National Crane NBT40 Series

Service Manual

For Reference Only

WARNING

California Proposition 65

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

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

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

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

California Spark Arrestor

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

For Reference Only

The original language of this publication is English.

NATIONAL CRANE
by Manitowoc

SERVICE MANUAL

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

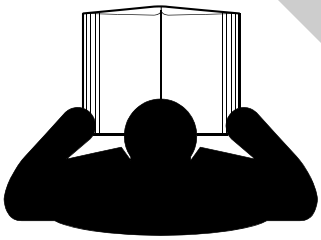
NBT40 Series Cranes

This Manual is divided into the following sections:

For Reference Only

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

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



⚠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 crane.

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Published 7-01-2021 Control # 287-13

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SECTION 1
INTRODUCTION

SECTION CONTENTS

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GENERAL

This manual has been compiled to assist you in properly operating and maintaining your Model NBT40 Series National Crane (Figure 1-1).

Before placing the crane in to service, all operators and persons working around the crane must thoroughly read and understand the contents of the Operators 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 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 crane, see the manufacturer's manual supplied with the crane. Manufacturers of rated capacity limiters may refer to them in their manuals as a load moment indicator (LMI), a hydraulic capacity alert system (HCAS), a safe load indicator (SLI), or an ECS5; National Crane refers to these systems as a rated capacity limiter (RCL) throughout its *Operator's* and *Service Manuals*.)

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

National Crane reserves the right to make specification and equipment changes without notice because of product improvements.

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 the information to assist you in a timely manner. We request that you first contact them for assistance. If you feel you need factory assistance, please ask the distributor's service management to coordinate the contact on your behalf.

Supplemental Information

Supplemental information for options such as remote controls, augers, varying control configurations, baskets, grapples, etc. is included in separate manuals.

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

Safety Information

A Safety Compact Disc (CD) which includes sections on Operation, Safety and Maintenance for National Crane

operators and owners is supplied when the crane is purchased new. Additional copies are available from your local distributor.

Basic Nomenclature

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

FIGURE 1-1

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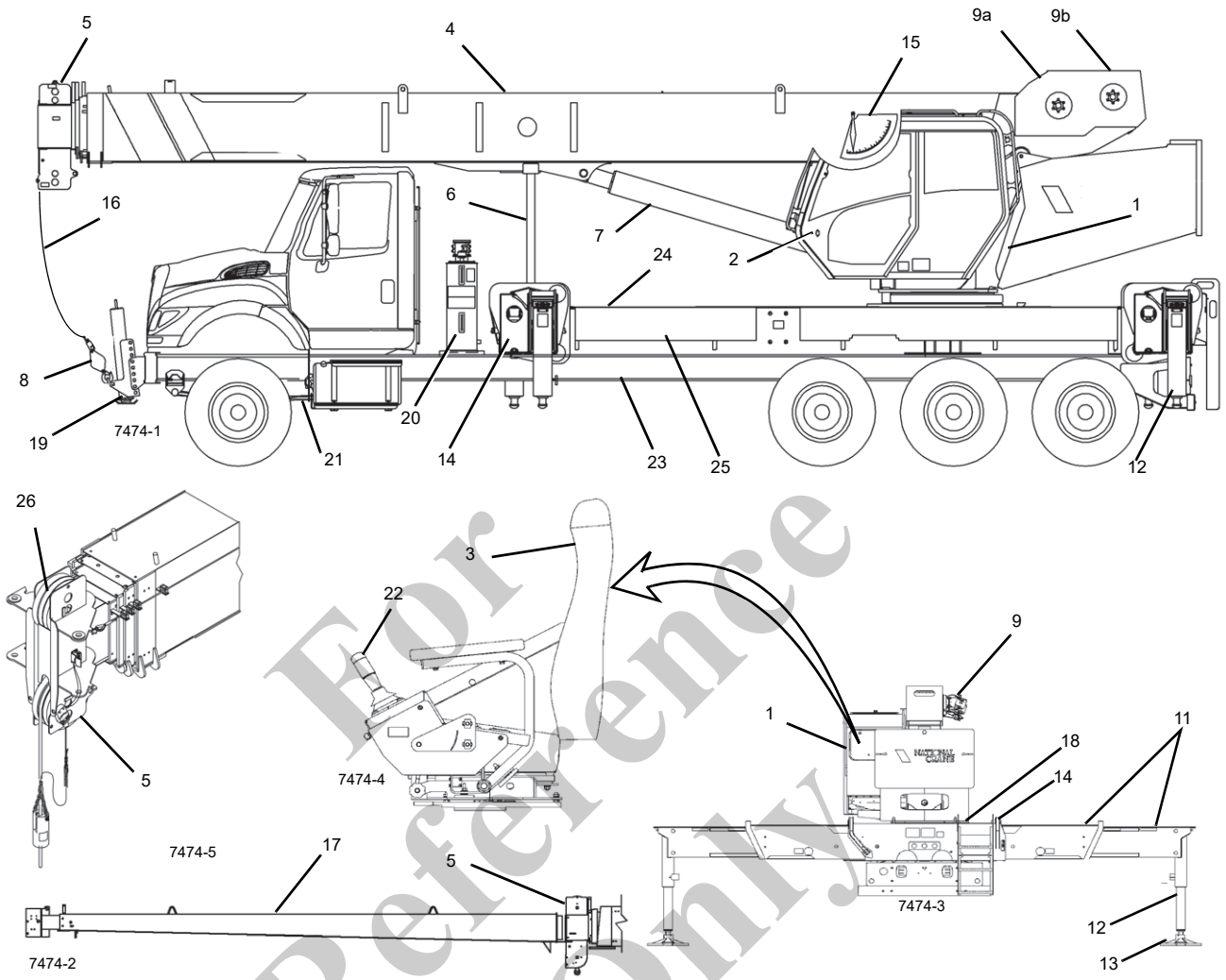

FIGURE 1-2

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	Downhaul Weight, Hook Block
9	Hoist (9a Auxiliary, 9b Main)
11	Outrigger Beam
12	Outrigger Jack
13	Out Rigger Float
14	Outrigger Box

Item	Component
15	Boom Angle Indicator
16	Hoist Cable
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
26	Sheave

For Reference Only

GENERAL MAINTENANCE

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

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

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

Cleanliness

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

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

Removal and Installation

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

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

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

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

CAUTION

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

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

Disassembly And Assembly

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

Pressing Parts

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

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

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

Locks

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

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

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

Shims

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

For Reference Only

Bearings

Antifriction Bearings

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

Double Row, Tapered Roller

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

Heating Bearings

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

Installation

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

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

Preload

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

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

Sleeve Bearings

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

Gaskets

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

Hydraulic Systems

⚠ DANGER

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

Visual Inspection

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

Valves and Manifolds

Inspect valves and manifolds for leaking ports or sections.

Hoses and Fittings

Inspect all hoses and fittings for the following:

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

If any 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 zone C after 8,000 hours of service.
- Climate zones A and C with high ambient temperatures and duty cycles after 4000 to 5000 hours of service.
- Climate zones D and E after 4000 to 5000 hours of service.

Cleanliness

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

For Reference Only

Keep The System Clean

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

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

Disassemble and assemble hydraulic components on a clean surface.

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

Sealing Elements

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

Hydraulic Lines

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

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

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

Electrical

Batteries

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

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

CAUTION

Disconnect batteries prior to working on the electrical system.

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

Connectors, Harnesses, Wires, and Connectors

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

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

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

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

- Climate zone C after 10,000 hours of service.
- Climate zones A and C with high ambient temperatures and duty cycles after 8000 hours of service.
- Climate zones D and E after 10,000 hours of service.
- Salt water conditions after 8,000 hours of service

Climate Zone Classification

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

For Reference Only

Fatigue Of Welded Structures

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

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

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

Loctite

⚠ DANGER

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

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

Application of Medium Strength Loctite

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

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

Adhesive/Sealant Application

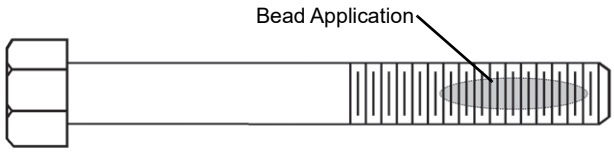

FIGURE 1-3

1. Apply a bead several threads wide in the approximate area of threaded contact (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 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 must be aware that he/she is working with a highly stressed component and the fastener should be torqued accordingly.

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

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

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

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

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

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

For Reference Only

Torque Wrenches

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

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

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

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

- Torque wrenches must be those specified and forces must be applied at the handle grip. The use of handle extensions will change applied torque to the bolt.
- All handles must be parallel to the step wrench during final tightening. Multiplier reaction bars may be misaligned no more than 30 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.

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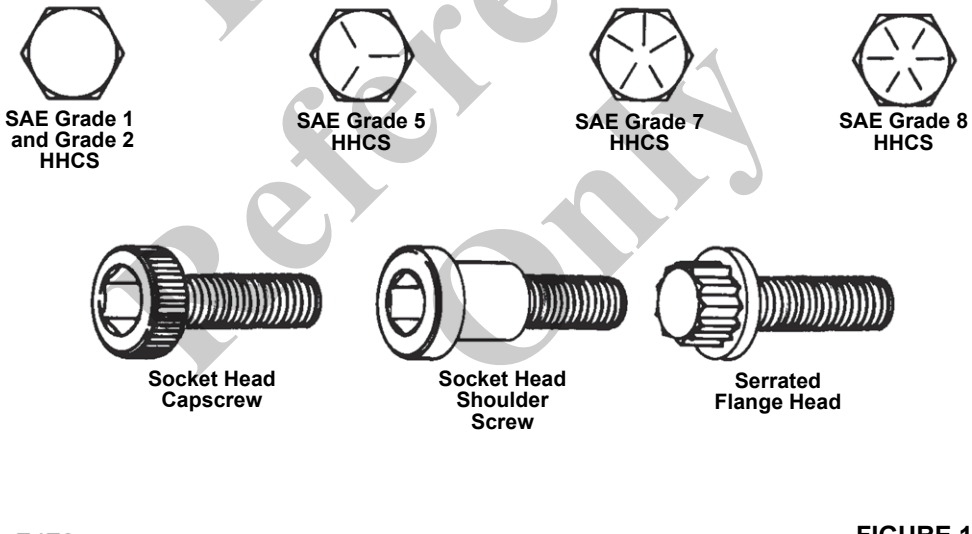

FIGURE 1-4

Table 1-1Inch 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	1001.4	976.4	951.4
1 1/4-7 UNC	5	880.5	858.5	836.5
	8	1413.1	1377.8	1342.5
1 3/8-6 UNC	5	1154.5	1125.6	1096.7
	8	1852.8	1806.5	1760.2
1 1/2-6 UNC	5	1532.0	1493.7	1455.4
	8	2458.8	2397.3	2335.8

For Reference Only

Table 1-2 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	1123.5	1095.4	1067.3
1 1/4-12 UNF	5	975.0	950.6	926.2
	8	1564.8	1525.7	1486.5
1 3/8-12 UNF	5	1314.4	1281.5	1248.6
	8	2109.5	2056.7	2004.0
1 1/2-12 UNF	5	1723.9	1680.8	1637.7
	8	2766.8	2697.6	2628.4

Table 1-3 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

For Reference Only

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	1002.2	977.1	952.1
M27x3	8.8	881.6	859.6	837.5
	10.9	1255.7	1224.3	1192.9
	12.9	1469.4	1432.7	1395.9
M30x3.5	8.8	1195.3	1165.5	1135.6
	10.9	1702.5	1659.9	1617.3
	12.9	1992.3	1942.4	1892.6

For Reference Only

Nominal Size, Threads per Inch, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M36x4	8.8	2089.8	2037.6	1985.3
	10.9	2976.4	2902.0	2827.6
	12.9	3483.0	3395.9	3308.9

Table 1-4 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

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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	1092.9	1065.6	1038.3
M27x2	8.8	951.4	927.6	903.8
	10.9	1355.0	1321.1	1287.2
	12.9	1585.6	1546.0	1506.3
M30x1.5	8.8	1369.2	1334.9	1300.7
	10.9	1950.0	1901.3	1852.5
	12.9	2281.9	2224.9	2167.8
M30x2	8.8	1324.6	1291.5	1258.4
	10.9	1886.6	1839.4	1792.2
	12.9	2207.7	2152.5	2097.3
M33x2	8.8	1784.5	1739.9	1695.3
	10.9	2541.6	2478.0	2414.5
	12.9	2974.2	2899.8	2825.4
M36x2	8.8	2340.1	2281.6	2223.1
	10.9	3332.8	3249.5	3166.2
	12.9	3900.2	3802.6	3705.1

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Table 1-5 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

Torque Values for fasteners **with lubrication** these 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 1-6 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

Torque Values for fasteners **with lubrication** these torque and preload 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.

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Table 1-7 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	2043	1964	1885

Table 1-8 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	1089	1047	1005
M27X3	10.9	1591	1530	1469

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Table 1-9 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	1342	1288	1234
1 1/4-7	5	1141	1097	1053
	8	2043	1964	1885
1 3/8-6	5	1519	1461	1403
	8	2496	2396	2296
1 1/2-6	5	2028	1946.5	1865
	8	3276	3150	3024

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Table 1-10 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	1009	970	931
1-14 UNS	5	670	644.5	619
	8	945	908.5	872
1 1/8-12	5	882	848	814
	8	1500	1440	1380
1 1/4-12	5	1251	1203	1155
	8	2092	2008.5	1925
1 3/8-12	5	1704	1638	1572
	8	2833	2719	2605
1 1/2-12	5	2288	2196.5	2105
	8	3640	3500	3360

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Table 1-11 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	1089	1047	1005
	12.9	1306	1256	1206

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Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M27x3	8.8	1134	1090	1046
	10.9	1591	1530	1469
	12.9	1910	1836.5	1763
M30x3.5	8.8	1538	1479	1420
	10.9	2163	2080	1997
	12.9	2595	2495	2395
M36x4	8.8	2681	2578.5	2476
	10.9	3964	3812	3660
	12.9	4639	4461	4283

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Table 1-12 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	1111	1068	1025

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Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M24x2	8.8	836	803.5	771
	10.9	1176	1130.5	1085
	12.9	1410	1356	1302
M27x2	8.8	1225	1171.5	1130
	10.9	1718	1652.5	1587
	12.9	2063	1983.5	1904
M30x1.5	8.8	1530	1471.5	1413
	10.9	2253	2166.5	2080
	12.9	2637	2536	2435
M30x2	8.8	1661	1597.5	1534
	10.9	2336	2246.5	2157
	12.9	2800	2695	2590
M33x2	8.8	2141	2059	1977
	10.9	3155	3034	2913
	12.9	3692	3550.5	3409
M36x2	8.8	2795	2688	2581
	10.9	4118	3960	3802
	12.9	4818	4634	4450

Weld Studs

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

Table 1-13: Weld Stud Torque Values

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

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HOIST CABLE INSPECTION AND MAINTENANCE

Hoist Rope

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

Environmental Conditions

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

Dynamic Shock Loads

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

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

Lubrication

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

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

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

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

Remove dirt from the rope before applying lubrication. Use a stiff wire brush and solvent, compressed air, or live steam to clean the rope. Lubricate the rope immediately after cleaning. Methods of lubrication are bath, dripping, pouring, swabbing, painting, or pressure spray (Figure 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.

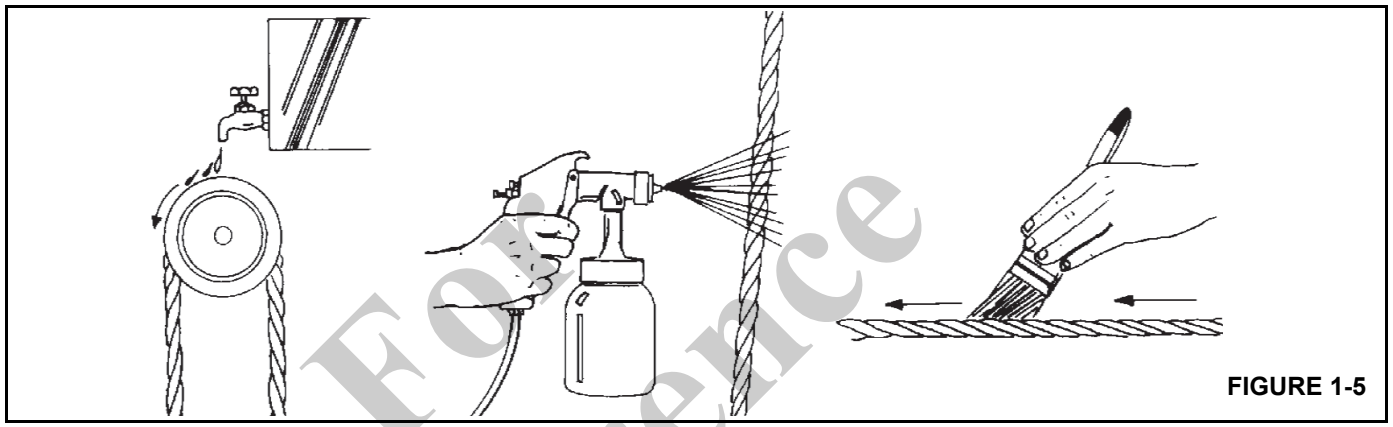

FIGURE 1-5

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 CraneCARE. 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 CraneCARE.

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.

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- Broken or cut strands.

Yearly Inspection

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

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

Boom Extension and Retraction Cables

Periodic Inspection

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:

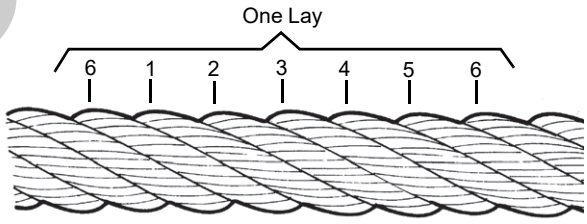
- reduction of rope diameter below nominal diameter.
- severely corroded or broken wires at end connections.
- severely corroded, cracked, bent, worn, or improperly applied end connections.
- deterioration in areas such as:
  - sections in contact with saddles, equalizer sheaves, or other sheaves where 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. 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 CraneCARE recommendations to help determine when wire rope needs to be replaced. Wire rope shall be taken out of service when any of the following conditions exist:

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



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

FIGURE 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.

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- 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 recommends that for cable extended booms, a single damaged wire rope assembly shall require replacement of the complete set of extension cables.
- National recommends that boom extension cables be replaced every seven (7) years.

Seizing Wire Rope

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

Method 1

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

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

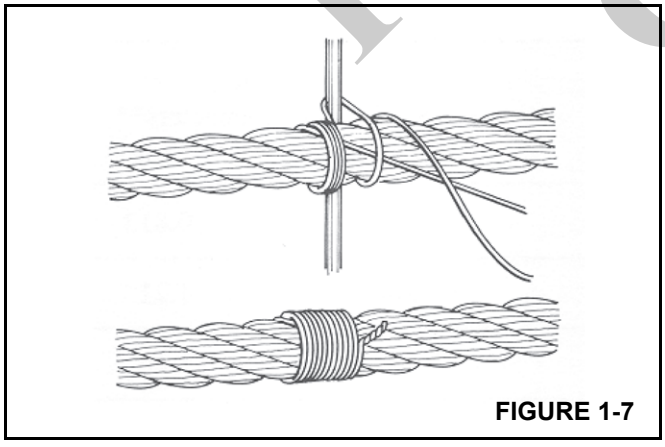

FIGURE 1-7

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).

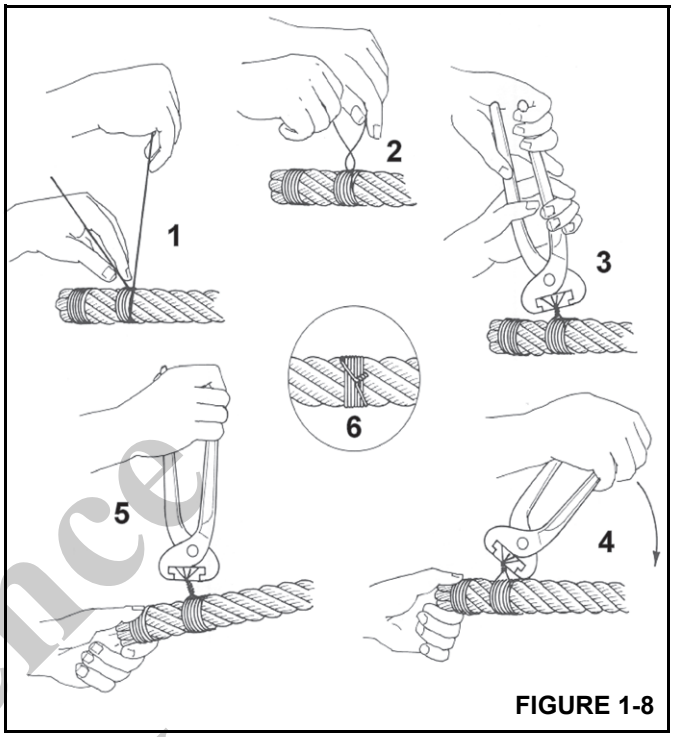

FIGURE 1-8

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

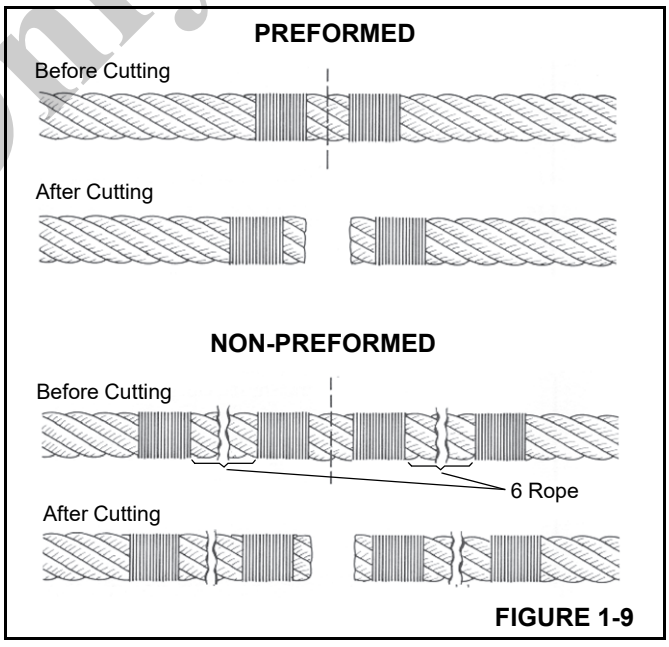

FIGURE 1-9

For Reference Only

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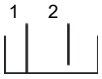
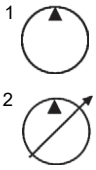
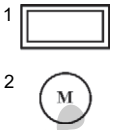
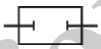
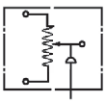
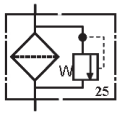
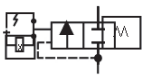
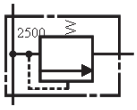
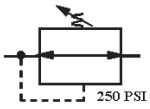
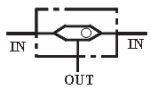
SECTION 2
HYDRAULIC SYSTEM

SECTION CONTENTS

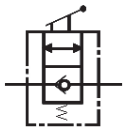
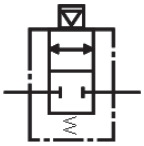
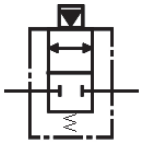
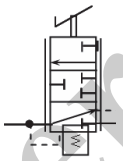
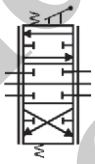
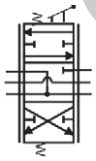
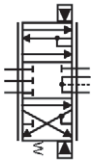
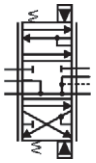
For Reference Only

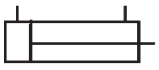
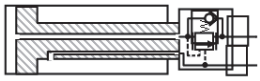
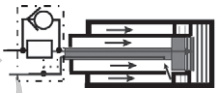
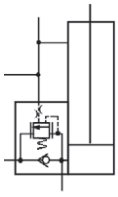
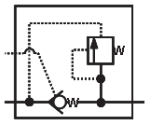
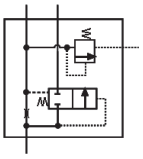
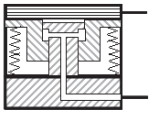
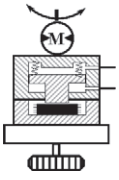
This section describes the hydraulic system, the components which make up the hydraulic system, and the components dependent upon the hydraulic system for their operation. This includes descriptions of the supply pressure and return circuit, pumps, valves, and cylinders. Detailed descriptions and operation 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.

Description	Symbol
Hydraulic Reservoir - Stores, cools, and cleans machines 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 cranes 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 back pressure.	
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 over pressurized.	
Pressure Reducing Valve - Regulates maximum pressure.	
Shuttle Valve - Used to direct maximum pressure to components.	

For Reference Only

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.	
MultiStage Telescope Cylinder - Used in milti-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 (i.e. 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.	

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MAINTENANCE

General

Before adjustments and repairs are started on a crane, the following precautions shall 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 removed from the hydraulic system if required, safety devices reactivated, and maintenance equipment and all warning tags 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 system and crane's electrical system may be damaged by welding on the truck or crane. The following precautions should be taken:

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

The hydraulic oil reservoir has a sight gauge located on the side of the reservoir. This sight gauge has a decal beside it that indicates a “full” level and an “add oil” level. The oil required to bring it from the “add” line to the “full” line is 5 gallons. Do not fill the reservoir above the “full” line. The oil level should be checked with the crane parked on a level surface, in the transport condition (all cylinders retracted and boom stowed) and the oil cold.

PARTS REPLACEMENT

Parts found damaged or out of tolerance when maintenance is being performed need to be replaced. Refer to the Manitowoc CraneCARE Parts Catalog for proper replacement parts.

SERVICE

Hydraulic Oil Recommendations

For hydraulic oil specifications, Reference Section 8 - LUBRICATION.

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.

For Reference Only

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, the reservoir level is too low, or 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 - 27.6 kPa (2 - 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.

For Reference Only

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 to below horizontal and fully telescope the boom in and out several times.
- If the air is still trapped, lower the boom to below horizontal, 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 type 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 series cranes consist of the following:

- Axial Piston Pump
- Three Section Main Control Valve (Standard)
- Optional Four Section Main Control Valve for Auxiliary Hoist
- RCL Lockout Manifold
- Swing Control Valve
- Outrigger Control Manifolds
- Hydraulic Tank with Filter
- Hydraulic Remote Controllers (HRC)

Axial Piston Pump

The axial piston pump is pressure compensated and supplies a 286 l (75.5 gpm) flow of up to 27579 kPa (4000 psi) at a pump shaft speed of 1900 rpm. A shaft speed of 1000 rpm delivers 35 gpm which is enough to run any single function at full speed. Higher speeds are required when running two or more functions at the same time. The pump has a load sense standby pressure of 2413-2757 kPa (350 - 400 psi).

Main Control Valve

The main control valve is located in the turret and has three sections. The main control valve and controls the hoist, lift, and telescope.

- Section one controls the boom up and down and contains a lift relief valve that protects the lift down circuit, lift up is protected by the system relief valve.
- Section two controls the hoist and uses the work port relief valve to protect the hoist circuit.
- Section three controls the telescope out and telescope in and contains the extend and retract relief valves.
- Optional fourth section controls the auxiliary hoist and uses the work port relief to protect the hoist circuit.

The main and the load sense relief valves are located in the main relief valve.

Swing Control Valve

The swing control valve is located in the turret and controls the swing motor. The valve limits the maximum flow to 72 l (16 gpm) in both directions and has internal relief valves that are set to 21373 kPa (3100 psi). The valve has an open center that goes back to tank when the valve is in the neutral position.

RCL Dump Manifold

The RCL dump manifold is located in the turret and disables crane functions when the RCL senses an impending tipping condition. The manifold dumps the HRC pressures for the crane functions that make the condition worse (hoist up, boom down, telescope out). The functions are returned when the impending tipping condition is eliminated.

Outrigger Control Manifolds

The outrigger manifolds control the outrigger functions. The outrigger circuit is set to operate at 20684 kPa (3000 psi)

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which is determined by a pressure relief valve located on the hydraulic pump.

Front Outrigger Manifold

The front outrigger manifold is located in the center of the front manifold and controls the extend and retract circuits for the front and rear outriggers. The manifold controls the outrigger component selection for the front outrigger.

Rear Outrigger Control Manifold

The rear outrigger manifold is mounted in the center of the rear outrigger. The rear outrigger manifold controls the selection of the rear outrigger components.

Hydraulic Tank

The hydraulic tank (Figure 2-10) is located behind the cab and has a capacity of 100 gallons to the full mark. The oil in the hydraulic tank is used to supply the oil to the hydraulic system when the hydraulic cylinders are extended.

Hydraulic Remote Controllers

The crane functions are controlled by hydraulic remote controllers (HRC) on the armrest of the operators seat. The controllers operate from a load sense pilot pressure which is applied to the bonnets on each side of the valve spools to shift the spool in the required direction.

HYDRAULIC VALVES

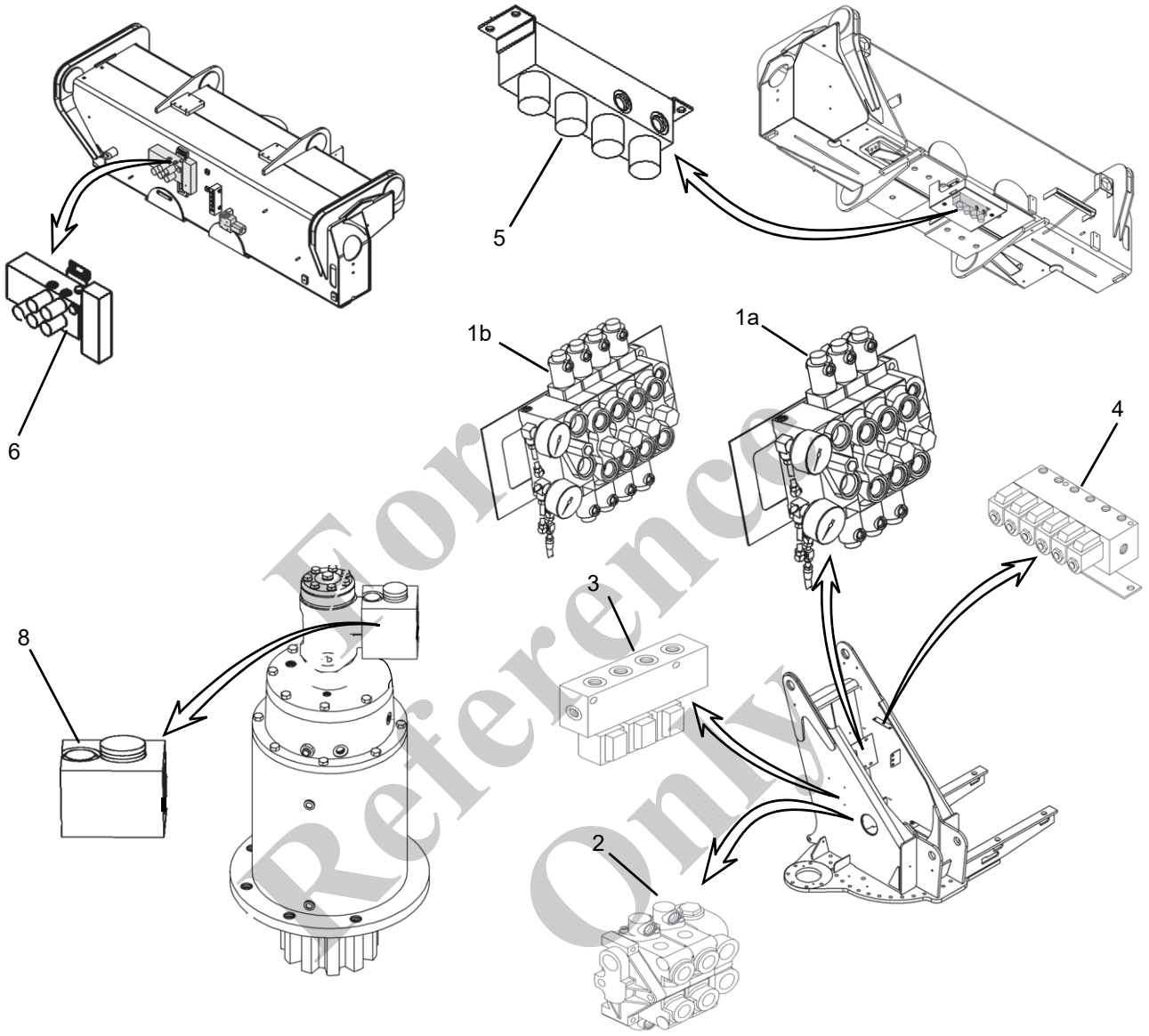
This section provides descriptive information for all the hydraulic valves used on this crane. For a listing of all valves, the circuit they are used in, and their physical location, refer to the table below. Refer to (Figure 2-1) for control valve and manifold locations. The description of each valve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

For Reference Only

Hydraulic Valves

Valve Name	Circuit Used In	Physical Location
Main Control Valve	Lift/Telescope(s)/Hoist(s)	Inside the turret.
Hydraulic Remote Controllers (HRC)	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 Speed Flow Control Valve	Swing	On swing motor
Holding Valves	Lift Telescope Outrigger	Port block on cylinder
Hoist Motor Control Valve	Hoist	Directional Control Valve
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	Single Front Outrigger
Flow Control Valve	Outriggers	Front outrigger box.
Telescope Pedal	Optional - with Aux Hoist	Cab Floor

Hydraulic Valve Locations



For Reference Only

Item	Component
1a	Main Control Valve (lift, telescope, hoist)
1b	Main Control Valve (Optional Aux Hoist)
2	Swing Control Valve
3	Pilot Valve (Air Conditioner/Swing Brake)
4	Dump Valve

Item	Component
5	Rear Outrigger Solenoid Manifold
6	Front Outrigger Solenoid Manifold
7	Outrigger Pressure Reducing Valve
8	Swing Speed Control Valve

FIGURE 2-1

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

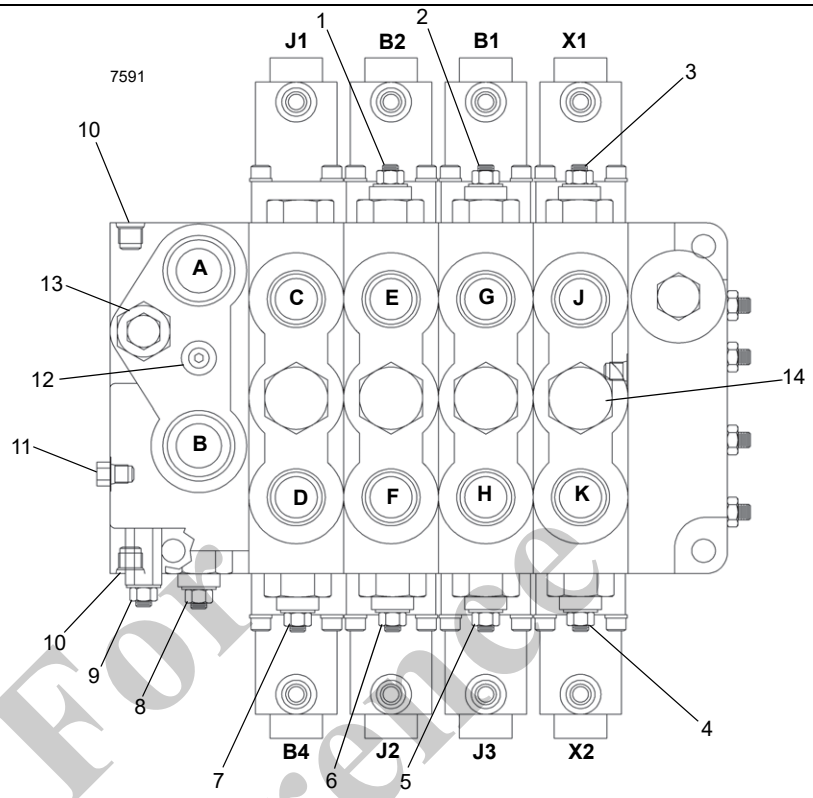


FIGURE 2-2

Main Control Valve (with Aux Hoist) Item Numbers

Item	Description	Item	Description	Item	Description
1	Aux Hoist Relief Valve - Up	6	Aux Hoist Relief Valve - up	11	Gauge Port
2	Tele Cyl Relief Valve - extend	7	Lift Cyl Relief Valve - up	12	Load Sense Bleed-Off
3	Main Hoist Relief Valve - raise	8	Main Relief Valve	13	Standby Pressure
4	Main Hoist Relief Valve - down	9	Load Sensing Relief	14	Check Valve (4 places)
5	Tele Cyl Relief Valve - retract	10	Pilot Supply		

Main Control Valve (with Aux Hoist) Port/Hosing

Port	Description	Port	Description	Port	Description
A	Outlet - swivel port 4	G	Tele Cyl - extend	B4	Hose - Dump Valve B1
B	Inlet - swivel port 3	H	Tele Cyl - retract	J1	Plugged
C	Lift Cyl - extend	J	Main Hoist Raise	J2	Hose - Dump Valve B2
D	Lift Cyl - retract	K	Main Hoist Down	J3	Plugged
E	Auxiliary Hoist - up	B1	Hose - Dump Valve B4	X1	Hose - Dump Valve B5
F	Auxiliary Hoist - down	B2	Hose - Dump Valve B3	X2	Hose - Dump Valve B6

For Reference Only

Main Control Valve (without Aux. Hoist) - 3 Section Valve

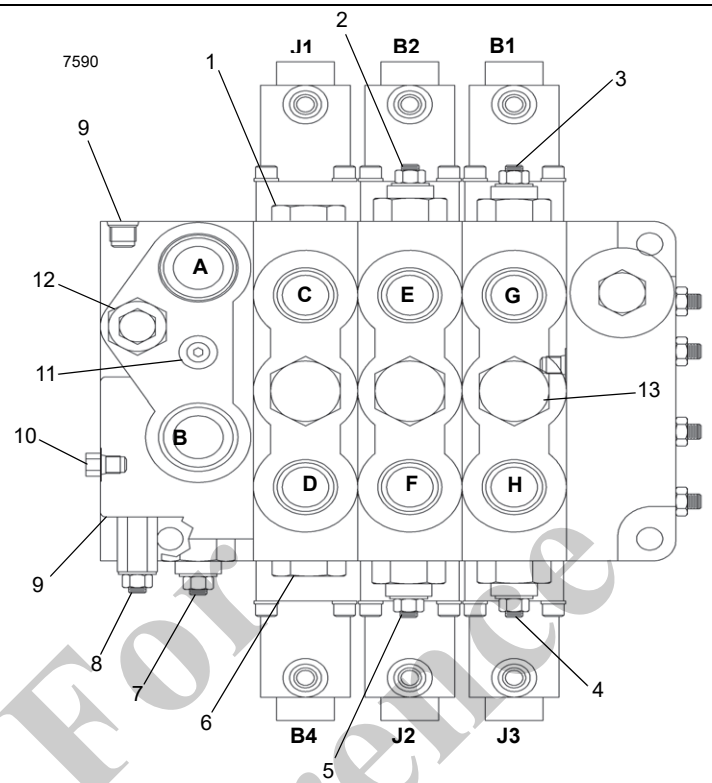


FIGURE 2-3

Main Control Valve Item Numbers - 3 Section

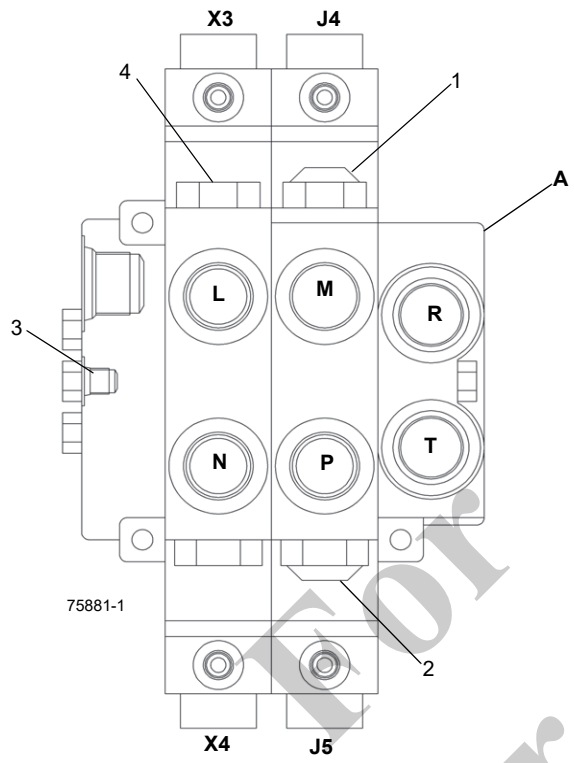
Item	Description	Item	Description	Item	Description
1	Lift Cyl Relief Valve - extend	6	Lift Cyl Relief Valve -	11	Load Sense Bleed-Off
2	Main Hoist Relief Valve - raise	7	Main Relief Valve	12	Standby Pressure
3	Tele Cyl Relief Valve - extend	8	Load Sensing Relief Valve	13	Check Valve (4 places)
4	Tele Cyl Relief Valve - retract	9	Pilot Supply		
5	Main Hoist Relief Valve - down	10	Gauge Port		

Main Control Valve Port/Hosing - 3 Section

Port	Description	Port	Description	Port	Description
A	Outlet - swivel port 4	G	Tele Cyl - extend	J2	Hose - Dump Valve B2
B	Inlet - swivel port 3	H	Tele Cyl - retract	J3	Plugged
C	Lift Cyl - extend	B1	Hose - Dump Valve B4		
D	Lift Cyl - retract	B2	Hose - Dump Valve B3		
E	Main Hoist - up	B4	Hose - Dump Valve B1		
F	Main Hoist - down	J1	Plugged		

For Reference Only

Swing Control Valve



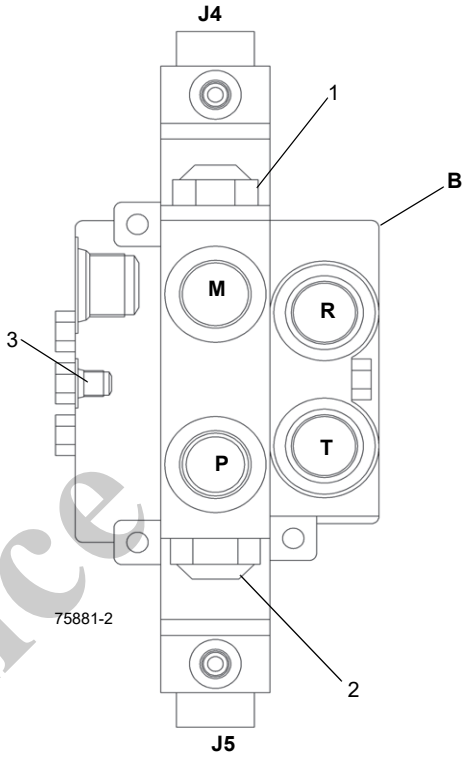


FIGURE 2-4

Swing Control Valve Item List & Port/Hosing

Item/Port	Description	Item/Port	Description	Item/Port	Description
A	Swing Control Valve w/Aux Hoist & A/C	J4		N	Hose - A/C Pressure
B	Swing Control Valve w/out A/C	J5		P	Hose - Swing Motor
1	Swing Relief Valve - Swing Motor	X3	Hose - Pilot Manifold A2	R	Outlet - Swivel 4A
2	Swing Relief Valve - Swing Motor	X4	Hose - Pilot Manifold P	T	Inlet - Swivel 3A
3	Load Sense Port - Swing Motor	L	Hose - A/C Return		
4	A/C Relief Valve	M	Hose - Swing Motor		

For Reference Only

RELIEF VALVE PRESSURE SETTING PROCEDURES

Description

The valves in the hydraulic system must be properly adjusted to protect a component, circuit, or system from over pressurization (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 34,500 kPa (0 to 5000 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 locknut 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 is to be 140° - 160°F.

CAUTION

Do not overtighten the adjustment screw or locknut.

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 - 60°C (120°F - 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.

For Reference Only

Relief Valve Pressure Settings

Valve To Be Set	Pressure Setting kPa (PSI)	Tolerance kPa (PSI)	Valve Adjustment Location
Telescope Retract Relief	15513 (2250)	±689 kPa (100 psi)	Main Control Valve
Telescope Extend Relief	18615 (2900)	±689 kPa (100 psi)	Main Control Valve
Load Sense Relief	28785 (4175)	±344 kPa (50 psi)	Main Control valve
Outrigger Relief (Flow Control Valve)	20684 (3000)	±689 kPa (100 psi)	Front Outrigger Box
Boom Up Relief	24821 (4550)	±344 kPa (50 psi)	Main Control Valve
Boom Down Relief	6894 (1000)	±689 kPa (100 psi)	Main Control Valve
Single Front Outrigger Extend (if equipped)	3447 (500)	±689 kPa (100 psi)	Port Block on SFO
Single Front Outrigger Retract (if equipped)	12065 (1750)	±689 kPa (100 psi)	Port Block on SFO
System Stand-by Pressure	2585 (375)	±344 kPa (50 psi)	Main Control Valve
Main/Aux Hoist Raise & Lower	29647 (4300)	±689 kPa (100 psi)	Main Control Valve
System/Boom Up Relief	31026 (4550)	±689 kPa (100 psi)	Main Control Valve
Swing Valve Relief (CW/CCW)	21373 (3100)	+689 kPa (200 psi) -0 PSI	Swing Control Valve
Air Conditioning Relief Valve	25855 (3750)	±689 kPa (100 psi)	Swing Control Valve
Single Front Outrigger Extend (if equipped)	3447 (500)	±689 kPa (100 psi)	Single Front Outrigger
Single Front Outrigger Retract (if equipped)	12065 (1750)	±689 kPa (100 psi)	Single Front Outrigger

System Pressure Check

Insert a T-connector with a pressure gauge in the hydraulic line at swivel port #3. This can be used to adjust the crane system hydraulic pressure.

Hoist

NOTE: The hoist hydraulic circuit relief is set by two relief valves on the main control valve.

1. Disconnect the two work port hoses (1, Figure 2-5) at the hoist motor and cap the hoist motor ports.
2. Plug the hoses.
3. Start the engine and set the throttle to governed rpm.
4. Try to hoist up or down. Adjust relief valves on the main control valve (Figure 2-2 & Figure 2-3) to 26200 ±689 kPa (4300 ±100 psi).
5. Shut down the engine.
6. Reconnect the hoses to the hoist.

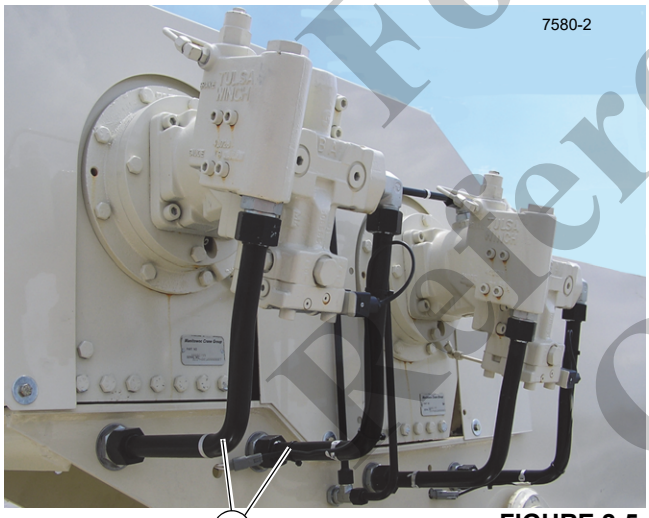


FIGURE 2-5

Boom Lift

1. Start the engine and set the throttle to governed rpm.
2. Boom down until the boom bottoms out.
3. Set the boom down relief valve on the main control valve (Figure 2-2 & Figure 2-3) to 6894 ±689 kPa (1000 ±100 psi).
4. Boom up until the boom stops or stop the engine, disconnect and cap the boom up hydraulic line.
5. Set the boom up relief valve on the main control valve (Figure 2-2 & Figure 2-3) to 24821 ±689 kPa (3600 ±100 psi)
6. Shutdown the engine.
7. Reconnect the boom up hydraulic line to the lift cylinder.

Telescope In and Telescope Out Reliefs

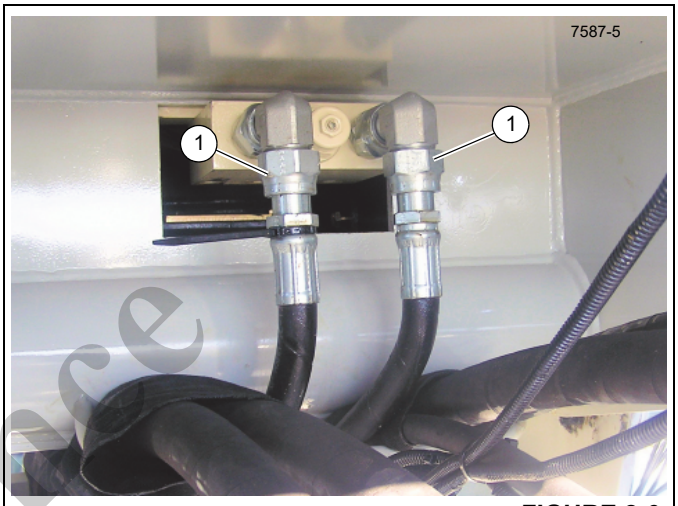


FIGURE 2-6

1. Remove the extend and retract (work port) hoses (1, Figure 2-6) from the telescope cylinder. Cap the telescope ports on the cylinder and plug the hoses.
2. Start the engine and set the throttle to governed rpm.
3. Push the telescope control lever to extend.
4. Adjust the telescope extend relief valve on the main control valve (Figure 2-2 & Figure 2-3) to 19994.8 ±689 kPa (2900 ±100 psi).
5. Pull the telescope control lever to retract.
6. Adjust the telescope retract relief valve on the main control valve (Figure 2-2 & Figure 2-3) to 15513 ±689 kPa (2250 ±100 psi).
7. Shut down the engine.
8. Reconnect the telescope cylinder hoses.

Outriggers

1. Select an outrigger (1, Figure 2-7) and remove one the hydraulic lines shown in Figure 2-7.
2. Install a tee connector with a pressure gauge in the disconnected line.

For Reference Only

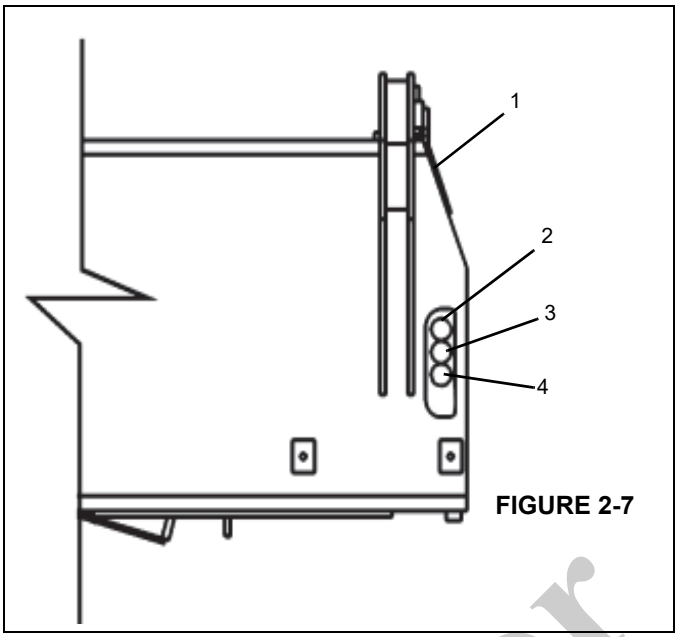


FIGURE 2-7

Figure 2-7 Table

Item	Description
1	Outrigger
2	Jack Cylinder - down
3	Bean Extension - out
4	Jack Cylinder/Bean Extension - up/out

3. Start engine and set throttle to governed rpm.
4. Activate the function for the selected outrigger hydraulic line and adjust the flow control relief valve (1, Figure 2-8) on the hydraulic pump manifold to 20684 kPa ±689 (3000 ±100 psi).

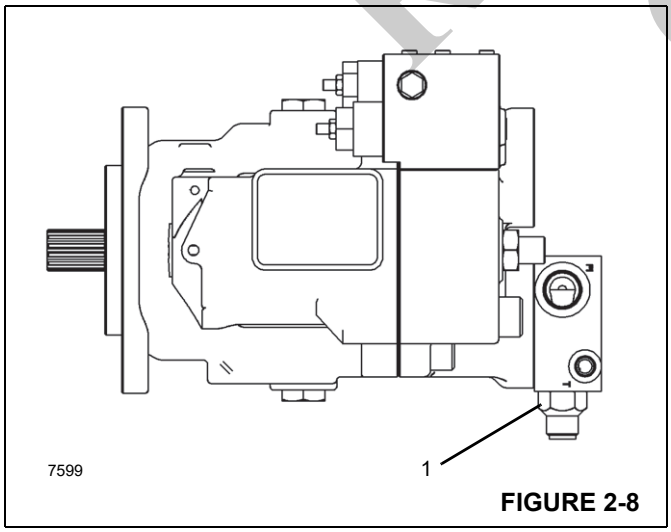


FIGURE 2-8

5. Shutdown the engine and disconnect the pressure gauge and reconnect the hydraulic line.

Swing Valve Relief

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

1. Disconnect the two work port hoses from the swing motor and cap the swing brake motor ports.
2. Plug one hose and install a gauge in the other hose.
3. Start engine and set throttle to governed rpm.
4. Activate the swing function and check for a pressure of 21373 kPa +689 -0 (3100 +200 - 0 psi).
5. Shut down the engine.
6. Remove the gauge from the one hose and install in the other hose. Plug the remaining open hose.
7. Start engine and set throttle to governed rpm.
8. Activate the swing function and check for a pressure of 21373 kPa +689 - 0 (3100 +200 - 0 psi).
9. Shut down the engine.
10. Replace swing relief valve(s) in the swing control valve (Figure 2-4) if pressure measured is not within specification.

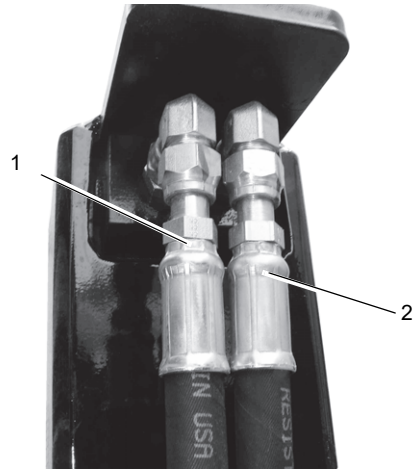
Single Front Outrigger (SFO) (if equipped)

1. Disconnect the SFO retract (1, Figure 2-9) and extend lines (2). Cap the retract line (1) and install a gauge in the extend line (2).

NOTE: Install a gauge in each line and set the extend and retract pressures as described below with extend/retract switch.

2. Start engine and set at governed rpm.
3. Depress the Single Front Outrigger extend/retract switch to extend.
4. Adjust the extend relief valve (4, Figure 2-9) on the single front outrigger port block to 3447 kPa +689/-0 (500 psi +100/-0).
5. Shut down the engine.
6. Remove the gauge from the extend line and install in the retract line. Cap the extend line.
7. Adjust the retract relief valve on the single front outrigger port block to 12065 kPa +689/-0 (1750 psi +100/-0)
8. Shutdown the engine, remove the gauge and cap, and reconnect the SFO hydraulic lines.

For Reference Only



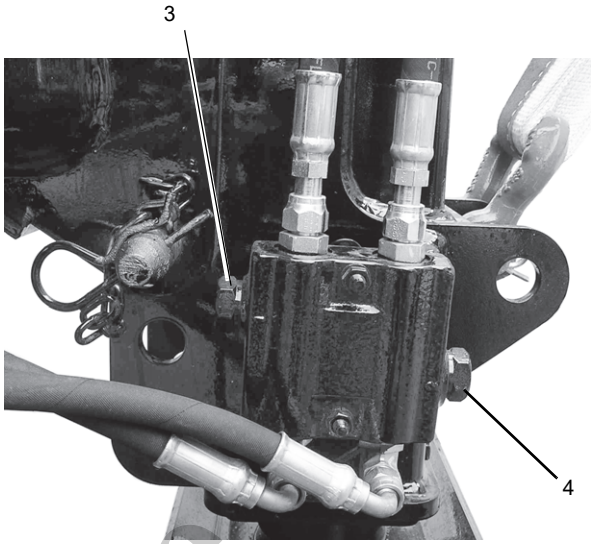


FIGURE 2-9

Hydraulic Reservoir and Filter

The reservoir, (Figure 2-10) is attached to the front of the truck bed and has a capacity of 100 U.S. gallons (378.5liters) to the full mark. The all-steel reservoir has an internally mounted full flow 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 at the top of the reservoir. The return lines that go directly into the reservoir (instead of through the filter) is from the swivel port 1, pump load sense, and outrigger return lines.

A magnetized drain plug in the bottom of the reservoir collects metal particles from the hydraulic oil if it becomes contaminated.

A sight gauge is located on the side of the reservoir to indicate hydraulic oil level.

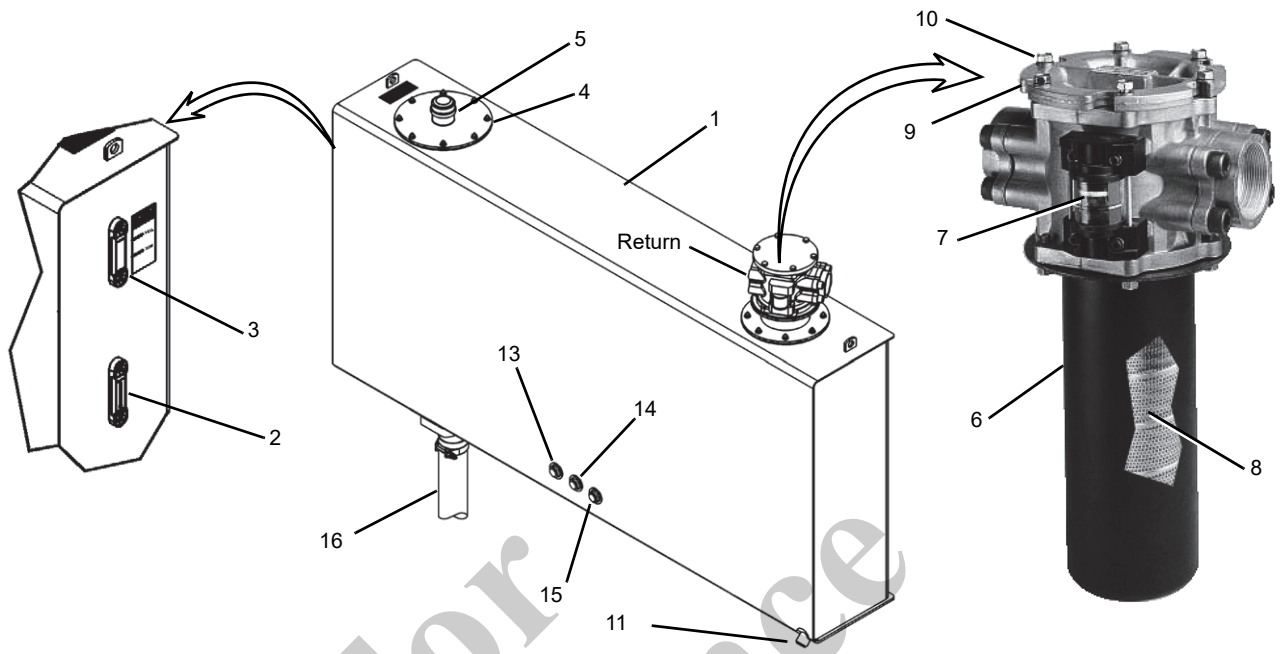
A filler cap on the top of the reservoir is for filling the reservoir. The filler cap includes a strainer for catching contaminants and gaskets to prevent leaking. A breather cap (vent) which is part of the filler cap allows air to enter or leave the reservoir. The breather must be kept clean to prevent damage to the reservoir.

A large access cover on the top of the reservoir provides access for cleaning. The cover is secured to the top of the reservoir with screws 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 (Figure 2-10) is located in the reservoir and bolts to the top of the reservoir. The filter housing contains a replaceable filter element.

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

For Reference Only



Item	Component
1	Hydraulic Reservoir
2	Temperature Gauge
3	Hydraulic Oil Level Gauge
4	Access Cover
5	Fill Cap
6	Bowl
7	Filter Element Gauge
8	Filter

Item	Component
9	Filter Cap
10	Capscrews (6)
11	Magnetic Drain Plug
12	Breather
13	Pump Load Sense Drain
14	Swivel Drain
15	Outrigger Drain
16	Suction to Pump

FIGURE 2-10

For Reference Only

Hydraulic Filter Replacement

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 assure the warranty remains in effect.

Element Removal

DANGER

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

1. Shut down the hydraulic system.
2. Wipe any dirt from the filter head and cap assembly.
3. Loosen the six bolts securing the filter cap to the filter head.
4. Twist to unlock and remove the filter cap.
5. Remove the filter element from the filter bowl (housing).
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 (housing).
2. Install the filter cap and twist to lock in place.
3. Tighten the six bolts to secure the filter cap.
4. Activate the hydraulic system and check for leaks. Make repairs as needed.

Hydraulic Oil Cooler

A hydraulic oil cooler (4, Figure 2-11) is located on the boom rest (7). The oil cooler return circuit (3) is in parallel with the reservoir return circuit (6). The oil cooler inlet (2) and return/ out circuits run through the by-pass block (5) on top of the reservoir (1). A 206 kPa (30 psi) check valve in the by-pass block (5) regulates flow through the oil cooler (9). 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 swivel port (4B) monitors the temperature of the hydraulic oil and illuminates a light on the crane cab console when the temperature reaches 96° C (205° F).

The oil cooler fan (9) is controlled by a relay in VEC module. To access the relay, remove the assess panel on the side of the housing. A temperature switch located in the cooling core energizes the fan relay when the oil temperature reaches 49 °C (120°F), the switch is connected to the oil cooler harness (8) at the temp sensor port.

NOTE: If the temperature sensor in the cooling core fails, the fan runs (9) continuously even when the crane ignition is off.

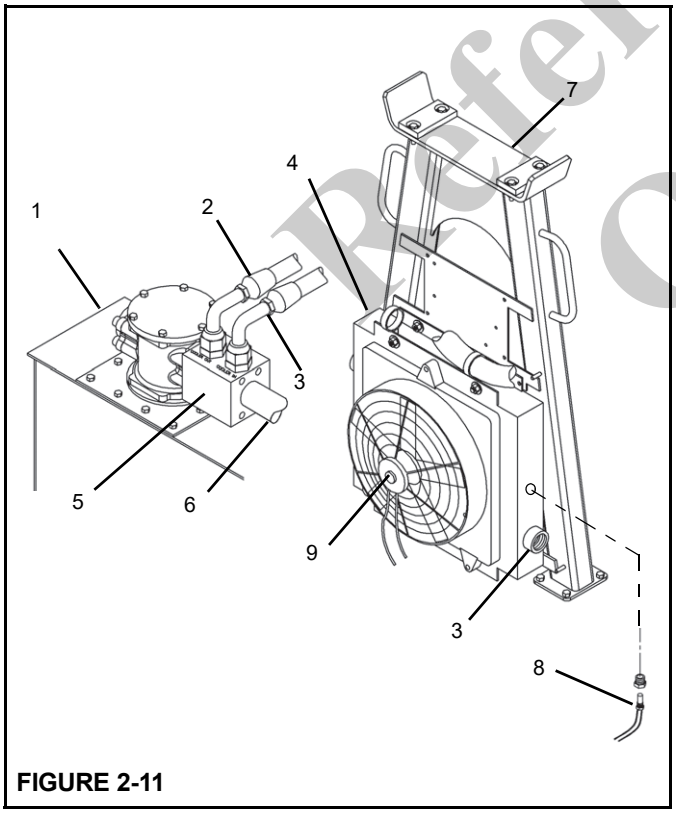


FIGURE 2-11

Oil Cooler Service & Maintenance

The heat exchanger must be kept clean to allow for efficient operation of the cooler system. Frequent washing of the heat exchanger core 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 back pressure from cold startup.

If the cooler 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 needs 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 control 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 a usually 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 check that the hydraulic system filter is still serviceable.

For Reference Only

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 they 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.

Main Control Valve

Removal

1. Tag and disconnect the hydraulic lines from the valve.
2. Cap the lines and plug ports.
3. Loosen and remove the valve mounting bolts and remove the valve bank.

Installation

1. Bolt the directional control valve to the enclosure.
2. Reinstall the hydraulic lines as per removal tags.

Functional Check

1. Start the engine and run it at normal speed.
2. Operate the control levers of the valve bank(s). Check for smooth operation of cylinders and motors.
3. Check the valve bank 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 operators seat. The controllers operate from a load sense pilot pressure which is generated by the pump and controlled by the main control valve. Pilot pressure is applied to the bonnets on each side of the control valve spools to shift the spool in the required 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 the optional front jack 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 boxes located on the side of the truck bed. An optional hand held outrigger control box can be installed in the crane cab.

