308 (18.8)	
279 (11)	257 (15.7)	290 (17.7)	321 (19.6)	352 (21.5)	
305 (12)	295 (18.0)	329 (20.1)	364 (22.2)	398 (24.3)	
330 (13)	333 (20.3)	370 (22.6)	408 (24.9)	446 (27.2)	
356 (14)	374 (22.8)	415 (25.3)	456 (27.8)	497 (30.3)	
381 (15)	416 (25.4)	461 (28.1)	505 (30.8)	582 (35.5)	

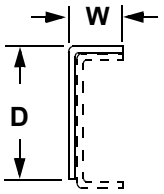


TABLE B
Section Modulus cm^3 (in^3)

Thickness 4.76 mm (3/16 in)					
D mm (in)	W mm (in)				
	70 (2.75)	83 (3.25)	95 (3.75)	108 (4.25)	
191 (7.5)	36 (2.2)	38 (2.3)	38 (2.3)	39 (2.4)	cm^3 (in^3)
216 (8.5)	46 (2.8)	48 (2.9)	49 (3.0)	49 (3.0)	
241 (9.5)	56 (3.4)	57 (3.5)	59 (3.6)	61 (3.7)	
267 (10.5)	67 (4.1)	70 (4.3)	72 (4.4)	74 (4.5)	
292 (11.5)	80 (4.9)	84 (5.1)	85 (5.2)	88 (5.4)	
318 (12.5)	95 (5.8)	98 (6.0)	100 (6.1)	103 (6.3)	
343 (13.5)	110 (6.7)	113 (6.9)	116 (7.1)	120 (7.3)	
368 (14.5)	124 (7.6)	129 (7.9)	133 (8.1)	136 (8.3)	

Thickness 6.35 mm (1/4 in)					
D mm (in)	W mm (in)				
	70 (2.75)	83 (3.25)	95 (3.75)	108 (4.25)	
191 (7.5)	48 (2.9)	49 (3.0)	51 (3.1)	52 (3.2)	cm^3 (in^3)
216 (8.5)	61 (3.7)	62 (3.8)	64 (3.9)	66 (4.0)	
241 (9.5)	74 (4.5)	77 (4.7)	79 (4.8)	82 (5.0)	
267 (10.5)	90 (5.5)	93 (5.7)	95 (5.8)	98 (6.0)	
292 (11.5)	106 (6.5)	110 (6.7)	113 (6.9)	116 (7.1)	
318 (12.5)	124 (7.6)	129 (7.9)	133 (8.1)	136 (8.3)	
343 (13.5)	144 (8.8)	149 (9.1)	154 (9.4)	157 (9.6)	
368 (14.5)	166 (10.1)	172 (10.5)	175 (10.7)	180 (11.0)	

Thickness 7.9 mm (5/16 in)					
D mm (in)	W mm (in)				
	70 (2.75)	83 (3.25)	95 (3.75)	108 (4.25)	
191 (7.5)	59 (3.6)	61 (3.7)	64 (3.9)	66 (4.0)	cm^3 (in^3)
216 (8.5)	75 (4.6)	77 (4.7)	80 (4.9)	82 (5.0)	
241 (9.5)	92 (5.6)	95 (5.8)	98 (6.0)	102 (6.2)	
267 (10.5)	111 (6.8)	116 (7.1)	120 (7.3)	123 (7.5)	
292 (11.5)	133 (8.1)	138 (8.4)	141 (8.6)	146 (8.9)	
318 (12.5)	156 (9.5)	161 (9.8)	166 (10.1)	170 (10.4)	
343 (13.5)	180 (11.0)	187 (11.4)	192 (11.7)	197 (12.0)	
368 (14.5)	206 (12.6)	213 (13.0)	220 (13.4)	224 (13.7)	

Thickness 9.5 mm (3/8 in)					
D mm (in)	W mm (in)				
	70 (2.75)	83 (3.25)	95 (3.75)	108 (4.25)	
191 (7.5)	70 (4.3)	74 (4.5)	75 (4.6)	79 (4.8)	cm^3 (in^3)
216 (8.5)	90 (5.5)	93 (5.7)	97 (5.9)	98 (6.0)	
241 (9.5)	110 (6.7)	115 (7.0)	118 (7.2)	121 (7.4)	
267 (10.5)	133 (8.1)	138 (8.4)	143 (8.7)	146 (8.9)	
292 (11.5)	159 (9.7)	164 (10.0)	169 (10.3)	174 (10.6)	
318 (12.5)	185 (11.3)	1921 (1.7)	198 (12.1)	203 (12.4)	
343 (13.5)	215 (13.1)	223 (13.6)	229 (14.0)	234 (14.3)	
368 (14.5)	247 (15.1)	254 (15.5)	262 (16.0)	269 (16.4)	

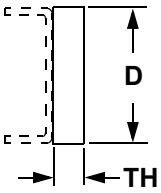


TABLE C
Section Modulus cm^3 (in^3)

TH mm (in)	D mm (in)									
	203 (8)	229 (9)	254 (10)	279 (11)	305 (12)	330 (13)	356 (14)	381 (15)	406 (16)	
4.76 (0.1875)	33 (2.0)	41 (2.51)	51 (3.10)	61 (3.75)	73 (4.46)	86 (5.24)	100 (6.08)	114 (6.98)	130 (7.94)	
6.35 (0.25)	44 (2.66)	55 (3.37)	68 (4.16)	82 (5.03)	98 (5.99)	115 (7.03)	134 (8.15)	153 (9.36)	172 (10.5)	
7.94 (0.3125)	55 (3.33)	69 (4.21)	85 (5.20)	103 (6.29)	123 (7.49)	144 (8.79)	167 (10.19)	192 (11.7)	218 (13.31)	**cm^3 (in^3)**
9.52 (0.375)	66 (4.0)	83 (5.06)	102 (6.25)	124 (7.56)	148 (9.00)	173 (10.56)	201 (12.25)	230 (14.06)	262 (16.0)	
11.11 (0.4375)	76 (4.67)	97 (5.9)	119 (7.29)	144 (8.82)	172 (10.5)	202 (12.32)	234 (14.29)	269 (16.4)	306 (18.66)	

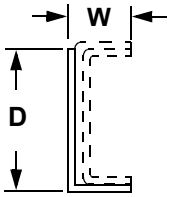


TABLE D
Section Modulus cm^3 (in^3)

Thickness 4.76 mm (0.1875 in)					
D mm (in)	W mm (in)				
	76 (3)	89 (3.5)	102 (4)	114 (4.5)	
216 (8.5)	5.7 (93)	105 (6.4)	115 (7.0)	126 (7.7)	cm^3 (in^3)
241 (9.5)	110 (6.7)	121 (7.4)	133 (8.1)	146 (8.9)	
267 (10.5)	126 (7.7)	139 (8.5)	152 (9.3)	166 (10.1)	
292 (11.5)	144 (8.8)	159 (9.7)	174 (10.6)	187 (11.4)	
318 (12.5)	164 (10.0)	179 (10.9)	195 (11.9)	210 (12.8)	
343 (13.5)	184 (11.2)	200 (12.2)	216 (13.2)	234 (14.3)	
368 (14.5)	205 (12.5)	223 (13.6)	239 (14.6)	257 (15.7)	
394 (15.5)	226 (13.8)	246 (15.0)	264 (16.1)	284 (17.3)	

Thickness 6.35 mm (0.25 in)					
D mm (in)	W mm (in)				
	76 (3)	89 (3.5)	102 (4)	114 (4.5)	
216 (8.5)	126 (7.7)	141 (8.6)	154 (9.4)	169 (10.3)	cm^3 (in^3)
241 (9.5)	149 (9.1)	164 (10.0)	179 (10.9)	195 (11.9)	
267 (10.5)	172 (10.5)	188 (11.5)	205 (12.5)	223 (13.6)	
292 (11.5)	195 (11.9)	215 (13.1)	233 (14.2)	252 (15.4)	
318 (12.5)	221 (13.5)	241 (14.7)	262 (16.0)	282 (17.2)	
343 (13.5)	249 (15.2)	2701 (6.5)	292 (17.8)	315 (19.2)	
368 (14.5)	277 (16.9)	300 (18.3)	323 (19.7)	347 (21.2)	
394 (15.5)	306 (18.7)	331 (20.2)	356 (21.7)	382 (23.3)	

Thickness 7.9 mm (0.3125 in)					
D mm (in)	W mm (in)				
	76 (3)	89 (3.5)	102 (4)	114 (4.5)	
216 (8.5)	161 (9.8)	177 (10.8)	195 (11.9)	211 (12.9)	cm^3 (in^3)
241 (9.5)	188 (11.5)	206 (12.6)	226 (13.8)	246 (15.0)	
267 (10.5)	218 (13.3)	238 (14.5)	259 (15.8)	280 (17.1)	
292 (11.5)	247 (15.1)	271 (16.5)	295 (18.0)	318 (19.4)	
318 (12.5)	280 (17.1)	305 (18.6)	331 (20.2)	356 (21.7)	
343 (13.5)	315 (19.2)	341 (20.8)	369 (22.5)	397 (24.2)	
368 (14.5)	351 (21.4)	379 (23.1)	408 (24.9)	438 (26.7)	
394 (15.5)	388 (23.7)	418 (25.5)	449 (27.4)	482 (29.4)	

Thickness 9.5 mm (0.375 in)					
D mm (in)	W mm (in)				
	76 (3)	89 (3.5)	102 (4)	114 (4.5)	
216 (8.5)	195 (11.9)	216 (13.2)	14.4 (236)	256 (15.6)	cm^3 (in^3)
241 (9.5)	229 (14.0)	251 (15.3)	16.7 (274)	297 (18.1)	
267 (10.5)	266 (16.2)	290 (17.7)	19.2 (315)	339 (20.7)	
292 (11.5)	302 (18.4)	329 (20.1)	21.8 (357)	385 (23.5)	
318 (12.5)	342 (20.9)	370 (22.6)	24.5 (402)	431 (26.3)	
343 (13.5)	384 (23.4)	415 (25.3)	27.3 (447)	480 (29.3)	
368 (14.5)	426 (26.0)	461 (28.1)	495 (30.2)	531 (32.4)	
394 (15.5)	472 (28.8)	31.0 (508)	546 (33.3)	583 (35.6)	

TRUCK PREPARATION

Plan the installation thoroughly before any work is done. Plan the location of the crane on the truck frame for the final front and rear axle weights and boom overhang.

Check the final weight to verify that the final truck weight with crane, reinforcement, counterweight, and options such as jib, etc., are compliant with the appropriate laws.

Welding Precautions

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

- Disconnect the truck battery cables (positive and negative)
- Attach the welding ground lead as closely as possible to the area to be welded

Positioning the Crane on the Truck

The installer of the crane must be familiar with state axle and length laws in force at the time the crane is mounted on the truck. The following items must be considered.

- **Overall Length**—Most states have a maximum straight truck length limit of 12 m (40 ft). Using too long a WB truck could cause the unit to exceed this limit.
- **Axle Weights**—Most states allow 20,000 lb (9,072 kg) single axle weight and 15,422 kg (34,000 lb) tandem axle weights on primary roads. However, some states restrict the axle weight to less on secondary roads or at certain times throughout the year. Be aware of your state's axle laws for weight restrictions.
- **Overhang**—The most restrictive overhang laws call for a maximum of three feet in front of the truck. Check your state requirements.
- **Federal Bridge Law**—The Federal Bridge Law in effect currently states that in order to carry 26,308 kg (58,000 lb) on a four-axle truck, the extremes of any group of axles must be at least 732 cm (24 ft) apart.

