National Crane 1400A

Service Manual

WARNING

California Proposition 65

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

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

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

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

California Spark Arrestor

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

The original language of this publication is English.

NATIONAL CRANE
by Manitowoc

SERVICE MANUAL

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

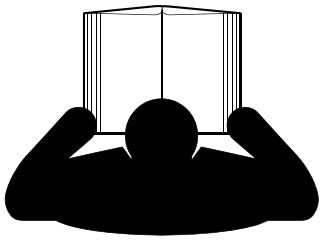
1400A

This Manual is Divided into the following Sections:

NOTICE

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

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



⚠DANGER

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

- You are trained in the safe operation of this crane. 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's Manual and Load Chart are in the holder provided on crane.

1-21-2019 Control # 104-07

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SECTION 1
INTRODUCTION

SECTION CONTENTS

GENERAL

This manual has been compiled to assist you in properly operating and maintaining your Model 1400A 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 Rated Capacity Limiter (RCL), a hydraulic capacity alert system (HCAS), or a safe load indicator (SLI); 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.

Whenever a question arises regarding your National product or this publication, please consult your National Distributor for the latest information.

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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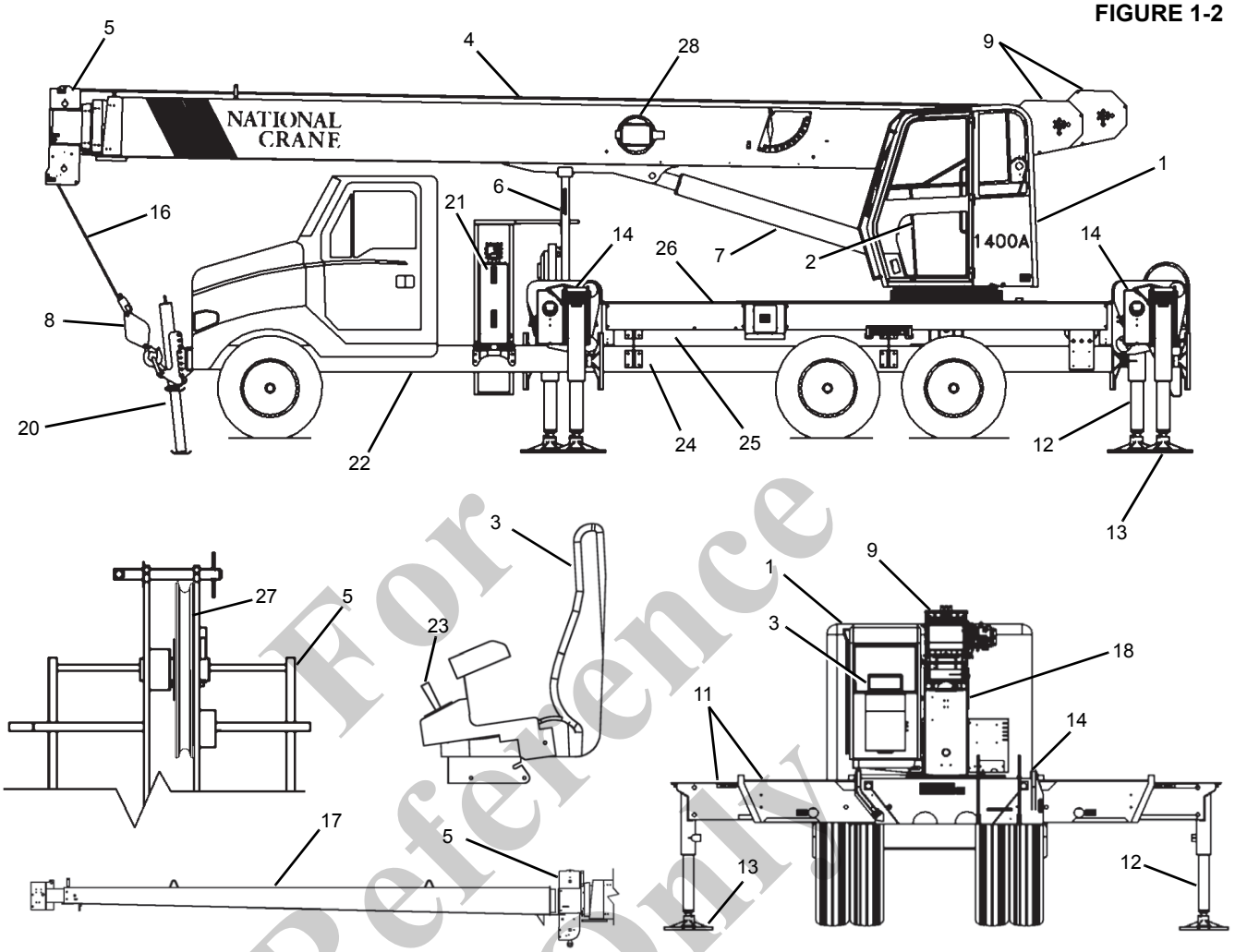
FIGURE 1-2



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
11	Outrigger Beam
12	Outrigger Stabilizer
13	Outrigger Float
14	Outrigger Box

Item	Component
16	Hoist Cable, Wire Rope
17	Jib
18	Turret
20	Stabilizer Front Outrigger (SFO), Front Outrigger Jack
21	Hydraulic Tank
22	Hydraulic Pump
23	Hydraulic Remote Controller (HRC)
24	Truck Frame
25	Truck Bed
26	Torsion Box Frame, T-Box Frame
27	Sheave
28	Rated Capacity Limiter (RCL) Reel

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.

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 4,000 to 5,000 hours of service.
- Climate zones D and E after 4,000 to 5,000 hours of service.

Cleanliness

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

Keep The System Clean

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

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

Disassemble and assemble hydraulic components on a clean surface.

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

Sealing Elements

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

Hydraulic Lines

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

When installing metal tubes, tighten all bolts finger-tight. Then, 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 8,000 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 18° C [64° F])
B (Dry or Arid)	Latitude 20° - 35° North and South (Deficient of precipitation most of the year)
C (Moist Mid-Latitude)	Latitude 30° - 50° North and South (Temperate with mild winters)
D (Moist Mid-Latitude)	Latitude 50° - 70° North and South (Cold winters)
E (Polar)	Latitude 60° - 75° North and South (Extremely cold winters and summers)

Fatigue of Welded Structures

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

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

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

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

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

Loctite

⚠ CAUTION

Skin and/or Eye Hazard!

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

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

Application of Medium Strength Loctite®

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

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

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

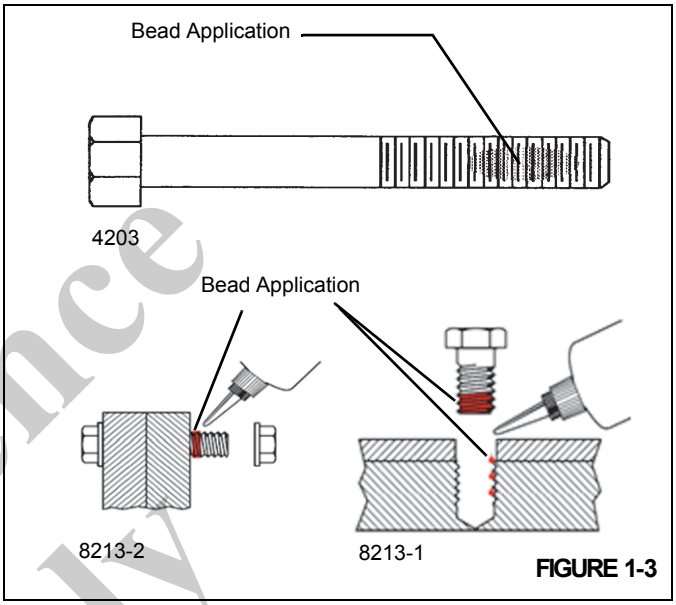


FIGURE 1-3

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

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

Fasteners and Torque Values

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

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

The torque tables are provided by 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 class is always necessary. When marked as a high strength bolt (class 5, 8, etc.), the mechanic must be aware that he/she is working with a highly stressed component and the fastener should be torqued accordingly.

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

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

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

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

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

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

Torque Wrenches

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

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

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

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

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

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

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

Torque Values

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

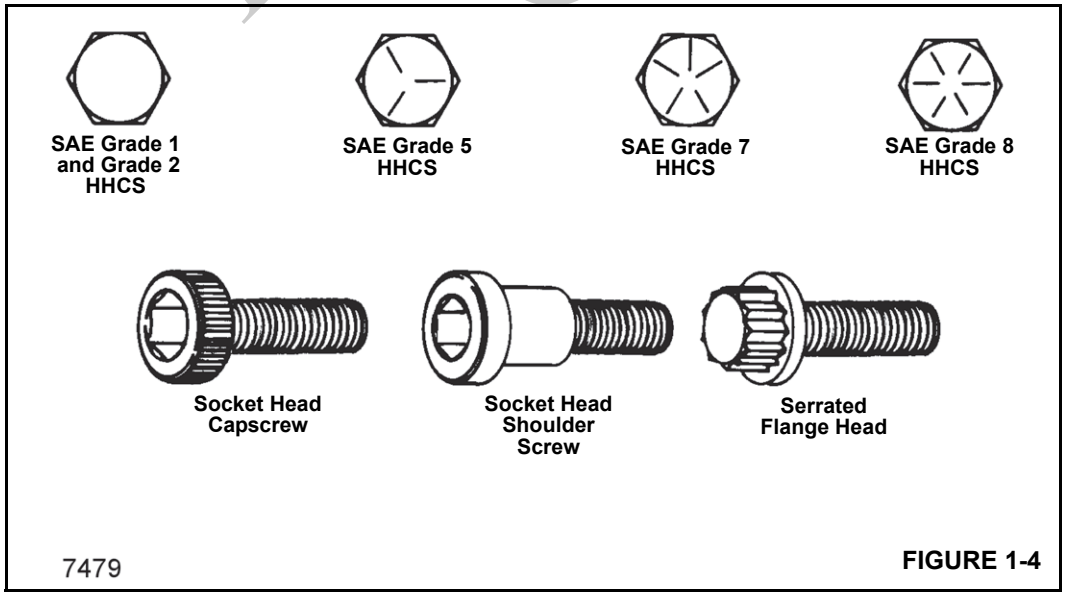


FIGURE 1-4

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

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

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

Table 1-2 Inch Series with Fine Threads (UNF) – Zinc Flake Coated (Continued)

Nominal Size, Threads per Inch, and Series Designation	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
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

Table 1-3 Metric Series with Coarse Threads – Zinc Flake Coated (Continued)

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

Table 1-3 Metric Series with Coarse Threads – Zinc Flake Coated (Continued)

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

Table 1-4 Metric Series with Fine Threads – Zinc Flake Coated (Continued)

Nominal Size, Threads per Inch, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
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
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

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

Table 1-5 Metric Series Screws of STAINLESS STEEL A2-70/A4-70 with Coarse Threads (Continued)

Size	Torque (Nm)
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.

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
M24X3	12.9	1306	1256	1206
M27X3	10.9	1591	1530	1469

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

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

Table 1-10 Inch Series with Fine Threads (UNF) – Untreated (black finish) (Continued)

Size	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
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	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

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

Table 1-11 Metric Series with Coarse Threads – Untreated (black finish) (Continued)

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
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
M27x3	8.8	1134	1090	1046
	10.9	1591	1530	1469
	12.9	1910	1836.5	1763

Table 1-11 Metric Series with Coarse Threads – Untreated (black finish) (Continued)

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
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

Table 1-12Metric 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

Table 1-12Metric Series with Fine Threads – Untreated (black finish) (Continued)

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
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
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

T-2-4

Torque Wrenches

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

NOTE: Torque values are in foot pounds (Nm). Torque values apply to plain finish and zinc plated fasteners. Torque values specified are dry with as received residual oils. Special lubricants are not recommended.

Torque values for bolts listed above are not affected with the use of Loctite.

Loctite should not be used on rotation bearing fasteners. Hardened washers should be used with Class 8 fasteners

Using Torque Wrench Extensions

1. Torque wrench extensions are designed to extend the range or versatility of torque wrenches. Torque wrench scale readings or limit settings shall be computed with the following formulas when an extension handle is employed. The sketch below shows which formula is to be used, adding “A” or subtracting “A” when calculating the torque wrench setting.
2. If the offset C/L is not in line with the torque wrench C/L, then you must measure the distance from the C/L of the torque wrench to the C/L of the offset by using a square. Then apply this dimension to the torque wrench setting formula. See sketch below.
3. If offset is positioned at right angles to the torque wrench, then the offset will not change the effective length. Therefore, TW-wrench setting and Ta-applied torque, will be the same value as if no offset were used.

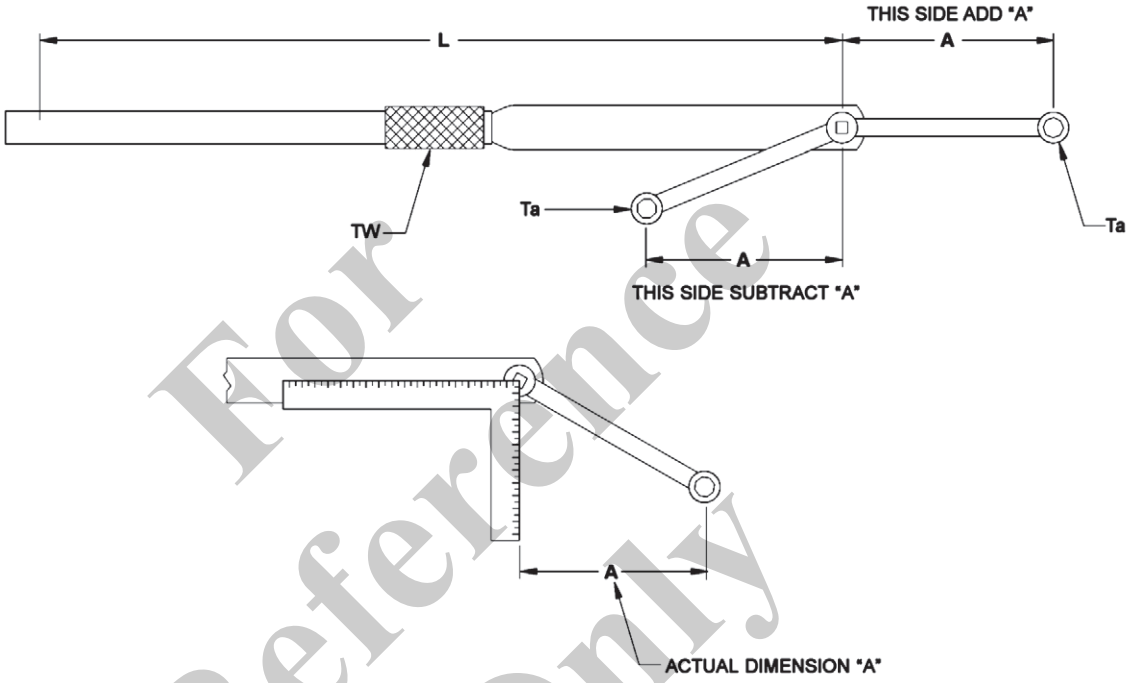
$$TW = \frac{Ta \times L}{L + A} \text{ or } \frac{Ta \times L}{L - A}$$

Ta = Torque required (specified)

TW = Wrench scale reading or limit setting of torque wrench

L = Length of torque wrench in inches (center of drive tang to handle pivot pin or center of hand grip extension handles are considered part of wrench length, when used).

A = Length of adapter extensions in inches



WIRE ROPE

General

The following information includes inspection, replacement, and maintenance guidelines for wire rope as established by ANSI/ASME B30.5, federal regulations, and National Crane specifications. The inspection interval 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.

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.
- 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 a weekly inspection of all boom extension and retraction cables be performed using the following guidelines. The inspection shall cover all visible areas of the extension and retraction cables of an assembled boom. Note that extending and/or retracting the boom may be required to access visual inspection holes.

The inspection shall cover the entire length of the extension and retraction cables of a disassembled boom prior to reassembly.This inspection should be used to monitor progressive degradation and to discover severe damages necessitating wire rope replacement or equipment repair.

Inspect the rope for:

- reduction of rope diameter below nominal diameter.
- severely corroded or broken wires at end connections.
- severely corroded, cracked, bent, worn, or improperly applied end connections.

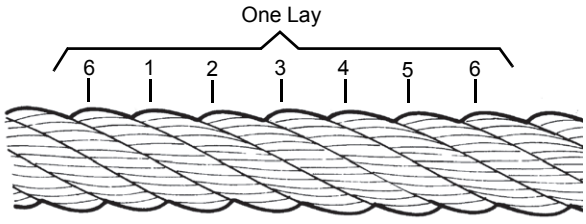
- deterioration in areas subjected to rapid deterioration, such as:
  - sections in contact with saddles, equalizer sheaves, or other sheaves where rope travel is limited.
  - sections of wire rope at or near terminal ends where corroded or broken wires may protrude.
  - sections of wire rope in contact 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 1-5).



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

FIGURE 1-5

- Wear of one-third the original diameter of outside individual wires.
- Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure.
- Evidence of heat damage.
- Reductions from nominal diameter of more than 5 %:
- 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 1-6).

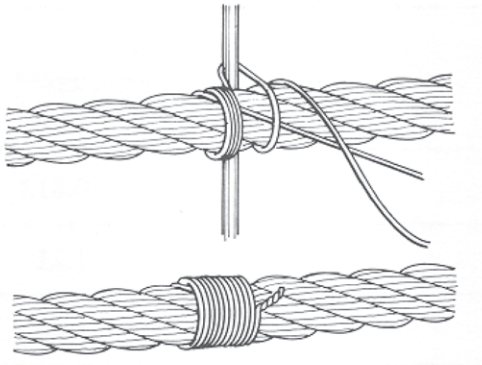


FIGURE 1-6

Method 2

Wind a length of soft annealed wire around the wire rope at least seven times. Twist the two ends together in the center of the seizing. Tighten the seizing by alternately prying and twisting. Cut off both ends of the wire and pound the twist flat against the rope (Figure 1-7).

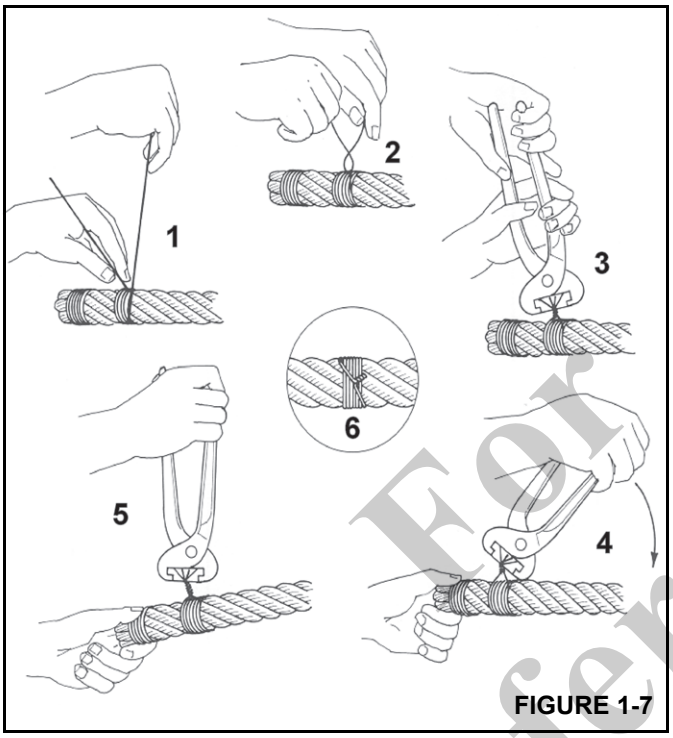


FIGURE 1-7

NOTE: Non-preformed wire rope should have two seizings located on each side of the cut (Figure 1-8).

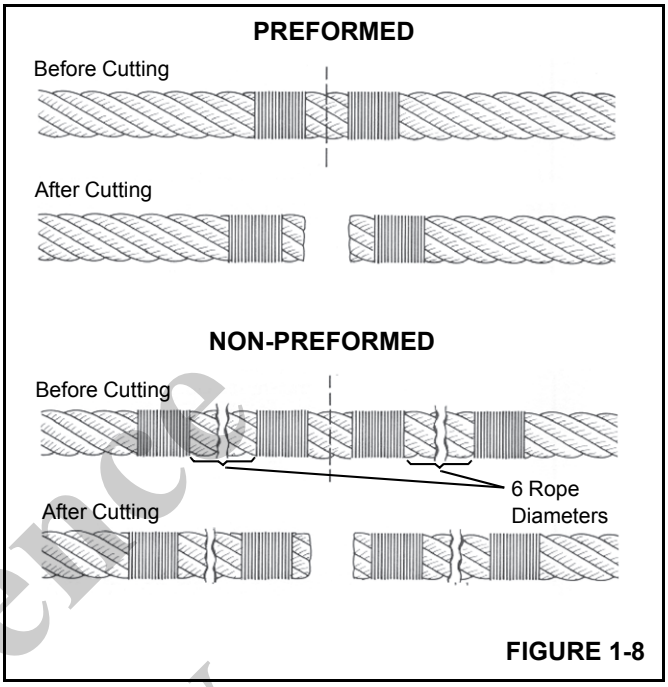
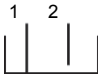
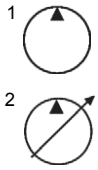
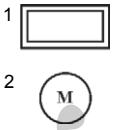
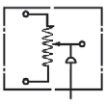


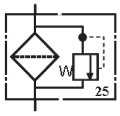
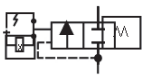
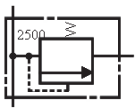
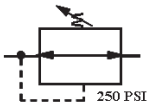
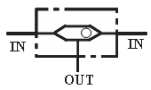
FIGURE 1-8

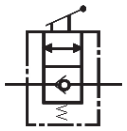
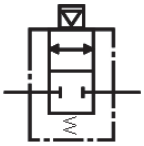
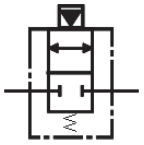
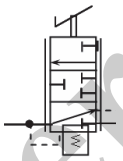
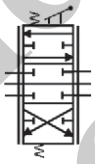
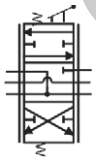
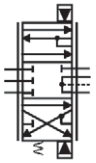
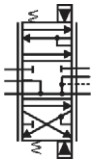
SECTION 2
HYDRAULIC SYSTEM

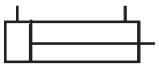
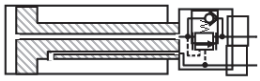
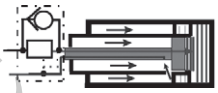
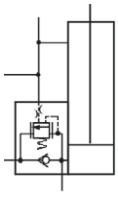
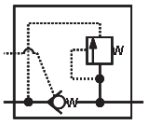
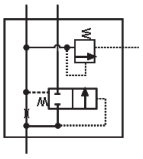
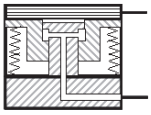
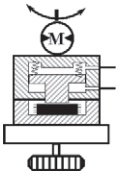
SECTION CONTENTS

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

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.	

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 Stabilizer - 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.	

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 the hydraulic oil specifications, refer to Section 9 - 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.

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 stabilizer cylinders and activate the cylinders to their maximum down positions.
11. Connect the return lines and raise the outrigger stabilizer 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. Working reservoir capacity is (capacity to full mark). 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 to 27.6 kPa (2 to 4 psi) and inspect all joints and fittings for evidence of leaks. A soap solution applied to the fittings and joints may also prove helpful in detecting minute leaks while the system is pressurized. Remove the pressure, repair any leaks found, and reopen any openings (such as a vent) closed for inspection. Refill the reservoir after completing any repairs or service. Operate all hydraulic circuits several times in both directions.
- This action should return any entrapped air to the reservoir where it can be removed by the internal baffles.

DANGER

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

- To remove entrapped air from telescope cylinders, lower the boom 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 1400A 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 265 lpm (70 gpm) flow of up to 27,579 kPa (4,000 psi) at a pump shaft speed of 1,900 rpm. A shaft speed of 1000 rpm delivers 132 lpm (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 2,413 to 2,757 kPa (350 to 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 the lift relief valves that protect the lift circuit.
- Section two controls the hoist and uses the system 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 system 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 16 gpm in both directions and has internal relief valves that are set to 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, tele 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 3000 psi which is determined by a flow control valve located on the front outrigger.

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 2-8) 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.

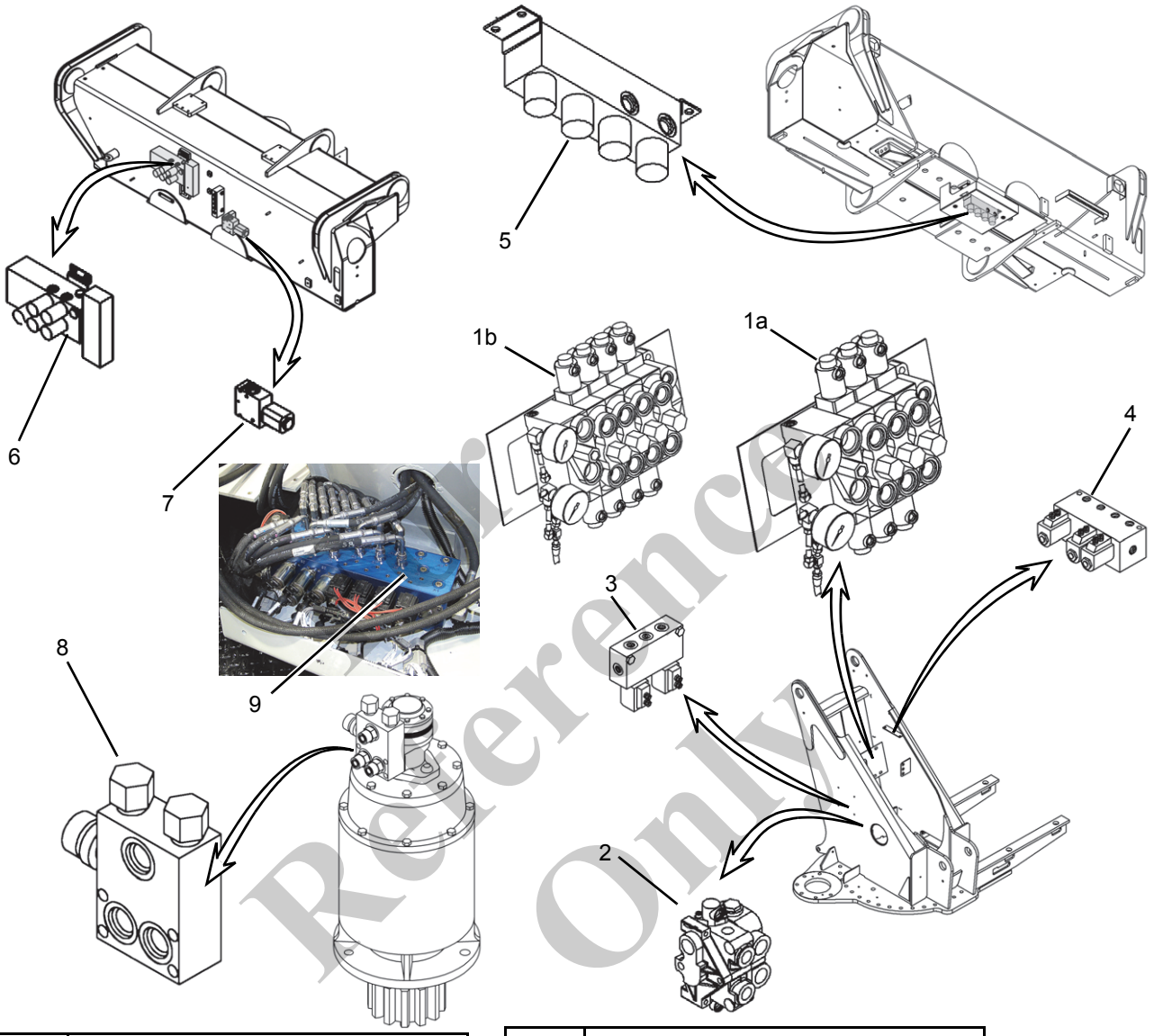
Hydraulic Remote Controllers

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.

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.

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 stabilizer cylinder (4)
Front center stabilizer relief valve	Outrigger	Front center outrigger
Flow Control Valve	Outriggers	Front outrigger box.

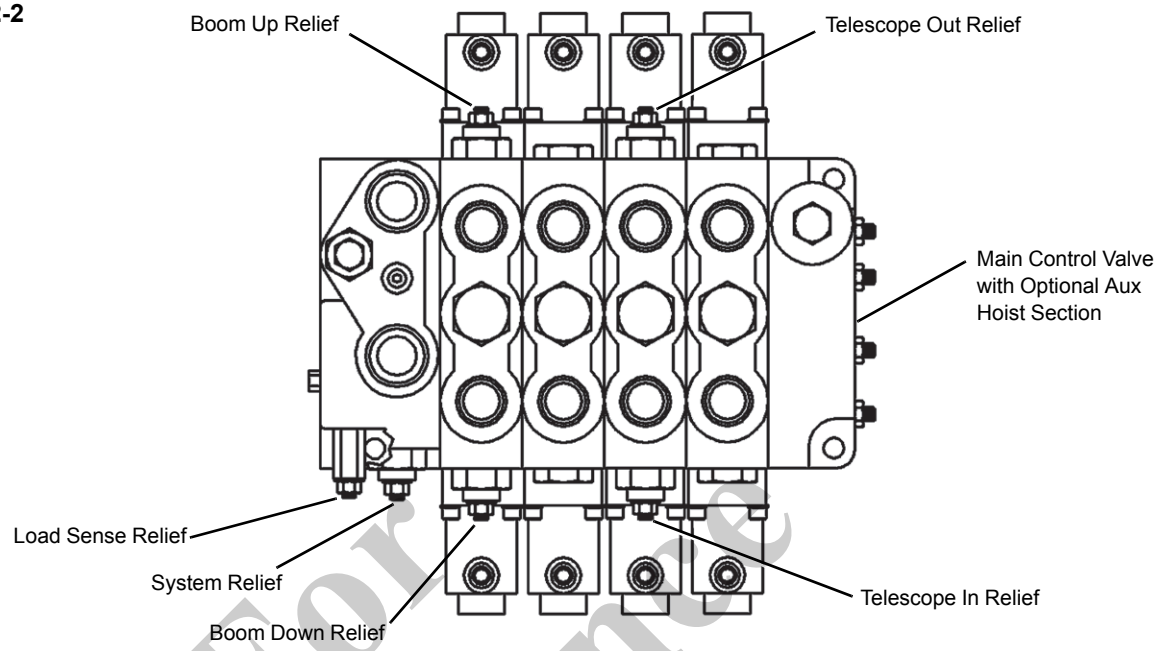


Item	Component
1a	Main Control Valve (lift, telescope, hoist)
1b	Main Control Valve (Optional Aux Hoist)
2	Swing Control Valve
3	Swing Brake Manifold
4	HRC Dump Manifold

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

FIGURE 2-1

FIGURE 2-2



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 5,000 psi (0 to 34,500 kPa) 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 60° to 71° C (140° to 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 60° to 71° C (140° to 160° 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.

Valve To Be Set	Pressure Setting kPa (PSI)	Tolerance kPa (PSI)	Adjustment Location
Telescope Retract Relief	15,513 (2,250)	±689 kPa (100 psi)	Main Control Valve
Telescope Extend Relief	18,615 (2,700)	±689 kPa (100 psi)	Main Control Valve
Hydraulic Remote Controller Load Sense Pilot	23,442 (3,400)	±689 kPa (100 psi)	Main Control valve
Outrigger Relief (Flow Control Valve)	20,684 (3,000)	±689 kPa (100 psi)	Front Outrigger Box
Boom Up Relief	24,821 (3,600)	±344 kPa (50 psi)	Main Control Valve
Boom Down Relief	25,165 (3,650)	±689 kPa (100 psi)	Main Control Valve
Hoist Relief (System Relief Valve)	26,200 (3,800)	±689 kPa (100 psi)	Main Control Valve
Front Stabilizer Extend	3,447 (500)	±689 kPa (100 psi)	Port Block on Front Stabilizer
Front Stabilizer Retract	12,065 (1,750)	±689 kPa (100 psi)	Port Block on Front Stabilizer

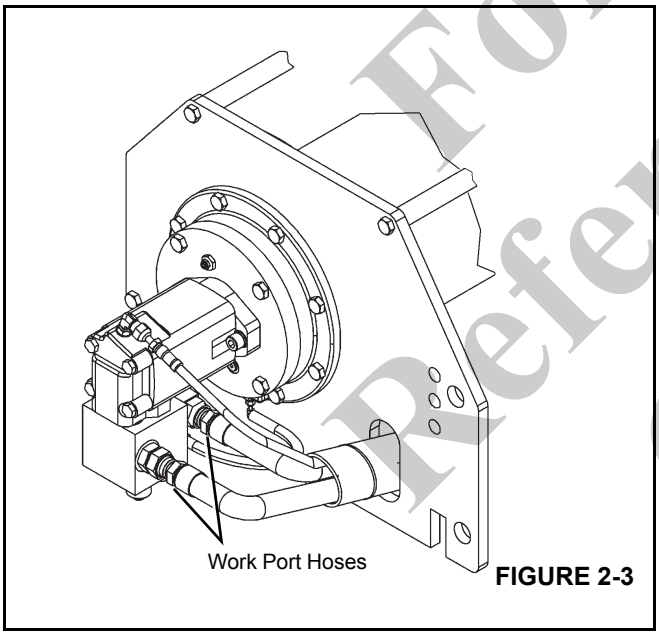


FIGURE 2-3

Relief Valve Setting Procedures

Insert a T-connector with a pressure gauge in the hydraulic line at swivel port #3. This can be use to adjust all pressure settings.

Hoist

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

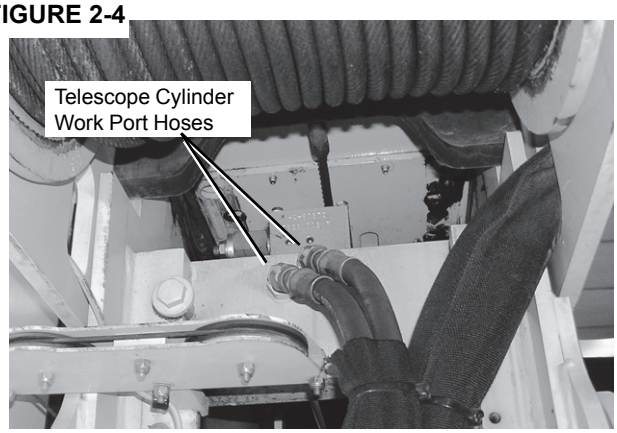
1. Disconnect the two work port hoses at the hoist motor (Figure 2-3) and cap the hoist motor ports.
2. Plug the hoses.
3. Start the engine and set the throttle to governed rpm.
4. Try to hoist up or down. Adjust the system relief valve on the main control valve to 26,200 ±689 kPa (3,800 ±100 psi).
5. Shut down the engine.
6. Reconnect the hoses to the hoist.

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) to 25,165 ±689 kPa (3,650 ±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) to 24,821 ±689 kPa (3,600 ±100 psi)
6. Shutdown the engine.
7. Reconnect the boom up hydraulic line to the lift cylinder.

Telescope In and Telescope Out Reliefs

FIGURE 2-4



1. Remove the extend and retract (work port) hoses from the telescope cylinder (Figure 2-4). 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) to 18,615 ±689 kPa (2,700 ±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) to 15,513 ±689 kPa (2,250 ±100 psi).
7. Shut down the engine.
8. Reconnect the telescope cylinder hoses.

Outriggers

1. Select an outrigger and remove the retract line from the outrigger extend cylinder.
2. Install a tee connector with a pressure gauge in the retract line (Figure 2-5).

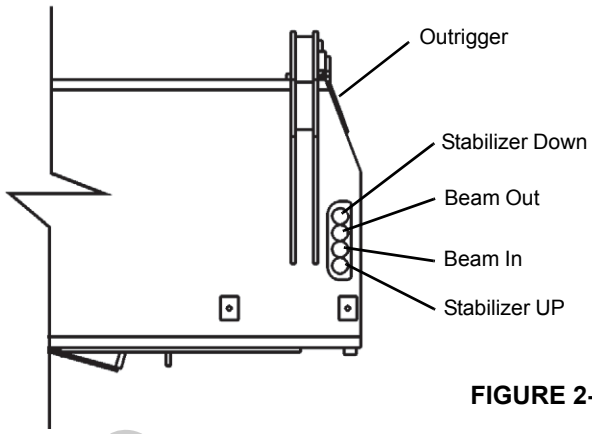


FIGURE 2-5

3. Start engine and set throttle to governed rpm.
4. Activate the retract function for the selected outrigger and adjust the flow control relief valve to 20,684 kPa ±689 (3,000 ±100 psi).
5. Shutdown the engine and disconnect the pressure gauge and reconnect the stabilizer retract line.

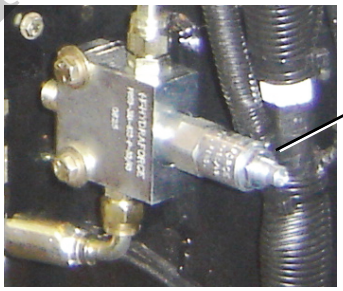


FIGURE 2-6

Single Front Outrigger (SFO)

1. Disconnect the SFO extend and retract lines (Figure 2-7). Cap the retract line and install a gauge in the extend line.

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 front outrigger extend/retract switch to extend.
4. Adjust the extend relief valve on the front outrigger port block to 3447+689/-0 kPa (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 front outrigger port block to 12065 +689/-0 kPa (1750 +100/-0 psi).
8. Shutdown the engine, remove the gauge and cap, and reconnect the SFO hydraulic lines.

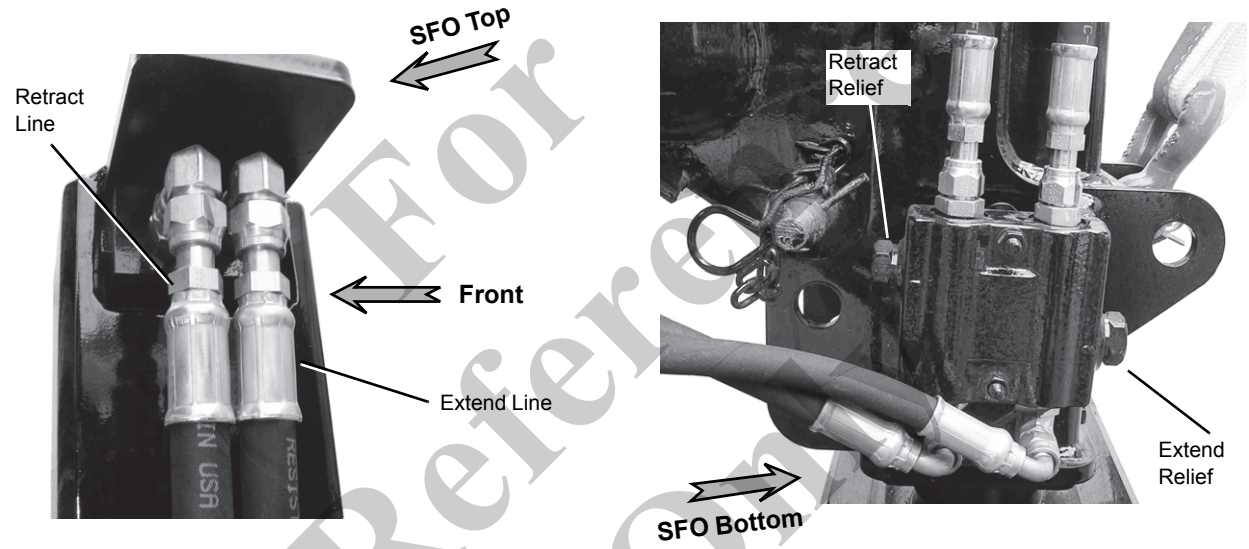


FIGURE 2-7

Hydraulic Reservoir and Filter

The reservoir, (Figure 2-8) is attached to the front of the truck bed and has a capacity of 378.5 liters (100 U.S. gallons) 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.

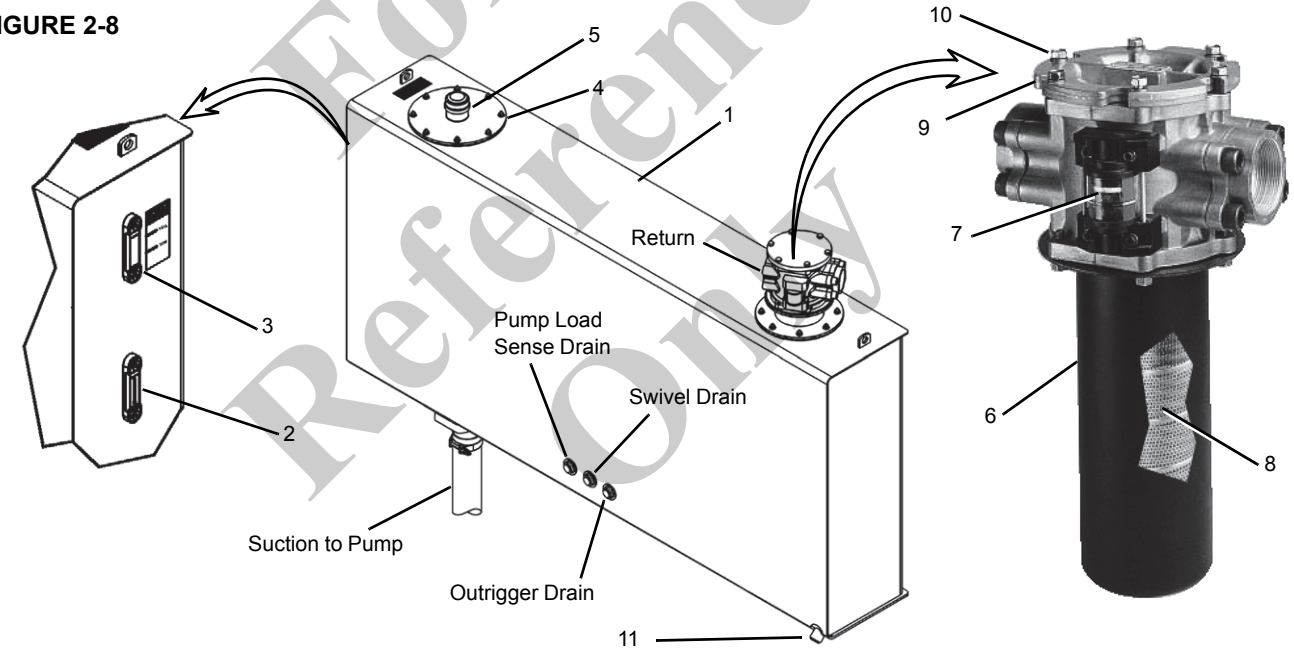
A filler cap on the top of the reservoir is for filling the reservoir. The filler cap includes a strainer for catching contaminants and gaskets to prevent leaking. A breather cap (vent) which is part of the filler cap allows air to enter or leave the reservoir. The breather must be kept clean to prevent 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 2-8) is located in the reservoir and bolts to the top of the reservoir. The filter housing contains a replaceable 5 Micron 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 103 kPa (15 psi), the filter head's bypass feature allows the hydraulic oil to bypass the filter and flow into the reservoir.

