Grove GRT8120

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.

GROVE

by Manitowoc

SERVICE MANUAL

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

GRT8120

Crane Model Number

Crane Serial Number

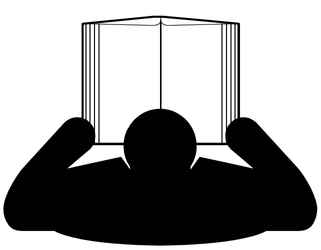
This Manual is Divided into the following Sections:

SECTION 1	**INTRODUCTION**
SECTION 2	**HYDRAULIC SYSTEM**
SECTION 3	**ELECTRICAL SYSTEM**
SECTION 4	**BOOM**
SECTION 5	**HOIST AND COUNTERWEIGHT**
SECTION 6	**SWING SYSTEM**
SECTION 7	**POWER TRAIN**
SECTION 8	**UNDERCARRIAGE**
SECTION 9	**MAINTENANCE AND LUBRICATION**

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 operator's cab. ***Always furnish crane serial number*** when ordering parts or communicating service problems with your distributor or the factory.



DANGER

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

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

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GENERAL

This Manual provides important information concerning your Grove Crane.

Overview of Manuals

Before placing the crane in service, take time to thoroughly familiarize yourself with the contents of this manual. After all sections have been read and understood, retain the manual for future reference in a readily accessible location.

NOTE: Throughout this Manual, reference is made to left, right, front, and rear when describing locations. These reference locations are to be considered as those viewed from the operator's seat with the superstructure facing forward over the front of the carrier frame.

Engine operating procedures and routine maintenance procedures are supplied in separate manuals with each crane, and should be referred to for detailed information. A separate safety manual is also provided with each crane. See the Operating Manual Section #2 for other Safety related issues.

Customer Support

Manitowoc and our Dealer 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.

General Crane Design

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

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

Specific Crane Description

The crane incorporates an all welded parallel box construction steel frame, utilizing two drive steer axles. Axle steering is accomplished utilizing hydraulic steer cylinders. The engine is mounted at the rear of the crane carrier and provides motive power through a six speed forward and reverse transmission. The outriggers are single stage, double box, telescopic beam type outriggers.

The superstructure is capable of 360° continuous rotation in either direction. All crane functions are controlled from the fully-enclosed cab mounted on the superstructure. The cab seat incorporates armrest-mounted electronic programmable single-axis or dual-axis controllers and a jog dial for easy data input. The crane is equipped with a seven-section MEGAFORM™ boom with TWIN-LOCK™ boom pinning system. Additional reach is obtained by utilizing an optional swingaway boom extension. Lifting is provided by a main hoist and an optional auxiliary hoist.

Lifting Capacities (Load Chart)

Lift Capacities are listed on the Load Chart Manual in the cab.

Basic Components

For basic Crane Component locations see Figure 1-2.

Axle Weight Distribution

For Axle Weight Distribution see Table 1-1.

Serial Number Location

Crane Serial Numbers are stamped on the left side of front frame and on manual holder in cab.

Transportation and Lifting Data

Transportation and Lifting data Figure 1-1 are located on the hydraulic tank on the right side of the crane.

LIST OF SPECIFICATIONS

General

Model GRT8120
Full Vision Cab . . . . 20° cab tilt
Rated Capacity. . . . See *Load Chart Manual* in cab
Drive. . . . . 4 x 4
Gross Weight . . See Axle Weight Distribution Table

Dimensions

NOTE: Dimensions listed are for a crane with all components fully retracted in the travel mode.

Wheelbase . . . . 4216 mm (166 in)
Length (Frame) . . . . 8632 mm (340 in)
Length (Overall) . . . . 13919 mm (548 in)
Width . . . . 3339 mm (131 in)
Height. 3748 mm (147 in)
Weight . . . . 58920 kg (129896 lb)
Outside Turning Radius
(with Boom Extension Installed)
2 Wheel Steer . . . . 17.5 m (57 ft 6 in)
4 Wheel Steer . . . . 11.9 m (39 ft 2 in)
Outside Turning Radius
(without Boom Extension Installed)
2 Wheel Steer . . . . 16.7 m (54 ft 10 in)
4 Wheel Steer . . . . 11.2 m (36 ft 10 in)
Outside Curb Clearance
2 Wheel Steer . . . . 14 m (45 ft 10 in)
4 Wheel Steer . . . . 7.8 m (25 ft 7 in)

Capacities

Fuel Tank (Usable) . . . . 271 L (72 gal)
Engine Cooling System . . . . 52.7 L (13.9 gal)
Engine Cooling System (Liquid Coolant
Conditioner) . . . . . . (test and add, as necessary)
Engine Crankcase with filter (Tier 4) . 20 L (5.3 gal)
Hydraulic Tank (Reservoir Capacity)
Total. . . . . 1029.4 L (271.9 gal)
Full Level. . . . . 926.5 L (244.8 gal)
Hoist Drums (each) . . . . 4.9 L (1.3 gal)
Swing Drive Gearbox . . . . 4 L (4.4 qt)
Swing Drive Gearbox
Brake Assembly . . . . 0.3 L (0.6 pt)
Axle Planetary Hubs and Wheel
Bearings (each wheel end). . . . . . 9.8 L (10.4 qt)
Axle Differentials (each) . . . . 35.2 L (9.3 gal)
Transmission (includes
Torque Converter). . . . . 41.6 L (44 qt)
Diesel Exhaust Fluid (DEF) Tank . . . 37.9 L (10 gal)

Transmission

Gear Ratios — Forward and Reverse
Low Range
1st. 12.59:1
2nd 6.06:1
3rd. 2.22:1
High Range
4th. 4.33:1
5th. 2.08:1
6th. 0.76:1
Maximum Drive Speed. . . . . . . 24.1 km/h (15 mph)
with counterweight installed

Torque Converter

Stall Ratio 1.82:1
Charge Pump
Capacity . . . 106 L/min (28 gal/min) @ 2000 rpm

Engine

Cummins QSB 6.7L - Tier 4F

Type . . . . 4-cycle, Diesel
with Cummins Compact Catalyst (CCC)
and Selective Catalytic Reduction (SCR)
6-cylinder Turbocharged . . . . After-Cooled Engine
Horse Power Rating. . 205kW (275 hp) @ 2500 rpm
Maximum Speed, No Load . . . . 2700 rpm
Max. Torque . . . . . 990 N·m (730 lbf-ft) at 1500 rpm
24 Volt Electrical System . . . . two 12 Volt Batteries
Fuel . . . . Maximum 15 ppm sulfur content (ULSD)
plus Diesel Exhaust Fluid (DEF)

Cummins QSB 6.7L - Tier 3

Type . . . . 4-cycle, Diesel
6-cylinder Turbocharged . . . . After-Cooled Engine
Horse Power Rating. . 205kW (275 hp) @ 2500 rpm
Maximum Speed, No Load . . . . 2750 rpm
Max. Torque . . . . . 990 N·m (730 lbf-ft) at 1500 rpm
24 Volt Electrical System . . . . two 12 Volt Batteries
Fuel . . . . Maximum 5000 ppm Sulfur Diesel

Axles

Total Axle Ratio 25.98:1
Carrier Ratio 4.33:1
Planetary Ratio 6:1

Steering

Type . . . . . . Independent Hydraulic Power Steering
Front axle . . . . controlled via steering wheel
Rear axle . . . . provides infinite variations
controlled via momentary switch in cab
Coordinated Turning Radius
Outside 4 Wheel Steer . . . . . . 7.5 m (24 ft 7 in)
Inside 4 Wheel Steer . . . . . . 4.8 m (15 ft 10 in)

Brakes

Type . . . . 4 Wheel Hydraulic Dry Disc
Acting on all Wheels w/ Dual Calipers
Parking. . . . . . . Front Axle Mounted, Spring Applied
Hydraulic Released

Wheels and Tires

Lugs per Wheel. 24
Torque . . . . .407 to 475 N·m (300 to 350 lbf-ft)
Tire Size . . . . 29.5 x 25, 34 bias ply rating

NOTE: For roading and lifting pressures, refer to the *Load Chart Manual* in the cab.

Boom

Length . . . . .11.3 m to 60 m (37.2 ft to 197 ft)
Power . . . . 7 Section, MEGAFORM™
Pinning . . . . .TWIN-LOCK™ Boom Pinning
Max Tip Height without
Extension . . . . 63.1 m (207 ft)
Elevation . . . .-3° to +80°
Extensions (Optional)
Manual Bi-Fold Lattice Swingaway
Jib. . . . . 10.5 m to 17.6 m (34.5 ft to 57.6 ft)
Manual Offsets at . . . . 0°, 20° and 45°
Maximum Tip Height. . . . . . . 80.8 m (265 ft)
Hydraulic Bi-Fold Lattice Swingaway
Jib. . . . . 10.5 m to 17.6 m (34.5 ft to 57.6 ft)
Hydraulic Offsets from . . . . .0°to 45°
Maximum Tip Height. . . . . . . 80.8 m (265 ft)

Outriggers

Outrigger Spread
Retracted . . . . 3150 mm (124 in)
Mid Extend . . . . 5233 mm (206 in)
Fully Extended . . . . 7316 mm (288 in)
Outrigger Pad Diameters
Polymer . . . . .600 mm (23.6 in)
Aluminum (Optional) . . . . . . .600 mm (23.6 in)
Max Individual Outrigger
Pad Load . . . . . . 556 kN (125,000 lbf or 125 kip)

Swivel Assembly

Electrical . . . . .20 Slip Rings
Hydraulic . . . . .10 ports
Water. . . . . .2 ports
Air Conditioning. . . . . .2 ports

Swing Gearbox

Reduction Ratio 35.2:1
Continuous Torque . . . . .8191 N·m (6042 lbf-ft)
Max Pinion Torque . . . . . .16382 N·m (12083 lbf-ft)

Hydraulic Pumps

NOTE: Pump flow rate (output) figures are theoretical.

Pump #1

Type . . . . Piston
Sections 1
Output - @ loaded engine speed
Section 1 flow rate . . . 204.4 L/min (54 gal/min)

Pump #2

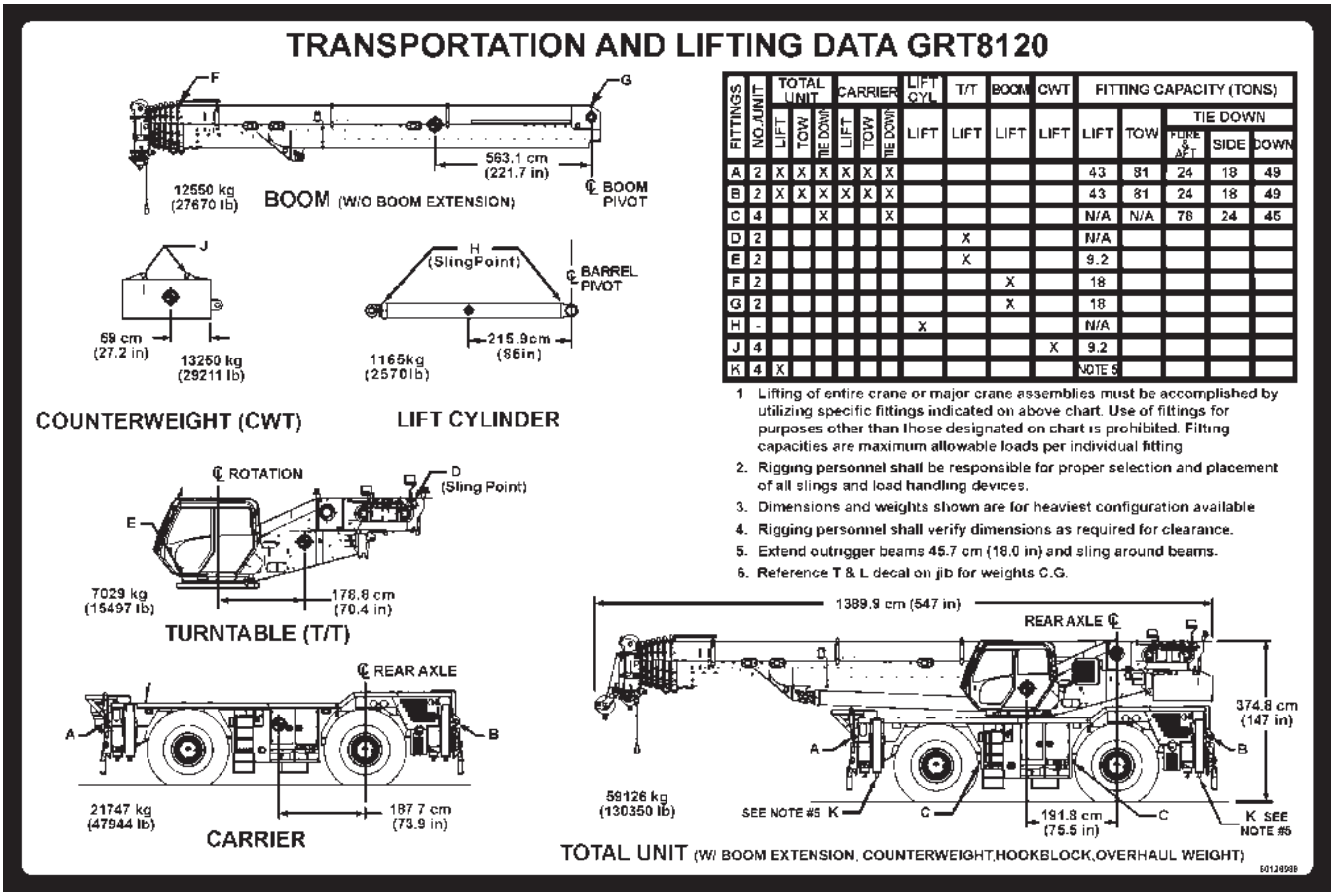
Type . . . . Piston
Sections 1
Output - @ loaded engine speed
Section 1 flow rate . . . 204.4 L/min (54 gal/min)

Pump #3

Type . . . . Gear
Sections 1
Output - @ loaded engine speed
Section 1 flow rate . . 86.7 L/min (22.9 gal/min)

Hoists

Drum Dimensions
Diameter . . . . .371 mm (14.6 in)
Length . . . . .549 mm (21.6 in)
Cable, Main, 35x7 Steel
Diameter . . . . .19 mm (0.75 in)
Length . . . . 250 m (820 ft)
Max Permissible
Single Line Pull . . . . . . .7784 kg (17,160 lb)
Cable, Aux., 35x7 Steel
Diameter . . . . .19 mm (0.75 in)
Length . . . . 185 m (607 ft)
Max. Permissible
Single Line Pull . . . . . . .7784 kg (17,160 lb)
Max. Single Line Speed . . . 148 m/min (490 ft/min)
Motor Displacement
Minimum . . . . 48 cc (2.9 in³)
Maximum . . . . 85 cc (5.2 in³)



FITTINGS	NO./UNIT	TOTAL UNIT			CARRIER			LIFT CYL	T/T	BOOM	CWT	FITTING CAPACITY (TONS)				
														TIE DOWN		
		LIFT	TOW	TIE DOWN	LIFT	TOW	TIE DOWN	LIFT	LIFT	LIFT	LIFT	LIFT	TOW	FORE & AFT	SIDE	DOWN
A	2	X	X	X	X	X	X					43	81	24	18	49
B	2	X	X	X	X	X	X					43	81	24	18	49
C	4			X			X					N/A	N/A	78	24	45
D	2								X			N/A				
E	2								X			9.2				
F	2									X		18				
G	2									X		18				
H	-							X				N/A				
J	4										X	9.2				
K	4	X										NOTE 5				

1 Lifting of entire crane or major crane assemblies must be accomplished by utilizing specific fittings indicated on above chart. Use of filtings for purposes other than those designated on chart is prohibited. Filting capacities are maximum allowable loads per individual fitting
2. Rigging personnel shall be responsible for proper selection and placement of all slings and load handling devices.
3. Dimensions and weights shown are for heaviest configuration available
4. Rigging personnel shall verify dimensions as required for clearance.
5. Extend outrigger beams 45.7 cm (18.0 in) and sling around beams.
6. Reference T & L decal on jib for weights C.G.

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FIGURE 1-1

Table 1-1Axle Weight Distribution Table

Description	CG To CL Rear Bogie cm (in)	Weight kg (lb)	FrontAxle kg (lb)	RearAxle kg (lb)
Maximum Axle Loads Allowed			31752 (70000)	31752 (70000)
Maximum Axle Loads Allowed while Towing			27216 (60000)	27216 (60000)
Maximum Tire Loads Allowed			32006 (70560)	32006 (70560)
Standard Carrier Assy (4x4) + All Fluids	185.17 (72.90)	21536 (47478)	9457 (20850)	12078 (26628)
Superstructure Assy w/Cab, Main Hoist (w/cable) & IPO Cwt	74.17 (29.20)	6805 (15003)	1197 (2639)	5608 (12364)
Removable Counterweight 29,200 lb	-156.21 (-61.50)	13245 (29200)	-4907 (-10818)	18152 (40018)
Boom Assy, 2/5 Sheaves, Lift Cyl Upr Pin & Pivot Pin, at 0°	558.55 (219.90)	12551 (27670)	16626 (36654)	-4075 (-8984)
Lift Cylinder & Lower Shaft	496.37 (195.42)	1192 (2628)	1403 (3094)	-211 (-466)
Complete Basic Machine: 11.3 - 60.0 m (37.2 - 196.9 ft) 7-Section Boom, Cummins QSB6.7 Tier 4F Engine, 29.5x25 (34 ply) Tires, Main Hoist w/250 m (820 ft) of 19 mm (3/4 in) 35x7 cable, Full Fuel and Hydraulic Oil	181.20 (71.34)	55329 (121979)	23777 (52419)	31552 (69560)
Add To Basic Machine Weight				
10.5 - 17.6 m (34.5 - 57.6 ft) Bi-fold Manual Boom Extension	710.03 (279.54)	1488 (3280)	2505 (5523)	-1017 (-2243)
10.5 - 17.6 m (34.5 - 57.6 ft) Bi-fold Hydraulic Boom Extension	717.93 (282.65)	1511 (3331)	2573 (5672)	-1062 (-2341)
Boom Extension Carrier Brackets (Bolt On)	540.00 (212.60)	183 (403)	234 (516)	-51 (-113)
Components for Hydraulic Extension (hose reel) (on boom)	653.44 (257.26)	215 (474)	333 (735)	-118 (-261)
Aux Boom Nose - installed	1175.77 (462.90)	88 (194)	245 (541)	-157 (-347)
11 t (12 USt) Overhaul Weight - tied to O/R Box	675.64 (266.00)	294 (648)	471 (1038)	-177 (-390)
9 t (10 USt) Overhaul Ball - tied to O/R Box	675.64 (266.00)	330 (727)	528 (1165)	-199 (-438)
9 t (10 USt) Overhaul Ball - stowed in optional tray	629.92 (248.00)	330 (727)	493 (1086)	-163 (-359)
100 t (112 USt) Hookblock (7 sheave) - tied to O/R box	675.64 (266.00)	1140 (2513)	1827 (4027)	-687 (-1514)
75 t (83 USt) Hookblock (5 sheave) - tied to O/R box	675.64 (266.00)	1070 (2359)	1715 (3780)	-645 (-1421)
45 t (50 USt) Hookblock (3 sheave) - tied to O/R box	675.64 (266.00)	770 (1698)	1234 (2721)	-464 (-1023)
26 t (29 USt) Hookblock (1 sheave) - tied to O/R box	675.64 (266.00)	535 (1179)	857 (1889)	-322 (-710)
Overhaul Ball Storage Tray	629.92 (248.00)	45 (100)	68 (149)	-22 (-49)
Refinery Package (T3 Engine)	-119.38 (-47.00)	29 (63)	-8 (-18)	37 (81)
Counterweight Stand	622.30 (245.00)	134 (295)	197 (435)	-64 (-140)
360 Degree Swing Lock	230.63 (90.80)	30 (66)	16 (36)	14 (30)

Description	CG To CL Rear Bogie cm (in)	Weight kg (lb)	Front Axle kg (lb)	Rear Axle kg (lb)
Driver	225.81 (88.90)	113 (250)	61 (134)	53 (116)
Cold Weather Package - Carrier (-29°)	86.36 (34.00)	77 (169)	16 (35)	61 (134)
Cold Weather Package - Carrier (-40°)	172.72 (68.00)	133 (293)	54 (120)	78 (173)
Cold Weather Package - S/S (-29° or -40°)	134.11 (52.80)	39 (87)	13 (28)	27 (59)
CE Components - Carrier	180.34 (71.00)	36 (80)	15 (34)	21 (46)
CE Components - Superstructure	88.39 (34.80)	106 (234)	22 (49)	84 (185)
Substitutions, Deletions, and Removals from Basic Unit Weight				
SUB: Aux Hoist (replace IPO cwt with aux hoist + cable)	-150.37 (-59.20)	402 (887)	-143 (-316)	546 (1203)
SUB: Cummins QSB6.7 Tier 3 Engine	-109.22 (-43.00)	-258 (-568)	67 (147)	-324 (-715)
REM: Main Hoist cable (250 m (820 ft) of 19 mm (3/4 in) 35x7)	-76.71 (-30.20)	-483 (-1065)	88 (194)	-571 (-1259)
REM: Aux Hoist cable (185 m (607 ft) of 19 mm (3/4 in) 35x7)	-163.07 (-64.20)	-357 (-787)	138 (304)	-495 (-1091)

Crane Nomenclature

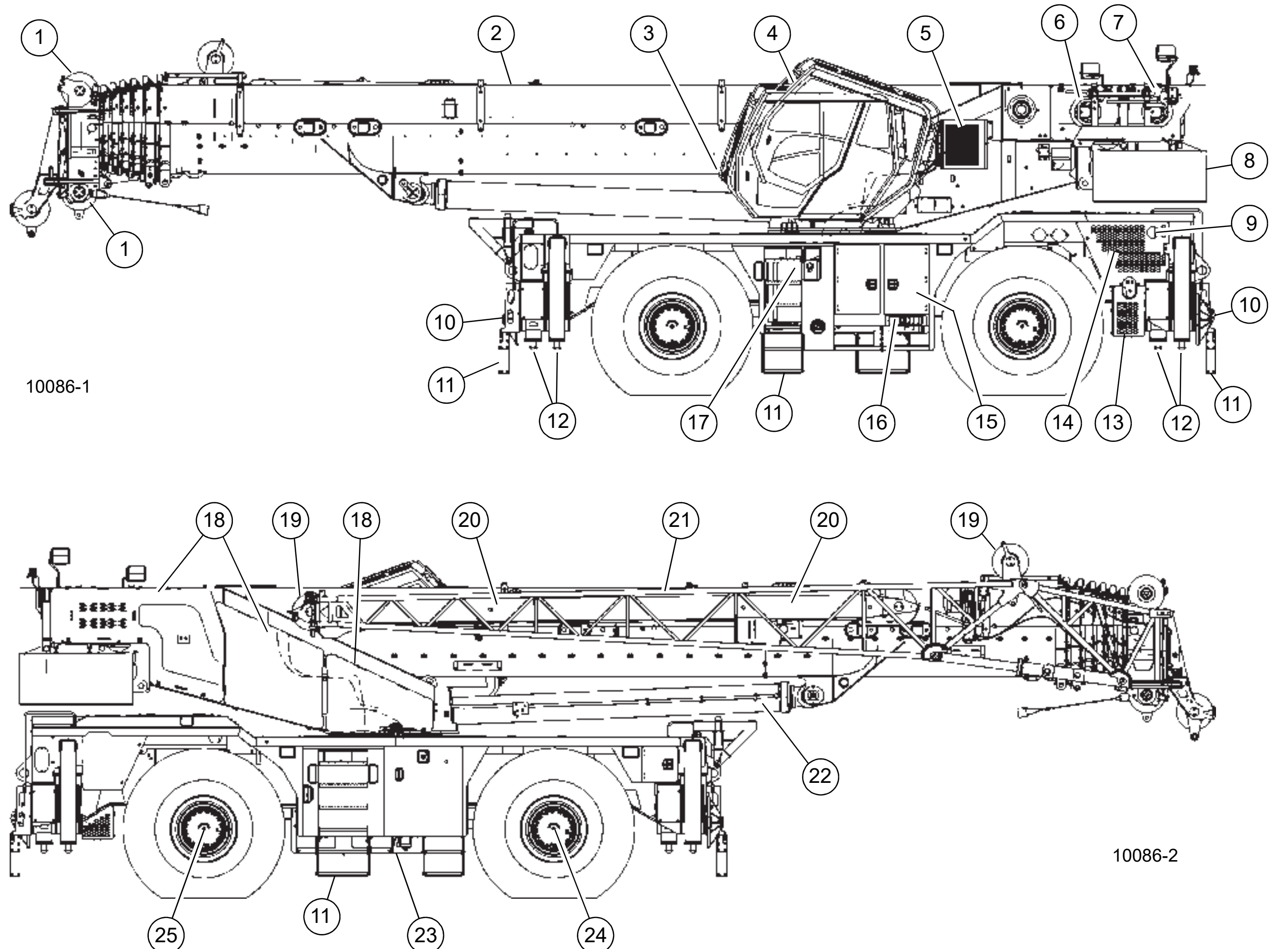

FIGURE 1-2

Item	Description	Item	Description
1	Boom Nose Sheaves	14	Exhaust Aftertreatment
2	Boom	15	Battery and Control Module Compartment
3	Work Lights	16	Battery Disconnect Switch
4	Cab	17	Fuel Tank*
5	Air Conditioning Condenser	18	Superstructure Valve Covers
6	Main Hoist	19	Boom Extension Sheaves
7	Auxiliary Hoist	20	Boom Extension Fly Section
8	Counterweight	21	Boom Extension Base Section
9	Tailpipe	22	Lift Cylinder
10	Outrigger Pads	23	Hydraulic Tank
11	Crane Steps and Grab Handles	24	Axle #1 (Front Drive and Steer)
12	Outrigger Jack Cylinders	25	Axle #2 (Rear Drive and Steer)
13	Diesel Exhaust Fluid (DEF) Tank*		
*Stage IV/Tier 4F engines use Ultra Low Sulfur Fuel (Max 15 ppm) and Diesel Exhaust Fluid (DEF)			

GENERAL MAINTENANCE

These general suggestions should be helpful in following the instructions in this manual. In analyzing a system malfunction, use a systematic approach to locate and correct the problem.

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

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

Cleanliness

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

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

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

Clean the rust preventive compound from all machined surfaces of new parts before installing them.

After Cleaning

Remove all water or solvent from the parts immediately after cleaning. Use compressed air or a clean cloth. Make sure the parts are completely dry and clean. DO NOT use compressed air on bearings. Spinning bearings without lubricant will cause damage to the bearing, and could cause the bearing to fly apart.

CAUTION

Eye Injury Hazard!

When using compressed air use only low air pressure and keep air stream from direction of face.

Always wear eye and face protection when using compressed air. Injury to eyes could occur.

Removal and Installation

When performing maintenance, do not attempt to manually lift heavy parts when hoisting equipment should be used. Never locate or leave heavy parts in an unstable position. When raising a crane or portion thereof, ensure the crane is blocked securely and the weight is supported by blocks or jack stands rather than by lifting equipment.

When using hoisting equipment, follow the hoist manufacturers recommendations and use lifting devices that will allow you to achieve the proper balance of the assemblies being lifted and to ensure safe handling. Unless otherwise specified, all removals requiring hoisting equipment should be accomplished using an adjustable lifting attachment or straps designed for that purpose. All supporting members (straps, chains and cables) should be parallel to each other and as near perpendicular as possible to the top of the object being lifted.

NOTE: 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

Some removals require the use of lifting fixtures to obtain proper balance. The weights of some components are given in their respective sections of the manual.

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

Disassembly and Assembly

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

Pressing Parts

When pressing one part 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.

Locking Devices

Lockwashers, flat metal locks, or cotter pins are used to lock nuts and bolts.

Flat metal locks must be installed properly to be effective. Bend one end of the lock around the edge of the part. Bend the other end against one flat surface of the nut or bolt head.

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

When installing lockwashers on housings made of aluminum or thin sheetmetal, use a flat washer between the lockwasher and the housing.

Wires and Cables

Batteries should always be disconnected prior to working on the electrical system.

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

Shims

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

Hoses and Tubes

⚠ DANGER

High Pressure/Temperature Hazard!

Exercise extreme care around pressurized hydraulic hoses or tubes. DO NOT work on a hydraulic system while it is in operation or until all pressure is released.

Hydraulic oil is hot, it can cause severe burns.

Pressurized hydraulic oil can cause death or serious injury.

Stay clear of all hydraulic oil leaks. Relieve system pressure and use a piece of cardboard or paper to check for leaks. Do not use your hands.

Fluid injected into skin must be surgically removed within a few hours by a doctor familiar with this type of injury or gangrene will result.

Inspection

Check hoses carefully. Do not use your bare hands to check for leaks.

Tighten all connections to recommended torque.

If the hose end connections are damaged, always replace the hose or tube. Damaged, dented, crushed, or leaking hose fittings restrict oil flow and the operation of the parts being served. Fittings showing signs of movement from their original position have failed and must be replaced.

Be sure hoses are in good condition. If in doubt, replace them.

Replace hoses if any of the following is evident Figure 1-3:

- Evidence of kinking or crushing (1)
- Chaffing or cuts; wire is exposed (2)
- Damaged or leaking fittings (3)
- Localized ballooning (4)

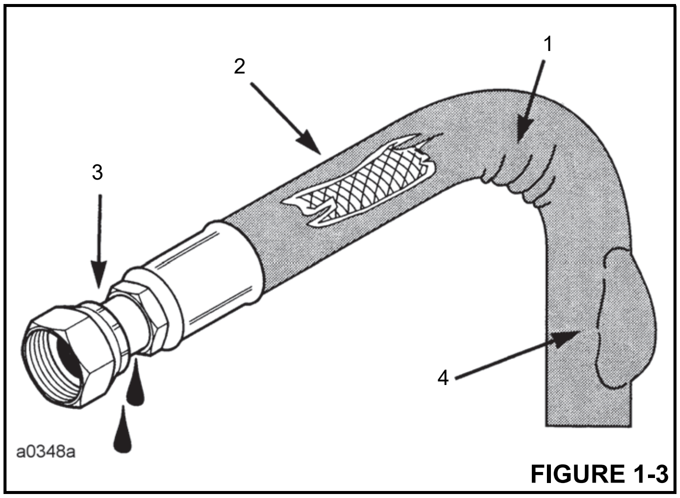

FIGURE 1-3

Installation

1. When installing a new hose, loosely connect each end and make sure the hose takes up the designed position before tightening the connection. Clamps should be tightened sufficiently to hold the hose without crushing and to prevent chafing.
2. If a hose is replaced on a part that moves during operation, be sure it moves freely by moving the part through its complete range of movement.
3. Be sure any hose which has been installed is not kinked or twisted.

Free moving, unsupported hoses must never rub on each other or related work surfaces. This causes chafing and reduces hose life.

Bearings

Antifriction Bearings

When an anti friction 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 show signs of heat damage. 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 anti friction bearing will be shortened if not properly lubricated. Dirt in an anti friction bearing can cause the bearing to lock resulting 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 usually 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 250 °F (121° C). 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 pre-loading. When installing a bearing, spacer, or washer against a shoulder on a shaft, be sure the chamfered side is toward the shoulder.

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

Preload

Preload is an initial load placed on the bearing at the time of assembly. Whether a tapered roller bearing should have preload could depend on any of several conditions: rigidity of the housings and shaft, bearing spread, speed of operation, etc.

To determine whether a bearing requires preload or end clearance, consult the disassembly and assembly instructions pertaining to that bearing.

Care should be exercised in applying preload. Misapplication while preloading bearings requiring end clearance can result in bearing failure.

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 a bearing into place, 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 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.

When removed, always install new cylinder head and manifold gaskets using recommended gasket compound on head gaskets to allow uniform sealing.

Batteries

Clean batteries by scrubbing them with a solution of baking soda and water. Rinse with clear water. After cleaning, dry thoroughly and coat terminals and connections with an anti corrosion compound or grease.

If the machine is to be stored or not used for an extended period of time, the batteries should be removed. Store the batteries in a cool (not subfreezing), 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.

Hydraulic Systems

> **⚠ DANGER**
>
> **High Pressure/Temperature Hazard!**
>
> Exercise extreme care around pressurized hydraulic systems. DO NOT work on a hydraulic system while it is in operation or until all pressure is released.
>
> Hydraulic oil is hot, it can cause severe burns.
>
> Pressurized hydraulic oil can cause death or serious injury.
>
> Stay clear of all hydraulic oil leaks. Relieve system pressure and use a piece of cardboard or paper to check for leaks. Do not use your hands.
>
> Fluid injected into skin must be surgically removed within a few hours by a doctor familiar with this type of injury or gangrene will result.

Cleanliness

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

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 always recommended.

Hydraulic Lines

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 on the machine or another hose and has a minimum of bending and twisting. Tighten 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.

Visual Inspection of Hoses and Fittings

1. Visually inspect hoses and fittings once a month or every 250 hours for the following:
   - Leaks at hose fitting or in hose
   - Damaged, cut, or abraded cover
   - Exposed reinforcement
   - Kinked, crushed, flattened, or twisted hose
   - Hard, stiff, heat cracked, or charred hose
   - Blistered, soft, degraded, or loose cover
   - Cracked, damaged, or badly corroded fittings
   - Fitting slippage on hose
   - Other signs of significant deterioration

If any of the above conditions exist, evaluate hose assemblies for correction or replacement. For replacement of hose assemblies, refer to your Manitowoc Crane Care Parts Manual.

2. At the same service interval, visually inspect all other hydraulic components and valves for the following:
   - Leaking ports.
   - Leaking valve sections or manifolds and valves installed into cylinders or onto motors.
   - Damaged or missing hose clamps, guards, or shields.
   - Excessive dirt and debris around the hose assemblies.

If any of these conditions exist, address them appropriately.

3. All hydraulic hose assemblies are recommended to be replaced after 8000 hours of service life.
4. Hydraulic hose assemblies operating in a temperature climate zone “C” (Table 1-2) are recommended to be replaced after 8000 hours of service life.
5. Hydraulic hose assemblies operating in climate zones “A” and “B” with high ambient temperatures, could see hose service life reduced by 40 to 50%, therefore, it is recommended to replace these hoses after 4000 to 5000 hours of service life.
6. Hydraulic hose assemblies operating in climate zones “D” and “E” should expect a degradation of mechanical properties such as elasticity, therefore, it is recommended these hoses be inspected and addressed accordingly.

Table 1-2: Climate Zones

Zone	Classification
A	Tropical Moist: All months average above 18° C. Latitude 15° - 25° North and South
B	Dry or Arid: Deficient precipitation most of the year. Latitude 20° - 35° North and South
C	Moist Mid-Latitude: Temperature with mild winters. Latitude 30° - 50° North & South
D	Moist Mid-latitude: Cold winters. Latitude 50° - 70° North & South
E	Polar: Extremely cold winters and summers. Latitude 60° - 75° North & South

Hydraulic Fittings

Flats from Finger Tight (F.F.F.T.) Method

Manitowoc recommends that the F.F.F.T. tightening method described here be used when assembling all hydraulic fittings. This method will minimize the risk of fitting damage or failure due to under or overtightening.

This method will also reduce the chance of a leaky connection which is normally caused by combinations of fittings with different types of plating. This method is particularly useful when the type of plating on the fitting is unknown, and during maintenance or repair when a joint may be oily.

Follow these steps when tightening all fitting connections:

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches or any foreign particles.
2. Align tube or hose to the mating fitting and check to see that the flare seats properly on the nose of the fitting.
3. Finger tighten the nut onto the fitting. If necessary, a wrench should be used to seat the nut snugly against the fitting. This is considered the "Finger Tight" condition.
4. Using a permanent-type ink marker, make a mark on one of the flats of the nut and continue it onto the hex of the static fitting or port

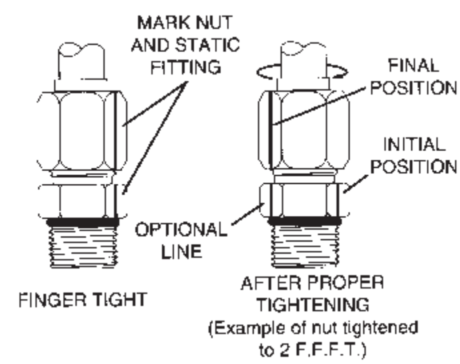

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FIGURE 1-4

5. Tighten the joint by the number of flats as specified in Table 1-3 and 1-4 for size and type of fitting.
6. Optionally for future tightening of the same connection: extend the line from the nut at its new location onto the hex of the static fitting or port (Figure 1-4).

37° Flared Steel Fitting: Tube or Hose to Fitting

Follow the F.F.F.T. method, described above.

Table 1-3: Tube and Swivel Nut/Hose Fittings

SAE SIZE	TUBE CONN. (F.F.F.T.)	SWIVEL NUT/ HOSE CONN. (F.F.F.T.)
2	–	–
3	–	–
4	2	2
5	2	2
6	1.5	1.25
8	1.5	1
10	1.25	1
12	1.25	1
14	1	1
16	1	1
20	1	1
24	1	1
32	1	1

T-2-5

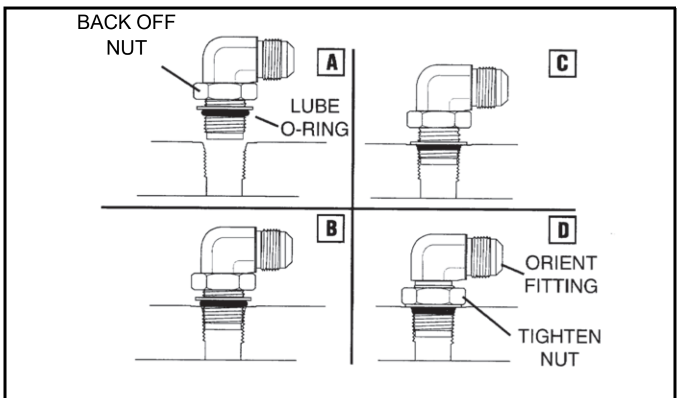
Adjustable Straight Thread O-ring Fittings

Refer to Figure 1-5 and Table 1-4 for the following procedure.

Table 1-4: Adjustable Straight Thread O-ring Fittings

ADJUSTABLE STEEL STR. THREAD O-RING FITTINGS	
SAE SIZE	(F.F.F.T.)
2	1.0 ± 0.25
3	1.0 ± 0.25
4	1.5 ± 0.25
5	1.0 ± 0.25
6	1.5 ± 0.25
8	1.5 ± 0.25
10	1.5 ± 0.25
12	1.5 ± 0.25
14	1.5 ± 0.25
16	1.5 ± 0.25
20	2.0 ± 0.25
24	2.0 ± 0.25
32	2.0 ± 0.25

T-2-6



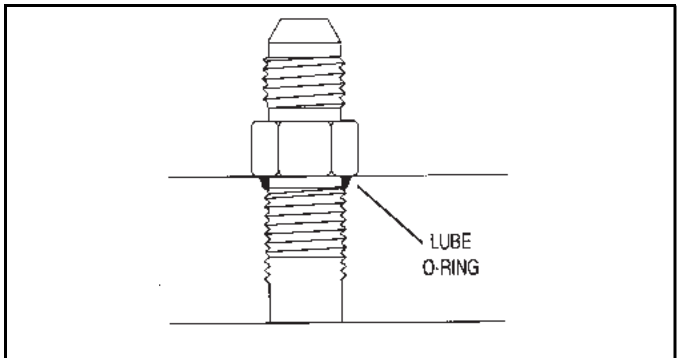
Adjustable Fitting to Port **FIGURE 1-5**

1. Inspect both mating parts for burrs, nicks, scratches, or foreign particles.
2. Lubricate O-ring with a light coat of clean oil.
3. Back off locknut as far as possible (A).
4. Screw the fitting into port by hand until the backup washer contacts the face of the port and is pushed all the way towards the locknut (C).
5. To orientate the fitting, unscrew the fitting the required amount, but not more than one full turn.
6. Hold the fitting in the desired position and tighten the nut (D) following the F.F.F.T. method starting with step 4.

Nonadjustable Straight Thread O-ring Fitting: Fitting to Port

Refer to (Table 1-5) for the following procedure.

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches or any foreign particles.
2. Lubricate O-ring with clean oil (Figure 1-6).



Non-Adjustable Fitting to Port **FIGURE 1-6**

3. Turn fitting until finger tight.
4. Using the assembly torque method, tighten to given torque for size from Table 1-5.

Table 1-5: Straight Thread Fittings

NON--ADJUSTABLE STEEL STR. THREAD O-RING FITTINGS		
SAE SIZE	TORQUE (lb in)	(lb ft)
2	90 ± 5	7.5 ± 0.5
3	170 ± 10	14 ± 1.0
4	220 ± 15	18 ± 1.0
5	260 ± 15	22 ± 1.0
6	320 ± 20	27 ± 2.0
8	570 ± 25	48 ± 2.0
10	1060 ± 50	90 ± 5.0
12	1300 ± 50	110 ± 5.0
14	1750 ± 75	145 ± 6.0
16	1920 ± 25	160 ± 6.0
20	2700 ± 150	225 ± 12.0
24	3000 ± 150	250 ± 12.0
32	3900 ± 200	325 ± 15.0

T-2-7

Electrical System

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, clean 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 Table 1-2. Recommended replacement of harness and cables is as follows:

- Climate zone C after 10,000 hours of service.
- Climate zones A and C with high ambient temperatures and duty cycles after 8000 hours of service.
- Climate zones D and E after 5,000 hours of service.
- Salt water conditions after 8,000 hours of service.

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 bolted to the crane superstructure or chassis.
- Counterweight support structures.
- Chassis axle and suspension mounting structures.
- Hydraulic cylinder end connections.

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

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

Loctite®

⚠ CAUTION

Skin and/or Eye Hazard!

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

Always follow 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 type of Loctite brand adhesives are available from the Parts Department of the local Manitowoc distributor.

Application of Medium Strength Loctite

NOTE: Fastener may be re-used. 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 male and female threaded surfaces are clean of contaminants, dirt, and oil.

1. Apply a bead perpendicular to the thread, several threads wide, in the approximate area of threaded engagement (Figure 1-7).
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.

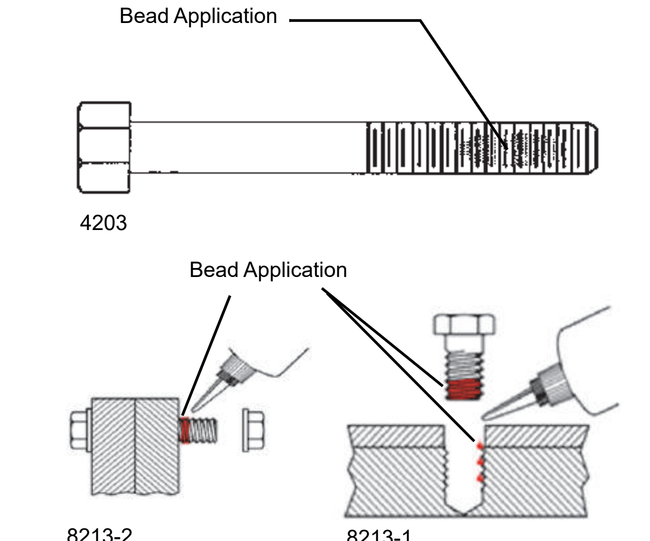


FIGURE 1-7

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

Fasteners and Torque Values

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

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

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

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

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

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

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

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

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

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

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

Torque Wrenches

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

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

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

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

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

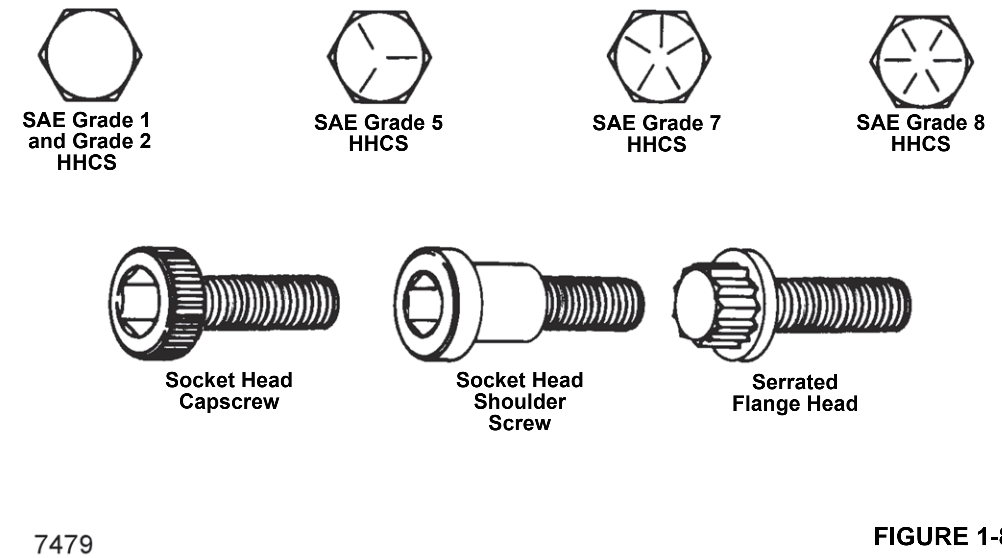

SAE Grade 1
and Grade 2
HHCS
SAE Grade 5
HHCS
SAE Grade 7
HHCS
SAE Grade 8
HHCS
Socket Head
Capscrew
Socket Head
Shoulder
Screw
Serrated
Flange Head
7479

FIGURE 1-8

Table 1-6Inch 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 1-7 Inch Series with Fine Threads (UNF) – Zinc Flake Coated

Nominal Size, Threads per Inch, and Series Designation	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1/4-28 UNF	5	7.5	7.3	7.1
	8	10.6	10.4	10.1
5/16-24 UNF	5	15.0	14.6	14.2
	8	21.1	20.6	20.1
3/8-24 UNF	5	27.2	26.5	25.8
	8	38.4	37.5	36.5
7/16-20 UNF	5	42.9	41.8	40.7
	8	60.6	59.1	57.6
1/2-20 UNF	5	66.0	64.4	62.7
	8	93.3	90.9	88.6
9/16-18 UNF	5	94.3	91.9	89.6
	8	133.2	129.9	126.6
5/8-18 UNF	5	132.1	128.8	125.5
	8	186.7	182.0	177.3
3/4-16 UNF	5	231.0	225.2	219.4
	8	326.4	318.2	310.1
7/8-14 UNF	5	367.7	358.5	349.3
	8	519.6	506.6	493.6
1-12 UNF	5	547.4	533.7	520.0
	8	773.5	754.2	734.8
1 1/8-12 UNF	5	700.0	682.5	665.0
	8	1123.5	1095.4	1067.3
1 1/4-12 UNF	5	975.0	950.6	926.2
	8	1564.8	1525.7	1486.5
1 3/8-12 UNF	5	1314.4	1281.5	1248.6
	8	2109.5	2056.7	2004.0
1 1/2-12 UNF	5	1723.9	1680.8	1637.7
	8	2766.8	2697.6	2628.4

Table 1-8 Metric Series with Coarse Threads – Zinc Flake Coated

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

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

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 1-9 Metric Series with Fine Threads – Zinc Flake Coated

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

Nominal Size, Threads per Inch, and Series Designation	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M20x1.5	8.8	386.0	376.3	366.7
	10.9	549.7	535.9	522.2
	12.9	643.3	627.2	611.1
M22x1.5	8.8	520.8	507.8	494.8
	10.9	741.7	723.2	704.7
	12.9	868.0	846.3	824.6
M24x2	8.8	655.8	639.4	623.0
	10.9	934.0	910.6	887.3
	12.9	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 1-10 Metric Series Screws of STAINLESS STEEL A2-70/A4-70 with Coarse Threads

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

Torque Values for fasteners **with lubrication** these torque values result in an 80% utilization of the yield strength.

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

Table 1-11 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 1-12 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 1-13 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 1-14 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 1-15 Inch Series with Fine Threads (UNF) – Untreated (black finish)

Size	Grade	Torque (ft/lb)		
		Maximum	Nominal	Minimum
1/4-28	5	10	9.5	9
	8	14.5	14	13.5
5/16-24	5	21	20	19
	8	26	25	24
3/8-24	5	36	35	34
	8	53	51	49
7/16-20	5	57	55	53
	8	85	82	79
1/2-20	5	88	84.5	81
	8	125	120	115
9/16-18	5	126	121	116
	8	177	170	163
5/8-18	5	182	174.5	167
	8	250	240	230
3/4-16	5	312	299.5	287
	8	425	409	393
7/8-14	5	458	439.5	421
	8	672	646	620
1-12	5	658	632	606
	8	1009	970	931
1-14	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 1-16 Metric Series with Coarse Threads – Untreated (black finish)

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M4x0.7	8.8	3.1	2.9	2.8
	10.9	4.5	4.3	4.1
	12.9	5.4	5.2	4.9
M5x0.8	8.8	6.5	6.2	5.9
	10.9	9.2	8.9	8.5
	12.9	11	10.5	10
M6x1	8.8	11	10.5	10
	10.9	16	15	14
	12.9	19	18	17
M8x1.25	8.8	27	26	25
	10.9	38	36.5	35
	12.9	45	43.5	42
M10x1.5	8.8	53	51	49
	10.9	75	72	69
	12.9	89	86	83
M12x1.75	8.8	93	89	85
	10.9	130	125	120
	12.9	156	150	144
M14x2	8.8	148	142	136
	10.9	212	203.5	195
	12.9	248	238	228
M16x2	8.8	230	221	212
	10.9	322	310	298
	12.9	387	372	357
M18x2.5	8.8	319	306.5	294
	10.9	455	436.5	418
	12.9	532	511	490
M20x2.5	8.8	447	430	413
	10.9	629	605	581
	12.9	756	727	698
M22x2.5	8.8	608	585	562
	10.9	856	823	790
	12.9	1029	989	949
M24x3	8.8	774	744	714
	10.9	1089	1047	1005
	12.9	1306	1256	1206

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

Table 1-17 Metric Series with Fine Threads – Untreated (black finish)

Size	Property Class	Torque (Nm)		
		Maximum	Nominal	Minimum
M8x1	8.8	29	28	27
	10.9	41	39.5	38
	12.9	49	47	45
M10x0.75	8.8	57	55	53
	10.9	81	78	75
	12.9	96	93	90
M10x1.25	8.8	57	55	53
	10.9	81	78	75
	12.9	96	93	90
M12x1	8.8	101	97.5	94
	10.9	150	144	138
	12.9	175	168	161
M12X1.25	8.8	100	96	92
	10.9	147	141.5	136
	12.9	172	165.5	159
M12x1.5*	8.8	100	96	92
	10.9	140	135	130
	12.9	168	162	156
M14x1.5	8.8	160	153.5	147
	10.9	229	220	211
	12.9	268	257	246
M16x1.5	8.8	248	238.5	229
	10.9	348	335	322
	12.9	418	402	386
M18x1.5	8.8	345	331.5	318
	10.9	491	471	451
	12.9	575	552	529
M20X1	8.8	471	453	435
	10.9	694	667.5	641
	12.9	812	781	750
M20x1.5	8.8	483	464.5	446
	10.9	679	653	627
	12.9	816	785	754
M22x1.5	8.8	657	632	607
	10.9	924	888.5	853
	12.9	1111	1068	1025

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

Weld Studs

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

Table 1-18: 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

WIRE ROPE

General

The following compendium of information is from various wire rope manufacturers and includes inspection, replacement, and maintenance guidelines for wire rope as established by ANSI/ASME B30.5, federal regulations, and Manitowoc. The inspection interval shall be determined by a qualified person and shall be based on such factors as expected rope life as determined by experience on the particular installation or similar installations, severity of environment, percentage of capacity lifts, frequency rates 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 provides inspection and maintenance procedures for wire ropes used on Grove products (e.g. wire rope used as load lines [hoisting cables], boom extension and retraction cables, pendant cables, tow winch cables, and hook block tie down cables).

Environmental Conditions

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

Dynamic Shock Loads

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

1. High velocity movement e.g.; hoisting or swinging of a load followed by abrupt stops.
2. Suspending loads while traveling over irregular surfaces such as railroad tracks, potholes, and rough terrain.
3. Moving a load that is beyond the rated capacity of the lifting mechanism, i.e.; overloading.

Lubrication

A wire rope cannot be lubricated sufficiently during manufacture to last it's entire life. Therefore, new lubricant must be added throughout the life of a rope to replace factory lubricant which is used or lost. It is important that lubricant applied as part of a maintenance program shall be compatible with the original lubricant, and to this end, the rope manufacturer should be consulted. Lubricant applied shall be of the type which does not hinder visual inspection. Those sections of rope which are located over sheaves or otherwise hidden during inspection and maintenance procedures require special attention when lubricating rope. The object of rope lubrication is to reduce internal friction and to prevent corrosion.

During fabrication, ropes receive lubrication; the kind and amount depends on the rope's size, type, and anticipated use. This in-process treatment will provide the finished rope with ample protection for a reasonable time if it is stored under proper conditions. But, when the rope is put into service, the initial lubrication may be less than needed for the full useful life of the rope. Because of this possibility, periodic applications of a suitable rope lubricant are necessary.

The following are important characteristics of a good wire rope lubricant:

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

Before applying lubrication, accumulations of dirt or other abrasive material should be removed from the rope. Cleaning can be accomplished by using a stiff wire brush and solvent, compressed air, or live steam. Immediately after the wire rope is cleaned, it should be lubricated. Many techniques may be used; these include bath, dripping, pouring, swabbing, painting or pressure spray methods. 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. It should be noted, the service life of wire rope will be directly proportional to the effectiveness of the method used and amount of lubricant reaching the working parts of the rope.

Precautions and Recommendations During Inspection or Replacement

1. Always lock out equipment power when removing or installing wire rope assemblies.
2. Always use safety glasses for eye protection.
3. Wear protective clothing, gloves, and safety shoes as appropriate.
4. Use supports and clamps to prevent uncontrolled movement of wire rope, parts, and equipment.

5. 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. Do not build lengths from individual components.
6. Replace an entire wire rope assembly. Do not attempt to rework damaged wire rope or wire rope ends.
7. Never electroplate wire rope assemblies.
8. Do not weld any wire rope assembly or component unless welding is recommended by the wire rope manufacturer. Welding spatter shall never be allowed to come in contact with the wire rope or wire rope ends. In addition, be sure that the wire rope is not an electrical path during other welding operations.
9. Wire ropes are manufactured from special steels. If heating a wire rope assembly is absolutely necessary for removal, the entire wire rope assembly shall be discarded.
10. On systems equipped with two or more wire rope assemblies operating as a matched set, they shall be replaced as an entire set.
11. Do not paint or coat wire ropes with any substance except approved lubricants.
12. Measure the rope's diameter across crowns (1) of the strands when determining if rope has become damaged ((Figure 1-9)).

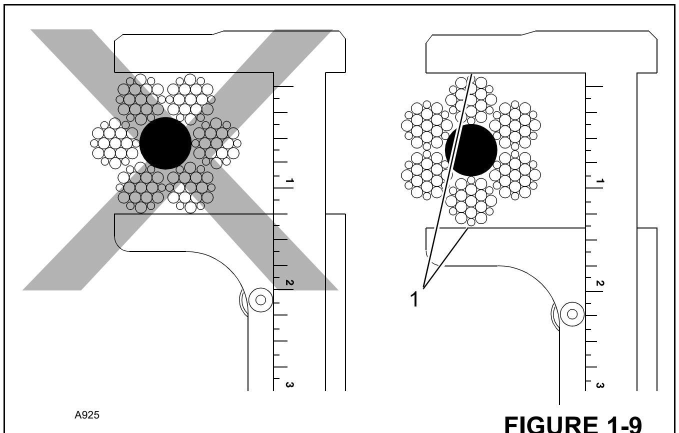


FIGURE 1-9

13. When checking for broken wires (5) (Figure 1-10) relax the rope, move it off "pick-up points", and flex it as much as possible. Defect in the rope is in relation to "Lay Length" (2) which is the distance measured along rope in which one strand (3) makes one complete revolution around the core (4).

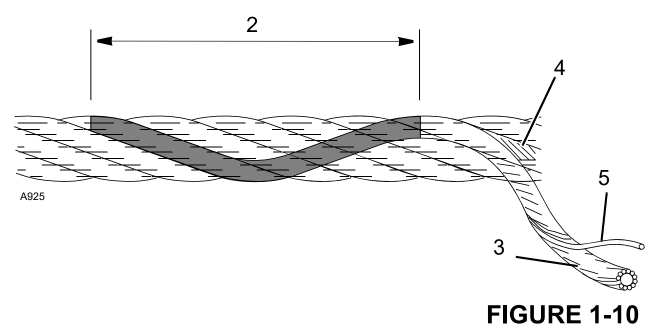


FIGURE 1-10

Wire Rope Inspection (Running Ropes and Pendant Cables)

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

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

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

Keeping Records

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

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

Frequent Inspection

A frequent daily visual inspection is recommended for all running ropes in service. This inspection should be made on all wire rope which can be expected to be in use during the day's operation. This inspection should be used to monitor progressive degradation and to discover severe damages necessitating wire rope replacement such as:

- Distortion, kinking, crushing, un-stranding, birdcaging, reduction of diameter, etc.

- General corrosion.
- Broken or cut strands.
- Number, distribution and type of broken wires.
- Evidence of core failure.
- End fitting wear/abrasion.

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

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

Periodic Inspection

Wire rope should be inspected periodically/annually or at a shorter time interval if necessitated by environmental or other adverse conditions, and shall cover the entire length of the wire rope. Only the outer surface of the wire rope need be inspected, and no attempt should be made to open the rope. Periodic inspection should include all items listed under frequent inspection plus the following:

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

Wire Rope Inspection (Boom Extension and Retraction Cables)

Periodic Inspection

It is recommended that a periodic inspection of all boom extension and retraction cables be performed using the following guidelines. This inspection shall cover the entire length of the extension and retraction cables. This inspection should be used to monitor progressive degradation and to discover severe damages necessitating wire rope replacement or equipment repair. Inspection criteria are as follows:

- Inspect for reduction of rope diameter below nominal diameter.
- Inspect for severely corroded or broken wires at end connections.
- Inspect for severely corroded, cracked, bent, worn, or improperly applied end connections.
- Inspect wire rope in areas subjected to rapid deterioration such as:
  - Sections in contact with saddles, equalizer sheaves, or other sheaves where wire rope travel is limited.
  - Sections of wire rope at or near terminal ends where corroded or broken wires may protrude.
  - Sections of wire rope in contact with stationary surfaces where abrasion or chafing may take place as a result of equipment vibration.
- Inspect for damaged or wobbly boom extension and retraction sheaves that may cause rapid deterioration of the wire rope.
- Inspect for unusual cable sag/stretch and 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 additional and more thorough inspection in order to determine and correct the cause.
- Manitowoc recommends that boom extension cables be replaced every seven (7) years.

Wire Rope Inspection/Replacement (All Wire Rope)

No precise rules can be given for determination of the exact time for replacement of wire rope since many variable factors are involved. Determination regarding continued use or replacement of wire rope depends largely upon the good judgment of an appointed and qualified person who evaluates the remaining strength in a used rope after allowance for any deterioration disclosed by inspection.

Wire rope replacement should be determined by the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies and as recommended by Manitowoc. All wire rope will eventually deteriorate to a point where it is no longer usable. Wire rope shall be taken out of service when any of the following conditions exist:

- Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.
- Evidence of any heat damage from any cause.
- Reductions from nominal diameter of more than 5%.
- In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay.
- 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.
- In rotation resistant rope, two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters.
- Severe corrosion as evidenced by pitting.
- Manitowoc recommends that for cable extended booms, a single damaged wire rope assembly shall require replacement of the entire set of extension cables.
- Manitowoc recommends for cable extended booms, 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 should 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 preferred methods for seizing wire ropes are:

Method 1

Using a length of soft annealed wire (Figure 1-11), 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.

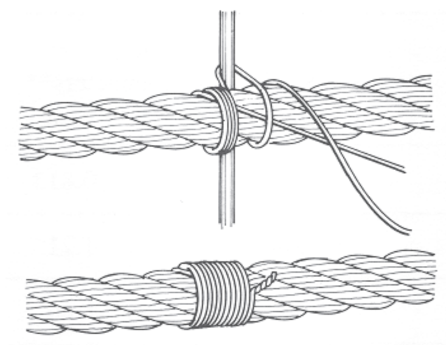


FIGURE 1-11

Method 2

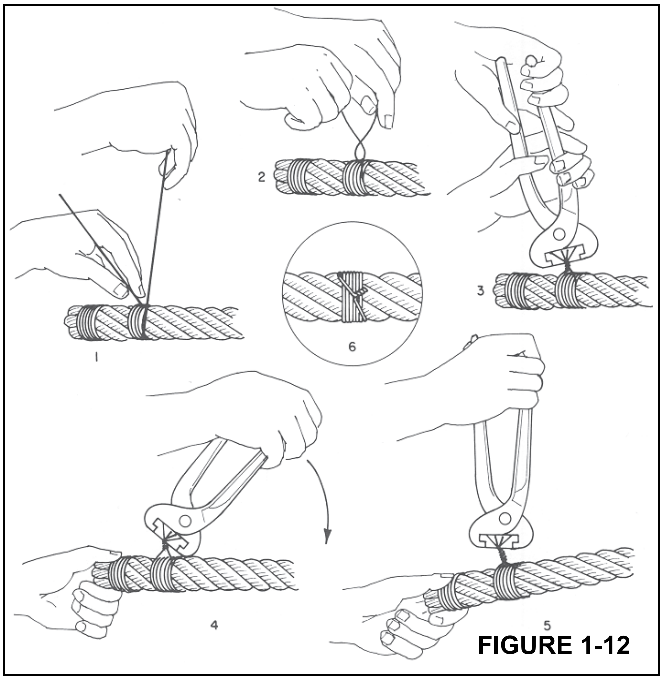


FIGURE 1-12

Wind a length of soft annealed wire (Figure 1-12) around the wire rope at least seven times. The two ends should be twisted 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.

NOTE: Non-preformed wire rope (1) (Figure 1-13) should have three seizings (3) located on each side of the cut (4) as compared to preformed wire rope (2).

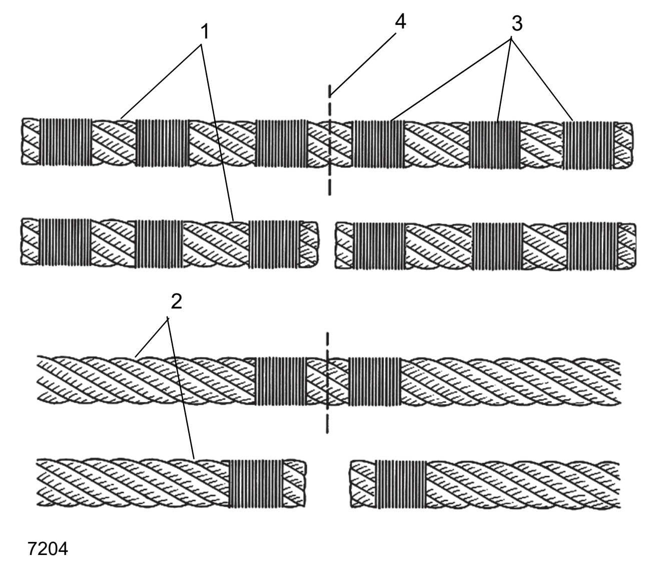


FIGURE 1-13

Installing 35x7 Class Wire Rope

CAUTION

Any cutting of this specific wire rope is not recommended. If 35x7class wire rope must be cut for any reason, it is necessary to follow the following instructions. Also, unlike other types of wire rope, the ends on this wire rope must be welded to retain the rotation resistant characteristics.

1. Unload properly and relieve any twists. Pull the rope off the shipping reel or unroll it from a shipping coil. (If done improperly, you may kink the rope, which will result in permanent damage to the rope.) Then, lay the rope on the ground in direct line with the boom. This helps release any twist in the rope.
2. Pull the rope over the point sheave and attach the end to the hoist drum. Be sure not to remove the welded end.
3. Wind rope onto drum slowly and carefully. At this point, it isn't necessary to provide additional load other than the weight of the rope being pulled across the ground.
4. Spool first layer tightly. It is essential on smooth-faced drums that the first layer is spooled with wraps tight and close together since the first layer forms the foundation for succeeding layers. If need be, use a rubber, lead or brass mallet (but never a steel hammer) to tap the rope into place.
5. Spool multiple layers with sufficient tension. It's very important to apply a tensioning load to the ropes during the rope breaking-in process. (If not, the lower layers may be loose enough that the upper layers become wedged into the lower layers under load, which can seriously damage the rope.) The tensioning load should range from 1 to 2% of the rope's minimum breaking force.
6. For ropes in multi-part systems: Reeve the traveling block and boom tip sheaves so the rope spacing is maximized and the traveling (hook) block hangs straight and level to help assure block stability.
7. Breaking in new 35x7 class rope—After installation, properly break in the rope, which allows the rope's component parts to adjust themselves to the operating conditions:

   With the boom fully raised and fully extended, attach a light load at the hook and raise it a few inches off the ground. Allow to stand for several minutes. Then cycle the load between the full "up" and "down" positions several times. Observe the drum winding and rope travel for any potential problems.

   After making the lifts with a light load, increase the load and cycle it up and down a few times. This procedure will train the rope and help assure smooth operation during its useful life.

   Ideally, you should run these loads with reeving that lets you place the loads on the block with all rope off the drum except the last three wraps. If this is not possible, alternate methods must be used to assure proper tensioning of the rope on the drum.

Procedures for Cutting and Preparing 35x7 Class Wire Rope

35x7 class rope is a special wire rope that must be handled differently than any other rope manufactured. One characteristic that makes this rope special is that the outer strands are not preformed. It is because of this that the following procedures for cutting and preparing 35x7class rope must be followed:

1. The welded ends prepared by the manufacturer are not to be removed.
2. Before cutting the rope, make three separate bands with seizing strand on each side of where the cut is to be made (total of six bands for each cut). Each band is to have a minimum length of one and one half times the rope diameter. The two bands closest to the cut should be located at a distance equal to one rope diameter away from the cut. The four remaining bands should be evenly spaced at a distance equal to three rope diameters.
   a. If a welder is available, the cut should be made with an abrasive saw. Immediately after the cut, both ends of the rope are to be cap welded so that all inner and outer strands are welded together, preventing any movement between them.

SECTION 2
HYDRAULIC SYSTEM

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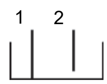
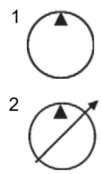
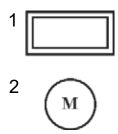
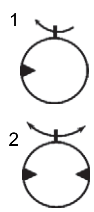
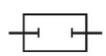
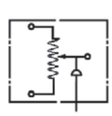
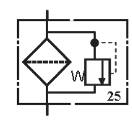
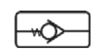
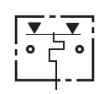
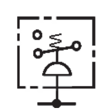
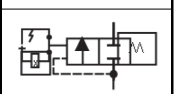
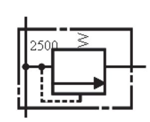
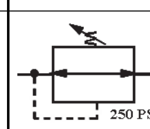
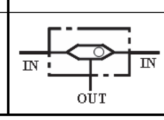
DESCRIPTION

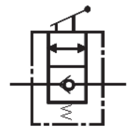
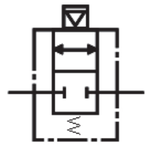
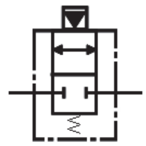
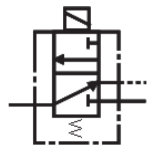
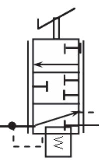
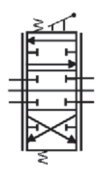
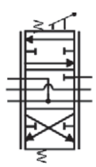
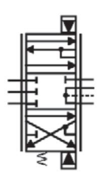
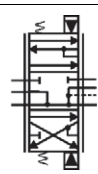
This section describes the hydraulic system, the components which make up the hydraulic system, and the components dependent upon the hydraulic system for their operation. This includes descriptions of the supply pressure and return hydraulic circuit, hydraulic pumps, all hydraulic valves, and all hydraulic cylinders. Detailed descriptions and operation of individual hydraulic circuits are discussed within their individual sections as applicable. A complete hydraulic system schematic showing all options is at the back of this manual.

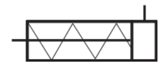
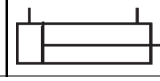
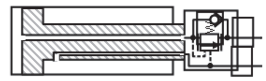
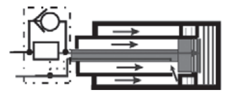
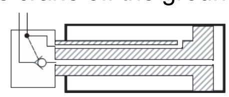
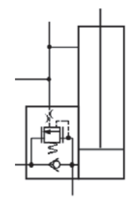
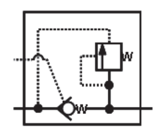
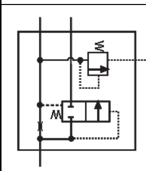
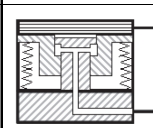
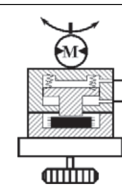
2

HYDRAULIC SYMBOLS

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 multi/section synchronized operations. 	
Inverted Outrigger Jack Cylinder - 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

Preparation

The following precautions shall be taken before maintenance, adjustments, and repairs are started on a crane:

- 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 crane'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 maintenance, 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.

Maintenance, adjustments and repairs shall be done only by designated personnel who are properly trained. Use only Manitowoc 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.

2

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.

Hydraulic Oil Recommendations

For the hydraulic oil specifications, refer to *Hydraulics Lubrication*, page 9-46.

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 turn the front and rear wheels to the extreme left. 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.

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

Draining the various components will be aided by connecting a drain line in place of the disconnected return line.

5. Disconnect the return line from the lift cylinder and raise the boom to maximum elevation.
6. Connect the cylinder return line and lower the boom to its stowed position. Replenish the reservoir hydraulic oil level as required.

7. Disconnect the return line from an outrigger extension cylinder and fully extend the outrigger.
8. Connect the outrigger return line and retract the outrigger. Replenish the reservoir hydraulic oil level as necessary.
9. Repeat Steps 7 and 8 for the remaining outriggers.

CAUTION

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

10. Disconnect the return lines from a pair of outrigger jack cylinders and activate the cylinders to their maximum down positions.
11. Connect the return lines and raise the outrigger jack cylinders to the stowed position. Replenish the reservoir hydraulic oil level as necessary.
12. Repeat Steps 10 and 11 for the remaining two outrigger cylinders.
13. Disconnect the return line from the telescope cylinder and fully extend the boom.
14. Connect the return line and retract the boom. Replenish the reservoir hydraulic oil level as necessary.
15. Disconnect the return lines from both front steer cylinders and turn the front wheels to the extreme right.
16. Connect the return lines and turn the front wheels to the extreme left and then back to center. Replenish the reservoir hydraulic oil level as necessary.
17. Repeat Steps 15 and 16 for the rear steering cylinders.
18. Raise the crane on outriggers.
19. Disconnect the line from port A of the axle lockout valve.
20. Using a jack under the rear wheel on one side of the crane, jack up the wheel to maximum travel.
21. Connect the line to port A of the axle lockout valve and disconnect the line from Port B.
22. Repeat step 19 using the other rear wheel.
23. Connect the line to port B of the axle lockout valve. Energize the axle lockout valve. Replenish the reservoir hydraulic oil level as necessary.
24. Disconnect the return line from the main hoist motor and fully hoist up the hoist.
25. Connect the return line to the main hoist motor and fully hoist down the hoist, then hoist up again. Replenish the reservoir hydraulic oil level as necessary.
26. Repeat Steps 24 and 25 for the auxiliary hoist as necessary.
27. Disconnect one of the lines from the swing motor and drive the motor in the direction it will go.
28. 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

When hydraulic oils are changed or added, ensure that hydraulic oils of different manufacturers are of the same specifications, however, discoloration (milkiness) may occur. Mixing incompatible hydraulic oils may result in improper operation or damage to the machine.

When hydraulic oils are changed, recheck the reservoir hydraulic oil level after brief system operation and add hydraulic oil as required. Working reservoir capacity y to full mark) is 926.5 L (245 gal). 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 will normally be removed automatically by passage of the hydraulic oil over the baffles in the hydraulic reservoir. If a component has been replaced, the reservoir level is too low, or a leak develops in the suction lines to the pumps, air can enter the system. If air becomes entrapped in the hydraulic oil, it may be detectable in pumps and motor operated components such as the swing mechanism and hoist(s), because it can cause these units to become noisy during operation. If noisy operation occurs, first check the level of the hydraulic reservoir and replenish as necessary. Then 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 0.138 to 0.276 bar (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 from the hydraulic oil by the baffles.

CAUTION

Always locate the machine on a firm supporting surface, extend the outriggers and level the machine and position the boom over the front to extend the boom at low angles. Injury or damage to the machine may result if this caution is not followed.

- 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 not readily removed, lower the boom to below horizontal, extend the telescope cylinders as far as practicable, and allow the boom to remain in this position overnight. This should allow entrapped 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 the cylinder.

CAUTION

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

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

- Entrapped air may be removed from cylinders having wet rods by cycling. On certain cylinders, a plugged port is provided on the rod end to bleed off entrapped air.
- In the event that air entrapment should persist, bleeding of air by loosening various clamp and screw type fittings may become necessary.
- If the above procedures fail to eliminate air entrapment, contact your authorized Grove distributor.

Parts Replacement

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

Directional Control Valves

The control valves that control the crane functions are installed on the right side of the turntable.

Inspection

Inspect the control valves 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 or torn 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 sign of the number one problem in hydraulics - 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 valves 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. The remedy is to clean the valve, but it is also a good idea to follow through and ensure 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, deteriorated hydraulic oil or contamination is the cause, flushing the system and replenishing with clean hydraulic oil may solve the problem. 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. As mentioned previously, the valve can be shimmed level.

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.

Visual Inspection of Hoses and Fittings

CAUTION

Ensure hydraulic hose is depressurized before loosening the connections.

Visually inspect hoses and fittings once a month or every 250 hours for the following:

- Leaks at hose fitting or in hose
- Damaged, cut, or abraded cover
- Exposed reinforcement
- Kinked, crushed, flattened, or twisted hose
- Hard, stiff, heat cracked, or charred hose
- Blistered, soft, degraded, or loose cover
- Cracked, damaged, or badly corroded fittings
- Fitting slippage on hose
- Other signs of significant deterioration

If any of the above conditions exist, evaluate hose assemblies for correction or replacement. For replacement of hose assemblies, refer to your Manitowoc Crane Care Parts Manual.

At the same service interval, visually inspect all other hydraulic components and valves for the following:

- Leaking ports
- Leaking valve sections or manifolds and valves installed into cylinders or onto motors.
- Damaged or missing hose clamps, guard, or shields.
- Excessive dirt and debris around the hose assemblies.

If any of these conditions exist, address them appropriately.

All hydraulic hose assemblies are recommended to be replaced after 8000 hours of service life. Working conditions, ambient temperatures and high duty circuits can affect service life of hose assemblies and must be taken into account when inspecting and replacing hoses. High duty circuits can include, but are not limited to, outriggers, hoist(s), boom lift, swing, pump suction and discharge to directional valves and directional valve return to the reservoir.

Hydraulic hose assemblies operating in a temperature climate zone “C” (Table 2-1) are recommended to be replaced after 8000 hours of service life.

Hydraulic hose assemblies operating in climate zones “A” and “B” (Table 2-1) with high ambient temperatures, could see hose service life reduced by 40 to 50%, therefore, it is recommended to replace these hoses after 4000 to 5000 hours of service life.

Hydraulic hose assemblies operating in climate zones “D” and “E” (Table 2-1), cold climates, should expect a degrade of mechanical properties, long term exposure to these cold temperatures will negatively impact service life. Therefore it is recommended for these hoses to be inspected thoroughly as service life may be less than 8000 hours.

Table 2-1 Climate Zones

Zone	Classification
A	Tropical Moist: All months average above 18° C. Latitude 15° - 25° North and South
B	Dry or Arid: Deficient precipitation most of the year. Latitude: 20° - 35° North and South
C	Moist Mid-Latitude: Temperature with mild winters. Latitude: 30° - 50° North & South
D	Moist Mid-latitude: Cold winters. Latitude 50° - 70° North & South
E	Polar: Extremely cold winters and summers. Latitude: 60° - 75° North & South

SUPPLY PRESSURE AND RETURN CIRCUIT

Description

The supply pressure and return circuit routes hydraulic oil from the three hydraulic pumps to the directional control valves for individual operating circuits. The supply pressure and return circuit consists of the reservoir and integral filter, three hydraulic pumps, a hydraulic oil cooler, and a 12-port hydraulic swivel. Refer to Hydraulic Pumps in this section for descriptions and maintenance instructions for each hydraulic pump. Refer to *Swing System*, page 6-1 for description and maintenance instructions for the hydraulic swivel. Each circuit description and components begin with the circuit directional control valve.

Hydraulic Reservoir, Filter, and Temperature Switches

The reservoir (Figure 2-1), attached to the right side of the carrier frame has a total capacity of 1029.4 L (272 gal), with a full level of 926.5 L (245 gal) and a low level of 871.1 L (230 gal).

The all-steel reservoir has an internally mounted full-flow filter (Figure 2-2) and integral baffles that help cool the hydraulic oil and prevent hydraulic oil foaming.

Three tubes located at the lower rear of the reservoir supply oil to the three hydraulic pumps. Return oil from the carrier combination manifold bypasses the hydraulic cooler and returns directly to the hydraulic oil filter in the top of the reservoir. Return oil from all other functions is directed through the hydraulic oil cooler and then to the hydraulic oil filter. All return oil to the reservoir comes from the No. 1 dual-port on the hydraulic swivel.

A temperature switch and thermistor are installed in the lower rear of the hydraulic reservoir. The temperature switch (190°F rising) (8, Figure 2-1) turns the hydraulic oil cooler fan on and off as needed (see *Oil Cooler*, page 2-16). The thermistor (200°F rising) (7, Figure 2-1) will cause a warning light in the cab to illuminate if the hydraulic oil temperature is too high. The thermistor will also turn on the oil cooling fan if the temperature switch fails.

NOTE: NOTE: Tightening torque for the thermistor is 20 Nm (15 ft-lbs)

Tightening torque for the temperature switch is 10.9 ±2.7 Nm (8 ±2 ft-lbs)

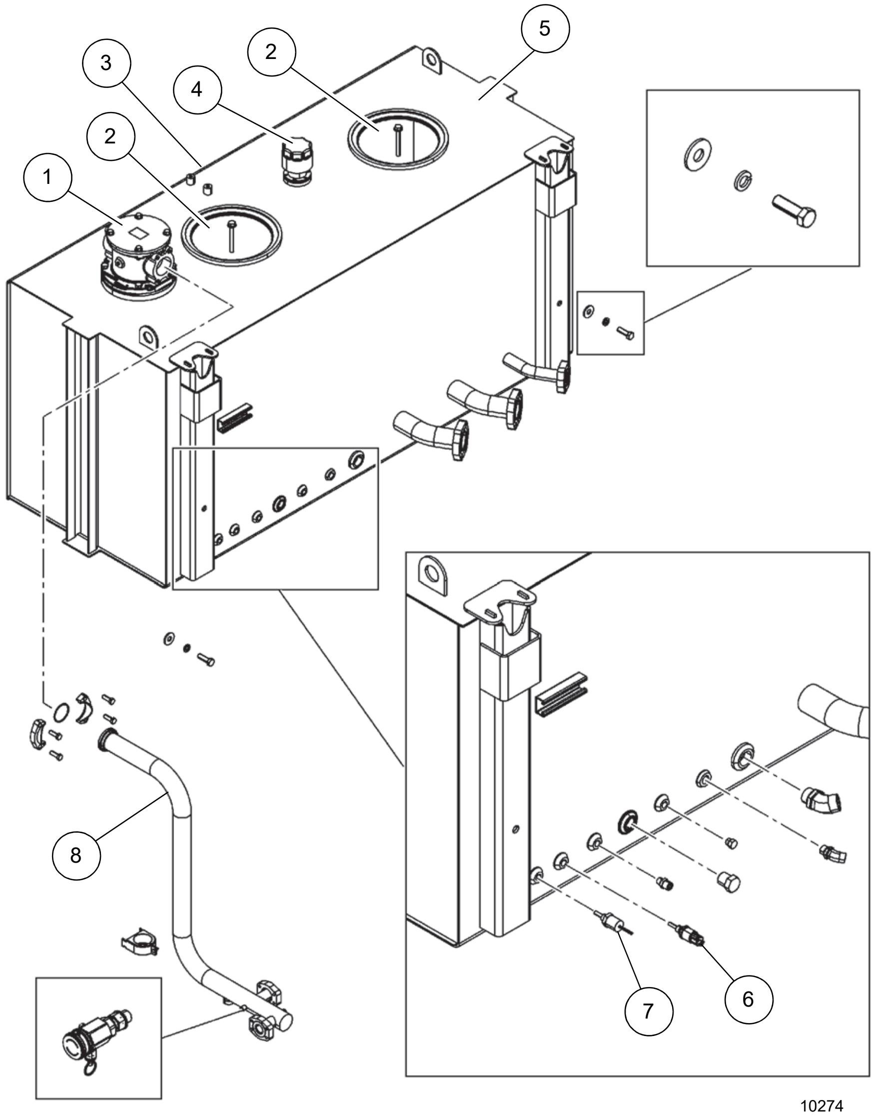
A sight gauge is located on the front end of the reservoir to indicate hydraulic oil level.

A filler neck and breather on top of the reservoir are for filling and venting the reservoir. The filler neck includes a strainer for catching contaminants and gaskets to prevent leaking. The breather allows air to enter or exhaust from the reservoir.The breather must be kept clean to prevent damage to the reservoir. A breather guard protects the breather and filler neck.

Two large round access covers on the top of the reservoir provide access for cleaning. The covers are bolted to the top of the reservoir and have gaskets to prevent leaking.

The hydraulic oil filter bolts to the top of the reservoir. The filter housing contains a replaceable filter element. Returning hydraulic oil flows through the filter head, filter element, and into the reservoir (see *Hydraulic Oil Return Filter Assembly*, page 2-14).

A gauge on the filter head indicates filter element restriction. When back pressure caused by a dirty filter element exceeds 1.7 bar (25 psi), the bypass feature of the filter head allows hydraulic oil to bypass the filter element and flow into the reservoir through the bypass outlet.



1	Return Filter	5	Hydraulic Tank
2	Cover	6	Thermistor (200°F) - High Oil Temp. Indicator Light
3	Oil Level Gauge (not shown)	7	Temperature Switch (190°F) - Oil Cooler Fan On/Off
4	Fill Cap/Breather	8	Return Hose

FIGURE 2-1

Hydraulic Pump Distribution

No. 1 Pump

The torque converter drives the No. 1 variable displacement piston pump, which supplies oil to the following manifolds and valves:

- Combination manifold on the carrier, which includes valves for controlling the rear steer, axle lockout, outriggers, and hydraulic oil cooler fan.
- Main directional control valve on the superstructure, which includes valves for controlling the auxiliary hoist, main hoist, boom telescope, and boom lift.

No. 2 Pump

The torque converter drives the No. 2 variable displacement piston pump, which supplies oil to the following manifolds and valves:

- Steer/brake/pilot supply valve on the superstructure, which includes valves for controlling the front steering, disc brakes, and swing brake.
- Main directional control valve on the superstructure, which includes valves for controlling the auxiliary hoist, main hoist, boom telescope, and boom lift.
- Telescope and telescope fill stage select/thermal contraction valve on the superstructure.
- Compact valve on the superstructure, which includes valves for controlling the boom lift, counterweight removal, counterweight pin, and cab tilt.
- Main and auxiliary hoist brake release valves.

No. 3 Pump

The engine drives the No. 3 gear pump, which supplies oil to the swing directional control valve on the superstructure.

Troubleshooting

Symptoms and Solutions

Symptom	Probable Cause	Solution
1. No hydraulic oil flows in systems.	**a.** Low hydraulic oil level.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Reservoir-to-pump suction lines broken or restricted. Air entering at suction lines. Pump not priming.	**b.** Clean, repair, or replace lines as necessary. Check lines for security, absence of cracks, and proper attachment. Tighten, repair, or replace parts as necessary.
	c. Pump shaft sheared or disengaged.	**c.** If drive shaft is damaged or sheared, remove and repair or replace as necessary
	d. Internal contamination.	**d.** Drain, flush with recommended oil mixture, then drain and refill system with recommended hydraulic oil.
2. Slow response.	**a.** Low hydraulic oil level.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Hydraulic oil temperature too high (watery thin oil) or too low (thick sluggish oil).	**b.** If too low, warm up system. As needed, troubleshoot cooler circuit. If too high, troubleshoot cooler circuit. Likely suspects are in-line check valve and related hydraulic circuits.
	c. Faulty pump.	**c.** Repair or replace pump.
3. Pump noise accompanied by hydraulic oil foaming in reservoir.	**a.** Low hydraulic oil level.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Excessive engine speed.	**b.** Regulate engine speed.
	c. Air entering at suction lines.	**c.** Check all lines for security and proper repair. Tighten, repair, or replace as needed.
4. Excessive pressure buildup.	**a.** System relief valve set too high.	**a.** Using adequate pressure gauge, adjust system relief valve as necessary.
	b. Restricted pump-to-control valve supply line.	**b.** Clean, repair, or replace line as necessary.
5. Specific hydraulic system (lift, hoist, telescope, swing) not working.	**a.** Leak in system.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Faulty hydraulic remote control valve.	**b.** Adjust or replace valve.
	c. Faulty directional control valve.	**c.** Replace valve.
	d. Poorly adjusted control in circuit.	**d.** Troubleshoot circuit with schematic. Adjust hydraulic component per schematic.
	e. Faulty hydraulic cylinder, motor, or valve.	**e.** Replace faulty component.

Troubleshooting Aids

1. **Hydraulic schematics** - an exact illustration of the arrangement of the system. The schematic shows all the components in relation to the system. The ability to understand the schematic is important to good troubleshooting. The schematic can be found at the end of this manual.
2. **Flowmeter** - an instrument that can be connected into the system to measure the flow of the oil in the system. The flow is measured in gallons per minute (gpm) or liters per minute (lpm). Normally, the flowmeter is used to check the output of the pump. The flow meter can also be used to find the location of leakage or restriction in the system. Instructions for installation of the flow meter and the use of the flowmeter are normally included with the flowmeter.
3. **Pressure Gauge** - an instrument for measurement of the pressure in the system. This indication is normally given in pounds per square inch (psi) or bar. On this machine, quick couplers are installed in the pressure lines from the pumps. Pressure taken at these locations will give an indication of operating pressure or relief pressure.

Troubleshooting Procedures

For good troubleshooting, a step by step analysis of the problem and the possible cause is necessary. First, find the symptoms.

1. Check with the operator. Learn if there was a loss of power (machine did not move the load) or a loss of speed (slow cycle time).
2. Learn if the problem is common to all circuits or is found in one or two circuits.
3. Make a visual inspection. Look for a restriction in the linkages, low level of hydraulic oil, bent tubes, collapsed or ballooned hoses, leakage around the hydraulic components, etc.

Second, make an analysis of symptoms. The function of each component in the system must be known before a correct analysis can be made.

Remember:

1. If a problem is common to all circuits, the component which is causing the problem must also be common to all circuits. Examples are: the engine, pump, hydraulic tank and filters.
2. If the problem is common to only two or three circuits, the component which is causing the problem must be common to those two or three circuits. Examples are: pump section, relief valve, hydraulic swivel, etc.
3. If a problem is in only one circuit, then the component which is causing the problem must be in that circuit. Examples are: valve section, cylinder, motor.

Again, use the schematic. Find which components are in the circuit or circuits. What component can cause the problem with these symptoms? Make a list of the possible causes. Start at the source of the flow in that circuit. If the problem is in all circuits, start at the pump. Know the direction of oil flow through each circuit.

Use the flowmeter and pressure gauge to check your diagnosis of the problem. Start at the source of the flow and check each component in sequence until the exact location of the problem is found.

If the problem is two or three circuits, check each circuit separately. After a circuit is checked, use caps or plugs to remove that circuit from the system. Continue to next circuit down the line until the problem is found.

Do not remove the main relief valve from the circuit. The relief valve must be kept in the circuit to prevent damage to the pump and other components.

Hydraulic Oil Return Filter Assembly

The hydraulic oil return filter assembly (see Figure 2-1 and Figure 2-2) is located in the reservoir. It bolts to the top of the reservoir and its bypass outlet fits into a tube welded in the reservoir. The filter housing contains a replaceable filter element. Returning hydraulic oil flows through the filter head, through the filter element, and into the reservoir.

An element condition indicator on the filter head indicates when to change the filter element. When back pressure caused by a dirty filter element exceeds 1.72 bar (25 psi), the filter head's bypass feature functions to allow the hydraulic oil to bypass the filter element and flow into the reservoir through the bypass outlet instead. A bypass filter screen prevents gross contamination from passing through the filter even during bypass.

Refer to the following procedures and Figure 2-2 when removing or installing the hydraulic oil return filter element.

CAUTION

Ensure that all hydraulic systems are shut down and the pressure is relieved. Moderate to minor injury may result when working on a pressurized system.

Wear eye protection. Hydraulic fluid can blind or severely damage eyes.

Element Removal

1. Shut down all hydraulic systems.
2. Wipe any dirt from the cap on top of the return filter head.
3. Remove the four bolts securing the cap to the return filter head. Remove cap.
4. Inspect the bypass valve (attached to the cap) for any damage. Replace if necessary.
5. Remove and discard the O-ring between the cap and the return filter head.
6. Remove the element from the return filter head.

Element Installation

1. Replace the filter with one having the same part number as the one removed. Lube the O-rings on both ends of the element and insert the element into the return filter head.
2. Install the cap on top of the return filter head making sure that the bypass valve is inserted into the element and that the new O-ring between the cap and filter head is installed correctly.
3. Secure the cap to the filter head using the bolts and lock washers; torque bolts to their specified value.
4. Activate the hydraulic system and check for leaks. Make repairs as needed.

Fill Cap/Breather

Removal and Replacement

CAUTION

Ensure that all hydraulic systems are shut down and the pressure is relieved. Moderate to minor injury may result when working on a pressurized system.

Wear eye protection. Hydraulic fluid can blind or severely damage eyes.

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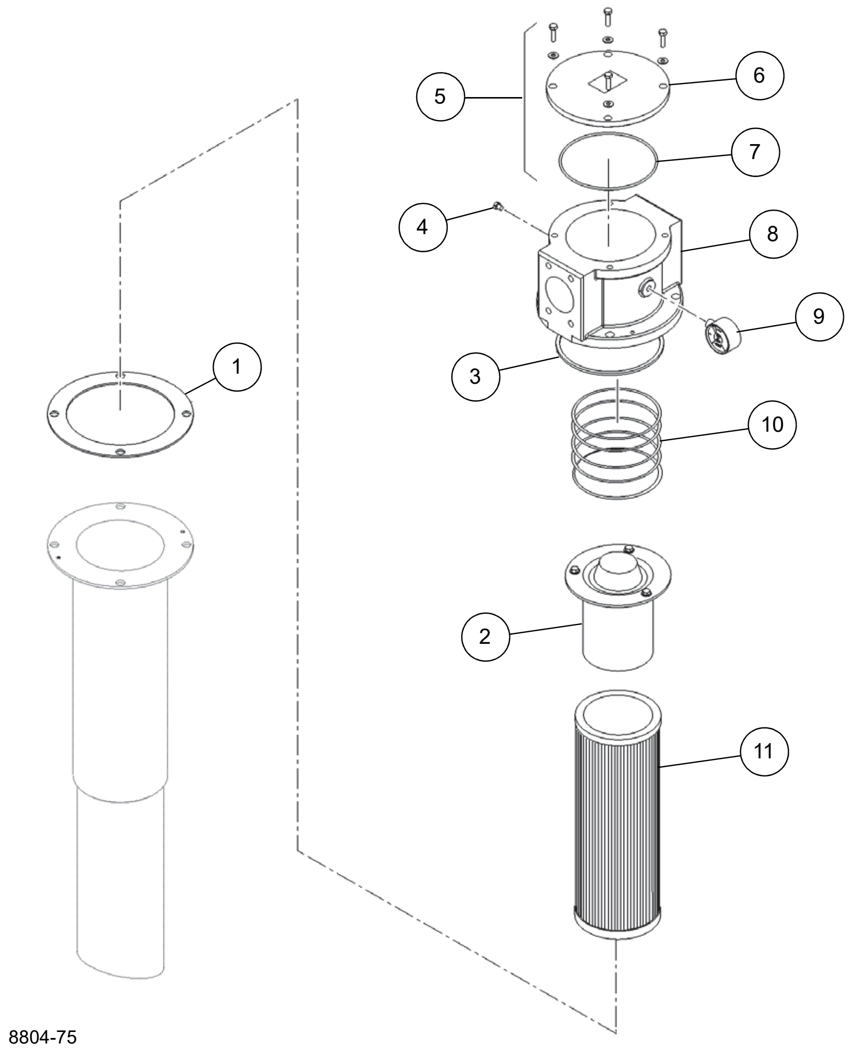
1. Wipe any dirt from the fill cap/breather.
2. Unscrew the fill cap/breather from the fill neck.
3. Screw the replacement fill cap/breather into the fill neck.



1	Gasket		7	O-ring
2	By-pass Assembly		8	Filter Head
3	O-ring		9	Gauge Assembly
4	Plug		10	Spring
5	Cap Assembly		11	Element
6	Cap			

FIGURE 2-2

OIL COOLER

Description

An air cooled hydraulic and transmission oil cooler (Figure 2-3) is located on the left side of the crane. The hydraulic oil cooler section is located closest to the front of the crane and the transmission oil cooler is located closest to the rear of the crane.

The return oil circuit for all functions on the carrier combination manifold bypasses the hydraulic cooler and returns directly to the hydraulic oil filter in the hydraulic tank.

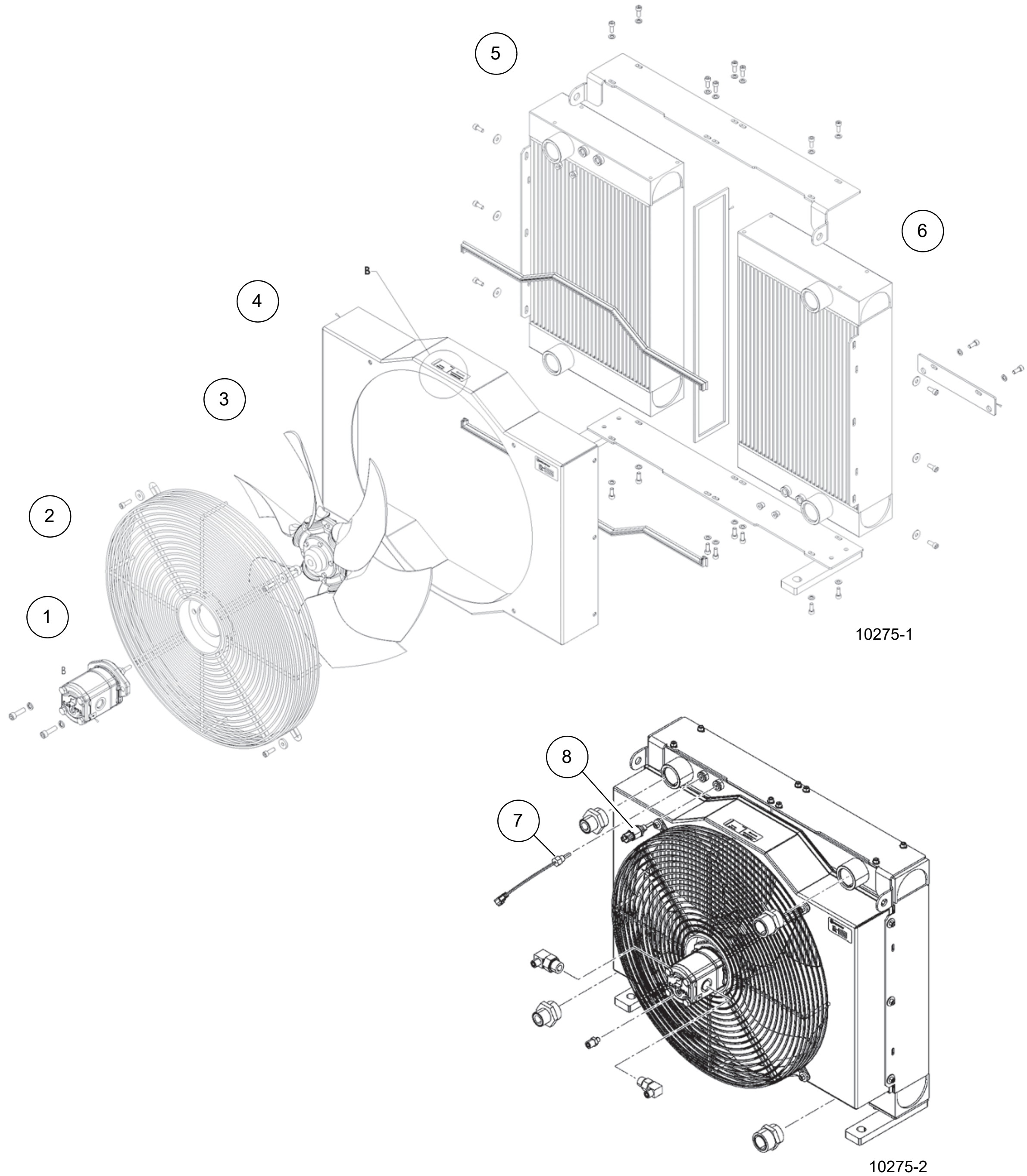
The return oil circuit for all other functions is directed through the hydraulic oil cooler and on to the hydraulic oil filter. A 15 psi check valve in this return oil circuit diverts oil to the return circuit which bypasses the hydraulic oil cooler if the return oil pressure ever increases due to several functions being operated simultaneously.

A hydraulically driven fan pulls cool air through the cooling fins on the two coolers. The fan is turned on and off as needed by a temperature switch (200°F rising) (7, Figure 2-3) that is installed in the hydraulic oil tank. A thermistor (200°F rising) (8, Figure 2-3) is installed in the hydraulic oil tank which will cause a warning light in the cab to illuminate if the hydraulic oil temperature is too high. The thermistor will also turn on the oil cooling fan if the temperature switch fails.

Maintenance

The oil cooler should be checked daily for dirt buildup, as a dirty cooler will result in high oil temperatures. High oil temperatures will reduce the performance and useful life of the oil, which can ultimately result in component failure.

If the cooler is contaminated with dust, it can be cleaned using compressed air. If the cooler is contaminated with a mixture of oil and dust, it should be disassembled and treated with a liquid cleaner, then cleaned of debris using compressed air. Take care when using compressed air, a high pressure washer, or a steam cleaner, as the fins of the cooler may be damaged. To ensure effective cleaning, the direction of air, water, or steam must be opposite to the direction of normal airflow through the cooler. On cranes that operate in corrosive environments (salt), frequently clean the cooler with water to help prevent corrosion.



1	Fan Hydraulic Motor		5	Transmission Cooler
2	Wire Fan Shroud		6	Hydraulic Oil Cooler
3	Fan		7	Temperature Switch (200°F)
4	Metal Fan Shroud		8	Thermistor

FIGURE 2-3

HYDRAULIC PUMPS

Description

The No. 1 and No. 2 hydraulic pumps are mounted to the torque converter (Figure 2-4). The No. 3 pump is mounted to the engine.

The purpose of these pumps is to convert engine and torque converter mechanical energy into fluid energy for operation of crane hydraulic components.

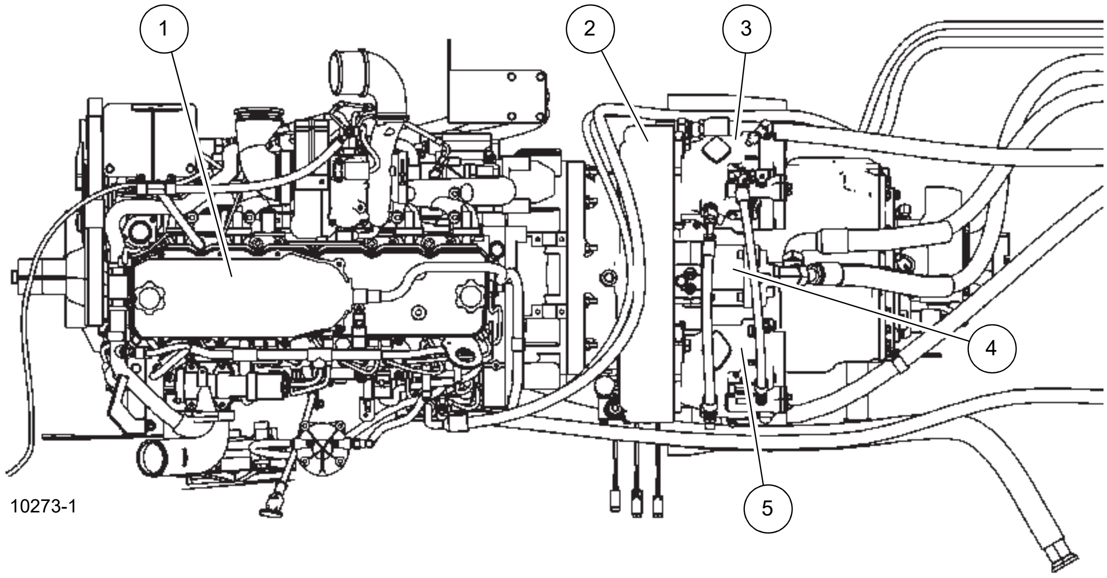
Pumps No. 1 and No. 2

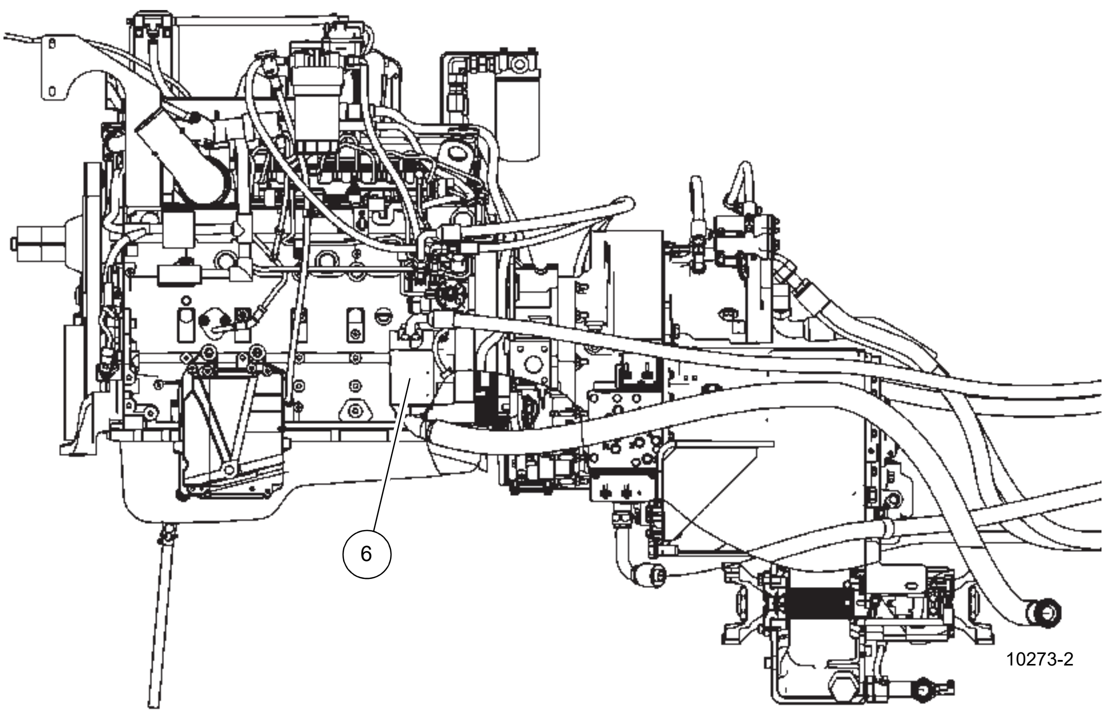
NOTE: Pump output figures are theoretical.