PTO, Pump, and Reservoir

1. Select the PTO according to the *PTO Requirements Section*. See "PTO Requirements" on page 9-14. PTO's are not furnished by National Crane.
2. Install the PTO and PTO shifting mechanism according to the PTO manufacturer's instructions. If the PTO has a reverse gear, it must be disabled to prevent operating the pump in the wrong direction.

CAUTION

Rotating the pump in the wrong direction damages the pump.

3. If PTO integral mount flanges are being used, the pump can be mounted directly to the PTO. Make sure there is adequate clearance for this type of pump mount. Sometimes space is limited and the pump is powered through a driveline. The maximum length and angle of the driveline should not exceed the manufacturers recommendations. The U-joint yokes on both ends of the driveline must be parallel with each other. Drivelines should be sized so they can safely carry the maximum pump horsepower requirements. See "PTO Requirements" on page 9-14. Drivelines are not furnished by National Crane.
4. Plan the location of the pump mounting bracket and driveline so that ample clearance is maintained between the pump and truck drive shaft and/or exhaust system. Position the pump so that the hydraulic lines can be connected without sharp bends, especially the large suction line. The pump mounting brackets can be attached to existing frame crossmembers or a 15.25 cm (6 in) channel crossmember can be installed.

NOTE: Some of the pipe fittings used are sealed by means of two threaded tapered sections, one male and one female. When these two tapered threads meet, a sudden increase in the force required to screw the fittings together will be felt. 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 (ORB) type. These are installed by first screwing the lock nut flush to the upper thread land and installing the fitting into the port until the nut makes contact with the surface of the port. Adjust the fitting to the desired direction and tighten the locknut.

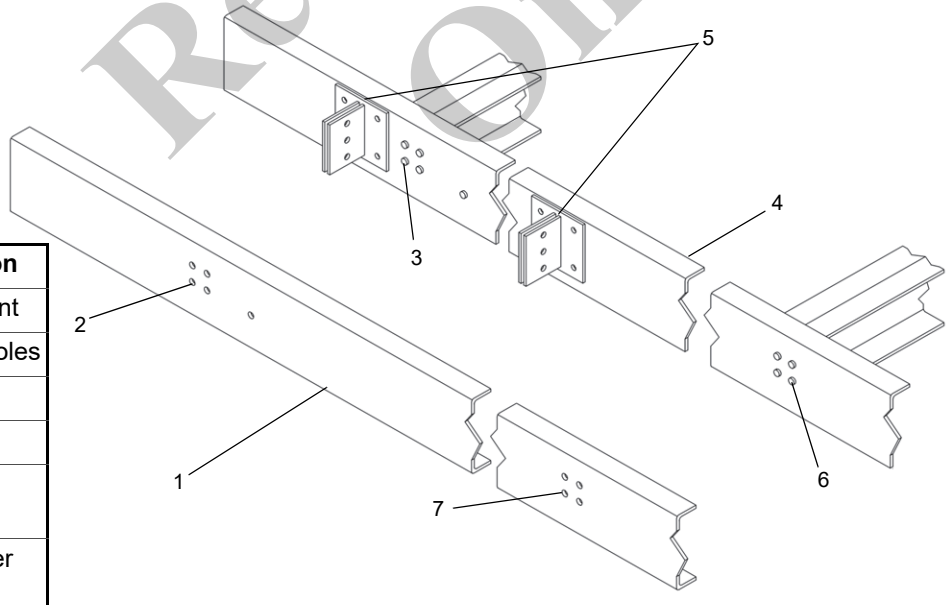
Most pressure fittings are the O-ring face seal (ORFS) type. A small O-ring is compressed between the male and female fittings of the joint. Make sure the O-ring is present on the male fitting and seated properly in its groove before the fittings are assembled and tightened.

5. 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 indicated by the arrow on the pump. If needed, rotate the pump in the mounting bracket so the suction side is toward the reservoir suction port.

6. If using a drive shaft type of mount, connect the PTO drive shaft to the pump and PTO. Drill a 7.9 mm x 3 mm (0.31 in dia. x 0.12 in) deep hole on the flat of the hex shaft at the fixed yoke end of the drive shaft to engage the yoke setscrew. A small flat area should be ground in the O.D. of the splined pump shaft to engage the pump yoke setscrew. Apply Loctite® and tighten the shaft setscrews. Apply grease to the PTO universal joints.

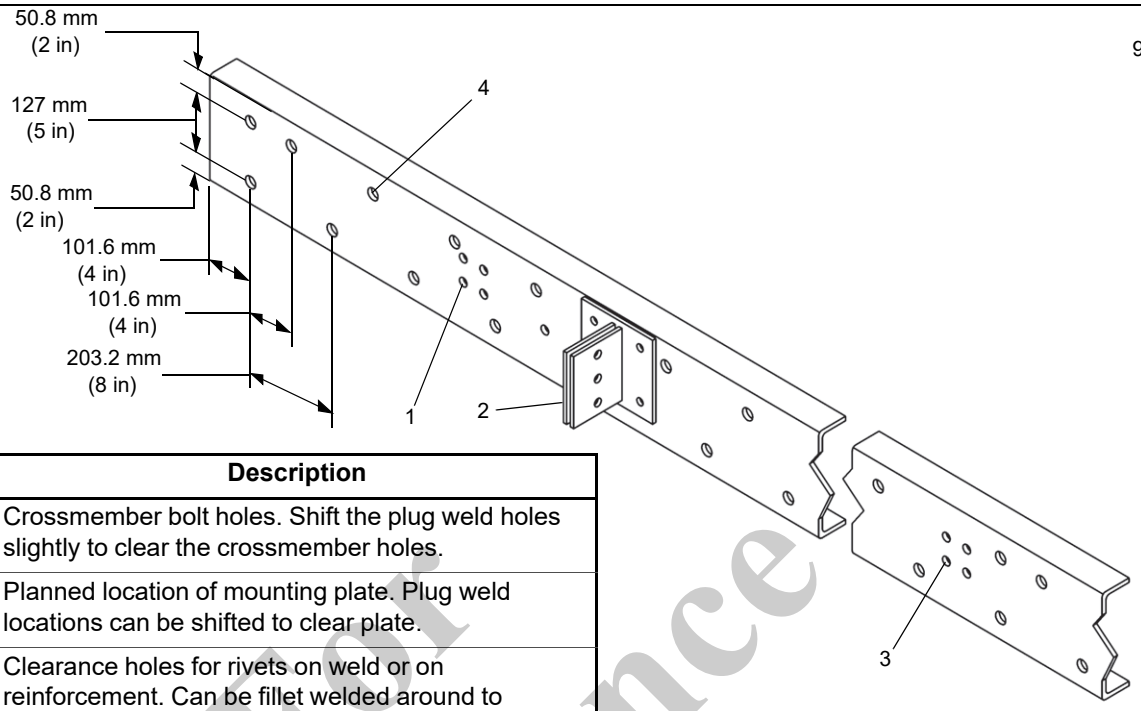
REINFORCEMENT AFTER-FRAME EXTENSION

1. See Truck Frame Strength and Section Modulus Tables. Determine the section modulus by measuring the truck frame. If reinforcing is required, always use at least 689 MPa (100,000 psi) 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 remove any rivets.*
3. If rivets are used to secure truck frame cross members, place the reinforcement (1, Figure 9-15) on the truck frame (4) and clamp in place.
   a. Mark the location of rivets (3) by striking the outside of the reinforcement over the rivet area with a hammer so that the rivets make an impression on the inside of the reinforcement.
   b. Mark the approximate location of the crane mounting anchors (5) on the reinforcement so that no obstructions exist.
   c. Remove the reinforcement and cut clearance holes (2) for the rivets.
4. If reinforcement is to be welded to the truck frame (4), remove the crossmember bolts (6).
   a. Place the reinforcement on the truck frame (4). Mark the existing truck frame hole pattern onto the reinforcing and then remove the reinforcement.
   b. Using the markings, cut the hole pattern in the reinforcing (1). Be sure to clear the crane mounting anchors (5).
5. Clamp the reinforcement in place on the truck frame (4), install crossmember bolts (6) that were previously removed, and weld to the truck frame as shown in Figure 9-16.
6. If bolt-on reinforcing is required, clamp the reinforcing in place and install crossmember bolts (6) into the holes that were previously removed.
   a. Drill through the reinforcement and truck frame. Make sure to clear the crane mounting anchors (5) and bolt the reinforcing in place.
   b. See Figure 9-17 for recommended drilling and bolting locating dimensions. Use 5/8 in Grade 8 bolts, drill holes (7) to 15.5 mm (39/64 in) diameter, drive fit bolts, and torque according to the torque chart in “Fasteners and Torque Values” on page 1-7.



Item	Description
1	Reinforcement
2	Clearance Holes
3	Rivets
4	Truck Frame
5	Mounting Anchors
6	Crossmember Bolts
7	Holes

FIGURE 9-15



Item	Description
1	Crossmember bolt holes. Shift the plug weld holes slightly to clear the crossmember holes.
2	Planned location of mounting plate. Plug weld locations can be shifted to clear plate.
3	Clearance holes for rivets on weld or on reinforcement. Can be fillet welded around to eliminate plug weld holes.
4	25.4 mm (1 in) diameter holes for plug welds