Holding Valves

Pilot operated check valves located in the valve block on each cylinder acts as holding valve 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 located on the front console 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 is illuminated 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 crane manifold located in the turret to activate the controllers in the crane cab. The operator must be in the operators seat for the crane function power switch to be active.

HYDRAULIC PUMP

Description

The hydraulic system pressure is supplied by a axial piston hydraulic pump mounted on the truck power take off (PTO). The hydraulic piston pump requires a PTO rating of 55.9 kw (75 hp) per 1000 rpm of shaft speed with 644 N.m (475 lb-ft) of torque.

Removal

If pump replacement is required, the hydraulic fluid should also be replaced to avoid possible contamination.

1. Drain the hydraulic tank.
2. Tag and disconnect the hydraulic lines from the pump.
3. Remove the bolts from the pump rear mounting bracket.

For Reference Only

4. Remove the bolts from the pump mounting flange and slide the pump out of the PTO drive coupling.

Installation

1. Lubricate the splines on the pump and PTO drive shaft coupling with heavy lithium grease.
2. Line up the splines on the PTO drive shaft coupling with the pump drive shaft and slide the pump drive shaft into the coupling.
3. Bolt the pump (1, Figure 2-12) to the PTO with the pump mounting flange.
4. Bolt the pump rear mounting bracket to the truck mounting bracket.

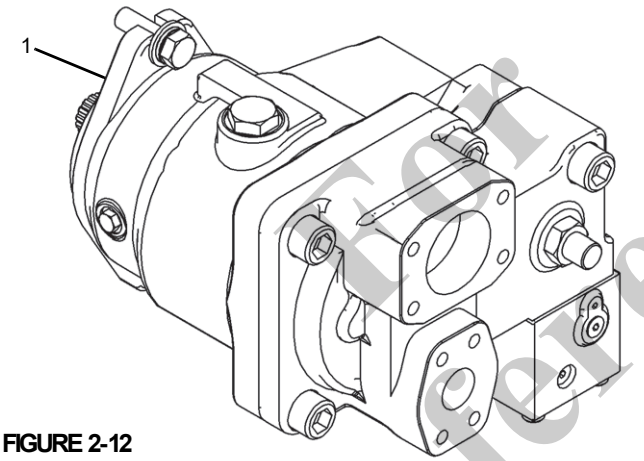


FIGURE 2-12

5. Reconnect the hydraulic lines as per removal tags.
6. Start up the pump following procedures described under *Pump Start-up*, page 2-19.

Pump Start-up

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

1. Install pump on PTO following procedures described under *Installation*, page 2-19.
2. Fill the reservoir with hydraulic oil.

CAUTION

The supply line shut-off valve must be open to allow flow to the pump to prevent pump damage.

3. Open the shut-off valve on the hydraulic line from the reservoir to the pump.
4. Fill the pump housing with hydraulic fluid. Pour the oil directly into the upper most case drain port.
5. Fill the inlet line from the pump to the reservoir with hydraulic oil. Check the line for properly tightened fittings, and be certain it is free of restrictions and air leaks.
6. Inspect the case drain line for leaks and restrictions.
7. Install a gauge at the pump pressure gauge port on the Main Directional Control Valve Manifold.
8. Start the engine and engage the PTO while monitoring the pressure gauge. Do not operate any hydraulic levers. If the pump does not build up pressure to 51 to 55 bar (750 to 800 psi), shut down the engine and take corrective action.
9. Idle the engine 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 2-20.
12. Check/adjust maximum pump pressure; see *Maximum Pump Pressure Setting*, page 2-20.
13. Remove pressure gauge. Check hydraulic oil level in reservoir and fill if needed.

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Table 2-1 Pressure Settings

Pump Margin Pressure	Maximum Pump Pressure	Load Sense Relief Valve Pressure
25.8 bar ±3.4 bar (375 psi ±50 psi)	310 bar -0 +3.4 bar (4500 psi -0+50 psi)	287.8 bar ±6.8 bar (4175 psi ±100 psi)

Pump Margin Pressure Setting

1. Install a gauge at the pump pressure gauge port (2) on the Main Directional Control Valve Manifold, Figure 2-14.
2. Idle engine with PTO engaged and do not operate any functions.
3. Verify margin pressure is 25.8 bar ±3.4 bar (375 psi ±50 psi).

   If margin pressure is not correct, adjust Load Sense (LS) Adjusting Screw (2, Figure 2-13) at pump. Turn screw (2) clockwise to increase the setting; each turn gains 18.9 bar (275 psi). Tighten lock nut 12 lb-ft to secure the setting.

Maximum Pump Pressure Setting

Install a gauge at the pump pressure gauge port (2) on the Main Directional Control Valve Manifold, Figure 2-14.

Crane Preparation

1. Prepare the crane to check the maximum pump pressure setting by doing one of the following:
2. Start engine and engage PTO.
3. Raise boom to its maximum elevation or cap both boom hoses.
4. Activate boom up to increase pump pressure to maximum setting.

Adjust Maximum Pressure

1. Idle engine with PTO engaged.
2. Verify maximum pump pressure is at correct settings (see Table 2-1, “Pressure Settings,” on page 20).
3. If maximum pressure is incorrect, adjust Pressure Compensating (PC) adjusting screw.

- Loosen locknut and turn PC adjustment screw (1, Figure 2-13) clockwise to increase the setting; each turn gains 99.9 bar (1450 psi). Tighten lock nut 16.2 nm (12 lb-ft) to secure setting.
- Reset the LSRV setting (see Load Sense Relief Valve Pressure Setting).

Load Sense Relief Valve Pressure Setting

1. 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

- Idle engine with the PTO engaged.
- Use method #1 or #2 and hold the joystick controller. Verify the LSRV pressure is at correct setting (see Table 2-1, “Pressure Settings,” on page 20).
- If LSRV pressure is not correct, adjust LSRV adjusting screw. Loosen locknut and adjust the setting. Turn PC adjustment screw (1, Figure 2-13) clockwise to increase the setting; each turn gains 58.6 bar (850 psi). Tighten lock nut 5.4 nm (4 lb-ft) to secure setting.

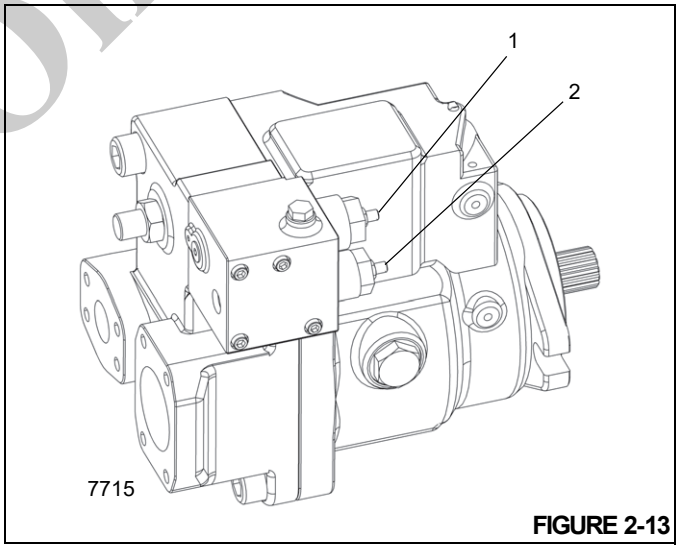

FIGURE 2-13

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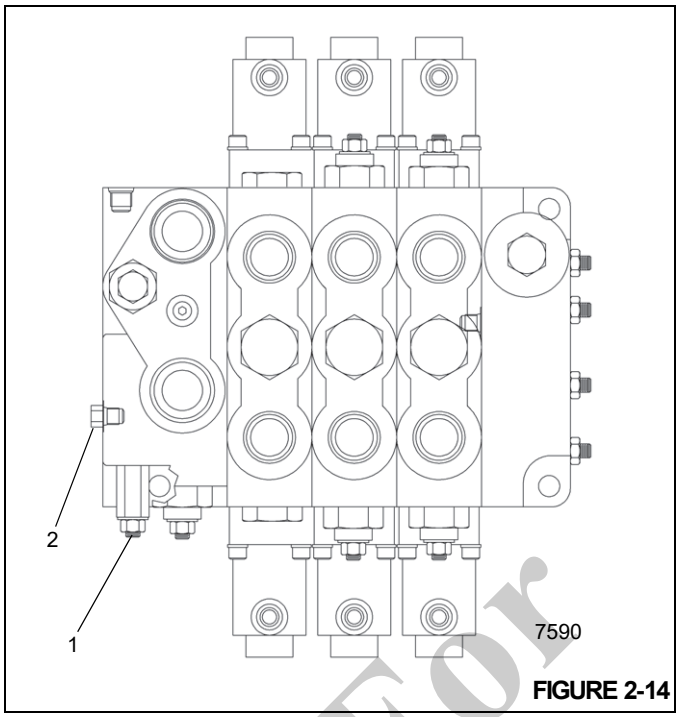

FIGURE 2-14

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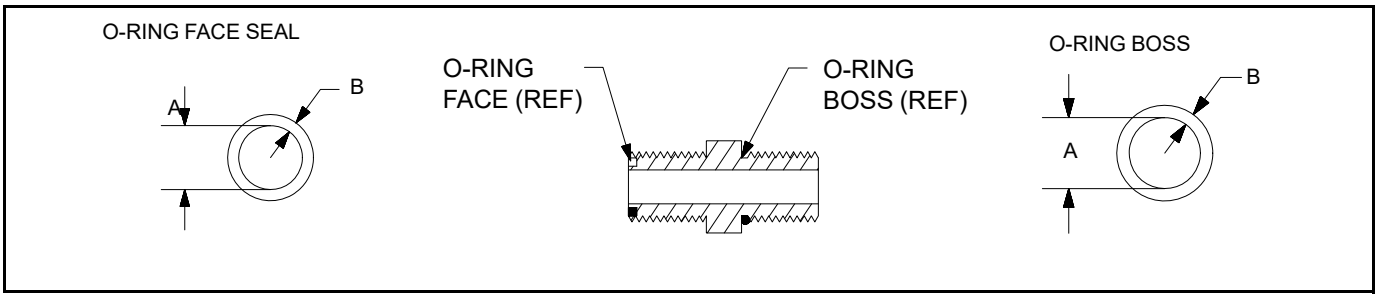

O-RING FACE SEAL			FITTING SIZE		O-RING BOSS		
THREAD SIZE	B inches (mm)	A inches (mm)	TUBE O. D.	MFGR'S SIZE CODE	A inches (mm)	B inches (mm)	THREAD SIZE
9/16-18	.07 (1.78)	.301 (7.64)	.250	4	.351 (8.92)	.072 (1.83)	7/16-20
11/16-16	.07 (1.78)	.364 (9.24)	.375	6	.458 (11.63)	.078 (1.98)	9/16-18
13/16-16	.07 (1.78)	.489(12.42)	.500	8	.644 (16.36)	.087 (2.21)	3/4-16
1-14	.07 (1.78)	.614 (15.60)	.625	10	.755 (19.18)	.097 (2.46)	7/8-14
1 3/16-12	.07 (1.78)	.739 (18.77)	.750	12	.924 (23.47)	.116 (2.95)	1 1/16-12
1 7/16-12	.07 (1.78)	.926 (23.52)	1.000	16	1.171 (29.74)	.116 (2.95)	1 5/16-12
1 11/16-12	.07 (1.78)	1.176 (29.87)	1.250	20	1.475 (37.46)	.118 (3.00)	1 5/8-12
2-12	.07 (1.78)	1.489 (37.82)	1.500	24	1.720 (43.69)	.118 (3.00)	1 7/8-12
NOTE: Contact your National Crane Distributor or Manitowoc Crane Care for O-Ring boss seal kits.							

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TROUBLE DIAGNOSIS

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.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
No hydraulic oil flows in systems.	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.

CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
Slow response.	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 section(s).	Repair or replace pump section(s) or entire 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 lines.	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.	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.	Insure RCL is programmed properly and Anti-Two Block/ Overload solenoids are powered.
	PTO not engaged.	Engage PTO.
	Low hydraulic fluid supply.	Check and fill as required.
	Suction line blocked.	Drain tank and hose and remove blockage.
	Broken hydraulic pressure line.	Replace as required.
	Defective hydraulic pump.	See Pump Service Manual.
	Incorrect relief valve setting.	Adjust relief.
	Relief valve sticking.	Clean relief or replace.
	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.
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 bad part.
	Plugged filter.	Change filter.

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CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
Poor hydraulic system performance (continued)	Valve spools not fully open.	Pilot pressure at valve bonnets should be 0.7 to 2.4 MPa (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.
Turn moves erratic or loosely (Glide Swing System)	Loose swing bearing.	Torque bearing mounting bolts.
	Loose swing gearbox mounting bolts.	Torque bolts.
	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 2.1 - 3.4 MPa (300 - 500 PSI).
	Dynamic brake not properly applying.	Check dynamic brake pressure. Must modulate between 0 - 3.4 MPa (0 - 500 PSI).
Turn 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 2.0 - 3.4 MPa(300 - 500 PS).
	Swing speed adjustment set too low.	Adjust valve on turn motor.
Turn 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.
Turn 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 1.4 MPa (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.

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CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
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 forshutdown.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.
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.	Reshim 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.

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CONDITION	POSSIBLE CAUSE	POSSIBLE SOLUTION
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 3.45 MPa (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 0.7 - 1 MPa (100 - 140 PSI) and be at full speed at 2.1 - 2.4 MPa (300 - 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.

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SECTION 3
ELECTRIC SYSTEM

SECTION CONTENTS

3

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DESCRIPTION

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

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

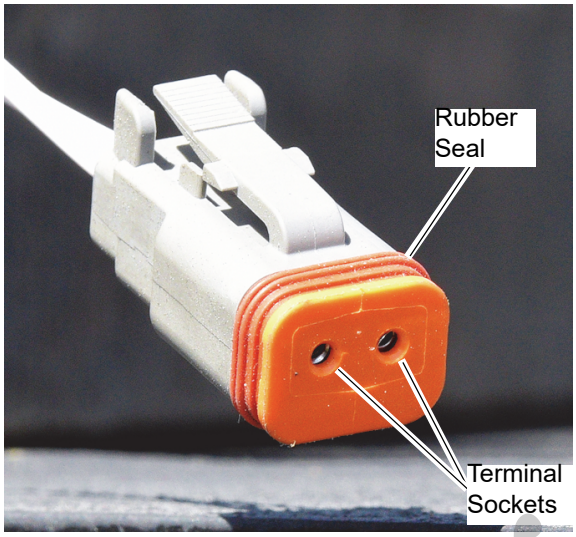
Do not apply dielectric grease to the following connections:

- 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. Trouble shoot 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 electrical system, you need a Windows-based personal computer, CAN-Link service software, and a connection cable.

Manitowoc Crane Care requests you have as part of your service tool kit inventory the CAN-Link service tool kit for the NBT40. The software will allow you to see in real time the status of all inputs and outputs on the system, and it will allow you to detect any errors on input or output. The CAN-Link service software and connection cable are available through Crane Care to those service technicians who have attended the Grove New Technology 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. Refer to 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 switch at a time can be energized.

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

When the crane ignition switch at the operators station is set to RUN and the PTO engaged, the throttle pedal in the operators station overrides the truck cab throttle, the RCL system is powered, and the crane functions

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can be activated. The outrigger controls are disabled when the crane function power switch is ON.

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 3-3.

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.

RCL SYSTEM DESCRIPTION

The RCL monitors crane operation and alerts the operator of stability or structural limits based on the load chart. The crane functions that worsen the condition (hoist up, boom down, telescope out) are disabled. A RCL override key switch is located behind the operator's seat. Turn the key switch ON to override the RCL. The RCL memory always has power supplied by the truck battery even when the truck ignition is in the OFF position.

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

RCL & ATB System Description

The anti-two-block system (ATB) is part of the RCL system that helps prevent damage to the hoist cable by sensing when the end of the hoist cable is near the boom tip and disables the functions that cause a two block condition.

Normal functioning is restored by hoisting down or retracting boom until the ATB weight is suspended freely. The ATB system is incorporated into the crane RCL system.

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 ATB/RCL cable (1, Figure 3-2) runs from the ATB reel (2) through the boom and to the ATB switch assembly (4). The ATB switch assembly cable is attached to the anti-two block weight (5).

The 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 end running down through the turret to the boom lift cylinder pressure transducer (6) and the other end to the cab operator's console.

Two hydraulic hoses (7) run from the pressure transducer (6) to the lift cylinder holding valve.

To replace the ATB/RCL (1) and the RCL cable (3) disconnect the cable at the anti-two block switch (4), cab operator's console and the cylinder pressure transducer (6) and then remove the cable from the reel (2).

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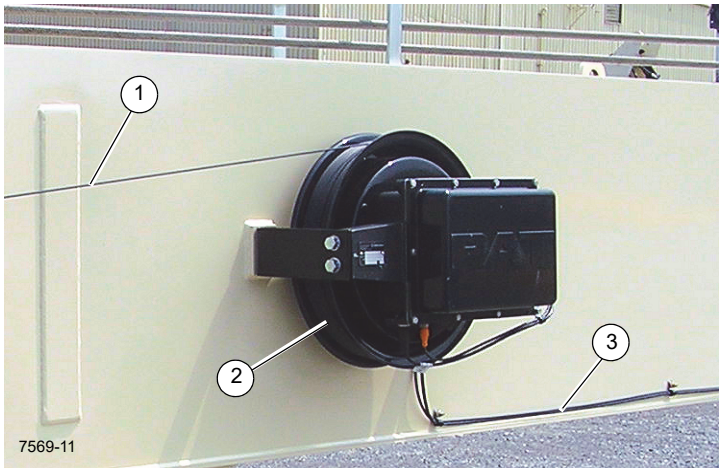

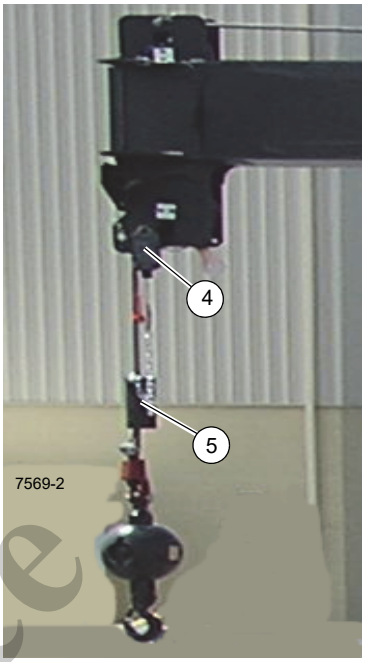

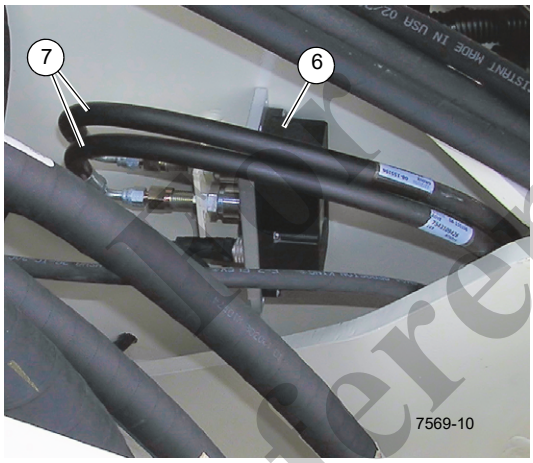

FIGURE 3-2

CAB MODULE, FUSE, RELAY PANEL

The cab and superstructure fuse/relay panel (9, Figure 3-3) is located behind the operator's seat. Remove the two screws securing the access panel to gain access to the fuse blocks, relays, cab control module, interface connectors and the cab RCL module.

NOTE: The cab control modules and RCL module are not serviceable; contact Crane Care Customer Service with any service or repair questions about the modules.

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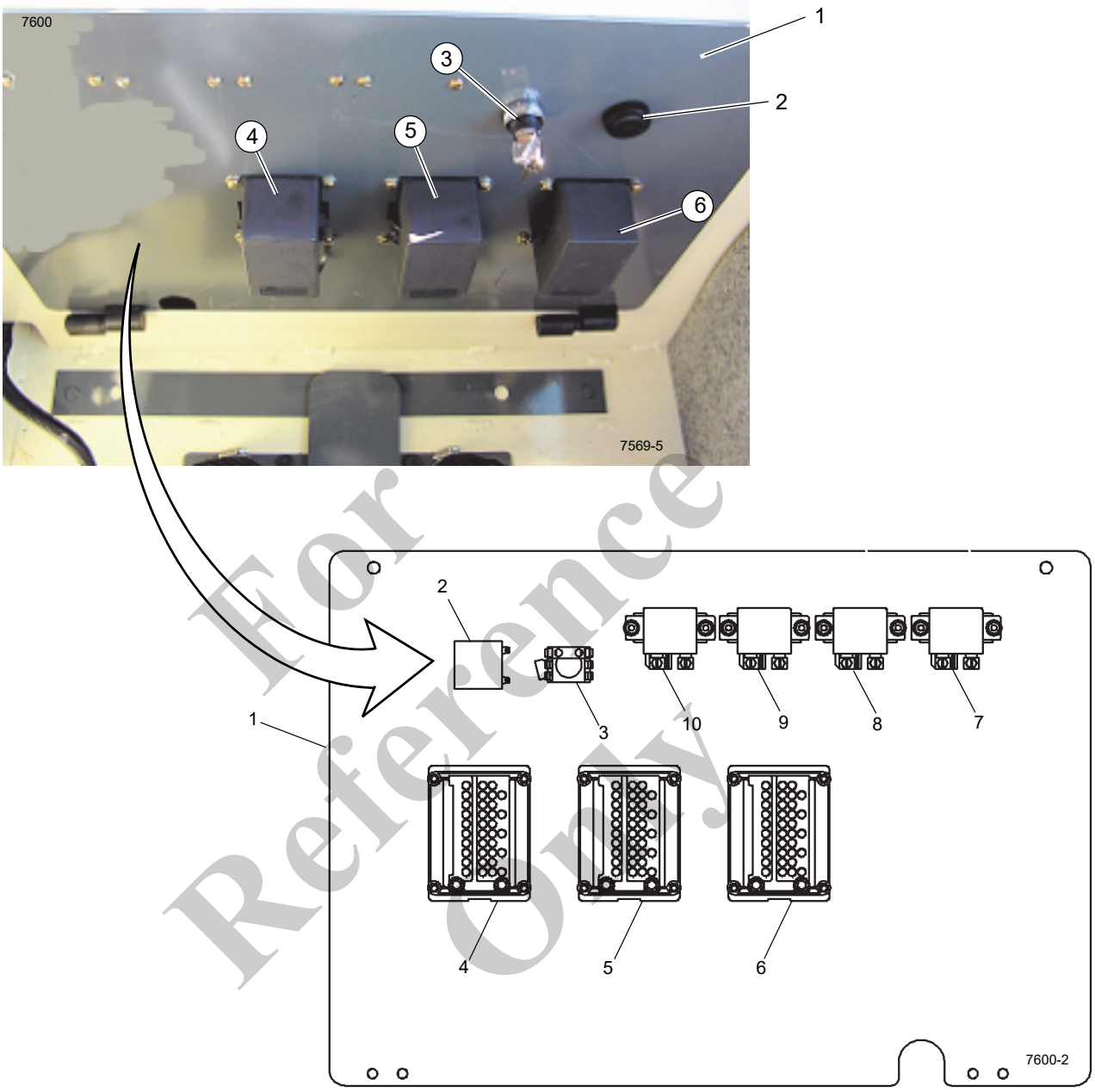

FIGURE 3-3

Figure 3-3 Item Numbers

Item	Component
1	Access Panel
2	Buzzer, 3rd Wrap Indicator
3	RCL Bypass Key Switch
4	Fuse Box #3
5	Fuse Box #2
6	Fuse Box #1
7	ACC Relay
8	Crane Relay
9	Remote Relay
10	HVAC Relay

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Fuse Box #1

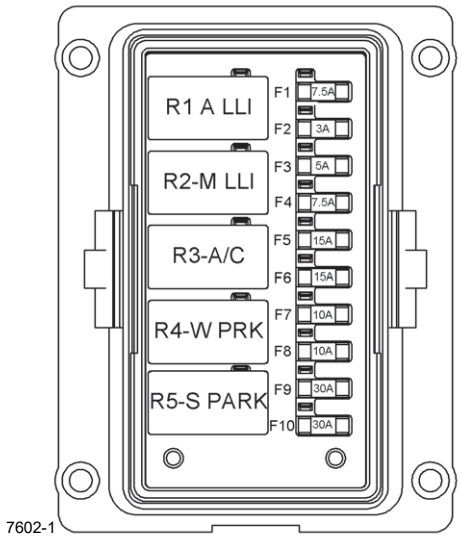

FIGURE 3-4

Micro Relay Fuse Box #1

The micro relay fuse block (4, 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 circuit
- R2 - Main Hoist 3rd Wrap Indicator circuit
- R3 - Air Conditioner Power Relay
- R4 - Windshield Wiper and Park Switch
- R5 - Skylight Wiper and Park Switch
- F1- Spare - Crane/Remote Power Relay
- F2 - Windshield Wiper Circuit - 3 amp
- F3 - Spare - 5 amp
- F4 - Crane/remote Power Relay and Crane Power Switch - 7.5 amp
- F5 - Air Condition Power Relay - 15 amp
- F6 - RCL Power and Override Switch, Circulation Fan Switch - 15 amp
- F7 - Horn, Horn Relay and Horn Switch - 10 amp
- F8 - Heater and Air Conditioner Controls - 10 amp
- F9 - Spare - 30 amp
- F10 - HVAC Power Relay - 30 amp

Fuse Box #2

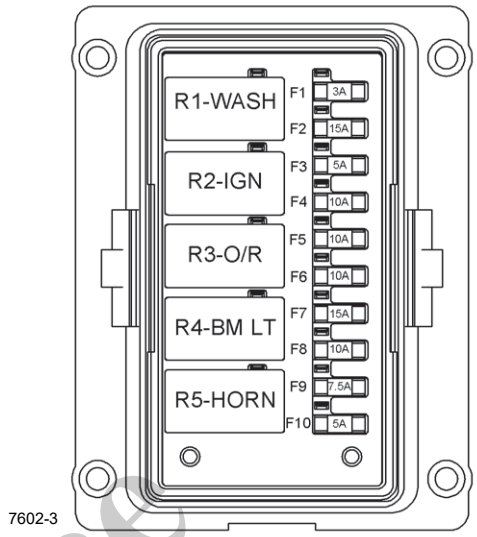

FIGURE 3-5

Micro Relay Fuse Box #2

The micro relay fuse block (5, Figure 3-3) is located in the middle of the fuse relay panel and contains the following components, see Figure 3-5:

- R1 - Washer Relay
- R2 - Ignition Relay
- R3 - Outrigger Control Relay
- R4 - Boom Lights Relay
- R5 - Horn Relay
- F1- Washer Relay - 3 amp
- F2 - Cab Work Lights, Cab Fan- 15 amp
- F3 - Spare - 5 amp
- F4 - Windshield Wiper - 10 amp
- F5 - RCL Power -10 amp
- F6 - Skylight Wiper - 10 amp
- F7 - Boom Lights - 15 amp
- F8 - 12V Charger - 10 amp
- F9 - Horn - 7.5 amp
- F10 - Seat Switch- 5 amp

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Fuse Box #3

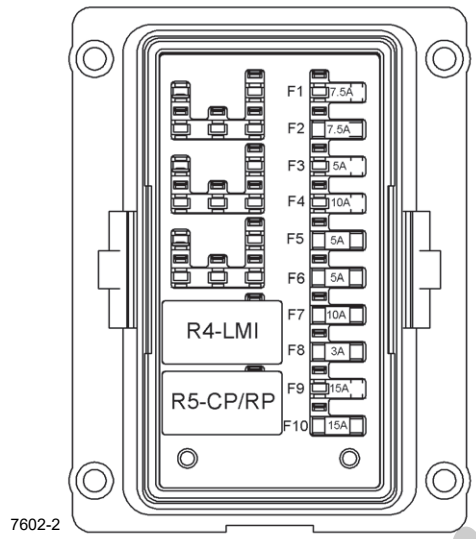

FIGURE 3-6

Micro Relay Fuse Box #3

The micro relay fuse block (6, Figure 3-3) is located on the right side of the fuse relay panel and contains the following components, Figure 3-6:

- R1 - Not Used
- R2 - Not Used
- R3 - Not Used
- R4 - Rated Capacity Limiter (RCL) Relay
- R5 - Crane Power and Remote Power
- F1 - Spare - 7.5 amp
- F2 - Hoist Speed Switch - 7.5 amp
- F3 - Spare - 5 amp
- F4 - Spare - 10 amp
- F5 - 3rd Wrap Lockout Solenoid - 5 amp
- F6 - Swing Brake Power, Hoist Thumper - 5 amp
- F7 - RCL Lockout Solenoid - 10 amp
- F8 - Hoist DRI/3rd Wrap Sensor - 3 amp
- F9 - Spare - 15 amp
- F10 - Outrigger Power - 15 amp

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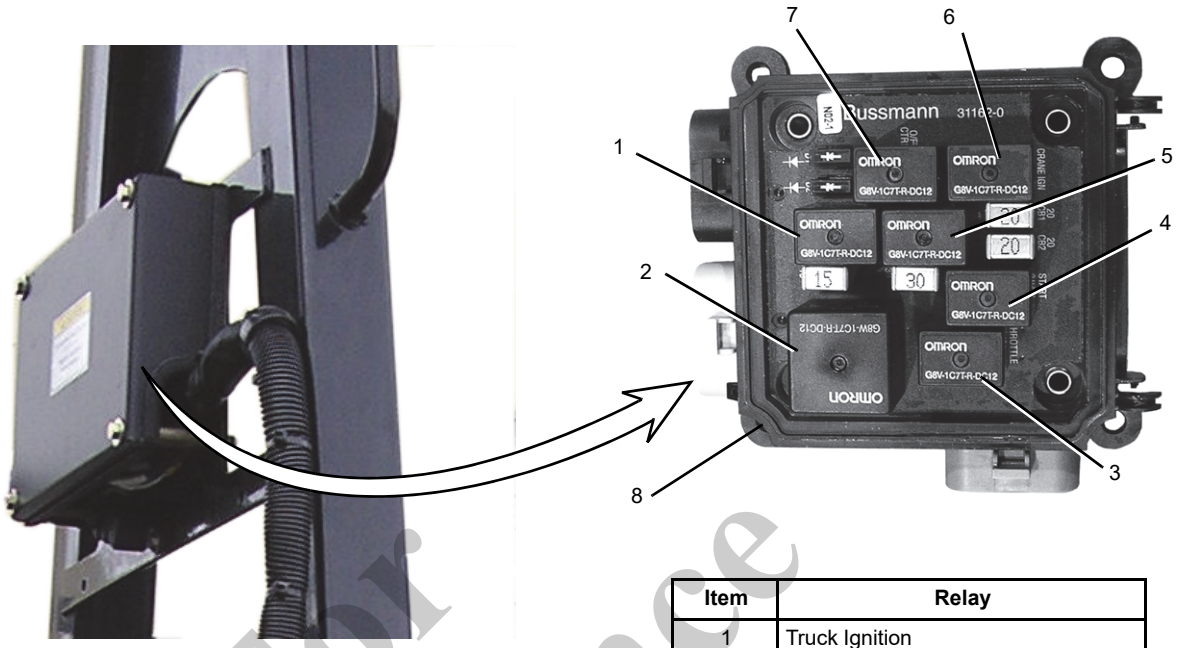

Item	Relay
1	Truck Ignition
2	Oil Cooler
3	Throttle Control
4	Engine Start
5	Outrigger Power
6	Crane Ignition
7	Outrigger Control

FIGURE 3-7

For Reference Only

VEC MODULE

The Vehicle Electrical Center (VEC) module (8, Figure 3-7) is located in an enclosure on the boom rest above the front outrigger manifold. The VEC module contains the following relays and circuit breakers:

- Truck ignition relay (1) disables the truck ignition when the engine is started from the crane cab or with the radio remote. The engine cannot be turned off from the truck cab when this relay is energized.
- Oil cooler relay (2) powers the oil cooler fan when the oil temperature switch closes.
- Throttle control relay (3) switches the throttle control from the truck to the crane. The radio remote option disables this relay when the truck is started with the radio remote.
- The engine start relay (4) energizes the engine starter circuit from the crane cab ignition or radio remote.
- Item 5 not used.
- Crane Ignition relay (6) disables the crane ignition switch when the truck is running.

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.

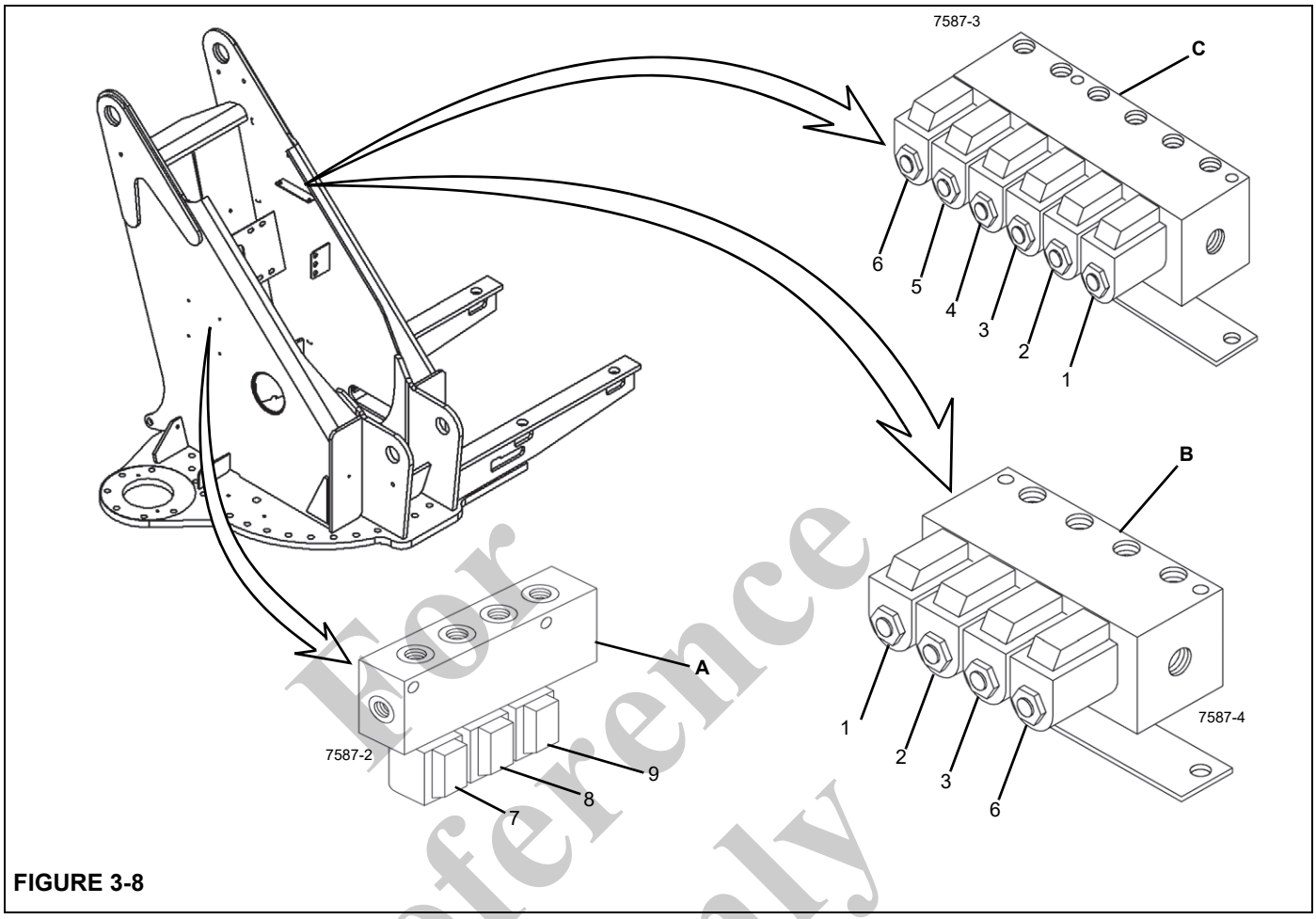

FIGURE 3-8

For Reference Only

Figure 3-7 Item List

Item	Solenoid Valve
1	Main Hoist Down
2	Main Hoist Up
3	Boom Telescope Extend
4	Auxiliary Hoist Up (optional)
5	Auxiliary Hoist Down (optional)
6	Lift Cylinder Retract
7	Crane Function Power
8	Air Conditioner or Plugged
9	Swing Brake
A	Crane Manifold Valve
B	Dump Valve (4 section)
C	Dump Valve (6 section, optional)

Crane Manifold Solenoids

The RCL and ATB solenoids are located on either the 6 or 4 section Dump Valve (B or C, Figure 3-8); they disable the crane operations that worsen an impending tipping or two block conditions. The operations listed below are disabled when the solenoids are energized.

1. Main Hoist Down
2. Main Hoist Up
3. Boom Telescope Cylinder - Extend the Boom
4. Auxiliary Hoist Up (optional)
5. Aux Hoist down (optional)
6. Lift Cylinder Retract - Boom Down

The crane manifold solenoids are located on the crane manifold valve (A, Figure 3-8) and provide for the following operations.

7. Crane Function Power - enables all crane functions when energized.
8. Air Conditioner - runs the air conditioner compressor when energized, if not used this port is plugged.
9. Swing Brake - applies the swing park brake when energized.

Before replacing a 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. This insulates the connection and prevents solenoid operation.

Fault	Check
RCL/A2B Solenoids fail to energize	• RCL relay R4 in the mini fuse block • Fuse F9 in the mini fuse block • Faulty RCL override switches • Fuse F7 in micro fuse block • Faulty crane power switch
3rd Wrap Indicator Switch solenoid fails to energize	• Faulty 3rd Wrap switch • Fuse F5 or F8 on the mini fuse block. • Faulty solenoid
Crane function power solenoid fails to energize	• Faulty crane power switch • Faulty solenoid • Fuse F1 or F10 in micro fuse block

OUTRIGGER MANIFOLDS

There are two outrigger manifolds located on the carrier frame. The front outrigger manifold is mounted on the center of the front outrigger box (Figure 3-9) and the rear outrigger manifold is mounted at the rear of the truck under the T-box (Figure 3-10).

The swing and outrigger functions are on the same hydraulic circuit however, only one function at a time can be working. When the crane function power switch is turned ON, the outrigger manifolds are disabled.

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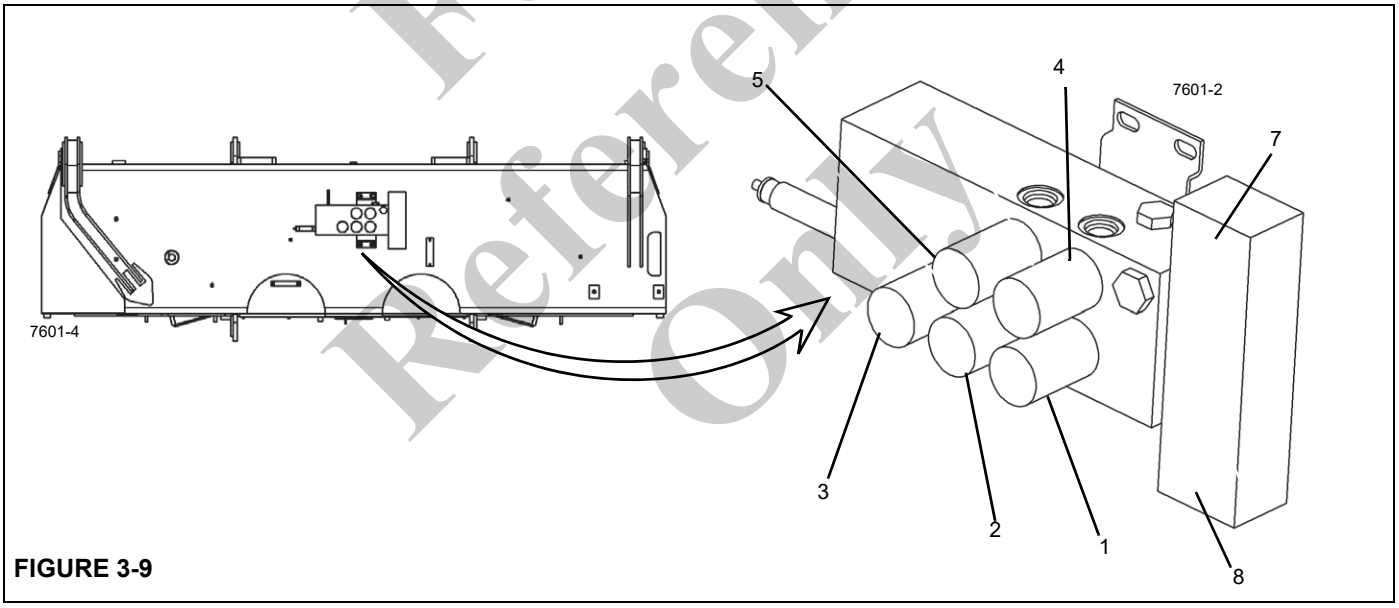

FIGURE 3-9

Figure 3-8 Item List

Item	Solenoid
1	Driver Side O/R Jack
2	Driver Side O/R Beam
3	Single Front Outrigger (SFO)

Item	Solenoid
4	Passenger Side O/R Beam
5	Passenger Side O/R Jack
7	Outrigger Extend
8	Outrigger Retract

Front Outrigger Manifold

The solenoids on the front outrigger manifold control the selection of the front outrigger components, 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 (3) solenoid extends or retracts the SFO when energized. Any time 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 3-9 for solenoid identification.
- The extend (7) retract (8) 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 3-10 (1 through 4) for solenoid identification.

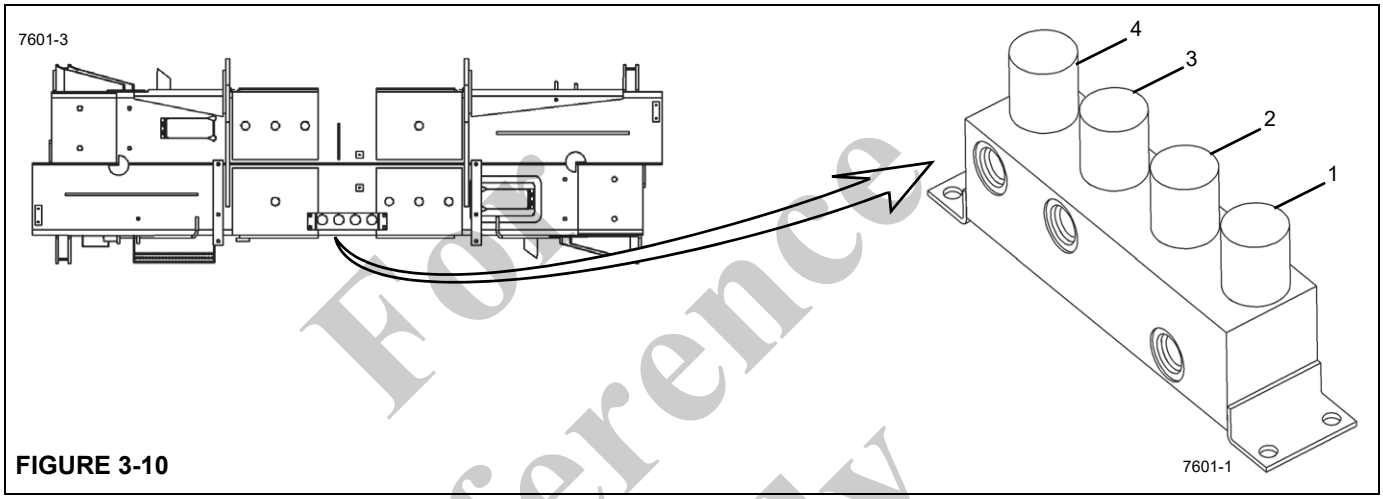

FIGURE 3-10

Figure 3-9 Item List

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

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HYDRAULIC OIL COOLER

The hydraulic oil cooler (3, Figure 3-11) 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).

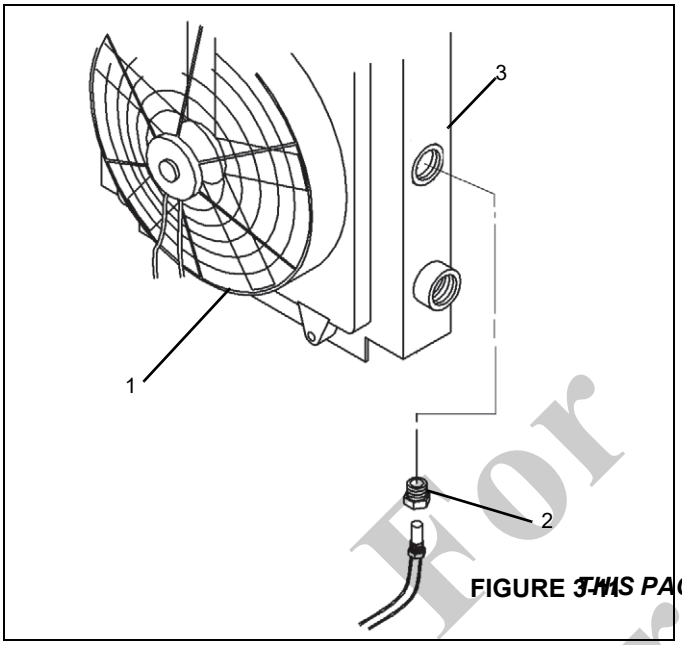

FIGURE 3-11

Not all return flow is routed through the oil cooler. A 206 kPa (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 3-11), 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 3-7) and turns the fan on when energized. If the fan does not run when the hydraulic oil is hot check the temperature sensor, relay, 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 #4 monitors the temperature of the return oil and turns the light on when the hydraulic oil reaches 96° C (205° F). If the light fails to illuminate, check the light and the temperature sensor in swivel port #4.

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SECTION 4
BOOM MAINTENANCE

SECTION CONTENTS

4

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FOUR SECTION BOOM

A two-stage, rod-fed, double-acting cylinder is attached to and supports the 1st, 2nd and 3rd stage boom sections.

The 2/3/4 extend cables (Figure 4-1) attach to the base of the 2nd stage boom, are reeved around sheaves at the tip of the 3rd stage cylinder and attach to the base and support the 4th stage boom.

The 4/3/2 retract cables (Figure 4-1) are attached to the base of the 4th stage boom, are reeved around sheaves at the base of the 3rd stage boom and attach to the tip of the 2nd stage boom.

The 1/2/3 extend cables (Figure 4-1) attach to the base of the 1st stage boom, are reeved around sheaves at the tip of the 2nd stage boom and attach to the base of the 3rd stage boom.

The 3/2/1 retract cables (Figure 4-1) attach to the base of the 3rd stage boom, are reeved around sheaves at the base of the 2nd stage boom and attach to the tip of the 1st stage boom.

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

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

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

A single stage cylinder will control first extendable section.

A dual stage cylinder will control second extendable section.

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

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

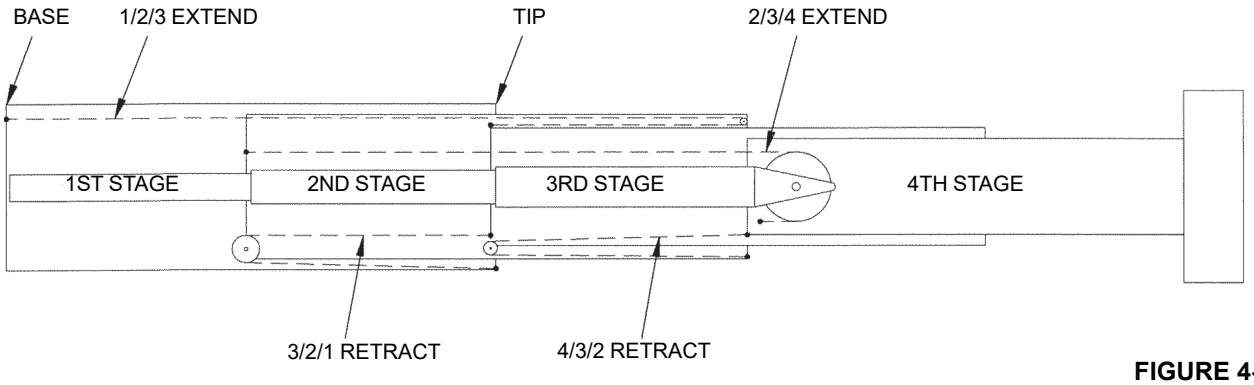

FIGURE 4-1

Reference Figure 4-1, Figure 4-2, Figure 4-4 and Figure 4-5 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 machine outriggers and Single Front Outrigger. Boom must be completely retracted and stowed in boom rest over front of truck.
2. If equipped, remove swing around jib according to procedures outlined in the Set-Up Section of the Operator's Manual.
3. Remove hook block or downhaul weight, wind up rope on hoist drum and stow wedge socket becket on pegs provided on 1st section. Shut down truck engine.
4. Attach lifting device to the counterweight to provide even weight distribution and raise the counterweight until weight is removed from the boom pivot pin. Remove 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 rod end of lift cylinder, remove boom lift cylinder pin keeper and pin from bottom of 1st section boom. Lower lift cylinder rod end to the deck.
6. Tag and disconnect extend cylinder lines and hoist hydraulic and electric lines. Cap all openings. Unplug anti-two-block/RCL cord from receptacle in turret.
7. Disconnect and cap all hoist hydraulic lines and openings. Hoist may be removed at this point, but 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 boom pivot pin keeper and boom pivot pin. Lift boom free of turret.

Additional Maintenance, Disassembled Boom

1. Clean all boom sections and inspect for wear, dents, bent or crooked boom sections, gouged metal, broken welds or any abnormal conditions. Repair or replace as required.
2. Inspect all sheaves for excessive groove wear or abnormal rim wear. Replace as required.
3. Inspect all sheave bearings for excessive wear or cut inner liner material. If installed bearing diameter is 0.015 in larger than pin diameter, bearing must be replaced. Any cut or gouge which causes the bearing liner to lose strands is cause for bearing replacement.
4. Clean and inspect all cable assemblies according to wire rope inspection procedures in this section. Pay particular attention to any wire breakage at the end connections. Replace cable assemblies as required. Lubricate all cable assemblies before reinstalling them in boom.
5. Inspect all sheave pins for nicks, gouges or pitting due to rust in the bearing surface area. Replace if any damage is evident.
6. Inspect all grease fittings and grease paths in pins to ensure proper grease flow. Clean and replace as required.
7. Replace all lubricating plugs (36) in all wear pads as necessary.

Four Section Cable Tensioning

After Boom Assembly or if Interior proportioning cables appear loose, cable tensioning may be required.

Tensioning Setup Procedure

Tensioning must be done with the boom in the horizontal position. reference Figure 4-4

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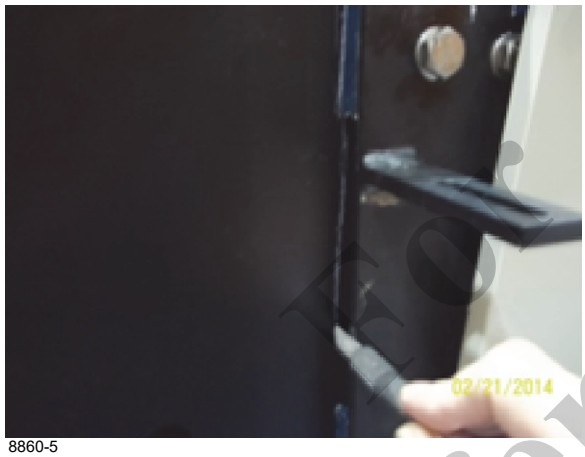
When tightening/loosening the first (adjustment) nuts on cables, secure cable using the wrench flats at the front of the cable ends to prevent cable twist. Excess twisting of cables can cause premature failure.

Ensure boom is completely assembled and fully retracted.

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



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8860-6

FIGURE 4-2

Cable Tightening Sequence

1. Cycle boom approximately 3 m (10 ft) out and in a few times (.75 m (2.5 ft per section). Fully retract the boom. Tighten the 4/3/2 retract, 2/3/4 extend, 3/2/1 retract and 1/2/3 extend cables (Steps 2-5) to remove slack and properly sequence bottoming out of boom sections.
2. Torque 4/3/2 retract cables at front of the 2nd section to 5.42 Nm (4 ft lbs). Start with two inside cable ends equally, then the two outside cable ends equally.
3. Torque 2/3/4 extend cables at back of 2nd section to 30.51 Nm (22.5 ft lb) each. To reach 2/3/4 extend cables, extend the boom out approximately 610 mm (24 in.); 115 mm (4.56 in) per section, and tighten through hole in back of base section.
4. Equally torque 3/2/1 retract cables at front of base section to 4.07 Nm (3 ft lb), start with two inside cable ends, then the two next outside cable ends, then the two outside cable ends.
5. Torque 1/2/3 extend cables, (rear base section) to 14.91 Nm (11 ft lb) each.
6. Check to ensure all boom sections are bottoming out simultaneously.
   a. If the 2nd section is bottoming out first, equally loosen 1/2/3 extend cables, tighten 3/2/1 retract cables, tighten 1/2/3 extend cables, and extend and retract the boom a few feet. Torque 3/2/1 retract cables as in step 4 and torque 1/2/3 extend cables as in step 5. Repeat until 2nd section bottoms out correctly.
   b. If 3rd section is bottoming out first, equally loosen 3/2/1 retract cables, tighten 1/2/3 extend cables, and extend and retract the boom a few feet. Torque 3/2/1 retract cables as in step 4 and torque 1/2/3 extend cables as in step 5. Repeat until 3rd section bottoms out correctly.
   c. If 4th section is bottoming out first, equally loosen 4/3/2 retract cables, tighten 2/3/4 extend cables, and extend and retract the boom a few feet. Torque 4/3/2 retract cables as in step 2 and torque 2/3/4 extend cables as in step 3. Repeat until 4th section bottoms out correctly.

   Repeat step 6 until all sections are bottoming out simultaneously.
7. Repeat steps 2 through 5 using the following torques. Torque 4/3/2 retract cables to 10.852 Nm (8 ft lb). Torque 2/3/4 extend cables to 61.01 Nm (45 ft lb) torque 3/2/1

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retract cables to 8.13 Nm (6 ft lb). Torque 1/2/3 extend cable to 29.83 Nm (22 ft lb).

8. Cycle the boom through a complete extend and retract cycle. Check that all cables are properly torqued and that all sections retract completely.

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

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

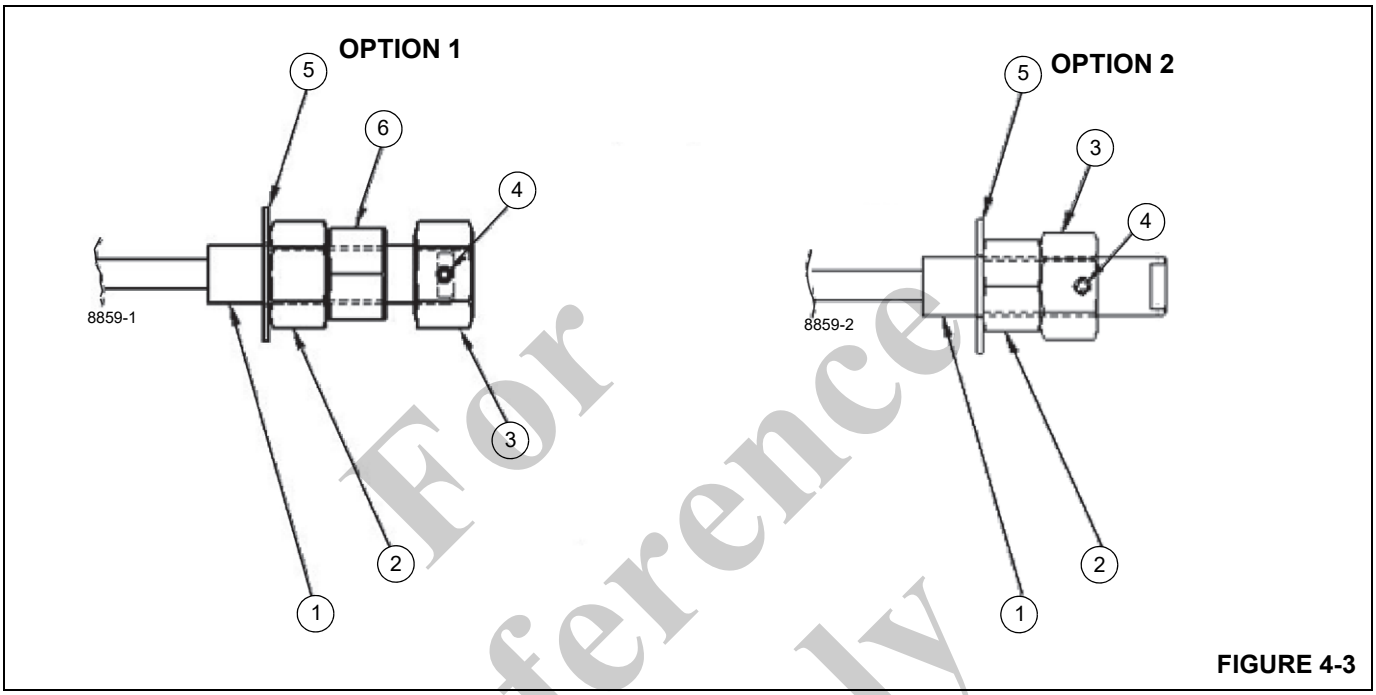

FIGURE 4-3

Cable Retention

Cable Retention Hardware

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

Nut configuration (see Figure 4-3) will be First Nut (ADJUSTMENT) and Second Nut (TORQUED).

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

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

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

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

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

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

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

Install set screw into Third nut and tighten.

Install cable protectors to all threaded cable ends.

(**OPTION 2**) method used ONLY when space constraints prevent **OPTION 1** usage (see Figure 4-3).

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TORQUE VALUES for Second Nut:

Inch Series with Coarse Threads (UNC)

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

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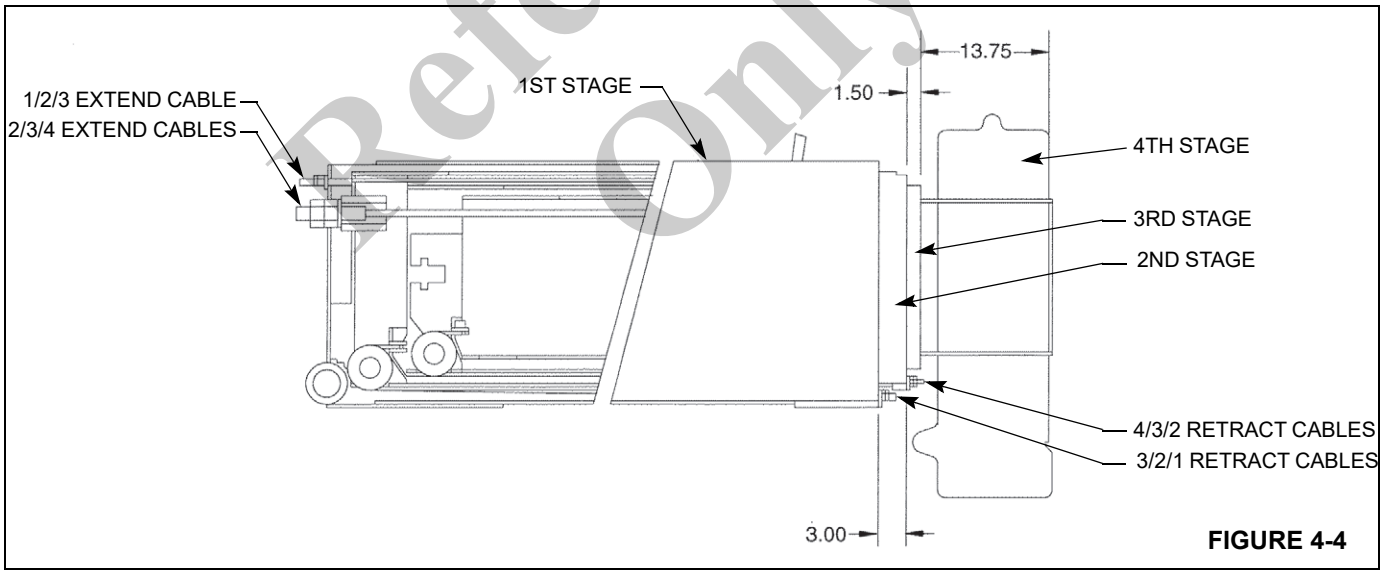

FIGURE 4-4

Four Section Top/bottom Pad Replacement, Assembled Boom

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

Excessive wear is wear in excess of 3/16 in from original thickness (1st, 2nd and 3rd stage bottom tip pads are 31.8mm (1.25 in) thick, and 2nd and 3rd stage top pads are 28.6mm (1.125 in) thick, 4th stage top pads are 11.6mm (.45 in) thick or uneven wear such as the outside edge of the pad worn in excess of 3/32 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 0.06 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 13.50 in (4.50 in per stage) so that upper wear pads on 3rd stage boom are visible through holes in the top plates of the 1st and 2nd stage booms.
2. Remove countersunk capscrews from the top base of the 3rd stage boom wear pad retaining plates and remove wear pad retaining plates from the 3rd stage boom. Mark these retaining plates so they can be reinstalled exactly as they were removed. Remove 3rd stage boom 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 base of the 1st stage boom. Tie the 1/2/3 extend cables with approximately 2 ft of wire and allow them to slack into the 1st stage boom removing cables from notch in 3rd stage boom pads.
4. Replace the 3rd stage boom wear pads and reinstall wear pad retaining plates exactly as removed onto the top plate of the 3rd stage boom. Loctite all flathead mounting screws.
5. If necessary, reinstall the 1/2/3 extend cables into the base of the 1st stage boom and reinstall the nuts which secure these cables to their original location previously marked on the threaded cable ends.
6. Extend the boom approximately 31.5 in (10.44 in per stage) so that upper wear pads on 2nd stage boom are visible through hole in the top plate of the 1st stage boom.
7. Remove countersunk capscrews from the top base of the 2nd stage boom wear pad retaining plates and slide wear pad retaining plates towards the center of boom. Mark these retaining plates so they can be reinstalled exactly as removed. Remove the 2nd stage boom wear pads.
8. Replace the 2nd stage boom wear pads and reinstall wear pad retaining plates onto the top plate of the 2nd stage boom exactly as removed. Loctite all flathead mounting screws.
9. Extend the boom approximately 40.7 ft (162.75 in per stage) so that base of the 4th stage boom passes the hole in the side plate of the 3rd stage boom. Raise the 4th stage boom tip to relieve pressure on wear pads on the top base of the 4th stage boom.
10. Remove countersunk capscrews from the bottom of the top plate on the base of the 4th stage boom that attach the wear pad retaining plates to the 4th stage boom.
11. Slide wear pad retaining plates and wear pads toward base of boom and remove. Mark the wear pad retaining plates so they can be reinstalled exactly as removed.
12. Replace the 4th stage boom wear pads and reinstall wear pad retaining plates exactly as removed onto the top plate of the 4th stage boom. Loctite all flathead mounting screws.

Bottom Pad Replacement

1. Lower the boom until the boom lift cylinder is bottomed out and extend the boom approximately six ft out (two ft per stage).
2. Raise the 4th stage boom tip, until weight is removed from the bottom pads in the 3rd, 2nd and 1st stage booms.
3. Remove the capscrews (two in each pad) which retain the 2nd and 1st stage boom bottom wear pads and remove and replace pads. Reinstall capscrews, Loctite and torque to proper tightness.
4. Remove the capscrews (two in each pad) which retain the 3rd stage boom bottom wear pads and remove and replace pads. Reinstall capscrews, Loctite and torque to proper tightness

4 Section Boom Disassembly

For reference, front (tip) is sheave case end, rear (base) is hoist mount end, 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 1st section and jib (if equipped) left on crane. all

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other steps apply to boom being removed from crane (See “Boom Removal” on page 4-2).