The No. 1 and No. 2 hydraulic pumps are variable displacement piston pumps with SAE-C 2-bolt mounting flanges. Each pump has a displacement per revolution of 85 cc (5.19 cu-in) and an output of 204.4 l/min (54 gal/min) at 2500 rpm. The displacement of both pumps is controlled by load sense lines.

Pump No. 3

The No. 3 hydraulic pump is a positive displacement, gear-type pump with SAE-B 2-bolt mounting flanges. Pump displacement per revolution is 39.0 cc (2.40 cu-in) and output is 98.0 l/min (25.9 gpm) at 2500 rpm.





1	Engine
2	Torque Converter
3	Hydraulic Pump No. 1

4	Transmission Charge Pump
5	Hydraulic Pump No. 2
6	Hydraulic Pump No. 3

FIGURE 2-4

Maintenance

No. 1 and No. 2 Pump Removal

CAUTION

Absolute cleanliness is essential when working on the hydraulic pumps. Always work in a clean area. The presence of dirt and foreign materials in the system can result in serious damage or inadequate operation.

1. Gain access to the pump. Pump No. 1 is bolted to the left side of the engine's torque converter and pump No. 2 is on the right.
2. Tag and disconnect the supply and distribution lines, load sense line, and case drain line from the pump. Cap or plug the lines and ports.

CAUTION

Keep pump as level as possible to avoid damaging the input spline.

3. Remove capscrews and washers attaching pump to torque converter drive pad. Remove pump.
4. Clean gasket material from drive pad and pump.
5. Cover drive pad opening to prevent contamination.

No. 1 and No. 2 Pump Installation

1. Clean drive pad and pump with Loctite® cleaning solvent 7070 or similar non chlorinated solvent.
2. Apply a light coating of Loctite® primer N7649 to drive pad and pump mounting surfaces. Allow primer to dry for one to two minutes. Primer must be dry. Mating of parts should occur within five minutes.
3. Apply gasket material Loctite® Master Gasket 518 to drive pad and pump mounting surfaces.
4. Install pump and gasket on torque converter drive pad with capscrews and washers. Make sure the splines mesh properly. Torque capscrews; refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
5. Connect the distribution and supply lines, load sense line, and drain line to the pump as tagged during removal. Install new O-rings on the flange halves.
6. Prime the pump. Refer to *Priming the Hydraulic Piston Pump*, page 2-20.

No. 3 Pump Removal

CAUTION

Absolute cleanliness is essential when working on the hydraulic pumps. Always work in a clean area. The presence of dirt and foreign materials in the system can result in serious damage or inadequate operation.

1. Gain access to the pump, which is bolted to the engine.
2. Tag and disconnect the suction and supply lines from the pump. Cap or plug the lines and ports.

CAUTION

Keep pump as level as possible to avoid damaging the input spline.

3. Remove capscrews and washers attaching pump to flywheel housing. Remove pump.
4. Clean gasket material from drive pad and pump.
5. Cover the drive pad opening to prevent dirt from entering.

No. 3 Pump Installation

1. Clean drive pad and pump with Loctite® cleaning solvent 7070 or similar non chlorinated solvent.
2. Apply a light coating of Loctite® primer N7649 to drive pad and pump mounting surfaces. Allow primer to dry for one to two minutes. Primer must be dry. Mating of parts should occur within five minutes.
3. Apply gasket material Loctite® Master Gasket 518 to drive pad and pump mounting surfaces.
4. Install pump and gasket on back of flywheel housing with capscrews and washers. Make sure the splines mesh properly. Torque capscrews; refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
5. Connect the pressure and supply lines to the pump as tagged during removal. Install new O-rings on the flange halves.
6. Prime the pump. Refer to *Priming/Starting-Up the Hydraulic Gear Pump*, page 2-21.

Priming the Hydraulic Piston Pump

CAUTION

Failure to follow this procedure can cause the pump to fail.

CAUTION

The Pump Priming Tool is set to 1-2 psi to prevent the reservoir from being over-pressurized and damaged. Do not adjust the Pump Priming Tool. Always monitor the pressure gauge of the Pump Priming Tool to ensure that 2 psi is not exceeded during the air bleeding process.

1. Ensure reservoir is filled with the proper hydraulic fluid to the high level mark on the reservoir sight gauge. If hydraulic oil is aerated (oil has a foamy white tint with bubbles), allow crane to sit until the air has escaped and the fluid is a dark solid color.
2. Kawasaki piston pumps only:
   - **a.** Remove the plug from the Dr port of the pump. Fill the pump casing with hydraulic oil, then re-install plug. Torque plug to 123 lb-ft.
   - **b.** Remove the plug from the T port.

   Rexroth piston pumps only:
   - **a.** Remove the adapter and hose from the T2 port. Fill the pump casing with hydraulic oil, then re-install plug. Torque plug to 146 b-ft.
   - **b.** Remove the plug from the R port.
3. Remove the breather from the hydraulic oil reservoir, then install the pump priming tool (Grove part number 80030367) onto the reservoir in place of the breather. Connect a compressed air supply (nominal 100 psi, maximum 300 psi) to the pump priming tool.

   Wait for a solid stream of fluid, free of air bubbles, to exit the:
   - T port on a Kawasaki pump
   - R port on a Rexroth pump

   Re-install the plug while oil is flowing out of the port. Torque plug to the following specification:
   - T port plug on Kawasaki pump: 9 lb-ft
   - R port plug on Rexroth pump: 146 lb-ft
4. Remove the air supply from the pump priming tool.
5. Remove the pump priming tool and reinstall the breather.
6. For newly installed piston pumps, check the pressure settings. Refer to *Checking/Setting the Piston Pumps Cut-off and Differential Pressures*, page 2-24.

Priming/Starting-Up the Hydraulic Gear Pump

CAUTION

Failure to follow this procedure can cause the pump to fail.

CAUTION

The Pump Priming Tool is set to 1-2 psi to prevent the reservoir from being over-pressurized and damaged. Do not adjust the Pump Priming Tool. Always monitor the pressure gauge of the Pump Priming Tool to ensure that 2 psi is not exceeded during the air bleeding process.

1. Ensure reservoir is filled with the proper hydraulic fluid to the high level mark on the reservoir sight gauge. If hydraulic oil is aerated (oil has a foamy white tint with bubbles), allow crane to sit until the air has escaped and the fluid is a dark solid color.
2. If gear pump is equipped with 7/16-20 UN-2B port in the inlet side of the pump housing, place an adequate container under Pump No. 2 to catch the hydraulic oil and then remove the plug from this port (if the pump has more than one gear section, remove the plug that is most convenient as they are common to the inlet).

   If gear pump is not equipped with 7/16-20 UN-2B port in the inlet side of the pump housing, place an adequate container under Pump No. 2 to catch the hydraulic oil and then slightly loosen the inlet port hose.
3. Remove the breather from the hydraulic oil reservoir, then install the pump priming tool (Grove part number 80030367) onto the reservoir in place of the breather. Connect a compressed air supply (nominal 100 psi, maximum 300 psi) to the pump priming tool.
4. If gear pump is equipped with 7/16-20 UN-2B port, wait for a solid stream of fluid, free of air bubbles, to exit the port, then re-install the plug while oil is still coming out. Torque plug to 10 lb-ft.

   If gear pump is not equipped with 7/16-20 UN-2B port, wait for a solid stream of fluid, free of air bubbles, to exit the loose hose connection, then re-tighten the hose fitting while oil is still coming out. Refer to *Hydraulic Fittings*, page 1-14 for proper tightening specification.
5. Perform this step on gear pumps that start up against high pressure, such as service brake charging or sequence valve circuits.
   - **a.** With the compressed air supply still attached to the pump priming tool, slightly loosen the outlet port hose of the pump.
   - **b.** Jog the engine starter until a solid stream of fluid, free of air bubbles, exits the loose hose connection,

then re-tighten the hose fitting while oil is still coming out. Refer to *Hydraulic Fittings*, page 1-14 for proper tightening specification.

6. If the pump's hydraulic circuit includes an air conditioning compressor motor, ensure this function is turned off before proceeding.
7. With the compressed air supply (nominal 100 psi, maximum 300 psi) still attached to the pump priming tool, start the engine and let it idle for two to three minutes with no crane functions actuated. Check for leaks and repair if required. If the pump outlet becomes too hot to keep your hand on it comfortably, stop the engine immediately.
8. Stop the engine and remove the pump priming tool and re-install the breather.
9. Start the engine. Slowly increase the engine speed to 1500 rpm and hold for 1 minute while making sure the hydraulic reservoir is filled to the proper level and the fluid is not aerated.
10. Slowly increase the engine speed to full rpm and hold for 1 minute while making sure the hydraulic reservoir is filled to the proper level and the fluid is not aerated.
11. At full engine rpm, cycle all functions without fully extending or retracting the cylinders to their stops to verify operation and that the pump(s) remain quiet and do not become excessively hot.
12. Check pressure settings. Refer to *Pressure Setting Procedures*, page 2-23.

PRESSURE SETTING PROCEDURES

The following procedures should be used to properly check, adjust and set the hydraulic system pressures.

The following equipment is required for checking the hydraulic pressure settings.

- Pressure Gauge (1) three dial gauge 0 to 34.5 MPa (0 to 5000 psi)
- Accumulator charging and gauging assembly for 20.7 MPa (3000 psi)
- ORFS reducers as required to attach work port hoses to the gauge.

NOTE: When checking the directional control valve relief settings, unless otherwise specified, start with the engine at idle RPM and move the controller to its fully stroked position. Then slowly accelerate the engine to the specified rpm. Read gauge and make adjustments to specified setting.

When checking the outrigger relief valve setting, start with the engine at idle rpm and activate and hold the extend or retract switch. Then slowly accelerate the engine to the specified rpm. Read gauge and make adjustment as required.

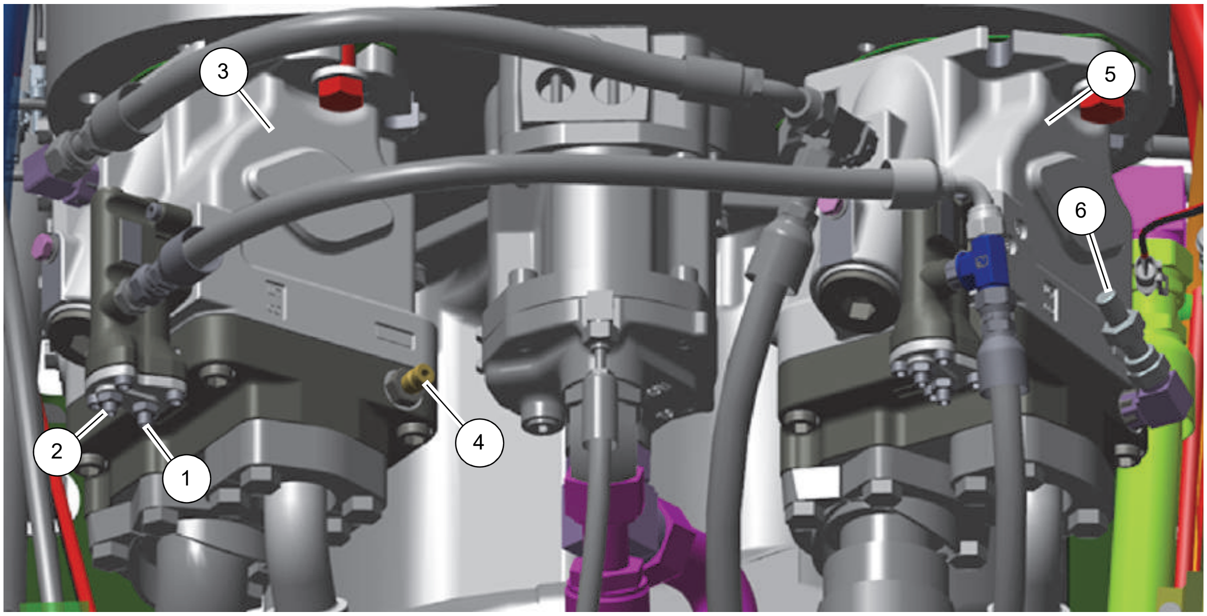
Table 2-2 Valve Pressure Setting Table

VALVE TO BE SET	GAUGE PRESSURE PSI (bar)	TOLERANCE PSI (bar)	GAUGE PORT & ADJUSTMENT LOCATION
Pump No. 1 differential pressure	475 to 525 (32 to 36)	See range	Gauge port on No. 1 pump; adjust differential pressure adjustment screw on No. 1 pump (Figure 2-5).
Pump No. 2 differential pressure	525 to 575 (36 to 40)	See range	Gauge port on No. 2 pump; adjust differential pressure adjustment screw on No. 2 pump (Figure 2-5).
Hoist(s) and lift pressures	4000 (276)	±100 (7)	GP port on main directional valve; adjust at LS relief on main directional valve (Figure 2-8)
Telescope retract pressure	3250 (224)	±100 (7)	GP7 port on steer/brake valve (Figure 2-10); adjust tele retract relief on main directional valve (Figure 2-9)
Telescope extend pressure	2900 (200)	±100 (7)	GP7 port on steer/brake valve (Figure 2-10); adjust tele extend relief on main directional valve (Figure 2-8)
Pilot supply pressure	600 (41)	±50 (4)	GP4 port on steer/brake valve; adjust pressure reducing valve on steer/brake valve (Figure 2-7)
Front steer pressure	2800 (193)	±50 (4)	GP7 port on steer/brake valve (Figure 2-10); adjust relief on steer/brake valve (Figure 2-10)
Cab tilt, counterweight removal and counterweight pinning pressures	2600 (179)	+50, -0 (+4, -0)	GP7 port on steer/brake valve (Figure 2-10); adjust pressure reducing valve on cab tilt/cwt manifold (Figure 2-19)
Swing brake release pressure	550-600 (38-42)	See range	GP3 port on steer/brake valve; adjust pressure reducing valve on steer/brake valve (Figure 2-7)
Swing left and right pressures	2750 to 3100 (190 to 214)	See range	GP5 port on swing directional valve (Figure 2-16)
Service brake high charge limit	2900 (200)	±145 (10)	Test nipple on brake accumulators (Figure 2-17) Non-adjustable

VALVE TO BE SET	GAUGE PRESSURE PSI (bar)	TOLERANCE PSI (bar)	GAUGE PORT & ADJUSTMENT LOCATION
Service brake low charge limit	2465 (170)	±145 (10)	Test nipple on brake accumulators (Figure 2-17) Non-adjustable
Service brake accumulator pre-charge	1500 to 1550 (103 to 107)	See range	Accumulator (Figure 2-18)
Outrigger jack extend and retract pressures	2750 (190)	±100 (7)	LS1 port of the carrier combination valve (Figure 2-20); adjust pressure using service tool
Outrigger beam extend pressure	1500 (103)	±50 (4)	LS1 port of the carrier combination valve (Figure 2-20); adjust pressure using service tool
Outrigger beam retract pressure	2000 (137)	±100 (7)	LS1 port of the carrier combination valve (Figure 2-20); adjust pressure using service tool
Rear steer pressure	2500 (172)	±100 (7)	LS1 port of the carrier combination valve (Figure 2-20); adjust pressure using service tool
Axle lockout pressure	100 (7)	±25 (2)	G3 port of the carrier combination valve (Figure 2-20); adjust pressure reducing valve integrated in the carrier combination valve (Figure 2-20)
Park brake pressure	2000 (137)	±50 (4)	LS1 port of the main carrier valve (Figure 2-20); adjust parking brake pressure reducing valve on carrier combination valve (Figure 2-20)
Luffing jib pressure	3500 (241)	±100 (7)	G port on luffing jib valve, adjust luffing jib relief valve on luffing jib valve (see Figure 2-21)

Checking/Setting the Piston Pumps Cut-off and Differential Pressures

1. With engine off, install a pressure check diagnostic quick disconnect (p/n 9999101806) with gauge onto the test nipple at pump No. 1 gauge port (see Figure 2-5). Turn the differential pressure adjustment screw counter-clockwise 2 full turns on both pumps.
2. Start engine and idle. Turn the differential pressure adjustment screw (see Figure 2-5) on pump No. 1 clockwise to increase or counter-clockwise to decrease so that a gauge reading of 475 to 525 psi (32 to 36 bar) is achieved.
3. Stop engine and remove the diagnostic coupler.
4. With engine off, install a pressure check diagnostic quick disconnect with gauge onto the test nipple at pump No. 2 gauge port (see Figure 2-5).
5. Start engine and idle. Turn the differential pressure adjustment screw (see Figure 2-5) on pump No. 2 clockwise to increase or counter-clockwise to decrease so that a gauge reading of 525 to 575 psi (36 to 40 bar) is achieved.
6. Stop engine and remove the diagnostic coupler.
7. Ensure piston pump cut-off max pressure setting is correct. The dimension from the end of the jam nut to the end of the adjusting screw should be 8.5 ±0.5 mm (see Figure 2-6). If it is not, loosen the jam nut and adjust it to the correct length. Do this for each of the two piston pumps.



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Piston Pumps	
1	Cut-off pressure adjustment screw
2	Differential pressure adjustment screw
3	Piston pump #1
4	Pump #1 gauge port
5	Piston pump #2
6	Pump #2 gauge port

FIGURE 2-5

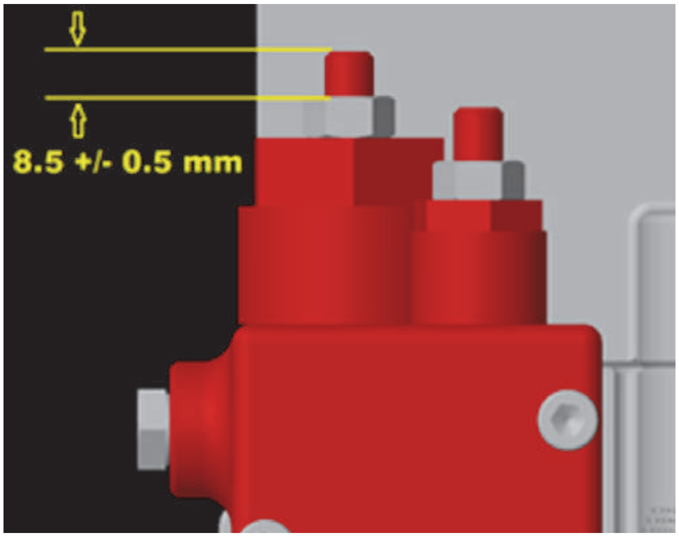

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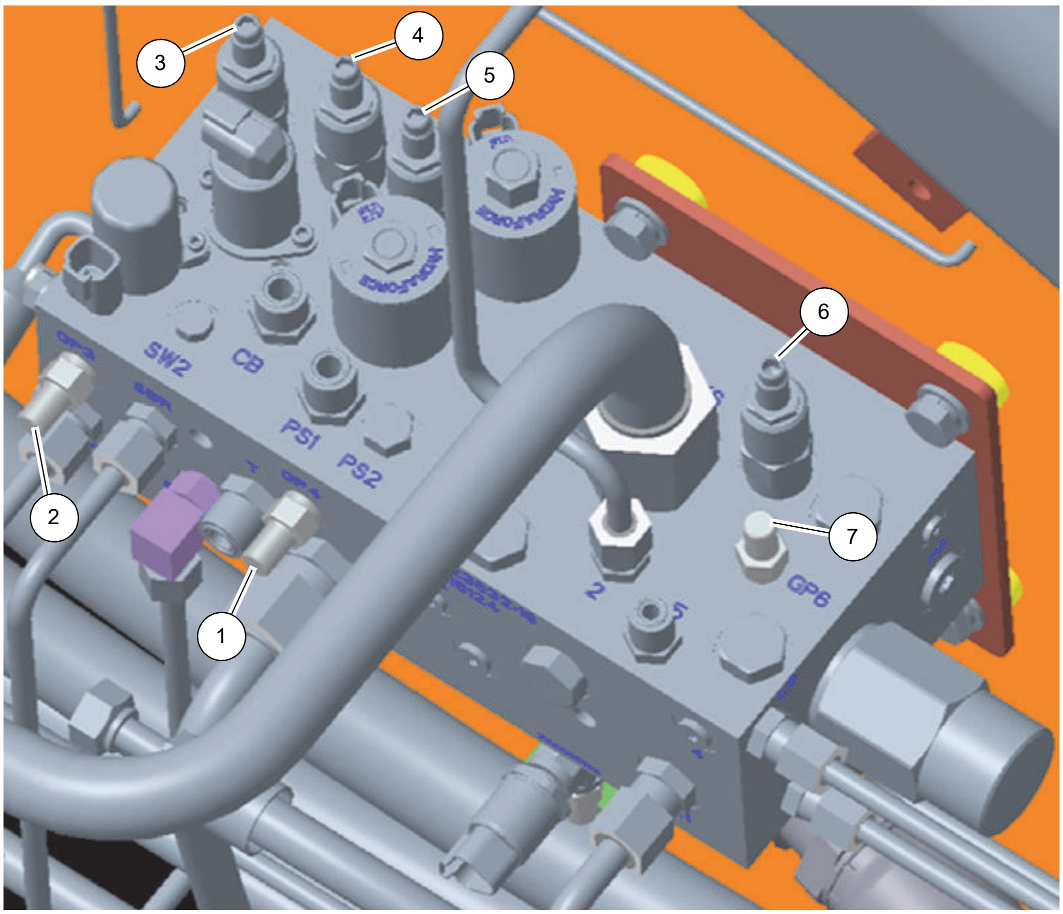
FIGURE 2-6

Checking/Setting the Pilot Supply Pressure

1. With the engine off, install pressure check diagnostic quick disconnect (9999101806) with gauge onto test nipple at GP4 port of the front steer/swing brake/pilot supply manifold (see Figure 2-7).
2. If the lift or tele cylinders are not installed, plug the hoses. If the cylinders are installed, skip this step.
3. Start engine and allow it to idle
4. Enable the Boom Lift function.
5. If lift cylinder is installed, fully retract the cylinder.

   Slowly actuate the lift down function and hold. Turn the pilot supply pressure reducing valve (see Figure 2-7) clockwise to increase or counter-clockwise to decrease until a gauge pressure reading of 600 ±50 psi (41 ±4 bar) is achieved.
6. Stop engine. Remove diagnostic couplers.



Steer/Swing Brake/Pilot Supply Manifold (top)	
1	GP4 port
2	GP3 port
3	Swing brake pressure reducing valve
4	Pilot supply pressure reducing valve
5	Tele fill relief valve
6	Accessory manifold pressure reducing valve
7	GP6 port

FIGURE 2-7

Checking/Setting the Main Directional Control Valve, Hoists, Lift, and Telescope Pressures

1. Adjust the LS relief (see Figure 2-8) pressure setting below the pressure setting of the piston pump cut-off pressure by turning the LS relief counter-clockwise 2 full turns.
2. With engine off, install a pressure check diagnostic quick disconnect (9999101806) with gauge onto test nipple at the GP gauge port on the main directional valve (see Figure 2-8).
3. If the lift or tele cylinders are not installed, plug the hoses. If the cylinders are installed, skip this step.
4. Start engine and idle. If the lift cylinder is installed, fully retract it first.

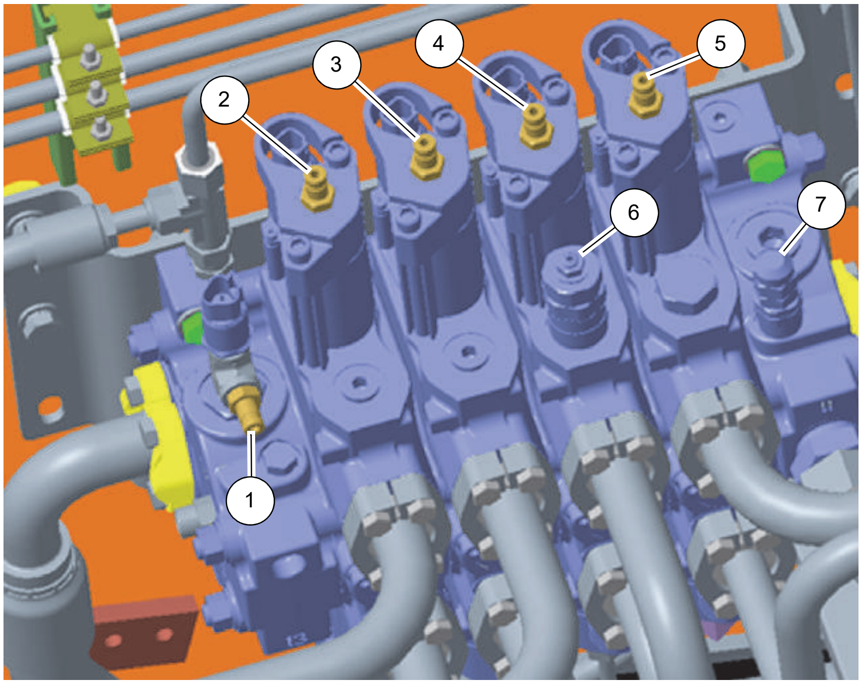
   Slowly actuate the lift down function until full stroke is achieved and hold. Slowly accelerate the engine to full rpm. Turn the LS relief (see Figure 2-8) clockwise to increase or counter-clockwise to decrease so that a gauge reading of 4000 ±100 psi (276 bar ±7 bar) achieved.
5. Stop engine. Remove the diagnostic coupler.

NOTE: If the pressure cannot be achieved in step 4, ensure each piston pump's cut-off max pressure setting is correct by doing the following.

6. Loosen both pump's jam nuts on the cut-off pressure adjustment screws (Figure 2-5).
7. Turn both pump's cut-off pressure adjustment screws clockwise one quarter turn at a time – one pump a quarter turn, then the other pump a quarter turn, repeat – until the specified LS pressure is achieved.
8. Once specified LS pressure is achieved, turn each pump's cut-off pressure adjustment screws clockwise 1/8 of a turn and tighten the jam nuts to lock the screws in position.

   Repeat step 4 to set the LS relief pressure.

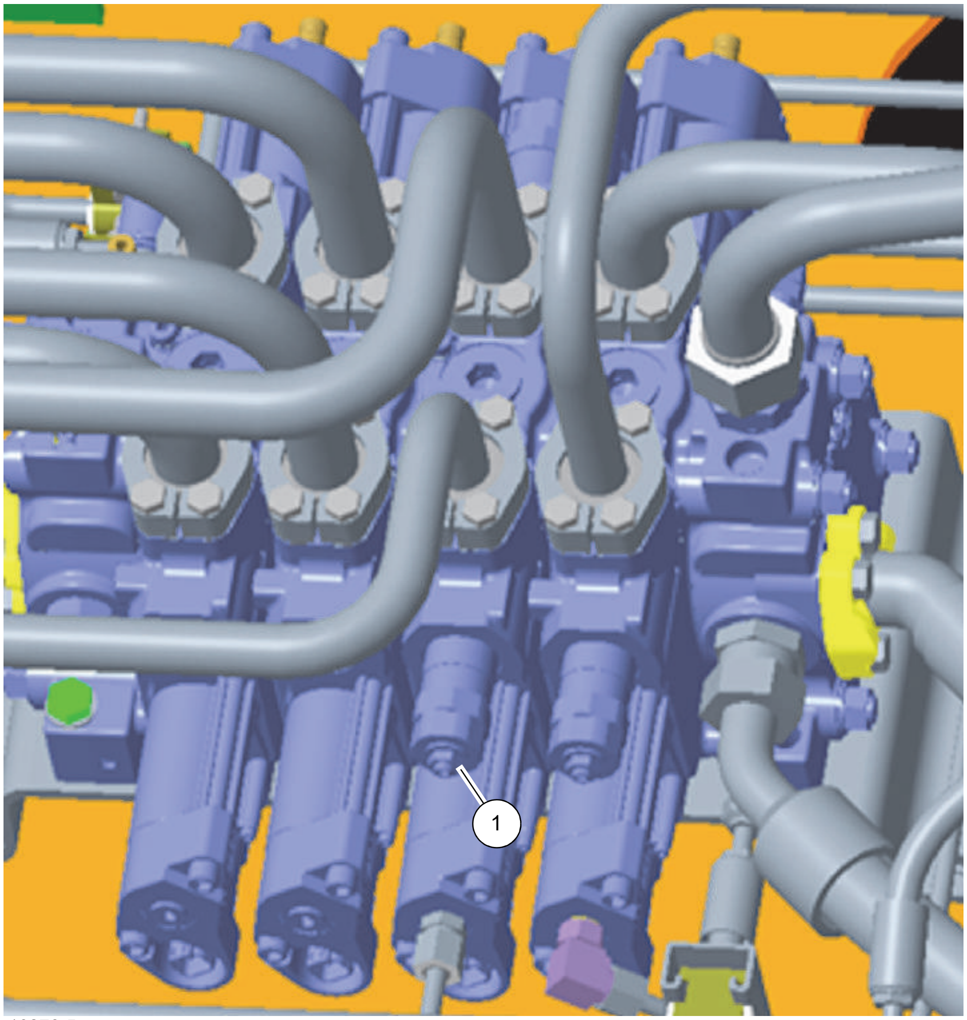
2



10276-4

Main Directional Valve	
1	Main directional valve GP port
2	GP1a
3	GP2a
4	GP3a
5	GP4a
6	Telescope extend relief
7	LS relief

FIGURE 2-8



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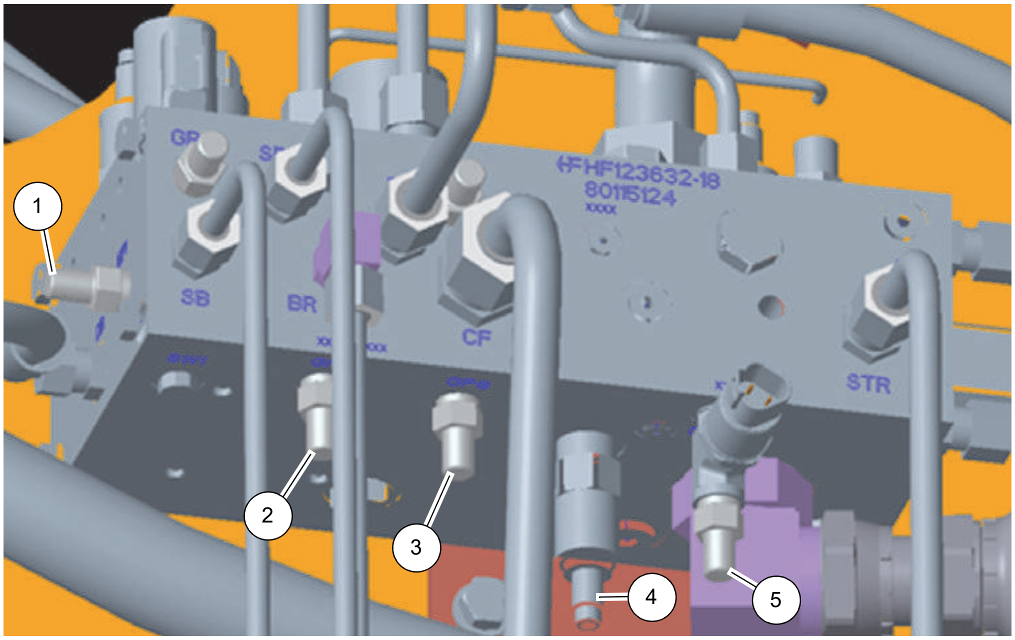
Main Directional Control Valve	
1	Tele retract relief valve

FIGURE 2-9



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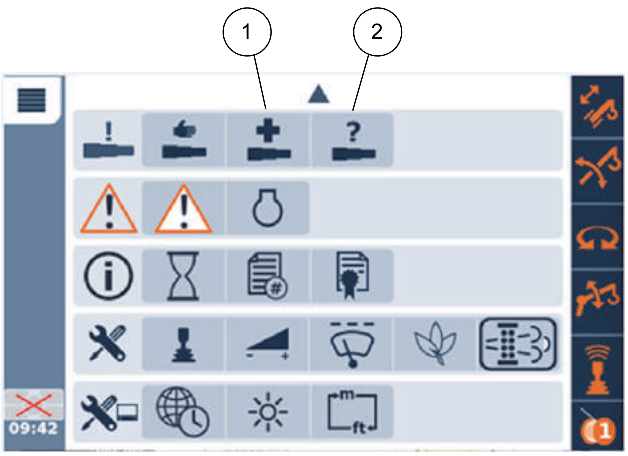
Steer/Swing Brake/Pilot Supply Manifold (bottom)	
1	GP1 port
2	GP5 port
3	GP8 port
4	Steering relief valve
5	GP7 port

FIGURE 2-10

Tele Extend and Retract Relief Pressures

1. With the engine off, install pressure check diagnostic quick disconnect (9999101806) with gauge onto the test nipple at GP7 port of the Steer/Swing Brake/Pilot Supply manifold (see Figure 2-10).
2. Start the engine.
3. Navigate to the boom recovery pinning screens in the Operator Display Module (ODM) (see Figure 2-11 thru Figure 2-13).

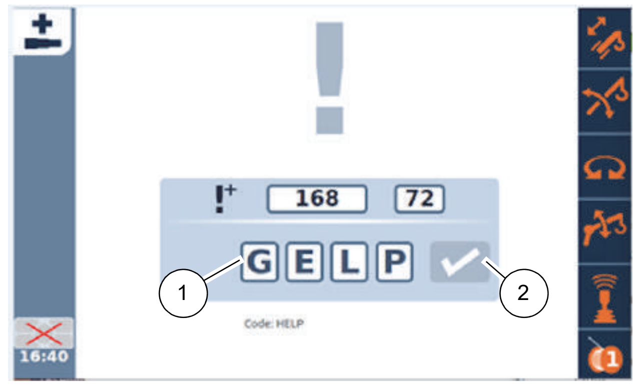


10276-7

1	Emergency Mode Icon
2	Boom Lost Icon

FIGURE 2-11

4. Select the Emergency Mode icon.
5. Use the jog dial and change the word “GELP” to “HELP” and then select the check box (see Figure 2-12).

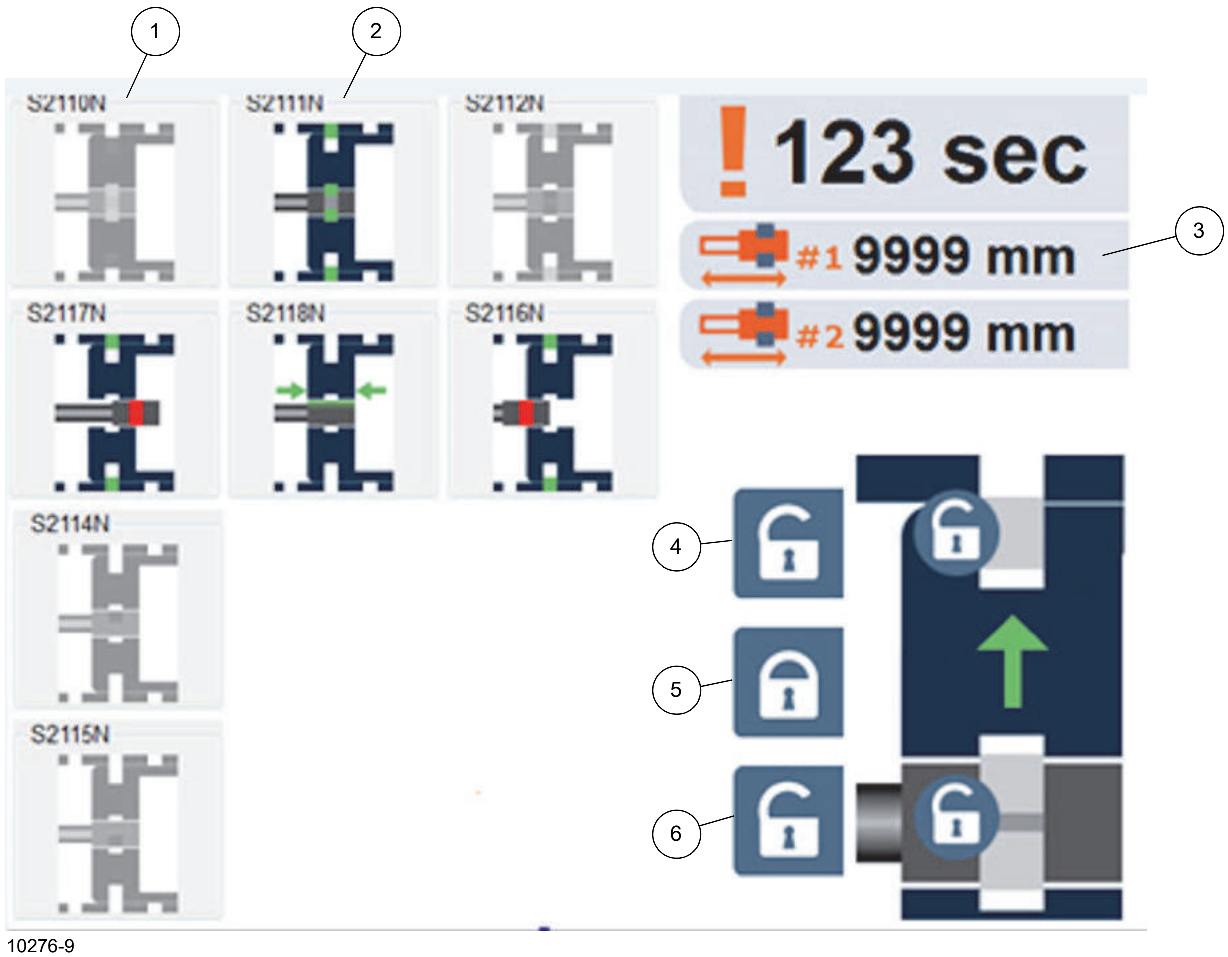


10276-8

1	Change “G” to “H”
2	Select check box

FIGURE 2-12

- Make sure cylinder #1 length is 0 ± 2 mm (see Figure 2-13).
  - **a.** If it is not, unlock the cylinder using the cylinder unlock button and the jog dial selector.
  - **b.** Use the joystick and retract cylinder #1 until the length reads 0 ± 2 mm.
- Make sure that S2111N is green.
  - **a.** If it is not use lock button and the jog dial to lock the boom and verify that S2111N is green.



1	S2110N	4	Section Unlock Button
2	S2111N	5	Lock Button
3	Cyl #1 Length	6	Cylinder Unlock Button

FIGURE 2-13

6. **Tele Extend:** Slowly actuate the tele extend function until the cylinder is deadheaded and hold. Slowly accelerate the engine to full RPM.

   The reading at GP7 should be 2900 ±100 psi (200 ±7 bar). If it is not, adjust the Tele extend relief (see Figure 2-8) "in" to increase or "out" to decrease until the reading is achieved.

7. **Tele Retract:** Slowly actuate the tele retract function until the cylinder is deadheaded and hold. Slowly accelerate the engine to full RPM.

   The reading at GP7 should be 3250 ±100 psi (224 ±7 bar). If it is not, adjust the Tele retract relief (see Figure 2-9) "in" to increase or "out" to decrease until the reading is achieved

8. Make sure that the cylinder is fully retracted – length reads 0 ± 2 mm.

Tele Extend Fill Tube Pressure

1. With the engine off, install pressure check diagnostic quick disconnect (9999101806) with gauge onto the test nipple at GP8 port of the Steer/Swing Brake/Pilot Supply manifold (see Figure 2-10).

2. While still in the Emergency Mode screen, with the cylinder and the boom fully retracted (#1 cylinder length shown on the screen as 0 ±2 mm), use the Section Unlock Button (refer to Figure 2-13). This unlocks the T1 boom section.

   Verify that there is space for the boom to extend up to 15 feet. Also, note that the Emergency Mode screen is only active for about 15 minutes (at which time the screen can be entered again for another 15 minutes).

3. Set engine speed to maximum rpm.

4. Extend the boom at full speed while noting the pressure in the fill tube (the limit bypass switch may be required).

   If the #1 cylinder length shown on the screen reaches 4000 mm, stop extending the boom, retract the boom fully, and extend again (if needed for further measurements).

   The reading at GP8 should be 85 ±10 psi (6 ±1 bar). If it is not use the service tool as follows to adjust.

5. To adjust the pressure, locate the following EEPROM value:

   Tools->EEPROM->View Parameters->Super->Pinned Boom Pinning Params

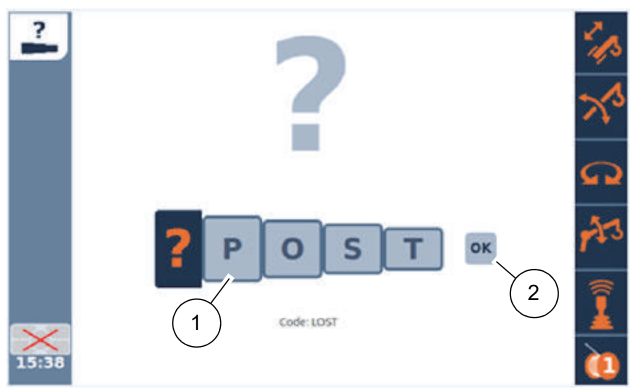
   ->112 GL300 TS Valve Tube Fill Current Setting

   The pressure is adjusted by a current setting (mA). To increase the pressure indicated by the gauge, increase the value (typically by increments of 10), and repeat the measurement procedure. To decrease the pressure indicated by the gauge, decrease the value (typically by increments of 10). When desired pressure is achieved make sure to "Save active to customer" and "Save active to factory".

6. Return the boom pinning to its normal state.

   a. Navigate to the Menu Screen of the ODM and select the Boom Lost icon (see Figure 2-11).

   b. Use the Jog Dial and change the word "POST" to "LOST" and then select the "OK" box (see Figure 2-14).

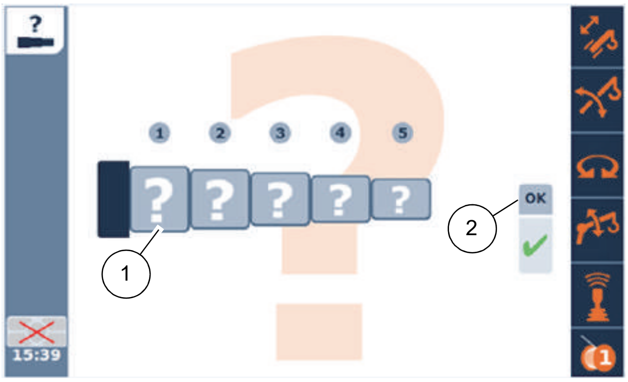


10276-10

1	Change "P" to "L"
2	Select OK box

FIGURE 2-14

c. Navigate to each boom section and enter 0 for the pinning position (see Figure 2-15). (Note: If the boom is not fully retracted, enter the appropriate pinning position for each section.)



10276-11

1	Boom Section Position
2	Select OK box

FIGURE 2-15

d. Select the "OK" button

7. Stop engine. Remove diagnostic couplers.

Checking/Setting the Front Steer Pressure

1. With the engine off, install pressure check diagnostic quick disconnect (9999101806) with gauge onto test nipple at GP7 port of the front steer/swing brake/pilot supply manifold (see Figure 2-10).
2. Start engine and throttle up to full rpm. Fully turn the steering wheel left or right against the axle stop and hold. Turn the steering load sense relief valve (see Figure 2-10) clockwise to increase or counter-clockwise to decrease until a gauge pressure of 2800 ±50 psi (193 ±4 bar) is achieved.
3. Stop engine. Remove diagnostic couplers.

Checking/Setting the Swing Brake Release Pressure

1. With the engine off, install pressure check diagnostic quick disconnect (9999101806) with gauge onto test nipple at GP3 port of the front steer/swing brake/pilot supply manifold (see Figure 2-7).
2. If the lift or tele cylinders are not installed, plug the hoses. If the cylinders are installed, skip this step.
3. Start engine and idle. Enable the Boom Lift function.
4. If the lift cylinder is installed, fully retract it first.

   Slowly actuate lift down and hold. Turn the swing brake release pressure reducing valve (see Figure 2-7) clockwise to increase or counter-clockwise to decrease so that the gauge pressure of 550-600 psi (38-42 bar) is achieved.
5. Stop engine. Remove the diagnostic coupler.

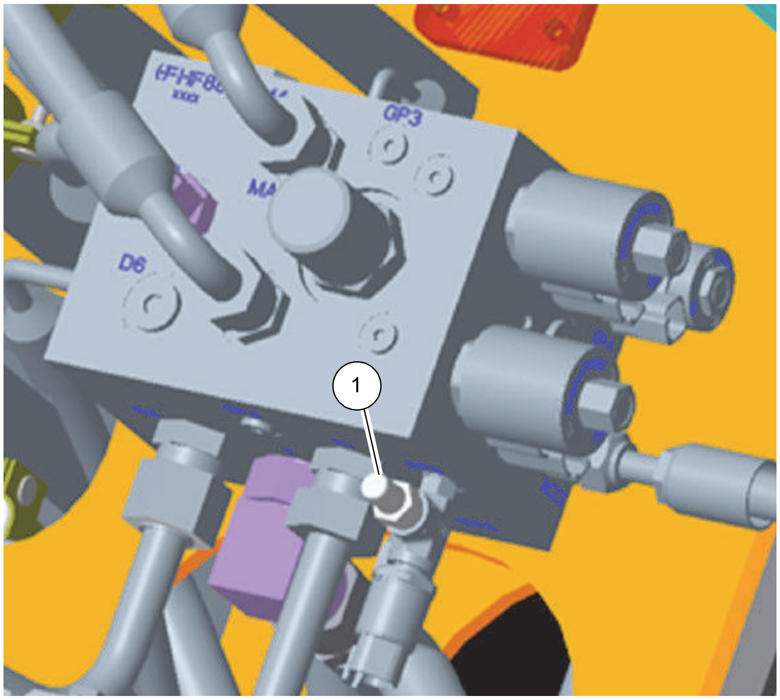
Checking the Swing Work Pressure

1. With the engine off, install a pressure check diagnostic coupler (9999101806) with gauge onto the diagnostic nipple at GP5 port of the superstructure swing directional valve (see Figure 2-16).
2. Start engine and throttle up to full rpm. Engage the swing house lock. Slowly actuate the swing right function until full controller stroke is reached and hold.

   The pressure gauge should read 2750 to 3100 psi (190 to 214 bar). If it does not, the Imax value in the joystick EEPROMs can be adjusted by raising the Imax to raise the pressure or reducing the Imax to decrease the pressure. Once proper pressure is achieved, make sure to “Save active to customer” and “Save active to factory”.

   If adjusting the Imax does not work, contact your Manitowoc distributor or Manitowoc Crane Care.
3. Repeat step 2 for swing left.
4. Stop engine. Remove the diagnostic coupler.

2



10276-12

Superstructure Swing Directional Valve	
1	GP5 port

FIGURE 2-16

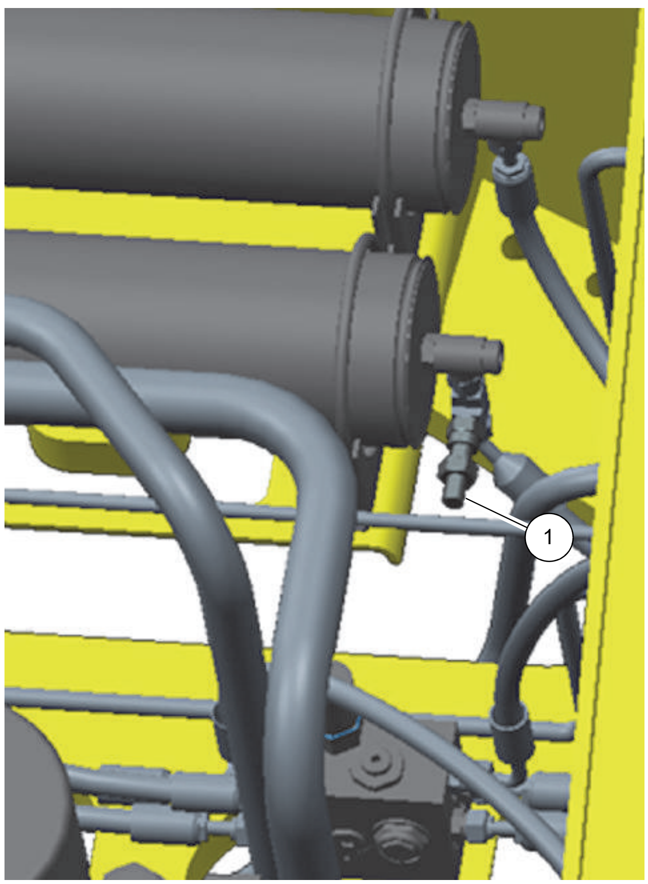
Checking the Service Brake Accumulator Charging Valve Pressure

1. With engine off, discharge all of the pressurized fluid stored in the accumulators by depressing the service brake pedal on the cab floor 12 to 15 times.
2. Install pressure check diagnostic quick disconnect (9999101806) with gauge onto test nipple at the brake accumulators (see Figure 2-17).
3. Start engine and idle. The charging valve will immediately start to charge the accumulators. Watch the pressure gauge, the high charge limit should read 2900 ±145 psi (200 ±10 bar) (when the pressure stops rising).

NOTE: Accumulator charge valve is non-adjustable.

4. If the pressure is under specification and the valve does not stop charging, turn the accessory manifold pressure reducing valve clockwise a half turn at a time (see step 2-7) and repeat step 3.

   It may require adjusting the accessory manifold pressure reducing valve by a half turn several times before the pressure is set high enough to allow the brake valve to fully charge.
5. With the engine still at idle, repeatedly depress the service brake pedal on the cab floor until the gauge pressure reads approximately 2600 psi (179 bar). Once this pressure has been attained, push the brake pedal again. The recharge cycle should start again (this could take two pedal applications). Watch the gauge and verify the low charging limit (the pressure at which the valve begins to charge) to be 2465 ±145 psi (170 .±10 bar).
6. Stop engine. Remove the pressure gauge.



10276-13

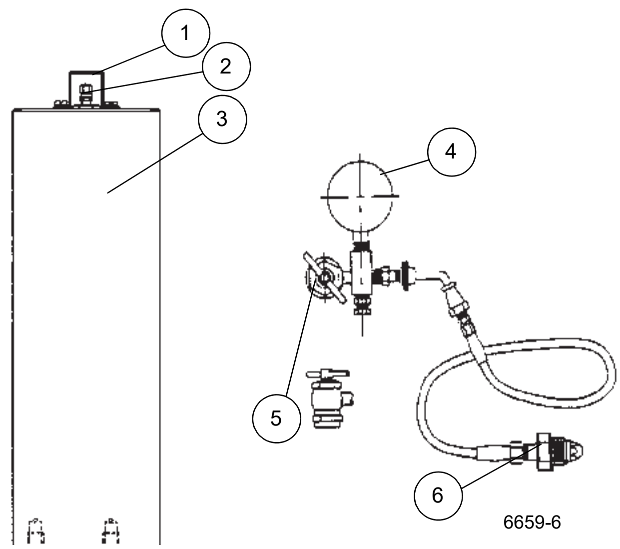
Brake Pressure Port Location	
1	Brake pressure port

FIGURE 2-17

Checking the Service Brake Accumulators Pre-charge

1. With the engine off, discharge all of the pressurized oil stored in the accumulators by depressing the service brake pedal on the cab floor 4 to 6 times.
2. Remove the gas valve guard and cap on the accumulator (see Figure 2-18).
3. Before attaching the gas charging assembly (see Figure 2-18) onto the gas valve, fully turn the gas chuck "T" handle counter-clockwise until it stops.
4. Close the charging assembly bleed valve. Attach the swivel nut onto the gas valve and tighten (10-15 in-lb).
5. Fully turn the gas chuck "T" handle clockwise which will depress the core in the gas valve.
6. Check the pre-charge pressure. The gauge should read 1500 to 1550 psi (103 to 107 bar).

   If the pressure is 1500 to 1550 psi (103 to 107 bar), remove the charging valve assembly by fully turning the "T" handle counter-clockwise on the gas chuck, then open the bleed valve and proceed to step 7 (see Figure 2-18). If the pressure is low, perform the procedure *Pre-charging the Accumulators*, page 2-37.
7. Secure the gas valve, loosen the swivel nut and remove the charging assembly. Replace the gas valve cap and guard.



Brake Accumulator	
1	Gas valve guard
2	Gas valve
3	Accumulator
4	Gauge
5	Gas Chuck
6	Bleed valve

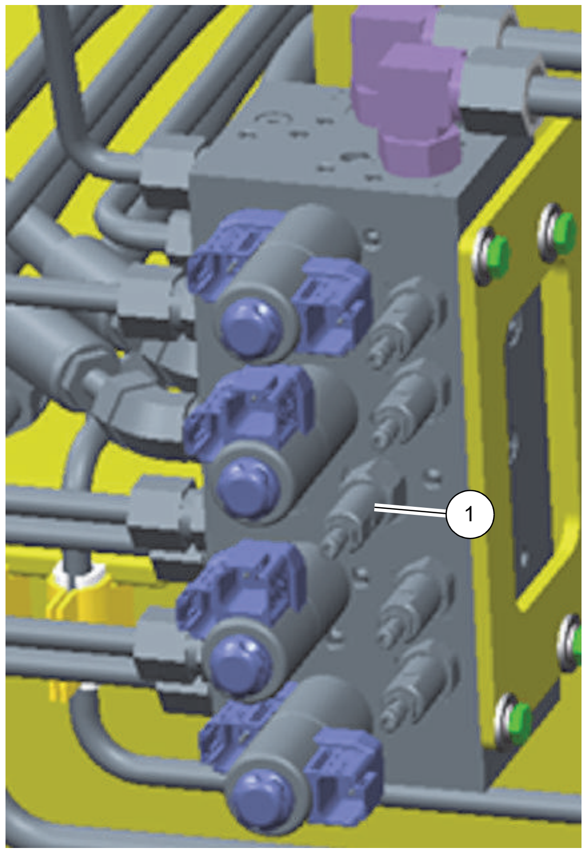
FIGURE 2-18

Pre-charging the Accumulators

1. With the engine off, discharge all of the pressurized oil stored in the accumulators by depressing the service brake pedal on the cab floor 10 - 12 times.
2. Remove the gas valve guard and cap on the accumulator (see Figure 2-18).
3. Ensure that the nitrogen supply bottle is shut off, then attach the charging valve assembly to it.
4. Before attaching the charging assembly to the accumulator gas valve, fully turn the gas chuck "T" handle counter-clockwise until it stops.
5. Close the charging assembly bleed valve. Without looping or twisting the hose, attach the swivel nut to the accumulator gas valve and tighten (10 to 15 in-lb).
6. Fully turn the gas chuck "T" handle clockwise which will depress the core in the gas valve.
7. Slowly open the nitrogen bottle valve and fill the accumulator. Close the valve when the pre-charge is 1500 to 1550 psi (103 to 107 bar).
8. If the pre-charge is higher than specified in step 7, close the nitrogen bottle and slowly open the bleed valve on the charging assembly (see Figure 2-18) until the pressure is to specification.
9. Remove the charging valve assembly by fully turning the "T" handle counter-clockwise on the gas chuck and then opening the bleed valve.
10. Secure the gas valve, loosen the swivel nut and remove the charging assembly. Replace the gas valve cap and guard.

Checking/Setting Cab Tilt, Counterweight Removal, and Counterweight Pinning Pressures

1. With the engine off, install pressure check diagnostic quick disconnect (9999101806) with gauge onto test nipple at GP7 port of the front steer/swing brake/pilot supply manifold (see Figure 2-10).
2. Start engine and throttle up to full rpm. Slowly actuate the cab tilt lower function until full controller stroke is reached and hold. Turn the counterweight circuit pressure reducing valve (see Figure 2-19) clockwise to increase or counter-clockwise to decrease until a gauge pressure of 2600 -0/+50 psi (179 -0/+4 bar) is achieved.
3. Stop engine. Remove diagnostic couplers.



10276-14

Counterweight/Cab Tilt Manifold	
1	Counterweight circuit pressure reducing valve

FIGURE 2-19

Checking/Setting the Outriggers and Rear Steer Pressures

1. With the engine off, install a pressure check diagnostic coupler (9999101806) with gauge onto the diagnostic nipple at the LS1 port of the carrier combination valve (see Figure 2-20).
2. **Outrigger Beam Extend** – Start engine and idle. Make sure that the outrigger beams can be fully extended safely. Extend any outrigger beam until full stroke of the cylinder is achieved and hold. Slowly accelerate the engine to full rpm.

   The reading at LS1 should be 1500 ± 50 psi (103 ± 4 bar). If it is not, use the service tool as follows to adjust.

   a. In the Tools->EEprom->View Parameters->Cabin->Solenoid PWM Control (carrier)->Pressure Sol – Outrigger Beams Extend Target params row, increase the valve to increase the pressure or decrease the valve to decrease the pressure (adjustment by 10 mA increments is suggested).

      Make sure to write column to “active settings”. Repeat this step until the pressure is achieved. If the value needs adjusted by more than 100 mA, there may be other issues in the circuit.

   b. Once the pressure is achieved, make sure to “Save active to customer” and “Save active to factory”.
3. **Outrigger Beam Retract** – Start engine and idle. Retract any outrigger beam until full stroke of the cylinder is achieved and hold. Slowly accelerate the engine to full RPM.

   The reading at LS1 should be 2000 ± 100 psi (137 ± 7 bar). If it is not, use the service tool as follows to adjust.

   a. In the Tools->EEprom->View Parameters->Cabin->Solenoid PWM Control (carrier)->Pressure Sol – Outrigger Beams Retract Target params row, increase the valve to increase the pressure or decrease the valve to decrease the pressure (adjustment by 10 mA increments is suggested).

      Make sure to write column to “active settings”. Repeat this step until the pressure is achieved. If the value needs adjusted by more than 100 mA, there may be other issues in the circuit.

   b. Once the pressure is achieved make sure to “Save active to customer” and “Save active to factory”.
4. **Outrigger Jack Extend Pressure** – Start engine and idle. Extend any outrigger jack until full stroke of the cylinder is achieved and hold. Slowly accelerate the engine to full RPM.

   The reading at LS1 should be 2750 ± 100 psi (190 ± 7 bar). If it is not, use the service tool as follows to adjust.

   a. In the Tools->EEprom->View Parameters->Cabin->Solenoid PWM Control (carrier)->Pressure Sol – Outrigger Jacks Extend Target params row, increase the valve to increase the pressure or decrease the valve to decrease the pressure (adjustment by 10 mA increments is suggested).

      Make sure to write column to “active settings”. Repeat this step until the pressure is achieved. If the value needs adjusted by more than 100 mA there may other issues in the circuit.

   b. Once the pressure is achieved make sure to “Save active to customer” and “Save active to factory”.
5. **Outrigger Jack Retract Pressure** – Start engine and idle. Retract any outrigger jack until full stroke of the cylinder is achieved and hold. Slowly accelerate the engine to full RPM. The reading at LS1 should be 2750 ± 100 psi (190 ± 7 bar). If it is not, use the service tool as follows to adjust.

   a. In the Tools->EEprom->View Parameters->Cabin->Solenoid PWM Control (carrier)->Pressure Sol – Outrigger Jacks Extend Target params row, increase the valve to increase the pressure or decrease the valve to decrease the pressure (adjustment by 10 mA increments is suggested).

      Make sure to write column to “active settings”. Repeat this step until the pressure is achieved. If the value needs adjusted by more than 100 mA there may other issues in the circuit.

   b. Once the pressure is achieved make sure to “Save active to customer” and “Save active to factory”.
6. **Rear Steer Pressure** – Start engine and idle. Slowly accelerate the engine to full RPM, operate rear steer switch until reaching an axle stop, and hold.

   The reading at LS1 should be 2500 ± 100 psi (172 ± 7 bar). If it is not, use the service tool as follows to adjust.

   a. In the Tools->EEprom->View Parameters->Cabin->Solenoid PWM Control (carrier)->Pressure Sol – Rear Steer Target params row, increase the valve to increase the pressure or decrease the valve to decrease the pressure (adjustment by 10 mA increments is suggested).

      Make sure to write column to “active settings”. Repeat this step until the pressure is achieved. If the value needs adjusted by more than 100 mA there may other issues in the circuit.

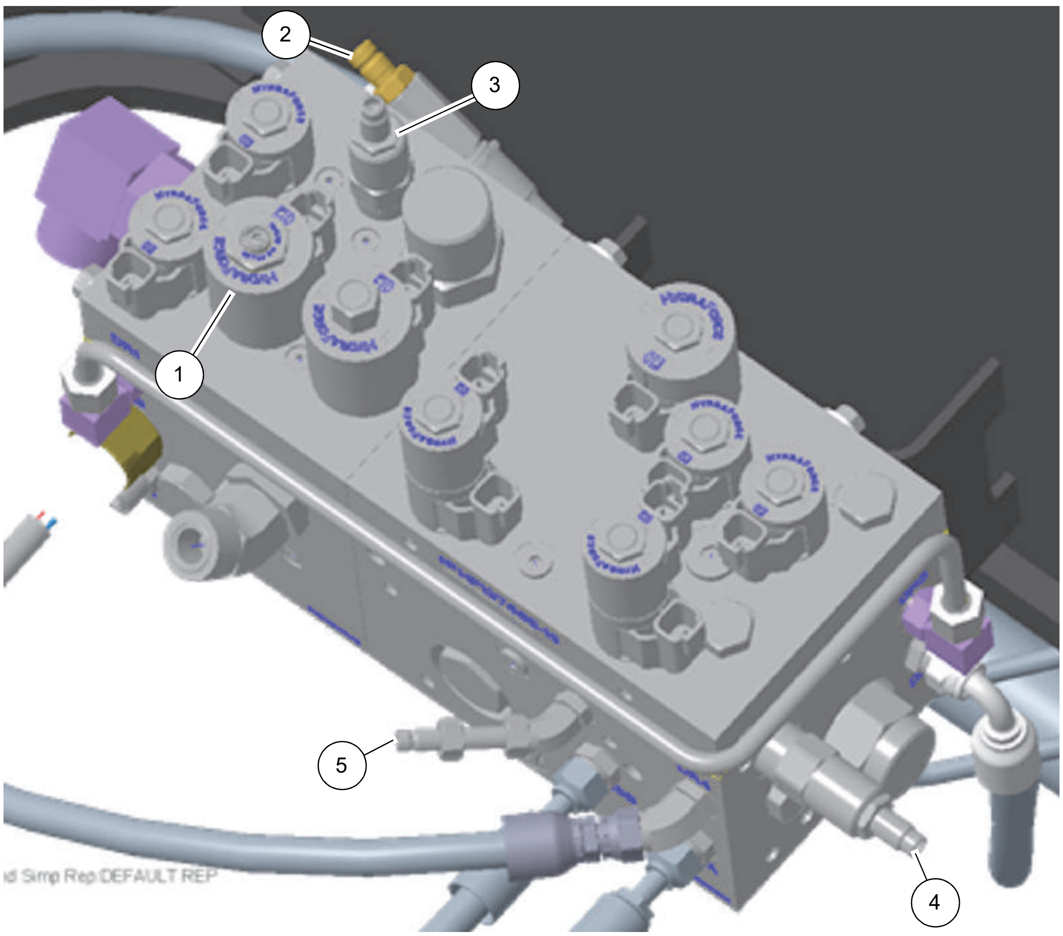
b. Once the pressure is achieved make sure to “Save active to customer” and “Save active to factory”.

7. Stop engine.

Checking/Setting the Axle Lockout Circuit Pressure

NOTE: Crane must be on outriggers when performing this procedure.

1. With the engine off, install a pressure check diagnostic coupler (9999101806) with gauge onto the diagnostic nipple at G3 port of the carrier combination valve (see Figure 2-20).
2. Start engine and let idle. Release the Parking Brake.
3. Turn the axle lockout pressure reducing valve integrated in the carrier combination valve (see Figure 2-20) clockwise to increase or counter-clockwise to decrease so that a gauge pressure of 100 ±25 psi (7 ±2 bar) is achieved.
4. Apply the Parking Brake. Stop engine. Remove diagnostic coupler.



10276-15

Carrier Combination Valve (bottom)	
1	Hydraulic/Transmission Fan Coil
2	LS1 Port
3	Parking Brake Pressure Reducing Valve
4	Axle Lockout Pressure Reducing Valve
5	G3 Port

FIGURE 2-20

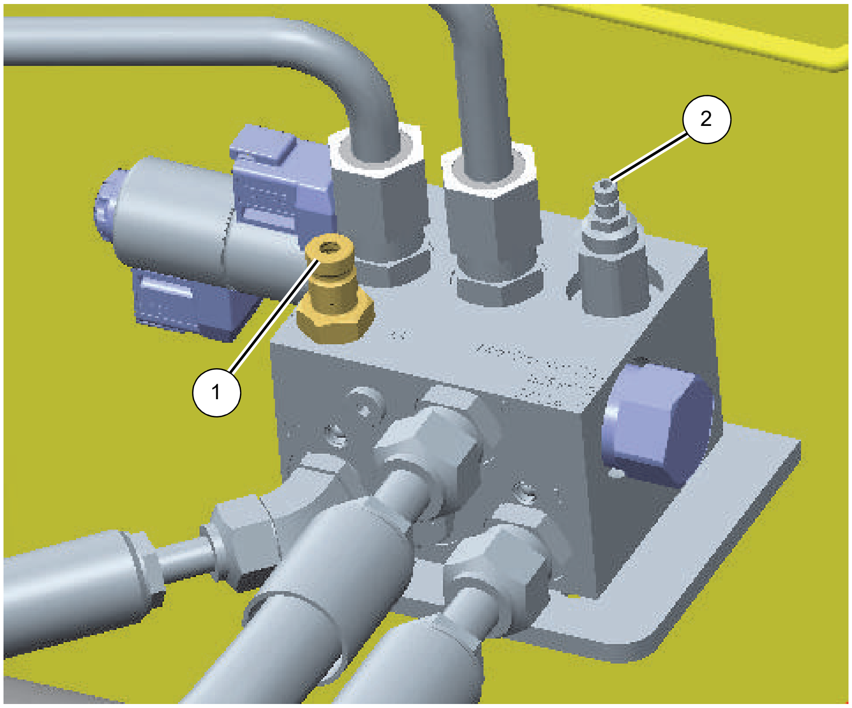
Checking/Setting the Parking Brake Pressure and Hydraulic/Transmission Fan Operation

1. With the engine off, install a pressure check diagnostic coupler (9999101806) with gauge onto the diagnostic nipple at the LS1 port of the main carrier valve (see Figure 2-20).
2. Start engine and idle. Make sure wheels are chocked or crane is on outriggers. Release (pressurize) the parking brake.

   Turn the pressure reducing valve (see Figure 2-20) clockwise to increase or counter-clockwise to decrease until a gauge pressure of 2000 ±50 psi (137 ±4 bar) is achieved. Apply the park brake.
3. Unplug transmission fan coil from harness (see Figure 2-20).
4. With coil unplugged, make sure that the hydraulic/transmission fan is running and moving air from the front of the crane towards the center. The speed of the fan is software controlled based on oil temperature. This is just a check to make sure it is running and plumbed correctly.
5. Stop engine. Remove diagnostic couplers. Plug fan coil back in to harness.

Checking/Setting the Luffing Jib Pressure

1. With the engine off, install a pressure check diagnostic coupler (9999101806) with gauge onto the diagnostic nipple at the G port of the luffing jib valve (see Figure 2-21).
2. If the luffing jib cylinder is installed, go to step 3. If the luffing jib cylinder is not installed, plug the hoses.
3. Start engine and let idle. If the luffing jib cylinder is installed, fully retract it first. Slowly actuate the luffing jib lower function until full controller stroke is reached and hold. Turn the luffing jib relief valve clockwise to increase or counter-clockwise to decrease so that the gauge pressure of 3500 ±100 psi (241 ±7 bar) is achieved (see Figure 2-21).
4. Stop engine. Remove diagnostic couplers.



8804-72

Luffing Jib Valve	
1	G port
2	Luffing jib relief valve

FIGURE 2-21

2

VALVES

General

This subsection provides descriptive information for several of the main hydraulic valves used on this crane. For a listing of the valves, the circuit they are used in, and their physical location, refer to Table 2-3. Refer to Figure 2-22 and Figure 2-23 for valve 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.

Table 2-3 Valve Usage Table

Item	Circuit	Location
Superstructure		
Main Directional Control Manifold Valves	Hoist/Lift /Telescope	Right side superstructure
Swing Manifold Valve	Swing	Right side superstructure
Compact Manifold Valve	Counterweight Removal/Cab Tilt	Right side superstructure
Accessory Manifold Valve	Front Steer/Swing Brake/Pilot Supply/Fill Tube	Right side superstructure
Dual Accumulator Charge Valve	Service Brakes	Inside superstructure side plates
Holding Valves	Lift Telescope	Lift cylinder (bolt on) Telescope cylinder port blocks
Hydraulic Brake Accumulators	Service Brakes	Inside the superstructure side plates
Carrier		
Carrier Combination Manifold Valve	Load Sense Dump/Rear Steer/Axle Lockout/Outriggers/Oil Cooler Fan/Parking Brake	Inside turret on carrier
Outrigger Control Manifolds	Outrigger	Front and rear outrigger boxes
Differential Lock/Range Shift Manifold Valve	Optional Cross-Axle Differential Lock/Hi-Low Range Shift/Axle Disconnect	Center of carrier frame near the turntable bearing

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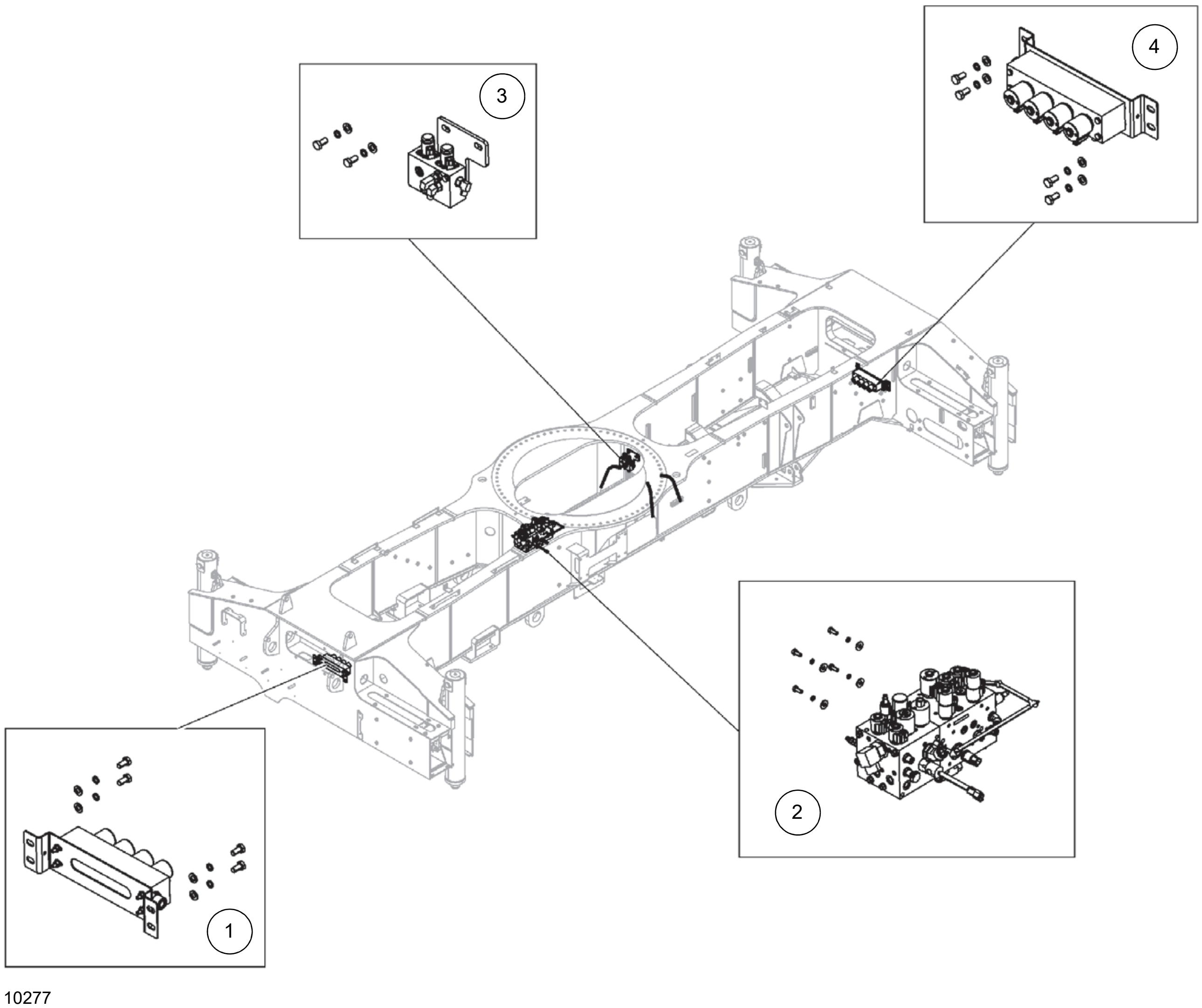
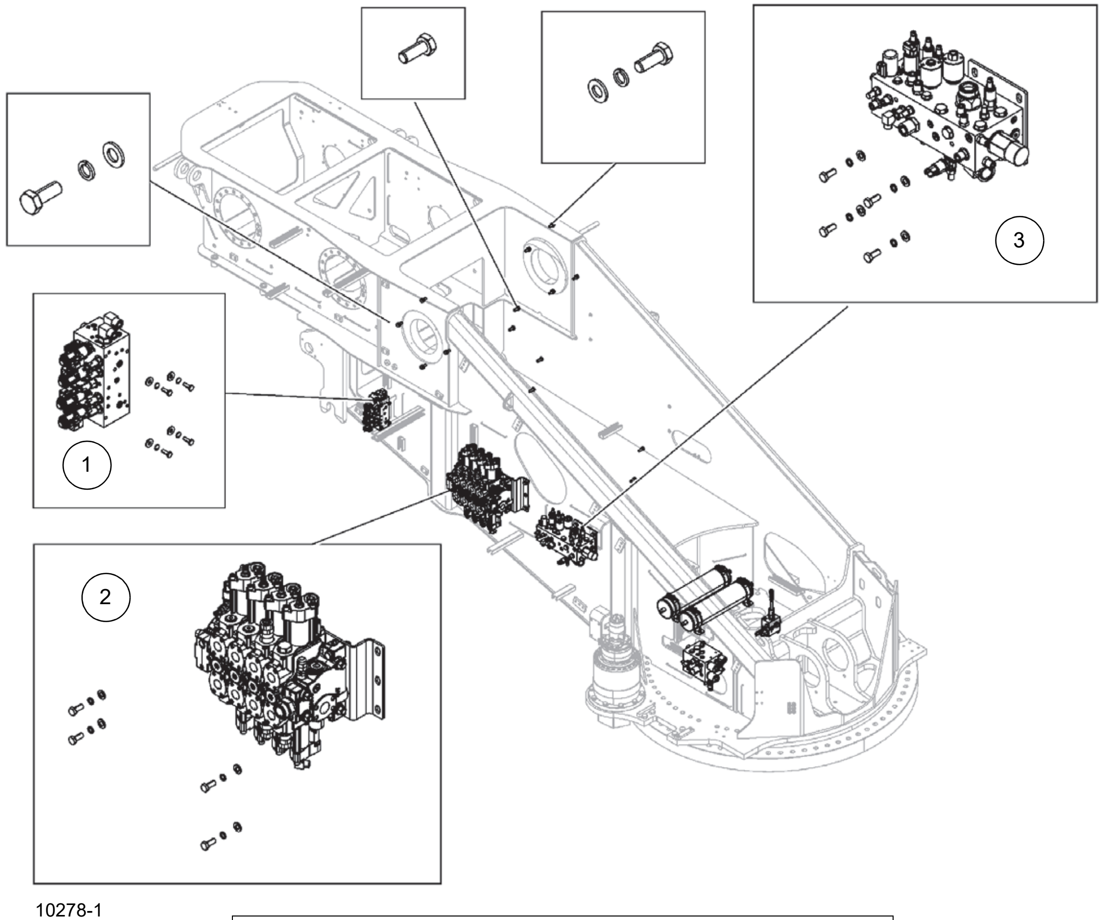


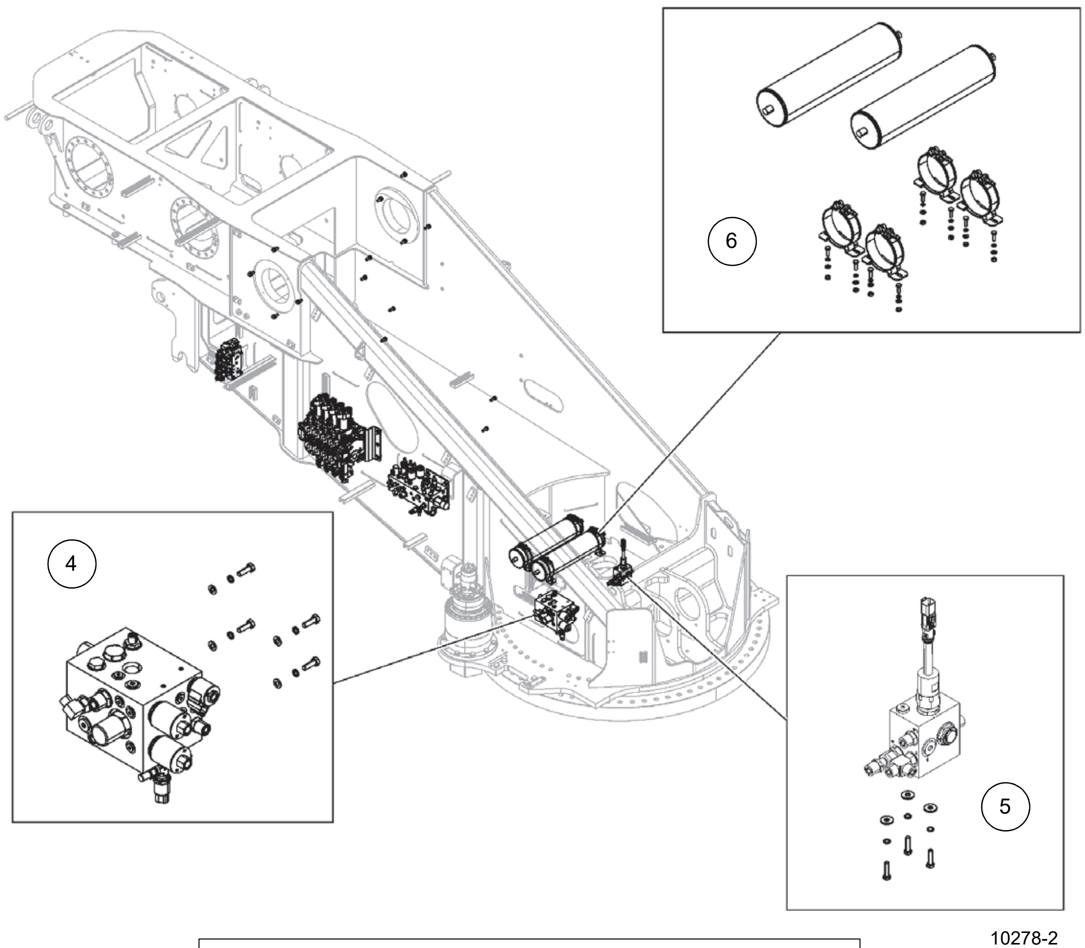
Valve Installation - Carrier	
1	Outrigger Control Manifold Valve - Front
2	Combination Manifold Valve
3	Range Shift/Park Brake Manifold Valve
4	Outrigger Control Manifold Valve - Rear

FIGURE 2-22



Valve Installation - Superstructure	
1	Compact Manifold Valve
2	Main Directional Control Manifold Valve
3	Accessory Manifold Valve

FIGURE 2-23



Valve Installation - Superstructure	
4	Swing Manifold Valve
5	Dual Accumulator Charge Manifold Valve
6	Brake Accumulators

FIGURE 2-23 continued

MAIN DIRECTIONAL CONTROL MANIFOLD VALVE

Description

The lift, telescope, and hoist directional valves (Figure 2-24 through Figure 2-26) located on the superstructure side plate (Figure 2-23) are three-position normally closed proportional valves. The lift, telescope, and hoist directional valves are each controlled by two two-position solenoid controlled proportional valves, which vary pilot supply circuit pressure to each directional control valve based on operator inputs through the electric joysticks in the operator's cab.

The two-position solenoid controlled proportional valves controlling the lift down, telescope out, and hoist up functions act as RCL lockout valves and are de-energized, regardless of joystick position, when the rated capacity limiter (RCL) detects an overload condition.

A load sense relief valve in the main directional control manifold valve limits the high pressure setting of the No. 1 and No. 2 pumps to 276 bar (4000 psi).

Maintenance

Main Directional Control Manifold Valve Removal

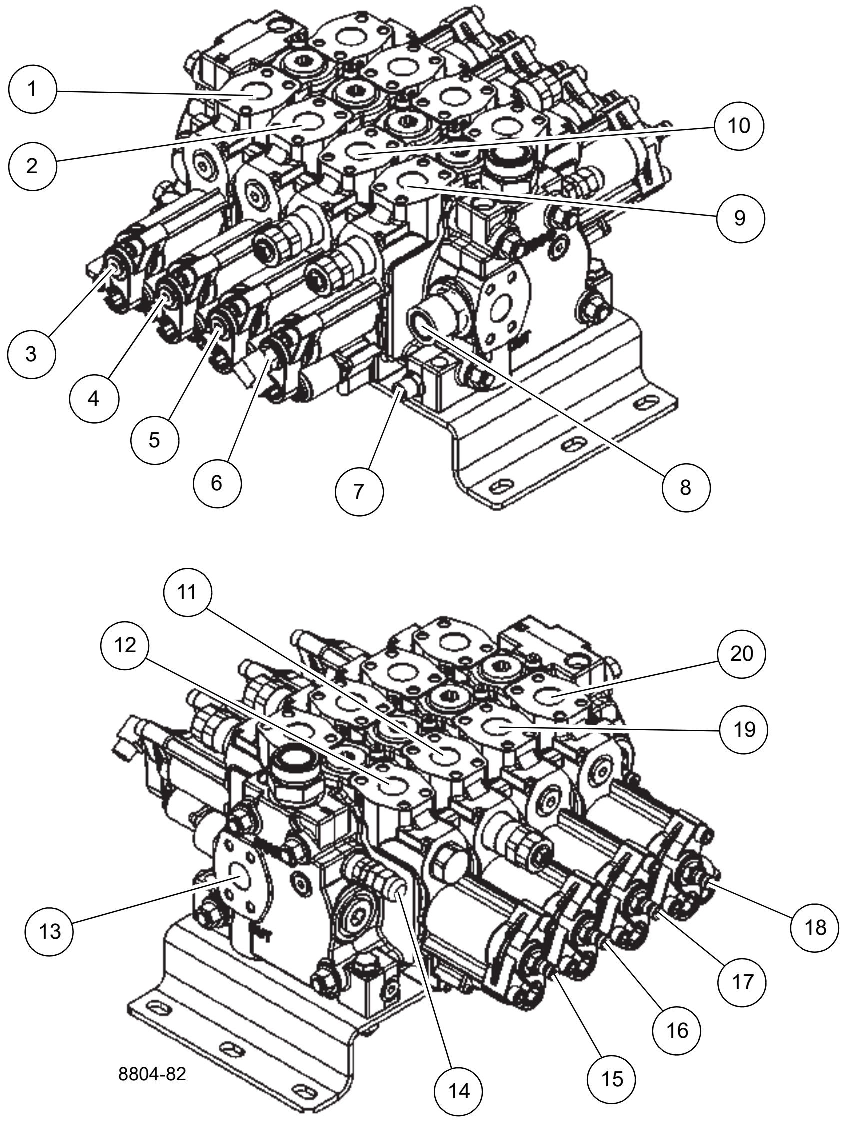
1. Tag and disconnect the hydraulic lines from the valve. Cap or plug the lines and ports.
2. Tag and disconnect electrical connectors from the valve.
3. Remove the capscrews, flatwashers, and lockwashers securing the valve. Remove the valve.

Main Directional Control Manifold Valve Installation

1. Install the valve on the turntable upright and secure with the capscrews, flatwashers, and lockwashers. Torque capscrews. Refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
2. Connect the electrical connectors to the valve as tagged during removal.
3. Connect the hydraulic lines to the valves as tagged during removal.

Functional Check

1. Start the engine and run it at normal speed.
2. Operate the joysticks of the valve bank(s). Check for smooth operation of cylinders and motors.
3. Check the valve bank(s) and lines for leakage. Make repairs as needed.

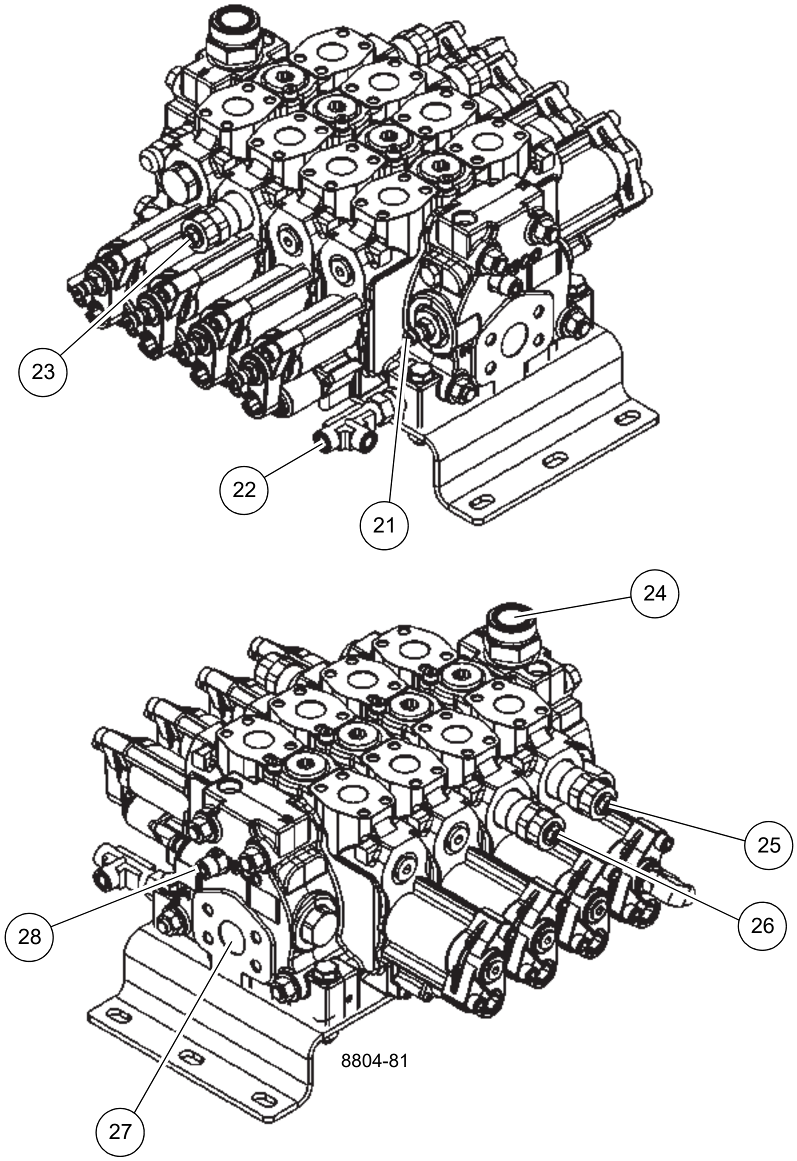


Main Directional Control Manifold Valve

1	Work Port - Auxiliary Hoist Lower
2	Work Port - Main Hoist Lower
3	Pilot Pressure Port - Auxiliary Hoist Lower
4	Pilot Pressure Port - Main Hoist Lower
5	Pilot Pressure Port - Tele Retract
6	Pilot Pressure Port - Lift Down
7	Pilot Drain Port
8	Outlet Port
9	Work Port - Lift Down
10	Work Port - Tele Retract

11	Work Port - Tele Extend
12	Work Port - Lift Up
13	Outlet Port
14	LS Relief
15	Pilot Pressure Port - Lift Up
16	Pilot Pressure Port - Tele Extend
17	Pilot Pressure Port - Main Hoist Raise
18	Pilot Pressure Port - Auxiliary Hoist Raise
19	Work Port - Main Hoist Raise
20	Work Port - Auxiliary Hoist Raise

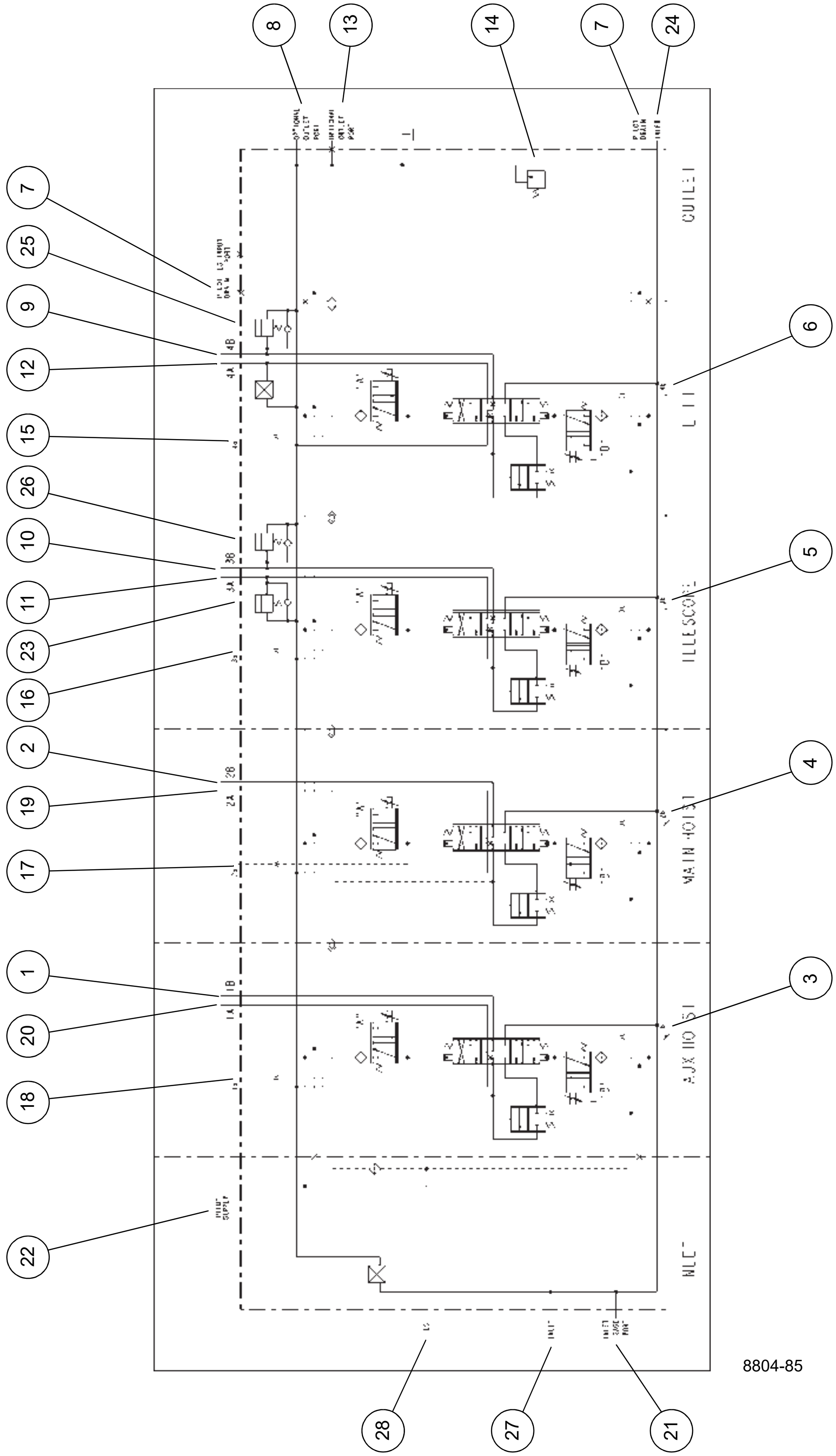
FIGURE 2-24



Main Directional Control Manifold Valve Cont.

21	Inlet Gauge Port
22	Pilot Supply Port
23	Pressure Relief Valve - Telescope Extend
24	Inlet Port
25	4300 psi Pressure Relief Valve - Lift Down
26	3250 psi Pressure Relief Valve - Telescope Retract
27	Inlet Port
28	LS Input Port

FIGURE 2-25



Main Directional Control Manifold Valve Cont.

FIGURE 2-26

SWING MANIFOLD VALVE

Description

The swing manifold valve (Figure 2-27 and Figure 2-28) is located on the superstructure side plate near the turntable bearing (Figure 2-23). A dual pilot-operated, proportional control valve controls the oil flow from the No. 3 gear pump to maintain pressure in the left and right swing circuits. Excess oil from the valve flows back to tank. The left and right swing functions are controlled by two pilot-operated, solenoid-controlled proportional valves. An additional solenoid-controlled valve acts as a “swing enable” valve, which is only energized when the left or right swing function is actuated. When energized, this valve sends oil through a pilot line to shift the dual pilot-operated, proportional control valve to send full flow from the No. 3 gear pump to the swing circuit.

Maintenance

Swing Manifold Valve Removal

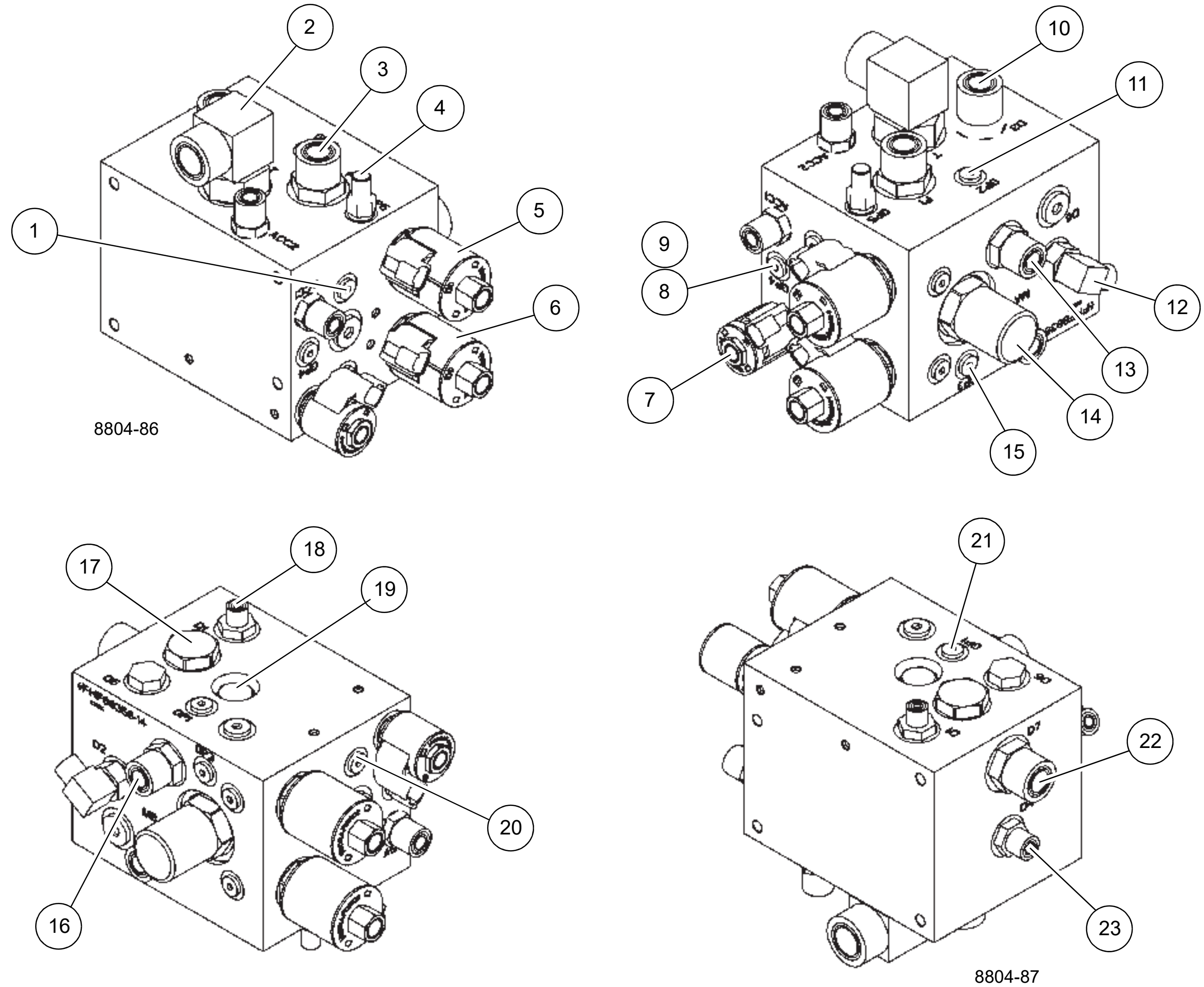
1. Tag and disconnect the hydraulic lines from the valves. Cap or plug the lines and ports.
2. Tag and disconnect electrical connectors from the valve.
3. Remove the capscrews, flatwashers, and lockwashers securing the valve. Remove the valve.

Swing Manifold Valve Installation

1. Install the valve on the turntable upright and secure with the capscrews, flatwashers, and lockwashers. Torque capscrews. Refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
2. Connect the electrical connectors to the valve as tagged during removal.
3. Connect the hydraulic lines to the valves as tagged during removal.
4. Remove the capscrews and nuts securing the valve. Remove the valve.

Functional Check

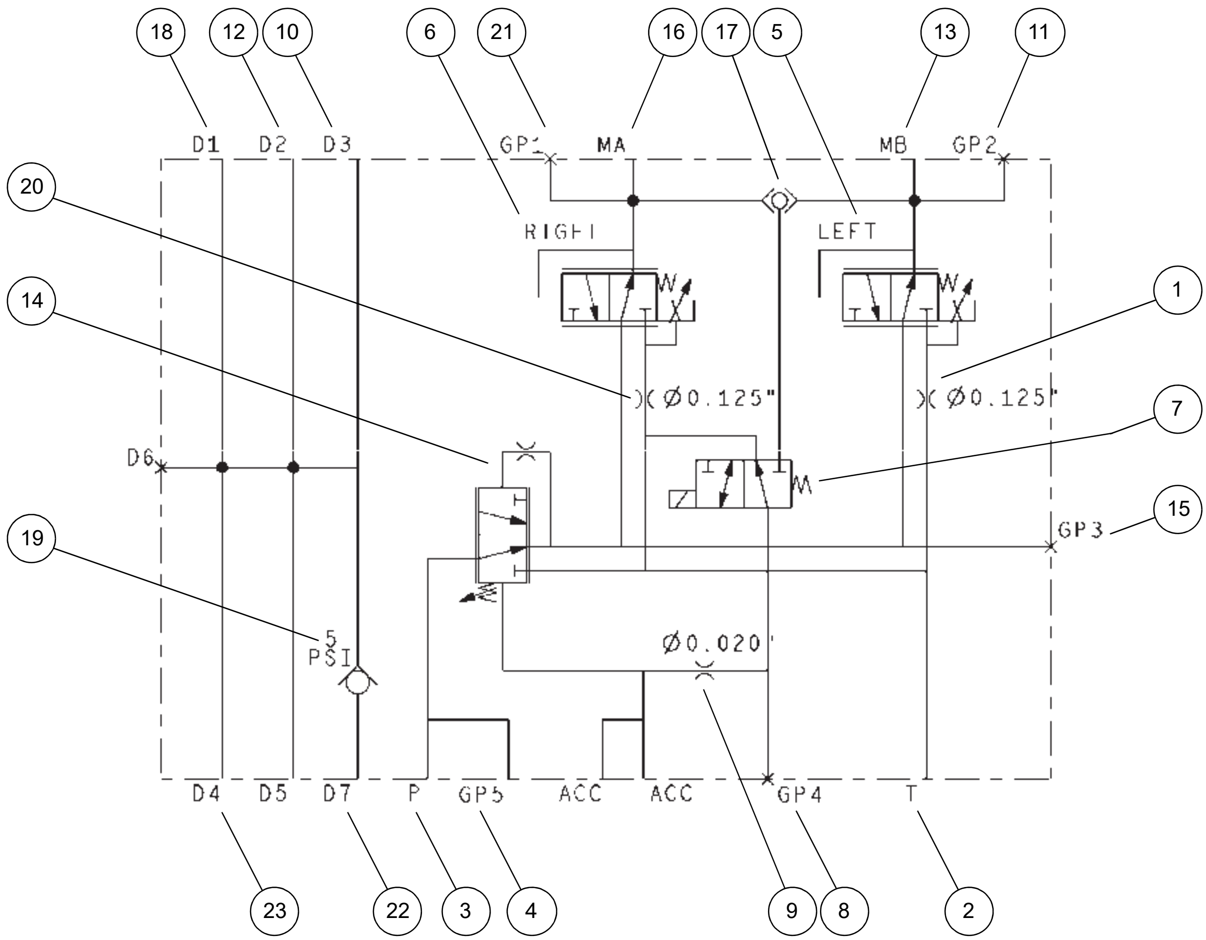
1. Start the engine and run it at normal speed.
2. Operate the joystick for sing right and left. Check for proper operation.
3. Check the valve bank(s) and lines for leakage. Make repairs as needed.