FIGURE 9-16

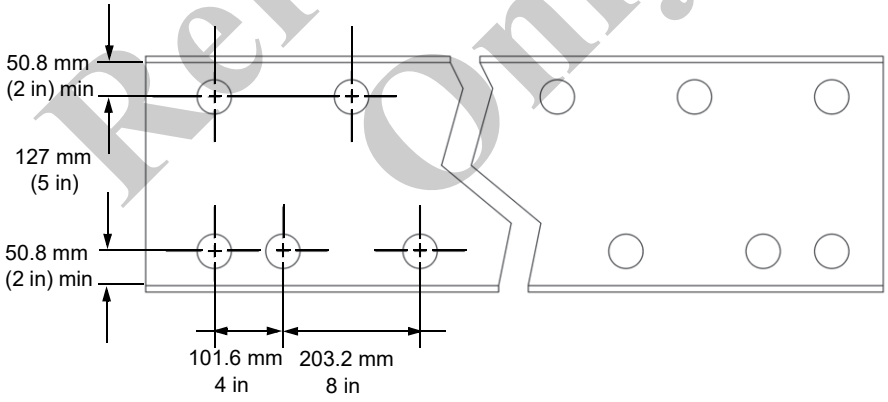
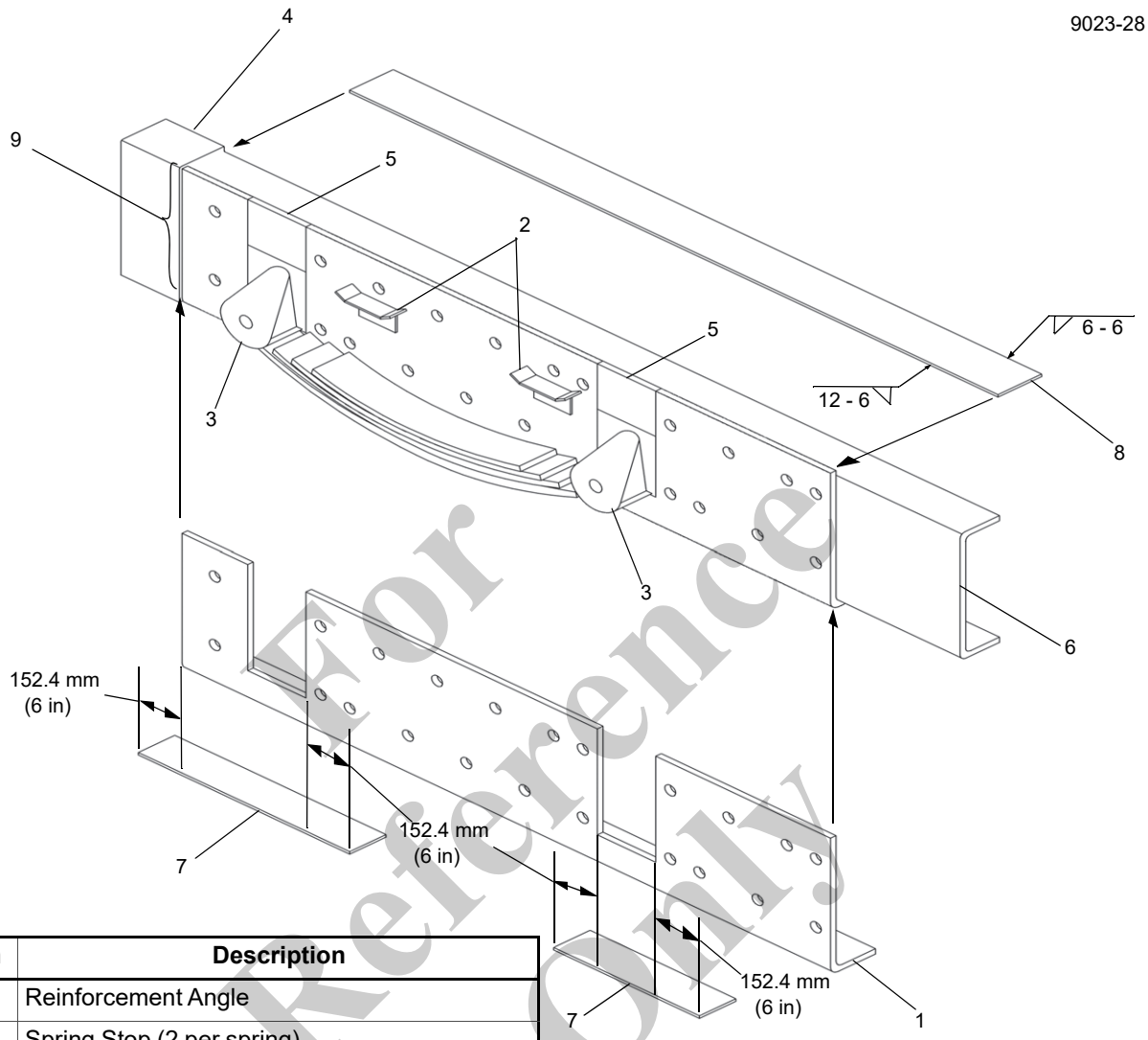


FIGURE 9-17



Item	Description
1	Reinforcement Angle
2	Spring Stop (2 per spring)
3	Spring Hangers (4 per spring)
4	Reinforcing Under Crane
5	Cut Out Reinforcement Pieces (quantity varies)
6	Existing Truck Frame
7	Lower Reinforcement Bar
8	Upper Reinforcement Bar
9	Butt Weld

FIGURE 9-18

7. If the frame through the rear suspension does not meet the minimum specifications for RBM and section modulus, it can be reinforced by adding a reinforcing angle as shown in Figure 9-18.

NOTE: See Section Modulus Table B on page 18 for the required size of the reinforcement angle.

a. Strip all easily removable equipment such as spring stops (2) from the frame.

b. Place the reinforcement angle (1) up against the reinforcement under the crane (4) reinforcement. Mark the areas that require cutting so that the reinforcing angle slides up around the spring hangers (3) and against the existing truck frame (6) and forward reinforcement.

c. Cut out the marked areas in the long leg of the reinforcement angle as deep as necessary. Install the reinforcement angle up from the underside of the existing truck frame to contact either the existing truck frame (6, Figure 9-18) bottom or spring hanger brackets, if they extend down below the existing truck frame.

8. If the reinforcement angle is welded to the truck frame, cut out the plug weld hole pattern as shown in Figure 9-16. and install onto the existing truck frame.

a. Slide the reinforcement angle (1) up from the bottom, place it up to the reinforcement under the crane (4), and butt weld (9) the reinforcement angle to the reinforcement under the crane.

b. Replace as much of the spring hanger cut-out areas as possible. Use the drop-off material from the cut-out (step 7), and butt weld these pieces in place.

c. Position the upper reinforcement bar (8) on top of the existing truck frame and skip weld as shown in Figure 9-18.

9. If the reinforcement angle is to be bolted on, drill the hole pattern according to Figure 9-17 and install bolts.

a. Reinforce the spring hanger cut-outs (5, Figure 9-18) and the weld area, by installing and welding the reinforcement bars (7 and 8) in place.

b. The bars should be of the same thickness, width, and yield strength as the reinforcement angle lip. The bar (7) should be long enough to extend at least 152 mm (6 in) past either side of the weld or cut-out areas. Weld these reinforcement bars to the reinforcement angle with lengthwise welds. Do not weld across the flanges.

c. Replace any equipment that had been removed.

10. Measure the after-frame of the existing truck frame.

NOTE: The required after-frame is dependent on the location of the crane on the truck chassis. See the mounting configuration section for suggested layouts.

a. Calculate the weight distribution of the complete machine in order to determine where the crane center of rotation is in relationship to the center of the rear axles. The after-frame must extend a minimum of 196 cm (77 in) behind the centerline of crane rotation. If the AF is too long, cut off the excess and remove any crossmembers from the back of the truck frame.

b. If the AF is too short, the frame needs to be lengthened. Use channels fabricated from 689 MPa (100,000 psi) 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 30 cm (12 in) on each side of the 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.

MOUNTING THE CRANE

DANGER

It is mandatory that swing bearing and T-box attaching bolts be inspected and re-torqued after the first 300 hours of crane operation and every 500 hours thereafter. The bolts may loosen and cause the crane to separate from the carrier which will result in damage to the crane and possible injury or death to personnel.

Make sure the truck has been configured to meet the minimum truck, PTO, and frame strength requirements as described previously in this section. Mount the crane to the truck frame is as follows. See Figure 9-19 for the following steps.

NOTE: All welds used to secure the crane to the truck frame must be AWS grade 90 or better.

1. Place the crane assembly on the truck frame. See “Positioning the Crane on the Truck” on page 9-21.

2. Install and weld the two front upper mounting plates (1, View D) and the two center upper mounting plates (4, View E) to the T-box frame (8).

3. Install two anchor bars (2, View A) to each left and right side front upper mounting plate.

4. Install one anchor bar (2, View B) to each left and right center upper mounting plate.

5. Install the lower mounting plates (3) to the anchor plates. Install the capscrews and nuts finger tight.

6. Align and position each lower mounting plate (3, View A and View B) directly below the upper mounting plates. Drill four 5/8 in holes through each lower mounting plate through the truck frame (7) using the existing holes (5) in the lower mounting plate to locate holes in the truck frame.

See Figure 9-20 for the following steps.

NOTE: Position the rear strap plate with the bend in the plate inward or outward depending on the width of the truck frame.

7. Locate and weld the rear strap plate (7 View F) and collar plate (9, View F) to the T-box frame (8). See Figure 9-20 for locater dimensions and weld requirements.

8. Cut the cross bar (11, View G) to fit inside the truck frame, making sure to include the width of the two end plates (12).

9. Weld the two end plates to the cross bar.

10. Position the welded cross bar assembly to the truck frame, in the center of both strap plates (6), and tack weld it to the truck frame.

11. Use the existing bolt holes (10, View F) in the rear strap plate as a template to locate and drill four 5/8 in. holes in the tuck frame and through the end plates.

12. Install eight 5/8 in x 2.75 in capscrews, flatwashers, and nuts. Tighten the nuts to the specification. See “Fasteners and Torque Values” on page 1-7.

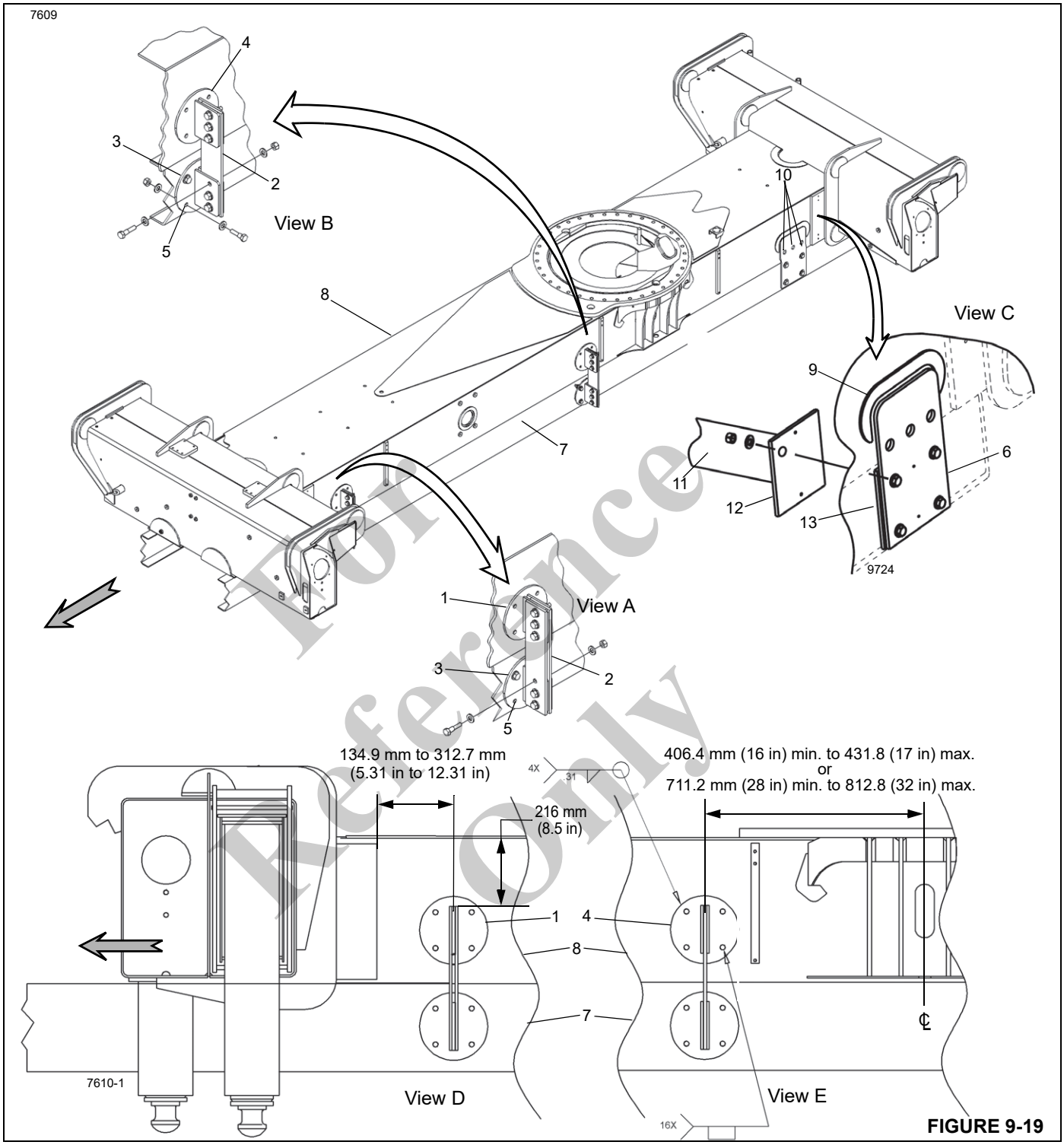


FIGURE 9-19

Item	Description
1	Front Upper Mounting Plate (2 used)
2	Anchor Bar (8 used)
3	Lower Mounting Plate Hole
4	Center Upper Mounting Plate (2 used)
5	Lower Mounting Plate Hole
6	Rear Strap Plate (2 used)