FIGURE 2-8



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

Item	Component
7	Filter Element Gauge
8	Filter (5 Micron)
9	Filter Cap
10	Capscrews (6)
11	Magnetic Drain Plug

Hydraulic Filter Replacement

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

The filter requires a 5 Micron replacement element. 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 (Figure 2-9) is located on the boom rest. The oil cooler return circuit is in parallel with the reservoir return circuit. A 30 psi (206 kPa) check valve in the cooler line regulates flow through the oil cooler. When the hydraulic oil is cold, most of the return oil goes directly to the tank. As the oil warms up and becomes thinner, more oil goes through the cooler.

NOTE: A temperature sensor located in 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 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).

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

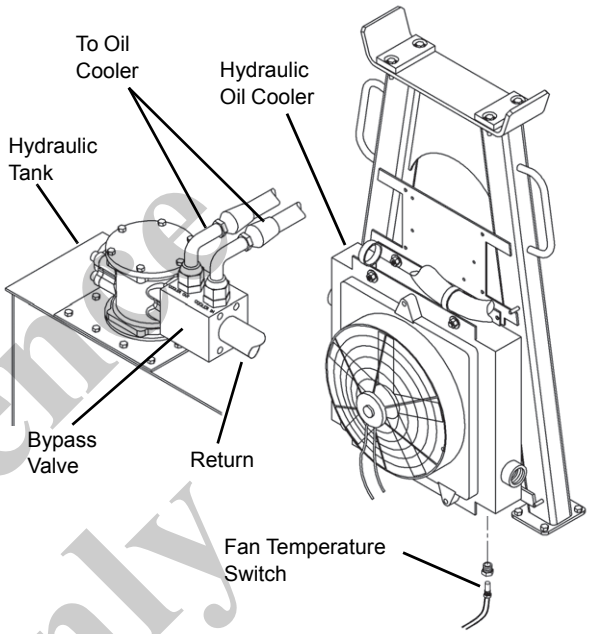


FIGURE 2-9

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 cooler the 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

Directional Control Valve

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

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.

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.

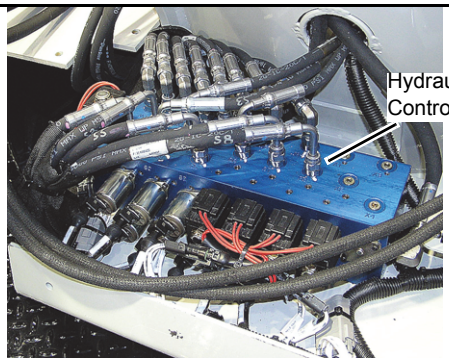
RCL Dump Valve

The purpose of the RCL dump valve is to disable those functions which worsen an overload condition. To check the RCL system, do the following:

1. Remove fuse F6 from the mini fuse panel to disconnect power to the RCL.
2. Start the engine.
3. Try to telescope the boom out, lower the boom, hoist up. Verify none of these functions work.
4. Shut down the engine. Reinstall fuse F6.
5. Telescope the boom out, lower the boom, hoist up. Verify all of these functions work.
6. Check for leaks and repairs as needed.

Hydraulic Remote Control Valve

The crane functions are controlled by hydraulic remote controllers (HRC) on the armrest of the operators seat which controls the hydraulic remote control valve located on the rear of the superstructure turntable. See (Figure 2-10). 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.



Valve Port	Remote Control Function
S1	Turn Right
S2	Boom Up
S3	Hoist down
S4	Telescope In
S5	Turn Left
S6	Boom Down
S7	Hoist Up
S8	Telescope Out

FIGURE 2-10

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 75 hp (55.9 kw) 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.
4. Remove the bolts from the pump mounting flange and slide the pump out of the PTO drive coupling.

Installation

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

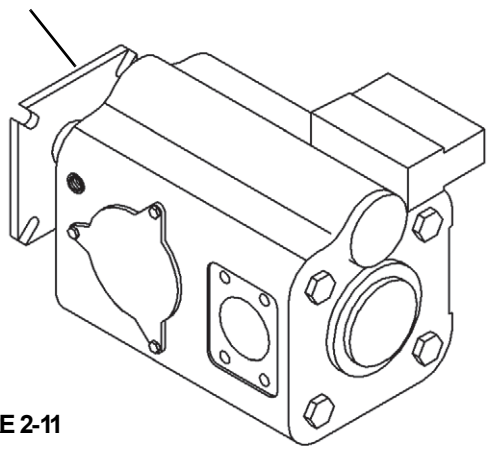


FIGURE 2-11

5. Reconnect the hydraulic lines as per removal tags.
6. Fill the hydraulic tank to the full mark with hydraulic oil.
7. Start the truck engine at idle and engage the PTO.
8. Let the truck idle until the system is pressurized to make sure that the hydraulic oil has replenished the system and that the system is not sucking air.
9. Shut the truck engine in the cab off and restart from the crane cab.
10. Check all crane functions.

Initial Pump Installation

For initial pump installation, use the following procedure:

1. The hydraulic pump has integral mounting flanges and can be bolted directly to the PTO. Be sure adequate clearance exists for this type of pump mount.
2. If the pump is powered through a drive line, a pump mount must be installed or bolt the pump to an existing frame cross member.
3. A mounting bracket needs to be installed so that the rear mounting bracket on the pump can be secured.
4. Be sure the drive line is sized to safely carry the maximum pump horsepower requirements (189 hp (140.9 kw) at 1800 rpm).
5. Do not locate the pump more than 107 cm (42 inches) from the PTO. Do not exceed a 7° drive line angle and the U-joints on both ends of the drive shaft must be parallel with each other.
6. Plan the location of the pump mount and drive line for adaquate clearance between the pump and truck drive shaft or exhaust system.
7. Position the pump so that hydraulic lines can be connected without sharp bends especially the large suction line from the reservoir.
8. For drive line installation, install the pump mount to the truck frame.
9. Lubricate the splines on the pump shaft and drive coupling with heavy lithium grease.
10. Bolt the pump mounting flange to the PTO or to the pump mount on the truck.
11. Torque the mounting flange nuts to 222N m (50 ft. lbs).
12. Bolt the pump rear mounting bracket to the truck mounting bracket.

NOTE: O-ring boss fittings are used for sealing hydraulic line connections. Make sure the O-ring is in its grove before tightening.

13. Remove the dust covers from the pump inlet and outlet ports and install the hydraulic fittings and lines.
14. Fill the reservoir with the proper hydraulic fluid to the high-level mark on the reservoir sight gage.
15. Start up the pump following procedures described under “Pump Start-up” on page 17.

Pump Start-up

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

1. Install pump on PTO following procedures described under “Initial Pump Installation” on page 17.
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 13 to 34 bar (200 to 500 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” on page 18.
12. Check/adjust maximum pump pressure; see “Maximum Pump Pressure Setting” on page 18.
13. Remove pressure gauge. Check hydraulic oil level in reservoir and fill if needed.

Table 2-1 Pressure Settings

Pump Margin Pressure	Maximum Pump Pressure	Load Sense Relief Valve Pressure
41 bar +0/6.8 bar (600 psi +0/-100 psi)	289 bar -0 +3.4 bar (4200 psi ±100 psi)	41 bar +0/6.8 bar (600 psi +0/-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 2-13.
2. Idle engine with PTO engaged and do not operate any functions.
3. Verify margin pressure is 41 bar +0/6.8 bar (600 psi +0/-100 psi).

   If margin pressure is not correct, adjust Load Sense (LS) Adjusting Screw (2, Figure 2-12) at pump. Turn screw (2) clockwise to increase the setting; each turn gains 13.7 bar (200 psi). Tighten lock nut 16.2 nm (12 lb-ft) to secure setting.

Maximum Pump Pressure Setting

Install a gauge at the pump pressure gauge port (2) on the Main Directional Control Valve Manifold, Figure 2-13.

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 18).
3. If maximum pressure is incorrect, adjust Pressure Compensating (PC) adjusting screw.

- Loosen locknut and turn PC adjustment screw (1, Figure 2-12) clockwise to increase the setting; each turn gains 27.5 bar (400 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 develope pressure.

Method #2

Disconnect and cap and plug the main hoist up/down hoses. Activate the hoist up and down function to develope 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 18).
- If LSRV pressure is not correct, adjust LSRV adjusting screw. Loosen locknut and adjust the setting. Turn PC adjustment screw (1, Figure 2-12) 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.

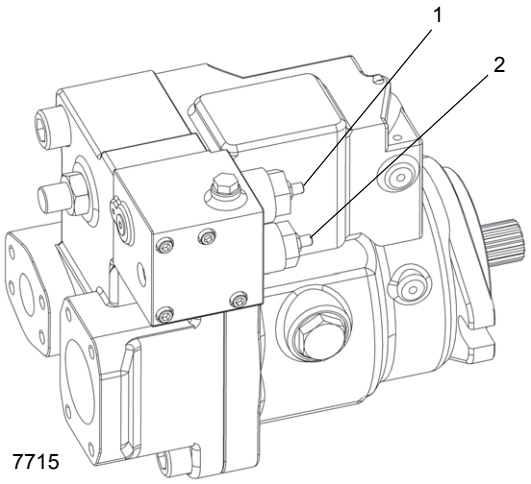


FIGURE 2-12

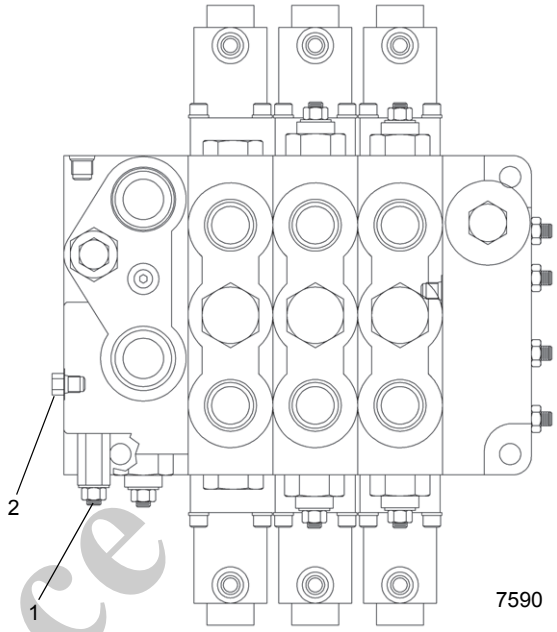
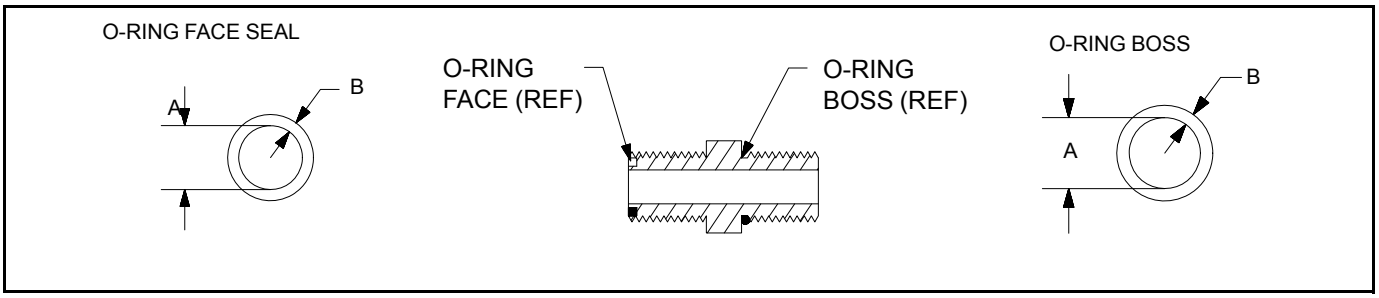


FIGURE 2-13



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.							

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.

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 to 3.4 MPa (300 to 500 PSI).
	Dynamic brake not properly applying.	Check dynamic brake pressure. Must modulate between 0 to 3.4 MPa (0 to 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 to 3.4 MPa (300 to 500 psi).
	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.

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.

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 till 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 to 1 MPa (100 to 140 psi) and be at full speed at 2.1 to 2.4 MPa (300 to 350 psi). Check for free movement of spool in valve body, hone spool if required. Replace spool spring pack if necessary.
Turn moves erratically in one quadrant	Machine out of level or windy conditions.	Level machine. Operate slowly and carefully in the wind.

SECTION 3
ELECTRIC SYSTEM

SECTION CONTENTS

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 torsion box and contains all wiring interface between the truck and the crane, including the electrical outrigger controls. The electrical circuits for crane control functions are routed through an electrical swivel located in the turret.

When key switch in the operators station is set to RUN, the throttle pedal in the operators station overrides the truck cab throttle, the RCL system is powered, and the crane functions can be activated. The outrigger controls are disabled when the crane function power switch is on.

JUMP STARTING THE CRANE

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.

All crane models, particularly those produced since 2000, have multiple computer systems (crane control, RCL, engine & 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.

Charging

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

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

MAINTENANCE

General

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

DANGER

Remove all rings, watches, and other jewelry before performing maintenance on live circuits as serious burns can result from accidental grounding or shorting circuits.

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. Using a multimeter, test a circuit for continuity if you suspect a broken circuit or for voltage if you suspect a power problem. Check the electrical schematic and wiring diagram for most accurate wiring information.
3. If the component proves faulty, replace it with a known working component. If wiring proves faulty, replace it with wiring of equal gauge.
4. Test the repaired circuit and verify that the circuit works properly.

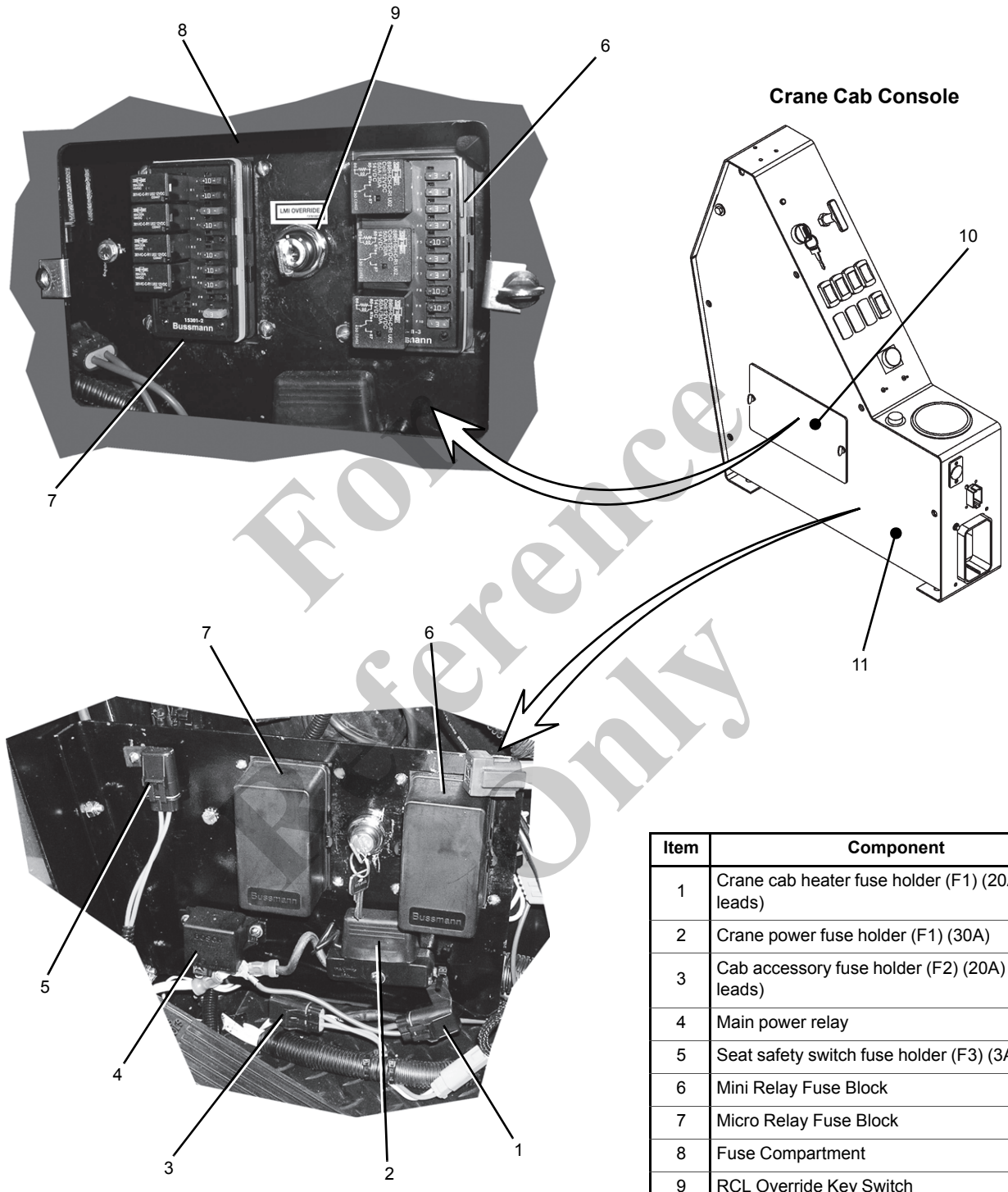
Troubleshooting the Electrical Swivel

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.

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 will probably be necessary to replace them.

Because the pins and sockets are crimped to the wires, it is not possible to remove them. Using the proper extraction tool, remove the pin(s) or socket(s) from the plug or receptacle. Cut the wire as close to the pin or socket as possible. After cutting the pin or socket off, the wire will most likely be too short. Using a wire that is too short will allow pressure to be applied to the pin or socket and wire where they are crimped when the pin or socket is inserted in the plug or receptacle. Add a short length of the same size wire to the short wire by crimp, splice or solder. Use heat shrinkable tubing or other suitable material to insulate the splice.



Item	Component
1	Crane cab heater fuse holder (F1) (20A) (red leads)
2	Crane power fuse holder (F1) (30A)
3	Cab accessory fuse holder (F2) (20A) (orange leads)
4	Main power relay
5	Seat safety switch fuse holder (F3) (3A)
6	Mini Relay Fuse Block
7	Micro Relay Fuse Block
8	Fuse Compartment
9	RCL Override Key Switch
10	Access Panel
11	Side Panel

FIGURE 3-1

INDIVIDUAL FUSE HOLDERS

There are several fuses contained in individual fuse holders located in the crane cab console (Figure 3-1). These are:

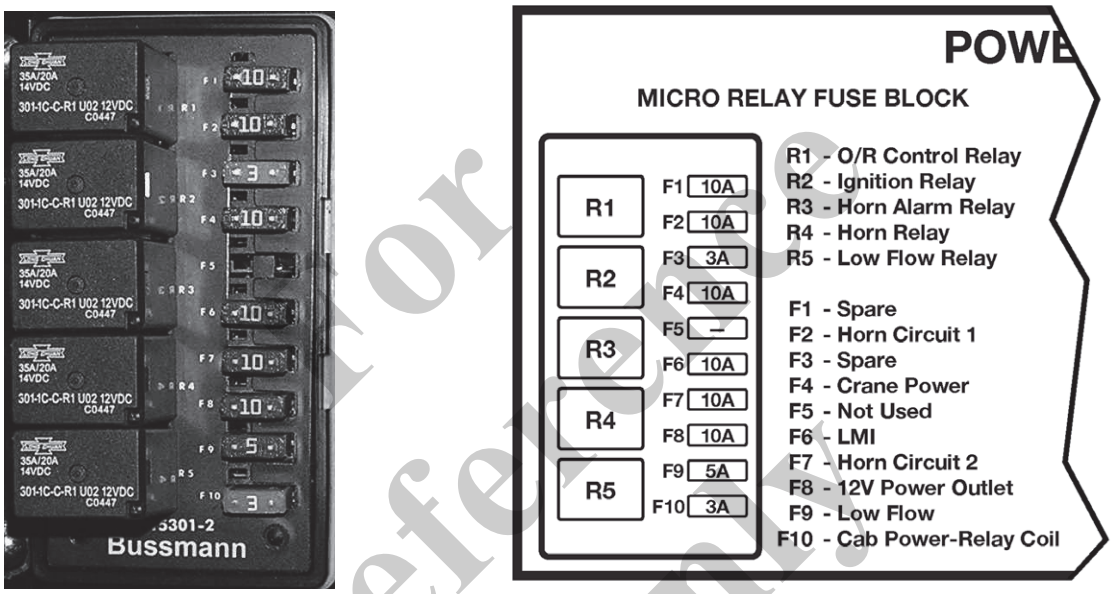
- Crane cab heater circuit fuse (1) (20A).
- Crane power fuse (2) (30A) in line circuit to both the micro and mini fuse block circuits.
- Seat safety switch circuit fuse (5) (3A).
- Crane cab accessory circuit fuse (3) (20A).

The side panel (13) may need to be removed to gain access to the individual fuse holders.

RELAY FUSE BLOCKS

There are two relay/fuse blocks located in fuse compartment (Figure 3-1) in the crane cab console. Loosen the two thumbscrews and remove the access panel located on the side of the crane cab console to gain access to the fuse block. A decal on the inside of the access panel identifies the relay and fuse circuits.

Micro Relay Fuse Block **FIGURE 3-2**



Micro Relay Fuse Block

The micro relay fuse block (Figure 3-2) is located on the left side of the fuse compartment and contains the following components:

- R1 - Outrigger Control Relay disables the outrigger controls when energized by the radio remote switch.
- R2 - Ignition Relay disables the crane and truck cab ignition switches and transfers the start function to the radio remote when energized by the radio remote switch.
- R3 - Horn Alarm Relay enables the horn when energized by the operators seat safety switch.
- R4 - Horn Relay supplies power for the horn alarm. R4 is energized by relay R3 or by the armrest safety switch or crane cab console horn switch.
- R5 - Low Flow Relay used with the radio remote to provide a slow control response.
- F1 - Spare
- F2 - Horn Circuit 1 supplies power to the horn relay R4 when armrest safety switch is closed or to the horn when the horn switch on the crane cab console is closed.
- F3 - Spare
- F4 - Crane Power Function supplies power to the crane power relay when the crane power switch is energized.
- F5 - Not used
- F6 - RCL power.
- F7 - Horn Circuit 2 supplies power for the horn alarm when horn relay R4 is energized.
- F8 - 12V Power Outlet supplies power to the 12V power outlet on the crane cab console.
- F9 - Low Flow supplies power to the low flow relay for radio remote slow speed operation.
- F10 - Crane Cab Power-Relay Coil supplies power to the crane cab power relay for crane cab accessory power.

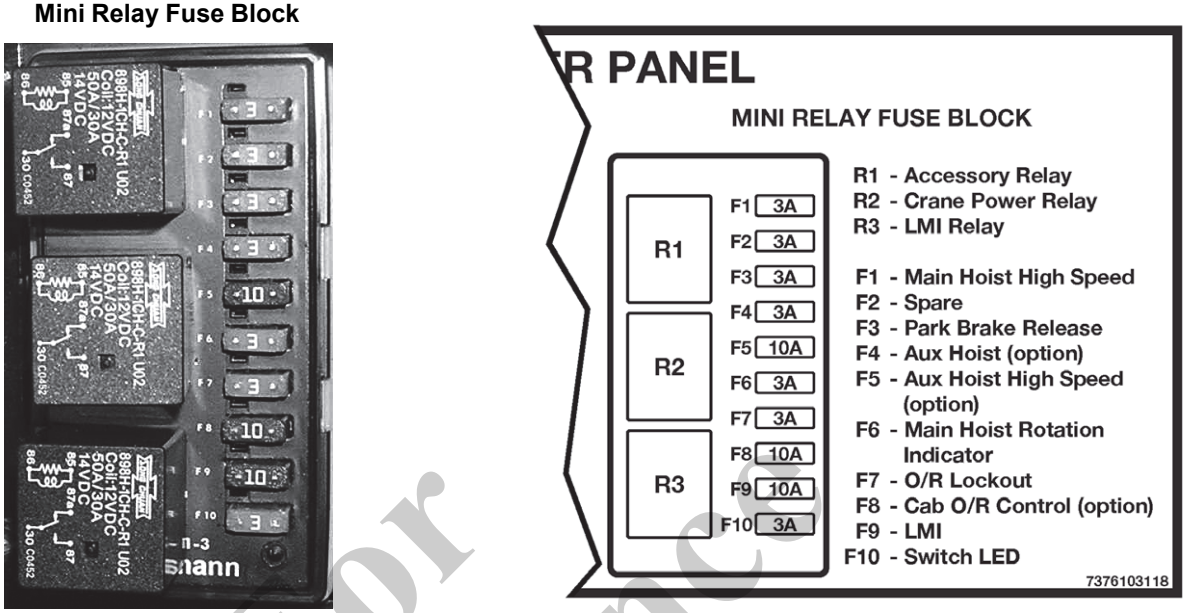


FIGURE 3-3

Mini Relay Fuse Block

The mini relay fuse block is located on the right and contains the following components:

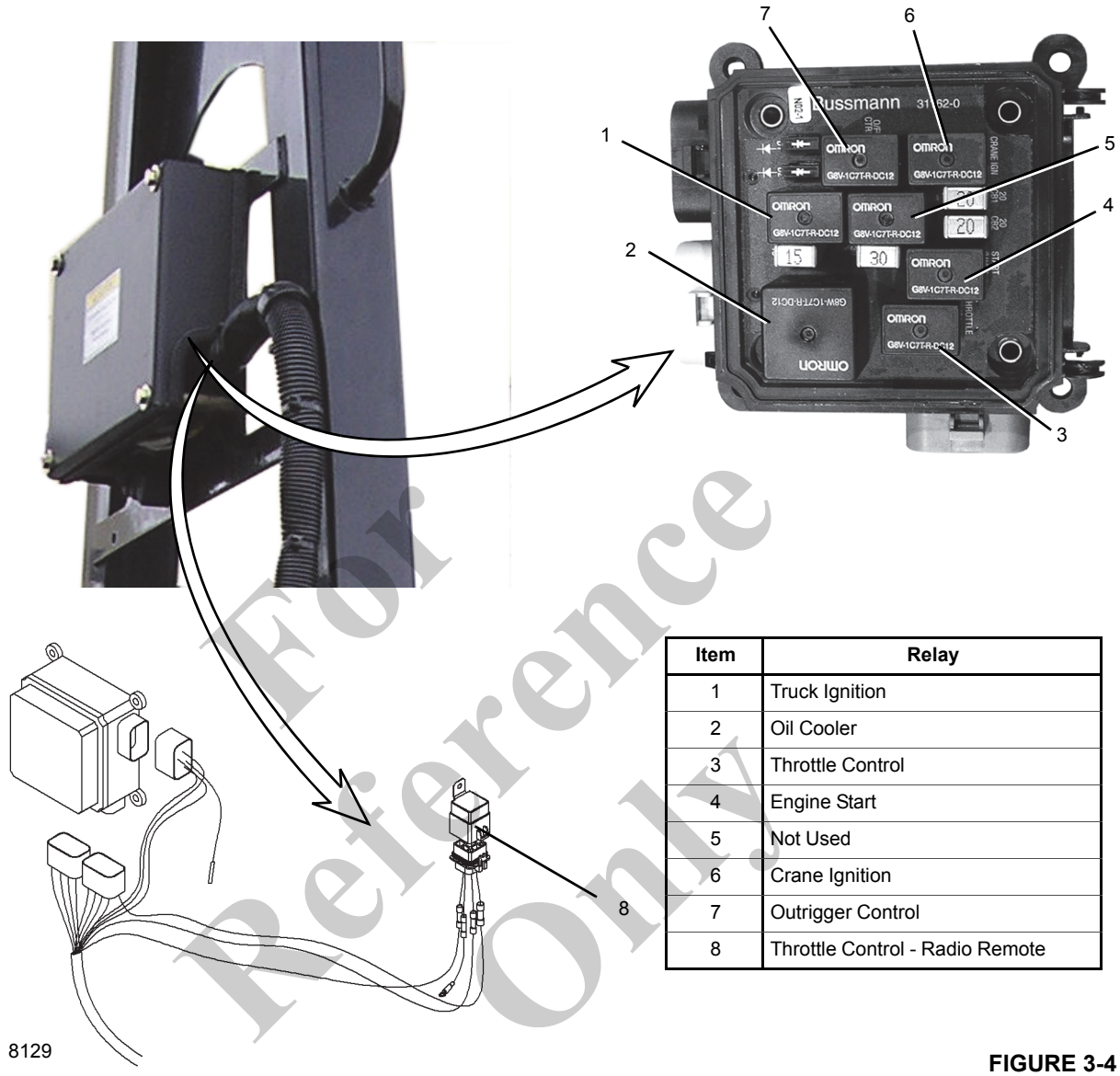
- R1 - Accessory relay supplies power to micro fuse block F1 through F10 when energized by the crane ignition switch.
- R2 - Crane power relay supplies power to mini fuse block F1 through F10 when energized by the crane power switch.
- R3 - Supplies power to the RCL dump solenoids when not at capacity, not two-blocked, or when overridden.
- F1 - Main hoist burst of speed circuit.
- F2 - Spare
- F3 - Park Brake Release circuit for the swing brake switch on the crane cab console.
- F4 - Auxiliary hoist circuit (optional).
- F5 - Auxiliary hoist high speed circuit (optional)
- F6 - Main hoist rotation indicator circuit.
- F7 - Outrigger Lockout circuit disables the outriggers when the crane function power switch is on.
- F8 - Cab Outrigger circuit for outrigger control from the crane cab (optional).
- F9 - RCL dump valve solenoid circuit.
- F10 - Switch LED's on the crane cab console.

Horn Alarm Circuit

The horn alarm sounds in the following conditions:

- The operator depresses the horn switch on the front console.
- The operator leaves the operators seat without turning off the crane function power switch.
- The operator depresses the horn switch in the left armrest.

Fault	Check
Horn switch does not activate horn	• Fuse F2 in micro fuse block • Horn switch
Seat safety switch does not activate horn	• Fuse holder in crane cab console (Figure 3-1 Item 5) • Horn relay R4 in micro fuse block • Horn alarm relay R3 in micro fuse block
Armrest horn switch does not activate horn	• Fuse F2 in micro fuse block • Horn switch



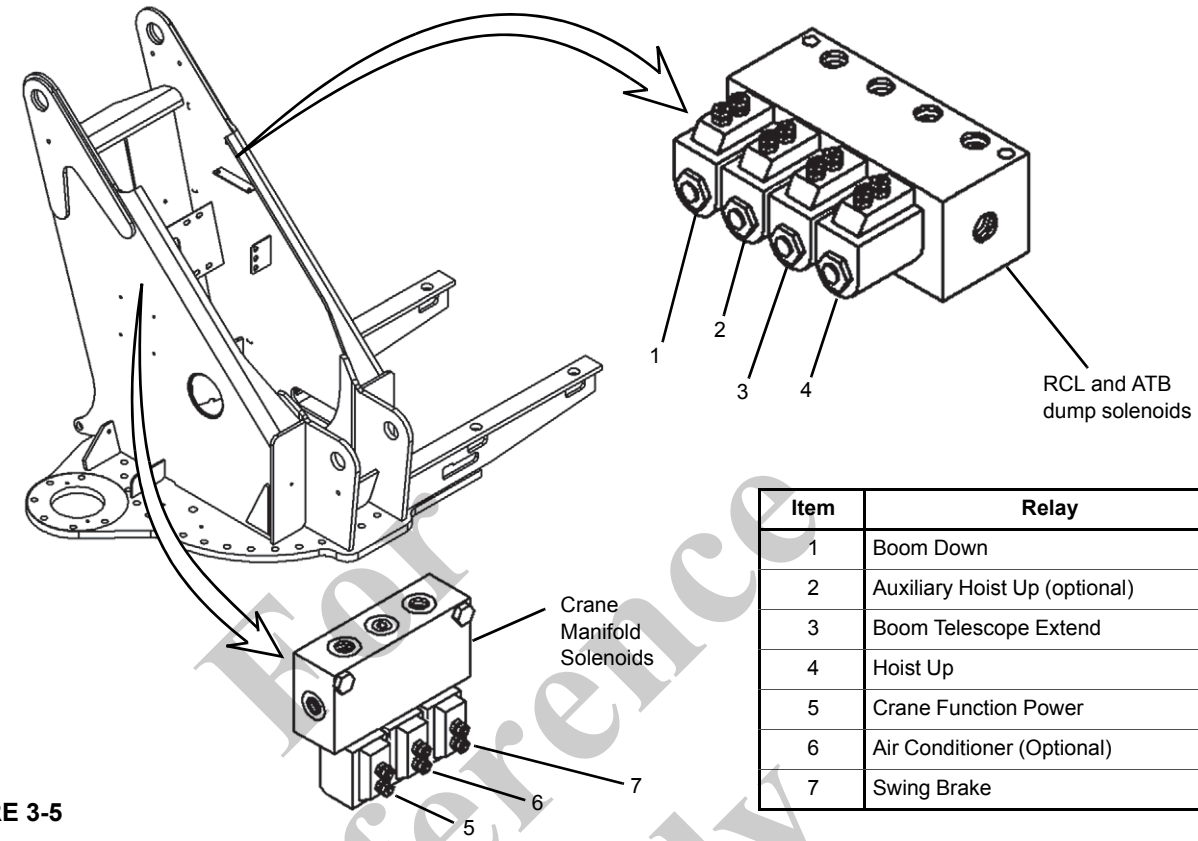
Item	Relay
1	Truck Ignition
2	Oil Cooler
3	Throttle Control
4	Engine Start
5	Not Used
6	Crane Ignition
7	Outrigger Control
8	Throttle Control - Radio Remote

FIGURE 3-4

VEC MODULE

The Vehicle Electrical Center (VEC) module is located in an enclosure 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 throttle control relay bump-up for the radio remote (8) is only used for International engine.
- 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.



Item	Relay
1	Boom Down
2	Auxiliary Hoist Up (optional)
3	Boom Telescope Extend
4	Hoist Up
5	Crane Function Power
6	Air Conditioner (Optional)
7	Swing Brake

FIGURE 3-5

RCL, ATB, and Crane Manifold Solenoids

The RCL and ATB solenoids are located in the turret and 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. Boom Down
2. Auxiliary Hoist Up (Optional)
3. Boom Telescope Extend
4. Hoist Up

The crane manifold solenoids are located in the turret and provide for the following operations.

5. Crane Function Power - enables all crane functions when energized.
6. Air Conditioner - runs the air conditioner compressor when energized.
7. Swing Brake - applies the swing 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 R3 in the mini fuse block • Fuse F9 in the mini fuse block • Faulty RCL override switches • Fuse F6 in micro fuse block • Faulty crane power switch
Burst of speed solenoid fails to energize	• Faulty BOS switch • Fuse F1 on the mini fuse block. • Faulty solenoid
Crane function power solenoid fails to energize	• Faulty crane power switch • Faulty solenoid • Fuse F4 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 3-6) and the rear outrigger manifold is mounted at the rear of the truck under the T-box (Figure 3-7).

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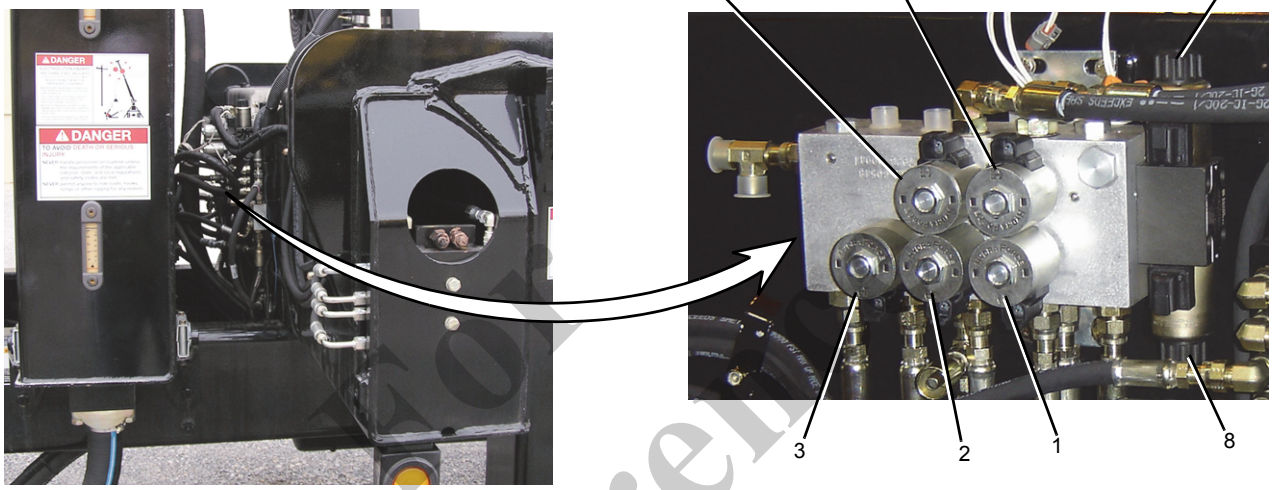
The swing and outrigger functions are on the same hydraulic circuit however, only one function at a time can be working. When the crane function power switch is turned ON, the outrigger manifolds are disabled.

FIGURE 3-6



Item	Solenoid
1	Passenger Side Stabilizer
2	Passenger Side Beam
3	Single Front Outrigger (SFO)

Item	Solenoid
4	Driver Side Beam
5	Driver Side Stabilizer
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.

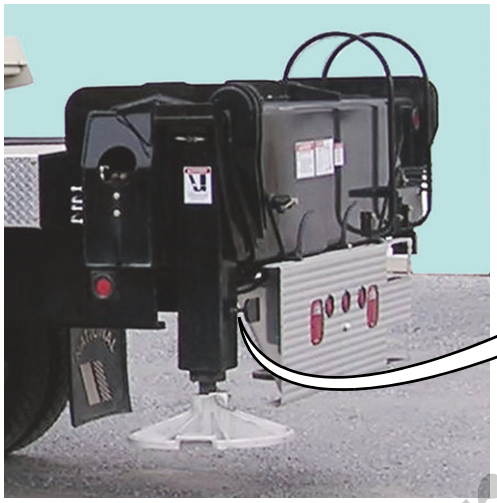
The solenoids on the front outrigger manifold provide the following functions:

NOTE: When the crane function power switch in the crane cab console is turned ON, all outrigger functions

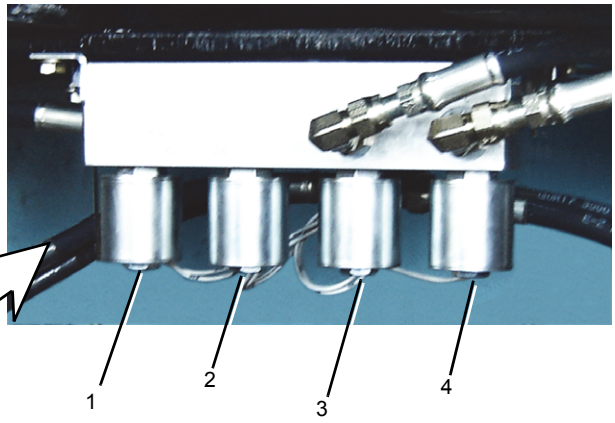
- The SFO (3) solenoid extends or retracts the SFO when energized. Any time the retract switch on the outrigger control is depressed, the SFO is first up.
- The component solenoids (2 through 5) control the front outrigger components. See Figure 3-6 for solenoid identification.
- The extend (7) retract (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 3-7 (1 through 4) for solenoid identification.



NOTE: Solenoid as viewed from the rear of the truck.



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

FIGURE 3-7

HYDRAULIC OIL COOLER

The hydraulic oil cooler (Figure 3-8) 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).