1. Extend and set the outriggers and 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 all lines and openings.
4. Loosen and remove two capscrews (11,8) and hardened washers which anchor the 1st stage extend cylinder rod (5) to the base of the 1st stage boom.
5. Mark the location of the nuts and washer (9,8) which secure the 1/2/3 extend cables (10) to the rear base of the 1st stage boom base section (1). Remove nuts and washers from 1/2/3 extend cables at 1st stage boom base. Mark and tag cables while leaving the cable ends draped inside the boom.
6. Remove hardware (125,126) and access plate (124) from top/rear of 1st section.
7. Attach a sling or chain to the tip of the 2nd stage boom and pull the 2nd stage boom (with the 3rd, and 4th stages) out approximately one foot or until the access openings on all boom sections align to the rear wear pad assemblies for all boom sections. Tag and remove rear wear pads from top of each boom section. Loosen attaching hardware for the adjusting cam plates and all rear top wear pads for all boom sections being removed.
8. Remove and tag attaching hardware (28,40,61) on front tip of lower 1st stage boom section. Loosen wear pad adjustment hardware (104,97) wear pads (63) and back plates (22,70).
9. Remove and tag upper plate (16) and shim (101) and hardware (23,21,56) from tip of 1st stage boom.
10. Remove and tag two upper side wear pad assemblies (163) with keeper side wear pad (164,160) and hardware (162,161) from tip of 1st stage boom.
11. Loosen cable adjusting nuts (113,12) on lower front 3/2/1 retract cables (19). Remove four capscrews (27) which retain the 3/2/1 retract cable anchors plates (115) to the bottom tip of the 1st stage boom. Pull the retract cable anchors out and keep retract cables taunt while pulling 2nd (with 3rd, and 4th) stage out of 1st stage. Partially pull 2nd stage boom from boom assembly until front tip of boom can be raised enough to remove and tag wear pads (165,166) and hardware (20,49) from bottom tip of 1st stage boom. Support the base end of the 2nd stage as it exits the 1st stage boom.
12. Place 2nd stage (with 3rd, and 4th) on a suitable horizontal surface.

NOTE: Use caution not to pinch or crush retract cables while lifting or supporting 2nd stage boom.

13. Tag and remove rear wear pads and shims from base of 2nd stage boom if replacing.
14. Remove capscrew (66) and retract cable guide roller (32) from each side of the bottom base of the 2nd stage boom.
15. Remove the two square head setscrews (117) which retain 3/4 retract sheave pin (38). Pull the retract sheave pin with retract sheaves (114) and bearing (35) spacers (36) and snap ring (37) assembled back out of its slot at the base of the 2nd stage boom. Smooth out any burrs which may be present on flat ends of pin to eliminate sheave bearing damage when sheaves are removed from pin.
16. Remove two capscrews (107), retract cable keeper bracket (108) and cable anchor assembly (51) from lower base at rear of 3rd stage boom. Store 3/2/1 retract cables (19), which are now free, in an area where they will not be damaged during further boom disassembly.
17. Mark the location of the nuts which secure the 2/3/4 extend cables (29) to the base of 2nd stage boom. Remove six large nuts (31), spacer (152) and the 2/3/4 extend cable anchor assembly (30) from the top/base of the 2nd stage boom.
18. Remove two socket head screws (118) and two socket flathead screws (27) which retain the wear pad (39) to 2/3/4 extend cable anchor (30) attached to the top/base of the 2nd stage boom.
19. Attach a sling or chain to the tip of the 3rd stage boom and pull 3rd stage boom (with the 4th stage) out approximately one foot. Remove and tag two lower side wear pads (15) with shims (14,13) and two upper side wear pads (164,163,160,162,161) from front tip of 2nd stage boom. Remove and tag two top inner steel pad (58) and shim (102) from tip of the 2nd stage section.
20. Remove and tag cable retainer assembly and hardware (54,33,56,21,55,57) located top front tip of the 2nd stage boom.
21. Slide the 1/2/3 extend cable sheave case assembly (44,45,46,47,43) out from the top/front tip of the 2nd stage boom and allow the sheave case assembly and cables (10) to rest on the top of the 3rd stage boom.
22. Loosen adjustment nuts (12,113) from retract cable (53) and remove four capscrews (27) which retain the 4/3/2 retract cable anchor plate assembly (26) to the bottom tip of the 2nd stage boom.
23. Raise tip of boom and remove wear pads (17) from between bottom tip of the 2nd stage and 3rd stage boom. Pull the retract cable anchors out and keep the retract cables taunt while pulling the 3rd, and 4th stage booms out of the 2nd stage boom.

For Reference Only

24. Place the 3rd, and 4th stage booms on a suitable horizontal surface.

NOTE: Use caution not to pinch or crush retract cables while lifting or supporting 3rd stage boom.

25. Tag and remove rear wear pads and shims from base of 3rd stage boom if replacing.

26. Remove the 1/2/3 extend cable (10) from top of 3rd stage boom base. Slide the top center rear sheave (71) toward the rear of boom and remove. Pull the cable (10) loop forward and remove from sheave keeper. Cable is now free at base of boom. Push the two sheaves at the front tip of the 2nd stage boom forward and remove them from the 1/2/3 extend cable sheave case assembly (44) and sheaves (46) previously removed and stored at the tip of the 3rd stage boom. 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 which may be present on the flat ends of the pins to eliminate sheave bearing damage and if necessary to remove pins from tip sheaves (47).

27. Loosen and remove two capscrews (27) retaining wear pad (72) to top base of 3rd stage boom. Loosen and remove two capscrews (48) lockwashers (49) and keepers (50) which anchor the extend cylinder (5) at the center base of the 3rd stage boom. Attach a sling to the base of the extend cylinder and pull the extend cylinder out of the 3rd stage boom approximately one foot keeping 2/3/4 extend cables taunt. Raise and support extend cylinder approximately five inches using a suitable block (wood).

NOTE: Avoid damage to retract cable roller (65) when lifting cylinder.

28. Remove capscrew (74) and retract cable roller (65) from each side of the bottom base of the 3rd stage boom. Pull the retract sheave pin (38) with retract sheaves assemblies (34,35,36,37) back out of its slot at the bottom base of the 3rd stage boom. Smooth out any burrs which may be present on flat ends of pin to eliminate sheave bearing damage if sheaves are removed from pin. Stow cable (53) out of way to avoid damage.

29. Push the 4/3/2 retract cable anchor assembly (78) forward out of its slot in the bottom base of the 4th stage boom and remove from 4th stage boom with wear pad (112) attached. Remove 4/3/2 retract cables (53) from 4/3/2 retract anchor (78) and store in an area where they will not be damaged during further boom disassembly.

30. Mark the location of the nuts which secure the 4/3/2 retract cables (53) to the tip of the 2nd stage boom and loosen nuts (12,113) and remove plate (26) and capscrew (27) from the threaded cable end.

31. Pull the 4/3/2 retract-2/3/4 extend pin (77) with cables (29) as an assembly out of slot in the bottom base of the 4th stage boom and drape out of the base of the 3rd stage boom.

32. Lower extend cylinder (5) to original position. Attach a sling or chain to the tip of the 4th stage boom and pull the 4th stage boom out of the 3rd stage boom approximately one foot. Remove the extend cylinder from the boom, keeping the 2/3/4 extend cables (29) taunt.

33. Remove rods (146) and roller (147) and plate (148) from cylinder sheave case tip. Remove sheaves (83) from extend cylinder, if necessary by removing two capscrews (81) and the keeper (150) from the sheave pin (142) and lightly tapping the pin while removing the sheaves from the tip of the extend cylinder.

34. Remove wear pads (144,145) if replacement is necessary.

35. Remove the 2/3/4 extend cables (29) from the 4/3/2 retract-2/3/4 extend pin and store cables and extend cylinder in an area where they will not be damaged during further boom disassembly.

36. Remove wear pads (17) from bottom tip of 3rd stage boom.

37. Place the 4th stage boom on a suitable horizontal surface. Take care not to pinch or crush the retract and extend cables while lifting or supporting the 4th stage boom. If necessary, tag and remove wear pads (69,68,67) and shims from the base of the 4th stage boom.

38. Remove loadline sheaves (94) if desired, by removing two capscrews, two lockwashers and the keeper (82) from the sheave pins (90,96) and lightly tapping the pin while removing sheaves and spacers until all sheaves are removed from boom tip.

Additional Maintenance, Disassembled Boom

1. Clean all boom sections and inspect for wear, dents, bent or crooked boom sections, gouged metal, broken welds or any abnormal conditions. Repair or replace as required.

2. Inspect all sheaves for excessive groove wear or abnormal rim wear. Replace as required.

3. Inspect all sheave bearings for excessive wear or cut inner liner material. If installed bearing diameter is 0.38 mm (0.015 in) larger than pin diameter, bearing must be replaced. Any cut or gouge which causes the bearing liner to lose strands is cause for bearing replacement.

For Reference Only

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

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

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

7. Inspect all wear pads for gouges or uneven wear on 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.

Four Section Boom Assembly

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 of cables will result in damage or failure of 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.

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

4th Section Boom Assembly

1. Assemble upper loadline sheaves (94) and bearings (95) into the 4th stage sheave case (4).

   a. Install sheave pin (90) in left side of the upper sheave case.

NOTE: Install spacers (92) between sheaves and between sheaves and side plates.

   b. Install small spacer (92).

   c. Install sheaves assembly (94,95) near the sheave case side plates with the grease fitting (93) facing the side plate to allow for greasing.

   d. Install spacer (91).

   e. Install center sheave assembly (94,95) with grease fitting (93) facing either side.

   f. Install top sheaves assembly (94,95) to the left hand side of the boom with the spacer (91) to the right hand side.

   g. Install keeper plates (82) to both sides of the sheave case using bolt (81) and washer (21).

2. Assemble lower loadline sheaves (94) and bearings (95) into the 4th stage sheave case (4).

   a. Install sheave pin (96) in left side of the sheave case.

NOTE: Install spacers (92) between sheaves and between sheaves and side plates.

   b. Install small spacer (92).

   c. Install sheaves (94,95) near the sheave case side plates with the grease fitting (93) facing the side plate to allow for greasing.

   d. Install small spacer (92).

   e. Install center sheave's (94) with grease fitting facing either side.

   f. Install sheaves (94) to the right hand side of the boom.

   g. Install the spacer (92).

   h. Install link (128) to outside of sheave case.

   i. Install keeper plates (127) to right side of the sheave case using bolt (81) and washer (21).

   j. Install keeper plates (82) to left side of the sheave case using bolt (81) and washer (21).

   k. Install tube (110) in lower forward sheave case.

   l. Install hitch pins three (89) in sheave case.

3. Install bottom rear wear pad (68), shims (67) with capscrew (69) to the base of the 4th stage boom (4).

4. Install two side wear pads (42) and shims (41) onto the rear base of the 4th stage boom (4). Shim according to calibration instructions in this section or as pads were originally removed and tagged.

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

5. Raise and support the 4th stage boom (4) in front of the 3rd stage boom (3).

4th and 3rd Section Boom

1. Install 4th stage boom (4) into 3rd stage boom (3) approximately five feet. Figure 4-7.

For Reference Only

NOTE: Take care not to damage cables.

2. Install bottom wear pad (68) and shims (67) capscrew (69) onto the base of the 4th stage boom (4) if replacing.

3. Install two side wear pads (42) and shims (41) onto pins at the base of the 4th stage boom. Shim according to calibration instructions in this section or as pads were originally removed and tagged.

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

4. Raise and support 4th stage booms and install into 3rd stage boom (3) approximately fifteen feet.

5. Raise 4th stage boom (4) against top of 3rd stage (3) boom and install wear pads (17) with capscrew (167) into the bottom tip of the 3rd stage boom.

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

6. Lower 4th stage boom onto wear pads in the 3rd stage boom. Push 4th stage boom into 3rd stage boom leaving approximately four feet of 4th stage boom left out of 3rd stage boom.

7. Install lower side wear pads (15) with shims (13,14) on front inside of 3rd stage boom securing with capscrew (59).

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

8. Assemble and install upper side wear pad assembly (164,163,160) securing with hardware (161,162) to tip of the 3rd stage boom (3).

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

9. Install top wear pad (52) with shims (100) and cable guide (76) with (75),wear pad and related hardware (103,21,56) on the top front of 3rd stage boom (3). Shim according to calibration instructions in this section.

10. Push 4th stage boom completely into 3rd stage boom and scribe a mark in the tip of the 4th stage boom in front of the side wear pad on the 3rd stage for retract sequencing.

11. Pull 4th stage boom out of 3rd stage boom approximately 12 in.

12. Assemble and install extend cylinder assembly (5).

a. Install bearings (84) into 2/3/4 extend cylinder sheaves (83).

b. Coat bearing with multi-purpose grease and install 2/3/4 extend sheaves into extend cylinder (5).

c. Install pin assembly (142) through cylinder sheave case securing with keeper plate (150) and two bolts (81).

d. Install two wear pads (144 and 145) each side on front tip of extend cylinder with capscrew (143).

13. Reeve 2/3/4 extend cables (29) over 2/3/4 extend cylinder sheaves (83) at the front of the telescope cylinder assembly (5) routing cables behind cylinder in correct order.

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

14. Install top keeper rod (146) with capscrew (151) and install rod and roller assembly (146,147) with capscrew (151) to bottom of extend cylinder sheave case. Install cable retaining plate (148) and screw (149) to bottom of extend cylinder sheave case.

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

15. Install extend cylinder (5) into the rear of the 4th stage boom leaving approximately two feet extended. Push 4th stage boom completely into the 3rd stage boom and raise extend cylinder to top of 3rd stage boom.

16. Assemble and install the 4/3/2 retract-2/3/4 extend pin assembly into anchor plate at the bottom base of the 4th stage boom (4).

a. Assemble 3 extend cables (29) on the 4/3/2 retract-2/3/4 extend pin (77).

b. Install one washer (60) and one retainer (99) on each side of the outer cables.

c. Install plug (64) in end of pin.

d. Install shaft assembly into retainer at base of 4th stage boom.

e. Install grease fittings (43) toward base of boom.

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

17. Lower extend cylinder and push into 3rd stage boom keeping cables taunt to approximately one foot behind cylinder anchors in the 3rd stage boom. Raise base of extend cylinder to top of 3rd stage boom.

18. Install wear pad (112) with capscrews (107) at the base of the fourth stage boom.

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

19. Route the two 4/3/2 retract cables (53) evenly centered around the 4/3/2 retract cable keeper (78). Route threaded ends of 4/3/2 retract cables (53) down through the opening in the base of the 3rd stage boom and pull threaded ends of 4/3/2 retract cables toward tip of boom

For Reference Only

(3). Install 4/3/2 retract cable keeper (78) into anchor plates at the base of the fourth stage boom.

20. Assemble and install the 4/3/2 retract-1/2/3 extend pin assembly (38) into anchor plate at the bottom base of the 3rd stage boom (3).

- **a.** Install one retainer (37) and one washer (36) inside of each sheave.
- **b.** Install bushing (35) into double groove sheave (34) and brush with chassis grease and install on both ends of pin.
- **c.** Loop 4/3/2 retract cables (53) around double grooved sheaves (34) and pin (38) assembly.
- **d.** Install plug (64) in end of pin (38).
- **e.** Install shaft assembly into retainer at base of 3rd stage boom (3).
- **f.** Install grease fittings (43) toward base of boom.

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

22. Install retract cable guides (65) with capscrew (74) into the base of the 3rd stage boom.

NOTE: Use caution when moving cylinder to avoid damage to cable guides (65).

23. Lower the extend cylinder onto wear pad (112).

3rd and 2nd Section Boom

1. Install two top wear pad mounting plates (152), wear pads (158), with capscrew (156), washer (155) onto the base of the 3rd stage boom (3).

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

2. Install adjustment cam plate (154), capscrews (156) and flatwashers (155).

3. Rotate cam (154) until gap is eliminated between wear pad (158) and boom section keeping sections centered for proper boom alignment.

4. Install bottom wear pad (80), and shims (79) with capscrew (69) onto the base of the 3rd stage boom.

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

5. Install two side wear pads (42) and shims (41) onto the base of the 3rd stage boom. Shim according to calibration instructions in this section.

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

6. Stretch out 1/2/3 sync extend cable (10), then bring threaded ends back together to form a loop and find the center of cable length.

- **a.** Slide this center loop from front to back through the cable anchor slot at base, top of the 3rd stage boom (3).
- **b.** Slide the keeper sheave (71) into this slot from back to front so raised portion of sheave slides into slot of cable anchor plate.
- **c.** Pull this loop of cable forward to lock 1/2/3 sync extend cable (10) to 3rd stage boom.
- **d.** Place the sheave case assembly (44) on top front of 3rd stage boom with its top bar up and forward.
- **e.** Loop both threaded ends of sync extend cable (10) toward back of boom to form two loops, left and right, at front of boom. Slide left and right loops into left and right sides of sheave case assembly.
- **f.** Install bearings (45) in sheaves.
- **g.** Brush with chassis grease.
- **h.** Install flattened end pins (47) in sheaves (46).

NOTE: Insure grease feed holes face toward the back of the boom.

- **i.** Slide pins (with sheaves) into slots in front of sheave case assembly (44). Fold back and position assembled sheave case on top of boom sections during assembly of next boom stage.
- **j.** Route and pull threaded ends of sync extend cable (10) toward base of boom and loop over base of boom.

7. Insure 2nd stage extend cylinder ears (5) are horizontal.

8. Raise and support 3rd/4th stage booms and install into 2nd stage boom (2) approximately fifteen feet.

NOTE: Take care to keep 3/2/1 retract cables taunt, not crossing cables and keeping all cables clear of pinch points created by slings and bottom pads.

9. Raise 3rd/4th stage booms against the top of the second stage boom (2) and install wear pads (17) with capscrew (167) into the bottom tip of the 2nd stage boom.

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

- **a.** Lower 3rd/4th stage booms onto wear pads (17) in the 2nd stage boom.
- **b.** Install 3rd/4th stage booms into 2nd stage boom leaving approximately four feet of 3rd/4th stage booms left out of 2nd stage boom.

10. Assemble 4/3/2 retract cable keeper plate assemblies (26) with capscrew (27) onto 4/3/2 retract cables (53). Install double nut (113,12) just beyond flat on 4/3/2 retract cables and assemble at bottom tip of 2nd stage boom (2).

For Reference Only

NOTE: Take care not to cross cables.

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

11. Install lower side wear pads (15), shims (13,14) with capscrew (109) on front inside of 2nd stage boom.

12. Install upper wear pad assembly (160,163,164) with capscrew (162),washer (161) at upper tip of 2nd stage boom.

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

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

13. Slide the previously assembled 1/2/3 extend cable sheave case assembly (44), which is on the top tip of the 3rd stage boom into position in the 2nd stage boom and secure with capscrew (57).

14. Install grease fittings (43) into 1/2/3 extend sheave pins (47).

15. Install wear pad (58) with shims (102) on inside top front of 2nd stage boom (2). Install wear pad (33), cable guide (54) with related hardware (56, 21,55) on the top front of 2nd stage boom (2). Shim according to calibration instructions in this section.

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

16. Push 3rd/4th stage booms into 2nd stage boom until it bottoms out against cylinder ears. Install capscrew (11), washer (8) with Loctite to retain the 2nd stage cylinder in the base of 2nd stage boom.

17. Install the cable wear pad (72) with capscrew (27) on top of the extend cylinder barrel (5).

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

18. Install the extend cylinder into the slots at the base of the 3rd stage boom. Install keepers (50) with capscrew (48), washer (49) with Loctite to retain the 2nd stage cylinder in the 2nd stage boom.

19. Install wear pad (39) on top of 2/3/4 extend cable anchor assembly (30), then install 2/3/4 extend cable anchor assembly in slots at base, top of 2nd stage boom (2) while guiding 2/3/4 extend cables (29) into anchor assembly (30). Install nuts (31) and spacer (152) on threaded ends of 2/3/4 extend cables (spacer is used on center cable only).

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

20. Lock cable anchor assembly (30) in place with capscrews (27) through the top and back side plates with capscrew (118) on the 2nd stage boom. Be sure 1/2/3 sync extend cables (10) are routed over the top of the 2/3/4 extend cable anchor.

21. Route three 3/2/1 retract cables (19) around 3/2/1 retract cable keeper (51) and install on mounting bracket (108) with capscrew (107) onto 3/2/1 retract cable anchor with 3/2/1 retract cables draped out behind boom.

22. Assemble and install the 3/2/1 retract pin assembly (38) into anchor plate at the bottom base of the 2nd stage boom (2).

a. Install one retainer (37) and one washer (36) inside of each sheave.

b. Install bushing (35) into three groove sheave (114) and brush with multipurpose grease (MPG) and install on both ends of pin.

c. Loop 3/2/1 retract cables (19) around three groove sheaves (114) and retract pin (38) assembly.

d. Install plug (64) in end of pin (38).

a. Install shaft assembly into anchor plates at the base of the 2nd stage boom pulling threaded ends of 3/2/1 retract cables (19) towards tip of boom.

b. Install 3/2/1 retract pin keeper setscrews (117) behind retract pin (38) into base of 2nd stage boom (2).

c. Install grease fittings (43) toward base of boom.

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

23. Install retract cable guides (32), with capscrew (66) into the base of the 2nd stage boom (2).

24. Install bottom wear pad (106) and shims (105) with capscrew (129) onto the base of the 2nd stage boom.

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

25. Route the 3/2/1 retract cables (19) between the bottom of the second stage boom and the bottom pad shims.

26. Install two side wear pads (42) and shims (41) onto the base of the 2nd stage boom. Shim according to calibration instructions in this section.

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

For Reference Only

27. Install two top wear pad mounting plates (153), wear pads (157), with capscrew (156), washer (155) onto the base of the 2nd stage boom (2).

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

28. Install adjustment cam plate (154), capscrews (156) and flatwashers (155).

2nd and 1st Section Boom

1. Install one bottom wear pad (106), and shims (105) with capscrew (129) onto the base of the 2nd stage boom if replacing.

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

2. Install two side wear pads (42) and shims (41) onto the base of the 2nd stage boom. Shim according to calibration instructions in this section.

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

3. Rotate 1st stage cylinder shaft so counterbalance valve is directly below shaft centerline.

4. Raise and support 2nd/3rd/4th stage booms and install into 1st stage boom (1) approximately fifteen feet. Take care to keep 3/2/1 retract cables taunt, not crossing cables and keeping all cables clear of pinch points created by slings and bottom pads.

5. Raise 2nd/3rd/4th stage booms against top of 1st stage boom and install wear pads (165,166) with capscrew (20) washer (49) into the bottom tip of the 1st stage boom.

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

6. Lower 2nd/ 3rd/4th stage booms onto wear pads in 1st stage boom. Push 2nd/3rd/4th stage booms into 1st stage booms leaving approximately four feet of 2nd/3rd/ 4th stage booms sticking out of 1st stage boom.

7. Assemble 3/2/1 retract cable keepers (115) with capscrew (27) onto 3/2/1 retract cables, double nut (113,12) just beyond flat on 1/2/3 retract cables (19) and assemble at bottom tip of 1st stage boom. Take care not to cross cables.

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

8. Install side wear pads (63) wear pad backup plate (22), back plate (70).

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

9. Install adjusting bolt (104) and jam nut (97) on lower front side of 1st stage boom. Install wear pad retaining hardware (28,40,61) in wear pad pocket.

10. Install upper wear pad assembly (164,163,160) with hardware (162,161) at upper tip of 1st stage boom.

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

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

11. Install top steel spacer pad (16) with shims (101) with hardware (23,21,56) at the tip of the 1st stage boom, Loctite capscrews. Shim according to calibration instructions in this section.

12. Push 2nd/3rd/4th stage booms keeping 3/2/1 retract cables taunt completely into 1st stage boom or until top wear pad aligns with the top access hole in 1st stage boom.

13. Install two top wear pad mounting plates (153), wear pads (157), with capscrew (156), washer (155) onto the base of the 2nd stage boom (2).

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

14. Install adjustment cam plate (154), capscrews (156) and flatwashers (155).

15. Rotate cam (154) until gap is eliminated between wear pads and boom section keeping sections centered for proper boom alignment and tighten clamping hardware.

16. Attach 1st stage cylinder rod to 1st stage hoist mount with washer (8) and shoulder bolt (11) that has been torqued and Loctite applied.

17. It is important in this step to have the nuts loose on the 3/ 2/1 retract cables (19) at the bottom tip of the 1st stage boom. Install the 1/2/3 sync extend cables (10) into the holes at the base of the 1st stage boom, install washer (8) and double nut (9) just beyond flats.

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

18. Torque cables per the “See “Four Section Cable Tensioning” on page 4-2” procedure.

19. Install all protective caps on threaded cable ends.

20. Install cable guide (76) with washer (56 and nut (111) to mounting studs at center top of 1st stage boom (1).

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21. Extend boom and align all boom sections.

22. Install access cover (124) with hardware (125,126) to top rear of 1st stage boom.

23. Install boom angle pendulum (121) and bearing (120) to left side of 1st stage boom with hardware (122,56).

For Reference Only

Four Section Boom

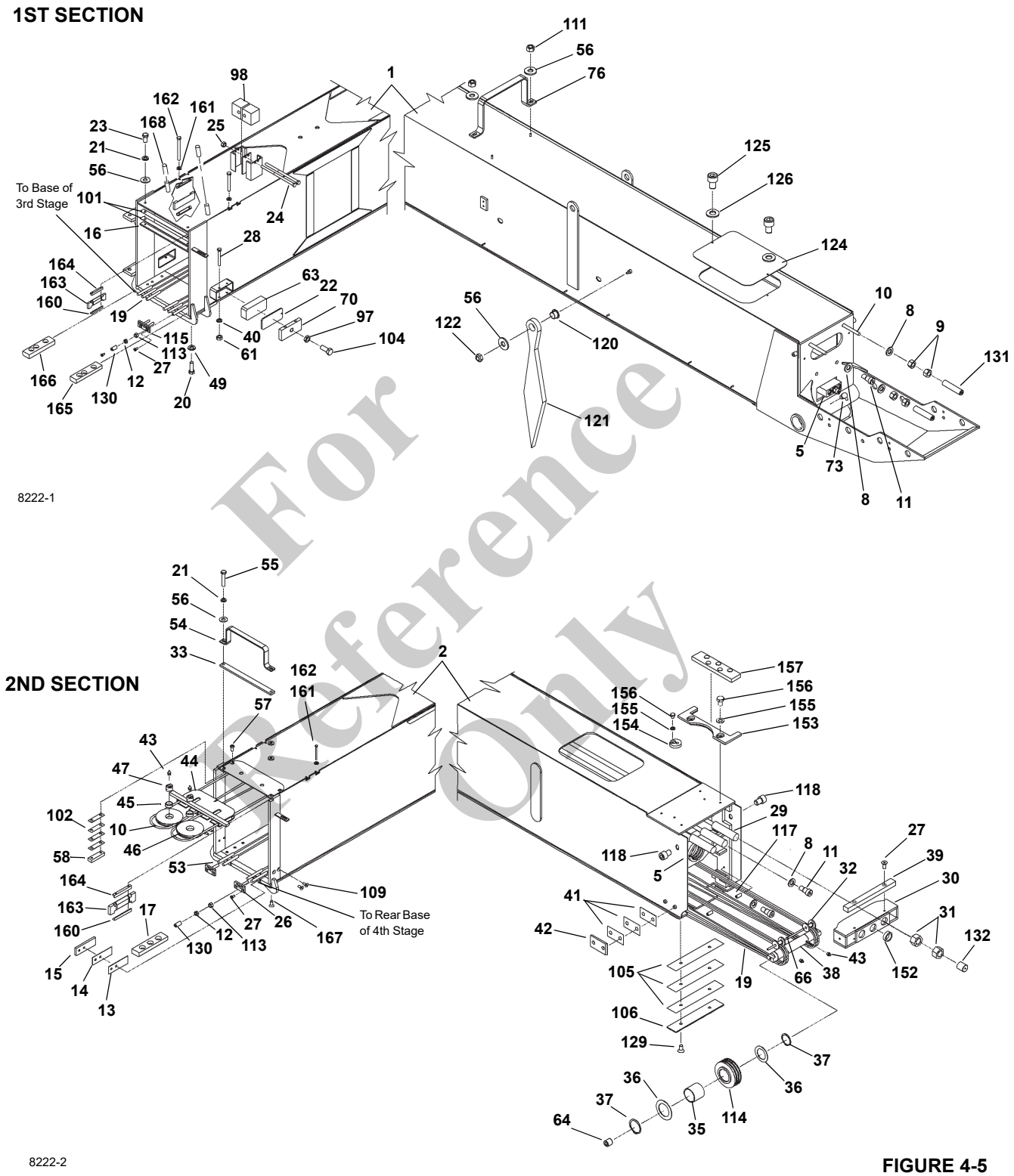

FIGURE 4-5

For Reference Only

Four Section Boom

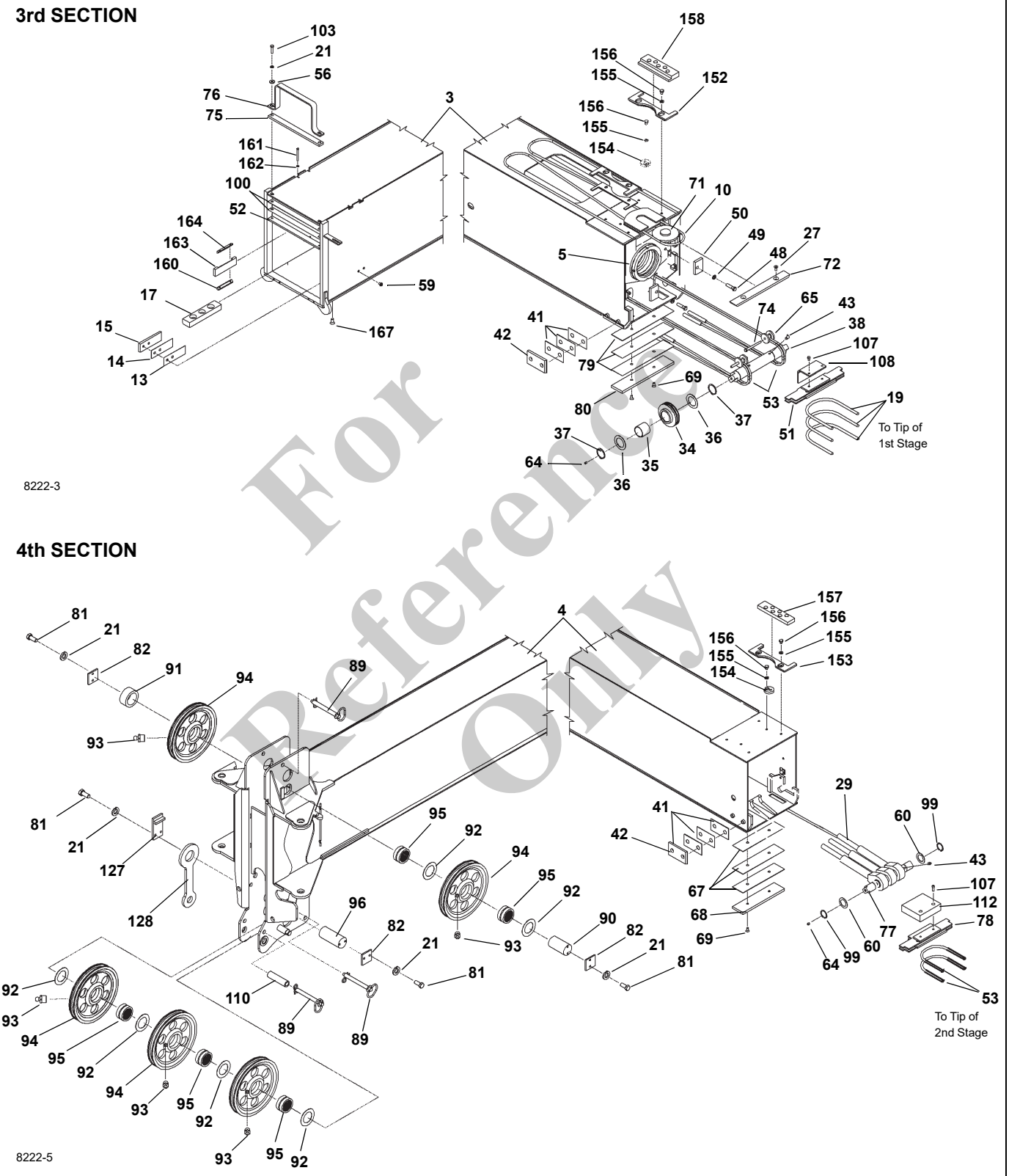

FIGURE 4-5

For Reference Only

Four Section Boom

EXTENSION CYLINDER

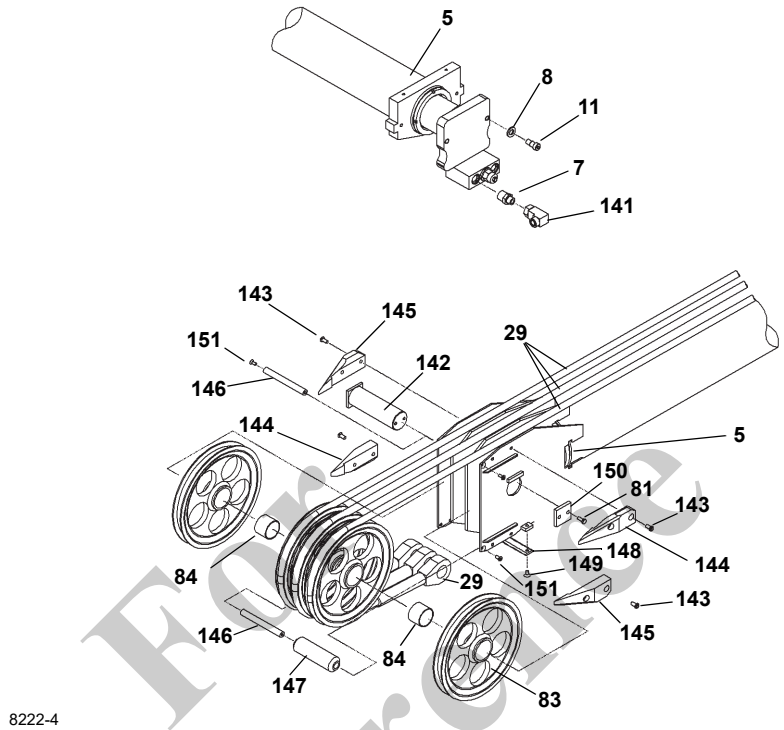

FIGURE 4-5

Item	4 Section Boom Description
1	1st Section Boom - Base Assembly
2	2nd Section Boom - Assembly
3	3rd Section Boom - Assembly
4	4th Section Boom - Assembly
5	Telescope Cylinder Assembly, 103'/127' Boom
7	Straight Thread Adapter
8	Flatwasher 3/4
9	Hex Nut 3/4-10
10	Cable Assembly
11	Socket Hd SS 3/4x0.75
12	Hex Jam Nut 5/8-11
13	Shim
14	Shim
15	Wear Pad
16	Plate
17	Wear Pad
18	Plug
19	Cable Assembly

Item	4 Section Boom Description
20	Capscrew Hex Hd-I 1/2-13 x1.50 G8
21	Lock Washer 3/8
22	Back Plate
23	Capscrew Hex Hd 3/8-16 x0.75 G5
24	Capscrew Hex Hd 3/8-16 G5
25	Hex Lock Nut 3/8-16
26	Plate Assembly
27	Capscrew Socket Flat Hd 3/8-16 x0.88
28	Capscrew Hex Hd M10x90
29	Cable Assembly
30	Cable Anchor Assembly
31	Hex Nut 1-3/4-5 Gr5
32	Roller
33	Wear Pad
34	Sheave
35	Bearing
36	Flatwasher 2.00x3.0x0.7
37	Retaining Ring 2.00
38	Pin

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Item	4 Section Boom Description
39	Wear Pad
40	Lock Washer 10
41	Shim
42	Wear Pad
43	Grease Fitting
44	Sheave Anchor Assembly
45	Bearing
46	Sheave
47	Pin
48	Capscrew Hex Hd 1/2-13 x2.00 G5
49	Lock Washer 1/2
50	Keeper
51	Cable Anchor Assembly
52	Plate
53	Cable Assembly
54	Cable Guide
55	Capscrew Hex Hd 3/8-16 x2 G5
56	Flatwasher 3/8
57	Capscrew - Socket Button 3/8-16 x0.88
58	Plate
59	Capscrew - Socket Button 3/8-16 x0.5
60	Flatwasher 1.5x2.25x0.7
61	Hex Nut M10 8
63	Wear Pad
64	Plug
65	Roller
66	Capscrew Hex Hd 3/8-16 x5 G5
67	Shim
68	Wear Pad
69	Capscrew Socket Flat Hd 3/8-16 x0.75
70	Wear Pad Backup Plate
71	Sheave
72	Wear Pad
73	Grease Fitting - 90
74	Capscrew Hex Hd 3/8-16 x4 G5
75	Wear Pad
76	Cable Guide
77	Pin
78	Cable Anchor Assembly
79	Shim
80	Wear Pad
81	Capscrew Hex Hd-l 3/8-16 x0.88 G8
82	Keeper

Item	4 Section Boom Description
83	Sheave
84	Bearing
89	Hitch Pin 0.75x7
90	Sheave Pin
91	Spacer
92	Spacer
93	Grease Fitting
94	Sheave
95	Bearing
96	Sheave Pin
97	Hex Jam Nut M20
98	Cable Block
99	Retaining Ring 1.50
100	Shim
101	Shim
102	Shim
103	Capscrew Hex Hd 3/8-16 x1.5 G5
104	Capscrew Hex Hd M20x50 8.8
105	Shim
106	Wear Pad
107	Capscrew Socket Hd 5/16-18 x1
108	Bracket
109	Capscrew Socket Flat Hd 3/8-16 x0.88
110	Tube
111	Hex Nut 3/8-16
112	Wear Pad
113	Hex Nut 5/8-11
114	Sheave
115	Plate Assembly
117	Sq Ss-cup 5/16-18 x0.75
118	Capscrew Socket Hd 3/8-16 x0.5
120	Bearing
121	Pendulum
122	Hex Lock Nut 3/8-24 Unf Sae-5.2
124	Plate
125	Capscrew Socket Hd M8x12 -10.9
126	Flatwasher 8
127	Keeper Assembly
128	Link
129	Capscrew Socket Flat Hd 1/2-13 x0.75
130	Cable Protector
131	Cable Protector
132	Cable Protector

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Item	4 Section Boom Description
141	90 Deg Elbow
142	Pin
143	Capscrew - Socket Button Hd 3/8-16 x0.75
144	Wear Pad
145	Wear Pad
146	Rod
147	Roller
148	Plate
149	Capscrew Socket Flat Hd 3/8-16 x0.63
150	Keeper
151	Capscrew Socket Flat Hd 5/16-18 x0.75
152	Spacer
153	Wear Pad Plate
154	Cam Plate Rear Wear Pad
155	Flatwasher 10
156	Capscrew Hex Hd M10x16
157	Wear Pad
158	Wear Pad
160	Keeper Side Wear Pad
161	Capscrew Hex Hd M6x70 -8.8
162	Flatwasher 6
163	Side Wear Pad
164	Keeper Side Wear Pad
165	Wear Pad, Left
166	Wear Pad, Right
167	Capscrew Socket Flat Hd 1/2-13 cx1
168	Cable Protector

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FIVE SECTION BOOM

A two-stage, rod fed, double-acting cylinder is attached to and supports the 1st, 2nd and 3rd stage boom sections.

The 3/4/5 extend cables (Figure 4-6) attach to the base of the 3rd stage boom, are reeved around sheaves at the tip of the 4th stage boom and attach to the base and support the 5th stage boom.

The 5/4/3 retract cables (Figure 4-6) are attached to the base of the 5th stage boom, are reeved around sheaves at the base of the 4th stage boom and attach to the tip of the 3rd stage boom.

The 2/3/4 extend cables (Figure 4-6) attach to the base of the 2nd stage boom, are reeved around sheaves at the tip of the 3rd stage cylinder and attach to the base and support the 4th stage boom. The 4/3/2 retract cables are attached to the base of the 4th stage boom, are reeved around sheaves at the base of the 3rd stage boom and attach to the tip of the 2nd stage boom.

The 1/2/3 extend cables (Figure 4-6) attach to the base of the 1st stage boom, are reeved around sheaves at the tip of the 2nd stage boom and attach to the base of the 3rd stage boom.

The 3/2/1 retract cables (Figure 4-6) attach to the base of the 3rd stage boom, are reeved around sheaves at the base of the 2nd stage boom and attach to the tip of the 1st stage boom.

The 3/2/1 retract cables (Figure 4-6) directly oppose the 1/2/3 extend cables to ensure that the 2nd and 3rd stage booms extend and retract equally at all times.

The 4/3/2 retract cables (Figure 4-6) directly oppose the 2/3/4 extend cables to ensure that the 3rd and 4th stage booms extend and retract equally at all times.

The 5/4/3 retract cables (Figure 4-6) directly oppose the 3/4/5 extend cables to ensure that the 4th and 5th stage booms 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 retract pressure is returned to neutral.

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

A single stage cylinder will control first extendable section.

A dual stage cylinder will control second extendable section.

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

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

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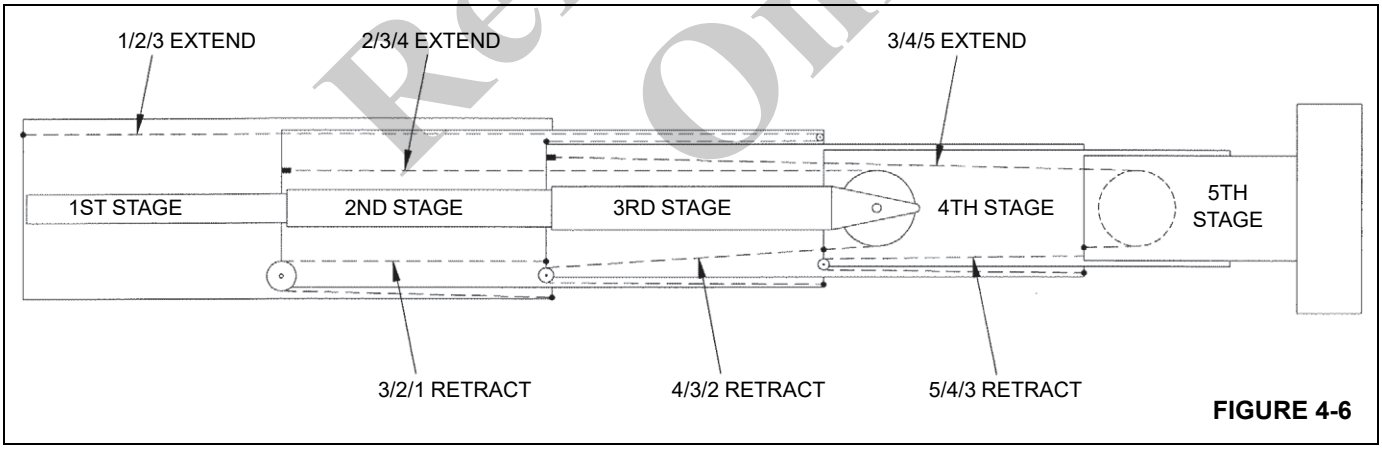

FIGURE 4-6

Reference Figure 4-6, Figure 4-7, Figure 4-8, Figure 4-12 and Figure 4-10 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 machine outriggers and Single Front Outrigger. Boom must be completely retracted and stowed in boom rest over front of truck.
2. If equipped, remove swing around jib according to procedures outlined in the Set-Up Section of the Operator's Manual.
3. Remove hook block or downhaul weight, wind up rope on hoist drum. Shut down truck engine.
4. Attach lifting device to the counterweight to provide even weight distribution and raise the counterweight until weight is removed from the boom pivot pin. Remove 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 rod end of lift cylinder, remove boom lift cylinder pin keeper and pin from bottom of 1st section boom. Lower lift cylinder rod end to the deck.
6. Tag and disconnect extend cylinder lines and hoist hydraulic and electric lines. Cap all openings. Unplug anti-two-block/RCL cord from receptacle in turret.
7. Disconnect and cap all hoist hydraulic lines and openings. Hoist may be removed at this point, but 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 boom pivot pin keeper and boom pivot pin. Lift boom free of turret.

5 Section Boom Disassembly

For reference, front (tip) is sheave case end, rear (base) is hoist mount end, 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 1st section and jib (if equipped) left on crane. all other steps apply to boom being removed from crane (See "Boom Removal" on page 4-21).

1. Extend and set the outriggers and 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 all lines and openings.
4. Loosen and remove two capscrews (11,8) and hardened washers which anchor the 1st stage extend cylinder rod (6) to the base of the 1st stage boom.
5. Mark the location of the nuts and washer (9,8) which secure the 1/2/3 extend cables (10) to the rear base of the 1st stage boom base section (1). Remove nuts and washers from 1/2/3 extend cables at 1st stage boom base. Mark and tag cables while leaving the cable ends draped inside the boom.
6. Remove hardware (161,162) and access plate (160) from top/rear of 1st section.
7. Attach a sling or chain to the tip of the 2nd stage boom and pull the 2nd stage boom (with the 3rd, 4th and 5th stages) out approximately one foot or until the access openings on all boom sections align to the rear wear pad assemblies for all boom sections. Tag and remove rear wear pads from top of each boom section. Loosen attaching hardware for the adjusting cam plates and all rear top wear pads for all boom sections being removed.
8. Remove and tag attaching hardware (61,62,63) on front tip of lower 1st stage boom section. Loosen adjustment hardware (111,70) wear pads (18) and back plates (22,28).
9. Remove and tag upper plate (16) and shim (136) and hardware (23,21,56) from tip of 1st stage boom.
10. Remove and tag two upper side wear pad assemblies (179) with keeper side wear pad (178,180) and hardware (176,177) from tip of 1st stage boom.
11. Loosen cable adjusting nuts (151,12) on lower front 3/2/1 retract cables (19). Remove four capscrews (27) which retain the 3/2/1 retract cable anchors plates (150) to the bottom tip of the 1st stage boom. Pull the retract cable anchors out and keep retract cables taunt while pulling 2nd (with 3rd, 4th, and 5th) stage out of 1st stage. Partially pull 2nd stage boom from boom assembly until front tip of boom can be raised enough to remove and tag wear pads (184,185) and hardware (20,49) from bottom tip of 1st stage boom. Support the base end of the 2nd stage as it exits the 1st stage boom.
12. Place 2nd stage (with 3rd, 4th and 5th) on a suitable horizontal surface.

NOTE: Use caution not to pinch or crush retract cables while lifting or supporting 2nd stage boom.

13. Remove capscrew and retract cable guide roller (149) from each side of the bottom base of the 2nd stage boom.
14. Remove the two square head setscrews (154) which retain 3/2/1 retract sheave pin (38). Pull the retract

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sheave pin with retract sheaves (148) and bearing (35) spacers (36) and snap ring (37) assembled back out of its slot at the base of the 2nd stage boom. Smooth out any burrs which may be present on flat ends of pin to eliminate sheave bearing damage when sheaves are removed from pin.

15. Remove two capscrews (145), retract cable keeper bracket (144) and cable anchor assembly (51) from lower base at rear of 3rd stage boom. Store 3/2/1 retract cables (19), which are now free, in an area where they will not be damaged during further boom disassembly.

16. Mark the location of the nuts which secure the 2/3/4 extend cables (29) to the base of 2nd stage boom. Remove six large nuts (31), spacers (87) and the 2/3/4 extend cable anchor assembly (30) from the top/base of the 2nd stage boom.

17. Remove two socket head screws (155) and two socket flathead screws (27) which retain the wear pad (39) to 2/3/4 extend cable anchor (30) attached to the top/base of the 2nd stage boom.

18. Remove two allen head shoulder bolts (11) with flatwashers (8) from the extend cylinder (6) anchor brackets as part of the center base at rear of the 2nd stage boom section.

19. Attach a sling or chain to the tip of the 3rd stage boom and pull 3rd stage boom (with the 4th and 5th stages) out approximately one foot. Remove and tag two lower side wear pads (15) with shims (14,13) and two upper side wear pads (178,179,180,162,161) from front tip of 2nd stage boom. Remove and tag two top inner steel pad (58) and shim (137) from tip of the 2nd stage section.

20. Remove and tag cable retainer assembly and hardware (54,33,56,21,55,117,57) located top front tip of the 2nd stage boom.

21. Slide the 1/2/3 extend cable sheave case assembly (44,45,46,47,43) out from the top/front tip of the 2nd stage boom and allow the sheave case assembly and cables (10) to rest on the top of the 3rd stage boom.

22. Loosen adjustment nuts (12,151) from retract cable (53) and remove four capscrews (27) which retain the 4/3/2 retract cable anchor plate assembly (26) to the bottom tip of the 2nd stage boom.

23. Raise tip of boom and remove wear pads (17) from between bottom tip of the 2nd stage and 3rd stage boom. Pull the retract cable anchors out and keep the retract cables taunt while pulling the 3rd, 4th and 5th stage booms out of the 2nd stage boom.

24. Place the 3rd, 4th and 5th stage booms on a suitable horizontal surface.

NOTE: Use caution not to pinch or crush retract cables while lifting or supporting 3rd stage boom.

25. Tag and remove wear pads and shims from base of 3rd stage boom if replacing.

26. Remove the 1/2/3 extend cable (10) from top of 3rd stage boom. Slide the top center rear sheave (71) toward the rear of boom and remove. Pull the cable loop forward and remove from sheave keeper. Cable is now free at base of boom. Push the two sheaves at the front tip of the 2nd stage boom forward and remove them from the 1/2/3 extend cable sheave case assembly (44) and sheaves (46) previously removed and stored at the tip of the 3rd stage boom. The cable loops may now be pulled back out of the sheave case and the 1/2/3 extend cable is free. 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 which may be present on the flat ends of the pins to eliminate sheave bearing damage and if necessary to remove pins from tip sheaves (47).

27. Loosen and remove two capscrews (27) retaining wear pad (72) to top base of 3rd stage boom. Loosen and remove two capscrews (48) lockwashers (49) and keepers (50) which anchor the extend cylinder (6) at the center base of the 3rd stage boom. Attach a sling to the base of the extend cylinder and pull the extend cylinder out of the 3rd stage boom approximately one foot keeping 2/3/4 extend cables taunt. Raise and support extend cylinder approximately five inches using a block (wood).

NOTE: Avoid damage to retract cable roller (65) when lifting cylinder.

28. Remove capscrew (74) and retract cable roller (65) from each side of the bottom base of the 3rd stage boom. Pull the retract sheave pin (191) with retract sheaves assemblies (34,35,36,37) back out of its slot at the bottom base of the 3rd stage boom. Disconnect lubrication tubes (192,193) between shaft and retract sheaves if equipped. Smooth out any burrs which may be present on flat ends of pin to eliminate sheave bearing damage if sheaves are removed from pin. Stow cable (53) out of way to avoid damage.

29. Push the 4/3/2 retract anchor (82) forward out of its slot in the bottom base of the 4th stage boom and remove from 4th stage boom with wear pad (81) attached. Remove 4/3/2 retract cables (53) from 4/3/2 retract anchor (82) and store in an area where they will not be damaged during further boom disassembly.

30. Mark the location of the nuts which secure the 5/4/3 retract cables (77) to the tip of the 3rd stage boom and loosen nuts (12,151) and remove plate (107) and capscrew (32) to the end of cable thread.

31. Remove capscrew (85) and retract cable roller (84) from each side of the bottom base of the 4th stage boom.

32. Remove 5/4/3 retract cable anchor capscrew (106) from the inside base of the 5th section. Remove 5/4/3 retract

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cables (77) from anchor plate in the bottom base of the 5th stage boom and drape outside of base end of 3rd stage boom.

33. Disconnect lubrication tubes (194, 195) and pull the 5/4/3 retract-2/3/4 extend pin (78) as an assembly out of slot in the bottom base of the 4th stage boom and drape out of the base of the 3rd stage boom. Remove and tag 5/4/3 retract sheaves (79) and cables (77) from pin.

34. Lower extend cylinder (6) to original position. Attach a sling or chain to the tip of the 5th stage boom and pull the 5th stage boom out of the 4th stage boom approximately one foot. Remove the extend cylinder from the boom, keeping the 2/3/4 extend cables (29) taunt.

35. Remove rods (153) and roller (165) and plate (166) from cylinder sheave case tip. Remove sheaves (112) from extend cylinder, if necessary by removing two capscrews (109) and the keeper (115) from the sheave pin (114) and lightly tapping the pin while removing the sheaves from the tip of the extend cylinder.

36. Remove wear pads (116,119) if replacement is necessary.

37. Remove the 2/3/4 extend cables (29) from the 5/4/3 retract-2/3/4 extend pin and store cables and extend cylinder in an area where they will not be damaged during further boom disassembly.

38. Remove four nuts (86) which retain 3/4/5 extend cables (96) to the top base end of the 3rd stage boom. Push 5th stage boom back into 4th stage boom. Replace 5/4/3 retract-2/3/4 extend pin (78) back into slot in the bottom base end of the 4th stage boom. Replace 5/4/3 retract cables (77) into anchor plates at the bottom base end of the 5th stage boom.

39. Attach a sling or chain to the tip of the 4th stage boom and pull (with the 5th stage boom) out approximately two feet. Remove and tag upper side wear pads with shims (94,93,92) and lower wear pads with shims (89,90,91) and one top wear pad with shims (104,102,139,105) from the tip of the 3rd stage boom.

40. Remove four capscrews which retain the 5/4/3 retract cable anchors (107) to the bottom tip of the 3rd stage boom. Remove wear pads (187) from bottom tip of 3rd stage boom. Pull the retract cable anchors out and keep retract cables taunt while pulling 4th stage boom (with 5th stage boom) out of 3rd stage boom.

41. Place the 4th and 5th stage booms on a suitable horizontal surface.

NOTE: Use caution not to pinch or crush retract cables while lifting or supporting 4th stage boom.

42. If necessary, tag and remove wear pads and shims from the base of the 4th stage boom.

43. Remove the 5/4/3 retract-2/3/4 extend pin (78) from the bottom base of the 4th stage boom. Remove the 5/4/3 retract cables (77) from the anchor plates at the bottom base of the 5th stage boom and store in an area where they will not be damaged during further boom disassembly.

44. Attach a sling or chain to the tip of the 5th stage boom and pull 5th stage boom out approximately six feet. Remove and tag lower side wear pad with shims (89,90,91) and two top wear pads with shims (94,93,92) from the tip of the 4th section boom.

45. Remove two allenhead capscrews, nuts and washers from 3/4/5 extend cable wear pads (88) at base of 4th stage boom and remove pads.

46. Remove grease fittings (95) from 3/4/5 extend sheave pin (189) at front tip of 4th stage boom. Remove ten allenhead capscrews from 3/4/5 extend sheaves pin (189) and remove from the 5th stage boom side plates and out of machined spot faces. Remove 3/4/5 extend sheaves (98).

47. Remove wear pads (100) from the bottom tip of the 4th stage boom. Pull the 5th stage boom out of the 4th stage boom while keeping extend cables taunt.

48. Place the 5th stage boom on a suitable horizontal surface. Take care not to pinch or crush extend cables while lifting or supporting 5th stage boom. If necessary tag and remove wear pads and shims from the base of the 5th stage boom.

49. Remove 3/4/5 extend cables from the anchor plates at the bottom base of the 5th stage boom and store in an area where they will not be damaged during further boom disassembly.

50. Remove loadline sheaves (120) if desired, by removing two capscrews, two lockwashers and the keeper (125) from the sheave pins (164) and lightly tapping the pin while removing sheaves and spacers until all sheaves are removed from boom tip.

Additional Maintenance, Disassembled Boom

1. Clean all boom sections and inspect for wear, dents, bent or crooked boom sections, gouged metal, broken welds or any abnormal conditions. Repair or replace as required.

2. Inspect all sheaves for excessive groove wear or abnormal rim wear. Replace as required.

3. Inspect all sheave bearings for excessive wear or cut inner liner material. If installed bearing diameter is 0.015 in larger than pin diameter, bearing must be replaced. Any cut or gouge which causes the bearing liner to lose strands is cause for bearing replacement.

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4. Clean and inspect all cable assemblies according to wire rope inspection procedures in this section. Pay particular attention to any wire breakage at the end connections. Replace cable assemblies as required. Lubricate all cable assemblies as required. Lubricate all cable assemblies before reinstalling them in boom.
5. Inspect all sheave pins for nicks, gouges or pitting due to rust in the bearing surface area. Replace if any damage is evident.
6. Inspect all grease fittings and grease paths in pins to ensure proper grease flow. Clean and replace as required.
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

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 of cables will result in damage or failure of 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.

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

5th Section Boom

1. Assemble upper loadline sheaves (120) and bearings (121) into the 5th stage sheave case (5).
   a. Install sheave pin (126) in left side of the upper sheave case.

NOTE: Install spacers (122) between sheaves and between sheaves and side plates.

   b. Install small spacer (122).
   c. Install sheaves (120,121) near the sheave case side plates with the grease fitting (95) facing the side plate to allow for greasing.
   d. Install small spacer (122).
   e. Install center sheave's (120,121) with grease fitting (95) facing either side.
   f. Install top sheaves (120,121) to the left hand side of the boom with the spacer (123) to the right hand side.
   g. Install keeper plates (125) to both sides of the sheave case using bolt (109) and washer (21).
2. Assemble lower loadline sheaves (120) and bearings (121) into the 5th stage sheave case (5).
   a. Install sheave pin (164) in left side of the sheave case.

NOTE: Install washers (122) between sheaves and between sheaves and side plates.

   b. Install small spacer (122).
   c. Install sheaves (120,121) near the sheave case side plates with the grease fitting (95) facing the side plate to allow for greasing.
   d. Install small spacer (122).
   e. Install center sheave's (120) with grease fitting facing either side.
   f. Install sheaves (120) to the right hand side of the boom.
   g. Install the spacer (122.
   h. Install link (128) to outside of sheave case.
   i. Install keeper plates (163) to right side of the sheave case using bolt (109) and washer (21).
   j. Install keeper plates (125) to left side of the sheave case using bolt (109) and washer (21).
   k. Install tube (60) in lower forward sheave case.
   l. Install hitch pins three (127) in sheave case.
3. Install bottom rear wear pad (110), shims (135) with capscrew (103) to the base of the 5th stage boom (5).
4. Install two side wear pads (134) and shims (41) onto the rear base of the 5th stage boom (5). Shim according to calibration instructions in this section or as pads were originally removed and tagged.

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

5. Raise and support the 5th stage boom (5) in front of the 4th stage boom (4).
   a. Route threaded end of 3/4/5 extend cables (96) through the tip of the 4th stage boom (4) and out the base of the 4th stage boom.
   b. Loop the button end of 3/4/5 extend cables (96) back beyond the cable anchor on the 5th stage

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boom and install the button end of the 3/4/5 extend cables (96) into outer side anchor plates at the base of the 5th stage boom and pull taunt.

5th and 4th Section Boom

1. Install 5th stage boom (5) into 4th stage boom (4) approximately five feet. Figure 4-7.

NOTE: Take care not to damage 3/4/5 extend cables (96).

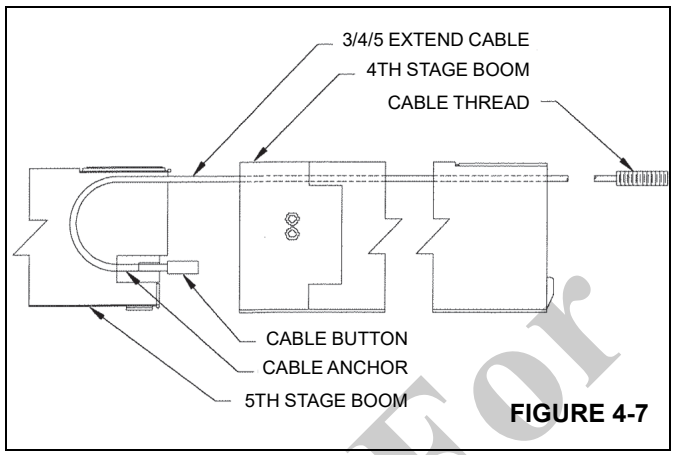

FIGURE 4-7

2. Raise 5th stage boom against the top of 4th stage boom and install wear pads (100) securing with capscrews (101) on the bottom tip of the 4th stage boom (4) and lube.

3. Lower the 5th stage boom (5) onto the wear pads in the 4th stage boom.

4. Install 3/4/5 extend sheave assembly (98) inside tip of 4th stage boom (4).

a. Install bearing assembly (99) in sheave (98).

b. Install wear plugs (97) into (fourteen) holes per sheave (98).

c. Loop 3/4/5 extend cables (96) around 3/4/5 extend sheaves (98) and install sheaves into the 4th stage boom (4).

NOTE: Install cables in their natural untwisted condition. Do not twist cables. Twisting of cables will result in damage or failure of cable.

d. Install 3/4/5 extend sheave pins (189) and plugs (97) into the recessed holes in the sides of the tip of the 4th stage boom.

e. Install retaining capscrews (40) into 3/4/5 extend sheave pins (189) and torque (See “Fasteners And Torque Values” on page 1-7).

f. Install grease fittings (95) into 3/4/5 extend sheave pins (189) and lube.

5. Install side wear pads (89), shims (90,91) with capscrews (27) to inside tip of the 4th stage boom (4).

6. Install cable guide assembly (105) on the top of 4th stage boom (4).

a. Insert upper steel wear pad (102) with shims (139) between 4th stage boom (4) and top of the 5th stage boom (5).

b. Install capscrew (59) in rear holes only.

c. Install wear pad (104) and cable guide (105) to outside tip of 4th stage boom (4). Install related hardware (146,21,56) to secure from the top front of the 4th stage boom.

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

d. Push the 5th stage boom completely into the 4th stage boom while keeping 3/4/5 extend cables (96) taunt.

e. Scribe a mark in the tip of the 5th stage boom in front of side wear pads on the 4th stage boom, for retract sequencing.

7. Install 3/4/5 extend cable retaining pads (88) with the flanged lip facing upward/toward the inside of the base of the 4th stage boom in order to support the cable (96).

8. Install the upper capscrew (108), washer (56), nut (133) only and swing the retaining pad (88) and position the 3/4/5 extend cables (96) between the opening of cable retaining pad and the side plate and with the threaded end of the 3/4/5 extend cable routed beyond the base of 4th stage boom. Swing the retaining pad (88) into place and install the lower capscrew (108), washer (56), nut (133) and tighten both capscrews. (See “Fasteners And Torque Values” on page 1-7).

9. Push threaded end of 5/4/3 retract cable (77) through sheave opening in the bottom base end of the 4th stage boom and pull 5/4/3 retract cables threaded ends towards tip of boom.

10. Install button end of the 5/4/3 retract cable (77) into cable anchor on the inside base end of the 5th stage boom (5).

11. Install cable retaining screw (106) to secure cable.

12. Temporarily install the retract-2/3/4 extend pin (78) assembly with sheave (79) at the bottom base of the 5th stage boom to aid in positioning cables (77) during assembly of next section.

13. Extend the 5th section approximately 1 foot to install the top wear pads through the opening on top of boom at the rear of the 4th section.

14. Install two top wear pad mounting plates (152), top wear pads (173), adjustment cam plate (200), capscrews (197) and flatwashers (196).

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

15. Rotate cam (200) until gap is eliminated between wear pad and boom section keeping sections centered for proper boom alignment.

4th and 3rd Section Boom

1. Install bottom wear pad (68) and shims (67) capscrew (69) onto the base of the 4th stage boom (4).

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

2. Install two side wear pads (42) and shims (41) onto pins at the base of the 4th stage boom. Shim according to calibration instructions in this section or as pads were originally removed and tagged.

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

3. Raise and support 4th/5th stage booms and install into 3rd stage boom (3) approximately fifteen feet. Take care to keep 5/4/3 retract cables (77) taunt, not crossing cables and keeping all cables clear of pinch points created by slings and bottom pads.

4. Raise 4th/5th stage booms (4,5) against top of 3rd stage (3) boom and install wear pads (187), capscrew (186) into the bottom tip of the 3rd stage boom.

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

5. Lower 4th/5th stage booms onto wear pads in the 3rd stage boom. Push 4th/5th stage booms into 3rd stage boom leaving approximately four feet of 4th/5th stage booms left out of 3rd stage boom.

6. Assemble 5/4/3 retract cable keepers (107) onto 5/4/3 retract cables (77), double nut (151,12) just beyond flat at threaded end of retract cables and assemble at bottom tip of 3rd stage boom (3) securing with capscrew (32).

7. Install lower side wear pads (15) with shims (13,14) on front inside of 3rd stage boom securing with capscrew (59).

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

8. Assemble and install upper side wear pad assembly (178,179,180) securing with hardware (176,177) to tip of the 3rd stage boom (3).

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

9. Install top wear pad (52) with shims (138) and cable guide (76) with (75),wear pad and related hardware (146,21,56) on the top front of 3rd stage boom (3). Shim according to calibration instructions in this section.

10. Push 4th/5th stage booms completely into 3rd stage boom and scribe a mark in the tip of the 4th stage boom in front of the side wear pad on the 3rd stage for retract sequencing. Keep 3/4/5 extend cables (96) and 5/4/3 retract cables (77) taunt and while guiding 3/4/5 extend cables (96) into anchor plates at upper base of 3rd stage boom. Thread nuts (86) onto 3/4/5 extend cables (96) just beyond flats.

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

11. Remove previously assembled 5/4/3 retract cables from anchor plate at the bottom base of the 5th stage boom and loop cables back away from base of boom.

12. Pull 5th stage boom out of 4th stage boom approximately 12 in.

13. Assemble and install extend cylinder assembly.

a. Install bearings (113) into 2/3/4 extend cylinder sheaves (112).

b. Coat bearing with multi-purpose grease and install 2/3/4 extend sheaves into extend cylinder (6).

c. Install pin assembly (114) through cylinder sheave case securing with keeper plate (115) and two bolts (109).

d. Install two wear pads (116 and 119) each side on front tip of extend cylinder with capscrew (118).