Item	Description
7	Truck Frame
8	T-box Frame
9	Collar Plate (2 used)
10	Rear Strap Plate Hole
11	Cross Bar
12	End Plates (2 used)
13	Spacer

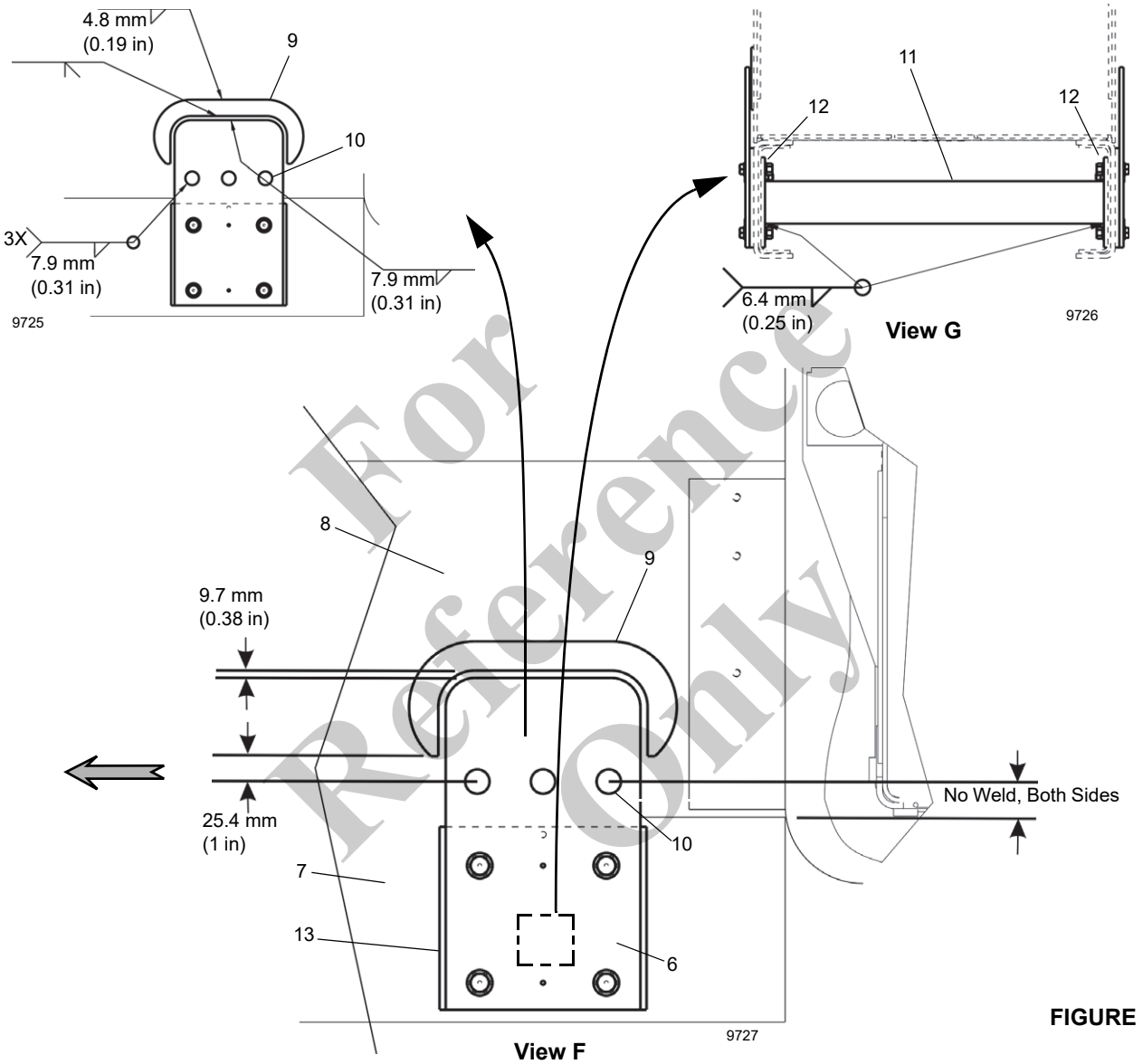


FIGURE 9-20

Item	Description
1	Front Upper Mounting Plate (2 used)
2	Anchor Bar (8 used)
3	Lower Mounting Plate Hole
4	Center Upper Mounting Plate (2 used)
5	Lower Mounting Plate Hole
6	Rear Strap Plate (2 used)

Item	Description
7	Truck Frame
8	T-box Frame
9	Collar Plate (2 used)
10	Rear Strap Plate Hole
11	Cross Bar
12	End Plates (2 used)
13	Spacer

Truck Interface Electrical Connection

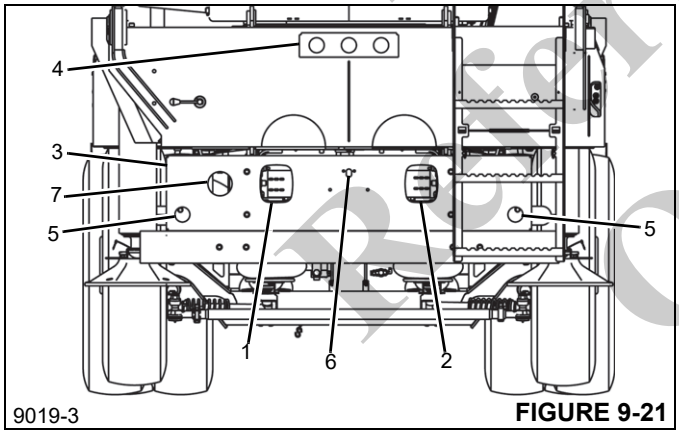
See Figure 9-21 for the following steps.

Make the required electrical connections between the crane and the truck using the following procedures and information.

NOTE: The following electrical installation is based on a Cummins ISB, ISX, ISC, or ISL engine installation. Contact National Crane for electrical connections on trucks with engines other than the models shown above.

1. Working at the rear of the truck, install the left brake/tail light assembly (1) and right brake/tail light assembly (2) in the light cover plate (3). Splice the marker light wire 1403 into the truck tail light wire located in the truck rear lighting harness using a butt connector with heat shrink to connect the rear marker lamps (4), triple marker lamps (5), and license plate lamp (6). Secure loose wires with wire ties.

2. Splice the back-up/motion alarm wire 28 into the reverse light wire in the truck rear lighting harness using a butt connector with heat shrink. Install the back-up/motion alarm (7) in the light cover plate. Secure loose wires with wire ties.



9019-3 **FIGURE 9-21**

See Figure 9-22 for the following steps.

NOTE: Wire 52 must be installed to the starter solenoid, not to the truck key switch.

3. Connect wire 52 (crane start signal) to the starter solenoid on the engine side of the firewall.

4. Route wire 112 (truck acc signal) of the crane main wire harness (x) through the truck's firewall, and into the truck cab behind the dashboard (x). Connect wire 112 to the ignition wire at the key switch.

NOTE: If two ignition wires are present at the key switch, wire 901 must be connected to both wires.

5. Route wire 901 (crane ignition signal) of the crane main wire harness through the truck's firewall, and into the truck cab behind the dashboard. Install socket 7826000087 onto wire 901 and install it into plug 7709000815 cavity 2. Install socket 7826000087 and install it into plug cavity 1. Splice the wire from cavity 1 and the red wire 142259 into the wires at the key switch. Route the red wire out through the truck cab firewall.

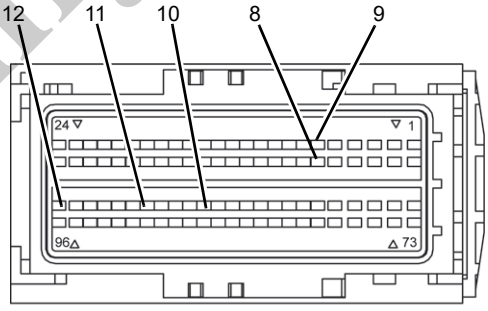
6. Splice the remote throttle ground wire 475 into the wire present at pin 32 (8) of ECM connector J2 using a butt connector with heat shrink.

7. Splice the remote throttle +5V power wire 473 into the wire present at pin 08 (9) of ECM connector J2 using a butt connector with heat shrink.

8. Remove the wire present at pin 63 (10) of ECM connector J2 and secure it to the J2 wire harness. Install terminal 80055236 onto the remote throttle signal wire 474. Insert the connector and wire into pin 63 cavity of ECM connector J2.

NOTE: Wires 477, 478, and 479 (not shown) are not used when the remote TPS is wired directly to the ECM. Wires must be stowed and secured in the T-box harness.

9. If present, remove the wire at pin 67 (11) of ECM connector J2 and secure it to the J2 wire harness. Install terminal 80055236 to the orange throttle activation wire. Insert the terminal and orange throttle activation wire into pin 67 cavity of ECM connector J2.



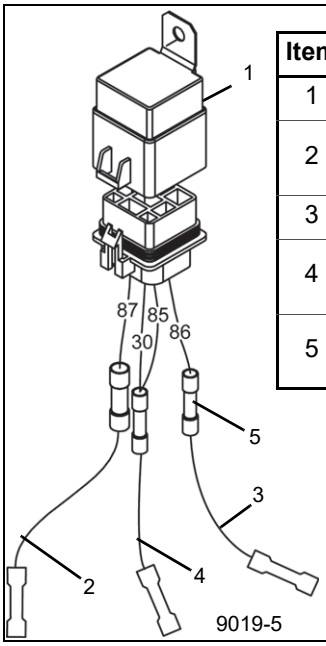
9019-2

Item	Description
8	Remote Throttle Ground Wire 475
9	Remote Throttle +5V Power Wire 473
10	Remote Throttle Signal Wire 474
11	Orange Throttle Activation Wire
12	Engine Warning Indication Wire

FIGURE 9-22

9

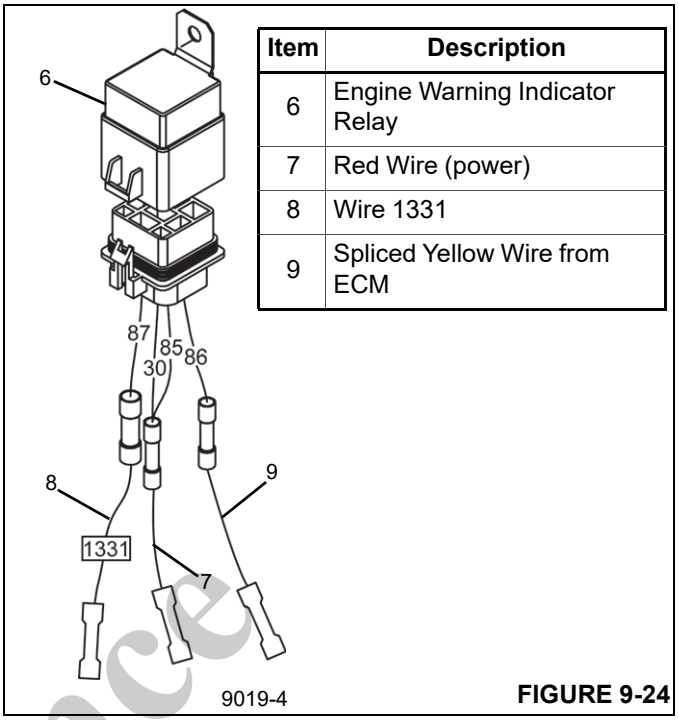
10. Install the throttle activation relay (1, Figure 9-23) to the engine side of the firewall. Connect the orange throttle activation wire (2) to terminal 87 of the relay. Splice the power feed wire (3) from terminal 86 of the relay to wire 901. Splice the orange PTO indicator wire (4) into the PTO indication circuit and connect it to terminals 85 and 30 of the relay. All splices must be made using a butt connector with heat shrink (5).