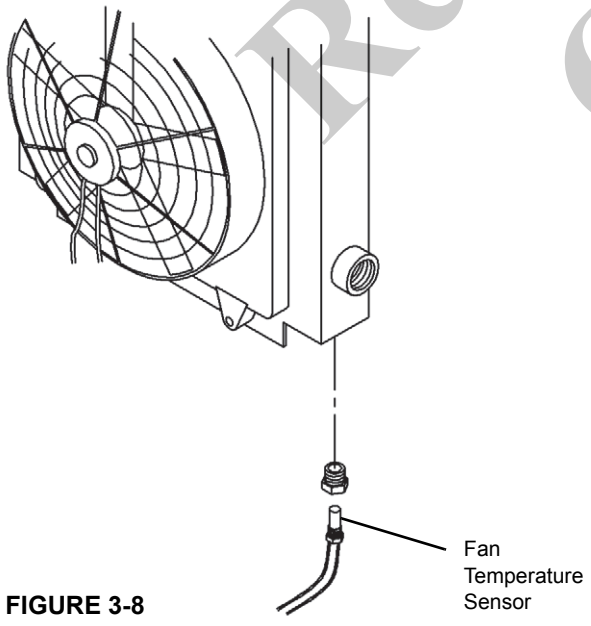


FIGURE 3-8

Not all return flow is routed through the oil cooler. A check valve 206 kPa (30 psi) 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 following:

- Electric Fan
- Fan Relay
- Temperature Senor

The temperature sensor 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 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

FOUR SECTION BOOM

A two-stage double-acting telescope cylinder, is attached to the 1ST, 2ND and 3RD boom sections. The telescope cylinder supports and propels the 2ND and 3RD boom sections.

The 4TH section extend cables are attach to the base end of the 2ND section boom, reeved around sheaves at the front on the telescope cylinder, and attached to the base of the 4TH boom section.

The 4TH section retract cables are attached to the front of the 2ND boom section, reeved around sheaves at the back of the 3RD boom section, and attach to the back the 4TH boom section.

The 3RD section retract cables are attached to the front of the 1ST boom section, reeved around sheaves at the back of the 2ND boom section, and attach to the back of the 3RD boom section.

A proportioning cable is attached to the rear of the 1ST section, reeved around a sheave at the front of the 2ND section, and anchored to the rear of the 3RD section to maintain proper cylinder extension proportion. Detailed service and maintenance is required to insure smooth and proper operation.

For information about cable tensioning, see “Cable Tensioning” on page 4-17.

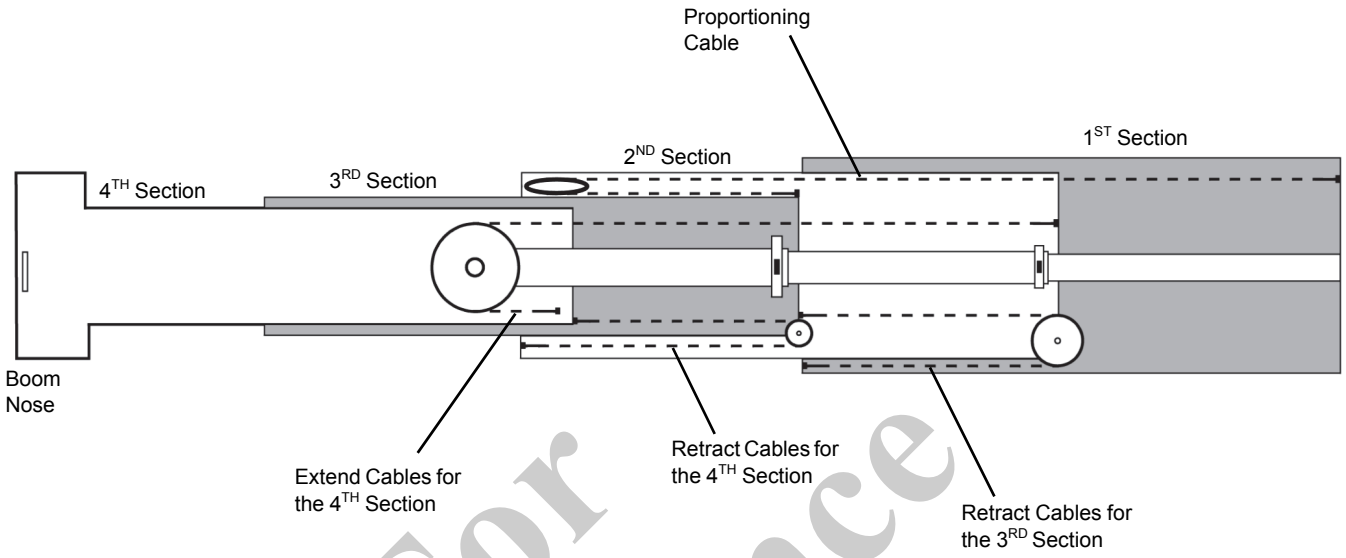


FIGURE 4-1

BOOM REMOVAL

1. Extend and set machine outriggers. The boom must be completely retracted and stowed in the boom rest.
2. If equipped, remove swing around jib according to procedures outlined in the operators manual.
3. Remove hook block or down haul weight and:

- wind up the rope on the hoist drum
- stow the wedge socket on the pegs on the 1ST section
- shut down truck engine

4. Attach a lifting device to rod end of lift cylinder and:

- remove boom lift cylinder pin keeper and pin from bottom of the 1ST section boom.
- lower lift cylinder to a suitable support.

5. Tag and disconnect extend cylinder lines and hoist hydraulic lines. Cap all open lines and ports.
6. Attach a lifting device to provide even weight distribution and raise the boom until weight is removed from the boom pivot pin. Remove the boom pivot pin keeper and boom pivot pin. Lift the boom free of the turret.

BOOM DISASSEMBLY

The boom can be disassembled by using two different methods.

a. Alternative #1 disassembles the boom in the conventional manner.

b. Alternative #2 removes the extend cylinder from the rear of the boom, after removal of the hoist. This feature facilitates cylinder service without complete boom teardown.

For reference, left and right are viewed from the rear of the boom. The hoist is mounted at the rear of the boom.

Use the procedures outlined below to service the boom while still pinned to 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.

1. Extend and set all outriggers and SFO.
2. Fully retract the boom and place in a horizontal position.
3. Hoist removal optional.

Boom Disassembly Alternative #1

NOTE: If wear pads and shims are removed, tag all shims and wear pads for proper reinstallation.

1. From the rear of the boom, loosen the capscrews that secure the keeper plates, the extend cable anchor, and the retract cables in the rear of the 3RD section. Remove the keeper plates.
2. Extend boom about 60 cm (24 inches).

- Remove the nuts which secure the extend cables to the cable anchor plate.
- Tag and disconnect the hydraulic lines from the extend cylinder.

3. Place the extend cables inside the boom and slide the cable anchor plate out of the side of the hoist mount (hoist removed).
4. Remove the two capscrews, lockwashers, and spacers that anchor the extend cylinder rod butt plate to the rear of the 1ST section.
5. Remove the two capscrews and lockwashers that secure the spacer bar to the inside top of the front of the 1ST section. Remove spacer bar.
6. Remove the four capscrews that secure the wear pads to the bottom of the 1ST section. Removal of side wear pads is optional. Adequate clearance exists between adjoining section side pads for boom disassembly. If the side pads are removed, tag all pads, and shims for proper reassembly.
7. Support the 2ND-3RD-4TH assembly at the front with an adequate lifting device. Raise the 2ND-3RD-4TH assembly inside the 1ST section and remove the bottom wear pads.
8. With the 2ND-3RD-4TH assembly supported, slide the assembly out of the 1ST. Relocate the sling point on the 2ND-3RD-4TH assembly for proper balancing of the assembly as it slides out of the 1ST section. Keep tension on retract cables as the assembly is pulled out of the 1st to minimize the chance of retract cable damage.
9. Place 2ND-3RD-4TH assembly on a suitable horizontal surface. Take care not to pinch or crush retract cables while lifting or supporting assembly.
10. Lift the top rear wear pads on the 2ND section off the cam plates. Do not remove or loosen the capscrews holding the cam plates to the 2ND section. This affects the side clearance during reassembly.
11. Remove the four capscrews securing the rear bottom wear pads on the 2ND section. This pad serves as a wear pad and retract cable keeper under the retract sheaves. Remove this pad to remove the retract cables from the retract sheaves. Place the retract cable ends in a location to minimize the possibility of damage.
12. Remove the six capscrews securing the retract sheave pin and the retract sheaves to the 2ND section. Remove the sheaves and pins.
13. Remove the two capscrews functioning as the upper retract cable keepers. Remove the retract cables.
14. Remove the two capscrews securing lock bar to the extend cylinder collar. This bar constrains the vertical movement of the extend cylinder. Remove the bar.
15. Loosen capscrews retaining the extend cable anchor to back of the 4th section.

- Remove the capscrews to dissemble the cable anchor.
- Back the capscrews out about 12 mm (0.50 inch) so that the anchor assembly can slide back and out of the section as the extend cylinder is removed.

16. Support extend cylinder with an appropriate lifting device and pull the extend cylinder out of the boom while keeping the extend cables tensioned slightly by hand to minimize the possibility of damage to the cables. Pull cylinder to within 91 cm (3 feet) of complete removal from the boom sections.
17. Reach into the rear of the 4TH section and pull the extend cable anchor out from its retaining pocket on the bottom of the 4TH section. A slight angle applied to the anchor as it's being pulled to the rear permits easier removal through the 2ND and 3RD sections.
18. Remove the extend cylinder from the boom. Do not allow the sheaves to fall off the front end of the extend cylinder. Remove the extend cables. Place the cylinder and cables in suitable area to prevent possible damage.
19. Remove the two capscrews, cable guide, wear pad, and spacer bar from the front top of the 2ND section.
20. Remove the four capscrews that secure the bottom pad plate to the 2ND section. Slightly lift the 3RD section, and remove pad plate.
21. Slide the 3RD section out of the 2ND section. Removal of the side pads is optional. If the side pads are removed, tag all shims, pads, and corresponding locations for proper re-assembly.
22. Remove the two capscrews, cable guide wear pad, and spacer bar from the front top of the 3RD section.
23. Remove the four capscrews attaching the bottom pad plate to the 3RD section. Slightly lift fourth section, and remove pad plate.
24. Slide the 4TH section out of the 2ND section. Removal of the side pads is optional. If the side pads are removed, tag all shims, pads and corresponding locations for proper reassembly.
25. Remove all remaining capscrews and wear pads from the sections.

Boom Disassembly Alternative #2

The extend cylinder can be removed from the rear of the boom without disassembly of the boom sections. This allows quick access to the cylinder, retract cables, and various internal boom components for service or replacement. If this procedure is used for disassembly, reverse procedure for reassembly, or locate the appropriate step in the assembly procedure in this manual to start reassembly from.

⚠ DANGER

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

1. Remove the hoist and anti-two block components.
2. From the rear of boom, remove capscrews securing the extend cable anchor in the rear of the 4TH section. Remove two capscrews securing lock bar to extend cylinder and remove the lock bar
3. Remove the nuts which secure the extend cables to the extend cable anchor in the back of the 2ND section.

- Remove the capscrews from keeper plates holding extend anchor in place.
- Remove the keepers.
- Remove the anchor.

4. Place extend cables inside the boom and slide the cable anchor plate out of the side of the hoist mount.
5. Remove the two capscrews, lockwashers, and spacers which anchor the extend cylinder rod butt plate to the rear of the 1ST section.
6. Using an appropriate lifting device, lift the extend cylinder up and out of retaining slots on rear of 2ND and 3RD sections. Retracting the cylinder with an external hydraulic power source during this step may be necessary.
7. Pull the cylinder out through the rear of boom assembly approximately one-half the length of the cylinder. Turning of the butt plate and rod 90 degrees may aid in sliding cylinder through the hoist mount area. Keep the extend cables tight to minimize the possibility of damage.

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 inch) 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 section one. 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 in all wear pads.

FOUR SECTION BOOM ASSEMBLY

NOTE: Note: Do not use Loctite on any cable threaded ends. Always use the locknut and nut provided.

When initially assembling threaded ends of cables, thread the first nut on past the flat in the cables so adjustment can be made later.

1. Assemble the sheaves into 4TH section sheave case. Install the top sheave to the left side of the boom with the spacer to the right side.
2. Attach the rear wear pads on bottom of 4TH section. Using Loctite 243, on all wear pad mounting capscrews.
3. Install 4TH section boom into 3RD section. Slide together approximately 152 cm (5 feet).
4. Assemble bottom front wear pads for 3RD section and Teflon wear plugs. Attach pads to pad plate.
5. Lift the 4th section with a lifting device to allow for wear pad/pad plate installation in front of the 3RD section. Install the wear pad/pad plate assembly. Slide the sections together within 30 cm (12 inches) of full retraction.
6. Install the cable guide and upper spacer to front of 3RD section.
7. Install the front side wear pads with appropriate shims between 4TH and 3RD sections. If the boom has been disassembled, and no sections have been replaced, reinstall the shims as removal tags.

8. Install the top rear wear pads and cam plates to the top of the 4TH boom section. Install the capscrews through the holes in outer boom sections.

The wear pads on each side at the top rear of the boom can be adjusted over a range of 4.8mm (3/16 inch) by rotating, end for end, the wear pad and plate together or independently. The holes in these parts are offset from the center and various combinations of rotation of these parts allow the adjustment.

9. Uncoil the 4TH section retract cable assemblies and insert the button end into anchors in back of the 4TH section. Place uncoiled cable in area that will minimize the potential for damage.

10. Uncoil the 3RD section retract cables and insert the button end into cable anchor pockets in back of the 3RD section. Place the uncoiled cable in an area that will minimize the potential for damage. Assemble the retract sheaves and sheave pins in the rear of the 3RD section. Coat the surfaces of the bearings and keeper plates with grease before assembly.

11. Place the retract cables anchored to 4TH section over the top of the retract sheaves on the 3RD section. Install the keeper capscrew above the sheave to hold the retract cables in place.

12. Reeve the cables over retract sheave and install the keeper with wear pad to the bottom rear of the 3RD section. This pad acts as a side pad, bottom pad, and cable retainer. Use Loctite 243 on wear pad hardware. Loctite all wear pad mounting capscrews.

13. Loop the 3RD section extend cable in half and place it on the top of the 3RD section with the loop end towards the front and the threaded and button end towards the rear of the section.

14. Install the clamp plate and capscrews with the button end of the cable installed in the anchor slot on the top rear of the 3RD section.

15. Place the sheave pin and sheave for the 3RD section extend cable in position on the front of the boom. Loop the cable around the sheave.

16. Slide the 3RD and 4TH section assembly into the 2ND section about 152 cm (5 ft). Be careful not to damage or cross the retract and upper extend cables attached to the 4TH-3RD section assembly.

17. Assemble bottom front wear pads and Teflon plugs for the 2ND section. Attach the pads to the pad plate.

18. Using an appropriate lifting device, lift the 3RD and 4TH section and install the wear pad and plate in front of the 2NDsection. Slide sections together within 30 cm (12 inches) of full retraction.

19. Install the cable guide and spacer to the top of the 2ND section.

20. Install the front side wear pads with appropriate shims between 3RD and 2ND sections. If no boom sections have been replaced, reinstall shims and wear pads as per removal tags.

21. Assemble the top rear wear pads and cam plates and install to the top of the 3RD boom section from the back of the boom. Install the capscrews through the holes in outer boom sections.

The wear pads on each side at the top rear of the boom can be adjusted over a range of 4.8mm (3/16 inch) by rotating, end for end, the wear pad and plate together or independently. The holes in these parts are offset from the center and various combinations of rotation of these parts allow the adjustment.

22. Position the sheave and sheave pin located in the cable loop on top of 3RD section to allow capscrew installation through top plate of the 2NDsection. Clamp the sheave pin and sheave to the bottom of the 2ND section top plate and install the capscrews and torque to specification.

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

24. Place retract cables anchored to 3RD oven top retract sheaves attached to rear of 2ND. Install keeper capscrew above sheave to hold retract cables in place.

25. Reeve the cables oven the retract sheave and install the keeper and wear pad to bottom rear of 2ND section. This pad acts as a side pad, bottom pad, and cable retainer.

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

27. Coil about of 304 cm (10 ft) extend cable around the extend sheaves. Make the coil about 20 cm (8 inches) in diameter. Install the cable anchors for the extend cable at the button end finger tight.

28. Install the wear pad over the extend cylinder sheave side plates. This keeps the end of the extend cylinder centered in the boom and is the extend cable retainer.

29. Slide the extend cylinder with extend cables into 2ND-3ND-4TH boom assembly enough to assemble the extend cable anchor into bottom rear of 4TH section. Be careful not to damage the extend cable when inserting the cylinder into boom sections.

30. Tighten the capscrews clamping extend cable anchor together. This also locks the anchor in the anchor cutouts in the 4TH section.

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

32. As the extend cylinder nears complete insertion into the 2^{ND}-3^{ND}-4^{TH} section assembly, adjust the height of the cylinder to allow the cylinder anchor collars to access the cylinder keeper cutouts in the doubler plates on the sides of the 2^{ND} and 3^{RD} sections.

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

34. Install the lock bar and capscrews to the extend cylinder collar in the 3^{RD} section.

35. Install the large extend cable anchor into anchor cutouts in the doubler plates in the near of the 2^{ND} section. Route the 22.22 mm (7/8 inch) extend cables through the anchor and the small 11.11 mm (7/16 inch) cable over the anchor. Slide the anchor fully into cutout.

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

37. Install 2^{ND}-3^{N}-4^{TH} section boom assembly into 1^{ST} section boom. Use caution when sliding sections together because the 3^{RD} section retract cables must maintain position to prevent damage. Do not let the boom rest on cables or damage will result.

38. Assemble bottom front wear pads for 1^{ST} section and Teflon wear plugs.

39. Use an appropriate lifting device and lift the 2^{ND}-3^{ND}-4^{TH} section assembly to allow for wear pad installation in front of 1^{ST}. Install the wear pads. Slide the sections together within 30 cm (12 inches) of full retraction.

40. Install the upper spacer to front of 1^{ST} section.

41. Install the front side wear pads with the appropriate shims between 2^{ND} and 1^{ST} sections. If the boom has been disassembled, and no sections have been replaced, reinstall shims as per removal tags.

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

43. Assemble the top rear wear pads and cam plates to the top rear of the 2^{ND} boom section. Install the capscrews through the holes in outer boom sections.

The wear pads on each side at the top rear of the boom can be adjusted over a range of 4.8mm (3/16 inch) by rotating, end for end, the wear pad and plate together or independently. The holes in these parts are offset from the center and various combinations of rotation of these parts allow the adjustment.

44. Install the thick hoist attachment bar through hoist mount. This bar anchors the 11.11 mm (7/16 inch) extend cable and serves as the upper hoist attachment point. Hold this bar up in its slot with a spacer on each side. This will facilitate easier assembly.

45. Install the threaded end of the 11.11 mm (7/16 inch) extend cable through hole in center of the hoist attachment bar.

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

47. Install hoist and anti-two block system.

FIVE SECTION BOOM

The five section boom is powered by a two-stage double-acting hydraulic cylinder. The cylinder is attached to and supports the 1ST, 2ND, and 3RD boom sections. Extend and retract cables in the boom extend and retract the 3RD, 4TH, and 5TH sections. The 5TH boom section extend cables are attached to the base of the 3RD section, reeved around sheaves at the tip of the 4TH section, and attached to the base and support the 5TH section. The 3RD boom section retract cables are attached to the base of the 5TH section, reeved around sheaves at the base of the 4TH section, and attached to the tip of the 3RD section. The 4TH boom section extend cables are attach to the base of the 2ND section, reeved around sheaves at the tip of the 3RD section, and attached to the base and support the 4TH section. The 2ND boom section retract cables are attached to the base of the 4TH section, reeved around sheaves at the base of the 3RD section, and attach to the tip of the 2ND section. The 3RD boom section extend cables are attached to the base of the 1ST section, reeved around sheaves at the tip of the 2ND section, and attach to the base of the 3RD section. The 3RD boom section retract cables are attach to the base of the 3RD section, reeved around sheaves at the base of the 2ND section and attached to the tip of the 1ST section.

The 3RD section retract cables are directly oppose the 3RD section extend cables to ensure that the 2ND and 3RD sections extend and retract equally at all times. The 4TH section retract cables directly oppose the 4TH section extend cables to ensure that the 3RD and 4TH sections extend and retract equally at all times. The 5TH section retract cables are directly oppose the 5TH section extend cables to ensure that the 4TH and 5TH sections extend and retract equally at all times.

For information about cable tensioning, see “Cable Tensioning” on page 4-17.

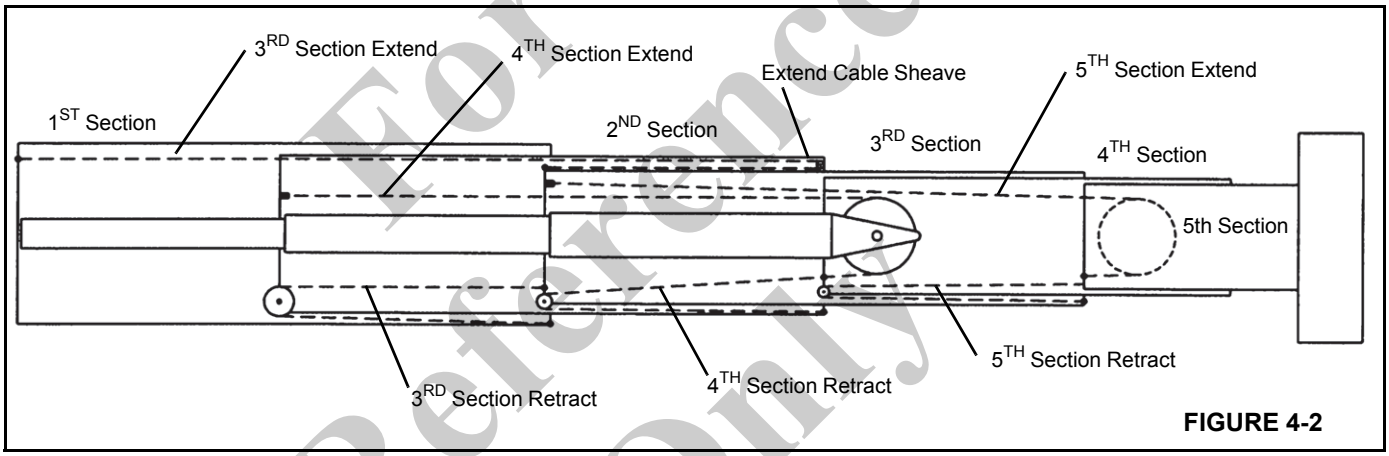


FIGURE 4-2

DANGER

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

Internal Cable Sheave Lubrication

Special Tools: Nozzle or needle grease gun fitting. The lubrication points on the sheaves are not equipped with grease fitting, therefore a 6.35 mm (0.25 inch) diameter nozzle grease gun tip is required. Contact the National Crane Product Support Department to obtain this nozzle tip, or numerous variations of the nozzle tip can be purchased at local hardware or auto parts retail outlets.

NOTE: A small amount of grease extrusion around the internal sheaves is sufficient lubrication. From the front of the boom, look back through the boom nose to observe the extend sheaves. From the back of the boom, look up through the hoist mount to observe the retract sheaves.

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

1. Extend the boom 198 cm (78 inches) per section 792 cm (26 ft) for a five section boom.
2. Visually check alignment between the grease access holes for the retract sheaves, when the holes align, the end of the extend cable sheave pin will be accessible through a hole in the 3RD section side plate for lubrication.
3. Grease all pins accessible at this boom length location with nozzle grease gun fitting.

NOTE: The extend cable sheaves located at the top front of the 2ND section can be accessed from any boom length.

Five Section Boom Removal

1. Extend and set the outriggers and single front outrigger. The boom must be completely retracted and stowed in boom rest over the front of the truck.
2. If equipped, remove the swing around jib according to procedures outlined in the Operator's Manual.
3. Remove hook block or down haul weight, wind up rope on hoist drum and stow wedge socket becket on pegs provided on 1ST section. Shut down truck engine.
4. Attach a lifting device to rod end of lift cylinder, remove boom lift cylinder pin keeper and pin from bottom of 1ST section boom. Lower lift cylinder rod end to the deck.
5. Tag and disconnect the extend cylinder and hoist hydraulic and electric lines. Cap all openings. Unplug anti-two-block/RCL from the receptacle in turret.
6. Attach a lifting device to provide even weight distribution and raise the boom until weight is removed from the boom pivot pin. Remove boom pivot pin keeper and boom pivot pin. Lift boom free of turret.

Five Section Boom Disassembly

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

⚠ DANGER

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

Steps 1 through 3 apply to a boom that is to be disassembled with the 1st section and jib (if equipped) left on crane.

1. Extend and set all outriggers and SFO.
2. Fully retract boom and place it in a horizontal position.
3. Tag and disconnect the hydraulic lines to the telescope cylinder. Cap all lines and fittings.
4. Loosen and remove the fasteners attaching the extend cylinder butt plate to the base of the 1st section boom.
5. Mark the location of the hex nuts which secure the 3RD section extend cables to the hoist bar. Remove the nuts and washers from 3RD section extend cables, and leave the cable ends draped inside the boom.
6. Attach a sling or chain to the front of the 2ND section boom, pull the 2ND-3RD-4TH-5TH assembly out of the 1ST section about 30 cm (12 inches).
   - Remove the front upper spacer bar from 1ST section.
   - Remove and tag the four side wear pads and shims from the front of the 1ST section.
   - Lift the 2ND-3RD-4TH-5TH assembly off of bottom pads.
7. Remove four capscrews which retain the lower front pad plate to the 1ST section.
   - Remove the pad plate.
   - Remove upper back wear pads and cam plates from 2ND section.
   - Pull the retract cables out and keep retract cables taunt while pulling the 2ND-3RD-4TH-5TH assembly out of the 1ST section. Support the base end of the 2ND as it exits the 1ST stage boom.
8. Place 2ND-3RD-4TH-5H assembly on a suitable horizontal surface. Take care not to damage the retract cables while lifting or supporting the 2ND-3RD-4TH-5H assembly.
9. Remove the lower L-pads, retract cables, and retract cable retaining capscrews from rear of 2ND section.
   - Remove retract cable retaining plates from the rear of the 3RD section.
   - Remove 3RD section retract cables from anchor pocket in 3RD section.
10. Remove retaining capscrews from cylinder anchor channels in the rear of the 2ND section. Remove upper top wear pads and cam plates from upper rear of the 3RD section.
11. Remove the cable guide and upper spacer bar cable retainers from the front top of the 2ND section.
    - Attach a sling or chain to the tip of the 3RD section boom and pull the 3RD-4TH-5TH assembly out of the 2ND section about 30 cm (12 inches).
    - Keep the 3RD section off of the lower wear pads.
12. Remove the capscrews retaining the 3RD section extend sheaves to the top plate of the 2ND section. This allows the sheaves, pins, and extend cables to lay on the top plate of the 3RD section.
13. Remove the four capscrews which retain the lower front pad plate to the 2ND section.
    - Remove the pad plate.
    - Remove and tag the four side wear pads with shims from front of the 2ND section.
    - Pull the retract cables out and keep retract cables taunt while pulling the 3RD-4TH-5TH assembly out of the 2ND section.
    - Support the base end of the 3RD section as it exits the 2ND section boom.

14. Place the 3RD-4TH-5TH assembly on a suitable horizontal surface. Take care not to damage the retract cables while lifting or supporting the 3RD-4TH-5TH assembly.
15. Remove 3RD section extend cables from the top of the 3RD section by removing the anchor plates and capscrews at the rear of the section, place cables in a area to avoid damage.
16. Remove the lower L-pads, retract cables, and retract cable retaining capscrews from rear of 3RD section.
    - Remove retract cable retaining plates from the rear of the 4TH section.
    - Remove 4TH section retract cables from the anchor pocket in the 4TH section.
17. Remove the lock bar and hardware from extend cylinder collar anchor pocket in the 3RD section.
    - Lift the butt plate end of the cylinder up to disengage the cylinder from its anchor pockets in the 3rd section.
    - Slowly pull cylinder out of the 3RD 4TH 5TH assembly. Keep the 4TH section extend cables taunt and in position to avoid damage as cylinder exits boom assembly.
    - Remove the 4TH section extend cable anchor in the 4TH section as the end of the cylinder nears the anchor position.
18. Place cylinder assembly on a suitable horizontal surface. Take care not to damage the extend cables while lifting or supporting the cylinder assembly. To remove the cables from the cylinder:
    - Remove the tapered wear pads on the front of the cylinder assembly.
    - Remove the cables through the access opening when the tapered wear pads were removed.
19. Remove cable guide and upper spacer bar from the front top of the 3RD section.
    - Loosen and remove hex nuts from threaded ends of 5TH section extend cables at rear of 3RD section.
    - Remove top rear wear pads and cam plates from top of 4TH section.
20. Attach a sling or chain to front of the 4TH section boom and pull the 4TH-5TH boom assembly out of the 3RD section about 30 cm (12 inches). Keep the 4TH section off of the lower wear pads.
21. Remove the 4 capscrews which retain the lower front pad plate to the 3RD section.
    - Remove the pad plate.
    - Remove and tag four side wear pads with shims from the front of the 3RD section.
    - Pull the retract cables out and keep retract cables taunt while pulling the 4TH-5TH section assembly out of the 3RD boom section.
    - Support the base end of the 4TH section as it exits the 3RD boom. section
22. Place 4TH-5TH boom assembly on a suitable horizontal surface. Take care not to damage the retract cables while lifting or supporting the 4TH-5TH boom assembly.
23. Remove lower L-pads, retract cables, and retract cable keeper from rear of 4TH section, coil 5TH section retract cables inside of 5TH section. Remove upper top wear pads and cam plates from upper rear of 5TH section.
24. Remove cable guide and upper spacer bar from the front of the 4TH section. Remove side wear pads for the cable retainer from front of 4TH section, leave 5TH section extend sheaves and 5TH section extend cables in place.
25. Attach sling to the front of the 5TH section boom and pull the 5TH section out of the 4TH until there is about 90 cm (36 inches) of the 5TH still inside in the 4TH section. Use caution to keep 5TH section extend cables from damage as boom sections slide apart. If possible keep tension on 5TH section extend cables from the base end of the 4TH boom section during this procedure.
26. Lift 5TH section off the lower pads and remove pads and hardware. Remove 5TH section extend sheaves and hardware.
27. Slide 5TH section completely out of 4TH section. Support the base end of the 5TH as it exits the 4TH section boom. Place 5TH section boom on a suitable horizontal surface.
28. Remove the cable retainers and hardware from side anchor locations on the 5TH section. Remove the 5TH section extend and retract cables from anchor points in the side of the 5TH section. Place in a suitable area to avoid damage.
29. Remove the loadline sheaves by removing retainers and lightly tapping on sheave pin while removing sheaves and spacers until all sheaves are removed from boom sheave case.

Additional Maintenance, Disassembled Boom

1. Clean all boom sections and inspect for wear, dents, bent or crooked boom sections, gouged metal, broken welds or any abnormal conditions. Repair or replace as required.
2. Inspect all sheaves for excessive groove wear or abnormal rim wear. Replace as required.
3. Inspect all sheave bearings for excessive wear or cut inner liner material. If installed bearing diameter is 0.38

mm (0.015 inch) 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.
5. Replace cable assemblies as required. Lubricate all cable assemblies as required. Lubricate all cable assemblies before reinstalling them in boom.
6. Inspect all sheave pins for nicks, gouges or pitting due to rust in the bearing surface area. Replace if any damage is evident.
7. Inspect all grease fittings and grease paths in pins to ensure proper grease flow. Clean and replace as required.
8. Replace all lubricating plugs in all wear pads.

Five Section Boom Assembly

1. Assemble the sheaves into 5TH section sheave case. Install the top sheave to the left side of the boom with the spacer to the right side.
2. Attach the rear wear pads to the bottom of the 5TH section. Use loctite 243 blue on all wear pad mounting capscrews.
3. Position the 5TH section boom in front of the 4TH section boom.
   - Route the 5th section extend cables through the 4TH section boom.
   - With the threaded end of the extend cable at the rear of the 4TH section and the button end out the front, loop the front button end of the extension cable beyond it's anchor point on the 5TH section and install the button end into 5TH section boom.
4. Install 5TH section retract cable button end into anchor point in 5TH section
   - Install the keeper plate and capscrews. The keeper plate locks both the extend and retract cables in place.
   - Coil 5TH section retract cables temporarily into 5TH section
5. Install 5TH section into 4TH section about 100 cm (3 feet). Take care not to damage 5TH section extend cables. They should be laying on the extended lip of the bottom plate of the 5TH section.

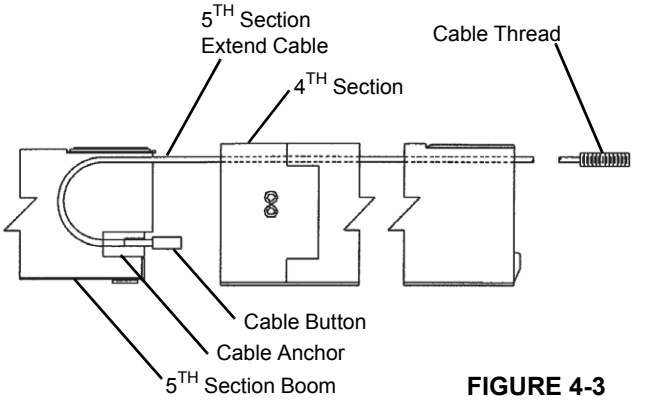


FIGURE 4-3

6. Install 5TH section extend sheave pins and bearings into the 5TH section extend sheaves.
   - Install wear plugs into the holes on each side of the extend sheaves.
   - Loop 5TH section extend cables around the 5TH section extend sheaves and slide the sheaves between the 4TH and 5TH boom sections. Make sure the grease hole in the pin is orientated correctly before attaching pin to 4TH section.
   - Install the countersunk capscrews attaching 5TH section extend sheave pins to 4TH section.
7. Raise the 5TH section against the top of the 4TH section and install the bottom wear pads between the 4TH and 5THsections. Lower 5TH section onto pads.
8. Install side wear pads with appropriate shims on front inside of the 4TH section boom.
   - Install the upper spacer bar and cable guide with wear pad and related hardware on the top of the 4TH section.
   - Shim per removal tags or according to calibration instructions.
9. Push the 5TH section completely inside the 4TH section until it bottoms out on the doubler plates in the rear of the 4TH. Keep 5TH section extend cables tight when installing the section. A scribe mark on the 5TH at full retraction aids in the cable tensioning for proper boom sequence later.
10. Uncoil 5th section retract cables out of 5TH section.
    - Assemble 4TH section retract sheaves and pins into the inside of the 4th section rear with the proper hardware and Loctite 243.
    - Reeve the cable over sheave.
    - Install the upper keeper capscrew and lower rear pad. This pad serves as a cable keeper.

11. Install 4TH section retract cable button end into anchor point in 4TH section.

- Install keeper plate and capscrews.
- The keeper plate is installed temporarily to keep the button ends in place during this phase of the assembly. It needs to come back out during cylinder and 4TH section extend cable installation. Coil the 4TH section retract cables temporarily into 5TH section.

12. Assemble top rear wear pads with the cam plates to the top of the 5TH section.

To adjust the wear pads, rotate the wear pad and plate together or separately end for end. The wear pad can be adjusted over a range of 4.8 mm (3/16 inch).

This is possible because the holes in these parts are offset from the center. The holes are 1.5 mm (0.06 inch) off center in the plate and 0.8 mm (0.03 inch) off center in the wear pad.

13. Pull threaded ends of 5TH section retract cable under the 4TH section towards front of boom.

14. Position the 4TH-5TH section assembly in front of 3RD section. Route the 5TH section retract cables to allow easy cable movement as the sections slide together.

15. Slide 4TH-5TH assembly into 3RD boom section about 90 cm (36 inches). Keep 4TH-5TH assembly suspended to avoid damage to 5TH section retract cables.

16. Assemble bottom wear pads on 3RD section pad plate. Raise 4th-5th assembly high enough to allow the plate with the pads to slide between the sections

- Place retract cables in the grooves in the bottom pad plate. As the boom sections are slid together, the retract cables are pulled through the grooves
- Fasten the pad plate to the bottom of the 3RD section with the appropriate hardware

17. Install a nut on the threaded ends of the 5TH section retract cables, to keep the cable ends from pulling through the anchor as the sections are pushed together.

18. Push the 4TH-5TH assembly inside the 3RD section, until it is within 90 cm (36 inches) of full insertion.

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

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

21. Assemble top rear wear pads with the cam plates to the top of the 4TH section. See step # 12 for pad installation detail.

- Uncoil 4TH section retract cables from of the 5TH section.
- Install the 3RD section retract sheaves and pins inside the rear of the 3RD section with the proper hardware and loctite 243.
- Reeve the cable over the sheave installing upper keeper capscrew and lower rear pad. This pad serves as a cable keeper and a lower and side pad for the rear of the section.

22. Pull threaded end of 4TH section retract cables, which are now under the 3RD section, towards front of boom.

23. Assembly step 22 completes the -3RD-4TH-5TH boom assembly. At this point the hydraulic extension cylinder and related cables and components are inserted into the 3RD-4TH-5TH section assembly starting with step 24.

24. Support extension cylinder in a workable location and install the 3 extend sheaves in the sheave case end of the cylinder. Position the pin so that the bearing grease holes are on the unloaded side of the pin (towards cylinder butt plate).

- Slide the pin in through the round area of keyway shaped slot.
- Install the sheaves one at a time as the pin is inserted through the sheave case.
- Align the slots in the pin with the square keyway side plate cut outs and push pin/sheaves towards cylinder butt plate into slot.

25. Install three 4TH section extend cables over the sheaves

- Place the button end through opening between the sheave and the front double tapered plate on the cylinder.
- After the cables are in place, install the plastic tapered cylinder pads on the top and bottom shelves of the cylinder sheave case.
- Apply loctite and jam nuts in these locations. The pads, when secured in place, act as cable retainers and wear pads.

26. Pull the three button ends through the extend cylinder sheave case until there is enough slack to install the 4TH section extend cable anchor.

27. Install the cable anchor on the extend cables. Tighten the capscrews just enough to clamp the two halves of the anchor so that the cables are prevented from escaping their positions. This allows easier assembly into the 4TH section anchor point.

28. Position the 4TH section extend cables that come off the top of the sheaves in an area to avoid damage, preferably on the top of the extend cylinder. This puts them in their approximate location as the cylinder is installed into the 3RD-4TH-5TH boom assembly.

29. Slide extend cylinder into the 3RD-4TH-5TH boom assembly approximately 90cm (36 inches).

- Raise the cylinder up at an angle slightly to allow easier access to the 4TH section extend cable anchor in the rear of the 4TH section.
- Install 4TH section extend cable anchor and cable ends into the anchor point.
- Install the keeper plates over the retract cable ends. The keepers are shaped to retain the 4TH section anchor as well as the retract cable ends.
- Tighten the capscrews holding the two halves of the 4TH section anchor assembly together.

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

31. Raise extend cylinder up to allow cylinder collar to slide through and align with the anchor pocket on the back of the 3RD section. The lower cylinder collar should move down into cylinder anchor pocket. Assemble the lock bar and proper hardware to the cylinder collar to retain the cylinder into the anchor pocket.

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

33. Lay the 3RD section extend cables on the top of the 3RD section with the proper sheaves and attach hardware. Arrange cables as shown below.

34. The 3RD-4TH-5TH section and cylinder assembly is now ready to install into the 2ND section boom.

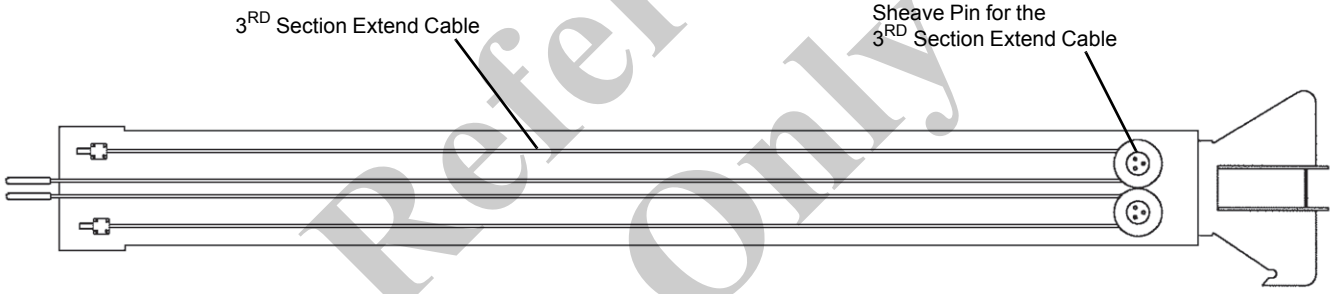


FIGURE 4-4

35. Slide the 3RD-4TH-5TH section and cylinder assembly into the 2ND section boom about 90 cm (36 inches). Keep the 3RD-4TH-5TH section and cylinder assembly suspended to avoid damage to the 4TH section retract cables.

36. Assemble the bottom wear pads on 2ND section pad plate

- Raise the 3RD-4TH-5TH section and cylinder assembly high enough in the 2ND section to allow the pad plate with pads to slide between the sections.
- Place the retract cables in the grooves in the bottom pad plate. As the boom sections slide together, the retract cables are pulled through the grooves
- Fasten the pad plate to the bottom of the 2ND section with the appropriate hardware.

37. Install a nut on the threaded ends of the 4TH section retract cables. This keeps the cable ends from pulling through the anchor as the sections are pushed together.

38. Push the 3RD-4TH-5TH section and cylinder assembly inside the 2ND section until it is within 90 cm (36 inches) of full insertion.

39. Install side wear pads with appropriate shims on front inside of the 2ND section

- Shim according to calibration instructions, or as pads were originally removed and tagged.
- Install 3RD section extend cable sheaves and pins in the 2ND section top plate.
- Assemble the cable keeper/spacer bar plates in 2ND section.

- Install the cable guide and wear pad to the top of the 2ND section.

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

41. A cylinder length adjustment may be necessary to properly position the cylinder collar in the anchor pocket with the 3RD section side plates. The collar bottoms out on the doublers in the rear of the 2ND section. A hydraulic power source may have to be utilized to adjust the cylinder length.