14. Reeve 2/3/4 extend cables (29) over 2/3/4 extend cylinder sheaves (112) at the front of the telescope cylinder assembly (6) routing cables behind cylinder in correct order.

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

15. Install top keeper rod (153) with capscrew (32) and install rod and roller assembly (153,165) with capscrew (32) to bottom of extend cylinder sheave case. Install cable retaining plate (166) and screw (101) to bottom of extend cylinder sheave case.

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

16. Install extend cylinder (6) into the rear of the 5th stage boom leaving approximately two feet extended. Push 5th stage boom completely into the 4th stage boom and raise extend cylinder to top of 3rd stage boom.

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17. Assemble and install the 5/4/3 retract-2/3/4 extend pin assembly into anchor plate at the bottom base of the 4th stage boom (4).

- **a.** Assemble 3 extend cables (29) on the 5/4/3 retract-2/3/4 extend pin (78).
- **b.** Install one washer (132) and one retainer (131) on each side of the outer cables.
- **c.** Install one retainer (131) and one washer (132) inside of each sheave.
- **d.** Install bushing into single groove sheave and brush with chassis grease and install on both ends of pin.
- **e.** Loop 5/4/3 retract cables (77) around single grooved sheaves and pin assembly.
- **f.** Install plug (64) in end of pin.
- **g.** Install shaft assembly into retainer at base of 4th stage boom and install button end of 5/4/3 retract cables (77) into anchor plate at the bottom base of the 5th stage boom.
- **h.** Install cable retaining capscrew (106) into threaded hole in cable retainer block at back bottom of 5th stage.
- **i.** Install grease fittings (95) toward base of boom. or [if equipped LH tube (194), RH tube (195), fitting (188) and two grease fitting (73].
- **j.** Apply multipurpose grease (MPG) to grease fittings.

18. Install retract cable guides (84) with capscrew (85) into the base of the 4th stage boom.

NOTE: Use caution when moving cylinder to avoid damage to cable guides.

19. Lower extend cylinder and push into 3rd stage boom keeping cables taunt to approximately one foot behind cylinder anchors in the 3rd stage boom. Raise base of extend cylinder to top of 3rd stage boom.

20. Install wear pad (81) with capscrews (83)at the base of the fourth stage boom.

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 (82). Route threaded ends of 4/3/2 retract cables (53) down through the opening in the base of the 3rd stage boom and pull threaded ends of 4/3/2 retract cables toward tip of boom (3). Install 4/3/2 retract cable keeper (82) into anchor plates at the base of the fourth stage boom.

22. Assemble and install the 4/3/2 retract-1/2/3 extend pin assembly into anchor plate at the bottom base of the 3rd stage boom (3).

- **a.** Install one retainer (37) and one washer (36) inside of each sheave.
- **b.** Install bushing (35) into double groove sheave (34) and brush with chassis grease and install on both ends of pin.
- **c.** Loop 4/3/2 retract cables (53) around double grooved sheaves (34) and pin (191) assembly.
- **d.** Install plug (64) in end of pin (191).
- **e.** Install shaft assembly into retainer at base of 3rd stage boom (3).
- **f.** Install grease fittings (95) toward base of boom or [if equipped LH tube (192), RH tube (193), fitting (188) and grease fitting (73].

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

24. Install retract cable guides (65) with capscrew (74) into the base of the 3rd stage boom.

NOTE: Use caution when moving cylinder to avoid damage to cable guides.

25. Lower the extend cylinder onto wear pad (83).

3rd and 2nd Section Boom

1. Install two top wear pad mounting plates (152), wear pads (172), with capscrew (198), washer (196) onto the base of the 3rd stage boom (3).

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

2. Install adjustment cam plate (200), capscrews (197) and flatwashers (196).

3. Rotate cam (200) until gap is eliminated between wear pad and boom section keeping sections centered for proper boom alignment.

4. Install one bottom wear pad (143), and shims (142) with capscrew (69) onto the base of the 3rd stage boom.

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

5. Install two side wear pads (42) and shims (41) onto the base of the 3rd stage boom. Shim according to calibration instructions in this section.

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

6. Stretch out 3/8 diameter, 1/2/3 sync extend cable (10), then bring threaded ends back together to form a loop and find the center of cable length.

- **a.** Slide this center loop from front to back through the cable anchor slot at base, top of the 3rd stage boom (3).

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b. Slide the keeper sheave (71) into this slot from back to front so raised portion of sheave slides into slot of cable anchor plate.

c. Pull this loop of cable forward to lock 1/2/3 sync extend cable (10) to 3rd stage boom.

d. Place the sheave case assembly (44) on top front of 3rd stage boom with its top bar up and forward.

e. Loop both threaded ends of sync extend cable (10) toward back of boom to form two loops, left and right, at front of boom. Slide left and right loops into left and right sides of sheave case assembly.

f. Install bearings (45) in sheaves.

g. Brush with chassis grease.

h. Install flattened end pins (47) in sheaves.

NOTE: Insure grease feed holes face toward the back of the boom.

i. Slide pins (with sheaves) into slots in front of sheave case assembly (44). Fold back and position assembled sheave case on top of boom sections during assembly of next boom stage.

j. Route and pull threaded ends of sync extend cable (10) toward base of boom and loop over base of boom.

7. Insure 2nd stage extend cylinder ears (6) are horizontal.

8. Raise and support 3rd/4th/5th stage booms and install into 2nd stage boom (2) approximately fifteen feet.

NOTE: Take care to keep 4/3/2 retract cables taunt, not crossing cables and keeping all cables clear of pinch points created by slings and bottom pads.

9. Raise 3rd/4th/5th stage booms against the top of the second stage boom (2) and install wear pads (17) with capscrew (186) into the bottom tip of the 2nd stage boom.

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

a. Lower 3rd/4th/5th stage booms onto wear pads in the 2nd stage boom.

b. Install 3rd/4th/5th stage booms into stage boom leaving approximately four feet of 3rd/4th/5th stage booms left out of 2nd stage boom.

10. Assemble 4/3/2 retract cable keeper plate assemblies (26) with capscrew (27) onto 4/3/2 retract cables (53). Install double nut (151,12) just beyond flat on 4/3/2 retract cables and assemble at bottom tip of 2nd stage boom (2).

NOTE: Take care not to cross cables.

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

11. Install lower side wear pads (15), shims (13,14) with capscrew (26) on front inside of 2nd stage boom.

12. Install upper wear pad assembly (180,179,178) with capscrew(176),washer (177) at upper tip of 2nd stage boom.

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

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

13. Slide the previously assembled 1/2/3 extend cable sheave case assembly (which is on the top tip of the 3rd stage boom) into position in the 2nd stage boom.

14. Install grease fittings (43) into 1/2/3 extend sheave pins (47).

15. Install wear pad (58) with shims (137) on inside top front of 2nd stage boom (2). Install wear pad (33), cable guide (54) with related hardware (56, 21,55,117,57) on the top front of 2nd stage boom (2). Shim according to calibration instructions in this section.

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

16. Push 3rd/4th/5th stage booms into 2nd stage boom until it bottoms out against cylinder ears. Install capscrew (11), washer (8) with Loctite to retain the 2nd stage cylinder in the 2nd stage boom.

17. Install the cable wear pad (72) with capscrew (27) on top of the extend cylinder barrel (6).

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

18. Install the extend cylinder into the slots at the base of the 3rd stage boom. Install keepers (50) with capscrew (48), washer (49) with Loctite to retain the 2nd stage cylinder in the 2nd stage boom.

19. Install wear pad (39) on top of 2/3/4 extend cable anchor assembly (30), then install 2/3/4 extend cable anchor assembly in slots at base, top of 2nd stage boom (2) while guiding 2/3/4 extend cables (29) into anchor assembly (30). Install nuts (31) and spacer (87) on threaded ends of 2/3/4 extend cables (spacer is used on center cable only).

NOTE: Do not twist cables. Twisting of cables will result in damage or failure of cable. When initially assembling threaded ends of cables, thread the

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first nut on past the flat so adjustment can be made later.

20. Lock cable anchor assembly (30) in place with capscrews (27) through the top back side plates of the 2nd stage boom. Be sure 1/2/3 sync extend cables (10) are threaded over the top of the 2/3/4 extend cable anchor.

21. Route three 3/2/1 retract cables (19) around 3/2/1 retract cable keeper (51) and install on mounting bracket (144) with capscrew (145) onto 3/2/1 retract cable anchor with 3/2/1 retract cables draped out behind boom.

22. Assemble and install the 3/2/1 retract pin assembly into anchor plate at the bottom base of the 2nd stage boom (2).

a. Install one retainer (37) and one washer (36) inside of each sheave.

b. Install bushing (35) into three groove sheave (148) and brush with multipurpose grease (MPG) and install on both ends of pin.

c. Loop 3/2/1 retract cables (19) around three groove sheaves (148) and retract pin (38) assembly.

d. Install plug (64) in end of pin (38).

a. Install shaft assembly into anchor plates at the base of the 2nd stage boom pulling threaded ends of 3/2/1 retract cables towards tip of boom.

b. Install 3/2/1 retract pin keeper setscrews (154) behind retract pin (38) into base of 2nd stage boom (2).

c. Install grease fittings (95) toward base of boom.

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

23. Install retract cable guides (149), with capscrew (74) into the base of the 2nd stage boom (2).

24. Install bottom wear pad (141) and shims (140) with capscrew (167) onto the base of the 2nd stage boom.

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

25. Route the 3/2/1 retract cables (19) between the bottom of the second stage boom and the bottom pad shims.

26. Install two side wear pads and shims onto the base of the 2nd stage boom. Shim according to calibration instructions in this section.

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

27. Install two top wear pad mounting plates (152), wear pads (173), with capscrew (198), washer (196) onto the base of the 2nd stage boom (2).

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

28. Install adjustment cam plate (200), capscrews (199) and flatwashers (196).

2nd and 1st Section Boom

29. Install one bottom wear pad (167), and shims (141,140) with capscrew (167) onto the base of the 2nd stage boom.

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

30. Install two side wear pads (42) and shims (41) onto the base of the 2nd stage boom. Shim according to calibration instructions in this section.

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

31. Rotate 1st stage cylinder shaft so counterbalance valve is directly below shaft centerline.

32. Raise and support 2nd/3rd/4th/5th stage booms and install into 1st stage boom (1) approximately fifteen feet. Take care to keep 3/2/1 retract cables taunt, not crossing cables and keeping all cables clear of pinch points created by slings and bottom pads.

33. Raise 2nd/3rd/4th/5th stage booms against top of 1st stage boom and install wear pads (184,185) with capscrew (20) washer (49) into the bottom tip of the 1st stage boom.

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

34. Lower 2nd/ 3rd/4th/5th stage booms onto wear pads in 1st stage boom. Push 2nd/3rd/4th/5th stage booms into 1st stage booms leaving approximately four feet of 2nd/3rd/4th/5th stage booms sticking out of 1st stage boom.

35. Assemble 3/2/1 retract cable keepers (150) with capscrew (27) onto 3/2/1 retract cables, double nut (151,12) just beyond flat on 1/2/3 retract cables (19) and assemble at bottom tip of 1st stage boom. Take care not to cross cables.

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

36. Install side wear pads (18) wear pad backup plate (22), back plate (28).

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

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37. Install adjusting bolt (70) and jam nut (111) on lower front side of 1st stage boom. Install wear pad retaining hardware (61,62,63) in wear pad pocket.

38. Install upper wear pad assembly (178,179,180) with hardware (176,177) at upper tip of 1st stage boom.

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

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

39. Install top steel spacer pad (16) with shims (136) with hardware (23,21,56) at the tip of the 1st stage boom, Loctite capscrews. Shim according to calibration instructions in this section.

40. Push 2nd/3rd/4th/5th stage booms keeping 3/2/1 retract cables taunt completely into 1st stage boom or until top wear pad aligns with the top access hole in 1st stage boom.

41. Rotate cam (200) until gap is eliminated between wear pads and boom section keeping sections centered for proper boom alignment and tighten clamping hardware.

42. Attach 1st stage cylinder rod to 1st stage hoist mount with washer (8) and shoulder bolt (11) that has been torqued and Loctite applied.

43. It is important in this step to have the nuts loose on the 3/2/1 retract cables (19) at the bottom tip of the 1st stage boom. Install the 1/2/3 sync extend cables (10) into the holes at the base of the 1st stage boom, install washer (8) and double nut (9) just beyond flats.

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

44. Torque cables per the “Five Section Cable Tensioning” procedure.

45. Install all protective caps on threaded cable ends.

46. Install cable guide (76) with washer (56 and nut (133) to mounting studs at center top of 1st stage boom (1).

47. Extend boom and align all boom sections according to boom alignment procedure.

48. Install access cover (160) with hardware (161,162) to top rear of 1st stage boom.

49. Install roller (202) and pin (201) with retaining ring (203) on lower front tip of 1st stage boom (if equipped).

50. Install boom angle pendulum (158) and bearing (157) to left side of 1st stage boom.

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Five Section Boom

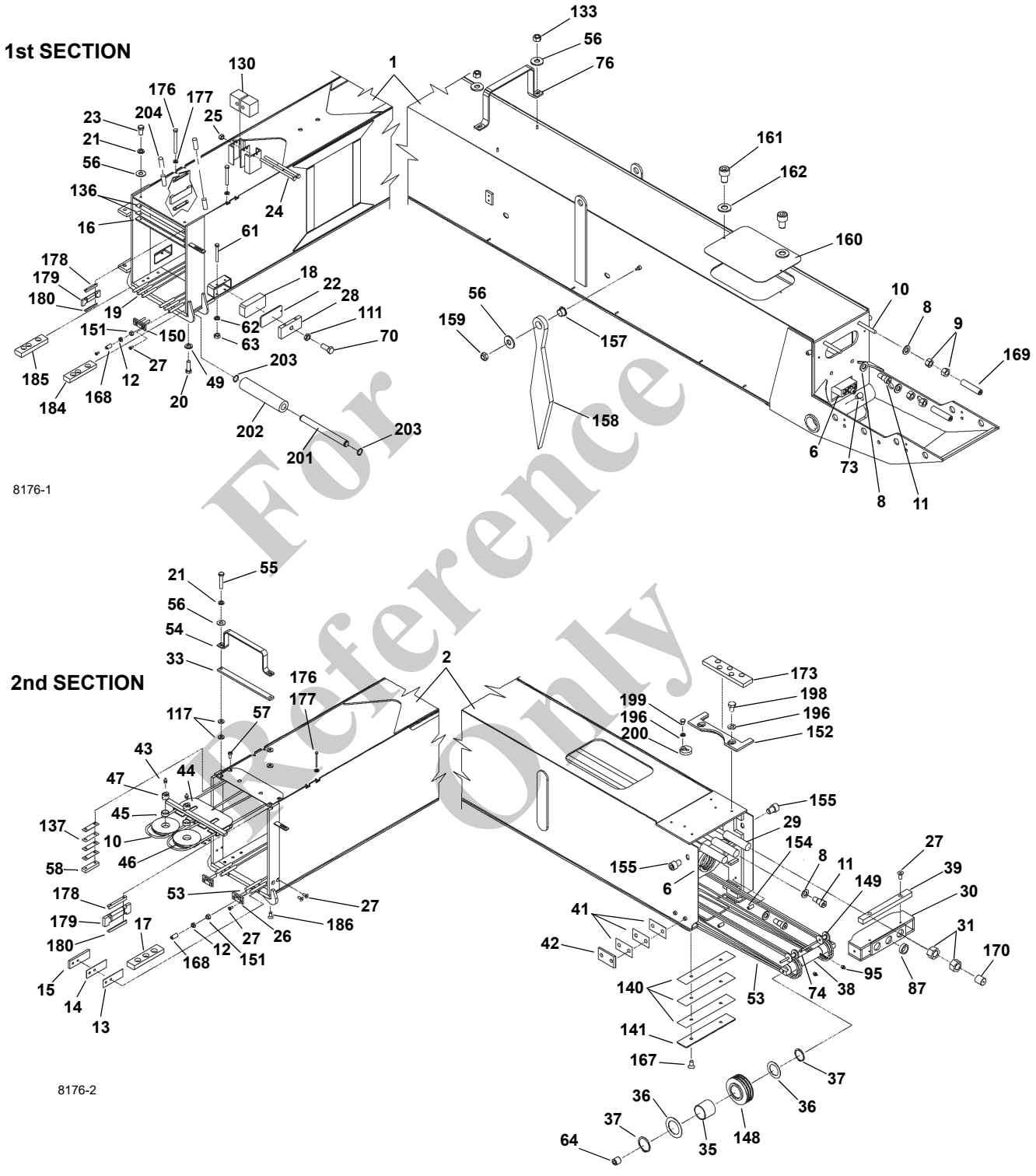

FIGURE 4-8

For Reference Only

Five Section Boom

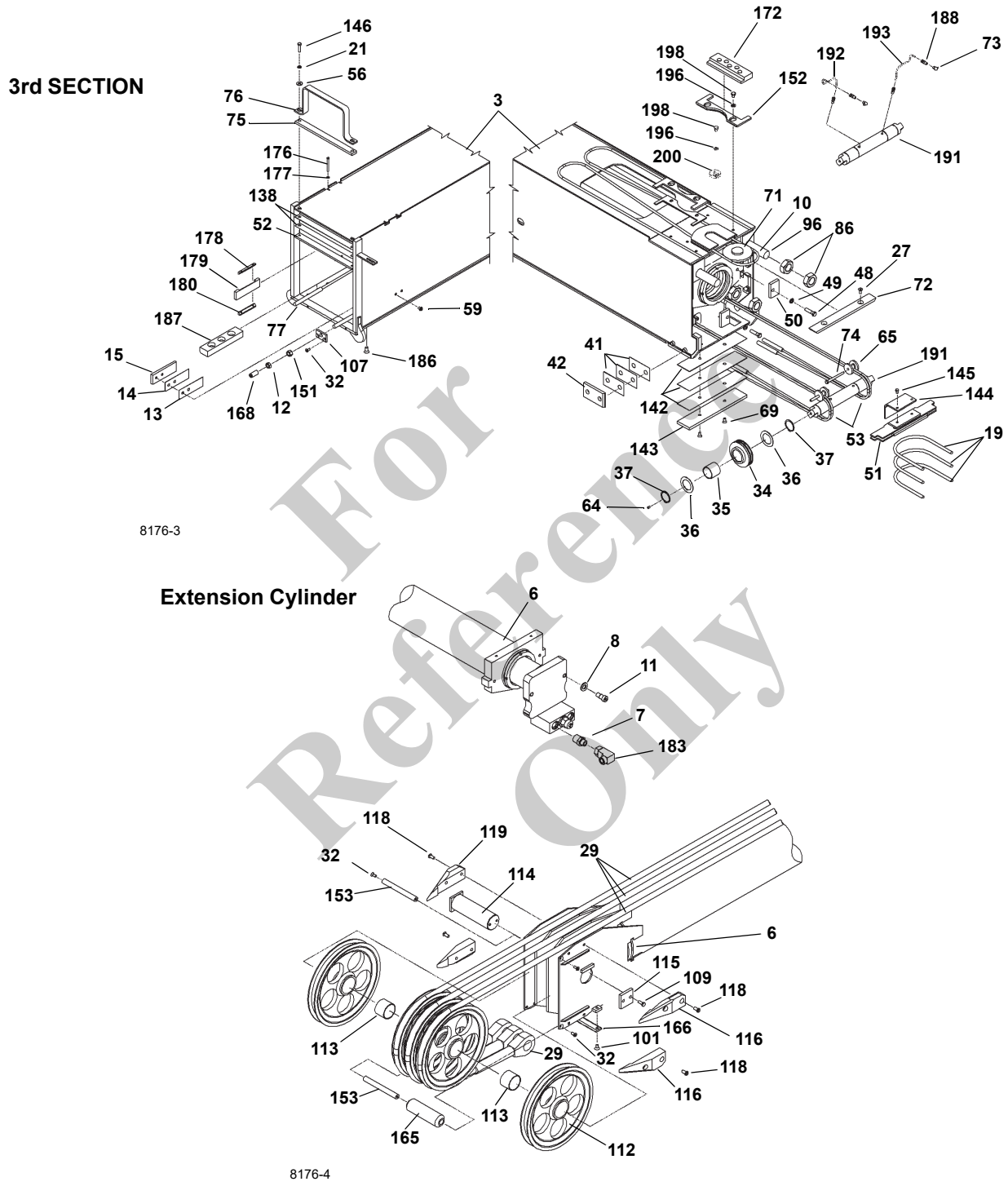

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FIGURE 4-8

Five Section Boom

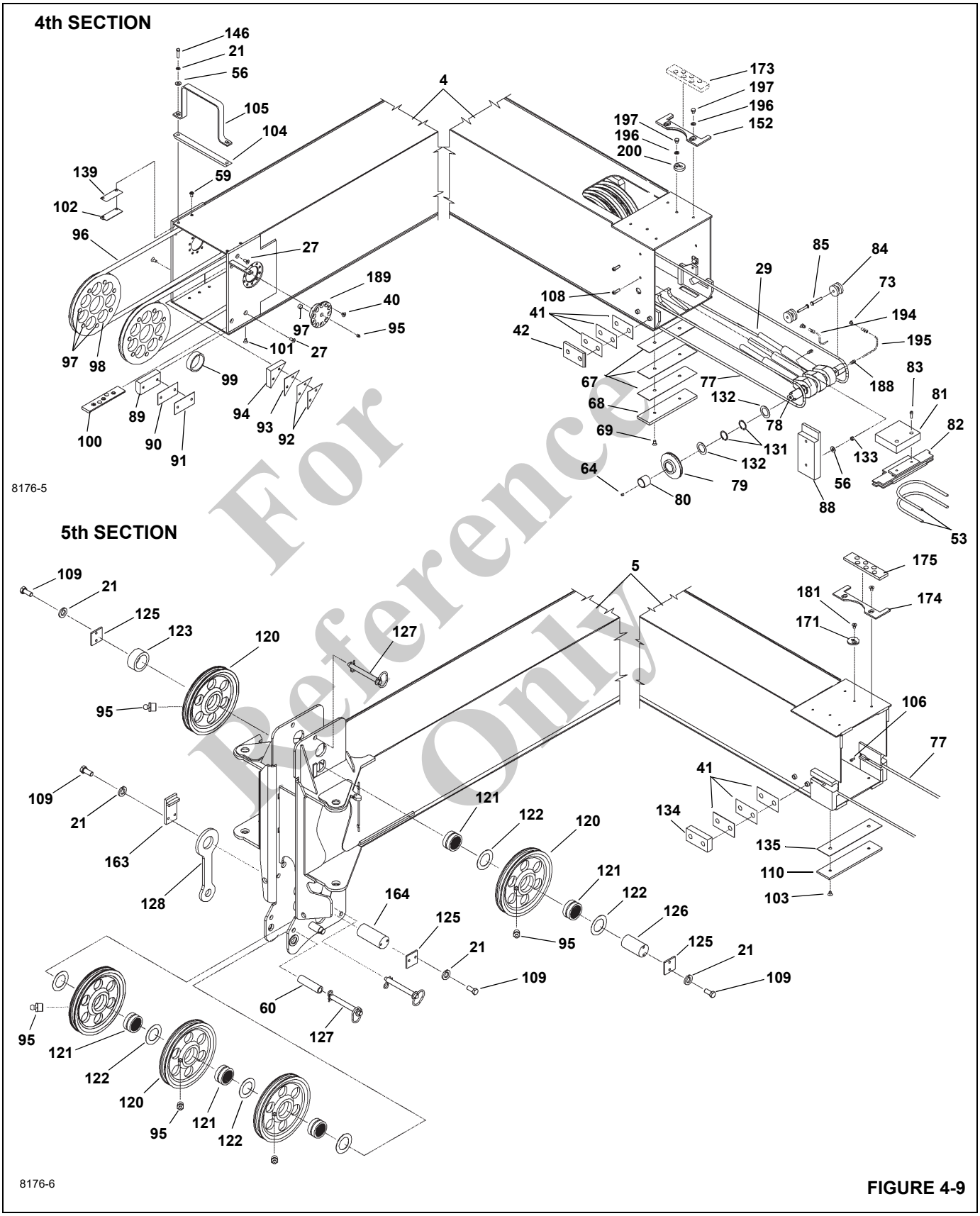

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FIGURE 4-9

For Reference Only

Item	Five Section Boom Description
1	1st Section Boom - Base Assembly
2	2nd Section Boom Assembly
3	3rd Section Boom Assembly
4	4th Section Boom Assembly
5	5th Section Boom Assembly
6	Telescope Cylinder Assembly
7	Straight Thread Adapter
8	Flatwasher 3/4
9	Hex Nut 3/4-10unc Sae-8
10	Sync Cable Assembly
11	Socket Head Set Screw 3/4x0.75
12	Hex Jam Nut 5/8 -11unc Sae-5.2
13	Shim
14	Shim
15	Wear Pad
16	Plate
17	Wear Pad
18	Wear Pad
19	R3 Cable Assembly
20	Hex Head Capscrew 1/2-13uncx1.50 G8
21	Lock Washer 3/8
22	Wear Pad Backup Plate
23	Hex Head Capscrew 3/8-16uncx0.75 G5
24	Hex Head Capscrew 3/8-16uncx7.5 G5
25	Hex Lock Nut 3/8-16unc
26	Plate Assembly
27	Socket Flat Head Capscrew 3/8-16uncx0.88
28	Back Plate
29	E4 Cable Assembly
30	Cable Anchor Assembly
31	Hex Nut 1-3/4-5unc Gr2
32	Socket Flat Head Capscrew 5/16-18uncx0.75
33	Wear Pad
34	Sheave
35	Bearing
36	Flatwasher 2.00x3.0x0.7
37	Retaining Ring 2.00
38	Pin
39	Wear Pad
40	Socket Flat Head Capscrew M10x12 -10.9
41	Shim
42	Wear Pad

Item	Five Section Boom Description
43	Grease Fitting
44	Sheave Anchor Assembly
45	Bearing
46	Sheave
47	Pin
48	Hex Head Capscrew 1/2-13uncx2.00 G5
49	Lock Washer 1/2
50	Keeper
51	Cable Anchor Assembly
52	Plate
53	R4 Cable Assembly
54	Cable Guide
55	Hex Head Capscrew 3/8-16uncx2 G5
56	Flatwasher 3/8
57	Socket Button Capscrew 3/8-16uncx0.88
58	Plate
59	Socket Button Capscrew 3/8-16uncx0.5
60	Tube
61	Hex Head Capscrew M10x90 Ss
62	Lock Washer 10
63	Hex Nut M10 8
64	Plug
65	Roller
66	Hex Head Capscrew 3/8-16uncx5 G5
67	Shim
68	Wear Pad
69	Socket Flat Head Capscrew 3/8-16uncx0.75
70	Hex Head Capscrew M20x50 8.8
71	Sheave
72	Wear Pad
73	90 Deg Grease Fitting
74	Hex Head Capscrew 3/8-16uncx4 G5
75	Wear Pad
76	Cable Guide
77	R5 Cable Assembly
78	Pin
79	Sheave
80	Bearing
81	Wear Pad
82	Cable Anchor Assembly
83	Socket Head Capscrew 5/16-18uncx1
84	Roller
85	Hex Head Capscrew 3/8-16uncx2.25 G5

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Item	Five Section Boom Description
86	Hex Jam Nut 1-1/2-6unc Sae-2
87	Spacer
88	Wear Pad
89	Wear Pad
90	Shim
91	Shim
92	Shim
93	Shim
94	Wear Pad
95	Grease Fitting 1/8 Npt
96	E5 Cable Assembly
97	Plug
98	Sheave
99	Bearing
100	Wear Pad Assembly
101	Socket Flat Head Capscrew 3/8-16uncx0.63
102	Wear Pad Steel
103	Socket Flat Head Capscrew M10x14 -10.9
104	Wear Pad
105	Cable Guide
106	Socket Head Capscrew 1/4-20uncx0.63
107	Plate
108	Socket Button Capscrew 3/8-16uncx1.25
109	Hex Head Capscrew 3/8-16uncx0.88 G8
110	Wear Pad
111	Hex Jam Nut M20
112	Sheave
113	Bearing
114	Pin Assembly
115	Keeper
116	Wear Pad
117	Flatwasher 5/16
118	Socket Button Capscrew 3/8-16uncx0.75
119	Wear Pad
120	Sheave
121	Bearing
122	Spacer
123	Spacer
125	Keeper
126	Sheave Pin
127	Hitch Pin 0.75x7
128	Link
130	Cable Block

Item	Five Section Boom Description
131	Retaining Ring 1.5
132	Flatwasher 1.5x2.25x0.7
133	Hex Nut 3/8-16unc
134	Wear Pad
135	Shim
136	Shim
137	Shim
138	Shim
139	Shim
140	Shim
141	Wear Pad
142	Shim
143	Wear Pad
144	Bracket
145	Hex Head Capscrew 5/16-18uncx0.5 G5
146	Hex Head Capscrew 3/8-16uncx1.5 G5
148	Sheave
149	Roller
150	Plate Assembly
151	Hex Nut 5/8-11
152	Wear Pad Plate
153	Rod
154	Square Stainless Steel-cup 5/16-18uncx0.75
155	Socket Head Capscrew 3/8-16uncx0.5
157	Bearing
158	Pendulum
159	Hex Lock Nut 3/8-24
160	Plate
161	Socket Head Capscrew M8x12 -10.9
162	Flatwasher 8
163	Keeper Assembly
164	Sheave Pin
165	Roller
166	Plate
167	Socket Flat Head Capscrew 1/2-13uncx0.75
168	Cable Protector
169	Cable Protector
170	Cable Protector
171	Cam Plate Rear Wear Pad
172	Wear Pad Assembly
173	Wear Pad Assembly
174	Upper Plate Rear Wear Pad
175	Wear Pad Assembly

For Reference Only

Item	Five Section Boom Description
176	Hex Head Capscrew M6x70
177	Flatwasher 6
178	Keeper Side Wear Pad
179	Side Wear Pad
180	Keeper Side Wear Pad
181	Socket Flat Head Capscrew M10x16 10.9
183	90 Deg Elbow
184	Wear Pad, Left
185	Wear Pad, Right
186	Socket Flat Head Capscrew 1/2-13uncx1
187	Wear Pad
188	Fitting
191	Pin
192	Tube L.h., 3rd Section
193	Tube R.h., 3rd Section
194	Tube L.h., 4th Section
195	Tube R.h., 4th Section
196	Flatwasher 10
197	Hex Head Capscrew M10x12 -10.9
198	Hex Head Capscrew M10x14 -10.9
199	Hex Head Capscrew M10x16 -10.9
200	Cam Plate Rear Wear Pad
201	Pin
202	Roller
203	Retaining Ring (1.25 Dia)
204	Cable Protector
300	Boom Wear Pad Kit

Five Section Cable Tensioning

After boom reassembly or from time to time if interior proportioning cables appear loose, cable tensioning may be required.

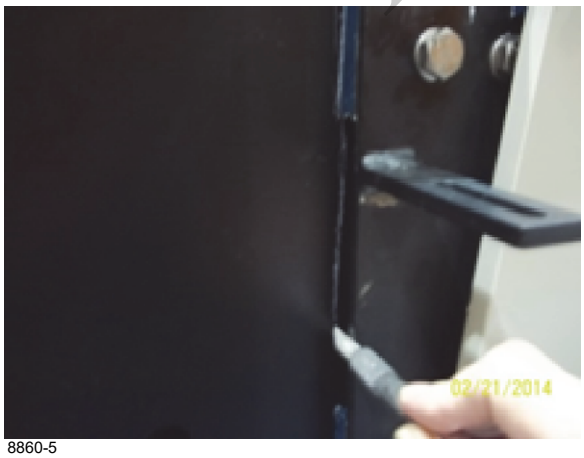
Tensioning Setup Procedure

Tensioning must be done with the boom in the horizontal position. reference Figure 4-10

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

Ensure boom is completely assembled and fully retracted.

1. Mark the front of each section with a chalk line as indicated in Figure 4-10.
2. Extend and retract boom several times to establish working state of cables.
3. Extend boom so scribed lines are exposed by approximately 12 inches.
4. Measure the extension gaps between each boom section and scribed line and note values.
5. Retract boom so that the scribed lines are exposed by approximately 6 inches.
6. Measure the retraction gaps between each boom section and scribed line and note values.
7. Extend and retract the boom a few times and then repeat measuring the extension gaps.
8. Adjust all corresponding cables according to following instructions.***Cable Tightening Sequence***



8860-5


8860-6

FIGURE 4-10

NOTE: When adjusting 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.

For Reference Only

Cable Tightening Sequence

1. Cycle boom approximately 3 m (10 ft) out and in a few times (.75 m, 2.5 ft per section). Fully retract the boom. Tighten the 4/3/2 retract, 2/3/4 extend, 3/2/1 retract, 1/2/3 extend, 5/4/3 retract and 3/4/5 extend cables.

   Extend the boom a few inches before tightening retract cables and retract the boom a few inches before tightening extend cables to remove slack and properly sequence bottoming out of boom sections.

2. Torque 4/3/2 retract cables (53) at front of the 2nd section to 5.42 Nm (4 ft lbs). Start with two inside cable ends equally, then the two outside cable ends equally.

3. Torque 2/3/4 extend cables (29) at back of 2rd section to 19.66 Nm (14.5 ft lb) each. To reach 2/3/4 extend cables, extend the boom out approximately 610 mm (24 in.) total, 115 mm (4.5 in) per section, and tighten through hole in back of base section.

4. Torque 3/2/1 retract cables (19) at front of base section to 4.07 Nm (3 ft lb), start with two inside cable ends equally, then the next two outer cable ends, then the two outside cable ends equally.

5. Torque 1/2/3 extend cables (10), (rear base section) to 14.91 Nm (11 ft lb) each.

6. Torque 5/4/3 retract cables (77) at the front of the 3rd section to 5.42 Nm (4 ft lbs).

7. Torque 3/4/5 extend cables (96) at rear of 3rd section to 11.52 Nm (8.5 ft lbs). To reach 3/4/5 extend cable, extend the boom out approximately 2.6 m (8.5 ft) total, 0.65 m (2.1 ft) per section and tighten through holes in top of base and 2nd sections.

8. Check to ensure all boom sections are bottoming out simultaneously.

   a. If the 2nd section is bottoming out first, loosen 1/2/3 extend cables, tighten 3/2/1 retract cables, and extend and retract the boom a few feet. Torque 3/2/1 retract cables as in step 4 and torque 1/2/3 extend cables as in step 5. Repeat until 2nd section bottoms out correctly.

   b. If 3rd section is bottoming out first, equally loosen 3/2/1 retract cables and tighten 1/2/3 extend cables and retract the boom a few feet. Torque 3/2/1 retract cables as in step 4 and torque 1/2/3 extend cables as in step 5. Repeat until 3rd section bottoms out correctly.

   c. If 4th section is bottoming out first, equally loosen 4/3/2 retract cables. Tighten 2/3/4 extend cables and extend and retract the boom a few feet. Torque 4/3/2 retract cables as in step 2 and torque 2/3/4 extend cables as in step 3. Repeat until 4th section bottoms out correctly.

   d. If 5th section is bottoming out first, equally loosen 5/4/3 retract cables, tighten 3/4/5 extend cables and extend and retract the boom a few feet. Torque 5/4/3 retract cables as in step 6 and torque 3/4/5 extend cables as in step 7. Repeat until 5th section bottoms out correctly.

9. Cycle the boom a few feet out and in. If all sections are not bottoming out simultaneously, repeat step 8.

10. Repeat steps 2 through 7 using the following torques. Torque 4/3/2 retract cables to 10.85 Nm (8 ft lb). Torque 2/3/4 extend cables to 39.32 Nm (29 ft lbs), torque 3/2/1 retract cables to 8.13 Nm (6 ft lb). Torque 1/2/3 extend cable to 29.83 Nm (22 ft lb), 5/4/3 retract cables to 10.85 Nm (8 ft lbs), 3/4/5 extend cables to 25.76 Nm (19 ft lbs).

11. Run the boom through a complete extend and retract cycle. Check that all cables are properly torqued and that all sections retract completely, repeat step 8 as needed.

12. Cycle the boom through a complete extend and retract cycle. Check that all cables are properly torqued and that all sections retract completely.

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

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

For Reference Only

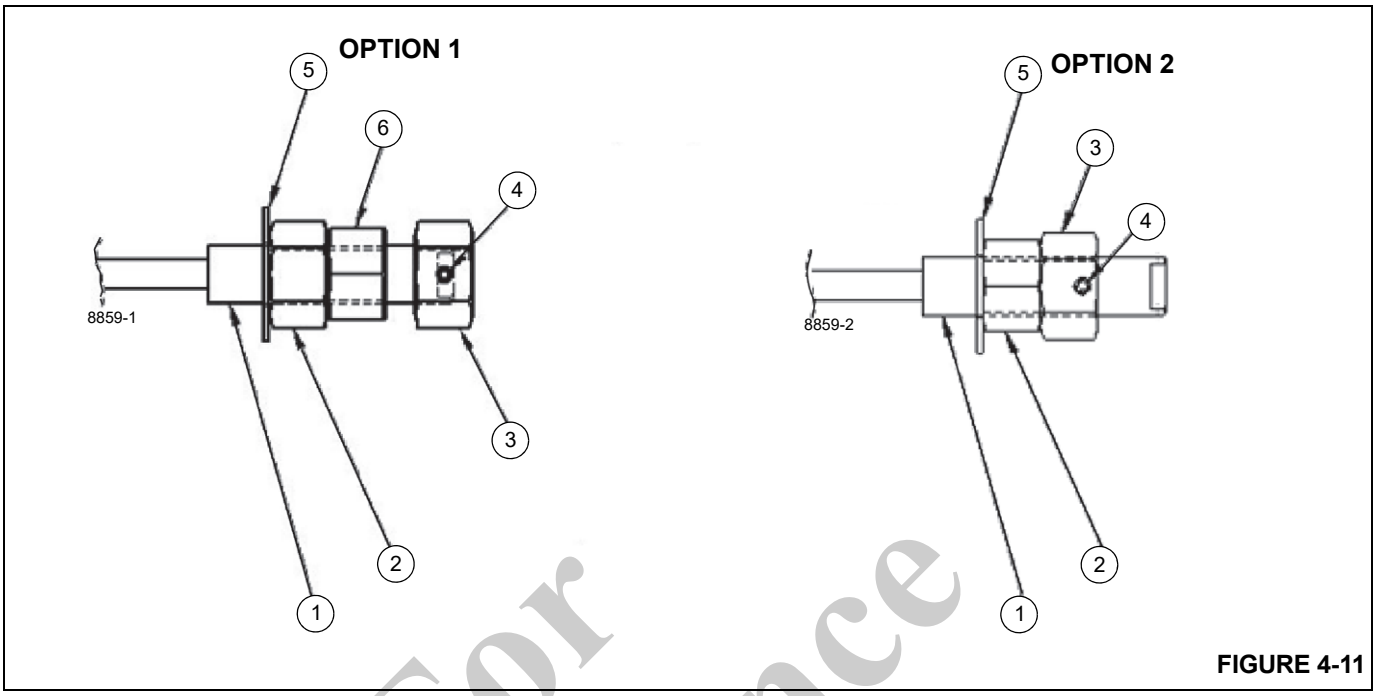


FIGURE 4-11

Cable Retention

Cable Retention Hardware

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

Nut configuration (see Figure 4-11) will be First Nut (ADJUSTMENT) and Second Nut (TORQUED).

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

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

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

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

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

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

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

Install set screw into Third nut and tighten.

Install cable protectors to all threaded cable ends.

(**OPTION 2**) method used ONLY when space constraints prevent **OPTION 1** usage (see Figure 4-11).

For Reference Only

TORQUE VALUES for Second Nut:

Inch Series with Coarse Threads (UNC)

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

For Reference Only

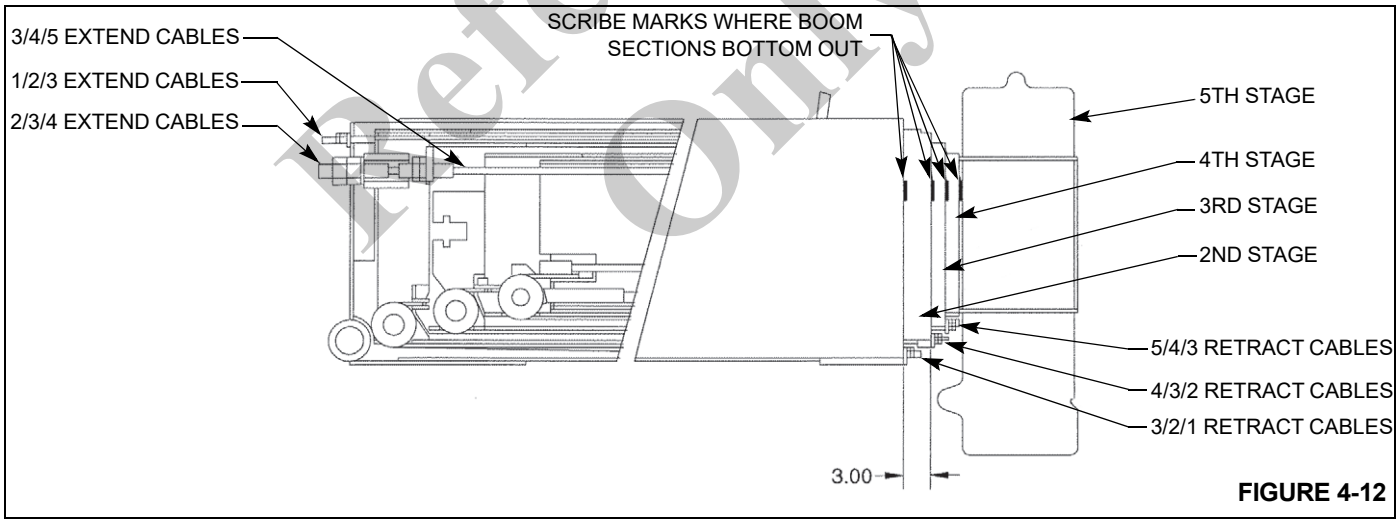


FIGURE 4-12

Five Section Top/bottom Pad Replacement, Assembled Boom

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

Excessive wear is wear in excess of 3/16 in from original thickness (1st, 2nd and 3rd stage bottom pads are 29.8mm (1.17 in) thick, 4th stage bottom pads are 11.6mm (.45 in) thick, 2nd 4th and 5th stage top pads are 11.6 (.45 in) thick, 3rd stage top pads are 25.4mm (1.0 in) thick, or uneven wear such as the outside edge of the pad worn in excess of 3/32 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 0.06 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 stage) so that upper wear pads on 3rd stage boom are visible through holes in the top plates of the 1st and 2nd stage booms.
2. Remove capscrews from the top base of the 3rd stage boom wear pad retaining plates and remove wear pad retaining plates from the 3rd stage boom. Mark these retaining plates so they can be reinstalled exactly as they were removed. Remove 3rd stage boom 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 base of the 1st stage boom. Tie the 1/2/3 extend cables with approximately 2 ft of wire and allow them to slack into the 1st stage boom removing cables from notch in 3rd stage boom pads.
4. Replace the 3rd stage boom wear pads and reinstall wear pad retaining plates onto the top plate of the 3rd stage boom. Loctite all flathead mounting screws.
5. If necessary, reinstall the 1/2/3 extend cables into the base of the 1st stage boom and reinstall the nuts which 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 stage) so that upper wear pads on 2nd stage boom are visible through hole in the top plate of the 1st stage boom.
7. Remove capscrews from the top base of the 2nd stage boom wear pad retaining plates and slide wear pad retaining plates towards the center of boom. Mark these retaining plates so they can be reinstalled exactly as removed. Remove the 2nd stage boom wear pads.
8. Replace the 2nd stage boom wear pads and reinstall wear pad retaining plates onto the top plate of the 2nd stage boom exactly as removed. Loctite all flathead mounting screws.
9. Extend the boom approximately 651.00 in (162.75 in per stage) so that base of the 4th stage boom passes the hole in the side plate of the 3rd stage boom and base of the 5th stage boom passes the hole in the side plate of the 4th stage boom. Raise the 4th and 5th stage boom tips to relieve pressure on wear pads on the top base of the 4th and 5th stage booms.
10. Remove countersunk capscrews from the bottom of the top plate on the base of the 4th stage boom that attach the wear pad retaining plates to the 4th stage boom.
11. Side wear pad retaining plates and wear pads toward base of boom and remove. Mark the wear pad retaining plates so they can be reinstalled exactly as removed.
12. Replace the 4th stage boom wear pads and reinstall wear pad retaining plates exactly as removed onto the top plate of the 4th stage boom. Loctite all flathead mounting screws.
13. Remove countersunk capscrews from bottom of the top plate on the base of the 5th stage boom that attach the wear pad retaining plates to the 5th stage boom.
14. Slide wear pad retaining plates and wear pads toward base of boom and remove. Mark the wear pad retaining plates so they can be reinstalled exactly as removed.
15. Replace the 5th stage boom wear pads and reinstall wear pad retaining plates exactly as removed onto the top plate of the 5th stage boom. Loctite 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 approximately eight ft out (two ft per stage).
2. Raise the 5th stage boom tip, until weight is removed from the bottom pads in the 4th, 3rd, 2nd and 1st stage booms.
3. Remove the capscrews (two in each pad) which retain the 4th, 2nd and 1st stage boom bottom wear pads and remove and replace pads. Reinstall capscrews, Loctite and torque to proper tightness.
4. Mark the location of the nuts which retain the 5/4/3 retract cables to the bottom tip of the 3rd stage boom. Loosen (to remove tension) the nuts on the 5/4/3 retract cables. Remove capscrews from 5/4/3 retract cable retainers and move retainers and cables towards center of boom.
5. Remove the capscrews (two in each pad) which retain the 3rd stage boom's bottom wear pads and remove and replace pads. Reinstall capscrews, Loctite and torque to proper tightness.
6. Reinstall 5/4/3 retract cable retainers and 5/4/3 retract cables into bottom tip of the 3rd stage boom. Tighten 5/4/3 retract cables to their original location previously marked on the threaded cable ends.

For Reference Only

BOOM CALIBRATION

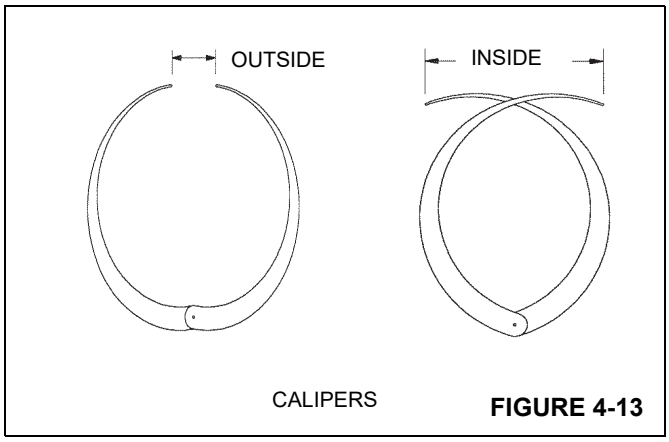


FIGURE 4-13

Top/rear Wear Pads

1. With a pair of inside/outside calipers, measure the inside width of the outer section (W_i) within 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.

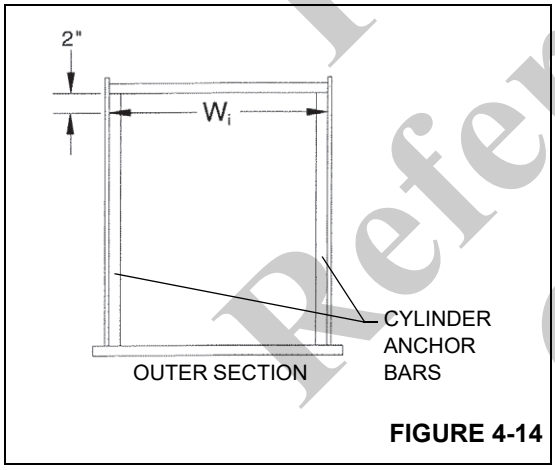


FIGURE 4-14

2. The top rear wear pads also act as the top side pads. These pads are anchored in place by means of offset retainers which are bolted on to 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 the mounting holes are placed off the centerline of the part. Use a combination of 0.53 and or 0.50 wear pad retainers on upper inner section to obtain a 0.00 - 0.06 clearance between these wear pads (W_o) and inside width (W_i) of outer section. Stamp wear pad retainers with R (right) or L (left) and with 2, 3, 4 or 5 (boom stage) in position as shown. Stamp top plate of boom sections with R or L corresponding to and in same general location as stamp on wear pad mounting plates as shown.

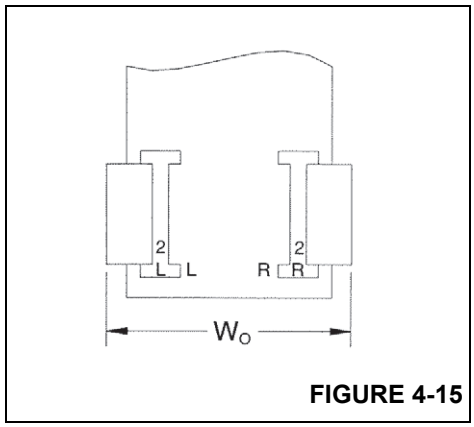


FIGURE 4-15

Inner Side Pads

1. With a pair of inside/outside calipers, measure the inside width of the outer section (W_i) at the front and back of the boom within 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.

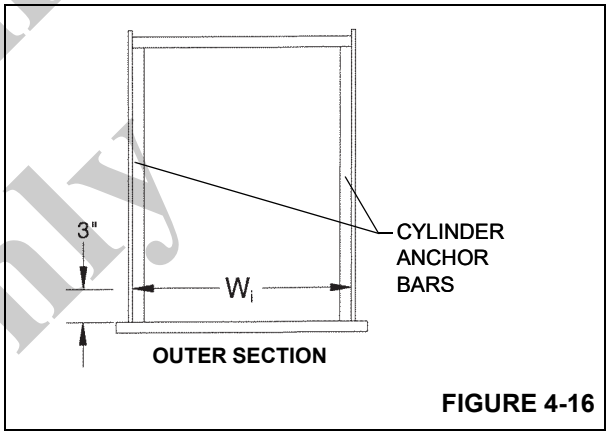


FIGURE 4-16

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

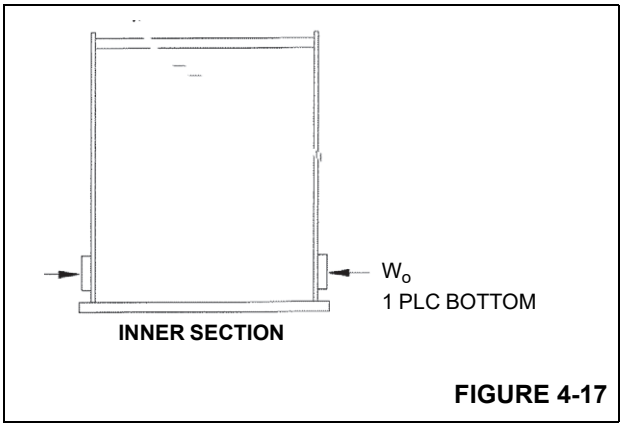


FIGURE 4-17

For Reference Only

3. Measure the thickness of the wear pads and record (twp),

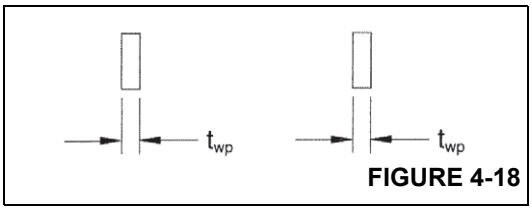


FIGURE 4-18

4. Subtract the outside width (W_o) of the inner section and the thickness of the two 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 0.00 - 0.06 clearance between the inner boom rear lower wear pads and the most narrow part of the outer boom when shims are installed.

Rear, Bottom 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.

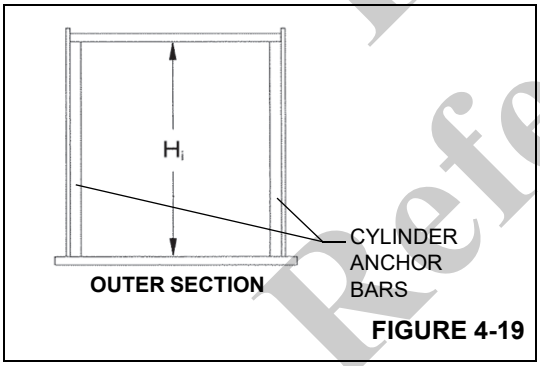


FIGURE 4-19

2. With the tape measure, measure the outside height of the inner section (H_o) at bottom, rear pad location. Record the largest measurement.

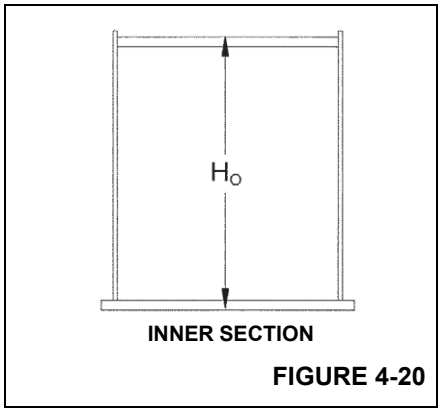


FIGURE 4-20

3. Measure the thickness of the top wear pads and record (twp).

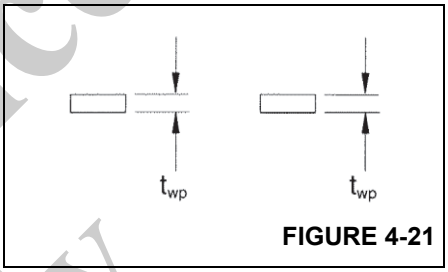


FIGURE 4-21

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 thick) to tighten the pads so that there is 0.06 - 0.12 clearance between the widest part of the inner boom and the most narrow part of the outer boom when shims and pads are installed.

For Reference Only

EXAMPLE

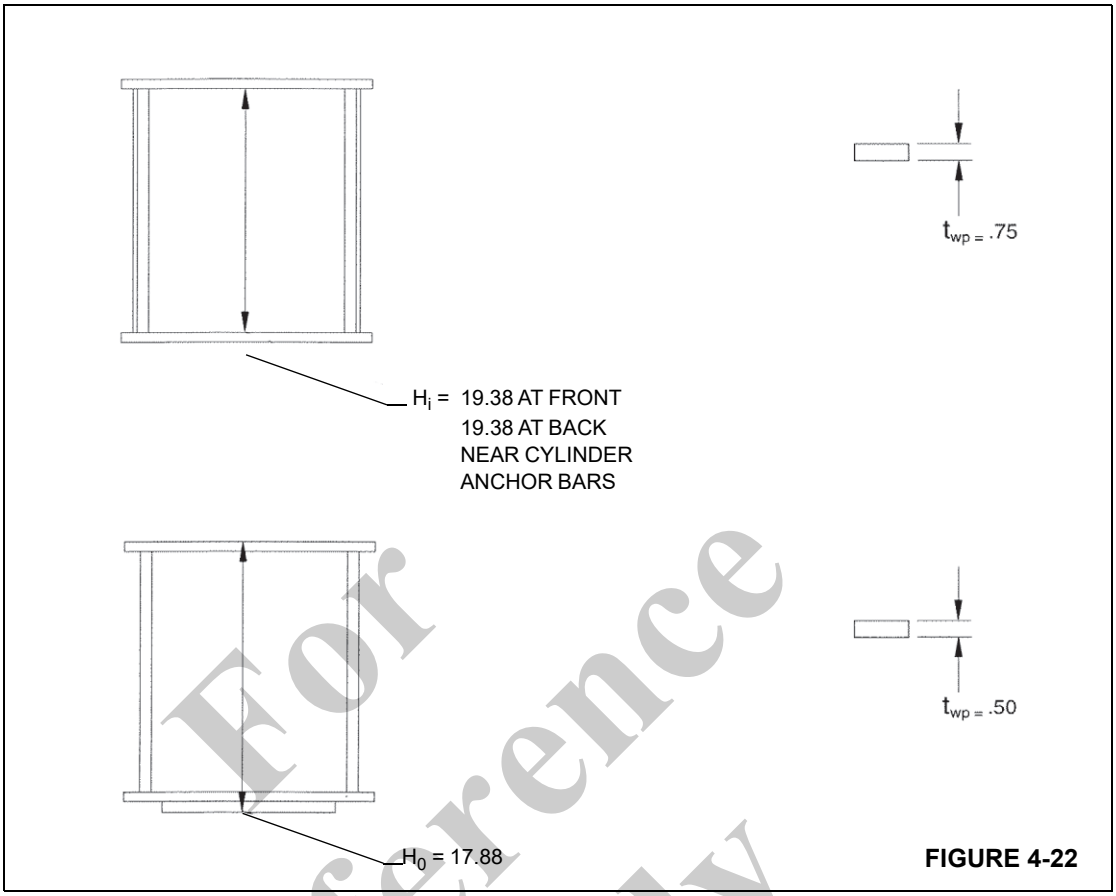


FIGURE 4-22

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**

For Reference Only

MULTI-STAGE EXTEND CYLINDER

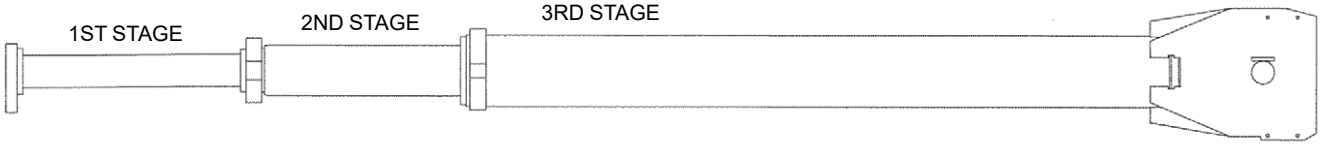


FIGURE 4-23

1. After cylinder has been disassembled from boom, place on supports and place drain pan under holding valve.

2. Using hydraulic power (porta power or crane circuit) extend cylinder sections approximately 24 in. If stages

do not move equally, retain the moving stage to allow for equal extension of cylinder. Remove the holding valve from the 1st stage butt plate and drain oil.

3. Using the proper size spanner wrench (listed on the cylinder parts page break down), loosen the packing gland and completely unscrew from the 3rd stage barrel assembly.
4. Remove the 2nd/1st stage cylinder assembly from the 3rd stage barrel assembly and place on supports. Caution must be exercised in the support and removal of 2nd/1st stage cylinder assembly as damage to the chrome surface will necessitate replacement.
5. Using the proper size spanner wrench (listed on the cylinder parts page break down), loosen the packing gland and completely unscrew from the 2nd stage cylinder assembly.
6. Remove the 1st stage cylinder assembly from the 2nd stage cylinder assembly and place on supports. Caution must be exercised in the support and removal of the 1st stage cylinder assembly as damage to the chrome surfaces will necessitate replacement.
7. Using a 3/16 in alien wrench, remove the locking setscrews from the 1st stage cylinder shaft piston and from the 2nd stage cylinder shaft piston. Using the proper size spanner wrench, loosen and completely unscrew pistons from the 1st and 2nd stage cylinder shaft assemblies. Remove stop tubes from the 1st and 2nd stage cylinder shaft assemblies.
8. Wipe and inspect all cylinder internal and external surfaces for damage. Wipe and inspect all threaded components for damage to threads.
9. Inspect wear pads on the 3rd stage barrel sheave case assembly. Replace as required.
10. Ensure that the O'ring seal area of the packing gland bores on both the 2nd stage cylinder assembly and the 3rd stage barrel assembly are smooth and free of nicks and lubricate to eliminate damage to the packing gland O'ring during reassembly.

Cylinder Reassembly

1. Replace cylinder packing parts as required on 1st stage cylinder assembly. Refer to parts pages for replacement packing kit part number. Warming the U-cup seals in 140°F oil will allow for easier assembly.
2. Reinstall packing gland and stop tube onto 1st stage cylinder shaft assembly.
3. Install O'ring and backup rings on inner diameter of 1st stage piston and thread onto 1st stage cylinder shaft assembly until snug making certain piston counterbore is seated over shaft assembly properly. Take care not to damage the O'ring while installing piston. Using the proper size spanner wrench tighten piston onto 1st stage cylinder shaft assembly to 600 lb-ft.
4. Install setscrew into piston using Loctite Type 243 according to Loctite recommendations and torque to 8 lb-ft. Loctite and install second set-screw on top of first setscrew and torque to 8 lb-ft.
5. Replace cylinder packing parts as required on 2nd stage cylinder assembly. Refer to parts pages for replacement packing kit part number.
6. Reinstall packing gland and stop tube onto 2nd stage cylinder shaft assembly.
7. Install O'ring and backup rings on inner diameter of 2nd stage piston and thread onto 2nd stage cylinder shaft assembly until snug making certain piston counterbore is seated over shaft assembly properly. Take care not to damage the O'ring while installing piston. Using the proper size spanner wrench, tighten piston onto 2nd stage cylinder shaft assembly to 600 lb-ft.
8. Install setscrew into piston using Loctite Type 243 according to Loctite recommendations and torque to 8 lb-ft. Loctite and install second set-screw on top of first setscrew and torque to 8 lb-ft.
9. Reinstall 2nd stage cylinder assembly with piston stop tube and packing gland into 3rd stage barrel assembly to within 24 in of fully assembled. Carefully start packing gland into 3rd stage barrel and tighten to within 1/4 in of snug. Using the proper size spanner wrench, torque the packing gland to 600 lb-ft.
10. Apply a 3/16 in wide band of Loctite 518 to outer threads of packing gland and complete installation.
11. Reinstall 1st stage shaft assembly with piston, stop tube and packing gland into 2nd stage cylinder assembly to within 24 in of fully assembled Carefully start packing gland into 2nd stage and tighten to within 1/4 in of snug.
12. Apply a 3/16 in wide band of Loctite 518 to outer threads of packing gland and complete installation. Using the proper size spanner wrench, torque the packing gland to 600 lb-ft.
13. Install holding valve onto 1st stage shaft butt plate. Cycle test cylinder to ensure leak proof operation. Apply oil to the 1st stage shaft assembly through the holding valve. Support the 2nd and the 3rd stages as they extend and retract.

JIB BOOM

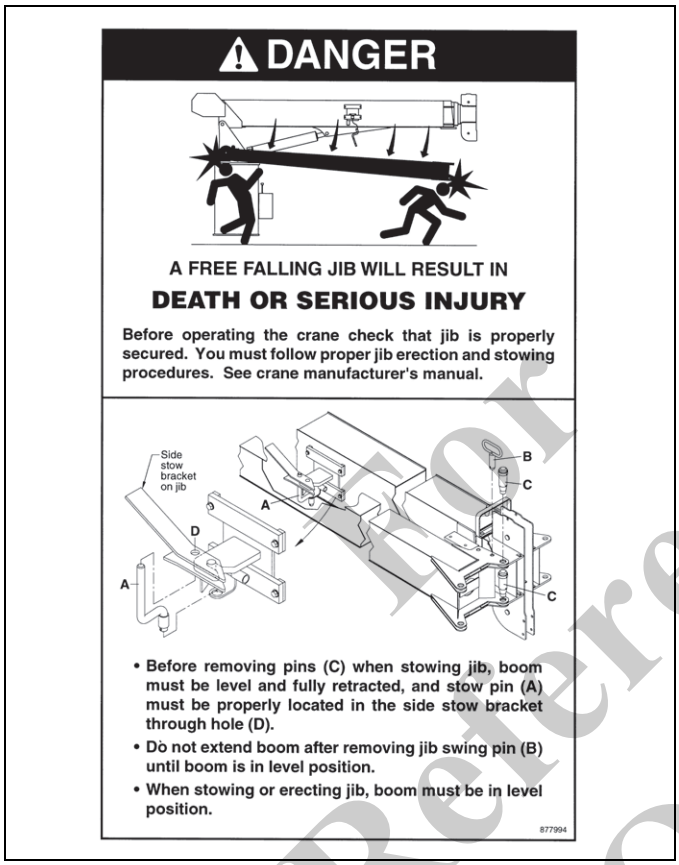
Jib Stowage Bracket Adjustment

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 4-27) and to the boom nose of the main boom.

For Reference Only

Use the following procedure to make adjustments to the jib stowage bracket.

Before beginning this procedure read and understand the following DANGER decal. Also review and understand the Operator's Manual Set-Up section 4 for jib safety, stowing and deployment instructions.



1. Loosely bolt the two ear assemblies with shims and bars as shown in Figure 4-24 to the side of the first boom section.