Item	Description
1	Throttle Activation Relay
2	Orange Throttle Activation Wire
3	Power Feed Wire
4	Orange PTO Indicator Wire
5	Heat Shrink Butt Connector

FIGURE 9-23

11. Install the engine warning indicator relay (6, Figure 9-24) to the engine side of the firewall. Route the red wire(7) that was spliced into wire 901 in step 5 through the truck's firewall and connect it to terminals 30 and 85 of the relay. Connect wire 1331 (8) to terminal 87 of the engine warning indicator relay. Splice the yellow wire (9) into the wire present at pin 72 (12, Figure 9-22) of ECM connector J2 and connect the free end to terminal 86 of the engine warning indicator relay. All splices must be made using a butt connector with heat shrink



Item	Description
6	Engine Warning Indicator Relay
7	Red Wire (power)
8	Wire 1331
9	Spliced Yellow Wire from ECM

FIGURE 9-24

J1939 Connection

The following is based on J1939 CAN system found in Kenworth and Peterbilt (PACCAR) trucks.

NOTE: If the crane is equipped with the A92.2 option, the jack definition module must be interfaced with the truck's engine ECM through the J1939 CAN. If the crane is not equipped with the A92.2 option, skip ahead to step 22.

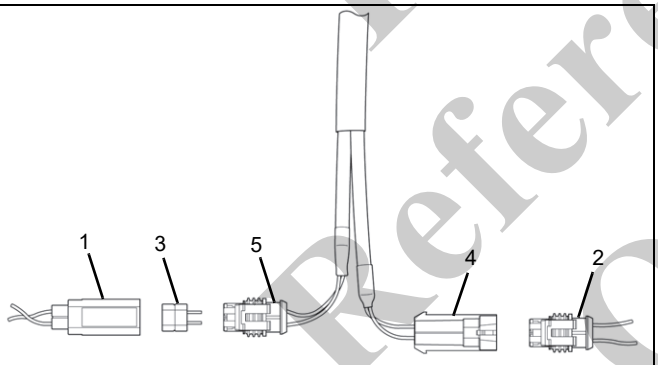
The location of the J1939 CAN terminating resistors in the following steps are based on the J1939 CAN system found in Kenworth and Peterbilt trucks. Locations of terminating resistors vary between truck manufacturers. Typically, one termination resistor is located in the dashboard or by the electrical distribution panel, and a second termination resistor is near the ECM. Consult the truck manufacturer or truck service literature for J1939 termination resistor locations.

1. Route the J1939 cable to the desired connection point on the truck.

2. Locate the J1939 connection. Look for a long blue connector housing.

See Figure 9-25 for the following steps.

3. Disconnect the male J1939 connector (1) from the female J1939 connector (2) and save the terminating resistor (3) inside the male connector.
4. Connect the female J1939 connector to the male jumper connector (4).
5. Make sure that the terminating resistor is reinstalled in the male J1939 connector and install the female jumper connector (5) into the male J1939 connector.
6. Connect the crane J1939 connector to the J1939 jumper harness.
7. Remove the terminating resistor located on the right side inside the panel from the crane frame. Using a multimeter, test for 60 ohms of resistance across wires 1289 and 1290.
   - If 60 ohms is present, remove the terminating resistor from the crane frame and install a blank 3 pass plug.
   - If 120 ohms is present, reinstall the terminating resistor in the crane frame.
8. If there is a different resistance reading, contact Manitowoc Crane Care for more information.

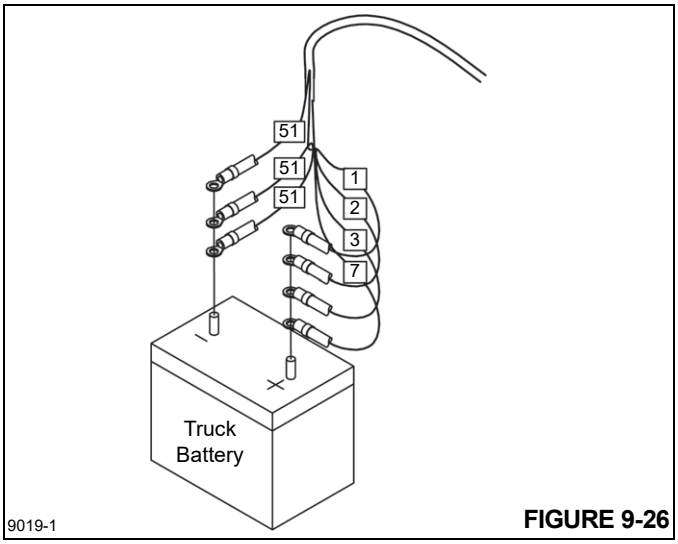


Item	Description
1	Male J1939 Connector
2	Female J1939 Connector
3	Terminating Resistor
4	Male Jumper Connector
5	Female Jumper Connector

9019-6 **FIGURE 9-25**

See Figure 9-26 for the following steps.

9. Connect the power wires (1, 2, 3, and 7) to the positive terminal of the battery.
10. Connect the ground wires (51) to the negative terminal of the truck battery.



9019-1 **FIGURE 9-26**

11. Using Cummins INSITE®, change the following parameters in the ECM using the information in the table below.

Cummins INSITE® Remote Throttle Parameters

Heading	Parameter	New Value
Remote Accelerator Pedal or Lever	Remote Accelerator Pedal or Lever	Enable
Remote Accelerator Pedal or Lever	Remote Accelerator Pedal or Lever Mode	Remote Accelerator Pedal with Transition Verification
Vehicle Speed Source	Maximum Engine Speed without VSS	Maximum PTO Engine RPM
Governor Type	Governor Type	Variable Speed 1

Hydraulic Pump Connection

CAUTION

Make sure the gate valve on the return line is open before starting the engine and engaging the pump or damage to the pump could result.

See Figure 9-27 for the following steps.

The hydraulic system pressure is supplied by a hydraulic pump (1, Figure 9-27) mounted on the truck power take-off (PTO) (8).

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 hydraulic pump is powered through a driveline, a pump mount must be installed or bolt the pump to an existing frame crossmember.
3. A mounting bracket needs to be installed so that the rear mounting bracket on the pump can be secured.

4. Make sure the driveline meets the minimum requirements for maximum pump horsepower. See “Specifications” on page 9-38.
5. Do not locate the hydraulic pump more than 107 cm (42 in) from the PTO. Do not exceed a 7° driveline angle, and make sure the U-joints on both ends of the drive shaft are parallel with each other.
6. Plan the location of the hydraulic pump mount and driveline for adequate clearance between the hydraulic 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 hydraulic pump mount to the truck frame.
9. Lubricate the splines on the hydraulic pump shaft. See “Lubrication” on page 8-1 for more information.
10. If using the configuration shown in Figure 9-27 be sure to position the case drain port (2) at the highest point above ground level.
11. Attach the pump mounting flange to the PTO or to the hydraulic pump mount on the truck.
12. Tighten the mounting flange nuts to a torque of 222 Nm (50 ft-lb).
13. Install the hydraulic 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 groove before tightening.

14. Remove the dust covers from the hydraulic pump inlet and outlet ports and install the hydraulic fittings and lines as shown in Figure 9-27.

NOTE: Figure 9-27, View A, shows the left (diver’s) side of the hydraulic pump installation and View B shows the right (passenger) side of the hydraulic pump installation.

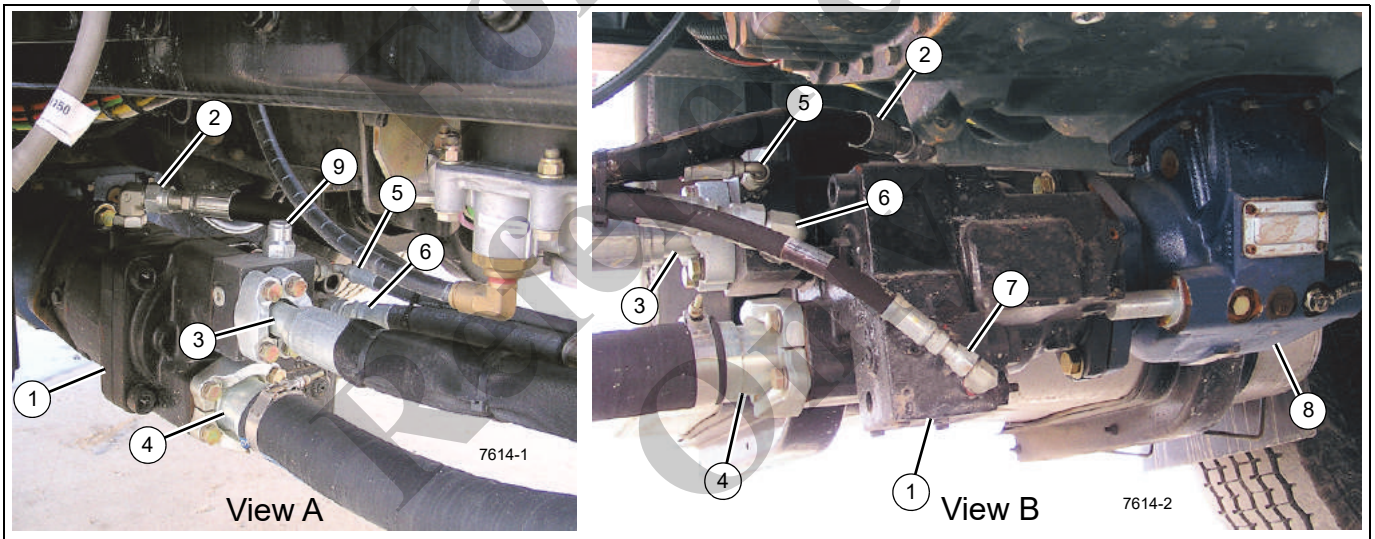


FIGURE 9-27

Item	Description
1	Hydraulic Pump
2	Case Drain Port
3	Hose - Swivel Port 3
4	Hose - Hydraulic Tank
5	Hose - Front O/R Valve, Port T
6	Hose - Front O/R Valve, Port P
7	Hose - Front O/R Valve, Port LS
8	Truck PTO
9	Outrigger Pressure-reducing Valve

Initial Pump Start-up

1. Fill the reservoir with the proper hydraulic oil to the high level mark on the reservoir sight gauge.
2. Verify that inlet valves are open to prevent cavitation or aeration of the hydraulic pump.
3. Pour hydraulic oil into the case drain port to fill the hydraulic pump housing. Reinstall the fitting and reconnect the case drain hose.
4. Fill the inlet line from the reservoir to the hydraulic pump. Check the line for properly tightened fittings to prevent air leaks.
5. Inspect the case drain hose for leaks.
6. Install a pressure gauge in the pressure port of the directional control valve (DCV).

7. While watching the pressure gauge, start the truck engine and idle until the gauge registers the pressure. System pressure must be within 51.7 bar to 55.1 bar (750 psi to 800 psi). If the hydraulic pump does not build pressure within this range, shut down the engine, and determine the cause.
8. If the system pressure is OK, operate the system under a light load five to ten minutes.
9. Verify or set the margin pressures. See “Pump Margin Pressure Setting” on page 2-23.
10. Verify or set the maximum system pressure. See “Maximum Pump Pressure Setting” on page 2-23.
11. Verify or set the load sense relief valve pressure. See “Load Sense Relief Valve Pressure Setting” on page 2-23.
12. Shut down the engine, relieve all hydraulic pressure, and remove the pressure gauge. Check the hydraulic oil level in the reservoir and fill if needed.