- Secure the extend cylinder collar to the cylinder mounting channels in the rear of the 2nd section boom with appropriate hardware.
- A scribe mark on the 3RD section at full retraction aids in cable tensioning for proper boom sequence later.

42. Install the top rear wear pads with the cam plates in the top of the 3RD section. See step #12 for pad installation detail.

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

44. Install the 2ND section retract sheaves and pins in the 2ND section boom. Use the proper hardware and Loctite 243.

- Reeve the 3RD section retract cables, anchored to 3RD section, over sheaves attached to 2ND section.
- Install the upper keeper capscrew and lower rear pad. The pad serves as a cable keeper, lower pad, and side pad for the rear of the section.

45. Pull threaded ends of 3RD section retract cables, now under the 2ND section, towards the front of the boom.

46. Suspend the assembled boom sections.

- Rotate the rod assembly to achieve proper orientation.
- Place the retract cables so as to avoid damage.
- Slide the assembled boom sections into the 1ST section about 90 cm (36 inches).
- Keep the boom assembly suspended to avoid damage to the retract cable.

47. Install the bottom wear pads on 2ND section pad plate.

- Raise the 2ND-3RD-4TH-5TH section and cylinder assembly high enough in 1ST section to allow the plate with pads to slide between the sections.
- Place the retract cables in the grooves in the bottom pad plate. As the boom sections slide together, the retract cables are pulled through the grooves. Use appropriate hardware and fasten the pad plate to the bottom plate of the 1ST section.

48. Install a nut on the threaded ends of the 3RD section retract cables to keep the cable ends from pulling through the anchor as the sections are pushed together.

49. Push the 2ND-3RD-4TH-5TH section and cylinder assembly inside the 1ST section, until it is within 90 cm (36 inches) of full insertion.

50. Install the side wear pads with the appropriate shims on the front inside of the 1ST section boom.

- Install upper spacer bar with appropriate hardware to the inside top of the 1ST.
- Shim according to calibration instructions, or as pads were originally removed and tagged.

51. Slide the 2ND-3RD-4TH-5TH section and cylinder assembly into the 1ST section until the extend cylinder butt plate contacts the back plate of the hoist mount.

- Use caution as the holding valve nears the hoist mount back plate. The holding valve to back plate clearance requires the butt plate to be level with the holding valve down.
- Use caution as the 3RD section retract cable threaded ends get close to the grooves in the lower front pad plate. Adjust as necessary to allow proper placement.

52. Install the proper hardware to secure the extend cylinder butt plate to the 1ST section hoist mount.

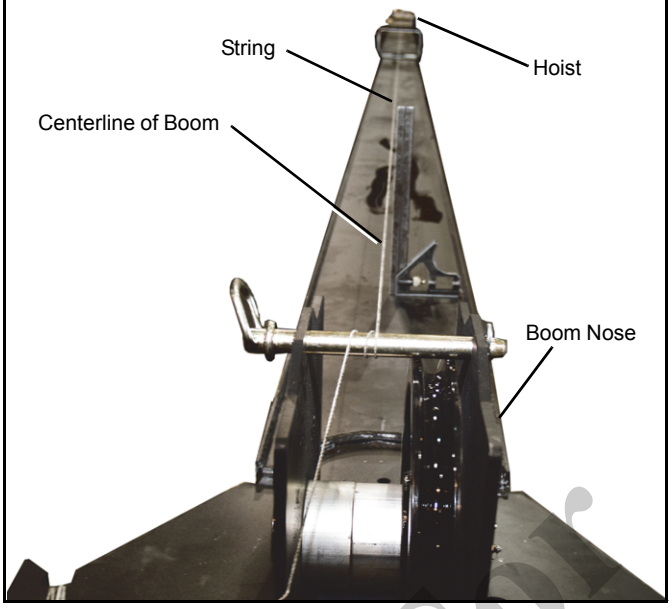
53. Assemble top rear wear pads with the cam plates to the top of the 2ND section. See step #12 for pad installation detail.

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

Boom Straightness

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

FIGURE 4-5



Top/Rear Wear Pad Adjustment

The top/rear wear pads are adjustable so that the rear of each boom section can be adjusted to the horizontal center of each successive section.

1. Fully retract the boom.
2. Center each successive boom section horizontally with a pry bar.
3. The mounting holes for the top/rear wear pads are off center which allows the wear pads to be adjusted horizontally. Rotate the pad and plate or each one independently to get the proper adjustment.

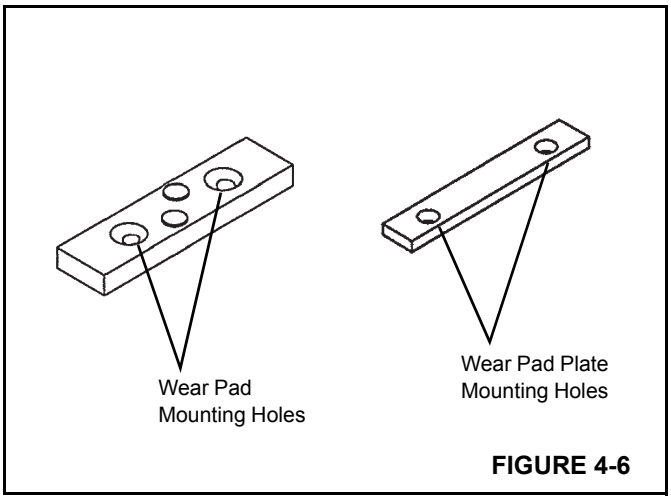


FIGURE 4-6

Wear Pad Inspection

Inspect the top and bottom wear pads periodically for signs of abrasion or excessive wear. Excessive is defined as 4.8 mm (3/16 inch) less than the original pad thickness. Original pad thicknesses are:

- top rear pad 19 mm (0.75 inch).
- bottom front sections 13 mm (0.44 inch).

Uneven pad wear of 2 mm (3/32 inch) from side to side on the wear pad would be considered excessive as well. If any of these conditions exist, the top and bottom pads can be replaced without complete disassembly of the boom.

Top Rear Pad Replacement

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

1. Retract boom completely.
2. Remove the capscrews through access holes on top rear of sections.
3. Remove wear pads, and shim plates from the rear of the boom through open hoist mount end.
4. Note all pad locations and tag accordingly.
5. Inspect pads as described in wear pad inspection. See “Wear Pad Inspection” on page 4-14.
6. Install the new pads through hoist mount end of boom. See “Top/Rear Wear Pad Adjustment” on page 4-14 for pad adjustment.

Front Bottom Pad Replacement

1. Extend boom about 120 cm (4 ft).
2. Remove the cable guides and upper spacer bars from front of boom sections.
3. Loosen and remove hex nuts on retract cables on the front of the 1ST and 2ND sections.
4. Using an appropriate lifting device, sling around the 4TH or 5TH depending on configuration section boom and lift it up until weight is removed from the bottom pads in the front of the interior sections.
5. Loosen and remove the capscrews holding the pad doubler plates in the front of the sections. Remove plates. Remove pads from these plates. Note all pad locations and tag accordingly.
6. Inspect pads for wear.See “Wear Pad Inspection” on page 4-14.

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

Inner Side Pad Clearance

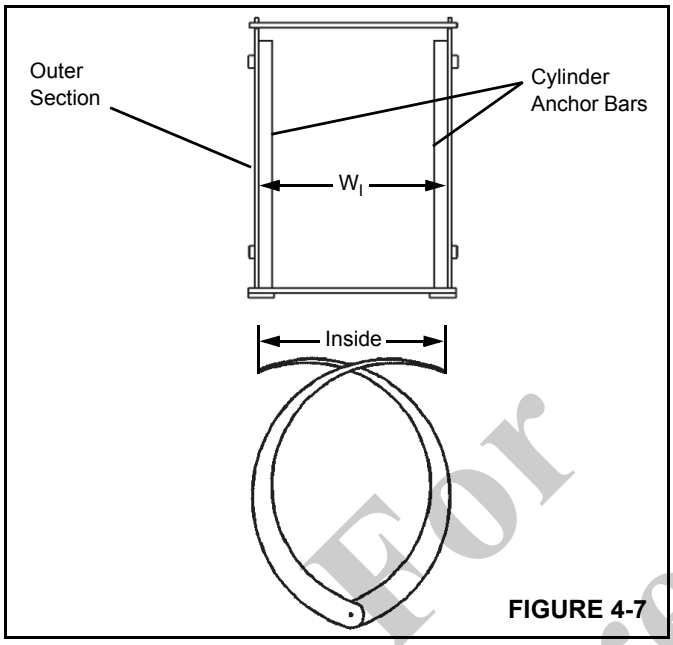


FIGURE 4-7

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

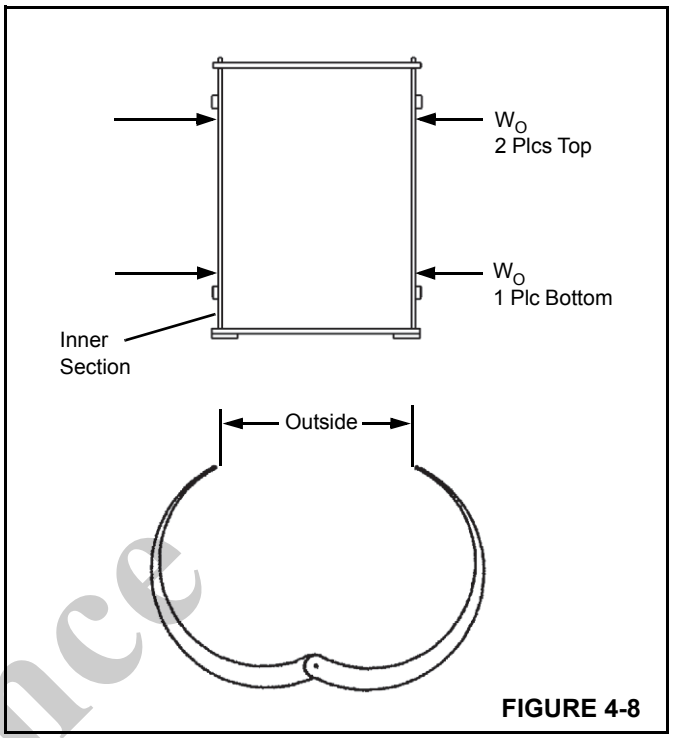


FIGURE 4-8

2. With the inside/outside calipers, measure the outside width of the inner section (W_0) at each side pad location. Record the largest measurement.

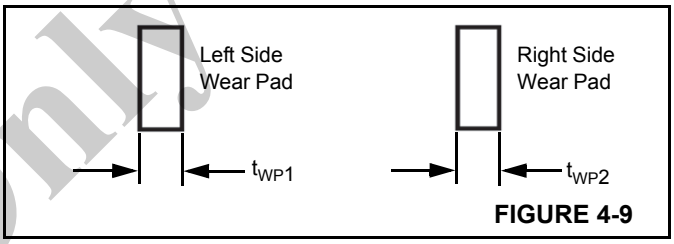


FIGURE 4-9

3. Measure the thickness t_{WP} of the left t_{WP1} and right t_{WP2}wear pads and record.

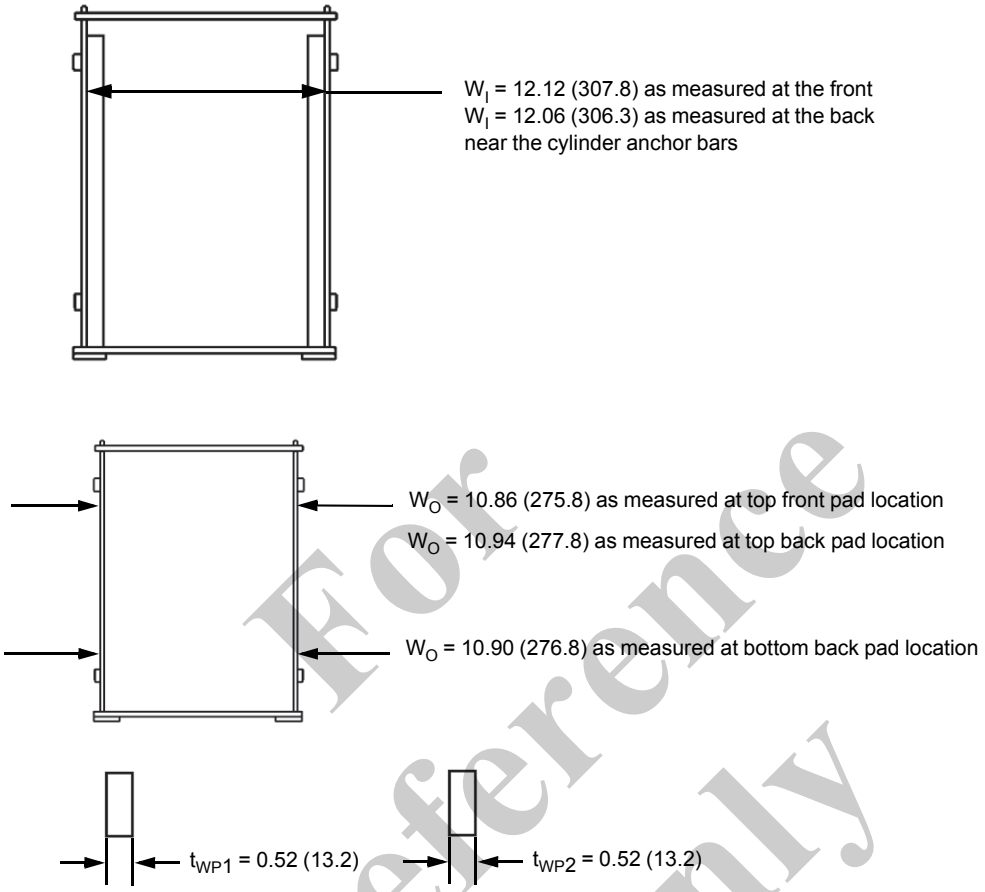
4. Subtract the largest outside width (W_0) of the inner section plus the thickness of the two pads (t_{WP}) from the smallest inside width (W_I) of the outer section.

   $W_I - (W_O + t_{WP1} + t_{WP2})$ = Clearance Before Shims

NOTE: Shim Thickness = 0.76 mm (0.03 in)

5. Add shims as required to tighten the pads so that there is 0.8 mm to 2.3 mm (0.03 inch to 0.09 inch) clearance between the widest part of the inner boom and the most narrow part of the outer boom. In some cases, there will be an unequal number of shims behind the pads at the top and bottom side pad locations (See Figure 4-10).

Inner Side Pad Clearance Example



Top Rear Clearance (Inches)

$W_I - (W_O + t_{WP1} + t_{WP2})$ = Clearance Before Shims
12.06 - (10.94 + 0.52 + 0.52) = Clearance Before Shims
12.06 - 11.98 = 0.08
Shim thickness = 0.03
Clearance Before Shim - Shim(s) Thickness = Final Clearance
0.08 - 0.03 = 0.05

Bottom Rear Clearance (Inches)

$W_I - (W_O + t_{WP1} + t_{WP2})$ = Clearance Before Shims
12.06 - (10.94 + 0.52 + 0.25) = Clearance Before Shims
12.06 - 11.98 = 0.08
Shim thickness = 0.03
Clearance Before Shim - Shim(s) Thickness = Final Clearance
0.08 - 0.03 = 0.05

Top Rear Clearance (mm)

$W_I - (W_O + t_{WP1} + t_{WP2})$ = Clearance Before Shims
306.3 - (277.8 + 13.2 + 13.2) = Clearance Before Shims
306.3 - 304.2 = 2.1
Shim thickness = 0.7
Clearance Before Shim - Shim(s) Thickness = Final Clearance
2.1 - 0.7 = 1.4

Bottom Rear Clearance (mm)

$W_I - (W_O + t_{WP1} + t_{WP2})$ = Clearance Before Shims
306.3 - (277.8 + 13.2 + 13.2) = Clearance Before Shims
306.3 - 304.2 = 0.08
Shim thickness = 0.7
Clearance Before Shim - Shim(s) Thickness = Final Clearance
2.1 - 0.7 = 1.4

FIGURE 4-10

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

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

A single stage cylinder will control first extendable section.

A dual stage cylinder will control second extendable section.

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

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

CABLE TENSIONING

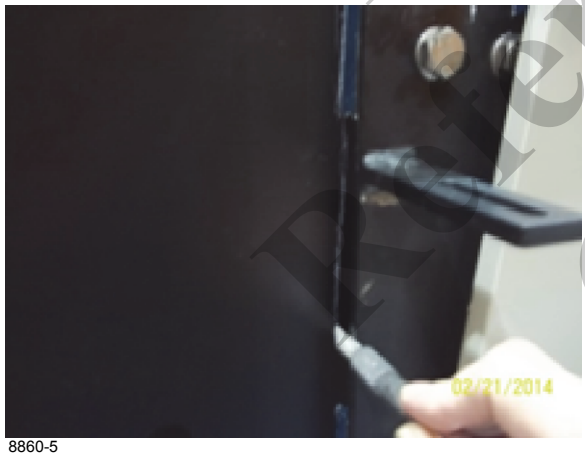
Tensioning Setup Procedure

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

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

Ensure boom is completely assembled and fully retracted.

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



8860-5


8860-6

FIGURE 5

Cable Tension Sequence

Five section boom with two stage cylinder.

Cable tensioning (See Figure 6) to be in the following order:

1. 321 retract cables
2. 123 extend (synchronizing) cables.
3. 234 extend cables
4. 432 retract cables.
5. 345 extend cables
6. 543 retract cables.

Four section boom with two stage cylinder.

Cable tensioning to be in the following order:

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

Four section boom with one stage cylinder.

Cable tensioning to be in the following order:

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

Three section boom with one stage cylinder.

Cable tensioning to be in the following order:

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

5 - Section Boom w/ 2 Stage Cylinder Cable Positioning

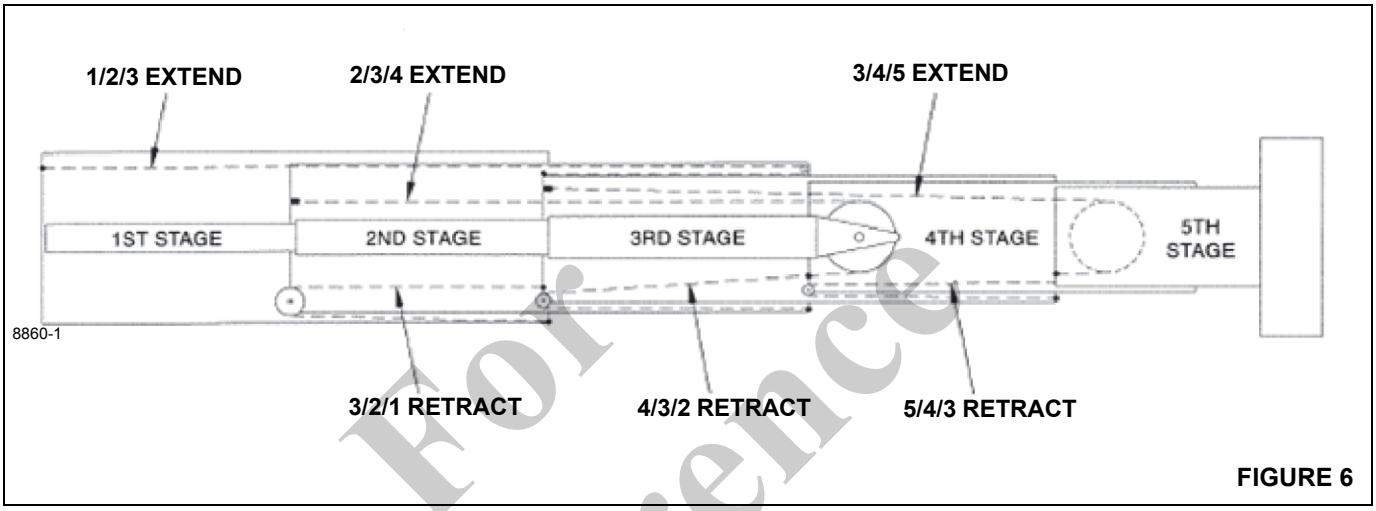


FIGURE 6

Cable Tightening Sequence 5 Section Boom with Two Stage Extend Cylinder

Boom must be in horizontal position when adjusting cable tension (See Figure 6.) Retract boom fully ensuring sections are bottomed out on section stops and do not spring back. (Reference Tensioning Setup Procedure)

321 and 123 cable balancing

Extension

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

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

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

The second section should have moved out.

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

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

Retraction

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

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

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

The third section should have moved out.

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

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

234 and 432 cable balancing

Extension

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

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

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

The fourth section should have moved out.

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

Retraction

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

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

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

The fourth section should have moved in.

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

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

345 and 543 cable balancing

Extension

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

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

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

The fifth section should move outward.

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

Retraction

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

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

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

The fifth section should have moved in.

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

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

4- Section Boom w/ 2 Stage Cylinder Cable Positioning

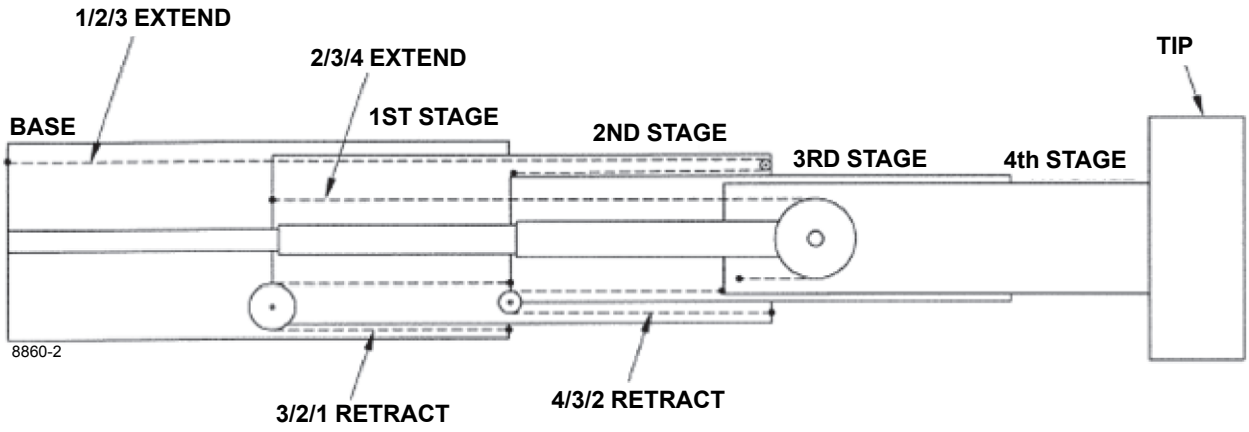


FIGURE 7

Cable Tightening Sequence 4 Section Boom with Two Stage Extend Cylinder

Boom must be in horizontal position when adjusting cable tension (See Figure 7.) Retract boom fully ensuring sections are bottomed out on section stops. Ensure all sections are fully bottomed out and do not spring back.(Reference Tensioning Setup Procedure)

321 and 123 cable balancing

Extension

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

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

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

The second section should have moved out.

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

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

Retraction

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

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

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

The third section should have moved out.

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

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

234 and 432 cable balancing

Extension

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

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

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

The fourth section should have moved out.

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

Retraction

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

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

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

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

The fourth section should have moved in.

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

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

4- Section Boom w/ 1 Stage Cylinder Cable Positioning

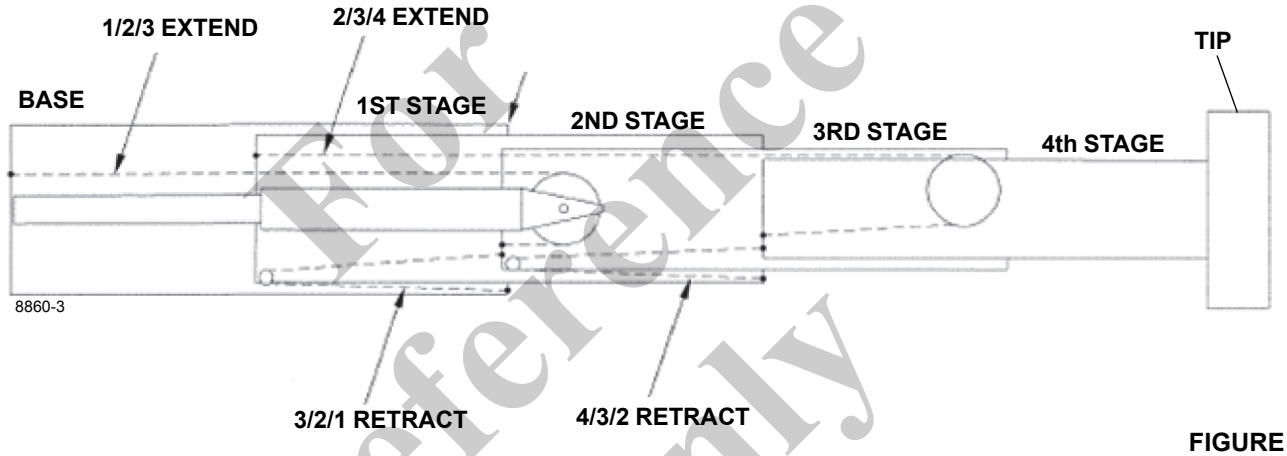


FIGURE 8

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

Boom must be in horizontal position when adjusting cable tension (See Figure 8.) Retract boom fully ensuring sections are bottomed out on section stops. Ensure all sections are fully bottomed out and do not spring back.(Reference Tensioning Setup Procedure)

321 and 123 cable balancing

Extension

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

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

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

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

The third section should have moved out.

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

Retraction

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

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

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

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

The third section should have moved in.

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

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

234 and 432 cable balancing

Extension

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

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

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

The fourth section should have moved out.

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

Retraction

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

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

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

The fourth section should have moved in.

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

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

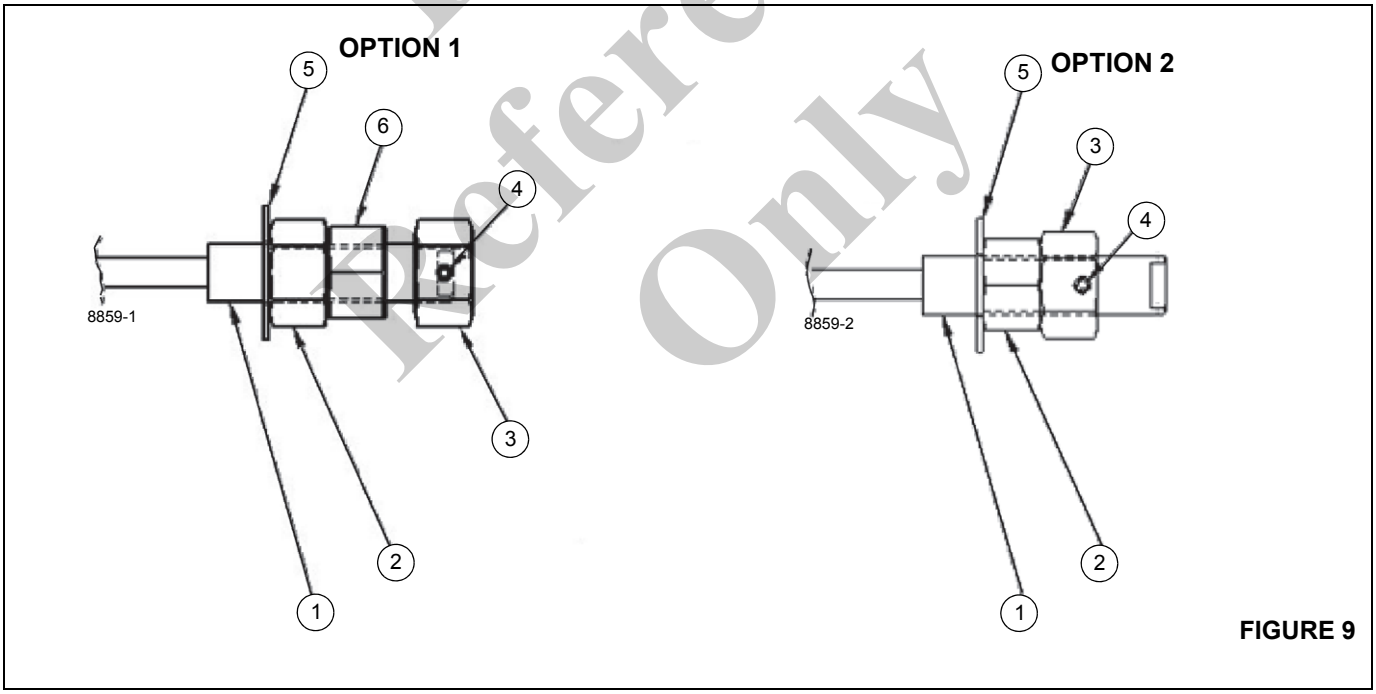


FIGURE 9

Cable Retention

Cable Retention Hardware

Item	Description
1	Threaded Cable End
2	Nut (Adjustment)

Item	Description
3	Nut (Positive Lock)
4	Setscrew
5	Washer
6	Nut (Torqued)

Nut configuration (see Figure 9) will be First Nut (ADJUSTMENT) and Second Nut (TORQUED).

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

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

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

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

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

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

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

Install set screw into Third nut and tighten.

(**OPTION 2**) method used ONLY when space constraints prevent **OPTION 1** usage (see Figure 9).

TORQUE VALUES for Second Nut:

Inch Series with Coarse Threads (UNC)

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

Metric Series with Coarse Threads

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

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SECTION 5
HOIST

SECTION CONTENTS

DESCRIPTION

The 1400A hoist is composed of motor control valve, a 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.

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 1,000 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.

5

Item	Component
1	Hoist
2	Brake
3	Motor
4	Motor Control Valve
5	Mounting Bolts

Item	Component
6	Alignment Ear
7	Boom
8	U-bolt
9	Rope Mesh Guard
10	Case Drain
11	Brake Hydraulic Pressure Line
12	Motor Hydraulic Pressure Line
13	Hydraulic Return Line
14	Alignment Slot

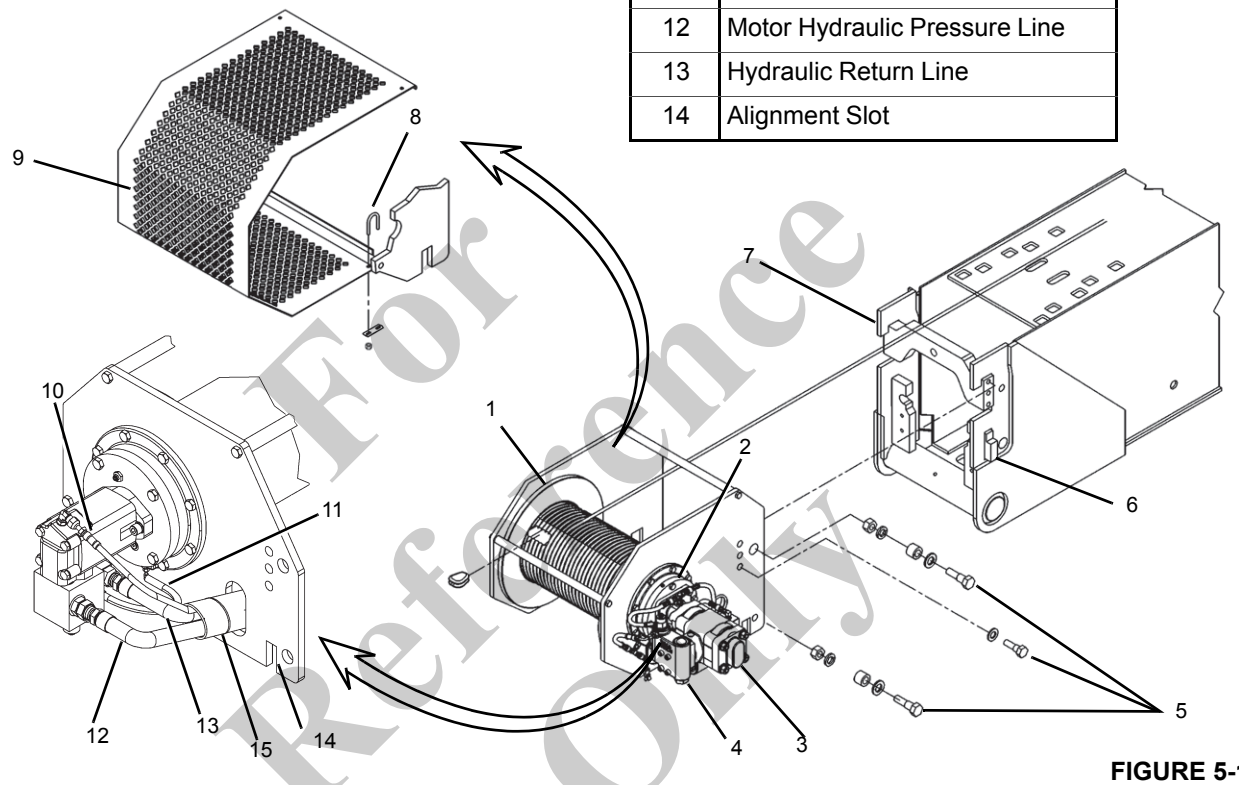

FIGURE 5-1

Warm-up Procedure

A warm-up procedure is recommended at each start-up and is essential if ambient temperature is below 4°C (+40°F). Run the crane at idle with the hoist control lever in neutral and allow sufficient time for the hydraulic system to warm up. Operate the hoist at low speeds, forward and reverse, several times to prime all lines with warm hydraulic oil and circulate lubricant through the planetary gear sets.

Removal

CAUTION

The combined weight of the hoist and 99 m (325 ft) of wire rope is 310 kg (685 lbs).

NOTE: See Figure 5-1 for item number (#) identification.

1. Remove the cable from the hoist drum.
2. Remove the U-bolts (8) and rope mesh guard (9).
3. Tag and disconnect the hoist hydraulic lines. Cap or plug all hydraulic openings.
4. Attach a lifting device to hoist and take up the slack.
5. Remove the mounting bolts (5) from the hoist.
6. Remove the hoist from the crane with the lifting device.

Hydraulic Hoses

1. Inspect the hydraulic hoses and replace as required.
2. Inspect the anti-chafing sleeve and replace as required.
3. Route replaced hydraulic hoses through the anti-chafing sleeve.

Hoist Installation

1. Remove the rope mesh guard from hoist and attach a lifting device to the hoist.
2. Lift the hoist with a lifting device onto the back of the boom.
3. Align the alignment slots on the hoist with the alignment ears on the boom and lower hoist onto the boom.
4. Install mounting bolts and washers.
5. Remove the lifting device.
6. Install the mesh guard and secure with the U-bolts.
7. Reinstall the hydraulic hoses as per removal tags.

DRUM ROTATION INDICATOR

The Drum Rotation Indicator (DRI) and Minimum Wrap Indicator (MWI) 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 Minimum Wrap Indicator (MWI) is programmed to notify the operator when there are three wraps of wire or synthetic rope left on the hoist drum.

The HMS is available with two systems, Series, "A" and Series "B". The HMS is available with a CAN J1939, (Series "B"), allowing the device to interface with the Rated Capacity Indicator (RCL) system.

Series "A" units can be distinguished by a single cable connection on the HMS, located on the left side of the hoist. Series "B" units have a second connection (CAN J1939) along with an integrated protection circuitry, acting as a circuit breaker, on the MWI and DRI (Thumper) outputs.

Removal

1. Loosen the collar on the connector and unplug the DRI cable (1, Figure 5-2).
2. Remove the two retaining screws (2).
3. Remove the DRI unit from the hoist.
4. Loosen set screw and remove shaft assembly from MWI.

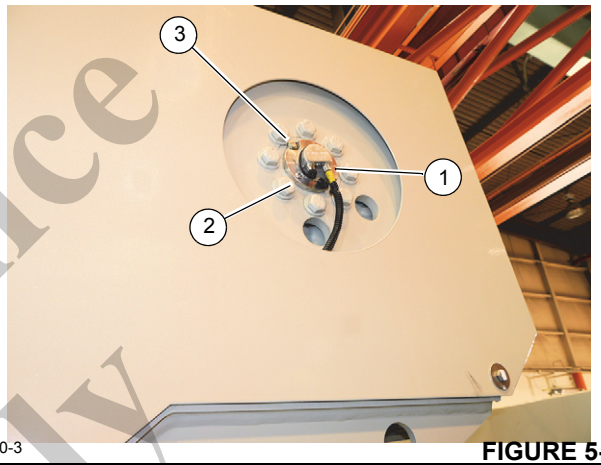

FIGURE 5-2

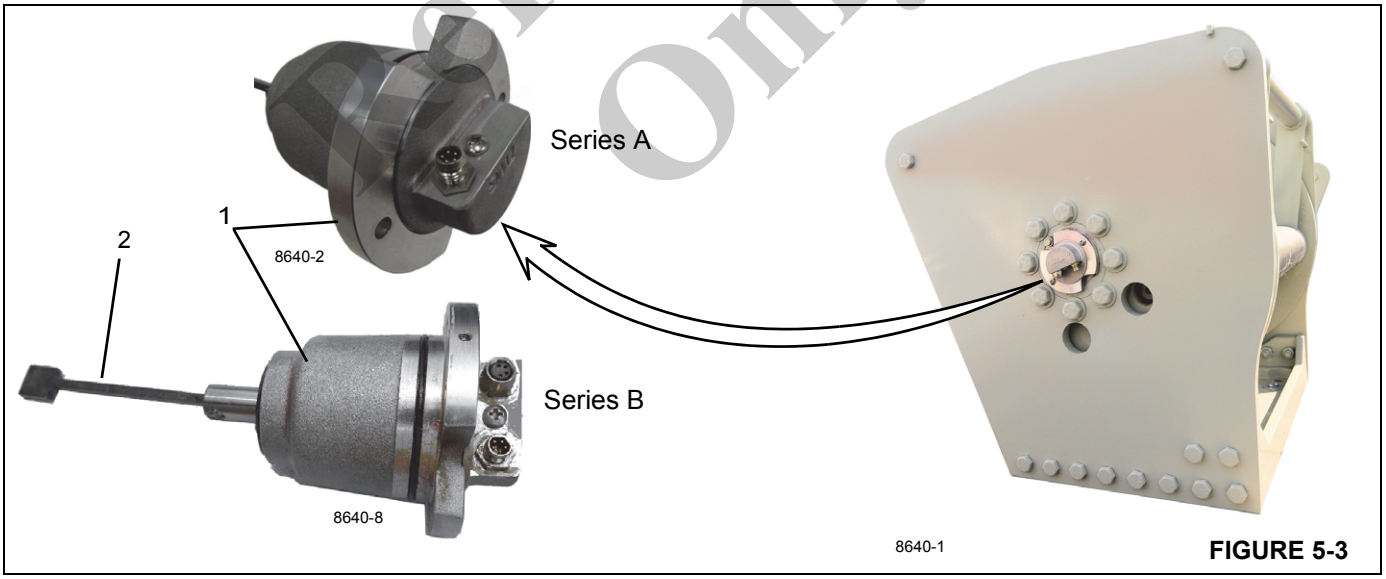

FIGURE 5-3

Installation

To install the DRI, use the following procedure:

1. Install shaft assembly into MWI.
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 5-3) 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 5-2).
6. Secure the DRI with the retaining screws (2, Figure 5-2).
7. Loosen the set screw (1, Figure 5-4) on the side of the DRI flange.
8. Using the spanner wrench holes (2, Figure 5-4) rotate the DRI so that the connector (3) is pointed down.
9. Tighten the set screw (1, Figure 5-4) after the DRI is positioned as desired.
10. Plug in the DRI cable and tighten the collar to secure the connector.

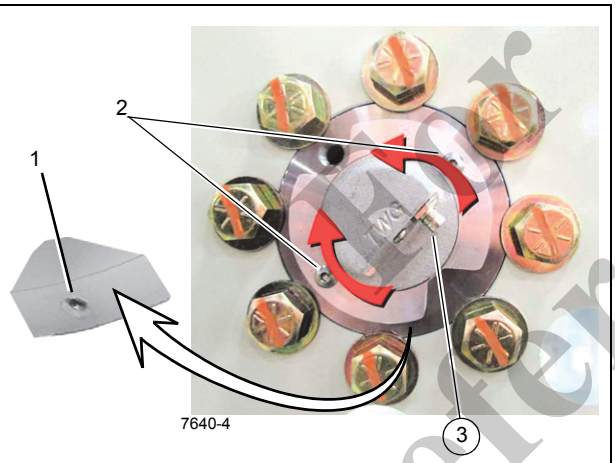

FIGURE 5-4

Programming the Minimum Wrap Indicator

The minimum wrap indicator (MWI) needs to be programmed to alert the operator when the cable is down to the third wrap of wire or synthetic hoist rope. To program the MWI 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 MWI by disconnecting the DRI cable (2, Figure 5-5).
3. Remove the sealed Hoist Monitoring System (HMS) programming button cover screw (1, Figure 5-5) on the DRI.
4. Push and gently hold the programming button (3, Figure 5-5) and return power to the MWI by reconnecting the DRI cable.

NOTE: Use an Allen Wrench or other small tool with a flat, blunt end approximately 1.5mm or (1/16") in width and at least 76 mm (3") in length. Use of a pointed or sharp tool can cause faulty setting or damage to the HMS. Excess force can damage the HMS operation.

5. Hold the programming button for at least 2 seconds, but less than 15 seconds, after power is applied and release.

NOTE: Holding the button for longer than 15 seconds puts the HMS into Shipping Mode for Series A units.(See Figure 5-5). 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 MWI/HMS programming screw. Tighten to 7 in-lbs.

NOTE: Failure to replace the programming screw (1, Figure 5-5) could effect the operation of the MWI.