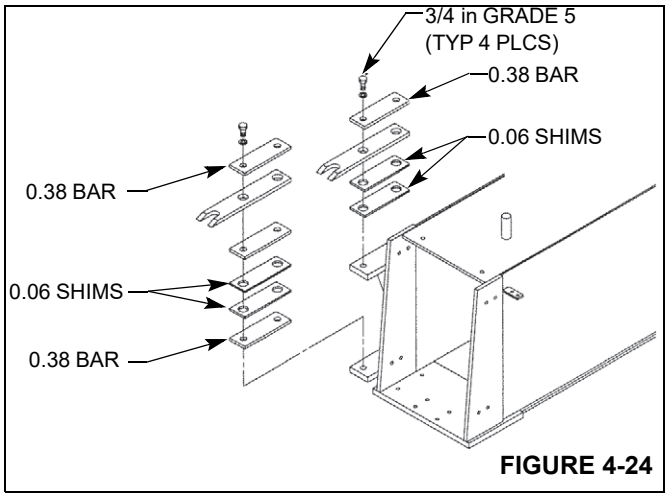


FIGURE 4-24

2. Loosely bolt the hook assembly to the side of the first boom section, Figure 4-25.

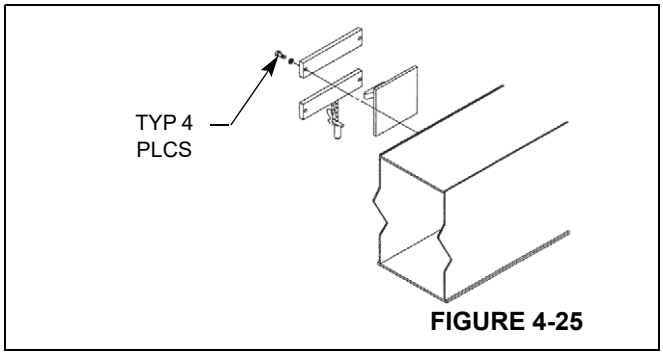


FIGURE 4-25

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 4-26.

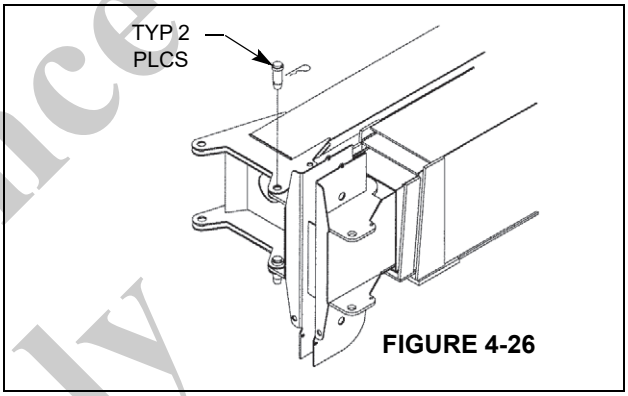


FIGURE 4-26

5. With jib pinned to the sheave head, swing the jib parallel to the boom and secure to the jib stowage bracket Figure 4-27.

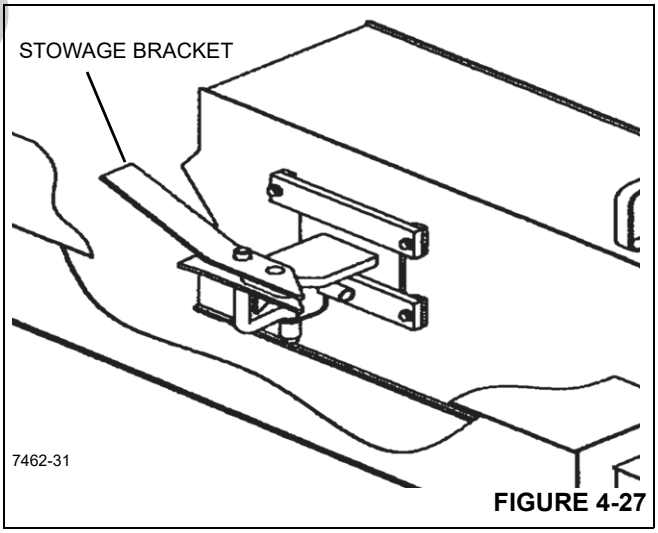


FIGURE 4-27

6. Slowly retract the boom until the jib ears are within 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

For Reference Only

supported by the jib ears. The jib will typically rest only on the upper support, Figure 4-28.

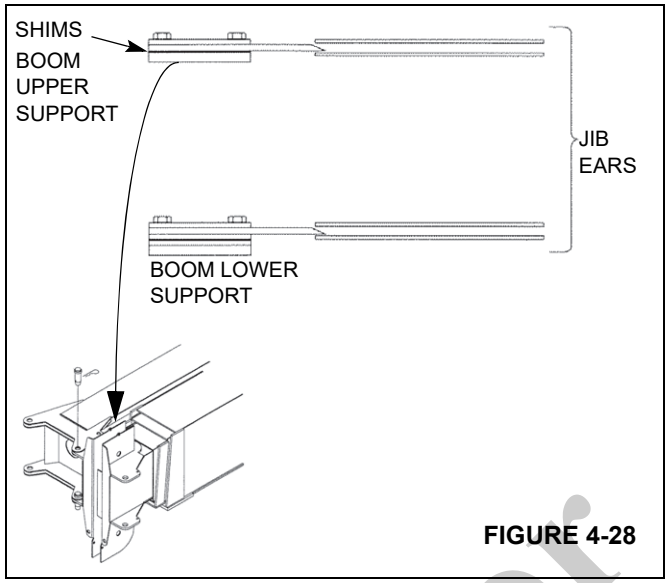


FIGURE 4-28

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 4-29.

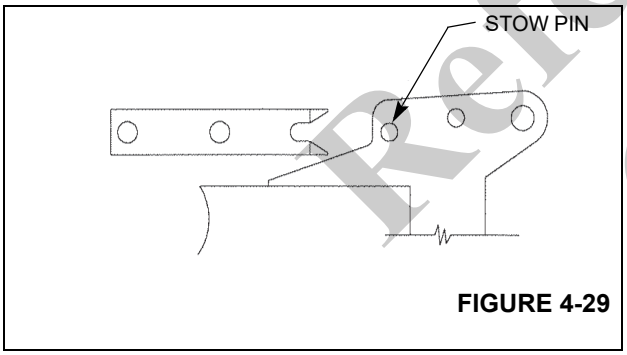


FIGURE 4-29

8. Retract the boom slowly. Observe the stow hook and lock assembly alignment as the boom is retracted, Figure 4-30.

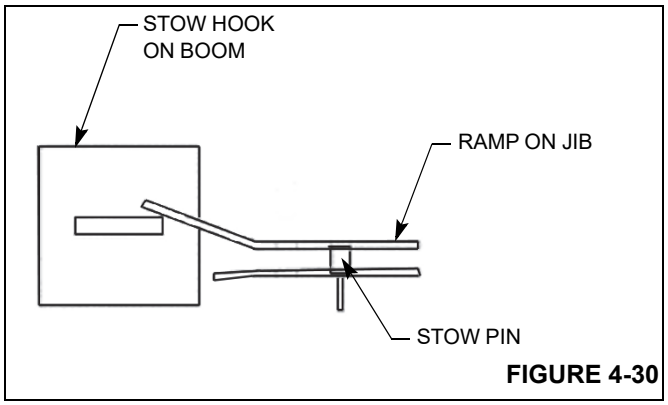


FIGURE 4-30

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 4-31.

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

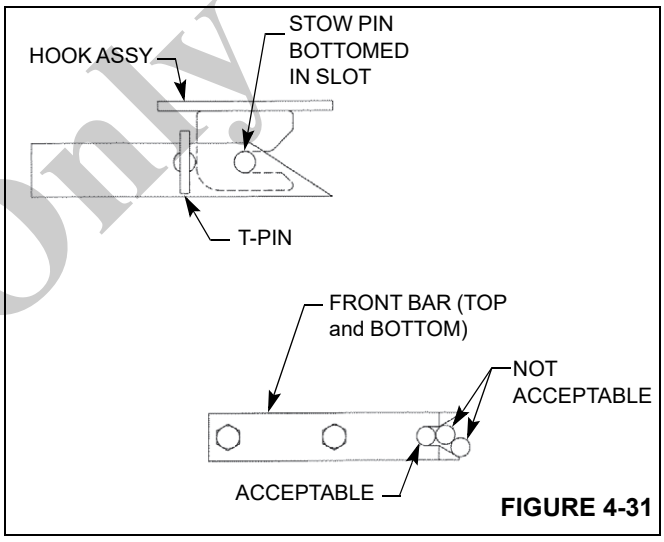


FIGURE 4-31

10. Try to remove the jib pins. If the pins are too tight, the stow hook assembly or front bars will have to be adjusted.

11. Torque all capscrews to their specified torque value (see table in Service and Maintenance Section). Install stow pin in lock assembly and remove the jib pins.

12. Extend and retract boom to insure proper alignment of jib pins.

13. Install jib pins and remove the stow pins.

For Reference Only

14. Extend and retract the boom and jib to ensure proper alignment of jib stow brackets.

15. Install jib stow pins and remove jib pins. Always save shims to allow future adjustment of jib stow if required.

Jib Jack Service 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.

Remove the jack (1, Figure 4-29) from the jib boom (2) by removing three bolts and flatwashers (3, Figure 4-29).

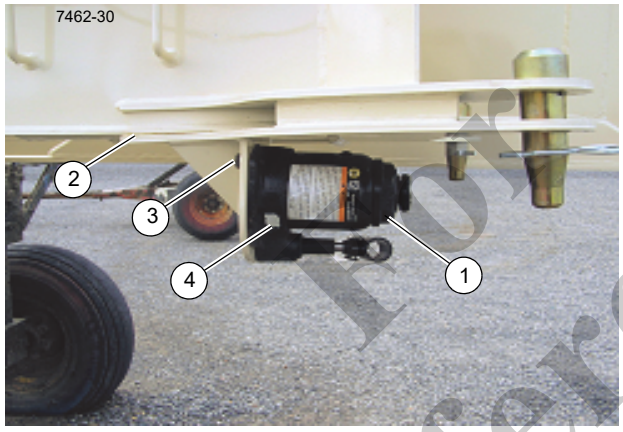


FIGURE 4-32

Adding Oil

1. With saddle fully lowered and piston depressed, set jack in its upright level position and remove oil filler plug. (4, Figure 4-32).

2. Fill until oil is level with filler plug hole.

Changing Oil

1. For best performance and longest life, replace the complete oil supply at least once a year.

2. To drain the oil, remove the filler plug (4, Figure 4-32.

3. Lay the jack on its side and allow the oil to run out into suitable drain pin. The oil will run slowly because air must enter as oil drains out.

4. Be careful to prevent dirt or foreign matter from entering the system.

5. Replace with proper oil as described above.

Lubrication

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

Rust Prevention

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

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

Troubleshooting

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

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SECTION 5
HOIST

SECTION CONTENTS

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DESCRIPTION

The NBT40 hoist is composed of motor control valve, a fixed displacement 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 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 applies to both the main and auxiliary hoist.

MAINTENANCE

Inspect the hoist daily for oil leaks, loose bolts, and worn hoist cable. Check the gearbox and brake oil every 500 hours. Do an oil change every 1000 hours. See Section 8 Lubrication. 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 start-up and is essential if ambient temperature is below +40°F (4°C). 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 390 ft. of wire rope is approximately 980 lbs (444.5 kg).

1. Remove the hoist cover (1, Figure 5-1) and attaching hardware 1,2, 11.
2. Remove the cable (8, Figure 5-1) from the hoist drum.
3. Tag and disconnect the hoist hydraulic lines (17, 18 & 23, Figure 5-1). Cap and plug all hydraulic openings.
4. Attach a lifting device to hoist (4, 7 Figure 5-1).

   Apply tension on the lifting device cable to prevent the hoist from falling when securing hardware is removed.
5. Remove the hoist mounting bolts, washers and nuts (5, 6, 12, 13 Figure 5-1) from the hoist.
6. Remove the hoist (4,7 Figure 5-1) from the crane with the lifting device.

Hydraulic Hoses

Inspect the hoist hydraulic hoses (17, 18 & 23, Figure 5-1) for cracks or damage that may cause leaks. Replace hoses as needed.

Hoist Installation

The following removal procedure applies to both the main and auxiliary hoist.

1. Attach a lifting device to the hoist (4, 7 Figure 5-1).
2. Lift the hoist with a lifting device onto the turret.
3. Install mounting bolts, washers (5, 6, 12, 13 Figure 5-1).
4. Remove the lifting device.
5. Reinstall the hydraulic hoses (17, 18 & 23, Figure 5-1) per removal tags.

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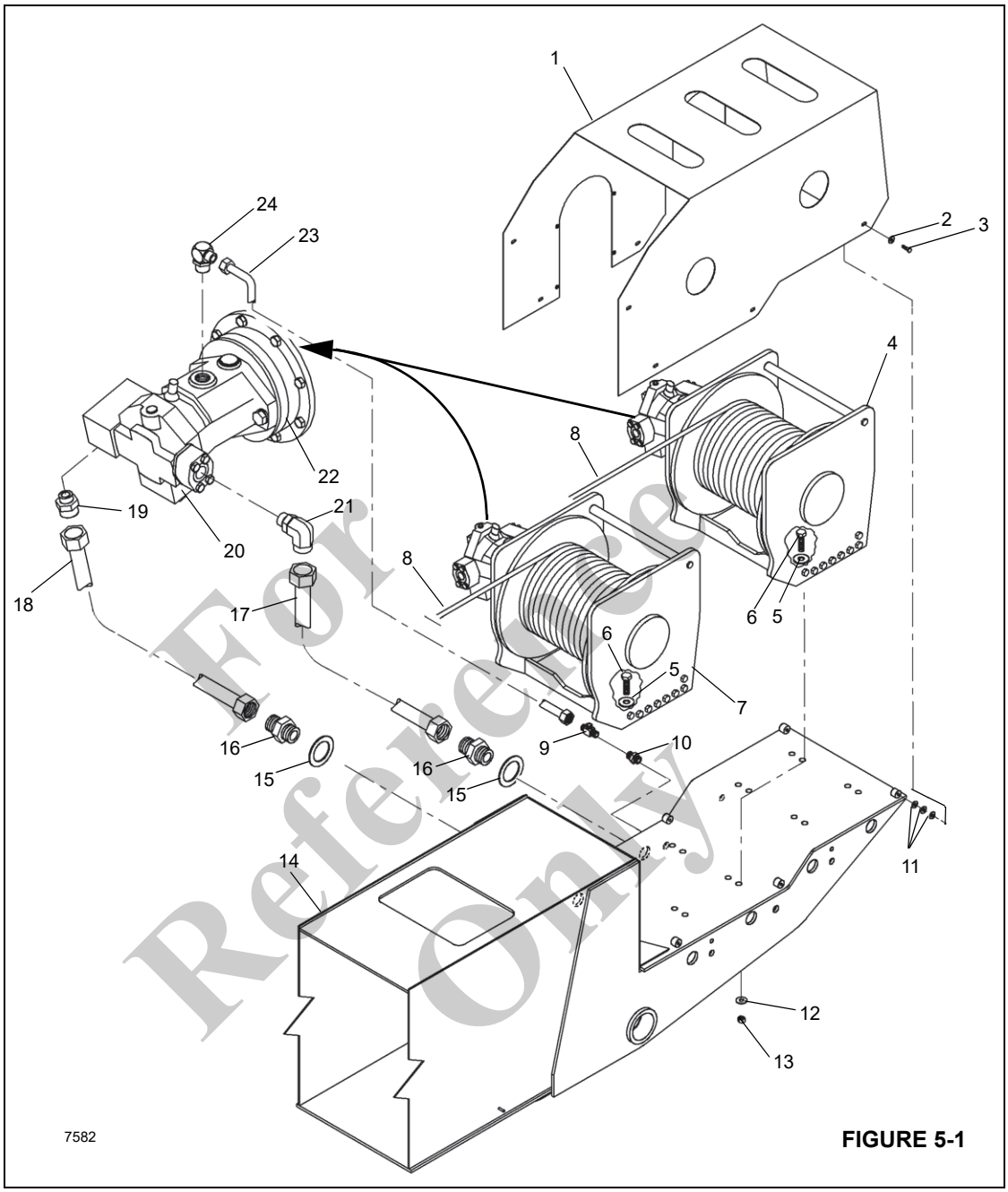


For Reference Only

Figure 5-1 Item Numbers

Item	Component	Item	Component
1	Cover	9	Elbow
2	Flatwasher	10	Union
3	HHCS	11	Washer
4	Main Hoist	12	Washer
5	Washer (8 places)	13	Nut
6	HHCS (8 places) 5/8-11UNC	14	Boom
7	Auxiliary Hoist	15	Washer
8	Cable, 5/8	16	Union

Item	Component	Item	Component
17	Tube, Lower	21	Elbow, 90
18	Tube, Raise	22	Brake
19	Adapter	23	Case Drain Hose
20	Motor	24	Elbow, 90

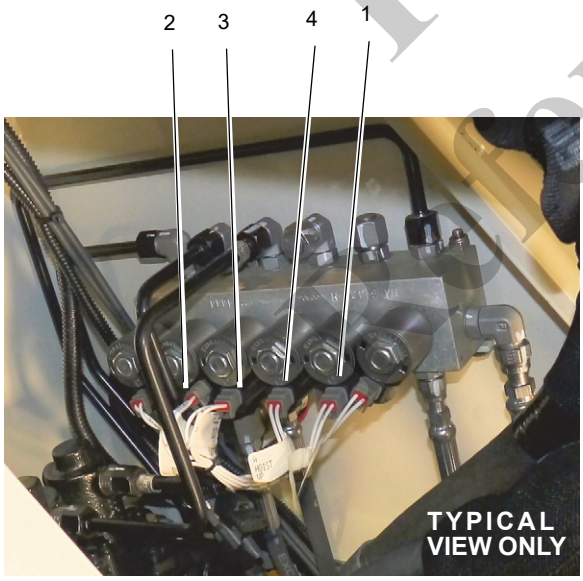
6. worn or damaged; replace it.

Hoist Rotation Indicator (HRI) Display System

The HRI Display 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 DRI).

Pressure Switches

The pressure switches are located on the main control valve Figure 5-2. The switch contacts close at 75 psi (5.17 bar).



8425-9

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 display is located in the front overhead panel Figure 5-3.

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 control module is located in the fuse and relay panel behind the driver’s seat in the cab Figure 5-4.

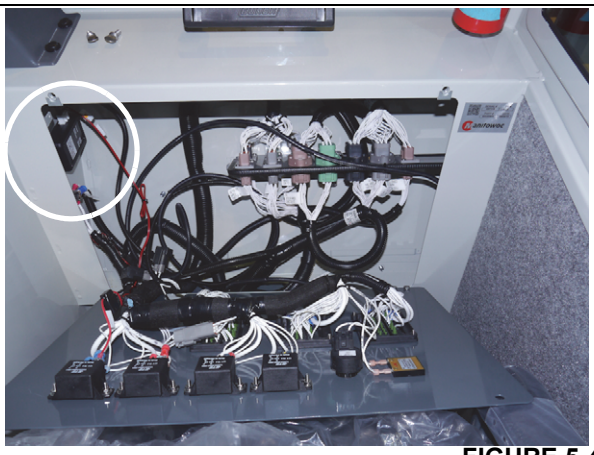


FIGURE 5-4

To replace the control module, tag and disconnect the wires from the module Figure 5-5. The module is mounted to the

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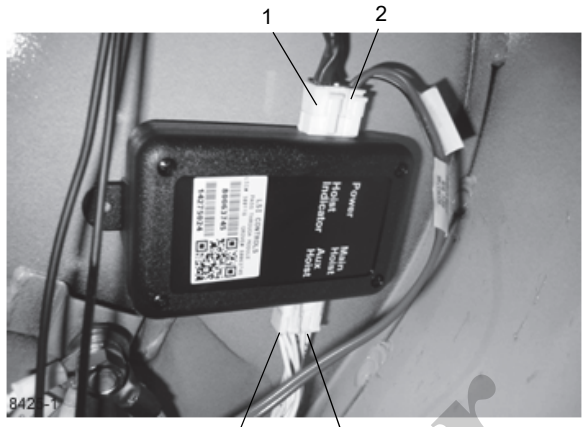
bulkhead using double-sided adhesive tape. To remove the module, pry it off the bulkhead. Remove any residual tape from the bulkhead. Secure the replacement module to the bulkhead with the foam tape. Connect the wires as tagged during removal.



8425-1b

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 rope or 8 wraps of 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 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.

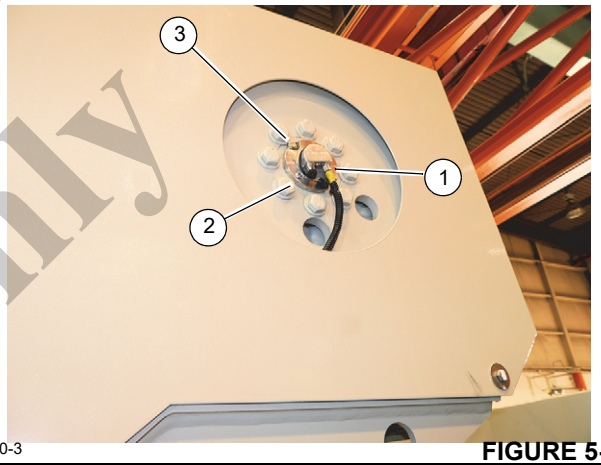


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FIGURE 5-6

For Reference Only

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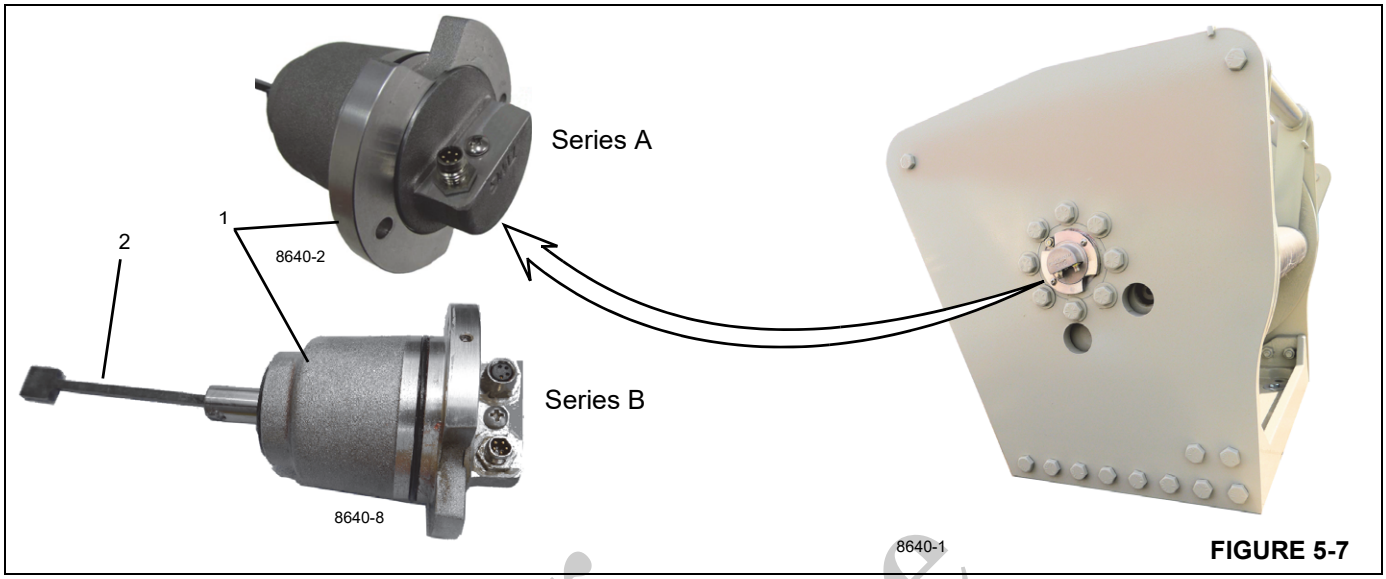

FIGURE 5-7

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.

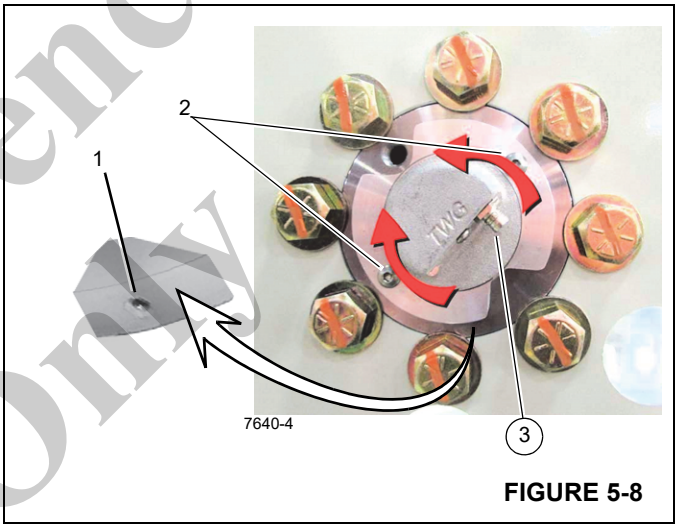

FIGURE 5-8

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 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.

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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.

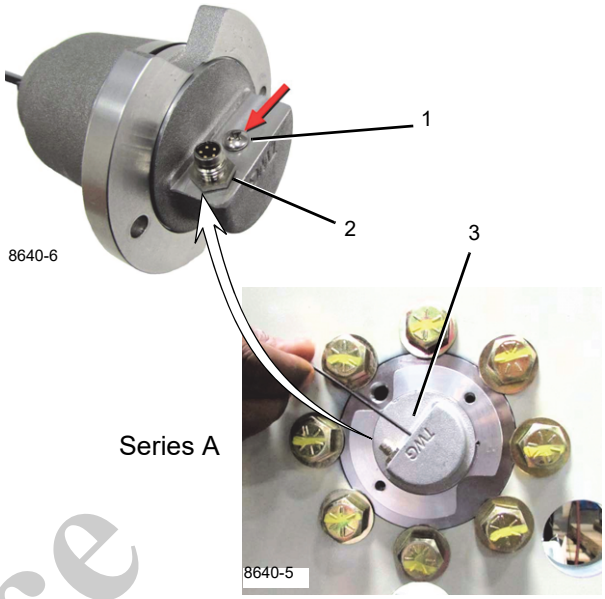
NOTE: It is recommended to transition to the second layer as the second set point.

7. Gently press and hold the programming button for 1-2 seconds, then release.

8. Replace the 3rd wrap/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.



Series A

Series B

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:

For Reference Only

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 /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 5-10 to disassembly 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 (Item 22) connected to the brake housing (Item 21). Remove the motor and counterbalance valve assembly from the hoist by removing four capscrews (Item 47). See Servicing The Motor section on page 10 for motor and counterbalance valve disassembly.
4. Remove the brake subassembly from the hoist by removing eight capscrews (Item 9) holding the brake housing to the side plate (Item 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 Servicing The Brake section on page 11 for brake repair.
5. Remove the side plate (Item 27) and base spacer (Item 60) by removing eleven capscrews (Items 1, 57, & 59) and two nuts (Item 58).
6. Remove the retaining ring (Item 52). Lift the ring gear (Item 25) out of the drum (Item 5). Remove the five pins (Item 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 bearing (Item 28) for signs of pitting or spalling and if necessary, replace the bearing and seal (Item 7-6).
7. Remove the thrust washer (Item 6) and input sun gear (Item 8) from the input planet gearset (Item 36). Inspect for damage and replace if needed.
8. Remove the input planet gearset (Item 36) from the drum (Item 5). Inspect the gearset for damage.
9. Remove the thrust washer (Item 6) and output sun gear (Item 16). Inspect for damage and replace if needed.
10. Remove the output planet gearset (Item 4) from the cable drum. Inspect the gearset for wear and repair as needed. See Servicing The Planetary Set section on page 13 for disassembly and repair.
11. Remove the drum (Item 5) by lifting straight up and off of the output shaft (Item 32). Inspect the bearing (Item 28) for signs of spalling or pitting and, if necessary, replace the bearing and seal (Item 7-6).
12. Inspect the retaining ring (Item 35) on the output shaft to ensure that it is still in the groove and is not bent, and replace if necessary.
13. Inspect the shaft (Item 32) for wear or damage and, if necessary, remove it from the side plate (Item 29) by removing six capscrews (Item 9).

Assembly (Refer to Figure 5-10)

Refer to Figure 5-10 and the Hoist Parts List on page 5-10 to disassembly the hoist.

1. 1. Thoroughly clean all parts. Replace those that show wear or damage.
2. Inspect the drum (Item 5) for structural integrity and the gear teeth for excessive wear, then replace if necessary.
3. Attach the output shaft (Item 32) to the side plate (Item 29) with six capscrews (Item 9), making sure the vent (Item 30) is oriented properly, then torque them to

For Reference Only

specification (see “Fasteners And Torque Values” on page 1-7 of this manual).

4. Install the retaining ring (Item 3) onto the shaft (Item 32).
5. Attach the spacer (Item 60), base (Item 56), and rod (Item 2) to the side plate (Item 29) with eleven capscrews (Items 1, 57, & 59) and two nuts (Item 58). Torque to specification (see “Fasteners And Torque Values” on page 1-7 of this manual).
6. If necessary, install a new bearing (Item 28) and oil seal (Item 7-6) into the drum.
7. Lay the unit down so that the rod (Item 2) and base (Item 56) are pointing up. Set the drum (Item 5) onto the shaft (Item 32) being careful not to damage the seal (Item 7-6), seating the drum on the bearing (Item 28).
8. Install the output planet gearset (Item 4) into the drum (Item 5), making sure it’s installed correctly onto the output shaft (Item 32).
9. Put a light coating of grease on the thrust washer (Item 6) to keep it in place. Install the thrust washer into the output gearset (Item 4), and then insert the output sun gear (Item 16). The slot in the sun gear must be installed facing the output shaft.
10. Install the input planet gearset (Item 36) into the drum (Item 5), making sure it’s installed correctly onto the output sun gear (Item 16).
11. Put a light coating of grease on the thrust washer (Item 6) to keep it in place. Install the thrust washer into the input gearset (Item 36), and then insert the input sun gear (Item 8).
12. Install a new o-ring (Item 7-4) and, if necessary, a new bearing (Item 28) and seal (Item 7-6) into the ring gear (Item 25). Grease 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 (Item 51) between the ring gear (Item 25) and the drum (Item 5). Then, install the retaining ring (Item 52) into the drum.
14. Position the spacer (Item 60) and side plate (Item 27) on top of the base (Item 56) and rod (Item 2). Attach the side plate with eleven capscrews (Items 1, 57, & 59) and two nuts (Item 58). Torque to specification (see “Fasteners And Torque Values” on page 1-7 of this manual).
15. Install the brake subassembly into the side plate (Item 27), making sure that the pilot of the brake housing aligns with the bearing (Item 28) and seal (Item 7-6) in the ring gear (Item 25) and that the holes for the motor are in the correct orientation. Also, make sure that the level and vent plugs in the cover are properly oriented. Install eight capscrews (Item 9) and torque them to specification (see “Fasteners And Torque Values” on page 1-7 of this manual).
16. Install a new o-ring (Item 7-5) on the face of the motor and re-install the motor/counterbalance valve assembly. Install four capscrews (Item 9) and torque them to specification (see “Fasteners And Torque Values” on page 1-7 of this manual).
17. Reconnect the tubing (Item 22) to the brake housing (Item 21).
18. Fill both the gearbox and the brake section with the proper amount and type of lubricants as instructed in the Recommended Oil (see “Hoist Brake Oil” on page 8-8) of this manual.

For Reference Only

Hoist Parts List

Item	Qty	Description	Item	Qty	Description
1	18	CAPSCREW	36-2	3	Planet Gear
2	2	Support rod	36-3	3	Planet Pin
3	1	Counterbalance Block	36-4	3	Retaining Ring
4	1	Gear Set	36-5	1	Plate
4-1	1	Carrier	36-6	3	Needle Bearing
4-2	3	Planet Gear	36-7	6	Fitting, Str Adapter
4-3	3	Planet Pin	37	1	Capscrew
4-4	3	Retaining Ring	38	4	Input Driver
4--5	1	Plate	39*	1	Bushing
4-6	6	Bearing	40	1	Pipe Plug
4-7	3	Spacer	42	2	Motor
4-8	6	Race	43	1	Straight Adapter
5	1	Drum	44	1	Tee Fitting
6	2	Race	45	1	90 deg Adapter
7	1	Seal Kit	46	1	90deg Adapter
8	1	Input Sun Gear	47	1	Capscrew
9	14	Capscrew	50	4	Flange
10	1	Brake Piston	51	1	Pind
11	4	Capscrew	52	5	Retaining Ring
12	1	Tubing	54	1	DRI/3rd Wrap Indicator
13	1	Brake Driver	56	1	Base
14	2	Race	57	1	Capscrew
15	2	Retaining Ring	58	4	Nut
16	1	Output Sun Gear	63	4	Screw
17	2	Bushing	64	2	Cordset
18	7	Friction Disk	65	1	Cable packer
19	8	Stator Plate	65-1	2	Bearing
20	1	Brake Cover	65-2	2	Arm
21	1	Brake Housing	65-3	1	Roller
22	1	Tubing	65-4	1	Roller
24	12	Brake Spring	65-5	2	Capscrew
25	1	Gear Insert	65-6	2	Ball Bearing
27	1	Side Plate	65-7	1	Spring, LH
28	2	Ball Bearing	65-8	1	Spring RH
29	1	Sideplate	68	1	CB Valve
30	2	Breather	76	1	Plug
31	4	Capscrew	81	1	Cordset, DRI/3rd Wrap Indicator
32	1	Output Shaft	82	1	Shaft, Drive, DRI
33	1	Plug	84	1	Roller
34	1	Clutch	85	2	Bushing
35	1	Retaining ring	86	1	Connector
36	1	Input Gear Set			
36-1	1	Carrier			

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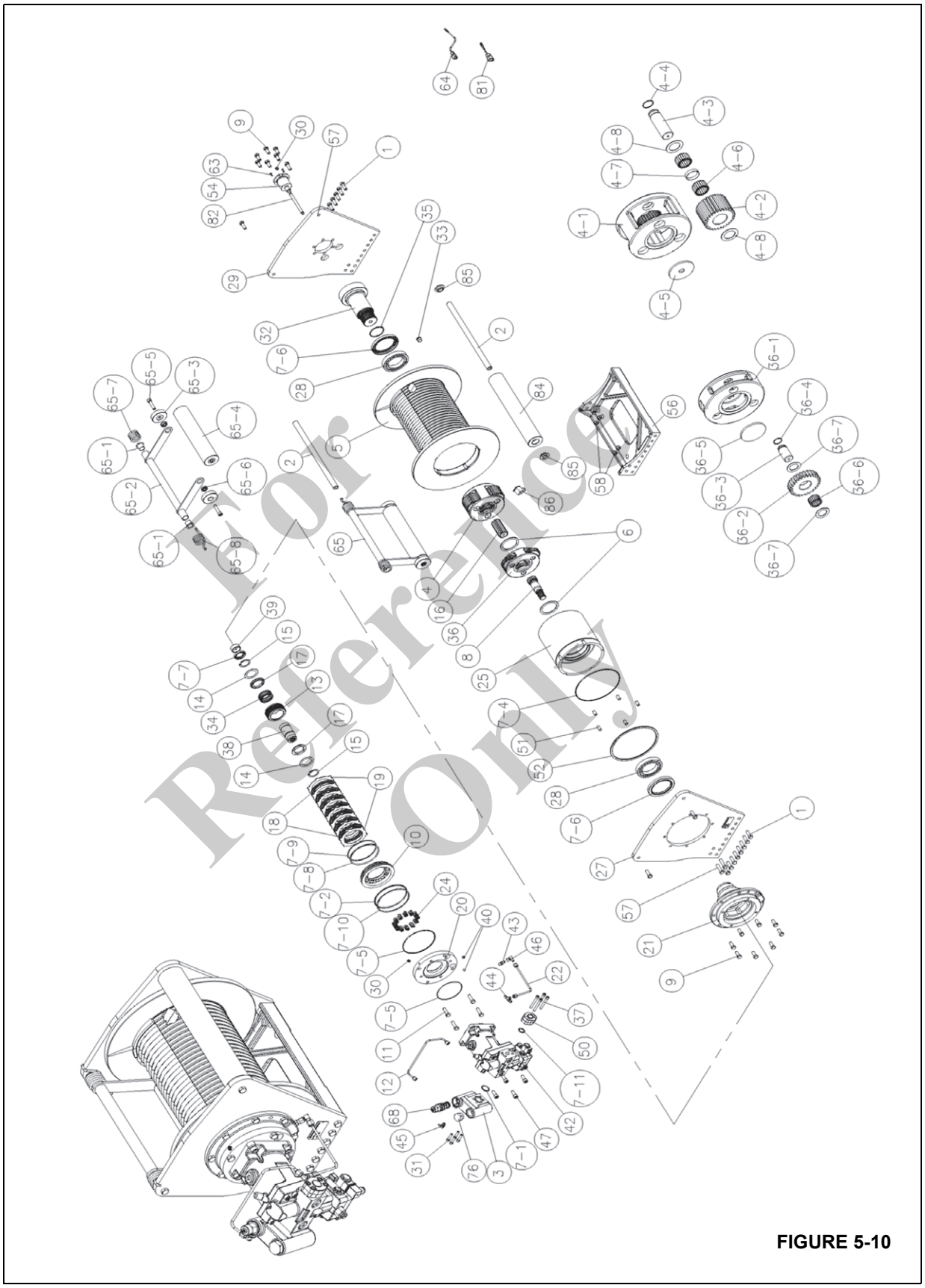

FIGURE 5-10

Brake

Refer to Figure 5-10 and the Hoist Parts List on page 5-10 for the following brake service steps.

1. Evenly remove the four capscrews (Item 11) holding the brake cover (Item 20) in place. Spring pressure will raise the cover as the capscrews are loosened. Remove the cover from the brake housing.
2. Remove the springs (Item 24) from the piston and check the free height. Each spring should measure at least 1.200 inches with no force on them.
3. Remove the brake piston (Item 10) by installing two pieces of 3/8”-16NC all-thread in the bottom of two spring pockets. Using jam nuts, screw the all-thread pieces in 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 (Items 13, 14, 15, 17, 34, and 38) from the brake housing (Item 21).
4. Remove the brake driver/clutch assembly (Items 13, 14, 15, 17, 34, and 38) from the brake housing (Item 21).
5. Remove the stator plates (Item 19) and friction discs (Item 18) from the brake housing and check them for excessive wear, then replace if necessary. Additionally, check the top stator plate for scoring caused by the removal tools and polish if necessary. Friction discs should measure no less than 0.055 inches thick and stator plates should measure no less than 0.064 inches thick.
6. If necessary, with a hook wire or pry bar, remove the seal (Item 7-7) from the brake housing.
7. Examine the bushing (Item 39) in the brake housing for wear and, if worn, replace it.
8. If the brake housing (Item 21) is removed from the hoist, examine the journal on the brake housing where the seal (Item 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 (Item 34) are facing. The clutch assembly must be re-assembled with the markings facing the proper direction in order for the hoist to function properly. Inspect the surface on the input and brake drivers (Items 13 & 38) where the clutch (Item 34) runs. If there is any pitting or spalling on the drivers then both it and the clutch must be replaced.
10. Re-assemble the driver/clutch assembly, making sure that the clutch is installed properly.
11. Install a new seal (Item 7-7) into the brake housing. If the brake housing is removed from the hoist, temporarily install the input sun gear (Item 38) into the brake housing and slide the driver/clutch assembly onto the sun gear spline.
12. Install the stator plates (Item 19) and friction discs (Item 18) into the brake housing starting with a stator and alternating friction discs and stator plates. There is one more stator plate than friction disc so you will finish with a stator plate.
13. After installation, check the brake stack-up to make sure that the dimensions are within the tolerance shown in Fig 5. If your measurement is greater than shown, either some friction discs 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 (Items 7-3, 7-7, 7-8, & 7-9) with light oil and install onto the piston (Item 10). See Figure 5-11 for proper o-ring/backup ring installation.

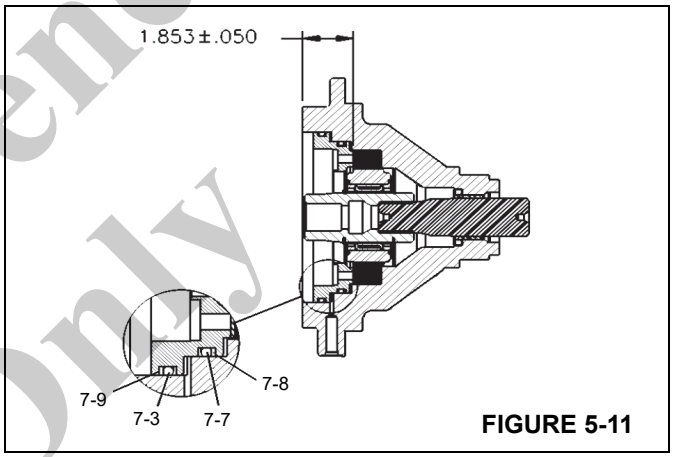

FIGURE 5-11

15. Carefully install the piston (Item 10) into the brake housing (Item 21) and gently tap it down until it is seated.
16. Install the springs (Item 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 (Item 7-3) with light oil and install it into the groove on the brake cover (Item 20).
18. Install the cover (Item 20) onto the brake housing (Item 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 225 PSI ±10%.

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Planetary Set

NOTE: See Figure 5-10 for item number (#) identification.

1. Remove the spiral retaining rings (4-4, 36-4) from the planet pins.
2. Remove the pins (4-3, 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 into the carriers (4-5, 36-5).
7. To re-assemble, 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

NOTE: See Figure 5-10 for item number (#) identification.

1. Remove and tag hoses.
2. Remove the counterbalance block (3) from the motor assembly by removing 4 capscrews (31).
3. Remove the counterbalance valve (68) from the counterbalance block (3) and inspect the small metering hole located on the side of the cartridge valve to make sure it is not obstructed (Figure 5-12). Also inspect the O-rings to insure that they are not cut or flattened.

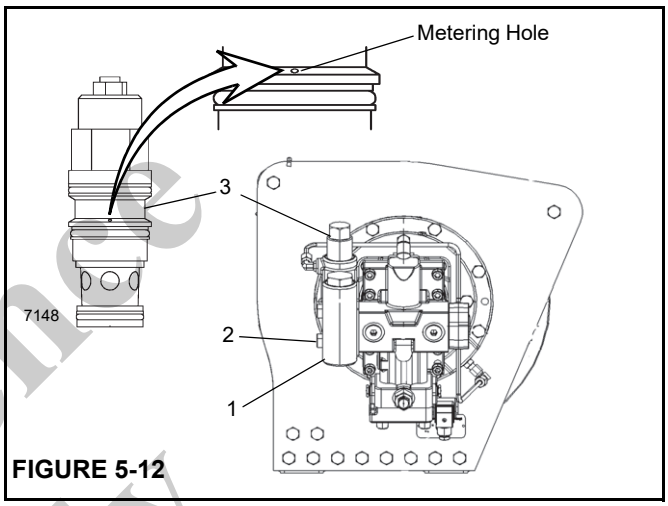

FIGURE 5-12

4. Motors and cartridge valves are not serviceable in the field. Return them to an authorized distributor for service.

TROUBLESHOOTING

Problem	Cause	Solution
Hoist does not hold 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.

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SECTION 6
SWING

SECTION CONTENTS

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DESCRIPTION

The purpose of the swing system is to allow the crane turret to rotate atop the carrier frame. The NBT40 swing system provides full 360 degree rotation in both directions and is equipped with free swing capabilities. With free 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, and swing brake pedal. The maximum rotation is 2.0 rpm. 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.

THEORY OF OPERATION

Swing Drive

The hydraulic power for the swing drive (Figure 6-1) is supplied by the PTO driven axial piston 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, the flow through the control valve is directed to the swing motor. If the SWING BRAKE selector 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.

Swing Brake

Hydraulic power for the swing brake control is supplied by the crane manifold and swing brake pedal valve. The hydraulic power for the swing brake release is supplied by swing brake release solenoid on the crane manifold. With the SWING BRAKE selector switch positioned to ON, the swing brake release valve blocks the regulated pressure to the brake release port and spring pressure in the swing brake applies the brake. When the SWING BRAKE selector switch is positioned to OFF, the regulated pressure is directed from the pressure reducing/sequence valve to the brake release port, overcoming the brake spring pressure and releasing the swing brake.

Swing Gear Box Assembly

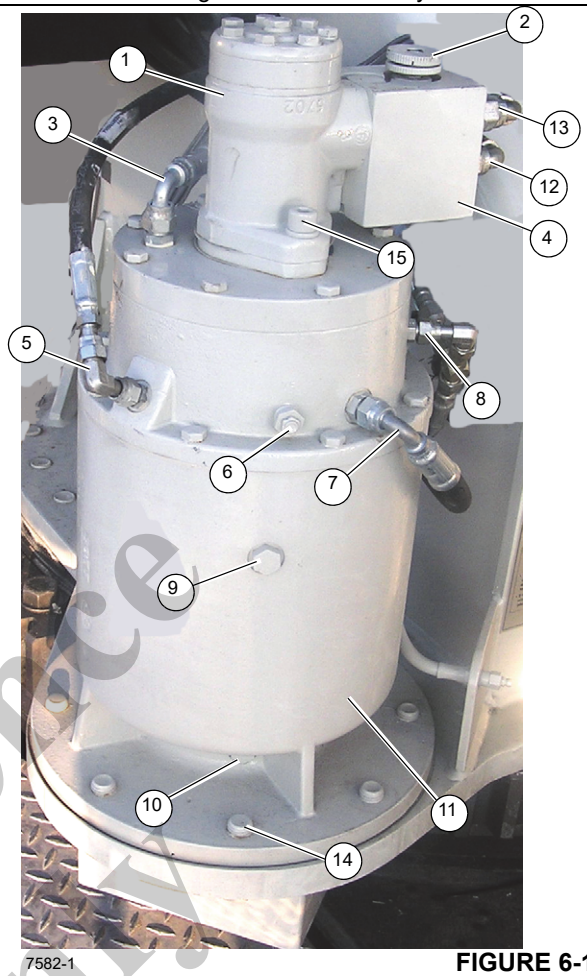

FIGURE 6-1

Figure 6-1 Item List

Item	Description	Item	Description
1	Motor	9	Fill
2	Adjustable Speed Valve	10	Drain
3	Hose Brake Coolant Out	11	Gear Box
4	Control Valve	12	Control Clockwise
5	Hose Service Brake Apply	13	Control Counter-clockwise
6	Breather	14	Screw & Flatwasher, 3/4”
7	Hose Brake Coolant In	15	Screw & Lockwasher, 1/2”
8	Hose Parking Brake Release		

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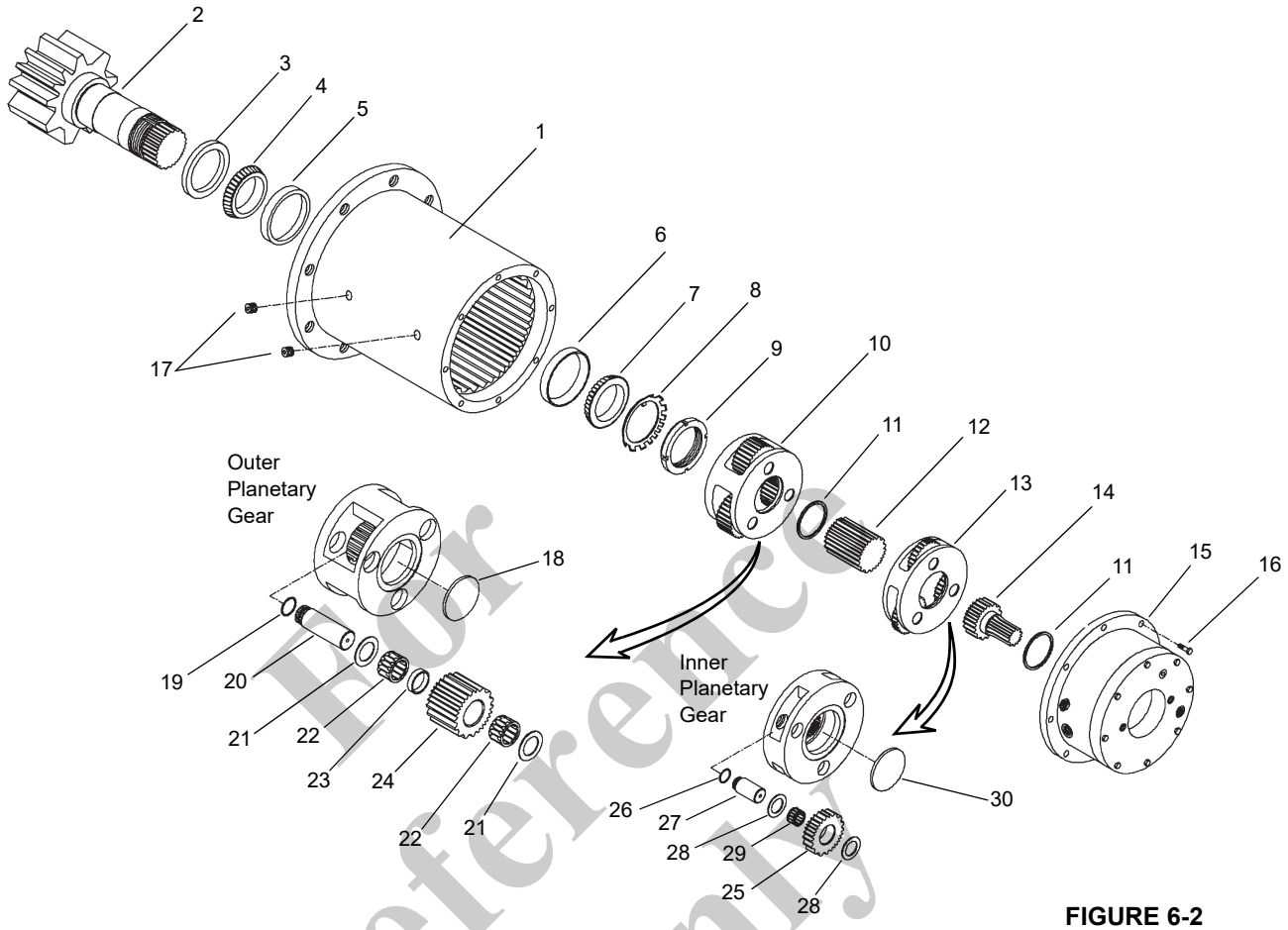

FIGURE 6-2

Item	Component
1	Housing
2	Output Shaft
3	Seal
4	Lower Bearing
5	Lower Bearing Race
6	Upper Bering Race
7	Upper Bearing
8	Lock Washer
9	Locknut
10	Output Planetary Assembly
11	Thrust Washer
12	Output Sun Gear
13	Input Planetary Assembly
14	Input Sun Gear
15	Brake Assembly

Item	Component
16	Cap Screw (8)
17	Drain Plugs
18	Plate
19	Retaining Washer
20	Output Planetary Pin
21	Washer
22	Needle Bearing
23	Spacer
24	Output Planet Gear
25	Input Planet Gear
26	Retaining Washer
27	Input Planetary Pin
28	Washer
29	Needle Bearing
30	Plate

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SWING GEARBOX AND BRAKE

The rotation drive is a double planetary gear reducer with an integral brake. The gear reducer is designed to give long life in heavy duty applications such as crane rotation. The gearbox incorporates tapered roller bearings on the output shaft and heavy duty bearings in the planet gears.

NOTE: Motor and cartridge valves are not serviceable in the field. Return them to an authorized distributor for service.

Removal and Installation

Removal

1. Tag all hydraulic hose and gearbox ports Figure 6-1. Remove all hoses from the gearbox and plug open ports.
2. Attach a lifting device to the gearbox (11, Figure 6-10) capable of lifting approximately 275 lbs. Apply tension to the lifting cable.
3. Remove six screws and six flatwasher (14, Figure 6-10) securing the gearbox to the turret. Lift the gearbox from the turret.
4. Remove two screws and two lock washers (15, Figure 6-10) securing the hydraulic motor (1) to the gearbox (11), remove the motor.

Installation

1. Secure the hydraulic motor (1, Figure 6-10) to the gearbox (11) with two screws and two lock washers (15).
2. Using a capable lifting devise, position the gearbox (11) onto the turret. Secure the gearbox (11) to the turret with six screws and six flatwasher (14).
3. Connect hydraulic hoses to the gearbox and hydraulic motor.

Disassembly & Assembly Instructions

If the rotation drive needs to be repaired, use the following procedure for disassembly.

NOTE: The weight of the rotation gearbox with integral brake and a hydraulic motor bolted on the input end of the assembly is approximately 275 lbs (124 kg).

Tools Required

- Scribe or small punch
- Oil drain pan
- Eye bolts 1/4”
- Retaining ring pliers
- Gear puller
- Ratchet wrench (1/2” drive)
- 9/16” socket (1/2” drive)
- Socket for pinion nut (Whittet-Higgins P/N BAS-14)
- Soft hammer (brass or plastic)
- Press
- Drift rod (1/4” to 3/8” diameter)
- Torque wrench [1/2” drive - approximately 100 ft-lb (135 N·m)]

Parts Required to Rebuild

- Seals
- O-rings
- Back-up rings
- Parts to replace damaged or worn parts
- Locknut (9) and lockwasher (8)

Disassembly

(See Figure 6-2 for reference (#) numbers.)

1. With a scribe or small punch make a set of marks on the brake assembly flange (15) 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 of the gearbox. If necessary, screw the hydraulic motor bolts into the brake assembly for use as handles.
5. Remove the thrust washer (11) and input sun gear (14) from the input planetary assembly (13).
6. Install three 1/4” eyebolts into the three planet pins of the input planetary assembly (13) and with a small chain pull the planet set (13) from the gear housing.
7. Remove the output sun gear (12) and thrust washer (11) from the output planetary assembly (10).
8. Using the eyebolt/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 lockwasher (8) out of the slot in the locknut (9). Loosen and remove the locknut (9) from the output shaft (2).

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CAUTION

The locknut 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 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, 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, then refer to the appropriate group repair section.

Input Planetary Repair

(See Figure 6-2 for reference (#) numbers.)

1. Remove the retaining washers (26) from the planet pins.

2. Use a press to remove the planet pins (27) from the carrier. Support the input carrier (13) to remove the planet pins (27).

3. Slide planet gears (25) and races (28) out of the input carrier (13).

4. Remove the plate (30) from the input carrier (13).

5. If needle bearings (29) must be replaced, they may now be removed out of the input planet gears (25).

6. Rebuild input gear set in reverse order using any required new parts.

7. Before reassembly, be sure to insert the plate (30) into the input carrier (13).

8. To reassemble, be careful to line up the planet pins (27) with the races (28) and the bearings (29) and then press the knurled part of the planet pin (27) into the input carrier (13). If the planet pins (27) are not lined up properly, the races (28) can be shattered during the pressing process. Reinstall the retaining washers (26) onto the planet pins.

Output Planetary Repair

(See Figure 6-2 for reference numbers.)

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 reference numbers.)

1. Tapered bearing (4) may be removed from output shaft (2) using a gear puller.

2. Remove old seal (3) and discard. Grease pack the lower bearing (4) with lithium grease or EP lube and install 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 seal (3) into the gear housing (1) until the 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 gear housing (1) Be careful not to damage seal (3) in gear housing.

Case Assembly Repair

(See Figure 6-2 for reference numbers.)

1. Remove the bearing race (6) and replace if required.

2. Clean all foreign material from case.

Unit Assembly

(See Figure 6-2 for reference numbers.)

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 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 lube. Slide the bearing (7) over the threaded end of output shaft (2) with the small end down. Press the bearing (7) on slowly until it is just seated.

Hold the output shaft (2) and rotate the gear housing (1) when installing the bearing (7). The bearing is seated when all rollers are rotating evenly.

NOTE: If bearing (7) is replaced, bearing race (6) must also be replaced.

4. Slide the lockwasher (8) down the threaded end of the output shaft (2) until it reaches the end of the bearing (7).

5. Thread the locknut (9) down the threads of the output shaft (2) and tighten until it is snug.

6. Set the bearing preload by tightening locknut (9) onto output shaft (2) to 100 ft-lb (135 N·m). Proper bearing preload is determined by the rolling torque method. This

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method involves increasing press load on the bearings (4 and 7) until drag or rolling resistance of 75 - 85 in-lb (8.4 - 9.6 N·m) is achieved when rotating the case.

This includes bearing as well as seal drag. The torque is equal to a force of 75 - 85 in-lb (8.4 - 9.6 N·m) on a bolt screwed into one of the brake assembly mounting holes to rotate the case. Bend tang of lockwasher (8) into place on locknut (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 gear set (10) into the gear housing (1) until the planet gears engage the teeth in the gear housing. Lower the output gear set (10) until the planet gears engage the teeth on the output shaft (2). Rotate the output gear set (10) or the output shaft (2) until the gear set (10) slides down to allow full contact between the two sets of gear teeth.
9. Firmly hold the pinion end of the output shaft (2) and slowly rotate the gearbox assembly to ensure free rotation of installed gear sets.
10. Install the thrust washer (11) and the output sun gear (12) in the end of the output gear set (10).
11. Lower the input gear set (13) into the gear housing (1) until the planet gears engage the teeth on the input end of the output sun gear (12).
12. Rotate the input gear set (13) or the output shaft (2) until the input gear set (13) 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 gear sets.
14. Install thrust washer (11) and the input sun gear (14) into the input gear set (13).
15. Lubricate a new O-ring (3-brake) and install 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 (15) on the gear housing (1).
17. Install the eight capscrews (16) in the brake assembly (15) and torque to 30 ft-lb (40 N·m).
18. Put pipe sealant on one of the pipe plugs (17) and install the plug in the lower hole of the gear housing (1).
19. Fill the gear housing (1) with 1 gallon (3.8 L) of EP 80-90 gear grease.
20. Put pipe sealant on the other pipe plug (17) and install the plug in the top hole in the gear housing (1).

SWING BRAKE

The brake is manufactured for two specific types of holding torque requirements. The brake has a “park” mode and is also set up to operate in a “glide-swing” mode. The brake is in the park mode until pressure is applied to one side of the piston in the brake assembly. As the 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. Rotation is controlled by applying pressure on the dynamic brake piston which reapplies pressure to the brake discs.

Disassembly

(See Figure 6-3 for item number (#) identification.)

1. With a scribe or punch make a pair of marks on the edge of the brake cover (23) and the top of the brake housing (3) to aid in reassembly.
2. Remove the hydraulic motor from the brake assembly.
3. Alternately loosen the eight capscrews (24) one turn at a time until all internal spring force is relieved.

⚠ DANGER

Do not clamp or otherwise restrain cover while removing capscrews because the brake is under high compressive spring load.

4. Lift the brake cover and remove from the brake housing.
5. Remove the brake springs (21) from the assembly.
6. Apply low hydraulic pressure [20 psi (.14 MPa)] to brake release port while holding one hand on top of the brake piston (20). The pressure will force the brake piston out of the brake housing.
7. Remove the friction discs (15) and the stator plates (14) 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 (12) from the brake housing.
9. If necessary, remove the two retaining rings (11 and 13) from the inside of the brake driver.
10. Apply low hydraulic pressure [20 psi (.14 MPa)] to dynamic brake port to push dynamic brake piston (10) out of the brake housing.
11. Remove the bearing (5) and the oil seal (4) from the brake housing.

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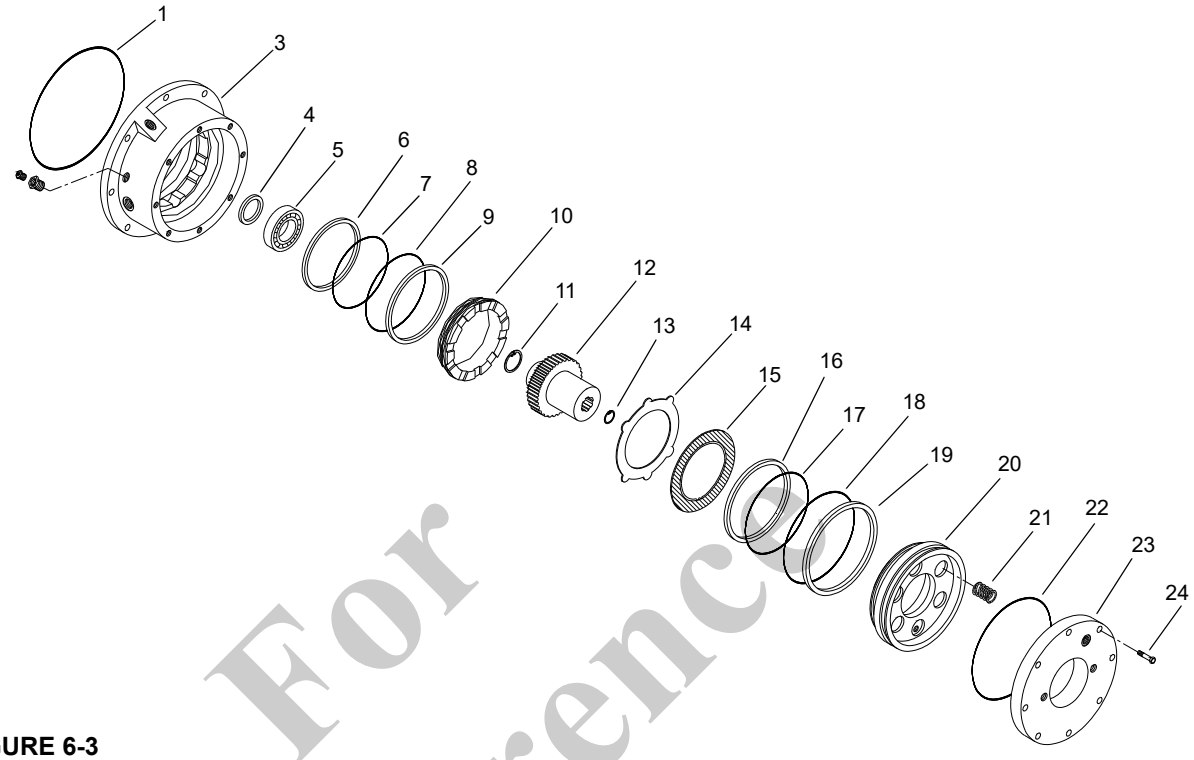

FIGURE 6-3

Item	Component
1	O-ring
3	Housing
4	Seal
5	Bearing
6	Backup Ring
7	O-ring
8	O-ring
9	Backup Ring
10	Brake Piston
11	Retaining Ring
12	Brake Driver
13	Retaining Ring

Item	Component
14	Stator Plates
15	Friction Discs
16	Backup Ring
17	O-ring
18	O-ring
19	Backup Ring
20	Park Brake Piston
21	Springs
22	O-ring
23	Cover
24	Capscrews (8)

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Assembly

(See Figure 6-3 for reference numbers.)

Assembly is in reverse order of disassembly with the following additional instructions.

1. Lubricate the sealing lip of the oil seal (4) with the same type of hydraulic oil that the crane uses. Press the oil seal into the brake housing (3) with the open side of the seal facing the hydraulic motor end of the brake assembly. Install the bearing (5) into the brake housing.
2. If replacing the dynamic brake o-rings (7 and 8), be sure to install the o-rings and their backup rings (6 and 9) in the same order in which they were removed. Lubricate with hydraulic oil to aid assembly.
3. Gently slide the brake piston (10) into the brake housing. Press down on the piston with the heal of both hands to squeeze the o-rings into the housing. Push the piston completely down into the housing.
4. Install the brake driver (12) into the brake housing by pushing down until the bearing shoulder on the driver is seated against the bearing. Be sure that retaining rings (11 and 13) are installed in the driver.
5. Install stator plates and the friction discs into the brake housing in exactly the 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 specified fluid media for approximately 10 minutes before installation.
6. Pour fluid media into the brake housing (3) until it is level with the top of the brake discs and stator plates.
7. If replacing the brake piston o-rings (17 and 18) be sure to reinstall the o-rings and their backup rings (16 and 19) in the same order in which they were removed. Lubricate o-rings and backup rings with hydraulic oil to aid in their assembly.
8. Gently slide the park brake piston (20) 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 (21) into the brake piston.
10. Lubricate the o-ring (22) with hydraulic oil and install on the brake cover (23).
11. Carefully set the brake cover on top of the piston springs so they remain upright on the brake piston.

Start the eight capscrews (24) into the brake housing by hand. Alternately tighten the capscrews one turn at a time until the cover is tight against the brake housing. Torque the capscrew to 30 - 35 ft-lb (41 - 47 N·m).

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 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 attach bolts IS A MUST to ensure safe and efficient operation.

TORQUING SWING BEARING BOLTS

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 proper torque value for bolts 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 bolt grade is important. When marked as a high strength bolt (grade 8), the serviceman must be aware of bolt classifications and that he is installing a high strength heat-treated tempered component and the bolt must be installed according to specifications. Special attention should be given to the existence of lubricant and plating that will cause variation from dry torque values. When a high strength bolt is removed, or un-torqued, the bolt must

For Reference Only

be replaced with a new bolt 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 right angle and the force must be applied at the center of the handle. Force value readings must be made while the tool is in motion. Rigid handle type, with torque limiting devices that can be pre-set to required values, eliminate dial readings and provide more reliable, less variable readings.