Swing Directional Control Manifold Valve

1	Orifice - Left Swing
2	Tank Port (T)
3	Inlet Port (P)
4	Gauge Port (GP5)
5	Pressure Reducing Valve - Left Swing
6	Pressure Reducing Valve - Right Swing
7	Directional Control Valve
8	Gauge Port (GP4)
9	Orifice - 0.020 in
10	Drain Port (D3)
11	Gauge Port (GP2)
12	Drain Port (D2)
13	Work Port (MB) - Left Swing
14	Pressure Compensating Valve
15	Gauge Port (GP3)
16	Work Port (MA) - Right Swing
17	Shuttle Valve
18	Drain Port (D1)
19	Check Valve
20	Orifice - Right Swing
21	Gauge Port (GP1)
22	Drain Port (D7)
23	Drain Port (D4)

FIGURE 2-27



Swing Directional Control Manifold Valve

FIGURE 2-28

COMPACT MANIFOLD VALVE

Description

The compact manifold valve (Figure 2-29 and Figure 2-30) is located on the superstructure side plate (Figure 2-23). The manifold valve includes directional valves for actuating the left and right counterweight removal cylinders and the counterweight pin cylinder. The manifold valve includes a directional control valve for the cab tilt function. The pressure inlet of the manifold includes a pressure reducing valve set at 179.26 bar (2600 psi) which protects all four functions.

Maintenance

Compact Manifold Valve Removal

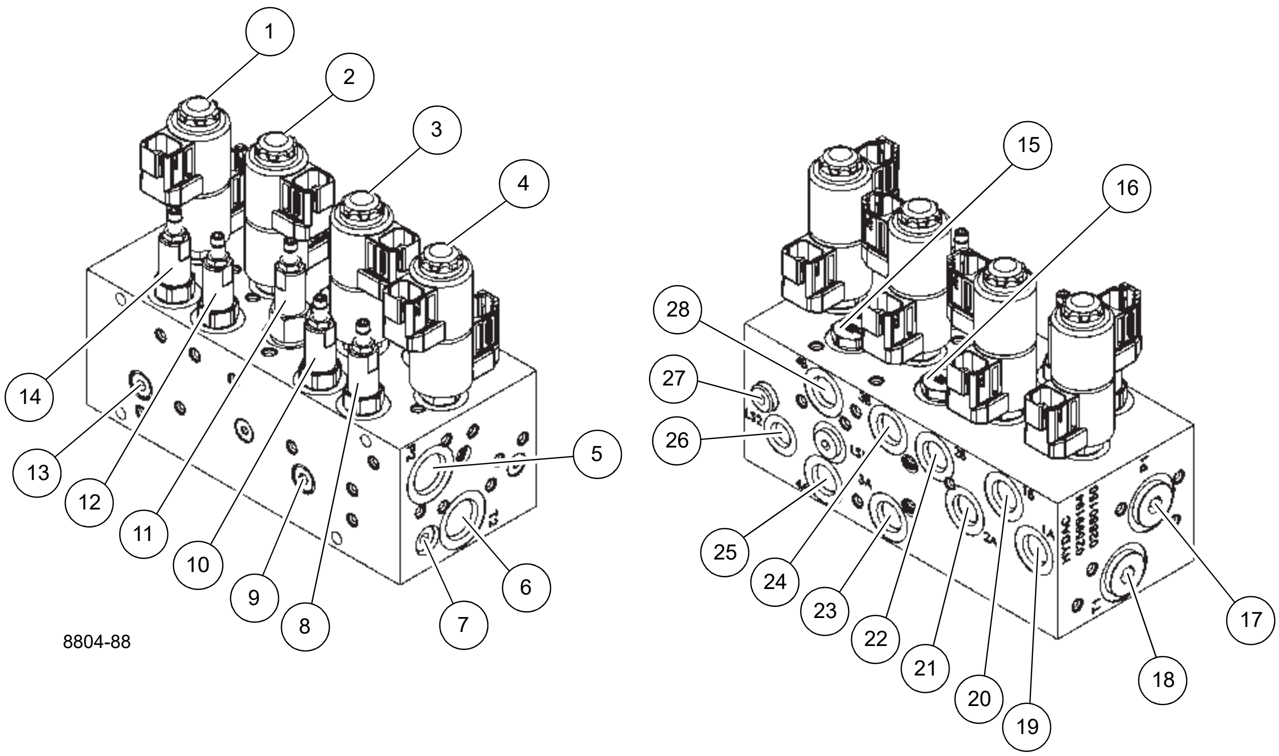
1. Tag and disconnect the hydraulic lines from the valve. Cap or plug the lines and ports.
2. Tag and disconnect electrical connectors from the valve.

Compact Manifold Valve Installation

1. Install the valve to the turntable and secure with the capscrews and nuts. Torque capscrews. Refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
2. Connect the electrical connectors to the valve as tagged during removal.
3. Connect the hydraulic lines to the valves as tagged during removal.

Functional Check

1. Start the engine and run it at normal speed.
2. Operate all functions controlled by the manifold valve. Check for smooth operation of cylinders and motors.
3. Check the manifold valve and lines for leakage. Make repairs as needed.

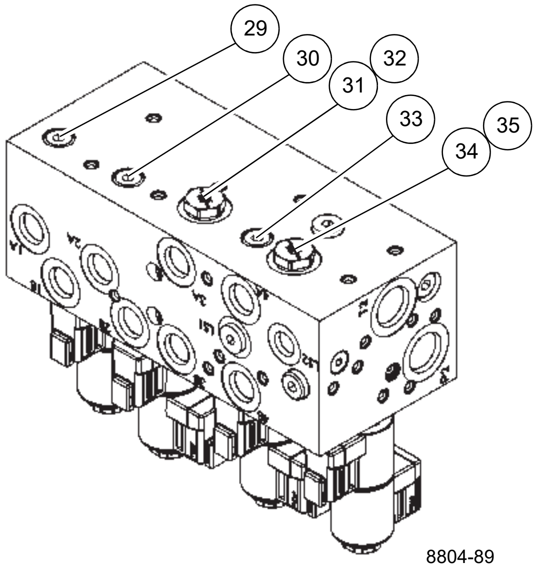


Compact Manifold Valve

1	Directional Control Valve - Right Ctwt Removal Cylinder
2	Directional Control Valve - Left Ctwt Removal Cylinder
3	Directional Control Valve - Ctwt Pin Cylinder
4	Directional Control Valve - Cab Tilt Cylinder
5	Inlet Port (P2)
6	Tank Port (T2)
7	Shuttle Valve
8	Flow Control Valve - Cab Tilt Cylinder
9	Shuttle Valve
10	Flow Control Valve - Ctwt Pin Cylinder
11	Pressure Reducing Valve
12	Flow Control Valve - Left Ctwt Removal Cyl
13	Shuttle Valve

14	Flow Control Valve - Right Ctwt Removal Cyl
15	Check Valve - Cab Tilt Down
16	Check Valve - Ctwt Pin Cylinder Retract
17	Inlet Port (P)
18	Tank Port (T)
19	Work Port (1A) - Right Ctwt Removal Cyl Up
20	Work Port (1B) - Right Ctwt Removal Cyl Down
21	Work Port (2A) - Left Ctwt Removal Cyl Up
22	Work Port (2B) - Left Ctwt Removal Cyl Down
23	Work Port (3A) - Ctwt Pin Cylinder Extend
24	Work Port (3B) - Ctwt Pin Cylinder Retract
25	Work Port (4A) - Cab Tilt Cylinder Up
26	Load Sense Port (LS2)
27	Shuttle Valve
28	Work Port (4B) - Cab Tilt Cylinder Down

FIGURE 2-29



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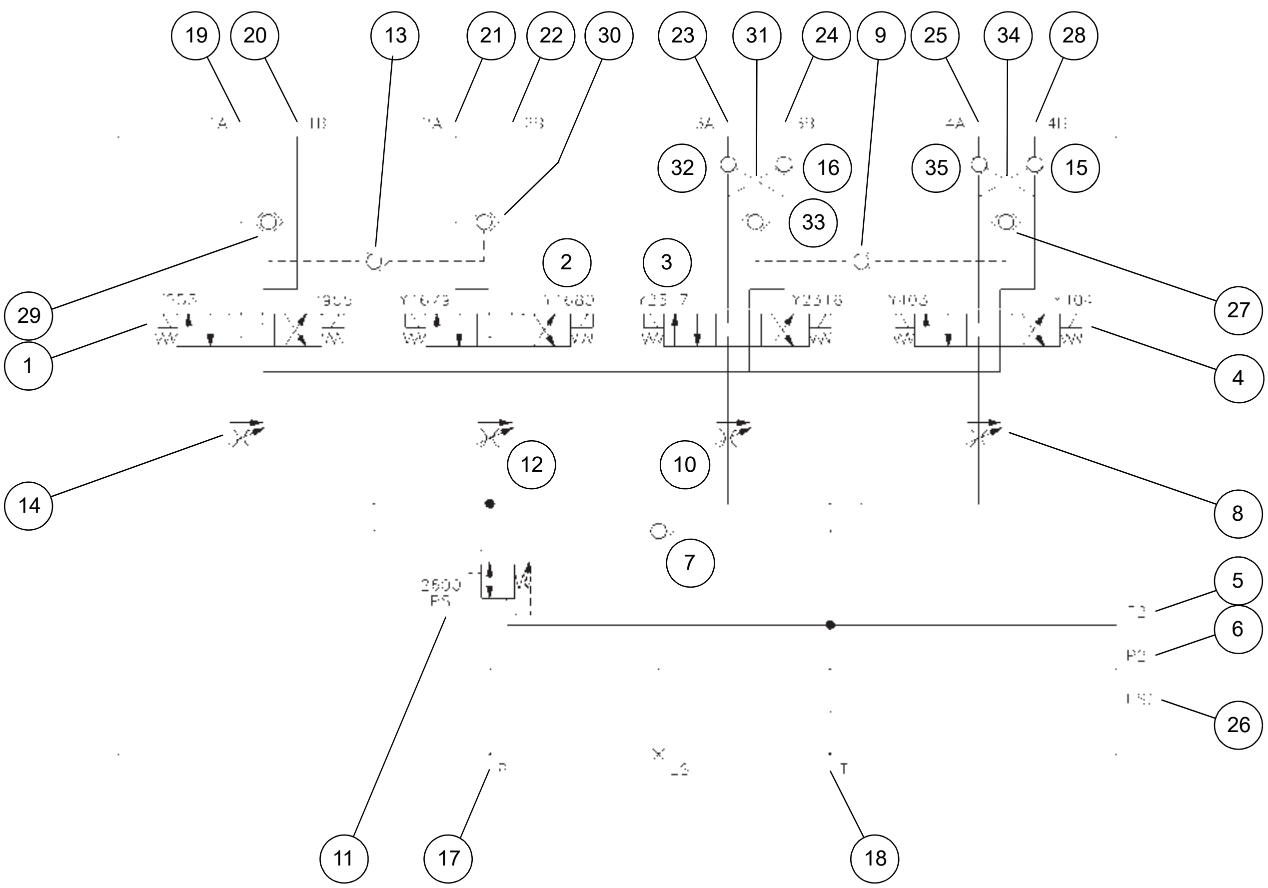
29	Shuttle Valve
30	Shuttle Valve
31	Dual Pilot Piston - Ctwt Pin Cylinder
32	Check Valve - Ctwt Pin Cylinder Extend
33	Shuttle Valve
34	Dual Pilot Piston - Cab Tilt Cylinder
35	Check Valve - Cab Tilt Up



Compact Manifold Valve

FIGURE 2-30

ACCESSORY MANIFOLD VALVE

Description

The accessory manifold valve (Figure 2-31 through Figure 2-33) is located on the superstructure side plate (Figure 2-23) and includes valves for controlling the front steer, swing brake, pilot supply, and telescope fill tube.

Front Steer

Supply oil for this valve comes from pump No. 2.

When the steer function is not activated, pressure held in the steer circuit shifts the priority flow valve to allow all the flow to pass through and onto the main directional control valve were it adds to the flow from pump No. 1. Upon actuating the steer function, the pressure through the load sense circuit shifts the priority flow valve to allow the proper amount of flow to the steering unit while the load sense relief keeps the steering pressure limited to 2800 psi.

A pressure reducing valve reduces pump pressure to 3250 psi for all other functions receiving supply oil from this valve assembly.

Swing Brake

The (static) swing brake is spring-applied, hydraulic released while the service (dynamic) brake is pressure applied. A two position solenoid valve controls the pressure to release the swing brake. A pressure reducing valve maintains a pressure of 260 to 300 psi to the inlet of both the brake release and brake apply valves. The circuit is designed such that when the engine is running and the swing enable switch is activated pressure is supplied to the swing brake release to release the brake while at the same time pressure is ramped up on the swing service brake proportionally to the max pressure. When the swing control joystick is actuated to swing left or right, the proportional valve is de-energized there by releasing the pressure from the swing service brake and allowing motion. When the swing joystick is returned to the center (neutral) position, the control system gradually re-energizes the proportional valve (apply valve), thereby slowly increasing oil pressure to apply the brake. Actuating the swing brake foot pedal results in the same action.

Pilot Supply

A pressure reducing valve set to 600 psi and a control valve supply the pilot supply oil to control the following valves and functions:

- Main directional control valve on the superstructure, which includes valves for controlling the auxiliary hoist, main hoist, boom telescope, and boom lift functions.
- Main and auxiliary hoist brakes (for brake release in the raise direction).
- Telescope stage selector circuit.

Fill Tube

The fill tube pressure regulating valve is a two-position, solenoid controlled, proportional valve that works with the telescope and tele stage select valve manifold to prevent the movement of the first stage (boom tele sections 2, 3, and 4) when the second stage (tele section 1) extends or retracts by maintaining oil pressure in the fill tube of the first stage and, conversely, the valve prevents the second stage from moving as the first stage extends or retracts by maintaining oil pressure in the fill tube of the second stage.

Maintenance

Removal

1. Tag and disconnect the electrical connectors to all valves.
2. Tag and disconnect the hydraulic lines from the manifold. Cap or plug the lines and ports.
3. Remove the capscrews, lockwashers and flatwashers securing the manifold. Remove the manifold and two spacer bushings.

Installation

1. Position the manifold and spacer bushings on turntable and secure with the capscrews, flatwashers and lockwashers. Torque capscrews - refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
2. Connect the hydraulic lines to the manifold as tagged during removal.
3. Connect the electrical connectors to the manifold as tagged during removal.

Function Check - Front Steer

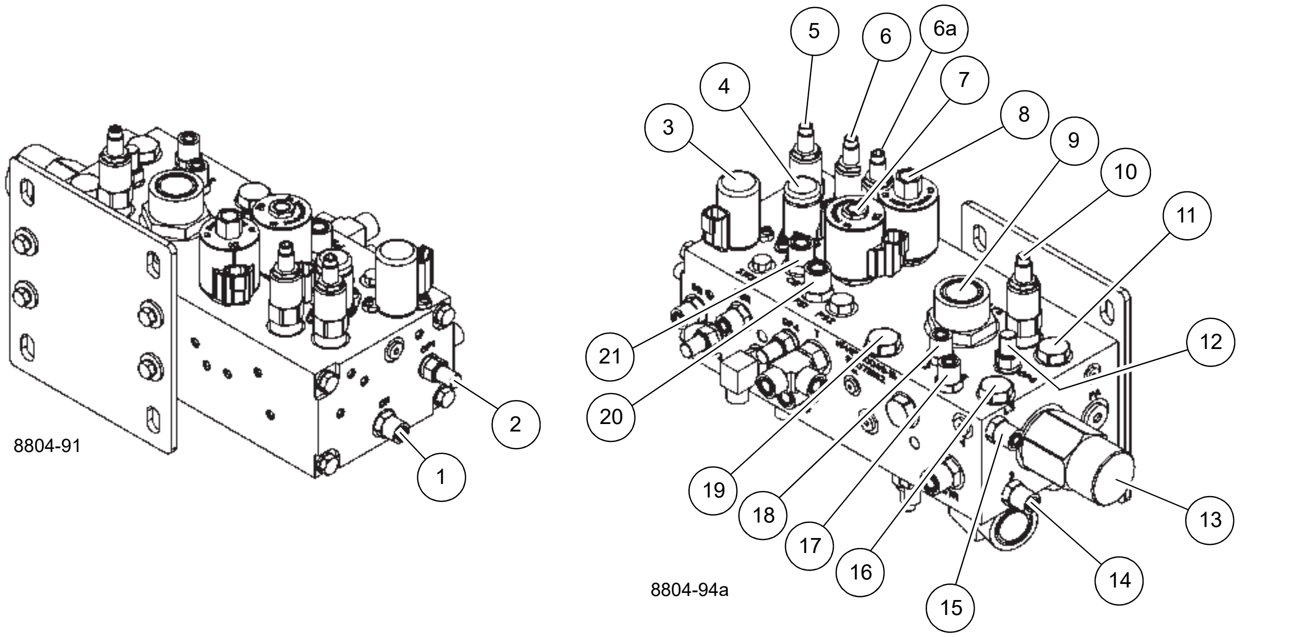
1. Start the engine.
2. Drive the crane at a slow speed and verify the front steering function works properly.

Function Check - Swing Brake Release Valve

1. Start the engine.
2. Enable all crane functions using the crane function switch to on.
3. Swing the turntable to verify the swing brake releases. Depress the swing brake pedal to stop the turntable.
4. Position the swing enable switch to off and verify the swing brake applied icon appears on the CCS display.
5. Activate the swing function and ensure the turntable does not rotate.
6. Check for leaks. Make repairs as needed.

Function Check - Pilot Supply and Telescope Fill Tube Valve

1. Start the engine.
2. Try to telescope the boom in and out, lower and raise the boom, and lower and raise the hoist rope. Verify none of these functions work.
3. Enable all crane functions using the crane function switch.
4. Verify the following crane functions operate properly:
   a. Telescope in and out
   b. Boom raise and lower
   c. Hoist up and down
   d. Turntable swing left and right
5. Check for leaks. Make repairs as needed.

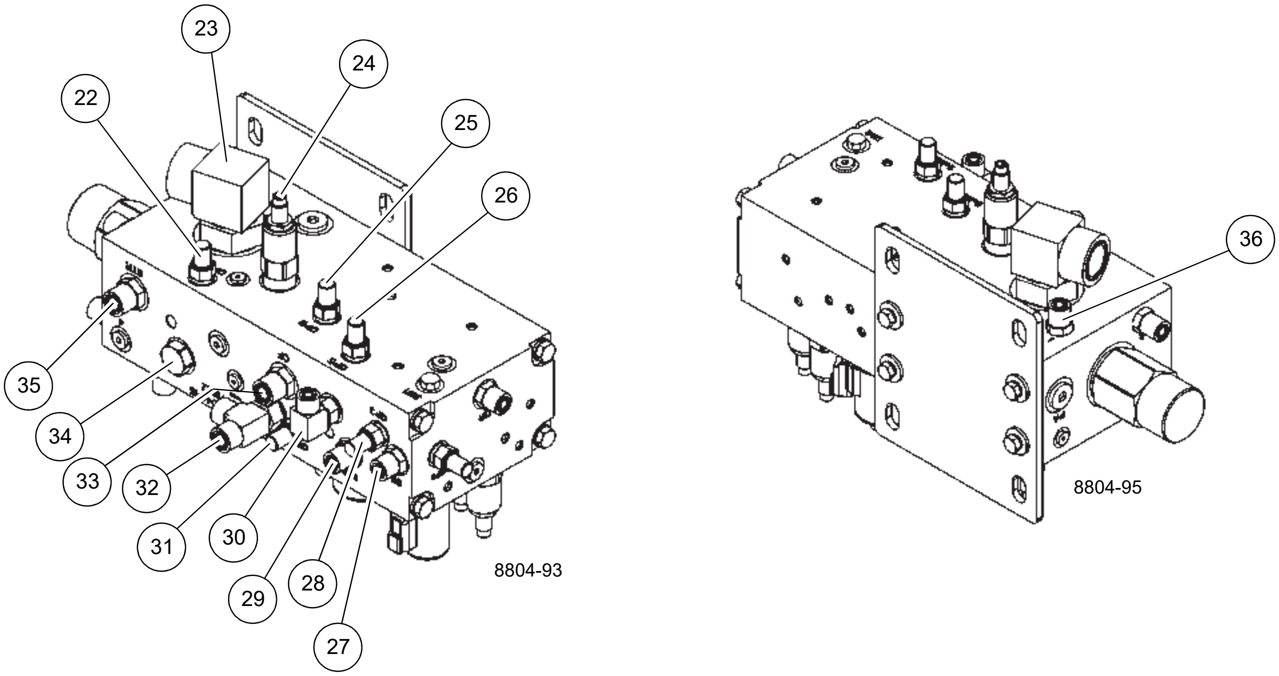


Accessory Manifold Valve

1	Drain Port Outlet (DR)
2	Gauge Port (GP1)
3	Pressure Regulating Valve - Swing Brake
4	Control Valve - Swing Brake Release
5	Pressure Reducing Valve - 550-600 psi
6	Pressure Reducing Valve - 600 psi
6a	Pressure Reducing Valve - 1800 psi
7	Control Valve - Pilot Supply
8	Pressure Regulating Valve - Fill Tube Pressure Regulating
9	Inlet Port (SYS)
10	Pressure Reducing Valve - 3250 psi

11	Check Valve
12	Gauge Port (GP6)
13	Priority Valve - Steering
14	Load Sense Port (3)
15	Load Sense Port (LS)
16	Check Valve
17	Load Sense (5)
18	Drain Port Inlet (2)
19	Check Valve
20	Pilot Supply Port (PS1)
21	Outlet Port (CB)

FIGURE 2-31

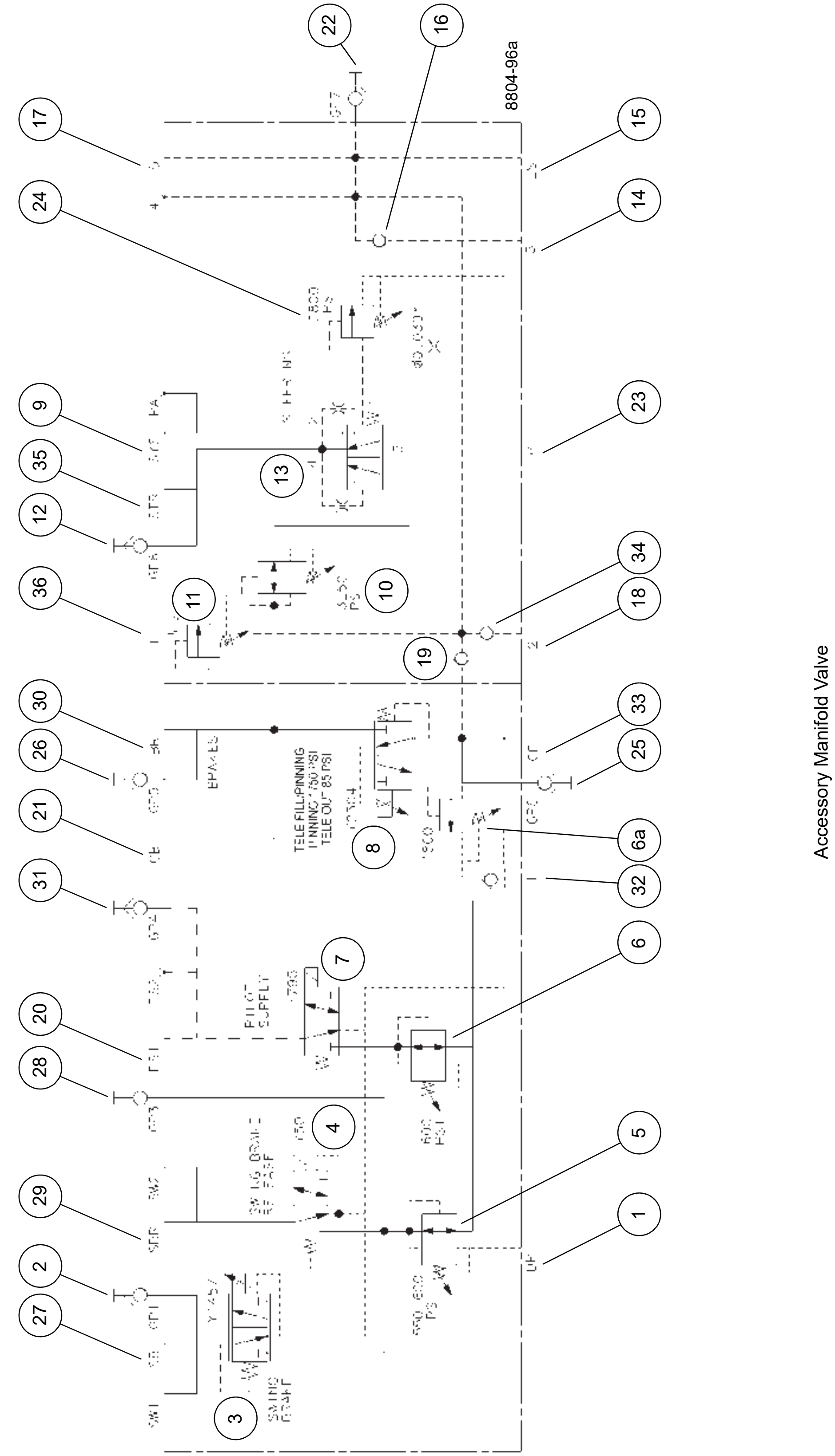


Accessory Manifold Valve

22	Gauge Port (GP7)
23	Inlet Port (P)
24	Pressure Relief Valve - 2800 psi
25	Gauge Port (GP8)
26	Gauge Port (GP5)
27	Work Port - Swing Brake Apply (SB)
28	Gauge Port (GP3)
29	Work Port - Swing Brake Release (SBR)

30	Work Port - Brakes (BR)
31	Gauge Port (GP4)
32	Tank Port (T)
33	Work Port - Tele Stage Selector (CF)
34	Check Valve
35	Work Port - Steering (STR)
36	Load Sense Port (1)

FIGURE 2-32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Accessory Manifold Valve

FIGURE 2-33

LIFT CYLINDER AND TELESCOPE CYLINDER CONTROL VALVES

Description

A externally-piloted cartridge style holding valve is installed on the lift cylinder and a cartridge style holding valve is installed into each telescope cylinder port block.

Maintenance

Removal

WARNING

Falling Boom

Never remove a holding valve from the lift or telescope cylinder circuits without first fully retracting the cylinders. Death or serious injury can occur.

WARNING

High Hydraulic Pressure

Never remove a holding valve from the lift or telescope cylinder circuits without first fully retracting the cylinders to remove the high hydraulic pressure in the circuits. Fluid in these hydraulic systems can be under enough pressure that it will penetrate the skin, causing serious injury or death.

1. Start the engine and fully retract the telescope the lift cylinders using the joysticks. Use the RCL override function to fully retract the lit cylinder.
2. Shut off engine.
3. Unscrew holding valve from its port block or manifold.

Installation

1. Check inside of port block or manifold for sharp edges or burrs. Remove as necessary with emery cloth.
2. Install new O-rings on holding valve.
3. Lubricate holding valve O-rings with clean hydraulic oil.

CAUTION

Do not damage O-rings during holding valve installation. If holding valve turns freely then hard to turn, then easy to turn, remove holding valve and check O-rings. They have probably been damaged by a sharp edge of a port.

NOTE: Holding valve should turn by hand until O-rings compress.

4. Carefully install holding valve into port block or manifold until fully seated.
5. Test holding valve and port block or manifold by operating lift cylinder and/or telescope cylinder, as applicable. Verify lift cylinder and/or telescope cylinder works without problems; verify there is no leaking. Make repairs as needed.

CARRIER COMBINATION MANIFOLD VALVE

Description

The carrier combination manifold valve (Figure 2-34 through Figure 2-35) is located on the inside carrier frame rail at the turntable bearing (Figure 2-22). Functions controlled by this manifold valve include the following:

- LS Dump
- Rear Steer
- Axle Lockout
- Outriggers (Extend/Retract)
- Oil Cooler Fan
- Parking Brake

Supply oil to the Oil Cooler Fan and Parking Brake functions on the carrier combination manifold valve is limited by a pressure reducing valve set to 2000 psi. Supply oil to the other functions on the carrier combination manifold valve is limited by a pilot-operated proportional pressure reducing valve which varies the pressure as follows:

- Axle Lockout - 400 psi
- Outrigger Beam Extend - 1500 psi
- Rear Steer - 2500 psi
- All other functions - 2750 psi

Load Sense Dump

The LS dump function consists of a shuttle valve and a control valve which combines the load sense oil received from the carrier and superstructure circuits and diverts it to tank during engine cranking. This action aids in starting the engine by preventing the pumps from building pressure during the engine cranking function, thereby lessening the load on the engine starter.

Rear Steer

The rear steer function is controlled by a control valve with dual cross-port, pilot-operated check valves in the work lines. The dual cross-port, pilot-operated check valves maintain pressure on the rod and piston of both rear steer cylinders when stationary and when turning.

Axle Lockout

The axle oscillation lockout functions consists of a 100 psi pressure regulating valve and two control valves. The circuit prevents the axle lockout cylinders from oscillating unless the turntable is centered forward.

For CE units, one of the two-way, two-position solenoid valves is replaced with a three-way, two-position solenoid valve. Additionally, four two-way, solenoid-controlled poppet cartridge valves are installed in the ports of the lockout cylinders.

An angle encoder located in the top of the electrical slip ring assembly sends a CAN bus message to the RCL. The RCL converts the data in the message to a position angle of the superstructure relative to the carrier (slew angle). If the slew angle is ±2° of directly over the front, the RCL sends a CAN bus message to the control system to allow axle oscillation. When the control system receives this message it switches ON a digital output thus energizing the axle oscillation solenoids. If the angle is more than 2° left or 2° right of directly over the front, the control system switches OFF the digital output thus de-energizing the axle oscillation solenoids.

When the axle oscillation normally-closed solenoid valves are de-energized, the lockout cylinders are isolated from hydraulic oil supply. This keeps the cylinders from oscillating (moving up and down to dampen axle movement) because hydraulic oil cannot leave the cylinders. Instead, the cylinders remain full of hydraulic oil and rigid.

When the axle oscillation solenoid valves are energized and open, hydraulic oil is allowed in and out of the cylinders, allowing them to oscillate.

Outriggers

The outrigger extend/retract circuit consists of a solenoid-controlled valve, which is controlled by the control system based on operator inputs. A request to extend or retract an outrigger jack or extension results in the crane control system energizing the respective solenoid, thereby sending system pressure to shift a dual pilot-controlled valve, which controls the flow of oil to extend and retract the four jack cylinders and four extension cylinders. A check valve maintains a maximum pressure of 100 psi in the retract circuit.

Oil Cooler Fan

The oil cooler fan circuit consists of a proportional flow control valve in sequence with a solenoid-operated, proportional flow control valve, which is controlled by the crane control system, based on inputs from the transmission oil temperature sending unit and the hydraulic oil sending unit. Return oil from the motor goes to tank.

Maintenance

Removal

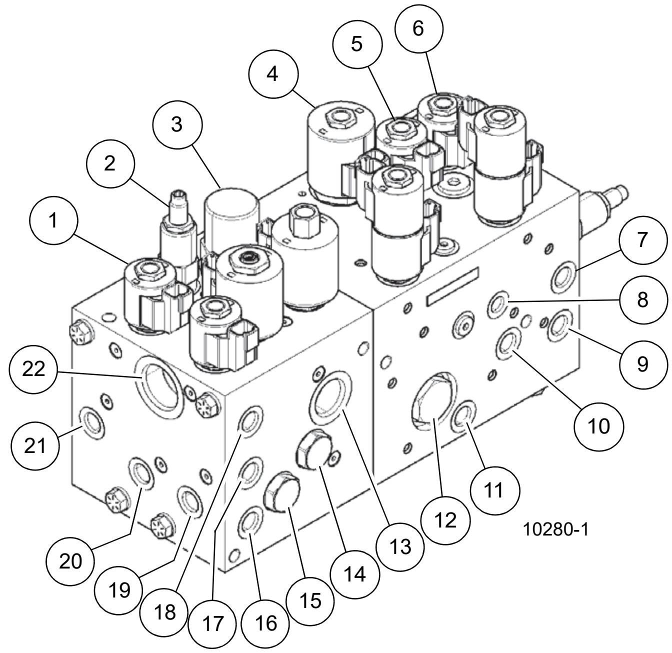
1. Tag and disconnect the electrical connectors to the valve. Tape the lead ends.
2. Tag and disconnect the hydraulic lines to the valve assembly. Cap or plug the lines and ports.
3. Remove the capscrews, nuts, and washers securing the valve assembly to the frame. Remove the valve as a complete assembly.

Installation

1. Install the valve assembly to the frame. Secure the valve assembly with the flatwashers, lockwashers, hex nuts and capscrews. Torque capscrews - refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
2. Connect the hydraulic lines to the valve assembly as tagged during removal.
3. Connect the electrical connectors to the valve assembly as tagged during removal.

Functional Check

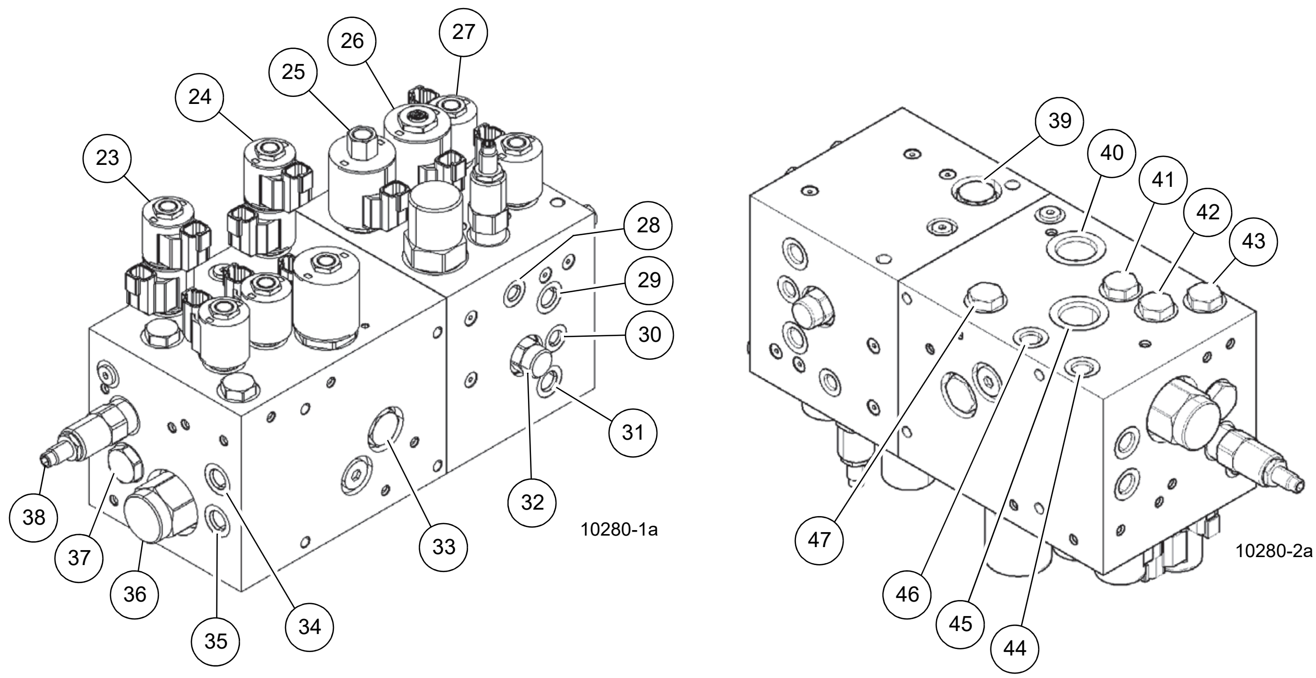
1. Cycle an outrigger cylinder several times. Verify the cylinder extends and retracts properly.
2. Rear steer the crane to the left and to the right several times. Verify the crane steers properly in both directions.
3. Ensure the axle lockout function operates properly by performing the procedures under *Axle Oscillation Lockouts Operation* in section 3 of the Operator Manual.



Carrier Combination Valve

1	Control Valve - Parking Brake		12	Check Valve
2	Pressure Reducing Valve		13	Supply Port (P)
3	Pressure Compensating Cartridge		14	Shuttle Valve
4	Flow Control Valve		15	Shuttle Valve
5	Control Valve - Axle Lockout (Right)		16	Work Port - Parking Brake Pressure Switch (PS)
6	Control Valve - Axle Lockout (Left)		17	Work Port - Parking Brake Cylinders (PB)
7	Drain Port (DR4)		18	Drain Port (DR1)
8	Gauge Port (G3)		19	Load Sense Port (LS3)
9	Work Port - Rear Cylinder Right Turn (RSA)		20	Load Sense Port (LS2)
10	Work Port - Rear Cylinder Left Turn (RSB)		21	Work Port - Oil Cooler Fan Supply (FAN)
11	Gauge Port (G2)		22	Tank Port (T)

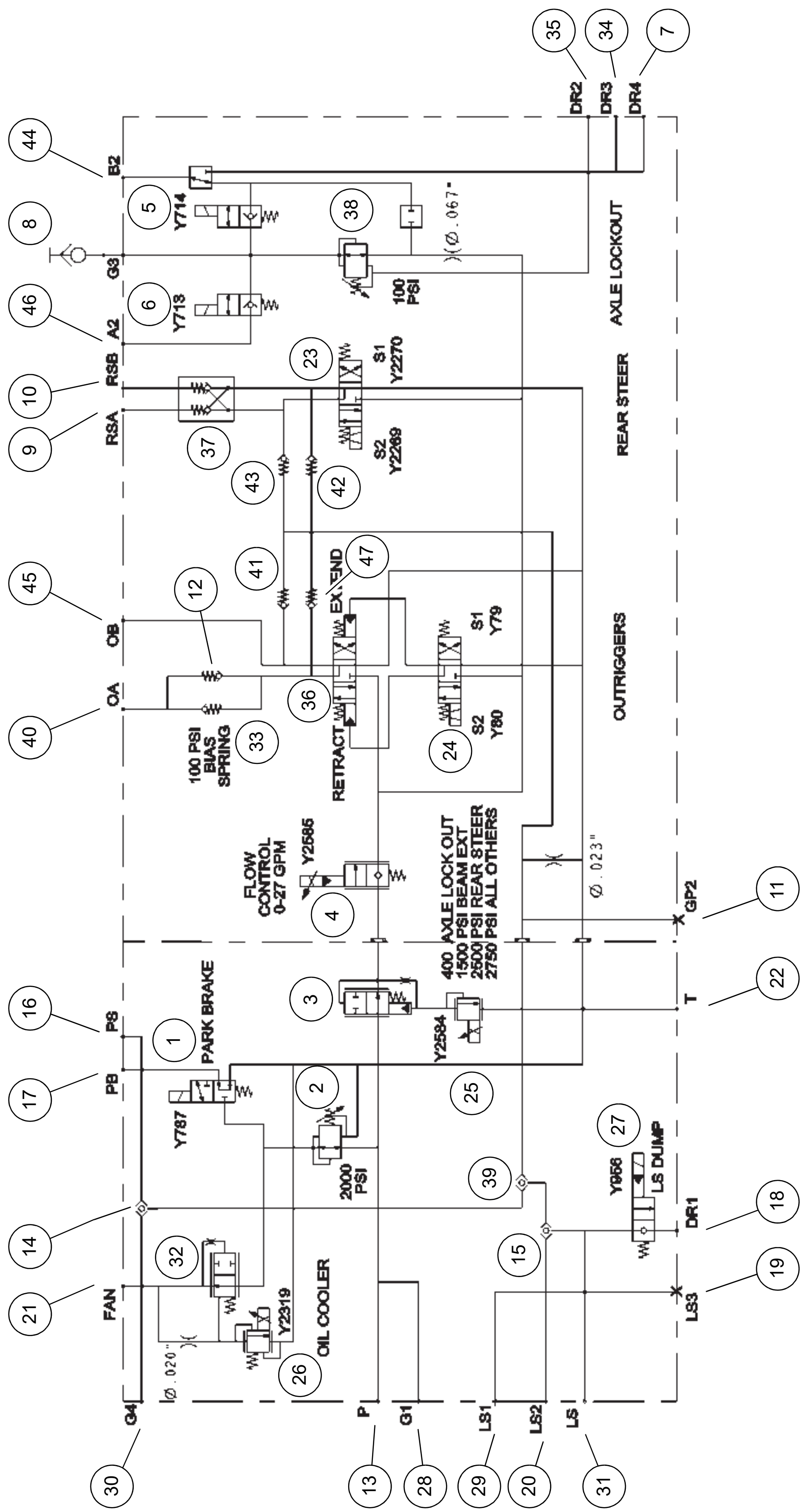
FIGURE 2-34



Carrier Combination Valve

23	Control Valve - Rear Steer		36	Control Valve
24	Control Valve - Outriggers Extend/Retract		37	Check Valve
25	Pressure Control Valve		38	Pressure Reducing Valve
26	Control Valve - Fan		39	Shuttle Valve
27	Control Valve - Load Sense Dump		40	Work Port - Outriggers Retract (OA)
28	Gauge Port (G1)		41	Check Valve
29	Load Sense Port (LS1)		42	Check Valve
30	Gauge Port (G4)		43	Check Valve
31	Load Sense Port (LS)		44	Work Port - Axle Lockout (B2)
32	Pressure Compensator Valve		45	Work Port - Outriggers Extend (OB)
33	Check Valve		46	Work Port - Axle Lockout (A2)
34	Drain Port (DR3)		47	Check Valve
35	Drain Port (DR2)			

FIGURE 2-34 continued



Carrier Combination Valve Cont.

FIGURE 2-35

OUTRIGGER CONTROL MANIFOLD

Description

There are two outrigger control manifolds (Figure 2-36 and Figure 2-37) utilized on the crane, one located on the front outrigger box for controlling the front outriggers and one located on the rear outrigger box for controlling the rear outriggers (Figure 2-22). Each manifold consists of four normally-closed, two-position, two-way solenoid valve assemblies, one for each jack and extension cylinder.

Maintenance

Removal

1. Tag and disconnect the hydraulic lines to the solenoid valves. Cap and plug all lines and openings.
2. Tag and disconnect the electrical connectors.
3. Remove the capscrews, hex nuts and washers securing the manifold to the outrigger box. Remove the manifold.

Inspection

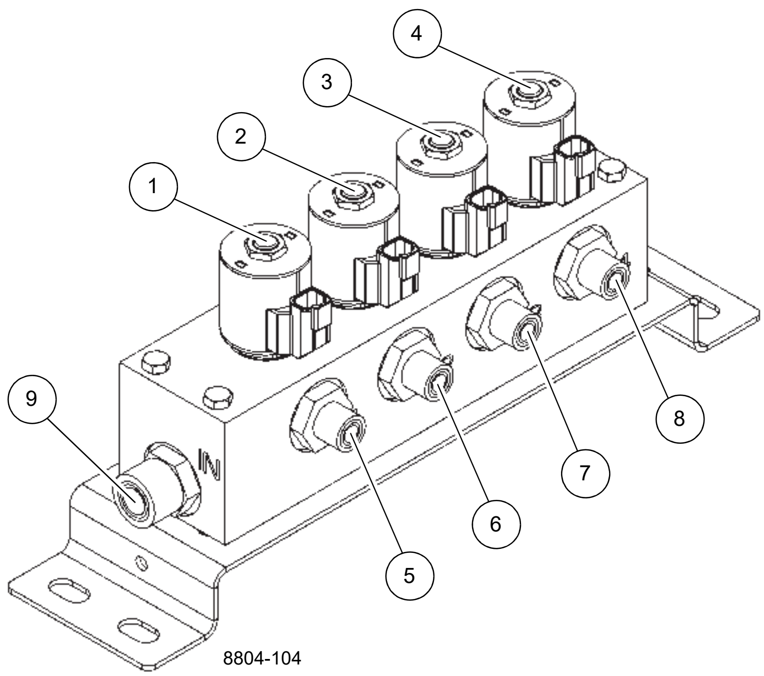
Visually inspect the valves and hydraulic connections for any evidence of leaks or other damage. Check security of the electrical connections. Inspect the wiring for any evidence of cracks or breaks.

Installation

1. Position the manifold on the outrigger box and secure with the washers, hex nuts, and capscrews. Torque capscrews - refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
2. Connect the electrical connectors to the solenoids as marked during removal.
3. Connect the hydraulic lines to the valves as marked during removal.

Functional Check

Activate hydraulic system and cycle affected cylinder(s) several times. Observe for proper functioning of affected cylinder(s). Ensure solenoid valve hydraulic connections are secure.

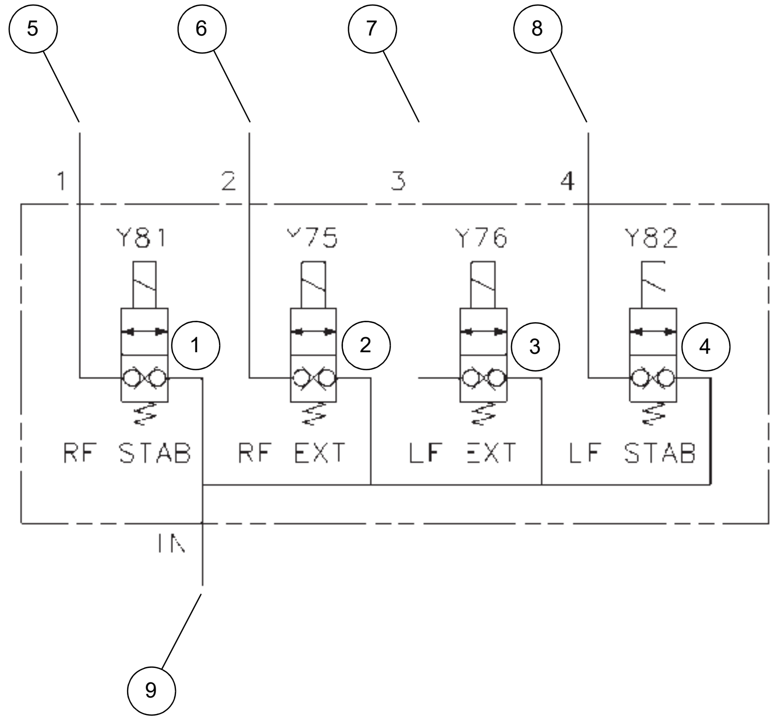


Outrigger Control Manifold

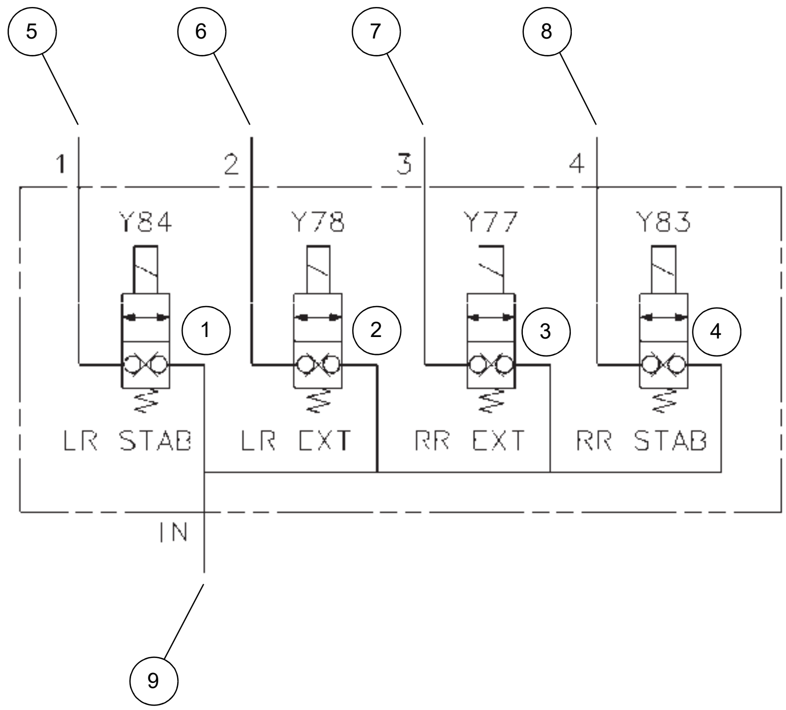
1	Control Valve - Right Front or Left Rear Jack
2	Control Valve - Right Front or Left Rear Extension
3	Control Valve - Left Front or Right Rear Extension
4	Control Valve - Left Front or Right Rear Jack

5	Work Port - Right Front or Left Rear Jack
6	Work Port - Right Front or Left Rear Extension
7	Work Port - Left Front or Right Rear Extension
8	Work Port - Left Front or Right Rear Jack
9	Inlet Port (IN)

FIGURE 2-36



Front Outrigger Control Manifold Cont.



Rear Outrigger Control Manifold Cont.

FIGURE 2-37

DIFFERENTIAL LOCK/RANGE SHIFT MANIFOLD VALVE

Description

The differential lock/range shift manifold valve controls the flow of oil to the differential lock, hi-low range and axle disconnect actuators by the use of two solenoid valves (see Figure 2-38). The valve is located on the center of the carrier frame near the turntable bearing (Figure 2-22). Pressure is supplied to the valve from the transmission charge pump.

The differential lock solenoid valve is a two-position, three-way valve. In its de-energized position, the inlet port is blocked and the differential lock actuator is drained to the reservoir. When the solenoid is energized, the reservoir port is blocked and pressurized oil is directed to the actuator, engaging the differential lock.

The range shift solenoid valve is a two-position, four-way valve. In its de-energized position, pressurized oil flows to the “A” port of the range shift actuator, while the “B” port is drained to the reservoir along with the axle disconnect actuator for two wheel drive/high range. When the solenoid is energized, pressurized oil is directed to the “B” port of the range shift actuator and the axle disconnect actuator while port “A” of the range shift actuator is drained to the reservoir for four wheel drive/low range.

Maintenance

Removal

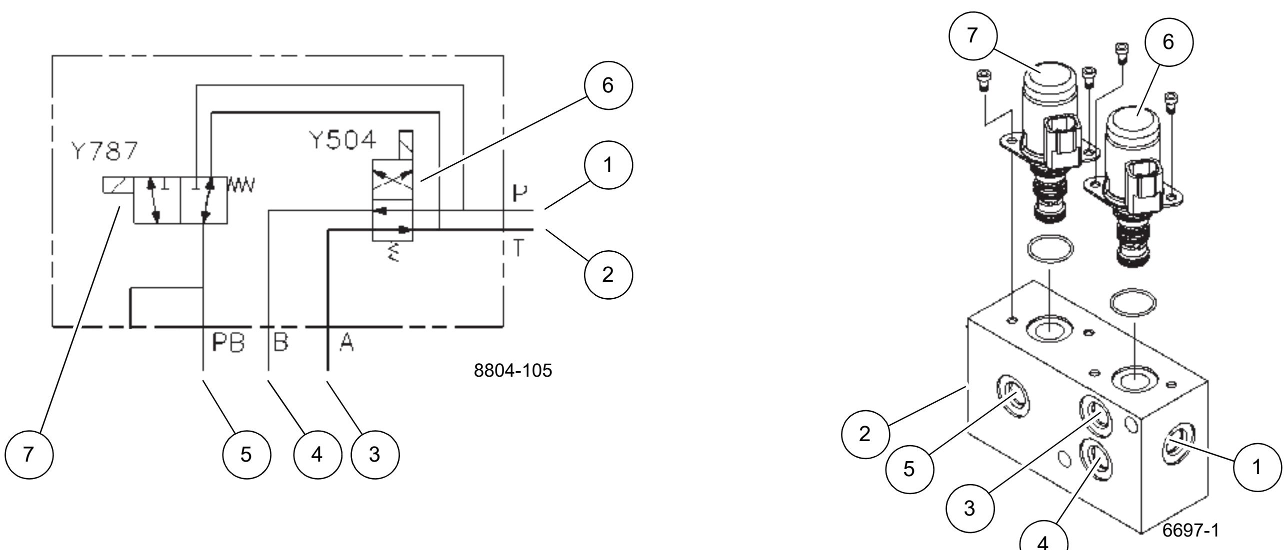
1. Tag and disconnect electrical connectors to the valve.
2. Tag and disconnect hydraulic hoses from the valve. Cap or plug lines and ports.
3. Remove capscrews, lockwashers, flatwashers, and nuts securing valve to the frame. Remove valve.

Installation

1. Secure valve to frame with nuts, flatwashers, lockwashers, and capscrews. Torque capscrews - refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
2. Connect hydraulic hoses to ports on valve as tagged during removal.
3. Connect electrical connectors to valve as tagged during removal.

Functional Tests

1. Start and idle engine.
2. With unit on outriggers, check for proper two/four wheel operation.



Differential Lock/Range Shift Valve

1	Inlet Port (P)	5	Work Port (PB) - Differential Lock
2	Tank Port (T)	6	Control Valve - Range Shift
3	Work Port (A) - Range Shift Actuator	7	Control Valve - Differential Lock
4	Work Port (B) - Range Shift Actuator		

FIGURE 2-38

DUAL ACCUMULATOR CHARGE MANIFOLD VALVE

Description

The dual accumulator charge manifold valve (Figure 2-39) is located on the inside of the left superstructure side plate (Figure 2-23). The valve provides pressure regulation to the service brake circuit.

The dual accumulator charge valve consists of a flow divider spool, cut-in/cut-out spool, check valve and two sequence valves. The LS port of the manifold valve is connected to the pump when the accumulator pressure reaches the cut-in setting [134 bar (1950 psi)]. The pump will deliver the required charge flow to charge the accumulators. When the cut-out setting of 160 bar (2320 psi) is reached, the cut-in/cut-out spool shifts to vent the LS line to tank. The sequence valves isolate the two accumulators. If one of the accumulator loses pressure, the other accumulator will continue to charge and provide flow to the brake circuit when required.

Maintenance

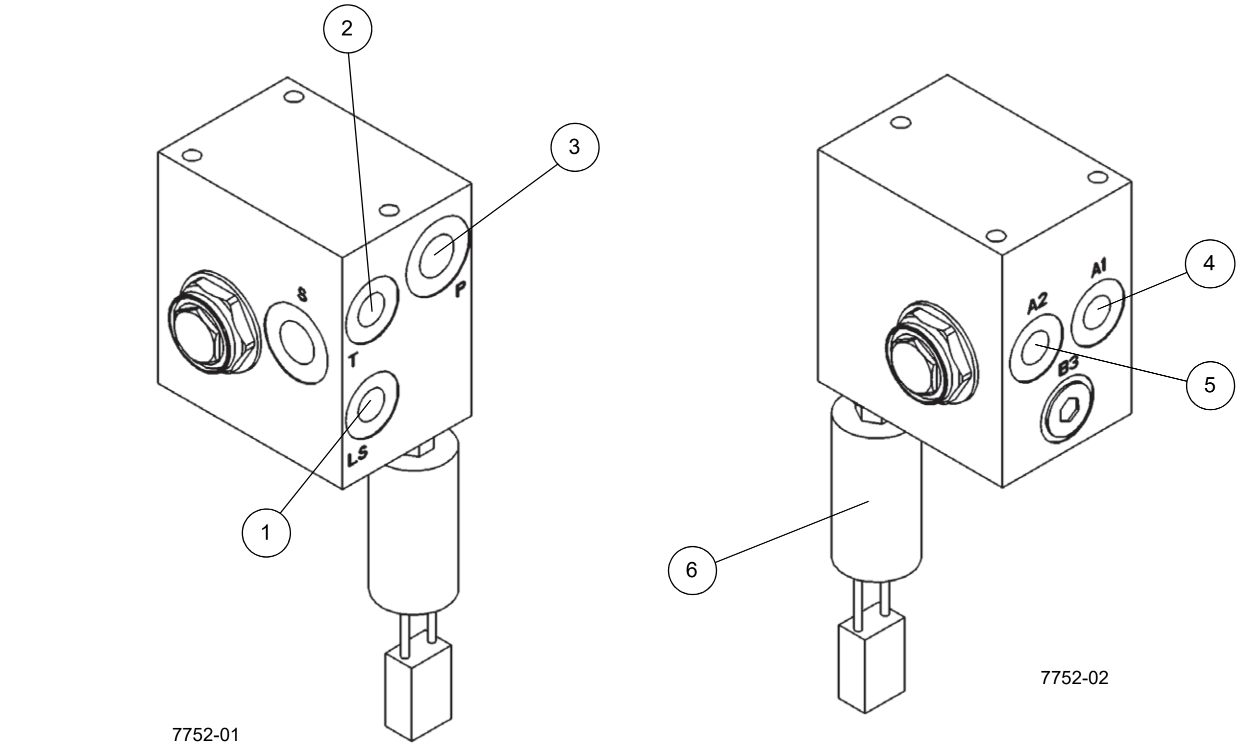
Removal

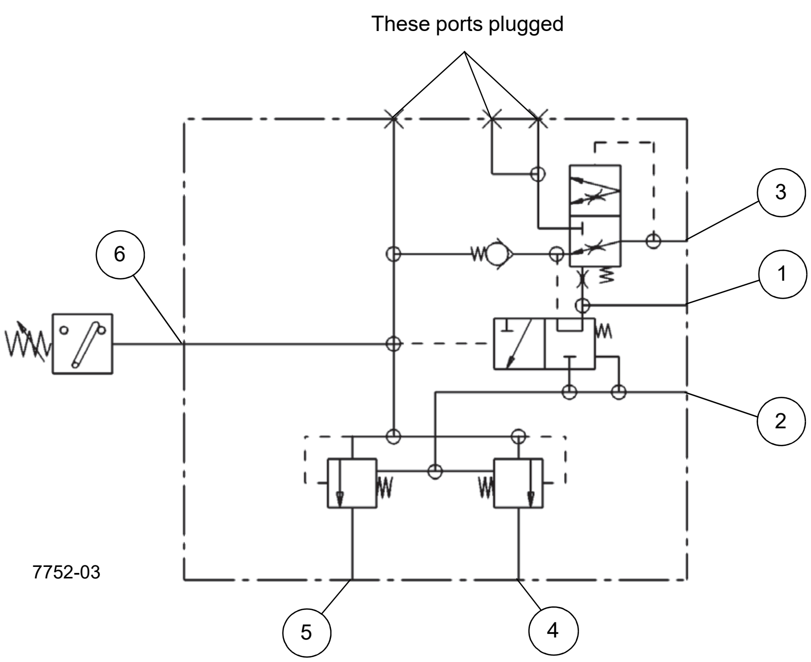
1. Tag and disconnect the hydraulic hoses from the valve. Cap or plug the lines and ports.
2. Remove the three bolts, washers, and lockwashers securing the valve to the turntable. Remove the valve.

Installation

1. Position the valve on the superstructure with ports A1, A2, and B3 facing up and secure with three bolts, washers, and lockwashers. Torque bolts.
2. Connect the hydraulic hoses to the valve ports as tagged during removal.
3. Start the engine and check for leaks. Make repairs as needed.
4. Depress the brake pedal several times to cause the brake valve to charge. Make several turns with the steering wheel, and swing the superstructure left and right. Verify the brakes, swing, and front steering work properly.

2





Item	Description
1	Load Sense Port (LS)
2	Tank Port (T)
3	Pressure Port (P)
4	Accumulator Port (1A)
5	Accumulator Port (2A)
6	Pressure Switch

Dual Accumulator Charge Valve

FIGURE 2-39

HYDRAULIC BRAKE ACCUMULATOR

Description

The hydraulic brake accumulators are located inside the superstructure side plates near the turntable bearing (Figure 2-23). The purpose of the two accumulators is to provide stored energy to actuate the service brake circuits.

Each accumulator has a oil volume of 2.83 l (173 in^3) and is pre-charge with high purity nitrogen to (1500 psi ±50). The dual accumulator charge valve regulates flow to the hydraulic accumulators to provide fully powered, independently separate, primary (front) and secondary (rear), service brake circuits.

Maintenance

Removal

1. With engine shut down, remove hydraulic pressure in accumulators by depressing the service brake pedal several times.
2. Tag and disconnect hydraulic hose from accumulator. Cap or plug line and port.
3. Remove two nuts securing each clamp half. Remove each clamp half and accumulator from turntable.

Installation

1. Position accumulator in the clamps. Secure with removable clamp halves and nuts.
2. Connect hydraulic hose to port on accumulator as tagged during removal.
3. Pre-charge accumulator. Refer to *Pre-charging the Accumulators*, page 2-37.
4. Start engine. Check accumulator and hoses for leaks. Make repairs as needed.
5. Depress brake pedal several times. Verify brakes work properly.

Servicing

Check pre-charge nitrogen pressure every 200 hours or once a month, whichever comes first. Refer to *Checking the Service Brake Accumulators Pre-charge*, page 2-37.

CYLINDERS

Cylinder Rod Surface Protection

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

It is recommended that all exposed cylinder rods be protected using Boeshield® T-9 Premium Metal Protectant. Manitowoc Crane Care has Boeshield® T-9 Premium Metal Protectant available in 12 oz. aerosol cans by ordering part number 9999101803.

CAUTION

Cylinder operation and inclement weather will remove the Boeshield® protectant; therefore, inspect machines once a week and reapply Boeshield® to unprotected rods.

Leak Check

A hydraulic cylinder should not be disassembled unless it is essential. The following checks will provide a means of determining if a cylinder has a faulty or leaking piston seal.

1. Extend rod to its maximum stroke. Remove retract hose from cylinder. Cap retract hose.

DANGER

Ensure pressure is applied to piston side of cylinder only and retract hose is capped.

2. Apply hydraulic pressure to piston side of cylinder and observe open cylinder port for leaks. If leaks are observed, cylinder seals must be replaced.
3. Fully retract cylinder rod (except telescope cylinder). Remove extend hose from cylinder. Cap extend hose.

DANGER

Ensure pressure is only applied to retract (rod) side of cylinder and extend hose is capped.

4. Apply hydraulic pressure to retract (rod) side of cylinder and observe open cylinder port for leaks.

   If leaks are observed, cylinder seals must be replaced.
5. Reconnect all cylinder ports.

Temperature Effects On Hydraulic Cylinders

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

The change in length of a cylinder is proportional to the extended length of the cylinder and to change in temperature of the oil in the cylinder.

For example, a cylinder extended 25 feet in which the oil cools 60°F would retract approximately 7 3/4 inches (see chart below).

A cylinder extended 5 feet in which the oil cools 60°F would only retract approximately 1 1/2 inches. The rate at which the oil cools depends on many factors and will be more noticeable with a larger difference in oil temperature verses the ambient temperature.

Thermal contraction coupled with improper or inadequate lubrication or improper wear pad adjustments, and operation at low boom angles may, under certain conditions, cause a “stick-slip” condition in the boom.

This “stick-slip” condition could result in the load not moving smoothly. Proper boom lubrication and wear pad adjustment is important to permit the boom sections to slide freely. Slow movement, of the boom may be undetected by the operator unless a load is suspended for a long period of time.

To minimize the effects of thermal contraction or “Stick-slip” it is recommended that the telescope joystick is activated periodically in the extend position to mitigate the effects of cooling oil.

If a load and the boom is allowed to remain stationary for a period of time and the ambient temperature is cooler than the trapped oil temperature, trapped oil in the cylinders will cool.

The load will lower as the telescope cylinder(s) retracts allowing the boom to come in. Also, the boom angle will decrease as the lift cylinder(s) retracts causing an increase in radius and a decrease in load height.

This situation will also occur in reverse. If a crane is set up in the morning with cool oil and the daytime ambient temperature heats the oil, the cylinders will extend in similar proportions.

The chart below has been prepared to assist you in determining the approximate amount of retraction/extension that may be expected from a hydraulic cylinder as a result of change in the temperature of the hydraulic oil inside the cylinder.

The chart is for dry rod cylinders. If the cylinder rod is filled with hydraulic oil, the contraction rate is somewhat greater.

NOTE: Operators and service personnel must be aware that load movement, as a result of this phenomena, can be easily mistaken as leaking cylinder seals or faulty holding valves.

If leaking seals or faulty holding valves are

Table 2-4 Boom Drift Chart (Cylinder length change in inches)

Coeff. =	0.00043	($in^3/in^3/°F$)								
STROKE	Temperature Change (°F)									
(FT.)	10	20	30	40	50	60	70	80	90	100
5	0.26	0.52	0.77	1.03	1.29	1.55	1.81	2.06	2.32	2.58
10	0.52	1.03	1.55	2.06	2.58	3.10	3.61	4.13	4.64	5.16
15	0.77	1.55	2.32	3.10	3.87	4.64	5.42	6.19	6.97	7.74
20	1.03	2.06	3.10	4.13	5.16	6.19	7.22	8.26	9.29	10.32
25	1.29	2.58	3.87	5.16	6.45	7.74	9.03	10.32	11.61	12.90
30	1.55	3.10	4.64	6.19	7.74	9.29	10.84	12.38	13.93	15.48
35	1.81	3.61	5.42	7.22	9.03	10.84	12.64	14.45	16.25	18.06
40	2.06	4.13	6.19	8.26	10.32	12.38	14.45	16.51	18.58	20.64
45	2.32	4.64	6.97	9.29	11.61	13.93	16.25	18.58	20.90	23.22
50	2.58	5.16	7.74	10.32	12.90	15.48	18.06	20.64	23.22	25.80
55	2.84	5.68	8.51	11.35	14.19	17.03	19.87	22.70	25.54	28.38
60	3.10	6.19	9.29	12.38	15.48	18.58	21.67	24.77	27.86	30.96

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

Table 2-5 Boom Drift Chart (Cylinder length change in millimeters)

Coeff. = 0.000774 (1/ °C)

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

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

SECTION 3
ELECTRICAL SYSTEM

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DESCRIPTION

General

The electrical system is 24-volt operation with 24-volt starting, consisting of an alternator and two lead-acid batteries wired in series. Electrical power is transferred to and from the carrier and superstructure through the electrical swivel. The CAN bus system consists of many control modules which are located on the carrier, superstructure, and operator's cab. For more detailed information on the electrical swivel, refer to *Swing System*, page 6-1.

Alternator

A belt-driven (2) 24 volt, 110 ampere alternator with an integral transformer - rectifier unit (1) is mounted on the engine. It provides power to the crane electrical circuits and voltage to recharge batteries and maintain them at a full state of charge.

FIGURE 3-1

Batteries and Battery Disconnect Switch

Batteries are located in a compartment on the left side of the crane. Batteries are the maintenance free type and completely sealed except for a small vent hole in the side. The vent hole allows a small amount of gases produced in the battery to escape. On some batteries, a test indicator located on top of the battery is used to determine if the battery can be tested in case of a starting problem.

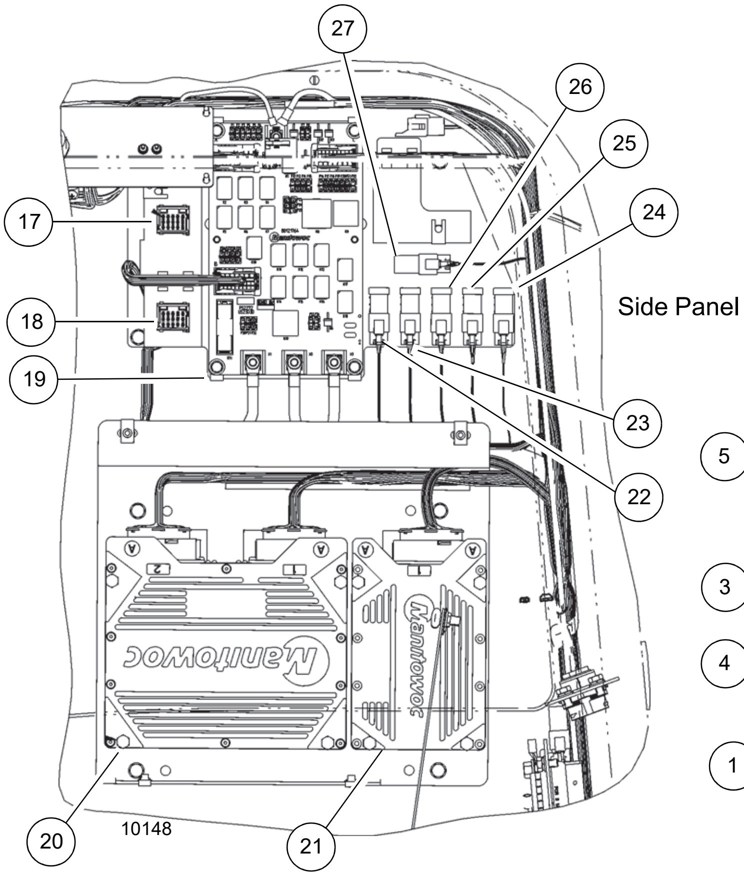
A Battery Disconnect Switch is located to the right of the battery compartment. To disconnect batteries, turn Battery Disconnect Switch OFF. Turn switch ON to connect the batteries.

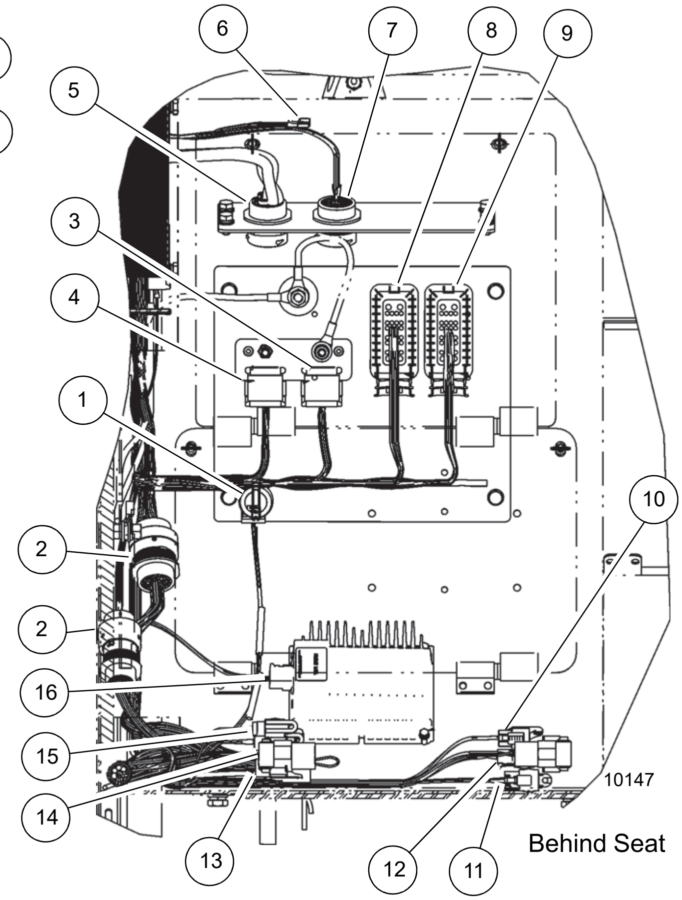
Cab Electrical Panel

NOTE: Refer to the electrical schematic in the back of this manual for a diagram of the electrical system.

The cab electrical panel (Figure 3-2 through Figure 3-3) is located inside the crane cab, behind the operator's seat. It contains cab and superstructure relay and fuse boxes, wiring harness connector bulkhead, RCL module, and the RCL Override switch.

NOTE: Cab control modules and RCL module are not serviceable. Contact Crane Care Customer Service with module service or repair questions.

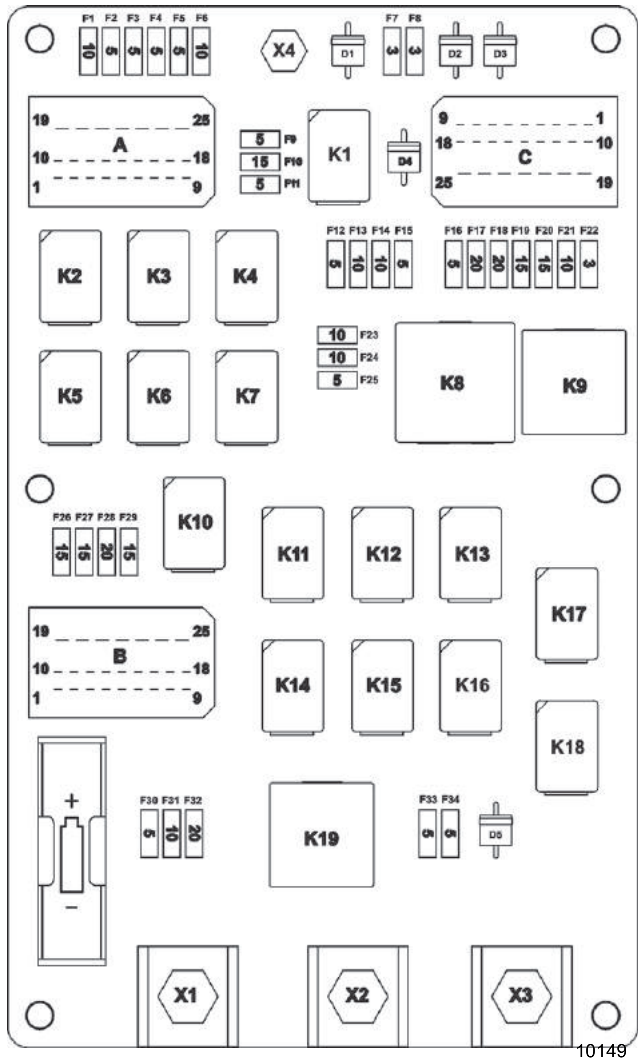




Cab Electrical Panel	
1	RCL Override Switch
2	Cab Rear
3	Ground SPL-B
4	Ground SPL-A
5	Cab-to-Swivel Connector
6	Circulation Fan Connector
7	Swivel Connector
8	Superstructure A
9	Superstructure B
10	Cold Weather Module
11	Crane Star Module
12	Camera Option
13	Options
14	Wireless Remote
15	Remote Charger
16	Converter
17	D1 Connector
18	D2 Connector

19	Cab Fuse Panel
20	Electronic Control Unit (MWIOL)
21	Electronic Control Unit (MWSCM)
22	CAN-A
23	CAN-B
24	CAN-C
25	CAN-D
26	CAN-E
27	Diagnostic Connector

FIGURE 3-2

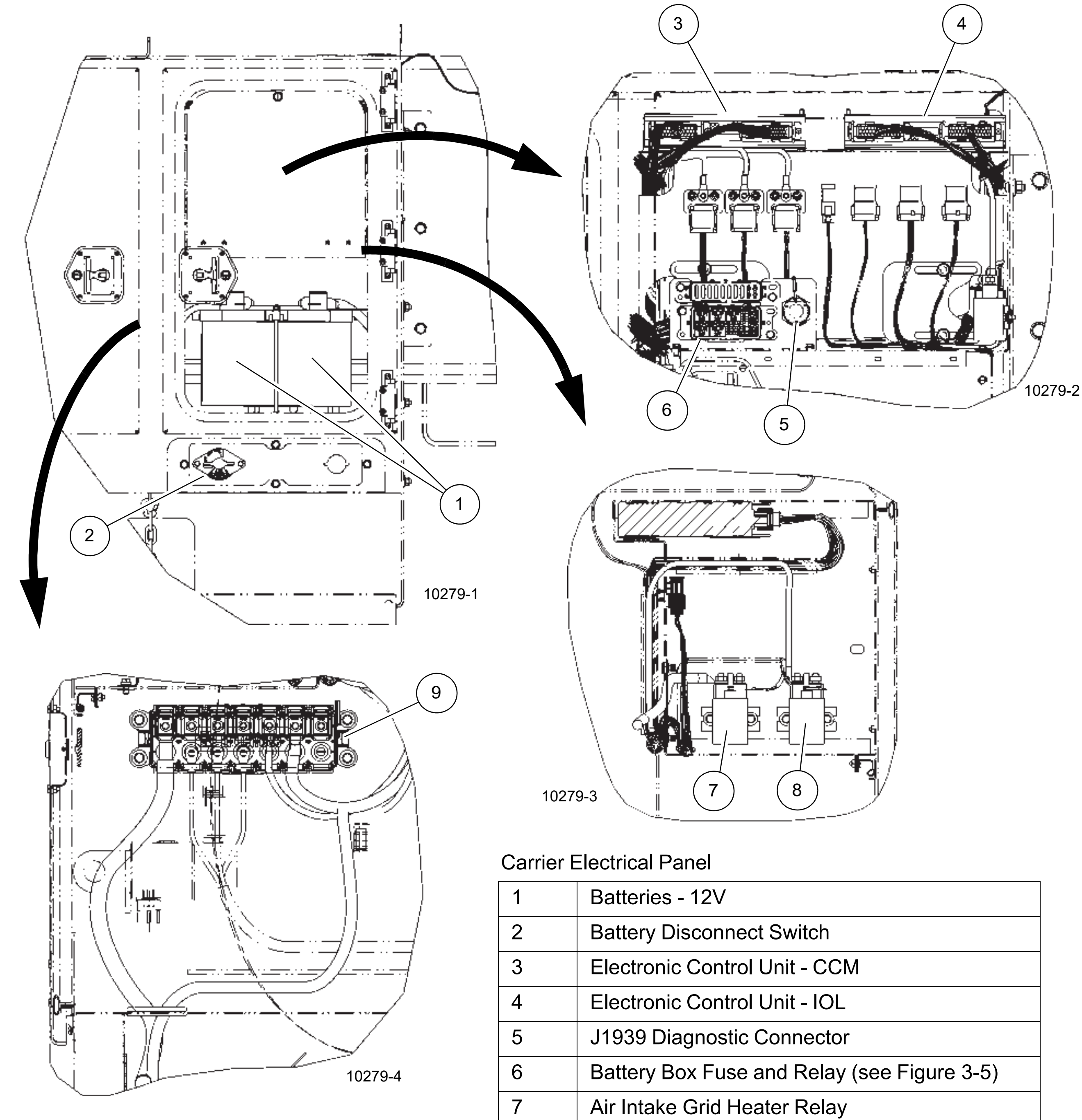


Fuse	Amp	Description
F1	10	Cab Work Lights
F2	5	E-Stop Switch Signal
F3	5	Boom Motorized Work Lights
F4	5	Accessory Lights
F5	5	Map Light and USB Power
F6	10	Radio Ignition Power
F7	3	System Wake-up
F8	3	Key Switch Signal
F9	5	Circulation Fan
F10	15	Heater / AC Switch Power
F11	5	Dome Light
F12	5	Windshield Washer Relay Fuse Power
F13	10	Heated Seat Power
F14	10	UE+ T/T CCM10/IOL45/IOS20 Module Battery Power
F15	5	Radio/Cranestar Battery Power
F16	5	UE+ Cab SCM0/IOL32 Module Battery Power
F17	20	Oil Cooler Power Fan 1
F18	20	Oil Cooler Power Fan 2
F19	15	UB+ T/T IOL45 Power
F20	15	UB+ T/T IOL45 Power
F21	10	UB+ IOL32
F22	3	B+ To Key Switch
F23	10	Sky Light Wiper
F24	10	Windshield Wiper Power
F25	5	Sky Light Washer Relay Fuse Power
F26	15	UB+ T/T CCM10
F27	15	UB+ T/T CCM10
F28	20	24V Supply 12V-DC Converter
F29	15	UB+ IOS20 / UE/UB+ IOS21
F30	5	Diagnostic Conn Power
F31	10	UB+ IOL32
F32	20	Actuator 1, 2, & 3 Relay Fuse Power
F33	5	Display / Jog Dial Relay Fuse Power
F34	5	Fused B+
K1		Windshield Washer Relay
K2		Sky Light Wiper Relay
K3		Sky Light Wiper Low
K4		Windshield Wiper High
K5		Windshield Wiper Relay
K6		Sky Light Wiper High
K7		Windshield Wiper Low
K8		Accessory Relay
K9		Oil Cooler Relay
K10		Sky Light Washer Relay
K11		Actuator 2 (IN) Relay
K12		Actuator 1 (Out) Relay
K13		Actuator 3 (In) Relay
K14		Actuator 2 (Out) Relay
K15		Actuator 1 (In) Relay
K16		Actuator 3 (Out) Relay
K17		Display / Jog dial Relay
K18		Horn Relay
K19		Actuator Enable Relay
X1		Battery Disconnect Switch Power Wire 1274
X2		Battery Disconnect SW Power Wire 6
X3		Battery Disconnect SW Power Wire 5
X4		Ground

FIGURE 3-3

Carrier Electrical Panel

The carrier electrical panel (Figure 3-5) is located on the fuel tank side of the crane, inside the electrical compartment. It consists of the two batteries, battery disconnect switch, fuse and relay boxes, starter and grid heater relays, and electronic control units.



Carrier Electrical Panel

1	Batteries - 12V
2	Battery Disconnect Switch
3	Electronic Control Unit - CCM
4	Electronic Control Unit - IOL
5	J1939 Diagnostic Connector
6	Battery Box Fuse and Relay (see Figure 3-5)
7	Air Intake Grid Heater Relay
8	Engine Start Relay
9	7 Position Fuse Box (see Figure 3-6)

FIGURE 3-4

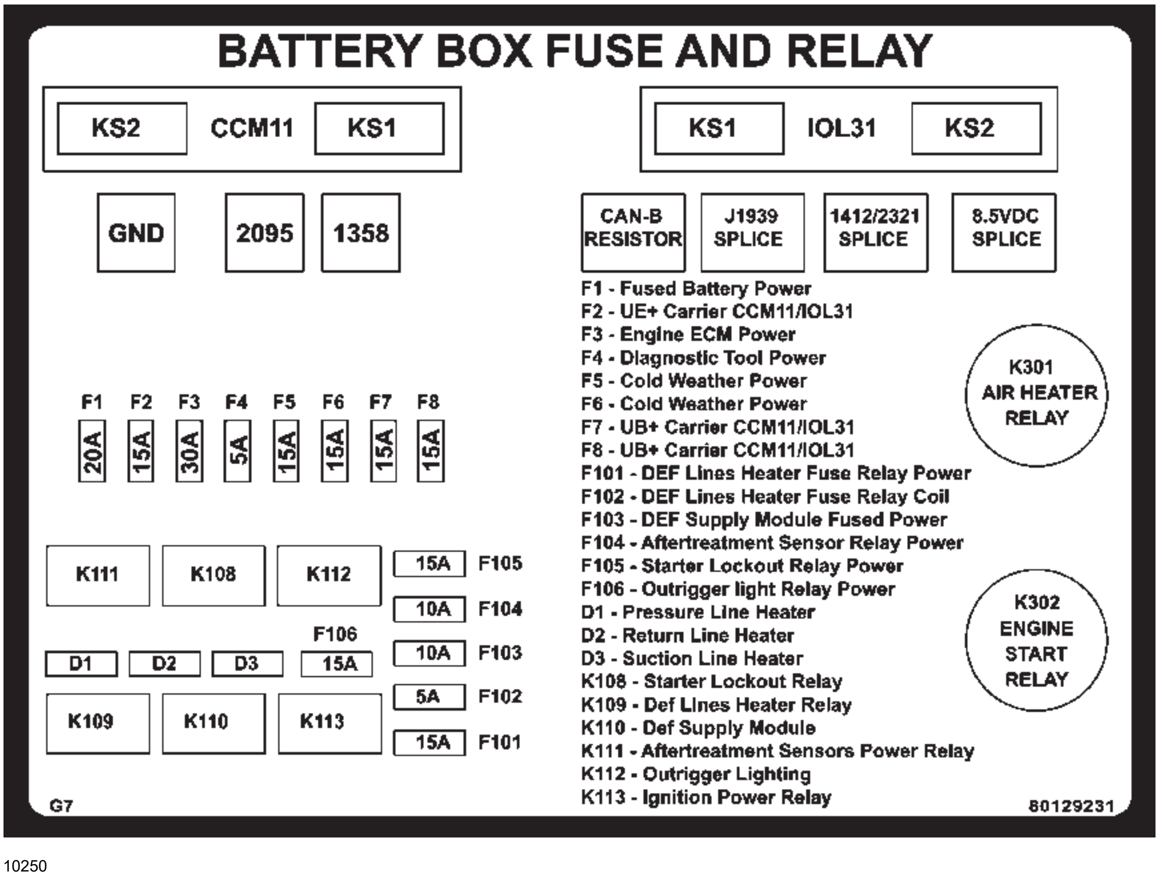


FIGURE 3-5

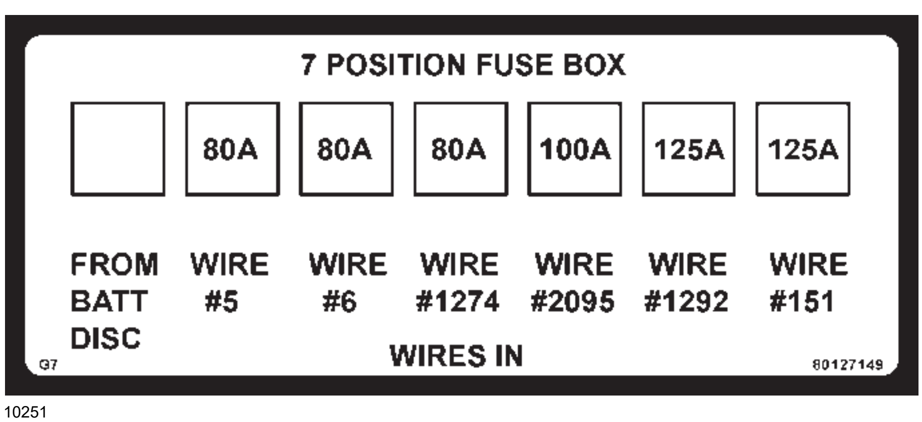


FIGURE 3-6

MAINTENANCE

General

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

DANGER

Serious burns may result from accidental grounding or shorting circuits

Ensure battery is disconnected before performing any maintenance on an electrical circuit.

If it is necessary to perform electrical maintenance on live or hot circuits, remove all rings, watches, and other jewelry before performing maintenance.

CAUTION

Never replace original wiring with wiring of a smaller size (gauge). Fire or other damage to machine may result.

Dielectric Grease

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

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

Excluded Connections

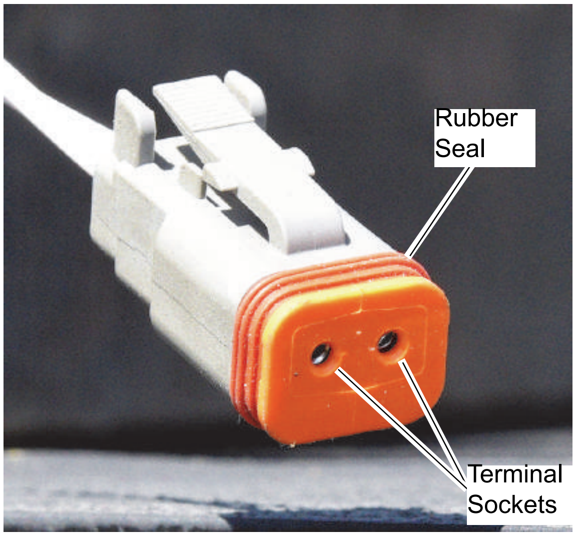
Do not apply dielectric grease to the following connections:

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

Applying Dielectric Grease to an Electrical Connector

Use the following procedure to apply dielectric grease to an electrical connection. Grease should be applied immediately prior to securing the connector. Ensure that grease is applied to all terminal sockets (Figure 3-7).

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



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

FIGURE 3-7

4. Use a clean towel to remove excess grease from the surface of the connector, and wipe grease into the terminal sockets (Figure 3-7).
5. Ensure grease is applied to each terminal socket. The towel with excess grease can be used to fill empty terminal sockets (Figure 3-7).
6. Ensure grease is applied to the entire surface of the connector's rubber seal (Figure 3-7).

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

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

Visual Inspection and Replacement of Electrical Harnesses and Cables

CAUTION

Ensure battery cables are disconnected from batteries before loosening any electrical connections.

Visually inspect all electrical harness and cable assemblies every month or at 250 hours of service life for the following:

- Damaged, cut or deteriorated harness loom covering.
- Damaged, cut or abraded individual wires or cable insulation.
- Exposed bare copper conductors.
- Kinked, crushed, flattened harnesses or cables.
- Blistered, soft, degraded wires and cables.
- Cracked, damaged, or badly corroded battery terminal connections.
- Inspect all machine ground connections for damaged terminals or excessive corrosion.
- Other signs of significant deterioration.

If any of these conditions exist, evaluate the harness assemblies for repair or replacement. For replacement of harness assemblies, refer to your Manitowoc Crane Care Parts Manual.

At the same service interval, visually inspect all Controller Area Network (CAN) nodes and electrical junction boxes for the following:

- Damaged or loose connectors.
- Damaged or missing electrical clamps or tie straps.
- Excessive corrosion or dirt on the junction box assemblies.
- Loose junction box mounting hardware.

If any of these conditions exist, address them appropriately.

Ambient temperature, humidity and other factors affect the life of electrical harness and cable assemblies. Use the following information for the inspection and replacement of these assemblies:

- Cranes operating in climate zone “C” should have the harness and cable assemblies replaced after 10,000 hours of service life.
- Cranes operating in climate zones “A” or “B” with high ambient temperatures could see electrical service life reduced by 25% to 40%. It is recommended to replace these assemblies after 8000 hours of service life.
- Cranes operating in climate zones “D” and “E”, cold climates, should expect a degradation of mechanical properties, long term exposure to these cold temperatures will negatively impact service life. Therefore, it is recommended these electrical harnesses and cable assemblies be inspected regularly as service life may be less than 10,000 hours.
- Cranes operating in salt water climates could see a significant reduction in service life. Therefore it is recommended for these electrical harnesses and cable assemblies to be inspected regularly as service life may be less than 8,000 hours.

Table 3-1

Zone	Classification
A	Tropical Moist: All months average above 18° C. Latitude 15° - 25° North and South
B	Dry or Arid: Deficient precipitation most of the year. Latitude: 20° - 35° North and South
C	Moist Mid-Latitude: Temperature with mild winters. Latitude: 30° - 50° North & South
D	Moist Mid-latitude: Cold winters. Latitude 50° - 70° North & South
E	Polar: Extremely cold winters and summers. Latitude: 60° - 75° North & South

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General Troubleshooting

NOTE: Make voltage checks at terminations when components are installed and operating. Make continuity checks (with batteries disconnected) when components are isolated or removed. Troubleshoot per the following guidelines:

1. Use reported symptoms to identify a problem or a suspect component.
2. Test suspect component per instructions in this section. Instructions identify fuses and components, and guide you from the easiest and most likely problems to the hardest and least likely problems.
3. Using a multimeter, test circuit for continuity if you suspect a broken circuit, or for voltage if you suspect a power problem. Check electrical schematic and wiring diagram for most accurate wiring information.
4. If component proves faulty, replace it with a known working component. If wiring proves faulty, replace it with wiring of equal gauge.
5. After troubleshooting, test the repaired circuit. Verify circuit works properly.

Tools for Troubleshooting

This machine uses a CAN bus Multiplex system. To effectively troubleshoot the electrical system, you need a Windows-based PC, CAN-link service software, and a connection cable. The CAN-link service software and connection cable are available through Crane Care to service technicians who have attended the Grove New Technology training course.

Swivel Electrical Troubleshooting

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

Connector Troubleshooting

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

Refer to the following tables listing required tools for connector maintenance.

Pins and sockets are crimped to the wires and cannot be removed. Remove pins or sockets from plugs or receptacles using an extraction tool. Cut wire as close to pin or socket as possible. After cutting off pin or socket, the wire may be too short.

Using a wire that is too short will apply tension to the pin, socket, or wire where they are crimped when pin or socket is inserted in a 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.

Table 3-2. AMP Extraction Tool Table

Description	AMP Part Number	Manitowoc Part Number
14 gauge wire (connectors)	305183	9999100176
12 to 8 gauge wire (connectors)	91019-3	9999100175
4 to 9 circuit (in-line connectors)	453300-1	N/A
15 circuit (in-line connectors)	458944-1	N/A

Table 3-3. AMP Crimping Tool Table

Description	AMP Part Number		Manitowoc Part Number	
	Tool	Die	Tool	Die
14 to 12 gauge wire	69710-1	90145-1	9999100177	N/A
10 to 8 gauge wire	69710-1	90140-1	9999100177	9999100178
4 to 9 circuit (in-line connectors)	69710-1	90306-1	9999100177	N/A
15 circuit (in-line connectors)	90299-1	--	N/A	--

Table 3-4. Deutsch Extraction Tool Table

Description	Deutsch Part Number	Manitowoc Part Number
12 gauge wire	114010	9999100194
16 gauge wire	0411-204-1605	9999100195
8-10 gauge wire	114008	7902000012
4-6 gauge wire	114009	7902000009

Table 3-5. Deutsch Crimping Tool Table

Description	Deutsch Part Number	Manitowoc Part Number
12, 14, 16, 18, 20 gauge wire	HDT-48-00	9999100808
4, 6, 8, 10 gauge wire	HDT04-08	9999100842

Alternator/Charging System Troubleshooting

Test batteries, alternator, and cables any time there is a problem with the charging system.

Required Tools

The following tools are required to diagnose the charging system:

Equipment	Example	Manitowoc Part No.
Digital Multimeter	Fluke® 177	9999101763
Carbon Pile Load Tester	Autometer® SB5	9999101765
Current Clamp Meter	Fluke® 336	9999101764

Visual Check

- Belts: tight, in good condition, not frayed, cracked or glazed.
- Pulley: tight, aligned with other pulleys, not glazed.
- Alternator mounting bolts and wiring connections: clean and tight, no signs of heat damage.
- Batteries: terminals and cables, clean and tight, no corrosion or signs of heat damage.
- Check alternator fuse if Alternator Charge Lamp is illuminated on the steering column display while engine is running.

Engine Off Tests

Batteries

DANGER

Do not smoke or allow sparks or open flame near batteries, they can explode.

When working with batteries always wear protective clothing, gloves and eye protection. Batteries contain corrosive liquids that can burn skin and eyes and destroy clothing.

Remove rings, watches or other jewelry before working with batteries. A battery can produce a short-circuit current high enough to weld a ring or similar to metal causing severe burns

Disconnect batteries and test each battery individually.

Check electrolyte level if possible.

Using a multimeter, measure voltage across terminals. If should read 130 A to 135 A.

NOTE: If correct readings were not obtained in the Engine On Tests, perform the following two tests.

Voltage Drop Test

Positive Side

1. Set multimeter to the 2 volt range.
2. Connect positive (+) lead to alternator output terminal and negative (–) lead to battery positive terminal or post. Do not connect meter to battery cable.
3. Run engine at 2000 rpm.
4. Load system with carbon pile load or lights and heater blower.

Allowable drop is 0.2 to 0.5 volts. Higher voltage drop indicates loose, corroded, or broken connections.

Negative Side

1. Set multimeter to 2 volt range.
2. Connect negative (–) lead to alternator case and positive (+) lead to battery negative terminal or post. Do not connect meter to battery cable.
3. Run engine at 2000 RPM.
4. Load system with carbon pile load, or lights and heater blower.

Allowable drop is 0.1 to 0.3 volts. Higher voltage drop indicates loose, corroded, or broken connections. If any voltage drop is greater than the normal range, troubleshoot system and repair any problems.

After correcting any problems, perform Engine On Tests again. If satisfactory results are not obtained, remove alternator and bench test.

Replace Alternator

Removal

1. Ensure key switch has been in the OFF position for 2 minutes.
2. Turn battery disconnect switch to OFF position.
3. Remove ECM power fuse.
4. Remove negative battery cables.
5. Open engine compartment.
6. Tag and disconnect electrical leads from alternator terminals.
7. Using a 1/2 in drive bar/ratchet, turn tensioner below the alternator clockwise to remove belt tension. Slip belt off alternator pulley. Let tensioner return to its normal position.
8. Remove alternator mounting capscrews and alternator.

3

Installation

1. Inspect belt. Verify it has no cracks or other damage. Replace damaged belt as needed.
2. Install alternator using mounting bolts and washers. Torque bolts; refer to *Fasteners and Torque Values*, page 1-17 for the proper torque value.
3. Install belt on all engine pulleys except alternator pulley.
4. Turn tensioner clockwise. Slip belt on alternator pulley, then carefully return t tensioner to its normal position. Make sure belt is centered on tensioner.
5. Check belt tension at center of longest distance between pulleys. Push in on belt with your thumb. Belt should deflect no more than 3/8 in - 1/2 in (10 mm - 13 mm). Or, using a belt tension gauge, verify 60 lb - 130 lb (267 N - 578 N) tension Replace belt if it is too loose (overstretched).
6. Verify tensioner bolt is torqued to 32 lb-ft (43 Nm).
7. Connect electrical leads to terminals as tagged during removal.
8. Close engine compartment.
9. Reconnect ground cables to the battery.
10. Install ECM power fuse.
11. Turn battery disconnect switch to ON position.

Check

1. Run engine. Verify reading of voltmeter on front console is 24 volts or greater. Make repairs as needed.
2. Continue troubleshooting charging system as needed if replacement of alternator did not correct problem in charging system.

Starter Replacement

Removal

1. Ensure key switch has been in the OFF position for 2 minutes.
2. Turn battery disconnect switch to OFF position.
3. Remove ECM power fuse.
4. Remove negative battery cables.
5. Open engine compartment.
6. Tag and disconnect electrical leads from starter terminals.
7. Remove bolts holding starter to mounting pad. Remove starter.

Installation

1. Place starter on mounting pad. Secure starter with bolts. Torque to 32 lb-ft (43 Nm).
2. Connect electrical leads to terminals as tagged during removal.
3. Reconnect the ground cables to battery.
4. Install ECM power fuse.
5. Turn the battery disconnect switch to the ON position.

Check

1. Try to start engine. Verify starter engages engine.
2. Start engine again and listen for starter noises. Verify there is no abnormal noise indicating starter gear is meshing properly with flywheel, gear hasn't remained engaged to the flywheel after the ignition switch is in the ignition (run) position, or some other problem. Install starter properly as needed.

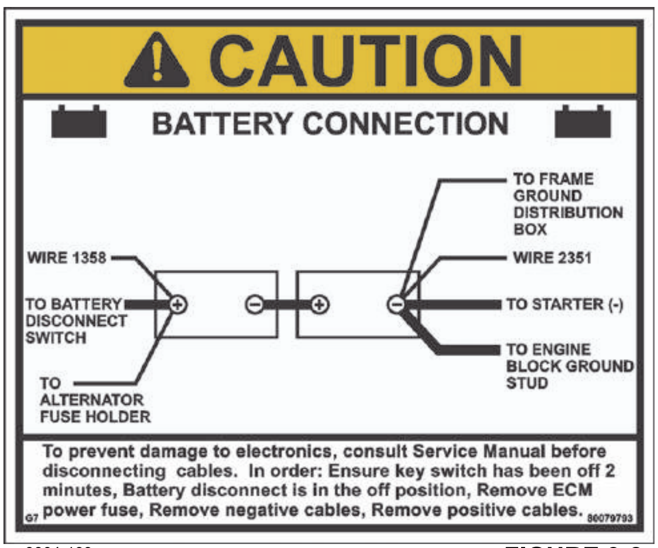
Battery Replacement

Removal

CAUTION

To avoid possible engine fault codes and undesirable operation, ensure keyswitch has been off 2 minutes before disconnecting batteries.

Disconnect batteries if machine will be inactive for over 24 hours.



8804-133

FIGURE 3-8

1. Open battery compartment door.
1. Ensure key switch has been in the OFF position for 2 minutes.
2. Turn battery disconnect switch to OFF position.
3. Remove ECM power fuse.
4. Remove negative battery cables.
5. Remove positive battery cables.
6. Remove nuts and washers from bracket hold down rods. Remove hold down bracket.
7. Remove batteries.

Installation

1. Place batteries in battery compartment.
2. Install hold down bracket. Secure bracket (and batteries) to bracket hold down rods with nuts and washers.
3. Connect leads to battery terminals starting with the positive terminals.
4. Install ECM power fuse.
5. Close battery compartment door.
6. Turn battery disconnect switch ON.
7. Verify replacement batteries work by starting crane's engine and operating various crane components.

Relay Panel Components

Accessory Relay

1. Ensure key switch has been in OFF position for 2 minutes.
2. Turn battery disconnect switch to OFF position.
3. Behind operators seat, loosen thumbscrews securing panel cover. Lower cover.
4. Tag and disconnect electrical leads from suspect relay.
5. Remove hardware securing suspect relay to relay panel assembly. Remove relay.
6. Install replacement relay on relay panel and secure it with attaching hardware.
7. Connect electrical leads to relay as tagged during removal.
8. Raise cover and secure with thumbscrews.
9. Verify proper installation by operating all components connected to replacement relay.

Buzzer Replacement

1. Behind operators seat, loosen thumbscrews securing panel cover. Lower cover.
2. Tag and disconnect electrical leads from buzzer.
3. Unscrew plastic collar ring under panel. Remove buzzer from hole in panel.
4. Install new buzzer through hole in panel and secure with plastic collar ring.
5. Connect electrical leads to buzzer as tagged during removal.
6. Raise cover and secure with thumbscrews.
7. Verify proper operation by placing ignition switch to RUN (1). Buzzer should sound when engine is not running.

Steering Column and Dashboard

Rocker Switch

Refer to Figure 3-9.

Removal

1. Ensure key switch has been in OFF position for 2 minutes.
2. Turn battery disconnect switch to OFF position.

NOTE: Only remove as much as needed to access switch being replaced.

3. Remove four screws (11) from dashboard cover (1).
4. Remove locking lever (15).
5. Remove four screws (14) from left side cover (16).
6. Remove left side cover (16) from steering column.
7. Disconnect wire harness from back of ignition switch (12).
8. Remove right side cover (10) from steering column assembly (9).
9. Disconnect wire harness (not shown) from bottom of switch to be replaced (19 – 24). Remove switch by squeezing retaining clips on each side of switch and pushing upwards until switch is free of cover.

Inspection

1. Visually check switch for evidence of cracks, damaged connections, or other damage. Replace switch as needed.
2. Check wiring for damaged insulation or damaged connectors. Repair as needed.
3. Check all connectors for corrosion. Replace corroded components as needed.

4. Use a multimeter to check for continuity between switch terminals with switch ON. Meter should register zero ohms. Place switch OFF. Meter should register infinity (no continuity). Replace switch if it fails either part of the check.

Installation

1. Note orientation of rocker markings to switch. Remove rocker (A – D) from old switch (19 – 24). Hold switch by its sides in one hand. Squeeze left and right sides of rocker with other hand and pull up.
2. Orient rocker markings correctly to switch (4). Install rocker in switch.
3. Push switch down through top of dashboard cover (1) until retaining clips click in place.
4. Connect wire harness to bottom of switch.
5. Install right side cover (10) on steering column (9).
6. Connect wire harness to ignition switch (12).
7. Install left side cover (16) on steering column overlapping right side cover.
8. Install four button head screws (14) through side covers.
9. Install dashboard cover (1) on side covers with four button head screws (11).
10. Install lever (15) on column assembly (9).
11. Pull column assembly rubber boot up and over bottom of side covers.