RCL CALIBRATION

After the crane has been installed and all electrical and hydraulic connections are completed, calibrate the RCL. Calibrate the RCL as described in the RCL manual titled Calibration/Service Manual.

INITIAL CRANE RUN-IN PROCEDURE

1. Park the crane in an open area where the crane can be run through all the functions.
2. Engage the PTO and do the following:
   - Start the truck engine from the crane cab.
   - Program the RCL.
   - Run the truck engine at idle.
   - Turn the crane power switch on and operate the crane and outriggers though all of their functions at least six times to purge the 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 the movement of the outriggers and boom correspond with the direction indicated on switches and levers.
   - Refer to the hydraulic and electrical sections and hydraulic or electrical schematics in this manual, if needed.

NOTE: Add oil to the reservoir as required to keep air from entering the system.

NOTE: The truck ECM must be properly programmed so that the maximum engine rpm in the remote throttle mode provides the maximum pump input rpm.

3. Set the throttle according to engine rpm and PTO ratio to achieve the proper hydraulic pump speed.
4. After all the cylinders have been run through six complete cycles, stow the crane with the outriggers retracted. The oil level should be visible at the full mark of the sight gauge.
5. Perform the lift and stability test.

NOTE: The initial crane run-in procedure must be completed before the stability test is started.

6. When lift and stability testing is completed, check the torque on all bearing, mounting, and cable clamp bolts.
7. Measure the overall height of the crane and truck. Post the overall height measurement inside the truck cab to inform the driver of the overall height.

STABILITY TEST

The purpose of the stability test is to verify that the rated load can be lifted with an 85% tipping factor. With an 85% tipping factor, the crane can lift a rated load and be at 85% of the tipping condition or less.

⚠ DANGER

Loads used for stability tests put the crane at the tipping point. Keep the load close to the ground. Control of boom position is critical. Do not swing test loads out past the rated radius. If the crane starts to tip and the boom angle is too low, the crane will overturn.

A stability test must be performed on each completed unit to determine the 85% tipping factor. Proceed as follows:

1. Put the test unit on a firm level surface. Place cribbing under the outrigger floats if required.
2. With the boom in the boom rest, raise and level the machine on the outriggers with all tires clear of the ground. See the Operator’s Manual. Set the front jack (if equipped).
3. To determine if the machine is stable with an 85% tipping factor, it is necessary to lift stability test loads at 1.176 times the rated load shown in Table 9-3.

Table 9-3

Model	Boom Length	Loaded Radius
40103-1 (std t-box)	91	85
	103	100
40103-1 (ext t-box)	91	85
	103	100
40127-1 (std t-box)	115	110
	127	110
40127-1 (ext t-box)	67	30
	127	110
40142-1 (std t-box)	88	40
	142	80
40142-1 (ext t-box)	88	40
	128	60
45103-1 (std t-box)	91	85
	103	100
45103-1 (ext t-box)	91	85
	103	100
45127-1 (std t-box)	79	35
	127	85
45127 (ext t-box)	79	35
	127	85
45142-1 (std t-box)	74	50
	128	65
45142-1 (std t-box)	74	45
	101	50
45161-1 (std t-box)	38	35
	116	105
45161 (ext t-box)	38	35
	116	105
36103-1 (std t-box)	91	80
	103	95
36103-1 (std t-box)	91	80
	103	95
36127-1 (std t-box)	115	85
	127	105
36127-1 (ext t-box)	67	30
	127	100

NOTE: Two test loads are required to ensure the crane is stable over both the sides and rear of the machine.

NOTE: Special care must be taken in performing the stability test if the crane is equipped with a jib extension. The stability test can be performed with or without the jib stowed on the side of the main boom.

Be sure to select the correct load capacity chart; the charts are titled—with stowed extension or without extension.

DANGER

Stability test conditions represent overloads at crane positions where boom weight and CG location make up a large portion of the overturning moment. Great care should be taken to control the boom position and keep the 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 the boom angle gets too low, the boom weight may cause the unit to upset.

NOTE: Make sure the weights lifted are accurate. A 1% increase in load weight can result in a 10% increase in stability test weight required.

NOTE: The following stability test examples show boom length, radius and lift capacities; these numbers should be used for the following example stability test only. They are not meant to be and should not be used for this machine's stability test.

Always see the load capacity chart provided with your machine for boom length, radius, and capacity.

example: Test Load 1 - NBT40-1 without extension

- NBT40-1 142 5-section boom, without extension, O/R fully extended, capacity at:
  - 43.3 m (142 ft) boom length
  - 24.4 m (80 ft) radius
  - 1,429 kg (3,150 lb) per capacity chart
- Stability test load (no extension stowed):
  - 1,429 kg x 1.176 = 1,681 kg (3,150 lb x 1.176 = 3,704 lb)

example: Test Load 2 - NBT45-1 with stowed extension

- NBT45-1 127 5-section boom, with stowed extension, O/R fully extended, capacity at:
  - 38.7 m (127 ft) boom length
  - 25.9 m (85 ft) radius
  - 1,384 kg (3,050 lb) per capacity chart
- Stability test load (with extension stowed):
  - 1,384 kg x 1.176 = 3,440.6 kg (3,050 lb x 1.176 = 3,587 lb)

4. Over the side:
   - Assemble the first stability test load as described above near the crane.
   - Measure the load radius from the center of rotation directly to one side of the machine.
   - Extend the boom to the specified boom length
   - Lift the stability test load just slightly off the ground (not over 0.3 m [1 ft]).
   - Slowly boom down while hoisting up to move the load out to the load radius.
   - Move the load very slowly when approaching the load radius so the stability test load does not swing out past the load radius. If the stability test load can be kept from contacting the ground at the load radius, the unit is stable over the side tested.
   - Slowly rotate the load 360 degrees to ensure that the stability test load is stable directly over both sides, the back, and the front.
5. Over the rear:
   - Assemble the second stability test load as described above near the crane.
   - Measure the load radius from the center of rotation directly to the rear of the machine.
   - Extend the boom to the specified boom length and lift the stability test load just slightly off the ground (not over 0.3 m [1 ft]).
   - Boom down while hoisting up to move the stability test load out to the load radius.
   - Move the load very slowly when approaching the load radius so the stability test load does not swing out past the load radius. If the stability test load can be kept from contacting the ground at the load radius, the unit is stable over the rear of the unit.
   - Slowly rotate the stability test load 360 degrees to ensure that the load is stable directly over both sides, the back, and the front.
6. If the unit is unstable, the counterweight needs to be added.
   - Add weight at the front bumper or at the front of the sub-base, if the crane is unstable over the rear.
   - Add weight close to the centerline of rotation if the crane is unstable over the side.

COUNTERWEIGHT

Each NBT40-1 and NBT45-1 model crane is equipped with a different removable counterweight combination. See Figure 9-29 and table for the proper crane counterweight combination.

NOTE: The NBT36-1 model crane is not equipped with a counterweight.

Use only the counterweight plate combinations as shown in the following counterweight Table 9-4 and Figure 9-29.

Each counterweight plate can be identified by the part number and weight stamped (1, Figure 9-28) into the side of the plate.

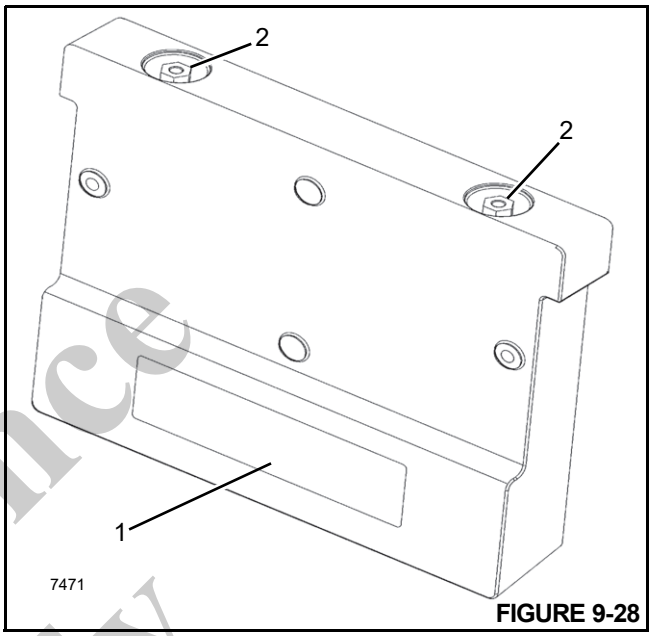


FIGURE 9-28

Item	Description
1	Part Number and Weight Stamp Location
2	Lift Inserts

DANGER

Do not add material to or change the configuration of the counterweights to increase the crane capacity.

Serious injury or death may occur if lifting weight above the crane rated capacity or using a weight combination not shown in Table 9-4 and Figure 9-29.

DANGER

Do not stand near or underneath the counterweight when removing or installing it.

Serious injury or death may occur when removing or installing the counterweight if the counterweight falls from the lifting device.

Counterweight Removal

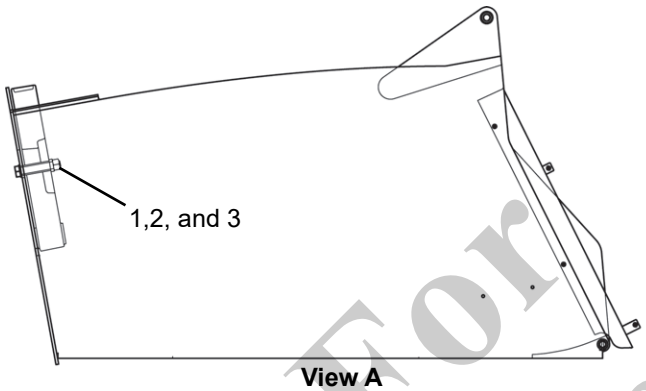
1. Position the crane on a firm, level surface. Fully extend and set the outriggers.
2. Position the superstructure over the front of the machine and engage the turntable lock.
3. Install two threaded lifting capscrews into the 1.25 x 7 UNC lift inserts (2, Figure 9-28). Using a proper lifting device, attach lifting straps to the capscrews. After the straps are attached, remove slack from the straps.
4. Remove the capscrews (1, Figure 9-29), washers (2), and lock nuts (3) securing the counterweight to the crane support weldment. Lift and remove the counterweight from the crane.

Counterweight Installation

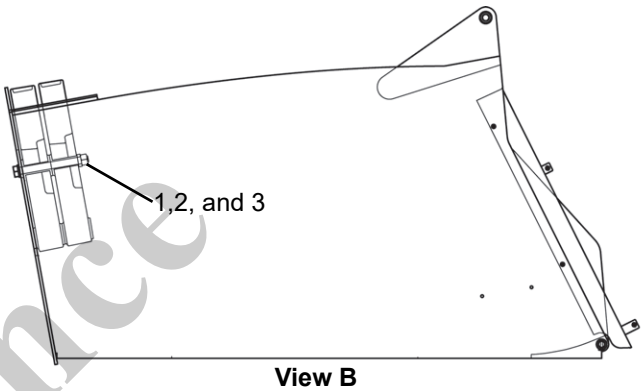
1. Position the crane on a firm level surface. Fully extend and set the outriggers.
2. Position the superstructure over the front of the machine and engage the turntable lock.
3. Install two lifting capscrews into the 1.25 x 7 UNC lift inserts (2, Figure 9-28). Using a proper lifting device, attach straps to each capscrew, and lift and place the counterweight inside the crane support weldment.
4. With the lifting device still attached, align the two counterweight and crane support weldment holes and install the capscrews (1, Figure 9-29), washers (2), and lock nuts (3).