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

Torque wrenches are precision instruments and must be handled with care. To ensure accuracy, calibrations must be made on a scheduled basis. Whenever there is a possibility that a torque wrench may have been either overstressed or damaged, it should immediately be removed from service until 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, 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 cranes’ capacity chart, then all swing bearing bolts must be inspected for looseness and re-torqued to specifications.

Torque the swing bearing bolts according to the procedures outlined in this section.

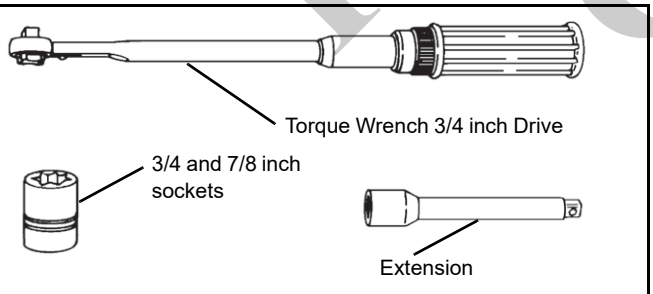

FIGURE 6-4

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

1. 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.
2. 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.
3. 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 Bolts

The inner race of the bearing is secured to the turret by 36, 1 inch Grade 8 bolts (Figure 6-5). The outer race of the bearing is secured to the carrier frame by 36, 7/8 inch, Grade L9 bolts (Figure 6-5).

Tools Required

A complete set of special tools required to torque the swing bearing bolts is listed and shown in (Figure 6-4).

Inner Race Torquing

The inner race bearing bolts are located on top of the inner race (Figure 6-5).

1. Extend and set the outriggers.
2. Fully elevate the boom.
3. Torque all bolts to 80% of the full torque value of 908 Nm ±35 Nm (670 lb-ft ± 26 lb-ft) following a star pattern sequence as shown in (Figure 6-5) starting with bolt number 1.

Tools used are the socket, multiplier, backlash adapter, necessary extensions, and torque wrench.

4. Return to bolt 1 and torque all bolts using the same star pattern sequence to the final torque of 857-929 lb-ft (1161.9-1259.6 Nm). The same tools are used as in step 3.

Outer Race Torquing

The outer race bearing bolts are located on top of the outer race (Figure 6-5).

1. Extend and set the outriggers.
2. Fully elevate the boom.
3. Torque all bolts to 80% of the full torque value of 470 lb-ft ±20 lb-ft (637 Nm ±27 Nm) following star pattern sequence as shown in (Figure 6-5) starting with bolt number 1.

Tools used are the socket, multiplier, backlash adapter, necessary extensions, and torque wrench.

4. Return to bolt 1 and torque all bolts using the same star pattern sequence to the final torque of 624-676 lb-ft (846-916 Nm). The same tools are used as in step 3.

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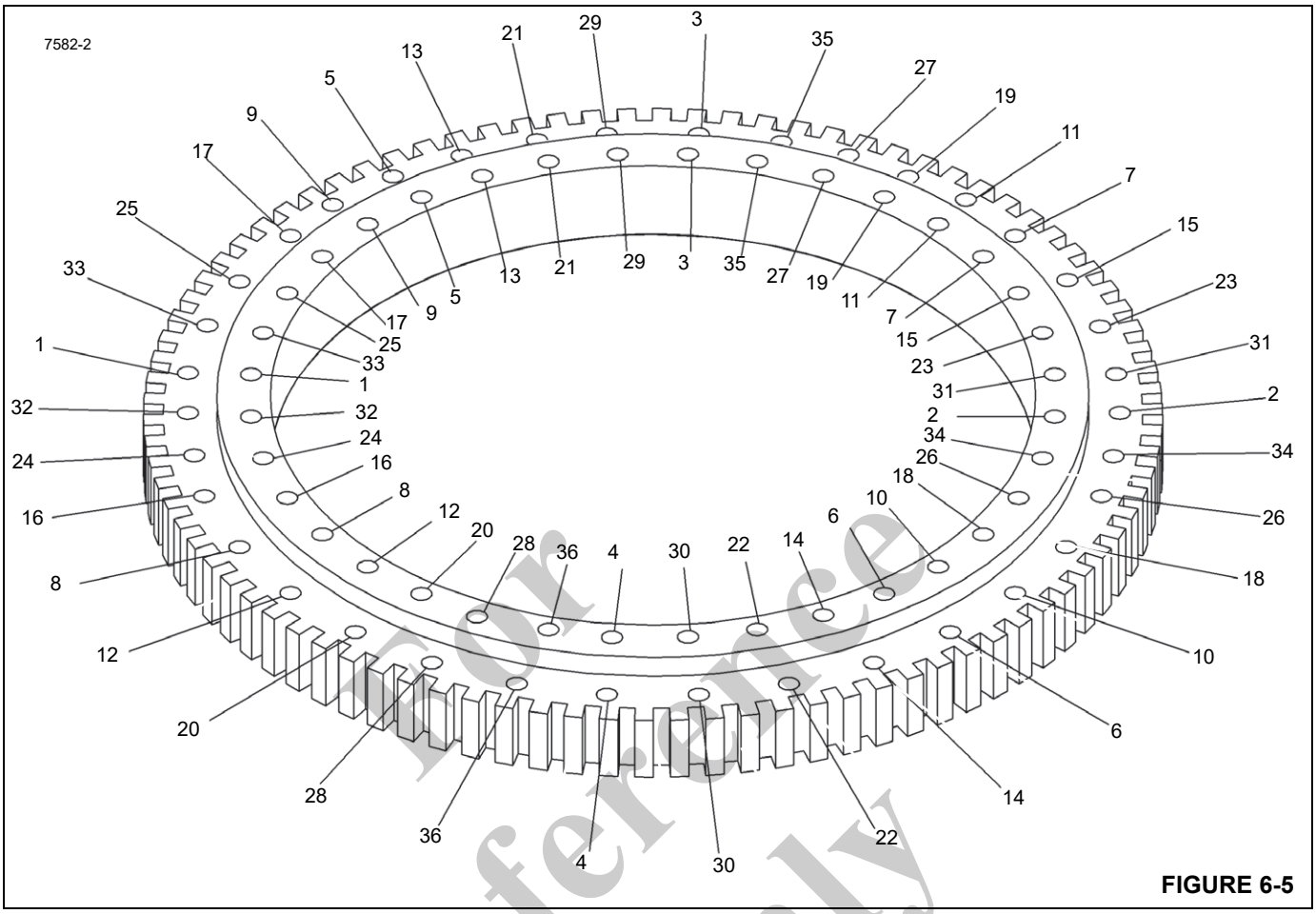

FIGURE 6-5

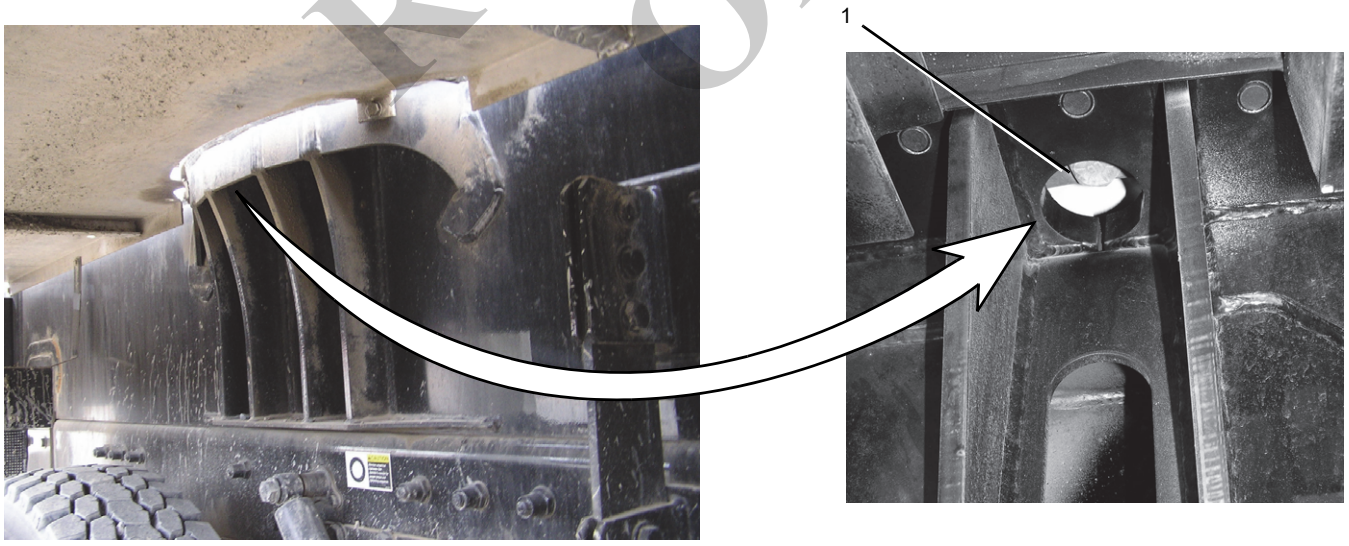

FIGURE 6-6

For Reference Only

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. (Reference 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 6-7) opposite the boom on the T-box frame (3).
3. Place the dial on the top of the turret bearing plate (1, Figure 6-7).
4. Power the boom down onto the boom rest.
5. Set the dial indicator at zero.
6. Raise the boom about 76mm (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 (Figure 6-8).
    a. Measure the deflection at positions 2, 3, 7, and 8 for 180° rotation and 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 76mm (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 is greater than 2.2 mm (0.090 in) at any position, replace the bearing.

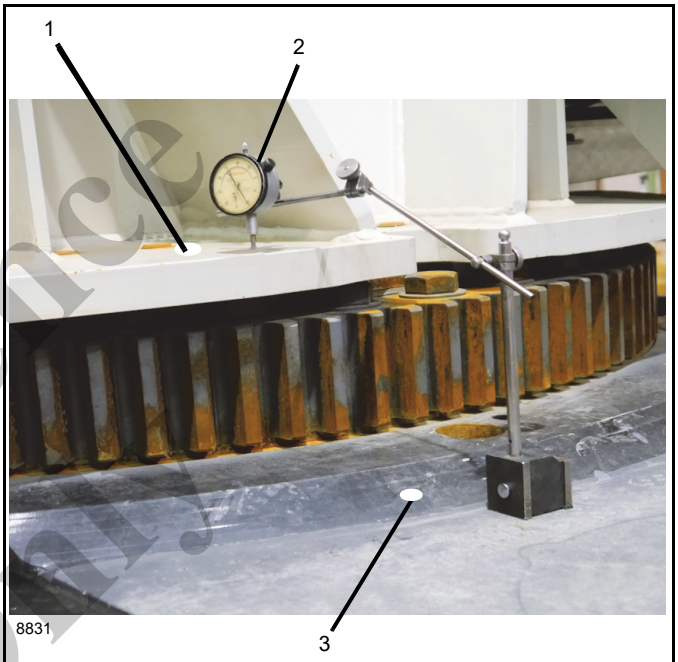

FIGURE 6-7

For Reference Only

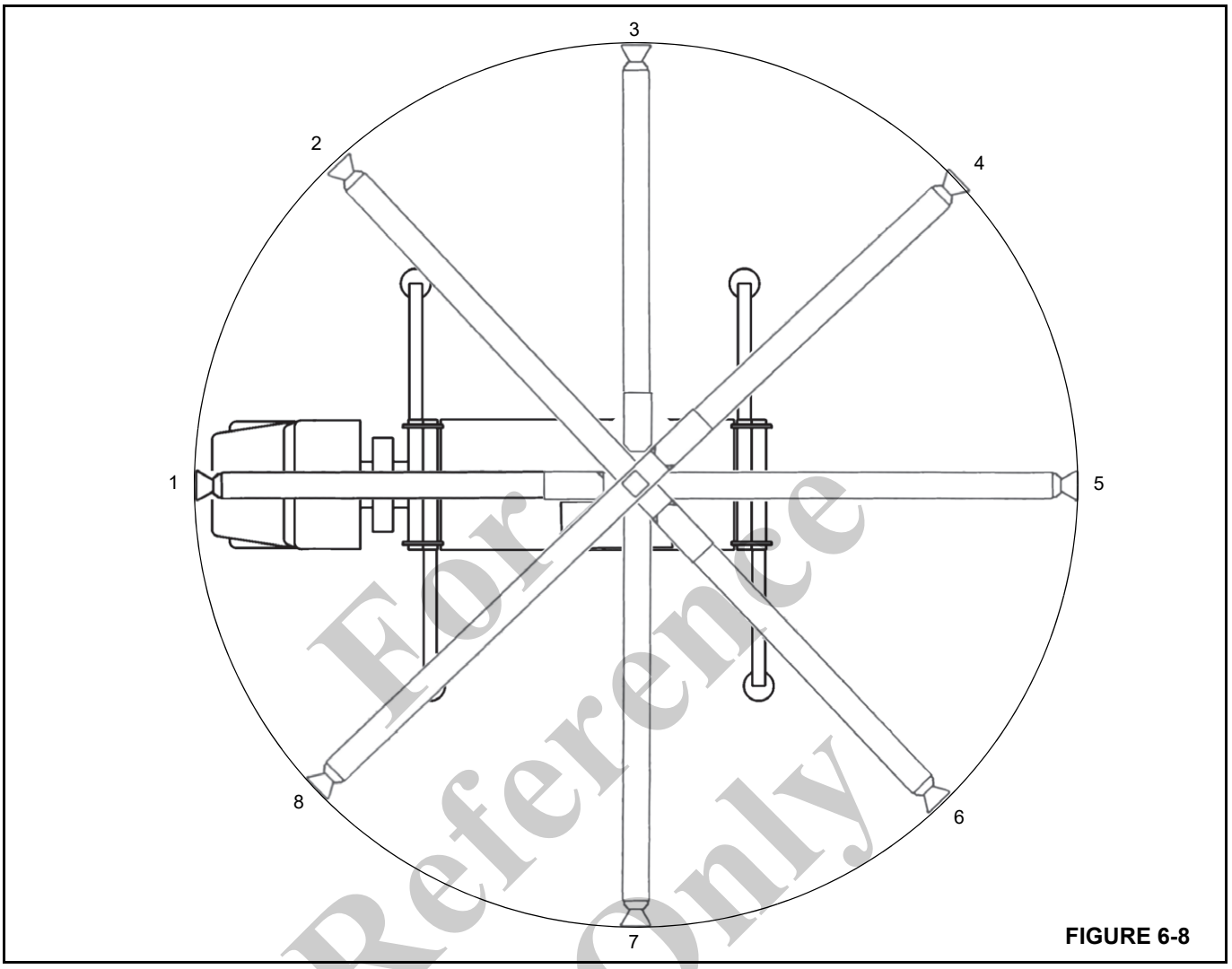

FIGURE 6-8

For Reference Only

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 bolts underneath the swing motor need to be removed before any other bearing bolts are removed.

4. Rotate the boom back to the front and remove the turntable bolts between the marks.

5. Slowly rotate the boom back to 20° off 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 all hydraulic lines from the swivel on the carrier side. Cap or 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 bolts and washers securing the swing bearing outer race to the carrier.

DANGER

Ensure 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 bearing on the turret before removal.

15. Remove the 36 bolts from the inner race of the turret bearing.

16. Lift the turret off the swing bearing and set on blocking.

NOTE: The bearing weighs about 625 lb (284 kg).

Check the bearing teeth for chipping or cracking. If any evidence of these is found, replace the bearing. Ensure the bolt holes are free of dirt, oil, or 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. New bolts ensure 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 bolts and washers securing the bearing to the turret. Refer to Inner Race Torquing, page 6-9.

3. Using an appropriate lifting device, align the turret over the carrier 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.

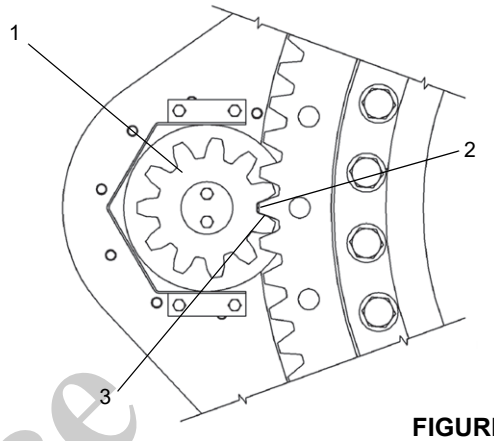

FIGURE 6-9

5. Install all bolts and washers that are not covered by the swing motor. Refer to Outer Race Torquing in 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, Figure 6-10 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) is aligned with the turret bearing high point. Check the backlash with a 0.008 in. (.203 mm) shim (3, Figure 6-9). If the pinion must be moved to achieve proper backlash, contact your local distributor.

7. Plug the swivel wiring harness connectors into the carrier receptacles.

8. Reconnect the hydraulic lines as per removal tags.

9. Install the boom and lift cylinder following the procedures outlined in Section 4- BOOM.

10. Reconnect the batteries.

11. Carefully swing the turret so that the bolt holes that were covered by the swing motor are accessible.

12. Install the remaining swing bearing bolts.

13. Check the slew potentiometer in the electrical swivel for proper orientation as described below.

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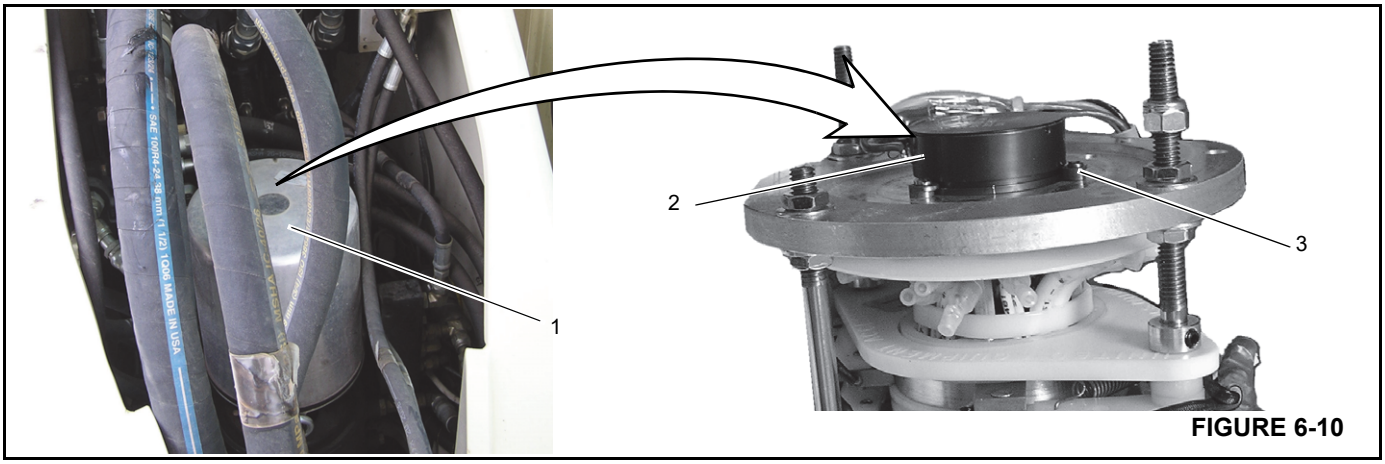

FIGURE 6-10

Slew Potentiometer Adjustment

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,Figure 6-10) and contains the slew potentiometer (2, Figure 6-10).

1. Remove the cover from the electrical swivel section (1).
2. Using the cab controls to rotate the turret over the front and set the swing brake.
3. Set the RCL console to read slewing angle as follows:

NOTE 1: Refer to the mentor QVGA RCL Manual for detailed instructions.

   a. Complete the RCL console setup according to the crane's current operating configuration.
   b. Press limits LIM.
   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. Swing the turret about 10° to the right (clockwise). Slowly swing back to over the front and set the swing brake.

NOTE: If the turret swings past the over the front position, step 4 must be repeated.

5. Loosen the three screws (3, Figure 6-10) that secure the slew potentiometer to the mounting plate.
6. Rotate the body of the slew potentiometer (2, Figure 6-10) until the slew angle indicates 0.6° ± 0.1°.
7. Tighten the three screws (3, Figure 6-10) to secure the slew potentiometer to the mounting plate. Install the electrical swivel cover.
8. Disengage the swing brake and swing approximately 10° to the left (counterclockwise). Slowly swing back to over the front and set the swing brake.

NOTE: If the turret swings past the house lock pin engaged position, step 8 must be repeated.

9. If the angle indicated on the console does not exceed ± 1.0°, proceed to step 13. If the indicated angle exceeds ± 1.0°, return to step 4.
10. Release the swing brake and swing approximately 10° to the right (clockwise). Slowly swing back to over the front and set the swing brake.

NOTE: If the Turret swings past the over the front 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 approximately 10° to the left (counterclockwise). Slowly swing back to over the front and set the swing brake.
13. Tighten screws and replace cover.

Slew Sensor Calibration

Testing

Activate the crane and check for proper function.

NOTE: If the turret does not turn freely after bearing and pinion replacement, contact your local distributor.

SWING LOCK

The swing 360° lock holds the turret in place preventing any type of movement in either a counterclockwise or clockwise direction.

For Reference Only

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 turret bearing ring teeth; releasing the pedal disengages the lock from the bearing ring teeth.

Removal

1. Release the swing lock foot pedal and be sure the lock is disengaged from the turret bearing ring (15, Figure 6-11).
2. Remove the clevis pin (1, Figure 6-11), cotter pin (2) and washer (3) securing the cable (4) to the swing lock (5).
3. Remove shim (6, Figure 6-12) and attaching hardware screws (7) and lockwashers (8).
4. Remove four screws (9, Figure 6-12), bushings (10) and flatwashers (11) and move swing lock (5) from the turret.
5. Remove two springs (12) from the swing lock. Inspection the springs for wear or damage, replace springs as needed.

   Inspect the swing lock assembly for wear or damage; replace parts as needed.

Installation

1. Position the swing lock (5, Figure 6-12) onto the turret and secure with four screws (9, Figure 6-12). bushings (10) and flatwashers (11).
2. Place shim (6, Figure 6-12) on top of swing lock mounting block and secure with screws (7) and lockwashers (8)

   Use shim to eliminate all side to side movement between the swing lock (5, Figure 6-12) and the swing lock mounting blocks welded to the turret.
3. Attach the cable (4, Figure 6-11) to the swing lock (5) with clevis pin (1), cotter pin (2) and washer (3).
4. Adjust the cable (4, Figure 6-11) using the following instructions.
   a. Engage swing lock assembly with turret bearing ring so that maximum tooth engagement is achieved.
   b. View A, Figure 6-12 shows a side view of the swing lock *engaged* with the turret bearing gear teeth (15).

      When the swing lock is *disengaged* the clearance between turret bearing teeth (15) and the swing lock is . 57 in (14.5 mm). This will allow the turret bearing ring to rotate freely and provide maximum engagement when the swing lock is applied.
   c. Adjust stop bolt (13, Figure 6-12) until the head of the bolt comes in contact with the link on swing assembly. Tighten hex nut (14).
   d. Adjust the cable so that the cable pulls the link rightly against the stop bolt (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 screws (9, Figure 6-12); refer to "Fasteners And Torque Values" on page 7 for the torque value for the screws.

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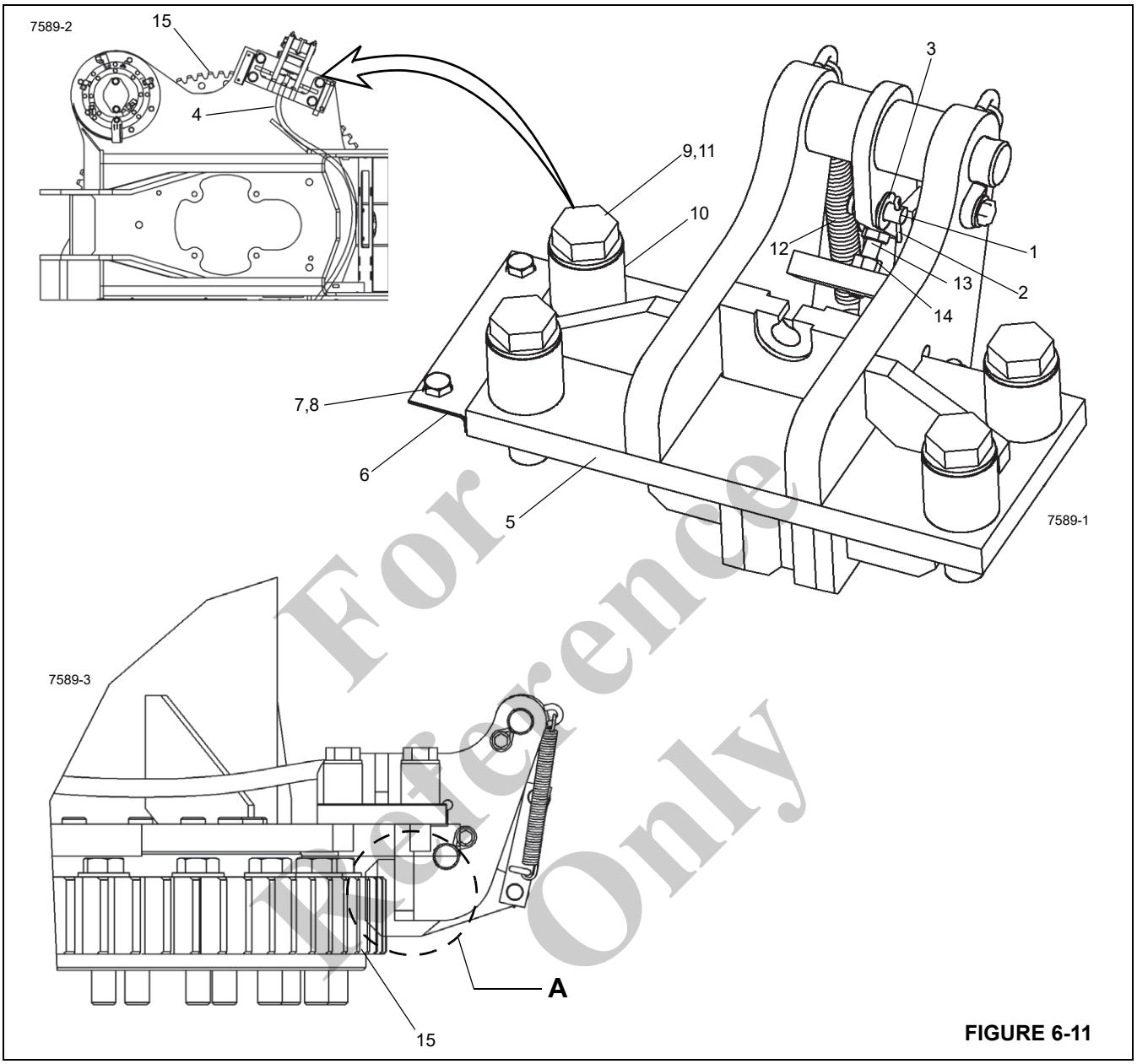

FIGURE 6-11

For Reference Only

SECTION 7
OUTRIGGERS

SECTION CONTENTS

DESCRIPTION

The two section outriggers are and used to provide stability for the truck when the crane is in use. The outriggers can be used in the fully retracted, at the mid-extended position, or the 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-extend position by rotating the lock pin into the lock position. The spring loaded lock pin is injected into the hole when the beam reaches the mid-extend position.

A hydraulic cylinder along with internal cables extend and retract the two section outrigger beams.

OUTRIGGER BEAM ASSEMBLY

The outrigger beam assembly consists of the following:

- 1^{ST} and 2^{ND} section outrigger beams
- stabilizer cylinders
- required hoses and mounting hardware

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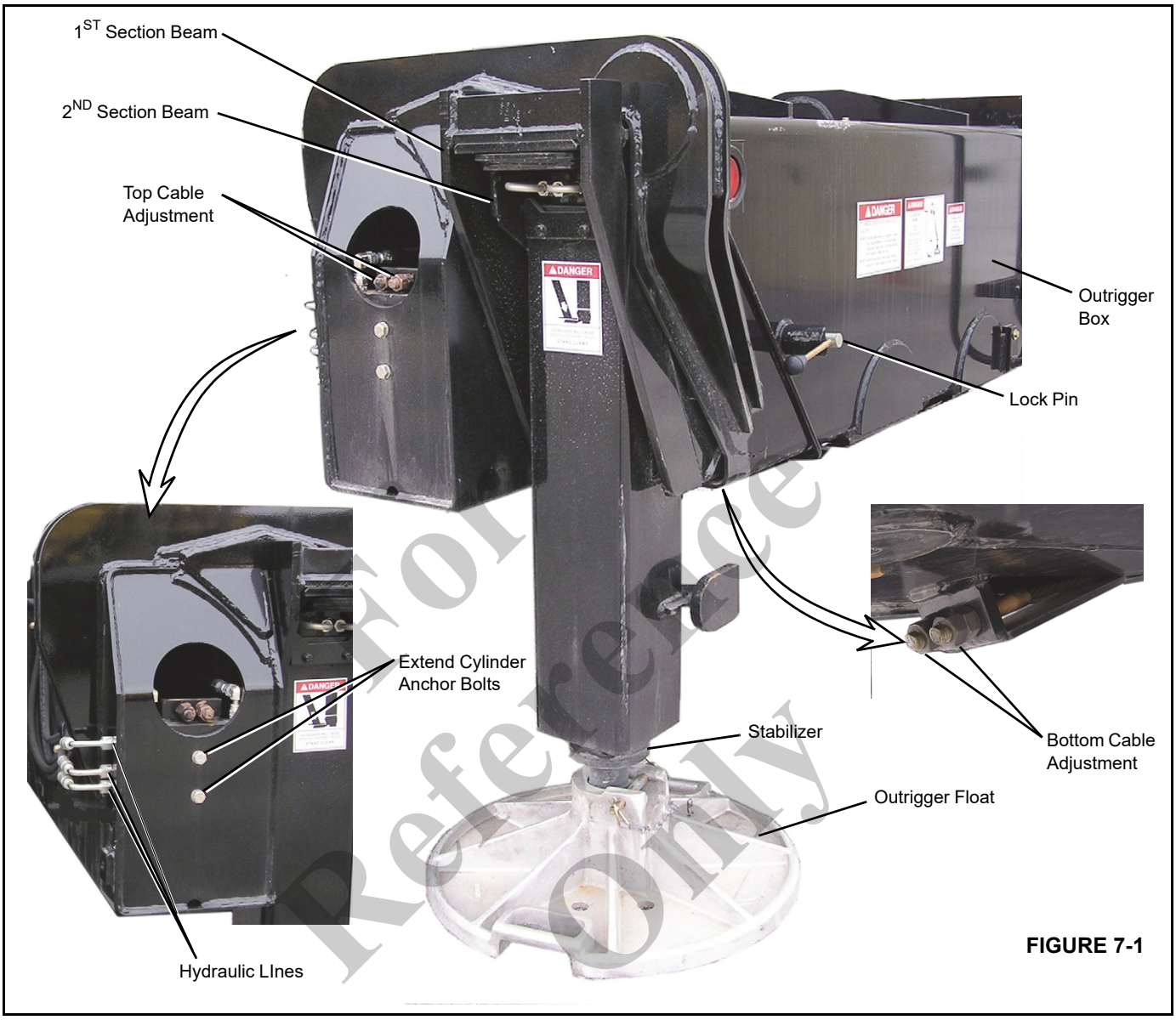

FIGURE 7-1

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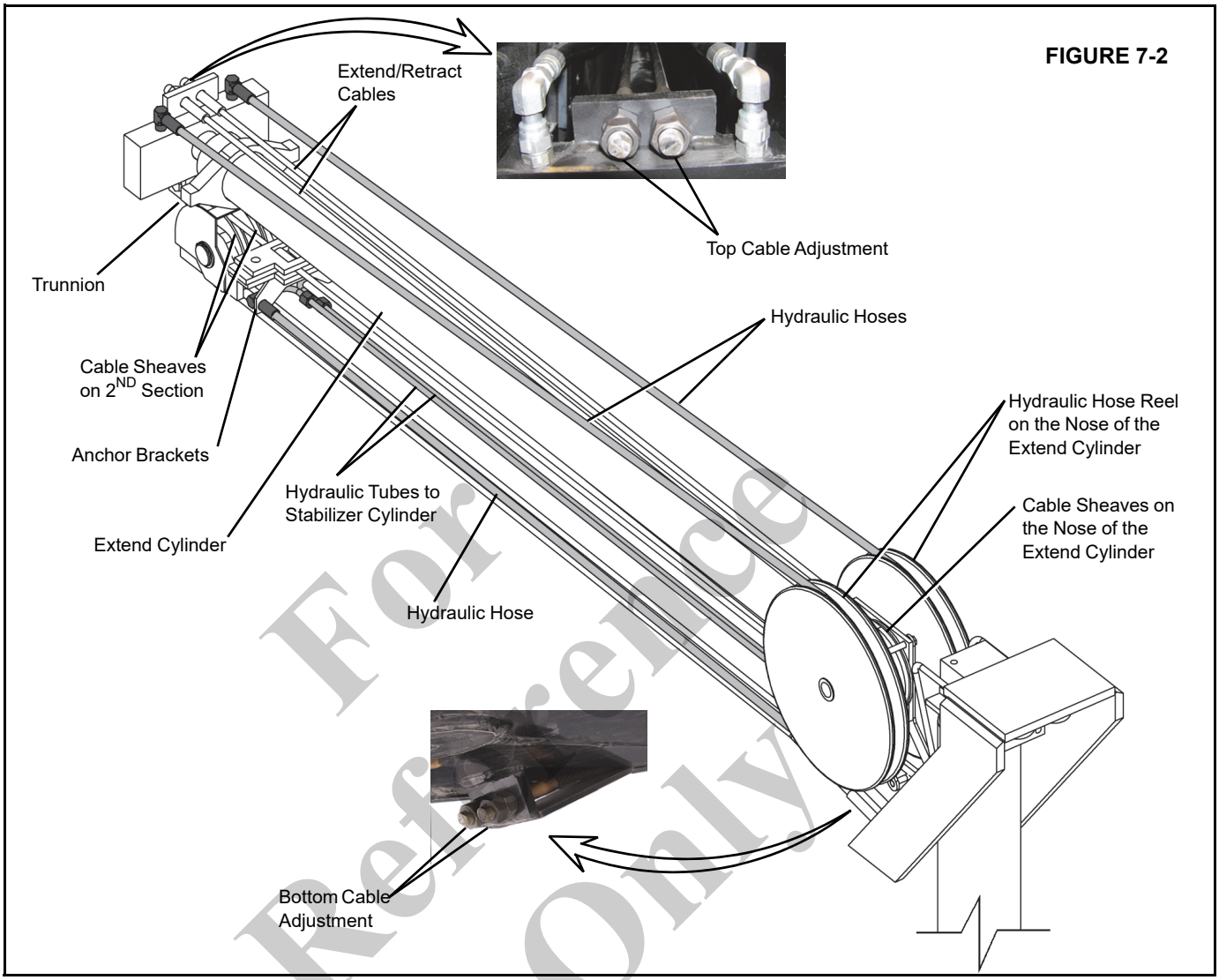
FIGURE 7-2



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7

Removal

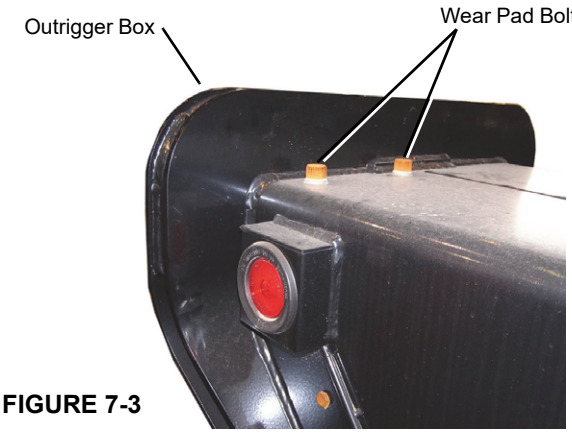

FIGURE 7-3

1. Check that the stabilizer is fully retracted and the float removed.
2. 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 reinstallation.

3. Extend the outrigger beam slightly so that a lifting strap (Figure 7-4) can be attached to the outrigger beam.

NOTE: To prevent nick and gouges to the bottom of the outrigger beam, do not attach chains to the outrigger beam.

4. Remove the hydraulic lines from the base of the extend cylinder (Figure 7-1).

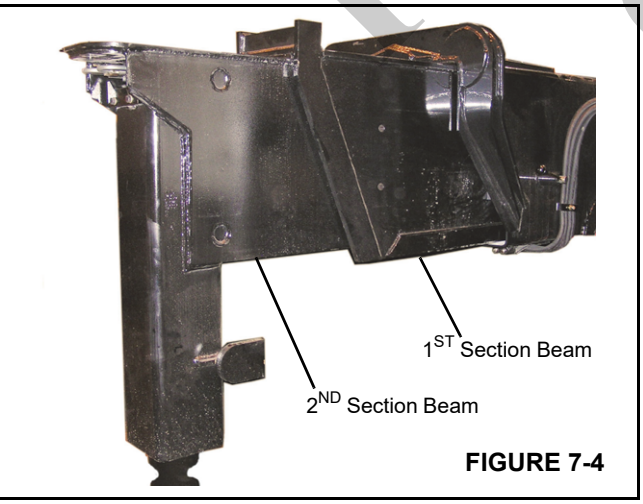

FIGURE 7-4

5. Remove the holding valve to allow extend cylinder rod movement.
6. Raise the 1ST-2ND section outrigger beam assembly against the outrigger box. Remove and tag the bottom wear pad and shims from the outrigger box.
7. Mark the position and remove the retaining nuts from the proportioning cable stops at the bottom of the outrigger box.
8. Route the cables back through anchor plate and pull the ends out between the outrigger box and the 1ST-2ND section beam assembly
9. Pull the 1ST-2ND section beam 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.
10. Place the 1ST-2ND assembly on a adequate blocking. Do not pinch or crush the proportioning cables while lifting or supporting the assembly.
11. Lift the extend cylinder trunnion out of anchor pockets in the 1ST section beam (Figure 7-2).
12. Remove the snap rings from the shaft in the rear of the 1ST section beam. Remove the shaft and sheaves from beam. Route the cables back through the opening in the bottom plate of the 2ND section after sheave removal.
13. Disconnect the internal hydraulic hoses from the anchor brackets at the rear of the 2ND section (Figure 7-2).
14. Remove the capscrews clamping the cable anchor together at the rear of the 2ND section and remove cable anchor assembly.
15. Pull extend cylinder out of the 1ST-2ND section assembly. Take care not to pinch or crush hoses or cables during extend cylinder removal. Use caution as cylinder is removed from 2ND section because loose parts such as the hose sheaves can fall off the shaft and be damaged.
16. Place the cylinder on a suitable horizontal surface and remove the hoses, cable sheaves, hose reels, and shaft.
17. Mark retaining nut positions on proportioning cables and remove cables from cylinder butt plate, place cables in location to avoid damage.
18. Remove and tag the side wear pads and shims from the front of the 1ST section beam.
19. Raise the 2ND section outrigger against the top pad of the 1ST section outrigger. Remove and tag the bottom wear pad between the 1ST and 2ND beam sections.
20. Pull the 2ND section outrigger out of the 1ST section and place on adequate blocking. If necessary remove and tag wear pads and shims from the 2ND section beam.
21. Disconnect and remove the hydraulic tubes from the stabilizer cylinder.

For Reference Only

22. Properly support the stabilizer cylinder from the bottom with a floor jack or hoist and remove the holding valve and o-rings.

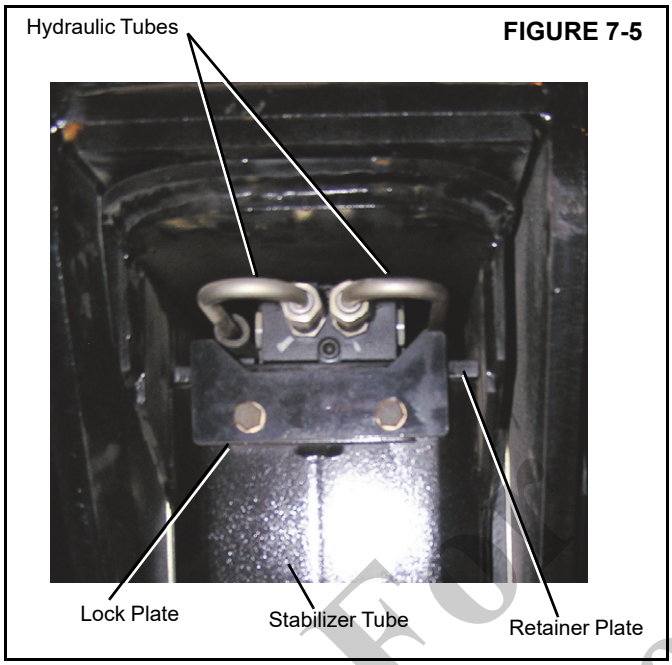

FIGURE 7-5

23. Remove the capscrews and lock plate from the stabilizer tube.
24. With the cylinder supported, slide the retainer plate out from under the cylinder butt plate.
25. Lower the cylinder out of stabilizer tube.
26. Remove the wear rings installed in grooves of 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 bolts.
- 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 2ND section beam.
2. Install wear rings into 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 (Figure 7-5).
6. Install holding valve on stabilizer cylinder.
7. Install hydraulic fittings and tubes on the holding valve.
8. Install the wear pads and shims to 2ND section beam.
9. Place the 1ST section beam on adequate blocking and slide the 2ND section into 1ST section until 2ND section stops.
10. Install the side wear pads and shims between 2ND and 1ST section beams. Raise the 2ND section and install the bottom front wear pads and shims.
11. Assemble proportioning cable sheave with shaft and hose reels onto extend cylinder. Install the cables and hoses and drape excess in area to avoid damage.
12. Insert extend cylinder into 1ST-2ND outrigger assembly. Use caution to avoid pinching the cables and hoses.
13. Lift the cylinder up 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 cable anchor and install the anchor in 2ND section beam.
15. Attach the fittings for the stabilizer cylinder hydraulic tubes to the cable anchor.
16. Route the cables through sheave hole on bottom of 2ND beam section. Reeve cables around dual sheave and install the sheave, shaft, and snap rings.
17. Lower cylinder trunnion into the pocket on the 1ST section beam.
18. With the 1ST -2ND section beam assembly on adequate blocking, install the wear pads, and shims.
19. Attach the cables, fittings, and hoses to cylinder butt plate. The cylinder length may need to be adjusted to allow assembly.
20. Slide the 1ST -2ND section beam assembly into outrigger box. Use caution not to damage the cables sliding in under the 1ST section. The 1ST - 2ND beam assembly may need to be lifted to install cable ends into the anchor points in bottom of the outrigger box. Guide the cable ends between outrigger box and the 1ST 2ND assembly back through the anchor points. Install anchor hex nuts in previously marked positions.
21. Push the 1ST 2ND beam 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. Reinstall the hydraulic lines and holding valve on the extend cylinder.
23. Install the side and bottom wear pads and shims.

For Reference Only

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CABLE TENSIONING

1. With outriggers assembled, cycle the outriggers and Single Front Outrigger through full extension and retraction for five complete cycles to remove air in cylinders.
2. Fully retract outriggers.
3. Look through the hole in the end of the outrigger box to determine the outrigger beam position. At full retraction:

- The base of the 1ST section beam bottoms out in the base of the outrigger box.
- The base of the 2ND section beam bottoms out against the sheave cable anchor plates in the base of the 1ST section outrigger.

4. If the outrigger beams do not bottom out as described above:

- Loosen the upper cable adjustment if the 1ST section beam does not bottom out in the outrigger box.
- Loosen the lower cable adjustment if the 2ND section beam does not bottom out in the 1ST section beam.

5. After the cables have been loosened to allow full retraction, torque cables to 30-35 ft-lb (40-47 Nm) by:

- torque the lower cables.
- torque the upper cable to equal the lower cables.

6. Check the outriggers for proper proportioning when extended and position retracted.

OUTRIGGER CALIBRATION

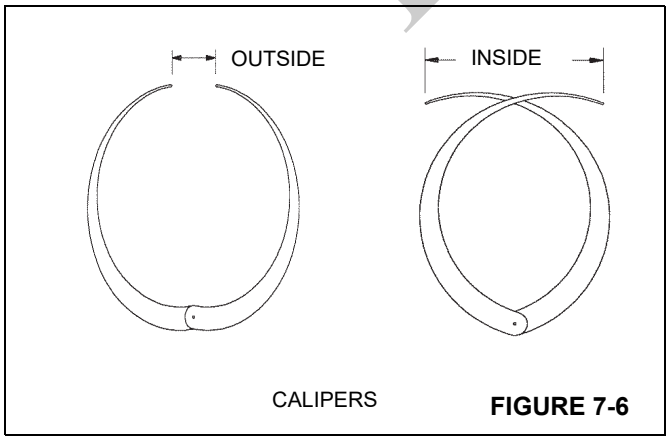

FIGURE 7-6

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 ft back from the front of the section and record the smallest measurement.

NOTE: Method of Calibration is the same for section the 1 or 2 of the outrigger.

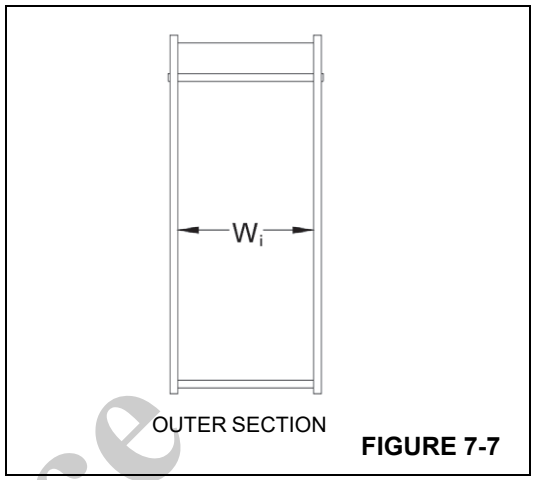

FIGURE 7-7

2. With the inside/outside calipers, measure the outside width of the appropriate inner section (Wo,Figure 7-8) at the rear of the section and three ft from the rear. Record the largest measurement.

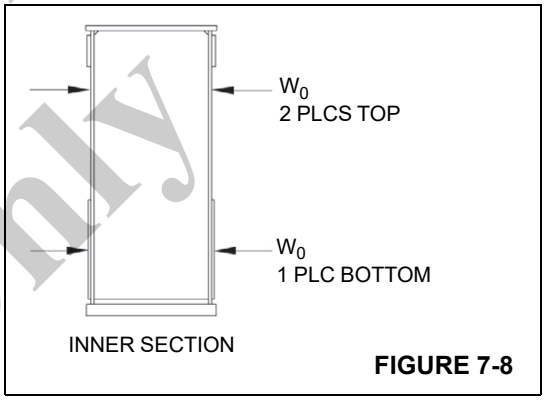

FIGURE 7-8

3. Measure the thickness of the wear pads and record (t_{wp}, Figure 7-9).

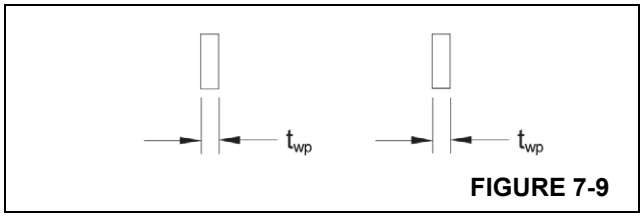

FIGURE 7-9

4. Subtract the largest outside width (W_o, 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 0.03 or 0.06 thick) to tighten the pads so that there is 0.00 - 0.06 clearance between the widest part of the inner outrigger section and the most narrow part of the outer outrigger

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section when shims and pads are installed. See example.

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

EXAMPLE

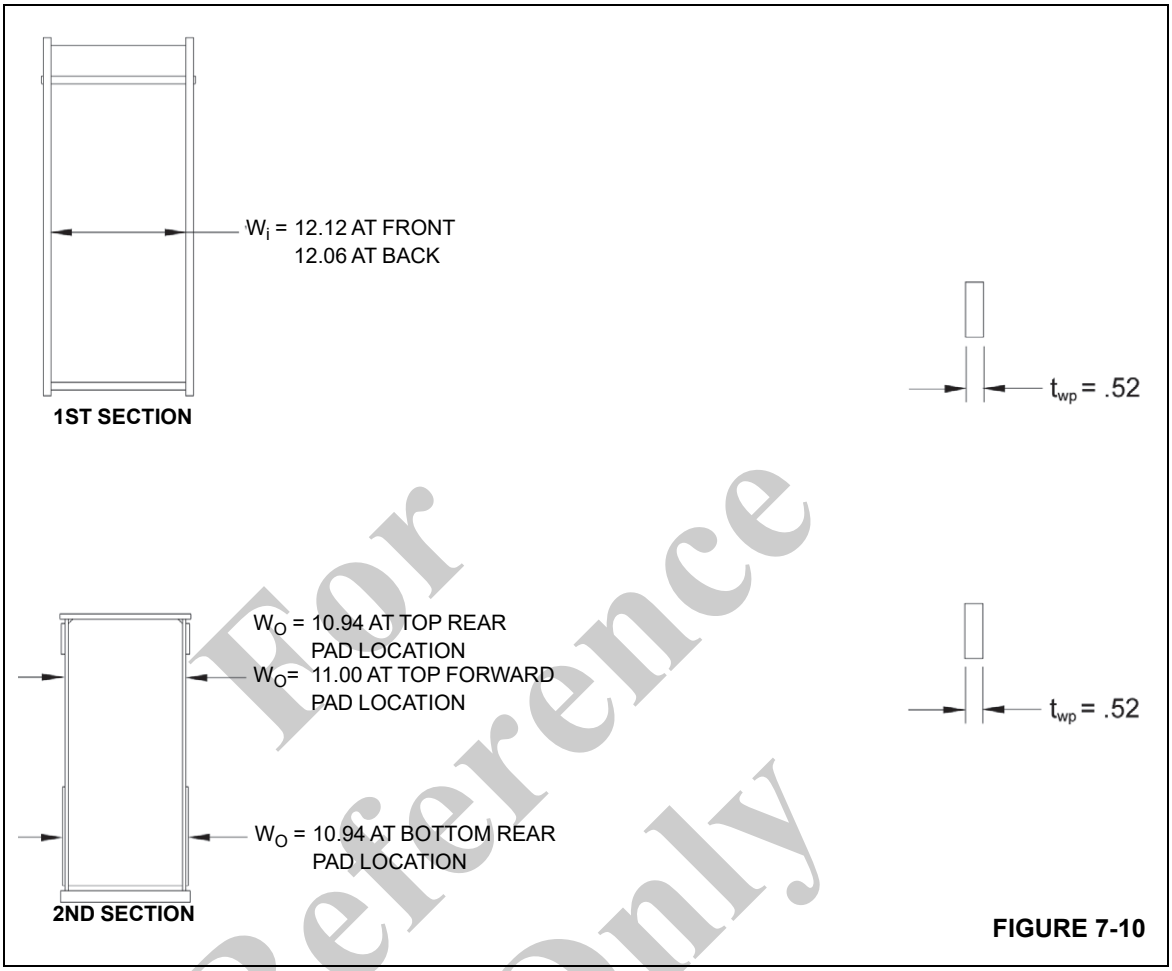

FIGURE 7-10

W_i	=	8.75
$-W_o$	=	- 7.81
$-t_{wp}$	=	- 0.38
$-t_{wp}$	=	- 0.38
Clearance	=	0.19
Left Side Shim	=	- 0.06
Right Side Shim	=	- 0.06
		0.06

For Reference Only

7

Top And Bottom Pads

1. With a pair of inside/outside calipers, measure the inside height of the outer section (Hi, Figure 7-11) three ft from the front of the section and record.

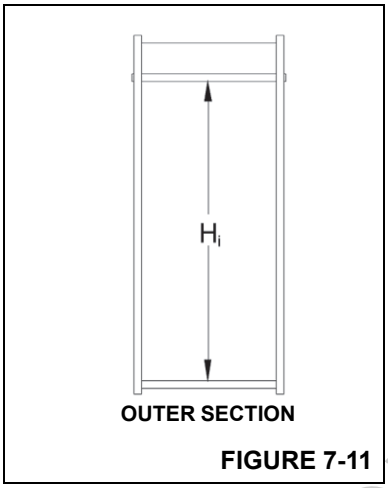

FIGURE 7-11

2. With the inside/outside calipers, measure 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 and record.

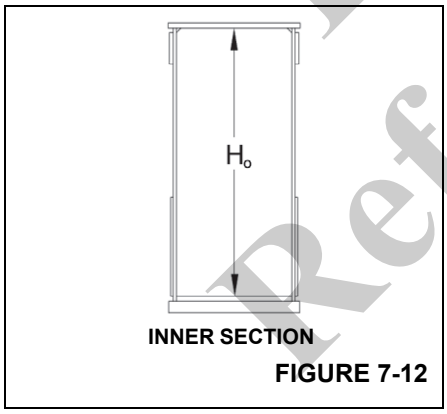

FIGURE 7-12

3. Measure the thickness of the top wear pads that attach to the inner section and record ($t_{wp,}$ Figure 7-13).

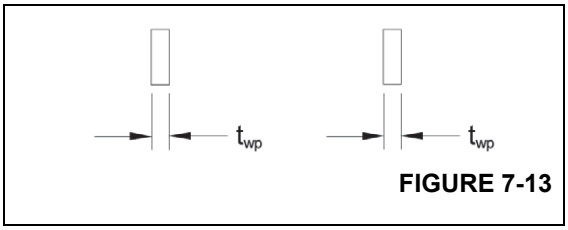

FIGURE 7-13

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 0.03 or 0.06 thick) to tighten the pads so that there is 0.003 - 0.006 clearance between the widest part of the inner outrigger and the most narrow part of the outer outrigger when shims and pads are installed. See example.

5. Install the inner outrigger section into the outer outrigger section. Nominal front bottom pad and shim thickness 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 0.03 - 0.09 total section clearance.

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

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

The Outrigger Monitoring System (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, one string potentiometer (1, Figure 7-14) in each outrigger beam, to identify if an outrigger beam is positioned to one of three pre-defined locations, including fully retracted, mid-extend, and fully extended.

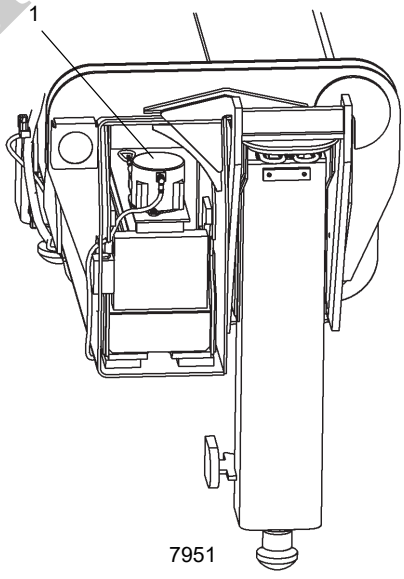

FIGURE 7-14

For Reference Only

String Potentiometer

Remove

1. Fully retract outrigger beam.
2. Remove outrigger box cover
3. Disconnect spring clip from its attaching point on outrigger beam.
4. Disconnect electrical connector at string potentiometer.
5. Remove the screws securing string potentiometer; remove string potentiometer.

Install

1. Fully retract outrigger.
2. Using screws, mount the string potentiometer to the outrigger box cover.
3. Connect electrical connector to string potentiometer.
4. Attach spring clip to attaching point on outrigger beam.
5. Mount outrigger box cover on outrigger box.
6. Calibrate string potentiometers; refer to *Calibrate*, page 7-9.

Calibrate

Calibrating the string potentiometer is done through the crane's RCL. Refer to the *Rated Capacity Limiter Operator's Manual* for detailed instructions.

For Reference Only

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SECTION 8
LUBRICATION

SECTION CONTENTS

For Reference Only

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, the frequency of lubrication, and other information. The information included in this section does not include lubrication requirements for the truck chassis. Refer to appropriate truck manufacturer's manual for this information.

The service intervals specified are for normal operation where moderate temperature, humidity, and atmospheric conditions prevail. In areas of extreme conditions, the service periods and lubrication specifications should be altered to meet existing conditions. For information on extreme condition lubrication, contact your local 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 National cranes includes — but is not limited to — oil, fuel, grease, coolant, air conditioning refrigerant, filters, batteries, and cloths which have come into contact with these environmentally harmful substances.

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

When filling and draining crane components, observe the following:

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

Lubricants

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

Arctic 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 Cranes 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 start-up 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 100°F (38°C) 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 melting point of 138°C (280°F). The grease is a heavy duty extreme pressure type lubricant (Lubricate Low Temp or equal).

Extreme Pressure Multipurpose Gear Lubricant (EPGL)

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

SAE Viscosity Number	Minimum Ambient Temperature C (F)	
75W	-40°C	(-40°F)
80W	-2°C	(-15°F)
85	-12°C	(+10°F)
90	-7°C	(+20°F)
140	+5°C	(+40°F)
250	+10°C	(+50°F)

Open Gear Lubricant

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

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 -9°C (15°F) and below, follow the procedures in the section titled “Arctic Conditions Below -9°C (15°F)” on page 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 temperature below 32°F (0°C) can cause damage to the extend cylinder.

For Reference Only

Arctic Hydraulic Oil

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

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

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

Petroleum based fluids developed especially for low temperature service may be used with satisfactory results. However, certain fluids, such as hologenated hydrocarbons, nitro hydrocabons and phosphate ester hydraulic fluids might not be compatible with hydraulic system seals and wear bands. Arctic hydraulic oil is not recommended for service in ambient temperatures above 0°C (32°F).

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

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

Hydraulic Oil Inspection

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

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

To inspect the hydraulic oil, fill a small glass container with a sample of the reservoir oil and another glass container with fresh oil. Let the samples stand, undisturbed, for one or two hours. Then, compare the samples. If the reservoir oil is heavily contaminated with water, the sample will appear “milky” with only a small layer of transparent oil on top. If the “milky” appearance is due to air foaming, it will dissipate and the oil should closely match the fresh oil. Remember, replacement oil must meet ISO 17/14 or better cleanliness level and must meet John Deere Standard JDM J20C. Contact your National Crane distributor or Manitowoc Crane Care if you have any questions.

LUBRICATION

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

DANGER

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

CAUTION

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

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

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

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

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

CAUTION

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

NOTE:

The following describe the lubrication points and gives the lube type, lube interval, lube amount, and application of each. Each lubrication point is numbered, and this number corresponds to the index number shown on the Lubrication Chart (Figure 8-1). Lube description and symbols are found in tables below.

For Reference Only

Table 8-1

Symbol	Description	National 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.			

For Reference Only

Lubrication Points

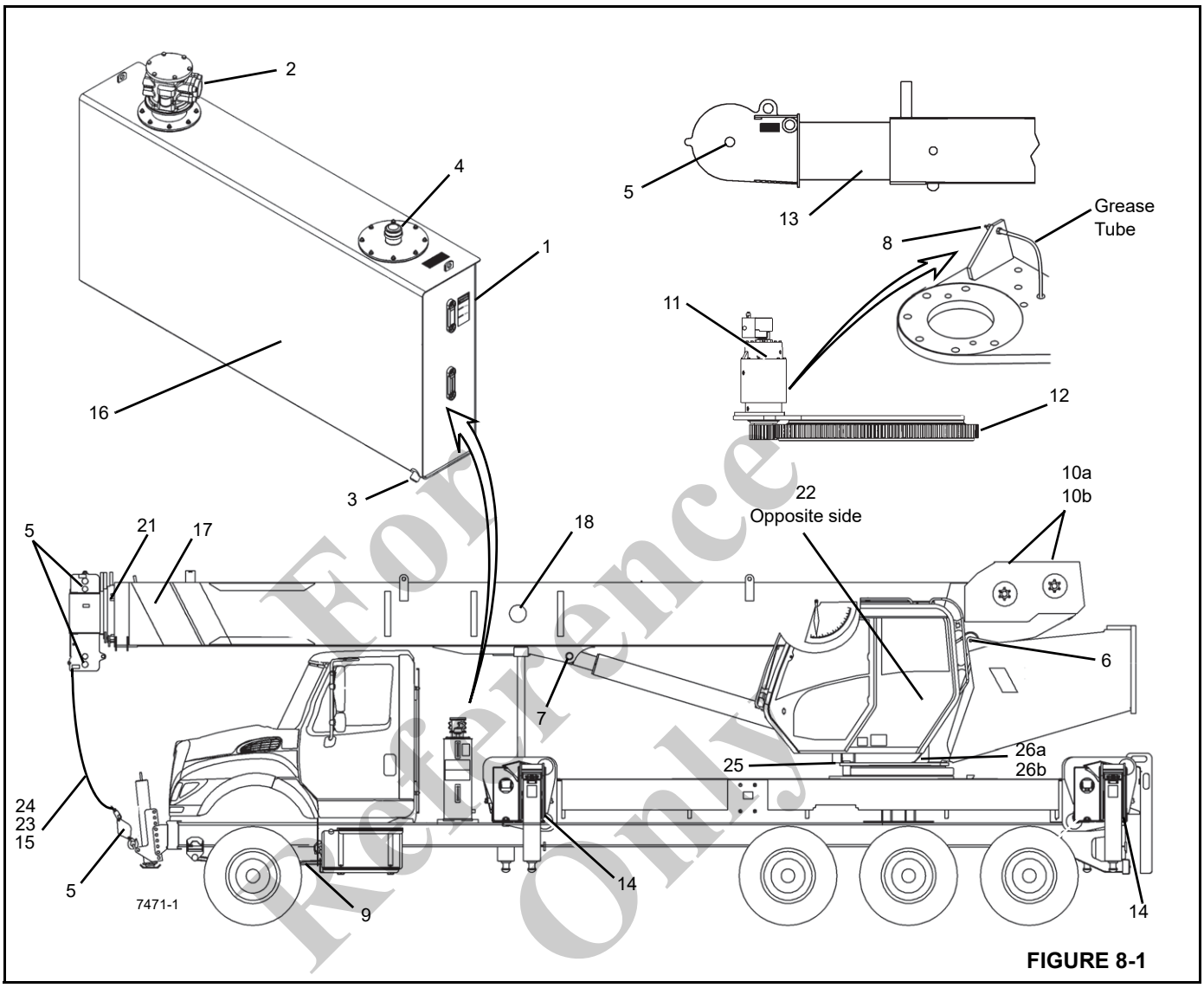

FIGURE 8-1

For Reference Only

Table 8-2

Item	Application	Recommended Lubricant	Procedure	Frequency
1	Hydraulic oil reservoir	Hydraulic Oil	Check fill change	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 (5 plcs), jib (1 pl), hook block (1 pl), Aux Boom Nose (1 pl)	EP-MPG	Grease gun	Weekly
6	Boom pivot pin	EP-MPG	Grease gun	Monthly
7	Lift cylinder pins - 2 ea.	EP-MPG	Grease gun	Monthly

Item	Application	Recommended Lubricant	Procedure	Frequency
8	Turntable bearing	EP-MPG	Grease gun	Weekly
9	Pump Drive U-Joint - 2 ea. (If Equipped) or Pump Spline Shaft (Direct Mount)	Chassis Grease Coupling Lube Spline Lubricant	Change Check and Fill Change	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 gear-box for leaks. Change: Every 1000 hours or 6 months.
10b	Hoist brake	EO-20W-20 or TES295	Check and fill Change	Check and fill: As part of daily crane inspection, check the gear-box for leaks. Change: Every 1000 hours or 6 months.
11	Swing drive gearbox	GL-5	Check and fill Change	Check and fill: As part of daily crane inspection, check the gear-box for leaks. Change: Every 1000 hours or 6 months.
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: 2nd Section 127 ft and 142 ft booms each Side	Chassis Grease #200S Silver Streak Special Multi-Lube (light)	Grease Gun	Weekly
17b	Extend Sheaves: 4th 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	Any Time 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
24	Hook Block Sheaves	EP-MPG	Grease gun	Monthly
25	Turntable Swing Lockpin	EP-MPG	Spray	Monthly

For Reference Only

Item	Application	Recommended Lubricant	Procedure	Frequency
26a	Air Conditioning	Pag Oil	Check & fill w/ 4 ounces above 6 ounces in compressor	Any Time A/C is Disconnected or Serviced
26b	Air Conditioning Refrigerant	134a	2 lbs	@ start-up

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

For Reference Only

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 the table above.
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.

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.

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers.
2. Lower the boom to horizontal.
3. Remove access plate at top rear of the base section.
4. Extend the boom until wear pads are centered in 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.

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers. Refer to (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.