Check

1. Turn battery disconnect switch to ON position.
2. Operate switch and verify each function works.
3. Troubleshoot any system or circuit malfunction not corrected by repair or replacement of switch or associated wiring.

Ignition Switch

Refer to Figure 3-9.

Removal

1. Ensure key switch has been in OFF position for 2 minutes.
2. Turn battery disconnect switch to OFF position.
3. Pull rubber boot off bottom of side covers (10,16).
4. Remove four screws (11) from dashboard cover (1) and pull up cover.
5. Remove four screws (14) from side covers and column assembly (9). Pull right side cover (10) away from column.
6. Disconnect wire harness (not shown) from back of ignition switch (12).
7. Remove lock nut (not shown) from ignition switch and remove switch.

Inspection

1. Visually check ignition switch for evidence of cracks, damaged connectors, or other damage. Replace switch as needed.
2. Check wiring for damaged insulation or damaged connectors. Repair as needed.
3. Use a multimeter to check for continuity between switch terminals with switch ON. Meter should register zero ohms. Place switch OFF. Meter should register infinity (no continuity). Replace switch if it fails either part of the check.

Installation

1. Install ignition switch (12) in right side cover (11). Secure with lock nut (not shown).
2. Install right side cover on steering column (9).
3. Connect wire harness (not shown) to ignition switch.
4. Install left side cover (16) on steering column overlapping right side cover.
5. Install four button head screws (14) through side covers.
6. Install dashboard cover (1) on side covers with four button head screws (11).
7. Install lever (15) on column assembly (9).
8. Pull column assembly rubber boot up and over bottom of side covers

Check

1. Turn battery disconnect switch to ON position.
2. Operate switch and verify each function works.
3. Troubleshoot any system or circuit malfunction not corrected by repair or replacement of switch.

Turn Signal and Transmission Shift Levers

Refer to Figure 3-9.

Removal

1. Ensure key switch has been in OFF position for 2 minutes.
2. Turn battery disconnect switch to OFF position.
3. Remove steering wheel cover (3). Use a twisting motion by pushing on side of cap closest to you with your thumbs while pulling on side of cap farthest from you with your fingers.
4. Remove nut (4) from column assembly shaft (9). Remove steering wheel (5).
5. Remove four screws (11) from dashboard cover (1).
6. Remove locking lever (15).
7. Remove four screws (14) from left side cover (16).
8. Remove left side cover (16) from steering column.
9. Disconnect wire harness from back of ignition switch (12).
10. Remove right side cover (10) from steering column assembly (9).
11. Tag and disconnect wire harness (not shown) from switches (19 – 24) and turn signal indicators (2).
12. Remove dashboard cover (1) from steering column.
13. Tag and disconnect wire harnesses from turn signal lever (18) and transmission shift lever (7).
14. Remove two screws (6) and locknuts (8). Remove turn signal and shift lever assemblies.

Installation

1. Ensure locking pin (17) is installed in turn signal lever assembly (18).
2. Align turn signal lever assembly (18) and transmission shift levers assembly (7) with holes in steering column (9). Secure levers with two screws (6) and locknuts (8).
3. Connect wire harnesses to levers (7).
4. Install switch cover (6) on steering column.
5. Install wire harnesses on switches (19 – 24) and turn signal indicators (2) as tagged during removal.
6. Install right side cover (10) on steering column (9).
7. Connect wire harness to ignition switch (12).
8. Install left side cover (16) on steering column overlapping right side cover.
9. Install four button head screws (14) through side covers.
10. Install dashboard cover (1) on side covers with four button head screws (11).
11. Install lever (15) on column assembly (9).
12. Pull column assembly rubber boot up and over bottom of side covers.
13. Install steering wheel (5). Install steering wheel nut (4). Torque to 30 lb-ft ±4 (40 Nm ±5).
14. Install steering wheel cap (3).
15. Turn battery disconnect switch to ON position.

Check

1. Operate turn signal lever or transmission shift lever per Operator Manual. Verify each function.
2. Troubleshoot any system or circuit malfunction not corrected by repair or replacement of lever or related wiring.

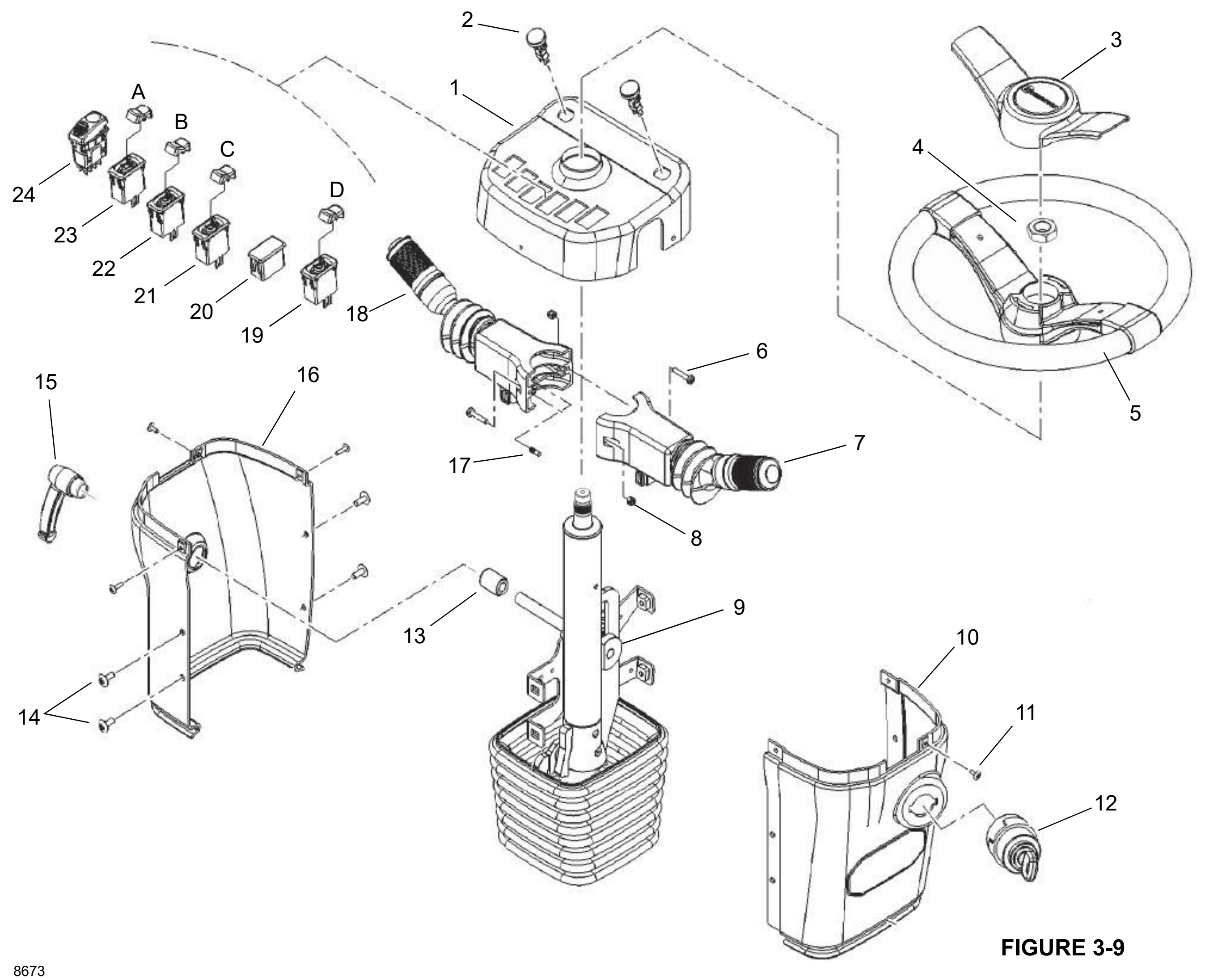


FIGURE 3-9

Item	Component	Item	Component
1	Dashboard Cover	13	Spacer
2	Turn Signal Indicator	14	M6 Button Head Screw
3	Steering Wheel Cap	15	Lock Handle
4	Steering Wheel Nut	16	Left Side Cover
5	Steering Wheel	17	Locking Pin
6	Screw	18	Turn Signal, Lights, Wiper Switch
7	Three-Speed Transmission Shift Switch	19	Engine Idle/Deceleration Switch
8	Locknut	20	Switch Blank
9	Column Assembly	21	Hazard On/Off Switch
10	Right Side Cover	22	2WD/4WD Switch
11	M4 Button Head Screw	23	Headlight Switch
12	Ignition Key Switch Assembly	24	Parking Brake Switch Assembly

Windshield Wiper Assembly Replacement

Removal

1. Ensure key switch has been in OFF position for two minutes.
2. Turn battery disconnect switch to OFF position.
3. Tag and disconnect electrical leads from motor.
4. Disconnect washer hose on wiper arm from washer nozzle fitting assembly.
5. Remove two cap nuts and washers securing wiper arm to adapter.
6. Remove wiper arm from adapter and pivot shaft.
7. Remove attaching hardware and motor to wiper link.
8. Remove flanged sleeve, nut, and two flat washers from pivot shaft kit.
9. Remove two capscrews and lockwashers securing adapter to cab exterior. Remove adapter and gasket.
10. Remove windshield wiper motor bracket from cab interior. Remove bracket, with motor and pivot shaft from cab.

NOTE: Remove other parts as needed to access motor and bracket. Do not damage parts.

11. Remove nut from wiper motor kit crank.
12. Remove three screws, washers, and wiper motor from bracket. Leave other parts attached to bracket.

Inspection

1. Visually check motor housing for evidence of cracks or other damage. Check for excessive shaft end play indicating worn or damaged bearings. Replace motor if damaged.
2. Inspect wiper blade for serviceability. Replace wiper blade when worn.
3. Inspect wiper arm and parts of linking component kits (pantograph adapter kit, pivot shaft kit, wiper motor kit link and crank, wiper motor bracket) for damage. Replace as needed.

Installation

1. Ensure pivot shaft and wiper motor kit link and crank are in place on the motor bracket. (Washers and clip springs fasten the link to the pivot pins on the crank and the pivot shaft. The pivot shaft's pivot pin mounts in the hole nearest the end of the pivot shaft's lever.)
2. Connect wiper motor to motor bracket with screws and washers. Connect wiper motor shaft to wiper motor kit crank with nut and washer.
3. Secure adapter and gasket of the pantograph adapter kit to the cab exterior with capscrews and lockwashers.
4. Install motor bracket and attached parts in cab interior with attaching hardware. Ensure pivot shaft fits through hole in pantograph adapter kit.

NOTE: Do not damage parts while moving bracket assembly around steering column.

5. Secure pivot shaft to adapter with pivot shaft kit nut and washers. Install flanged sleeve on pivot shaft.
6. Install wiper arm on adapter kit shafts and the pivot shaft kit. Secure wiper arm to adapter kit shaft with washer and cap nut.
7. Secure wiper arm to pivot shaft with pivot shaft kit tapered sleeve, washer, and cap nut.
8. Connect wiper arm washer hose to washer nozzle fitting assembly.
9. Connect electrical leads to wiper motor as marked before removal.
10. Turn battery disconnect switch to ON position.

Check

1. Squirt some cleaning fluid onto the windshield with windshield washer.
2. Test windshield wiper. Replace wiper blade if it streaks or wipes poorly.

Windshield Washer Assembly Replacement

Removal

1. Ensure key switch has been in OFF position for 2 minutes.
2. Turn battery disconnect switch to OFF position.
3. Locate windshield washer container and pump on left rear side of cab.
4. Tag and disconnect pump electrical lead and ground wire.
5. Disconnect hose from windshield washer pump. Point it so it won't spill cleaning fluid. Catch cleaning fluid from windshield washer container with a suitable container.
6. Remove four self tapping screws securing the windshield washer container to the cab. Remove the windshield washer container and pump.
7. Remove pump and pump seal from container.

Inspection

1. Visually check pump for evidence of cracks, leaks, or other damage. Replace pump if damaged.
2. Inspect container for leaking. Replace pump seal if it is leaking. Replace container if it is damaged and leaking.
3. Inspect spray nozzle on the wiper arm. As needed, clean nozzle with a fine piece of wire and compressed air.

Installation

1. Install pump and pump seal on container.
2. Install windshield washer container on the cab. Secure the container with four self tapping screws.
3. Attach hose to windshield washer pump.
4. Connect pump's electrical lead and ground wire as tagged during removal.
5. Turn battery disconnect switch to ON position.
6. Fill container with cleaning fluid.

Check

1. Test windshield washer operation.
2. Perform additional troubleshooting and repair as needed.

Skylight Wiper Assembly Replacement

Removal

1. Ensure key switch has been in OFF position for two minutes.
2. Turn battery disconnect switch to OFF position.
3. Tag and disconnect electrical leads from motor.
4. Remove wiper arm from motor shaft.
5. Remove nut, spacer, leather washer, and nylon flat washer from motor shaft outside cab roof.
6. Remove nut and lockwasher securing motor bracket to cab roof and remove motor from cab roof. Remove large nylon flat washer from motor shaft and flat washer and smaller nylon flat washer from mounting screw.
7. Remove mounting screw and nylon flat washer from outside cab roof.
8. Clean any sealing material from around holes in cab roof.

Inspection

1. Visually check motor housing for evidence of cracks or other damage. Check for excessive shaft end play indicating worn or damaged bearings. Replace motor if damaged.
2. Inspect wiper blade for serviceability. Replace wiper blade when worn.
3. Inspect wiper arm and parts for damage. Replace as needed.

Installation

1. Install sealant material around both holes in cab roof, both inside and outside.
2. Install screw with nylon flat washer (from outside) through mounting hole in cab roof.
3. Install flat nylon washer on motor shaft and insert motor shaft through hole in cab roof. Position small nylon washer and flat washer on screw between mounting bracket and cab roof. Secure with lockwasher and nut.
4. Install nylon flat washer, leather washer, spacer, and nut on motor shaft. Tighten nut.
5. Install wiper arm and blade on motor shaft.
6. Connect electrical leads to wiper motor as marked before removal.
7. Turn battery disconnect switch to ON position.

Check

1. Operate skylight wiper for correct operation. Replace wiper blade if it streaks or wipes poorly.

Adjusting Electronic Joysticks

If the meter-in dead band of a joystick function is too fast or too slow or its maximum function speed is slower or faster than design specifications, adjustments can be made using the Grove CAN-link service software providing the following have been performed:

- All function pressures have been set correctly following the procedures in the *Hydraulic System*, page 2-1.
- Correct function speeds cannot be attained by adjustments made through the crane control system (CCS) control screens.
- Correct function control cannot be attained by adjustments made through the CCS control screen selectable curves.

To adjust the meter-in dead band and maximum function speed of a joystick, a Windows-based PC, CAN-link service software (9999102409), and a connection cable (80059224) are required. The CAN-Link service software and connection cable are available through Manitowoc Crane Care to those service technicians who have attended the Grove New Technology training course.

CALIBRATING ODM SENSORS

ODM sensors are located throughout the crane. When a sensor requires calibration, its icon appears in the ODM. The sensors are calibrated at the factory before the crane is delivered, but must to be calibrated through the ODM in the following circumstances:

- The sensor readings are inaccurate (individual sensor only must be calibrated)
- The sensor or component being measured is replaced, adjusted, removed, or reinstalled (individual sensor only must be calibrated)
- The software has been updated (all sensors must be calibrated)
- The ODM display is replaced (all sensors must be calibrated)

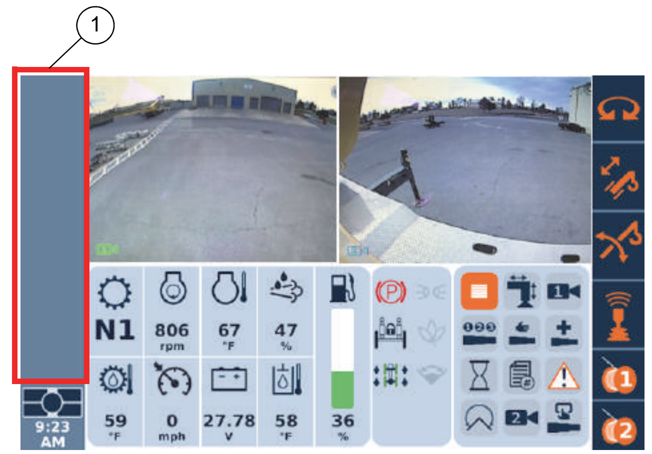
Detailed information about the calibration process is available to technicians who have attended the Grove New Technology training course.

DIAGNOSTICS

The following sections describe the GRT8120 diagnostic functions.

Fault Codes

The crane control system (CCS) monitors the engine, transmission, and crane functions to ensure they are functioning properly. If a malfunction is detected within any of these systems, the CCS will show an alert in the Alerts Area (1, Figure 3-10) of the Operator Display Module (ODM).



10254-39b

FIGURE 3-10

The Engine Fault Active Alert comes on when an engine or transmission fault is present, and the Crane Fault Active Alert comes on when a crane function fault is present (Figure 3-11).

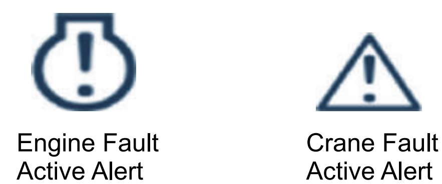
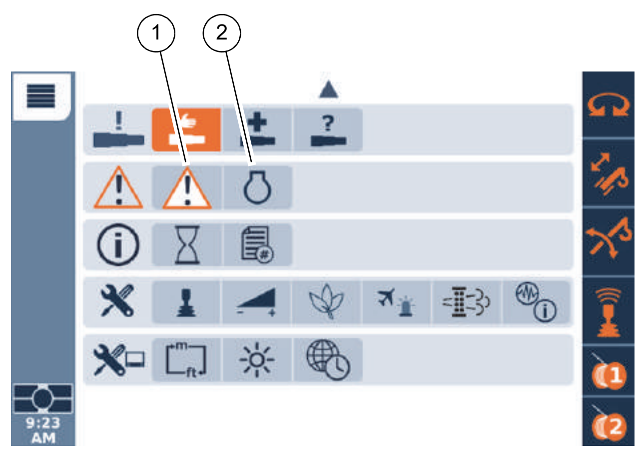


FIGURE 3-11

To view an active fault, select the Crane Faults icon (1, Figure 3-12) or the Engine Faults icon (2) under the Faults Menu Group of the ODM.



10254-4

FIGURE 3-12

The Fault Code function screen (Figure 3-13) displays active fault codes.

If several fault codes are active, use the Jog Dial or Arrow Buttons on the Navigation Control Pad to select the arrow at the top or bottom of the screen to scroll through the codes

10296-1

FIGURE 3-13

Fault codes with an “X” beside them can be cleared by the operator. Fault codes with an “X” surrounded by a red circle with strike-through cannot be cleared without first correcting the malfunction, then cycling the ignition key to the Off position and back to the On position.

Additional information about the fault can be accessed by first highlighting a fault code, then pressing the Additional Information Button (1, Figure 3-14) at the ODM Navigation Control Pad.

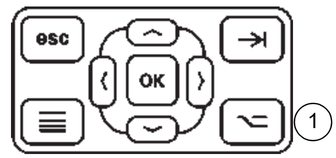
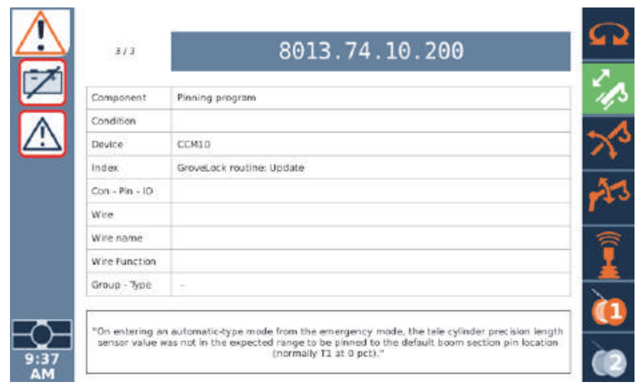


FIGURE 3-14

The Additional Information screen (Figure 3-15) gives the operator details about the location of the system that is at fault, along with an explanation.



10296-2

FIGURE 3-15

A list of all fault codes and their definitions are also available through the Manitowoc Diagnostic Code application. For more information, see *About the Manitowoc Diagnostic Code Mobile Application*, page 3-21.

About the Manitowoc Diagnostic Code Mobile Application

The Manitowoc Diagnostic Code Mobile Application is a free mobile application that enables the user to enter and retrieve information about specific crane fault codes on a mobile device. The application is available from the Google and Apple stores and compatible with most Android and Apple mobile devices.

To look up a fault code with the Manitowoc Diagnostic Code mobile application:

1. Find the fault code you want to research in the Fault Code function screen of the Operator Display Module (ODM).
2. Open the Manitowoc Diagnostics Code Application on your mobile device.

   The Diagnostic Code Application splash screen appears.

10156

FIGURE 3-16

3. Click CCS.

   The CCS screen appears.

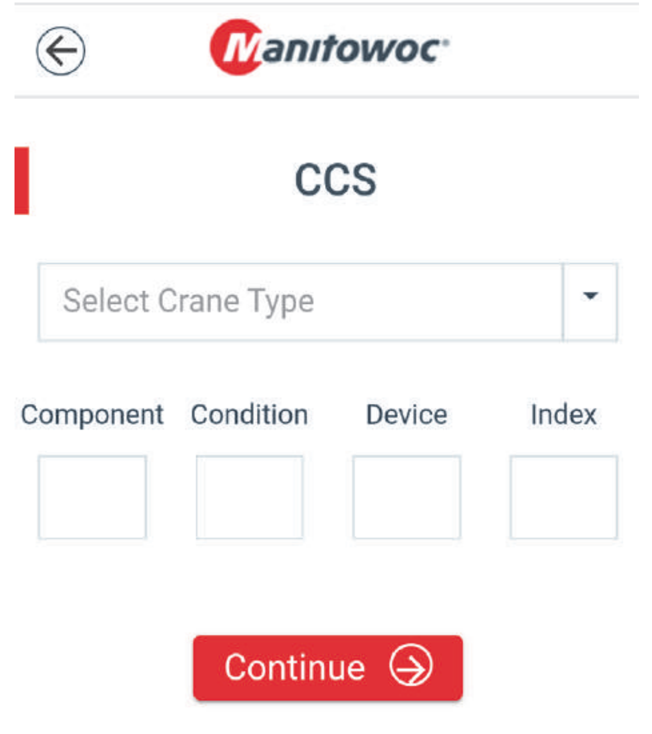


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FIGURE 3-17

4. Complete the following using information from the error code displayed on the ODM:
   - Select Crane Type—Select the crane model from the drop-down list.
   - Component—Enter the component information from the fault code.
   - Condition—Enter the condition information from the fault code.
   - Device—Enter the device number from the fault code.
   - Index—Enter the index number information from the fault code.

5. Click Continue.

   The Fault code information is displayed.

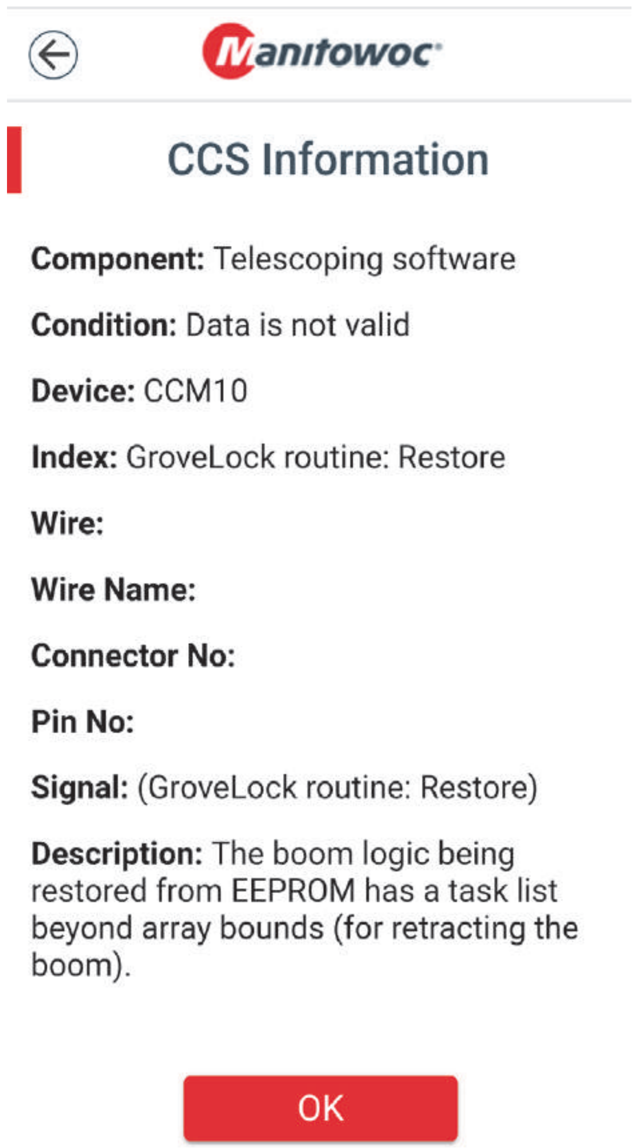

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FIGURE 3-18

6. Click OK to return to the main screen.

OPTIONAL EQUIPMENT

This section is provided to give a brief description of optional equipment for the crane which is not discussed elsewhere in this service manual.

Beacon Light

The beacon light is installed on the left side of the turntable in front of the main hoist.

Boom Mounted Floodlights

The boom light switch is located in the cab overhead panel. The switch is an On/Off rocker switch that will turn the lamps located on the underside of the boom On and Off.

Rear View Mirror

The rear view mirror installation consists of a rear view mirror mounted on the top left corner of the cab. Mirror can be adjusted for optimum view from cab while boom is over front of crane.

Air Conditioner

An electrically driven air conditioner is installed on the left side of the turntable. It consists of a compressor motor, condenser unit, and a cab unit mounted under the operators seat. It is turned on and off by a rotary switch mounted on the overhead console. Refer to Air Conditioner Control Switch (Optional) in the Operator Manual (Section 3 -Operating Controls and Procedures).

When servicing the air conditioning system, observe the following specifications:

- Minimum Evacuation Time — 60 minutes
- Refrigerant Charge Levels — 2.5 pounds (± 0.5 oz)
- Additional Pag Oil Required Above the 6 ounces in Compressor — 5.0 ounces

Cold Weather Operation

Regions with ambient temperatures below -9°C (15°F) are considered arctic. The following recommendations are for operating Grove cranes in very low temperatures.

Use particular care to ensure that cranes being operated in very cold temperatures are operated and maintained in accordance with the procedures as provided by Manitowoc. Always ensure adequate lubrication during system warm-up and proper operation of all crane functions when operating in cold weather. Regardless of oil viscosity, always follow cold weather start-up and operating procedures described in the *Operator Manual.* To ensure adequate lubrication during system warm-up and proper operation of all crane functions, Refer to *Warm-up Procedure*, page 5-2.

Individual crane functions should be operated to ensure they are sufficiently warmed prior to performing a lift.

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

Component Coolant Heater

A diesel fueled coolant heater circulates warm coolant through engine and crane components when operating during arctic temperatures. The coolant heater should be activated 2 hours before starting the crane to allow sufficient time to preheat fluids and assist with easy start-up conditions.

3

WARNING

Explosion Hazard!

Before switching on, check if heater can be operated at the work site. There is a danger of explosion when using the heater around combustible objects! Do not park vehicle near flammable objects.

Use caution near exhaust tailpipe as it will also become very hot.

To activate heater, ensure fuel supply valve from heater fuel reservoir is turned to ON position. Ensure battery disconnect switch is turned to ON position. Push activation button at heater control panel. A green light will illuminate indicating system is activated. Start-up and shutdown cycles may take approximately 2 minutes for initialization. Ensure coolant, transmission heater, swivel, battery heater, in-line fuel pump, in-line fuel heater, and hydraulic reservoir heater are heating properly.

To de-activate heater, push button at heater control panel. The green light will turn off indicating system is deactivated. Shutdown cycle may take approximately 2 minutes.

NOTE: Accelerated discharging of battery will occur when crane engine is switched off. If you run the heater while the crane engine is stopped, the batteries voltage will need to be recharged after short periods of time.

Troubleshooting

In case of faults, check the following points:

- If heater does not start after being switched on:
  - switch heater off and on again.
- If heater still does not start, check if:
  - Fuel in the tank
  - Fuses are OK

- Electrical cables, connections etc. are OK
- Anything clogging combustion air supply or exhaust system?

- Check openings of combustion air supply and exhaust system after longer standstill periods. Clean if necessary!
- If heater remains faulty after these points have been checked or another malfunction occurs in your heater, contact an authorized Manitowoc distributor or Manitowoc Crane Care.

Maintenance Instructions

- Switch heater on once a month for about 10 minutes, even outside heating period.
- Before heating period starts, heater should undergo a trial run. If persistent extreme smoke develops, unusual burning noise, a clear fuel smell, or if electric / electronic parts heat up, switch off heater and remove from service by removing the fuse. The heater should not be started again until it has been checked by qualified staff who have been properly trained.

SECTION 4
BOOM

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BOOM REMOVAL

NOTE: The boom, without any boom extension, weighs about 12,600 kg (27,778 lbs).

1. Extend and set the outriggers to level the crane and ensure the boom is fully retracted and in a horizontal position over the front of the crane.
2. Counterweight must be removed from the crane.
3. Rotate turntable so boom is over the front of the crane and engage the turntable lock pin.
4. Fully retract and lock the telescopic sections.
5. If installed, remove the boom extension and auxiliary nose.

CAUTION

Injury Hazard!

Wear gloves when handling wire rope, metal slivers and/or cuts may result.

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6. Remove the hook block or overhaul ball and wind all the wire rope onto the hoist drum.
7. Elevate boom to allow access to the telescope hose disconnects.
8. Disconnect main telescope hydraulic lines. Tag and disconnect the telescopic hydraulic lines from the compact block, if equipped, also disconnect the hydraulic boom extension hydraulic lines from the compact block.

NOTE: At this point you can continue to remove the boom or choose to remove the equipment that is attached to the boom to prevent it from being damaged. You can also choose to remove the attached equipment after the boom has been removed and is supported on cribbing.

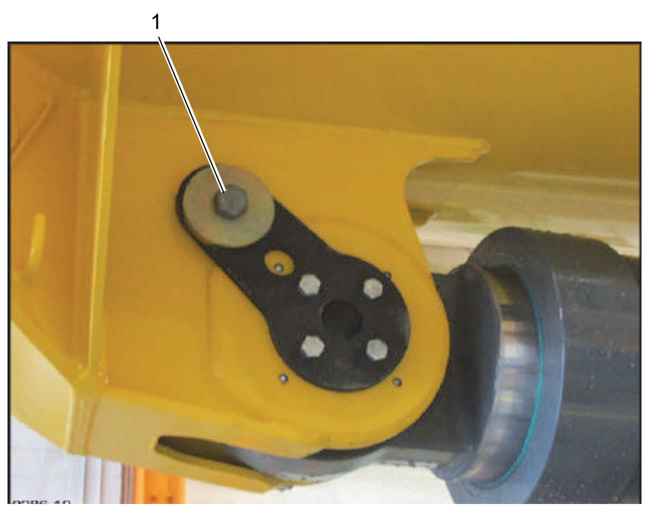
9. Lower the boom to zero degrees.
10. Move a crane hook to the front above the lift cylinder. Attach a strap under the lift cylinder and lift it (Figure 4-1).

NOTE: Install a piece of wood to prevent damaging the electrical harness as shown in the red circle (Figure 4-1).

9286-6

FIGURE 4-1

11. Prior to disconnecting the lift cylinder, install blocking under the lift cylinder.
12. Lower the boom so that the lift cylinder is supported on the blocking.
13. Remove the bolt that secures the pin (1), (Figure 4-2).
14. Unscrew stop bolts (1), (Figure 4-4) on the other side of boom.



9286-10

FIGURE 4-2

15. Attach two cranes to the boom (Figure 4-3).

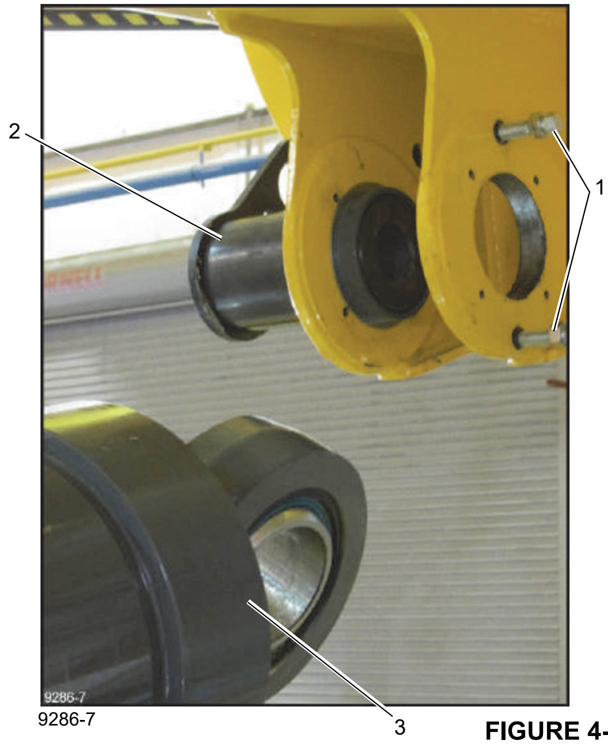
9286

9286-1

FIGURE 4-3

16. Slightly lift the boom to remove weight on the pivot pins.

17. Pull lift cylinder pin (2), (Figure 4-4) far enough out that the cylinder (3), (Figure 4-4) will clear it. Tag and remove the shims and bushing/plates on the pin.



9286-7

FIGURE 4-4

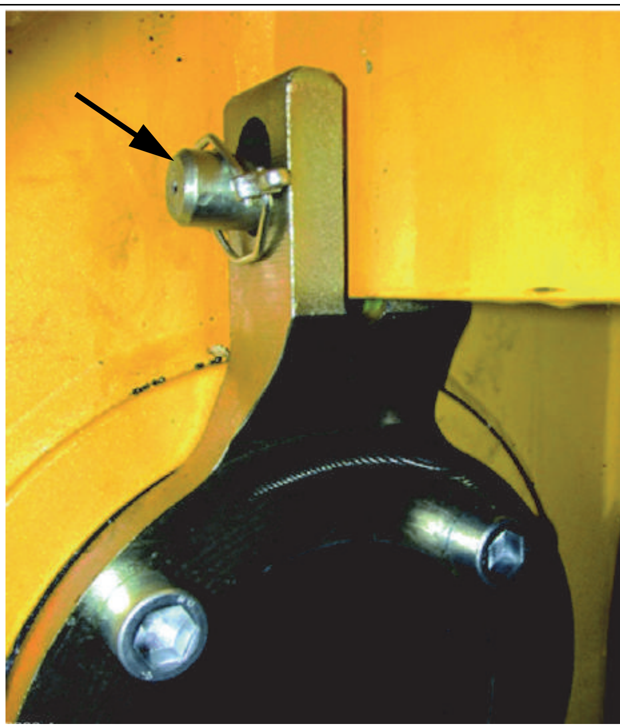
WARNING

Crushing Hazard!

Make sure that the lifting device is capable of supporting the boom assembly.

Severe injury or death may result.

18. Reach in access hole at top of boom, remove pins on stop plates (Figure 4-5).



9286-4 **FIGURE 4-5**

19. Using a mallet and block of wood drive the pivot pins fully in.

20. The weight of the boom is now held by the support cranes.

21. Raise the boom clear of the crane and lower it to the ground or trailer. Set cribbing to support the boom and prevent tipping.

22. Remove rigging and chains from the boom.

BOOM INSTALLATION

NOTE: The following procedure applies to the entire boom assembly that has been totally removed from the crane.

The boom, without any boom extension, weighs about 10,577 kg (23,320 lbs).

DANGER

Crushing Hazard!

Make sure that blocking and lifting devices are capable of supporting the boom assembly.

Block the boom before doing any work under the boom.

Failure to properly support the boom and/or the lift cylinder may result in death or serious injury.

1. With the machine properly set up on outriggers, attach two cranes to the boom (Figure 4-3) and suspend the boom over the machine.

2. Make sure that the pins are pushed all the way in (Figure 4-6) and will not get caught up during lowering into the turntable.

3. Lower the rear of the boom into position. Align the boom pivot mounting holes with mounting holes in the turntable. Make sure that all hydraulic and electrical cables are out of the way so they will not be damaged.

9286-2 **FIGURE 4-6**

4. Lubricate the pivot bushings in the turntable.

NOTE: The boom may need to be raised or lowered to aid in the installation of the boom pivot shafts.

5. Apply anti-seize compound to the boom pivot shafts.

6. Using a long bar, insert through pin, and tap backside of opposite pin (Figure 4-7). Install pin on non-cab side first. Continue until pin comes through mounting bushing and is flush with the outside.


9286-3

FIGURE 4-7

7. Reach in access hole at top of boom, install pins on stop plates already installed on back of mounting pins (Figure 4-8).

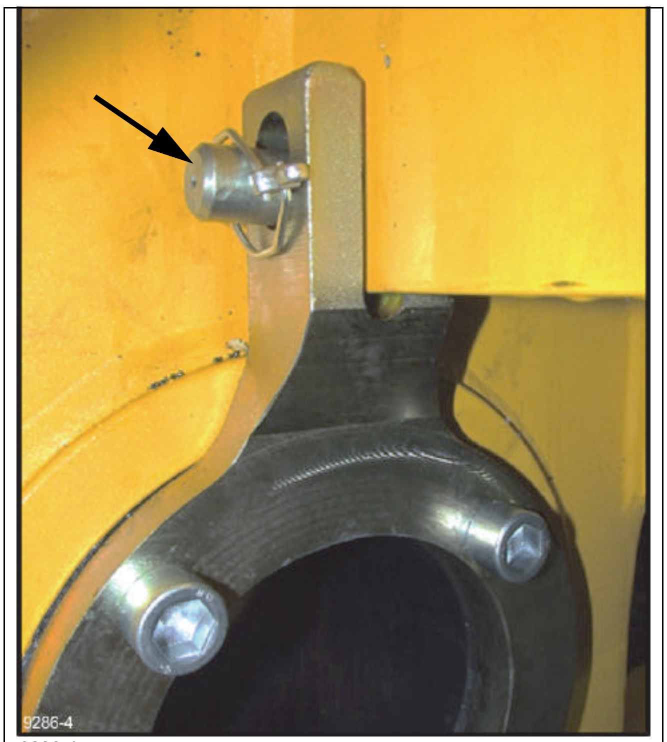

9286-4

FIGURE 4-8

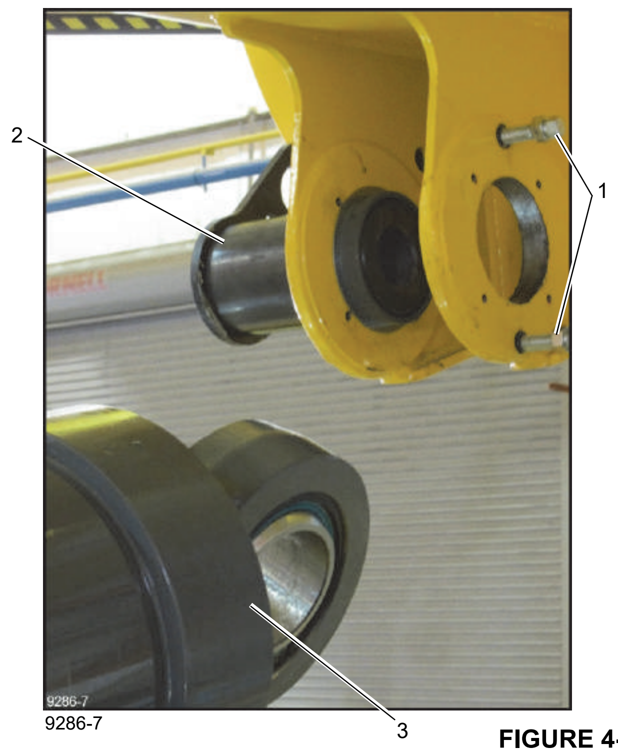
8. Prior to starting the lift cylinder to boom installation, make sure the lift cylinder is securely resting on the blocking.

9. Move the rear crane hook to the front above the lift cylinder. Attach a strap under the lift cylinder and lift it (Figure 4-1).

NOTE: Install a piece of wood to prevent damaging the electrical harness as shown in the red circle (Figure 4-1).

10. Run stop/adjustable bolts (1), (Figure 4-9) on the side of the weldment completely out.

11. Pull lift cylinder pin (2), (Figure 4-9) far enough out that the cylinder (3), (Figure 4-9) will clear it. Install shim and bushing/plate on the pin.



9286-7

FIGURE 4-9

12. Have an operator in the crane extend the lift cylinder until aligned with boom mounting holes.

NOTE: This should be carefully controlled. If the lift cylinder rod is extended too far, it cannot be retracted using the main directional control valve.

NOTE: This may take a combination of both cranes lifting the boom and lifting the cylinder up and down and the operator in the crane moving the cylinder in and out.

CAUTION

Equipment Damage Hazard!

If the hydraulic system must be activated to extend or retract the lift cylinder, ensure the rod end is properly aligned with the lift cylinder pivot.

13. Install shims and bushing/plate in other side of lift cylinder.

CAUTION

Pinch Hazard!

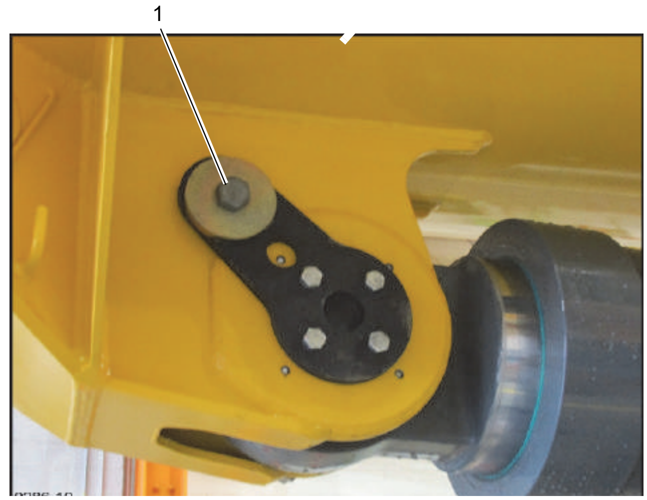
Use caution when installing pin, high pinch point risk.

14. Tap lift cylinder pin all the way in, be sure pin is properly aligned with bolt hole on side of boom (Figure 4-10).

9286-9

FIGURE 4-10

15. Install bolt to secure pin (1), (Figure 4-11).
16. Adjust stop bolts on other side of boom.



9286-10

FIGURE 4-11

17. Connect the hydraulic lines as tagged before removal from the boom to the turntable.
18. Connect the electrical cables from the boom to the turntable.

Functional Check

1. Activate the hydraulic system and check for proper operation and leaks.
2. Make sure that the boom will extend and retract properly.

NOTE: Cycle the boom several times to evacuate air from the telescope cylinder.

3. Make sure the lift cylinder does not allow the boom to drift down

BOOM NOSE SHEAVES

Do not attempt to work on the boom without experienced supervision.

DANGER

Accident Hazard!

To prevent serious injury or death, always wear personal protective equipment; i.e., a hard hat, eye protection, gloves and metatarsal boots.

Boom Nose Sheaves Removal

1. Remove the securing pins (16), (Figure 4-12) from the cable retainer pins (15, 20, 21), (Figure 4-12) and

remove the cable retainer pins from the upper and lower part of the boom nose.

2. Remove the two hex head screws (5), (Figure 4-12) securing the cover plate (4), (Figure 4-12) to the upper boom nose axle (2), (Figure 4-12). Remove the cover plate.

NOTE: The boom nose sheave shafts weigh approximately 12.5 kg (27.5 lb) each. The boom nose sheaves weigh approximately 17.4 kg (38 lb) each.

3. Carefully pull the upper boom nose sheave shaft (6), (Figure 4-12) from the boom nose, removing the spacers, and boom nose sheaves (4), (Figure 4-12). **Note** the quantity of the spacers for installation.

4. Repeat Steps 2 and 3 and remove the lower boom nose sheave shaft.

5. Remove the shim, washer, keyed washer and locknut from both sheave shafts.

Telescope Section 6 Assembly

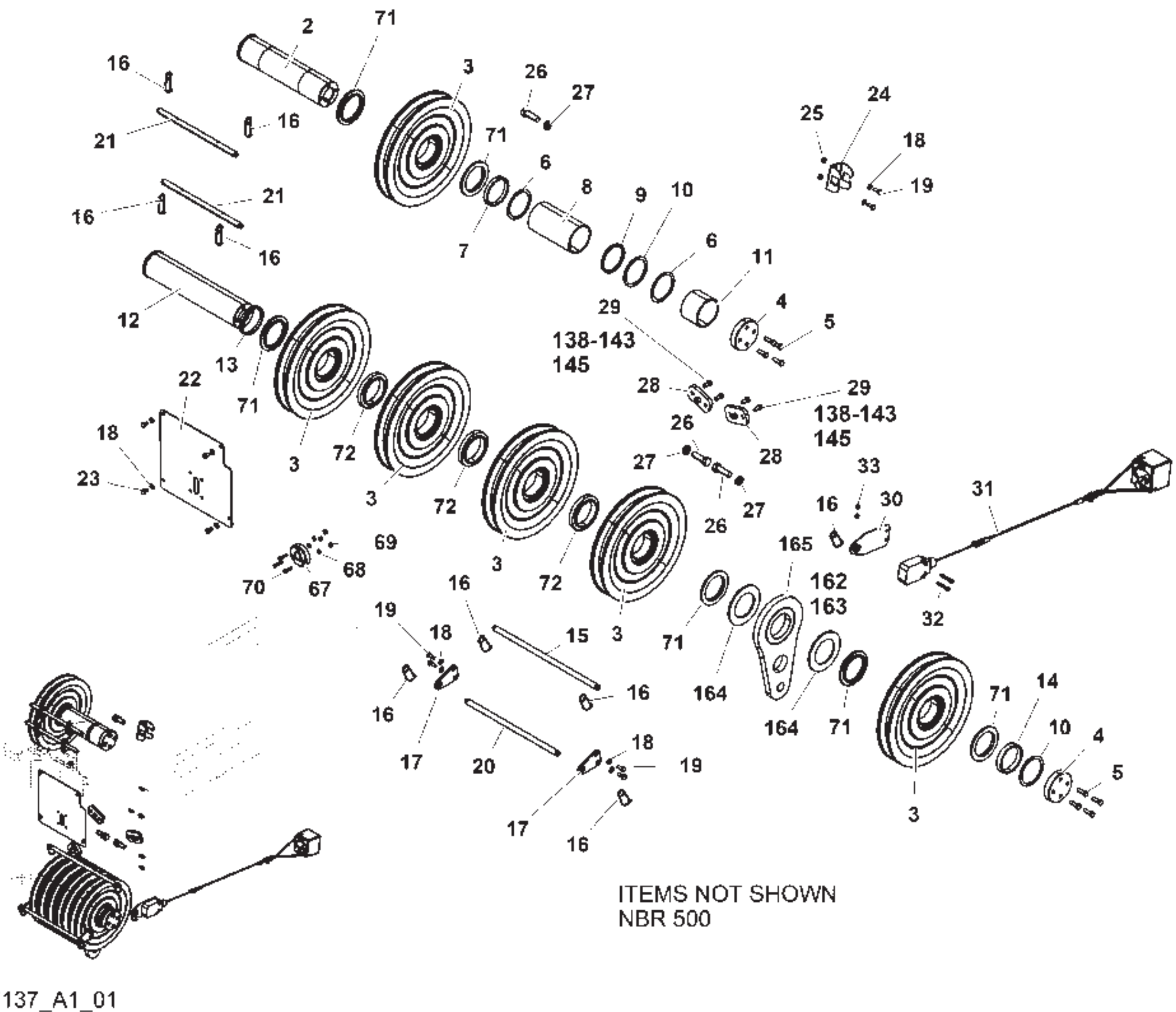


FIGURE 4-12

Telescope Section 6 Assembly (Continued)

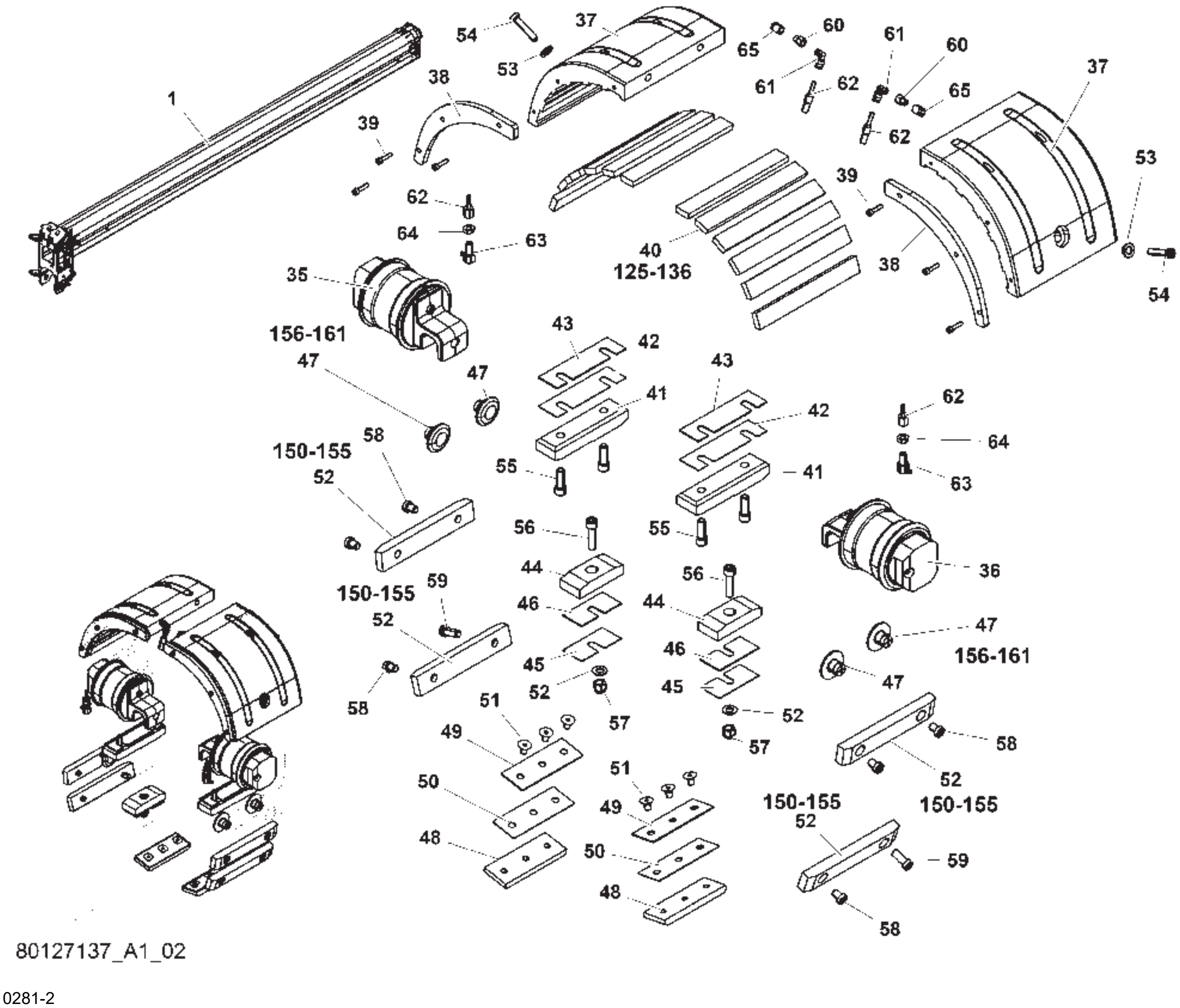


FIGURE 4-12 continued

Item Number	Description
1	TELESCOPIC PART 6
2	AXLE
3	SHEAVE
4	COVER PLATE
5	HEX HEAD SCREW
6	SHIM,2MM
7	SPACER RING
8	RING, SPACER
9	SPACER RING
10	SHIM RING
11	SPACER RING
12	AXLE
13	SPACER RING
14	SPACER RING
15	PIN
16	SECURING PIN
17	PLATE
18	WASHER
19	HEXAGON HEAD SCREW
20	PIN
21	PIN
22	PLATE
23	HHCS M10X16 8.8
24	OUTER STOCK SUPPORT
25	HEX NUT
26	HEXAGON HEAD SCREW
27	HEXAGON THIN NUT
28	SPACER
29	SOCKET-HEAD SCREW
30	SHACKLE
31	LIMIT SWITCH - WEIGHT ASSEMBLY
32	SHCS M8x50 8.8
33	HEX NUT M8 8
34	CABLE CLIP
35	LOCKING UNIT ASSY
36	LOCKING UNIT ASSY
37	WEAR PAD TELE 6 ASSY.
38	PLATE

Item Number	Description
39	CAP SCREW
40	STRIP
41	SLIDER
42	PLATE
43	PLATE
44	SLIDER
45	PLATE
46	PLATE
47	GUIDE PILOT
48	SLIDER
49	FILL PLATE
50	FILL PLATE
51	SFS, M10X16
52	WEAR PAD
53	WASHER, 12 FLAT
54	SHCS M10X50
55	SHCS M12x35 8.8
56	CAP SCREW
57	HEX L NUT M12
58	SOCKET-HEAD SCREW
59	SOCKET-HEAD SCREW
60	ADAPTER
61	ANGLE PIPE UNION
62	LUBRICANT HOSE
63	PIPE UNION
64	NUT, THIN
65	INSERT
66	COVER
67	WEAR PAD
68	F WASHER
69	HEXAGON NUT M8
70	SHCS M8X30
71	DISTANCE RING
72	DISTANCE RING
73	WEAR PAD TELE 6 ASSY.

Boom Nose Sheaves Installation

Refer to (Figure 4-12) when performing this installation.

NOTE: This procedure can be greatly simplified if two technicians are used. One technician to hold the sheave in place and the other to insert the spacers and axle.

1. Install the rings (7, 10, 13), spacers (72) and sheaves (3) onto the axle (12) while installing the axle into the lower boom nose.
2. Secure the axle with the cover (66) and hex head screws (5).
3. Repeat Steps 1 and 2 for the upper boom nose sheaves and axle.
4. Install the cable retainer pins into the upper and lower part of the boom nose and secure in place with the securing pins.

BOOM DISASSEMBLY

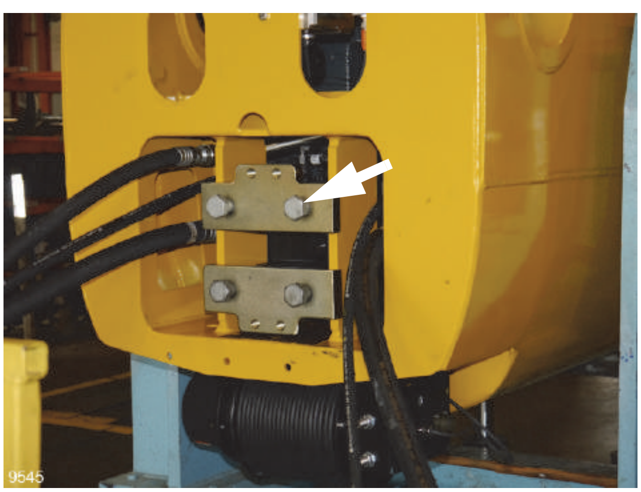
Do not attempt to work on the boom without experienced supervision.

DANGER

Accident Hazard!

To prevent serious injury or death, always wear personal protective equipment; i.e., a hard hat, eye protection, gloves and metatarsal boots.

1. Pin the cylinder to Tele 1.
2. Remove the four cylinder retaining bolts (Figure 4-13) and two retaining plates.



9545 **FIGURE 4-13**

3. Climb into the base section and secure the hoses to the cylinder to keep them from being damaged when removing the tele cylinder.
4. Remove the sliders, strips and plates (3, 4, 10, 12), (Figure 4-21).
5. Remove the sliders, holders, strips and plates (5, 6, 7, 8, 11, 13, 14), (Figure 4-21).
6. Remove Tele Section 1 from the Base Section (1), (Figure 4-21).
7. Remove the tele power plug (1), (Figure 4-14).
8. Remove the tele power cable strain relief (2), (Figure 4-14).

9551 **FIGURE 4-14**

9. Remove the Tele cylinder.
10. Remove the wear pads, plates, and strips (28, 29, 30, 32), (Figure 4-20), as necessary.
11. Remove the sliders, fill plates, plates, and guide pilots (33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47), (Figure 4-20) as necessary. Tag the plates and sliders as to their location for reassembly.
12. Remove the wear pads, holders, strips and plates (3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14), (Figure 4-20).
13. Remove the rope protection bar (2), (Figure 4-20).
14. Remove the guide (162), (Figure 4-20).
15. Remove Tele Section 2 (1), (Figure 4-19).
16. Remove the wear pads, plates, and strips (29, 30, 32), (Figure 4-19) as necessary.
17. Remove the sliders, fill plates, plates, and guide pilots (33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47), (Figure 4-19) as necessary. Tag the plates and sliders as to their location for reassembly.

18. Remove the wear pads, holders, strips, and plates (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14), (Figure 4-19).
19. Remove the rope protection bar (2), (Figure 4-19).
20. Remove the guide (162), (Figure 4-19).
21. Remove Tele Section 3 (1), (Figure 4-18).
22. Remove the wear pads, plates, and strips (29, 30, 32), (Figure 4-18) as necessary.
23. Remove the sliders, fill plates, plates, and guide pilots (33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47), (Figure 4-18) as necessary. Tag the plates and sliders as to their location for reassembly.
24. Remove the wear pads, holders, strips, and plates (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14), (Figure 4-18).
25. Remove the rope protection bar (2), (Figure 4-18).
26. Remove the guide (162), (Figure 4-18).
27. Remove Tele Section 4 (1), (Figure 4-17).
28. Remove the wear pads, plates, and strips (29, 30, 32, 59), (Figure 4-17) as necessary.
29. Remove the sliders, fill plates, plates, and guide pilots (33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46), (Figure 4-17) as necessary. Tag the plates and sliders as to their location for reassembly.
30. Remove the wear pads, holders, strips, and plates (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14), (Figure 4-17).
31. Remove the rope protection bar (2), (Figure 4-17).
32. Remove the guide (162), (Figure 4-17).
33. Remove Tele Section 5 (1), (Figure 4-16).
34. Remove the wear pads, plates, and strips (29, 30, 32), (Figure 4-16) as necessary.
35. Remove the sliders, fill plates, plates, and guide pilots (33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45), (Figure 4-16) as necessary. Tag the plates and sliders as to their location for reassembly.
36. Remove the wear pads, holders, strips, and plates (3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14), (Figure 4-16).
37. Remove the rope protection bar (2), (Figure 4-16).
38. Remove the guide (162), (Figure 4-16).
39. Remove Tele Section 6 (1), (Figure 4-12).
40. Remove the wear pads, strips, and plates (37, 38, 40), (Figure 4-12).
41. Remove the sliders, plates, guide pilots, fill plates and wear pads (41, 42, 43, 44, 45, 46, 47, 48, 49, 50), (Figure 4-12). Tag the plates, sliders, fill plates, and wear pads as to their location for reassembly.

BOOM ASSEMBLY

Do not attempt to work on the boom without experienced supervision.

DANGER

Accident Hazard!

To prevent serious injury or death, always wear personal protective equipment; i.e., a hard hat, eye protection, gloves and metatarsal boots.

NOTE: Apply Loctite 243 to the threads of all attaching hardware except cable ends and cable lock nuts.

Apply multipurpose grease (MPG) to all wear surfaces.

Use standard torque values specified in Section 1 of this Manual unless otherwise specified.

NOTE: **Wear Pads**. When installing upper and lower side wear pad, use shims as necessary so wear pad is within 1.52 mm (0.06 inch) from side plate of next inner section. Use equal number of shims on each side.

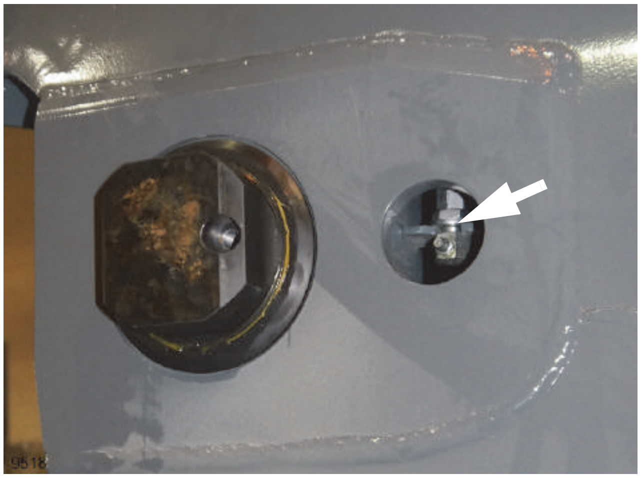
If wear pad shims were previously removed, place shims in same locations that was noted during removal.

Telescope Section 6 Assembly

Refer to (Figure 4-12) when assembling this section.

1. Install the plates (49, 50) and sliders (48).
2. Install the wear pads (52).
3. Install the plates (45, 46) and sliders (44).
4. Install the guide pilots (47).
5. Install the plates (42, 43) and sliders (41).
6. Place the wear pad (37) on the section and insert six strips (40) inside.
7. Secure the wear pad (37) with the plate (38).
8. Install the opposite wear pad (73), strips (40) and plate (38).
9. Assemble the lubrication hoses (60, 61, 62, 65) and connect to the wear pads (37, 73).

10. Attach the thin nuts (64) and pipe unions (63) to the lubrication hoses and secure the hoses to the tabs (Figure 4-15) inside the section.



9518

FIGURE 4-15

11. Install the locking unit assemblies (35, 36), (Figure 4-12).

12. Insert Section 6 into Section 5 just far enough to measure the gaps between the sliders and wear pads and Section 5. The gaps should be no greater than 1.52 mm (0.06 in). Adjust the gaps by adding or removing plates or using thicker or thiner sliders and wear pads.

13. Insert Section 6 into Section 5 half way.

Telescope Section 5 Assembly

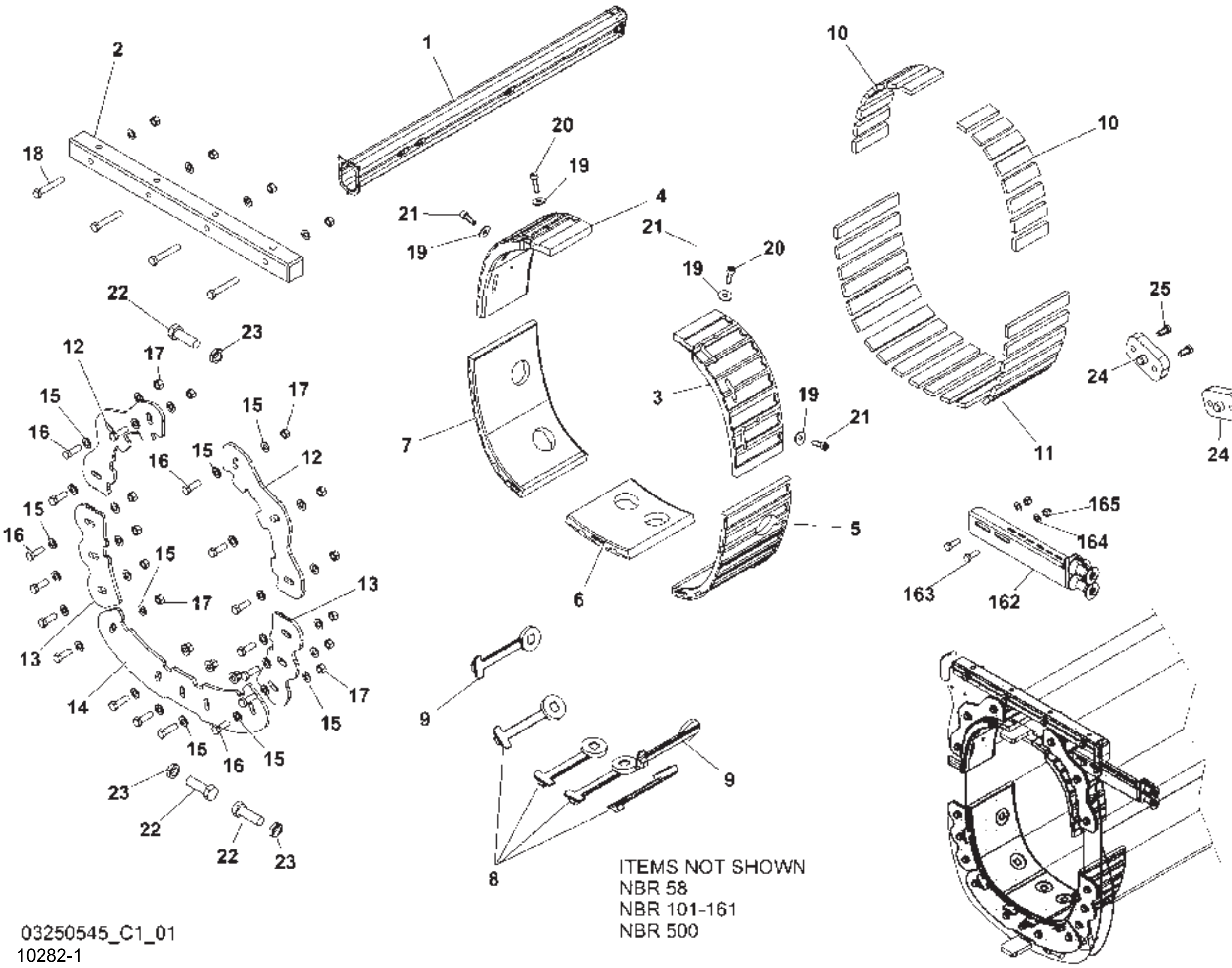
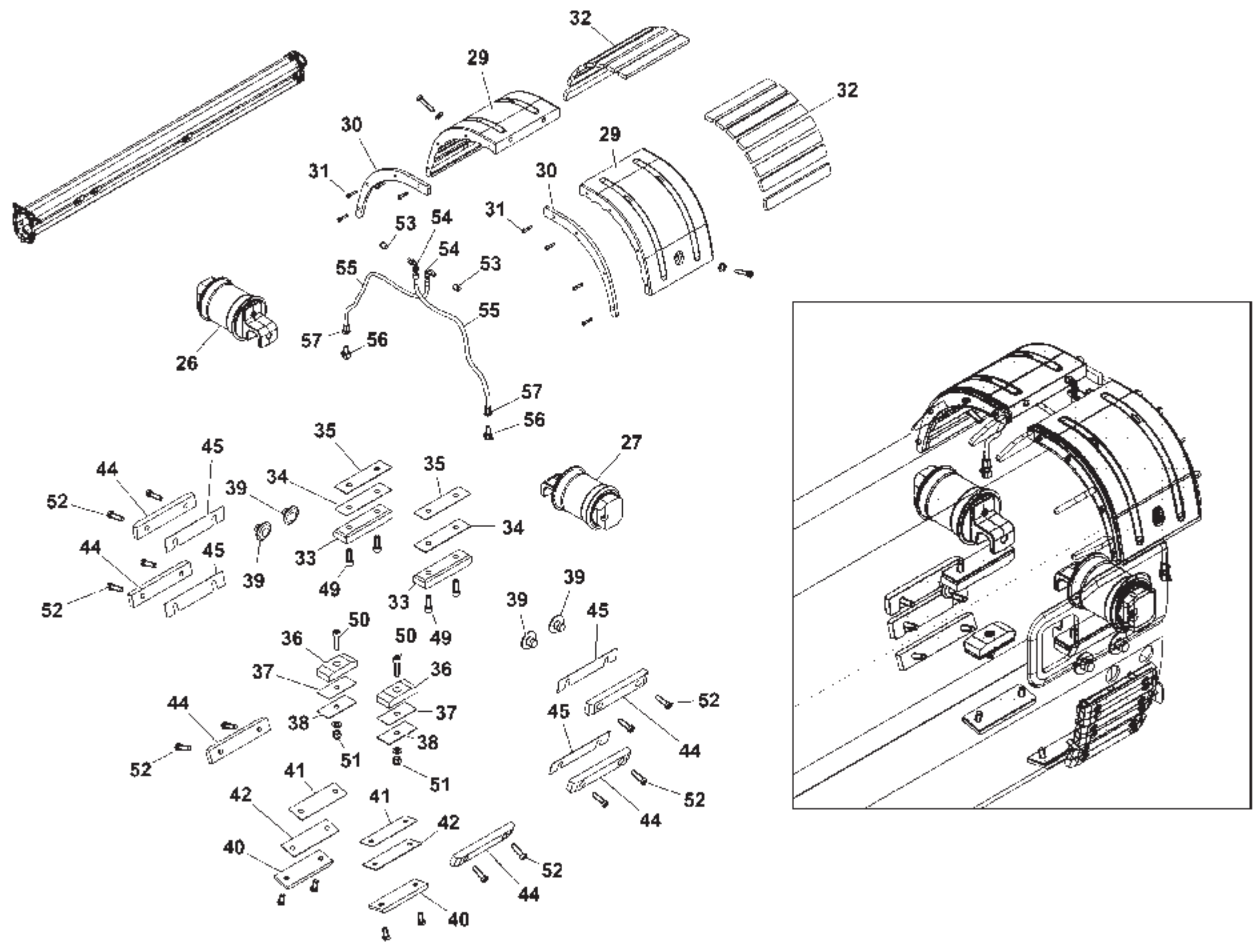


FIGURE 4-16

Telescope Section 5 Assembly (Continued)



10282-2

FIGURE 4-16 continued

Item Number	Description
1	TELESCOPIC PART 5
2	ROPE PROTECTION
3	WEAR PAD - TELE 5
4	WEAR PAD - TELE 5
5	WEAR PAD - TELE 5
6	WEAR PAD - TELE 5
7	WEAR PAD - TELE 5
8	HOLDER
9	HOLDER
10	STRIP T=11
11	STRIP T=10
12	PLATE
13	PLATE
14	PLATE
15	WASHER, 12 FLAT
16	HHCS M12x35 8.8
17	HEX NUT M12
18	HEXAGON HEAD BOLT
19	WASHER
20	SHCS M10X35 8.8
21	SHCS M10X30 8.8
22	HEXAGON HEAD SCREW
23	HEXAGON THIN NUT
24	SPACER
25	SOCKET HEAD SCREW
26	LOCKING UNIT ASSY
27	LOCKING UNIT ASSY
29	WEAR PAD TELE 5 ASSY
30	PLATE
31	CAP SCREW
32	STRIP T=11
33	SLIDER SUSTAGLIDE
34	PLATE
35	PLATE
36	SLIDER SUSTAGLIDE
37	PLATE
38	PLATE

Item Number	Description
39	GUIDE PILOT
40	SLIDER
41	FILL PLATE - 1 MM
42	FILL PLATE - 2MM
44	WEAR PAD SUSTAGLIDE
45	PLATE
49	SHCS M12x35 8.8
50	CAP SCREW
51	HEX L NUT M12
52	SOCKET-HEAD SCREW
53	ADAPTER
54	ANGLE PIPE UNION
55	LUBRICANT HOSE
56	PIPE UNION, M12X1
57	NUT, THIN
58	INSERT
61	FLAT COLLAR NUT M12
62	HEXAGON HEAD SCREW
162	GUIDE
163	CAP SCREW
164	WASHER
165	HEXAGON NUT

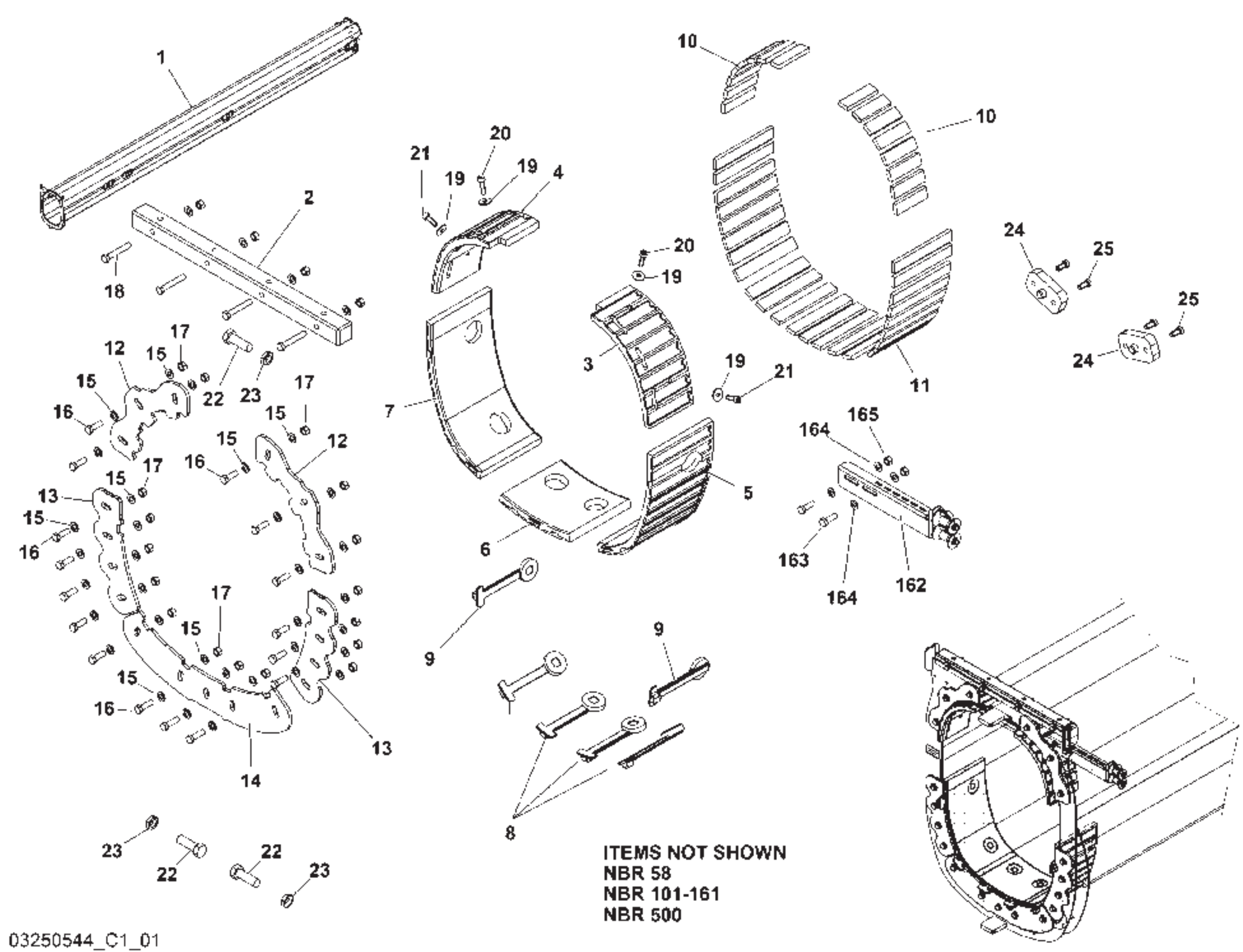
Telescope Section 5 Assembly

Refer to (Figure 4-16) when assembling this section.

1. Connect a strap to Tele 6, then using an overhead lifting device or another crane, lift Tele 6 so the strips (11), holders (8, 9) and wear pads (5, 6, 7) can be installed.
2. Install the hexagon head screws (22) and hexagon thin nuts (23).
3. Install the spacers (24).
4. Secure the strips and wear pads in place with the plates (13, 14).
5. Lower Tele 6.
6. Install the wear pads (3, 4).
7. Install the strips (10).
8. Secure the strips and wear pads with the plates (12).
9. Install the rope protection bar (2).
10. Install the guide (162).

11. On the opposite end of Tele 5, install sliders (40) and fill plates (41, 42).
12. Install wear pads (44) and plates (45).
13. Install sliders (36) and plates (37, 38).
14. Install the guide pilots (39).
15. Install the sliders (33) and plates (34, 35).
16. Place wear pads (29) on the section and insert eight strips (32) inside each pad.
17. Secure the wear pads (29) with the plates (30).
18. Assemble the lubrication hoses (53, 54, 55) and connect to the wear pads (29).
19. Attach the thin nuts (57) and pipe unions (56) to the lubrication hoses and secure the hoses to the tabs inside the section.
20. Install the locking unit assemblies (26, 27).
21. Insert Section 6 completely into Section 5.
22. Insert Section 5 into Section 4 just far enough to measure the gaps between the sliders and wear pads and Section 4. The gaps should be no greater than 1.52 mm (0.06 in). Adjust the gaps by adding or removing plates or using thicker or thiner sliders and wear pads.
23. Insert Section 5 into Section 4 half way.

Telescope Section 4 Assembly



10283-1

FIGURE 4-17

Telescope Section 4 Assembly (Continued)

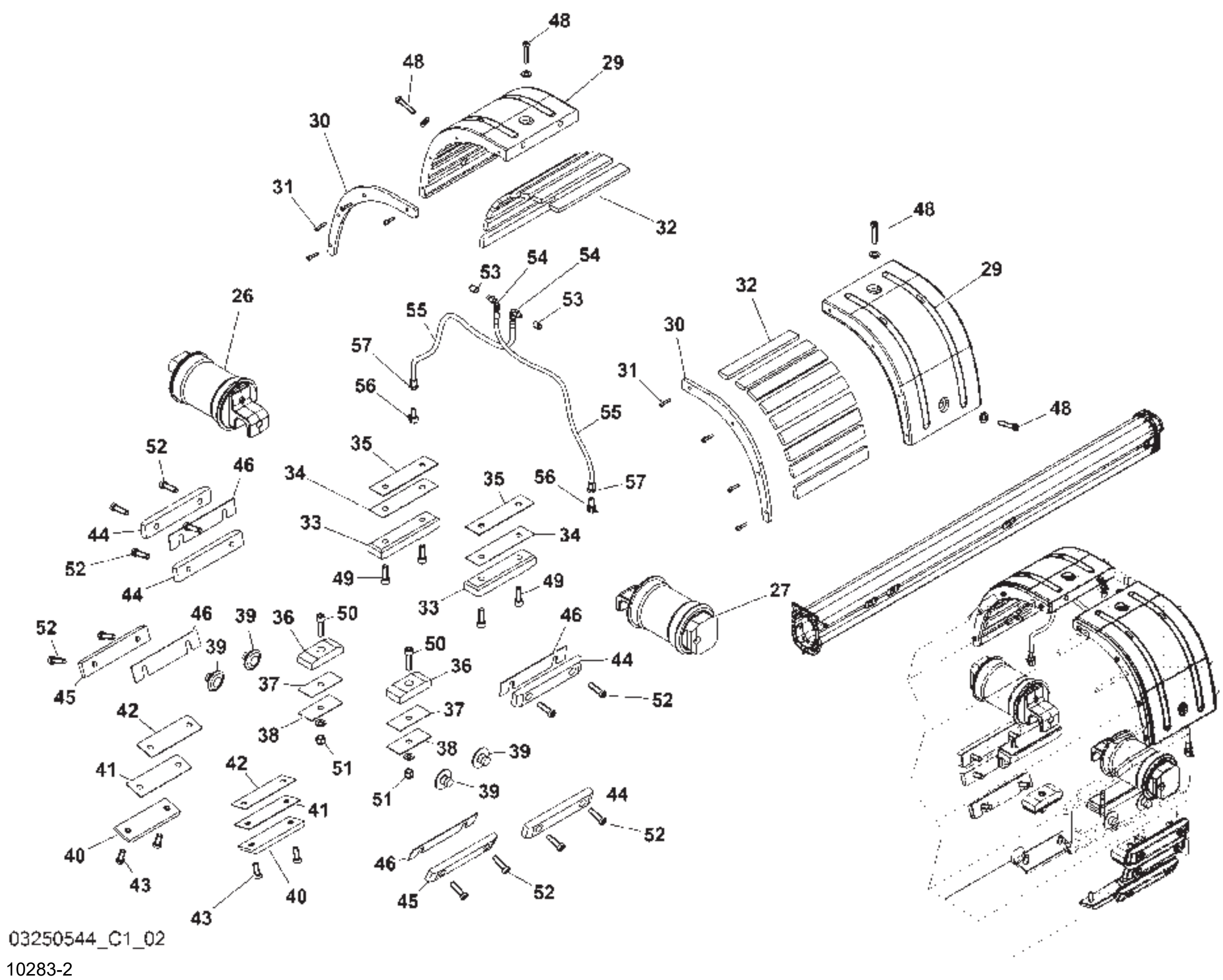


FIGURE 4-17 continued

Item Number	Description
1	TELESCOPIC PART 4
2	ROPE PROTECTION
3	WEAR PAD - TELE 4
4	WEAR PAD - TELE 4
5	WEAR PAD - TELE 4
6	WEAR PAD - TELE 4
7	WEAR PAD - TELE 4
8	HOLDER
9	HOLDER
10	STRIP T=11
11	STRIP T=10
12	PLATE
13	PLATE
14	PLATE
15	WASHER, 12 FLAT
16	HHCS M12x35 8.8
17	HEX NUT M12
18	HEXAGON HEAD BOLT
19	WASHER
20	SHCS M10X35 8.8
21	SHCS M10X30 8.8
22	HEXAGON HEAD SCREW
23	HEXAGON THIN NUT
24	SPACER
25	SOCKET-HEAD SCREW
26	LOCKING UNIT ASSY
27	LOCKING UNIT ASSY
29	WEAR PAD TELE 4 ASSY.
30	PLATE
31	CAP SCREW
32	STRIP T=11
33	SLIDER
34	FILE PLATE
35	FILL PLATE
36	SLIDER SUSTAGLIDE
37	PLATE
38	PLATE
39	GUIDE PILOT
40	SLIDER
41	FILL PLATE - 1 MM
42	FILL PLATE - 2MM
43	SOCKET-HEAD SCREW
44	WEAR PAD SUSTAGLIDE
45	WEAR PAD SUSTAGLIDE
46	PLATE
48	SHCS M10X50
49	SHCS M12x35 8.8
50	CAP SCREW
51	HEX L NUT M12
52	SOCKET-HEAD SCREW
53	ADAPTER
54	ANGLE PIPE UNION
55	LUBRICANT HOSE
56	PIPE UNION, M12X1
57	NUT, THIN
58	INSERT
59	WEAR PAD TELE 4 ASSY.
61	FLAT COLLAR NUT M12
62	HEXAGON HEAD SCREW
162	GUIDE
163	CAP SCREW
164	WASHER
165	HEXAGON NUT

Telescope Section 4 Assembly

Refer to (Figure 4-17) when assembling this section.

1. Connect a strap to Tele 5, then using an overhead lifting device or another crane, lift Tele 5 so the strips (11), holders (8, 9) and wear pads (5, 6, 7) can be installed.
2. Install the hexagon head screws (22) and hexagon thin nuts (23).
3. Install the spacers (24).
4. Secure the strips and wear pads in place with the plates (13, 14).
5. Lower Tele 5.
6. Install the wear pads (3, 4).
7. Install the strips (10).

8. Secure the strips and wear pads with the plates (12).
9. Install the rope protection bar (2).
10. Install the guide (162).
11. On the opposite end of Tele 4, install sliders (40) and fill plates (41, 42).
12. Install wear pads (44) and plates (45).
13. Install sliders (36) and plates (37, 38).
14. Install the guide pilots (39).
15. Install the sliders (33) and plates (34, 35).
16. Place wear pads (29) on the section and insert nine strips (32) inside each wear pad.
17. Secure the wear pads (29) with the plates (30).
18. Assemble the lubrication hoses (53, 54, 55, 58) and connect to the wear pads (29).
19. Attach the thin nuts (57) and pipe unions (56) to the lubrication hoses and secure the hoses to the tabs inside the section.
20. Install the locking unit assemblies (26, 27).
21. Insert Section 4 into Section 3 just far enough to measure the gaps between the sliders and wear pads and Section 3. The gaps should be no greater than 1.52 mm (0.06 in). Adjust the gaps by adding or removing plates or using thicker or thiner sliders and wear pads.
22. Insert Section 4 into Section 3 half way.

Telescope Section 3 Assembly

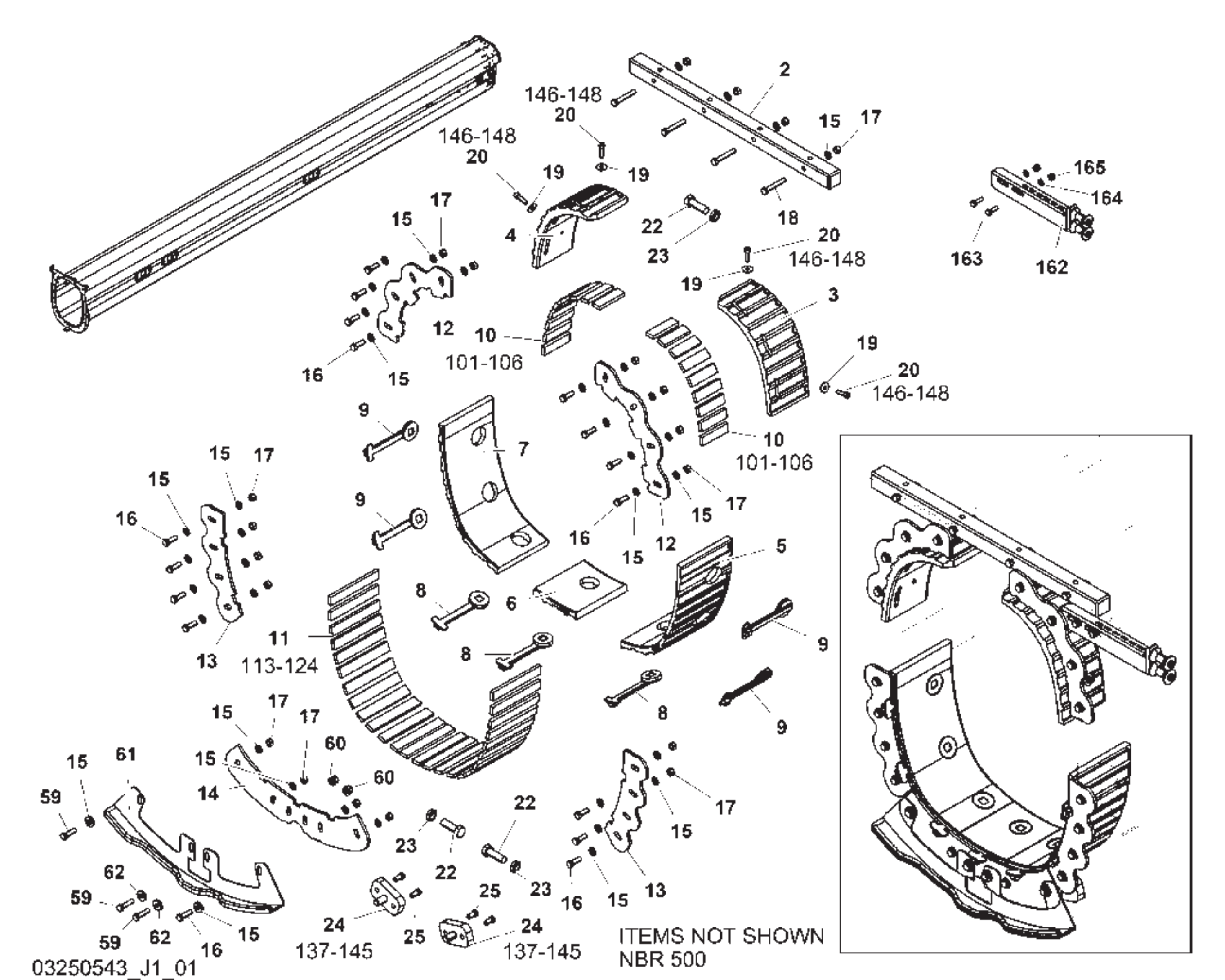
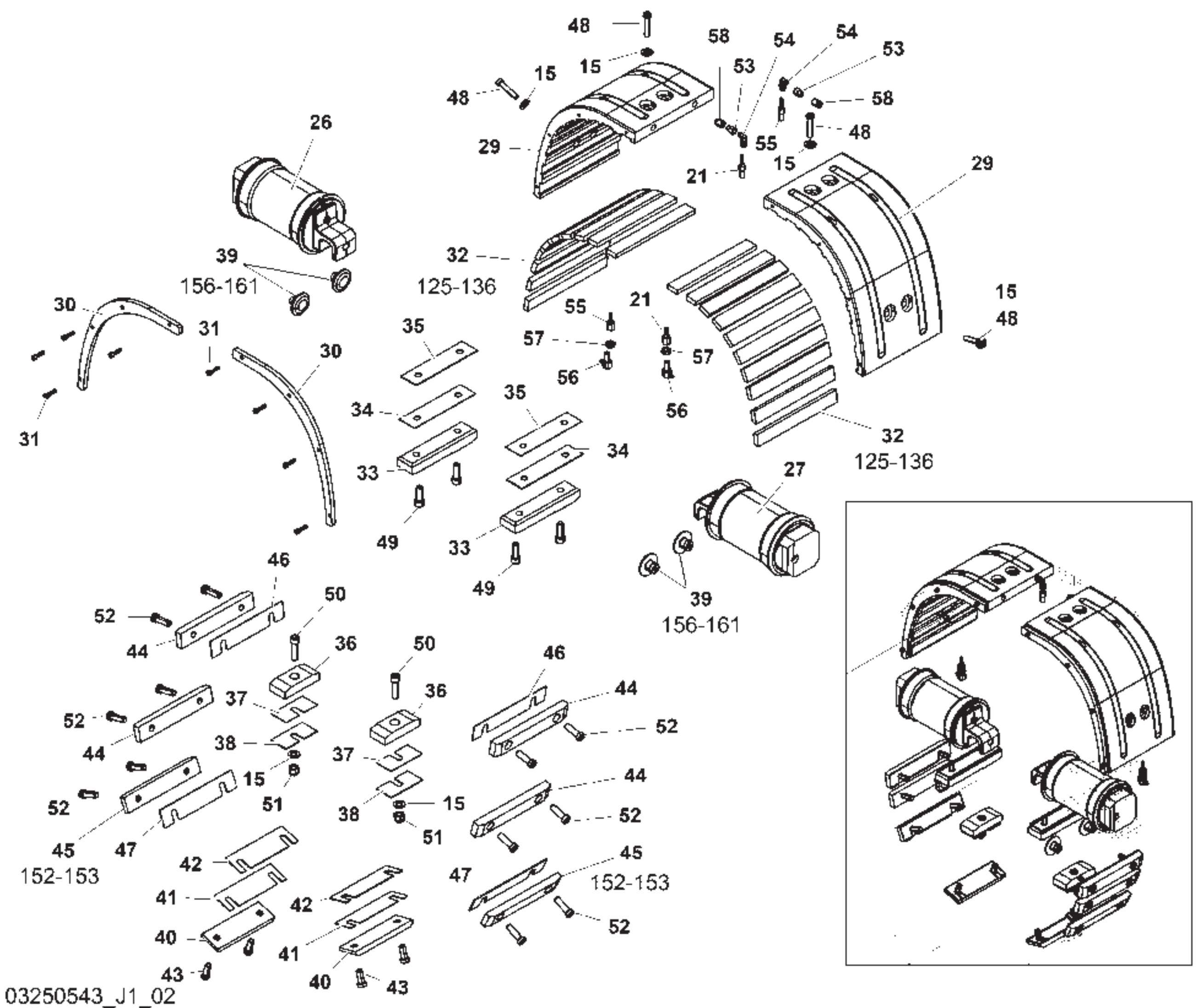


FIGURE 4-18

Telescope Section 3 Assembly (Continued)



10284-2

FIGURE 4-18 continued

Item Number	Description
1	TELESCOPIC PART 3
2	ROPE PROTECTION
3	WEAR PAD - TELE 3
4	WEAR PAD - TELE 3
5	WEAR PAD - TELE 3
6	WEAR PAD - TELE 3
7	WEAR PAD - TELE 3
8	HOLDER
9	HOLDER
10	STRIP T=11
11	STRIP T=10
12	PLATE
13	PLATE
14	PLATE
18	HEXAGON HEAD BOLT
19	WASHER
20	SHCS M10X35 8.8
22	HEXAGON HEAD SCREW
23	HEXAGON THIN NUT
24	SPACER
25	SOCKET-HEAD SCREW
26	LOCKING UNIT ASSY
27	LOCKING UNIT ASSY
29	WEAR PAD TELE 3 ASSY.
30	PLATE
31	CAP SCREW
32	STRIP T=11
33	SLIDER
34	FILE PLATE
35	FILL PLATE
36	SLIDER
37	PLATE
38	PLATE
39	GUIDE PILOT
40	SLIDER
41	FILL PLATE - 1 MM
42	FILL PLATE - 2MM
43	SOCKET-HEAD SCREW

Item Number	Description
44	WEAR PAD
45	WEAR PAD
46	PLATE
47	PLATE
48	SHCS M10X50
49	SHCS M12x35 8.8
50	CAP SCREW
51	HEX L NUT M12
52	SOCKET-HEAD SCREW
53	ADAPTER
54	ANGLE PIPE UNION
55	LUBRICANT HOSE
56	PIPE UNION, M12X1
57	NUT, THIN
58	INSERT
59	HHCS M12X40
162	GUIDE
163	CAP SCREW
164	WASHER
165	HEXAGON NUT

Telescope Section 3 Assembly

Refer to (Figure 4-18) when assembling this section.

1. Connect a strap to Tele 4, then using an overhead lifting device or another crane, lift Tele 4 so the strips (11), holders (8, 9) and wear pads (5, 6, 7) can be installed.
2. Install the hexagon head screws (22) and hexagon thin nuts (23).
3. Install the spacers (24).
4. Secure the strips and wear pads in place with the plates (13, 14).
5. Lower Tele 4.
6. Install the wear pads (3, 4).
7. Install the strips (10).
8. Secure the strips and wear pads with the plates (12).
9. Install the rope protection bar (2).
10. Install the guide (162).
11. On the opposite end of Tele 3, install sliders (40) and fill plates (41, 42).

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12. Install wear pads (44) and plates (45).
13. Install sliders (36) and plates (37, 38).
14. Install the guide pilots (39).
15. Install the sliders (33) and plates (34, 35).
16. Place the wear pads (29) on the section and insert ten strips (32) inside each wear pad.
17. Secure the wear pads (29) with the plates (30).
18. Assemble the lubrication hoses (53, 54, 55, 58) and connect to the wear pads (29).
19. Attach the thin nuts (57) and pipe unions (56) to the lubrication hoses and secure the hoses to the tabs inside the section.
20. Install the locking unit assemblies (26, 27).
21. Insert Section 3 into Section 2 just far enough to measure the gaps between the sliders and wear pads and Section 2. The gaps should be no greater than 1.52 mm (0.06 in). Adjust the gaps by adding or removing plates or using thicker or thiner sliders and wear pads.
22. Insert Section 3 into Section 2 half way.

Telescope Section 2 Assembly

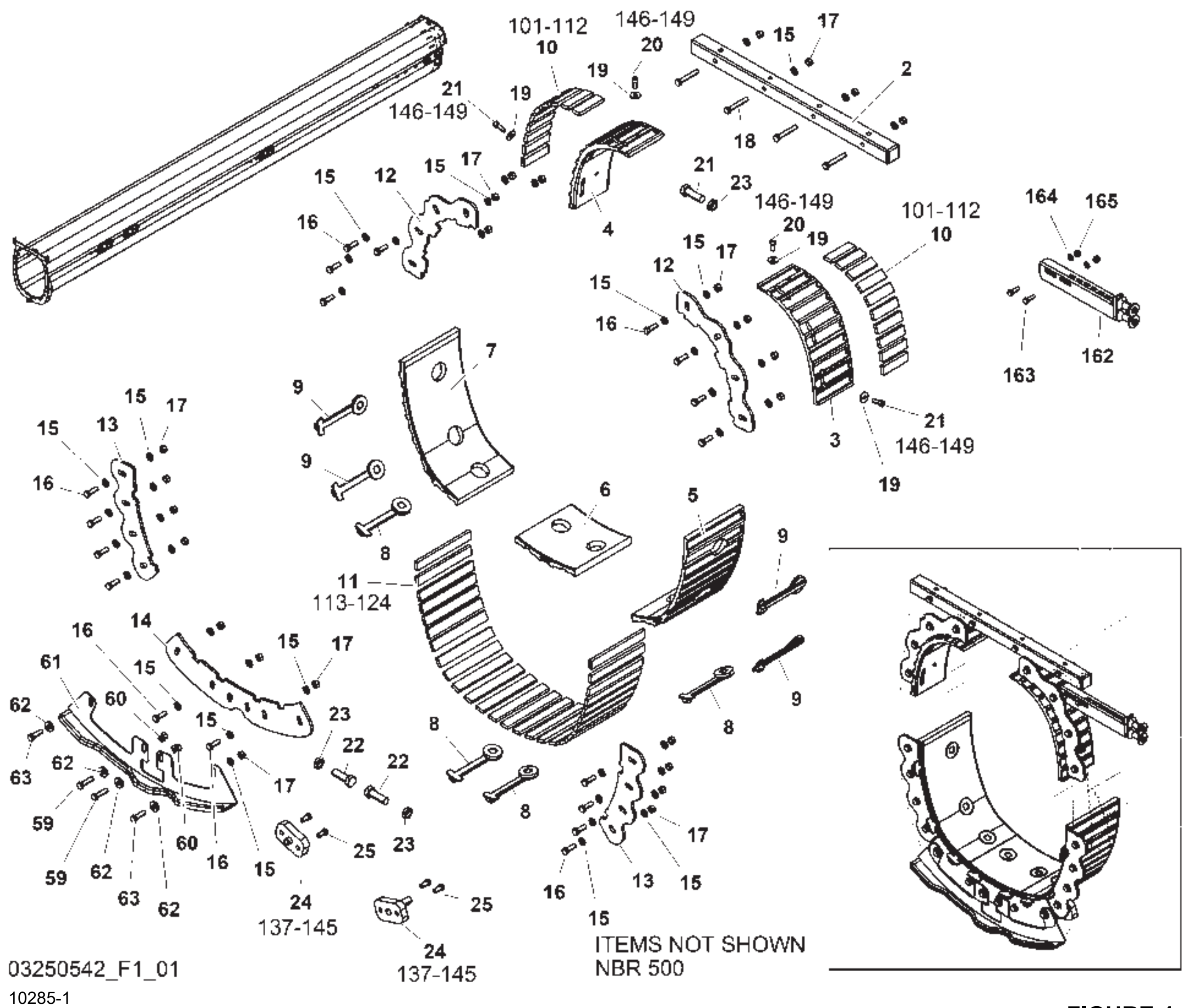


FIGURE 4-19

Telescope Section 2 Assembly (Continued)

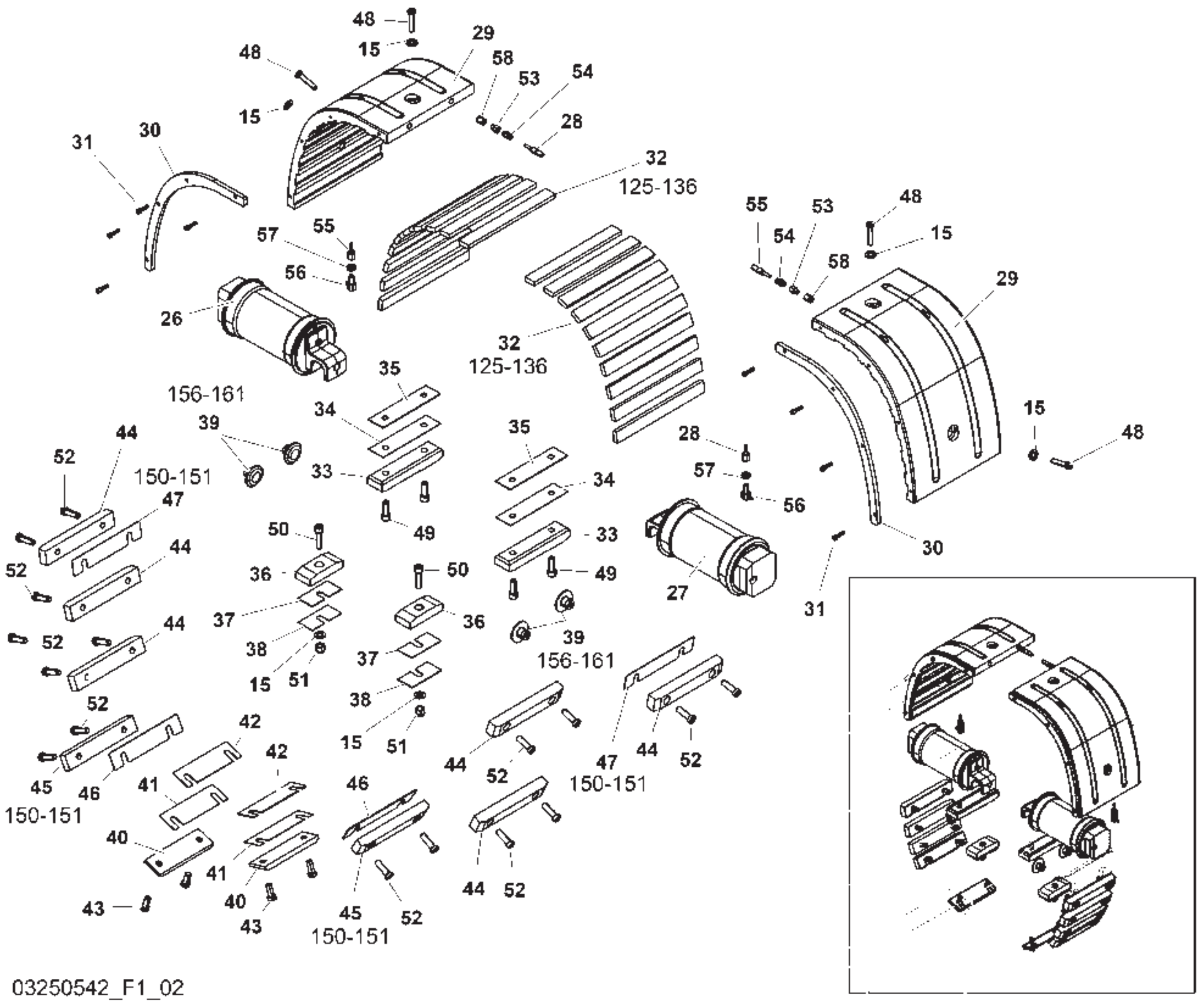


FIGURE 4-19 continued

Item Number	Description
1	TELESCOPIC PART 2
2	ROPE PROTECTION
3	WEAR PAD - TELE 2
4	WEAR PAD - TELE 2
5	WEAR PAD - TELE 2
6	WEAR PAD - TELE 2
7	WEAR PAD - TELE 2
8	HOLDER
9	HOLDER
10	STRIP T=11
11	STRIP T=10
12	PLATE
13	PLATE
14	PLATE
15	WASHER, 12 FLAT
15	WASHER, 12 FLAT
16	HHCS M12x35 8.8
17	HEX NUT M12
18	HEXAGON HEAD BOLT
19	WASHER
21	SHCS M10X30 8.8
22	HEXAGON HEAD SCREW
23	HEXAGON THIN NUT
24	SPACER
25	SOCKET-HEAD SCREW
26	LOCKING UNIT ASSY
27	LOCKING UNIT ASSY
29	WEAR PAD TELE 2 ASSY.
30	PLATE
31	CAP SCREW
32	STRIP T=11
33	SLIDER
34	FILE PLATE
35	FILL PLATE
36	SLIDER SUSTAGLIDE
37	PLATE
38	PLATE

Item Number	Description
39	GUIDE PILOT
40	SLIDER
41	FILL PLATE - 1 MM
42	FILL PLATE - 2MM
43	SOCKET-HEAD SCREW
44	WEAR PAD SUSTAGLIDE
45	WEAR PAD SUSTAGLIDE
46	PLATE
47	PLATE
48	SHCS M10X50
49	SHCS M12x35 8.8
50	HEXAGON SOCKET HEAD CAP SCREW
51	HEX L NUT M12
52	SOCKET-HEAD SCREW
53	ADAPTER
54	FITTING
55	LUBRICANT HOSE
56	PIPE UNION, M12X1
57	NUT, THIN
58	INSERT
59	AXLE
60	ROLLER
61	RING, SNAP
62	WEAR PAD TELE 2 ASSY
64	FLAT COLLAR NUT M12
65	HEXAGON HEAD SCREW
162	GUIDE
163	CAP SCREW
164	WASHER
165	HEXAGON NUT

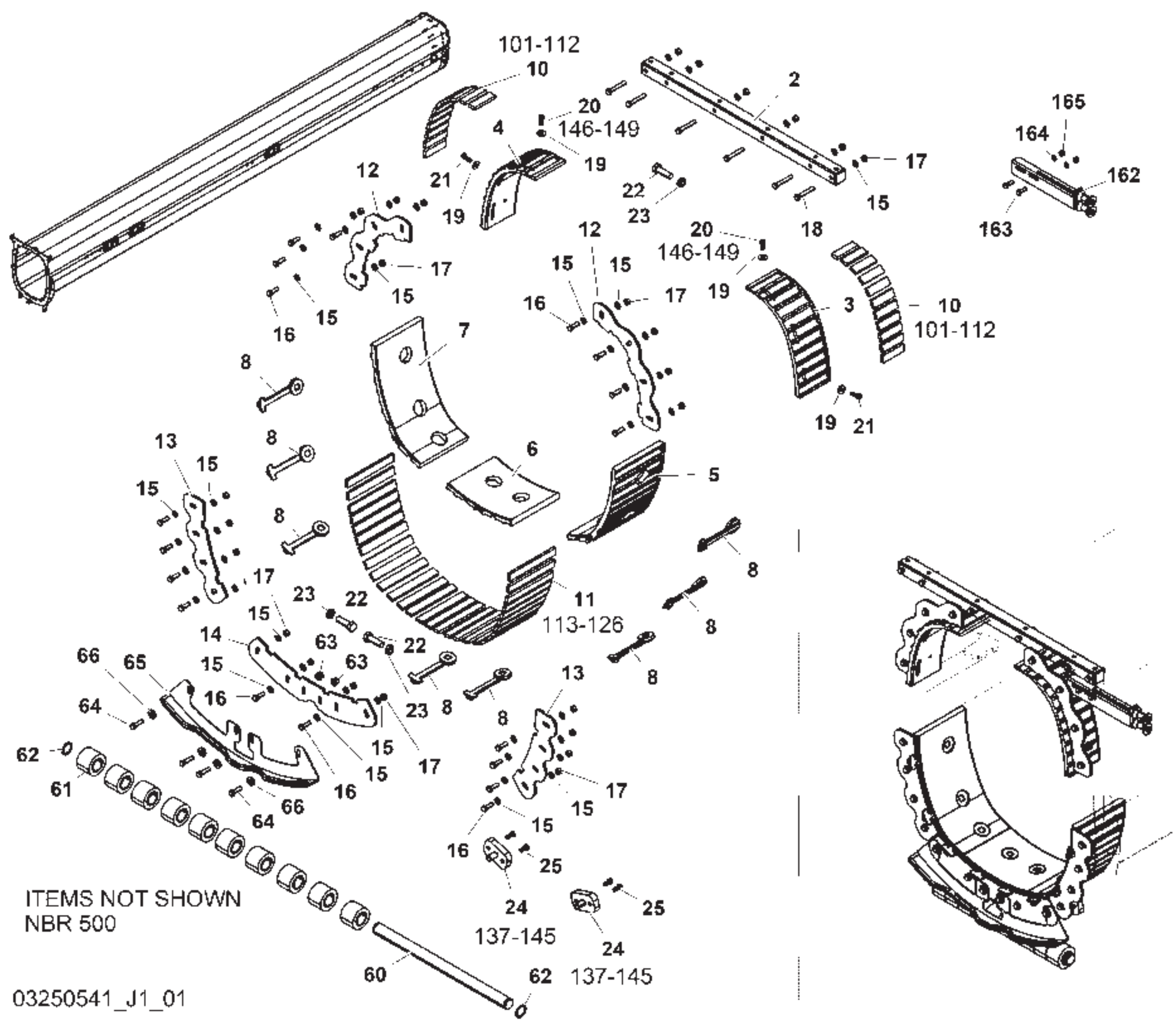
Telescope Section 2 Assembly

Refer to (Figure 4-19) when assembling this section.