Table 9-4

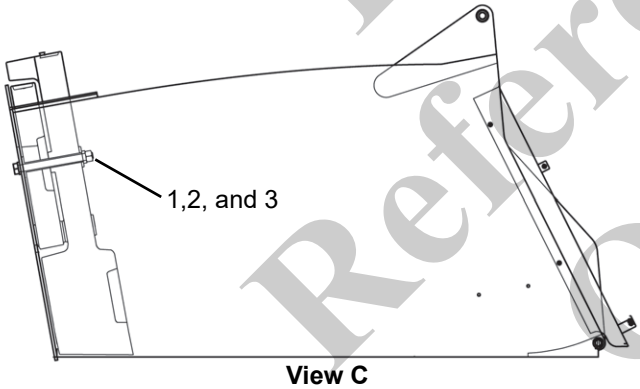
Model	Description	Figure 9-29 View
NBT36-1	N/A	N/A
NBT40-1 Standard	454 kg (1,000 lb)	A
NBT40-1 + 1,000 Option	907 kg (2,000 lb)	B
NBT45-1 Standard	2,041 kg (4,500 lb)	C
NBT45-1 + 1,000 Option	2,494 kg (5,500 lb)	D
NBT45-1TM	454 kg (1,000 lb)	E



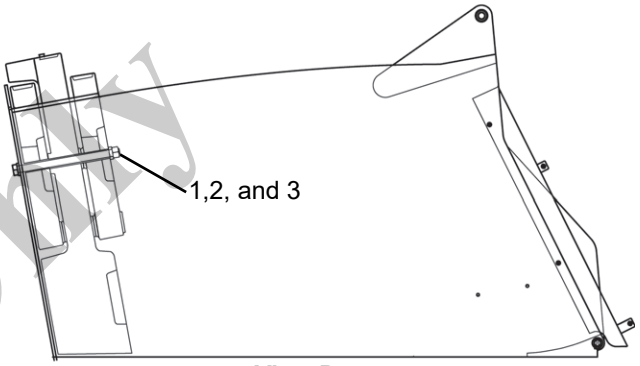
View A



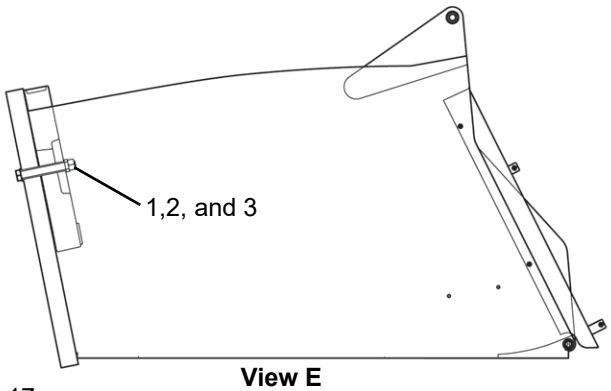
View B



View C



View D



View E

Item	Description
1	Capscrew (2 used)
2	Washer (4 used)
3	Lock Nut (3 used)

9017-17

FIGURE 9-29

SPECIFICATIONS

PTO

PTO Minimum Torque Rating	644 Nm (475 lb-ft)
PTO Minimum Horsepower Rating	67 kW (90 hp) per 1,000 rpm of PTO shaft speed 148 KW (199 hp) per 2,200 rpm of PTO shaft speed

Hydraulic

Hydraulic Pump	286 lpm (75.5 gpm) at 2,200 rpm, Variable displacement, axial piston with load sense
Displacement	130 cc/rev (7.93 in^3/rev)
Pressure Rating (rated)	320 bar (4,600 psi)
Pressure Rating (peak)	345 bar (5,000 psi)
Case Refill Capacity	1.40 L (0.37 gal)
Minimum Operating Speed	600 rpm
Outrigger System	224 bar +/- 6.9 bar (3,250 psi +/-100 psi)
Boom Up	132.4 lpm at 314 bar (35 gpm at 4,550 psi)
Boom Down	64 lpm at 69 bar (17 gpm at 1,000 psi)
Telescope Extend	132.4 lpm at 200 bar (35 gpm at 2,900 psi)
Telescope Retract	64 lpm at 155.1 bar (17 gpm at 2,250 psi)
Aux/Main Hoist System & Relief	132.4 lpm at 296 bar (35 gpm at 4,300 psi)
Swing	68 lpm at 214 bar +13.7/-00 bar (18 gpm at 3,100 psi +200/-00 psi)
Swing Park Brake	Hydraulic released disc, released at 12 bar (175 psi)

Hydraulic Reservoir

Reservoir- Standard Capacity	379 L (100 gal)
Reservoir- XL Capacity	414.8 L (109.6 gal)
Reservoir Return Filter	5 micron
Reservoir Suction Filter	25 micron

Hydraulic Intensifier Valve - Optional

Hydraulic System	Open or Closed Center
Operating Pressure	96.5-138 bar (1,400-2,000psi)
Flow Range	15-26.5 lpm (4-7 gpm)
Optimum Operating Pressure	.124 bar @ 22.7 lpm (1,800 psi @6 gpm)

Air Conditioner

Air Conditioner Hydraulic System Pressure	241 bar +/- 6.9 bar (3,500 +/-100 psi)
Minimum Evacuation Time	30 minutes
Refrigerant Charge Level	0.9 (+/-0.014) kg (2 lb +/- 0.5 oz)
Refrigerant Type	R134a
Air Conditioner Lubrication Type	Polyalkylene Glycol (PAG)
Air Conditioner Compressor Lubrication Capacity	170.1 g (6 oz)
Air Conditioning Total System Lubrication Capacity	283.5 g (10 oz)

Hoist System

Wire Rope:	
Length	137 m (450 ft)
Diameter (Rotation Resistant)	16 mm (5/8 in)
Nominal Breaking Strength	25,582 kg (56,400 lb)
Operating Pressure	303.4 +/- 6.9 bar (4,400 +/-100 psi)
Flow	132.4 lpm (35 gpm)

Hoist Line Pull/Layer		
Layer	**Low Speed kN (lb)**	**High Speed kN (lb)**
1	66.7 (15,000)	33.4 (7,516)
2	60.2 (13,529)	30.1 (6,765)
3	54.7 (12,299)	27.4 (6,150)
4	50.2 (11,275)	25.1 (5,637)
5	46.3 (10,407)	23.1 (5,204)

Line Speed (no load at high engine idle speed)		
Layer	**Low Speed m/sec (ft/sec)**	**High Speed m/sec (ft/sec)**
1	43.9 (144)	87.5 (287)
2	48.5 (159)	97.2 (319)
3	53.3 (175)	107.0 (351)
4	58.2 (191)	116.7 (383)
5	63.1 (207)	126.5 (415)

Equipment Operating Speeds

(Performance based on full governed rpm and 37.8°C (100°F) hydraulic reservoir temperature.)

Rotation 360° ..... 30 ± 7 sec (1.8 ± 0.2 rpm) Adjustment Knob Closed

Boom up -10° to 80° ..... 34 ± 5 sec

Boom Down 80° to -10° ..... 34 ± 5 sec

Boom Telescope ..... (See Boom Telescope Speed Table)

Boom Telescope Speed (Angle 60°- no load at high engine speed)		
Boom Length	**Extend**	**Retract**
9.44 - 31.39 m (31 - 103 ft)	105 sec (± 10 sec)	105 sec (± 10 sec)
9.44 - 38.70 m (31 - 127 ft)	120 sec (± 10 sec)	120 sec (± 10 sec)
10.36 - 43.28 m (34 - 142 ft)	135 sec (± 10 sec)	135 sec (± 10 sec)
11.88 - 49.07 m (39 - 161 ft)	150 sec (± 10 sec)	150 sec (± 10 sec)

Outrigger Beam Extend ..... 10 ±3 sec

Outrigger Beam Retract..... 10 ±3 sec

Outrigger Jack Extend ..... 10 ±3 sec

Outrigger Jack Retract..... 10 ±3 sec

Counterweight

NBT36-1 Counterweight Slab ..... N/A

NBT40-1 Standard Counterweight ..... 454 kg (1,000 lb)

NBT40-1 + 1,000 lb Option Counterweight..... 907 kg (2,000 lb)

NBT45-1 Standard Counterweight ..... 2,041 kg (4,500 lb)

NBT45-1+ 1,000 lb Option Counterweight..... 2,494 kg (5,500 lb)

NBT45-1 TM ..... 454 kg (1,000 lb)

General

NBT36-1	32.6 metric tons (36 tons) at 2.13 m (7 ft) radius
NBT40-1	36.3 metric tons (40 tons) at 2.13 m (7 ft) radius
NBT45-1	40.8 metric tons (45 tons) at 2.13 m (7 ft) radius
*NBT36-1 103 ft. Boom	14,203 kg (31,313 lb) -205.5 cm (-80.9 in) HCG
*NBT36-1 127 ft Boom	14,798 kg (31,623 lb) -214.1 cm (-84.3 in) HCG
*NBT40-1 103 ft Boom	15,109 kg (33,441 lb) -179.3 cm (-70.6 in) HCG
*NBT40-1 127 ft Boom	15,763 kg (34,751 lb) -188.7 cm (-74.3 in) HCG
*NBT40-1 142 ft Boom	16,350 kg (36,046 lb) -210.8 cm (-83.0 in) HCG
*NBT40-1 103 ft EXTB	15,727 kg (34,672 lb) -202.7 cm (-79.8 in) HCG
*NBT40-1 127 ft EXTB	16,321 kg (35,982 lb) -210.8 cm (-83.0 in) HCG
*NBT40-1 142 ft EXTB	16,909 kg (37,277 lb) -231.4 cm (-91.1 in) HCG
*NBT45-1 103 ft Boom	16,741 kg (36,908 lb) -139.7 cm (-55.0 in) HCG
*NBT45-1 127 ft Boom	17,335 kg (38,218 lb) -149.4 cm (-58.8 in) HCG
*NBT45-1 142 ft Boom	17,922 kg (39,513 lb) -170.9 cm (-67.3 in) HCG
*NBT45-1 161 ft Boom	18,401 kg (40,567 lb) - 205.2 cm (-80.8 in) HCG
*NBT45-1 103 ft EXTB	17,300 kg (38,139 lb) -162.0 cm (-63.8 in) HCG
*NBT45-1 127 ft EXTB	17,894 kg (39,449 lb) -170.7 cm (-67.2 in) HCG
*NBT45-1 142 ft EXTB	18,481 kg (40,744 lb) -191.0 cm (-75.2 in) HCG
*NBT45-1 161 ft EXTB	18,959 kg (41,798 lb) -224.0 cm (-88.2 in) HCG

NOTE: *The weights include only the super structure, boom, counterweight T-box (EXTB= extended T-box), decking, lift cylinder, hydraulic reservoir, and full fluids. Horizontal CG is measured from the centerline of the crane rotation (negative number indicates the HCG is toward the boom nose, not the hoists).