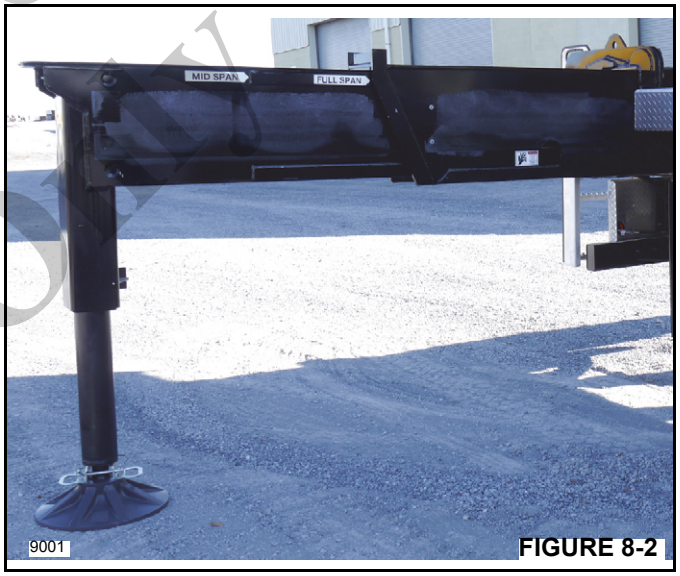

FIGURE 8-2

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.

For Reference Only

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 vent/fill (1) plug hole until oil is at the bottom level of the inspection hole.

Drain /Add New Hoist Brake Oil

To drain and add new oil:

- Remove the drain plug (3), (Figure 8-3), inspection plug (2) and vent plug (1).
- Drain the brake oil.
- Reinstall 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). See(Table 8-2). The hoist brake fill capacity is 0.23 liter (.25 quart).
- Install the inspection plug (2) and the oil vent and 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.

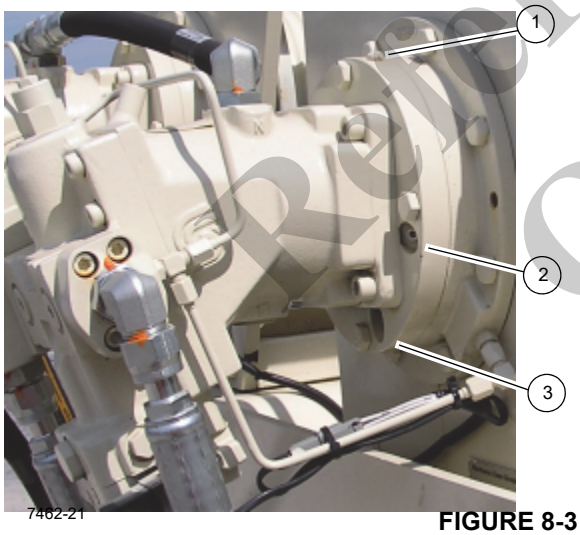

FIGURE 8-3

DANGER

Do not use EP type gear lubes 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:

- Rotate the drum until the oil fill plug (1, (Figure 8-4) is visible in the inspection hole.
- 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 Table 8-2)
- Re-install fill/level plug (1).

Fill Hoist Gearbox with Oil.

- To fill with oil, rotate the drum so the gearbox fill/level port (1, (Figure 8-4) is visible through the upper hole.
- Remove fill/level plug (1) with a hex socket.
- Install a 1” pipe with elbow into the fill hole (1) to assist with adding oil.
- Remove the vent plug (3) to assist with adding the oil.
- Fill 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 (Table 8-2).

Drain and Fill Hoist Gearbox with Oil.

- To drain and add new oil, remove the vent plug (3, Figure 8-4) to assist with draining the oil.
- Remove fill/level plug (1) with a hex socket.
- Remove the drain plug (2) with a hex head socket.
- Screw a 1” pipe into the drain plug hole to assist with draining the oil.
- Drain the oil.
- Remove the 1” drain pipe.
- Install oil drain plug (2).
- Install a 1” pipe with elbow into the fill hole (1) to assist with adding oil.
- Fill 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 (Table 8-2).
- Remove the 1” fill pipe.
- Install the inspection plug (1).
- 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.

For Reference Only

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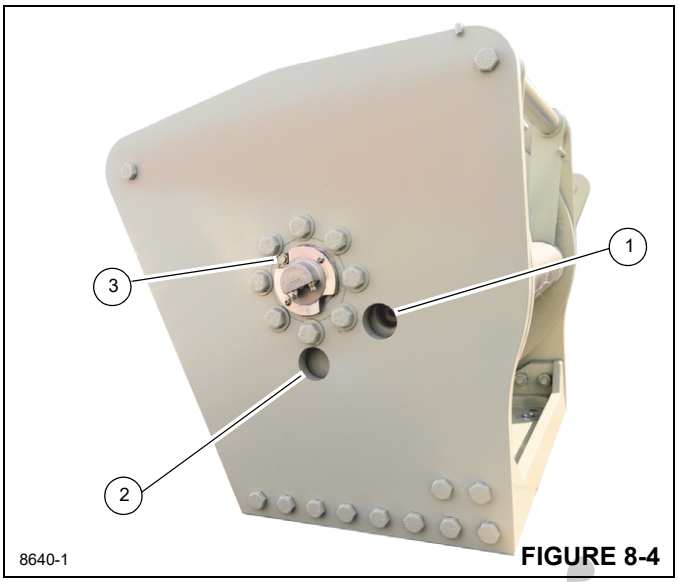

FIGURE 8-4

For Reference Only

Swing Gearbox and Brake Oil

Check Swing Gearbox oil level:

The oil in the gearbox and brake sections is recommended to be changed after first 50 hours of operation and every 1000 hours or 6 months of usage. Gearbox oil is drained by removing the drain plug and remove 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 fill/vent plug. *See "Lubrication" on page 3 of this manual.*

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

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

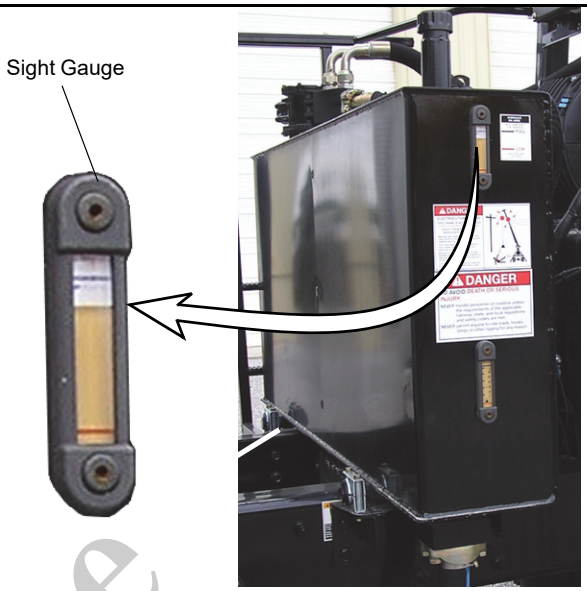

FIGURE 8-6

AIR CONDITIONING

When servicing air conditioner, evacuate system prior to disconnecting any components connected to the pressurized lines. Follow the specifications listed on section titled *Air Conditioner*, page 9-32.

After servicing ensure air conditioning system is re-charged with refrigerant and oil according to specifications listed on (Table 8-2, page 8-5).

WIRE ROPE LUBRICATION

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

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

- free from acids and alkalis.
- have sufficient adhesive strength to remain on the rope.

For Reference Only

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

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

- bath
- dripping
- pouring
- swabbing
- painting
- pressure spray

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

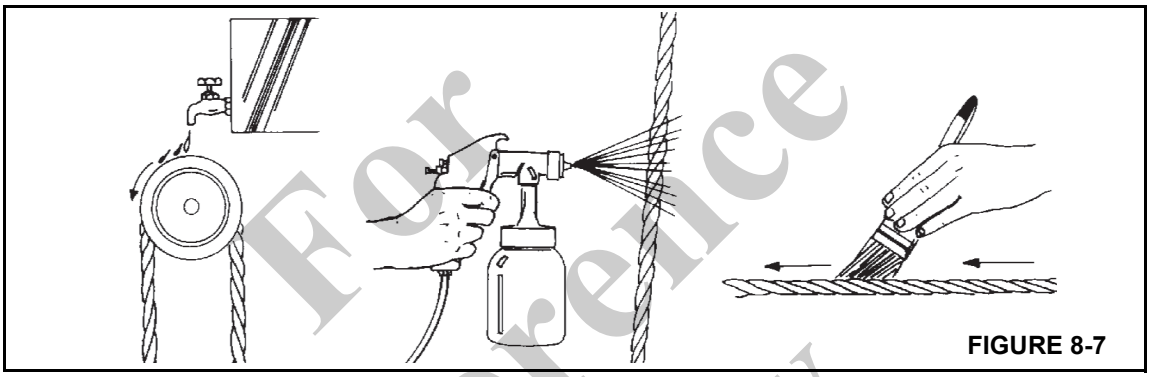

FIGURE 8-7

For Reference Only

CARWELL® RUST INHIBITOR

Protecting Cranes From Rusting

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

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

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

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

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

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

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

The most common causes of corrosion include the following:

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

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

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

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

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.

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

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

Inspection and Repair

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

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

CAUTION

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

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

For scratches and marks in areas of low visibility:

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

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

Application

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

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

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

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

NOTE: Unit must be completely dry before applying treatment.

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

Please contact Manitowoc Crane Care should you have any questions.

For Reference Only

Areas of Application

Refer to Figure 8-8

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

For Reference Only

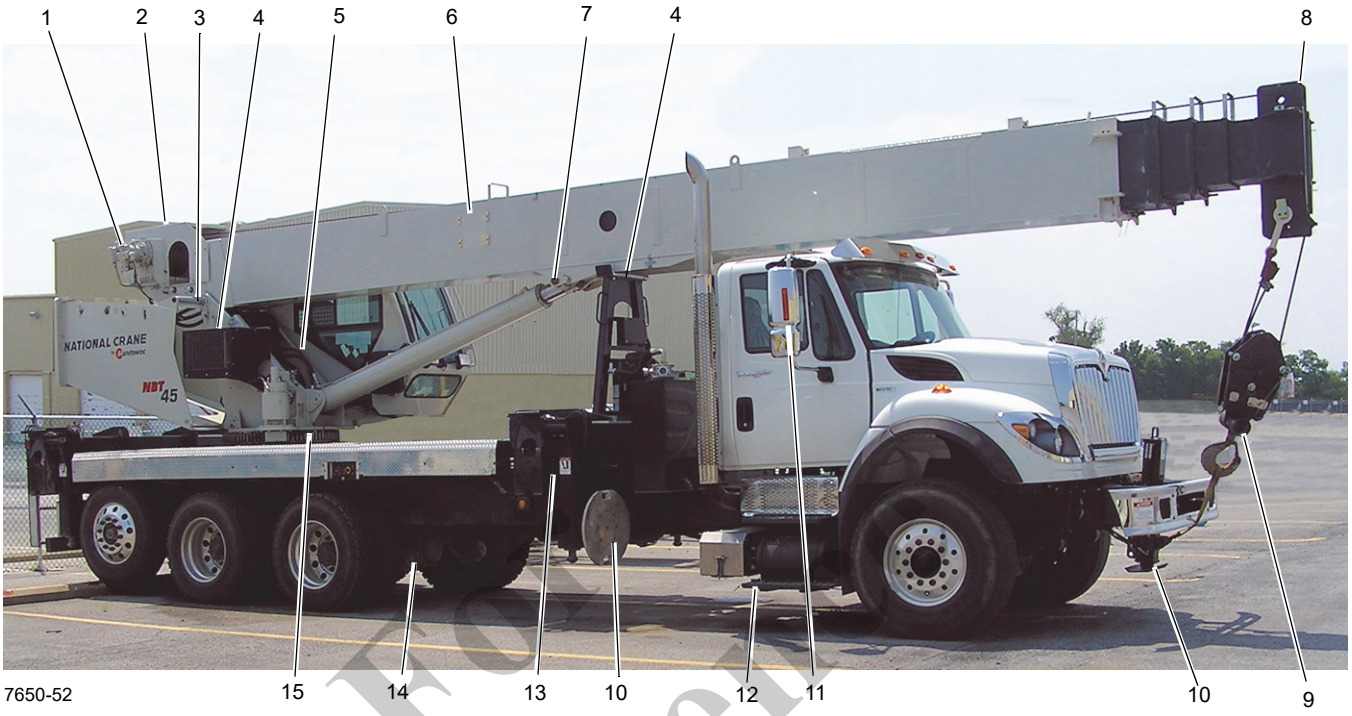


FIGURE 8-8

For Reference Only

Item	Description
1	Hoist Plumbing Connections
2	Tension Spring
3	Counterweight Pins
4	All Hardware, Clips, Pins, Hose Connections not painted O/R Pins, Clips
5	Valvebank, Hose Connections inside turntable
6	Boom Extension Hardware (Optional)
7	Pivot Shaft
8	Boom Nose Pins, Clips

Item	Description
9	Downhaul Weight/Hook block
10	O/R Pins, Clips
11	Mirror Mounting Hardware
12	Powertrain Hardware
13	O/R Hose Connections
14	Entire underside of unit
15	Turntable Bearing Fasteners
16	Wire Rope
17	Outrigger Beam Hardware

For Reference Only

For Reference Only

SECTION 9
CRANE INSTALLATION

SECTION CONTENTS

For Reference Only

GENERAL

This section provides information for proper mounting and initial check out of the crane. Improper mounting can result in damage to the truck frame and drive train, the 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, overhang, etc.

The final manufacturer of the vehicle must certify that the axle ratings have not been exceeded with all permanently attached equipment including a full load of fuel and men [at 200 lb (90 kg) each].

National Cranes must meet ASME/ANSI B30.5 (latest) when completed as cranes and ASME/ANSI B30.23 (latest) when completed as a personnel lifting system. These standards require welds to meet AWS D14.3 or AWS D1.1 respectively. Any work done in mounting must be done in compliance with these codes.

Verify that the number on the serial number plates on the major components match the main serial number located on the crane frame. If the serial numbers do not match, contact the factory before proceeding. Matching serial numbers insure that accurate information is recorded at the factory.

MINIMUM TRUCK REQUIREMENTS

Many factors must be considered in the selection of a proper truck for a NBT40 series crane. Items which must be considered are:

1. **Axle Rating.** Axle ratings are determined by the axles, tires, rims, springs, brakes, steering and frame strength of the truck. If any one of these components is below the required rating, the gross axle rating is reduced to its weakest component value.
2. **Wheelbase (WB), Cab-to-Trunnion (CT) and Bare Chassis Weight.**
   - Mounting Configuration
   - Boom Length
   - Bed Length

9

The wheelbase, CT and chassis weights shown are required so the basic NBT40 can be legally driven in all states and meet stability requirements. The dimensions given assume the sub-base is installed properly behind the truck cab. If exhaust stacks, transmission protrusions, etc. do not allow a close installation to the cab, the WB and CT dimensions must be increased. Refer to the Mounting Configuration pages for additional information.

3. **Axle Weight Limits**. Individual states vary on the permissible loads that a three axle or a four axle truck may carry on state highways. Some states allow 25,000 pounds on the steering axle and 45,000 pounds on a 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. Three axles (a tandem axle with a pusher or a tag axle) must be spaced more than eight ft apart to carry 42,000 pounds. Four axles (a steering axle and tandem axle with pusher or tag) must be spaced at least 23.5 ft apart to carry 58,000 pounds of gross weight and 26.5 ft to carry 60,000 pounds. These measurements are taken between the extremes of the front and the rear axles.

4. **Truck Frame**. Try to select a truck frame that will minimize or eliminate frame reinforcement or extension of the after frame (AF). Many frames are available that have the necessary after frame (AF) section modulus (S.M.) and resistance to bending moment (RBM) so that reinforcing is not required. The front hydraulic jack is used for a 360° working range around the truck. The frame under the cab through the front suspension must have the minimum S.M. and RBM because reinforcing through the front suspension is often difficult because of engine, radiator mounts and steering mechanics. See “Truck Requirements” and “Frame Strength” pages for the necessary section modulus and resistance to bending moment values.

5. **Additional Equipment**. In addition to the axle ratings, wheelbase, cab-to-axle requirements and frame, it is recommended that the truck is equipped with electronic engine control, increased cooling and a transmission with a PTO opening available with an extra heavy duty PTO. See “PTO Selection” pages. A conventional cab truck should be used for standard crane mounts.

6. **Neutral Start Switch**. The chassis must be equipped with a switch that prevents operation of the engine starter when the transmission is in gear.

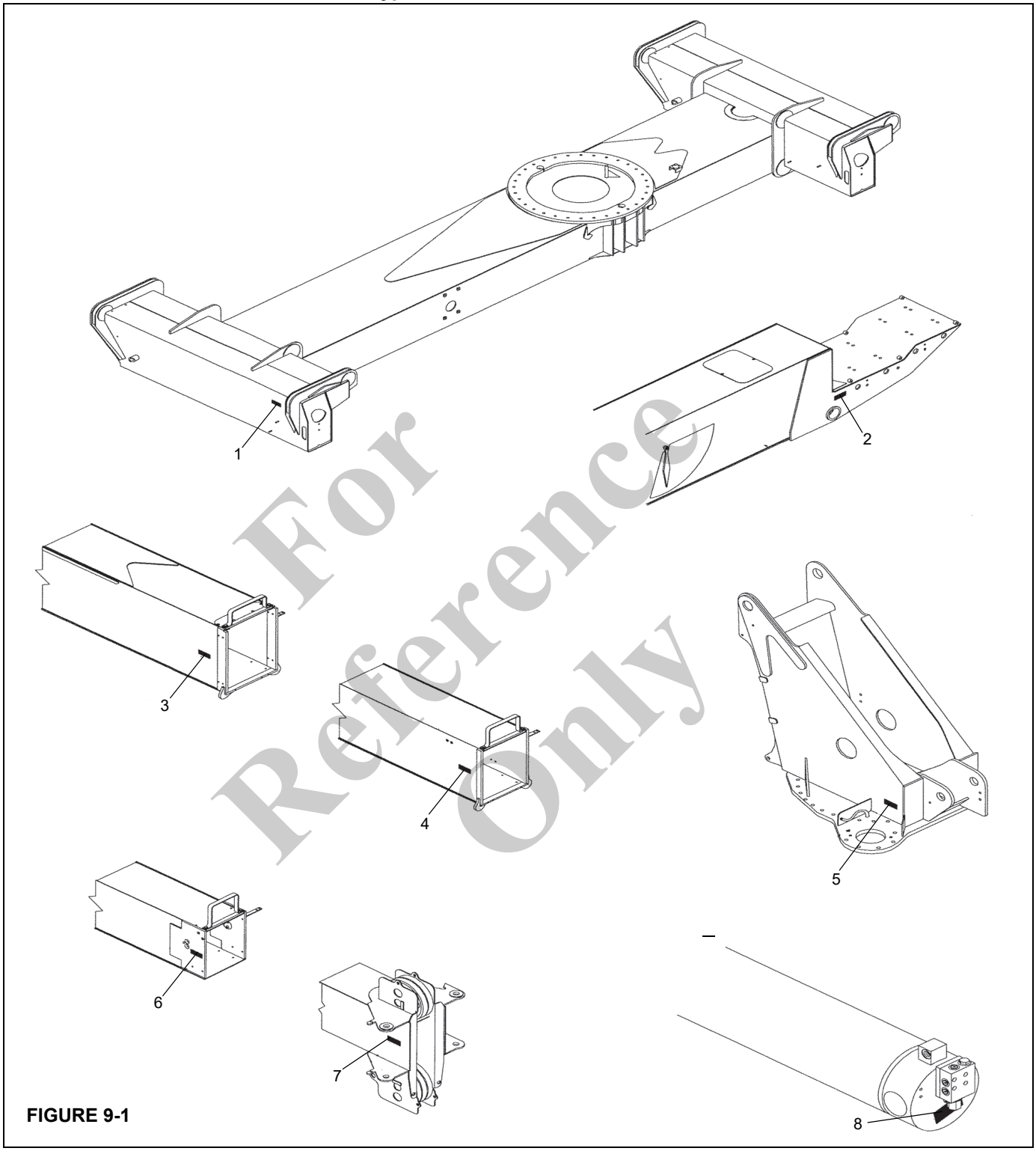
7. **Serial Number Identification** - Figure 9-1 shows the typical locations for the Serial Number identification tags that are fastened to the main components of the crane.

   Before proceeding with the installation, verify that the number on the serial number plates on the major components match the main serial number which is found on the crane frame.

   If the serial numbers do not match, contact the factory before proceeding. Matching the serial number plates insures that accurate warranty information will be recorded at the factory and will aid in dispensing service bulletins and other pertinent information.

For Reference Only

Typical Serial Number Location



For Reference Only

FIGURE 9-1

1	Sub Base	5	Turret
2	1st Section Boom	6	4th Section Boom
3	2nd Section Boom	7	5th Section Boom
4	3rd Section Boom	8	Lift Cylinder

MOUNTING CONFIGURATIONS

Configuration With Tag Axle 60,000 GVWR (103/127 ft) Boom – NBT40 and NBT45

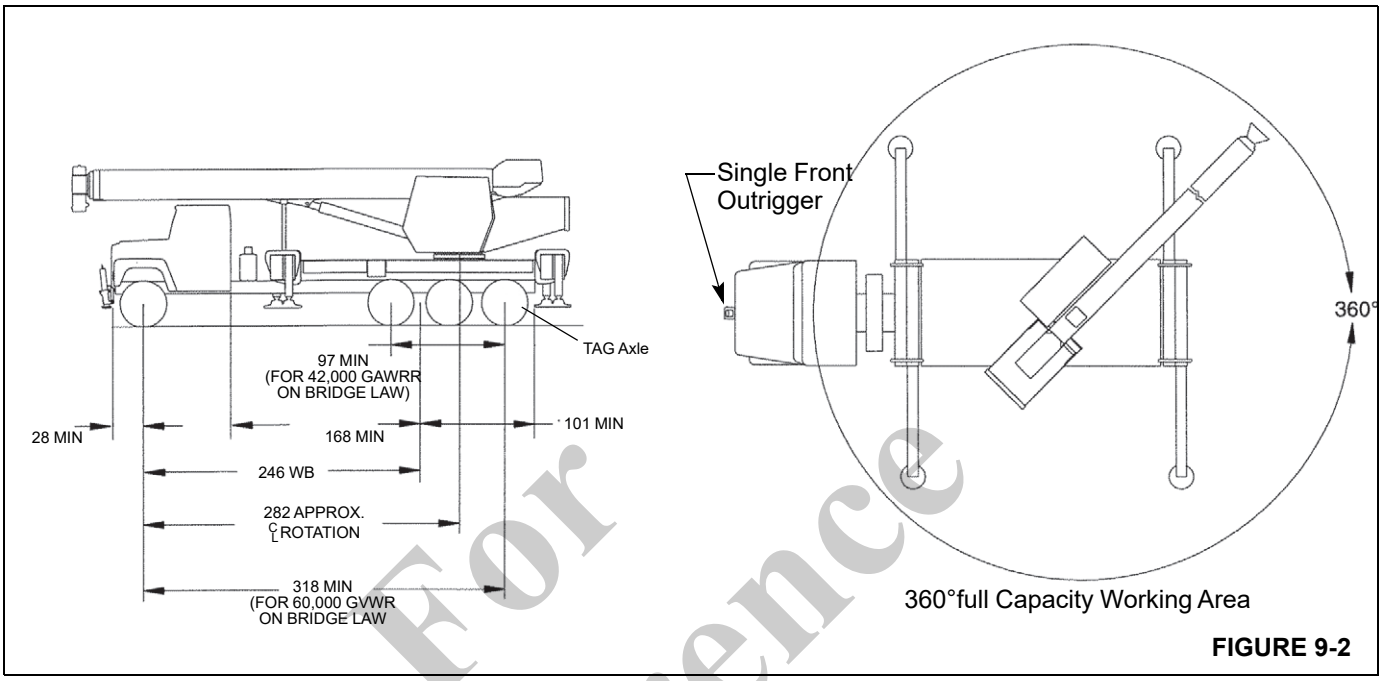


FIGURE 9-2

The mounting configuration (with tag axle 60,000 lb GVWR, 103/127 ft boom) shown in Figure 9-2 is based on a 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, counterweight will be required.

A summary of mounting and truck requirements are as follows:

- Working area 360°
- Gross Axle Weight Rating (GAWR), front 20,000 lb
- Gross Axle Weight Rating (GAWR), rear 40,000 lb
- Gross Vehicle Weight Rating 60,000 lb
- Gross Tag Axle Rating 10,000 lb (min)
- Wheelbase (WB) 246 in
- Tag Axle Location from Front Axle 318 in (min for 60,000 GVWR on bridge law)
- Frame Section Modulus (SM), front axle to end of AF 30 in^3
- After Frame (AF) 101 in (min)
- Minimum truck and tag weight required for stability (truck with tag axle raised)
  - 20,250 lb gross
  - 9,450 lb front axle
  - 10,800 rear axle
  - Less Weight required if equipped with auxiliary hoist or additional swinging counterweight.
  - Additional options or heavier bare chassis weights will require additional axles or a GVWR in excess of 60,000 lb; in some states special permits for overload are required.
- Estimated Final Weight with the following machine configuration.

  NBT40 (Wet) - 57,500 lb and NBT 45 (Wet) - 61,000 lb
  - 127 ft Boom, 400 lb 3 part block
  - Steel Decks
  - 100 gal fuel and two men in cab
  - Add - 1590 lb for 31/55 ft jib, 1105 lb for aux. hoist with rooster sheave and 180 lb downhaul weight.

Figure 9-2 shows the 360° working area that can be achieved with the Single Front Outrigger (if equipped). The Single Front Outrigger is essential when extending the boom and lifting loads over the front of the truck. See “Truck Frame Strength” section for truck frame strength required for mounting crane and Single Front Outrigger.

For Reference Only

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 energize-to-run fuel solenoid for smooth crane operation; electronic fuel injection is required.

All mounting data is based on a National Series NBT40 with subbase and an 85 percent stability factor.

The complete unit must be installed in accordance with factory requirements, and a test performed to determine actual stability and counterweight requirements; contact the factory for details.

Transmission neutral safety interlock switch is required.

Configuration With Pusher Axle 58,000 lb GVWR, 103/127 ft Boom – NBT40 and NBT45

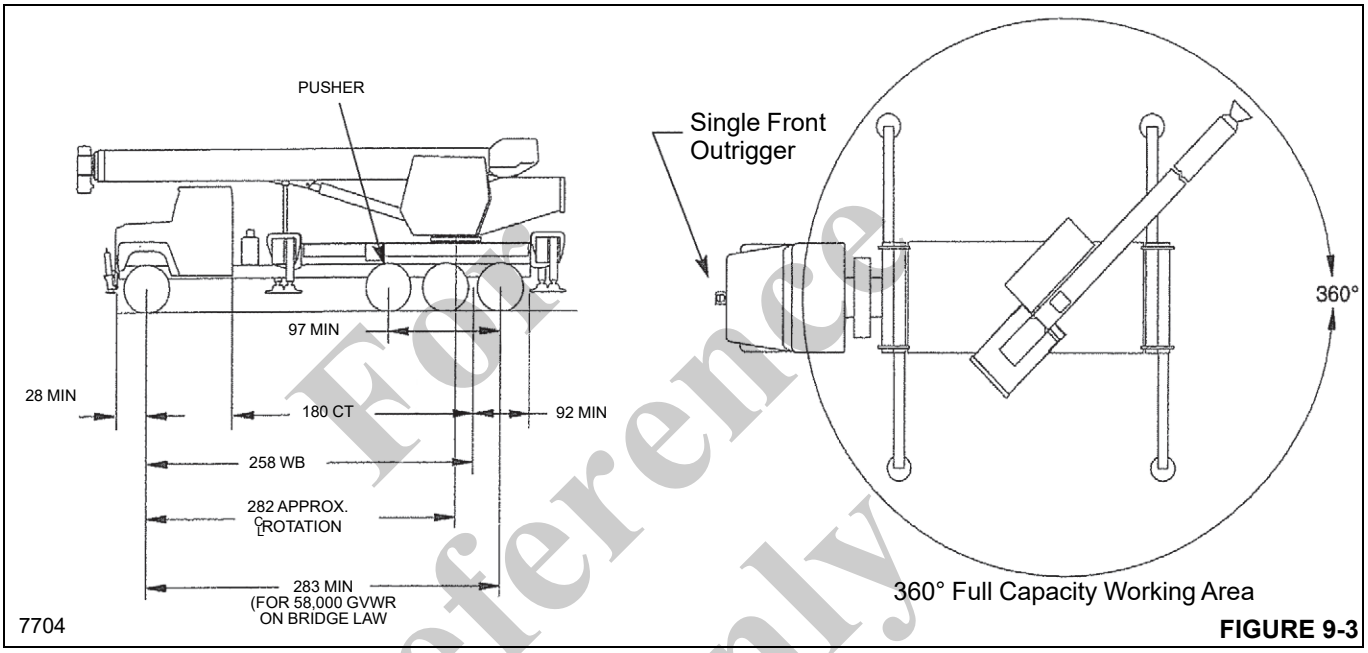


FIGURE 9-3

The mounting configuration (with pusher axle 58,000 lb GVWR, 103/127 ft boom) 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, and a test performed to determine actual stability and counterweight requirements, since individual truck chassis vary.

NOTE: If bare truck weights are not met, counterweight will be required.

A summary of mounting and truck requirements are listed as follows:

- Working area 360°
- Gross Axle Weight Rating (GAWR), front 20,000 lb
- Gross Axle Weight Rating (GAWR), rear 40,000 lb
- Gross Vehicle Weight Rating 58,000 lb
- Gross Pusher Axle Rating 10,000 lb (min)
- Wheelbase (WB)258 in (Min. for 58,000 lb GVWR on bridge law)
- Pusher Axle Location from Front Axle 180 in (Typ.)
- Frame Section Modulus (SM), front axle to end of (AF) 30 in^3
- After Frame (AF) 92 in (min)
- The minimum truck and pusher weight required for stability (truck with pusher axle raised).
  - 20,250 lb gross
  - 9,475 lb front axle
  - 10,275 rear axle
- Less Weight required if equipped with auxiliary hoist or additional swinging counterweight.
- Additional options or heavier bare chassis weights will require additional axles or a GVWR in excess of 58,000 lb; in some states special permits for overload are required.

For Reference Only

- Estimated Final Weight with the following machine configuration.

  NBT40 (Wet) - 57,500 lb and NBT 45 (Wet) - 61,000 lb

  - 127 ft Boom, 400 lb 3 part block
  - Steel Decks
  - 100 gal fuel and two men in cab
  - Add - 1590 lb for 31/55 ft jib, 1105 lb for aux. hoist with rooster sheave and 180 lb downhaul weight.

Figure 9-4 shows the 360° working area that can be achieved with the Single Front Outrigger (if equipped). The Single Front Outrigger is essential when extending the boom and lifting loads over the front of the truck. See “Truck Frame Strength” section for truck frame strength required for mounting crane and Single Front Outrigger.

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.

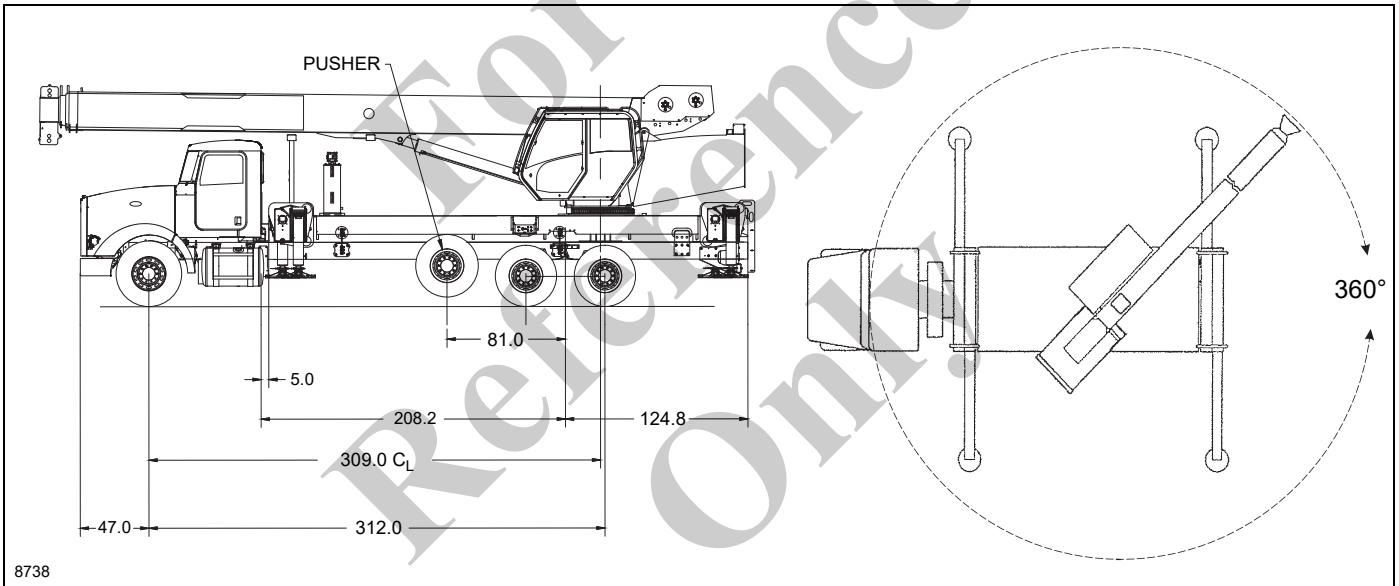
Diesel engines require a variable speed governor and energize-to-run fuel solenoid for smooth crane operation; electronic fuel injection is required.

All mounting data is based on a National Series NBT40 with subbase and an 85 percent stability factor.

The complete unit must be installed in accordance with factory requirements, and a test performed to determine actual stability and counterweight requirements; contact the factory for details.

Transmission neutral safety interlock switch is required.

Configuration With Extended T-Box – NBT40-127 and NBT45-127



360° Full Capacity Working Area

FIGURE 9-4

For Reference Only

Mounting configuration (with pusher axle 58,000 lb GVWR, 103/127 ft boom) 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, and a test performed to determine actual stability and counterweight requirements, since individual truck chassis vary.

NOTE: If bare truck weights are not met, counterweight will be required.

A summary of mounting and truck requirements are listed as follows:

- Working area 360°
- Gross Axle Weight Rating (GAWR), front 20,000 lb
- Gross Axle Weight Rating (GAWR), rear 52,000 lb
- Gross Vehicle Weight Rating 65,000 lb
- Gross Pusher Axle Rating 13,000 lb (min)
- Wheelbase (WB) 285 in
- Pusher Axle Location from Front Axle 204 in (Typ.))
- Frame Section Modulus (SM), front axle to end of (AF) 27.5 in^3
- After Frame (AF) 92 in (min)

- Minimum truck and pusher weight required for stability (truck with pusher axle raised).
  - 22,798 lb gross
  - 10,468 lb front axle
  - 11,830 rear axle

NOTE: RC1000 add-on rotating counterweight may be required for stability on NBT 40 depending on configuration.

- Less Weight required if equipped with auxiliary hoist or additional swinging counterweight.
- Additional options or heavier bare chassis weights will require additional axles or a GVWR in excess of 65,000 lb; in some states special permits for overload are required.
- Estimated Final Weight with the following machine configuration.

  NBT40 (Wet) - 62,000 lb and NBT 45 (Wet) - 64,500 lb
  - 127 ft Boom, 400 lb 3 part block
  - Aluminum Decks
  - 70 gal fuel and two persons in cab
  - Add - 1820 lb for 31/55 ft jib, 1105 lb for aux. hoist with rooster sheave and 180 lb downhaul weight.

Figure 9-4 shows the 360° working area. See “Truck Frame Strength” section for truck frame strength required for mounting crane.

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 energize-to-run fuel solenoid for smooth crane operation; electronic fuel injection is required.

All mounting data is based on a National Series NBT40 with subbase and an 85 percent stability factor.

The complete unit must be installed in accordance with factory requirements, and a test performed to determine actual stability and counterweight requirements; contact the factory for details.

For Reference Only

Configuration With Tag Axle 60,000 lb GVWR, 142 FT Boom – NBT40 and NBT45

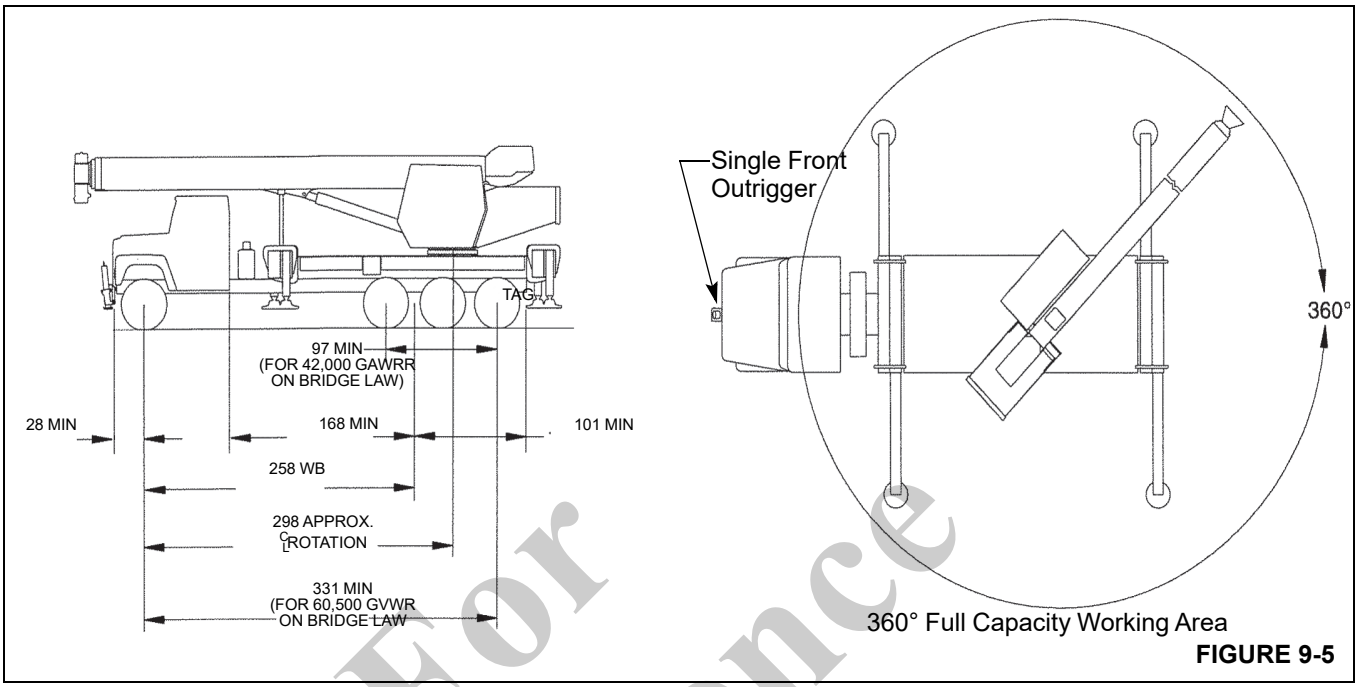


FIGURE 9-5

Mounting configuration (with Tag Axle 60,000 lb GVWR, 142 FT Boom shown in Figure 9-5 is based on 85% stability factor.

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, counterweight will be required.

Summary of mounting and truck requirements follows:

- Working area 360°
- Gross Axle Weight Rating (GAWR), front 20,000 lb
- Gross Axle Weight Rating (GAWR), rear 40,000 lb
- Gross Vehicle Weight Rating 60,000 lb
- Gross Tag Axle Rating 10,000 lb (min)
- Wheelbase (WB)258 in
- Tag Axle Location from Front Axle 331 in (min. for 60,500 lb GVWR on bridge law)
- Frame Section Modulus (SM), front axle to end of AF 30 in^3
- After Frame (AF) 101 in (min)
- Minimum Truck and Tag Weight Required for Stability (truck with tag axle raised).
  - 20,250 lb gross weight
  - 9,975 lb front axle
  - 10,275 lb rear axle
- Estimated Final Weight with the following machine configuration:

  NBT40 - 60,250 lb and NBT 45 - 63,750 lb
  - 142 ft Boom, 400 lb 3 part block,
  - Steel Decks
  - 100 gal fuel
  - two persons in cab.
  - Add - 785 lb for 26 ft jib, 1105 lb for aux. hoist with rooster sheave and 180 lb downhaul weight.
  - Less Weight required if equipped with auxiliary hoist or additional swinging counterweight.
  - Additional options or heavier bare chassis weights will require additional axles or a GVWR in excess of 60,000 lb; in some states special permits for overload are required.

Diagrams above show the 360° working area that can be achieved with the Single Front Outrigger (if equipped). The Single Front Outrigger is essential when extending the boom and lifting loads over the front of the truck. See “Truck Frame Strength” section for truck frame strength required for mounting crane and Single Front Outrigger.

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.

For Reference Only

Diesel engines require a variable speed governor and energize-to-run fuel solenoid for smooth crane operation; electronic fuel injection is required.

All mounting data is based on a National Series NBT40 with subbase and an 85 percent stability factor.

Complete unit must be installed in accordance with factory requirements, and a test performed to determine actual stability and counterweight requirements; contact factory for details.

Transmission neutral safety interlock switch is required.

The speeds shown above are optimum operating speeds. The engine must be operated at a speed such that the horsepower developed is adequate to pull the pumps under pressure and flow requirements.

For Reference Only

Configuration With Tag Axle 94,000 GVWR, 103 ft Boom – NBT45TM

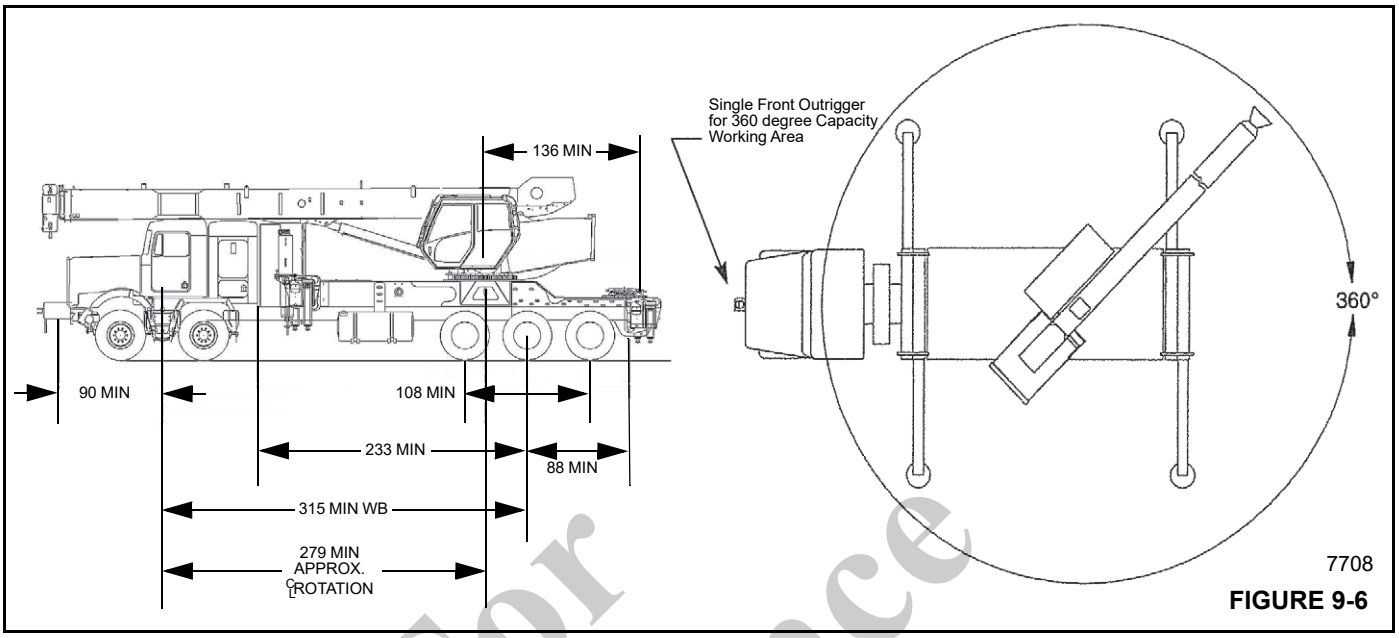


FIGURE 9-6

Mounting configuration (with tag axle 94,000 lb GVWR, 103 ft boom) shown in Figure 9-6 is based on a 85% stability factor.

Complete unit must be installed on 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, counterweight will be required.

Mounting and truck requirements:

- Working area 360° (240° without SFO)
- Gross Axle Weight Rating (GAWR), front 36,000 lb
- Gross Axle Weight Rating (GAWR), rear 58,000 lb
- Gross Vehicle Weight Rating 94,000 lb
- Wheelbase (WB) 310 in
- Frame Section Modulus (SM), front axle to end of AF 30 in^3
- After Frame (AF) 88 in (min)
- Minimum truck weight required for stability
  - 32,000 lb gross
  - 19,000 lb front axle
  - 13,000 rear axle
  - Less Weight required if equipped with auxiliary hoist or additional swinging counterweight.
  - Additional options or heavier bare chassis weights will require additional axles or a GVWR in excess of 94,000 lb; in some states special permits for overload are required.
- Estimated Final Weight with following machine configuration:

  NBT45TM (Wet) - 70,000 lb
  - 103 ft Boom, 400 lb 3 part block
  - 100 gal fuel and two men in cab
  - Add 1590 lb for 31/55 ft jib, 1105 lb for aux. hoist with rooster sheave and 180 lb downhaul weight.

Figure 9-6 shows the 360° working area that can be achieved with Single Front Outrigger (optional on Series NBT45TM; 240° stable without SFO). The Single Front Outrigger is essential when extending the boom and lifting loads over front of truck. See “Truck Frame Strength” section for truck frame strength required for mounting crane and Single Front Outrigger.

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 energize-to-run fuel solenoid for smooth crane operation; electronic fuel injection is required.

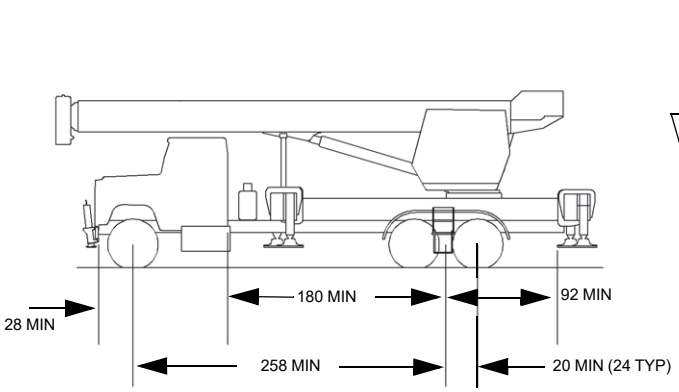
All mounting data is based on a National Series NBT40 with subbase and an 85 percent stability factor.

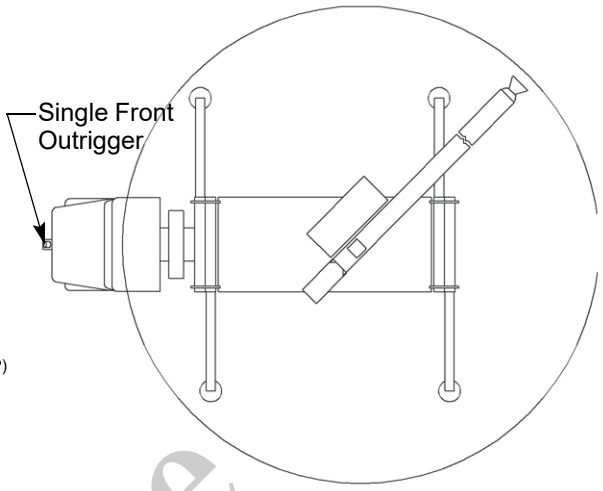
The complete unit must be installed in accordance with factory requirements, and a test performed to determine actual stability and counterweight requirements; contact the factory for details.

Transmission neutral safety interlock switch is required.

For Reference Only

Configuration With 103/127 ft Boom – NBT36





360° Full Capacity Working Area

FIGURE 9-7

Mounting configuration (with 103/127 ft boom) shown in Figure 9-7 is based on a 85% stability factor.

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, counterweight will be required.

Summary of mounting and truck requirements are as follows:

- Working area 360°
- Gross Axle Weight Rating (GAWR), front 20,000 lb
- Gross Axle Weight Rating (GAWR), rear 34,000 lb
- Gross Vehicle Weight Rating 54,000 lb
- Wheelbase (WB) 258 in
- Cab to Axle/Trunnion (CT)
- After Frame (AF) 92 in (min)
- Frame Section Modulus (SM), front axle to end of afterframe:
  - 110,000 psi (759 MPa) 30-in^3 (492-cm^3)
- Estimated bare chassis weight required for stability prior to installation of crane or accessories:
  - Front 9,700 lb to 10,000 lb
  - Rear 8,500 lb to 8,800 lb
  - Required to mount basic crane with 31 ft jib. Additional options or heavier bare chassis weights will require additional axles or a GVWR in excess of 54,000 lb. In some states special permits for overload are required.
- Estimated Final Average Weight
  - 51,880 lb
  - Includes basic crane without jib, 100 gallon fuel tank and two workers in cab.

Figure 9-4 shows the 360° working area that can be achieved with the Single Front Outrigger (standard on the NBT36). The Single Front Outrigger is essential when extending the boom and lifting loads over the front of the truck. See “Truck Frame Strength” section for truck frame strength required for mounting crane and Single Front Outrigger.

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 energize-to-run fuel solenoid for smooth crane operation; electronic fuel injection is required.

All mounting data is based on a National Series NBT40 with subbase and an 85 percent stability factor.

The complete unit must be installed in accordance with factory requirements, and a test performed to determine actual stability and counterweight requirements; contact the factory for details.

Transmission neutral safety interlock switch is required.

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PTO REQUIREMENTS

Horsepower

The crane is equipped with a piston hydraulic pump (1, Figure 9-8) that supplies 75 gpm to the crane functions. The pump shaft needs to turn at proper RPM as shown below to provide these flows. The PTO torque rating need to be at least 475 lb-ft (641 N.m) or 89 HP (67kW) per 1000 RPM of PTO shaft speed.

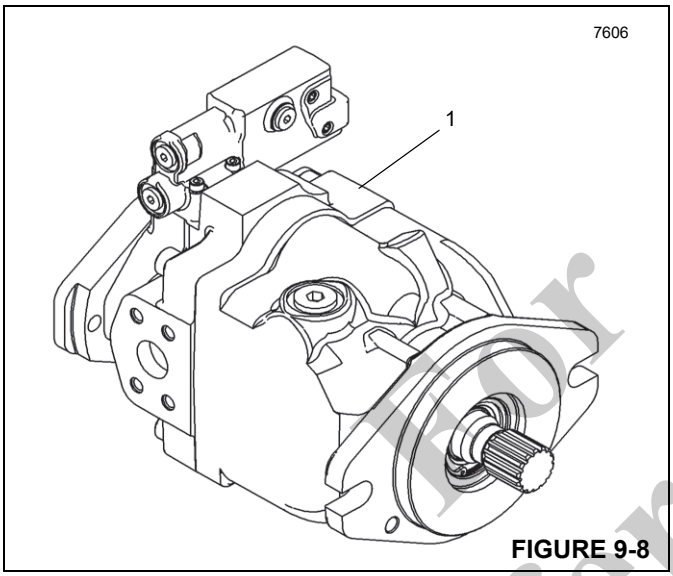

FIGURE 9-8

Direct PTO Mount

Most pump installations can be direct mounted to the PTO using adapter assemblies available from the PTO supplier. If the pump is direct mounted, its weight should be supported by a strap between the pump and the transmission. The splined shaft coupling in a direct mount pump installation requires lubrication. A special multi-lube (#200S Silver Streak) is applied to the shaft during original installation and should be reapplied to the shaft the on PTO semi-annually thereafter.

PTO Ratio

Pump shaft speed is determined by truck engine RPM and PTO ratio:

Pump Shaft Speed = Truck Engine RPM x PTO Ratio

The following PTO ratio and engine speed combinations provide proper pump shaft speed which is the recommended maximum speed for the NBT40 pump.

The speeds shown below are optimum operating speeds. The engine must be operated at a speed such that the horsepower developed is adequate to run the pump under pressure and 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.

Engine Optim Speed Range (RPM)	PTO Ratio - 2200 RPM PUMP
2000	110%
1800	122%
1600	138%
1500	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 certain which direction the power take off output shaft rotates before selecting a clockwise (CW) or counter-clockwise (CCW) rotation hydraulic pump. Either CW or CCW rotation pumps are available and are marked clearly with a directional arrow on the pump housing.

CAUTION

Rotating the pump in the wrong direction damages the pump.

Do not confuse engine crankshaft rotation with power take off rotation. If the power take off shaft rotates opposite the

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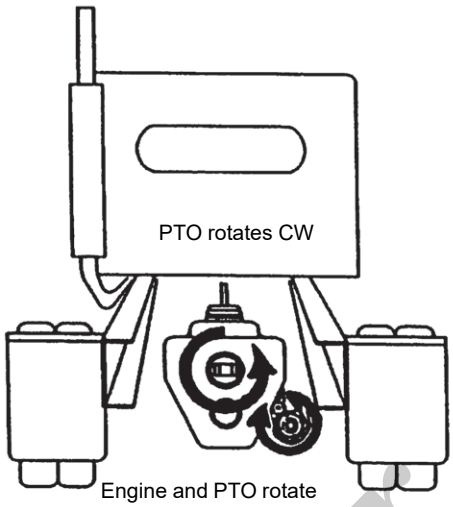
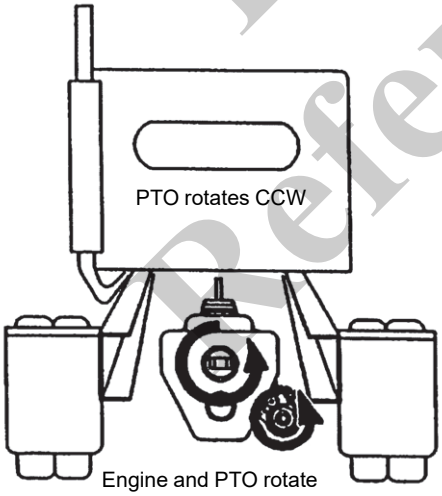
FIGURE 9-9





TRUCK FRAME STRENGTH

For a truck frame to be suitable for a Series NBT40 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 (S.M.), 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 section modulus of each frame rail by the yield strength of the rail material.

The NBT40 Series require a minimum of 3,300,000 in-lb (372,850 N·m) RBM and 27.5 in^3 (451 cm^3) S.M. 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 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 section modulus is calculated and compared to the table below to ensure adequate strength exists for Single Front Outrigger loading.

The distances listed in the chart below are shown in Figure 9-10.

Distance From SFO Attachment Inches (centimeters)	Section Modulus Per Rail $in.^3$ (cm^3)
0 - 12 (0 - 30)	2.7 (44)
12 - 24 (30 - 61)	5.5 (90)
24 - 36 (61 - 91)	8.2 (134)
36 - 48 (91 - 121)	11.0 (180)
48 - 60 (121 - 152)	13.7 (224)
60 - 72 (152 - 182)	16.5 (270)
72 - 84 (182 - 213)	19.2 (315)
84 - 96 (213 - 243)	21.9 (359)
96 - 108 (243 - 274)	24.7 (405)
108 - 120 (274 - 304)	27.4 (449)
120+ (304 +)	30.0 (492)

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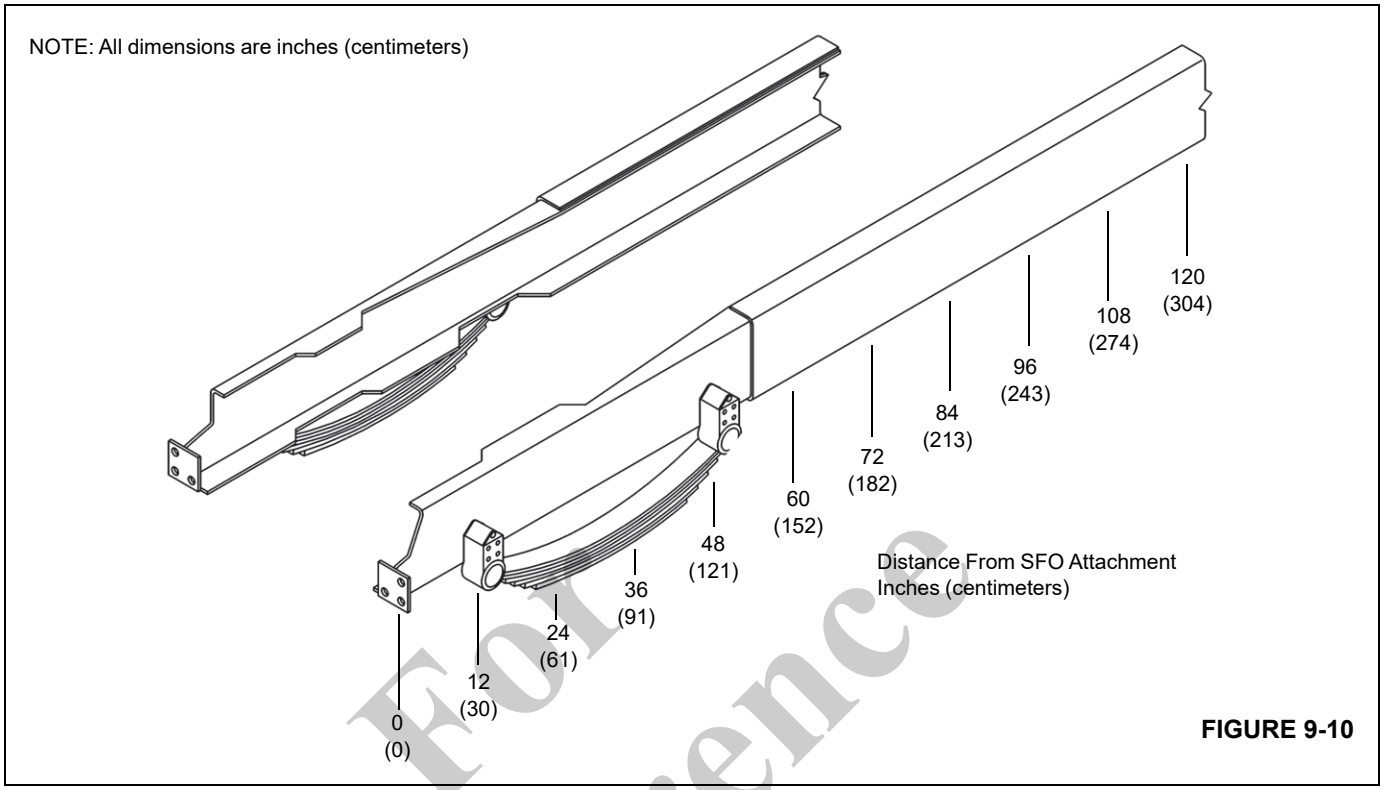

FIGURE 9-10

The following tables (A,B,C,D) determine the section modulus of the truck frame. Measure the truck frame and check the tables to be sure that the truck factory listed section modulus is correct.

- **Channel (Table A page 15)** - Table A provides the section modulus of channel frames in thicknesses of 3/16” (4.76 mm), 1/4” (6.35 mm), 5/16” (7.94 mm), and 3/8” (9.52 mm) with each grouping a flange width and web depth column. When the depth of frame channel and flange width is known, the point at which these two lines intersect is the section modulus from that particular channel.

  If the section modulus of the channel does not meet the requirements, the channel should be reinforced in the most applicable method following.

- **Channel Reinforcement (Table A page 15)** - In order to provide more strength, a channel of suitable thickness can be added to the existing frame.

  The depth and flange width of this channel should be chosen so it fits over the existing frame.

  The section modulus of the needed channel is obtained from Table A and should be added to the section modulus obtained from the truck frame. Add this to the section modulus of the channel obtained from Table A.

- **Angle Reinforcement (Table B page 16)** - If the truck is reinforced with an angle, refer to Table B for the data on the added strength provided by the angle. Add this to the section modulus of the channel obtained from Table A.

- **Fish Plate Reinforcement (Table C page 16)** - 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 page 16)** - This table lists the section modulus of an angle with the flange under the truck frame that is added to a frame with an angle reinforcement already added. Add the section modulus from Table D to the section modulus obtained from tables A and B to determine total section modulus.

  The edges of the reinforcing angles or channels are to be flush with the edges of the frame.

Welding - Two rows of 1" (25.4 mm) diameter plug welds are to be placed in a staggered pattern of the web; the rows to be spaced 5" (127 mm) apart with welds at an interval of 4" (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.

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If you have any questions concerning frame strength or reinforcing, contact National Crane before proceeding.