1. Connect a strap to Tele 3, then using an overhead lifting device or another crane, lift Tele 3 so the strips (11), holders (8, 9) and wear pads (5, 6, 7) can be installed.
2. Install the hexagon head screws (22) and hexagon thin nuts (23).
3. Install the spacers (24).

4. Secure the strips and wear pads in place with the plates (13, 14).
5. Lower Tele 3.
6. Install the wear pads (3, 4).
7. Install the strips (10).
8. Secure the strips and wear pads with the plates (12).
9. Install the rope protection bar (2).
10. Install the guide (162).
11. On the opposite end of Tele 2, install sliders (40) and fill plates (41, 42).
12. Install wear pads (44, 45) and plates (46, 47).
13. Install sliders (36) and plates (37, 38).
14. Install the guide pilots (39).
15. Install the sliders (33) and plates (34, 35).
16. Place wear pads (29) on the section and insert ten strips (32) inside each wear pad.
17. Secure the wear pads (29) with the plates (30).
18. Assemble the lubrication hoses (53, 54, 55) and connect to the wear pads (29).
19. Attach the thin nuts (57) and pipe unions (56) to the lubrication hoses and secure the hoses to the tabs inside the section.
20. Install the locking unit assemblies (26, 27).
21. Insert Section 2 into the Section 1 just far enough to measure the gaps between the sliders and wear pads and the Section 1. The gaps should be no greater than 1.52 mm (0.06 in). Adjust the gaps by adding or removing plates or using thicker or thiner sliders and wear pads.
22. Insert Section 2 into the Section 1 half way.

Telescope Section 1 Assembly



10286-1

FIGURE 4-20

Telescope Section 1 Assembly Continued

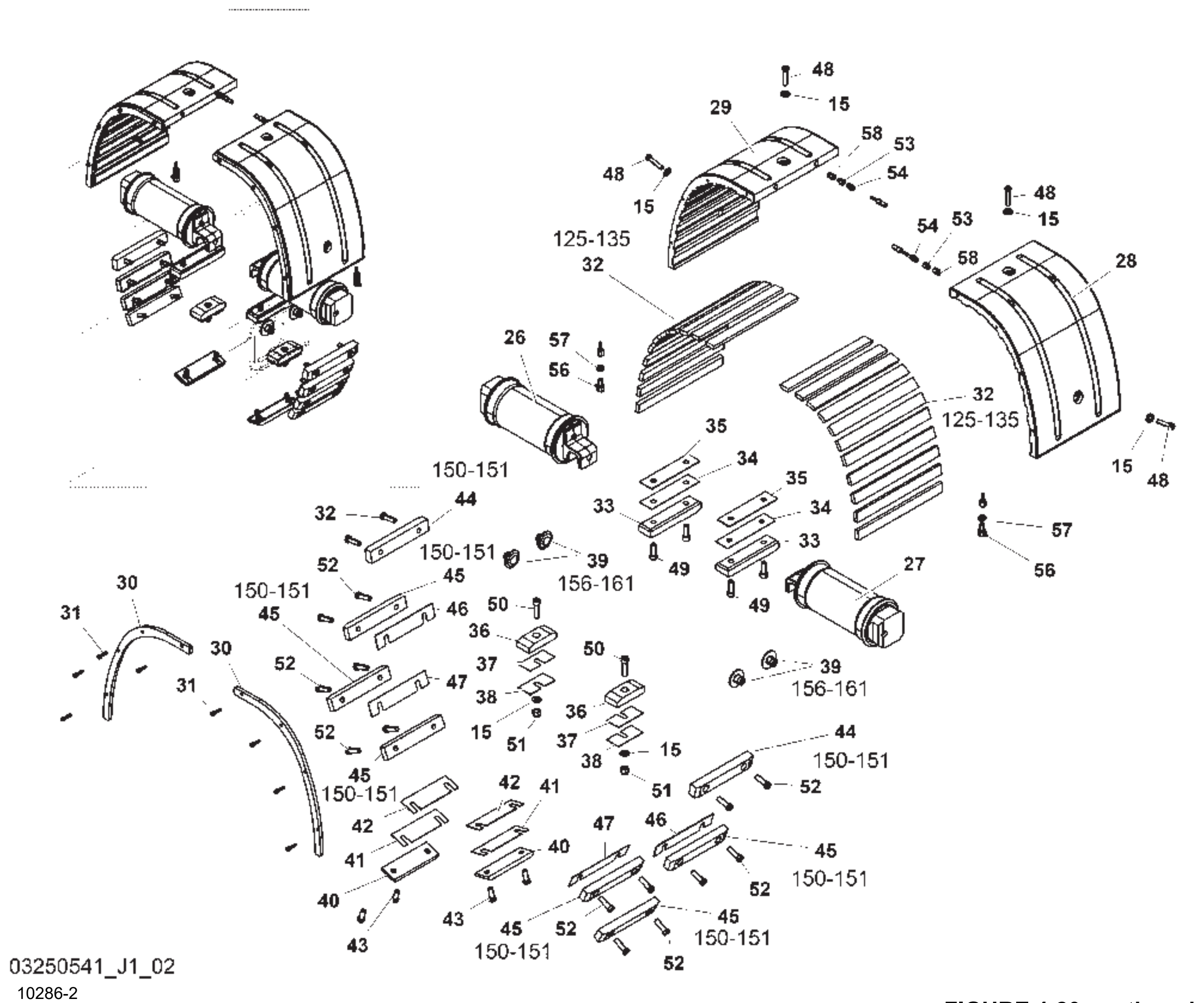


FIGURE 4-20 continued

Item Number	Description
1	TELESCOPIC PART 1
2	ROPE PROTECTION
3	WEAR PAD - TELE 1
4	WEAR PAD - TELE 1
5	WEAR PAD - TELE 1
6	WEAR PAD - TELE 1
7	WEAR PAD - TELE 1
8	HOLDER
10	STRIP T=11
11	STRIP T=10
12	PLATE
13	PLATE
14	PLATE
15	WASHER, 12 FLAT
15	WASHER, 12 FLAT
16	HHCS M12x35 8.8
17	HEX NUT M12
18	HEXAGON HEAD BOLT
19	WASHER
20	SHCS M10X25
21	SHCS M10X30 8.8
22	HEXAGON HEAD SCREW
23	HEXAGON THIN NUT
24	SPACER
25	SOCKET-HEAD SCREW
26	LOCKING UNIT ASSY
27	LOCKING UNIT ASSY
29	WEAR PAD TELE 1 ASSY.
30	PLATE
31	CAP SCREW
32	STRIP T=11
33	SLIDER
34	FILE PLATE

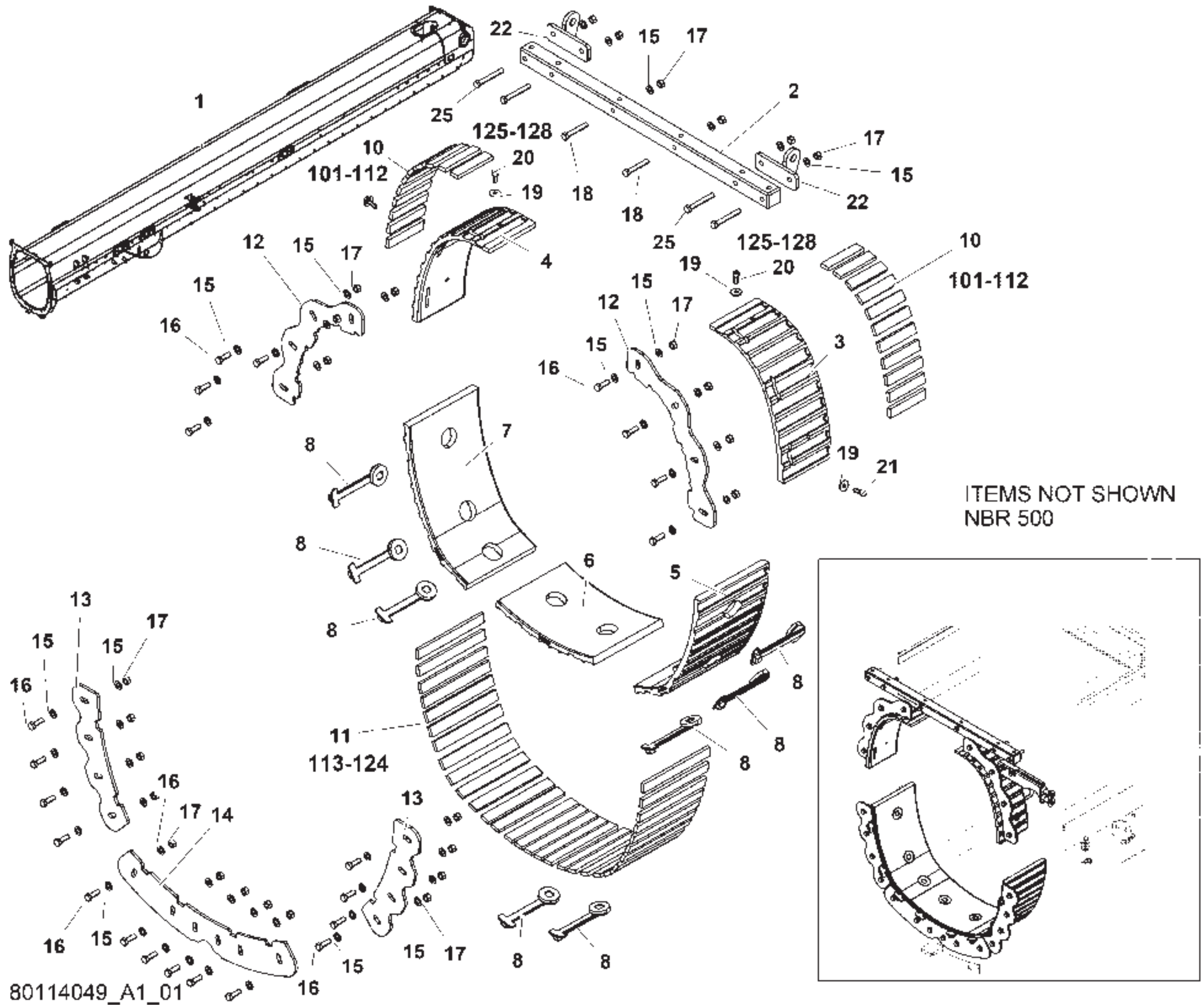
Item Number	Description
35	FILL PLATE
36	SLIDER
37	PLATE
38	PLATE
39	GUIDE PILOT
40	SLIDER
41	FILL PLATE - 1 MM
42	FILL PLATE - 2MM
43	SOCKET-HEAD SCREW
44	WEAR PAD
45	WEAR PAD
46	PLATE
47	PLATE
48	SHCS M10X50
49	SHCS M12x35 8.8
50	HEXAGON SOCKET HEAD CAP SCREW
51	HEX L NUT M12
52	SOCKET-HEAD SCREW
53	ADAPTER
54	FITTING
55	LUBRICANT HOSE
56	PIPE UNION, M12X1
57	NUT, THIN
58	INSERT
59	AXLE
60	ROLLER
61	RING, SNAP
62	WEAR PAD TELE 1 ASSY
64	FLAT COLLAR NUT M12
65	HEXAGON HEAD SCREW
162	GUIDE
163	CAP SCREW
164	WASHER
165	HEXAGON NUT

Telescope Section 1 Assembly

Refer to (Figure 4-20) when assembling this section.

1. Connect a strap to Tele 2, then using an overhead lifting device or another crane, lift Tele 2 so the strips (11), holders (8) and wear pads (5, 6, 7) can be installed.
2. Install the hexagon head screws (22) and hexagon thin nuts (23).
3. Install the spacers (24).
4. Secure the strips and wear pads in place with the plates (13, 14).
5. Lower Tele 2.
6. Install the wear pads (3, 4).
7. Install the strips (10).
8. Secure the strips and wear pads with the plates (12).
9. Install the rope protection bar (2).
10. Install the guide (162).
11. On the opposite end of Tele 1, install sliders (40) and fill plates (41, 42).
12. Install wear pads (44, 45) and plates (46, 47).
13. Install sliders (36) and plates (37, 38).
14. Install the guide pilots (39).
15. Install the sliders (33) and plates (34, 35).
16. Place the wear pad (28) on the section and insert eleven strips (32) inside.
17. Secure the wear pad (28) with the plate (30).
18. Install the opposite wear pad (29), strips (32) and plate (30).
19. Assemble the lubrication hoses (53, 54, 58) and connect to the wear pads (28, 29).
20. Attach the thin nuts (57) and pipe unions (56) to the lubrication hoses and secure the hoses to the tabs inside the section.
21. Install the locking unit assemblies (26, 27).
22. Insert the telescope cylinder assembly into Section 1.
23. Install the tele power cable strain relief (2), (Figure 4-14).
24. Install the tele power plug (1), (Figure 4-14).
25. Insert Section 1 into the Base Section just far enough to measure the gaps between the sliders and wear pads and the Base Section. The gaps should be no greater than 1.52 mm (0.06 in). Adjust the gaps by adding or removing plates or using thicker or thiner sliders and wear pads.
26. Insert Section 1 into the Base Section half way.

Telescope Base Section Assembly



10287-1

FIGURE 4-21

Telescope Base Section Assembly (Continued)

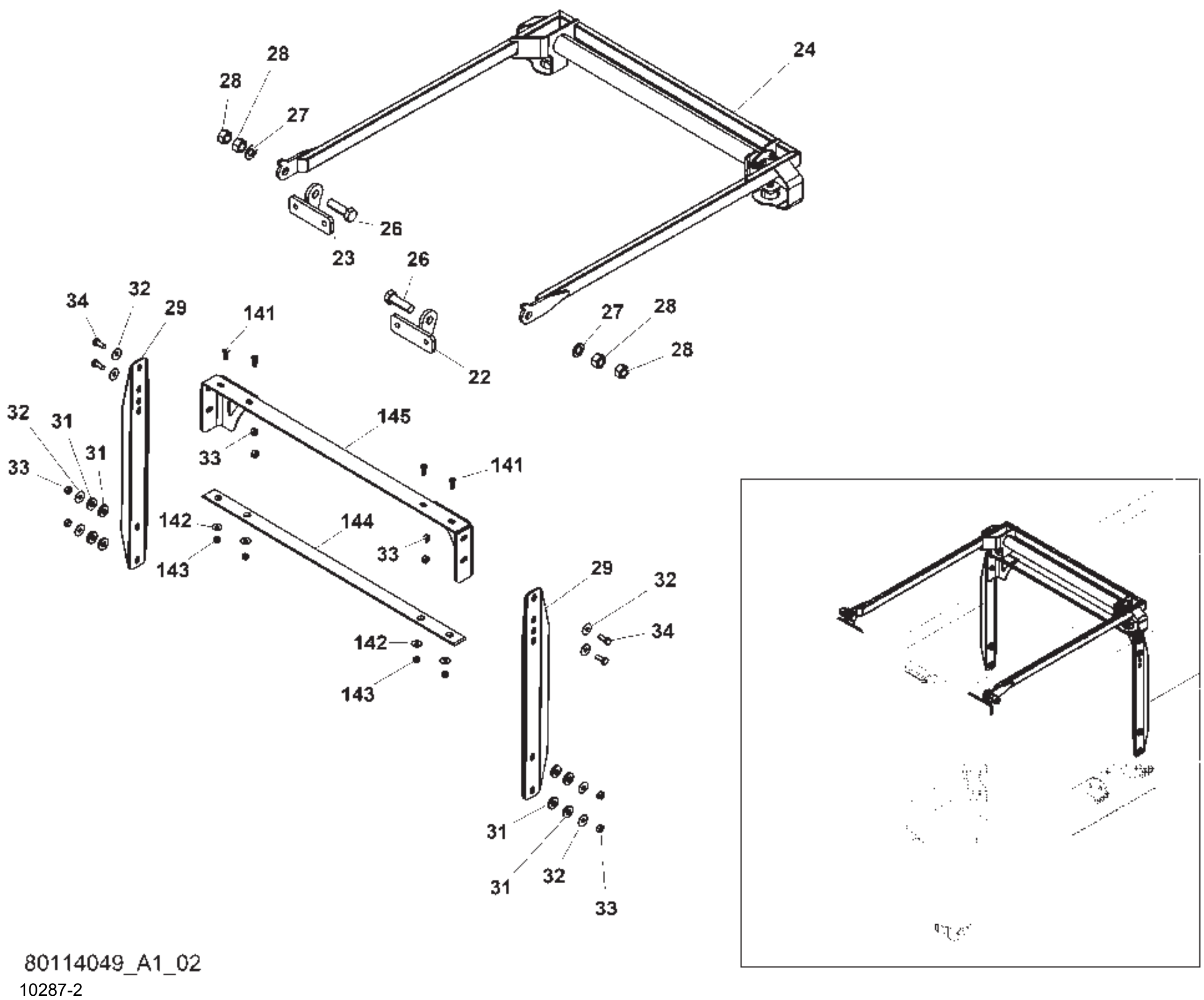
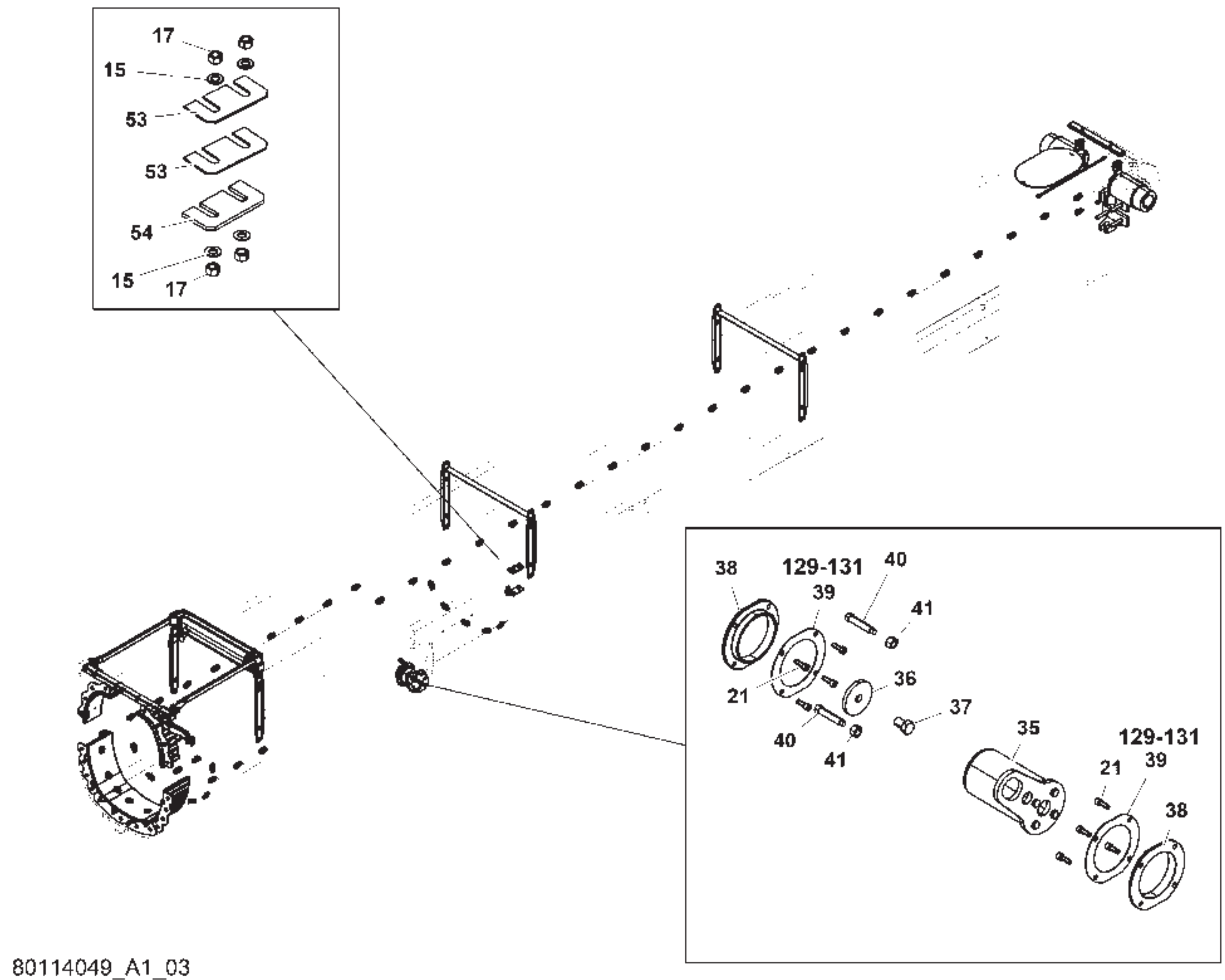


FIGURE 4-21 continued

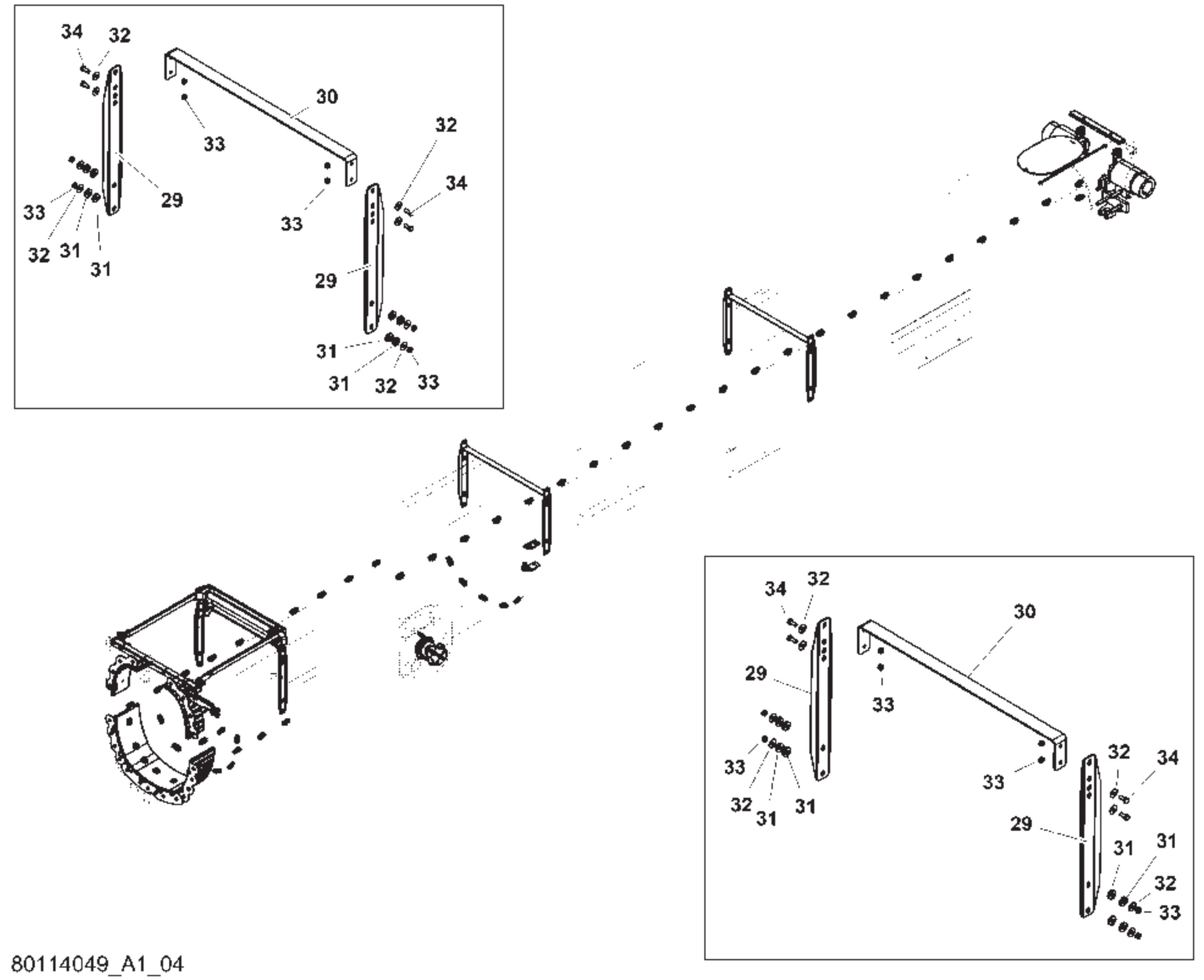
Telescope Base Section Assembly (Continued)



10287-3

FIGURE 4-21 continued

Telescope Base Section Assembly (Continued)



10287-4

FIGURE 4-21 continued

Telescope Base Section Assembly (Continued)

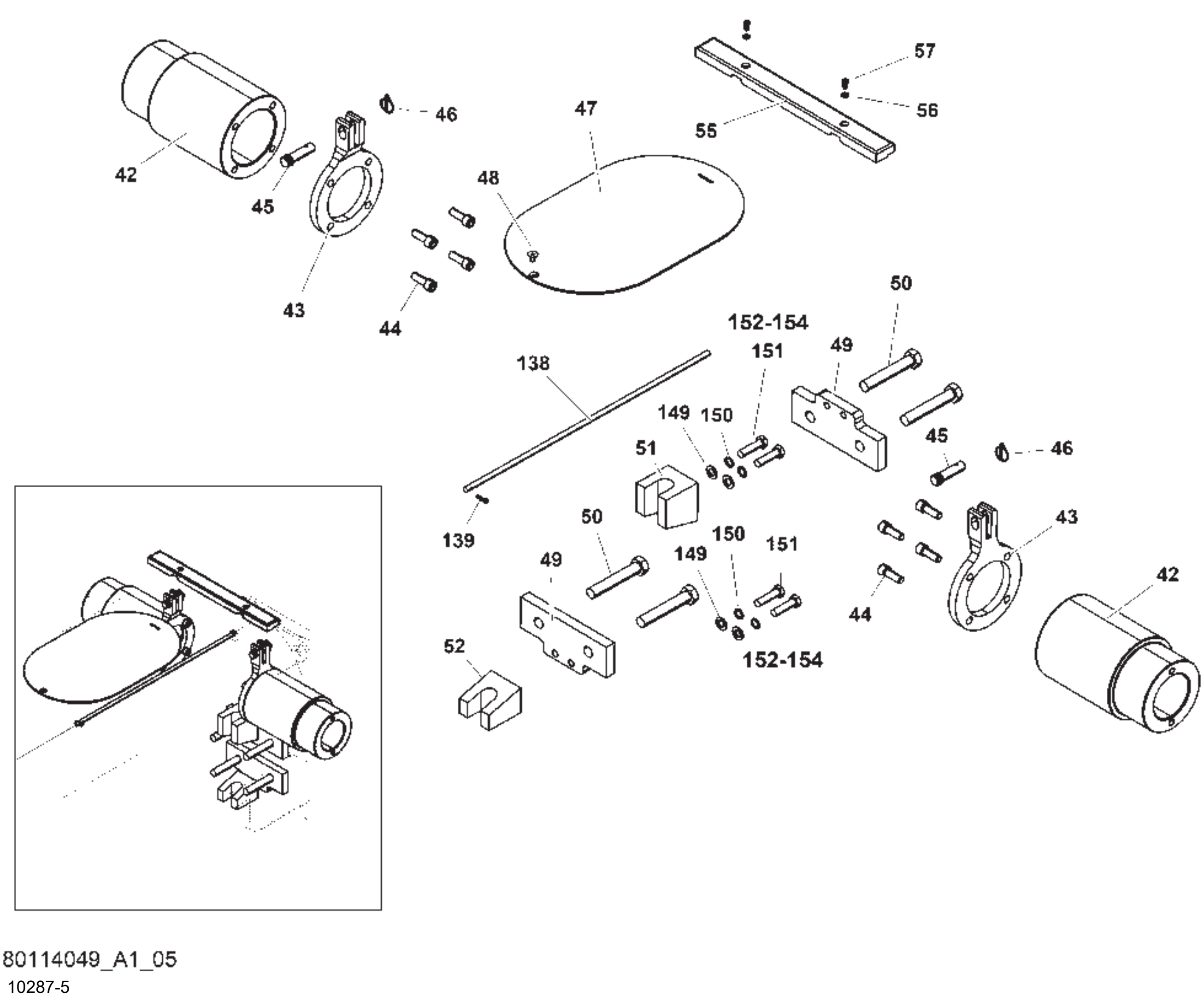
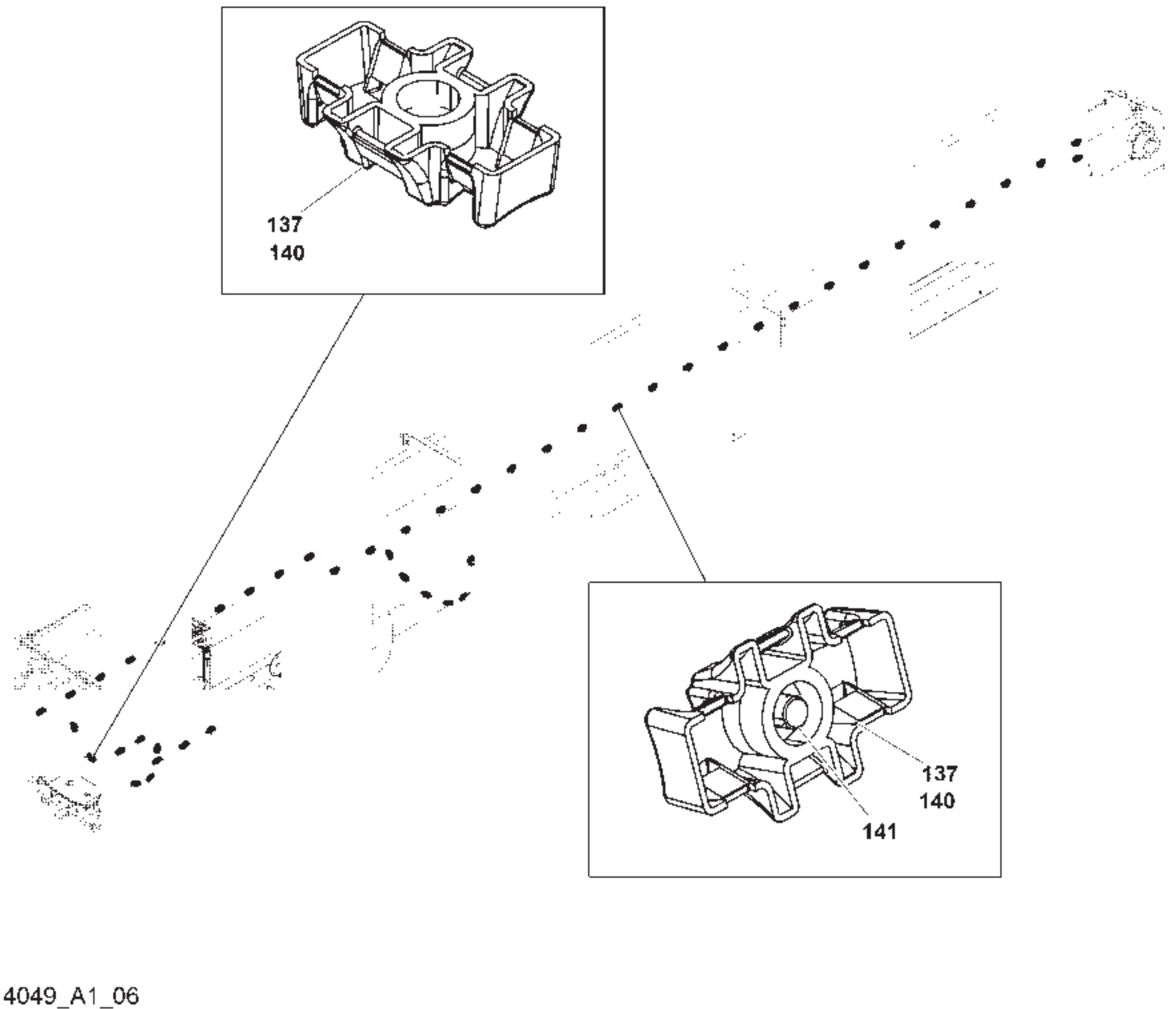


FIGURE 4-21 continued

Telescope Base Section Assembly (Continued)



10287-6

FIGURE 4-21 continued

Item Number	Description
1	BASE SECTION WELDMENT
2	ROPE PROTECTION
3	SLIDER
4	SLIDER
5	SLIDER
6	SLIDER
7	SLIDER
8	HOLDER
10	STRIP
11	STRIP
12	PLATE
13	PLATE
14	PLATE
15	F WASHER
16	HHCS M12X35
17	HEX NUT M12
18	HEXAGON HEAD BOLT M12X75
19	F WASHER
21	SHCS M10X30
22	BRACKET
23	BRACKET
24	U-BRACKET ASSY
25	HHCS M12X90
26	HEXAGON HEAD SCREW M20X65
27	F WASHER
28	HEX NUT M20
29	PLATE
30	PLATE
31	F WASHER
32	WASHER
33	HEX NUT M10
34	HHCS M10X25

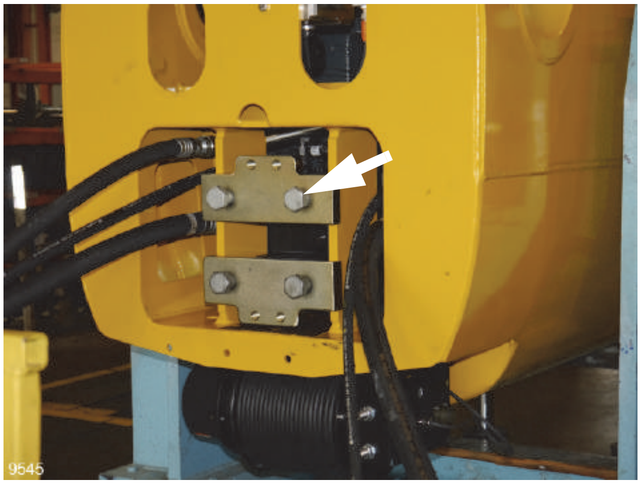
Item Number	Description
35	AXLE ASSEMBLEY
36	F WASHER
37	HHCS M20X30
38	FLANGE
39	PLATE
40	HSS
41	HEX NUT M16
42	AXLE
43	PLATE
44	SHCS M16X45
45	PIN
46	LINCH PIN
47	COVER
48	SFHCS M10X16
49	PLATE
50	HHCS M24X140
51	COTTER
52	COTTER
53	FILL PLATE
54	FILL PLATE
55	SHIM T=25
56	F WASHER
57	SOCKET-HEAD SCREW M8X16
132	GUIDE
133	HHCS M10X30
134	WASHER
135	HEX L NUT M10
136	CABLE CLIP
137	CABLE CLIP
138	AXLE
139	SHCS-LOW M6X25
140	SBCS M8X10

Item Number	Description
141	SFHCS M8X25
142	F WASHER
143	HEX L NUT M8
144	PLATE
145	PLATE
149	F WASHER
150	SHIM RING
151	HHCS M16X60

Telescope Base Section Assembly

Refer to (Figure 4-21) when assembling this section.

1. Connect a strap to Tele 1, then using an overhead lifting device or another crane, lift Tele 1 so the strips (11), holders (8) and sliders (5, 6, 7) can be installed.
2. Secure the strips and sliders in place with the plates (13, 14).
3. Lower Tele 1.
4. Install the wear pads (3, 4).
5. Install the strips (10).
6. Secure the strips and wear pads with the plates (12).
7. Climb inside the Base Section and remove the tie straps restraining the cylinder hoses. Route the hoses out the rear of the Base Section as shown in (Figure 4-22).
8. Secure the tele cylinder with the four cylinder retaining bolts (Figure 4-22) and two retaining plates.



9545

FIGURE 4-22

PINNING BOOM COMPONENTS

Mechanical Locking Head Description

It is important to understand that a pinned boom has a telescoping cylinder that can disconnect and reconnect (unlock/lock) to boom sections, as well as disconnect and connect (unlock/lock) boom sections to each other. This is accomplished by a pinning mechanism or pinning “head” at the near end of the barrel of the telescoping cylinder (the rod is fixed to the Base Section and the barrel extends within the boom). This pinning mechanism has a set of sensors and an electronic module to communicate with the Crane Control System (CCS). Using these sensors, as well as a precision length sensor for the linear location of the telescoping cylinder within the boom, the Crane Control System commands the pinning mechanism to perform the locking operations.

The key component for the pinned boom then is the pinning mechanism. For the GRT8120, this is referred to as the Mechanical Locking Head. Be aware that this pinning mechanism is quite different from a past design that was referred to as TwinLock.

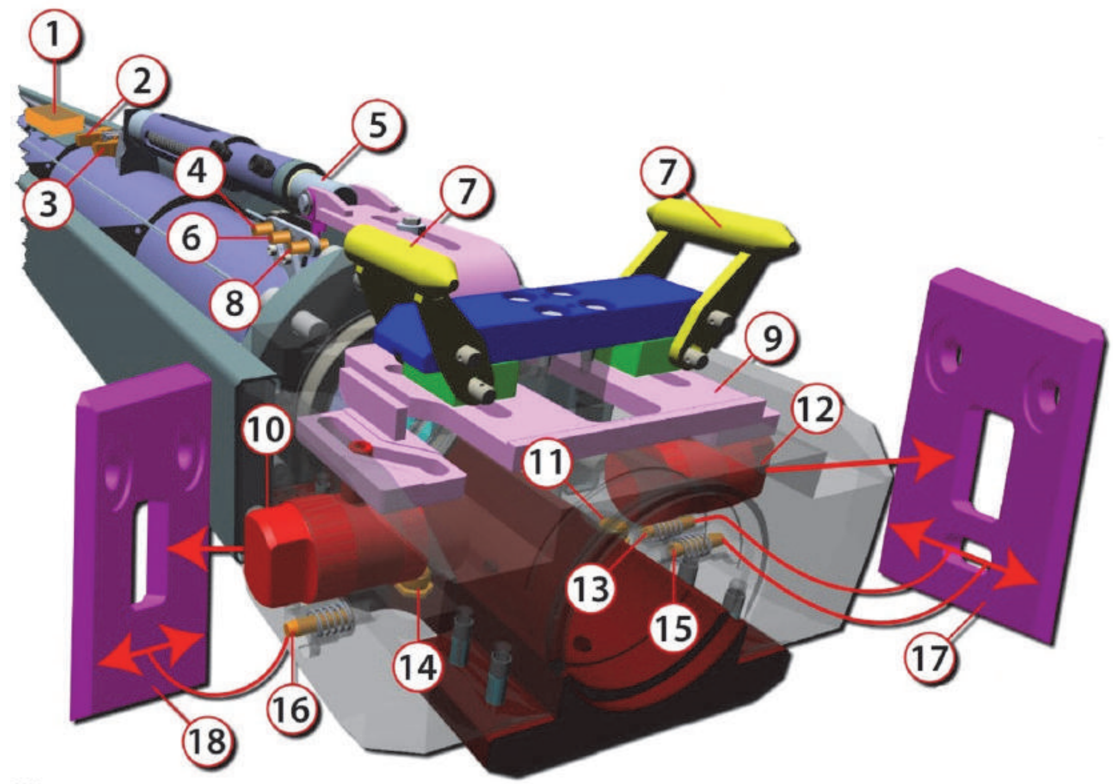
(Figure 4-23) shows a layout for the Mechanical Locking Head design.

The actuator sliding plate (9), (Figure 4-23) has slots that guide the ends of small pins. The small pins are connected to components that can retract and release the pinned boom locking pins. The cylinder pins (10 and 12), (Figure 4-23) are directly connected to the small pins, and when the sliding plate slides in the direction of telescoping cylinder extending, the cylinder pins are retracted. The section pins (not shown in Figure 4-23) are moved by the butterfly levers (7), (Figure 4-23). The butterfly levers are moved as the sliding plate slides in the other direction (telescoping cylinder retracting direction).

The sliding plate is moved by the hydraulic actuator (5), (Figure 4-23).

4

Mechanical Locking Head Layout



9300

FIGURE 4-23

Item Number	Description
1	I/O Module
2	Valve for pinning control
3	Valve for pinning control
4	Proximity Switch S2112N
5	Double-acting hydraulic actuator
6	Proximity Switch S2111N
7	Butterfly levers that engage with section pins
8	Proximity Switch S2110N
9	Actuator sliding plate
10	Left side cylinder pin that engages with boom sections

Item Number	Description
11	Proximity switch S2115N
12	Right side cylinder pin that engages with boom sections
13	Proximity Switch S2116N
14	Proximity Switch S2114N
15	Proximity Switch S2117N
16	Proximity Switch S2118N
17	Sample boom section plate in “foot area” that includes a slot
18	Sample boom section plate in “foot area” that is solid

Proximity Switch Descriptions

There are a number of proximity switches used in the pinning mechanism. Some of the switches confirm the location of components in the mechanism. Some are used to determine the alignment of the telescoping cylinder with boom sections.

Proximity Switches for Hydraulic Actuator Position

There are 3 proximity switches for confirming the position of the hydraulic actuator (5), (Figure 4-23). They detect a target plate that is attached to one of the pieces that move with the sliding plate. These switches are the following:

- **S2110N** - (8), (Figure 4-23): This switch is expected to detect that the sliding plate has moved all the way in the direction that retracts the section pins via the butterfly levers.
- **S2111N** - (6), (Figure 4-23): This switch is expected to detect that the sliding plate has moved to the middle or neutral position which indicates that neither the cylinder pins or the section pins have been retracted.
- **S2112N** - (4), (Figure 4-23): This switch is expected to detect that the sliding plate has moved all the way in the direction that retracts the cylinder pins.

Proximity Switches for Cylinder Pins Retracted

There are 2 proximity switches for confirming the position of the cylinder pins (10 and 12), (Figure 4-23). They detect the pins themselves. These switches are the following:

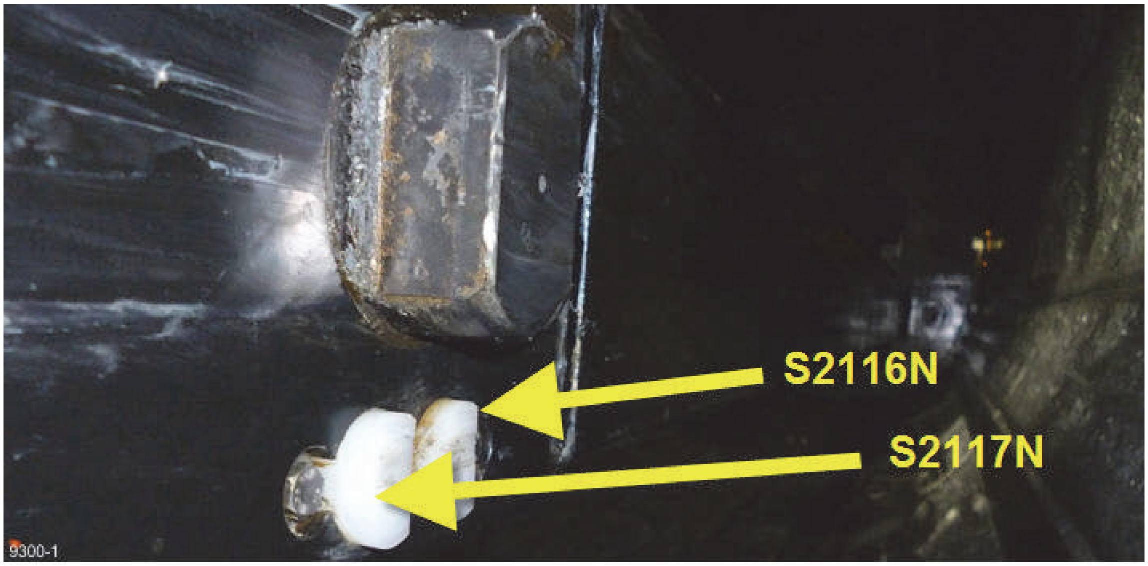
- **S2114N** - (14), (Figure 4-23): This switch is expected to detect that the left side cylinder pin is in the retracted position.
- **S2115N** - (11), (Figure 4-23): This switch is expected to detect that the right side cylinder pin is in the retracted position.

Proximity Switches for Cylinder Alignment to Boom Section

There are 3 proximity switches for confirming the position of the telescoping cylinder relative to a Boom Section. Two of these switches indicate the telescoping cylinder at a slot in a plate in the “foot area” of the Boom Section (13 and 15), (Figure 4-23). (Figure 4-24) shows these two switches, and that they are located on spring-loaded cylindrical bodies that can ride in and out of slots in the Boom Sections. The third proximity switch is on the other side of the telescoping cylinder (16), (Figure 4-23).

As shown with the arrows for Items 17 and 18 in (Figure 4-24), when switches S2116N and S2117N are OFF, and switch S2118N is ON, then the telescoping cylinder can be considered aligned with a Boom Section. The telescoping cylinder would now be in position to connect to that Boom Section. The following provides identification of these proximity switches:

- **S2116N** - (13), (Figure 4-23): This switch is expected to detect slot in the “foot area”. When it turns ON, the telescoping cylinder has extended too far, so it can be described as the “too high” switch since the precision length sensor value is too high; the telescoping cylinder would be expected to be retracted so that it turns OFF.
- **S2117N** - (15), (Figure 4-23): This switch is expected to detect slot in the “foot area”. When it turns ON, the telescoping cylinder has not extended far enough, so it can be described as the “too low” switch since the precision length sensor value is too low; the telescoping cylinder would be expected to be extended so that it turns OFF.
- **S2118N** - (16), (Figure 4-23): This switch is expected to detect that the telescoping cylinder is in a region where S2116N and S2117N information would be valid. It is in this region when the switch is ON. When it is OFF, then the telescoping cylinder is not in the needed region and the S2116N and S2117N information can be ignored. The precision length sensor data would then be relied upon to move the telescoping cylinder to a desired location.



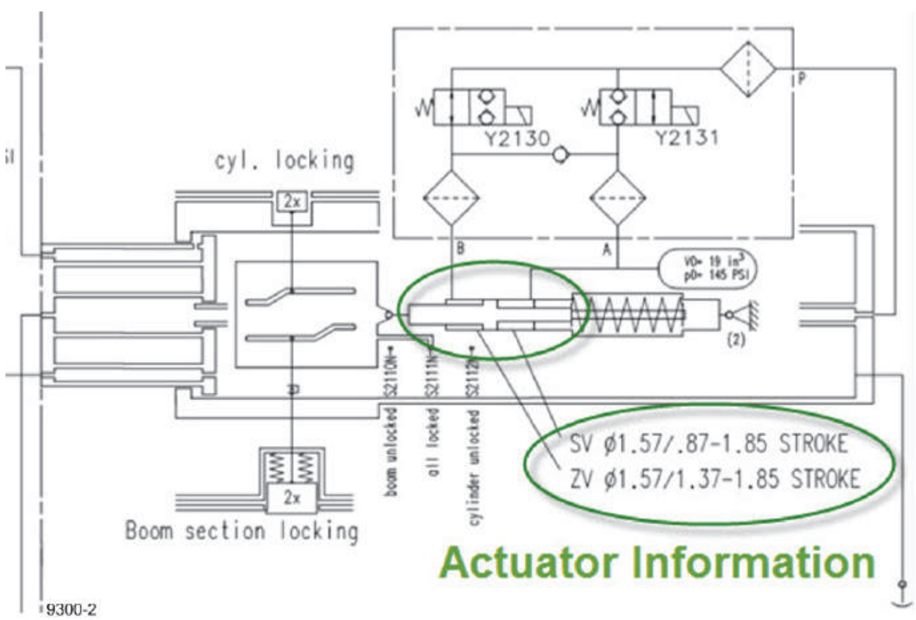
9300-1

FIGURE 4-24

Hydraulic Actuator Description

Item 5, (Figure 4-23), indicates the hydraulic actuator for the pinning mechanism. This actuator is expected to move the sliding plate in either direction from its neutral position. The actuator utilizes pressure from a trombone-tube (or fill-tube or transfer-tube) in the center of the hollow rod of the telescoping cylinder via a tube on the outer surface of the telescoping cylinder barrel.

There are two ON/OFF valves (2 and 3, (Figure 4-23) that control where pressure for the actuator is directed. These valves are designated Y2130 and Y2131.



9300-2

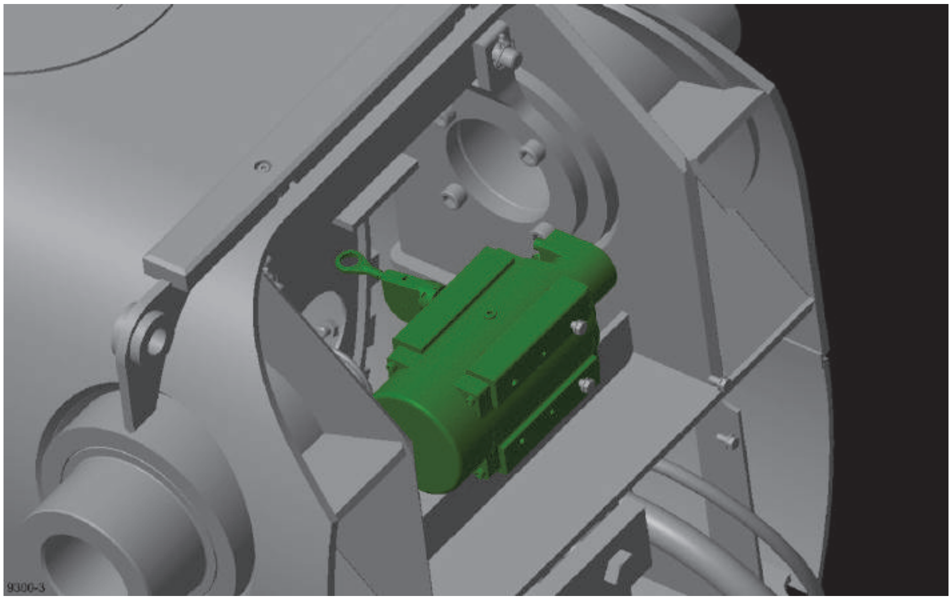
FIGURE 4-25

(Figure 4-25) shows a region of a typical hydraulic schematic for the Mechanical Locking Head Design. In the schematic, the highlighted actuator is shown to have a piston with rods at both sides for the double-acting actuator. However, one rod diameter is larger than the other. The other highlighted area shows the rod diameters as 0.87" and 1.37". This difference gives an exposed area difference for the hydraulic pressure to act upon. If pressure is applied to just the left side of the piston, then the actuator will shift to the right, and this retracts the cylinder pins. If pressure is applied to both sides of the piston, then due to the area difference, the actuator will shift to the left, and this retracts the section pins.

As shown in (Figure 4-25), the setting of the Y2130 and Y2131 valves can be manipulated to have the pressure applied to one side or both sides (with appropriate relieving of pressure where needed).

Precision Length Sensor Description

An important component of the pinned boom system is the precision length sensor.(Figure 4-26) shows a typical example highlighted in green with the back plates of the base section not shown. This sensor has a cable reel. The cable is attached to the pinning mechanism at the near end of the telescoping cylinder barrel. As the barrel extends, the sensor measures the distance. This distance is the most important data that is used by the Pinned Boom Control System. It allows motion to be monitored, and for the cylinder to be placed in the correct location for pinning operations.



9300-3

FIGURE 4-26

Pinned Boom Control System Description

The Pinned Boom Control System for the telescoping system manages the state of the sensors, switches, valves, and information to/from the display screens. There are a number of different approaches to using the telescoping system. These are referred to as the Semi-Auto Mode, the Manual Mode, and the Emergency Mode.

It is important to realize that for some of the modes the control system is performing automated motions within the boom at some point in the telescoping process. At other times, the operator is able to move the boom components. Then the automated motions can occur once again after the operator has indicated the appropriate next action for telescoping the boom.

The control system requires that the telescoping cylinder and pinning mechanism perform within expected parameters. For instance, if there is entrapped air within the trombone-tube, the hydraulic pressure will initially move the hydraulic actuator as expected, but after the pressure is trapped in the actuator and the pressure in the trombone-tube is reduced, there may be motion of the components that is not expected by the control system. If there is unexpected friction in the sliding components, then the pressure may not be sufficient to move the components within the time allotted by the control system. If the boom is at a very low angle, the boom sections may drift with respect to each other and then the telescoping cylinder will not align with boom sections in the expected range of the data from the precision length sensor.

Therefore, it is essential that the telescoping cylinder and boom sections be maintained properly so that the control system can work properly.

MECHANICAL EMERGENCY UNLOCKING AND LOCKING OF THE TELESCOPIC SECTIONS

The mechanical emergency operation must be used whenever the telescoping cylinder can no longer be moved.

For manual unlocking and locking of the telescopic sections, a screw is inserted into each side in the locking pins. When screwed in, the screw collapses the spring internal to the locking pin, thus pulling the locking pin which pulls the locking pin into the telescopic section and thus unlocks the section.

The screw is screwed out again to lock the section manually.

The main boom is designed in such a way that the locks can be operated in emergency mode from the outside for most fixed lengths.

NOTE: If the telescoping cylinder is in the foot section of a telescopic section, this telescopic section cannot be locked or unlocked manually.

Prerequisites

WARNING

Crushing Hazard!

Failure to follow these prerequisites could allow a boom section to retract uncontrolled resulting in injury or equipment damage.

The following prerequisites must be fulfilled before unlocking a telescopic section manually:

- The telescopic section to be unlocked is attached to an auxiliary crane with sufficient load bearing capacity and, in this way, is secured against independent retraction.

OR

- The main boom is lowered into a horizontal position so that the telescopic section is unable to retract independently.

Maintenance

For manual unlocking, two screws are supplied for each telescopic section:

- 120 mm (4.7 in) length for telescope section 6
- 135 mm (5.3 in) length for telescopic section 5
- 170 mm (6.7 in) length for telescopic section 4
- 200 mm (7.9 in) length for telescopic section 3
- 230 mm (9.1 in) length for telescopic section 2
- 270 mm (10.6 in) length for telescopic section 1

You can only lock or unlock a telescopic section manually if the recess (2), (Figure 4-27) in the locking pin (1), (Figure 4-27) no longer engages in the telescopic section (3), (Figure 4-27) above it.

Extend the Telescopic Section approximately 35 mm (1.4 in) (with an auxiliary crane, forklift or other means of external force). The locking pin (1), (Figure 4-27) must be centered in the opening and the recess (2), (Figure 4-27) may no longer engage in the telescopic section (3), (Figure 4-27) above it.

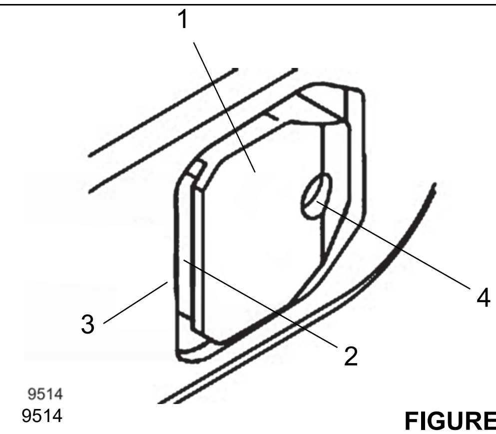


FIGURE 4-27

Unlocking Telescopic Sections

When unlocking Telescopic Sections, start with Tele 6 (fly) and work your way in towards Tele 1 as far as possible. Unlock and lock only one section at a time.

1. Remove the grease fitting from the bore hole (4), (Figure 4-27).
2. Insert a screw into the hole (4), (Figure 4-27). The locking pin (1), (Figure 4-27) is retracted in the process. You can assist this process by lightly hammering on the locking pins.
3. Tighten the screw against the spring load until the locking pin (1), (Figure 4-27) is pulled in as far as it will go and is situated behind the side wall of the telescopic section.
4. Unlock the other side of the telescopic section using the same procedure.

CAUTION

Released Lock Hazard!

Under no circumstances may you operate the telescoping cylinder as long as the lock is mechanically released. Therefore unscrew all screws out of the bore holes immediately after finishing the repair work.
In this way, you prevent the telescoping cylinder from hitting the locking system and consequently damaging it.

Do not unlock a section and then boom up until it slides in. Damage to equipment will result.

Once the pins are retracted, use your external means (second crane, forklift, etc.) to retract that section and then remove the bolts to pin that section in a retracted state. Move to the next section to be retracted (as necessary).

Locking Telescopic Sections

1. Retract the telescopic section until the locking pin (1), (Figure 4-27) is in the middle of the opening.
2. Remove the screw from the bore hole (4), (Figure 4-27).

The locking pin (1), (Figure 4-27) is then pushed out of the opening due to spring tension.

3. Install the grease fitting into the bore hole.
4. Retract the telescopic section until the recesses (2), (Figure 4-27) have been set down on the telescopic section (3), (Figure 4-27) above it.

NEW YORK HOUSE LOCK

CAUTION

Free Swing Hazard!

The New York House Lock is strictly an additional backup device. The swing brake must always be installed. Equipment damage or injury possible.

The New York House Lock is designed to meet the New York regulations for a mechanical locking of the superstructure. It is not intended for other applications, such as traveling with a load, etc.

It operates with an electrical actuator Up = disengaged (unlocked) and down = engaged (locked). It can be operated by either the super cab display or by the hand held remote. There are 2 proxy switches, one for fully disengaged (unlocked) and one for fully engaged (locked). This can be seen on the screen of ODM display or remote.

BLEEDING THE TELESCOPING CYLINDERS

There are two vent screws on the telescoping cylinder for bleeding the cylinder chambers. The vent screws are accessible through hand holes in the telescopic sections.

Prerequisites

With the following requirements it is assumed that no lattice extension is rigged.

- Park the truck crane on a level surface.
- Support the crane with at least the outrigger span : 7.00 m X 5.61 m (22.97 x 18.4 ft).
- Remove the counterweight.
- Enter the RCL rigging code for the current rigging mode of the truck crane.
- Completely retract all telescopic sections.
- Unreeve the hook block.
- Swing the superstructure to the rear or to the side.
- Lower the boom into a horizontal position.

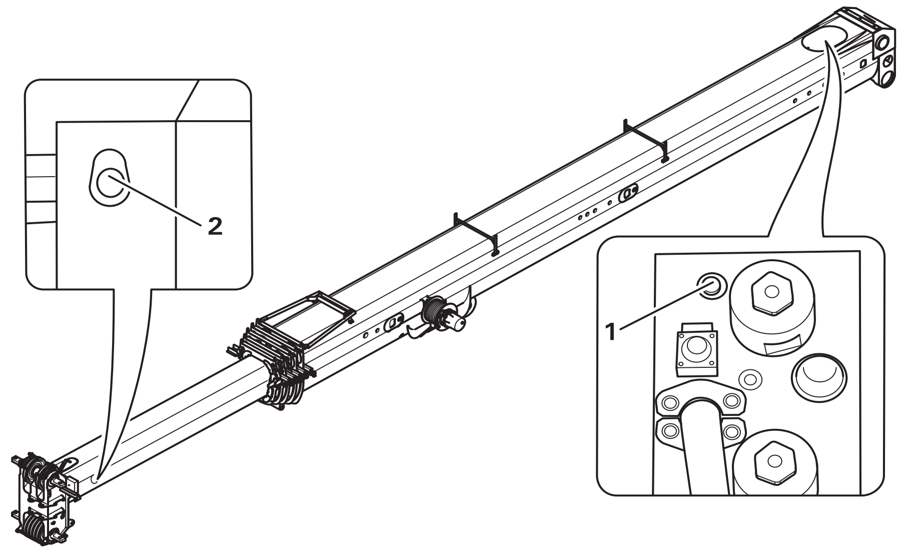
Bleeding Procedure

Carry out the bleeding procedure on all vent screws in turn.

- Remove the cap from the relevant vent screw.
- Place a transparent hose onto the vent screw. Hold the other end of the hose in a container filled with oil.
- Loosen the vent screw by 1 – 2 turns.
- Carefully drain the telescoping cylinder of hydraulic oil until the oil flowing through the hose no longer contains any bubbles. Carefully extend the relevant telescopic section in the direction specified.

The oil collected in the container must not be used again as it contains air.

Location of Vent Screws



Position Number	Vent For:	Access to Vent on Basic Section Via:
1	Set of Piston Rings	Manhole in Top of Base Section
2	Piston Chamber	Opening in Telescopic Section 6 Left-Hand Side

FIGURE 4-28

Telescoping Status

The position numbers indicated below relate to the illustrations in the Location of Vent Screws (Figure 4-28) in this section.

Vent Screw Position No. 1

WARNING

Crushing Hazard!

Do not reach into the manhole until the boom has been secured so that it cannot retract inadvertently. If you are carrying out this operation with the help of someone else, communicate with the person in the crane cab by means of clear hand signals.

- Screw off the manhole cover plate.
- Extend telescopic section 1 approximately 2.0 m (6.5 ft) so that the access to the manhole is free.
- Fit the bleeder key through the manhole onto the vent screw (1), (Figure 4-28) on the telescoping cylinder and open with one or two turns.
- Make sure nobody is in the manhole or is reaching into the manhole.
- Carefully move the control lever for telescoping in the retract direction so that the pressure in the set of piston rings increases and the air is pushed out through the plastic hose.
- Tighten the vent screw (1), (Figure 4-28).
- Close the manhole again with the cover plate.

Vent Screw Position No. 2

- Extend the telescopic section 6 approximately 0.5 m (1.7 ft).
- Insert bleeder key through the opening on the left side of telescopic Section 6 onto the vent screw and open 1 or 2 turns.
- Carefully move the control lever for telescoping in the extend direction so that the pressure in the piston chamber increases and the air is pushed out through the plastic hose.
- Tighten the vent screw (2), (Figure 4-28).

TELESCOPE SLIDE PAD ADJUSTMENT

WARNING

Overturning Hazard!

Make sure that all the *Prerequisites*, page 4-43 are met. If you do not keep to the rigging mode specified there, the truck crane could overturn.

- Extend telescope sections at 15% and shim and torque all bolts securing slide pads to boom. Make sure retaining plates are tight against the slide pads.

NOTE: Length of bolt varies at front top radius pad bolts depending on the pad shims required. Use a 20mm bolt for 5mm shims; 25mm bolt for 6mm-10mm shims and 30mm bolt for 11mm-15mm shims.

- Apply Loctite 243 and tighten the bolts (1), (Figure 4-29) by hand until the washer is within 0.5mm of the boom. Check periodically to ensure bolts remain snug and washer turns freely.

CAUTION

Damage to Equipment Hazard!

Bolts in telescope slide pad are intentionally left loose. Do not over tighten or possible damage may occur to equipment.

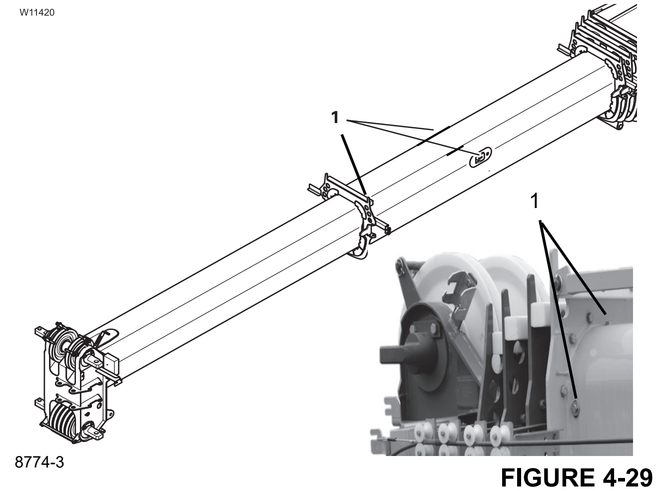


FIGURE 4-29

WARNING

Overturning Hazard!

Make sure that all the *Prerequisites*, page 4-43 are met. If you do not keep to the rigging mode specified there, the truck crane could overturn.

Falling Hazard!

There is grease residue on the telescopic sections. For this reason, you must not walk on the main boom.

Use the extendable ladder provided with your crane.

CHECK THE LOCKING SYSTEM

WARNING

Lack of Maintenance Work Hazard!

Have the additional maintenance work on the main boom locking system performed by your authorized Grove Crane distributor or Manitowoc Crane Care regularly.

This prevents the complete unlocking of a telescoping section in Emergency operation/Emergency program mode, which could cause serious accidents and damage to the crane.

- Have the main boom locking system checked by your authorized Grove Crane distributor or Manitowoc Crane Care.

RATED CAPACITY LIMITER

Maintenance of the Slip Ring Assembly of the Cable Drum

Maintenance of the slip ring assembly is carried out in order to prevent contamination and corrosion and to prevent malfunctions on the RCL.

The crane has a cable drum whose slip ring assembly needs to be maintained.

The cable drum (1), (Figure 4-30) is located on the left side of the main boom.

9287-2

FIGURE 4-30

Prerequisites

Before maintenance, the following requirements must be met:

- The main boom must be resting in the boom rest.
- The battery master switch is switched off.

CAUTION

Damage to the Rated Capacity Limiter Hazard!

Before maintenance work on the slip ring assembly, always switch off the battery master switch so that the cable drum is current-free.
This prevents short circuits which may lead to damage to the central unit.

Maintenance of the Slip Ring Assembly

To remove abrasion particles from the contact brushes, use only dry, oil-free air or a clean, lint-free cloth.

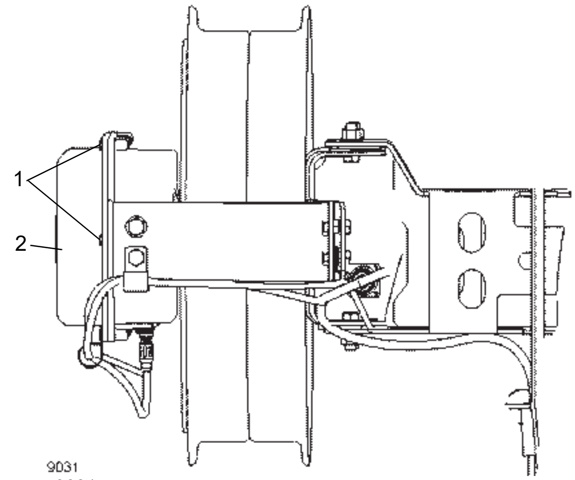


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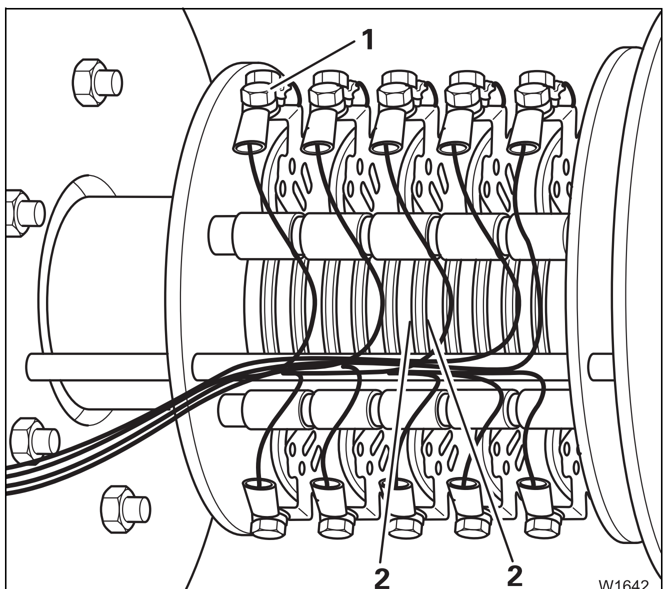
FIGURE 4-31

- Make sure that the cable drum is current-free.
- Unscrew all screws (1), (Figure 4-31) and remove the casing (2), (Figure 4-31).
- Check the seal on the casing for damage and replace it if necessary.
- Remove any moisture in the casing with a clean, lint-free cloth.



For reference only, your slip ring assembly may look different

FIGURE 4-32

- Remove visible dirt on the slip rings (2), (Figure 4-32) with a clean, lint-free cloth.

You can turn the drum by pulling the RCL Cable in the direction of the main boom head. If you let go of the cable, the drum turns back because of the initial tension.

- Check to make sure all screws (1), (Figure 4-33) are tight.

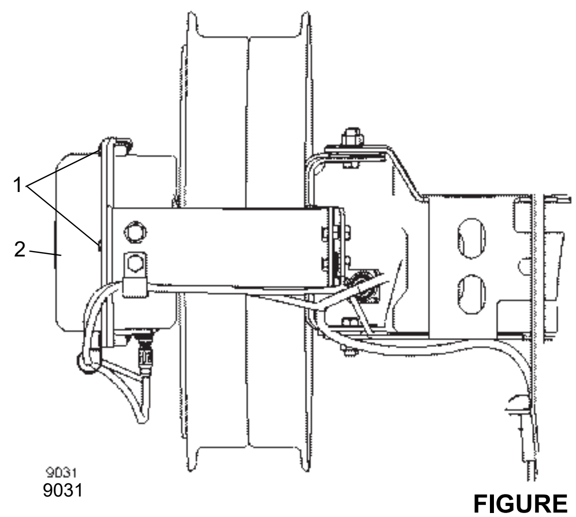


FIGURE 4-33

- Put the casing (2), (Figure 4-33) back in place. Make sure that the seal is in the right place.
- Fasten the casing with all the screws (1), (Figure 4-33).

When all the cable has been wound on the drum it needs to stay on the drum while you are doing the 8 ± 1 revolutions of pre-tension on the entire reel, then start pulling the cable off to route out alongside the boom section.

HOIST ROPES

Checking the Position of Sheaves and Rope Drums

WARNING

Entanglement Hazard!

Keep yourself and other people away from the turning rope drum. Death or serious injury may result if entanglement occurs during hoist operation. Keep all body parts and loose clothing clear while hoist is running.

- Check the position of the hoist ropes on the rope drums of the main hoist and the auxiliary hoist.
- Slowly turn the rope drum at least one turn in the lowering direction. Watch the rope on the drum as you do this.
  - The rope must be wound evenly on the drum.
  - The rope turns on the drum must be evenly spaced at a distance of 0 to 2 mm (0 to 0.07 in).
  - The cross-over points must be at an angle of approximately 180°.

NOTE: The upper rope lines lie over the lower rope lines at the cross-over points.

- Check the position of the hoist ropes on the sheaves at the boom head and in the hook block.
- Check the sheaves for damage and wear, and check that they run freely.

WARNING

Incorrectly Set Lowering Limit Switch Hazard!

Never turn the free rope end under the drum. Turns on the drum which are unwound when the rope drum is stationary cannot be detected by the lowering limit switch. This causes the lowering limit switch to become set incorrectly and to switch off too late or not at all. Consequently the load may fall causing equipment damage or injury.

- Check the securing of the rope end in the rope end clamp (2), (Figure 4-34) for proper seating and correct positioning of rope.
- The rope end clamp (1), (Figure 4-34) must be attached to the free end of the rope and the rope must be secured around the rope wedge (3), (Figure 4-34).

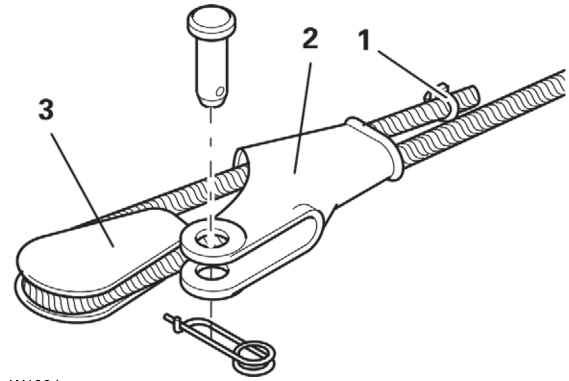


FIGURE 4-34

NOTE: The recommended hook-blocks are designed to be of sufficient weight to overhaul the rope properly when using the parts of line required for the allowed load at the chosen boom length. Operating with a higher number of parts of line than is necessary for a particular boom length may result in poor rope spooling behavior and loosely stored rope, which can result in future rope damage. If operation in these extended ranges is desired, extra weight should be carried by the hookblock or a heavier hookblock should be used.

WIRE ROPE INSPECTION/REPLACEMENT (ALL WIRE ROPE)

NOTE: For cranes equipped with synthetic rope refer to the synthetic rope manual.

No precise rules can be given for determination of the exact time for replacement of wire rope since many variable factors are involved. Determination regarding continued use or replacement of wire rope depends largely upon the good judgment of an appointed and qualified person who evaluates the remaining strength in a used rope after allowance for any deterioration disclosed by inspection.

Wire rope replacement should be determined by the following information excerpted from a National Consensus Standard as referenced by Federal Government Agencies and as recommended by Manitowoc. All wire rope will eventually deteriorate to a point where it is no longer usable. Wire rope shall be taken out of service when any of the following conditions exist:

- Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.
- Evidence of any heat damage from any cause.
- Reductions from nominal diameter of more than 5%.
- In running ropes, six randomly distributed broken wires in one lay or three broken wires in one strand in one lay

- 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.
- In rotation resistant rope, two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters.
- Severe corrosion as evidenced by pitting.
- Manitowoc recommends that for cable extended booms, a single damaged wire rope assembly shall require replacement of the entire set of extension cables.
- Manitowoc recommends for cable extended booms, that boom extension cables be replaced every seven (7) years.

The following tables show the number of wire breaks in a length 6 times and 30 times the rope diameter which would require rope replacement, for the most common rope diameters.

Number of Load-Bearing Outer Wires	Number of Visible Wire Breaks									
	Regular Lay Rope									
	∅ 13 mm		∅ 16 mm		∅ 19 mm		∅ 22 mm		∅ 24 mm	
	to 78 mm	to 390 mm	to 96 mm	to 480 mm	to 114 mm	to 570 mm	to 132 mm	to 660 mm	to 144 mm	to 720 mm
101–120	5	10	5	10	5	10	5	10	5	10
121–140	6	11	6	11	6	11	6	11	6	11

Load-Bearing Outer Wires (Quantity)	Number of Visible Wire Breaks									
	Lang Lay Rope									
	∅ 13 mm		∅ 16 mm		∅ 19 mm		∅ 22 mm		∅ 24 mm	
	to 78 mm	to 390 mm	to 96 mm	to 480 mm	to 114 mm	to 570 mm	to 132 mm	to 660 mm	to 144 mm	to 720 mm
101–120	2	5	2	5	2	5	2	5	2	5
121–140	3	6	3	6	3	6	3	6	3	6

NOTE: The number of visible wire breaks indicated here only applies to the hoist ropes! This information only applies to the initial equipment and original spare parts!

CAUTION

Remember that other factors may also make it necessary to replace the hoist rope before the number of wire breaks requiring rope replacement has been reached (age of rope, frequency of use or exceptional loading).

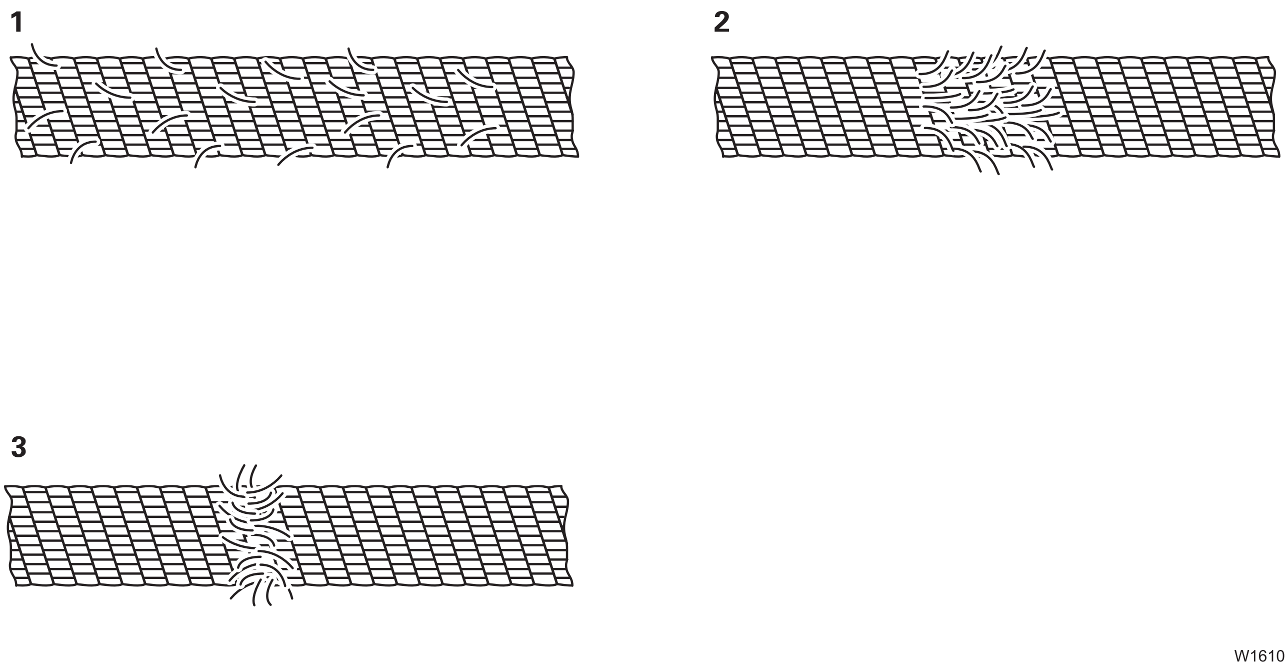


FIGURE 4-35

Damage	Description	Cause	Replacement
Wire Breakage (1), (Figure 4-35) **Wire Breakage Clusters (2), (Figure 4-35)** **Strand Breakage (3), (Figure 4-35)**	Individual wires are broken; the broken ends of the wires are protruding from the rope.	General wear caused by aging of the rope or subsequent damage resulting from damage to the rope.	Replace hoist rope **at the latest** when the maximum permissible number of wire strand fractures according to the table are visible externally. Replace hoist rope **immediately** if wire breakage clusters or strand breakage occur. The frequency of wire breakage increases with rope age. For reasons of safety, it is advisable to replace the hoist rope while the number of broken wires is still low.
Effect of Heat	Tarnishing color is visible externally on the rope.	Rope has been subjected to strong heat.	Replace hoist rope **immediately**.

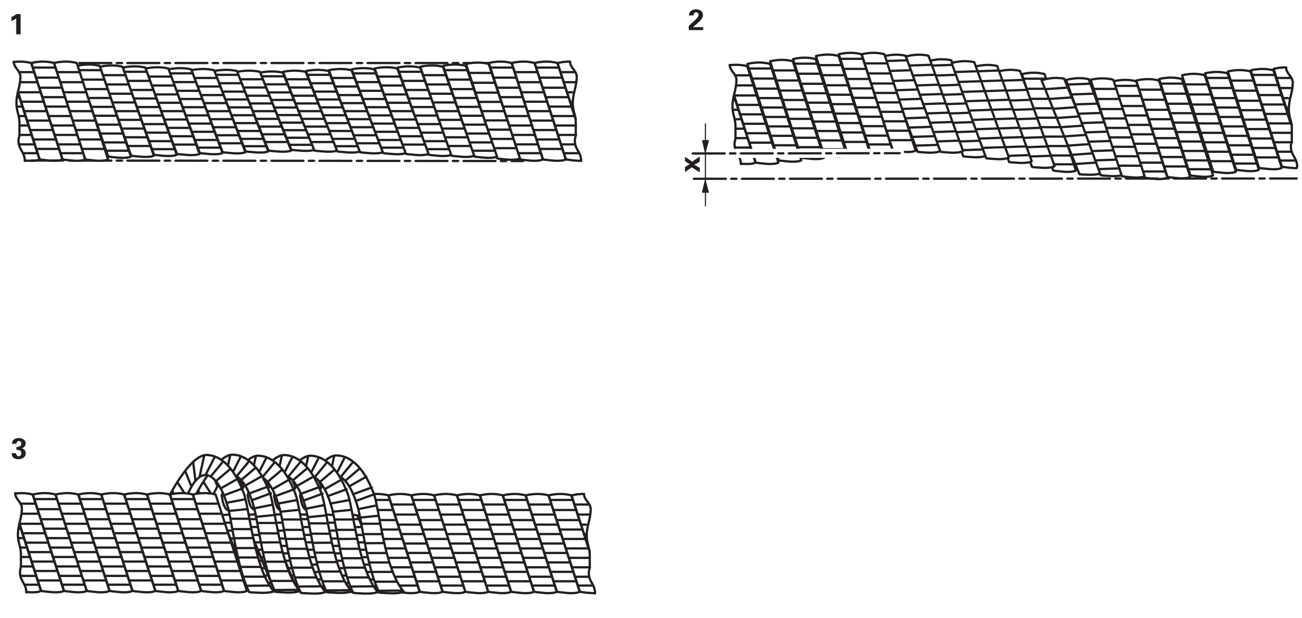


FIGURE 4-36

Damage	Description	Cause	Replacement
Diameter Reduction (1), (Figure 4-36)	The diameter of the rope has become smaller along large sections.	Structural changes.	**Immediately** replace hoist rope if the diameter has decreased by 15% or more with respect to the nominal diameter.
		Corrosion or abrasion.	**Immediately** replace the hoist rope if the diameter has decreased by 10% or more with respect to the nominal diameter.
Corkscrew Deformation of Rope (2), (Figure 4-36)	The rope winds its way along its longitudinal axis in a way which is similar to a corkscrew. The deformation is measured with the attached hook block.	Damage resulting from overloading.	Even a small amount of deformation leads to increased abrasion, wire breakage and rough operation of the cable drive. If deformation 'x' at a position on the hoist rope is greater than a third of the rope diameter, the hoist rope must be replaced **immediately**.
Basket-Type Deformation (3), (Figure 4-36)	Wires from the outer layer are protruding from the rope. In various areas of the rope, the ply has buckled or is protruding from the rope.	Outer and inner layers have dislocated from one another.	Replace the hoist rope **immediately**.

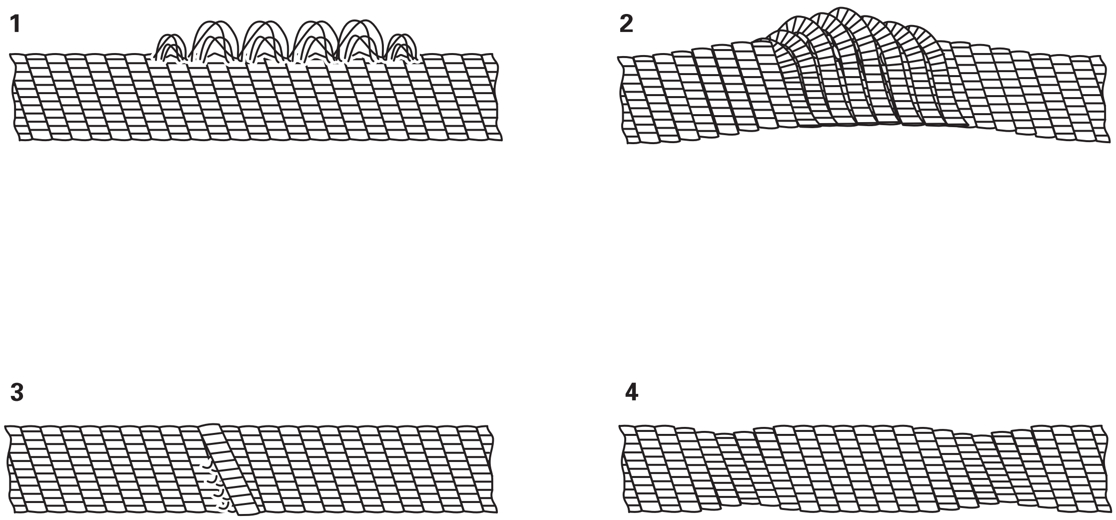


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FIGURE 4-37

Damage	Description	Cause	Replacement
Loop Formation (1), (Figure 4-37)	Outer layer wires in the form of hair pins are protruding from the rope on the side opposite the sheave.	General wear due to aging of the rope or subsequent damage resulting from damage to the rope.	**Immediately** replace hoist rope if the rope structure has been substantially altered by the loop formations.
Loosening of Wires or Strands (2), (Figure 4-37)	Outer wires or strands have become loose. Only the inner strands continue to bear the load.	Corrosion or abrasion.	Replace hoist rope **immediately**.
		Other causes.	The number of broken wires determines when the rope must be replaced.
Knot Formation (3), (Figure 4-37)	Repeatedly occurring knot-like thickening of rope; core often protrudes. The strands bear on each other at thin points resulting in increased occurrence of wire breakage.	General wear due to aging of the rope or subsequent damage resulting from damage to the rope.	Determine number of broken wires; if serious knot formation occurs, replace rope **immediately**.
Constriction (4), (Figure 4-37)	Diameter reduction over short sections.	General wear caused by aging of the rope.	Replace hoist rope **immediately** if serious constriction.

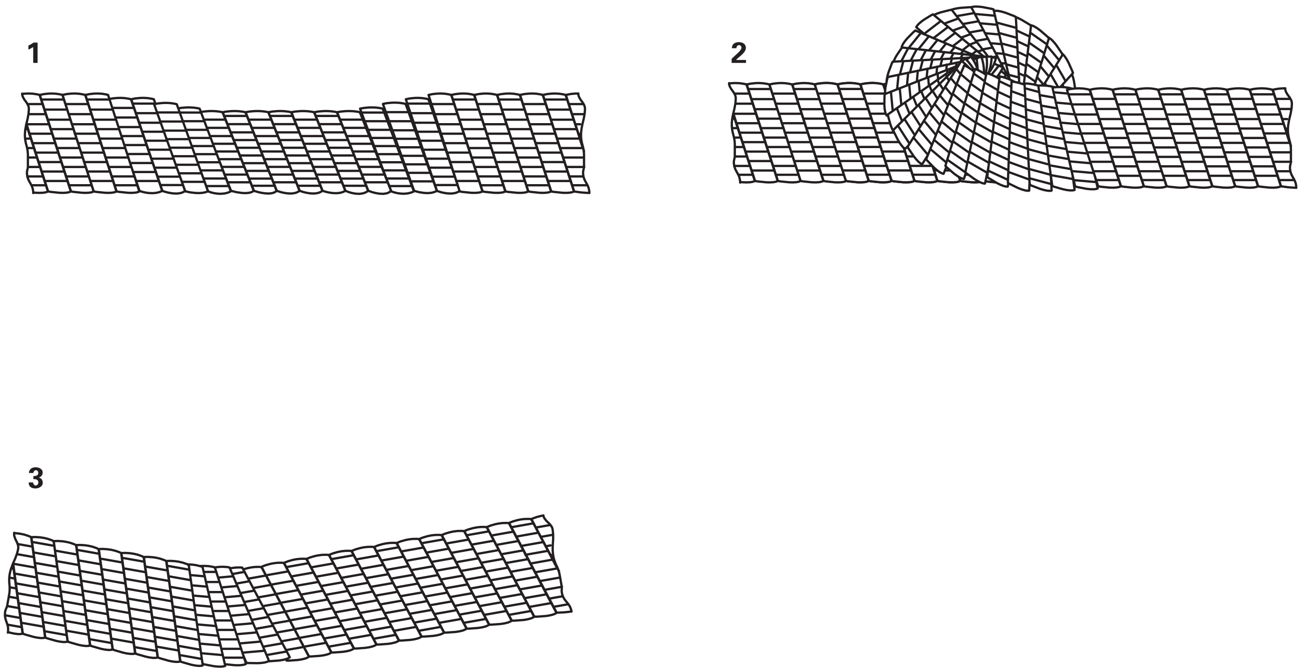

FIGURE 4-38

Damage	Description	Cause	Replacement
Flattening (1), (Figure 4-38)	Crushed areas, mostly with wire breakage.	Mechanical damage, e.g. due to driving over the rope.	Determine number of broken wires; replace hoist rope **immediately** if serious crushing occurs.
Crinkle Formation	Crinkle type rope deformation.	Loaded hoist rope was pulled over an edge.	Replace hoist rope **immediately**.
Kink (2), (Figure 4-38)	Rope deformation with twisting and broken wires.	Rope was pulled straight while twisted and located in eyes.	Replace hoist rope **immediately**.
Buckle (3), (Figure 4-38)	Buckled section in rope.	Mechanical damage.	Replace hoist rope **immediately**.

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SECTION 5
HOIST AND COUNTERWEIGHT

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5

DESCRIPTION

One standard hoist is available for both the main and auxiliary, the MTW19-71-241 (Figure 5-4). The hoist incorporates one dual displacement piston motor which drives a reduction unit within the hoist. The hoist utilizes planetary reduction with a multi-disc automatic brake that is spring applied and hydraulically released. The hoist motor controls both speed and torque of the hoist.

The hoist operates in two modes - High or Low Speed. In High Speed the pilot solenoid valve shifts the selector spool on the motor to provide minimum motor displacement. This gives high line speed and low torque.

In Low Speed the pilot solenoid valve shifts the selector spool on the motor to provide maximum motor displacement. This gives low line speeds and high torque.

THEORY OF OPERATION

Flow from pump number one and two is routed through the swivel to the directional control valve bank.

When the main hoist joystick in the cab is moved from neutral, it sends an electrically controlled signal to the main hoist directional control valve to shift the valve spool to route hydraulic flow to the hoist motor or motor control valve.

When the auxiliary hoist joystick in the cab is moved from neutral, it sends an electrically controlled signal to the auxiliary hoist directional control valve to shift the valve spool to route hydraulic flow to the hoist motor or motor control valve.

MAINTENANCE

Warm-up Procedure

A warm-up procedure is recommended at each start-up and is essential at ambient temperatures below 4°C (40°F).

The prime mover should be run at its lowest recommended RPM with the hydraulic hoist control valve in neutral allowing sufficient time to warm up the system. The hoist should then be operated at low speeds, forward and reverse, several times to prime all lines with warm hydraulic oil, and to circulate gear lubricant through the planetary gear sets.

Refer to the *GRT8120 Operator Manual* for specific information to warm-up the hoist hydraulic system and other major components of the crane.

DANGER

Failure to properly warm up the hoist, particularly under low ambient temperature conditions, may result in temporary brake slippage due to high back pressures attempting to release the brake, which could result in property damage, severe personal injury or death.

Hoist Area Access

DANGER

Do not use platform for hauling passengers. Death or serious injury could occur.

No storage of components is allowed on the platform.

Only one person at a time is allowed on the platform.

Working Position

Refer to (Figure 5-1).

1. Lift and pull out steps (4) until they hang vertically from bracket.
2. Remove two pins and raise side rail (3). Reinsert pins.
3. Remove two pins and raise rear rail (2). Reinsert pins.
4. Raise two hoist mirrors (1) until they lock in position or adjust as needed to perform maintenance tasks.

FIGURE 5-1

Travel Position

Refer to (Figure 5-2).

1. Lower two hoist mirrors (1).
2. Remove two pins and lower rear rail (2). Reinsert pins.
3. Remove two pins and lower side rail (3). Reinsert pins.
4. Lift and slide steps (4) into retaining bracket. Pull out on steps to ensure notch is engaged in bracket.

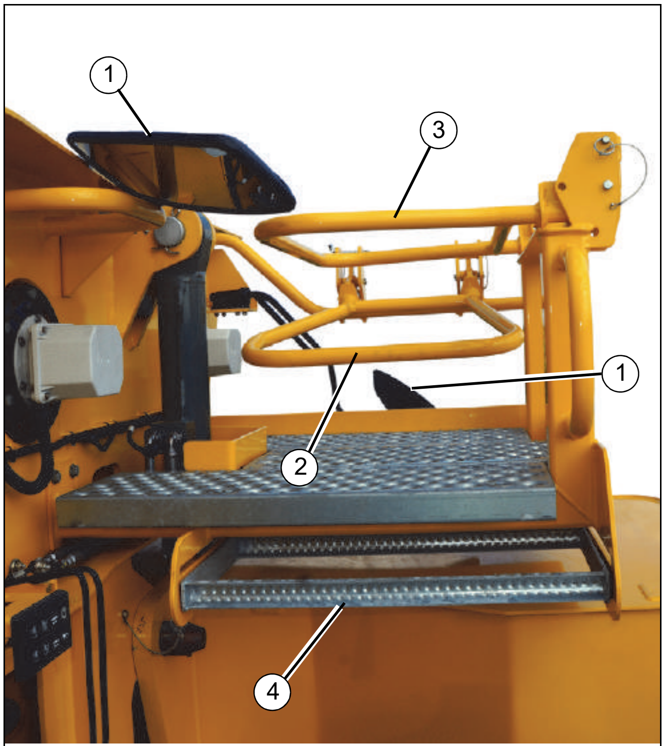

FIGURE 5-2

INSTALLING CABLE ON HOIST

Refer to (Figure 5-3).

CAUTION

If cable is wound from storage drum, rotate reel in same direction as hoist.

NOTE: Straighten cable before installing on hoist drum.

1. Place cable (1) over boom nose sheave and route to hoist drum (2).
2. Rotate hoist drum so cable slot located on left side of drum is easily accessible.
3. Insert cable through slot (3) and wedge block (4). Slowly wind the drum and rope tail in the hoist up direction until they are toward the top of the superstructure. Pull the rope up into the open space and loop around anchor wedge (6) and route back through wedge block to clamp (5). Ensure cable is routed over guide in side of drum. End of cable should extend approximately 50 mm (2 in) beyond clamp. Tighten clamp.
4. Adjust cable so clamp side is snug against guide. Position anchor wedge in wedge block. Slowly rotate the drum downward until cable entry hole is visible. Pull firmly on inside hoist side of cable to secure the wedge.
5. If wedge does not seat securely in slot, carefully tap cable and top of wedge (7) with a mallet.

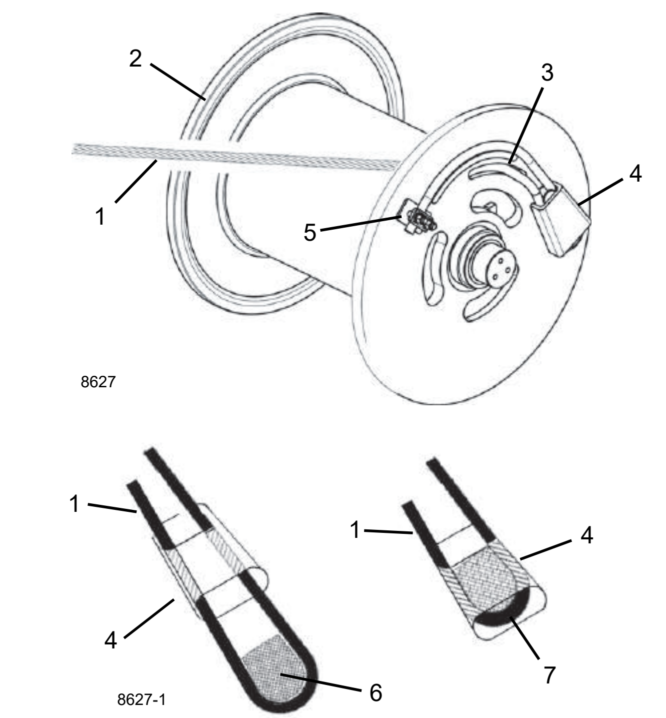

FIGURE 5-3

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6. Slowly rotate drum and ensure cable lays immediately in the first groove.
7. Install remainder of cable as required.

REMOVING/INSTALLING THE HOIST

Refer to Figure 5-4, on page 5-5.

Removing

1. Remove cable from hoist drum.
2. Tag and disconnect hoist hydraulic lines from motor and brake. Cap or plug all lines and openings.
3. Remove lower hose from sight glass. Collect oil as it drains.
4. Remove gearbox sight glass hoses and fittings from gearbox.
5. Tag and disconnect hoist control valve electrical wires.
6. Remove hydraulic motor (6).
7. Remove the hydraulic motor adapter plate and O-ring.
8. Remove standoff fitting from right side of hoist assembly.
9. Tag and disconnect hoist rotation indicator sensor electrical wires.
10. Remove hoist rotation indicator sensor (5).
11. Remove two shafts (7).
12. Remove hoist roller (11).
13. Using an adequate lifting device, slightly lift hoist assembly.

NOTE: Hoist assembly weighs approximately 412 kg (908 lb).

14. Remove bearing support (8) capscrews (6 long, 3 short). Install three long capscrews into the three short capscrew holes. Used capscrews as jack screws to pull the bearing support (8) off the drum shaft (1).
15. Remove the hoist mounting capscrews and washers, then remove the hoist assembly.

Installing

1. Ensure the hoist and superstructure mounting surfaces are clean and free from debris and the hoist has not been damaged during handling.
2. With the hoist supported by a suitable lifting device, position the hoist inside the superstructure.

NOTE: Hoist assembly weighs approximately 412 kg (908 lb).

3. Secure the hoist assembly to the superstructure using the capscrews and washers. Torque the capscrews - refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
4. Install the bearing support assembly (8) to the drum shaft with grease fittings at the 11-o'clock position. Align and install the six long capscrews into the threaded turntable holes. Install the three short capscrews into the blind holes. Torque capscrews following specification under *Fasteners and Torque Values*, page 1-17
5. Install the hoist roller (11).
6. Install the two shafts (7)
7. Install the hoist rotation indicator sensor (5).
8. Connect the hoist rotation indicator sensor electrical connectors as tagged during removal.
9. Install the standoff fitting. Torque standoff fitting to 35 Nm (26 ft-lb).
10. Lubricate O-ring, then install O-ring and hydraulic motor adapter plate. Apply medium strength thread locker to the capscrews and torque to 42 Nm (31 ft-lb).
11. Install new O-ring (22). Lube O-ring, then install hydraulic motor.
12. Connect the hoist control valve electrical connectors as tagged during removal.
13. Reattach gearbox sight glass hoses and fittings.
14. Reattach lower hose to bottom of sight glass.
15. Connect the hydraulic lines to the motor and brake as tagged during removal.
16. Ensure the bearing is full of grease.
17. Ensure gear box is filled with oil to the proper level. Refer to section titled *Hoist Lubrication*, page 9-44.
18. Install cable onto hoist assembly. Refer to *Installing Cable On Hoist*, page 5-3.
19. Adjust the minimum wrap switch, refer to *Adjusting Minimum Wrap Switch*, page 5-9.