9. The MWI setup routine is complete.

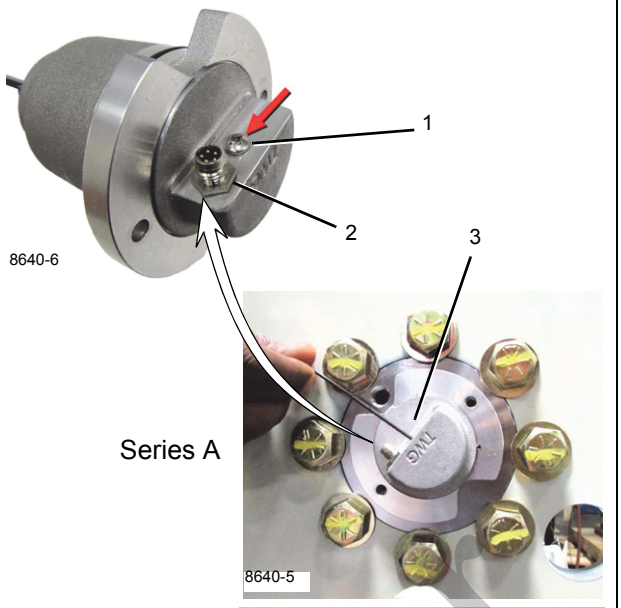

FIGURE 5-5

Shipping Mode (Series A Only)

If the programming button is held down for more than 15 seconds, the HMS will enter "Shipping Mode (Series A Only)." The HMS rapidly pulses the "Warning" output indicating the HMS is entering or exiting "Shipping Mode." While in "Shipping Mode", the HMS will pulse the "Warning" output two times with a 30 second pause.

Shipping Mode allows the OEM to set the set points on the cable before shipping to a job site. This prevents the need to recalibrate the set points when the winch is installed on the machine.

NOTE: The drum rotation indication, commonly a thumper handle, remains operational while the HMS is in shipping mode.

To use Shipping Mode:

1. Install the wire rope on the drum. Refer to the appropriate winch manual for more information.
2. See See “Programming the Minimum Wrap Indicator” on page 5-4 to set the end points.
3. Remove the programming button cover screw (1, Figure 5-5).
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 MWI/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 MWI 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

The following steps describe how to disassemble the hoist. Inspect and replace all worn parts.

1. Stand the hoist on its end with the motor pointing up. Place blocking under the side plate so the hoist is not sitting on the shaft (Figure 5-6).

NOTE: See Figure 5-7 for item number (#) identification.

2. Remove the brake hose (46) from the straight adapter (45).
3. Remove the motor and counterbalance assembly from the hoist by removing two capscrews (47) and two

lockwashers (44) holding motor (12-4) to the brake cover (20). See Servicing The Motor section for motor and counterbalance valve disassembly.

4. Remove the brake sub-assembly from the hoist by removing the eight capscrews (9) holding the brake housing to the side plate (41). Re-install two of these capscrews into the two extra tapped holes and tighten them evenly until the brake housing is loose from the side plate. Take note of the vent (30) location for reassembly. See Servicing The Brake section for brake repair.

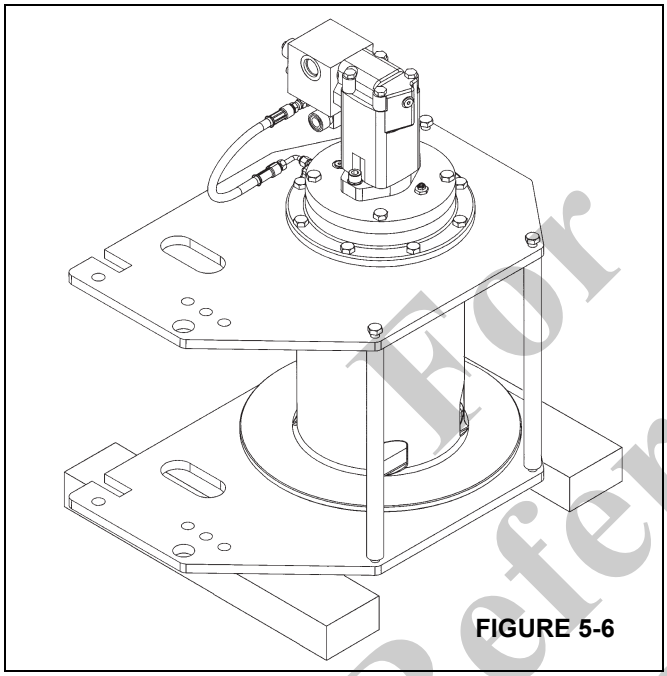

FIGURE 5-6

5. Remove the side plate (41) by removing the three capscrews (1).
6. Lift the bearing carrier (26) from the drum. If necessary remove and replace the bearing (28) and seal (7-4).
7. Remove the input sun gear (8) and thrust washer (6) from the input planet assembly (36).
8. Remove the input planet set (36) from the drum. Inspect the planet set for wear. See Servicing The Planetary Set section for disassembly and repair.
9. Remove the output sun gear (16) and thrust washer (6) from the output planet assembly (4).
10. Remove the output planet set (4) from the cable drum. Inspect the planet set for wear. See Servicing The Planetary Set section for disassembly and repair.
11. Remove the cable drum (5) and inspect the gear teeth for excessive wear. Remove and replace the bearing (28) and seal (7-4) located in the drum.
12. Inspect retaining ring (48) to insure it is still in groove and is not bent over.
13. If necessary remove output shaft (32) from side plate (29) by removing six capscrews (3) holding sideplate (29) to shaft (32). Take note of vent (30) location for reassembly.

Reassembly

NOTE: See Figure 5-7 for item number (#) identification.

1. Thoroughly clean all parts. Replace those that show wear or damage.
2. Inspect the cable drum (5) for structural integrity and replace if necessary.
3. Attach the shaft (32) to the side plate (29) using the six capscrews (3). Make sure the vent (30) is oriented properly. Torque the capscrews to 100 to 110 lb-ft.
4. Install retaining the ring (48) onto the shaft (32)
5. Lay the unit down with the rods (2) pointing up. Support the side plate (29) with blocking (Figure 5-6) so that the hoist is not setting on shaft (32).
6. Set cable drum (5) onto shaft (32) and seat drum on bearing (28). Be careful not to damage seal (7-4).
7. Install the output planet set (4).
8. Install the output sun gear (16) into the output planet set.
9. Install the thrust washer (6) into the output planet set.
10. Install the input planet set (36) into the drum. Make sure that it fits over the output sun gear (16).
11. Install the input sun gear (8) and thrust washer (6) into the input planet set.
12. Install the thrust washer (6) into the input planet set.
13. Install a new O-ring (7-10) and if necessary bearing (28) & seal (7-4) into the bearing carrier (26). Grease the O-ring and seal then install the bearing carrier into the drum.
14. Position the side plate (41) over cable drum on rods (2). Secure the side plate with the three capscrews (1). Tighten capscrews to 80 to 90 lb-ft.
15. Install the brake sub-assembly into the side plate (41). Make sure that the pilot of the brake housing aligns with the bore in the bearing and that the bolt holes for the motor and vent are oriented properly. Install the eight capscrews (9). Tighten the capscrews evenly to 80 to 90 lb-ft.
16. Install a new O-Ring (7-2) onto the face of the motor and reinstall the motor/counterbalance valve assembly. Reconnect the hose (46).

17. Fill both the gearbox and the brake section with the proper amount and type of lubricants. See Section 8 Lubrication.

HOIST SERVICE

Brake

NOTE: See Figure 5-7 for item number (#) identification.

1. Evenly remove the four capscrews (11) holding the brake cover (20) in place. Spring pressure will raise the cover up as the capscrews are loosened. Remove the cover from the brake housing.

2. Remove the springs (24) from the piston and check the springs for free height. Each spring should measure at least 1.200 inches with no force.

3. To remove the brake piston (10), install two pieces of all-thread (3/8-16NC) in the bottom of two spring pockets.

4. 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 shop air to slowly pressurize the brake cavity until the piston is out of the bore.

5. Grasp the brake driver/clutch assembly (Items 38, 13, 23, 14, 15 & 17) and remove it from the brake housing.

6. Remove the stator plates (19) and friction discs (18) from the brake housing and check for excessive wear. Be sure to 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 in. thickness and stator plates should measure no less than 0.068 in. thickness.

7. With a hook wire or pry bar, remove the seal (7-5).

8. Examine the bushing (39) in the brake housing for wear and replace if necessary.

9. If brake housing (21) is removed from the hoist, examine the journal on the brake housing where the seal (7-4) runs for wear. If severely worn, replace the brake housing.

10. Carefully disassemble the brake driver/clutch assembly noting the direction of lockup for the clutch (34). The clutch assembly must be re-assembled with the arrow pointing in the proper direction for the hoist to function properly. Inspect the O. D. on the input driver (38) and I. D. of the brake driver (13) where the clutch (34) runs. If there is any pitting or spalling on the driver then it and the clutch must be replaced.

11. Re-assemble the driver/clutch assembly, making sure that the clutch is installed properly.

12. Install a new seal (7-5) into the brake housing. If the brake housing is removed from the hoist temporarily install the input sun gear into the brake housing, and slide the driver/clutch assembly onto the sun gear spline.

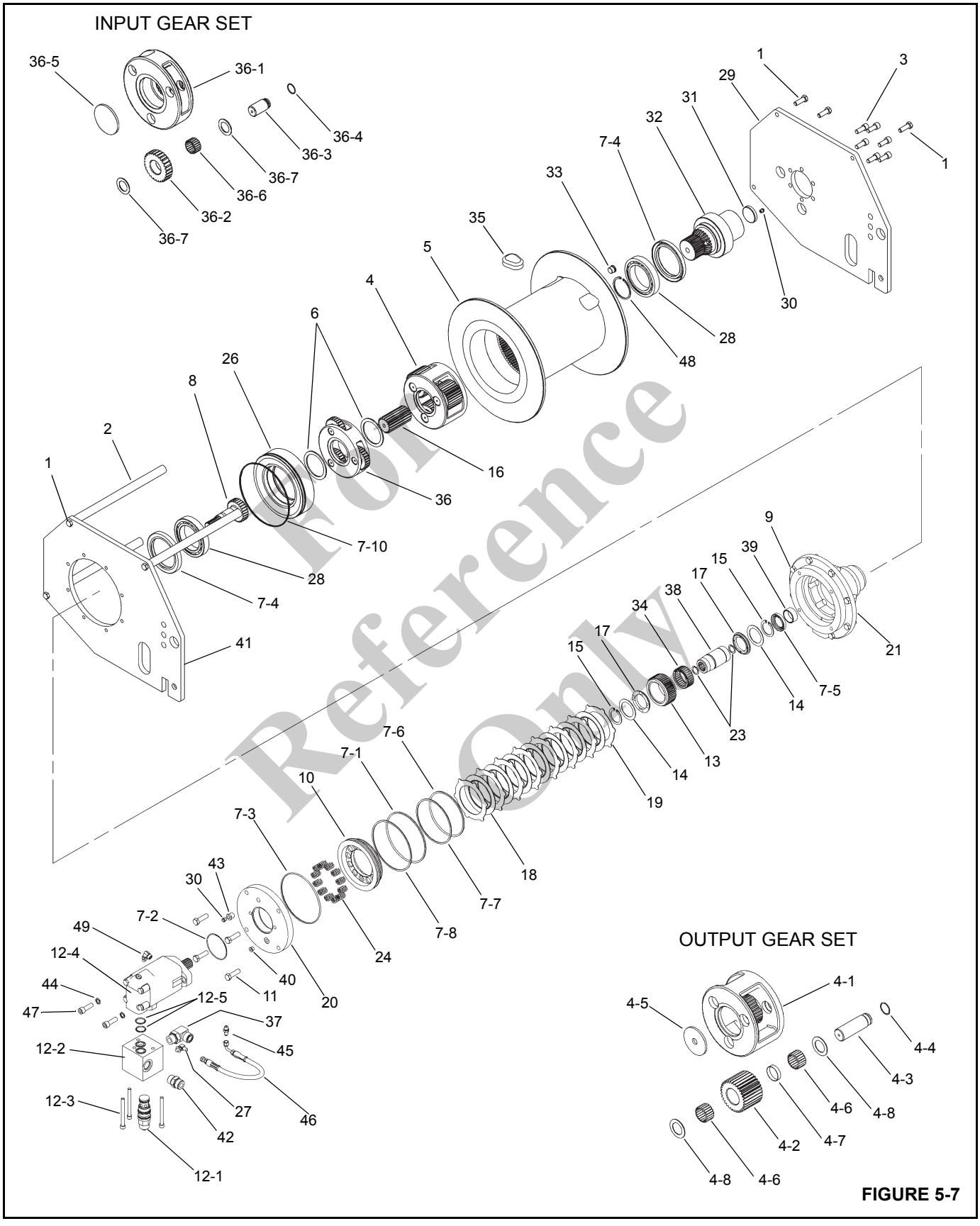

FIGURE 5-7

Item	Quantity	Description
1	6	Capscrew
2	3	Support Rod
3	6	Capscrew
4	1	Output Gear Set
4-1	1	Output Carrier
4-2	3	Planet Gear
4-3	3	Planet Pin
4-4	3	Retaining Ring
4-5	1	Plate
4-6	6	Bearing
4-7	3	Spacer
4-8	6	Race
5	1	Drum
6	2	Race
7	1	Kit, Seal
7-1	1	O-ring
7-2	1	O-ring
7-3	1	O-ring
7-4	2	Seal, Oil
7-5	1	Seal, Oil
7-6	1	O-ring
7-7	1	Ring, Backup
7-8	1	Ring, Backup
7-9	Omit	Omit
7-10	1	O-ring
8	1	Input Sun Gear
9	8	Capscrew
10	1	Brake Piston
11	4	Capscrew
12	1	Kit, Counterbalance, Motor
12-1	1	Counterbalance Valve
12-2	1	Block, Valve
12-3	3	Capscrew
12-4	1	Motor
12-5	2	O-ring
13	1	Brake Driver
14	2	Race
15	2	Retaining Ring
16	1	Output Sun Gear

Item	Quantity	Description
17	2	Bushing
18	7	Friction Disc
19	8	Stator Plate
20	1	Brake Cover
21	1	Brake Housing
22	Omit	Omit
23	2	Retaining Ring
24	12	Brake Spring
25	Omit	Omit
26	1	Carrier, Bearing
27	1	90 Deg. Adapter
28	2	Ball Bearing
29	1	Sideplate
30	2	Breather
31	1	Plug
33	1	Plug
34	1	Clutch
35	1	Cable Wedge
36	1	Input Gear Set
36-1	1	Input Carrier
36-2	3	Planet Gear
36-3	3	Planet Pin
36-4	3	Retaining Ring
36-5	1	Plate
36-6	3	Bearing
36-7	6	Race
37	1	90 Deg. Adapter
38	1	Input Driver
39	1	Bushing
40	1	Plug
41	1	Sideplate
42	1	Straight Adapter
43	1	Pipe Bushing
44	1	Lock washer
45	1	Straight Adapter
46	1	Hose Assy
47	1	Capscrew
48	1	Retaining Ring
49	1	90 Deg. Adapter

13. Install the stator plates (19) and friction discs (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.

14. After installation, check the brake stackup to make sure that the dimensions are within the tolerance shown in Figure 5-8. 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.

15. Coat the new backup rings (Items 7-7 & 7-8) and o-rings (Items 7-1 & 7-6) with light oil and install onto the piston (10) with the backup rings toward the outside of the piston. See Figure 5-8 for proper o-ring and backup ring installation.

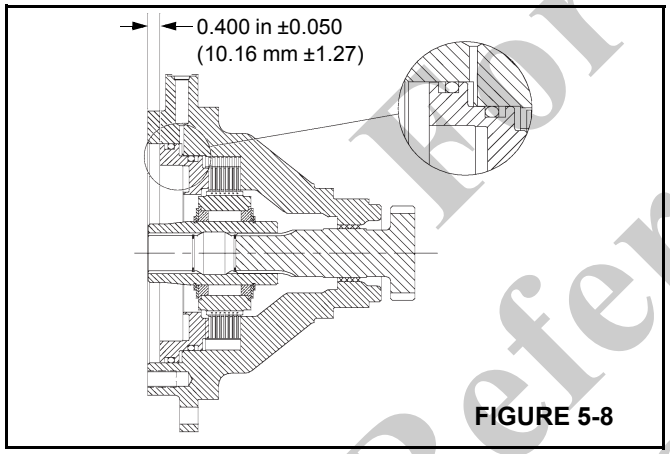

FIGURE 5-8

16. Carefully install the piston into the brake housing and gently tap it down until it is seated.

17. Install the springs (24) into the spring pockets of the piston. If working in a horizontal position, coat the bottom of each spring with chassis lube to keep it in position.

18. Coat the new o-ring (7-3) with light oil and install into the groove on the brake cover (20).

19. Install the cover (20) onto the brake housing (21) and draw it down evenly, alternating between opposite capscrews. Make sure that the cover is aligned properly with the brake housing to orient the motor and vent as they should be.

20. Check the brake release with a portable hydraulic pump. Full release should be obtained at 250 psi, plus or minus 20 psi. Also, check the brake for proper operation by applying 155 psi to the brake port and adapting a torque wrench to the input shaft. The torque here in the payout direction should be 95 to 115 lb-ft.

Planetary Set

NOTE: See Figure 5-7 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

1. Remove the hose from the counterbalance block (12-2).

2. To remove the counterbalance block (12-2), loosen and remove the 3 capscrews (12-3).

3. Remove the counterbalance valve (12-1) from the counterbalance block (12-2) and inspect the small metering hole located on the side of the cartridge valve to make sure it is not obstructed (Figure 5-9). Also inspect the O-rings to insure that they are not cut or flattened.

4. Motors and cartridge valves are not serviceable in the field. Return them to an authorized distributor for service.

TROUBLESHOOTING

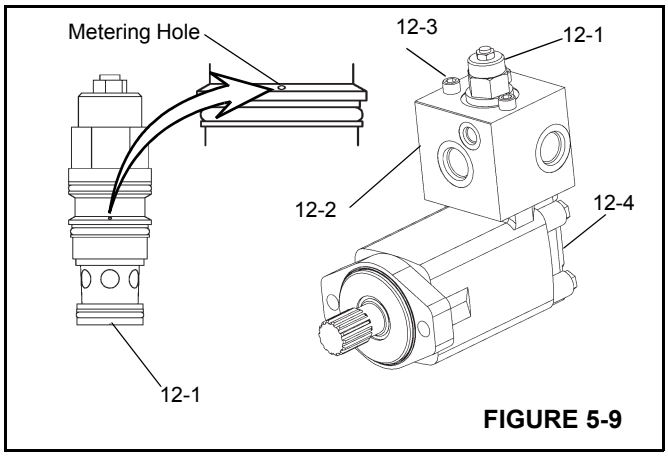

FIGURE 5-9

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

DESCRIPTION

The purpose of the swing system is to allow the crane turret to rotate atop the carrier frame. The 1400A 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 6-2) 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 flow 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 flow is directed from the pressure reducing/sequence valve to the brake release port, overcoming the brake spring pressure and releasing the swing brake.

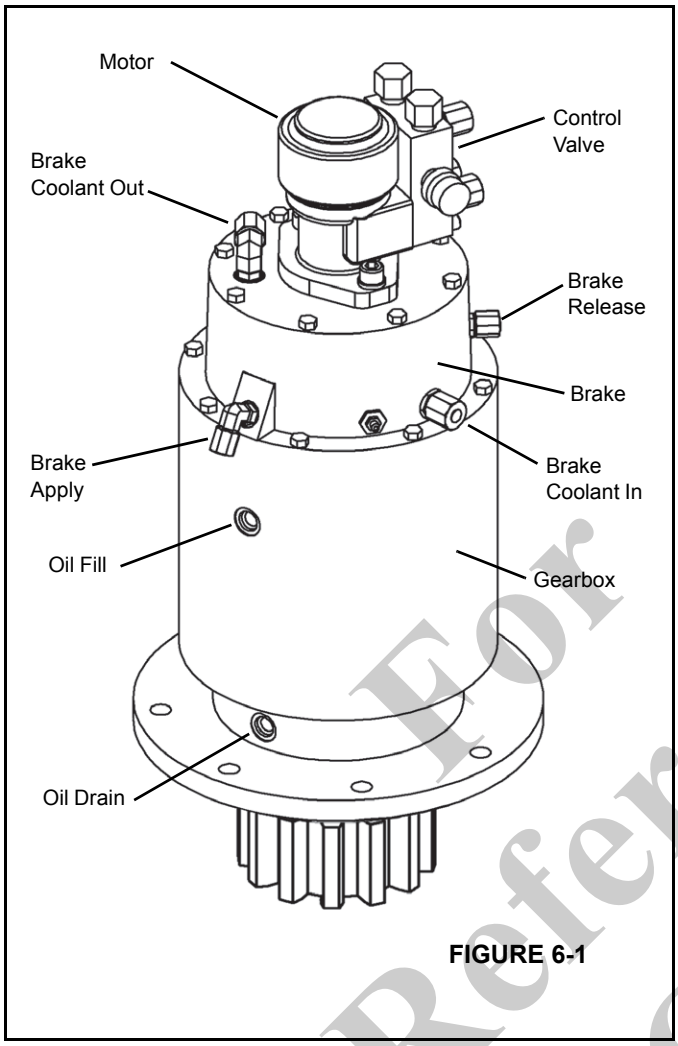

FIGURE 6-1

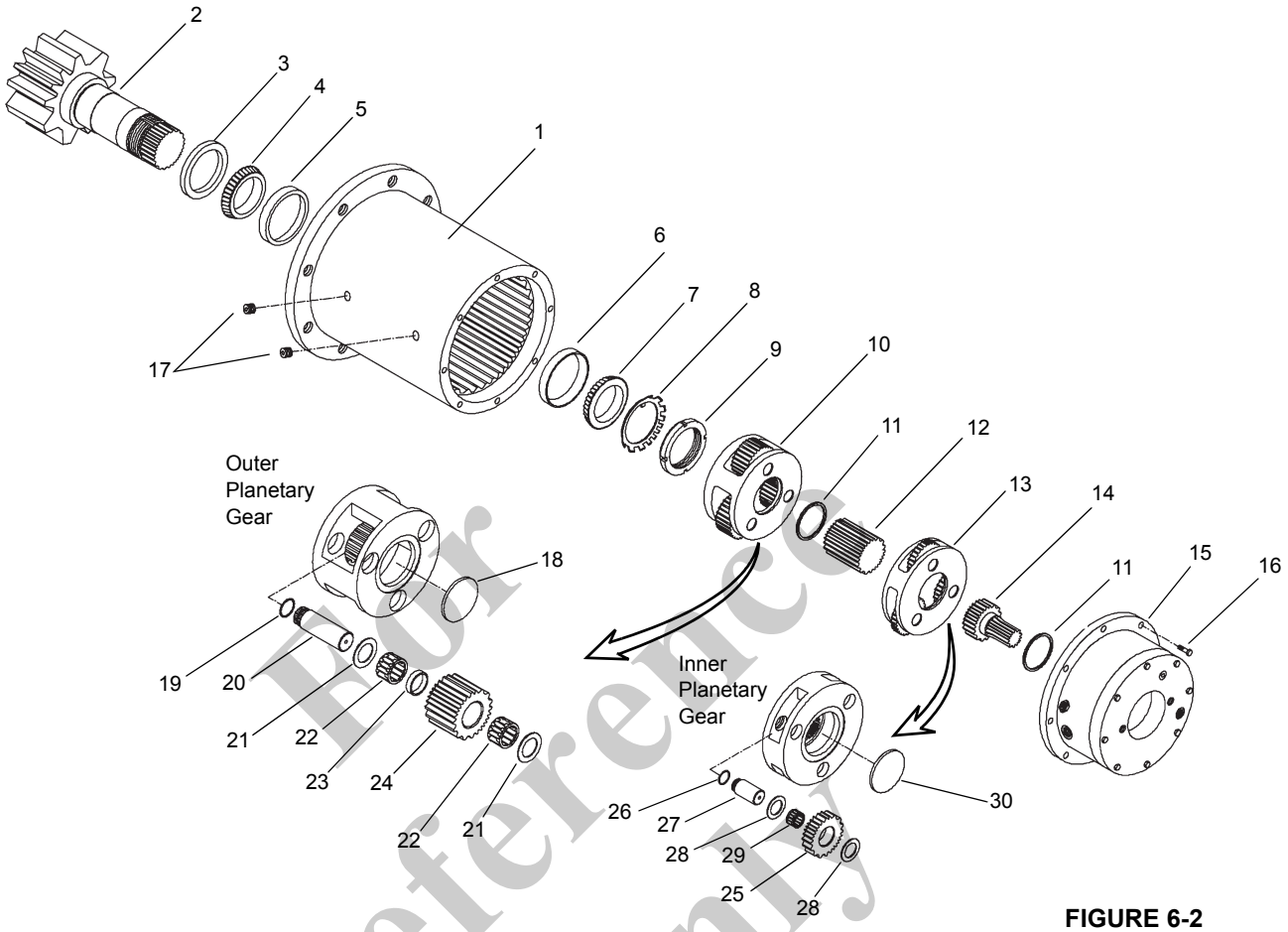

FIGURE 6-2

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

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.

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 124 kg (275 lbs).

Tools Required

- Scribe or small punch
- Oil drain pan
- Eye bolts 1/4 in
- Retaining ring pliers
- Gear puller
- Ratchet wrench (1/2 in drive)
- 9/16 in socket (1/2 in drive)
- Socket for pinion nut (Whittet-Higgins P/N BAS-14)
- Soft hammer (brass or plastic)
- Press
- Drift rod (1/4 in to 3/8 in diameter)
- Torque wrench [1/2 in drive - approximately 135 N·m (100 ft-lb)]

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).

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 135 N·m (100 ft-lb). Proper bearing preload is determined by the rolling torque method. This method involves increasing press load on the bearings (4 and 7) until drag or rolling resistance of 8.4 - 9.6 N·m (75 - 85 in-lb) is achieved when rotating the case.

   This includes bearing as well as seal drag. The torque is equal to a force of 8.4 - 9.6 N·m (75 - 85 in-lb) 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 40 N·m (30 ft-lb).

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 3.8 L (1 gallon) 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.14 MPa (20 psi) 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.14 MPa ([20 psi)] 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.

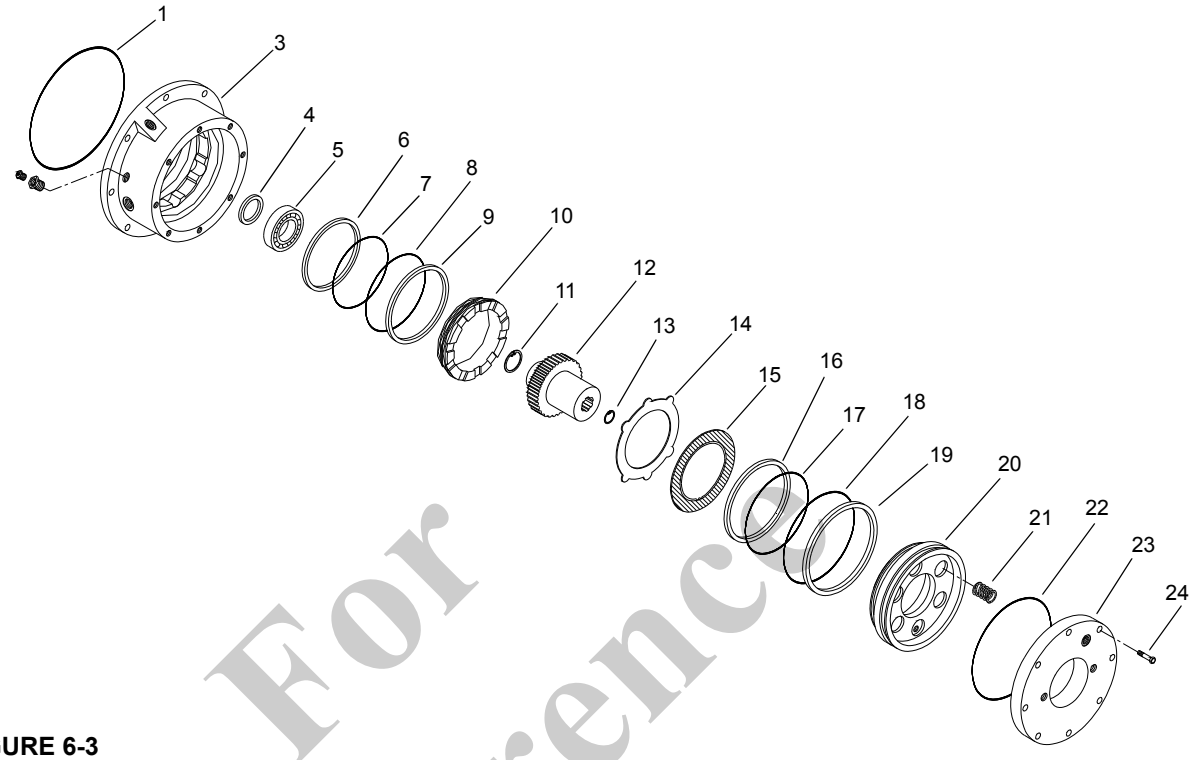

FIGURE 6-3

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)

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 41 - 47 N·m (30 - 35 ft-lb).

SWING BEARING

Description

The swing bearing is an anti-friction roller bearing that mates the turret to the carrier. The bearing inner race is bolted to the turret and the outer race is bolted to the Carrier. The inner race contains four grease fittings for lubrication of the bearing. The outer race incorporates gear teeth that mesh with the pinion gear of the swing gearbox to provide rotation.

MAINTENANCE

General

The swing bearing is the most critical maintenance point of the crane. It is here, at the centerline of rotation, that 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 be replaced with a new bolt of the same classification.

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.

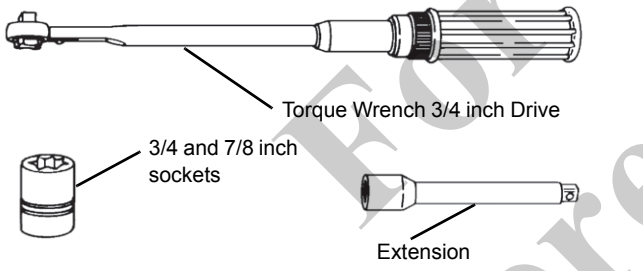

FIGURE 6-4

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, 7/8 inch Grade 8 bolts (Figure 6-5). The outer race of the bearing is secured to the carrier frame by 32, 3/4 inch, Grade 8 bolts (Figure 6-5).

Torque Values

Torque all swing bearing bolts to a final torque: **Fasteners and Torque Values on page 1-7**.

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 bolts can be accessed through the access holes underneath the bed (Figure 6-6).

1. Extend and set the outriggers. Fully elevate the boom.
2. Torque eight bolts (Figure 6-5) to 637 Nm ±27 Nm (470 lb-ft ± 20 lb-ft) using the following sequence pattern; 1, 19, 10, 28, 6, 23, 15, and 33. Tools used are the socket, multiplier, backlash adapter, necessary extensions, and torque wrench.
3. Return to bolt 1 and torque all bolts sequentially in a clockwise direction to the final torque: **Fasteners and Torque Values on page 1-7**. The same tools are used as in step 1.

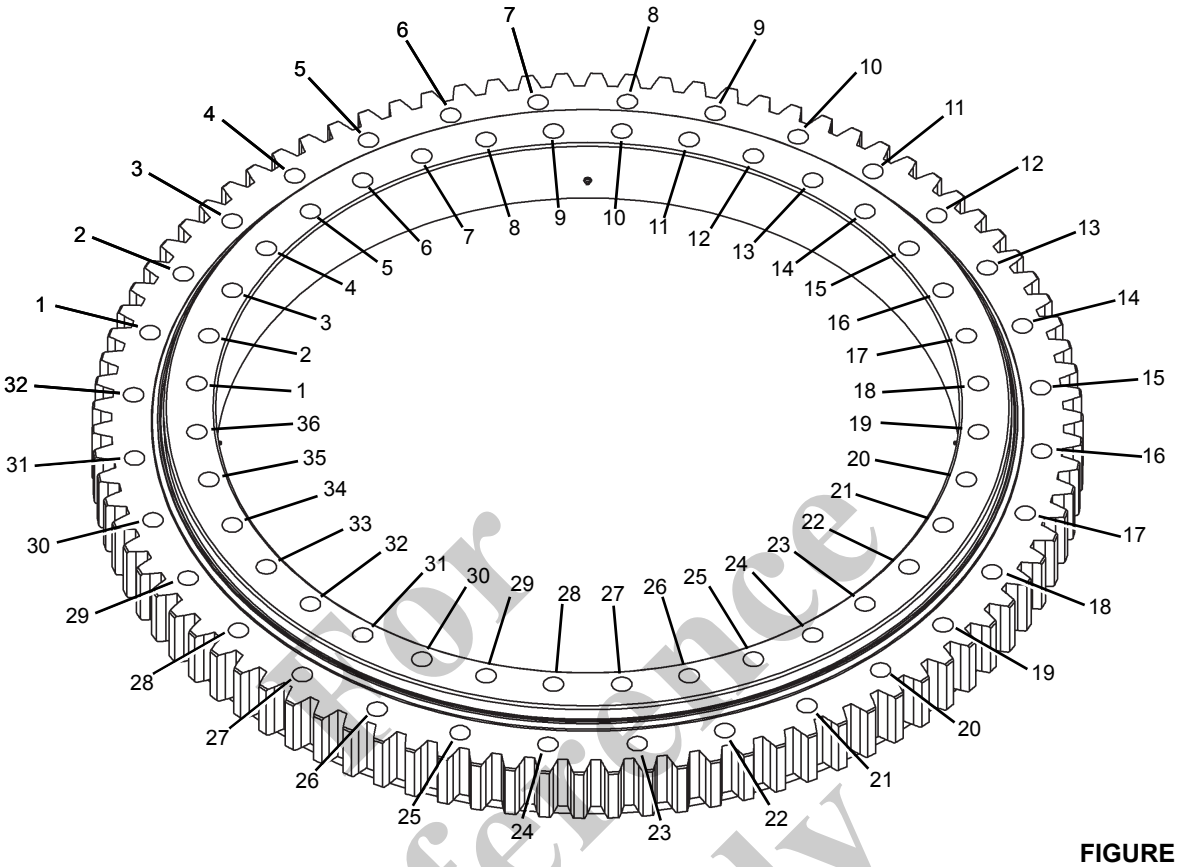

FIGURE 6-5

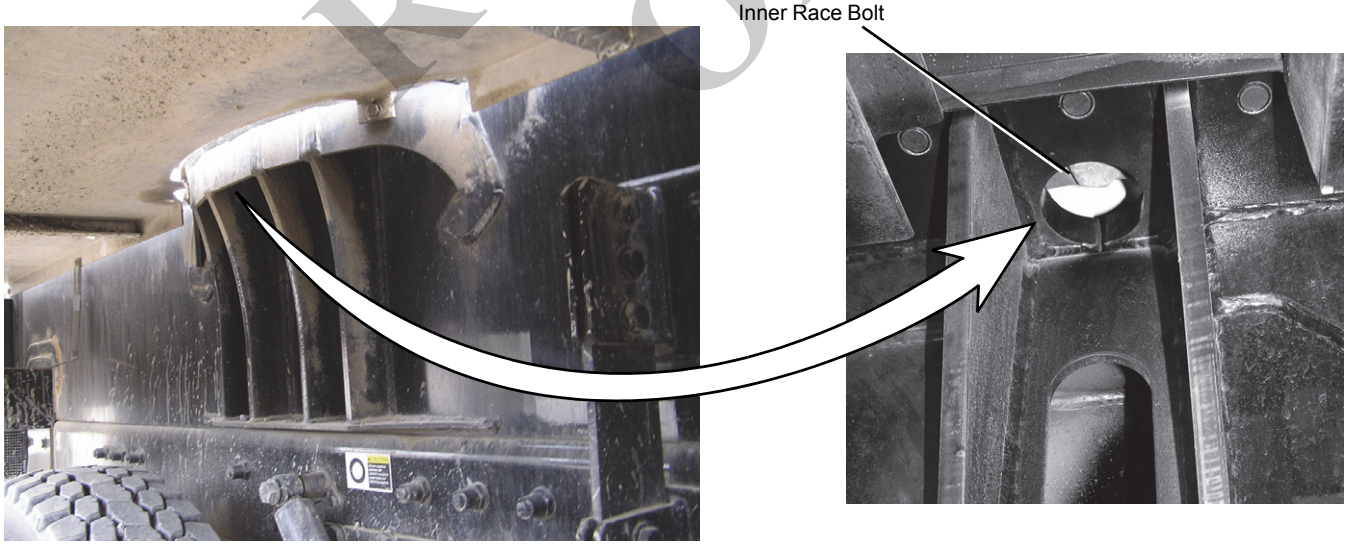

FIGURE 6-6

Outer Race Torquing

The outer race bolts are located on top of the bearing (Figure 6-7).

1. Extend and set the outriggers. Fully elevate the boom.

   Torque eight bolts (Figure 6-5) to 637 Nm ±27 Nm (470 lb-ft ±20 lb-ft) using the following sequence pattern; 1, 17, 9, 25, 4, 20, 12, and 28. Tools used are the socket, multiplier, backlash adapter, necessary extensions, and torque wrench.

2. Return to bolt 1 and torque all bolts sequentially in a clockwise direction: **Fasteners and Torque Values on page 1-7**. The same tools are used as in step 1.

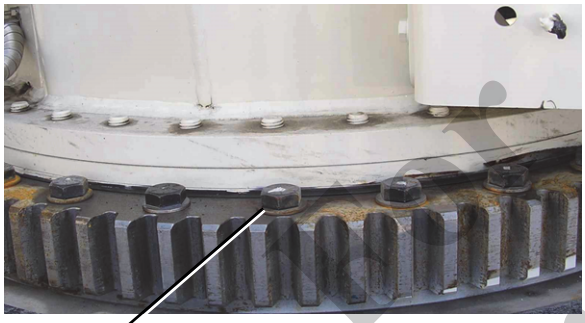

FIGURE 6-7

BEARING CLEARANCE

If a swing bearing exhibits the following symptoms, it may have reached the end of its useful life.

- metal particles in the grease
- increased drive power required
- noise
- rough operation
- acceleration in the increase 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 font and set the outriggers.
2. Put a dial indicator (2, Figure 6-8) opposite the boom on the T-box frame (3).
3. Place the dial on the top of the swing bearing (1, Figure 6-8).
4. Power the boom down onto the boom rest.
5. Set the dial indicator at zero.
6. Raise the boom about 3 inches 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 0.090 inches, replace the bearing.
10. If the average is less than 0.090 inches, repeat the measurement at every 45° around the total working area of the crane (Figure 6-9).
    a. Measure the deflection a 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 3 inches.
    f. Record the reading on the dial indicator.
    g. Repeat steps d through f three time.
    h. Average the readings.
    i. If the averages is greater than 0.090 inches at any position, replace the bearing.

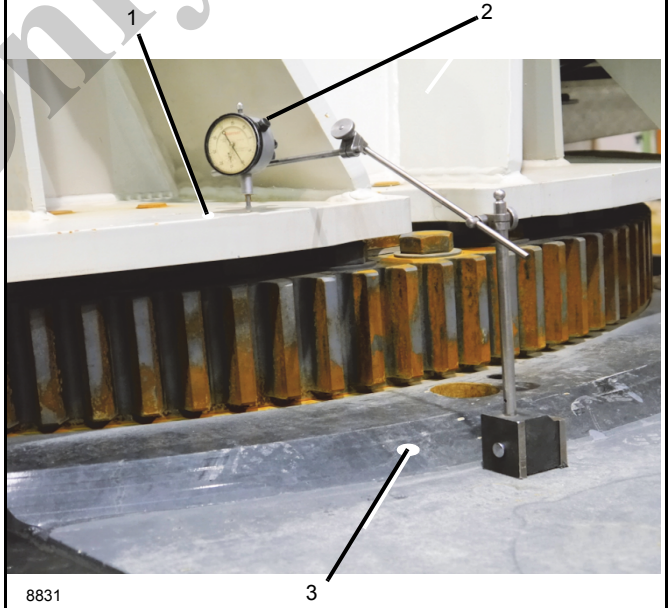

FIGURE 6-8

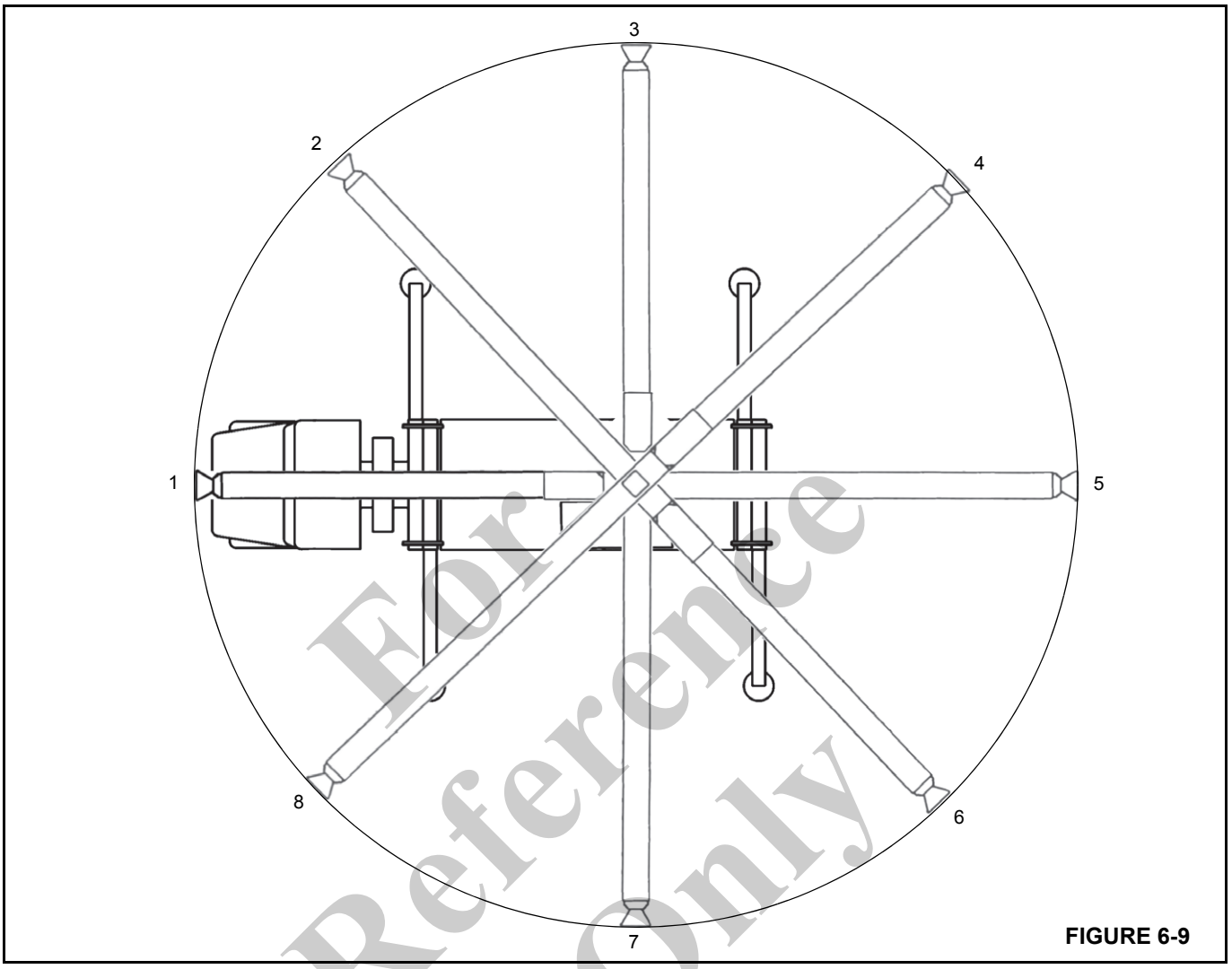

FIGURE 6-9

BEARING REPLACEMENT

Removal

1. Fully extend and set the outriggers enough to take up the slack in the pads.

NOTE: Do not raise the machine on the outriggers.