Boom Weight - including hoist/rope

103 ft Boom	5,869 kg (12,940 lb)
127 ft Boom	6,504 kg (14,339 lb)
142 ft Boom	6,849kg (15,100 lb)
161 ft Boom	7,854kg (17,315 lb)

DIMENSIONAL DRAWING

NBT40-1 and NBT45-1 Extended T-Box

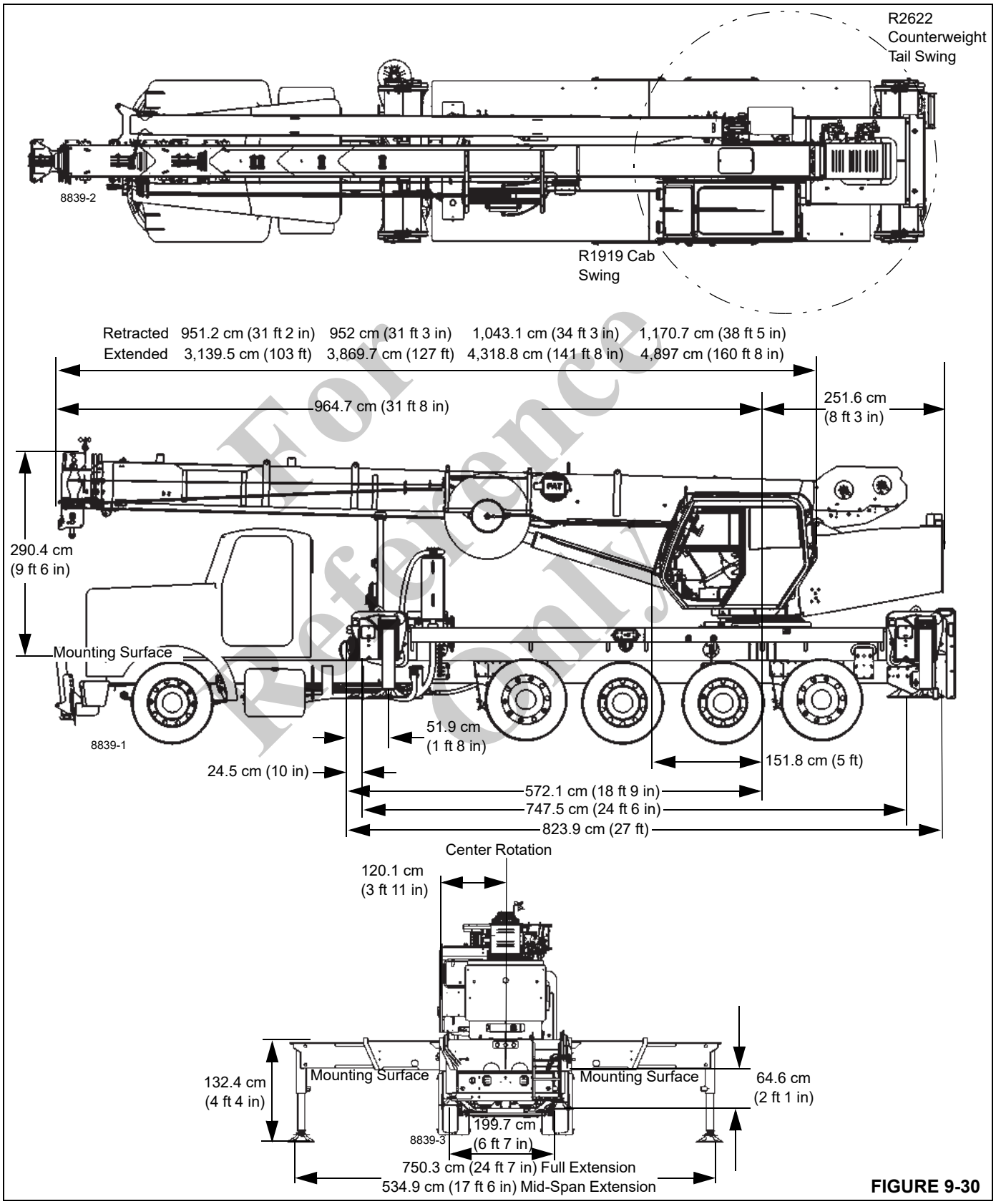


FIGURE 9-30

9

NBT40-1 and NBT45-1 Standard T-Box

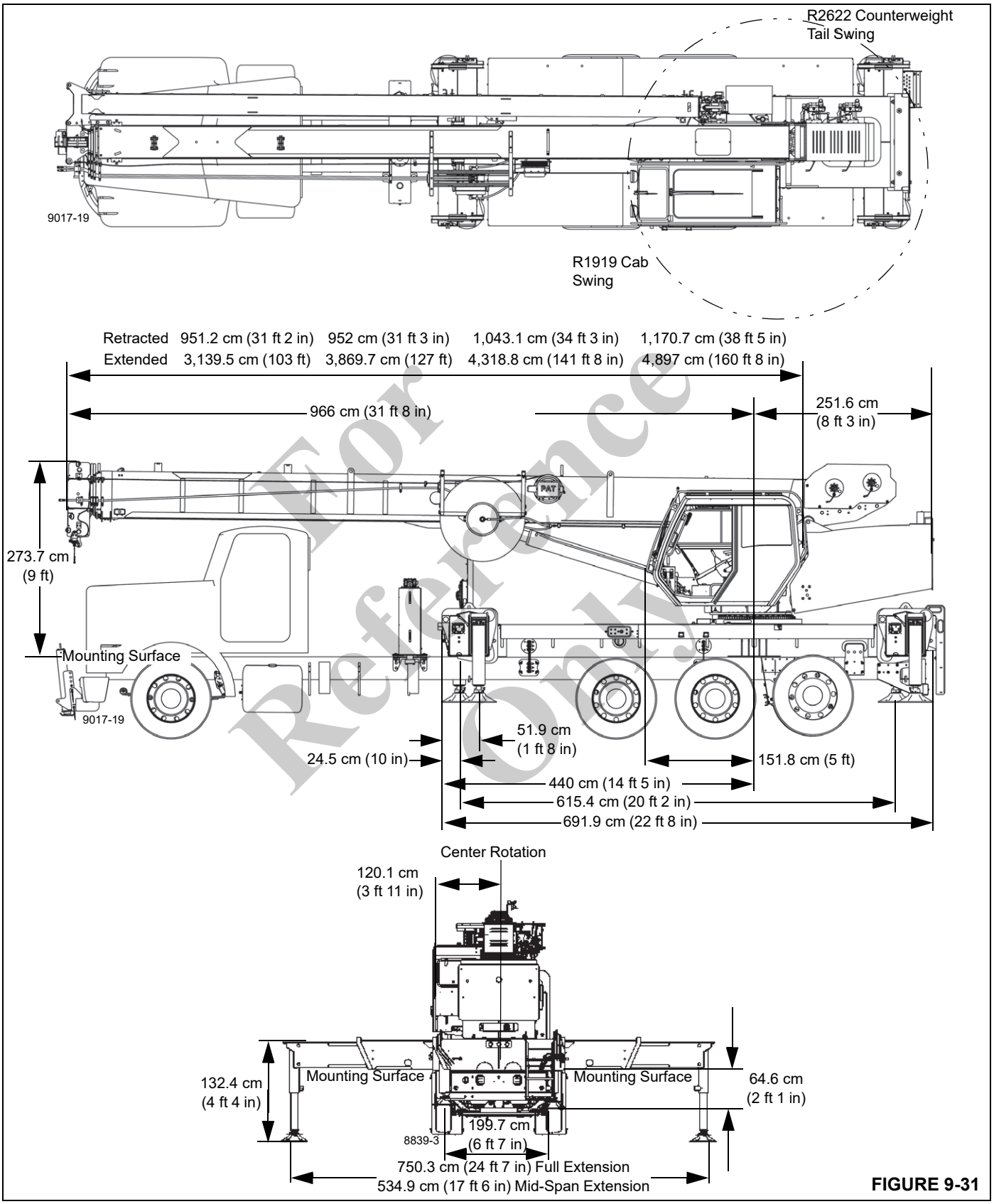


FIGURE 9-31

NBT36-1 Extended T-Box

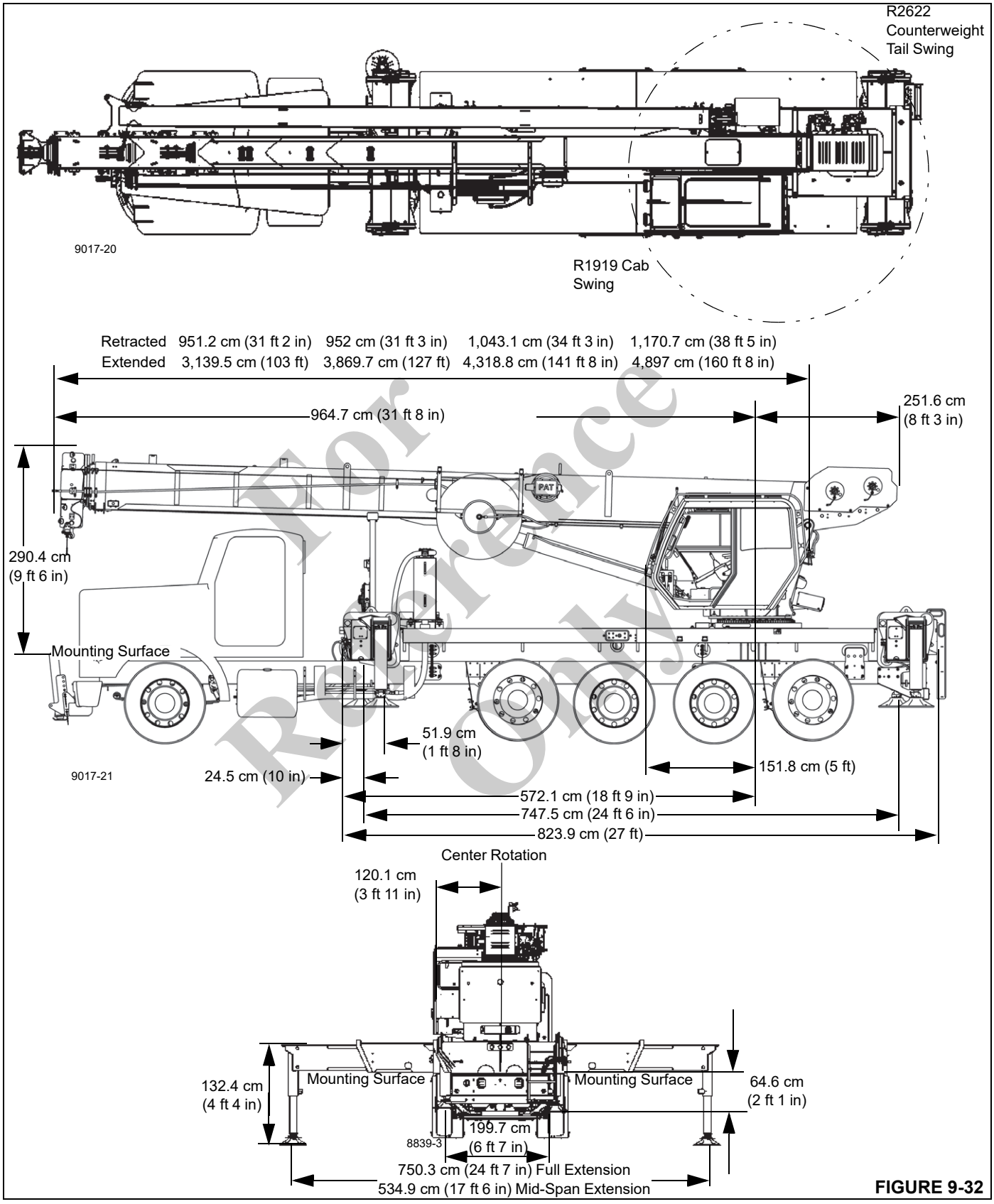


FIGURE 9-32

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SECTION 10
SCHEMATICS

For your convenience, the latest version of schematics available at the time of printing are placed in this section.

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