Functional Check

1. Attach a test weight to the hook. Raise and lower the load several times.
2. Check for smooth operation of the hoist motor and brake system.
3. Ensure hydraulic connections are secure and free from leaks.

Hoist Fluid Level Check

Refer to the sub-section titled *Hoist Lubrication*, page 9-44 for information on properly checking the hoist oil level.

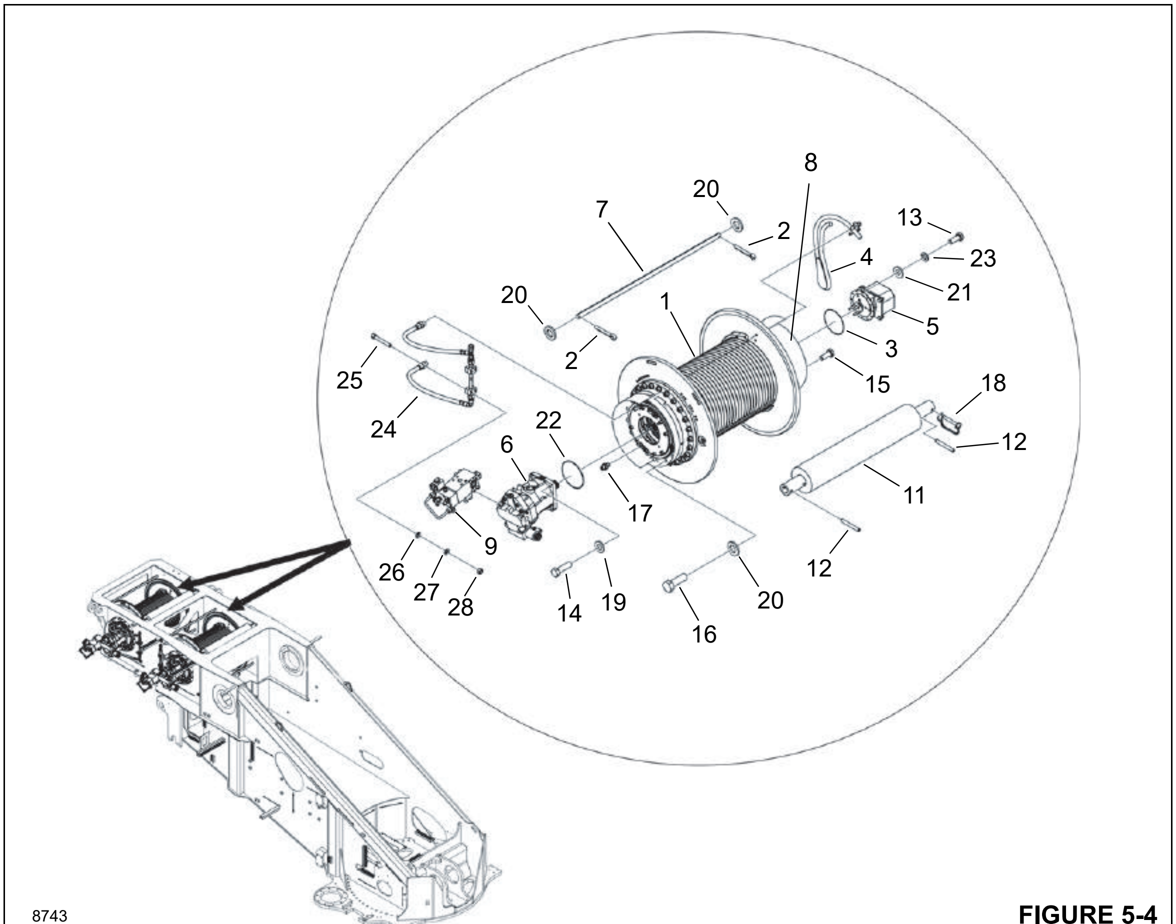

FIGURE 5-4

1	Hoist	10	Shaft	19	Flat Washer
2	Cotter Pin	11	Hoist Roller	20	Flat Washer
3	O-Ring	12	Roll Pin	21	Narrow Flat Washer
4	Cable Wedge	13	Capscrew	22	O-Ring
5	Limit Switch Assembly	14	Capscrew	23	Lockwasher
6	2 Speed Motor Piston	15	Capscrew	24	Sight Glass
7	Shaft	16	Capscrew	25	SHCS
8	Bearing Support	17	Straight Thread Adapter	26	Washer
9	Motor Control Valve Assy	18	Pin	27	Lockwasher
				28	Nut

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A comprehensive hoist line pull and load holding test must be carried out following any such repair work.

Manitowoc Crane Care offers prepackaged kits that include all seals, bearings, fasteners, washers, brake disks, brake stators, and springs required for reassembling hoist after inspection. If components not included in the kit are found to be worn or damaged, contact your Manitowoc Cranes distributor or Manitowoc Crane Care to order a replacement.

Usage and Inspection

Inspection procedures for hoists are divided into five general categories based on usage or duty cycle which determines appropriate intervals for inspections. Usage categories must be assigned by the crane user on a consistent crane-by-crane basis. The five crane/hoist usage categories are as follows:

Idled - The crane/hoist has not been used for three months.

Infrequent Usage - The crane/hoist is used less than ten hours per month based on a three month average

Moderate Usage - Crane/hoist used 10 - 50 hours per month based on a three month average.

Heavy Usage - Crane/hoist used 50 - 200 hours per month.

Severe Usage - Crane/hoist is operated more than 200 hours per month OR where 50% of the lifts exceed 75% of the rated capacity for the hoist.

The following chart lists inspections required for each type of usage category.

	PRE-USE DAILY INSPECTION	QUARTERLY INSPECTION	SEMI-ANNUAL INSPECTION	ANNUAL INSPECTION
IDLED Not used for 3 months or longer	REQUIRED BEFORE PLACED IN SERVICE	REQUIRED BEFORE PLACED IN SERVICE	REQUIRED BEFORE PLACED IN SERVICE	N/A
INFREQUENT USAGE Less than 10 hours per month	REQUIRED	REQUIRED	REQUIRED	REQUIRED
MODERATE USAGE 10-50 hours per month	REQUIRED	REQUIRED	REQUIRED	REQUIRED
HEAVY USAGE 50-200 hours per month	REQUIRED	REQUIRED MONTHLY	REQUIRED QUARTERLY (3 MONTHS)	REQUIRED SEMI-ANNUALLY (6 MONTHS)
SEVERE USAGE 200+ hours per month or 50% of lifts exceed 75% rated capacity	REQUIRED	REQUIRED	REQUIRED QUARTERLY (3 MONTHS)	REQUIRED SEMI-ANNUALLY (6 MONTHS)

Preventative Maintenance

It is extremely important to be aware of deterioration of internal critical components within the hoist reduction unit. Hoist reduction units contain planetary gears, and multi-disc brake assemblies, which do not have an infinite life span. Although these components are designed for long service life, reliability can be reduced by a variety of factors such as:

- High cycle operation.
- Operating in high ambient temperatures.
- High external contaminations, such as dusty or sandy conditions.
- Level of maintenance.

DANGER

Failure to implement and adhere to a hoist inspection and maintenance program may result in damage to the crane, other property damage, and/or serious injury or death to persons working on or near the crane.

The following should be carried out following instructions in *Maintenance and Lubrication*, page 9-1 and/or manufacturers instructions.

1. Pre-Use or Daily Inspection.

Must include but is not limited to the following inspections that will be performed prior to placing the crane into service and then as necessary during extended operation. This inspection must be performed by a qualified crane operator or qualified crane technician.

- Check for external oil leaks and repair as necessary. This is extremely important due to accelerated wear from insufficient lubricating oil in the hoist. Hoists with a sight glass; check oil level daily. Hoists without a sight glass; check oil level monthly if no external oil leaks are detected. Lubricant level must be maintained between the minimum and maximum levels; midway up sight glass or at bottom of level plug port as equipped. Use ONLY the recommended type of lubricant. Refer to *Maintenance and Lubrication*, page 9-1.
- Check hydraulic fittings and hoses for chaffing, deterioration or corrosion and repair as necessary.
- Visually inspect for corroded, loose or missing bolts, pins or other fasteners and replace or tighten as necessary.
- Visually inspect rotation indicator transmitters, anti-two-blocking switches and other safety equipment and repair as necessary.

2. Quarterly Inspection (every three months).

Must include but is not limited to the following inspections that must be performed by a qualified crane operator or qualified crane technician.

- Perform pre-use inspection.
- Inspect for corrosion of fasteners, hoist base, drum, etc. and repair/replace as required to maintain structural integrity of the hoist.
- Check hoist oil level. Inspect hoist gearbox for oil leaks.

3. Every 250 hours or 3 months.

- If applicable, lubricate cable guide roller and cable guard roller bearings.

4. Semi-Annual Inspections (every six months).

Must include but is not limited to the following inspections that must be performed by a qualified crane operator or qualified crane technician.

- Perform Pre-Use and Quarterly inspections.
- Take a sample of lubricant from hoist gear cavity as described in *Gear Oil Sampling and Analysis*, page 5-7 and analyze it for wear metals content, correct viscosity, lubricant deterioration, moisture and other contaminants. If oil sample contains a high amount of metallic particles, hoist must be taken out of service to undergo a tear down inspection.

NOTE: Oil analysis alone cannot detect or warn against a fatigue failure.

5. Annual Inspection.

This inspection must be carried out by a qualified crane technician. Annual inspection MUST include, but not be limited, to the following:

- Perform Pre-Use/Daily Inspection, Quarterly Inspection, and Semi-Annual Inspection.
- Change lubricating oil in hoist gear cavity after an oil sample has been taken as described in *Gear Oil Sampling and Analysis*, page 5-7. Refill hoist to proper level with recommended lubricant. Refer to *Maintenance and Lubrication*, page 9-1.

DANGER

Failure to use proper type and viscosity of planetary gear oil may contribute to intermittent brake clutch slippage which could result in death, serious injury or damage to property and equipment. Some gear lubricants contain large amounts of Extreme Pressure (EP) and anti-friction additives which may contribute to brake clutch slippage or damage to brake friction discs or seals. Oil viscosity with regard to ambient temperature is also critical to reliable brake clutch operation. Our tests indicate excessively heavy or thick gear oil may contribute to intermittent brake clutch slippage. Ensure gear oil viscosity used in your hoist is correct for your prevailing ambient temperature.

- Check for correct function of hoist brake by conducting a high line pull load test. Ensure brake holds without creeping and hoist control is correct. Check hoist brake function more often if abnormal operating conditions or characteristics exist.

6. Every 10,000 hours or every ten years, it is recommended that the hoist assembly be disassembled and that all major components be examined for damage and/or wear, i.e. gears, spline couplings, shafts, etc. New components must be installed if any are found to be worn or if there is evidence of heat or other damage. The hoist should be reassembled using all new seals, bearings, fasteners, washers, brake discs, brake stators, and springs. A comprehensive hoist line pull and load holding test must be conducted following the repair work.

Oil Sampling

Oil Change

Hoist gear oil must be changed after the first 100 operating hours then on an annual basis, at a minimum thereafter. In severe duty applications, the gear oil should be changed every six months. Use the recommended lubricants. Refer to *Maintenance and Lubrication*, page 9-1.

Gear Oil Sampling and Analysis

Proper gear oil sampling and analysis is a vital part of a comprehensive preventive maintenance program. Information obtained from the oil analysis allows the maintenance technician to substitute preventive maintenance for more costly unscheduled down time or a far more dangerous failure. Early detection of accelerated component wear allows the scheduling of corrective maintenance.

CAUTION

Hot oil may cause personal injury and/or burns to unprotected skin. Make certain the oil has cooled to a safe temperature (typically less than 110°F or 43°C) before taking an oil sample, changing oil or servicing the hoist.

Prepare hoist by cleaning drain area and to obtain an uncontaminated sample. Operate hoist in both directions for one or two minutes to thoroughly mix the gear oil. Take sample from midstream flow of oil to obtain an accurate representation of the oil condition. After taking the oil sample, continue with oil change or refill hoist gear cavity to proper level with recommended lubricant.

General Guidelines for Iron Contaminant Level

100-500 ppm

Normal

500-800 ppm

Caution - Abnormal Sample. Change oil and retake sample after 50 hours of operation. If second sample is above 500 ppm, remove hoist from service and perform tear-down inspection to determine source of contamination.

800+ ppm

Unacceptable. Remove hoist from service and perform tear-down inspection to determine source of contamination.

NOTE: Iron contaminant levels will be on high side of “Normal' during initial break-in.

Equally important as level of contamination is a change in level of contamination. An effective oil analysis program should provide the technician with a view of the progression of wear or a trend. If a sample shows a sudden rise in contaminant level action should be taken to determine what has changed.

NOTE: Oil analysis alone cannot detect nor warn against a fatigue failure.

Brake Test Procedure

These planetary hoists have a spring applied, hydraulically released, multiple disc brake inside the hoist housing. This brake holds a suspended load when the directional control valve is in neutral, or when hydraulic power is lost. A load cannot be lifted or lowered, however, without applying hydraulic pressure to the release port and releasing the brake.

(Test to be performed with no load on the hoist)

Remove and cap or plug the brake release line from fitting in the hoist brake release port.

With hydraulic power unit running, move directional control valve handle slowly to the full open, lowering position.

Increase the engine speed, if necessary, to bring system pressure up to the relief valve setting. The hoist drum should remain stationary.

If the hoist drum rotates, the hoist should be disassembled and the brake components should be examined for wear. In addition, the brake springs should be measured for the correct free length in those hoist using helical compression springs.

Replace any parts showing excessive wear and any spring whose length is shorter than the minimum shown in the applicable hoist Service Manual.

Reassemble the brake and hoist and repeat the above steps.

When testing is complete, reattach the brake release line to the brake release port.

MOTOR, MOTOR CONTROL VALVE, AND BRAKE

Description

Each hoist has a hydraulic motor, a motor control valve, a brake cylinder, and a brake clutch which controls motion of the hoist’s drum. These parts mount on or in the gearbox. The hydraulic motor connects to the hoist’s brake, which in turn connects to the gear train of the hoist. The entire hoist assembly must be removed from the crane to service the brake cylinder and clutch.

Removal

1. Power-wash the hoist on the motor side to wash away potential contaminants from the drive components of the hoist.
2. Drain the oil from the hoist gearbox. Refer to the hoist draining procedures on page 9-44. Once oil is drained, reinstall the plug or hose at bottom of sight glass.
3. Tag and disconnect the hydraulic lines from the motor and the motor control valve. Cap or plug all lines and openings.
4. Remove the bolts and washers to free the motor and motor control valve from the brake cylinder and brake clutch, which are in the motor control valve gearbox. Remove the motor and motor control valve as a unit. Discard the O-ring.
5. Cover the motor opening in the brake cylinder to protect drive components inside the hoist drum. As needed, secure the brake clutch from inside the brake cylinder.

Installation

1. Uncover the motor opening in the gearbox. Verify these parts are clean.
2. Install a replacement O-ring on the motor's pilot after lubricating it with gear oil or petroleum jelly.
3. Engage the motor shaft to the input shaft of the gearbox. Secure the motor and brake valve to the gearbox with bolts and washers. Torque bolts to 40 Nm (29.5 lb-ft).
4. Connect the hydraulic lines to the motor and brake valve as tagged during removal.
5. Fill the gearbox with oil. Refer to the hoist filling procedures on page 9-44.

HOIST ROTATION AND THIRD WRAP INDICATOR SYSTEM

Description

The main and auxiliary hoists are each equipped with an encoder (Figure 5-5 and Figure 5-6) that is part of the hoist rotation and third wrap indicator systems. The encoder is mounted to the end of each hoist and senses the rotation of the drum.

Hoist Rotation Indicator

The hoist rotation indicator system provides the operator with a touch indication of the hoist drum rotation so he or she knows if and at what speed the hoist drum is rotating. The system also displays symbols on the rated capacity limiter (RCL) display and crane control operation (CCS) display indicating which hoist is operating and in what direction it is rotating (hoist up or hoist down).

The hoist rotation indicator system uses a thumb thumper solenoid to provide a physical indication to the operator of hoist operation. Actuation of the thumb thumper is controlled by the CAN bus modules from input supplied by the hoist drum encoder. The pulsing thumb thumper solenoid is located in the main and auxiliary hoist joystick handles and provides feedback proportional to the hoist line speed by pulsing the rubber button on top of the hoist joystick. The thumb thumper solenoid will cease operation at high line speeds to prevent damage to the solenoid.

Third Wrap Indicator

The third wrap indicator system uses the main and auxiliary hoist encoders to indicate when there are three wraps of cable remaining on the respective hoist. When three wraps of cable are reached on the main or auxiliary hoist, the crane control system will sound a buzzer in the cab, cut-out the hoist down function, and display the third wrap symbol on the RCL display to indicate that three wraps of cable remain on the respective hoist. The encoder must be properly adjusted for this system to function properly. Refer to *Adjusting Minimum Wrap Switch*, page 5-9.

Maintenance

General

DANGER

Disconnect the batteries before performing any maintenance on this system. Serious burns may result from accidental shorting or grounding of live circuits.

Proper circuit operation can be checked for each individual electrical component. If a malfunction occurs within the system, repairs should be limited to finding and replacing the faulty component(s). To determine which component is at fault, refer to the troubleshooting section of your CAN bus CD.

Adjusting Minimum Wrap Switch

1. Install hoist rope on the hoist.
2. Reeve hook block with four parts of line from hoist to be adjusted.
3. Fully raise and extend boom.
4. Lower hook block until three wraps of rope remain on hoist drum.

NOTE: If using synthetic rope, lower hook block until eight wraps of line remain on hoist drum.

5. Remove four screws and cover from switch.
6. Rotate adjustment screw (2) until switch activates. Service software may be used to monitor an indicator light on the appropriate display.
7. Raise hook block until there are ten rope wraps on hoist drum.
8. Lower hook block to verify lower limit switch actuates with three rope wraps on hoist drum.
9. Correct setting of switch if necessary.
10. Install cover and secure with four screws.
11. Repeat for auxiliary hoist.

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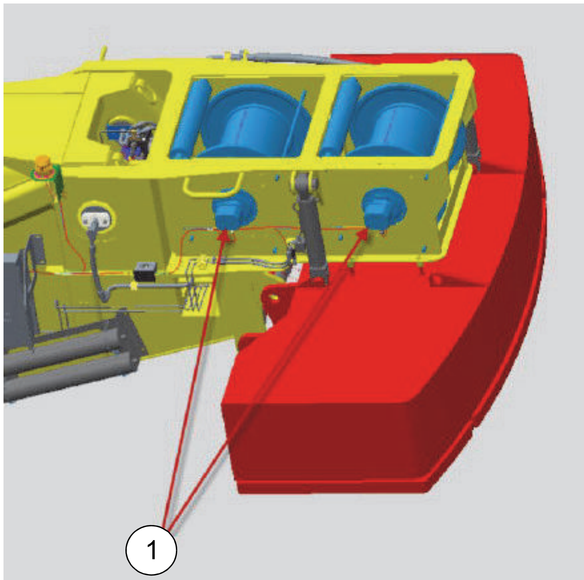


FIGURE 5-5

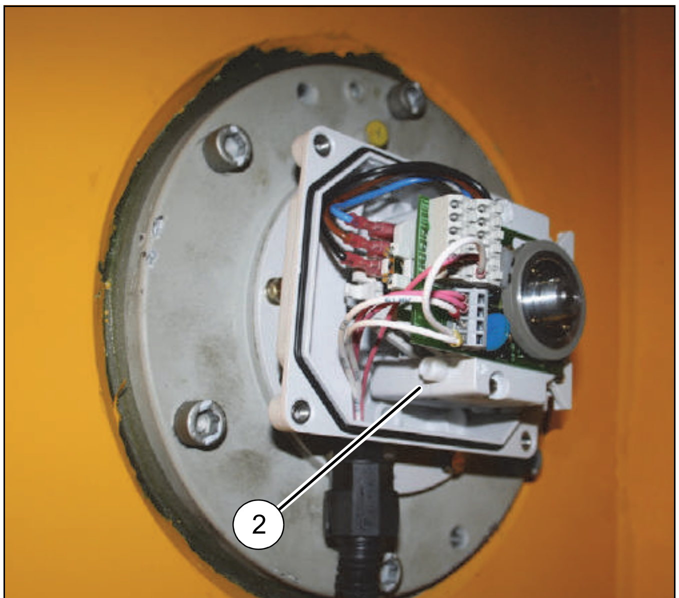


FIGURE 5-6

HOIST CONTROL VALVES

Description

NOTE: For more detailed information, refer to *Valves*, page 2-42 in Section 2 - Hydraulic System.

Hydraulic Hoist Motor Control Valve

The hydraulic hoist motor control valve is mounted on the hoist motor and is designed to provide an even flow of oil to the hoist motor in both directions. This is a different valve than the hoist brake valve that applies and releases the hydraulic piston and hydraulic cylinder.

Hoist Directional Control Valve

The hoist directional control valve is used to control the operation of the hoist. It is a four-way, pilot operated valve and is mounted on the right side of the turntable.

REMOVABLE COUNTERWEIGHT

DANGER

Falling counterweight can crush and cause death or serious injury.

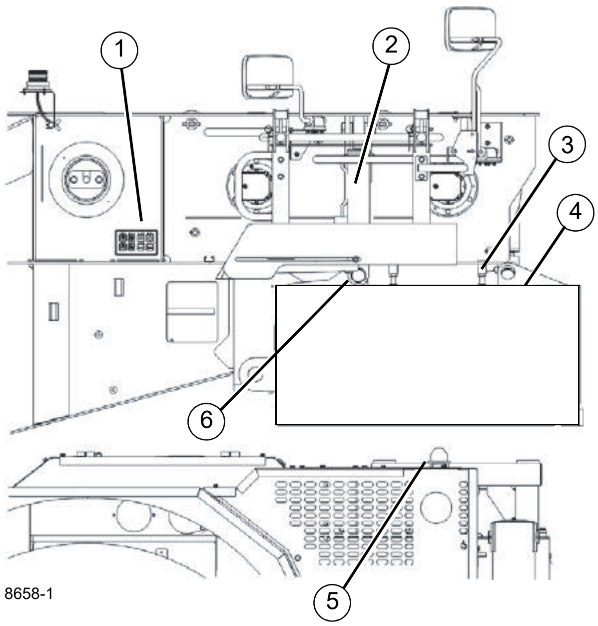
Ensure all mounting pins are properly installed and locked, during and after operating the counterweight removal system.

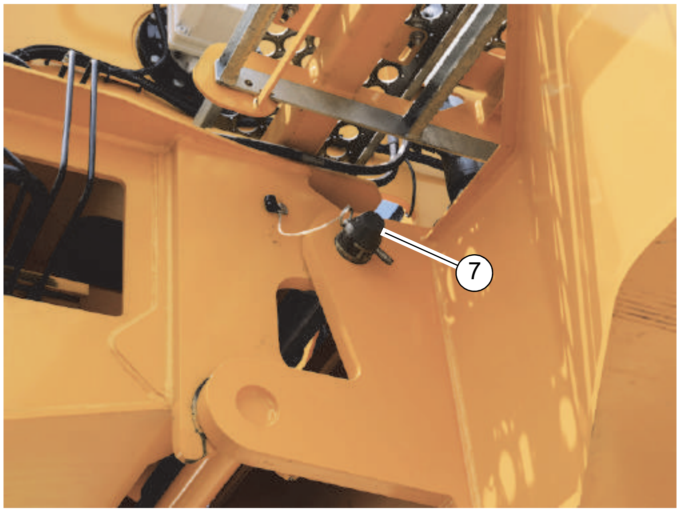
Counterweight is installed and removed using hydraulic cylinders controlled by a counterweight control panel located on each side of the superstructure. The counterweight assembly is held in place by a hydraulic cylinder and locking pins with pin clips.

Counterweight is lowered or lifted from two centering pins located on the rear deck.

DANGER

Travel is not permitted with removable counterweight on carrier deck.





Item	Description	Item	Description
1	Control Panel	5	Centering Pins
2	Lift Cylinder	6	Lock Cylinder
3	Leveling Bolt (4 ea)	7	Lock Cylinder Pin
4	Counterweight		

FIGURE 5-7

5

Counterweight Control Panel

Counterweight control panels are located on each side of the superstructure between the boom pivot and main hoist. Only one control panel can be used at a time. The crane engine must be running with parking brake ON and no other functions enabled for system to be fully operational.

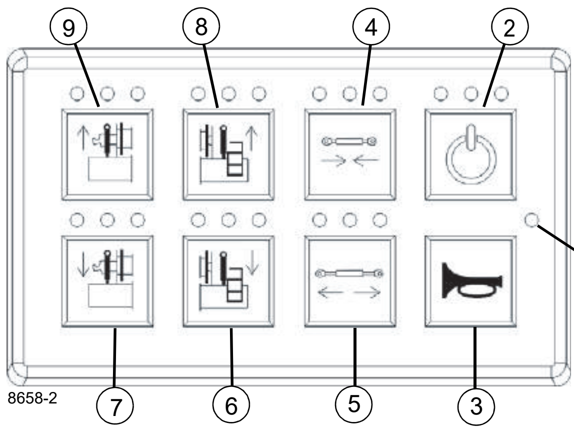


FIGURE 5-8

Item	Description
1	Main Power Indicator
2	Keypad Enable
3	Horn
4	Lock Cylinder Retract
5	Lock Cylinder Extend
6	Left Counterweight Cylinder Lower
7	Right Counterweight Cylinder Lower
8	Left Counterweight Cylinder Raise
9	Right Counterweight Cylinder Raise

Flashing green LED (1) indicates main power is on. Enable and Horn buttons are illuminated and active.

Three LED's above each button indicate:

Green - Function enabled.

Yellow - Error condition.

Red - Function not available or system not enabled.

NOTE: The horn button (3) is always active. Enable does not have to be pressed before using the horn.

The Enable button (2) must be pressed and released before selecting a function. The function must be selected within five seconds after pressing the Enable button or the system will time out and the Enable button must be pressed again.

If the Enable button is pressed and held for more than 2 seconds, the red LED will illuminate. No other functions are available until the button is released and pressed again.

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Removing the Counterweight

Refer to Figure 5-7 and Figure 5-8.

CAUTION

When raising or lowering the counterweight, make sure that the weight remains level by using the left and right cylinder control buttons

1. Position crane on a firm level surface. Fully extend and set outriggers.
2. Place superstructure in normal travel position with counterweight centered at rear of vehicle. Engage turntable lock.
3. Make sure counterweight support (1, Figure 5-9) is securely attached at rear of carrier.

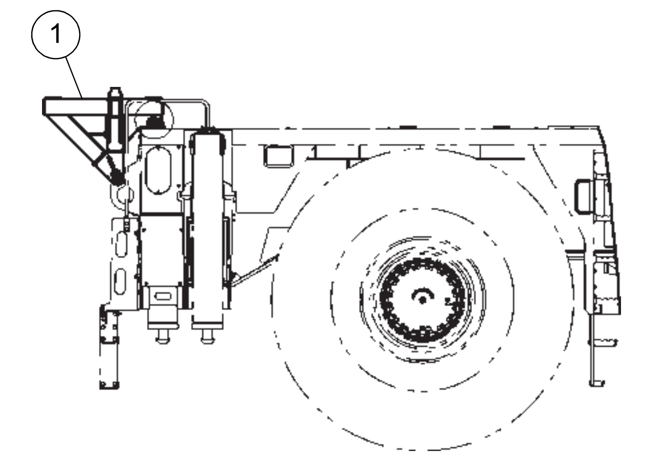

FIGURE 5-9

4. Remove pin clips from lock cylinder pin (8, Figure 5-7) on each side of superstructure.
5. Press and release Enable button (2, Figure 5-8). Press and hold Lock Cylinder Retract button (4) until lock cylinder pins are completely retracted.
6. Check area is clear around counterweight and carrier rear deck. Press horn button (3, Figure 5-8).

CAUTION

To prevent machine damage, make sure that the Lock Cylinder Pins are fully retracted and the counterweight is hanging freely from the lifting cylinders before lowering the counterweight

CAUTION

When lowering the counterweight, make sure that the weight remains level to avoid crane damage.

7. Press and release Enable button (2, Figure 5-8). Press and hold Left (6) and Right (7) Counterweight Cylinder Lower buttons until counterweight is completely lowered on centering pins and rear deck.
8. Remove lock pins and retaining pins from lift cylinders and counterweight.

NOTE: Operate left or right cylinder as needed to remove pins.

9. Press and release Enable button (2, Figure 5-8). Press and hold Left (8) and Right (9) Counterweight Cylinder Lift buttons until cylinder rods are completely retracted. Reinstall retaining pins and lock pins.

NOTE: Do not leave cylinder rods extended. Corrosion or other damage may occur.

DANGER

Travel is not permitted with removable counterweight on carrier deck.

10. Release turntable lock. Rotate superstructure 90° for clear access to rear deck.

NOTE: Counterweight weighs 13,245 kg (29,200 lb).

11. Lift counterweight from carrier deck to transport vehicle.
12. Select proper “Without Counterweight” operating code on the RCL.

    Removing the counterweight increases loading on the front axle. Refer to the *Load Chart Manual and the* section *Driving the Crane*, page 4-12 in this manual for details about travel with counterweight removed.

5

Installing the Counterweight

Refer to Figure 5-7 and Figure 5-8.

CAUTION

When raising or lowering the counterweight, make sure that the weight remains level by using the left and right cylinder control buttons

1. Position crane on a firm level surface. Fully extend and set outriggers.
2. Make sure counterweight support (1, Figure 5-10) is securely attached at rear of carrier.

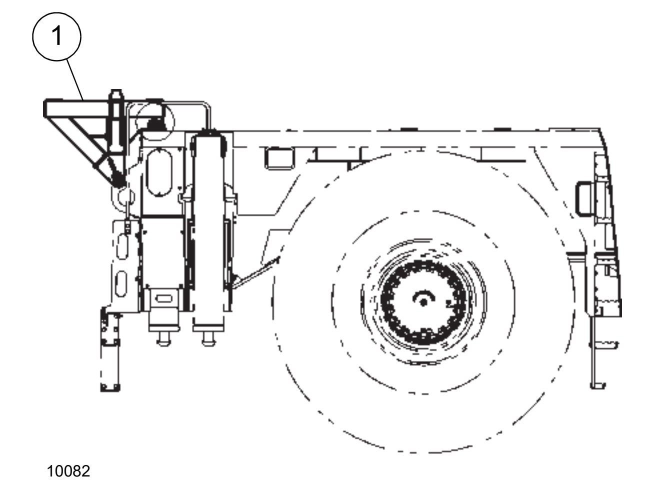

FIGURE 5-10

3. Rotate superstructure 90° for clear access to rear deck.

NOTE: Counterweight weighs 13,245 kg (29,200 lb).

4. Lift counterweight from transport vehicle and position on rear deck centering pins.
5. Place superstructure in normal travel position with boom centered over front of vehicle. Engage turntable lock.
6. Remove lock pins and retaining pins from counterweight lift cylinders.

DANGER

Hand Crushing Hazard!

Do not place hand between counterweight cylinders and the top of the counterweight while cylinders are in motion.

7. Press and release Enable button (2, Figure 5-8). Press and hold Left (6) and Right (7) Counterweight Cylinder Lower buttons until cylinder rod ends engage counterweight.
8. Install lock pins and retaining pins in lift cylinders and counterweight.

NOTE: Operate left or right cylinder as needed to install pins.

CAUTION

When raising the counterweight, make sure that the weight remains level to avoid crane damage.

9. Press and release Enable button (2, Figure 5-8). Press and hold Left (8) and Right (9) Counterweight Cylinder Lift buttons until counterweight engages superstructure and lock cylinder holes are aligned with lock cylinder rods on both sides.

NOTE: Operate left or right cylinder as needed to align lock cylinder holes with lock cylinder pins.

10. Press and release Enable button (2, Figure 5-8). Press and hold Lock Cylinder Extend button (5) until lock cylinder pins (8, Figure 5-7) are completely extended.
11. Install pin clips in counterweight lock cylinder pins on each side of superstructure.
12. Adjust four counterweight bolts and jam nuts to provide a consistent stop and proper alignment with the pinning holes.
13. Select proper counterweight operating code on the RCL.
14. Crane is now ready for operation with counterweight installed.

SECTION 6
SWING SYSTEM

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DESCRIPTION

The purpose of the swing system is to allow the crane superstructure to rotate atop the carrier frame. The superstructure swing system provides full 360 degree rotation in both directions and is equipped with free swing capabilities. The term free swing means that, the superstructure will swing freely after the Swing joystick is released until it coasts to a stop or the Swing Brake Pedal is depressed.

Swing is activated using a joystick in the cab. When the Swing joystick is actuated, hydraulic pressure is routed to the Swing Motor to drive the gearbox in the appropriate direction. As the gearbox rotates, the pinion gear meshes with the teeth on the swing bearing and rotates the superstructure. The maximum rotation is 2 rpm. Braking is accomplished by depressing a Swing Brake Pedal which is a proportionate control valve that provides a controlled braking of the swing motion.

The swing system consists of a electric remote controller, a directional control valve, the swing drive, the swing brake assembly, the brake pedal and power brake valve, and a swing brake release solenoid valve.

The crane is equipped with a pin type swing lock as standard and an optional 360 degree positive swing lock. The 360 degree positive swing lock meshes with the swing gear teeth at any point of rotation. The pin type swing lock can only be engaged when the boom is centered over the front or rear of the carrier. Both swing locks are operated from the cab.

THEORY OF OPERATION

Swing Drive

The hydraulic power for the swing drive (Figure 6-1) is supplied by the engine driven hydraulic pump. Oil flows from the pump to the hydraulic swivel. Flow from the swivel is routed to the Swing Directional 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 Enable Switch is in the ON position, the superstructure will rotate in the desired direction. Shifting the control to neutral and depressing the swing brake pedal will stop the swing.

Swing Brake

The (static) swing brake is spring-applied, hydraulic released while the service (dynamic) brake is pressure applied. A two position solenoid valve controls the pressure to release the swing brake. A pressure reducing valve maintains a pressure of 600 psi to the inlet of both the brake release and brake apply valves. The circuit is designed such that when the engine is running and the swing enable switch is activated pressure is supplied to the swing brake release to release the brake while at the same time pressure is ramped up on the swing service brake proportionally to the max pressure. When the swing control joystick is actuated to swing left or right, the proportional valve is de-energized there by releasing the pressure from the swing service brake and allowing motion. When the swing joystick is returned to the center (neutral) position, the control system gradually re-energizes the proportional valve (apply valve), thereby slowly increasing oil pressure to apply the brake. Actuating the swing brake foot pedal results in the same action.

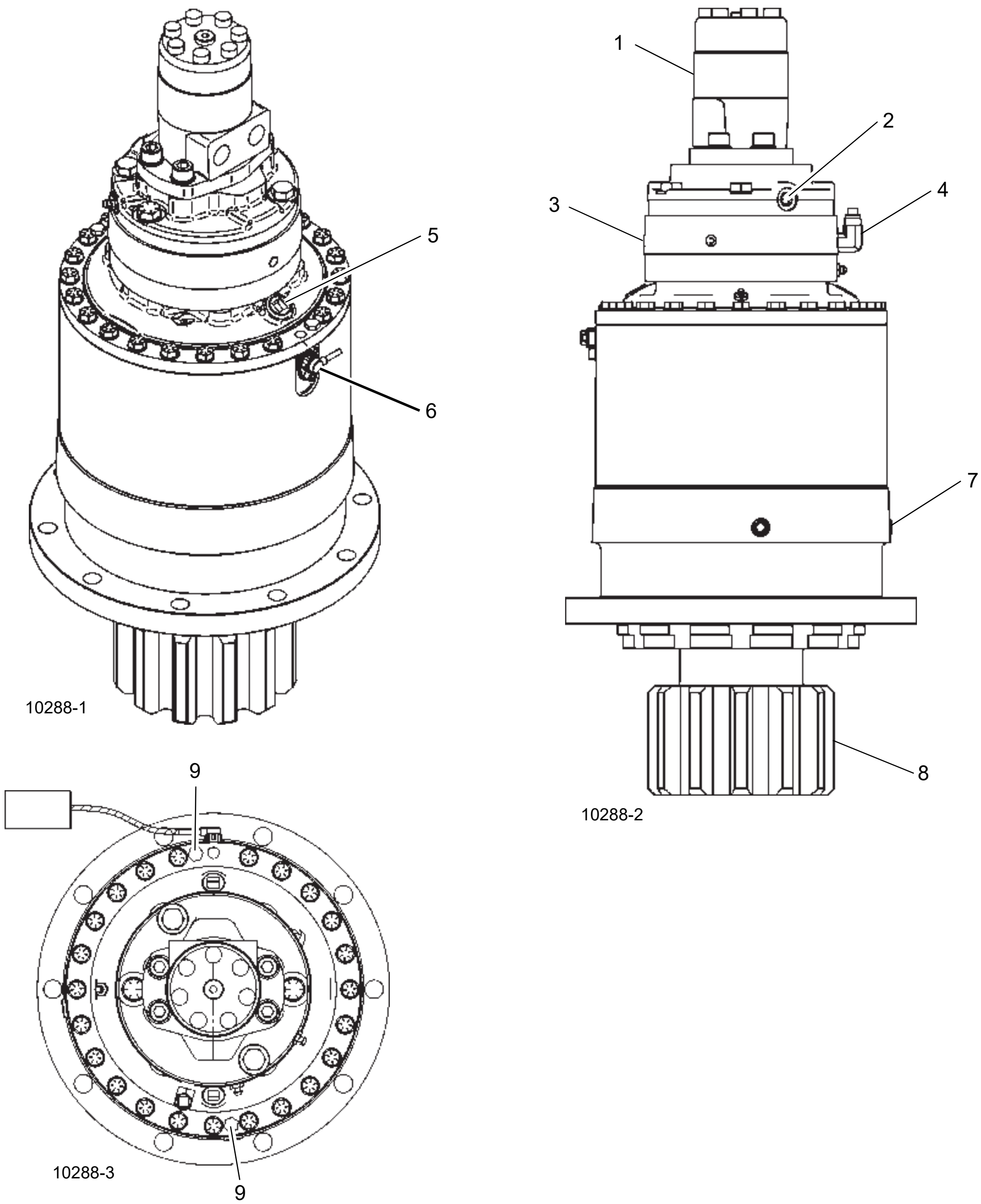


FIGURE 6-1

1	Motor	6	Slew Angle Sensor
2	Hydraulic Port - Swing Brake Release	7	Swing Gearbox Drain Plug
3	Hydraulic Port - Swing Brake Pedal Apply	8	Pinion
4	Swing Brake Fill Port	9	Lifting Holes - M10x1.5
5	Swing Gearbox Fill Port		

MAINTENANCE

Table 6-1: Troubleshooting

Symptom	Probable Cause	Solution
1. Boom swing operation erratic in either direction.	**a.** Damaged relief valve.	**a.** Replace relief valve.
	b. Swing brake dragging (not releasing properly).	**b.** Readjust and/or replace parts.
	c. Low engine rpm.	**c.** Increase engine rpm to obtain smooth swing operation.
	d. Low hydraulic oil.	**d.** Check system for leaks. Make repairs as needed. Fill reservoir.
	e. Improper movement of control to neutral.	**e.** Feather controls to neutral to maintain smooth stopping action.
	f. Insufficient lubricant on swing bearing.	**f.** Lubricate bearing properly. Refer to *Maintenance and Lubrication*, page 9-1.
	g. Crane not level.	**g.** Level crane using outriggers.
	h. Damaged swing motor.	**h.** Repair or replace swing motor.
	i. Excessive overload.	**i.** Reduce load. Refer to load capacity chart.
	j. Restricted or partly clogged hydraulic hose or fittings.	**j.** Replace hose or fittings. Refer to the Manitowoc Crane Care Parts Manual.
	k. Pump cavitation in swing section.	**k.** Tighten suction hose or replace damaged fittings. Check hydraulic tank level.
	l. Improperly torqued turntable bolts.	**l.** Torque turntable bolts evenly.
	m. Excessive preload on upper and lower pinion shaft bearing.	**m.** Adjust as necessary.
	n. Improperly torqued swing motor attachment bolts.	**n.** Torque swing motor attachment bolts.
	o. Malfunction of the swing box.	**o.** Remove swing box and make necessary repairs.
	p. Worn or damaged pump.	**p.** Repair or replace damaged pump.
	q. Damaged swing directional control valve.	**q.** Repair or replace swing directional control valve.
	r. Damaged swing pinion.	**r.** Replace pinion.
	s. Damaged turntable bearing.	**s.** Replace turntable bearing.
	t. Controller settings	**t.** Check settings
	u. Electrical connection	**u.** Inspect wiring and connections

Symptom	Probable Cause	Solution
2. Boom swing operation erratic in one direction only.	**a.** Crane not level.	**a.** Level crane using outriggers.
	b. Turntable bearing binding due to continuous limited swing. (Example: concrete pourer.)	**b.** Rotate machine 360 degrees in both directions several times and lubricate bearing.
	c. Restricted hose or fitting.	**c.** Replace hose or fitting.
	d. Damaged swing directional control valve.	**d.** Replace swing directional control valve.
	e. Damaged swing pinion.	**e.** Replace pinion.
	f. Damaged turntable bearing.	**f.** Replace turntable bearing.
3. Boom will not swing in either direction.	**a.** Damaged relief valve.	**a.** Remove, clean, and repair or replace relief valve.
	b. Damaged swing motor.	**b.** Repair or replace swing motor.
	c. Swing brake not releasing properly.	**c.** Repair as necessary.
	d. Damaged hydraulic remote control valve.	**d.** Replace hydraulic remote control valve.
	e. Internal damage to swing box.	**e.** Remove swing box and repair.
	f. Worn or damaged hydraulic pump.	**f.** Replace pump section.
	g. Damaged swing directional control valve.	**g.** Replace swing directional control valve.
	h. Damaged swing pinion.	**h.** Replace pinion.
	i. Damaged turntable bearing.	**i.** Replace turntable bearing.
	j. Excessive overload.	**j.** Reduce load. Refer to load capacity chart.
4. Swing operation slow in either direction.	**a.** Damaged relief valve.	**a.** Adjust, repair or replace valve.
	b. Improperly adjusted swing brake.	**b.** Readjust.
	c. Damaged hydraulic remote control valve.	**c.** Replace hydraulic remote control valve.
	d. Improperly lubricated swing bearing.	**d.** Lubricate bearing per recommendations. Refer to *Maintenance and Lubrication*, page 9-1.
	e. Improper size hose and/or fittings installed.	**e.** Replace hose or fittings. Refer to the Manitowoc Crane Care Parts Manual.
	f. Clogged or restricted hydraulic hoses or fittings.	**f.** Clean or replace damaged parts.
	g. Worn or damaged output shaft bearings	**g.** Replace bearings.
	h. Worn or damaged swing motor.	**h.** Repair or replace motor.
	i. Worn or damaged hydraulic pump.	**i.** Repair or replace pump.
	j. Crane not level.	**j.** Level crane.
	k. Damaged swing directional control valve.	**k.** Replace swing directional control valve.
5. Swing operation slow in one direction only.	**a.** Crane not level.	**a.** Level crane.
	b. Damaged hydraulic remote control valve.	**b.** Replace hydraulic remote control valve.
	c. Damaged swing directional control valve.	**c.** Replace the swing directional control valve.
	d. Clogged or restricted hose.	**d.** Replace hose or fitting.
	e. Improperly torqued turntable bearing.	**e.** Torque turntable bearing.

6

Symptom	Probable Cause	Solution
6. Swing brake operation erratic.	**a.** Improper brake adjustment.	**a.** Adjust brake.
	b. Air in swing brake system.	**b.** Bleed brake system.
	c. Brake pedal not fully retracted.	**c.** Check brake pedal return spring; repair or replace spring.
	d. Dirty or glazed brake disc.	**d.** Clean or replace disc.
	e. Malfunction of the glide swing power brake valve.	**e.** Repair or replace glide swing power brake valve.
	f. Kinked or bent lines and/or hoses and fittings.	**f.** Straighten or replace as required.
7. Swing brake system will not operate.	**a.** Damaged swing brake release valve.	**a.** Replace release valve.
	b. Damaged glide swing power brake valve.	**b.** Repair or replace glide swing power brake valve.
	c. Internal damage to the swing brake assembly.	**c.** Repair or replace affected parts.
	d. Loose or restricted brake lines or fittings.	**d.** Tighten or replace lines and fittings.
8. Swing brake pedal is spongy.	**a.** Damaged glide swing power brake valve.	**a.** Repair or replace the glide swing power brake valve.
	b. Loose or restricted brake lines or fittings.	**b.** Tighten or replace brake lines and fittings.
9. Swing brake drags.	**a.** Damaged glide swing power brake valve.	**a.** Repair or replace the glide swing power brake valve.
	b. Damaged swing brake release valve.	**b.** Replace release valve.
	c. Internal damage to the swing brake assembly.	**c.** Repair or replace affected parts.
	d. Loose or restricted brake lines or fittings.	**d.** Tighten or replace brake lines and fittings.
10. Boom swings slowly.	**a.** Insufficient hydraulic volume.	**a.** Check delivery of hydraulic pump. Ensure sufficient fluid is available to pump. Check pump drive speed.
	b. Damaged relief valve.	**b.** Adjust, repair, or replace valve.
	c. Damaged swing motor.	**c.** Repair or replace motor.
11. Swing motor continues to operate when swing control is in neutral.	**a.** Hydraulic remote control valve sticking or valve otherwise damaged.	**a.** Repair or replace valve.
	b. Control valve sticking or valve otherwise damaged.	**b.** Repair or replace valve.
12. Swing motor turning in wrong direction.	**a.** Improper port connections.	**a.** Reverse port connection.
	b. Improper wiring connection	**b.** Inspect wiring and connections
13. Swing motor noisy.	**a.** Air in system.	**a.** Refer to *Hydraulic System*, page 2-1, for removal of air from the system.
	b. Motor binding.	**b.** Repair or replace motor.

SWING MOTOR

Description

The Swing Motor is mounted on the swing brake housing and drives the swing gearbox through the brake assembly (Figure 6-1). The motor has two ports for connection to the hydraulic system.

Maintenance

Removal

1. Ensure swing brake and swing lock are engaged.
2. Clean port area around motor. Tag and disconnect hydraulic hoses from motor assembly. Cap or plug all openings.

CAUTION

Hydraulic oil can be hot and cause burns. Always wear gloves and allow the hydraulic system to cool.

3. Unscrew drain plug, filler and level plugs, and drain oil. After oil is drained, replace drain plug.

CAUTION

Pull straight up on motor assembly to avoid damaging splined shaft.

4. Remove two screws and separate motor from brake flange. Remove and discard O-ring from groove in the swing brake.

Installation

CAUTION

Use care when engaging swing motor drive gear. Do not force shaft to engage. Damage to gears may result

1. Install new O-ring in swing brake groove. Position swing motor on swing brake.
2. Apply Loctite 243 on two screws. Install screws and secure motor to brake housing.
3. Replace plugs and extensions. Fill assembly with oil. Refer to *Maintenance and Lubrication*, page 9-1.
4. Connect hydraulic lines to swing motor as tagged during removal.

Test

1. Test swing of superstructure in each direction. Stop and start swing several times.
2. Inspect for hydraulic leaks and repair as necessary.

6

SWING GEARBOX AND BRAKE

Description

The Swing Gearbox and Brake (Figure 6-1), used with the Swing Motor, rotates and stops the superstructure. A pedal on the cab floor activates the Swing Brake. The Swing Gearbox is bolted to the superstructure base plate. Its pinion gear meshes with the turntable bearing ring gear to rotate the turntable.

The Swing Gearbox uses double reduction planetary gearing. The multi-disc swing brake assembly is an integral part of the Swing Gearbox and is located between the Swing Motor and Swing Gearbox. The brake mechanism is a disc pack that is hydraulically released and spring applied.

Maintenance

NOTE: Swing Brake can be removed and disassembled independently of Swing Gearbox.

Swing Brake

Removal

1. Engage turntable lock pin.
2. Tag and disconnect hydraulic lines connected to swing motor and brake. Cap and/or plug all openings.
3. Remove swing motor from swing brake following Swing Motor - Removal procedures in this Section.
4. Remove bolts and washers securing brake to gearbox. Remove brake assembly.
5. Remove and discard the O-ring from the brake housing.
6. Cover swing gearbox opening to ensure no dirt, dust, etc., gets into the gearbox.

Installation

1. Install a new O-ring onto the brake housing and insert the brake assembly into the gearbox. Secure with the bolts.
2. Install swing motor into the swing brake according to the procedures found in this Section under Swing Motor - Installation.
3. Connect hydraulic lines to motor and brake.
4. Fill swing brake with oil following procedures and specifications found in the section *Maintenance and Lubrication*, page 9-1.
5. Bleed air from brake assembly.

Testing

1. WithSwing Brake switch in the ON position, position the swing joystick in both directions. Superstructure rotation should not occur.
2. Position Swing Brake switch to OFF and swing superstructure in both directions. Use the swing brake pedal to stop rotation.
3. Check for hydraulic leaks and repair as necessary.

Gearbox

Removal

1. Engage turntable lock pin.
2. Tag and disconnect hydraulic lines from swing motor and swing brake. Cap and/or plug all openings.
3. Remove three bolts attaching pinion gear to output shaft. Remove pinion gear.

NOTE: Gearbox assembly with motor weighs approximately 108.4 kg (240 lb).

4. Attach a suitable lifting device to the swing gearbox. Remove capscrews, washers, and bushings securing gearbox to mounting plate.
5. Remove swing gearbox.
6. If necessary, remove swing motor according to the procedures found in this Section under Swing Motor - Removal.
7. If necessary, remove swing brake according to the procedures found in this Section under Swing Brake Removal.
8. Cover swing gearbox opening to ensure no dirt, dust, etc., gets into the gearbox.

Installation

1. If removed, install swing brake according to the procedures found in this Section under Swing Brake - Installation.
2. If removed, install swing motor according to the procedures found in this Section under Swing Motor - Installation.
3. Attach a suitable lifting device to the swing gearbox and lift and position the swing gearbox in place on the mounting plate.
4. Install capscrews, washers, and bushings. Torque capscrews; refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
5. Install pinion gear on output shaft. Secure with three bolts.
6. Connect hydraulic lines to swing brake.

7. Connect hydraulic lines to swing motor.
8. Service gearbox as indicated under Servicing.

Servicing

As with all highly stressed mechanisms, reasonable operating procedures are always required. Normal maintenance should only consist of proper lubrication and a periodic check of mounting bolt torque values. Lubrication consists of maintaining the gearbox oil level. Oil in a new gearbox should be drained and flushed out after approximately 50 hours of operation, and replaced with premium quality AGMA No. 4 EP gear lube after approximately 1000 hours of operation or each year, whichever occurs first. Operation in high humidity or polluted air areas will require more frequent changes to minimize moisture or contaminate accumulation. Change the oil as follows.

a. Unscrew drain plug. Remove fill plug to ensure all oil has been removed.
b. Flush case with a light flushing oil.

NOTE: Cleaning gearbox with a solvent is recommended to prevent accumulation of grit and grime. Avoid steam cleaning where moisture and dirt might be driven into the swing bearing.

c. After oil is drained, replace drain plug and any other plugs removed to drain oil.
d. To refill with oil, make sure breather is open. Fill to bottom of fill hole. Reinstall fill hole plug
e. Tighten breather.

Checking the Oil Level

a. Remove fill hole plug and check oil level.
b. If necessary, add oil until oil is level with bottom of fill hole.
c. Replace fill hole plug.

Testing

1. Test swing of superstructure in each direction. Stop and start swing several times.
2. Inspect for hydraulic leaks and repair as necessary.

6

SWING BEARING

Description

The swing bearing is an anti-friction roller bearing that mates the superstructure to the carrier. The bearing inner race is bolted to the superstructure and the outer race is bolted to the carrier. The inner race contains two grease fittings for lubrication of the bearing which are hosed to two fittings at the front of the turntable center section. The outer race also contains two grease fittings and 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 superstructure and carrier. Therefore, proper care of the bearing and periodic maintenance of the turntable-to-bearing attach bolts -IS A MUST -to ensure safe and efficient operation.

Torquing Turntable Bolts

General

DANGER

Failure to maintain proper torque of turntable bearing attaching bolts will result in damage to the crane and possible injury 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 superstructure 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.

DANGER

It is mandatory that bearing attaching bolts be inspected for lack of torque and retorqued, as required, after the first 300 hours of crane operation. The bolts may loosen in service due to vibration, shock-loads, and temperature changes, therefore, periodic inspection should be accomplished every 500 hours thereafter, ensuring the bolts are properly torqued.

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 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.

If it is reported by the crane operator or suspected that the crane has been overloaded beyond the capacities specified above the bold line on the crane's capacity chart, then all turntable bolts must be inspected for looseness and retorqued to specifications.

Turntable bolts should be torqued according to the procedures outlined in this section.

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 step wrench during final tightening. Multiplier reaction bars may be misaligned no more than 30 degrees without causing serious error in torque.

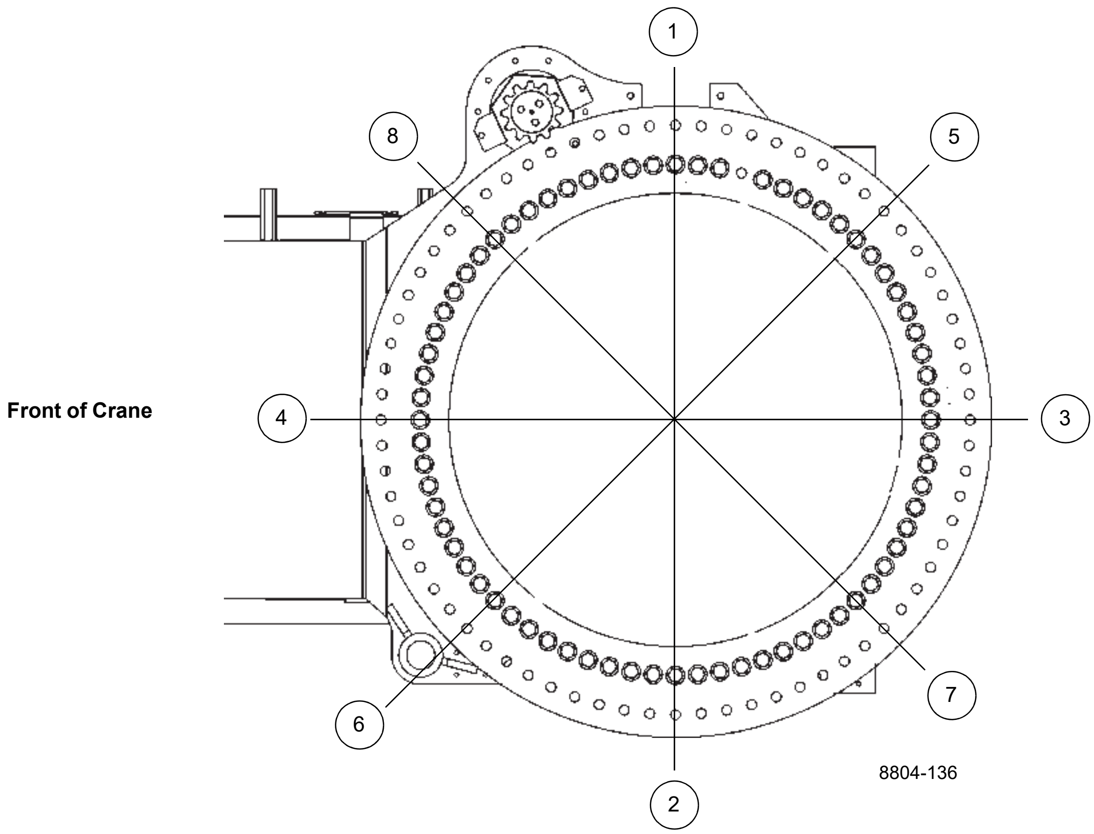


FIGURE 6-2

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.
4. The inner race of the bearing is secured to the turntable by a quantity of 71, 24 mm x 160 mm, 10.9 grade bolts. The outer race of the bearing is secured to the carrier frame by a quantity of 72, 24 mm x 160 mm, 10.9 grade bolts.

Tools Required

The figure Figure 6-3 illustrates and lists the complete set of special tools required to torque the turntable bolts.

Inner Race Torquing

1. Extend and set the outriggers. Fully elevate the boom.
2. Torque eight bolts to 80% of their specified torque value using the sequence pattern shown in Figure 6-2; refer to *Fasteners and Torque Values*, page 1-17 for proper torque value. Tools used are the socket, multiplier, backlash adapter, necessary extensions, and torque wrench.
3. Return to bolt 1 and torque <u>all</u> bolts sequentially in a clockwise direction to their final torque value specified. The same tools are used as in step 2.

Outer Race Torquing

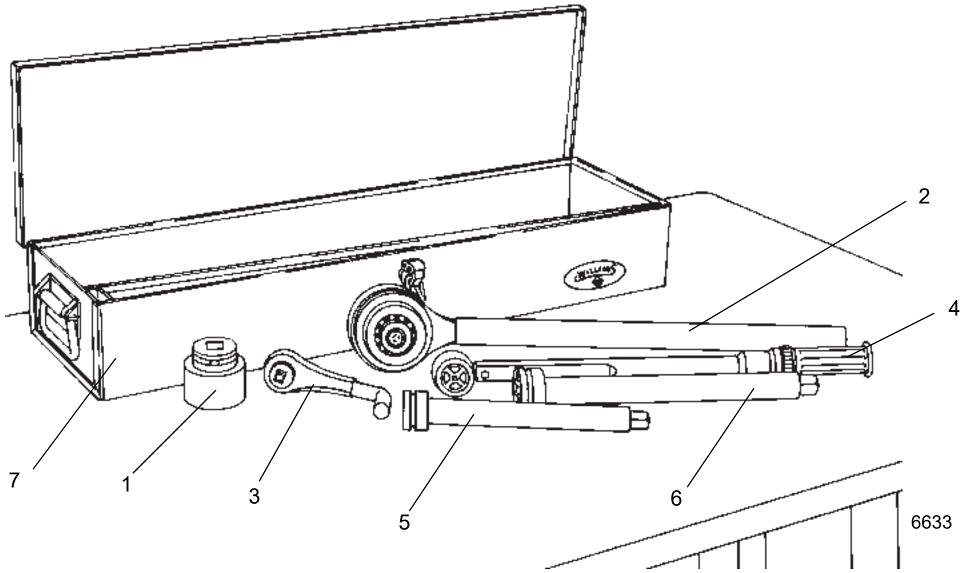
1. Extend and set the outriggers. Fully elevate the boom.
2. Torque eight bolts to 80% of their specified torque value using the sequence pattern shown in Figure 6-2; refer to *Fasteners and Torque Values*, page 1-17 for proper torque value. Tools used are the socket, multiplier, backlash adapter, necessary extensions, and torque wrench.
3. Return to bolt 1 and torque <u>all</u> bolts sequentially in a clockwise direction to their final torque value specified. The same tools are used as in step 2.

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. Ensure the boom is in the travel position and the turntable lock pin is engaged.
3. Elevate the boom slightly and shut down the engine.
4. Tag and disconnect the battery cables from the batteries.



Orders for special tools shall be referred to:

The Manitowoc Company, Inc
1565 Buchanan Trail East
Shady Grove, PA 17256
Phone: (717) 597-8121
Fax: (717) 593-5929

Description	Grove Part Number	Quantity Required
1. 1½" Socket 3/4" Drive	9999100143	1
2. 4 to 1 Torque Multiplier (1/2" Input 3/4" Output)	9999100134	1
3. Backlash Adapter	9999100141	1
4. 1/2" Drive Torque Wrench	9999100136	1
5. 10" Extension 3/4" Drive	9999100138	A/R
6. 13" Extension 3/4" Drive	9999100137	A/R
7. Tool Box (Optional)	9999100146	1

FIGURE 6-3

5. Remove the boom and lift cylinder following the procedures outlined in Section 4 - Boom.

NOTE: Counterweight weighs 9,979 kg (22,000 lb). Optional 2,268 kg (5,000 lb) pinned slab increases counterweight to 12,247 kg (27,000 lb).

6. Remove the counterweight. Refer to *Hoist and Counterweight*, page 5-1.

7. Tag and disconnect all water and oil lines from the bottom of the swivel. Cap or plug all lines and openings.

8. Locate the connectors and ground wire that joins the swivel wiring harness to the receptacles and ground stud on the carrier.

9. Disconnect swivel wiring harness connectors from carrier wiring receptacles. Remove ground wire from ground stud.

10. Remove clamp securing swivel wiring harness to retainer plate on bottom of hydraulic swivel assembly.

11. Coil wiring harness and secure it to the swivel to prevent damage to harness during turntable removal.

12. On bottom of the hydraulic swivel, bend retainer tabs away from bolt heads. Remove four bolts and two bolt retainers securing retainer plate to the spool. Remove retainer plate from spool and lugs on carrier frame.

NOTE: Swivel assembly will be removed with turntable.

DANGER

Ensure lifting device is capable of fully supporting weight of the superstructure and superstructure will not tilt or slide during lifting and moving. Failure to do so may result in death or serious injury and damage to equipment.

NOTE: If a lifting device capable of lifting entire superstructure is not available, superstructure weight may be reduced by removing various components such as hoist(s).

13. Attach a suitable lifting device to four superstructure lifting lugs (two at boom pivot shaft bushings and two at lower lift cylinder pivot shaft bushings). Take in cable or chain to remove slack. Do not pull up on superstructure.

DANGER

Ensure superstructure is fully supported before proceeding. Death or serious injury may result.

NOTE: It is necessary to rotate the superstructure while attached to the lifting device. Outer race bolts can only be removed from the front or from under cab.

14. Remove 72 bolts and washers securing turntable bearing outer race to carrier.

DANGER

Ensure any blocking material used is capable of fully supporting weight of superstructure and will not allow it to tilt or shift. Failure to do so may result in death or serious injury.

15. Carefully lift superstructure, using care not to damage swivel assembly, and set it on blocking that will not allow superstructure to tilt or shift, or rest on the swivel. Leave lifting device attached.

NOTE: If same bearing is to be used again, mark position of bearing on superstructure so it can be installed in the exact position before removal.

NOTE: Bearing weighs between 704 kg (1552 lb). Ensure bearing lifting device is capable of supporting the weight.

16. Place an adequate lifting device under bearing and remove 71 bolts and washers securing turntable bearing to superstructure.

17. Using lifting device, remove turntable bearing from under superstructure.

Inspection

Check bearing teeth for chipping or cracking. If any evidence of these is found, replace bearing. Ensure bolt holes are free of dirt, oil, or foreign material.

Installation

DANGER

Anytime a turntable bolt has been removed, it must be replaced with a new grade 8 bolt. Death or serious injury may result.

NOTE: If the same bearing is to be used again, align the marked teeth on the pinion shaft and the marked teeth on the bearing.

Installation is in the travel position. Ensure the swing lock is disengaged before attempting to mate the bearing to the superstructure.

1. Using an appropriate lifting device, position the turntable bearing under the superstructure. If the same bearing is being used, position it as marked prior to removal.
2. Install 71 new bolts and washers securing the bearing to the superstructure. Refer to Inner Race Torquing in this Sub-Section.
3. Using an appropriate lifting device, align the superstructure over the carrier in the travel position and carefully lower the superstructure, being careful not to damage the swivel assembly, into position on the carrier bearing plate.

NOTE: It will be necessary to rotate the superstructure while attached to the lifting device. Outer race bolts can only be installed from the front or from under the cab.

4. Install 72 new bolts and washers. Refer to *Outer Race Torquing*, page 6-11.

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

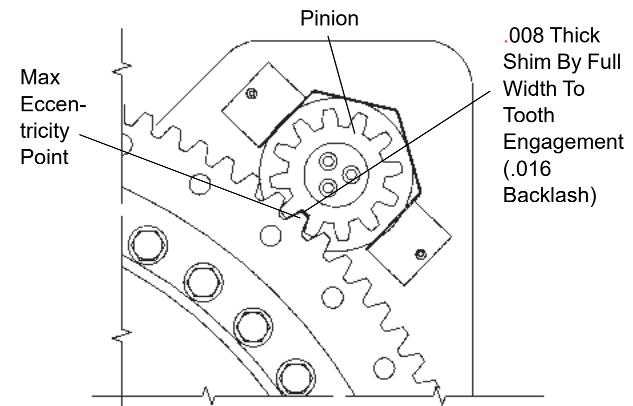


FIGURE 6-4

5. Install gearbox pinion, aligning high point (maximum eccentricity) on turntable bearing. Using a 0.203 mm (0.008 in) thick shim, check backlash Figure 6-4. If pinion must be moved to achieve proper backlash, contact your local distributor.
6. Position retainer plate on bottom of hydraulic swivel spool. Engage lugs on carrier frame and secure to spool with two bolt retainers and four bolts after applying Loctite #271 to bolt threads. Torque bolts to 270 Nm (199 lb-ft). Bend all retainer tabs to make contact with bolt heads.
7. Plug swivel wiring harness connectors in carrier receptacles. Secure ground wire to ground stud using a washer, lockwasher, and nut.
8. Install clamp securing swivel wiring harness to retainer plate on bottom of hydraulic swivel.
9. Connect all water and hydraulic lines to ports on bottom of swivel as tagged during removal.
10. Install boom and lift cylinder following procedures outlined in Section 4 - Boom.

NOTE: Removable counterweight weighs approximately 13,245 kg (29,000 lb).

11. Attach an adequate lifting device to the counterweight. Position the counterweight under the turntable aligning the pin holes. Install the pins and clip pins securing the counterweight to the turntable.
12. Reconnect batteries.
13. Check slew potentiometer in the electrical swivel for proper orientation. Refer to *Swivels*, page 6-15.

Testing

Activate crane and check for proper function.

NOTE: If superstructure does not turn freely after bearing and pinion replacement, contact your local distributor.

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SWIVELS

Description

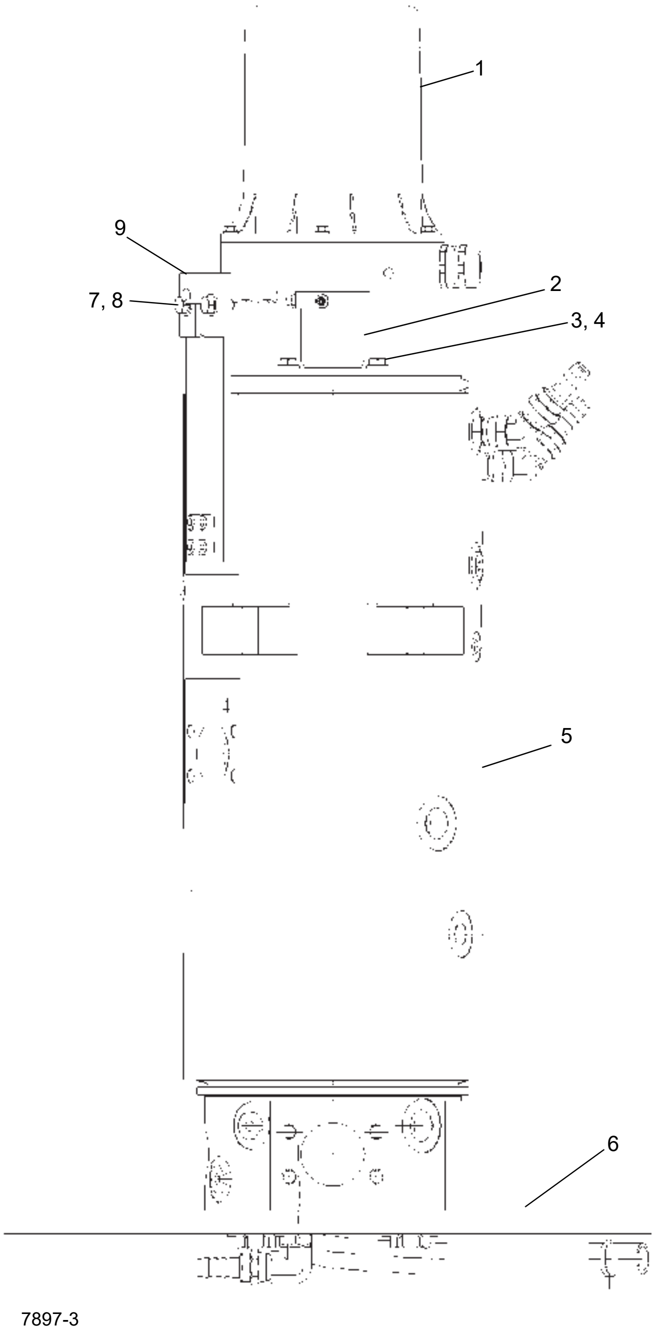
The swivel assembly consists of a 12 port hydraulic swivel (Figure 6-5), a 2 port water swivel, and a 20 conductor slip ring electrical swivel. Solid connections cannot be used to transfer oil, heater hot water and electricity between the carrier and superstructure due to the continuous 360 degree swing. Use of swivels efficiently accomplishes this function.

The barrel portion of the hydraulic swivel is attached to the turntable base plate by four bolts, washers, and bushings which connect to mounting lugs on the case.

The spool portion of the swivel rides on a thrust ring at the top of the swivel case. The spool portion is held stationary to the carrier by bolts and bolt retainer plates attached to the swivel retainer plate. This engages the carrier frame lugs with bolts and jam nuts and allows the spool to remain stationary with the carrier as the case rotates with the superstructure.

The spool portion of the water swivel is attached to the spool of the hydraulic swivel by four bolts. The hydraulic and water swivel spools remain stationary with the carrier as the superstructure rotates. The water swivel case contains a lug which is keyed to a corresponding lug on the hydraulic swivel case, causing the water swivel to rotate with the superstructure.

The electrical swivel center or collector ring assembly is secured by setscrews to a center post which is bolted to the spool of the hydraulic swivel. This allows the collector ring assembly to remain stationary with the carrier. The outer portion or brush assembly is mounted on two studs which are located on the mounting plate assembly retained to the water swivel barrel by a bolt. This allows the brush assembly to rotate with the superstructure around the stationary collector core.



Item	Description
1	20 Conductor Slip Ring Assembly
2	Center Post
3	Capscrew
4	Flatwasher
5	Swivel Assembly
6	Retainer Plate
7	Capscrew
8	Flat Washer
9	Plate

Picture may not be same model as your machine, it is for reference only.

FIGURE 6-5

HYDRAULIC SWIVEL

Description

Each port on the spool and case of the swivel is stamped with the port number. The function of each port is described below.

Port #	Test Pressure Bar (psi)	Function
1	35 (100)	Return
1	35 (100)	Return
2	330 (4790)	Supply
3	330 (4790)	Supply
4	4 (50)	Drain
5	270 (3920)	Swing
6	170 (2500)	Steer Left
7	170 (2500)	Steer Right
8	306 (4436)	Load Sense
9	145 (2100)	Brakes Front
10	145 (2100)	Brakes Rear
11	2 (30)	A/C Supply
12	2 (30)	A/C Return
A	2 (30)	Heater
B	2 (30)	Heater

Theory of Operation

The hydraulic swivel allows oil to flow from the pumps to various crane functions on the superstructure. All oil is routed into the spool portion of the swivel where, through a series of internally drilled passages, oil is transferred to circumferential channels on the spool exterior. These channels correspond with a mating port on the outer case of the swivel. Each channel is separated by a series of nylon and O-ring seals that prevent transfer of oil and pressure. Return flow from the crane superstructure is accomplished in the same manner through another set of ports.

Maintenance

Removal

1. Extend and set outriggers. Ensure crane is level and boom is over the front.
2. Elevate boom and note at what boom angle, you have the most clearance between the lift cylinder and the turntable side plate. Shut down engine.
3. Measure distance from top of lift cylinder to base of boom section where lift cylinder attaches. Cut two pieces of 10 x 10 cm (4 x 4 in) oak to fit.

NOTE: It may be necessary to raise boom slightly to allow installation of blocking.

NOTE: This blocking is to add extra support for the boom. Any seepage or leakage in the holding valves or internally in the cylinders will allow the boom to settle over a period of time.

4. Use oak blocking to block between barrel of lift cylinder and boom base section.
5. Tag and disconnect hydraulic lines from case of hydraulic swivel. Cap or plug all lines and openings.
6. Tag and disconnect the hydraulic lines and water lines from the spool of the hydraulic swivel. Cap or plug all lines and openings.
7. Tag and disconnect water lines from case of water swivel. Cap or plug all lines and openings.
8. Disconnect swivel wiring harness connectors from carrier receptacles and yellow ground wire from

connector mounting bracket on carrier frame. If necessary, remove electrical swivel. Refer to Electrical Swivel in this Section.

NOTE: Hydraulic and water swivel weighs approximately 171.5 kg (378 lb). Combined hydraulic, water, and electrical swivels weigh approximately 181.5 kg (400 lb).

9. Disconnect the swivel linkage assembly from the retainer plate on the bottom of the spool on one end and from the carrier lug on the other.
10. On the bottom of the swivel, bend the retainer tabs away from the bolt heads. Remove the four bolts and two bolt retainers securing the retainer plate to the spool. Remove the retainer plate from the spool.

NOTE: It may be necessary to remove some drive line components to remove the swivel.

11. Position adequate supporting device beneath swivel.
12. Remove four bolts, washers, and bushings securing swivel barrel to turntable base plate. Lower swivel to the ground.

Installation

NOTE: Hydraulic and water swivel weighs approximately 171.5 kg (378 lb). Combined hydraulic, water, and electrical swivels weigh approximately 181.5 kg (400 lb).

1. Lift swivel into position.
2. Secure hydraulic swivel to turntable base plate with four bushings, bolts, and washers. Torque bolts. Refer to *Fasteners and Torque Values*, page 1-17 for proper torque.
3. Apply Loctite 271 to bolt threads. Secure retainer plate with four bolts and two bolt retainers. Torque bolts to 270 Nm (199 lb-ft). Bend retainer tabs to make contact with bolt heads.
4. Connect the swivel linkage assembly to the retainer plate on the bottom of the spool on one end and to the carrier lug on the other.
5. Install electrical swivel if removed. Refer to Electrical Swivel in this Section. Connect swivel wiring harness connectors to carrier receptacles and yellow ground wire to mounting bracket on carrier frame. Reuse previously removed bolt and star washers. Refer to Grove Engineering Specification 6829100386 for proper electrical termination of grounds.
6. Install clamp, washer, flatwasher, and capscrew to bottom of swivel retainer plate securing wiring harness.
7. Connect hydraulic lines to spool of hydraulic swivel as tagged during removal.
8. Connect hydraulic lines to hydraulic swivel case as tagged during removal.
9. Connect water lines to water swivel case as tagged during removal.
10. Remove blocking material from lift cylinder.
11. Activate all systems. Cycle all functions and observe for proper operation and any leakage.

TWO PORT WATER SWIVEL

Description

The two port water swivel allows engine coolant to flow from the carrier-mounted engine to the hot water heater in the operator's cab. Coolant is transferred to a circumferential groove on the water spool exterior through an internally drilled passage in the 12 port hydraulic swivel spool. This groove corresponds with a mating port on the outer case of the water swivel. Spool grooves are separated by a quad ring/telflon bronze ring seal. The lip seal prevents coolant from leaking externally. Return engine coolant flow from the hot water heater is accomplished in the same manner through the opposite port of the water swivel.

Maintenance

Removal

1. Perform steps 1 thru 4 of Hydraulic Swivel - Removal in this section.
2. Remove electrical swivel. Refer to Electrical Swivel - Removal in this section.
3. Tag and disconnect lines from the case of the water swivel. Cap or plug all lines and openings.
4. Remove screw and shim(s) from water/hydraulic swivel keying lugs.
5. Remove four capscrews and washers securing water swivel and electrical swivel center post to hydraulic swivel. Remove water swivel and center post.

Disassembly

NOTE: Any maintenance requiring disassembly of the water swivel should include replacement of all seals and rings.

1. Withdraw the spool from the case.
2. Place spool on a clean work surface in a dust-free area. Block spool to prevent movement during disassembly.

CAUTION

When removing seals and rings, avoid scratching grooved and gland surfaces. Damage to spool may result in unexpected operation.

NOTE: Aligning discarded seals and rings in order of disassembly will assist with installation of new seals and rings.

3. Remove seals and rings from spool.

Cleaning and Inspection

WARNING

Cleaning solvents can be toxic, flammable, an irritant to the skin, or give off harmful fumes. Avoid prolonged skin contact, inhalation of vapors, or smoking. Always use approved safety equipment; gloves, face masks, and eye wear. Failure to comply can result in injury or death to personnel.

1. Clean spool and case with a suitable solution and dry with compressed air. Plug all ports with plastic caps.
2. Check spool and inside of case for scratches, grooves, scoring, etc. If any grooves have developed with a depth of 0.127 mm (0.005 in) the unit should be replaced.

Assembly

NOTE: Lubricate interior of swivel to prevent rusting from condensation.

1. Lubricate spool, seals, and rings.

CAUTION

When installing seals and rings, avoid stretching seals or scratching grooved and gland surfaces. Damage to the spool assembly may result in unexpected operation.

Proper alignment when installing the case is required. Do not force the spool into the case. Damage to the seals may result.

2. Install new seals and rings on spool.
3. Insert spool in barrel.

Installation

1. Install water swivel on top of hydraulic swivel. Align keyed lug on water swivel with lug on hydraulic swivel. Secure water swivel and electrical swivel center post with four capscrews and washers.
2. Install shim(s) on keying lug to provide a snug fit. Secure with screw.
3. Connect lines to swivel case as tagged during removal.
4. Install electrical swivel. Refer to Electrical Swivel - Installation in this Section.
5. Perform steps 8 and 9 of Hydraulic Swivel - Installation in this Section.
6. Activate all systems and cycle all functions. Check for proper operation and leaks.

ELECTRICAL SWIVEL

Description

The swivel assembly consists of a 20 conductor slip ring and cover assembly.

Each brush set incorporates two brushes and leads which are attached to a brush holder assembly. The brush set leads are formed into harnesses which are routed through the mounting plate on the swivel. The collector ring leads are formed into one harness which is routed downward through the center of the hydraulic swivel. Extending from the base of the hydraulic swivel, the collector ring leads are also formed into connectors which plug into receptacles from the chassis power supply.

The swivel cover is secured with a seal and bolts

The slip ring assembly contains an angle encoder. The encoder sends data via CAN bus to the RCL. The RCL converts this data into a slew angle which is used to determine the working area definition and also for controlling the rear axle oscillation.

Theory of Operation

The electrical swivel is located on top of the water swivel and transfers electricity between the carrier and superstructure. Wiring harnesses transmit the electricity between the carrier and superstructure.

Maintenance

Removal

1. Perform steps 1 through 4 of HYDRAULIC SWIVEL - REMOVAL in this section.

CAUTION

Disconnect batteries before performing any maintenance on the electrical system. Serious burns may result from accidental shorting or grounding of live circuits.

2. Disconnect batteries. Refer to *Electrical System*, page 3-1.
3. Locate connectors which join the collector ring harness to carrier receptacles.
4. Tag connectors and their receptacles with numbers. Disconnect connectors from chassis wiring receptacles.

NOTE: Connectors are too large pass through center of hydraulic swivel. They must be removed.

5. Remove clamp securing wiring harness to retainer plate on bottom of hydraulic swivel assembly.
6. Tag each wire on each connector. Using the appropriate pin removal tools, remove pins with wires still attached. Mark each wire with the connector pin socket number. Secure wires into one bundle. Mark bundle with connector number. For a list of pin removal tools, refer to *Connector Troubleshooting*, page 3-9.
7. Secure connectors and wires from each of the numbered connectors so harness can be pulled through center of hydraulic swivel.
8. Tag and disconnect connectors from receptacles on the cab bulkhead mounting plate.
9. Loosen jam nuts and setscrews securing electrical swivel mounting tube to water swivel center post.
10. Remove bolts, washers, and plate that holds the electrical swivel anti-rotation pin in place on the water swivel case bracket (Figure 6-6).

CAUTION

When pulling wiring harness through center of hydraulic and water swivels, ensure wires are not damaged.

11. Remove swivel and wiring harness from crane. If necessary, remove spacer bushing from center post.

Installation

1. If removed, install the spacer bushing on the center post. Route the collector core wiring harness through the center of the hydraulic and water swivels.

NOTE: The boom should be centered directly over the front of the crane before adjustment is made to the slew encoder.

2. Slide electrical swivel mounting shaft on center post.

3. Ensure the anti-rotation pin (1, Figure 6-6) in the bottom of the electrical swivel base is aligned with the slot in the bracket (2) on the water swivel case (Figure 6-6). Using two bolts and washers, secure anti-rotation pin in place with plate.

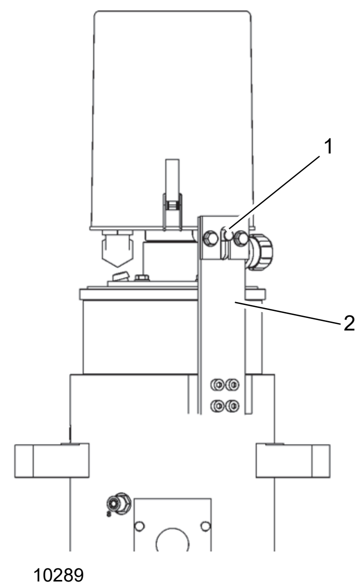


FIGURE 6-6

4. Apply medium strength Loctite to set screws securing electrical swivel to center post. Torque 45 to 55 lb-in (5 to 6 Nm). Tighten jam nuts.
5. Connect wiring harness connectors to receptacles on cab bulkhead mounting plate as tagged during removal.
6. Unbundle wires of collector core wiring harness. Install pins, with wire attached, to connector as tagged during removal.
7. Plug connector into carrier wiring receptacle, connect wires as tagged during removal. Install yellow ground wire to connector mounting bracket on carrier frame using the bolt and star washers taken of at removal and refer to Grove Engineering Specification 6829100386 for proper electrical termination of grounds.
8. Install clamp securing harness to retainer plate on bottom of hydraulic swivel assembly.
9. Connect batteries.

CAUTION

The slew potentiometer must be adjusted any time work is done to the electrical swivel. Personnel injury or damage to the machine may result.

10. Activate all systems, cycle all functions, and observe for proper operation. Adjust slew angle in accordance with *Slew Angle Verification*, page 6-21.

Preventive Maintenance

It is recommended a normal inspection of the electrical swivel collector ring and brush assembly be established. An example of this could be at approximately 100 to 150 engine operating hours. When this time limit is reached, perform the following.

1. Check collector ring and brush assembly for any corrosion, pitting, arcing, and wear.
2. Check collector ring setscrews are tight.
3. Check brush and arm assembly springs. Ensure they are holding brushes firmly against the collector rings.

Slew Angle Verification

1. Rotate superstructure over front and engage house lock pin.
2. Go to the RCL Setup Screen of the RDM and program the RCL with the crane's current operating configuration (refer to the *GRT8120 Operator Manual* for details on programming the RCL).
3. From the RCL Setup Screen, select and confirm the check mark symbol at the lower right corner of the screen to open the Monitoring Menu screen.
4. Verify swing angle indicated does not exceed 0.0 ± 1.0°. If the swing angle is outside this tolerance, recalibrate the slew sensor. Refer to

Slew Angle Zero Adjustment Procedure

This machine uses a CAN bus Multiplex system. To calibrate the slew angle sensor, you need a Windows-based PC, CAN-link service software, and a connection cable. The CAN-link service software and connection cable are available through Crane Care to service technicians who have attended the Grove New Technology training course.

SWING LOCK PIN

Description

The purpose of the swing lock pin is to lock the superstructure in position directly over the front for pick and carry loads. The pin swing lock installation consists of a large pin, a control handle in the right side of the cab, and control linkage that allows the crane operator to set and free the pin.

When the superstructure is directly over the front, pushing the control handle down drops the swing lock pin into a socket on the carrier frame, locking the superstructure in place. Pulling the control handle up pulls the pin out of the socket, unlocking the superstructure.

Maintenance

Verify linkage is installed to avoid damage from superstructure rotation and is undamaged. Verify pin, turntable bushing pin passes through, and socket on the frame are undamaged. Verify all attaching hardware is secure and undamaged.

Ensure linkage is adjusted properly. If it is, the pin bottom will stick out about 5.89 cm (2.32 in) from the bottom of its bushing in the turntable. (If it is too far in, it might not lock properly. If it is too far out, it might hang up). Using the jam nuts on the linkage parts, adjust the linkage so the pin bottom will stick out about 5.89 cm (2.32 in) from the bottom of its bushing in the turntable; verify the superstructure can lock properly and the superstructure can rotate without lock pin hangup.

360° SWING LOCK CONTROL (POSITIVE LOCK TYPE) (OPTIONAL)

Description

The purpose of the swing lock is to secure the superstructure in position at one of the positions in its rotation. There are roughly 120 spots about 3.0 degrees apart for the superstructure to lock to in its 360 degree of rotation. The 360 degree swing lock control lever is on the right side of cab. Pushing the swing lock control lever down engages the lock between the teeth of the swing gear. Pulling the swing lock control lever up disengages the lock.

Maintenance

Verify cable is routed to avoid damage from superstructure rotation and is undamaged. Verify swing lock assembly is undamaged and working properly. Verify spring is undamaged and has enough strength to pull blade of swing lock assembly completely out of the gear teeth when the control lever is up. Verify the linkage can put the blade of the swing lock assembly as far as possible between the gear teeth when the control lever is down. Verify all attaching hardware is secure and undamaged. Make adjustments as needed. When the lever is fully up, the top diagonal surface of the blade of the swing lock assembly (the beveled surface from the blade's top horizontal surface to its "ax blade" vertical surface should be 1.45 cm (0.57 in) from the tips of the gear teeth.

If the swing lock assembly is damaged, install a replacement. Align the blade of the swing lock assembly so it will fall between gear teeth. Use the shim and the related attaching hardware (two 5/16-18 screws and 5/16 ID lockwashers) to ensure the swing lock assembly cannot move side to side, and can lock up the superstructure. Torque the four 3/4-10 mounting bolts to their specified torque found in *Fasteners and Torque Values*, page 1-17.

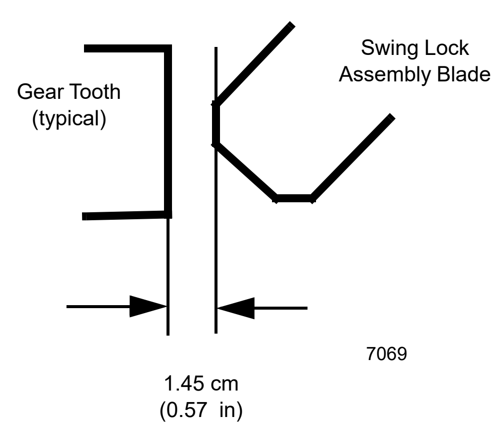


FIGURE 6-7

SECTION 7
POWER TRAIN

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ENGINE

Description

The engine is a Cummins QSB 6.7 diesel engine. This Service Manual does not include detailed information on the engine itself. A separate manual as prepared in detail by the engine manufacturer, is supplied with this Service Manual. However, a short description and maintenance of certain components of the fuel system, air intake system, and water cooling system is provided in this section.

The engine is electronically controlled by the Electronic Control Module (ECM); it is the control center of the system. It processes all of the inputs and sends commands to the fuel systems as well as vehicle and engine control devices.

Engine speed is controlled by the foot throttle pedal in the cab. It controls engine RPM which increases or decreases proportionately with the amount of foot pressure applied to the pedal. Engine speed is also controlled by the idle switch, which is a three position rocker switch located on the front of the steering column. The idle switch allows the operator to infinitely vary and hold the engine speed between the engine's minimum and maximum idle settings (refer to Section 3, Operating Controls and Procedures in the applicable Operation Manual for details on the operation of the idle switch). The foot throttle pedal is electrically connected to the superstructure control module which sends the signal to the engine ECM via the J1939 data link.

The engine and its components are enclosed in a hood assembly with a grill in the rear of the hood for adequate air circulation. Access to the engine is gained through a door assembly in the top of the hood that opens from both sides.

The air intake filter is mounted on the right rear hood assembly. The muffler is mounted on the left side on the rear outrigger box.

WARNING

Do not spray starting fluid into the air inlet. The spray will contact the heater elements and could explode causing personal injury.

The engine is equipped with electric air heating elements located in the engine intake air stream to aid in cold starting and reduce white smoke at start-up. In preheat mode, the engine should not be cranked until Wait-to-Start Lamp turns off. The Wait-to-Start Lamp is illuminated during the preheat time that takes place when the ignition switch is in the ON position during cold weather starting. The ECM checks information it receives from various sensors on the engine to determine how long to energize the air heater before extinguishing the Wait-to-Start Lamp. Once the engine is started, the electric air heating element will be energized again for a time period determined by intake air temperature.

Maintenance

Engine Removal

1. Set outriggers and position boom over the side.
2. Open and remove hood top door assembly.
3. Disconnect air filter tubing at engine and air cleaner. Remove and lay aside.
4. Disconnect exhaust tubing at engine and muffler. Lay to the side.
5. Tag and disconnect engine electrical harness connector from carrier harness connector and battery cables.
6. Unbolt fuel filter and engine lubrication filter from frame and lay on the engine.
7. Drain engine coolant system.
8. Drain engine lubrication system.
9. Drain transmission/torque converter oil system.
10. Remove engine hood assembly and pump cover from machine.
11. Disconnect and remove drive shaft(s) between transmission/torque converter and axle(s). Refer to *Drive Shafts*, page 7-25 in this Section.
12. Tag and disconnect all lines from the radiator. Disconnect coolant level sensor harness from engine harness. Tie up excess harness so it is out of the way. Remove radiator. Refer to *Radiator Removal and Installation*, page 7-21 in this Section.
13. Tag and disconnect all lines and tubing from engine, transmission/torque converter, and all other components.

DANGER

Lifting device must be able to support combined weight of engine and transmission.

NOTE: Engine and transmission/torque converter assembly weighs approximately 1266 kg (2790 lb).

14. Attach a lifting device to engine capable of supporting weight of engine and transmission/torque converter.
15. With lifting device supporting weight of engine, remove two bolts, four flat washers, two lock washers, and two nuts securing front of engine to frame (see Figure 7-2). Remove two 2-piece isolator mounts, two capscrews, two nuts, and two dock washers, and four washers securing each side of transmission/torque converter to frame (see Figure 7-1).
16. Using lifting device, lift engine and transmission/torque converter as an assembly from the crane.
17. If a new engine is installed, remove all components, fittings, etc., from old engine and install them on new engine in same locations.

NOTE: Ensure same grade hardware, torque values, and Loctite as were installed by the factory are used.

Engine Installation

NOTE: Use same grade hardware, torque values, and Loctite used by factory.

DANGER

Lifting device must be able to support combined weight of engine and transmission.

1. With all components and fittings installed on the new engine, lift the engine into the crane.
2. With engine in position, secure each side of transmission/torque converter with two 2-piece isolator mounts, two capscrews, two nuts, and two dock washers, and four washers (see Figure 7-1). At front of the engine, secure engine mount to frame with two bolts, four flat washers, two lock washers, and two nuts (see Figure 7-2).

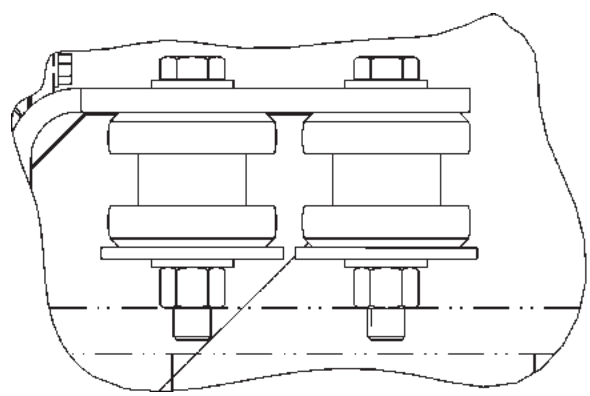
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FIGURE 7-1

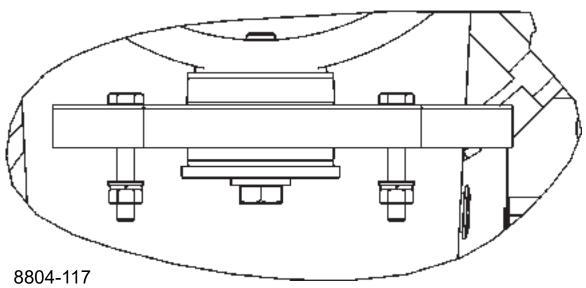

FIGURE 7-2

3. Remove lifting device.
4. Connect all lines and tubing to the engine, torque converter, and all other components in accordance with identification marks made during removal.

CAUTION

Do not apply sealant to inside of hydraulic suction hoses.

5. Apply a moderate coat of Permatex® Type No. 2 to the male hose adapter and install the hydraulic hoses. Do not apply sealant to the inside of the hydraulic hose, and push it onto the male adapter. This can result in excess sealant being pushed ahead of the male adapter and being exposed to the hydraulic oil.
6. Install radiator. Refer to *Radiator Removal and Installation*, page 7-21. Connect all hoses and electrical harnesses to the radiator as tagged during removal.
7. Connect drive shafts between transmission/torque converter and axles. Refer to *Drive Shafts*, page 7-25.
8. Install hood assembly. Install pump cover.
9. Attach fuel filter and engine lubrication filter to the frame. Connect battery cables and engine electrical harness connector in accordance with identification marks made during removal.
10. Connect electrical wiring to the hourmeter as tagged during removal.
11. Connect air filter tubing at engine and air filter. Connect exhaust tubing to engine and muffler. On Tier 4 engines, replace exhaust tube gaskets with new ones.
12. Install hood top door assembly.
13. Service transmission, engine lubrication system, and engine cooling system.
14. Start engine. Check all hoses and fittings for leaks. Recheck all fluid levels.

Engine Drive Belts

Proper operation of engine belt-driven components such as alternator, fan and water pump depend on proper condition and tension of the engine drive belt.

NOTE: Belt tension is maintained with an automatic belt tension device.

The engine drive belt should be inspected visually on a daily basis. Inspect drive belt should for cracks, frayed areas, and glazed or shiny surfaces (see Figure 7-3). A drive belt that is glazed or shiny indicates belt slippage.

Engine drive belt damage can be caused by various factors such as incorrect tension, incorrect belt size, misaligned engine pulleys, incorrectly installed belt, or by oil, grease, or hydraulic fluid on the belt.

Refer to engine manufacturer's manual for special tools or belt tension specifications.

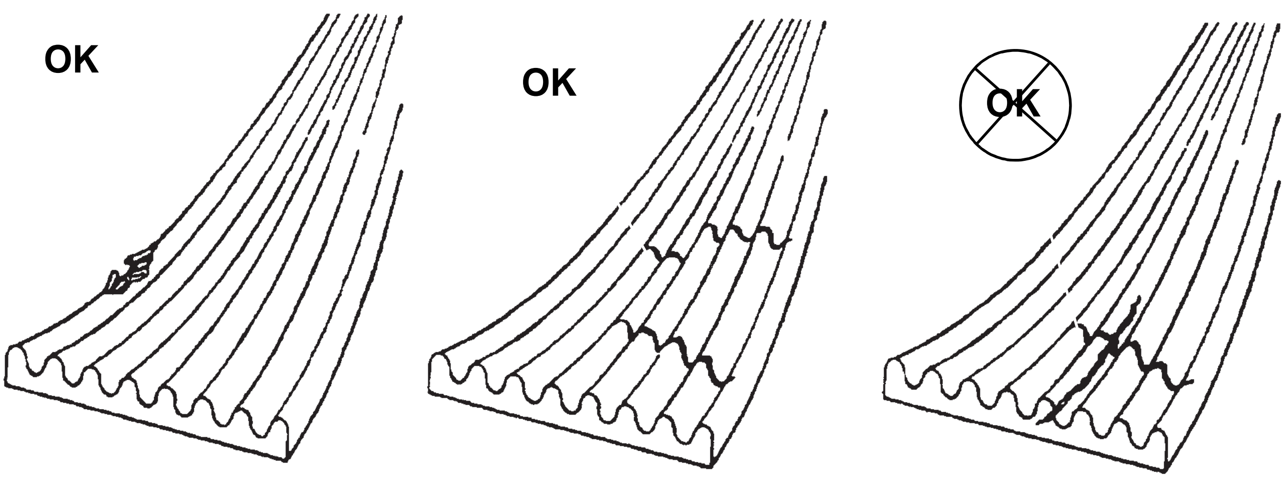

FIGURE 7-3

ELECTRONIC CONTROL SYSTEM

Description

The engine control system is an electronically operated fuel control system that also provides many operator and vehicle features as well as reducing exhaust emissions while optimizing engine performance.

The ECM performs diagnostic tests on most of its circuits and will activate a fault code if a problem is detected in one of these circuits. Along with the fault code identifying the problem, a snapshot of engine operating parameters at the time of fault activation is also stored in memory. Some fault codes will cause a diagnostic lamp to activate to signal the driver. The fault codes can be viewed on the crane control system display in the operator’s cab.The ECM communicates with service tools supplied by Cummins through a SAE J1939 datalink.

The ECM also monitors the condition of the diesel particulate filter (tier 4 engines only) and will alert the operator by way of an indicator on the crane control system display if the filter becomes clogged with carbon. When the filter becomes clogged, the ECM will control the exhaust system cleaning process to clean the filter of particulate matter.

Engine Control System Indicator Lights

Engine Stop Light

The Engine Stop Light is located in the crane control system display. It is a red indicator light that illuminates to signify a serious engine problem that requires the vehicle and the engine to be stopped as soon as safely possible. The engine should remain shut down until the fault can be repaired.

Engine Warning Light

The Engine Warning Light is located in the crane control system display. It is an amber indicator light that is a part of the engine’s electronic control system and when illuminated, gives the operator a signal that there is a engine or transmission problem which must be corrected.

Exhaust System Cleaning Required Indicator

The Exhaust System Cleaning Required indicator is located in the crane control system display. This indicator illuminates amber when the diesel particulate filter is getting filled with soot and needs to be cleaned out.

CAUTION

Engine Shut-down Condition!

When the DPF indicator illuminates or flashes, start the exhaust system cleaning process.

Should the engine light come on with the DPF indicator, the engine will shut down and an authorized engine manufacturer service person must be contacted to re-start the engine.

The indicator will be lit continuously during the early stages of clogging. If the system continues to clog, the lamp will begin to flash.

If even more clogging occurs, the engine warning light will illuminate in addition to the DPF indicator and a slight engine derate will occur.

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WARNING

Fire or Burn Hazard!

During the exhaust system cleaning process the exhaust becomes very hot. Do not park the vehicle near flammable objects.

Use caution near the exhaust tailpipe during exhaust system cleaning as it will become very hot.

FUEL SYSTEM

Description

The fuel system consists of the fuel tank, fuel-water separator, secondary filter, lift pump, high-pressure pump, high-pressure common fuel rail (Tier 4 only) and the fuel injectors. All components except the fuel tank are installed on the engine or supplied with the engine for remote mounting.

Fuel Tank

The fuel tank (Figure 7-4) is a steel cylinder-type tank located on the left side of the machine. The fuel tank has a draw capacity of 271 L (72 gal). A connection on the bottom of the tank provides for fuel supply to the engine. Surplus fuel from the engine is provided to the bottom of the fuel tank below the fuel level. The tank is equipped with a non-vented filler cap, chain-attached to the tank, and a fuel quantity sender unit which provides a signal to a fuel quantity gauge on the instrument panel in the cab. The fuel tank for the CE units has a lockable vented filler cap.

Injection Fuel Pump

The fuel oil is finely atomized as it is injected into the cylinder and ignited by the heat of compression. It is metered also, before injection, to meet the load requirements imposed upon the engine. Surplus fuel, returning from the injectors, is bypassed back to the fuel tank or to the inlet side of the pump. The continuous flow of fuel through the injectors helps to cool the injectors and to purge air from the system.

Fuel Filter-Water Separator

The fuel filter-water separator removes impurities from the fuel and also removes water from the fuel before it reaches the engine. The filter is mounted near the fuel tank on the left side of the crane.

The fuel mixture passes through the outer wrap of the first stage of the filter paper, where large droplets of water are formed as it is stripped from the fuel. The water falls out into the void between the two paper elements and goes to a reservoir in the bottom of the housing, where it can be drained through a drain plug at the bottom of the housing.

The water in fuel sensor is located in the fuel filter housing. Once the storage space in the bottom of the filter housing fills with a certain amount of water, the sensor will signal the ECM. The Water In Fuel Lamp will illuminate at the operator controls, indicating that the water should be drained from the fuel filter assembly.

Maintenance

NOTE: The entire fuel system must be maintained air tight to prevent loss of prime.

Fuel Tank

The fuel tank should be kept filled, especially overnight, to reduce condensation to a minimum. Refer to the applicable engine manual for the recommended schedule for draining any water or sediment from the tank.

Removal

1. Position a suitable container under the fuel tank and drain all fuel from the tank.
2. Tag and disconnect the two lines from the bottom of the tank.
3. Disconnect the electrical lead from the fuel level sender unit.
4. Support the weight of the tank, loosen and remove the two nuts and washers securing the straps to the mounting brackets. Remove the tank and steps.
5. If a new tank is to be installed, remove the two fittings, the fuel level sender, and steps from the tank and install them in the new tank.