2. Rotate the boom to about 20° off the front position so that the boom is clear of the truck cab.

NOTE: The lift cylinder pins need to be accessible from the truck deck.

3. Mark the position of the swing motor. The 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 “Boom Removal” on page 4-2.

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 284 kg (625 lb).

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 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 on 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.

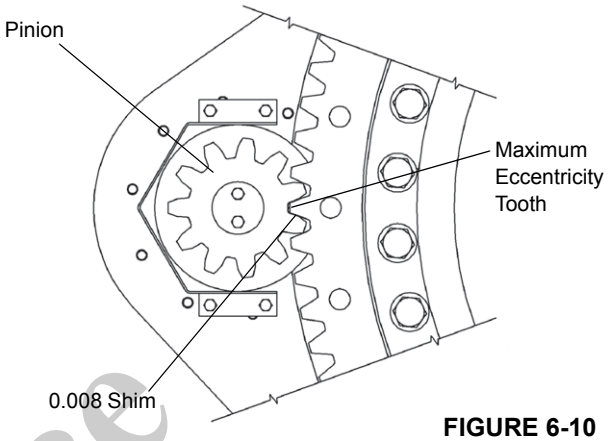

FIGURE 6-10

5. Install all bolts and washers that are not covered by the swing motor. Refer to Outer Race Torquing on 11.

NOTE: If a new bearing is installed, a new pinion gear must also be used. Align the high point (maximum eccentricity) on the bearing with the high point on the new pinion gear (Figure 6-10).

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 0.203 mm (0.008 in) thick shim (Figure 6-10). 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.

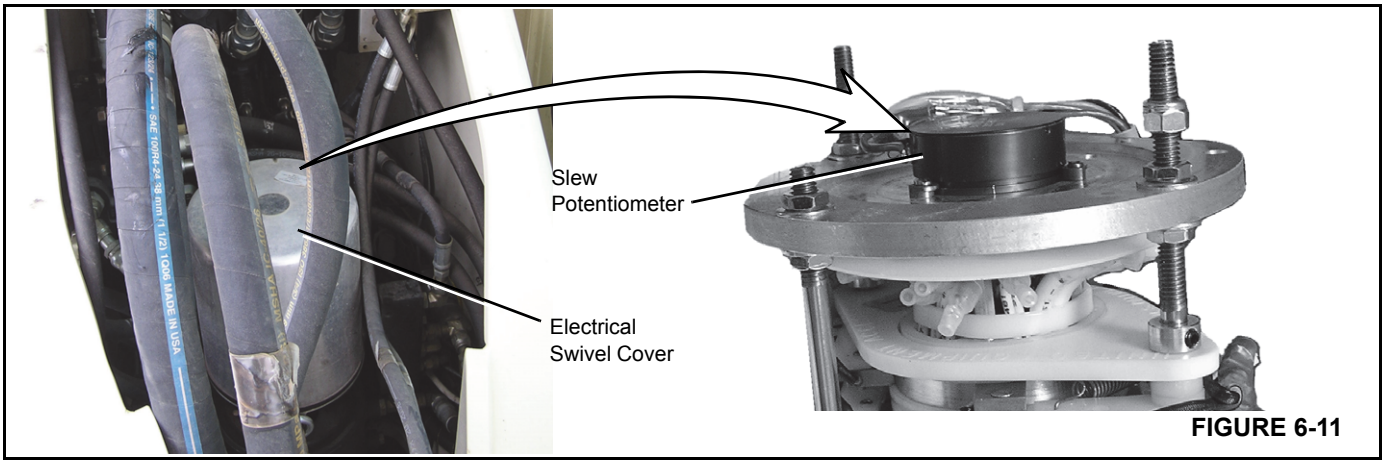

FIGURE 6-11

Slew Potentiometer Adjustment

1. Rotate the turret over the front and set the swing brake.
2. Set the RCL console to read slewing angle as follows:

NOTE 1: Refer to the RCL Rated Capacity Limiter Service Manual for detailed instructions.

   a. Complete the RCL console setup according to the crane's current operating configuration.
   b. Press limits LMI.
   c. Press the OK button.
   d. Toggle down to SLEW and press the ok button to display the slew angle work area definition limits.

3. Remove the electrical swivel cover.
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 that secure the slew potentiometer to the mounting plate.
6. Rotate the body of the slew potentiometer until the slew angle indicates 0.6° ± 0.1°.
7. Tighten the three screws 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 10. 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 3.
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.

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.

SECTION 7
OUTRIGGERS

SECTION CONTENTS

DESCRIPTION

The two section outriggers are 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:

- 1ST and 2ND section outrigger beams
- stabilizer cylinders
- required hoses and mounting hardware

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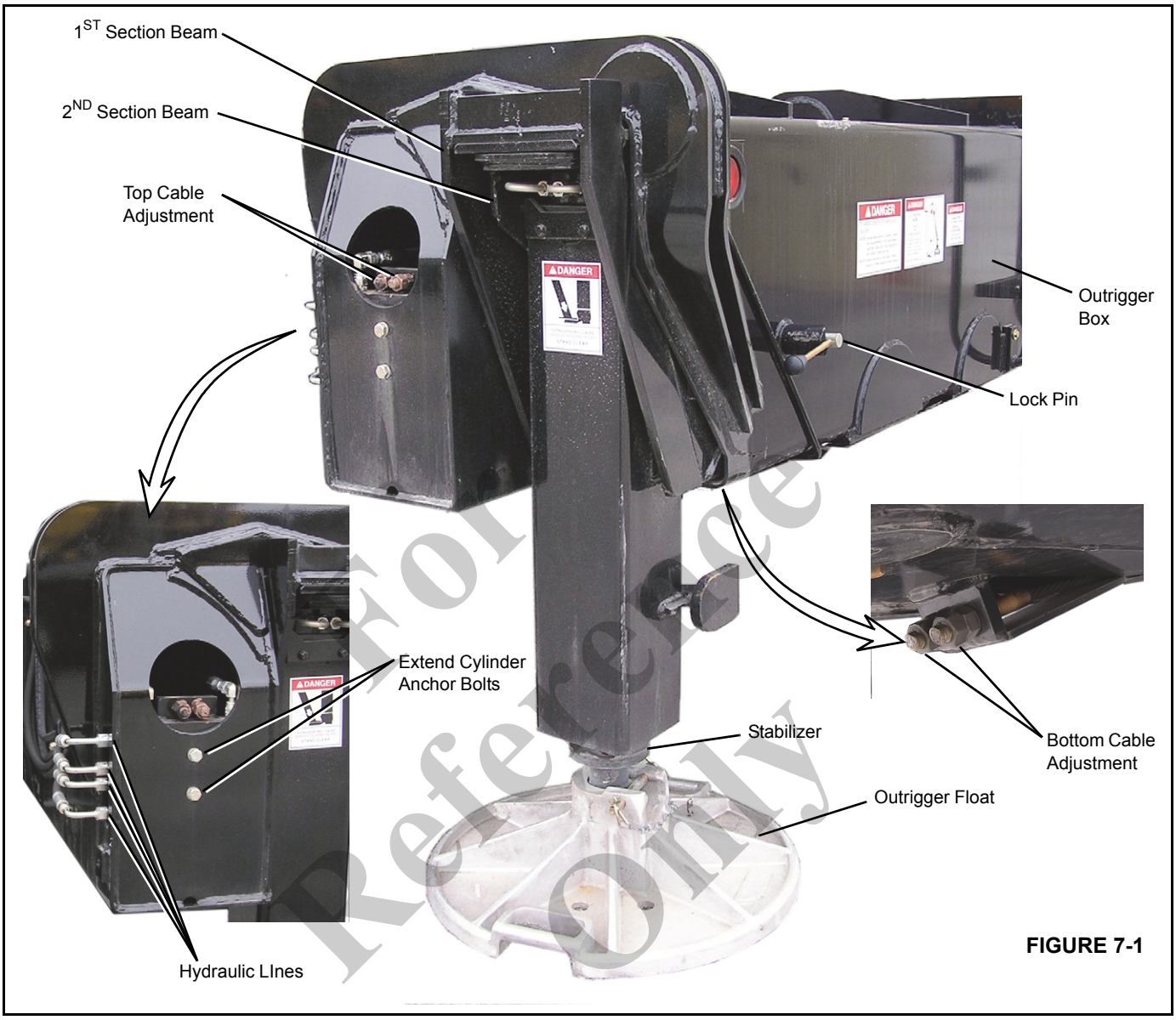

FIGURE 7-1

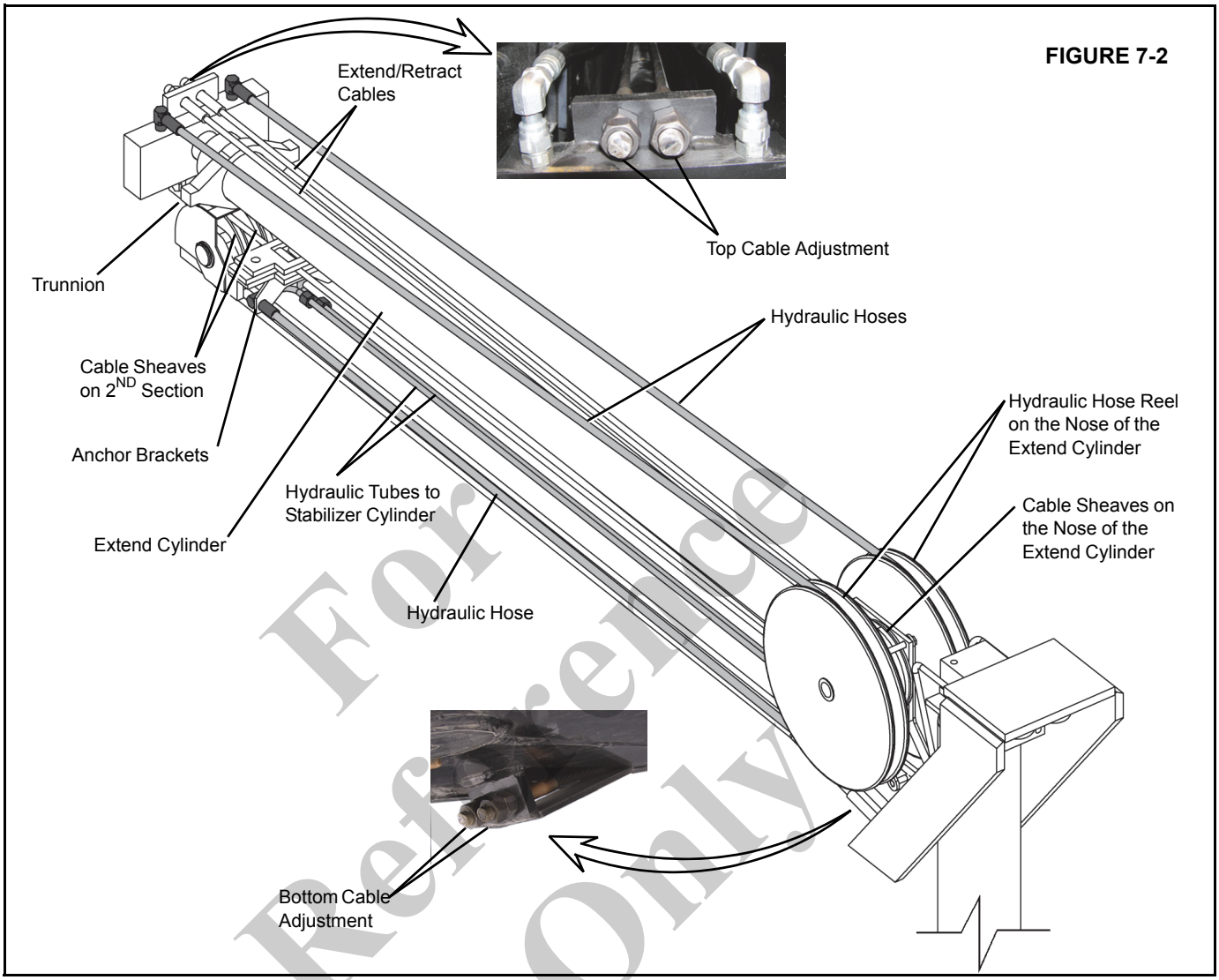

FIGURE 7-2

Removal

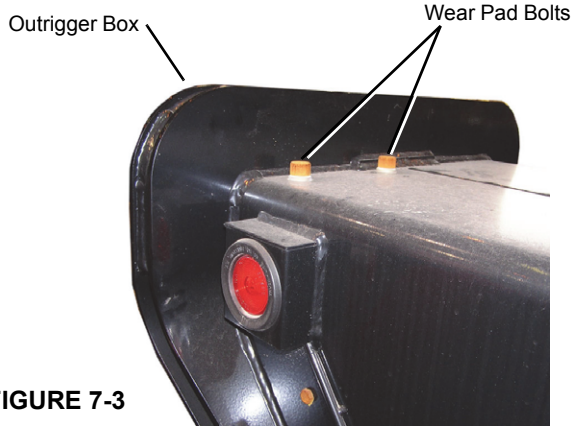

FIGURE 7-3

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).

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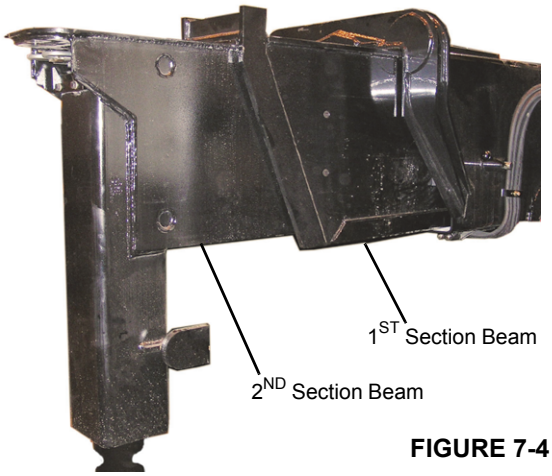

FIGURE 7-4

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.
22. Properly support the stabilizer cylinder from the bottom with a floor jack or hoist and remove the holding valve and o-rings.

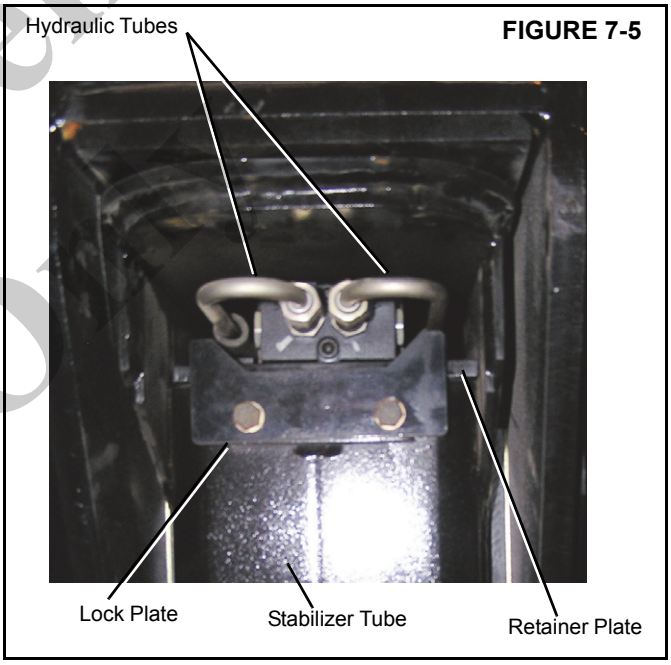

FIGURE 7-5

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.

Installation

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.

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 40-47 Nm (30-35 ft-lb) 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 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 potentiometer in each outrigger beam, to identify if an outrigger beam is positioned to one of three predefined locations, including fully retracted, mid-extend, and fully extended.

String Potentiometer

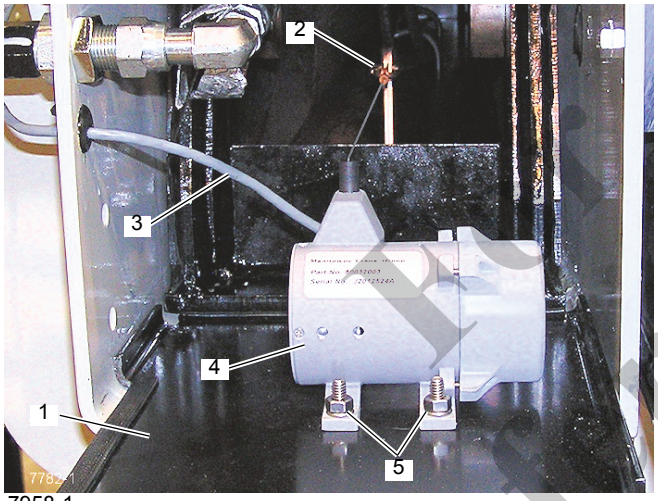

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FIGURE 7-6

Remove

1. Fully retract outrigger beam.
2. Remove outrigger box cover (1, Figure 7-6).
3. Disconnect spring clip (2, Figure 7-6) from its attaching point on outrigger beam.
4. Disconnect electrical connector (3, Figure 7-6) at string potentiometer (4).
5. Remove the screws (5, Figure 7-6) securing string potentiometer; remove string potentiometer.

Install

1. Fully retract outrigger.
2. Using screws (5, Figure 7-6), mount the string potentiometer (4) to the outrigger box cover (1).
3. Connect electrical connector (3, Figure 7-6) to string potentiometer (4).
4. Attach spring clip (2, Figure 7-6) to attaching point on outrigger beam.
5. Mount outrigger box cover (1, Figure 7-6) on outrigger box.
6. Calibrate string potentiometers; refer to *Calibrate*, page 7-6

Calibrate

Calibrating the string potentiometer is done through the crane's RCL. Refer to the *Load Moment Indicator Operator's Manual* for detailed instructions.

SECTION 8
LUBRICATION

SECTION CONTENTS

GENERAL

To ensure a maximum crane lifetime and utilization, follow a designated lubrication procedure. 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. Lubrication requirements for the truck chassis are not included here. Refer to appropriate truck manufacturer's manual for this information.

The service intervals specified are for normal operation with moderate temperature, humidity, and atmospheric conditions. In areas of extreme conditions, the service periods and lubrication specifications need to be altered for 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 38°C (100°F) is recommended.

CAUTION

The multipurpose grease installed during manufacture is of a lithium base. Use of a non-compatible grease could result in damage to equipment.

Low Temperature Grease

This special grease for low temperature remains plastic at -51° C (-60° F) with 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	-26°C	(-15°F)
85	-12°C	(+10°F)
90	-7°C	(+20°F)
140	+5°C	(+40°F)
250	+10°C	(+50°F)

Open Gear Lubricant

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

Antifreeze/Coolant (for Cab Heater)

The standard antifreeze/coolant filled from the factory is intended to provide protection against freeze-up down to -36° C (-34° F) and boil-over up to 129° C (265° F) using a 15 psi pressure cap.

Anti-wear Additives

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

Hydraulic Oil

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

CAUTION

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

NOTE: When operating the crane in temperatures -9°C (15°F) and below, follow the procedures in the section titled “Arctic Conditions Below -9°C (15°F)” on page 8-1.

Standard Hydraulic Oil

Temperature Above -9°C (15°F)

The factory fill standard hydraulic oil is ISO grade 46/68 Hydraulic Oil. This fluid is acceptable for operating temperatures above -9°C (15°F).

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

CAUTION

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

Arctic Hydraulic Oil

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

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

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

Petroleum based fluids developed especially for low temperature service may be used with satisfactory results. However, certain fluids, such as hologenated hydrocarbons, nitro hydrocabons and phosphate ester hydraulic fluids might not be compatible with hydraulic system seals and wear bands. Arctic hydraulic oil is not recommended for service in ambient temperatures above 0°C (32°F).

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

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

Hydraulic Oil Inspection

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

Hydraulic Oil Reservoir Level

The hydraulic oil reservoir has a sight gauge (1,Figure 8-1) 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.

7462-18 **FIGURE 8-1**

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.

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 8-2). Lube description and symbols are found in tables below.

Symbol	Description	Manitowoc Lube Specification	
		Standard	Cold Weather - 40°C (-40°F)
AFC	Antifreeze/Coolant (for Cab Heater)	6829101130	6829104212
EP-MPG	Extreme Pressure Multipurpose Grease	6829003477	6829104275
GL-5	GL-5 Gear Lubricant	6829012964	6829014058
HYDO	Hydraulic Oil	6829006444	6829006993
EP-OGL	Open Gear Lubricant, CEPLATTYN 300 Spray, NLGI Grade 1-2	6829102971	6829102971
AGMA EP-4	Extreme Pressure Gear Lubricant.	6829100213	6829103636
WRL	Wire Rope Lubricant	6829015236	6829010993
EO-20W-20	Engine Oil (Light non-EP Oil), Mil-L-46152	6829005570	-
TES 295	TES295 Compliant Fluid	-	6829101690

NOTE: Cold weather lubricants are not sufficient for temperatures below 40° C (-40° F). Use hydraulic tank heaters and insulate where appropriate.

Lubrication Chart

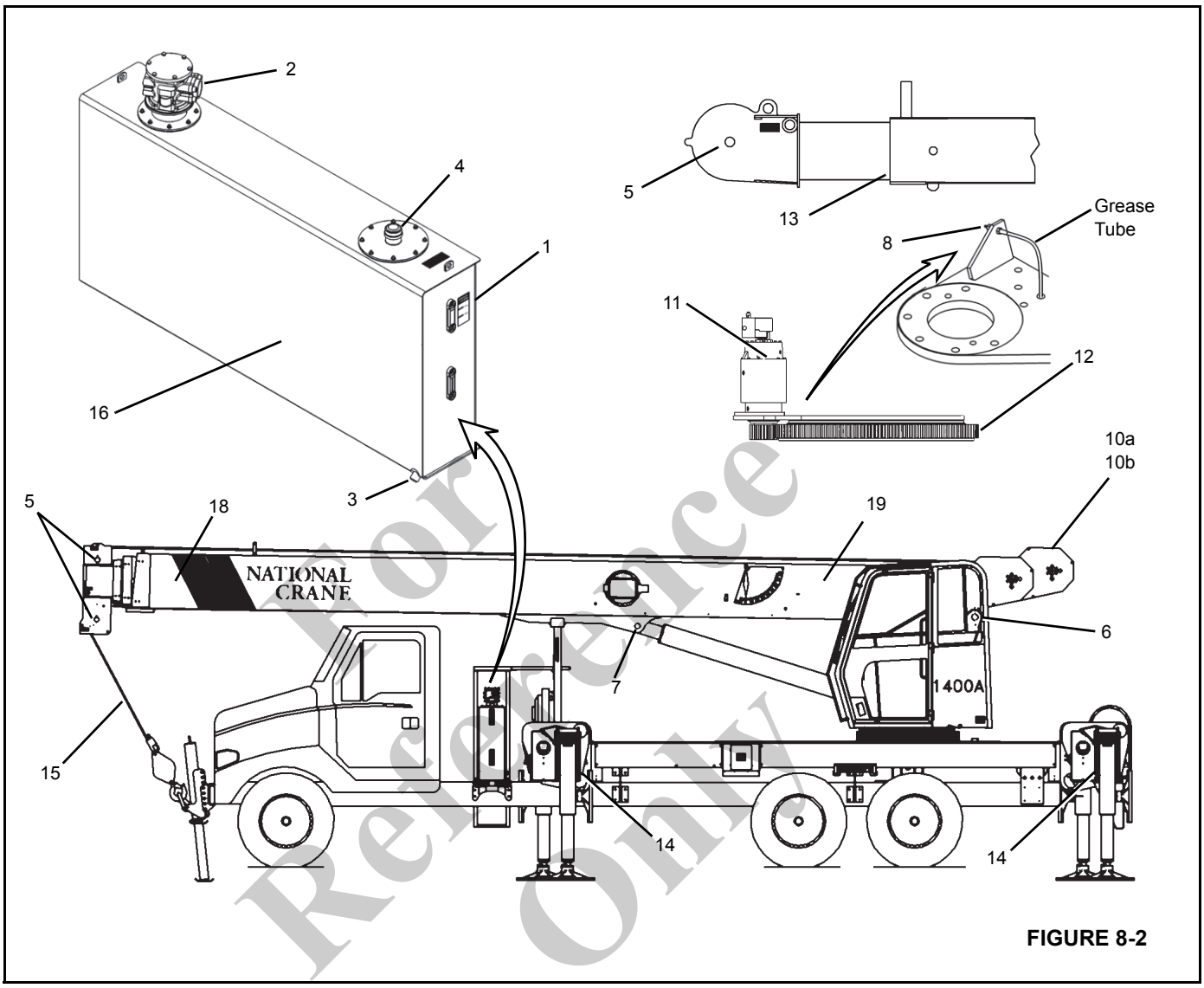


FIGURE 8-2

Table 8-1

Item	Application	Recommended Lubricant	Procedure	Frequency
1	Hydraulic oil reservoir	HYDO	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 (5 plcs), jib (1 pl), block (1 pl), rooster sheave (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
8	Turntable bearing (4 plcs)	EP-MPG	Grease gun	Weekly

Item	Application	Recommended Lubricant	Procedure	Frequency
10a	Hoist gearbox.	AGMA EP-4	Check and fill	Gearbox check and fill: As part of daily crane inspection, check the gearbox for visible leaks.
			Change	Gearbox change: Every 1,000 hours or 6 months.
10b	Hoist brake	HYDO	Check and fill	Brake check and fill: As part of daily crane inspection, check the gearbox for visible leaks.
			Change	Brake change: Every 1,000 hours or 6 months.
11	Swing drive gearbox	AGMA EP-4	Check and fill	Check and fill: As part of daily crane inspection, check the gearbox for visible leaks.
			Change	Change: After the first 50 hours and at 500 hour intervals thereafter.
12	Swing gear teeth	EP-OGL	Spray Can	Monthly
13	Boom Jib	EP-MPG	Brush, roller, or grease gun	Monthly or as required
14	Outrigger beams, bottom, sides	EP-MPG	Brush or roller	Monthly or as Required
15	Wire rope (loadline)	EP-OGL	Brush or spray	Semi-Annually
16	Diffuser strainer, Hydraulic oil reservoir		Clean	Semi-Annually with Oil Change
18	Extend Sheaves.	EP-MPG	Grease Gun	Weekly
19	Retract Sheaves.	EP-MPG	Grease Gun	Weekly
20	Wire Rope Extension Cables	WRL	Spray or Brush	Any Time Boom is Disassembled or 5 Years
21	Boom Wear Pads (Not Shown)	EP-MPG	See Boom Lubrication	Monthly or as Required

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.

A grease gun adapter is required to lubricate the internal sheaves. The required needle grease gun fitting is:

- A6.35 mm (0.25 in) diameter nozzle grease gun tip (National P/N 955045).
- Contact Manitowoc Crane Care to obtain this tip.

Lubrication of the extend and retract sheaves is as follows:

1. Extend the boom until the grease access holes on the side of the 2nd and 3rd sections are lined up.
2. Lubricate the pin for the extend cable sheaves (18) (Figure 8-2) until a small amount of grease extrudes from the pin. From in front of the boom, look back through the sheave case at the pin to determine the amount of grease.
3. This position also aligns the access holes in the rear of the 1st and 2nd sections for lubrication.
4. Lubricate the pins for the retract sheaves until a small amount of grease extrudes from the sheave pins. From in back of the boom, look up through the hoist mount at the pins to determine the amount of grease.

Boom Lubrication Inner Wear Pad

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers.
2. Apply grease at all contact points for the wear pads on the top of the 2nd section through the access holes in the 1st section with a grease gun (Figure 8-3).
3. Extend the boom to line up the access holes on the 2nd section with the wear pads on the 3rd section. Apply grease to all contact points for the 3rd section wear pads with a grease gun.
4. Extend the boom to line up the access holes on the 3rd section with the wear pads on the 4th section. Apply grease to all contact points for the 4th section wear pads with a grease gun.
5. Raise the boom to at least 75°.
6. Extend the boom about 1/3 and retract to spread the grease.
7. Repeat steps 2 - 5. Extend the boom about 2/3 and retract to spread the grease.
8. Repeat steps 2 - 5. Fully extend and retract the boom to spread the grease.

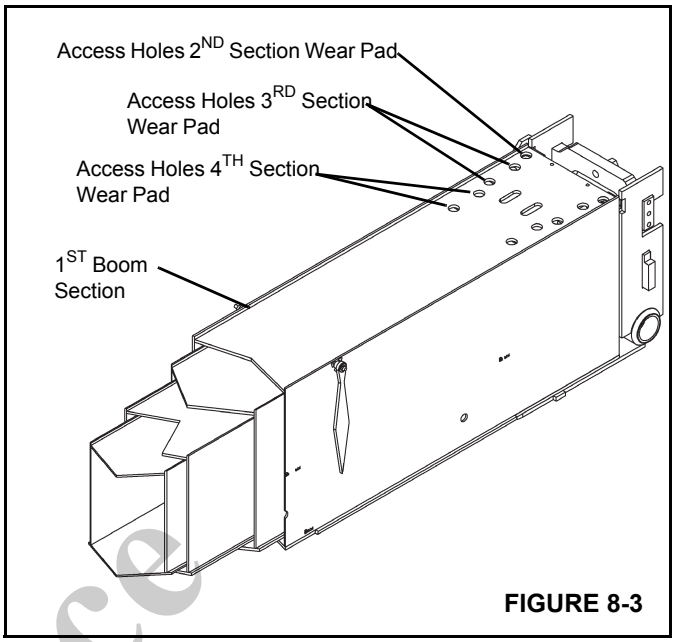


FIGURE 8-3

Boom Lubrication Side/Bottom Wear Pads

Recommended lubricant is EP-3MG grease.

1. Fully extend and set the outriggers.

NOTE: A fully extended boom at horizontal needs to have an assist from a crane or forklift to retract. Lift the front of the boom enough to relieve pressure on the bottom wear pads. This should be sufficient for the boom to retract.

2. Lower the boom to horizontal.
3. Fully extend the boom and apply grease to all contact points at the side and bottom of the 2nd, 3rd, and 4th sections with a brush.
4. Extend and retract the boom several times until the grease is evenly spread.
5. Repeat steps 3 and 4 as necessary to ensure the boom is fully lubricated.

Hoist Brake Oil

⚠ DANGER

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

Check Hoist Brake Oil

To check the hoist brake oil, remove the inspection plug (Figure 8-4) and visually inspect the oil level. The fluid should be visible within the bottom of the inspection hole. If more fluid is needed, add through the brake oil vent and fill plug hole 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 (Figure 8-4), inspection plug and vent plug and drain the brake oil. Reinstall drain plug and add fluid at the brake oil vent hole until oil is at the bottom level of the inspection hole. Install the inspection plug and the oil vent and fill plug. See “Lubrication” on page 8-3.The hoist brake fill capacity is 0.23 liter (.25 quart).

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

DANGER

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

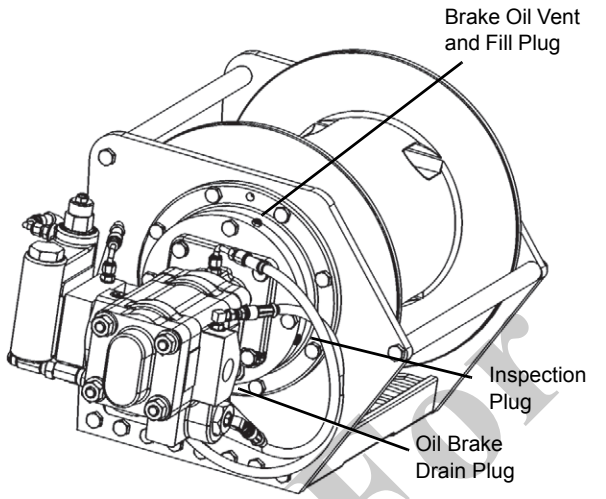


FIGURE 8-4

Hoist Gearbox Oil Level Check

To check the hoist gearbox oil level:

1. Rotate the drum until the oil fill/drain plug is level with the oil level/fill inspection hole (Figure 8-5).
2. Remove the oil fill/drain plug and visually inspect the level. The oil should be level with the bottom of the inspection hole. If more oil is needed, add SAE 90 EP gear lube.

NOTE: Hoist gear and brake lubricants are satisfactory for operation in temperatures from -23°C to 43°C (-10°F to +110°F). For operation outside this range, contact Manitowoc Crane Care for recommendations.

Hoist Gearbox Oil Change

Oil Drain

1. Rotate the drum until the oil/fill plug is level with the drain hole (Figure 8-5).
2. Screw a 1” pipe drain into the drain hole so that the oil can be drained into an approved container.
3. Remove the drain/fill plug with a 3/8” hex wrench.
4. Remove the breather.

Oil Fill

1. Remove the 1” fill pipe from the drain hole.
2. Rotate the drum until the drain/fill hole is level with the fill hole.
3. Install a 1” fill pipe with elbow in the drain/fill hole.
4. Fill the gearbox with 1.5 quarts of new gear lube. The lube should be level with the bottom of the fill hole.
5. Remove the fill pipe.
6. Check that the breather is not frozen. Replace if necessary.
7. Install the drain/fill plug and breather.

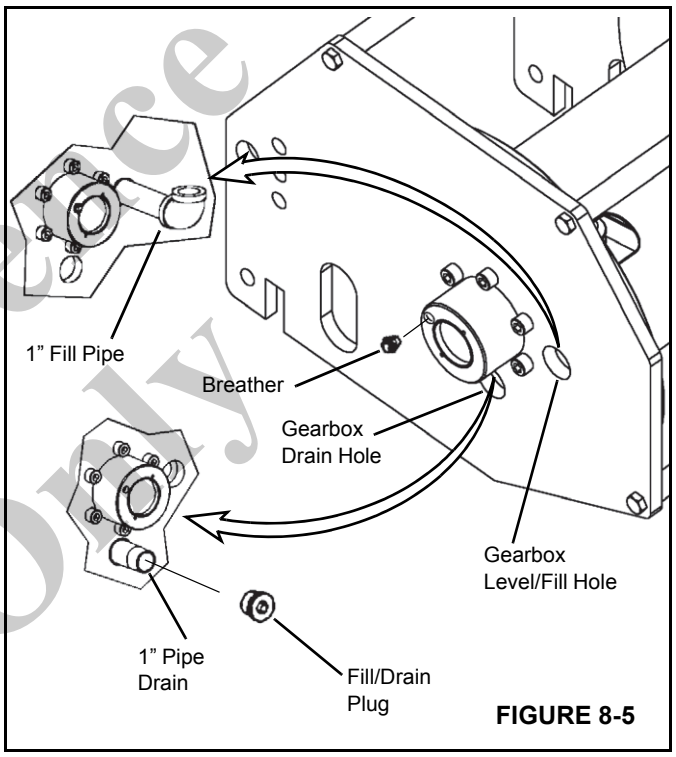


FIGURE 8-5

Swing Gearbox and Brake Oil

Check and Fill Gearbox:

Visually inspect the gearbox for leaks as part of a daily crane inspection. Fill the oil as necessary.

Change 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.

1400A Hydraulic Oil Reservoir Level

The hydraulic oil reservoir has a sight gauge located on the side of the reservoir (Figure 8-6). The oil in the hydraulic reservoir is sufficient when the level is between the upper and lower 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 too low, add the recommended hydraulic oil until the oil level is even with the upper mark. If the oil level is high, drain oil until the oil level is even with the upper mark.

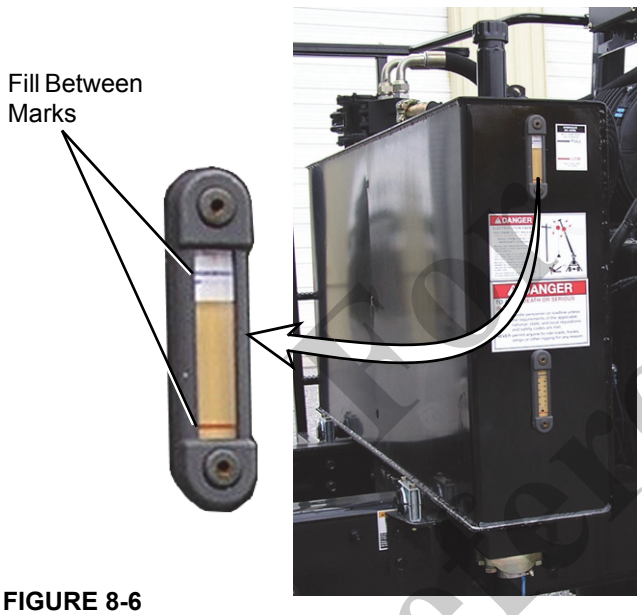


FIGURE 8-6

WIRE ROPE LUBRICATION

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

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

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

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

- bath
- dripping
- pouring
- swabbing
- painting
- pressure spray

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

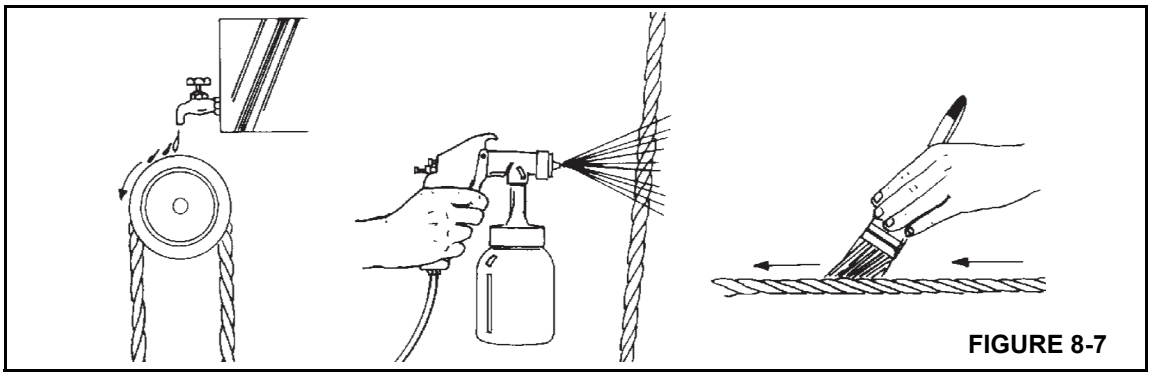


FIGURE 8-7

CARWELL© RUST INHIBITOR

Protecting Cranes from Corrosion

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

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

Carwell T32-CP-90 is a treatment, not a coating. It contains no silicones, solvents, CFCs or anything that would be classified as hazardous under OSHA Regulation 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, Carwell T32-CP-90 can appear to leave a slightly “oily” residue on painted surfaces and until the red tinting fades could initially be mistaken for a hydraulic oil leak. While the product is not harmful to painted surfaces, glass, plastic or rubber, it must be removed using standard steam-cleaning techniques.

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

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

The most common causes of corrosion include the following:

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

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

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

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

Cleaning Procedures

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

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

CAUTION

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

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

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

Inspection and Repair

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

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

CAUTION

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

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

For scratches and marks in areas of low visibility:

- Consider touching up the spots with a brush technique to cover the bare metal. This will retard the effects of corrosion and enable you to do the repair at a later time during a normal maintenance interval.
- Spots should be touched up with quality paint. Primers tend to be porous; using a single coat of primer only will allow air and water to penetrate the repair over time.

Application

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

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

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

- Do not apply to recently primered and painted areas for at least 48 hours after paint is properly dried and cured. For minor touch up areas a 24 hour period is needed for cure time before applying Carwell.