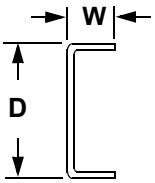

TABLE A
Section Modulus in^3 (cm^3)

Thickness 3/16 in. (4.76 mm)					
D in. (mm)	W in. (mm)				
	2.5 (64)	3 (76)	3.5 (89)	4 (102)	
8 (203)	5.3 (87)	6.0 (98)	6.7 (110)	7.5 (123)	in^3 (cm^3)
9 (229)	6.3 (103)	7.1 (116)	7.9 (130)	8.7 (143)	
10 (254)	7.3 (120)	8.2 (134)	9.1 (149)	10.0 (164)	
11 (279)	8.4 (138)	9.4 (154)	10.4 (170)	11.4 (187)	
12 (305)	9.5 (156)	10.6 (174)	11.7 (192)	12.8 (210)	
13 (330)	10.8 (177)	11.9 (195)	13.1 (215)	14.3 (234)	
14 (356)	12.0 (197)	13.3 (218)	14.6 (239)	15.9 (261)	
15 (381)	13.4 (220)	14.7 (241)	16.1 (264)	17.5 (287)	

Thickness 1/4 in. (6.35 mm)					
D in. (mm)	W in. (mm)				
	2.5 (64)	3 (76)	3.5 (89)	4 (102)	
8 (203)	6.9 (113)	7.8 (128)	8.8 (144)	9.7 (159)	in^3 (cm^3)
9 (229)	8.2 (134)	9.2 (151)	10.3 (169)	11.4 (187)	
10 (254)	9.5 (156)	10.7 (175)	11.9 (195)	13.1 (215)	
11 (279)	11.0 (180)	12.3 (202)	13.6 (223)	14.9 (244)	
12 (305)	12.5 (205)	13.9 (228)	15.3 (251)	16.8 (275)	
13 (330)	14.1 (231)	15.6 (256)	17.2 (282)	18.8 (308)	
14 (356)	15.8 (259)	17.5 (287)	19.1 (313)	20.8 (341)	
15 (381)	17.5 (287)	19.3 (316)	21.2 (348)	23.0 (377)	

Thickness 5/16 in. (7.9 mm)					
D in. (mm)	W in. (mm)				
	2.5 (64)	3 (76)	3.5 (89)	4 (102)	
8 (203)	8.4 (138)	9.5 (156)	10.7 (175)	11.9 (195)	in^3 (cm^3)
9 (229)	10.0 (164)	11.3 (185)	12.6 (206)	13.9 (228)	
10 (254)	11.6 (190)	13.1 (215)	14.6 (239)	16.0 (262)	
11 (279)	13.4 (220)	15.0 (246)	16.6 (272)	18.3 (300)	
12 (305)	15.3 (251)	17.1 (280)	18.8 (308)	20.6 (338)	
13 (330)	17.3 (284)	19.2 (315)	21.1 (346)	23.1 (379)	
14 (356)	19.4 (318)	21.4 (351)	23.5 (385)	25.6 (420)	
15 (381)	21.6 (354)	23.8 (390)	26.0 (426)	28.3 (464)	

Thickness 3/8 in. (9.5 mm)					
D in. (mm)	W in. (mm)				
	2.5 (64)	3 (76)	3.5 (89)	4 (102)	
8 (203)	9.8 (161)	11.2 (184)	12.5 (205)	13.9 (228)	in^3 (cm^3)
9 (229)	11.7 (192)	13.2 (216)	14.8 (243)	16.3 (267)	
10 (254)	13.6 (223)	15.4 (252)	17.1 (280)	18.8 (308)	
11 (279)	15.7 (257)	17.7 (290)	19.6 (321)	21.5 (352)	
12 (305)	18.0 (295)	20.1 (329)	22.2 (364)	24.3 (398)	
13 (330)	20.3 (333)	22.6 (370)	24.9 (408)	27.2 (446)	
14 (356)	22.8 (374)	25.3 (415)	27.8 (456)	30.3 (497)	
15(381)	25.4 (416)	28.1 (461)	30.8 (505)	35.5 (582)	

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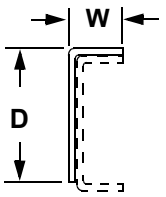

TABLE B
Section Modulus in^3 (cm^3)

Thickness 3/16 in. (4.76 mm)					
D in. (mm)	W in. (mm)				
	2.75 (70)	3.25 (83)	3.75 (95)	4.25 (108)	
7.5 (191)	2.2 (36)	2.3 (38)	2.3 (38)	2.4 (39)	in^3 (cm^3)
8.5 (216)	2.8 (46)	2.9 (48)	3.0 (49)	3.0 (49)	
9.5 (241)	3.4 (56)	3.5 (57)	3.6 (59)	3.7 (61)	
10.5 (267)	4.1 (67)	4.3 (70)	4.4 (72)	4.5 (74)	
11.5 (292)	4.9 (80)	5.1 (84)	5.2 (85)	5.4 (88)	
12.5 (318)	5.8 (95)	6.0 (98)	6.1 (100)	6.3 (103)	
13.5 (343)	6.7 (110)	6.9 (113)	7.1 (116)	7.3 (120)	
14.5 (368)	7.6 (124)	7.9 (129)	8.1 (133)	8.3 (136)	

Thickness 1/4 in. (6.35 mm)					
D in. (mm)	W in. (mm)				
	2.75 (70)	3.25 (83)	3.75 (95)	4.25 (108)	
7.5 (191)	2.9 (48)	3.0 (49)	3.1 (51)	3.2 (52)	in^3 (cm^3)
8.5 (216)	3.7 (61)	3.8 (62)	3.9 (64)	4.0 (66)	
9.5 (241)	4.5 (74)	4.7 (77)	4.8 (79)	5.0 (82)	
10.5 (267)	5.5 (90)	5.7 (93)	5.8 (95)	6.0 (98)	
11.5 (292)	6.5 (106)	6.7 (110)	6.9 (113)	7.1 (116)	
12.5 (318)	7.6 (124)	7.9 (129)	8.1 (133)	8.3 (136)	
13.5 (343)	8.8 (144)	9.1 (149)	9.4 (154)	9.6 (157)	
14.5 (368)	10.1 (166)	10.5 (172)	10.7 (175)	11.0 (180)	

Thickness 5/16 in. (7.9 mm)					
D in. (mm)	W in. (mm)				
	2.75 (70)	3.25 (83)	3.75 (95)	4.25 (108)	
7.5 (191)	3.6 (59)	3.7 (61)	3.9 (64)	4.0 (66)	in^3 (cm^3)
8.5 (216)	4.6 (75)	4.7 (77)	4.9 (80)	5.0 (82)	
9.5 (241)	5.6 (92)	5.8 (95)	6.0 (98)	6.2 (102)	
10.5 (267)	6.8 (111)	7.1 (116)	7.3 (120)	7.5 (123)	
11.5 (292)	8.1 (133)	8.4 (138)	8.6 (141)	8.9 (146)	
12.5 (318)	9.5 (156)	9.8 (161)	10.1 (166)	10.4 (170)	
13.5 (343)	11.0 (180)	11.4 (187)	11.7 (192)	12.0 (197)	
14.5 (368)	12.6 (206)	13.0 (213)	13.4 (220)	13.7 (224)	

Thickness 3/8 in. (9.5 mm)					
D in. (mm)	W in. (mm)				
	2.75 (70)	3.25 (83)	3.75 (95)	4.25 (108)	
7.5 (191)	4.3 (70)	4.5 (74)	4.6 (75)	4.8 (79)	in^3 (cm^3)
8.5 (216)	5.5 (90)	5.7 (93)	5.9 (97)	6.0 (98)	
9.5 (241)	6.7 (110)	7.0 (115)	7.2 (118)	7.4 (121)	
10.5 (267)	8.1 (133)	8.4 (138)	8.7 (143)	8.9 (146)	
11.5 (292)	9.7 (159)	10.0 (164)	10.3 (169)	10.6 (174)	
12.5 (318)	11.3 (185)	11.7 (192)	12.1 (198)	12.4 (203)	
13.5 (343)	13.1 (215)	13.6 (223)	14.0 (229)	14.3 (234)	
14.5 (368)	15.1 (247)	15.5 (254)	16.0 (262)	16.4 (269)	

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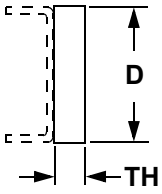

TABLE C
Section Modulus in^3 (cm^3)

TH in. (mm)	D in. (mm)								
	8 (203)	9 (229)	10 (254)	11 (279)	12 (305)	13 (330)	14 (356)	15 (381)	16 (406)
3/16 (4.76)	2.0 (33)	2.51 (41)	3.10 (51)	3.75 (61)	4.46 (73)	5.24 (86)	6.08 (100)	6.98 (114)	7.94 (130)
1/4 (6.35)	2.66 (44)	3.37 (55)	4.16 (68)	5.03 (82)	5.99 (98)	7.03 (115)	8.15 (134)	9.36 (153)	10.5 (172)
5/16 (7.94)	3.33 (55)	4.21 (69)	5.20 (85)	6.29 (103)	7.49 (123)	8.79 (144)	10.19 (167)	11.7 (192)	13.31 (218)
3/8 (9.52)	4.0 (66)	5.06 (83)	6.25 (102)	7.56 (124)	9.00 (148)	10.56 (173)	12.25 (201)	14.06 (230)	16.0 (262)
7/16 (11.11)	4.67 (76)	5.9 (97)	7.29 (119)	8.82 (144)	10.5 (172)	12.32 (202)	14.29 (234)	16.4 (269)	18.66 (306)

in^3 (cm^3)

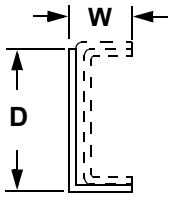

TABLE D
Section Modulus in^3 (cm^3)

Thickness 3/16 in. (4.76 mm)					
D in. (mm)	W in. (mm)				
	3 (76)	3.5 (89)	4 (102)	4.5 (114)	
8.5 (216)	5.7 (93)	6.4 (105)	7.0 (115)	7.7 (126)	in^3 (cm^3)
9.5 (241)	6.7 (110)	7.4 (121)	8.1 (133)	8.9 (146)	
10.5 (267)	7.7 (126)	8.5 (139)	9.3 (152)	10.1 (166)	
11.5 (292)	8.8 (144)	9.7 (159)	10.6 (174)	11.4 (187)	
12.5 (318)	10.0 (164)	10.9 (179)	11.9 (195)	12.8 (210)	
13.5 (343)	11.2 (184)	12.2 (200)	13.2 (216)	14.3 (234)	
14.5 (368)	12.5 (205)	13.6 (223)	14.6 (239)	15.7 (257)	
15.5 (394)	13.8 (226)	15.0 (246)	16.1 (264)	17.3 (284)	

Thickness 1/4 in. (6.35 mm)					
D in. (mm)	W in. (mm)				
	3 (76)	3.5 (89)	4 (102)	4.5 (114)	
8.5 (216)	7.7 (126)	8.6 (141)	9.4 (154)	10.3 (169)	in^3 (cm^3)
9.5 (241)	9.1 (149)	10.0 (164)	10.9 (179)	11.9 (195)	
10.5 (267)	10.5 (172)	11.5 (188)	12.5 (205)	13.6 (223)	
11.5 (292)	11.9 (195)	13.1 (215)	14.2 (233)	15.4 (252)	
12.5 (318)	13.5 (221)	14.7 (241)	16.0 (262)	17.2 (282)	
13.5 (343)	15.2 (249)	16.5 (270)	17.8 (292)	19.2 (315)	
14.5 (368)	16.9 (277)	18.3 (300)	19.7 (323)	21.2 (347)	
15.5 (394)	18.7 (306)	20.2 (331)	21.7 (356)	23.3 (382)	

Thickness 5/16 in. (7.9 mm)					
D in. (mm)	W in. (mm)				
	3 (76)	3.5 (89)	4 (102)	4.5 (114)	
8.5 (216)	9.8 (161)	10.8 (177)	11.9 (195)	12.9 (211)	in^3 (cm^3)
9.5 (241)	11.5 (188)	12.6 (206)	13.8 (226)	15.0 (246)	
10.5 (267)	13.3 (218)	14.5 (238)	15.8 (259)	17.1 (280)	
11.5 (292)	15.1 (247)	16.5 (271)	18.0 (295)	19.4 (318)	
12.5 (318)	17.1 (280)	18.6 (305)	20.2 (331)	21.7 (356)	
13.5 (343)	19.2 (315)	20.8 (341)	22.5 (369)	24.2 (397)	
14.5 (368)	21.4 (351)	23.1 (379)	24.9 (408)	26.7 (438)	
15.5 (394)	23.7 (388)	25.5 (418)	27.4 (449)	29.4 (482)	

Thickness 3/8 in. (9.5 mm)					
D in. (mm)	W in. (mm)				
	3 (76)	3.5 (89)	4 (102)	4.5 (114)	
8.5 (216)	11.9 (195)	13.2 (216)	14.4 (236)	15.6 (256)	in^3 (cm^3)
9.5 (241)	14.0 (229)	15.3 (251)	16.7 (274)	18.1 (297)	
10.5 (267)	16.2 (266)	17.7 (290)	19.2 (315)	20.7 (339)	
11.5 (292)	18.4 (302)	20.1 (329)	21.8 (357)	23.5 (385)	
12.5 (318)	20.9 (342)	22.6 (370)	24.5 (402)	26.3 (431)	
13.5 (343)	23.4 (384)	25.3 (415)	27.3 (447)	29.3 (480)	
14.5 (368)	26.0 (426)	28.1 (461)	30.2 (495)	32.4 (531)	
15.5 (394)	28.8 (472)	31.0 (508)	33.3 (546)	35.6 (583)	

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TRUCK PREPARATION

Plan the installation of the crane location for:

- the front axle weight.
- the rear axle weight.
- the boom overhang.

Check the final weight to verify that final truck weight with crane, reinforcement, counterweight and options such as jib, etc. complies with the appropriate laws.

Welding Precautions

Sensitive truck computer and crane RCL system components can be damaged by welding on the truck or crane. The following precautions must be taken:

- Disconnect both positive and negative battery cables.
- Attach welding ground lead as close as possible to area to be welded.

Positioning the Crane On the Truck

The final user of the crane must be familiar with state axle and length laws in force at the time the crane is mounted on the truck. Following are items which must be considered.

- **Overall Length** - Most states have a maximum straight truck length limit of 40 feet (12.19 m). Using a truck that has a too long WB may exceed this limit.
- **Axle Weights** - All states allow 20,000 lb (9,072 kg) single axle weight and 34,000 lb (15,422 kg) 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 on your state requirements.

PTO, PUMP, AND RESERVOIR

1. Select the PTO according to the PTO Requirements Section on page 9-12. PTO's are not furnished by the 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 blocked out. The pump cannot run backwards (page 9-12).

CAUTION

Rotating the pump in the wrong direction damages the pump.

3. If mounting flanges integral to the PTO are used, the pump can be mounted directly to the PTO. Be sure adequate clearance exists for this type of pump mount.
4. If a drive line is used, locate the pump no more than 42 inches (106 cm) from the PTO. Do not exceed a 15° angle on the drive line.

   The drive line U-joint yokes on both ends of the drive shaft must be parallel with each other. The drive lines need be sized so they can safely carry the maximum pump horsepower requirements. Drive lines are furnished by National Crane.
5. Plan the location of the pump mounting bracket and drive line so that ample clearance is maintained between pump and truck drive shaft 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 6 inch (15.25 cm) channel crossmember be installed.
6. Install the pump mounting bracket (driveline driven pumps only) securely to the truck frame. Attach the pump to the pump mounting plate or directly to the PTO using the capscrews provided.

   Install a pump support bar at the rear of the pump.

   If the pump is driven by a driveline, bolt or weld the upper end to a crossmember.

   If the pump is mounted on the PTO, the rear mounting bar can be attached to a transmission bolt. The rear of the pump must be supported regardless of the mounting method.

NOTE: Some of the pipe fittings are sealed with two threaded tapered sections, one male and one female. When these two tapers meet, there is a sudden increase in the force required to screw the fittings together. Further tightening does not increase the seal of the joint and can ruin the connection. Use pipe thread sealant on tapered pipe fittings.

Other fittings are of the O-ring boss type. To install this fitting, screw the lock nut in to the upper thread land. Insert the fitting into the port until the nut contacts 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 types. A small O-ring is compressed between the male and female fittings of the joint. Be sure the O-ring is present on the fitting and seated properly in its groove before the fittings are tightened.

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- Remove the dust covers from the pump inlet and outlet ports. Verify that the suction and pressure sides of the pump are correct while rotating the pump in the same direction as the PTO. Rotate the pump in the mounting bracket so suction side is toward the reservoir suction port. Refer to the pump manual for information on how to rotate pump ports and how to convert pump rotation.
- If using a drive shaft type of mount, connect the PTO drive shaft to the pump and PTO. Drill a 0.31" dia. x 0.12" (7.87 mm x 3 mm) deep hole on the flat of the hex shaft at the fixed yoke end of the drive shaft to engage the yoke set screw. A small flat area should be ground in the O.D. of the splined pump shaft to engage the pump yoke set screw. Apply Loctite and tighten the shaft setscrews and grease the PTO universal joints.

REINFORCING AFTER FRAME EXTENSION

1. Measure the truck frame and use the Section Modulus Tables to determine the section modulus of the frame. If reinforcing is required, use at least 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 rivets.*
3. If rivets are used to secure truck frame cross members. Place the reinforcing (1, Figure 9-11) on the truck frame (4) and clamp in place.

   Mark the location of rivets (3) by striking the outside of the reinforcing (4) over the rivet area with a hammer so that the rivets make an impression on the inside of the reinforcing.

   Mark the approximate location of the crane mounting anchors (5) on the reinforcing (1) so that no obstructions exist.

   Remove the reinforcing (1) and cut clearance holes for the rivets (3) (Figure 9-11).
4. If reinforcing (1, Figure 9-11) is to be welded to the truck frame (4), remove the crossmember bolts (6).

   Place the reinforcing (1) on the truck frame (4). Mark the existing truck frame hole pattern onto the reinforcing (1) and then remove the reinforcing (1).

   Using the markings, cut the hole pattern in the reinforcing (1). Be sure to clear the crane mounting anchors (5).
5. Clamp the reinforcing (1) in place on the truck frame (4), install crossmember bolts (6) that were previously removed, and weld to truck frame as shown in Figure 9-12.
6. If bolt-on reinforcing is required, clamp the reinforcing (1, Figure 9-11) in place and install crossmember bolts (6) that were previously removed.

   Drill through the reinforcing and truck frame. Be sure to clear crane mounting anchors (5) and bolt reinforcing (1) in place.

   See Figure 9-13 for recommended drilling and bolting locating dimensions. Use 5/8”, Grade 8 bolts, drill holes to 39/64” (15.5mm) diameter, drive fit bolts and torque according to Torque Chart in Section One. Note that all dimensions are in inches (millimeter).

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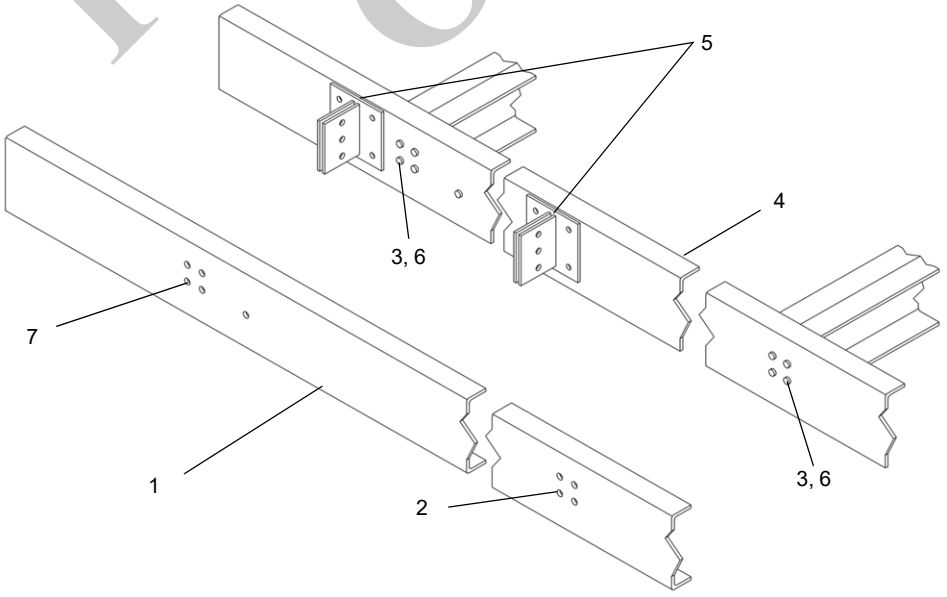

FIGURE 9-11

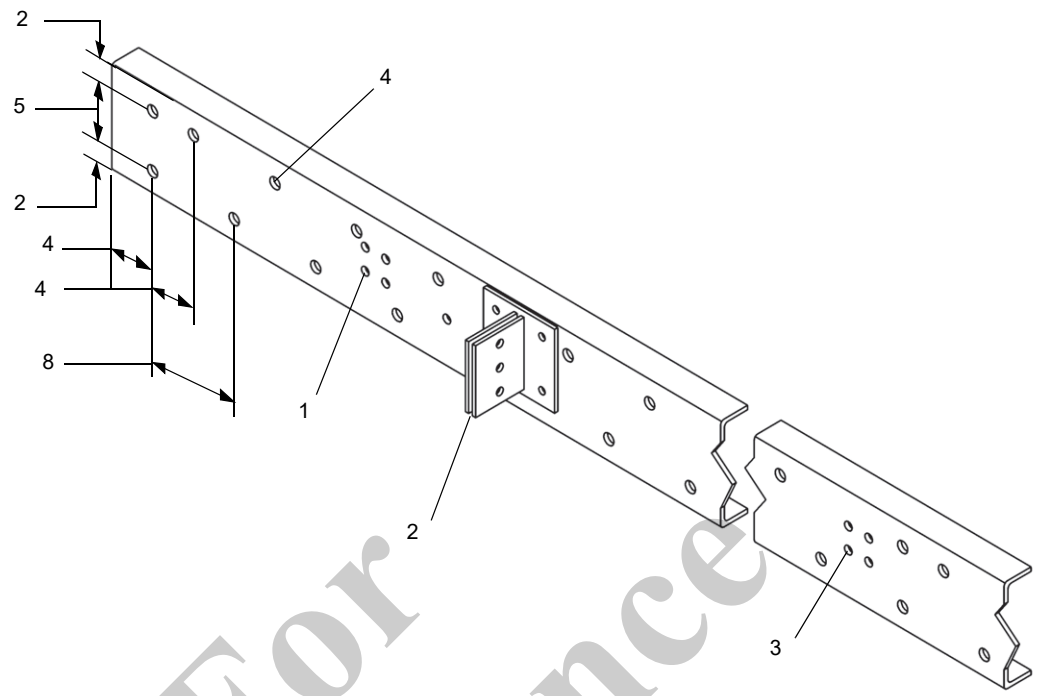

FIGURE 9-12

Figure 9-12 Item Numbers

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 filet welded around to eliminate plug weld holes.
4	1" (25.4) diameter holes for plug welds
NOTE: All Figure 9-12 dimensions are inches	

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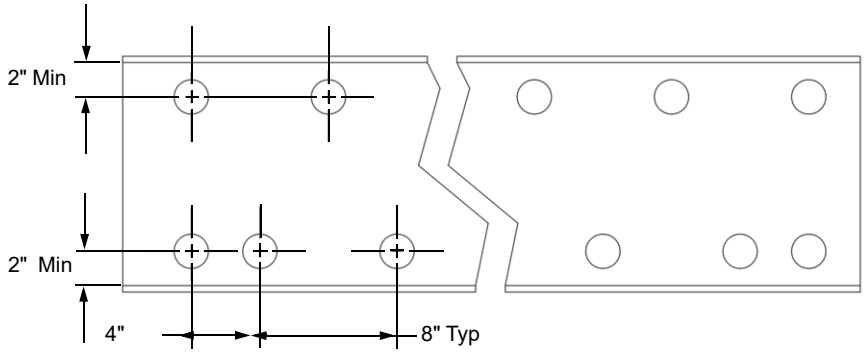

FIGURE 9-13

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 9-14.

See Section Modulus Table B on page 16 for the required size of reinforcing.

Strip all easily removable equipment from the frame through the suspension such as spring stops (2), etc.

Butt the reinforcing angle (1, Figure 9-14) up against the forward reinforcing (4) of the suspension. Mark the areas that require cutting (5) so that the angle slides up around the spring hangers (3) and against the existing truck frame (6) and forward reinforcing (4).

Torch out the marked areas in the long leg of the angle deep enough so that the angle can be slid up from the underneath the frame to contact either existing truck frame (6, Figure 9-14) or spring hanger brackets (3) (if they extend down below the existing truck frame).

8. If reinforcing angle (1, Figure 9-14) is welded to truck frame, cut out plug weld hole pattern as in Figure 9-12.

Slide the reinforcing angle (1, Figure 9-14) up from the bottom, butt it to existing forward reinforcing (4) and weld (9) rear suspension reinforcing to forward reinforcing.

Replace as much of the spring hanger (5) cut out areas as possible. Use the drop-off material from the cut out (step 7), and butt weld these pieces in.

Position bar (8) on top of truck frame (6) and skip weld as noted in Figure 9-14.

9. If reinforcing angle (1, Figure 9-14) is to be bolted on, drill hole pattern according to Figure 9-13 and install bolts.

Reinforce spring hanger cut outs (5, Figure 9-14) and the weld area, suspension reinforcing to forward reinforcing by adding bars (7) and (8).

The bars should be of the same thickness, width and yield strength as the reinforcing angle lip. Bar (7) should be long enough to extend at least 6" (152mm) beyond either side of the weld or cut out areas. Weld these reinforcing bars to the reinforcing angle (1) with length-wise welds. Do not weld across the flanges.

Replace any equipment that had been removed.

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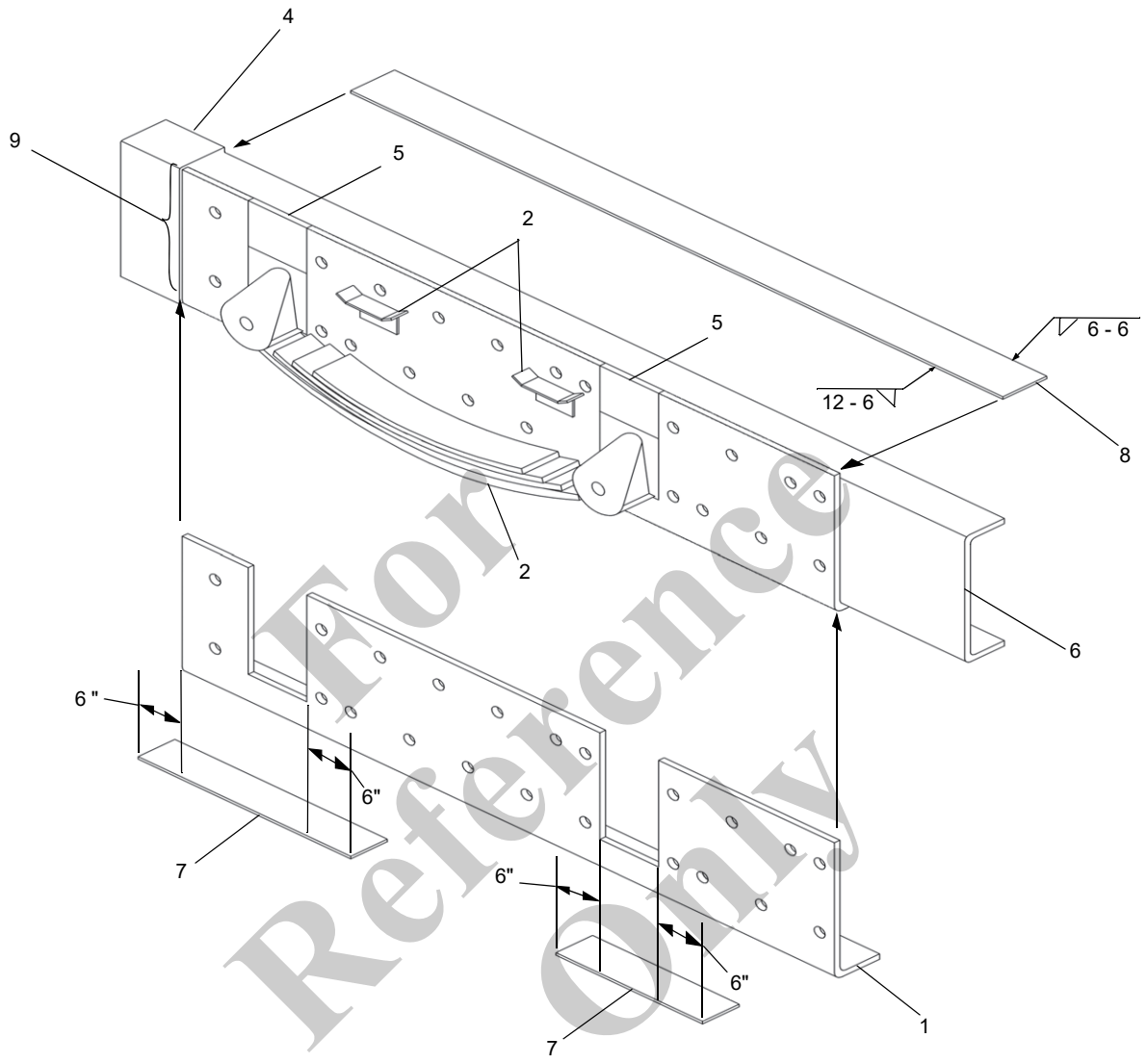

For Reference Only

FIGURE 9-14

10. The NBT40 needs an after frame of about 92 inches (233 cm).

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. A typical mount positions the crane centerline of rotation from 20 to 24 inches (50 to 61 cm) behind the center of tandems. At this location, an after frame (AF) length (distance from center of tandems to back of truck frame) of 90 to 94 inches (228 to 238 cm) is required. If the AF is too long, cut off the excess and remove any crossmembers from back of truck frame.

If the AF is too short, the frame needs to be lengthened. Use channels fabricated from 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 12 inches (30 cm) on each side of joint. Plug weld this channel to the inside of the truck frame, then skip weld the inside edge of the top and bottom flanges to the truck frame flanges.

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. Mounting the crane to the truck frame is as follows:

NOTE: All welds used to secure the crane to the truck frame must be grade 70 or better.

1. Place the crane assembly on the truck frame as determined by the information contained in the section titled Positioning the Crane On the Truck on page 9-18.

2. Locate and weld four upper mounting plates (1, Figure 9-15) on the T-box frame (7) per detail A and B, Figure 9-15.

3. Secure two anchor bars (2, Figure 9-13) to each left and right side upper mounting plates (1), view A.

Secure one anchor bar (2, Figure 9-13) to each left and right center upper mounting plates (1a), view B.

4. Bolt four lower mounting plates (3, Figure 9-15) to anchor bars (2) finger tight.

5. Align and position each lower mounting plate (3, Figure 9-15) directly below the upper mounting plates (1).

Drill four 5/8 holes through the truck frame. Use existing holes (4, Figure 9-15) in the lower mounting plate (3) to locate holes in the truck frame (6).

6. Locate and weld the rear strap plate (5, Figure 9-16) and collar plate (8) to the T-box frame (7). See detail C, Figure 9-16 for locator dimensions and weld requirements.

Position rear strap plate (5) with the bend in the plate inward or outward depending on the width of the truck frame.

7. Cut the cross bar (10, Figure 9-16) to fit inside the truck frame (6), be sure to include the width of two plates (11).

8. Weld the two end plates (11, Figure 9-16) to the cross bar (10).

9. Position the welded cross bar assembly (step 8) to the truck frame as shown in Figure 9-16, in the center of both strap plates (5) and tack weld it to the truck frame (6).

10. Use existing bolt holes (9, Figure 9-16) in the rear strap plate (5) as a template to locate and drill four 5/8 in. holes in the tuck frame (6) and through the cross bar weldment plate (11).

11. Weld complete the cross bar weldment (10, 11 Figure 9-16) to the truck frame (6)

12. Install and secure, four 5/8 x 2.75 bolts (9, Figure 9-16), flatwashers and nuts.

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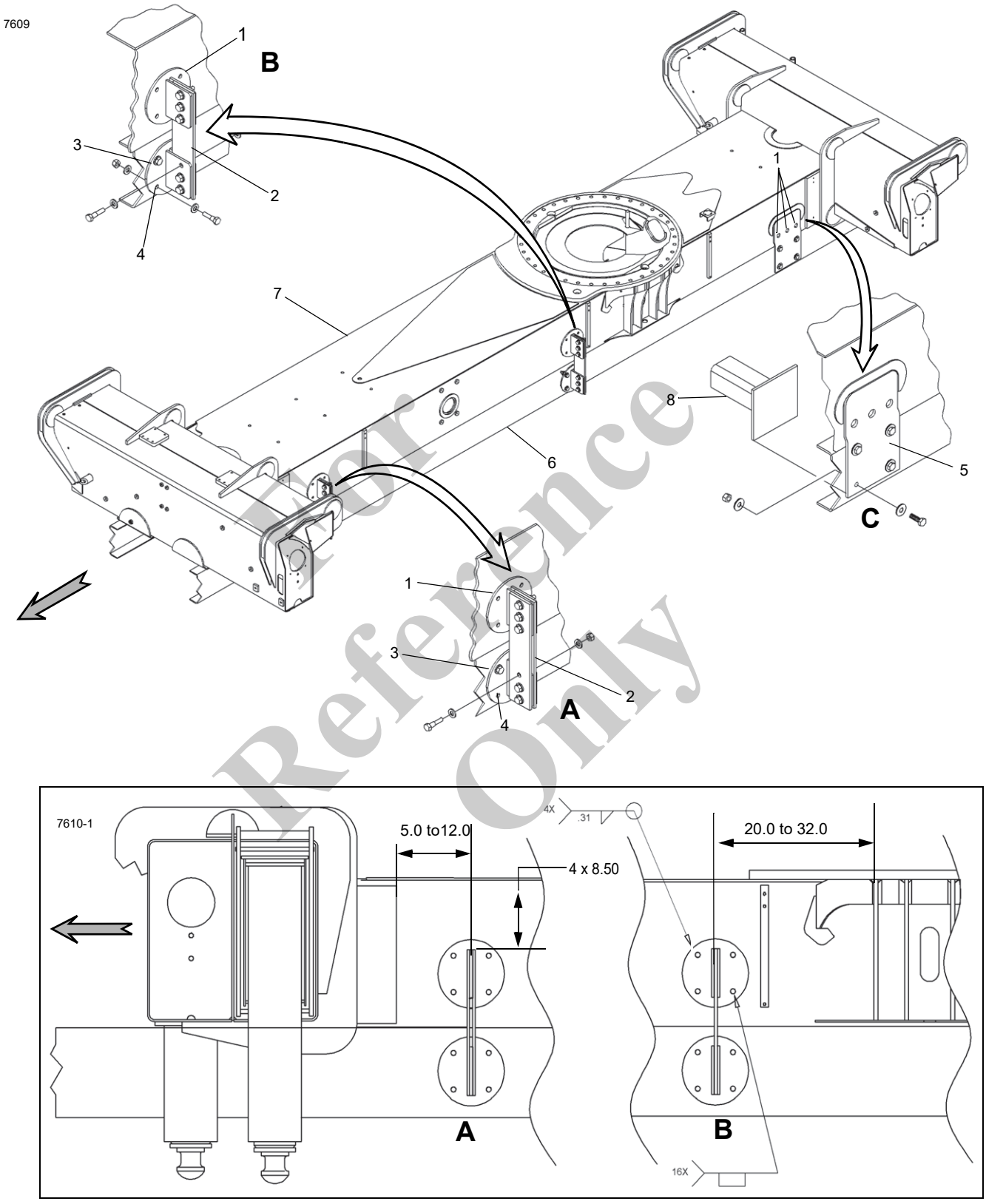

FIGURE 9-15

For Reference Only

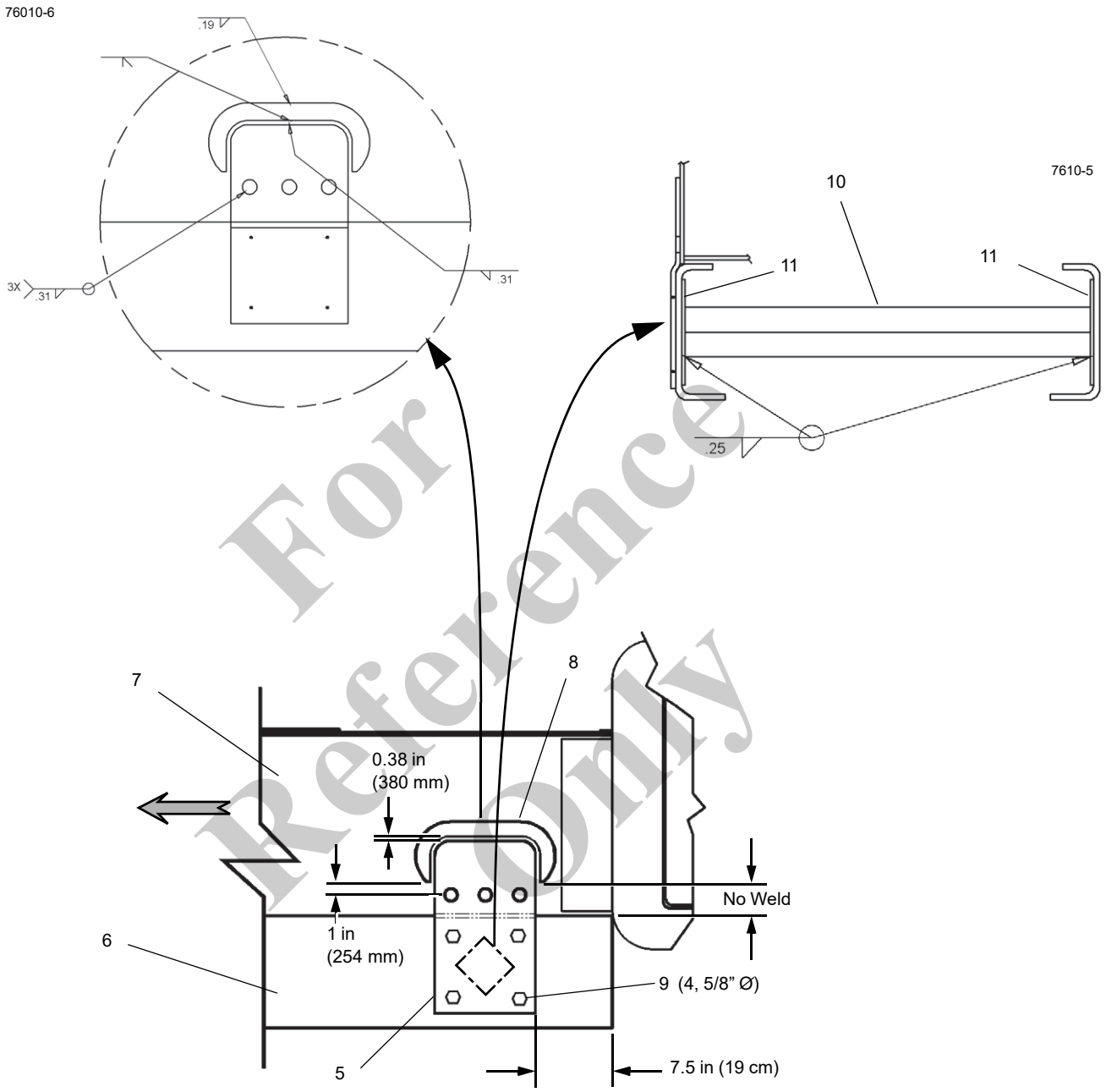

FIGURE 9-16

Truck Interface Electrical Connection

Connections to the truck electrical system is as follows:

NOTE: Keep the harness away from the drive line and exhaust system.

- The accessory and ignition wires are tied into the back of the ignition switch in the truck cab.
- If there are two ignition wires when tying into the truck ignition, tie into both wires.
- Be sure the wires are not pinched or cut.

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- The start wire must be tied to starter solenoid on the engine side of the firewall. Do not tie the start wire into back of truck key switch.
- Use Item 3, Figure 9-17 to connect to the truck front lights. Connect wire 1403 to connect to truck light harness and connector 51A to truck ground.
- Use crane rear marker wiring harness (not shown in Figure 9-15) to connect to the truck rear lights. Connect wire 1403 to truck light harness, connect wire 28 to truck reverse lights for back up alarm, connect wire 51 to truck ground.

NOTE: The type of throttle supplied with the truck determines if three leads or six leads (1, Figure 9-17) are required.

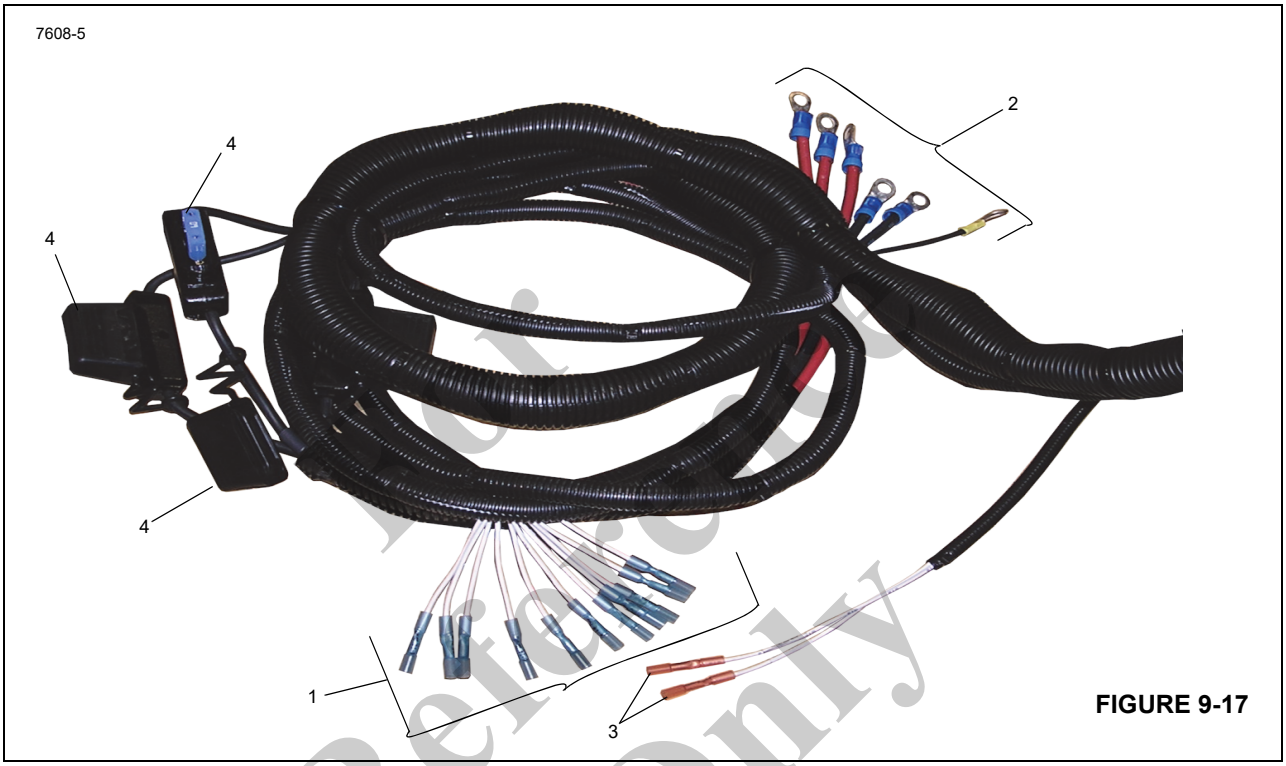

FIGURE 9-17

Truck Interface Harness (Item #1 - Figure 9-17)	
Wire #	**Truck Function**
473 - 475	Throttle Leads (473 - 475 for three lead)
477 - 479	Throttle Leads (473 - 479 for six lead)
476	Throttle - Remote Signal
901	Ignition Switch
52	Start Switch
112	Accessory Switch
1331	Engine Warning - EET group

Truck Battery Harness (Item #2 - Figure 9-17)	
Wire/Fuse #	**Truck Function**
51A, 51AA, 51B	(-) Ground (black wire)
1, 2, 3	(+) Positive (red wire)

Crane Front Maker Lights (Item #3 - Figure 9-17)	
Wire #	**Truck Function**
1403	Front Marker Lights
51A	Ground

Truck Battery Harness (Item #4 - Figure 9-17)	
Wire #	**Truck Function**
80 amp fuse	Wire #1
80 amp fuse	Wire #2
60 amp fuse	Wire #3

Reference Only

Crane Rear Maker Lights (Not Shown in Figure 9-17)	
Wire #	**Truck Function**
1403	Rear Red Markers, License Plate Light
51A	Ground
28	Reverse Light, Back-up Alarm, O/R Alarm
150	O/R Motion Alarm

Hydraulic Pump Connection

CAUTION

Make sure the gate valve on the return line is open before starting the pump or damage to the pump could result.

The hydraulic system pressure is supplied by a hydraulic piston pump (1, Figure 9-18) mounted on the truck power take off (PTO) (8). The pump is driven counter clockwise and supplies 75 gpm.

For initial pump installation, use the following procedure:

1. The hydraulic pump has integral mounting flanges and can be bolted directly to the PTO. Be sure adequate clearance exists for this type of pump mount.
2. If the pump is powered through a drive line, a pump mount must be installed or bolt the pump to an existing frame cross member.
3. A mounting bracket needs to be installed so that the rear mounting bracket on the pump can be secured.
4. Be sure the drive line is sized to safely carry the maximum pump horsepower requirements (189 hp (140.9 kw) at 1800 rpm).
5. Do not locate the pump more than 42 inches (107 cm) from the PTO. Do not exceed a 7° drive line angle and the U-joints on both ends of the drive shaft must be parallel with each other.
6. Plan the location of the pump mount and drive line for adequate clearance between the pump and truck drive shaft or exhaust system.
7. Position the pump so that hydraulic lines can be connected without sharp bends especially the large suction line from the reservoir.
8. For drive line installation, install the pump mount to the truck frame.
9. Lubricate the splines on the pump shaft and drive coupling with heavy lithium grease.
10. If using the configuration shown in Figure 9-18 be sure to position the case drain port (2) at the highest point above ground level.
11. Bolt the pump mounting flange to the PTO or to the pump mount on the truck.
12. Torque the mounting flange nuts to 50 ft. lbs (222N· m).
13. Bolt the pump rear mounting bracket to the truck mounting bracket.

NOTE: O-ring boss fittings are used for sealing hydraulic line connections. Make sure the O-ring is in its groove before tightening.

14. Remove the dust covers from the pump inlet and outlet ports and install the hydraulic fittings and lines, see Figure 9-18.

    In Figure 9-18 photo A is from the drivers side; photo B is from the passengers side.

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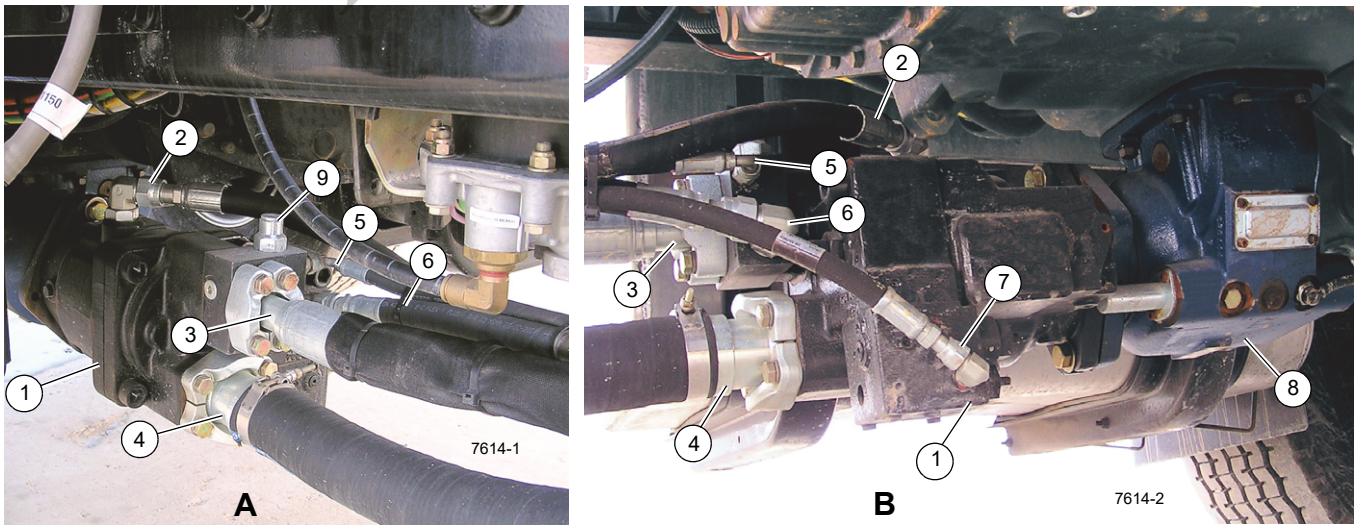

FIGURE 9-18

9

Figure 9-18 item Numbers

Item	Description
1	Hydraulic Pump
2	Case Drain Hose
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	Relief Valve, 30 gpm, 3000psi

Initial Pump Start-up

1. Fill the reservoir with the proper hydraulic fluid to the high-level mark on the reservoir sight gage.
2. Make sure the pump case is filled with clean, filtered fluid identical to that used in the rest of the system. The pump case must be full at all times to ensure proper lubrication of internal components.
3. Verify that piping is completed and any inlet valves are open to prevent cavitation or aeration of the pump.
4. Confirm that the direction of rotation of the prime mover matches the pump installed.
5. Jog start the prime mover with the pump unloaded and operate until the air is bled from the system.
6. Check the pump for external leakage, abnormal noise, and vibration.
7. Adjust the throttle for the engine RPM and PTO ratio to get proper pump shaft speed.

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. Put the unit in an open area where the crane can be run through all 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 (6) 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.

NOTE: Add oil to reservoir as required to keep air from reentering the system.

3. Set the throttle according to engine RPM and PTO ratio to get the proper pump shaft 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 gage.
5. The lift and stability test must now be performed.

   The Initial Crane Run in Procedure must be completed before the stability test is started.
6. After testing is completed, check the torque on all bearing, mounting and all 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 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 the following table:

For Reference Only

Rated Load Table

Model	Boom Length	Loaded Radius
40103	91	85
	103	100
40127	115	110
	127	110
40142	128	105
	142	100
45103	91	85
	103	100
45127	115	110
	127	110
45142	115	105
	128	110
36103	91	80
	103	95
36127	115	90
	127	95

4. Two test loads are required to ensure the crane is stable over both the sides and rear of the machine.

5. 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 represents 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 boom position and keep hook load close to the ground. Test loads should not be allowed to swing out past rated radius. If overturning caused by the load is allowed to start, and boom angle gets too low, boom weight may cause the unit to upset.

NOTE: Be 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. T hey are not meant to be and should not be used for this machines Stability Test.

Always refer to the load capacity chart provided with your machine for boom length, radius and capacity.

EXAMPLE: Test Load #1 - NBT40/45 without extension

- NBT40-127 5-Section Boom, without extension, O/R fully extended, capacity at:
  - 103 ft (32 m) boom length
  - 95 ft (29 m) radius
  - 2,250 lb (1020.6 kg) per capacity chart
- Stability Test Load (no extension stowed):
  - 2,250 lb x 1.176 = 2646 lb
  - 1020.6 kg x 1.176 = 1200.23 kg

EXAMPLE: Test Load #2 - NBT40/45 with stowed extension

- NBT40-127 5-Section Boom, with stowed extension, O/R fully extended, capacity at:
  - 79 ft (32 m) boom length
  - 60 ft (18.3 m) radius
  - 6,450 lb (2925.7 kg) per capacity chart
- Stability Test Load (with extension stowed):
  - 6450 lb x 1.176 =7585.2 lb
  - 2925.7 kg x 1.176 = 3440.6 kg

6. 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 1 ft 0.3 m).
- 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° to ensure that the stability test load is stable directly over both sides, the back, and the front.

For Reference Only

7. 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 above 1 ft 0.3 m).
- 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° to ensure that the load is stable directly over both sides, the back, and the front.

8. If unit is unstable, counterweight needs to be added.

- Add weight at the front bumper or at the front of the subbase, 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 and NBT45 model crane is equipped with a different removable counterweight combination. See Figure 9-20 and the following counterweight table for the proper crane counterweight combination.

The NBT36 model crane is not equipped with a counterweight.

Use only the counterweight plate combinations as shown in the following counterweight table and Figure 9-20.

Each counterweight plate can be identified by the part number and weight steel stamped (1, Figure 9-19) into the side of the plate.

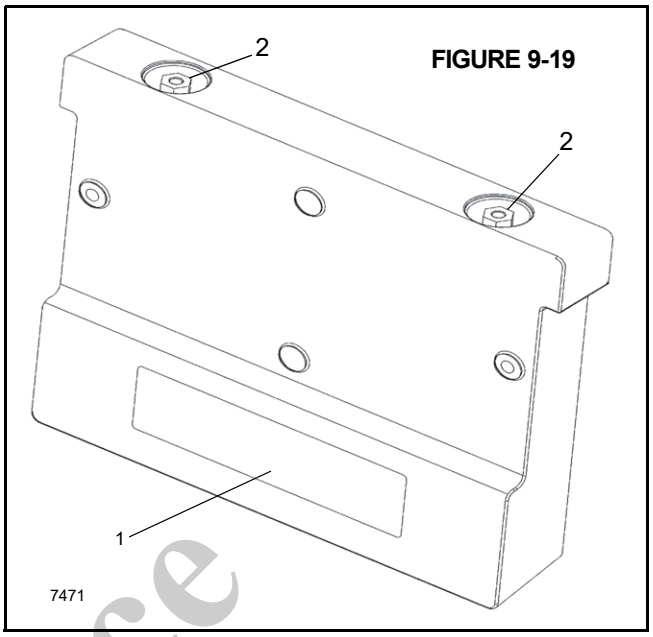

FIGURE 9-19

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 the counterweight table and Figure 9-20.

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 bolts into the 1.25 x 7 UNC lift inserts (2, Figure 9-19). Using a proper lifting device, attach lifting straps to the bolts. After straps are attached remove slack from the straps.

4. Remove the two bolts (1, Figure 9-20), lockwashers (2) nuts (3) securing the counterweight to the crane support weldment. Lift and remove the counterweight from crane.

For Reference Only

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 bolts into the 1.25 x 7 UNC lift inserts (2, Figure 9-19). Using a proper lifting device attach straps to each bolt, 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 two bolts (1, Figure 9-20), lockwashers (2), nuts (3).

Counterweight Table

Model	Plate Part Number	Description	Figure 9-20 Letter Call Out
NBT36	N/A	N/A	N/A
NBT40 Standard	80018805	1000 lbs	A
NBT40 + 1000 Option	80018805 (2)	2000 lbs	B
NBT45 Standard	80018804	4500 lbs	C
NBT45 + 1000 Option	80020222	5500 lbs	D

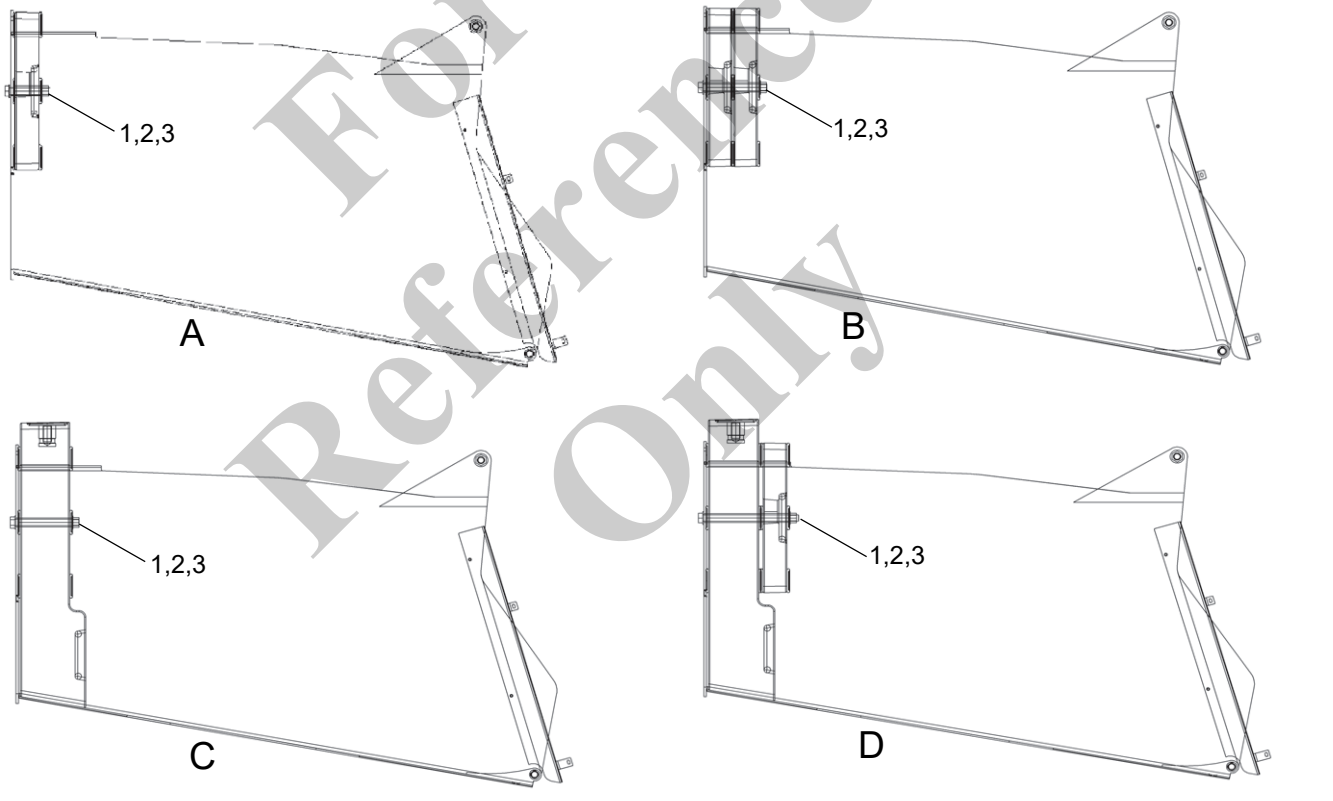

FIGURE 9-20

For Reference Only

SPECIFICATIONS

Hydraulic

Hydraulic Pump ..... 75.5 gpm (286 1/min) at 2200 rpm, Variable displacement, axial piston with load sense
- Displacement ..... 8.54 in^3/rev (140 cc/rev)
- Pressure Rating (rated) ..... 4600 psi (320 bar)
- Pressure Rating (peak ..... 5075 psi (350 bar)
- Case Refill Capacity ..... .37 gal (1.40 liter)
- Minimum Operating Speed ..... 600 rpm

Outrigger System ..... 3250 (+/-100) psi
Boom Up ..... 35 gpm at 4550 psi
Boom Down ..... 17 gpm at 1000 psi
Telescope Extend ..... 35 gpm at 2900 psi
Telescope Retract ..... 17 gpm at 2250 psi
Aux/Main Hoist System & Relief ..... 35 gpm at 4300 psi
Swing ..... 18 gpm at 3100 (+200/-00) psi
Swing Park Brake ..... Hydraulic released disc, released at 175 psi (12 bar)
Reservoir Capacity ..... 100 gal (351.3 L)
Reservoir Return Filter ..... 5 micron
Reservoir Suction Filter ..... 25 micron

Air Conditioner

Air Conditioner Hydraulic System ..... 3500 (+/-100) psi
Minimum Evacuation Time ..... 30 minutes
Refrigerant Charge Levels ..... 2.0 pounds
Additional Pag Oil Required Above 6 ounces in Compressor 4.0 ounces

Hoist System

Wire Rope:
- Length ..... 450 ft (137 m)
- Diameter (Rotation Resistant) ..... 5/8 in. (16 mm)
- Nominal Breaking Strength ..... 56,400 lb (25,582 kg)

Operating Pressure ..... 4300 (+/-100) psi (296.5 bar)
Flow ..... 35 gpm (2.21L/s)

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)

For Reference Only

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)

For Reference Only

Crane 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 sec ± 5 sec

Boom Telescope .....

Boom Telescope Speed (Angle 60°- no load at high engine speed)		
Boom Length	**Extend**	**Retract**
9.44 - 31.39m (31 - 103ft)	105 sec (± 10 sec)	105 sec (± 10 sec)
9.44 - 38.70m (31 - 127ft)	120 sec (± 10 sec)	120 sec (± 10 sec)
10.36 - 43.28m (34 - 142ft)	135 sec (± 10 sec)	135 sec (± 10 sec)
11.88 - 49.07m (39 - 161ft)	150 sec (± 10 sec)	150 sec (± 10 sec)

Outrigger Beam Extend ..... 10 sec ±3 sec

Outrigger Beam Retract ..... 10 sec ±3 sec

Outrigger Jack Extend ..... 10 sec ±3 sec

Outrigger Jack Retract ..... 10 sec ±3 sec

Counterweight

Weight ..... See Operator's Manual

General

NBT36 ..... 36 tons (32.6 metric tons) at 7 ft (2.13 m) radius

NBT40 ..... 40 tons (36.3 metric tons) at 7 ft (2.13 m) radius

NBT45 ..... 45 tons (40.8 metric tons) at 7 ft (2.13m) radius

NBT36 127 ft Boom ..... 35,550 lbs (16,125.21 kg)

NBT40 127 ft Boom ..... 37,300 lbs (16,919 kg)

NBT45 127 ft Boom ..... 40,950 lbs (18,574.61 kg)

Boom Weight

103 ft Boom ..... 12,425 lbs (5,636 kg)

127 ft Boom ..... 12,985 lbs (5,890 kg)

142 ft Boom ..... 14,338 lbs (6,504kg)

161 ft Boom ..... 17,526 lbs (7,950kg)

For Reference Only

DIMENSIONAL DRAWING

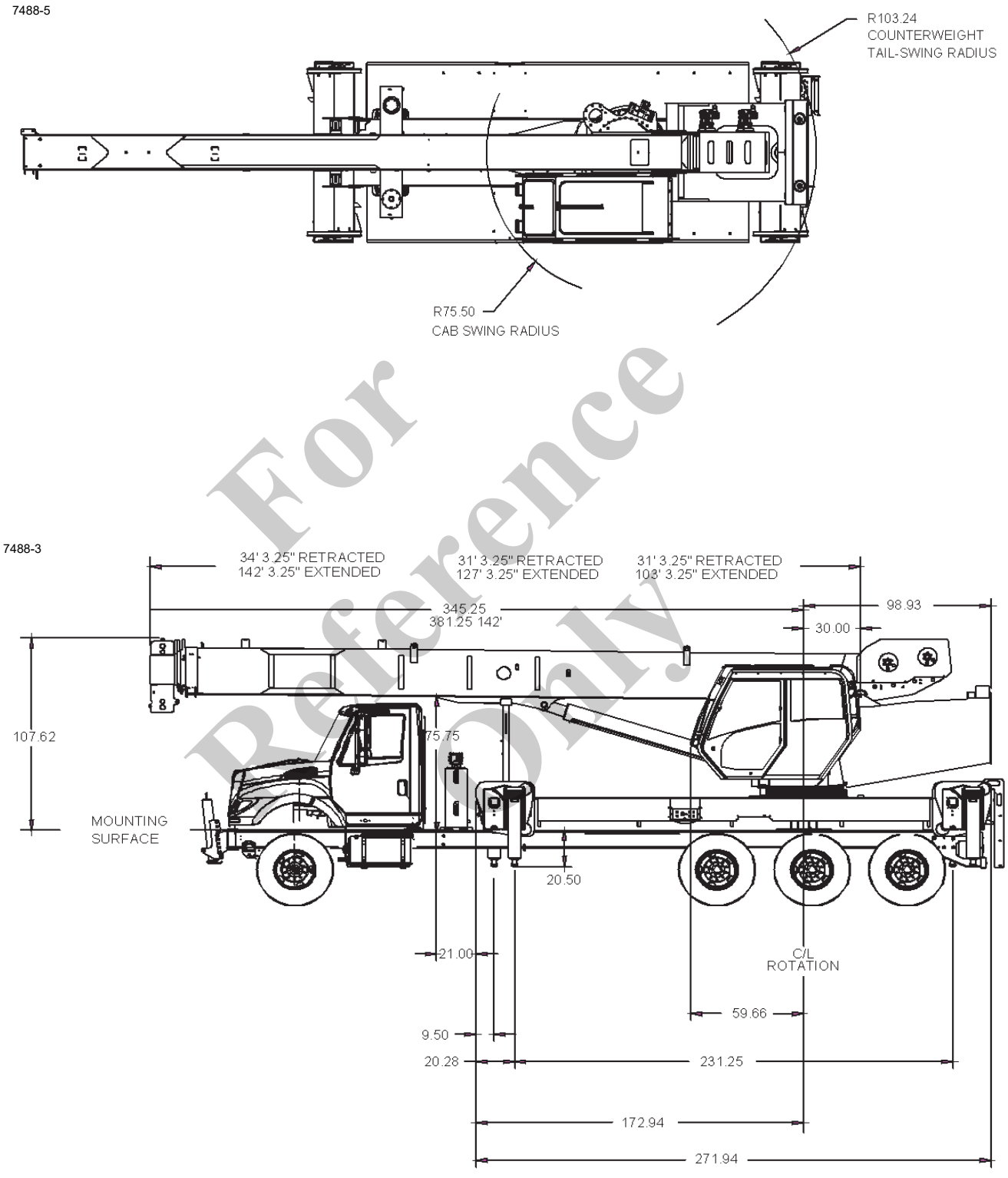

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FIGURE 9-21

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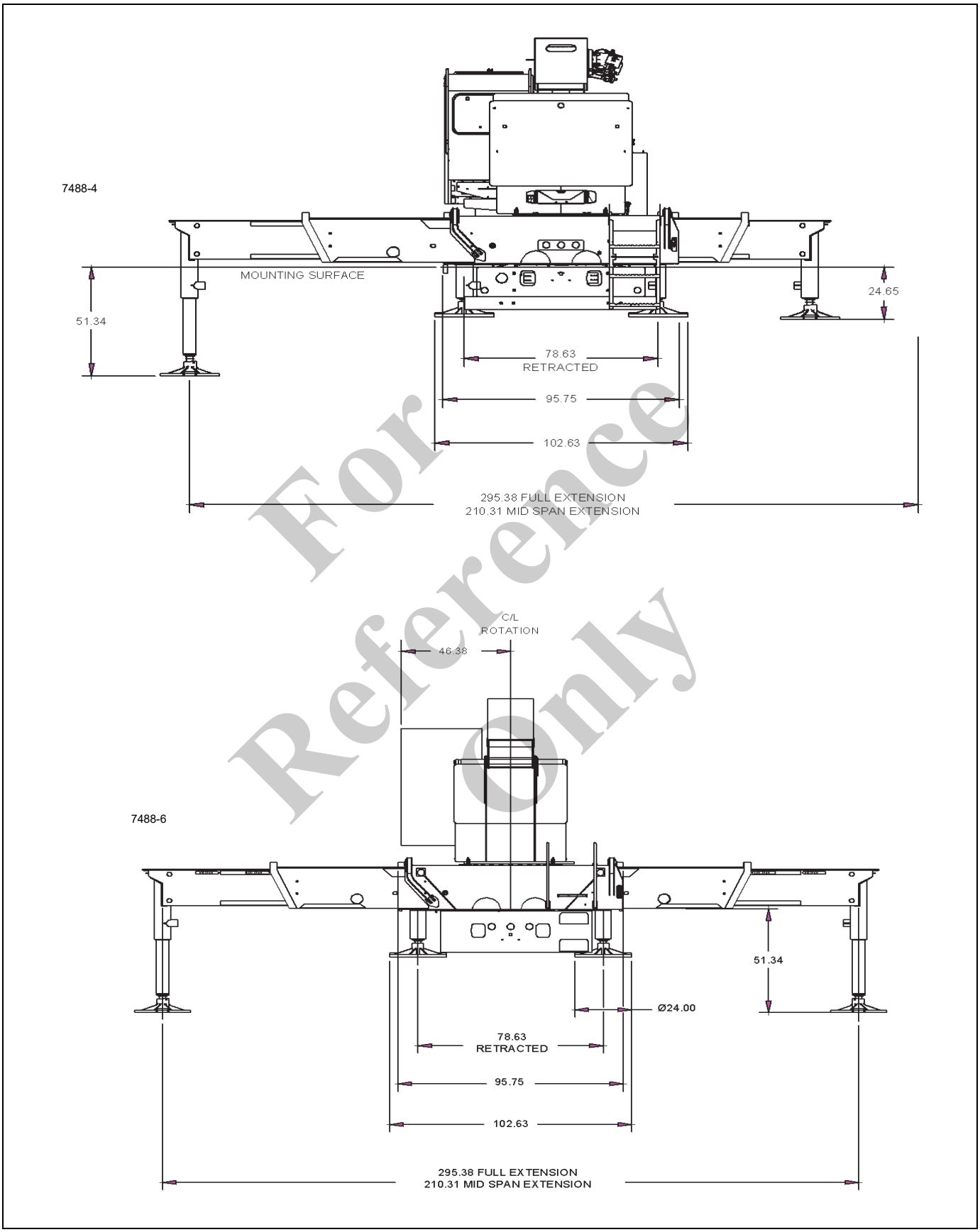

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SECTION 10
SCHEMATICS

For your convenience, the latest version of schematics available at the time of printing are placed in this section.

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