Installation

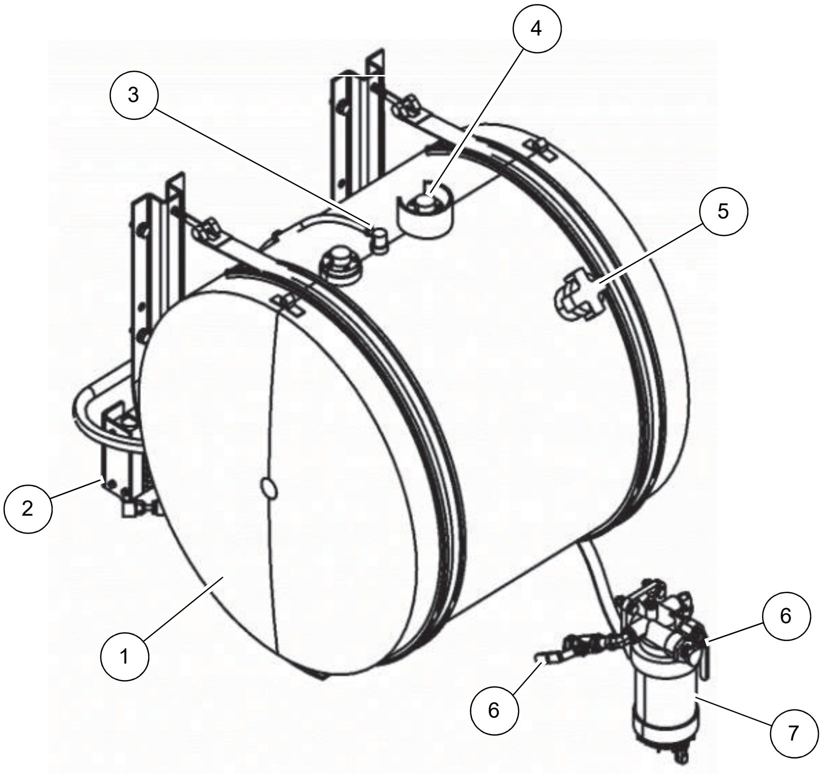
1. Position the new tank on the mounting brackets and install the nuts and washers on the two straps.
2. Connect the electrical lead to the fuel quantity sender unit.
3. Connect the two lines to the fittings on the bottom of the tank in accordance with the identification marks made during removal.
4. Service the tank.

Fuel Filter-Water Separator

Draining

The sump of the fuel filter-water separator should be drained daily, 30 minutes after the engine is shut down, to remove any water and sediment. Adhere to the following procedure.

1. Open the drain plug.
2. Drain until fuel appears.
3. Close the drain plug.



1	Fuel Tank
2	Fuel Cooler
3	Breather
4	Fuel Level Sending Unit
5	Filler Cap
6	Ball Valve
7	Fuel Filter/Water Separator

FIGURE 7-4

AIR INTAKE AND EXHAUST SYSTEM

Description

The air intake system (Figure 7-7) controls the quality and amount of air available for combustion. System components are the Air Cleaner, Turbocharger, Charge Air Cooler, Cylinder Head, and Exhaust Manifold. Inlet air is pulled through the Air Cleaner, compressed and heated in the compressor side of the Turbocharger. The air is pushed through the Charge Air Cooler to the Air Inlet Manifold. Cooling the inlet air increases combustion efficiency, lowers fuel consumption, and increases the horsepower. The air is forced into the cylinder head to fill the inlet ports. Air flow from the inlet port into the cylinder is controlled by the intake valves.

Each cylinder has two intake valves and two exhaust valves. When the intake valves open, cooled compressed air from the inlet port is pulled into the cylinder. The intake valves close and the piston begins to move up on the compression stroke. Fuel is injected into the cylinder and combustion starts. The piston is forced down and is on the exhaust stroke when it moves up again. The exhaust valves open and exhaust is expelled through the exhaust port into the exhaust manifold.

The exhaust gas from the exhaust manifold enters the turbine side of the turbocharger and causes the turbine to turn driving the compressor. Exhaust from the turbocharger passes through the exhaust pipe and diesel particulate filter into the atmosphere.

The Air Cleaner (Figure 7-7) is the dry-type with a replaceable element and is located on the right rear fender. On tier 3 engines, a service indicator (2, Figure 7-5), designed to indicate red when servicing is required, is installed in the right center deck and is connected to the Air Cleaner by a brass fitting in the air cleaner. On tier 4 engines, an Air Intake Restriction Monitor (AIRM) system is designed to calculate real-time air filter restriction at operational flow rate using the temperature and pressure input from the TBAP sensor (3, Figure 7-8) installed on the air cleaner housing.

On the Cummins QSB Engine there are electric air heating elements that are located in the engine's intake air stream. These elements heat the intake air when starting the engine in cold ambient conditions. Startability and white smoke control are enhanced by the use of the intake air heater. A Wait-to-Start Lamp is located on the crane control system display to indicate when to crank the engine.

Air Intake

Air Cleaner Checks

Dust passing the air cleaner, even through small holes, can cause rapid engine wear. Ensure all connections between the air cleaner and the engine are tight and sealed. If these connections are all well sealed, and there is still evidence of dust leakage, check the following places for possible trouble.

NOTE: Dust that gets by the air cleaner system can often be detected by looking for dust streaks on the air transfer tubing or just inside the intake manifold inlet.

1. Inspect the air cleaner outlet tube for damage.
2. Ensure the element sealing surface is not damaged and seals well against the element.
3. Inspect the element sealing surface for damage.
4. Check for structural failures. Any damaged parts must be replaced.

Check For Filter Restriction

As a dry cleaner element becomes loaded with dust, the vacuum on the engine side of the air cleaner (at the air cleaner outlet) increases.

The vacuum is generally measured as restriction in inches of water. The engine manufacturer places a recommended limit on the amount of restriction the engine will stand without loss in performance before the element must be cleaned or replaced.

On tier 3 engines, a service indicator attached to the air cleaner housing will indicate when the filter needs to be replaced. Reset the indicator each time the air cleaner is serviced.

On tier 4 engines, a TBAP sensor attached to the air cleaner housing provides input to the Air Intake Restriction Monitor (AIRM) system to activate a fault code when the filter needs to be replaced. The Engine Warning Indicator will blink at engine start for fault code 5576 indicating the air cleaner is becoming clogged. The indicator will be on solid for fault code 3341 indicating the filter is clogged and must be changed.

If the accuracy of either the mechanical service indicator or TBAP sensor is suspect, a water manometer is the most accurate and dependable method of measuring vacuum.

To use the manometer, hold it vertically and fill both legs approximately half full with water. One of the upper ends is connected to the pressure tap on the outlet side of the air cleaner by means of a flexible hose. The other end is left open to the atmosphere.

Maximum restriction in the air cleaner occurs at maximum air flow. On this turbocharged diesel engine, the maximum air flow occurs only at maximum engine power.

With the manometer held vertically and the engine drawing maximum air, the difference in the height of the water columns in the two legs, measured in inches or centimeters is the air cleaner restriction. The maximum restriction for this engine is 25 inches of water.

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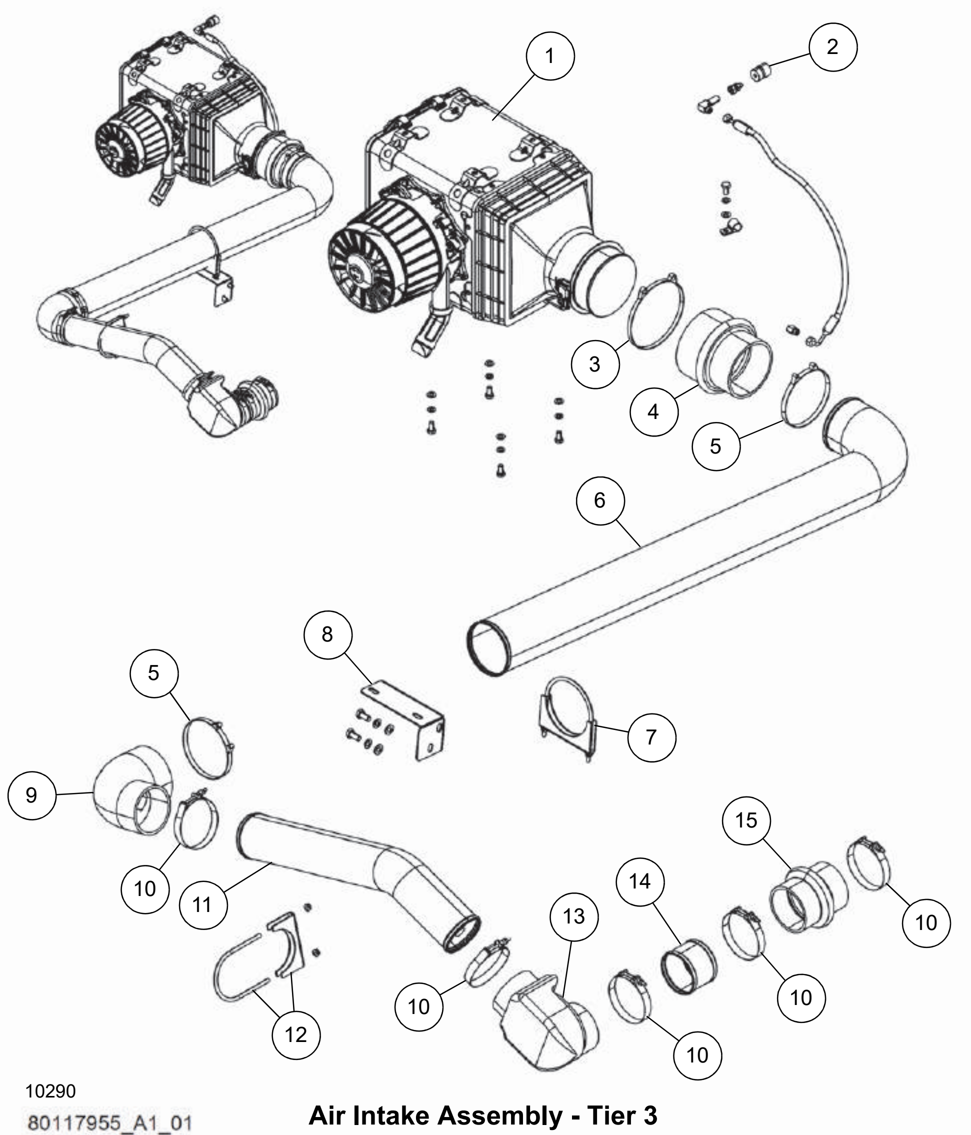
If the initial restriction on a new or clean filter reads above the maximum allowed for the engine, check the following items.

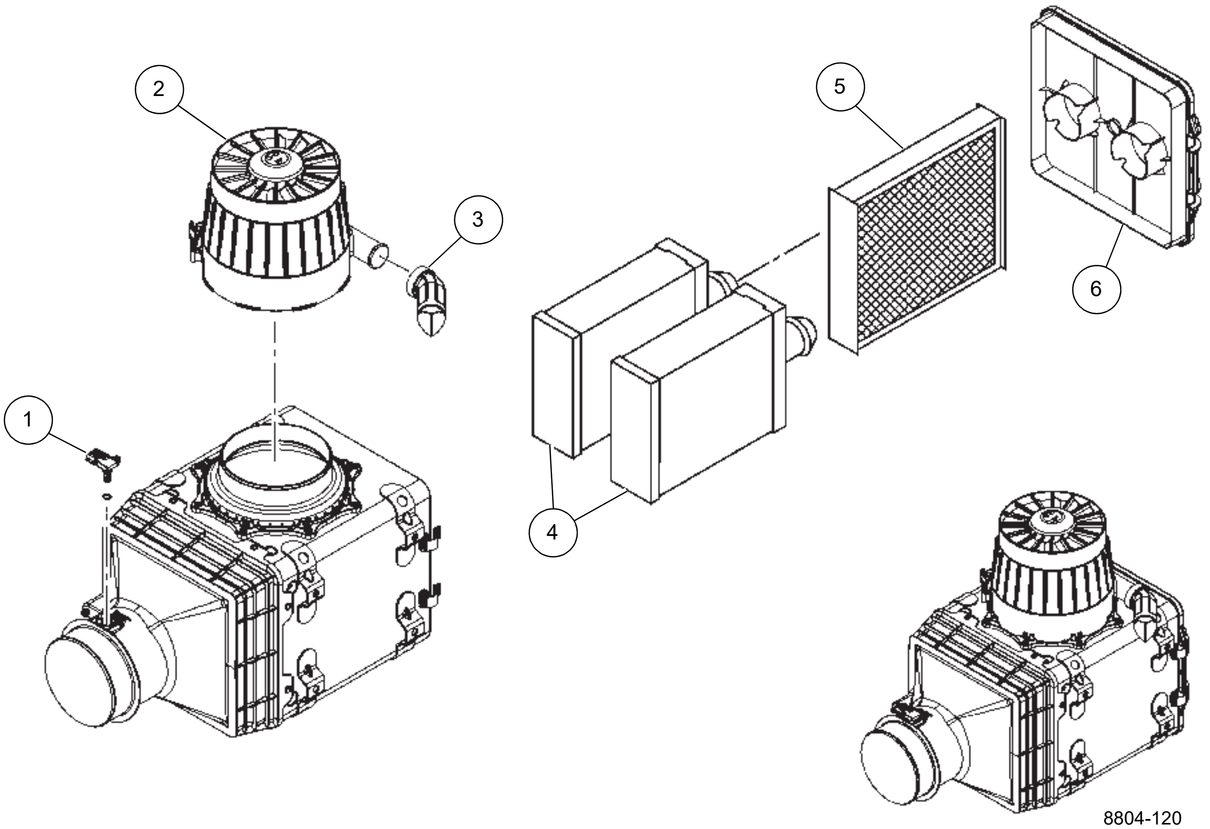
1. Ensure the air cleaner inlet is not plugged.
2. Inspect the air cleaner outlet to be sure it is not plugged by paper, rags, etc.
3. Ensure the correct size connections are used between the air cleaner and the engine.
4. Ensure all inlet accessories are the correct size and are not plugged by any foreign object.



Air Intake Assembly - Tier 3

1	Air Cleaner	9	Elbow
2	Service Indicator	10	T-bolt Clamp
3	Clamp	11	Air Intake Tube
4	Reducer	12	Muffler Clamp
5	Clamp	13	Elbow
6	Tube	14	Air Inlet Tube
7	Muffler Clamp	15	Adapter
8	Bracket		

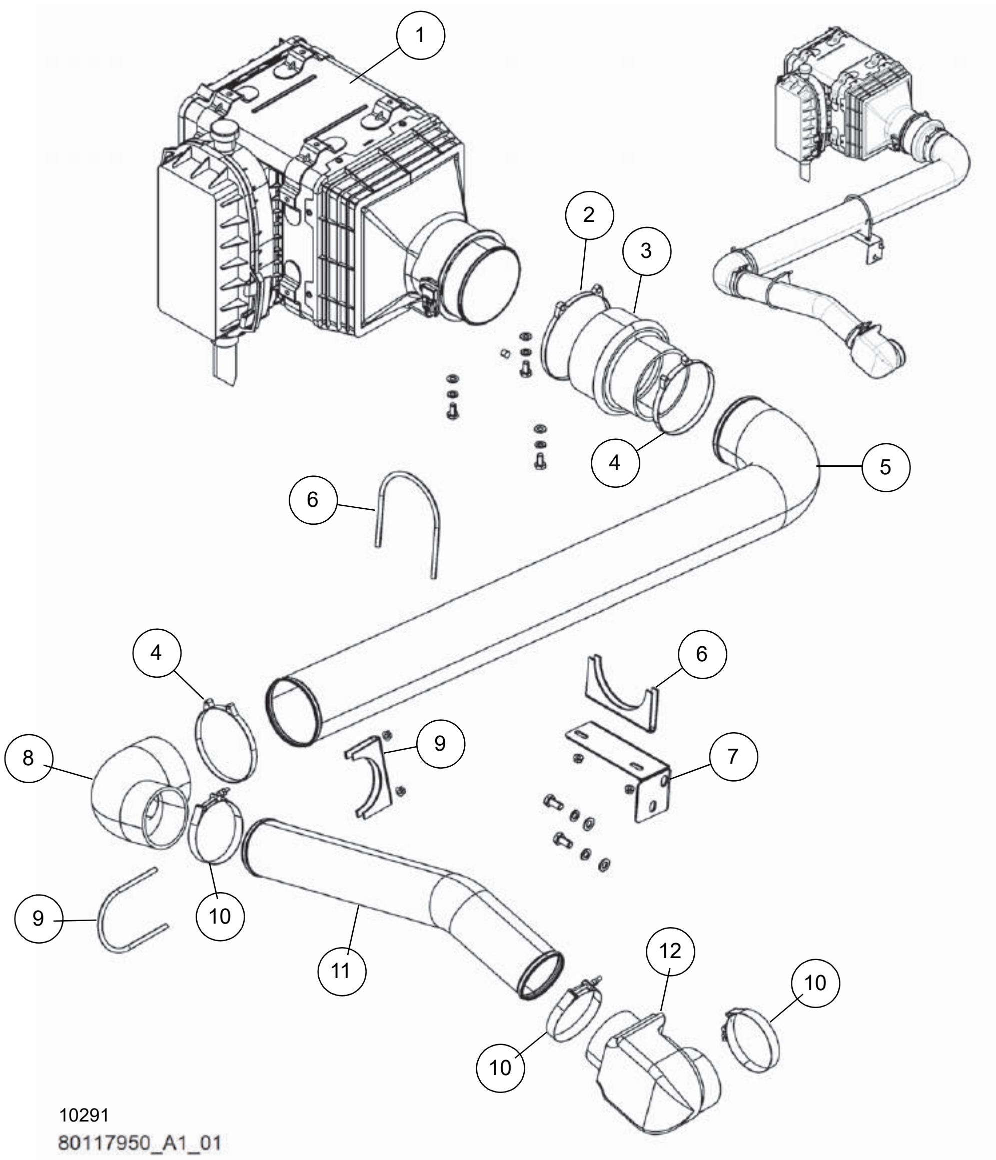
FIGURE 7-5



Air Filter Assembly - Tier 3

1	Temp/Air Pressure Sensor
2	Pre-cleaner
3	Vacuator Valve
4	Primary Air Filter
5	Secondary Air Filter
6	Service Door

FIGURE 7-6

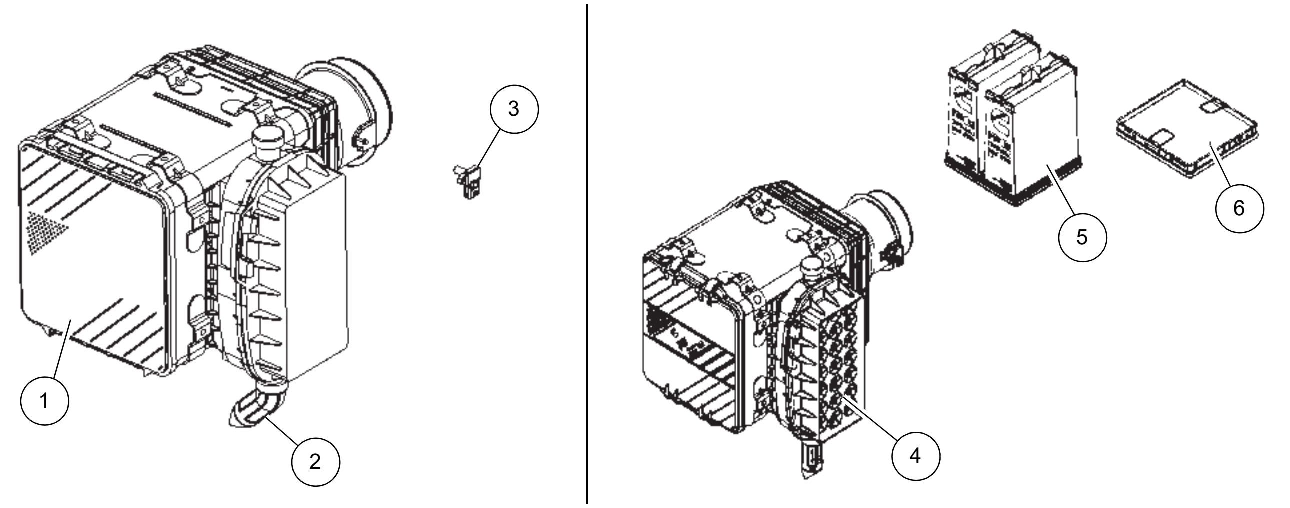


Air Intake Assembly - Tier 4

1	Air Cleaner Assembly
2	Clamp
3	Reducer
4	Clamp
5	Tube
6	Muffler Clamp

7	Bracket
8	Elbow
9	Muffler Clamp
10	T-Bolt Clamp
11	Tube
12	Elbow

FIGURE 7-7



Air Filter Assembly - Tier 4

1	Service Door
2	Vacuator Valve
3	TAP Sensor

4	Pre-cleaner
5	Primary Air Filter
6	Secondary Air Filter

FIGURE 7-8

Filter Element Replacement

CAUTION

Never service the air cleaner while the engine is running.

1. Lift the clips (1) ((Figure 7-9)) securing the cover to the air cleaner body and remove the cover.

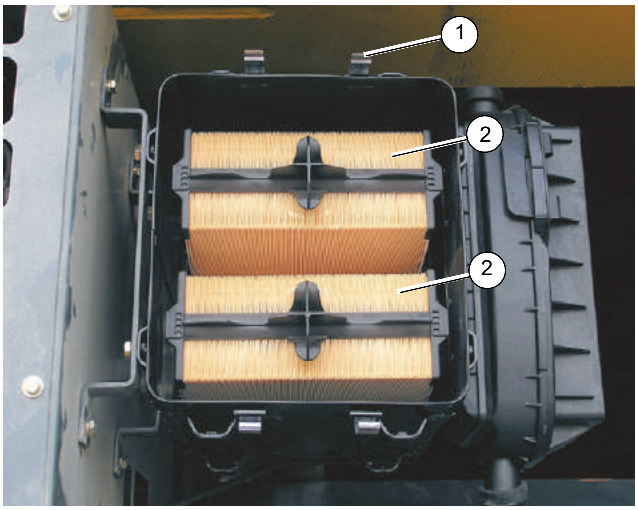


FIGURE 7-9

2. Remove Primary Filter from the Air Cleaner and inspect for foreign material and marks of dust. Replace as necessary
3. Remove Secondary Filter (not shown) from behind the Primary Filter. Replace Secondary Filter every third time the Primary Filter is changed.
4. Thoroughly clean the sealing surface and inside of the air filter housing. Inspect all parts of the intake system and air cleaner.
5. Place the cover back on the air cleaner housing and secure with clips (1).
6. Check all connections and ducts for an air tight fit. Make sure that all clamps, bolts, and connections are tight. Check for holes in piping. Leaks in the air intake system may send dust directly to the engine.

Element Cleaning

It is not recommended that filter elements be cleaned. Cummins and most other manufacturers will not warrant a cleaned air filter.

Air Cleaner Body

Before installing the filter element, remove foreign material (leaves, lint or other foreign matter) that may have collected inside the air cleaner body. Inspect the inside of the body for dents or other damage that would interfere with air flow or with the fins on the element or inside the body. Repair any body dents, being careful not to damage the sealing surfaces. Be sure to clean the sealing surface of the outlet tube and the inside of the outlet tube, taking care not to damage the sealing area on the tube.

Pre-cleaner

The pre-cleaner (1, Figure 7-10) prevents large debris from entering the air cleaner and should be cleaned periodically, especially when working in severe dust conditions. Remove the top half of the pre-cleaner by releasing the two latches on the sides of the pre-cleaner. Remove all debris from inside pre-cleaner and reassemble.

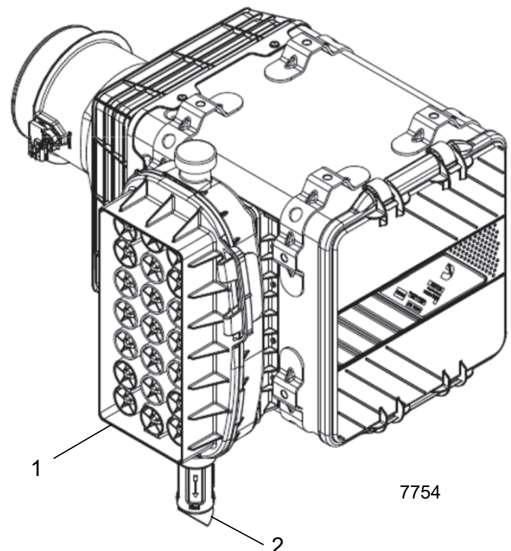


FIGURE 7-10

Vacuator Valve

Vacuator valve (2, Figure 7-10) (Figure 7-11) is designed to automatically expel loose dust and dirt from the air cleaner body, thus lengthening the element service life. The valve lips must point straight down and be kept free of debris to operate effectively. Mud and chaff can lodge in these lips periodically and hold them open during engine operation.

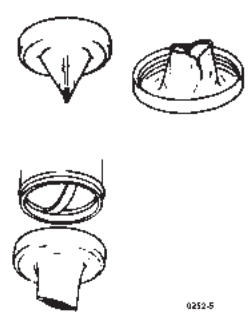


FIGURE 7-11

Check the condition of the valve and lips frequently and keep them clean. The valve lips should be open only when the engine is shut down, or running at low idle speed. If the valve is turned outside in, check for a clogged air cleaner inlet. Malfunction of this valve does not reduce the air cleaner effectiveness, but does allow the element to get dirty faster and reduces serviceable life. If a valve is lost or damaged, replace it with a new valve of the same part number.

Duct Work

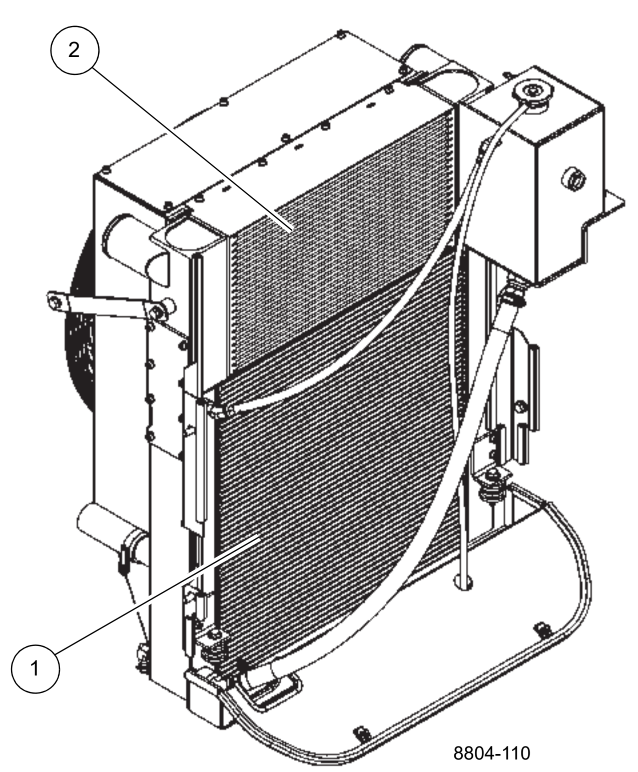
1. Check the intake pipe cap and screen for accumulation of leaves, trash, and other debris that could restrict air flow. Repair the screen or replace the cap if any large holes are found in the screen.
2. Check all mounting hardware for security to eliminate possible vibration of intake piping. Such vibration leads to early failure of hoses, clamps, and mounting parts, and can cause hoses to slip off the connecting pipes, allowing un-filtered air into the engine air intake.
3. Check hoses for cracks, chafing, or deterioration, and replace at the first sign of probable failure.

Charge-Air Cooler System

The charge-air cooler (CAC) (Figure 7-12) is used to cool engine air after it has passed through a turbocharger, but before it enters the engine. The charge-air cooler provides better horsepower, increased fuel efficiency, and reduces engine emissions.

The CAC system consists of the ducting to and from the charge-air cooler and a hydraulically driven fan. The charge-air cooler system must be air-tight in order to work efficiently.

The ducting consists of metal tubing, hose clamps and bellows. The recommended installation torque for the large constant tension clamps is 10.2 to 11.3 Nm (90 to 100 lb-in) and the small constant tension clamps is 5.7 Nm (50 in-lb). Do not compress the spring completely, the bellows and/or clamp may be damaged from thermal expansion of the CAC tube.



1	Engine Coolant Radiator
2	CAC Assembly

FIGURE 7-12

Maintenance

1. Check hose clamps for proper torque.
2. Inspect bellows for cracks or holes.
3. Clean charge-air cooler. Remove any dirt or debris.
4. Verify fan is operating correctly and there are no hydraulic leaks.

Exhaust System

Tier 3 Exhaust System

The Tier 3 exhaust system (Figure 7-13) is made of a muffler and various tubes, elbows, and clamps.

When removing and installing a muffler, tighten all hardware to specifications found under *Fasteners and Torque Values*, page 1-17, unless specified otherwise:

- Tighten V-band clamps to 13.5±1.5 Nm (9.96±1.10 ft-lb).
- Tighten slip joint to 9 to 11.3 Nm (85 to 100 ft-lb).
- Tighten mounting bands to 5.4 Nm (4.0 ft-lb).

Tier 4 Exhaust System

The Tier 4 exhaust system (Figure 7-14) is made of a diesel oxidation catalyst (DOC), decomposition reactor tube, a selective catalytic reduction (SCR) unit and various tubes, elbows and clamps.

Removal

CAUTION

Burn Hazard!

Do not touch exhaust parts until they are at ambient temperature. Severe burning may result.

1. Remove the sheet metal guard to gain access to the exhaust system.
2. Remove clamp to free exhaust tailpipe.
3. Tag and disconnect electrical connections.
4. Disconnect the DEF hose.
5. Remove V-band clamp to free SCR from exhaust elbow.
6. Remove V-band clamps to free decomp reactor tube from the elbows.
7. Remove V-band clamps to free DOC from the elbow and tube.
8. Remove V-band clamps to free flexible exhaust hose from the tubes.
9. Remove remaining tubes as necessary.
10. Inspect SCR, decomp reactor tube, DOC, exhaust tailpipe, exhaust tubes, bracket, and attaching hardware. Repair or replace any of these parts if damaged or missing.

Installation

NOTE: Tighten all hardware to specifications found under *Fasteners and Torque Values*, page 1-17, unless specified otherwise.

Tighten V-band clamps to 13.5±1.5 Nm (9.96±1.10 ft-lb).

Tighten slip joint to 9 to 11.3 Nm (85 to 100 ft-lb).

Tighten mounting bands to 5.4 Nm (4.0 ft-lb).

1. Secure the DOC to the exhaust tube and elbow with V-band clamps.
2. Install the decomp reactor tube and secure with the V-band clamps.
3. Install the SCR and secure with the V-band clamps.
4. Secure exhaust components to their mounting brackets.
5. Connect electrical connections as tagged during disassembly.
6. Connect DEF hose.
7. Install sheet metal guard.

Slip Joint Exhaust Connectors - Tier 3 and 4

Slip joint exhaust couplers require tightening to avoid exhaust leaks. Perform the following procedures at the appropriate intervals.

After 1000 Hours, or One Year

Visually inspect the exhaust connector. If necessary, tighten the V-band clamps by one full turn of the nuts.

2000 Hours or 2 Years

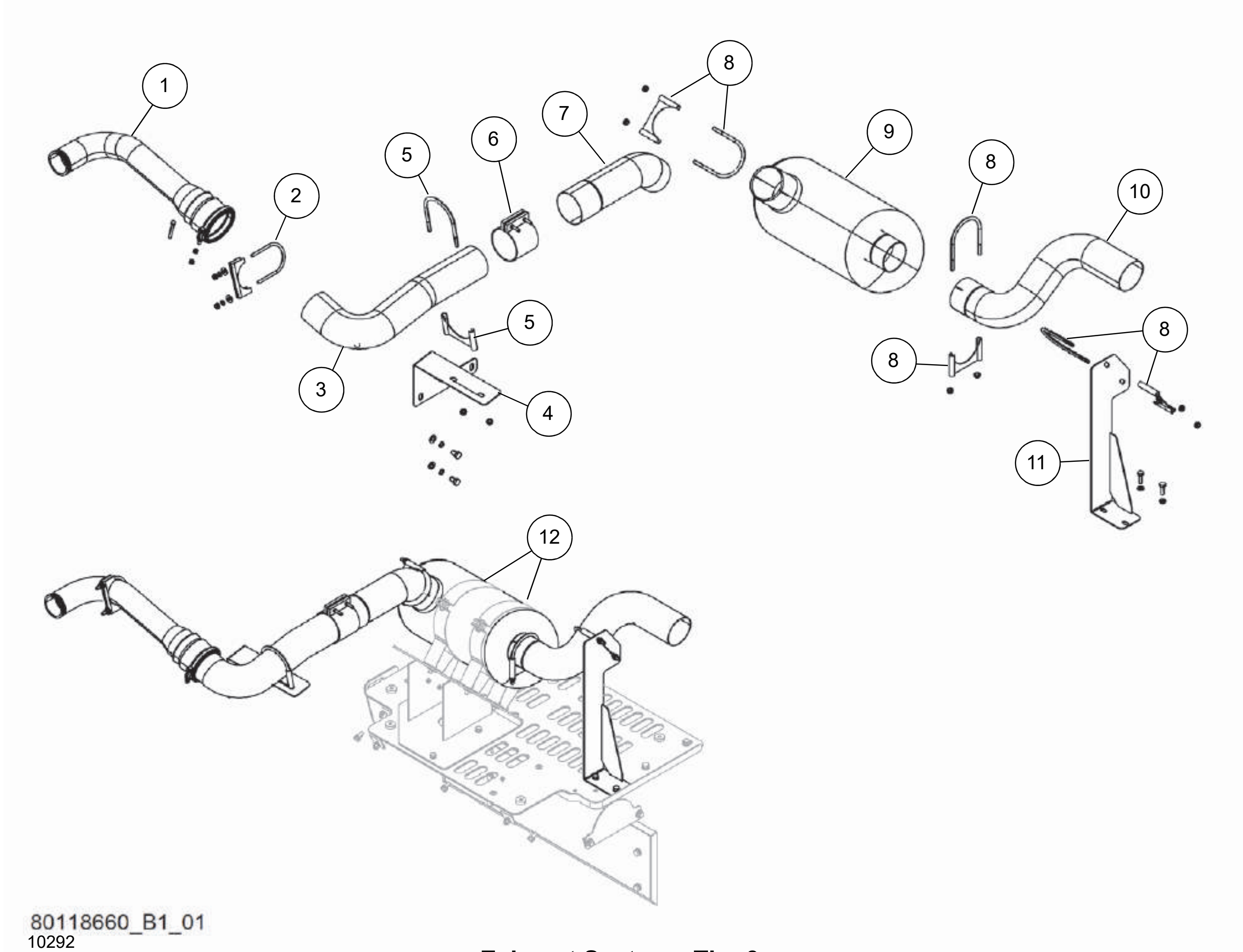
Tighten the V-band clamps by 1 ½ turns of the nuts.

4000 Hours or 4 Years

Tighten the V-band clamps by 1 ½ turns of the nuts.

5000 Hours or 5 Years

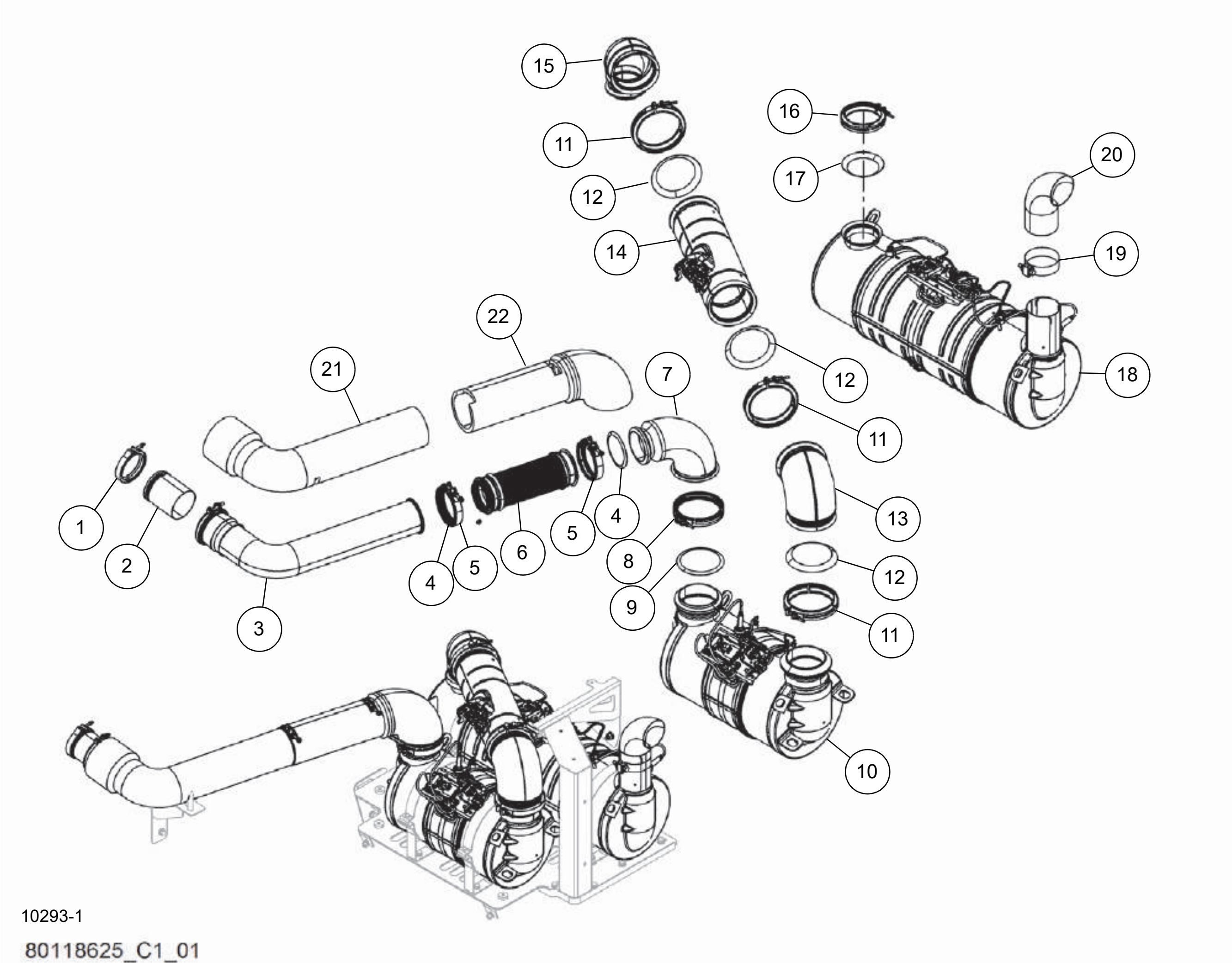
Remove the V-band clamps and gaskets, and replace them with new gaskets and clamps. Tighten the V-band clamps to 13.5±1.5 Nm (9.96±1.10 ft-lb) of torque.



Exhaust System - Tier 3

1	Exhaust Tube	7	Downpipe Tube
2	Muffler Clamp	8	Muffler Clamp
3	Downpipe Tube	9	Muffler
4	Bracket	10	Tailpipe Tube
5	Muffler Clamp	11	Bracket
6	Clamp	12	Mounting Bands

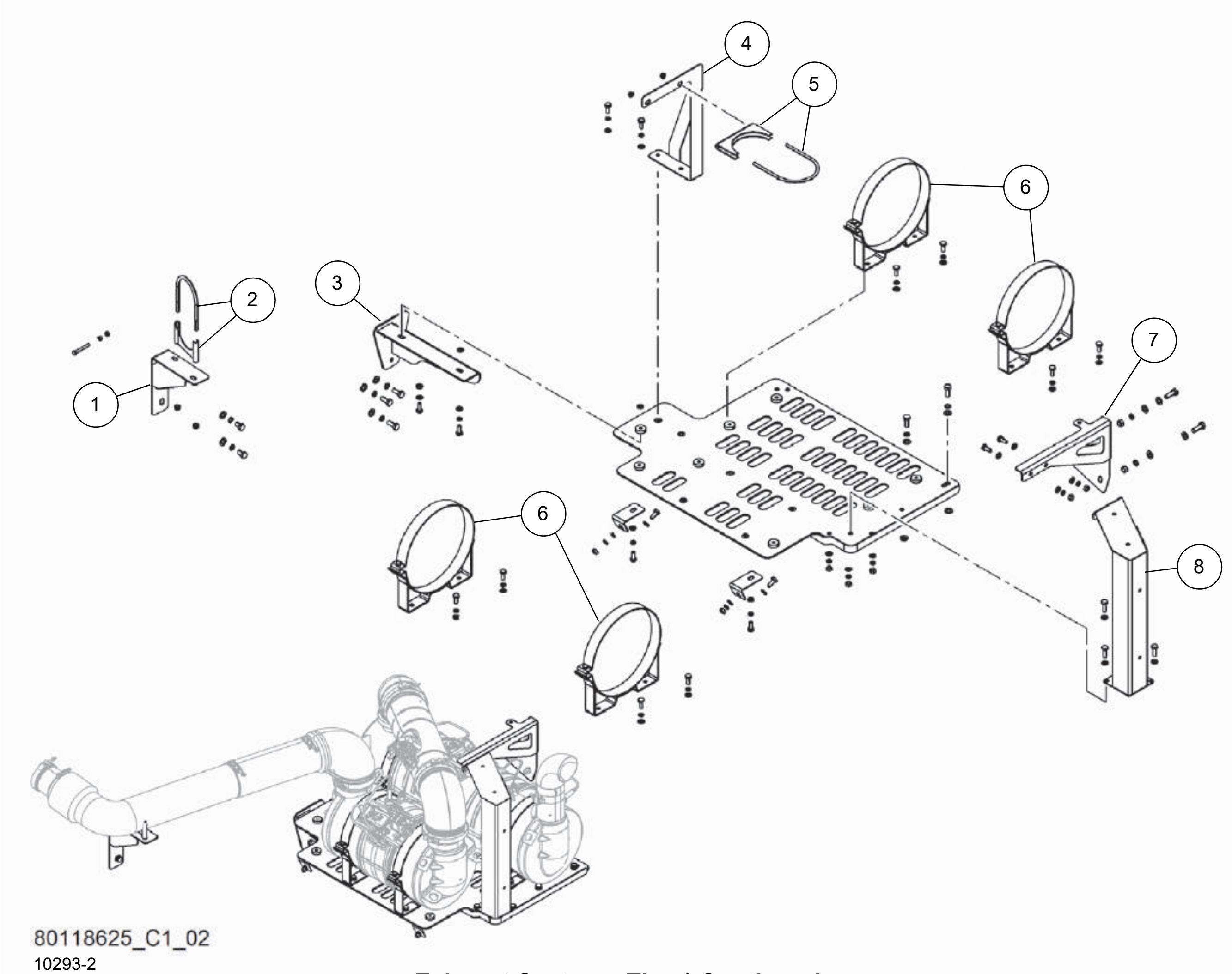
FIGURE 7-13



Exhaust System - Tier 4

1	V-band Clamp		12	Gasket
2	Slip Joint		13	Elbow
3	Exhaust Tube		14	Decomp Reactor Tube
4	Decomp Pipe Gasket		15	Elbow
5	V-band Clamp		16	V-band Clamp
6	Flexible Exhaust Hose		17	Gasket
7	Elbow		18	Selective Catalytic Reduction (SCR) Device
8	Clamp		19	Clamp
9	Gasket		20	Tailpipe
10	Oxidation Catalyst		21	Insulation
11	V-Band Clamp		22	Insulation

FIGURE 7-14



Exhaust System - Tier 4 Continued

1	Bracket		5	Muffler Clamp
2	Muffler Clamp		6	Mounting Band
3	Bracket		7	Bracket
4	Bracket		8	Bracket

FIGURE 7-14 continued

WATER COOLING SYSTEM

Description

The cooling system (Figure 7-16) consists of a radiator, surge tank, engine cooling circuit, and the connecting hoses and connecting tubes. At all times, the antifreeze/coolant should be properly inhibited against corrosion. It is recommended that a mixture of AFC-50/50 blended ethylene-glycol, low silicate, fully formulated, engine antifreeze/coolant concentrate and water which does not require a pre-charge of supplemental coolant additives (SCA) for use in initial fill of heavy duty liquid cooled internal combustion engines be used at all times.

The crane is equipped with a cab hot water heater. Hot water is supplied by the engine coolant system through a strainer and two port water swivel to the cab heater. The strainer is a cleanable type and is located on the left side of the transmission by the rear engine/transmission mount. Refer to *Maintenance and Lubrication*, page 9-1 for service of the strainer.

Maintenance

General

The cooling system includes the Radiator, Surge Tank, Thermostat, the Fan, and Water Pump. Radiator hoses are also included in this group.

The cooling system is often neglected because the effects or damage that result from an improperly maintained system usually occur gradually. The cooling system needs to be maintained with the same attention as other systems.

The circulation of water through the cooling system relies entirely upon the water pump. The water pump draws water from the radiator and forces it through the water jacket and cylinder head. There it accumulates heat and flows to the radiator tank. Then the water flows across through the radiator core and is cooled by air from the fan. This process of removing heat from water as it circulates holds the engine to its efficient operating temperature.

The following paragraphs point out several facts about cooling system components, the effects of cooling system neglect, and procedures to be followed for cooling system maintenance.

Effects of Cooling System Neglect

Whenever an engine does not perform at top efficiency, a neglected cooling system may be at fault even though the part directly responsible is not a part of the cooling system. Most of these problems can be traced to overheating; however, an engine that is running too cold can be just as troublesome.

Overheating

An engine that is overheating may lead to troubles such as the following:

1. Burned valves.
2. Pinging or knocking.
3. Excessive fuel consumption.
4. Poor lubrication - increased engine wear.
5. Sticking valves.
6. Short injector life.
7. Engine hot spots.
8. Need for higher grade fuel.

Overcooling

The following engine troubles result when an engine is overcooled:

1. Excessive fuel consumption.
2. Sludge formation in crankcase.
3. Corrosive acids formed in crankcase.
4. Excessive fuel deposits in the exhaust system.

Antifreeze/Coolant

Heavy duty diesel engines require a balanced mixture of water and antifreeze/coolant. For maximum rust, freeze, and boiling point protection, a 50/50 blended, fully formulated extended life antifreeze/coolant should be maintained at all times. Refer to *Maintenance and Lubrication*, page 9-1. Do not use more than 50 percent antifreeze/coolant in the mixture unless additional freeze protection is required. Never use more than 68 percent antifreeze/coolant under any condition. Antifreeze/coolant at 68 percent provides the maximum freeze protection; antifreeze/coolant protection decreases above 68 percent.

Rust Prevention

To keep engines operating at like new efficiency, all forms of rust formation must be prevented. The formation of rust in the cooling system is a result of the interaction of water, iron, and oxygen, and can only be prevented by maintaining full strength corrosion protection at all times. Supplemental coolant additives (SCA) are recommended for this cooling system. Antifreeze/coolant alone does not provide sufficient protection for heavy-duty diesel engines. Refer to *Section 9* for SCA specification and compatible brands.

Engine Antifreeze/Coolant Fill Procedure

1. Fill system with a 50/50 blended, fully formulated extended life antifreeze/coolant. Fill to bottom of the surge tank filler neck. Fill slowly. Flow exceeding 3 gpm (11.2 L/min) can give a false reading.
2. Wait one minute and recheck the antifreeze/coolant level. Refill as necessary repeating step 1.
3. Run engine for 5 minutes and recheck the antifreeze/coolant level. Refill as necessary repeating step 1. Refer to *Maintenance and Lubrication*, page 9-1.

Antifreeze/Supplemental Coolant Additives Maintenance Summary

Cooling System Level Check Interval

Daily or 10 hours

Check cooling system level every 10 hours of operation or daily, whichever comes first. Refer to *Maintenance and Lubrication*, page 9-1.

SCA Level Check Interval

6 months or 500 hours

- Check SCA Levels (use only Coolant Test Kit, Grove part number 9414101675, to check the coolant additive concentration in the cooling system).

  Only add coolant additive if levels are less than 1.2 units/gal (see *: Approved Lubricant Reference Table*, page 9-11 for specification and recommended additives).

NOTE: An inadequate concentration of coolant additive can result in major corrosive damage to the cooling system components. Over-concentration can cause formation of a “gel” that can cause restriction or plugging of coolant passages, and overheating.

1 year or 1000 hours

- Test antifreeze/coolant for contamination.

  Condemning limits are:

  - Sulfate level greater than or equal to 1500 ppm.
  - Chloride level greater than or equal to 200 ppm.
  - pH level is less than 6.5
  - Oil or fuel contamination can be identified by odor or color.

  If condemned, flush the system using a commercially available flushing agent. Refill system with fully formulated extended life coolant. Refer to *Maintenance and Lubrication*, page 9-1.

NOTE: Remove radiator cap when draining system to ensure proper draining.

Cleaning

CAUTION

Burn Hazard!

The cooling system contains very hot pressurized liquid and injury can result when removing the radiator cap at operating temperature. Use proper protection to remove the radiator cap.

1. Coolant shut-off valves to heaters and other accessories should be open to allow complete circulation during cleaning, flushing, and draining. Run the engine with radiator covered if necessary until temperature is up to operating range 71 to 82°C (160 to 180°F). Stop the engine, remove the radiator cap, and drain the system by opening the drain cocks on the radiator and engine block.

NOTE: Use a cleaning compound that is not corrosive to aluminum to prevent damage to the radiator.

2. Allow engine to cool, close drain cocks, and pour the cleaning compound into the surge tank according to the directions. Fill system with water.
3. Place a clean drain pan to catch the overflow, and use it to maintain the level in the radiator. Do not spill the solution on the vehicle paint.
4. Replace the radiator cap and run the engine at moderate speed, covering the radiator if necessary, so the system reaches a temperature of 82°C (180°F) or above, but does not reach the boiling point. Allow the engine to run at least two hours, or according to recommendations of the manufacturer of the cleaning compound, at 82°C (180°F) so the cleaning solution may take effect. Do not drive the vehicle or allow the liquid level in the radiator to drop low enough to reduce circulation.
5. Stop engine as often as necessary to prevent boiling.
6. With engine stopped, feel the radiator core with bare hands to check for cold spots, and then observe the temperature gauge reading. When there is no change in temperature for some time, drain the cleaning solution.
7. If clogging of the core is relieved but not fully corrected, allow the engine to cool, pressure-flush the system (see *Pressure Flushing*) and repeat the cleaning operation.
8. If problem persists, replace radiator.

Pressure Flushing

1. Disconnect both radiator hoses that connect the radiator to the engine.
2. Clamp a convenient length of hose to the radiator core outlet opening, and attach another suitable length of hose to the radiator inlet opening to carry away the flushing stream.
3. Connect the flushing gun to compressed air and water pressure, and clamp the gun nozzle to the hose attached to the radiator outlet opening.
4. Fill core with water. Turn on air pressure in short blasts to prevent core damage.
5. Continue filling the radiator with water and applying air pressure as above until the water comes out clear.
6. Clamp the flushing gun nozzle firmly to a hose attached securely to the engine water outlet opening. Fill the engine block with water, partly covering the water inlet opening to permit complete filling.
7. Turn on compressed air to blow out water and loose sediment. Continue filling with water and blowing out with air until flushing stream comes out clear.
8. When the vehicle is equipped with a water heater connected to the cooling system, flush the heater, following the same procedure as for the radiator core.
9. After completing the flushing operation, clean out the surge tank overflow pipe; inspect the water pump; clean the thermostat and the radiator cap control valves. Check the thermostat for proper operation before installation.
10. Blow insects and dirt from the radiator core air passages. Use water to soften obstructions if necessary.

Component Inspection

Radiator/Surge Tank

1. Side Tanks - Look for leaks, particularly where the tank is attached to the core. Vibration and pulsation from pressure can fatigue soldered seams.
2. Filler Neck - The sealing seat must be smooth and clean. Cams on filler neck must not be bent or worn so as to allow a loose fitting cap. Ensure the overflow tube is not plugged.
3. Radiator Cap - This is the pressure-setting type. Its purpose is to hold the cooling system under a slight pressure, increasing the boiling point of the cooling solution and preventing loss of solution due to evaporation and overflow.

The cap has a spring-loaded valve, the seat of which is below the overflow pipe in the filler neck. This prevents the escape of air or liquid while the cap is in position. When the cooling system pressure reaches a predetermined point, the cap valve opens and will again close when the pressure falls below the predetermined point.

When removing the pressure type cap, perform the operation in two steps. Loosening the cap to its first notch raises the valve from the gasket and releases the pressure through the overflow pipe. In the first stage position of the cap, it should be possible to depress the cap approximately 3 mm (0.13 in). Prongs on the cap can be bent to adjust this condition. Care must be taken that the cap is not too loose as this would prevent proper sealing.

CAUTION

Burn Hazard!

Loosen cap slowly and pause a moment to avoid possible burning by hot water or steam. Continue to turn the cap to the left until it can be removed.

4. Tubes are very small and can easily become clogged by rust and scale. The general condition of the cooling system and operating temperature are indications as to whether or not tubes are clean. Another good test is to feel the core for cold spots.
5. Fins are thin metal sheets that dissipate heat picked up by the tubes. They should be kept free of bugs, leaves, straw etc., so as to allow the free passage of air. Bent fins should be straightened.

Engine Water Jacket

The water jacket permits coolant to be circulated around the cylinder walls, combustion chamber, and valve assemblies. Some of these coolant passages are small and can easily become clogged, if the cooling system does not receive the proper maintenance.

1. Core Plugs - These are sometimes mistakenly called freeze plugs. They do not provide protection against freezing expansion, but are only present because of engine block casting methods. Remove and replace core plugs that show signs of leaking or rusting through. Use an installation tool for core plug replacement.
2. Drain Plugs - The water jacket of each engine could have one or more drain plugs. These should receive seasonal care and be kept free of rust and scale.
3. Gaskets - All gaskets must be in good condition to prevent both internal and external leaks. If there are external leaks around gaskets, there may also be internal leaks into the engine. Proper tightening of the head bolts with a torque wrench is essential for preventing leaks around the head gasket.

Water Pump

The pump should be checked carefully for leaks and proper lubrication. Replace or rebuild if leaking, cracked, or worn.

Fans and Belts

The fan should be checked for cracked or broken blades.

Refer to *Engine Drive Belts*, page 7-3.

Thermostat

The thermostat is of the nonadjustable type and is incorporated in the cooling system for the purpose of retarding or restricting the circulation of coolant during engine warm up. Engine overheating and loss of coolant is sometimes due to an inoperative thermostat. To check for this condition, remove the thermostat and test by submerging it in hot water and noting the temperature at which the thermostat opens and closes. Use an accurate high temperature thermometer for making this test.

Hoses and Clamps

Hoses and their connections must be checked regularly because they are often the source of hidden trouble. Hoses may often times appear in good condition on the outside while the inside will be partially deteriorated. If there are any doubts about a hose doing its job, replacement should be made. The clamps should be inspected to make sure they are strong enough to hold a tight connection.

Radiator Removal and Installation

Removal

1. Set the outriggers and position the boom to over the side.
2. Open the drain cock at the bottom of the radiator and drain the coolant into a suitable container. Dispose of the coolant in accordance with local and EPA regulations.

NOTE: Remove the radiator cap when draining the system to ensure proper draining.

3. Open and remove the hood top door assembly.
4. Remove the bolts and nuts holding the rear engine hood panel to the engine hood. This will gain access to the rear of the radiator and the surge tank mounting hardware.
5. Tag and disconnect the hoses from the surge tank to the engine and from the surge tank to the radiator.
6. Remove the two bolts, washers, lockwashers and nuts holding the surge tank to the frame. Remove the surge tank.
7. Remove the nuts, washers and muffler clamps securing the left and right charge air cooler tubes to the frame.
8. Remove the hose clamps and bellows connecting the radiator to the charge air cooler tubes. Remove the hose clamps and radiator hose connecting the radiator to the radiator tubes.
9. Remove the bolts and washers attaching the fan shroud to the radiator.
10. Remove the bolts, washers and lockwashers that connect the plates to the top of the radiator and the top of the frame rail.
11. Disconnect the electrical harness from the coolant level sensor.

NOTE: The radiator weighs approximately 94 kg (208 lb).

12. Attach an adequate lifting device to the radiator assembly.
13. Remove the two bolts, washers, lockwashers, nuts and mounting bushings securing the radiator flange to the frame mounting brackets. Remove the radiator assembly from the carrier.
14. If a new radiator is to be installed, remove all fittings and hoses from the old one and install them in the same locations on the new one.

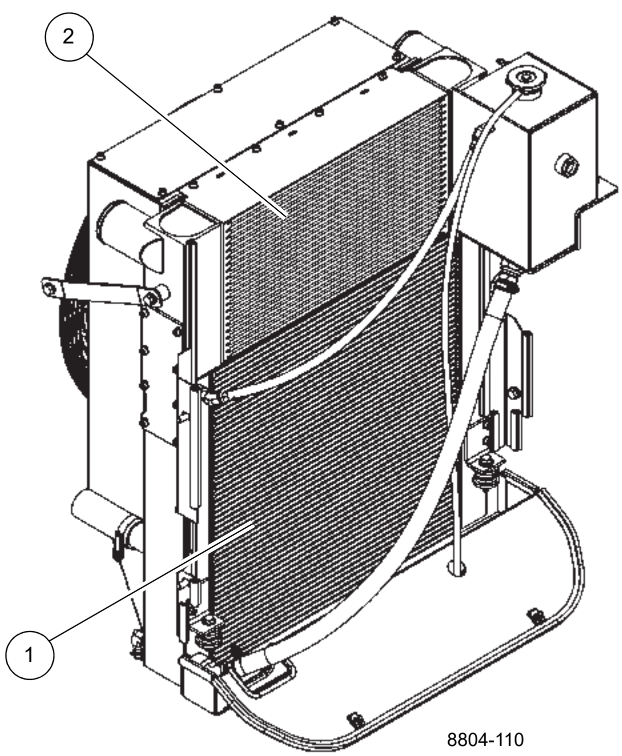
Installation

1. Ensure all fittings and hoses are installed on the radiator.
2. Position the radiator assembly in the carrier using a lifting device. Secure the radiator flange to the frame mounting brackets using two bolts, washers, lockwashers, nuts and mounting bushings.
3. Reconnect the two plates between the top of the radiator and the top of the frame rail using bolts, washers, lockwashers and nuts.
4. Attach the fan shroud to the radiator using the bolts and washers.
5. Connect the electrical harness to the coolant level sensor.
6. Connect the two radiator tubes to the radiator with hose clamps and the radiator hose. Tighten clamps to 10.2 to 11.3 Nm (90 to 100 in-lb).
7. Secure the radiator return tube to the top of the engine using nuts, washers and a muffler clamp.
8. Reconnect the charge air cooler tubes to the CAC radiator using hose clamps and bellows. Tighten clamps to 11.3 Nm (100 lb-in). Do not compress spring completely, clamp may be damaged from thermal expansion of CAC tube.
9. Secure the charge air cooler tubes to the left and right sides of the frame with nuts, washers and muffler clamps.

10. Tighten the drain cock at the bottom of the radiator.
11. Mount the surge tank to the frame using the two bolts, washers, lockwashers and nuts.
12. Connect the hose between the surge tank and the radiator and the hose from the engine to the surge tank. Tighten clamps to 5.7 Nm (50 in-lb).
13. Fill the engine coolant system, refer to *Engine Antifreeze/Coolant Fill Procedure*, page 7-19. Start the engine, operate all systems and check for leaks.
14. Install the hood assembly.
15. Install the bolts and nuts holding the rear engine hood panel to the engine hood.
16. Install the hood top door assembly.

Radiator Fill and Servicing

Refer to *Maintenance and Lubrication*, page 9-1 for complete fill and service procedures.



1	Engine Coolant Radiator
2	CAC Assembly

FIGURE 7-15

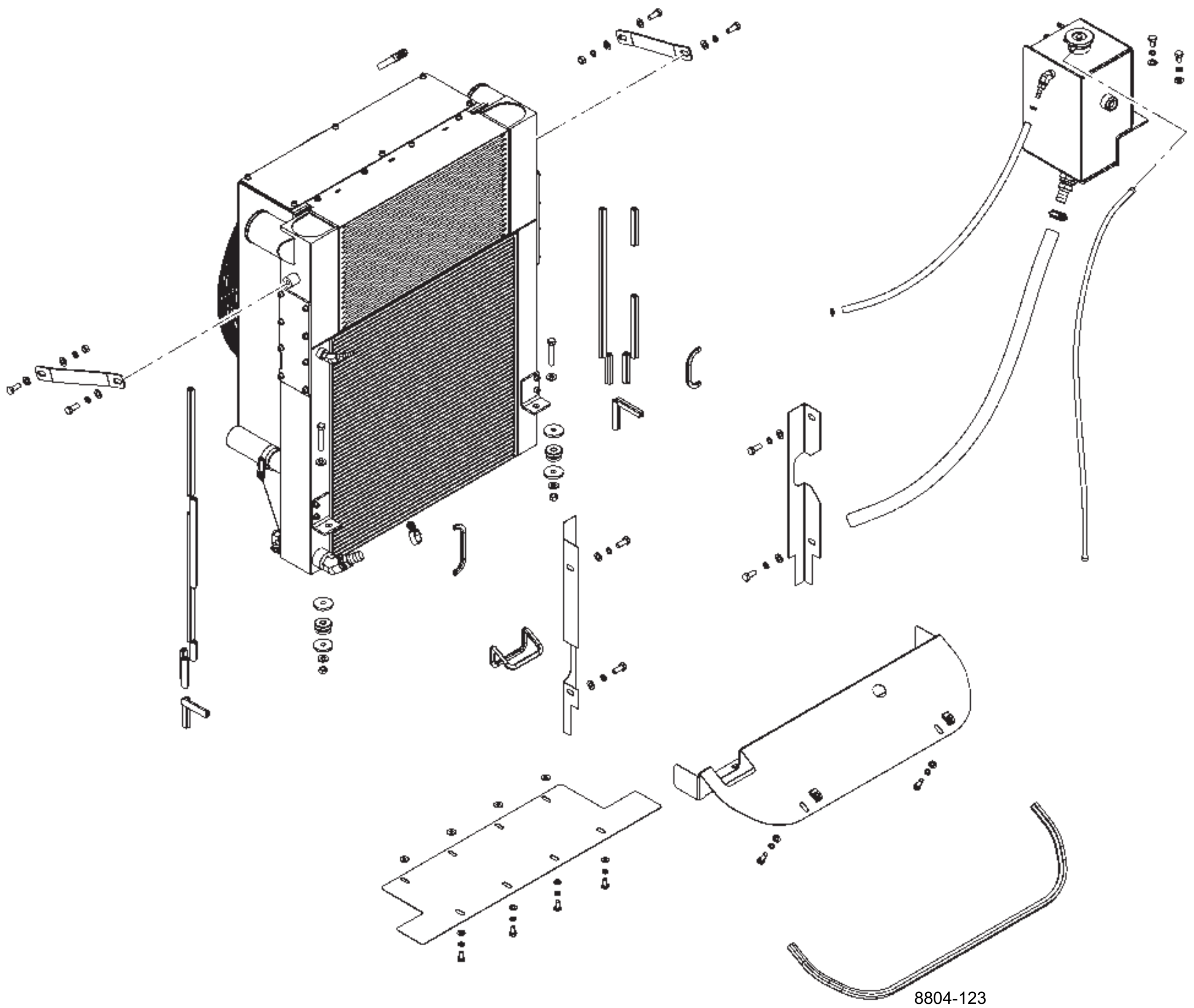


FIGURE 7-16

DRIVE TRAIN

Description

The drive train consists of the transmission/torque converter assembly and two drive lines.

The transmission/torque converter is mounted on and driven by the engine. The torque converter assembly provides for mounting and driving the two variable displacement pumps and one gear pump. The transmission is a Range Shift with six forward speeds and six reverse speeds. The transmission is controlled electrically by a shift lever/knob located on the right side of the steering column and an axle drive mode selector rocker switch located on the steering wheel console.

The transmission/torque converter oil is cooled by passing the oil through an externally mounted transmission cooler that is located on the left side of the crane. An oil filter is mounted on the left frame rail near the fuel tank.

Three drive lines are used. Two drive lines are connected between the transmission/torque converter and the front axle and the other drive line is connected between the transmission/torque converter and the rear axle.

Maintenance

Transmission

Refer to the Cummins engine and Spicer transmission manual and other portions of this section for removal, scheduled maintenance and corrective maintenance, and installation.

1	Driveline - Coupling Shaft
2	Bearing
3	Driveline - Slip Shaft
4	Driveline

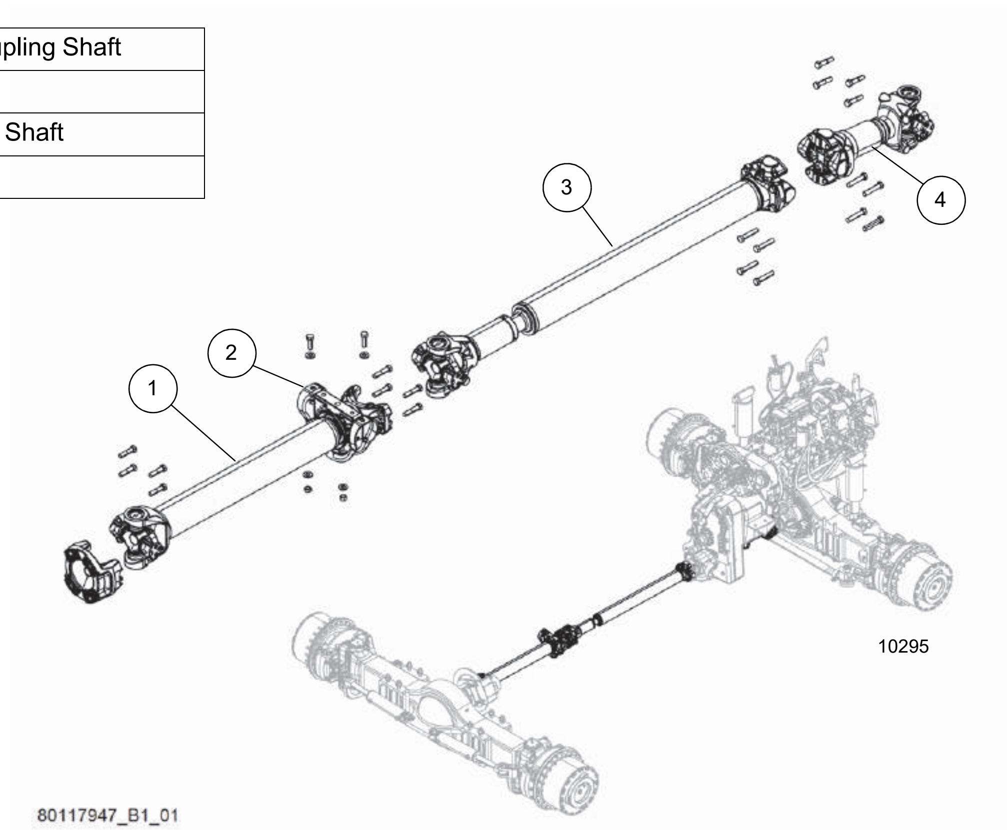


FIGURE 7-17

Drive Shafts

CAUTION

Do not disassemble drive lines when removing them from the crane. Dirt can enter the spline and cannot be purged. In addition, the drive lines are assembled in a specific orientation when manufactured and can easily be incorrectly reassembled.

Removal

1. Support the drive shaft being removed so it does not fall when disconnected. If removing the coupling shaft or the forward slip shaft, support the other shaft also.
2. If removing the coupling shaft, free its bearing from the frame by removing two bolts, two locknuts, and four washers.
3. Remove the bolts from the bearing cap on each end of the drive line. Note the lengths of the bolts and if they have lockwashers. Remove the drive line.

Installation

1. For any drive shaft which has mating marks (arrows), align these mating marks to ensure proper phasing of coupler yokes.
2. Position the drive shaft between the couplers on the two components it is joining.
3. For the coupling shaft, secure its bearing to the frame with bolts, locknuts, and washers.
4. Secure the drive shaft to the coupler with bolts. Torque the bolts to the following specifications:
   - Front and rear axle connection, and carrier bearing connection:
     156 Nm to 183 Nm (115 lb-ft to 135 lb-ft)
   - Transmission connection:
     149 Nm to 164 Nm (110 lb-ft to 121 lb-ft).

Lubrication

The drive line slip joints require lubrication. Refer to *Maintenance and Lubrication*, page 9-1.

TRANSMISSION/TORQUE CONVERTER

Description

The transmission/torque converter assembly is mounted to the engine and is connected to the front and rear axles by three drive shafts. The main hydraulic pump and hydraulic pump number three are mounted on the torque converter.

Theory of Operation

The transmission and torque converter function together and operate through a common hydraulic system. Therefore, it is necessary to consider both units in discussing operation.

With the engine running, the converter charging pump draws oil from the transmission pump through the removable oil suction screen and directs it through the pressure regulating valve and oil filter.

The pressure regulating valve maintains pressure to the transmission control for actuating the direction and speed clutches. This requires a small portion of the total volume of oil used in this system. The remaining volume of oil is directed through the torque converter circuit to the oil cooler and returns to the transmission for positive lubrication. This regulator valve consists of a hardened valve spool operating in a closely fitted bore. The valve spool is spring loaded to hold the valve in a closed position. When a specific pressure is achieved, the valve spool works against the spring until a port is exposed along the side of the bore. This sequence of events provides the proper system pressure.

After entering the converter housing, the oil is directed through the reaction member support to the converter blade cavity and exits in the passage between the turbine shaft and reaction member support. The oil then flows out of the converter to the oil cooler. After leaving the cooler, the oil is directed to a fitting on the transmission. Then, through a series of tubes and passages, lubricates the transmission bearings and clutches. The oil then gravity drains to the transmission sump.

The torque converter consists basically of three elements and their related parts to multiply engine torque. The engine power is transmitted from the engine flywheel to the impeller element through the impeller cover. This element is the pump portion of the hydraulic torque converter and is the primary component which starts the oil flowing to the other components which results in torque multiplication. This element can be compared to a centrifugal pump, in that it picks up fluid at its center and discharges at its outer diameter.

The torque converter turbine is mounted opposite the impeller and is connected to the output shaft of the torque converter. This element receives fluid at its outer diameter and discharges at its center. Fluid directed by the impeller out into the particular design of blading in the turbine and reaction member is the means by which the hydraulic torque converter multiplies torque.

The reaction member of the torque converter is located between and at the center of the inner diameters of the impeller and turbine elements. Its function is to take the fluid which is exhausting from the inner portion of the turbine and change its direction to allow correct entry for recirculation into the impeller element.

The torque converter will multiply engine torque to its designed maximum multiplication ratio when the output shaft is at zero rpm. Therefore, as the output shaft is decreasing in speed, the torque multiplication is increasing.

The shift control valve assembly consists of a valve body with selector valve spools. A detent ball and spring in the selector spool provides one position for each speed range. A detent ball and spring in the direction spool provides three positions, one each for forward, neutral, and reverse.

With the engine running and the directional control lever in the neutral position, oil pressure from the regulating valve is blocked at the control valve, and the transmission is in neutral. Movement of the forward and reverse spool will direct oil, under pressure, to either the forward or reverse direction clutch, as desired. When either directional clutch is selected, the opposite clutch is relieved of pressure and vents back through the direction selector spool. The same procedure is used in the speed selector.

The direction or speed clutch assembly consists of a drum with internal splines and a bore to receive a hydraulically actuated piston. The piston is oil tight by the use of sealing rings. A steel disc with external splines is inserted into the drum and rests against the piston. Next, a friction disc with splines at the inner diameter is inserted. Discs are alternated until the required total is achieved. A heavy back-up plate is then inserted and secured with a snap ring. A hub with OD splines is inserted into the splines of discs with teeth on the inner diameter. The discs and hub are free to increase in speed or rotate in the opposite direction as long as no pressure is present in that specific clutch.

To engage the clutch, the control valve is placed in the desired position. This allows oil under pressure to flow from the control valve, through a tube, to a chosen clutch shaft. This shaft has a drilled passageway for oil under pressure to enter the shaft. Oil pressure sealing rings are located on the clutch shaft. These rings direct oil under pressure to the desired clutch. Pressure of the oil forces the piston and discs against the heavy back-up plate. The discs, with teeth on the outer diameter, clamping against discs with teeth on the inner diameter, enables the hub and clutch shaft to be locked together and allows them to drive as a unit.

There are bleed balls in the clutch piston which allow quick escape for oil when the pressure to the piston is released.

Maintenance

General Information

1. Always check oil level with engine idling, and transmission in neutral at normal operating temperature (180 to 200°F (82 to 93°C)).
2. Change oil filter element every 500 hours. Drain and refill system every 1000 hours or 6 months.

Troubleshooting

Following is an aid to locating the source of difficulty in a malfunctioning unit. It is necessary to consider the torque converter charging pump, transmission, oil cooler, and connecting lines as a complete system when checking for source of trouble, since proper operation of any unit depends greatly on condition and operation of the others. By studying principles of operation together with data in this section, it may be possible to correct malfunctions which occur in the system. Troubleshooting procedures basically consist of hydraulic checks.

Hydraulic Checks

Before checking the transmission/torque converter and associated hydraulic system for pressures and rate of oil flow, it is essential that the following preliminary checks be made.

1. Check oil level in transmission. This should be done with oil temperature at 82°C to 93°C (180°F to 200°F). Do not attempt these checks with cold oil.
2. To bring oil temperature to this level, it is necessary to either work the machine or stall out the converter. When it is impractical to work the machine, stall out the converter as follows.
   a. Apply parking brake and service brakes.
   b. Position shift lever to forward and high speed.
   c. Accelerate the engine to between half and three-quarter throttle.

CAUTION

Full throttle stall speeds for an excessive length of time will overheat the torque converter.

   d. Hold converter stalled until desired temperature is reached.

NOTE: Always make all troubleshooting checks with the converter outlet temperature at least 82°C to 93°C (180°F to 200°F).

Table 7-1Troubleshooting

SYMPTOM	PROBABLE CAUSE	REMEDY
1. Low clutch pressure.	**a.** Low oil level.	**a.** Fill to proper level.
	b. Clutch pressure regulating valve spool stuck open.	**b.** Clean valve spool and housing.
	c. Faulty charging pump.	**c.** Replace pump.
	d. Broken or worn clutch shaft or piston sealing rings.	**d.** Replace clutch shaft or sealing rings, as applicable.
	e. Clutch piston bleed valve stuck open.	**e.** Clean bleed valves thoroughly.
2. Low converter charging pump pressure.	**a.** Low oil level.	**a.** Fill to proper level. Refer to *Maintenance and Lubrication*, page 9-1
	b. Suction screen plugged.	**b.** Clean suction screen.
	c. Defective oil pump.	**c.** Replace pump.
3. Overheating.	**a.** Worn oil sealing rings.	**a.** Remove, disassemble, and rebuild converter assembly.
	b. Worn oil pump.	**b.** Replace pump.
	c. Low oil level.	**c.** Fill to proper level.
4. Noisy converter.	**a.** Worn oil pump.	**a.** Replace pump.
	b. Worn or damaged bearings.	**b.** A complete disassembly will be necessary to determine what bearing is faulty.
5. Lack of power.	**a.** Low engine RPM at converter stall.	**a.** Tune engine and check governor.
	b. See “Overheating” and make same checks.	**b.** Make corrections as explained in “Overheating.”

7

Removal

1. Extend and set outriggers just enough to take up the slack in the outrigger pads. Chock the wheels.
2. Position the boom over the side and stop the engine.
3. Remove the engine and transmission/torque converter from the crane as an assembly. Refer to *Engine Removal*, page 7-2.
4. Remove the two-section and single section hydraulic pumps from the transmission/torque converter. Cover all openings. Refer to in *Hydraulic Pumps*, page 2-18 for removal of the pump.

NOTE: The transmission/torque converter weighs approximately 438 kg (966 lb) dry.

5. Attach an adequate lifting device to the transmission/ torque converter and take up any slack.
6. Remove the capscrews and hardened flat washers securing the drive plate assembly to the flywheel.
7. Remove the nuts and washers securing the transmission/torque converter housing to the engine flywheel housing.

Installation

NOTE: The transmission/torque converter assembly weighs approximately 438 kg (966 lb) dry.

1. If a new transmission/torque converter is to be installed, remove all fittings and brackets from the old one and install them in the same locations on the new transmission/torque converter.
2. Install the two variable displacement pumps and the gear pump on the transmission/torque converter. Refer to *Hydraulic Pumps*, page 2-18 for installation of the hydraulic pump.
3. Position the transmission/torque converter to the engine with the lifting device.
4. Remove all burrs from the flywheel mounting face and nose pilot bore. Clean the drive plate surface with solvent.

NOTE: Refer to Figure 7-18.

5. Check the engine flywheel and housing for conformance to standard S.A.E. No. 3/S.A.E. J-927 tolerance specifications for bore size, pilot bore runout and mounting face flatness. Measure and record engine crankshaft end play.
6. Install the 12 studs in the engine flywheel housing. Rotate the engine flywheel to align a drive plate mounting screw hole with the flywheel housing front access hole.
7. Install a 101.6 mm (4.00 in) long drive plate locating stud 3/8-24 UNF in a drive plate nut.
8. Rotate transmission/torque converter to align locating stud in the drive plate with flywheel drive plate mounting screw hole positioned in step 6. Locate the transmission on the flywheel housing, aligning the drive plate to the flywheel and the transmission on the flywheel housing mounting studs. Install the transmission to flywheel housing nuts and washers. Tighten the nuts to 41 Nm (30 lb-ft).
9. Remove drive plate locating stud. Install one drive plate attaching capscrew and lockwasher. Snug capscrew but ***do not tighten***.

NOTE: Some engine flywheel housings have a hole located on the flywheel housing circumference in line with the drive plate screw access hole. A screwdriver or pry bar used to hold the drive plate against the flywheel will facilitate installation of the drive plate capscrews.

10. Rotate engine flywheel and install the remaining seven flywheel to drive plate attaching capscrews and hardened flat washers. Snug the capscrews but ***do not tighten***. After all eight capscrews and hardened flat washers have been installed, torque the capscrews to 38 Nm (28 lb-ft). This will require torquing each capscrew, then rotating the engine flywheel until all capscrews have been torqued.
11. Measure the engine crankshaft end play after the transmission/torque converter has been completely installed on the engine flywheel. This value must be within 0.025 mm (0.001 in) of the end play recorded in step 5.
12. Install the engine and transmission/torque converter in the crane as an assembly. Refer to *Engine*, page 7-1.
13. Service the crane as outlined under *Servicing the Crane after Transmission/torque Converter Overhaul*, page 7-30.
14. Cycle all functions and observe for proper operation.

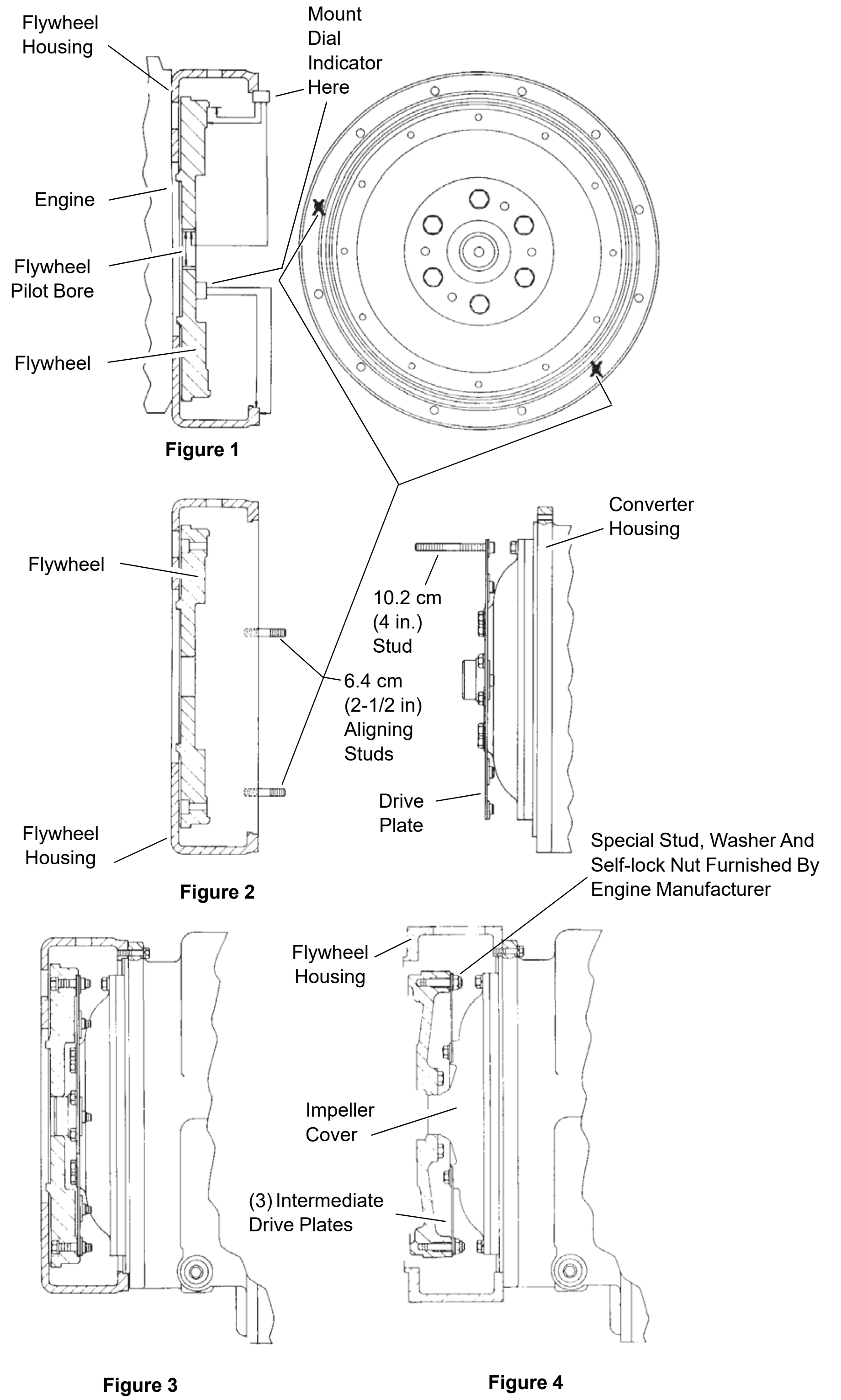


FIGURE 7-18

15.

Servicing the Crane after Transmission/torque Converter Overhaul

The transmission/torque converter and its allied hydraulic system are important links in the drive line between the engine and the wheels. The proper operation of either the unit or the system depends greatly on the condition and operation of the other; therefore, whenever repair or overhaul of the transmission/torque converter is performed, the balance of the system must be considered before the job can be considered completed.

After the overhauled or repaired transmission/torque converter has been installed in the crane, the oil cooler and connecting hydraulic system must be thoroughly cleaned. This can be accomplished in several ways, and a degree of good judgment must be exercised as to the method employed.

The following are considered the minimum steps to be taken:

1. Drain the entire system thoroughly.
2. Disconnect and clean all hydraulic lines. Where feasible, hydraulic lines should be removed from the machine for cleaning.
3. Replace oil filter elements, cleaning out the filter cases thoroughly.
4. The oil cooler must be thoroughly cleaned. The cooler should be back flushed with oil and compressed air until all foreign material has been removed. Flushing in the direction of normal oil flow will not adequately clean the cooler. If necessary, the cooler assembly should be removed for cleaning, using oil, compressed air and a steam cleaner for that purpose.

CAUTION

Do not use flushing compounds for cleaning purposes.

5. Remove the drain plug from the transmission/torque converter and inspect the interior of the unit housing, gears, etc. If the presence of considerable foreign material is noted, it will be necessary for the unit to be removed, disassembled, and cleaned thoroughly. It is realized this entails extra labor, however, such labor is a minor cost compared to the cost of difficulties which can result from the presence of such foreign material in the system.
6. Assemble all components and use only the type oil recommended. Fill the transmission through the fill pipe until fluid is at the top of the fill range on the dipstick. Run the engine for two minutes at idle (1200 rpm) to prime the torque converter and hydraulic lines. Recheck the level of oil in the transmission with the engine running at idle (1200 rpm). Add oil as necessary to bring the level to the LOW mark on the dipstick. After the oil temperature reaches 82°C to 93°C (180°F to 200°F), add oil to bring the level to the FULL mark on the dipstick.
7. Recheck all drain plugs, lines, connections, etc., for leaks and tighten where necessary.

Lubrication

Type of Oil and Capacities

Refer to *Maintenance and Lubrication*, page 9-1 for types of oil and capacities.

Normal Drain Period

NOTE: Normal drain periods and filter change intervals are for average environmental and duty-cycle conditions. Severe or sustained high operating temperatures or very dusty atmospheric conditions will cause accelerated deterioration and contamination. For extreme conditions, judgment must be used to determine the required change intervals.

NOTE: It is recommended that filter elements be changed after 50 and 100 hours of operation on new and rebuilt or repaired units, then at normal intervals thereafter. Refer to *Maintenance and Lubrication*, page 9-1.

a. Drain transmission and remove pump screen. Clean screen thoroughly and replace, using a new gasket.
b. Remove and discard oil filter. Clean filter housing and install new filter.
c. Refill transmission to LOW mark.
d. Run engine at 1200 rpm to prime converter and lines.
e. Recheck level with engine running at 1200 rpm and add oil to bring level to LOW mark. When oil temperature is hot [82°C to 93°C (180°F to 200°F)], make final oil level check. Bring oil level to full mark.

Towing or Pushing

Before towing crane, disconnect both front and rear drive lines. Engine can not be started by pushing or towing because of hydraulic system design.

SECTION 8
UNDERCARRIAGE

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AXLES

Description

To provide maximum maneuverability, both the front and rear axles are steerable. The rear axle is mounted on a pivoting cradle (fifth wheel) which allows the axle to oscillate while traversing uneven terrain. The front axle is bolted directly to the frame. All four wheels utilize a disc type hydraulic braking system. A disc-type parking brake is mounted of the front axle input shaft.

Each axle incorporates a single reduction carrier with hypoid gearing mounted in the axle center. The final reduction is of planetary design spur gearing built into the wheel hubs.

The design of these axles permits the hypoid gearing of the differential carrier and the axle shafts to carry only a nominal torsional load while at the same time providing the highest practical numerical gear reduction at the wheels.

The hypoid pinion and differential assembly of the first reduction are supported by tapered roller bearings. The pinion bearing preload is adjusted and maintained by a hardened precision spacer between the inner and outer bearing. The differential tapered bearing preload is adjusted and maintained by the positioning of the threaded adjusting rings in the carrier leg and cap bores.

In the planetary wheel ends, the spur teeth of the sun gear mesh with teeth of the planet spur gears. The planet spur gears rotate on planet pins which are mounted in a spider. The planet spur gear teeth in turn mesh with teeth of the floating ring gear.

Power is transmitted by the hypoid gear set in the differential carrier to the axle shafts and the sun gear of the final reduction, through the revolving planet gears, and into the planetary spider which drives the wheel hub.

As an option, the front axle and rear axle may be provided with a differential lock. When in the locked mode, the axle shafts and the differential are locked together and there is no differential action between the wheels.

Maintenance

NOTE: The axles do not have to be removed from the crane to remove the planetary wheel ends or the drive units.

8

Removal

1. Using the outriggers, raise the wheels off the ground.
2. Install blocking under the frame at the outboard ends of the four outrigger boxes.

CAUTION

Do not disassemble drive lines when removing them from the crane. Dirt can enter the spline and cannot be purged. In addition, the drive lines are assembled in a specific orientation when manufactured and can easily be incorrectly reassembled.

---

3. Disconnect and remove the drive line from the applicable axle. Do not disassemble the drive lines. Refer to *Drive Shafts*, page 7-25.
4. Tag, disconnect, and cap the hydraulic brake line at each wheel.
5. Tag, disconnect, and cap the hydraulic lines to the steer cylinders.
6. On the front axle only, tag and disconnect the hydraulic line from the park brake actuator.
7. On the left side of the rear axle only, tag and disconnect the electrical wires from the rear wheels not centered switch.

NOTE: Each tire and wheel installation weighs approximately 749 kg (1651 lb).

8. Remove the wheels from the axle.

NOTE: Each axle weighs approximately 1735 kg (3825 lb).

9. Position jacks, which are capable of handling the weight of the axle, under the axle for support.
10. Remove the eight nuts, washers, bushings and bolts securing the axle to the frame/cradle.
11. Lower the axle to the ground and move it to a clean working area.
12. If a new axle is to be installed, remove the following from the old axle and install them on the new one.
    a. The steer cylinders.
    b. The rear wheels not centered switch actuator bracket (rear axle only).
    c. The parking brake actuator (front axle only). Refer to *Brake System*, page 8-12 in this section.

Cleaning

Completely assembled axles may be steam cleaned on the outside only, to facilitate initial removal and disassembly, providing all openings are closed. Breathers, vented shift units, and all other openings should be tightly covered or closed to prevent the possibility of water entering the assembly.

Installation

1. If a new axle is to be installed, remove the following from the old axle and install them on the new one.
    a. The steer cylinders.
    b. The rear wheels not centered switch actuator bracket (rear axle only).
    c. The parking brake actuator (front axle only). Refer to *Brake System*, page 8-12 in this section.
2. Position the axle under the crane on jacks which are capable of handling the weight of the axle.
3. Raise the axle into place and secure with the eight attaching bolts, washers, bushings and nuts. Torque bolts - refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
4. Install the wheels onto the axle. Refer to *Wheels And Tires*, page 8-4 in this section.
5. Connect the hydraulic lines to the steer cylinder as tagged during removal.
6. Connect the hydraulic brake line to each wheel as marked during removal.
7. On the front axle only, connect the hydraulic line to the parking brake actuator.
8. On the left side of the rear axle only, connect the electrical wires to the rear wheels not centered switch. Adjust the switch as outlined under, *Rear Steer Indicator Adjustment Procedure*, page 8-3.
9. Connect the drive line to the applicable axle. Refer to *Drive Shafts*, page 7-25.
10. Refer to *Brake System*, page 8-12 and bleed the hydraulic brake system.
11. Remove the blocking under the frame and retract the outriggers to lower the wheels to the ground.

Wheel Alignment Check Procedure

1. Check the axle for wheel alignment. The wheels are to be straight ahead with no toe-in or toe-out. Adjust if necessary by turning the tie rod ends in the direction necessary.
2. Check pre-set axle stop as follows:
    a. Turn the wheels to the extreme left.
    b. Check the clearance between the inside of the tire and the nearest object.

c. Clearance should be 25.4 mm (1.00 in) minimum, If necessary, adjust the axle stop to provide clearance.

3. Turn axle to extreme right and repeat step 2.
4. With the axles set at a 25.4 mm (1.00 in) clearance, check the steer cylinders to see that they are not bottomed out. To check the steer cylinders, remove the pin at the rod end and apply pressure to move the cylinder rod. The cylinder rod should travel a minimum of 3.0 mm (0.12 in).

Rear Steer Indicator Adjustment Procedure

1. Ensure the wheels are straight ahead.

NOTE: When performing rear steer indicator adjustment using the following steps, refer to Figure 8-1.

2. Slide the proximity switch through hole in rear steer sensor bracket and loosely secure with nuts and washers.
3. Set face of proximity switch 4 mm to 6 mm (0.16 in to 0.24 in) from opening in rear steer sensor plate. Tighten the fasteners.
4. Turn the rear wheels to verify proper operation. Rear Wheels Not Centered Light in Operator Display Module (ODM) should not be on when rear wheels are centered and the sensor switch is centered in the slot of the sensor plate.

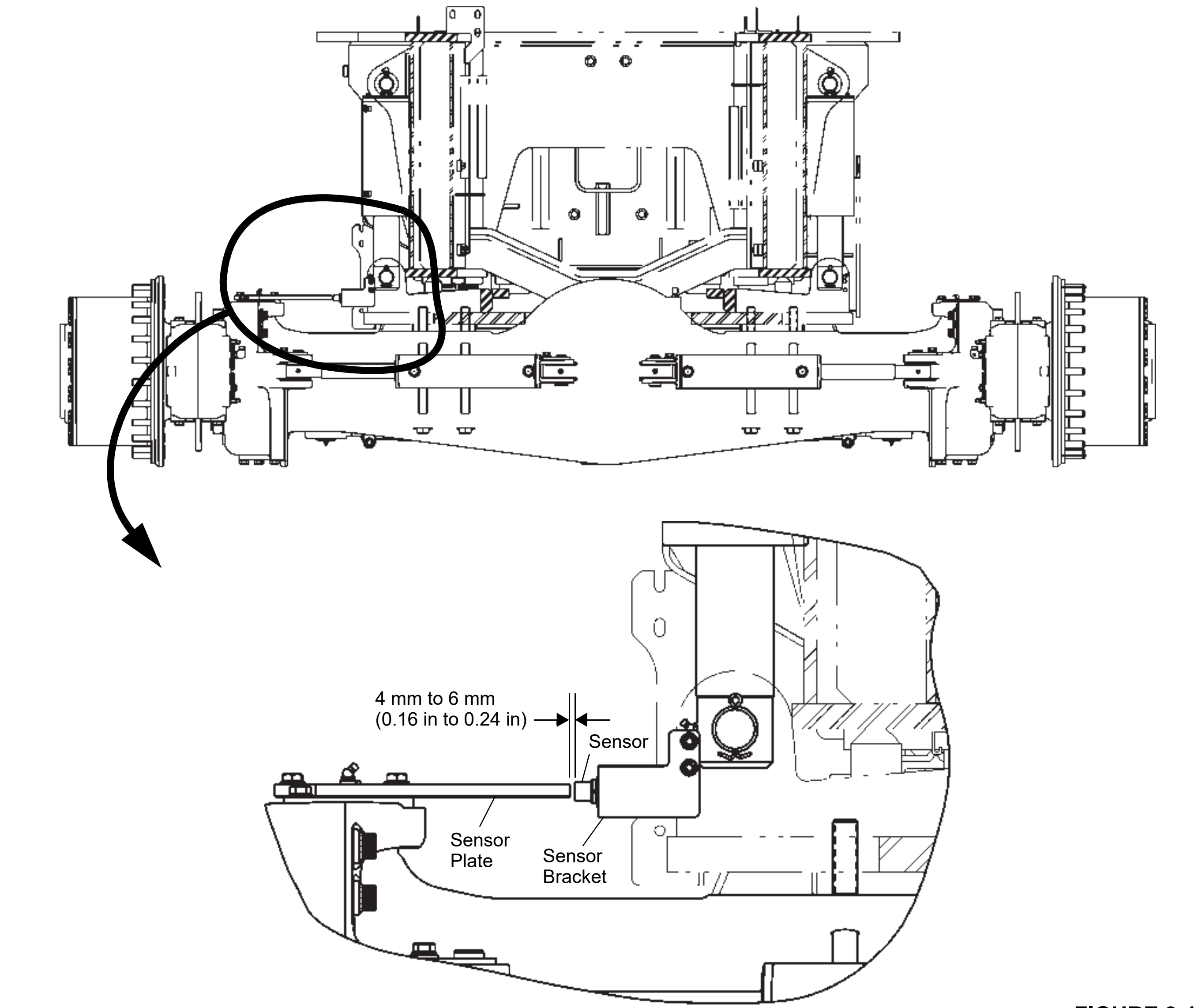


FIGURE 8-1

8

Wheels And Tires

Description

The standard tire size for this unit is 29.5 x 25.

WARNING

Possible equipment damage and/or personal injury!

Driving the crane with a tire under inflated at 80% or less of its recommended pressure can cause the wheel and/or tire to fail. Per OSHA Standard 1910.177(f)(2), when a tire has been driven under inflated at 80% or less of its recommended pressure, it must first be completely deflated, removed from the axle, disassembled, and inspected before re-inflation.

CAUTION

Do not mix tires or rims from different manufacturers. Vehicle stability can be affected.

Each wheel assembly (tire and rim) is mounted on the planetary hub with 24 grade 8 lug nuts.

NOTE: The tire diameters, widths, and weights may vary slightly depending on the tire manufacturer.

Off-highway tires are designed to operate with a certain sidewall deflection or bulge. Correct air pressure ensures prior deflection which, in turn, ensures proper traction, flotation, support of load, and prevents excessive flexing of the tire. Over inflation increases rim stresses, which results in lowered rim life.

Refer to and adhere to the inflation pressures in the Load Chart Book in the crane cab.

Maintenance

DANGER

Do not attempt to demount or mount tires without proper training. The high pressures involved can cause tire and rim parts and tools to fly with explosive force, if proper procedures are not used, causing severe injury or death to personnel and damage to the crane and surrounding area.

Mounting Wheel Assemblies

NOTE: Do not lubricate the wheel studs or lug nuts.

1. Raise the crane on outriggers so the wheels are off the ground.

NOTE: Prior to wheel installation remove any dirt or grease from wheel mounting surfaces.

2. Position the wheel assembly on the mounting studs. Install the lug nuts and tighten them to 70 Nm (50 lb-ft) in the sequence shown in Figure 8-2.
3. Ensure the wheel assembly is positioned properly on the hub.

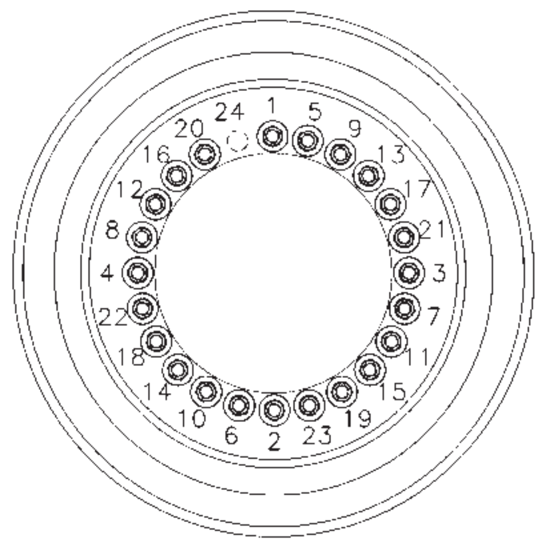


FIGURE 8-2

4. Continue to torque the lug nuts 407 Nm to 475 Nm (300 lb-ft to 350 lb-ft) in the sequence shown in Figure 8-2.
5. Lower the crane onto its tires. Retract and stow the outrigger assemblies and the floats.
6. Retorque lug nuts after approximately one hour of travel.

Typical Wear Patterns

Incorrect Tire Pressure

Too high air pressure Figure 8-3, View 1) gives rapid wear in the middle of the tire. Too low air pressure (Figure 8-3, View 2) gives rapid shoulder wear.

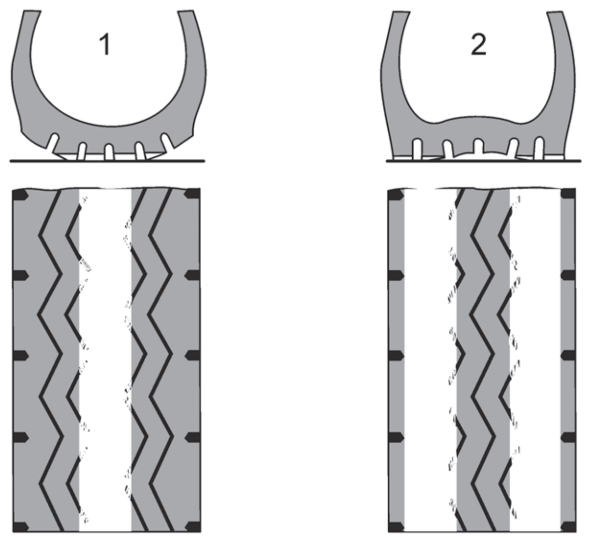


FIGURE 8-3

Incorrect Camber

Incorrect camber gives abnormal wear on one half of the tire.

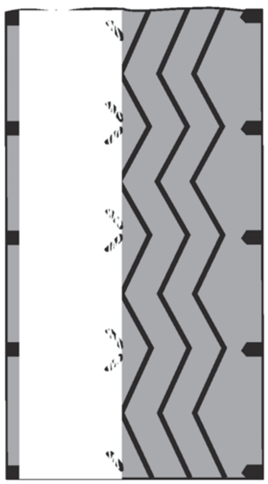


FIGURE 8-4

Incorrect Toe and Axle Alignment

Incorrect toe has a “scrubbing” effect on the front wheels that shows in rapid shoulder wear or across the tire.

Incorrect axle alignment has a “scrubbing” effect on all wheels.

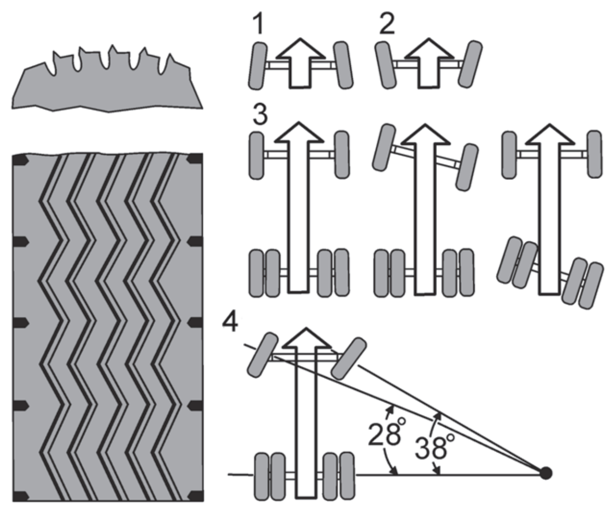


FIGURE 8-5

Item	Description
1	Incorrect Toe-In
2	Incorrect Toe-Out
3	Out-of-line Axles
4	Steering Arm Defect

Incorrect Caster and Wheel Imbalance

Incorrect caster or wheel imbalance shows as spot wear that is either in the middle of the tire or extends to the shoulder.

This rapidly wears the mechanical parts of steering linkage, kingpin and wheel bearing.

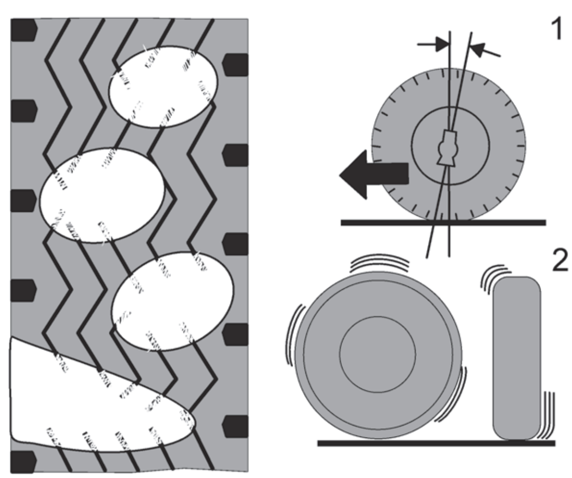


FIGURE 8-6

8

Cuts in the Tire Tread

Cuts are due to poor roads, air pressure too high or incorrect tire type for the application.

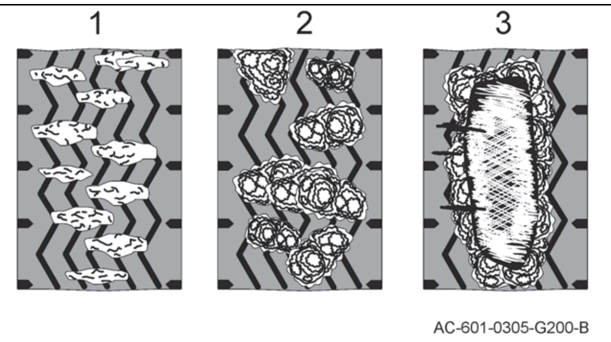


FIGURE 8-7

Item	Description
1	Cuts
2	Flaking Cuts
3	Rubber Flaking

Spot Wear

Sudden braking, locking brakes or out-of-round brake drums give spot wear.