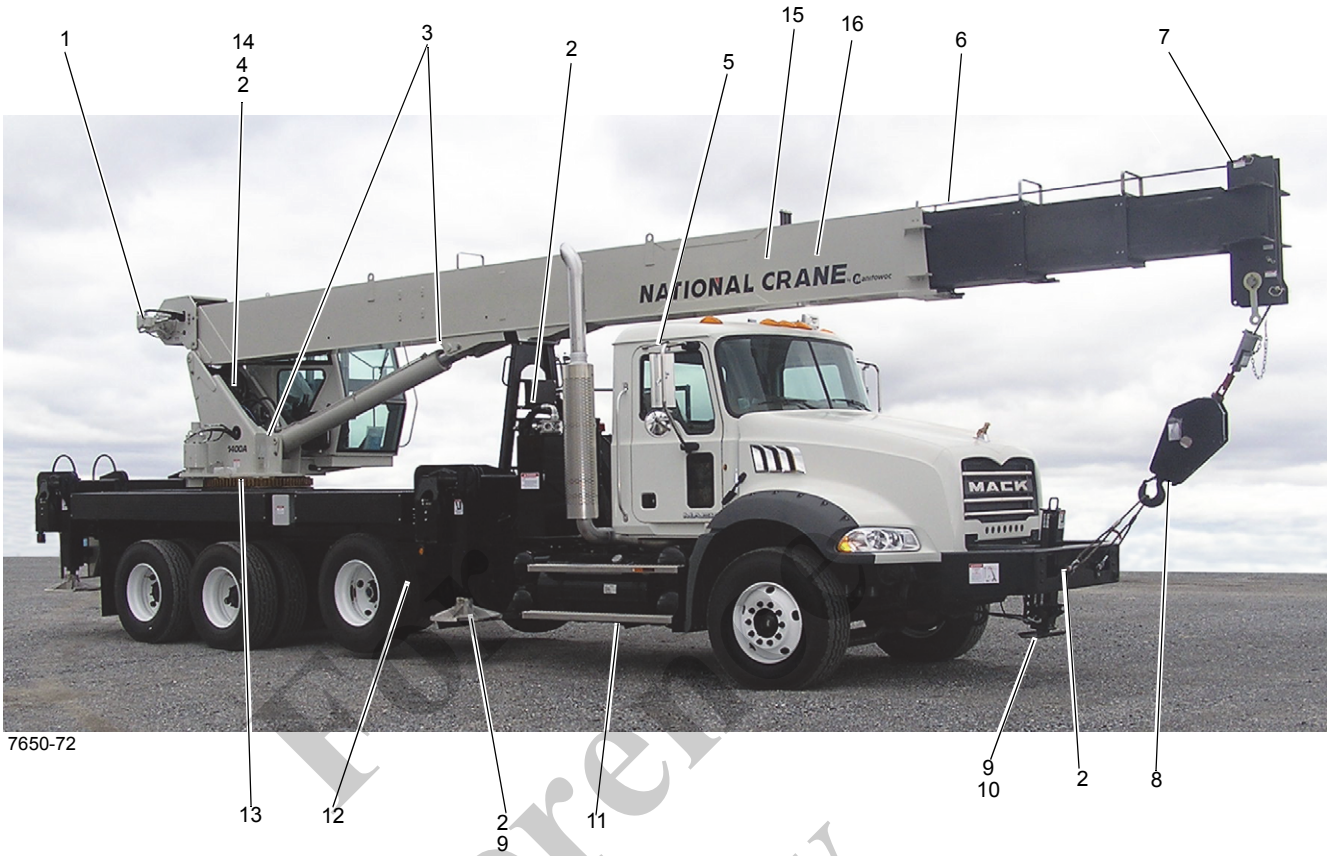
NOTE: Unit must be completely dry before applying Carwell.

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

Please contact Manitowoc Crane Care should you have any questions.

Areas of Application

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



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

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

SECTION 9
CRANE INSTALLATION

SECTION CONTENTS

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 90 kg (200 lb) each].

National Cranes must meet ASME/ANSI B30.5 (latest) when completed as cranes and ASME/ANSI B30.23 (latest) when completed as a personnel lifting system. 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.

NOTE: 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

The minimum truck requirements for mounting the 1400A series cranes are as follows:

- **Axle Rating** — Axle ratings are determined by the axles, tires, rims, springs, brakes, steering and frame strength of the truck. If any one of these components is below the required rating, the gross axle rating is reduced to its weakest component value.

- **Wheelbase (WB), Cab-to-Trunnion (CT) and Cab-to-Axle (CA)** — The WB, CT and CA requirements are determined by:
  - Mounting Configuration
  - Boom Length
  - Bed Length

  The WB and CT shown in Figure 9-2 are required so the basic 1400A 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 Mounting Configuration on page “Mounting Configuration” on page 9-4 for additional information.

- **Truck Frame** — Select a truck frame that minimizes or eliminates frame reinforcement or extension of the after frame (AF). Many frames are available that have the necessary AF section modulus (SM) and resistance to bending moment (RBM) so that reinforcing is not required. The frame under the cab through the front suspension must have the minimum SM and RBM because reinforcing through the front suspension is often difficult because of engine, radiator mounts and steering mechanics. See “Truck Frame Strength” on page 9-6 for the necessary section modulus and resistance to bending moment values.
- **Additional Equipment** — Additional equipment recommendations are as follows:
  - electronic engine control system
  - increased cooling system
  - extra heavy duty PTO. See the “PTO Requirements” on page 9-5.

  A conventional truck cab should be used for standard crane mounts.
- **Neutral Start Switch** — The chassis must be equipped with a switch that prevents operation of the engine starter when the transmission is in gear.

Typical Location of Serial Number Identification Tags

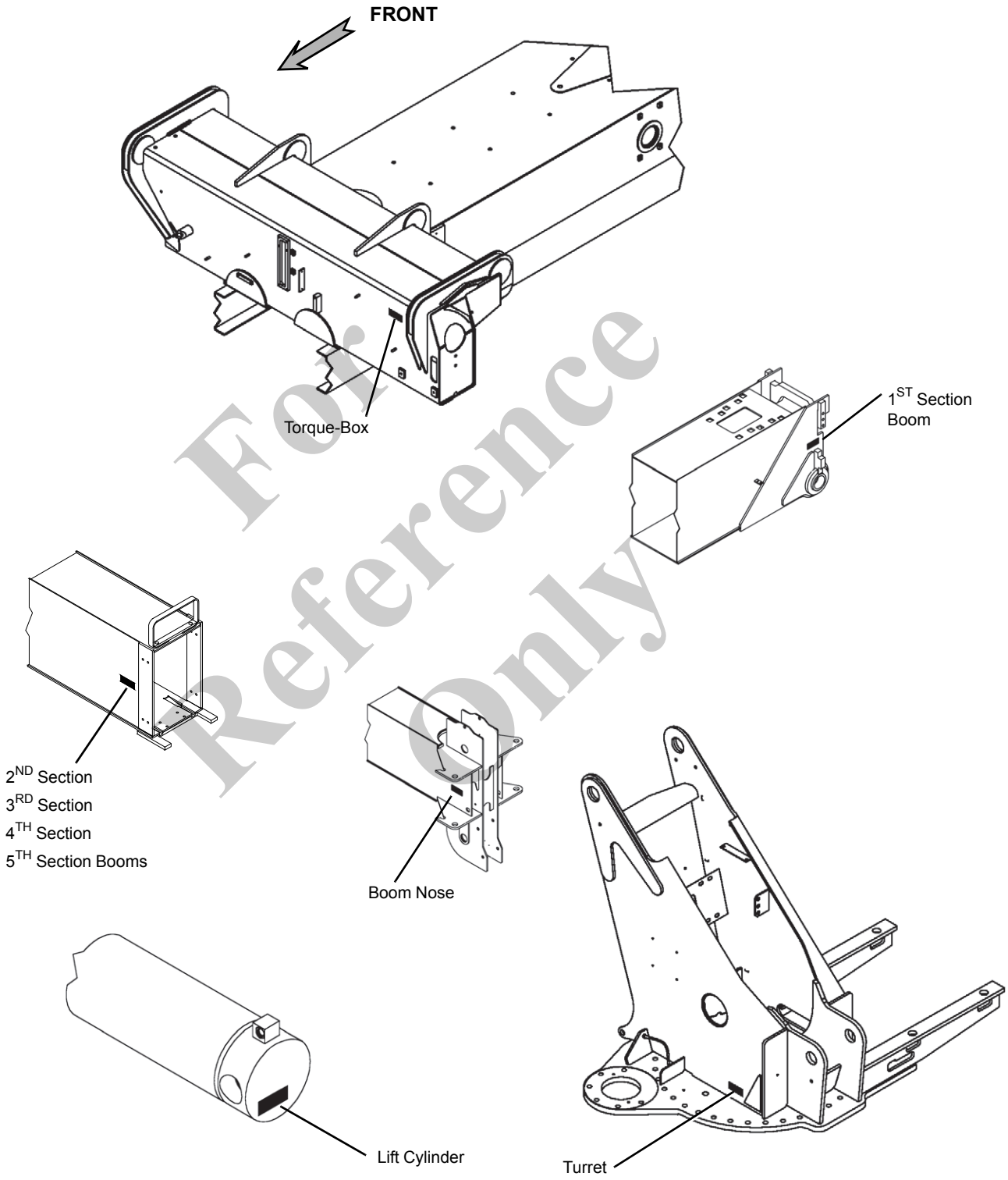

FIGURE 9-1

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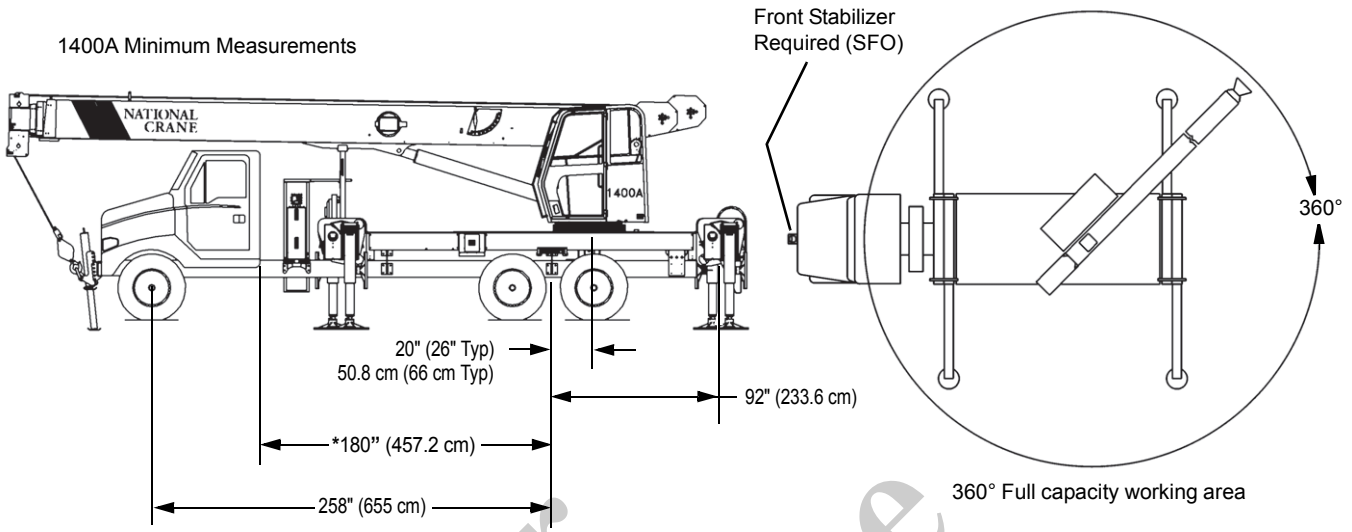


*Clear of obstructions (mufflers, exhaust stacks, ect.) on top of the truck frame for a full 8 foot (2.44m) of width.

FIGURE 9-2

MOUNTING CONFIGURATION

The mounting configuration shown 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 the actual stability and counterweight requirements. If the bare truck weights are not met, counterweight is required. A summary of mounting and truck requirements is as follows:

- Working area 360°
- Gross Axle Weight Rating (GAWR) Front 9072 kg (20,000 lb)
- Gross AxleWeight Rating (GAWR) Rear 15422 kg (34,000 lb)
- Gross Vehicle Weight Rating 24 494 kg (54,000 lb)
- Wheelbase (WB) 655 cm (258 in)
- Cab to Axle/Trunnion (CT) 457 cm (180 in) minimum
- After Frame (AF) 234 cm (92 in) minimum, 279 cm (110 in) preferred Frame Section Modulus (SM), front axle to end of after frame: 759 MPa (110,000 psi) 492 cm^3 (30 in^3). See “Truck Frame Strength” section.
- Estimated bare chassis weight required for stability prior to installation of crane or accessories:
  - Front* 4082 kg (9,000 lb)
  - Rear* 3629 kg (8,000 lb)
- Maximum bare chassis weights to mount 30.5 m (100 ft) or 33.5 m (110 ft) booms with 16.5 m (54 ft) of jib, cab and continuous rotation, 379 L (100 gal) of fuel, 136 kg (300 lb) of men to achieve a final mounted weight of 24 131 kg (53,200 lb):4355 kg (9,600 lb) front axle and 3765 kg (8,300 lb) rear axle.
- Maximum bare chassis weights to mount 38.7 m (127 ft) boom with 9.1 m (30 ft) jib, cab and continuous rotation, 379 L (100 gal) fuel, 136 kg (300 lb) of men to achieve a final mounted weight of 24131 kg (53,200 lb): 4128 kg (9,100lb) front axle and 3,629 kg (8,000 lb) rear axle.
- Additional options (e.g. auxiliary hoist, man baskets, etc.) or heavier bare chassis weights will require additional axles or a GVWR in excess of 24,494 kg (54,000 lb); in some states special permits for overload are required.
- The diagrams above show the 360° working area that can be achieved with the single front outrigger (SFO) (standard on the Series 1400A), The SFO is required when extending the boom and lifting loads over the front of the truck. See Truck Frame Strength on page 9-6 for truck frame strength required for mounting crane and SFO.

NOTE:

Gross Vehicle Weight Rating (GVWR) is dependent on all components of the vehicle (axles, tires, springs, frame, etc.) meeting the 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 also required.

All mounting data is based on a National Series 1400A 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 per SAE J765; contact the factory for details.

Transmission neutral safety interlock switch is required.

PTO REQUIREMENTS

Horsepower

The crane is equipped with a piston hydraulic pump that supplies 132 LPM (35 GPM) to the hoist,132 LPM (35 GPM) to the boom and telescope, and 61 LPM (16 GPM) to the turn and outrigger circuit. 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 542 N.m (400 lb-ft) or 63 kW (85 HP) per 1000 RPM of PTO shaft speed.

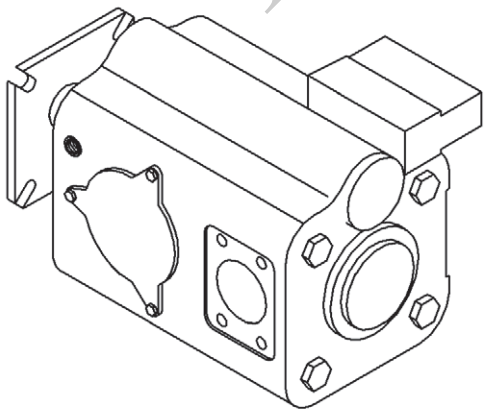


FIGURE 9-3

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 1400A 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. Optimum speed for the 1400A is 1900 RPM.

ENGINE SPEED (RPM)		PTO RATIO		
		1800 RPM PUMP	2000 RPM PUMP	2200 RPM PUMP
Gasoline Engine Optimum Speed Range	2900	62%	69%	76%
	2800	64%	71%	79%
	2600	69%	77%	85%
	2400	75%	83%	91%
	2200	82%	91%	100%
Diesel Engine Optimum Speed Range	2000	90%	100%	110%
	1800	100%	111%	122%
	1600	113%	125%	138%
	1500	120%	133%	147%
	1400	129%	143%	157%

Pump Rotation

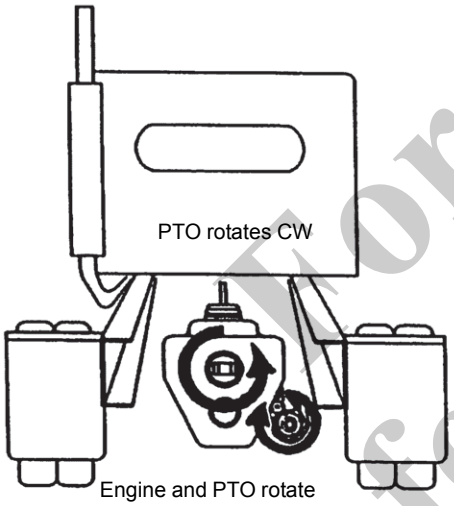
The hydraulic pump must be installed so that the pump rotates the same direction as the arrow on the pump housing. Make certain which direction the power take off output shaft rotates before selecting a clockwise (CW) or counter-clockwise (CCW) rotation hydraulic pump. Either CW or CCW rotation pumps are available and are marked clearly with a directional arrow on the pump housing.

CAUTION

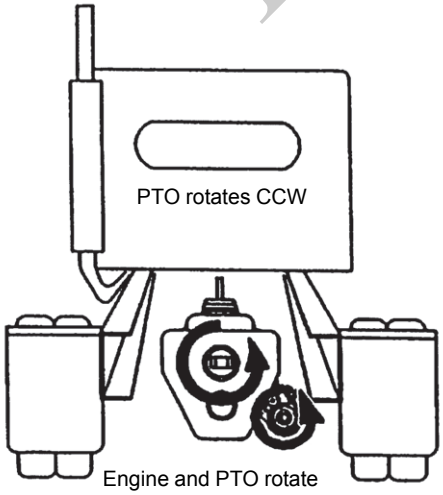
Rotating the pump in the wrong direction damages the pump.

Do not confuse engine crankshaft rotation with power take off rotation. If the power take off shaft rotates opposite the engine crankshaft, it is turning in a CW direction when viewed from the rear of the truck. If the power take off shaft rotates the same as the engine crankshaft, it is turning in a CCW direction when viewed from the rear of the truck.

FIGURE 9-4



Engine and PTO rotate in opposite directions.



Engine and PTO rotate in the same direction.

TRUCK FRAME STRENGTH

For a truck frame to be suitable for a Series 1400A 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 1400A Series require a minimum of 372,850 N·m (3,300,000 in-lb) RBM and 492 cm^3 (30 in^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 9-7.

Distance From SFO Attachment centimeters (Inches)	Section Modulus Per cm^3 (Rail $in.^3$)
0 - 30 (0 - 12)	44 (2.7)
30 - 61 (12 - 24)	90 (5.5)
61 - 9 (124 - 36)	134 (8.2)
91 - 121 (36 - 48)	180 (11.0)
121 - 152 (48 - 60)	224 (13.7)
152 - 182 (60 - 72)	270 (16.5)
182 - 213 (72 - 84)	315 (19.2)
213 - 243 (84 - 96)	359 (21.9)
243 - 274 (96 - 108)	405 (24.7)
274 - 304 (108 - 120)	449 (27.4)
304 + (120+)	492 (30.0)

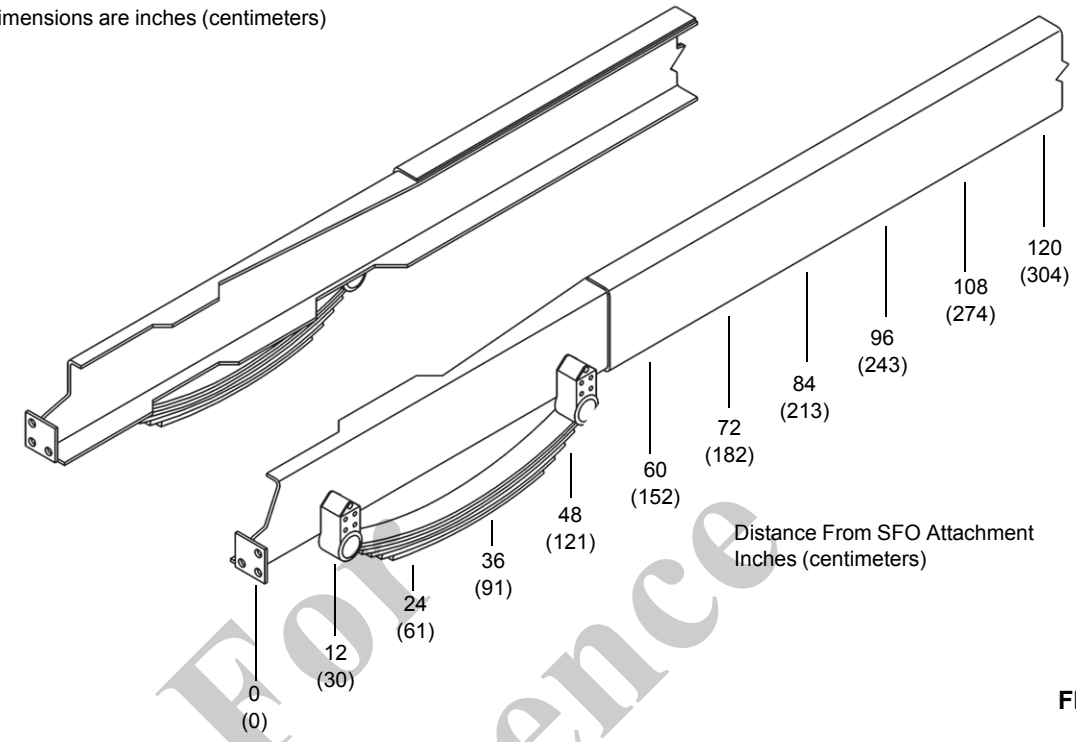


FIGURE 9-5

The following tables 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 9-8) - Table A provides the section modulus of channel frames in thicknesses of4.76 mm (3/16 in), 6.35 mm (1/4 in), 7.94 mm (5/16), and 9.52 mm (3/8 in) 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 9-8) - 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 9-9) - 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 9-9) - 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 9-9) - 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 25.4 mm (1 in) diameter plug welds are to be placed in a staggered pattern of the web; the rows to be spaced 127 mm (5) apart with welds at an interval of 102 mm (4). Do not weld on the flanges.

Where thickness, depth or flange width vary, interpolation between tables or variables within a given table will provide the strength for the section.

If you have any questions concerning frame strength or reinforcing, contact National Crane before proceeding.

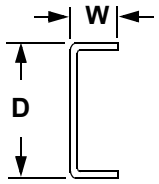


TABLE A
Section Modulus cm^3 (in^3)

4.76 mm Thickness (3/16 in.)					
D mm (in.)	W mm (in.)				
	64 (2.5)	76 (3)	89 (3.5)	102 (4)	
203 (8)	87 (5.3)	98 (6.0)	110 (6.7)	123 (7.5)	
229 (9)	103 (6.3)	116 (7.1)	130 (7.9)	143 (8.7)	
254 (10)	120 (7.3)	134 (8.2)	149 (9.1)	164 (10.0)	
279 (11)	138 (8.4)	154 (9.4)	170 (10.4)	187 (11.4)	
305 (12)	156 (9.5)	174 (10.6)	192 (11.7)	210 (12.8)	
330 (13)	177 (10.8)	195 (11.9)	215 (13.1)	234 (14.3)	
356 (14)	197 (12.0)	218 (13.3)	239 (14.6)	261 (15.9)	
381 (15)	220 (13.4)	241 (14.7)	264 (16.1)	287 (17.5)	in^3 (cm^3)

Thickness 6.35 mm (1/4 in.)					
D mm (in.)	W mm (in.)				
	64 (2.5)	76 (3)	89 (3.5)	102 (4)	
203 (8)	113 (6.9)	128 (7.8)	144 (8.8)	159 (9.7)	
229 (9)	134 (8.2)	151 (9.2)	169 (10.3)	187 (11.4)	
254 (10)	156 (9.5)	175 (10.7)	195 (11.9)	215 (13.1)	
279 (11)	180 (11.0)	202 (12.3)	223 (13.6)	241 (4.94)	
305 (12)	205 (12.5)	228 (13.9)	251 (15.3)	275 (16.8)	
330 (13)	231 (14.1)	256 (15.6)	282 (17.2)	308 (18.8)	
356 (14)	259 (15.8)	287 (17.5)	313 (19.1)	341 (20.8)	
381 (15)	287 (17.5)	316 (19.3)	348 (21.2)	377 (23.0)	in^3 (cm^3)

Thickness 7.9 mm (5/16 in.)					
D mm (in.)	W mm (in.)				
	64 (2.5)	76 (3)	89 (3.5)	102 (4)	
203 (8)	138 (8.4)	156 (9.5)	175 (10.7)	195 (11.9)	
229 (9)	164 (10.0)	185 (11.3)	206 (12.6)	228 (13.9)	
254 (10)	190 (11.6)	215 (13.1)	239 (14.6)	262 (16.0)	
279 (11)	220 (13.4)	246 (15.0)	272 (16.6)	300 (18.3)	
305 (12)	251 (15.3)	280 (17.1)	308 (18.8)	338 (20.6)	
330 (13)	284 (17.3)	315 (19.2)	346 (21.1)	379 (23.1)	
356 (14)	318 (19.4)	351 (21.4)	385 (23.5)	420 (25.6)	
381 (15)	354 (21.6)	390 (23.8)	426 (26.0)	464 (28.3)	in^3 (cm^3)

Thickness 9.5 mm (3/8 in.)					
D mm (in.)	W mm (in.)				
	64 (2.5)	76 (3)	89 (3.5)	102 (4)	
203 (8)	161 (9.8)	184 (11.2)	205 (12.5)	228 (13.9)	
229 (9)	192 (11.7)	216 (13.2)	243 (14.8)	267 (16.3)	
254 (10)	223 (13.6)	252 (15.4)	280 (17.1)	308 (18.8)	
279 (11)	257 (15.7)	290 (17.7)	321 (19.6)	352 (21.5)	
305 (12)	295 (18.0)	329 (20.1)	364 (22.2)	398 (24.3)	
330 (13)	333 (20.3)	370 (22.6)	408 (24.9)	446 (27.2)	
356 (14)	374 (22.8)	415 (25.3)	456 (27.8)	497 (30.3)	
381 (15)	416 (25.4)	461 (28.1)	505 (30.8)	582 (35.5)	in^3 (cm^3)

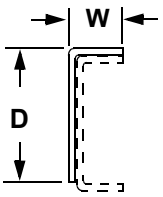


TABLE B
Section Modulus cm^3 (in^3)

4.76 mm Thickness (3/16 in.)					
D mm (in.)	W mm (in.)				
	70 (2.75)	83 (3.25)	95 (3.75)	108 (4.25)	
191 (7.5)	36 (2.2)	38 (2.3)	38 (2.3)	39 (2.4)	in^3 (cm^3)
216 (8.5)	46 (2.8)	48 (2.9)	49 (3.0)	49 (3.0)	
241 (9.5)	56 (3.4)	57 (3.5)	59 (3.6)	61 (3.7)	
267 (10.5)	67 (4.1)	70 (4.3)	72 (4.4)	74 (4.5)	
292 (11.5)	80 (4.9)	84 (5.1)	85 (5.2)	88 (5.4)	
318 (12.5)	95 (5.8)	98 (6.0)	100 (6.1)	103 (6.3)	
343 (13.5)	110 (6.7)	113 (6.9)	116 (7.1)	120 (7.3)	
368 (14.5)	124 (7.6)	129 (7.9)	133 (8.1)	136 (8.3)	

Thickness 6.35 mm (1/4 in.)					
D mm (in.)	W mm (in.)				
	70 (2.75)	83 (3.25)	95 (3.75)	108 (4.25)	
191 (7.5)	48 (2.9)	49 (3.0)	51 (3.1)	52 (3.2)	in^3 (cm^3)
216 (8.5)	61 (3.7)	62 (3.8)	64 (3.9)	66 (4.0)	
241 (9.5)	74 (4.5)	77 (4.7)	79 (4.8)	82 (5.0)	
267 (10.5)	90 (5.5)	93 (5.7)	95 (5.8)	98 (6.0)	
292 (11.5)	106 (6.5)	110 (6.7)	113 (6.9)	116 (7.1)	
318 (12.5)	124 (7.6)	129 (7.9)	133 (8.1)	136 (8.3)	
343 (13.5)	144 (8.8)	149 (9.1)	154 (9.4)	157 (9.6)	
368 (14.5)	166 (10.1)	172 (10.5)	175 (10.7)	180 (11.0)	

Thickness 7.9 mm (5/16 in.)					
D mm (in.)	W mm (in.)				
	70 (2.75)	83 (3.25)	95 (3.75)	108 (4.25)	
191 (7.5)	59 (3.6)	61 (3.7)	64 (3.9)	66 (4.0)	in^3 (cm^3)
216 (8.5)	75 (4.6)	77 (4.7)	80 (4.9)	82 (5.0)	
241 (9.5)	92 (5.6)	95 (5.8)	98 (6.0)	102 (6.2)	
267 (10.5)	111 (6.8)	116 (7.1)	120 (7.3)	123 (7.5)	
292 (11.5)	133 (8.1)	138 (8.4)	141 (8.6)	146 (8.9)	
318 (12.5)	156 (9.5)	161 (9.8)	166 (10.1)	170 (10.4)	
343 (13.5)	180 (11.0)	187 (11.4)	192 (11.7)	197 (12.0)	
368 (14.5)	206 (12.6)	213 (13.0)	220 (13.4)	224 (13.7)	

Thickness 9.5 mm (3/8 in.)					
D mm (in.)	W mm (in.)				
	70 (2.75)	83 (3.25)	95 (3.75)	108 (4.25)	
191 (7.5)	70 (4.3)	74 (4.5)	75 (4.6)	79 (4.8)	in^3 (cm^3)
216 (8.5)	90 (5.5)	93 (5.7)	97 (5.9)	98 (6.0)	
241 (9.5)	110 (6.7)	115 (7.0)	118 (7.2)	121 (7.4)	
267 (10.5)	133 (8.1)	138 (8.4)	143 (8.7)	146 (8.9)	
292 (11.5)	159 (9.7)	164 (10.0)	169 (10.3)	174 (10.6)	
318 (12.5)	185 (11.3)	192 (11.7)	198 (12.1)	203 (12.4)	
343 (13.5)	215 (13.1)	223 (13.6)	229 (14.0)	234 (14.3)	
368 (14.5)	247 (15.1)	254 (15.5)	262 (16.0)	269 (16.4)	

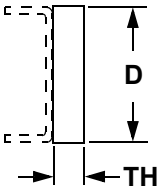


TABLE C
Section Modulus cm^3 (in^3)

TH mm(in.)	D in. (mm)								
	203 (8)	229 (9)	254 (10)	279 (11)	305 (12)	330 (13)	356 (14)	381 (15)	406 (16)	
4.76 (3/16)	33 (2.0)	41 (2.51)	51 (3.10)	61 (3.75)	73 (4.46)	86 (5.24)	100 (6.08)	114 (6.98)	130 (7.94)	in^3 (cm^3)
6.35 (1/4)	44 (2.66)	55 (3.37)	68 (4.16)	82 (5.03)	98 (5.99)	115 (7.03)	134 (8.15)	153 (9.36)	172 (10.5)	
7.94 (5/16)	55 (3.33)	69 (4.21)	85 (5.20)	103 (6.29)	123 (7.49)	144 (8.79)	167 (10.19)	192 (11.7)	218 (13.31)	
9.52 (3/8)	66 (4.0)	83 (5.06)	102 (6.25)	124 (7.56)	148 (9.00)	173 (10.56)	201 (12.25)	230 (14.06)	262 (16.0)	
11.11 (7/16)	76 (4.67)	97 (5.9)	119 (7.29)	144 (8.82)	172 (10.5)	202 (12.32)	234 (14.29)	269 (16.4)	306 (18.66)	

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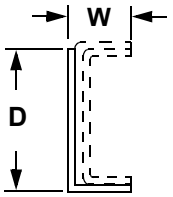


TABLE D
Section Modulus cm^3 (in^3)

4.76 mm Thickness (3/16 in.)					
D mm (in.)	W mm (in.)				
	76 (3)	89 (3.5)	102 (4)	114 (4.5)	
216 (8.5)	93 (5.7)	105 (6.4)	115 (7.0)	126 (7.7)	
241 (9.5)	110 (6.7)	121 (7.4)	133 (8.1)	146 (8.9)	
267 (10.5)	126 (7.7)	139 (8.5)	152 (9.3)	166 (10.1)	
292 (11.5)	144 (8.8)	159 (9.7)	174 (10.6)	187 (11.4)	
318 (12.5)	164 (10.0)	179 (10.9)	195 (11.9)	210 (12.8)	
343 (13.5)	184 (11.2)	200 (12.2)	216 (13.2)	234 (14.3)	
368 (14.5)	205 (12.5)	223 (13.6)	239 (14.6)	257 (15.7)	
394 (15.5)	226 (13.8)	246 (15.0)	264 (16.1)	284 (17.3)	in^3 (cm^3)

Thickness 6.35 mm (1/4 in.)					
D mm (in.)	W mm (in.)				
	76 (3)	89 (3.5)	102 (4)	114 (4.5)	
216 (8.5)	126 (7.7)	141 (8.6)	154 (9.4)	169 (10.3)	
241 (9.5)	149 (9.1)	164 (10.0)	179 (10.9)	195 (11.9)	
267 (10.5)	172 (10.5)	188 (11.5)	205 (12.5)	223 (13.6)	
292 (11.5)	195 (11.9)	215 (13.1)	233 (14.2)	252 (15.4)	
318 (12.5)	221(13.5)	241 (14.7)	262 (16.0)	282 (17.2)	
343 (13.5)	249 (15.2)	270 (16.5)	292 (17.8)	315 (19.2)	
368 (14.5)	277 (16.9)	300 (18.3)	323 (19.7)	347 (21.2)	
394 (15.5)	306 (18.7)	331 (20.2)	356(21.7)	382 (23.3)	in^3 (cm^3)

Thickness 7.9 mm (5/16 in.)					
D mm (in.)	W mm (in.)				
	76 (3)	89 (3.5)	102 (4)	114 (4.5)	
216 (8.5)	161 (9.8)	177 (10.8)	195 (11.9)	211 (12.9)	
241 (9.5)	188 (11.5)	206 (12.6)	226 (13.8)	246 (15.0)	
267 (10.5)	218 (13.3)	238 (14.5)	259 (15.8)	280 (17.1)	
292 (11.5)	247 (15.1)	271 (16.5)	295 (18.0)	318 (19.4)	
318 (12.5)	280 (17.1)	305 (18.6)	331 (20.2)	356 (21.7)	
343 (13.5)	315 (19.2)	341 (20.8)	369 (22.5)	397 (24.2)	
368 (14.5)	351(21.4)	379 (23.1)	408 (24.9)	438 (26.7)	
394 (15.5)	388 (23.7)	418 (25.5)	449 (27.4)	482 (29.4)	in^3 (cm^3)

Thickness 9.5 mm (3/8 in.)					
D mm (in.)	W mm (in.)				
	76 (3)	89 (3.5)	102 (4)	114 (4.5)	
216 (8.5)	195 (11.9)	216 (13.2)	236 (14.4)	256 (15.6)	
241 (9.5)	229 (14.0)	251 (15.3)	274 (16.7)	297 (18.1)	
267 (10.5)	266 (16.2)	290 (17.7)	315 (19.2)	339 (20.7)	
292 (11.5)	302 (18.4)	329 (20.1)	357 (21.8)	385 (23.5)	
318 (12.5)	342 (20.9)	370 (22.6)	402 (24.5)	431 (26.3)	
343 (13.5)	384 (23.4)	415 (25.3)	447 (27.3)	480 (29.3)	
368 (14.5)	426 (26.0)	461 (28.1)	495 (30.2)	531 (32.4)	
394 (15.5)	472 (28.8)	508 (31.0)	546 (33.3)	583 (35.6)	in^3 (cm^3)

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 12.19 m (40 feet). Using a truck that has a too long WB may exceed this limit.
- **Axle Weights** - All states allow 9,072 kg (20,000 lb) single axle weight and 15,422 kg (34,000 lb) tandem axle weights on primary roads. However, some states restrict the axle weight to less on secondary roads or at certain times throughout the year. Be aware of your state's axle laws for weight restrictions.

- **Overhang** - The most restrictive overhang laws call for a maximum of three feet in front of the truck. Check on your state requirements.
- **Federal Bridge Law** - The Federal Bridge Law in effect currently states that in order to carry 24,493 kg (54,000 lb) on a three axle truck, the extremes of any group of axles must be at least 7.16 m (23.5 feet) apart. This equates to a truck with a wheelbase of at least 655 cm (258 inches) with a minimum length of 61 cm (24 inches) from the center of tandems to the center of the rear axle.

PTO, PUMP, AND RESERVOIR

1. Select the PTO according to the PTO Requirements Section on page 9-5. 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 9-5).

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 106 cm (42 inches) 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 15.25 cm (6 inch) 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 and, 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.

- 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 7.87 mm x 3 mm (0.31" dia. x 0.12") 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.

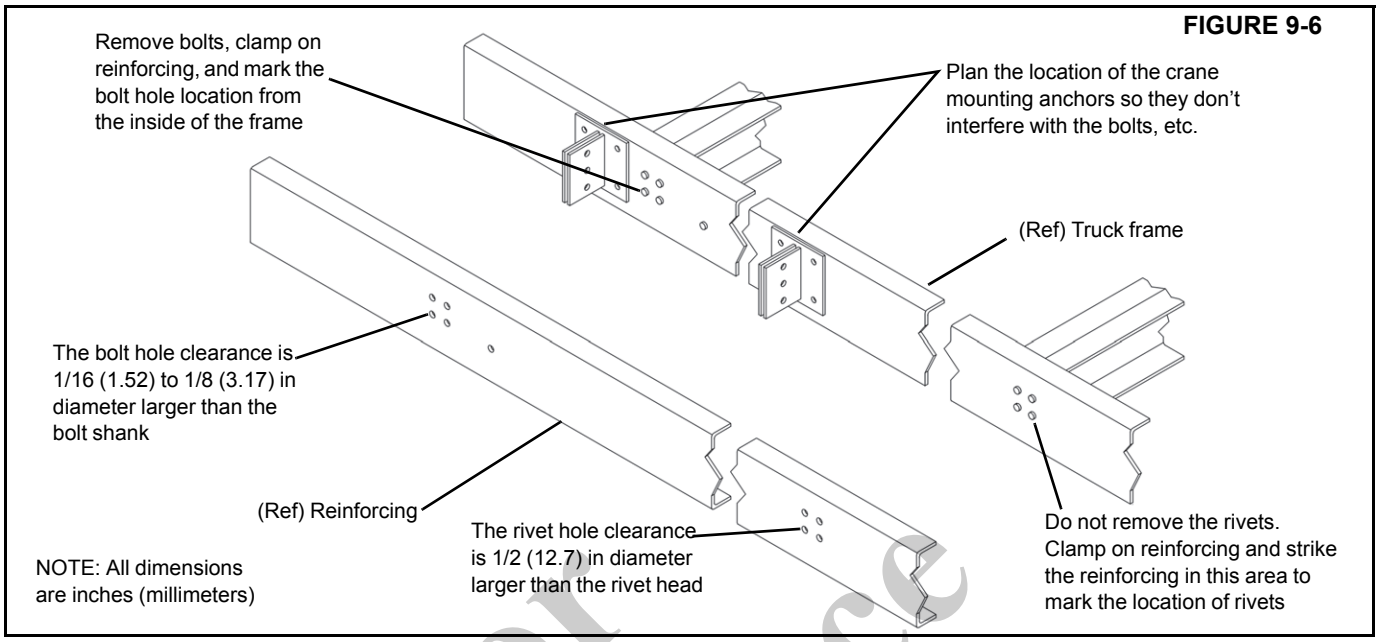


FIGURE 9-6

3. Place the reinforcing on the truck frame and clamp in place. Mark the location of rivets by striking the outside of the reinforcing over the rivet area so that the rivets make an impression on the inside of the reinforcing. Mark the approximate location of the crane mounting anchors so that no obstructions exist. Remove the reinforcing and cut clearance holes for the rivets (Figure 9-6).
4. If reinforcing is to be welded to the frame, remove the crossmember bolts, mark, and cut the hole pattern in the reinforcing. Be sure to clear the crane mounting anchors. Clamp the reinforcing in place, install crossmember bolts that were previously removed, and weld to truck frame as shown in Figure 9-7.

If bolt-on reinforcing is required, clamp the reinforcing in place and install crossmember bolts that were previously removed. Drill through the reinforcing and truck frame. Be sure to clear crane mounting anchors and bolt reinforcing in place. See Figure 9-8 for recommended drilling and bolting procedure. Use 5/8", Grade 8 bolts, drill holes to 15.5mm (39/64 in) diameter, drive fit bolts and torque according to Torque Chart in Section One.

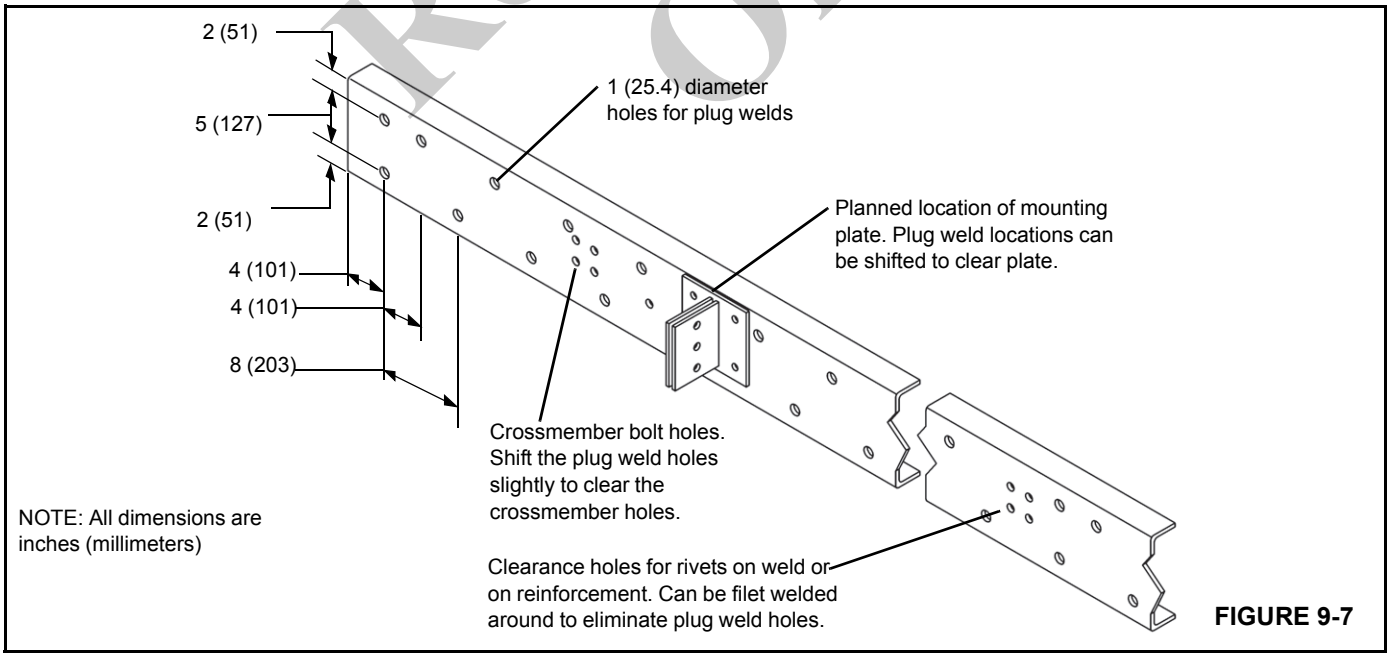
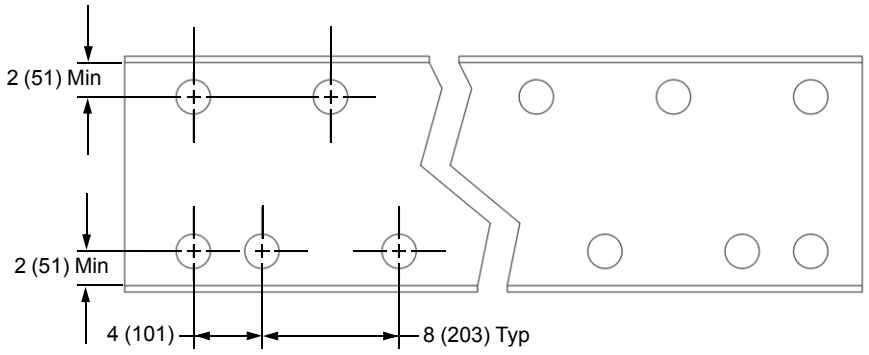


FIGURE 9-7



NOTE: All dimensions are inches (millimeters)

FIGURE 9-8

5. 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 9-9. See Section Modulus Table B on page 9-9 for the required size of reinforcing. Strip all easily removable equipment from the frame through the suspension such as spring stops, etc. Butt the reinforcing angle up against the reinforcing forward of the suspension and mark the areas that require cutting so that the angle slides up around the spring hangers and against the existing truck frame and forward reinforcing. Torch out the marked areas in the long leg of the angle deep enough so that the lip of the angle can be slid up from the underneath the frame to contact either existing truck frame or spring hanger brackets (if they extend down below the existing truck frame). If reinforcing angle is welded to truck frame, cut out plug weld hole pattern as in Figure 9-7.

Slide the reinforcing angle up from the bottom, butt it to existing forward reinforcing and weld rear suspension reinforcing to forward reinforcing. Replace as much of the spring hanger cut out areas as possible and butt weld these pieces in.

- If reinforcing angle is to be bolted on, drill hole pattern and install bolts according to Figure 9-8. Reinforce spring hanger cut outs and the weld area, suspension reinforcing to forward reinforcing by adding bars under these areas. The bars should be of the same thickness, width and yield strength as the reinforcing angle lip, and should be long enough to extend at least 152mm (6in) beyond either side of the weld or cut out areas. Weld these reinforcing bars to the underside of the reinforcing with length-wise welds. Do not weld across the flanges. Replace any equipment that had been removed.

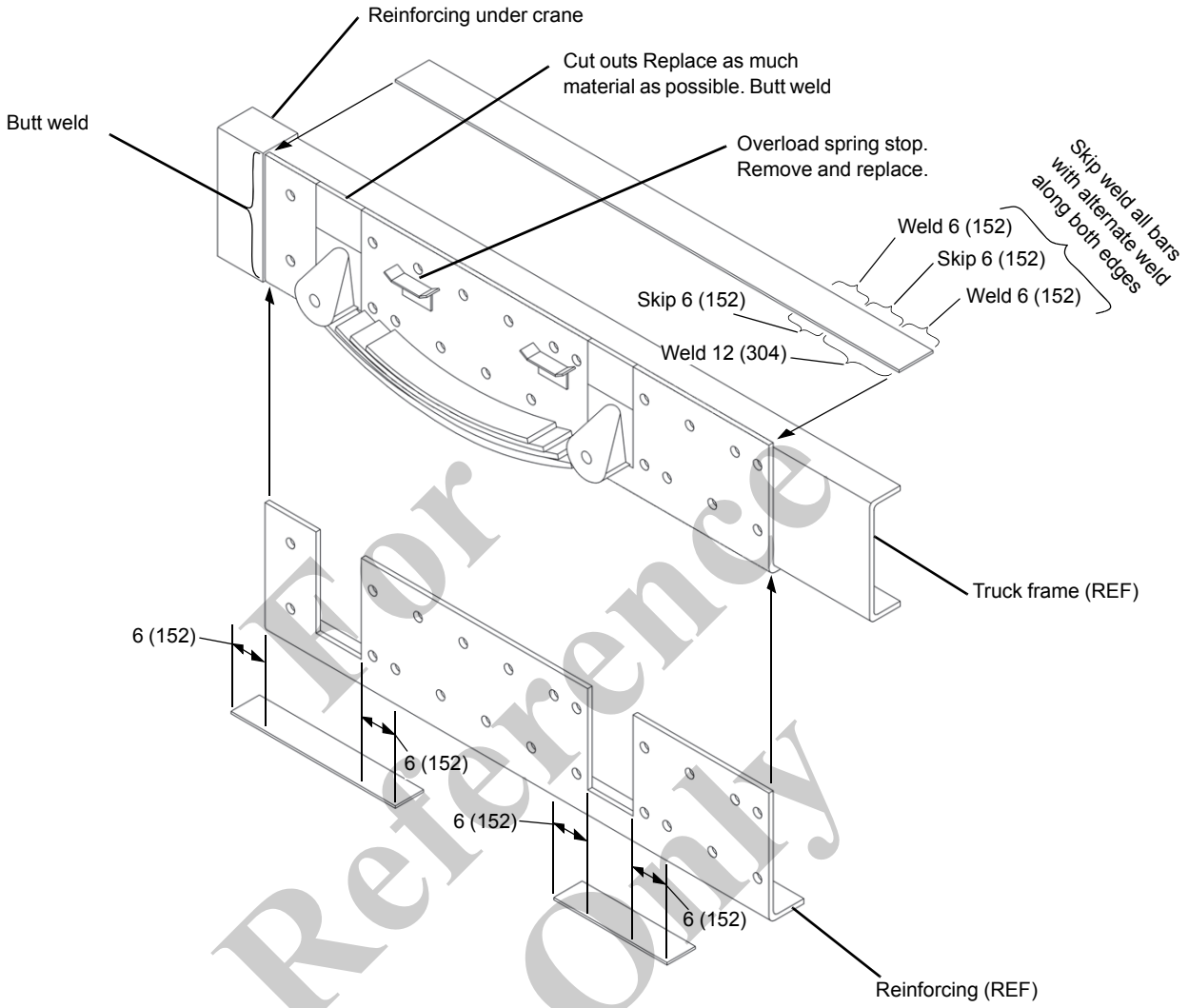


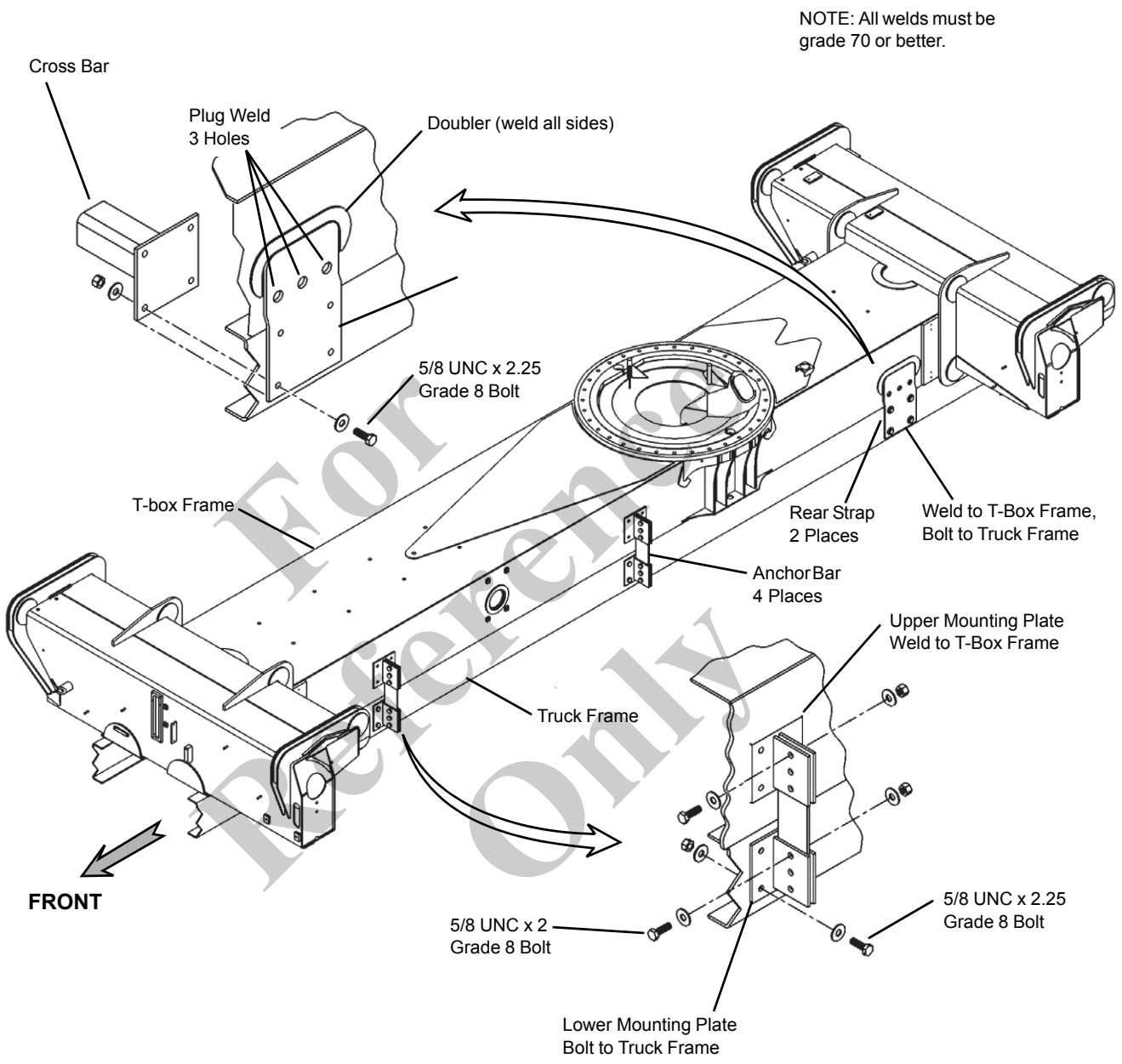
FIGURE 9-9

NOTE: All dimensions are inches (millimeters)

6. The 1400A needs an after frame of about 233 cm (92 inches). 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 50 to 61 cm (20 to 24 inches) behind the center of tandems. At this location, an after frame (AF) length (distance from center of tandems to back of truck frame) of 228 to 238 cm (90 to 94 inches) 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 30 cm (12 inches) 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



5/8 Dia Grade 8 Bolts Torque to 216 - 234 lb-ft (292.8 - 317 N.m)

FIGURE 9-10

9

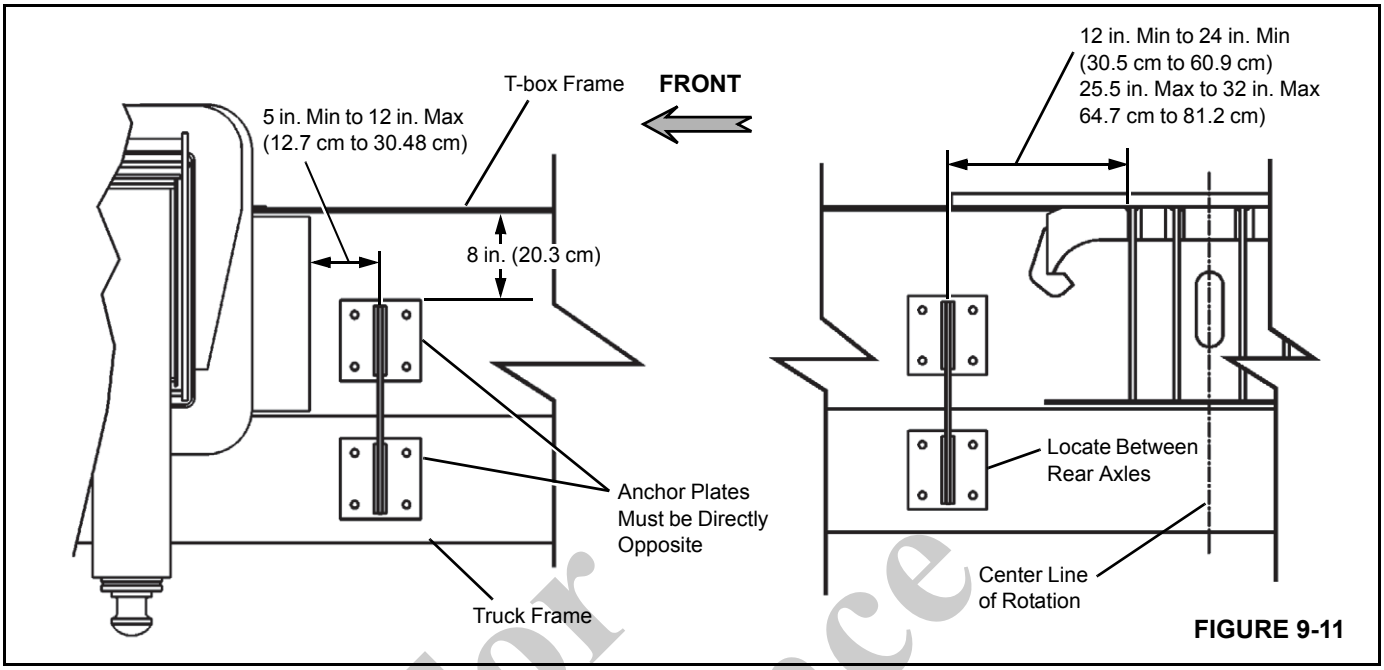


FIGURE 9-11

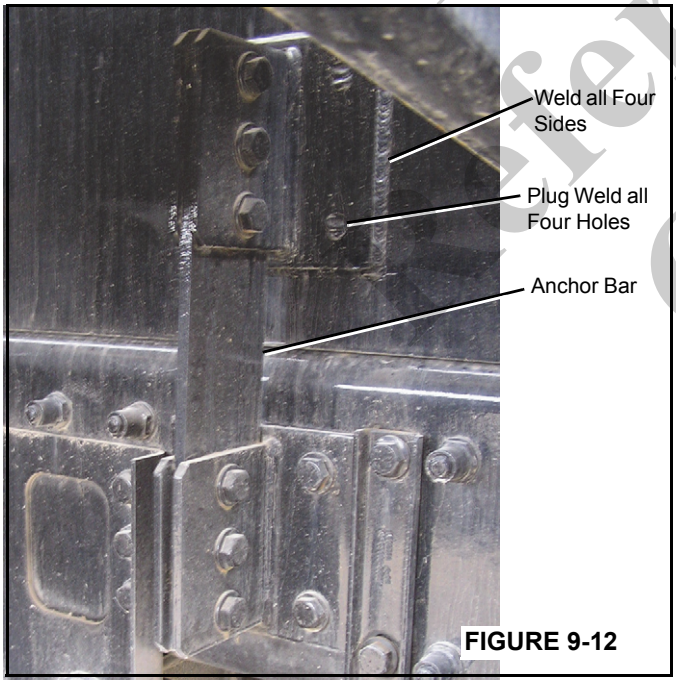


FIGURE 9-12

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 on pages 9-1 through 9-15. Mounting the crane to the truck frame is as follows:

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 9-10.
2. Locate the upper mounting plates (4 places) on the T-box frame as shown in Figure 9-10 and Figure 9-11.
3. Weld each plate on four sides Figure 9-12.
4. Bolt the anchor bar (Figure 9-12) to the upper mounting plate finger tight.
5. Bolt the lower mounting plate to the anchor bar finger tight.
6. Drill four bolt holes through the truck frame using the lower mounting plate to locate the bolt holes.

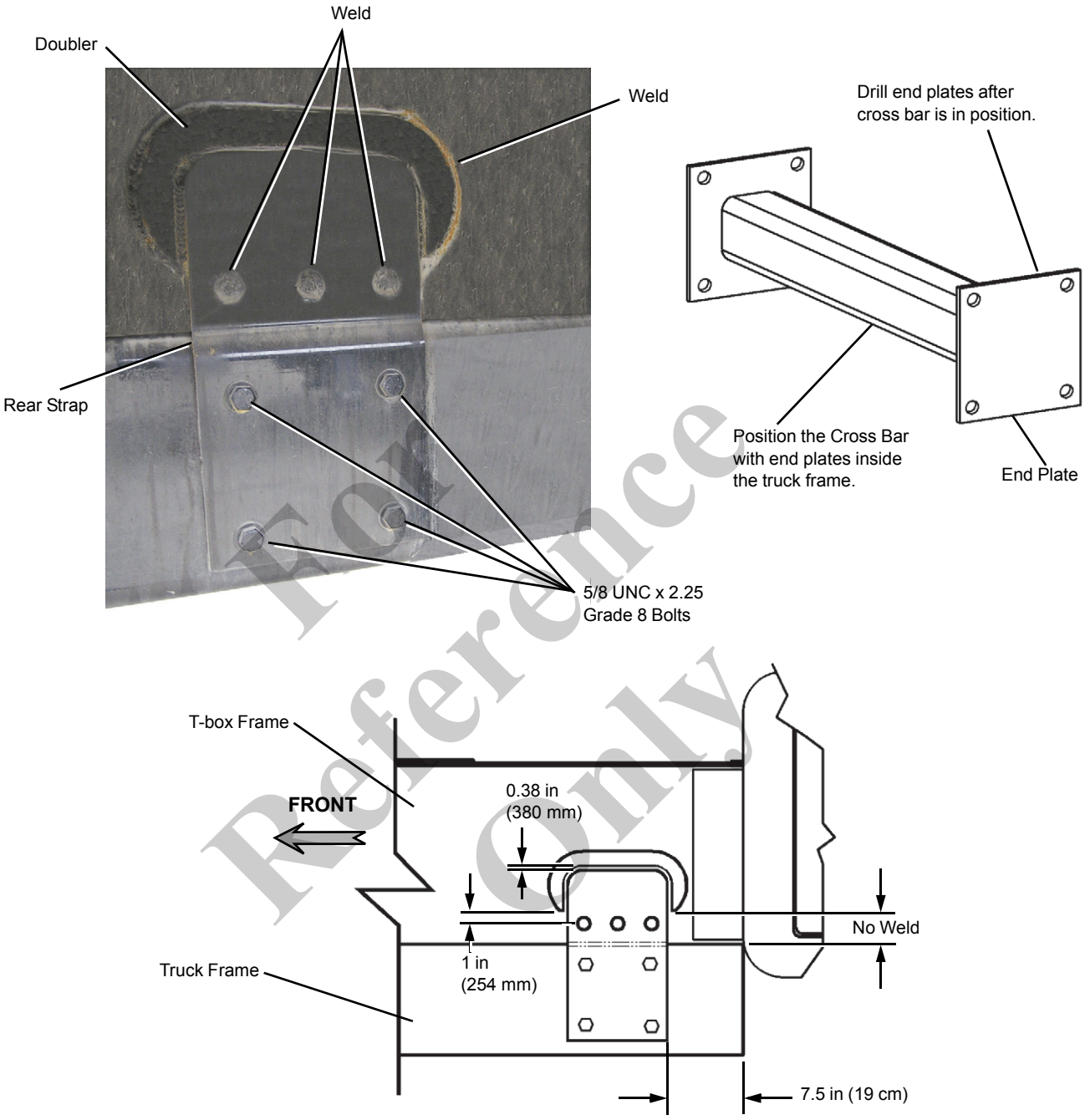


FIGURE 9-13

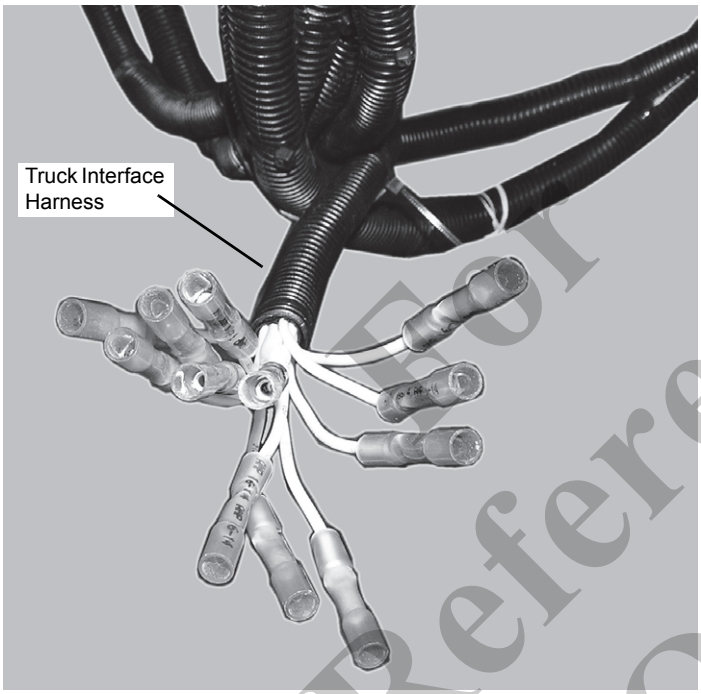
7. Locate and weld the rear strap to the T-box frame (Figure 9-13).
8. Cut the cross bar to fit (Figure 9-13) inside the truck frame with the end plate.
9. Weld the end plate to the cross bar.
10. Clamp the cross bar in place and drill four bolt holes using the Lower Mounting Plate to locate the bolt holes in the cross bar (Figure 9-13).
11. Tighten all mounting bolts to the proper torque.

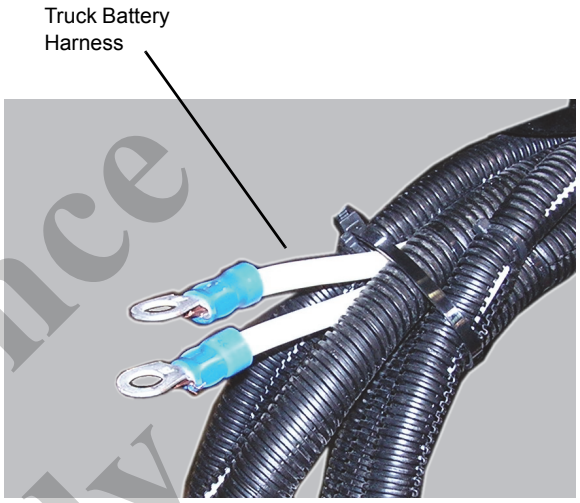
Truck Interface Electrical Connection

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.
- Route wires 5 & 51 to the truck battery. Be sure the wires not pinched or cut. Cut to length and crimp on the terminals.
- 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.





Truck Interface Harness	
Wire #	**Truck Function**
473 - 475	Throttle Leads (473 - 475 for three lead connections)
477 - 479	Throttle Leads (473 - 479 for six lead connections)
450	Throttle Splitter Power
51	Throttle Splitter Ground
901	Ignition Switch
52	Start Switch
112	Accessory Switch
5	Auxiliary Power (Optional)

Truck Battery Harness	
Wire #	**Truck Function**
51	(-) Ground
5	(+) Positive

NOTE: The type of throttle supplied with the truck determines if three leads or six leads are required.

Throttle Splitter Power (450) and Throttle Splitter Ground (51) are not used when the throttle is direct wired to the truck.

FIGURE 9-14

Hydraulic System 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 mounted on the truck power take off (PTO). The pump is driven counter clockwise and supplies the following at governed rpm:

- 132 LPM (35 GPM) to the hoist
- 132 LPM (35 GPM) to the boom and telescope
- 61 LPM (16 GPM) to the turn and outrigger circuit.

Connect the hydraulic hoses to the pump sections as marked.

12. Adjust the throttle for the engine RPM and PTO ratio to get proper pump shaft speed.

13. 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.

14. The Initial Crane Run in Procedure must be completed before the stability test is started.

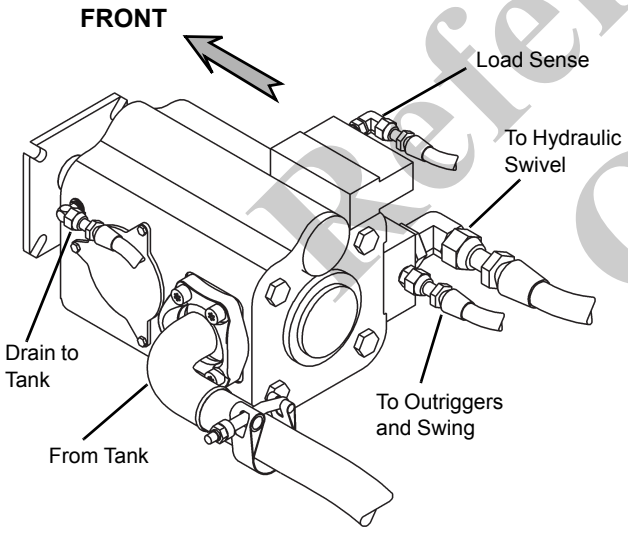


FIGURE 9-15

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.

6. After testing is completed, check the torque on all bearing, mounting and all cable clamp bolts.

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. Loads listed in the Load Chart that are not in the shaded area are limited by stability. 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.
4. Two test loads are required to ensure the crane is stable over both the sides and rear of the machine. Special care must be taken in performing the stability test if the crane is equipped with a jib. The stability test can be performed with or without the jib stowed on the side of the main boom. If the stability test is performed with the jib stowed on the side of the main boom, adjust the stability load as shown in the table below.

Model	Boom Length	Loaded Radius	Add To Rated Load When Jib Stowed*
14127A	38.7 m (127 ft) 21.3 m (70 ft)	29.0 m (95 ft) 15.2 m (50 ft)	76.2 kg (168 lb) 84.8 kg (187 lb)
14110A	28.7 m (94 ft) 18.9 m (62 ft)	25.9 m (85 ft) 15.2 m (50 ft)	112.0 kg (247 lb) 117.9 kg (260 lb)
14100A	26.2 m (86 ft) 17.7 m (58 ft)	21.3 m (70 ft) 15.2 m (50 ft)	151.5 kg (334 lb) 175.5 kg (387 lb)

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.

EXAMPLE 1: 14110A No Jib Stowed

Test Load #1

- Boom Length: 28.7 m (94 ft)
- Loaded Radius: 25.9 m (85 ft)
- 14110 capacity at:
  - 25.9 m (85 ft) boom length
  - 28.7 m (94 ft) radius
  - 794 kg (1750 lb) per capacity chart
- Stability Test Load (no jib stowed):
  - 1750 x 1.176 = 2058 lb*
  - 794 x 1.176 = 934 kg*

Test Load #2

- Boom Length: 18.9 m (62 ft)
- Loaded Radius: 15.2 m (50 ft)
- 14110 capacity at
  - 15.2 m (50 ft) radius
  - 18.9 m (62 ft) boom length
  - 3266 kg (7200 lb) weight per capacity chart
- Stability Test Load (no jib stowed):
  - 7200 x 1.176 = 8467 lb*
  - 3266 x 1.176=3841 kg*

EXAMPLE 2: 14110A WITH 30 - 54 ft JIB STOWED

Test Load #1

- Boom Length: 28.7 m (94 ft)
- Loaded Radius: 25.9 m (85 ft)
- 14110 capacity at:
  - 25.9 m (85 ft) radius
  - 28.7 m (94 ft) boom length
  - 794 kg (1750 lb) per capacity chart
- 136 kg (300 lb) deduct for 30 - 54 ft jib stowed at 28.7 m (94 ft) boom length.
- 112 kg (247 lb) added per the table to compensate for the effects of the jib stowed on the main boom during the stability test.
- Stability Test Load (30 - 54 ft jib stowed):
  - (1750 -300 +247) x 1.176 = 1996 lb*
  - (794 -136 +112) x 1.176 = 906 kg*

Test Load #2

- Boom Length: 18.9 m (62 ft)
- Loaded Radius: 15.2 m (50 ft)
- 14110 capacity at:
  - 15.2 m (50 ft) radius
  - 18.9 m (62 ft) boom length

- 3266 kg (7200 lb) per capacity chart

- 204 kg (450 lb) deduct for 30 - 54 ft jib stowed at 18.9 m (62 ft) boom length
- 117.9 kg (260 lb) added per the table to compensate for the effects of the jib stowed on the main boom during the stability test.
- Stability Test Load (30 - 54 ft jib stowed):
  - (7200 -450 +260) x 1.176 = 8244 lb*
  - (3266 -204 +117.9) x l.176 = 3740kg*

NOTE: *Includes weights of slings and hook block

5. Over the side:

- Assemble the first stability test load as described above near the crane.
- Measure the load radius from the center of rotation directly to one side of the machine.
- Extend the boom to the specified boom length
- Lift the stability test load just slightly off the ground (not over 0.3 m [1 ft]).
- Slowly boom down while hoisting up to move the load out to the load radius.
- Move the load very slowly when approaching the load radius so the stability test load does not swing out past the load radius. If the stability test load can be kept from contacting the ground at the load radius, the unit is stable over the side tested.
- Slowly rotate the load 360° to ensure that the stability test load is stable directly over both sides, the back, and the front.

6. 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 0.3 m [1 ft]).
- Boom down while hoisting up to move the stability test load out to the load radius.
- Move the load very slowly when approaching the load radius so the stability test load does not swing out past the load radius. If the stability test load can be kept from contacting the ground at the load radius, the unit is stable over the rear of the unit.
- Slowly rotate the stability test load 360° to ensure that the load is stable directly over both sides, the back, and the front.

7. 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.

SPECIFICATIONS 1400A

Hydraulic System

Requirements:

Boom Up	132 LPM (35 GPM),24.8 MPa ±344.7 kPa (3600 psi ±50)
Boom Down	64 LPM (17 GPM), 25 MPa ±689 kPa (3650 psi ±100)
Boom Telescope Out	132 LPM (35 GPM), 18.6 MPa ±689 kPa (2700 psi ±100)
Boom Telescope In	64 LPM (17 GPM), 15.5 MPa ±689 kPa (2250 psi ±100)
Hoist System	132 LPM (35 GPM), 26 MPa +689/-0 kPa (3800 psi +100/-0)
Outrigger	60.5 LPM (16 GPM), 20.6 MPa +689/-0 kPa (3000 psi +100/-0)
Swing	60.5 LPM (16 GPM), 21.3 MPa +1379/-0 kPa (3100 psi +200/-0)
Reservoir Capacity	287.6 L (99 gal.) at full mark
System Capacity	586.7 L (155 Gallons)
Filtration	10 Micron (Return Filter)

Flow rates listed are at free flow condition (approx. 698 kPa/100 psi)

Hoist System

Wire cable Standard ..... 114 m (375 ft) of 15.8 mm (5/8 in.) dia. Rotation Resistant Nominal Breaking Strength - 20,539 kg (45,500 lbs.)

Hoist Performance (with 1 part of line)

Layer	Hoist Pull		Hoist Speed		BOS Hoist Speed		BOS Hoist Pull	
	kg	(lbs)	mpm	(fpm)	mpm	(fpm)	(kg)	(lbs)
1	5488	(12,100)	39	(128)	77.7	(255)	2,630	(5,800)
2	4898	(10,800)	42.9	(141)	86.2	(283)	2,358	(5,200)
3	4490	(9,900)	47.5	(188)	76.5	(338)	2,177	(4,800)
4	4082	(9,000)	51.8	(200)	83.2	(363)	1,995	(4,400)
All ratings based on 124.9 LPM at 26.2 MPa (33 GPM at 3800 psi.)								

Crane Operating Speeds

Rotation, 360° ..... 28 sec. ±7 sec.
Boom Up, (-10° to 80°) ..... 30 sec. ±5 sec.
Boom Down, (80° to -10°) ..... 32 sec. ±5 sec.
Boom Extend * ..... 11.5 mpm ±1.5 mpm (38 fpm ±5 fpm)
Boom Retract * ..... 11.5 mpm ±1.5 mpm (38 fpm ±5 fpm)
Boom Extend ** ..... 13.4 mpm ±1.5 mpm (44 fpm ±5 fpm)
Boom Retract ** ..... 13.4 mpm ±1.5 mpm (44 fpm ±5 fpm)
Outrigger Beam Extend ..... 16 sec ±3 sec.
Outrigger Beam Retract ..... 18 sec ±3 sec.

* Boom Length of 9.4 m - 30.4 m and 10 m - 33.5 m (31 ft - 100 ft and 33 ft - 110 ft)

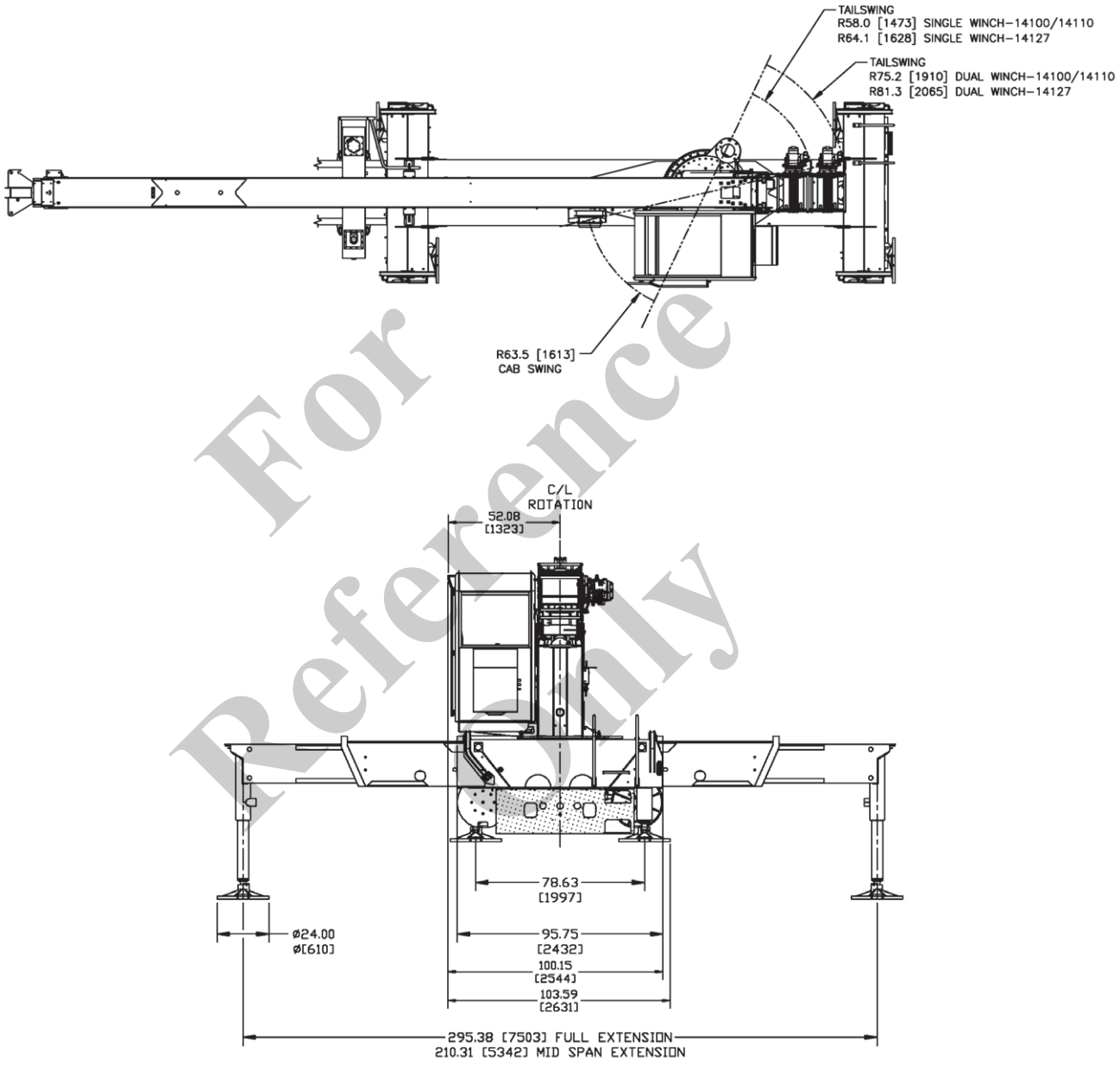
** Boom Length of 9.7 m - 38.7 m (32 ft - 127 ft)

NOTE: Crane operating speeds based on engine speed at governed RPM and hydraulic reservoir temperature at 37.7°C (100°F).

Air Conditioner (Optional)

Hydraulic Requirements ..... 30.28 LPM (8 GPM) @ 10.34 MPa (1500 PSI Max)
Minimum Evacuation Time ..... 30 minutes
Refrigerant Charge Levels ..... 2.0 pounds (+/- 0.5 Ounce)
Additional Pag Oil Required Above 6 ounces in Compressor 4.0 ounces

DIMENSIONAL DRAWING



NOTES:
1. DIMENSIONS ARE IN inches [mm] UNLESS OTHERWISE SPECIFIED.

Manitowoc Crane Group | NATIONAL CRANE | GROVE.

TITLE
1400A DIMENSIONAL DRAWING

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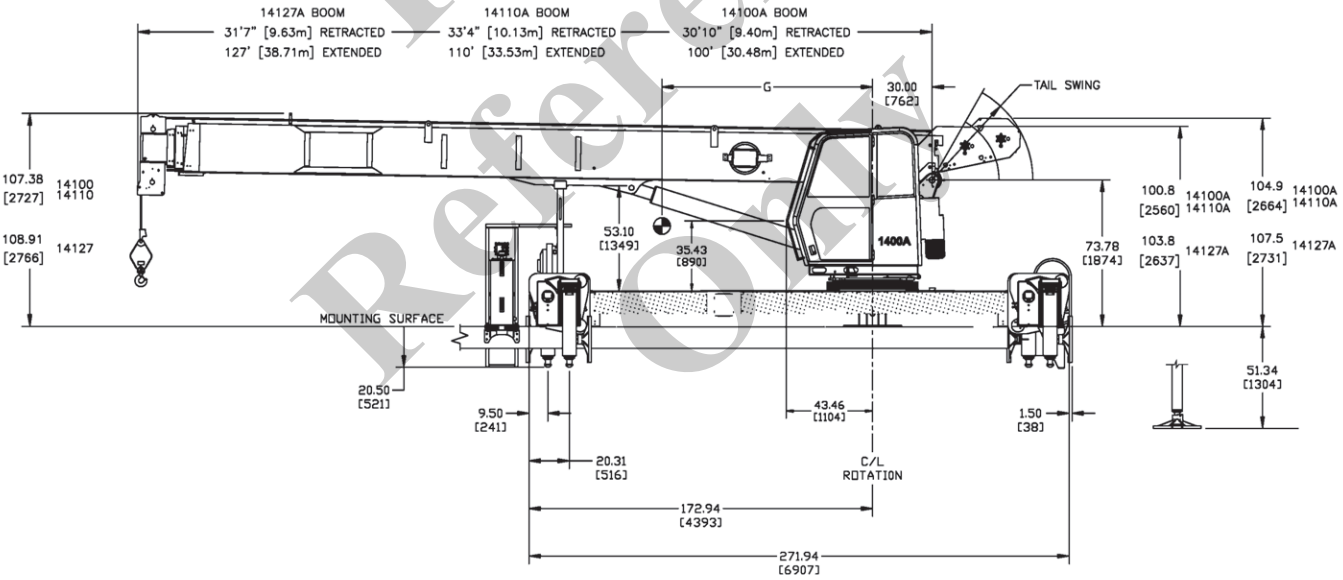
NOTES:
1. DIMENSIONS ARE IN inches [mm] UNLESS OTHERWISE SPECIFIED.

G CENTER OF GRAVITY FROM CENTERLINE		
SERIES	G	W/OIL WEIGHT*
14100A	80" [2032mm]	29,640 lbs [13,473kg]
14110A	82" [2083mm]	30,510 lbs [13,868kg]
14127A	85" [2159mm]	32,380 lbs [14,718kg]

*WEIGHT INCLUDES ALL ITEMS INCLUDING COMPLETE HO OUTRIGGERS, 180 lb [82 kg] DOWNHAUL WEIGHT, RESERVOIR, DECKS, LADDERS, AND SFO. BOOMS FULLY RETRACTED. PUMP, PTO, AND SFO NOT INCLUDED.



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TITLE
1400A DIMENSIONAL DRAWING

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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ALPHABETICAL INDEX