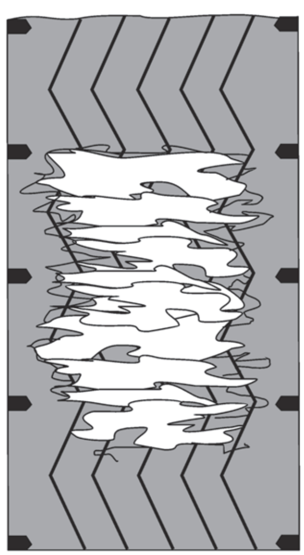


FIGURE 8-8

Feathered Edges

Normal occurrence on non-driving wheels on good roads and high mileage.

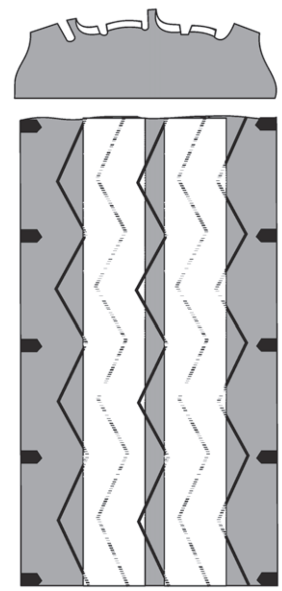


FIGURE 8-9

Cupping

Cupping is a normal occurrence that depends on the tread pattern - the higher the load, the greater the wear.

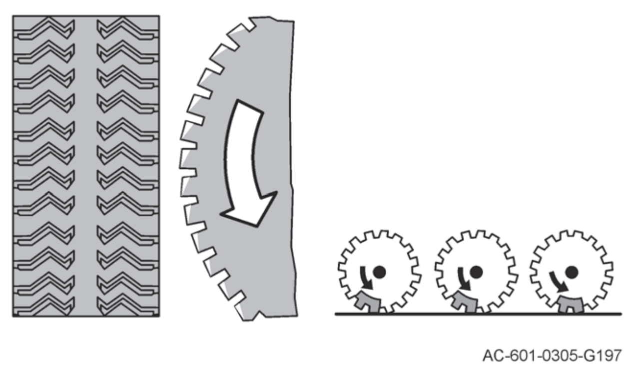


FIGURE 8-10

STEERING SYSTEMS

Description

To maximize maneuverability, the crane can be steered by the front axle, the rear axle, or by the front and rear axles simultaneously. The crane utilizes two separate steering systems, one to control front axle steering and one for rear axle steering.

Front Steering System

The front steering system consists of a load sense steer priority flow valve (part of the accessory manifold valve), load sense steering control valve, and two steer cylinders. Refer to *Accessory Manifold Valve*, page 2-56 for a description of the front steer hydraulic components, their function, and maintenance information.

Rear Steering System

The rear steering system consists of a three-position, dual solenoid controlled directional valve; two cross-port check valves; and two steer cylinders. Refer to *Carrier Combination Manifold Valve*, page 2-61 for a description of the rear steer hydraulic components, their function, and maintenance information. A rear steer indicator system is provided to indicate when the rear wheels are not centered. This system consists of an indicator light located on the front console in the cab and a switch located on the left side of the rear axle. When the rear wheels are turned to the left or right, the amber indicator light will illuminate.

Secondary Steering System (CE Units)

The secondary steering system is provided to back up the normal front steering system if loss of hydraulic flow occurs due to pump or engine failure. The system consists of two hydraulic accumulators; a pilot-operated, two-position control valve; one check valve; and a pressure switch, which receive hydraulic oil flow from the service brake dual-accumulator charge valve to supplement the normal front steer circuit.

Maintenance

Front Steering System

Troubleshooting

Table 8-1

Symptom	Probable Cause	Solution
1. Hard to steer left and right.	**a.** Hydraulic oil low.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Clogged or loose hydraulic lines or fittings.	**b.** Clean or tighten lines or fittings.
	c. Defective flow divider valve(s).	**c.** Repair or replace valve(s).
	d. Defective steering control valve.	**d.** Repair or replace valve.
	e. Defective hydraulic pump.	**e.** Repair or replace pump.
2. Hard to steer either left or right.	**a.** Clogged or loose hydraulic lines or fittings.	**a.** Clean or tighten lines or fittings.
	b. Defective steer cylinder.	**b.** Repair or replace cylinder.
3. Steering is erratic left and right.	**a.** Hydraulic oil low.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Clogged or loose hydraulic lines or fittings.	**b.** Clean or tighten lines or fittings.
	c. Defective steering control valve.	**c.** Repair or replace valve.
	d. Defective hydraulic pump.	**d.** Repair or replace pump.

Symptom	Probable Cause	Solution
4. Noisy hydraulic pump caused by cavitation.	**a.** Hydraulic oil low.	**a.** Refill hydraulic reservoir. Refer to *Maintenance and Lubrication*, page 9-1.
	b. Suction line plugged or too small.	**b.** Clean line and check for size.
5. Hydraulic pump shaft seal leakage.	**a.** Worn shaft seal. **NOTE:** If replacing the shaft seal does not stop leakage, the pump should be disassembled and checked for the following:	**a.** Replace shaft seal.
	b. Broken diaphragm seal or backup gasket.	**b.** Replace seal or gasket. Refer to your Manitowoc Crane Care Parts Manual.
	c. Bearing out of position.	**c.** Replace bearing.
	d. Excessive internal wear.	**d.** Replace pump.

Functional Check

A normal periodic functional check of the entire steering system will generally be adequate to ensure satisfactory service.

1. Check all fittings for leakage. An accumulation of moist, black dirt is a good indication of leakage.
2. With the engine running at idle and at full throttle, and with the machine standing still and moving, turn the steering wheel through the full range of travel. Note any speed irregularities and sticky sensation. This may indicate dirt in the fluid. If the steering wheel continues to rotate when started and released, a condition known as Motoring exists. This may also indicate dirty fluid in the system.
3. Ensure the system has adequate power. If there is an indication of hard steering, this can be caused by either a reduced oil flow to the control valve or a reduced system relief pressure. Adequate oil flow under all conditions can best be checked by timing the full travel of the cylinder with the steered axle unloaded and loaded. If there is a great difference at low engine speed and slight difference at high engine speeds this may indicate a defective pump drive. Refer to *Checking/ Setting the Front Steer Pressure*, page 2-34.

Secondary Steering System (CE Units) Maintenance

Refer to *Hydraulic System*, page 2-1 for checking accumulator pre-charge pressure and for pre-charging accumulator using the steering control valve to discharge the accumulator pressure.

Front Steering Control Valve

The steering control valve is located under the dash and is actuated by a conventional steering wheel and steering column, providing precise, full hydraulic steering. Precise steering is accomplished by a metering system within the valve that is directly connected to the steering column and wheel.

Removal

1. Thoroughly clean the steering control valve and the surrounding area before removing the hydraulic hoses from the valve.
2. Tag and disconnect the five hydraulic hoses from the steering control valve. Cap or plug each hose and the five ports of the valve.
3. Remove the capscrews, lockwashers, and flatwashers securing the valve to the bracket and the steering column. Remove the control valve, leaving the steering column in the cab.

Installation

1. Position the control valve to the bracket and steering column and install the flatwashers, lockwashers, and capscrews. Torque capscrews; refer to *Fasteners and Torque Values*, page 1-17 for proper torque.
2. Connect the hydraulic hoses to the control valve as tagged during removal.
3. Start the engine and check for proper operation and any leakage.

Rear Steering System

Troubleshooting

Table 8-2

Symptom	Probable Cause	Solution
1. Rear steering inoperative.	**a.** Hydraulic oil low.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Clogged, broken, or loose hydraulic lines or fittings.	**b.** Clean, tighten, or replace lines or fittings.
	c. Steer cylinder locked.	**c.** Repair or replace cylinders.
	d. Defective control valve.	**d.** Repair or replace valve.
	e. Defective steer cylinder(s).	**e.** Repair or replace cylinder(s).
	f. Lack of electrical signal	**f.** Check electrical connections/wiring
2. Hard to steer left and right.	**a.** Hydraulic oil low.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Clogged or loose hydraulic lines or fittings.	**b.** Clean or tighten lines or fittings.
	c. Defective steering control valve.	**c.** Repair or replace valve.
	d. Defective hydraulic pump.	**d.** Repair or replace pump.
	e. Clogged or loose hydraulic lines or fittings.	**e.** Clean or tighten lines or fittings.
	f. Defective steer cylinder.	**f.** Repair or replace cylinder.
	g. Damaged relief.	**g.** Replace relief valve.
3. Steering is erratic left and right.	**a.** Hydraulic oil low.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Clogged or loose hydraulic lines or fittings.	**b.** Clean or tighten lines or fittings.
	c. Defective steering control valve.	**c.** Repair or replace valve.
	d. Defective hydraulic pump.	**d.** Repair or replace pump.

Steer Cylinders

The steer cylinders are mounted on the axles, two cylinders on each axle. The barrel end of each cylinder is attached to a bracket on the axle housing and the rod end is attached to the steering lug on the axle end. The cylinders are controlled hydraulically by the steering control valve.

Removal

1. Tag and disconnect the hydraulic lines from the steer cylinder. Cap or plug all openings.
2. Remove the capscrew, flatwasher, and lockwasher securing each pin weld in the rod end and barrel end of the cylinder.

NOTE: Steer cylinder weighs approximately 20 kg (44 lb).

3. Remove both pin welds and two thrust washers (rod end only), and remove the cylinder from the axle.

Installation

1. Position the cylinder onto the attachment fittings on the axle and install both pin welds. On the rod end, install a thrust washer top an bottom of lug.
2. Secure each pin weld with the capscrew, flatwasher, and lockwasher. Torque capscrews - refer to *Fasteners and Torque Values*, page 1-17 for proper torque value.
3. Connect the hydraulic lines to the cylinder as tagged during removal.
4. Operate the steering system and check the cylinder for proper operation and any leakage.

REAR AXLE OSCILLATION LOCKOUT SYSTEM

Description

The rear axle oscillation system Figure 8-11 and Figure 8-12 consists of two lockout cylinders, a lockout valve, and an angle encoder. The lockout cylinders are mounted between a cradle (fifth wheel) and the carrier frame. The lockout valve is mounted on the left inner center frame rail and hydraulically controls the oscillating abilities of the lockout cylinders. The angle encoder is located in the electrical swivel assembly.

Theory Of Operation

The rear axle is mounted on a cradle (fifth wheel) allowing maximum oscillation of 25.4 cm (10 in) total while traveling over uneven terrain. Oscillation is provided only when the superstructure is within 3° left or right of directly over the front. When the superstructure is within 3° left or right of directly over the front, the RCL sends a CAN bus message to the Crane Control System to allow axle oscillation. When the Crane Control System receives this message it switches ON a digital output thus energizing the axle oscillation solenoids. When the solenoids are energized, the valve spools are shifted to allow hydraulic transfer between the two lockout cylinders. As one side of the axle is forced up by traveling over uneven terrain, the hydraulic oil flows from the rod end of cylinder A to the barrel end of cylinder B and from the rod end of cylinder B to the barrel end of cylinder A. The system is not pressurized and oil is moved from one cylinder to the other by the action of the axle moving the cylinder.

When the superstructure is more than 3° left or right of directly over the front, the Crane Control System switches OFF the digital output thus de-energizing the axle oscillation solenoids. This de-energizes the solenoids on the lockout valve and allows the springs in the valve to shift the valve spools to the closed position to prevent hydraulic oil flow between the cylinders. By stopping the flow of oil, a hydraulic lock is created and the axle is held rigid in that position.

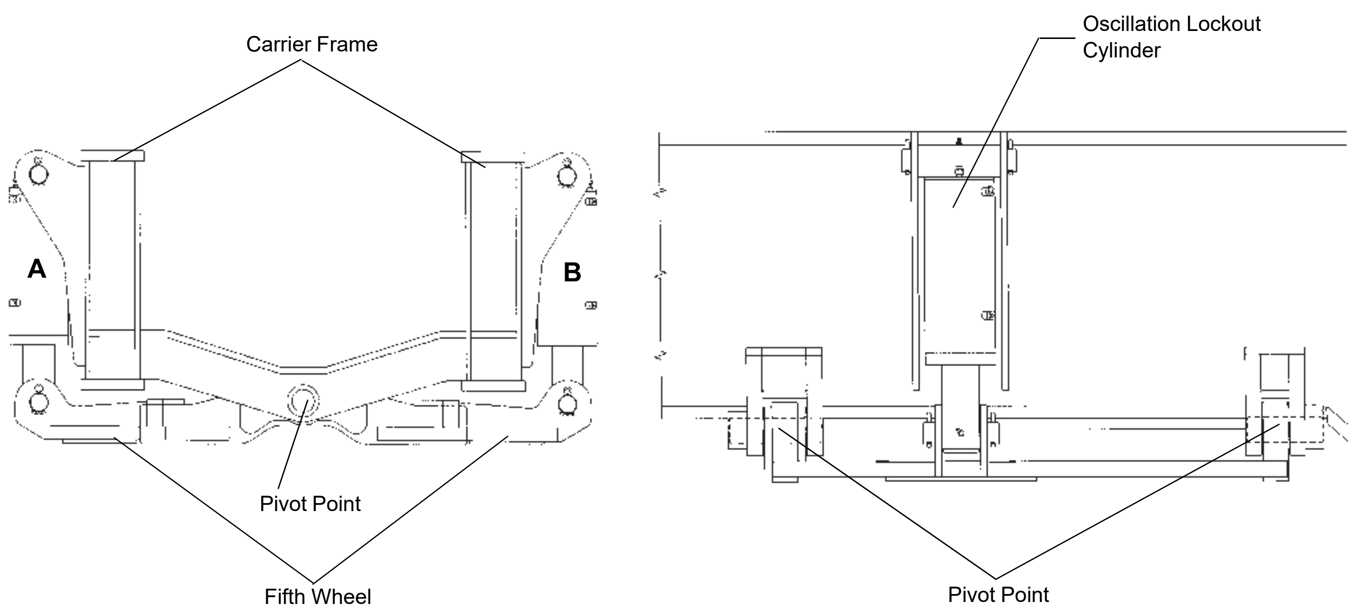
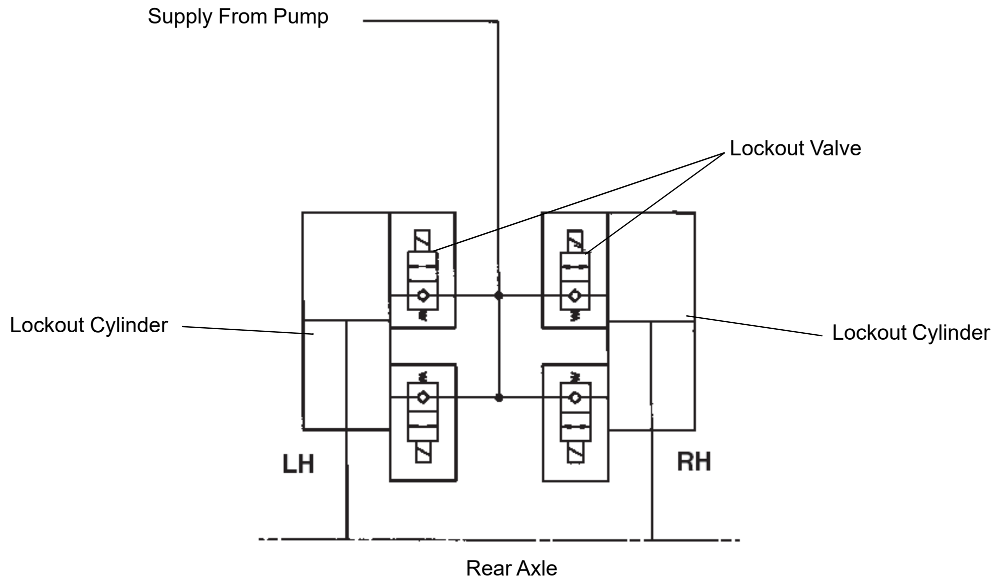


FIGURE 8-11


Supply From Pump
Lockout Valve
Lockout Cylinder
Lockout Cylinder
LH
RH
Rear Axle
FIGURE 8-12

Axle Oscillation Lockout Cylinders

Description

Two hydraulic lockout cylinders are installed on the rear axle, one left side and one right side. The base end of each cylinder is attached to each side of the carrier frame and the rod ends are attached to each side of the cradle (fifth wheel). The lockout cylinders are connected hydraulically so that hydraulic oil flows from the rod side of the left cylinder to the barrel side of the right cylinder and from the rod side of the right cylinder to the barrel side of the left cylinder.

Each cylinder weighs approximately 38.8 kg (85.5 lb).

Removal

1. Raise the crane up on outriggers.
2. Rotate the turntable more than 3° in either direction from directly over the front to lock out the oscillation cylinders.
3. Remove the wheel and tire assembly from the axle.
4. Tag and disconnect both hydraulic hoses from the ports on the cylinder. Cap or plug both hoses and the ports on the cylinder.
5. At the rod end of the cylinder, remove one of the cotter pins securing the retaining pin to the cradle attach fitting.
6. Tap out the retaining pin, freeing the rod end from the cradle.
7. At the barrel end of the cylinder, remove one of the cotter pins securing the retaining pin to the frame attach fitting.
8. Tap out the retaining pin and remove the cylinder.

Installation

1. Position the barrel end of the cylinder in the frame attach fitting and tap in the retaining pin.
2. Secure the retaining pin with the cotter pin.
3. Align the rod end of the cylinder in the cradle attach fitting and tap in the retaining pin.
4. Secure the retaining pin with the cotter pin.
5. Remove the caps or plugs from the two hydraulic hoses and the cylinder ports and connect the hoses to the appropriate cylinder ports as tagged during removal.
6. Install the wheel and tire assembly on the axle. Tighten the lug nuts. Refer to *Wheels And Tires*, page 8-4.
7. Lubricate both ends of the cylinder using the fittings provided.
8. Function test the axle oscillation system in accordance with the Operator's Manual to ensure proper operation.

Axle Oscillation Lockout Valve

Description

The axle oscillation lockout valve (also called the double solenoid valve), located on the carrier combination manifold valve, is used in the rear axle oscillation lockout circuit. The valve is mounted on the left rear face of the carrier frame rear cross member forward of the rear axle. It consists of a valve body and two normally-closed, two-way, two-position solenoid valves. It keeps the lockout cylinders from oscillating unless the turntable is centered forward.

For the CE Units with Dual Axis Controllers, the axle oscillating lockout valve is replaced with four two way solenoid operated poppet cartridge valves installed in the ports of the lockout cylinders.

The angle encoder located in the top of the electrical slip ring assembly sends a CAN bus message to the RCL. The RCL converts the data in the message to a position angle of the superstructure relative to the carrier (slew angle). If the slew angle is ±3° of directly over the front, the RCL sends a CAN bus message to the Crane Control System to allow axle oscillation. When the Crane Control System receives this message it switches ON a digital output thus energizing the axle oscillation solenoids. If the angle is more than 3° left or 3° right of directly over the front, the Crane Control System switches OFF the digital output thus de-energizing the axle oscillation solenoids.

When the axle oscillation normally closed solenoid valves are de-energized the lockout cylinders are isolated from hydraulic oil supply. This keeps the cylinders from oscillating (moving up and down to damp axle movement) because hydraulic oil cannot leave the cylinders. Instead, the cylinders remain full of hydraulic oil and more rigid.

When the axle oscillation solenoid valves are energized and open, hydraulic oil is allowed in and out of the cylinders, allowing them to oscillate.

BRAKE SYSTEM

Description

The brake system includes all the components necessary for the application of the service brakes and the parking brake.

Service Brakes

The service brakes are full power hydraulic brakes which are hydraulically controlled and are used to apply the brake assemblies on all four wheels. The system consists of the tandem brake valve with treadle pedal, the dual accumulator charge valve, two hydraulic accumulators, the brake assemblies, and all the associated hoses and tubing. The operator depresses the pedal on the tandem brake valve, located on the cab floor, and the valve modulates the brake line pressure to the brake assemblies at each wheel. The full powered brake system supplies a high brake system pressure with relatively low reactive pedal forces, while controlling the maximum brake line pressure. The service brake dual accumulator charge valve regulates flow to the hydraulic accumulators to provide fully powered independently separate, primary (front) and secondary (rear), service brake circuits. Hydraulic pressure is constantly maintained in the brake circuits by the accumulators and the charging valve. The brake assemblies are disc type brakes.

Parking Brake

The parking brake is a hydraulically-controlled, disc-type brake, located on the front axle. It is spring applied and hydraulically released. The system consists of a two-position switch, a three-way solenoid valve, actuator, brake assembly, and all the associated hardware and tubing. The selector switch, located on the steering column in the cab, is used to activate the solenoid valve which controls the park brake actuator, which applies and releases the park brake.

NOTE: For Description and Maintenance of the tandem brake valve with treadle pedal, the accumulators, and the dual accumulator charge valve, refer to *Valves*, page 2-42.

Theory Of Operation

Service Brakes

Braking begins when the operator depresses the brake pedal in the cab. Mechanical linkage transfers the force created by the lever action of the brake pedal to the hydraulic brake valve which modulates the brake line pressure to the brake assemblies at each wheel.

Hydraulic oil is supplied to the dual accumulator charge valve by the accessory manifold valve. The dual accumulator charge valve charges the accumulators from the open center circuit upon demand and within its present operating charge rate and the high limit pressure setting. However, when the open center circuit pressure reaches the brake relief setting, which is higher than the high accumulator charge limit, then the accumulators will be charged to the relief valve setting. The dual accumulator charge valve regulates flow to the hydraulic accumulators to provide fully powered independently separate, primary (front) and secondary (rear), service brake circuits. Hydraulic pressure is constantly maintained in the brake circuits by the accumulators and the charging valve. The charged accumulators supply pressurized fluid to the closed tandem brake valve.

Once the operator depresses the brake pedal, the tandem brake valve modulates fluid out to the brakes to provide the means of braking. The tandem brake valve will modulate the pressure in the brake system by increasing or decreasing pressure as required in proportion to the input force from the operator via the brake pedal. The hydraulic force acts within the brake assemblies to force the brake pads against the brake discs, acting to slow wheel rotation. Fully powered separate primary (front) and secondary (rear) braking circuits are provided with independent accumulators. A low pressure warning switch is used to sense the accumulator pressures and warn the operator through visual brake warning indicator light on the cab console in the event the pressure in the accumulators drops to an unsafe operating level. In the event of engine failure, the accumulators are pre-charged with dry nitrogen gas and properly sized to provide power-off stopping capacity for secondary braking.

Parking Brake

Hydraulic flow from the transmission charge pump is routed to the parking brake control valve. When the Park Brake Switch is in the ON position, the parking brake solenoid valve shifts to route flow from the hydraulic parking brake actuator back to the transmission sump. The actuator spring pulls on the lever on the brake assembly, applying the parking brake.

8

Maintenance

Troubleshooting

Table 8-3

Symptom	Probable Cause	Solution
1. Brakes are poor.	**a.** Lining thickness less than 0.125 in (3 mm).	**a.** Replace lining.
	b. Brake pedal operation.	**b.** Free mechanical linkage.
	c. Restriction or leaks in lines.	**c.** Check all lines for leaks and restrictions.
	d. Low hydraulic oil flow.	**d.** Check the hydraulic oil level in reservoir and check flow from the tandem brake valve.
	e. Air in brake lines.	**e.** Bleed the brakes.
	f. Brake pads/linings are grease-soaked.	**f.** Replace pads/linings.
	g. Engine not running.	**g.** Start engine. Due to the operation, the engine must be running to provide full brake power.
	h. Brake relief valve stuck open.	**h.** Replace the relief valve.
	i. Dual accumulator charge valve not charging	**i.** Check valve operation and repair or replace valve.
	j. Accumulators not pre-charged.	**j.** Check accumulator pre-charge.
2. Hard brake pedal with engine running.	**a.** Pedal travel being interfered with.	**a.** Check all pedal linkage and ensure it is free and adjusted properly.
3. Brakes lock up.	**a.** Too much hydraulic flow.	**a.** Check the flow from the flow divider. Too much flow will cause the brakes to be applied by the oil trapped in the power boost chamber.
	b. Brake pedal push rod improperly adjusted, causing brakes to be always applied.	**b.** Adjust the push rod linkage so the brake pedal and push rod fully return.
4. Uneven braking or pad wear.	**a.** Lining thickness less than 0.125 in (3 mm).	**a.** Replace the lining.
	b. Grease on the pads/linings.	**b.** Replace the pads/linings.

General

A schedule for the periodic adjustment, cleaning, inspection, and lubrication of brake equipment should be established by the operator on the basis of past experience and severity of operation.

The disc brakes are not adjustable. Brakes should be cleaned, inspected, and linkage lubricated periodically to assure maximum performance.

Bleeding the Brake System

The brake system should be bled whenever air becomes entrapped within the brake system (usually characterized by a spongy feeling during brake pedal application), whenever any brake system line has been opened, or whenever any brake component has been replaced.

Always start at the point in the system that is furthest from the tandem brake valve and work back toward the tandem brake valve. Bleed every bleeder screw on every caliper/actuator on every wheel. When you complete a bleeder screw, go to the next closest bleeder screw on the same caliper/actuator. When you complete a wheel, go to the furthest bleeder screw on the next closest wheel.

Pressure Bleeding The Brake System

NOTE: Before bleeding the brake system, ensure the hydraulic accumulators are fully charged.

1. Install the bleeding adapter.
2. Using a clean bleeding tank, fill the tank at least half full with hydraulic oil. Position the tank so it will not have to be moved again until all bleeding is finished.
3. Connect a 240 kPa (35 psi) air source to the bleeder tank.
4. Open the bleeder tank valve and bleed all air out of the hose to be connected to the adapter. Connect the bleeder hose to the adapter and open the bleeder valve.
5. Connect the end of the bleeder hose to the bleeder screw on the caliper/actuator. Submerge the other end in a glass jar partially filled with the proper type of clean hydraulic oil.
6. Open the bleeder screw and allow fluid to flow into the jar until it is a solid stream free of air bubbles. Close the bleeder screw and torque 11.3 Nm to 13.6 Nm (100 lb-in to 120 lb-in).
7. Repeat steps 5 and 6 for the remaining wheel calipers/actuators.
8. Remove the air supply from the bleeder tank.
9. Close the bleeder tank valve and disconnect the hose and the bleeder adapter.
10. Remove the bleeder tank and hose.
11. Remove the bleeder adapter.

Manually Bleeding the Brake System

NOTE: Before bleeding the brake system, ensure the hydraulic accumulators are fully charged.

1. Connect the end of the bleeder hose to the bleed screw on the caliper. Submerge the other end in a jar partially filled with clean hydraulic oil.
2. Open the bleed screw on the caliper/actuator and allow fluid to flow into the jar, while depressing the brake pedal. Depress the brake pedal and close the bleeder screw, then release the brake pedal. Torque the bleeder screw 11.3 Nm to 13.6 Nm (100 lb-in to 120 lb-in).
3. Repeat step 2 until a solid stream free of air bubbles is obtained.
4. Repeat steps 1 thru 3 for the remaining wheel calipers/actuators.

SERVICE BRAKES

Description

The brakes utilized on the later model axles are hydraulic disc-type brakes. One brake assembly is used at the end of each axle. The action of the brake pads riding against the brake discs acts to slow the rotation of the wheels.

Maintenance

NOTE: To perform maintenance on the brake caliper, remove the tire and wheel assembly. Refer to *Axles*, page 8-1 in this section.

CAUTION

To prevent serious eye injury, always wear eye protection when doing maintenance or service.

Removal

Linings

1. Block the wheels.
2. Remove the bolts securing the end plates to one side of the caliper housing. Remove the end plates.
3. Loosen the bleeder screws to release hydraulic pressure in the caliper.

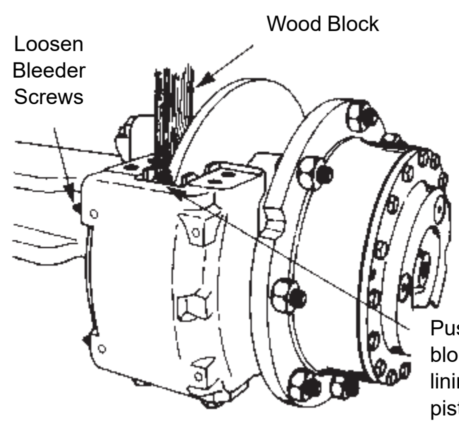


FIGURE 8-13

4. Use a piece of wood against the linings as a pry bar to push the pistons completely into the housing. Tighten the bleeder screws Figure 8-13.
5. Remove the linings from the caliper housing. If necessary, discard the linings.

Caliper

1. Block the wheels
2. Disconnect the hydraulic brake line from the inlet fitting on the caliper. Cap or plug all openings.
3. Remove the linings as described under linings.
4. Remove the bolts securing the caliper housing to the mounting bracket. Remove the caliper housing from the mounting bracket. If shims are used mark the position of the shims.

Disassembly

Caliper

1. Remove the inlet fitting and o-ring from the cylinder cap.
2. Drain and discard the brake fluid.
3. Clean the outside of the housing with isopropyl alcohol. Dry the housing with a clean cloth.
4. If installed, remove the bolts that secure the end plates to the housing. Remove the end plates and linings.
5. Remove the pistons from the side of the housing opposite the mounting plate according to the following procedure.
    a. Use a C-clamp to hold a 12.7 mm (0.5 in) block of wood against two pistons on the mounting side of the housing. Ensure the C-clamp is not in the area in front of the piston bore. Refer to Figure 8-14.

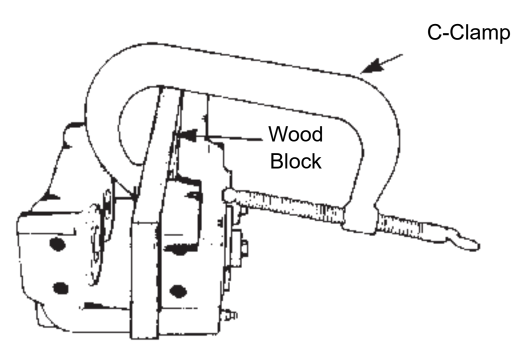


FIGURE 8-14

DANGER

Do not place hand in front of pistons when forcing them out. Serious personal injury may occur.

   b. Apply compressed air to the inlet fitting to force the pistons out of the other housing. If one piston comes out before the other piston, put a piece of wood in front of the piston that comes out first. Apply compressed air to force the other piston out of the housing. Refer to Figure 8-15.

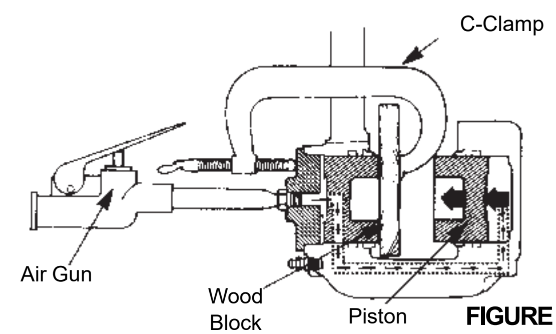


FIGURE 8-15

   c. Remove the wood block and the C-clamp from the housing.
   d. Remove the pistons from the bores that are opposite from the mounting plate.

6. Remove the two bleeder screws from the housing.
7. Remove the cylinder caps from the housing using an open end wrench. Remove and discard the O-rings Figure 8-16.

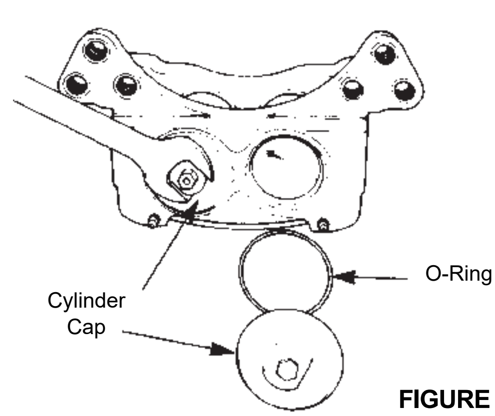


FIGURE 8-16

8. Remove the pistons from the mounting plate side of the housing. Push on the ends of the pistons to force them out of the disc side of the housing. Refer to Figure 8-17.

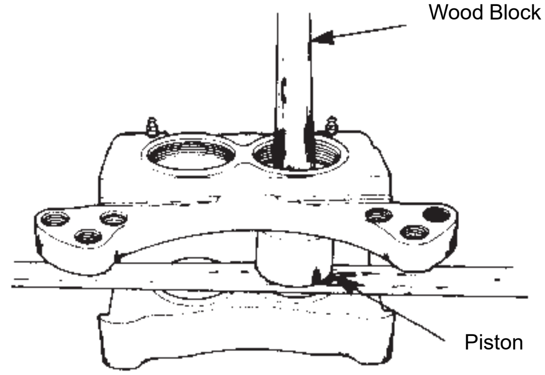


FIGURE 8-17

9. Remove the dust seals from the housing.

10. Remove and discard the O-ring and the backup rings. Refer to Figure 8-18.

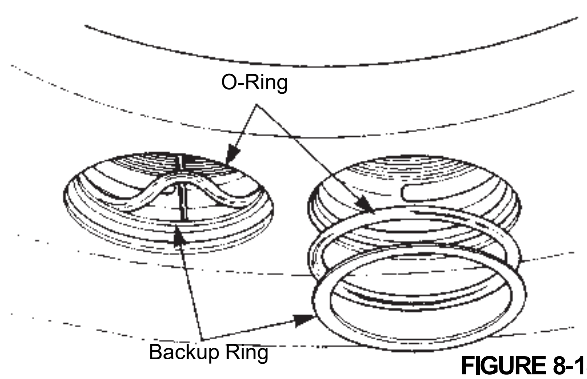


FIGURE 8-18

11. Inspect the ring grooves in the housing for scratches and rust. Remove small scratches and rust with emery cloth. Replace the housing if there are large scratches or large amounts of rust. Refer to *Caliper Parts*, page 8-18 in this section.

12. Inspect the pistons and the bores for scratches and rust. Remove small scratches and rust with emery cloth. Replace the components if they are worn or if there are large scratches or large amounts of rust. Refer to *Caliper Parts*, page 8-18 in this section.

Inspection

Periodic On-Vehicle

Inspect the caliper, linings, and disc for any damage.

Shoes, Linings, and End Plates

Remove the shoes and linings. To help prevent abnormal lining wear, replace worn, bent, or cracked end plates and distorted backing plates. Inspect end plate bolts for wear. Replace the bolts if worn. Inspect the linings for:

- Lining Wear: Replace the linings when the thickness of the lining is less than 3.2 mm (0.125 in) from the back plate. Refer to Figure 8-19.
- Lining Wear Not Even: Replace the linings if the thickness of the two linings is significantly different. Check the pistons for correct operation. Replace the piston and/or housing if a piston is cocked in the bore. Check that the disc surface is flat and parallel to the linings. Refer to Figure 8-19.

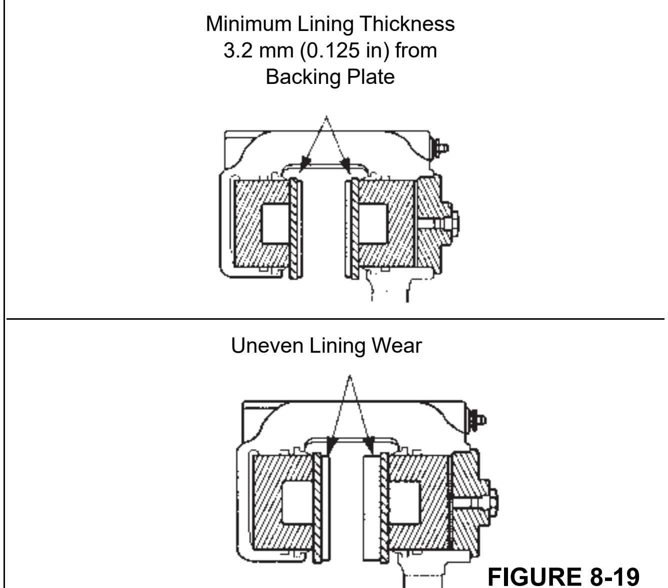


FIGURE 8-19

- Oil or Grease on Linings. Replace the linings.
- Cracks on Linings. Replace linings that have large or deep cracks.

NOTE: Small, tight cracks on the surface of the lining are normal when the caliper is used under high temperature conditions.

Caliper for Leaks

Inspect the following areas for fluid leaks. Refer to Figure 8-20.

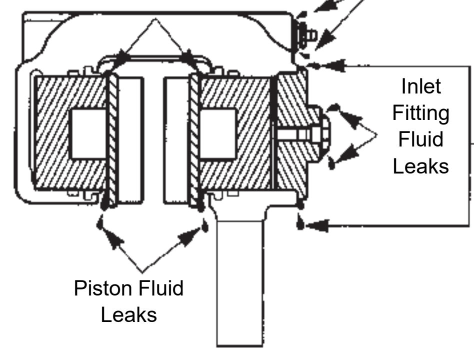


FIGURE 8-20

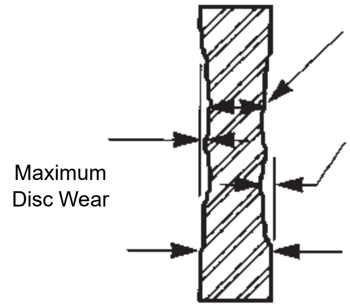
- **Pistons:** If fluid leaks at a piston, disassemble the caliper. Inspect the piston, the bore, the o-rings, and back-up rings. Service as necessary.
- **Cylinder Cap:** If fluid leaks at a cylinder cap, tighten the cylinder cap, the inlet fitting, and the plug. If the leak continues, disassemble the caliper. Inspect the cylinder cap threads, the housing threads, and the o-ring. Service as necessary.
- **Bleeder Screw:** If fluid leaks at the bleeder screw, tighten the bleeder screw. If the leak continued, replace the bleeder screw.
- **Inlet Fitting:** If fluid leaks at the inlet fitting, tighten the fitting. If the leak continues, replace the O-ring.

Dust Seals

Ensure the dust seals are soft and flexible. Disassemble the caliper and replace dust seals that are hard or damaged.

Disc

If the disc is worn beyond the wear limits, replace the disc. Refer to Figure 8-21.



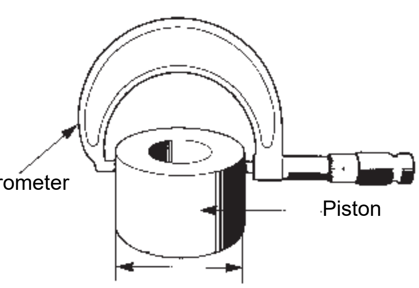
Typical Section Through Disc Showing Recommended Maximum Wear Limits

FIGURE 8-21

Lining Backing Plate Thickness	Maximum Disc Wear Each Side	Minimum Disc Thickness
7.1 mm (0.28 in)	1.5 mm (0.06 in)	12.7 mm (0.50 in)
8.6 mm (0.34 in)	2.3 mm (0.09 in)	11.2 mm (0.44 in)

Caliper Parts

1. Inspect the pistons, housing bores, and o-ring grooves for scratches or corrosion. Remove small scratches or corrosion with fine emery cloth. Replace the components if they are worn beyond wear limits or if there are large scratches or large amount of corrosion.
2. Measure the diameter of the piston. Replace the piston if the outer diameter is worn less than 76.073 mm (2.995 in). Refer to Figure 8-22.



Replace Piston if Outer Diameter is Worn to Less than 76.073 mm (2.995 in)

FIGURE 8-22

3. Measure the diameter of the housing bore. Replace the housing if the diameter is worn to more than 3.003 in (76.276 mm). Refer to Figure 8-23.

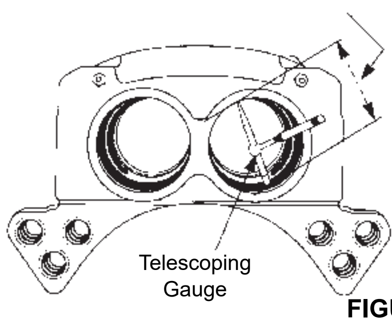


FIGURE 8-23

4. Inspect the linings as described previously.

5. Inspect the threads of the caliper, cylinder caps, and all fittings. Replace any component that has thread damage that cannot be repaired.

6. Discard all back-up rings, O-rings, and dust seals. Use new ones when assembling the caliper.

Cleaning

DANGER

Use of cleaning solvents, hot solution tanks, or alkaline solutions incorrectly, can cause serious personal injury. To prevent serious personal injury, follow the instructions supplied by the manufacturer of these products. Do not use gasoline to clean parts. Gasoline can explode and cause serious personal injury.

- Use solvent cleaners to clean all metal parts that have ground or polished surfaces. Examples of ground or polished parts are the piston and the piston bore in the caliper.
- Metal parts with rough surfaces can be cleaned with solvent cleaners or with alkaline solutions.
- Use a wire brush to clean the threads of fasteners and fittings.
- Use soap and water to clean parts that are not made of metal.
- Scrape away build-ups of mud and dirt on the linings. Replace all linings contaminated with oil or grease.
- Immediately after cleaning, dry all parts with clean paper or rags.

Corrosion Protection

Apply brake system fluid to the cleaned and dried parts that are not damaged and are to be immediately assembled. **Do Not** apply fluid to the brake linings or the disc.

If parts are to be stored, apply a special material that prevents corrosion to all surfaces. **Do Not** apply the material to the brake linings or the disc. Store the parts inside special paper or other material that prevents corrosion.

Assembly

Caliper

CAUTION

Use only specified components when assembling the calipers. Do not mix components from other calipers. Installing the wrong components may cause the caliper not to operate correctly and may cause damage to equipment. Use of non manufacturer's parts can cause damage, loss of braking, and serious personal injury.

NOTE: The O-rings, back-up rings, pistons, and bores must be lubricated before installing the pistons.

1. Lubricate all pistons, bores, O-rings, and back-up rings with silicone grease. If silicone grease is not available, use the same type of fluid that is used in the brake system.

2. Install new O-ring and a new back-up ring in the groove in the middle of the bore. The O-ring is installed toward the outboard end of the bore. The back-up ring is installed toward the lining side of the bore. Refer to Figure 8-24.

CAUTION

Do not use silicone grease on the dust seal. Damage to the seal could occur

8

3. Install a new dust seal in the top groove of the bore. Refer to Figure 8-24.

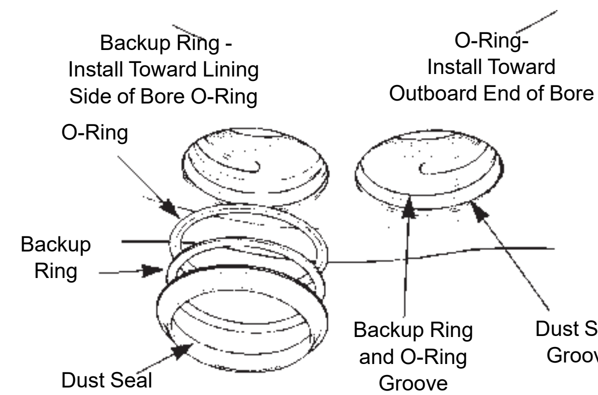


FIGURE 8-24

4. Install the pistons in the housing. Push the pistons in from the lining side of the housing. Ensure the pistons are straight in the bores. Push each piston into the bore until the top of the piston is even with the top of the dust seal. Refer to Figure 8-25.

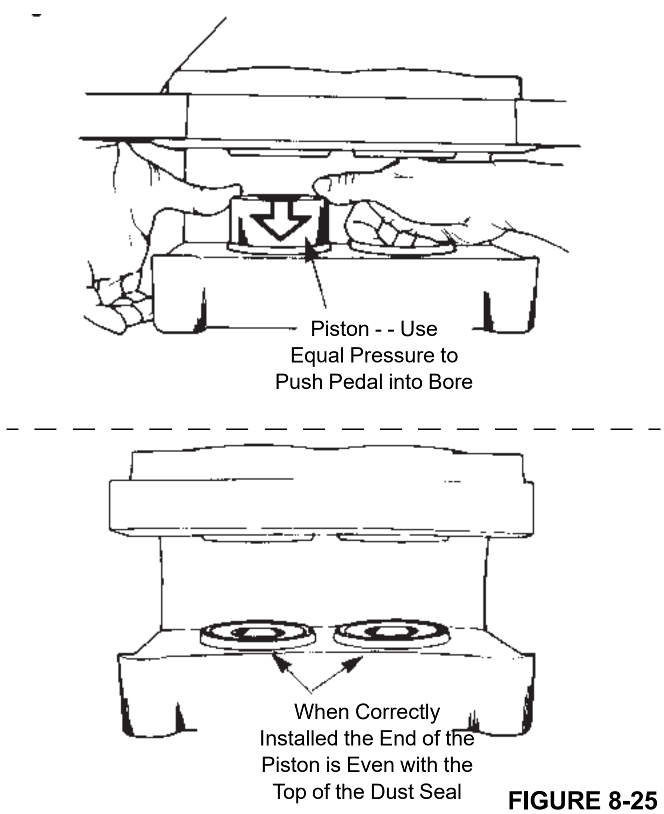


FIGURE 8-25

5. Install a new O-ring in the groove of the cylinder cap. Ensure the O-ring is not cut by the threads on the cylinder cap.

NOTE: Apply extra grease on O-ring before installing cylinder caps. this will keep O-ring from catching on threads as cylinder cap is threaded into housing.

6. Install the cylinder caps in the caliper housing. Tighten the cylinder caps to 102 Nm (75 lb-ft) minimum as shown in Figure 8-26.

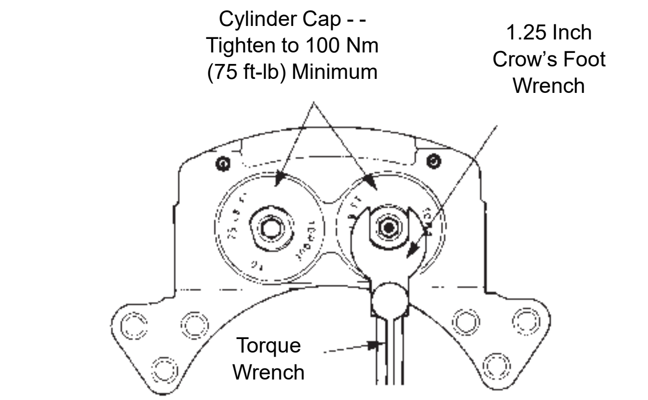


FIGURE 8-26

7. Install the bleeder screws in the housing. Tighten to 11.3 Nm to 13.6 Nm (100 lb-in to 120 lb-in).

8. Install the O-ring and the inlet fitting in the cylinder cap.

Installation

Linings

CAUTION

Always replace both linings. If only one lining is replaced, possible disc damage can occur.

1. Block the wheels.
2. Install the linings in the caliper housing.
3. Apply Loctite 271 or equivalent to the bolt threads. Position the end plates on the housing and secure with bolts. Tighten the bolts to 224 Nm to 285 Nm (165 lb-ft to 210 lb-ft).
4. Ensure the linings move freely in the housing.
5. Bleed the brake system.
6. Apply and release the brakes three times to ensure the caliper operates correctly. Check for fluid leaks. Ensure the linings move freely.

Caliper

1. Position the caliper housing on the mounting bracket. If shims where used, place them as marker during removal.
2. Secure the caliper housing with the bolts and tighten them to 678 Nm to 813 Nm (500 lb-ft to 600 lb-ft).
3. Install the linings. Refer to *Linings*, page 8-15.
4. Ensure the housing is installed correctly on the mounting bracket. The disc must be within ±1.5 mm (±0.06 in) of being centered between the lining end plates.
   a. To increase outboard clearance and decrease inboard clearance, install a shim either between the housing and mounting bracket or between the hub and disc.
   b. The shims must be steel, ground flat, and parallel and must cover the entire mounting surface of the hub or housing. The linings must move freely in the housing and between the end plates. Refer to Figure 8-27.

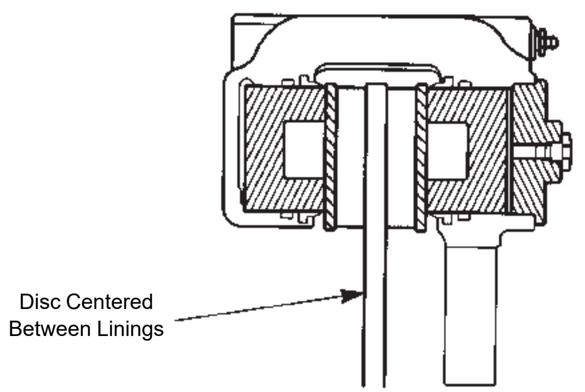


FIGURE 8-27

5. Connect the hydraulic brake line to the inlet fitting.
6. Bleed the brake system.
7. Apply and release the brakes three times to ensure the caliper operates correctly. Check for fluid leaks. Ensure the linings move freely.

PARKING BRAKE ACTUATOR

Description

The spring-applied, hydraulically-released parking brake actuator is located on the front axle and is used to apply and release the parking brake.

Maintenance

Removal

1. Chock the wheels to prevent crane movement.
2. Start the engine, ensure the transmission is in neutral, and position the Park Brake Switch to OFF. This will pressurize the brake actuator to release the tension on the brake linkage. Engine must remain running. Air pressure of 1862 kPa (270 psi) may be used to pressurize the actuator.
3. Remove the capscrews holding actuator to the brake caliper, and slide the actuator off the actuator rod.
4. Position the Park Brake Switch to ON and shut down the engine.
5. Disconnect the hydraulic line from the brake actuator, then cap or plug all openings.

Installation

1. Connect the hydraulic line to the brake actuator.
2. Start the engine, ensure the transmission is in neutral, and position the Park Brake Switch to OFF. This will pressurize brake the brake actuator to release the tension on the brake linkage. Engine must remain running. Air pressure of 1862 kPa (270 psi) may be used to pressurize the actuator.
3. Slide the actuator over the actuator rod and install the capscrews to attach the actuator to the caliper.
4. Position the Park Brake Switch to ON and shut down the engine.

Adjustment

1. Chock the wheels to prevent crane movement.
2. Start the engine, ensure the transmission is in neutral, and position the Park Brake Switch to OFF. This will pressurize the brake actuator to release the tension on the brake linkage. Air pressure of 1862 kPa (270 psi) may be used to pressurize the actuator. Screw the caging nut up under the actuator chamber.
3. Install the rod ball joint until the ball joint will just connect to the brake linkage with the brake lever in a horizontal position.
4. Lock the rod ball joint with the jam nut and back off the caging nut.
5. Position the Park Brake Switch to ON and shut down the engine.

PARKING BRAKE

Description

The parking brake is mounted on the front axle input shaft in line between the front axle and the driveline from the transmission. The brake is a disc-type brake that is controlled by a switch on the front console in the cab and is spring-applied and hydraulically released by an actuator.

Maintenance

Removal

Use the following procedure and refer to Figure 8-28 when removing the brake.

1. Chock the wheels to prevent crane movement.

CAUTION

Do not exceed 207 Bar (3000 psi) hydraulic pressure to avoid damage to the brake; 90 Bar (1300 psi) is required to fully release the brake.

2. Start the engine, ensure the transmission is in neutral, and position the Park Brake Switch to OFF. This will pressurize the brake actuator to release the tension on the brake linkage.
3. Remove cap, back off both jam nuts, loosen bolt (3), and adjustment screw.
4. Position the Park Brake Switch to ON and turn off engine.
5. Disconnect the brake line and cap inlet port.
6. Loosen jam nut/sleeves, remove hex mounting bolts from the bracket and remove brake.

Installation

Use the following procedure and refer to Figure 8-28 when installing the brake.

NOTE: Mount brake so that the linings are parallel with the disc within 0.381 mm (0.015 in).

1. Slide brake over disc and into the mounting position.
2. Start hex mounting bolts into mounting surface far enough to just support the brake.
3. Remove cap and tighten adjustment screw until linings are clamped on to the disc. This locates and holds the brake in the proper position to set the hex mounting bolts.
4. Make sure the bolt (3) does not protrude out far enough to make contact with the mounting bracket at this time. If bolt (3) does make contact, loosen bolt until it clears mounting surface.
5. Tighten mounting bolts until they make contact with the urethane springs, then tighten 4 flats [approximately 1.778 mm (0.07 in)] more. This puts the proper amount of pre-load on the urethane springs.
6. Tighten jam nut/sleeves against mounting surface and torque to 271.1 to 307.7 Nm (200 to 227 lb-ft).

CAUTION

Brake linings are susceptible to contamination. When installing or servicing brakes, keep all oil and fluids away from the linings. Poor brake performance may result if the linings are contaminated.

7. Attach brake line to inlet port.

CAUTION

Do not exceed 207 Bar (3000 psi) hydraulic pressure to avoid damage to the brake; 90 Bar (1300 psi) is required to fully release the brake.

8. Apply hydraulic pressure to the brake by starting the engine and positioning the Park Brake Switch to OFF.
9. Set the running clearance by doing the following:
   a. Remove the cap.
   b. Turn the adjustment screw clockwise until the brake is clamped on to the disc.
   c. Loosen jam nut (4) and adjust bolt (3) until it makes contact with the bump stop on the mounting bracket. Then back it off ¼ turn.
   d. Hold the socket head cap screw (3) in place while tightening the jam nut (4) against the inner hex nut to 40.7 to 47.5 Nm (30 to 35 lb-ft).
   e. Back off the adjusting screw ½ turn. Reinstall cap.
10. Position the Park Brake Switch to ON and shut down the engine.

NOTE: Re-adjust the brake when running clearance reaches a total of 2.82 mm (0.111 in).

PARK BRAKE SOLENOID VALVE

Refer to *Differential Lock/Range Shift Manifold Valve*, page 2-68 for a description of the park brake solenoid valve, its function, and maintenance information.

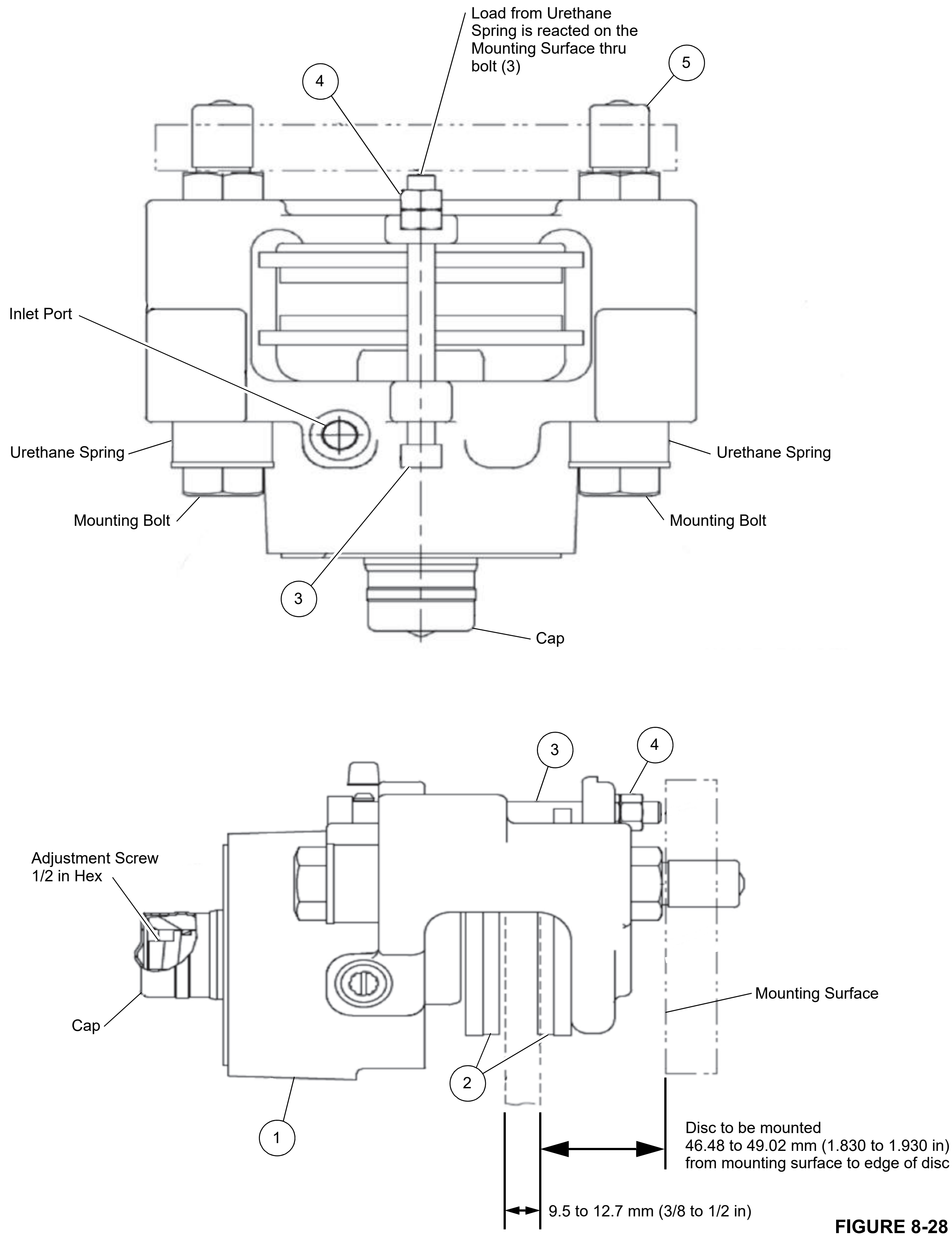

Load from Urethane Spring is reacted on the Mounting Surface thru bolt (3)
4
5
Inlet Port
Urethane Spring
Urethane Spring
Mounting Bolt
Mounting Bolt
3
Cap
3
4
Adjustment Screw 1/2 in Hex
Cap
Mounting Surface
2
1
Disc to be mounted
46.48 to 49.02 mm (1.830 to 1.930 in)
from mounting surface to edge of disc
9.5 to 12.7 mm (3/8 to 1/2 in)

FIGURE 8-28

OUTRIGGER

Outrigger Circuit

Description

The outrigger circuit consists of four extension cylinders with integral encoders, four jack cylinders, an extend/retract directional control valve, front and rear outrigger control manifolds, and an Outrigger Monitoring System (OMS) (Optional—Standard in North America). The front two extension cylinders are mounted in the front outrigger beams and the rear two extension cylinders are mounted in the rear outrigger beams. The front and rear outrigger beams are mounted on their respective outrigger boxes; in turn the jack cylinders are mounted on the end of each outrigger beam. The extend/retract directional control valve is part of the carrier combination manifold valve, which is mounted to the inside carrier frame rail at the turntable bearing. The front and rear outrigger control manifolds are mounted on the inside center of their respective outrigger box. The encoder integral to each extension cylinder is part of the OMS. The OMS indicates the horizontal position to the Rated Capacity Limiter (RCL), which aids the operator in accurately programming the RCL.

Both the extend/retract directional control valve and the manifold solenoid valves are electrically actuated through operator inputs made at the rated capacity limiter (RCL) display and controls in the operator cab.

A sight bubble level is mounted inside the cab on the right side by the emergency stop switch. The sight bubble level provides the operator with a visual indication of crane level attitude.

Theory Of Operation

The Operator Display Module (ODM), through inputs from the operator, controls the extend/retract directional control valve and the beam and jack cylinder valves on the two outrigger control manifolds. Actuating an outrigger function through the ODM causes that respective outrigger jack or beam solenoid valve to open and the extend/retract control valve spool to shift to allow flow to either the extend or retract line as applicable. When extending a jack or beam, the flow continues through the open solenoid valve to the piston side of the cylinder. If the jack cylinder is to be extended oil from the rod end flows through the extend/retract valve, and then to the reservoir.

When retracting a jack or beam, the flow through the extend/retract control valve is directed to the rod side of the cylinder. The oil in the piston side flows through the respective open solenoid valve, back to the extend/retract control valve, then to the reservoir. When extending a jack or beam, the flow through the extend/retract control valve is directed to the respective open solenoid valve and on to the piston side of the cylinder. The oil in the rod side flows through back to the extend/retract control valve, then to the reservoir.

Maintenance

Troubleshooting

Table 8-4

Symptom	Probable Cause	Solution
1. Slow or erratic operation of outrigger extension cylinders.	**a.** Damaged relief valve.	**a.** Remove relief valve; clean or replace.
	b. Low hydraulic oil.	**b.** Check system for leaks. Make repairs as needed. Fill reservoir.
	c. Sticking solenoid valve spool.	**c.** Repair or replace valve spool.
	d. Improper ground to base of solenoid.	**d.** Ground properly.
	e. Directional selector switch sticking.	**e.** Clean or replace switch.
	f. Collector ring dirty or glazed.	**f.** Clean and deglaze collector ring.
	g. Damaged wiring to solenoid.	**g.** Replace wiring.
	h. Weak brush springs on collector ring.	**h.** Replace brush springs.
1. Slow or erratic operation of outrigger extension cylinders. (continued)	**i.** Damaged extension cylinder (internal parts).	**i.** Remove extension cylinder and repair as necessary.
	j. Bent cylinder rods.	**j.** Replace piston rods and seals.
	k. Excessive material on outrigger beams.	**k.** Clean outrigger beams.
	l. Binding outrigger beam.	**l.** Repair or replace outrigger beam.
	m. Damaged outrigger valve.	**m.** Repair or replace valve.
	n. Damaged valve coil.	**n.** Replace coil.
	o. Main hydraulic pump cavitation.	**o.** Replace or tighten hose or fitting. Refer to your Manitowoc Crane Care Parts Manual.
	p. Partially shifted hydraulic spool in selector valve or manifolds.	**p.** Disassemble, clean, and polish spool and valve housing with very fine emery cloth (water paper).
	q. Insufficient voltage for operation of solenoid valve.	**q.** Solenoids require a minimum of 9.5 volts to energize. Check outrigger wiring and electrical coupling collector rings.
	r. Damaged piston seals.	**r.** Replace all cylinder seals.
	s. Worn or damaged hydraulic pump section.	**s.** Repair or replace pump section.
	t. Scored cylinder barrel.	**t.** Repair or replace extension cylinder.
	u. Cracked or damaged piston.	**u.** Replace rod weld and all cylinder seals.

Symptom	Probable Cause	Solution
2. Sticking spool.	**a.** Dirt in the system.	**a.** Change oil and flush system.
	b. Distortion caused by tie bolts being overtorqued.	**b.** Retorque tie bolts.
	c. Flow in excess of valve rating.	**c.** Limit flow through valve to that recommended. Check pump output and cylinder ratio.
	d. Pressure in excess of valve rating.	**d.** Check relief valve setting or pump compensation with that recommended.
	e. Electrical failure.	**e.** Check wiring and solenoids.
3. External leakage.	**a.** Damaged O-ring or quad rings.	**a.** Check for chipped packings and replace.
	b. Loose tie bolts.	**b.** Retorque tie bolts.
	c. Damaged solenoid.	**c.** Replace damaged parts.
4. Solenoid failure.	**a.** No current.	**a.** Check power source of at least 85% of coil rating.
	b. Damaged solenoid assembly.	**b.** Replace solenoid.
	c. Short in solenoid.	**c.** Replace coil.
	d. Loss of solenoid force.	**d.** Decrease time of solenoid energization, decrease cycle rate.
5. Outrigger jack cylinder slow or erratic.	**a.** Low in hydraulic oil.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Damaged main relief valve.	**b.** Repair or replace valve.
	c. Damaged holding valve seals.	**c.** Replace holding valve seals.
	d. Bent cylinder rod.	**d.** Replace cylinder rod and seals.
	e. Bent outrigger housing.	**e.** Repair or replace outrigger housing.
	f. Excessive material on beams.	**f.** Clean outrigger beams.
	g. Sticking solenoid valve spool.	**g.** Repair or replace valve spool.
	h. Damaged wiring to solenoid.	**h.** Repair or replace wiring.
	i. Weak brush springs on collector rings.	**i.** Replace brush springs.
	j. Collector ring dirty or glazed.	**j.** Clean or deglaze collector ring.
	k. Directional selector switch sticking.	**k.** Clean or replace switch.
	l. Main hydraulic pump cavitation.	**l.** Replace or tighten hose and fittings.
	m. Worn or damaged hydraulic pump section.	**m.** Repair or replace pump section.

Symptom	Probable Cause	Solution
6. Outrigger jack cylinder retracts under load.	**a.** Damaged piston seals.	**a.** Replace all cylinder seals.
	b. Damaged holding valve seals.	**b.** Replace seals.
	c. Damaged holding valve.	**c.** Replace valve assembly.
	d. Scored cylinder barrel.	**d.** Repair or replace cylinder.
	e. Cracked or damaged piston.	**e.** Replace piston and all cylinder seals.
7. Outrigger jack cylinder extends while machine is traveling.	**a.** Damaged piston seals.	**a.** Replace all cylinder seals.
	b. Scored cylinder barrel.	**b.** Replace jack cylinder.
	c. Cracked or damaged piston.	**c.** Replace piston and seals.
	d. Piston loose on cylinder rod.	**d.** Replace seal and retorque.
8. Outrigger system will not activate (from stowed or extended and down position).	**a.** Hydraulic oil low.	**a.** Check system for leaks. Make repairs as needed. Fill reservoir.
	b. Loose or broken wire on switch.	**b.** Repair or replace wiring.
	c. Clogged, broken, or loose lines or fittings.	**c.** Clean, tighten, or replace lines or fittings.
	d. Damaged relief valve or damaged control valve.	**d.** Repair or replace valve.
9. Outrigger system activates, but selected outrigger will not stow or extend and lower as desired.	**a.** Clogged, broken, or loose hydraulic lines or fittings.	**a.** Clean, tighten, or replace lines or fittings.
	b. Loose or broken wire on control switch or solenoid valve.	**b.** Repair or replace wiring.
	c. Damaged solenoid valve.	**c.** Repair or replace valve.
	d. Damaged control switch.	**d.** Replace switch.
	e. Damaged hydraulic cylinder.	**e.** Repair or replace cylinder.
10. Outriggers will not set.	**a.** Improper sequence of activation.	**a.** Activate individual control switch; then activate system control switch.
11. Two outriggers activate from single control switch	**a.** Damaged solenoid valves.	**a.** Repair or replace.
12. The two outriggers will not stow.	**a.** Hydraulic lock.	**a.** Recycle individual outrigger(s).
13. Individual outrigger will not set or stow.	**a.** Damaged piston seals.	**a.** Replace seals.
	b. Damaged check valve.	**b.** Repair or replace valve.
	c. Loosen or broken wire on control switch or solenoid valve.	**c.** Repair or replace wiring.
	d. Damaged solenoid valve.	**d.** Repair or replace valve.

8

Outrigger Beam

Description

The outrigger beam assembly consists of an outrigger beam, a jack cylinder, an extension cylinder with integral Outrigger Monitoring System (OMS) encoder, and the required hoses and mounting hardware.

Theory Of Operation

When the outrigger extension is activated, it extends or retracts the outrigger beam within the outrigger box. The outrigger beam can be extended to the mid-extend position or fully extended position.

The Outrigger Monitoring System (OMS) (if equipped) includes an integral encoder inside each extension cylinder to monitor the position of the extension beam—full, half or retracted.

The jack cylinder is mounted to the end of the beam and applies force to the outrigger beam vertically. This sequence of events provides for lifting and stabilizing the crane for operation.

Maintenance

NOTE: Outrigger beam removal and installation is similar for both the front and rear outriggers beams (Figure 8-30).

Removal

1. Remove the outrigger beam end cover.
2. On the jack cylinder end of the beam, loosen the two socket head adjustment screws for the wear pads.
3. Extend the outrigger slightly and attach an adequate lifting device to the outrigger beam (see Figure 8-29).

NOTE: Lifting belts or straps should be used for lifting purposes so as to avoid nicking or scratching the bottom edges of the outrigger beam (Figure 8-29).

Outrigger beam assembly, with jack cylinder, weighs approximately 660 kg (1455 lb).

DANGER

Be sure any blocking material used is capable of supporting the weight of the outrigger beam. Do not allow it to tilt or slide.

4. Place adequate blocking material under outrigger beam.
5. Tag and disconnect the hydraulic lines at the cylinder barrel end of the extension cylinder. Cap all lines and fittings.
6. If crane is equipped with the Outrigger Monitoring System (OMS), disconnect the electrical connection from the cylinder.
7. Remove the cotter pin and clevis pin securing the cylinder barrel end of the extension cylinder to the outrigger housing. Carefully pull the outrigger beam out of the outrigger box until the extension cylinder is free of the box and carefully lay the end of the cylinder on the bottom of the outrigger beam or leave on blocking.

NOTE: Do not allow the end of the outrigger beam cylinder to fall when the clevis pin is removed. Use blocking to limit the drop or an adequate soft support to cushion any distance the rod will drop.

8. Pull the outrigger beam out of the outrigger box, re-adjusting the lifting attachment to prevent the extension cylinder from sliding out of the outrigger beam when the beam clears the outrigger box.

DANGER

Be sure any blocking material used is capable of supporting outrigger beam weight. Do not allow it to tilt or slide.

9. Position outrigger beam on blocking material.

Inspection

Inspect outrigger beams for bends, evidence of cracks, or other damage. Check outrigger beam internally for hydraulic fluid, which may indicate a leaking cylinder, loose connection, or damaged hydraulic line.

Installation

1. If removed, install two wear pads into bottom inside of outrigger box using two socket head screws. Apply anti-seize compound to the wear pads.

   Adjust the two wear pads such that they protrude 5 mm (0.20 in) inside the outrigger box. This will prevent the beam from riding on the bottom of the box during installation.

2. If removed, install two wear pads and plates to the top of the outrigger beam using two flat head socket screws. Apply anti-seize to the wear pads.
3. Attach an adequate lifting device of straps or belts to the beam. Do not use chains, as they may nick the bottom edges of the outrigger beam (see Figure 8-29).

NOTE: Outrigger beam assembly, with jack cylinder, weighs approximately 660 kg (1455 lb).

4. Slide the beam into the outrigger housing and align the cylinder bushing with the mounting hole. Be sure jack

cylinder hydraulic hoses do not get trapped against the outrigger box during insertion.

5. Apply anti-seeze compound to the clevis pin. Secure the cylinder barrel to the housing with the clevis pin and cotter pin.

CAUTION

Be sure that the piston side of all outrigger cylinders are connected to the solenoid valve bank. Reversal of port connection of the rod and piston sides could result in severe damage to the cylinders as very high pressure intensification will occur.

6. If crane is equipped with the Outrigger Monitoring System (OMS), connect the electrical connection to the cylinder.
7. Connect the hydraulic lines as tagged during to removal.

NOTE: If extension cylinder was replaced with a new cylinder, recalibrate the outriggers.

8. Fully extend and retract the outrigger beam, ensuring the beam assembly rides on the top and bottom wear pads. If necessary, adjust the bottom two wear pads and add shims (maximum two shims per wear pad) to achieve this condition.

   Also ensure there is a minimum gap of 2 mm (0.08 in) per side between the outrigger beam side plates and the inside of the outrigger box during full travel.

9. Install the outrigger beam end cover.

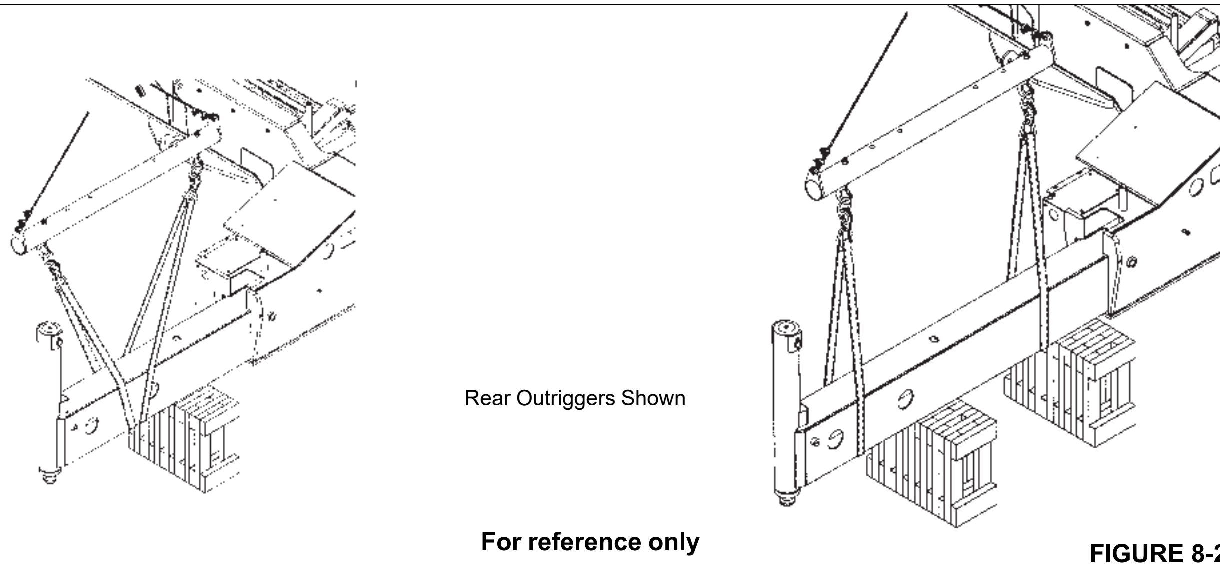
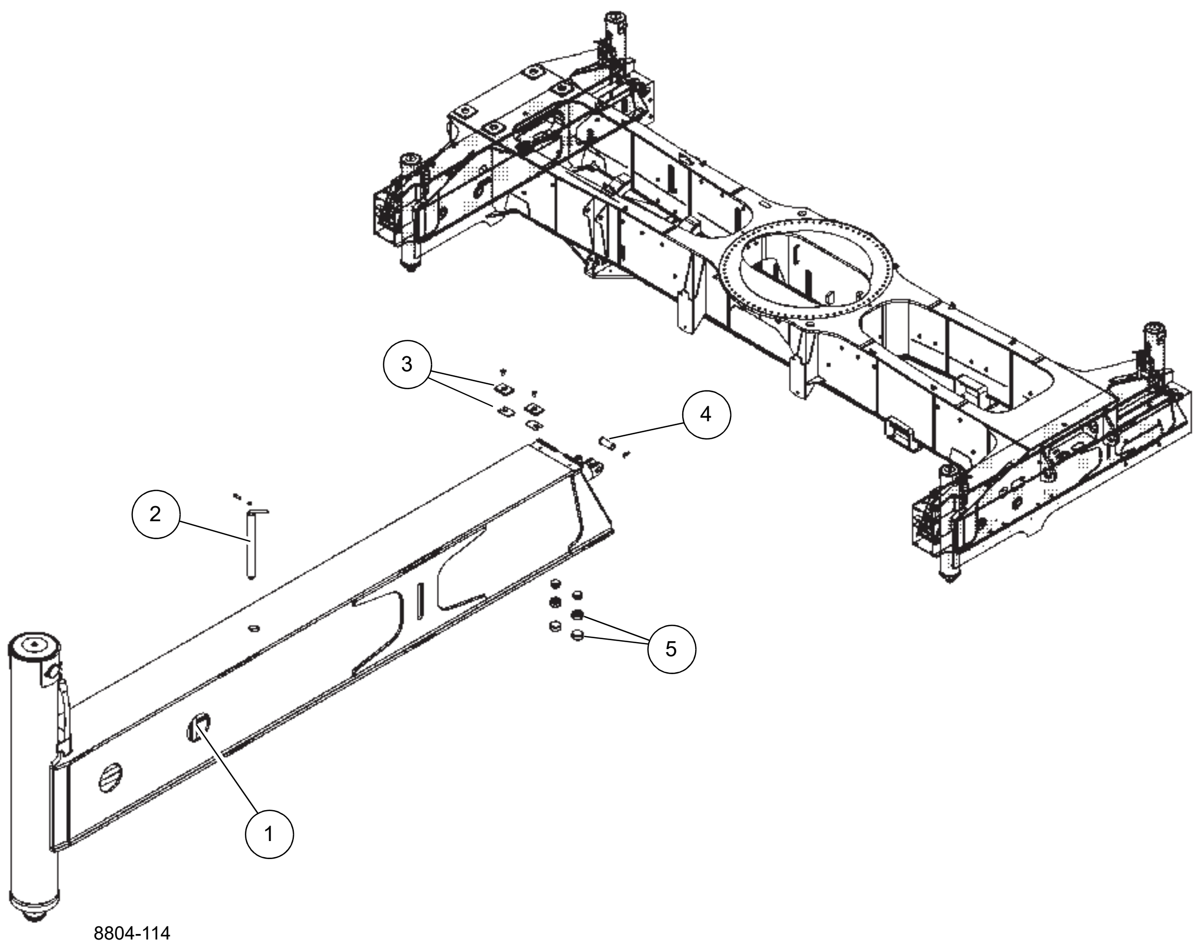


FIGURE 8-29



Item	Description
1	Cylinder Clevis Pin (rod end)
2	Mid-extend Pin
3	Plates and Wear Pads (beam mounted)
4	Cylinder Clevis Pin (piston end)
5	Wear Pad Assembly (O/R box mounted)

FIGURE 8-30

Extension Cylinder

Description

Two outrigger extension cylinders are utilized within each outrigger box assembly. The extension cylinders provide the force for the outrigger beam's horizontal movement. The cylinder weighs approximately 42 kg (93 lb).

Maintenance

Removal

1. Extend the outrigger beam until the second side access hole is exposed (see Figure 8-30). Shut off the engine.
2. Remove the cotter pin and clevis pin securing the rod end of the extension cylinder to the outrigger beam.
3. Remove the cotter pin and clevis pin securing the piston end of the extension cylinder to the outrigger box.
4. Pull the extension cylinder from the outrigger beam until the hydraulic hoses on the rod end of the cylinder can be accessed. Tag and disconnect the hoses from the rod end of the cylinder. Cap or plug all openings.
5. If crane is equipped with the Outrigger Monitoring System (OMS), disconnect the electrical connection from the cylinder.
6. Remove the cylinder.

Installation

1. Place the cylinder in the beam.
2. Position the extension cylinder so the hydraulic ports on the rod end of the cylinder can be accessed. Connect the hydraulic hoses to the ports as tagged during removal. Verify the piston side of the extension cylinder is connected to the solenoid valve bank to prevent damage.
3. If crane is equipped with the Outrigger Monitoring System (OMS), connect the electrical connection to the cylinder.
4. Push the cylinder into the outrigger beam. Align the cylinder rod with the clevis in the beam. Apply anti-seeze to the clevis pin and secure in place with the clevis pin and cotter pin.
5. Align the cylinder piston with the clevis in the outrigger box. Apply anti-seeze to the clevis pin and secure in place with the clevis pin and cotter pin.
6. If extension cylinder was replaced with a new cylinder, recalibrate the outriggers.

Functional Check

1. Activate the hydraulic system. Fully extend and retract the outrigger.
2. Observe the operation of the outrigger beam. If hydraulic lines are reversed, stop immediately and connect lines properly per instructions. Verify no jack cylinder hose is trapped by full outrigger beam retraction. If any is, stop immediately and install lines properly to avoid trapping.
3. Check the hydraulic connections and hoses for any evidence of leakage. Make repairs as needed.

Outrigger Monitoring System (Optional—Standard in North America)

Description

The Outrigger Monitoring System (OMS) aids the operator in accurately programming the Rated Capacity Limiter (RCL) by automatically identifying the horizontal position of each outrigger beam. The OMS uses four encoders, one in each extension beam cylinder, to indicate when an outrigger beam is positioned to one of three pre-defined locations, including fully retracted, mid-extend, and fully extended.

If the crane is setup on outriggers and "On Outriggers" is chosen when programming the RCL, then the OMS indicates to the RCL the horizontal position of each of the four outrigger beams. Based on this information, the RCL will default to the most conservative outrigger beam configuration; that is, if three outriggers are fully extended and one is retracted, the RCL will select retracted as the outrigger configuration. A confirmation of this outrigger configuration is all that is needed. Refer to the *GRT8120 Operator Manual* for detailed instruction of the Rated Capacity Limiter system.

Jack Cylinder

Description

Four jack cylinders are used on the crane, one at the end of each outrigger beam. The jack cylinders provide the force for the outrigger beam's vertical movement. The cylinder weighs approximately 108.6 kg (239.4 lb).

Removal

1. Slightly extend outrigger beam for improved access to the jack cylinder. Shut down the engine.
2. Tag and disconnect the hydraulic hoses from the jack cylinder (see Figure 8-31). Remove the fittings from the ports. Cap or plug all openings.
3. Remove the cylinder cap.
4. Place a jack capable of supporting the weight of the jack cylinder at the base of the cylinder barrel. Jack up the

cylinder just enough to relieve any pressure on the cylinder retaining pin.

NOTE: Jack cylinder weighs approximately 108.6 kg (239.4 lb).

5. Remove the cotter pins securing the cylinder retaining pin and remove the cylinder retaining pin and cylinder cap retaining bracket.
6. Using jack, raise cylinder up just enough to insert retaining pin into cylinder. Insert retaining pin in lugs on cylinder. Secure pin in place with cotter pins.

CAUTION

Use a nylon strap to remove cylinder. This will ensure retaining pin is not damaged.

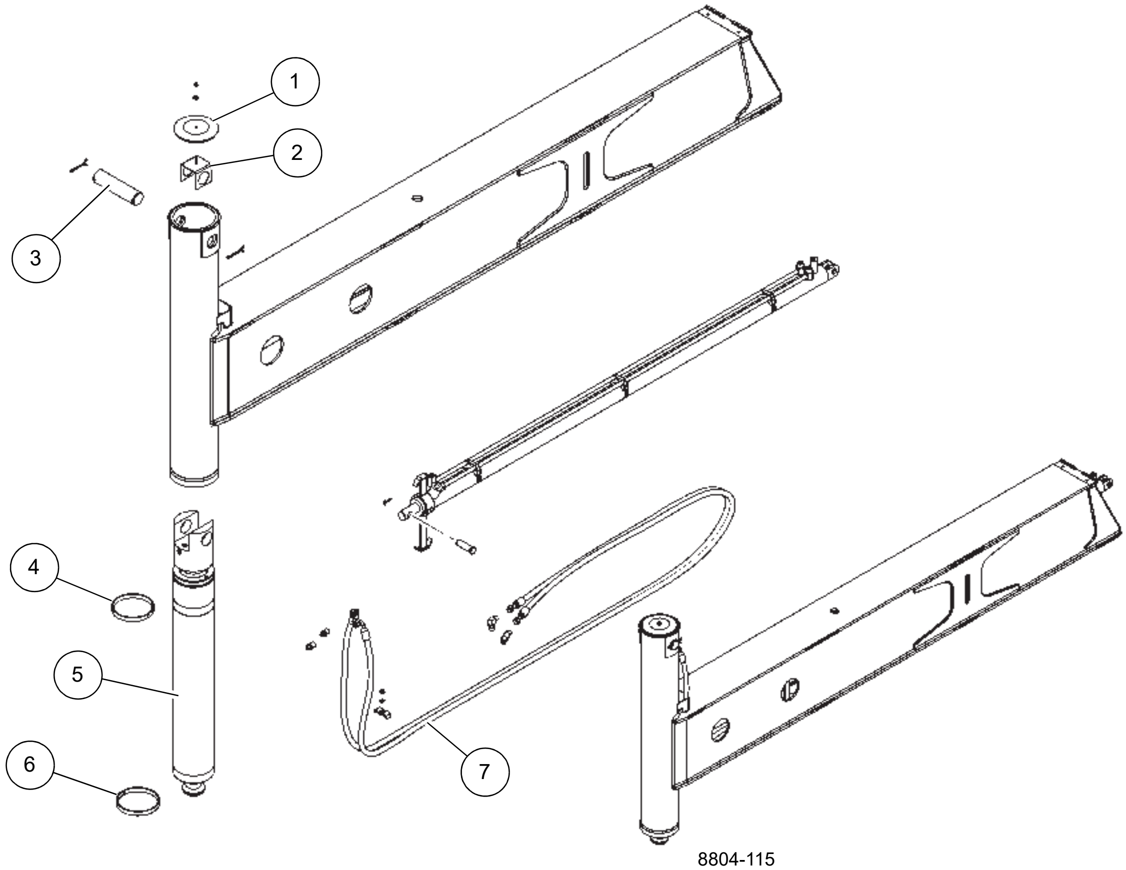
7. Fasten a nylon strap onto the cylinder retaining pin and use an adequate lifting device to lift the jack cylinder out of tube of the beam assembly.

Installation

1. Apply grease (EP-MPG) to ID of jack cylinder support tube.
2. If removed, install wear ring in groove in bottom of support tube and in groove at top on jack cylinder.
3. Place a jack beneath the cylinder tube on the outrigger beam. Using the same method as described under Removal, lower the jack cylinder into the cylinder tube on the outrigger beam until the retaining pin is just above the tube. Position the jack so that it will support the cylinder in this position. Remove lifting device from cylinder.
4. Remove retaining pin and cotter pins from cylinder.
5. Using the jack, lower the cylinder until holes in cylinder rod align with holes in outrigger beam.
6. Apply anti-seeze compound to retaining pin. Secure cylinder and cylinder cap retaining bracket to support tube with retaining pin and cotter pins.
7. Install cylinder cap.
8. Install the fittings in the cylinder ports and connect the hoses as tagged during removal. Verify the piston side of the jack cylinder is connected to the solenoid valve bank to prevent damage. Verify no jack cylinder hose will be trapped by full outrigger beam retraction.

Functional Check

1. Activate the hydraulic system. Fully extend and retract the jack cylinder.
2. Observe the operation of the jack cylinder. If hydraulic lines are reversed, stop immediately and connect lines properly per instructions. Verify no jack cylinder hose is trapped by full outrigger beam retraction. If any is, stop immediately and install lines properly to avoid trapping.
3. Check the hydraulic connections and hoses for evidence of leakage. Make repairs as needed.



Item	Description
1	Jack Cylinder Cap
2	Cap Bracket
3	Pin
4	Head Wear Ring
5	Jack Cylinder
6	Bearing
7	Jack Cylinder Hydraulic Hoses

FIGURE 8-31

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SECTION 9
MAINTENANCE AND LUBRICATION

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GENERAL

Following the designated lubrication procedures is important to ensure maximum crane lifetime and utilization. Procedures and lubrication charts in this section include information on types of lubricants used, location of the lubrication points, frequency of lubrication, and other information.

Refer to your *Inspection and Lubrication Service Log* for routine checks which will help maintain the safety, dependability, and productivity designed into your crane.

One copy of the *Inspection and Lubrication Service Log* is provided in the original package of manuals shipped with the crane. Additional copies are available through the Grove distributor network or Manitowoc Crane Care.

Refer to your *Service Manual* for specific maintenance and adjustment procedures.

ENVIRONMENTAL PROTECTION

Dispose of waste properly! Improperly disposing of waste can threaten the environment.

Potentially harmful waste used in Grove cranes includes—but is not limited to—oil, fuel, grease, coolant, filters, air conditioning refrigerant, 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 filling pump.
- Immediately clean up any spills.

LUBRICANTS AND LUBRICATION INTERVALS

Use lubricants as listed in this section of the *Operator Manual*. See also your GRT8120 *Service Manual* for maintenance and lubrication instructions.

CAUTION

Possible Equipment Damage!

The multipurpose grease installed during manufacture of this crane contains a lithium base.

Do not apply chassis grease lubricants with air pressure devices, as chassis contains sealed fittings.

Use of non-approved lubricant may damage components and/or invalidate published lubricant intervals.

Failure to follow this instruction may cause damage to equipment.

Grove recommends the use of Standard lubricants for Grove cranes operating in regions where moderate ambient temperature, humidity, and atmospheric conditions prevail. These Standard lubricants are effective in ambient temperatures down to -9°C (+15°F).

Cold weather temperatures below -9°C (+15°F) are considered arctic. Grove recommends the use of Cold Weather lubricants for Grove cranes operating in arctic conditions.

In regions where Grove cranes are operating with arctic conditions down to -29°C (-20°F), Grove recommends the use of the Cold Weather lubricants found in Table 9-2.

In regions where Grove cranes are operating with arctic conditions down to -40°C (-40°F), Grove recommends the use of the Cold Weather lubricants found in Table 9-3.

NOTE: All fluids and lubricants may be purchased by contacting an authorized Grove distributor or Manitowoc Crane Care Parts Department.

Standard Lubricants

Standard lubricants are used on all Grove cranes. Cranes can also be ordered with Cold Weather lubricants. The Standard lubricants listed in Table 9-1 are effective in ambient temperatures down to -9°C (+15°F).

Table 9-1 : **Standard Lubricants [Down to -9°C (+15°F)]**

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Hoist Gear Oil Swing Drive Gear Oil	6829014058	CITGO Synthetic Gear Lube Eaton Roadranger EP Mobil Mobilube SHC Mobil Delvac Synthetic Gear Shell Spirax S6 Sunoco Durагear EP Petro-Canada Traxon E Synthetic Phillips 66 Triton Syngear FE	75W-90	OEM Meritor 076N (GL-5)
Engine Oil (SAE) (EO 15W-40)	6829104182	Conoco Fleet Supreme EC Mobil Delvac 1300 Super Mobil Delvac MX ESP	15W-40	CJ-4
Hydraulic/Transmission Oil	6829006444	Phillip 66 PowerTran XP Exxon Mobil 424	ISO 46/68	Must meet John Deere Standard JDM J20C
Extreme Pressure Swing Drive Gearbox Brake Assembly Oil	6829100213	Mobil Mobilgear 600XP 150 Gear Oil Texaco Meropa 150 Phillips 66 Extra Duty Gear Oil	AGMA EP-4	AGMA No. 4 EP
Extreme Pressure Multipurpose Grease (EP-MPG)	6829003477	Citgo Lithoplex MP# 2 (red) Chevron Starplex EP-2 (red) Phillips 66 Multiplex Red (red) Mobil Mobilgrease XHP 222 (dark blue)	NLGI 2	GC-LB Certified
Open Gear Lube (EP-OGL)	6829102971	Fuchs Ceplattyn 300 Spray	NLGI 1-2	
Antifreeze Coolant	6829101130	Old World Industries, Inc. Fleet Charge SCA (red) Caterpillar DEAC (magenta) Fleetguard ES Compleat EG (blue)	AFC - 50/50 Mix 50/50	
Liquid Coolant Conditioner (LCC)	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencool 3000	LCC	

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Table 9-1 : **Standard Lubricants [Down to -9°C (+15°F)]**

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Diesel Exhaust Fluid (DEF)	80019225	Fleetguard StableGuard™ Urea 32 Premix AdBlue® TerraCair Ultrapure® DEF	DEF	
Extreme Pressure 3% Moly Grease (EM-3MG)	6829015304	Citgo Lithoplex CM2 Mobil Mobilgrease CM-P Phillips 66 Megaplex XD3 Ipiranga IPIFLEX LI-COMP MOLY 2 (Gray)	NLGI 2 NLGI 2 NLGI 1 NLGI 2	 GC-LB Certified GC-LB Certified
BECHEM PAL1	01373458			
BECHEM RHUS SW-2	03325216		NLGI 1-2	

ARCTIC LUBRICANTS AND CONDITIONS

Arctic Conditions Below -9°C (+15°F)

Regions with ambient temperatures below -9°C (+15°F) are considered arctic. In general, petroleum based fluids developed especially for low temperature service may be used with satisfactory results. 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 or lubricant, check with an authorized Grove distributor or Manitowoc Crane Care.

NOTE: All fluids and lubricants may be purchased by contacting your local Grove distributor or Manitowoc Crane Care.

Regardless of temperature and oil viscosity, always follow the cold weather start-up and operating procedures, as described in *Section 4 - Operating Procedures,* to ensure adequate lubrication during system warm-up and proper operation of all crane functions.

Cold Weather Package and Lubricants

Grove recommends specific Cold Weather lubricants for use in ambient temperatures down to -29°C (-20°F). Refer to Table 9-2 for a list of these recommended Cold Weather lubricants.

Additionally, Grove recommends specific Cold Weather lubricants for use in ambient temperatures down to -40°C (-40°F). Refer to Table 9-3 for a list of these recommended Cold Weather lubricants.

These recommended Cold Weather lubricants alone are not sufficient to operate the crane in extreme low temperatures (arctic conditions). Therefore, Grove recommends that the crane be equipped with specific cold weather accessories, as listed under the section *Crane Warm-up Procedures*, page 4-11.

Table 9-2 : **Cold Weather Lubricants in Arctic Conditions [Down to -29°C (-20°F)]**

Lubricant/Fluid	Grove Spec.	Recommended Lubricant Type	Grade	Classification
Synthetic Axle Gear Oil	6829014058	CITGO Synthetic Gear Lube Eaton Roadranger EP Mobil Mobilube SHC Mobil Delvac Synthetic Gear Shell Spirax S6 Sunoco Duragear EP Petro-Canada Traxon E Synthetic Phillips 66 Triton Syngear FE	75W-90	OEM Meritor 076N (GL-5)
Engine Oil (SAE)	80056036	Shell Rotella® T6 Mobil Delvac 1 ESP Caterpillar Cat DE0-ULS Cold Weather	0W-40	CJ-4
Hydraulic Oil	6829101559	Petro-Canada Duratran Synthetic THF Chevron All Weather THF Texaco TDH Oil SS		Must Meet John Deere Std. JDM J20C & J20D
Transmission Oil	6829006993	Exxon/Mobil UNIVIS HVI 26	ISO 26	
Hoist Gear Oil Swing Drive Gearbox Brake Assembly Oil	6829103636	Petro-Canada ENDURATEX Synthetic EP 150 Mobil SHC629 Phillips 66 Syncon EP Plus	ISO 150	AGMA No. 4 EP
Extreme Pressure Multipurpose Grease (Cold Weather) (EP-MPG)	6829104275	Mobil Mobilith SHC 220 (red) Petro-Canada Precision Synthetic EP1 Multiplex FS 220 (purple)	NLGI 2	GC-LB Certified
Open Gear Lube	6829102971	Fuchs: Ceplattyn 300 Spray	NLGI 1-2	
Antifreeze Coolant	6829101130	Old World Industries, Inc. Fleet Charge SCA Caterpillar DEAC Fleetguard Compleat EG	Mix 50/50	
Liquid Coolant Conditioner	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencool 3000		
Diesel Exhaust Fluid (DEF)	80019225	Fleetguard StableGuard™ Urea 32 Premix AdBlue® TerraCair Ultrapure® DEF		

Table 9-2 : **Cold Weather Lubricants in Arctic Conditions [Down to -29°C (-20°F)]**

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Extreme Pressure 3% Moly Grease	6829104275	Mobil Mobilith SHC 220 Petro-Canada Precision Synthetic EP1	NLGI 2	
Windshield Washer fluid	90037773	Splash De-icer		
Diesel Fuel	80069407	NOCO Kerosene, 3, UN1223, III Product #1	#1	NLOCK08
BECHEM PAL1	01373458			
BECHEM RHUS SW-2	03325216		NLGI 1-2	

Table 9-3 : **Cold Weather Lubricants in Arctic Conditions [Down to -40°C (-40°F)]**

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Axle Gear Oil Hoist Gear Oil Swing Drive Gear Oil	6829014058	Petro-Canada Traxon E Synthetic CITGO Synthetic Gear Lube Eaton Roadranger EP Mobil Mobilube SCH Shell Spirax S Sunoco Duragear EP	75W-90	GL-5
Engine Oil (SAE)	80056036	Shell Rotella® T6 Mobil Delvac 1 ESP Caterpillar Cat DE0-ULS Cold Weather	0W-40	CJ-4
Hydraulic Oil	6829101559	Petro-Canada Duratran Synthetic THF Chevron All Weather THF Texaco TDH Oil SS		Must Meet John Deere Std. JDM J20C & J20D
Transmission Oil	6829006993	Exxon/Mobil UNIVIS HVI 26	ISO 26	
Swing Drive Gearbox Brake Assembly Oil	6829103636	Petro-Canada ENDURATEX Synthetic EP 150 Mobil SHC629		AGMA No. 4 EP
Grease, Extreme Pressure Multipurpose	6829104275	Petro-Canada Precision Synthetic EP1 Mobil, Mobilith SHC 220	NLGI 2	
Open Gear Lube	6829102971	Fuchs Ceplattyn 300 Spray	NLGI 1-2	

Table 9-3 : **Cold Weather Lubricants in Arctic Conditions [Down to -40°C (-40°F)]**

Lubricant/Fluid	Grove Spec.	Recommended Lubricant		
		Type	Grade	Classification
Antifreeze Coolant	6829104212	Old World Industries, Inc. Fleet Charge SCA Pre-charged Fleetguard Compleat EG Petro-Canada	Mix 60/40	
Liquid Coolant Conditioner	6829012858	Fleetguard DCA4 Fleetguard DCA2 Penray Pencool 3000		
Diesel Exhaust Fluid (DEF)	80019225	Fleetguard StableGuard™ Urea 32 Premix AdBlue® TerraCair Ultrapure® DEF		
Extreme Pressure 3% Moly Grease	6829104275	Mobil Mobilith SHC 220 Petro-Canada Precision Synthetic EP1	NLGI 2	
Windshield Washer fluid	90037773	Splash De-icer		
Diesel Fuel	80069407	NOCO Kerosene, 3, UN1223, III	#1	NLOCK08
BECHEM PAL1	01373458			
BECHEM RHUS SW-2	03313195		NLGI 2	

CYLINDER ROD SURFACE PROTECTION

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

It is recommended that all exposed cylinder rods be protected using Boeshield® T-9 Premium Metal Protectant. Manitowoc Crane Care has Boeshield® T-9 Premium Metal Protectant available in 12 oz. aerosol cans by ordering part number 9999101803 through the Parts Department.

Cylinder operation and inclement weather will remove the Boeshield® protectant; therefore, inspect crane once a week and reapply Boeshield® to unprotected rods.

WIRE ROPE LUBRICATION

Wire rope is lubricated during manufacturing so that the strands, and individual wires in strands, may move as the rope moves and bends. A wire rope cannot be lubricated sufficiently during manufacture to last its entire life. Therefore, new lubricant must be added periodically throughout the life of a rope to replace factory lubricant which is used or lost. For more detailed information concerning the lubrication and inspection of wire rope, refer to *Wire Rope* in *Section 1 - Introduction* of the *Service Manual*.

LUBRICATION POINTS

A regular frequency of lubrication must be established for all lubrication points. Normally, this is based on component operating time. The most efficient method of keeping track of lube requirements is to maintain a job log indicating crane usage. The log must use the engine hourmeter to ensure coverage of lube points that will receive attention based on their readings. Other lubrication requirements must be made on a time basis, for example, weekly, monthly, etc.

Check all oil levels with crane parked on a level surface in transport position, while oil is cold, unless otherwise specified.

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

All grease fittings are SAE STANDARD unless otherwise indicated. Grease non-sealed fittings until grease is seen extruding from the fitting. One pump on a standard 0.45 kg (1 lb) grease gun equals 28 grams (1 oz) of EP-MPG.

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

Unless otherwise indicated, items not equipped with grease fittings, such as linkages, pins, levers, etc., should be lubricated with oil once a week. Motor oil, applied sparingly, will provide the necessary lubrication and help prevent the formation of rust. An Anti-Seize compound may be used if rust has not formed, otherwise the component must be cleaned first.

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

Where wear pads are used, cycle the components and lubricate again to make sure that the entire wear area is fully lubricated.

CraneLUBE

Grove highly recommends use of Manitowoc CraneLUBE lubricants to increase crane reliability and performance. Contact your Grove distributor for information about the Manitowoc CraneLUBE lubrication program.

Cummins Oil Registration List

Cummins has a program that lists engine oils that have been tested and meet the requirements of Cummins Engineering Specifications. A listing of recommended oils is on QuickServe® Online. Log on to quickserve.cummins.com and login with a current username and password. Or create a new account by selecting “Create an Account” under information, then choose Limited Owners Plan, and register. Once logged in, click on the “Service” Tab in the top red bar, “Service Tools” mini-tab and “Oil Registration Lists” link within the Service Tools list. This will load a list of the different Cummins Engineering Specification numbers. Select the one that applies to your engine, and view the registered oils.

Safety

WARNING

Crushing Hazard!

Movement of the superstructure the boom, and outriggers may create a crushing and/or pinching hazard.

Make sure that personnel maintain an adequate clearance from moving parts when these parts are operated during lubrication of the crane.

Failure to follow this instruction may cause serious injury or death to personnel.

To lubricate many of the locations on the crane, the engine must be started. Parts of the crane, to include the boom, superstructure, outriggers, and the like, must be retracted or extended, or swung left or right, which movement may cause pinching and crushing hazards.

After positioning areas of the crane for lubrication, turn off the engine and make sure that the moving parts of the crane are stopped before approaching.

Table 9-4 : **Approved Lubricant Reference Table**

Ref.	Approved Lubricant	Lube Specification Down To -9˚C (+15˚F)	Lube Specification Down To -29˚C (-20˚F)	Lube Specification Down To -40˚C (-40˚F)
A	Extreme Pressure Multipurpose Grease	6829003477	6829104275	6829104275
B	Gear Lube (GL-5)	6829014058	6829014058	6829014058
C	Fully Formulated Anti-Freeze Coolant	6829101130	6829101130	6829104212
D	Liquid Coolant Conditioner (LCC)	6829012858	6829012858	6829012858
E	Tractor Hydraulic Fluid	6829006444	6829101559	6829101559
F	Engine Oil (SAE)	6829104182 (15W-40)	80056036 (0W-40)	80056036 (0W-40)
G	Open Gear Lube	6829102971	6829102971	6829102971
H	Extreme Pressure Gear Lube	6829100213	6829103636	6829103636
J	Hydraulic Oil	6829006444	6829006993	6829006993
K	Diesel Exhaust Fluid (DEF)	80019225	80019225	80019225
L	Extreme Pressure 3% MOLY Grease	6829015304	6829104275	6829104275
M	BECHEM PAL1	01373458	01373458	01373458
N	BECHEM RHUS SW-2	03325216	03325216	03313195

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Drive Train						
1	Engine Air Cleaner Filter for QSBT4F-275 HP	Figure 9-1	—	—	When engine fault shows in ODM **See NOTE 3.**	REPLACE air cleaner filter **See NOTE 1.**
	Engine Air Cleaner Filter for QSBT3-275 HP				When indicator shows red (25″ H_2O) **See NOTE 2.**	REPLACE air cleaner filter **See NOTE 1.**
2	Engine Cooling System (Cummins)	Figure 9-1	C	52.7 L(14 gal) **See NOTE 4.**	Every 10 hours, or daily, whichever interval comes first	CHECK level using sight gauge (2A) **See NOTE 5.**
					LIFETIME See Service Manual.	DRAIN and FILL **See NOTE 6.**
	Liquid Cooling Conditioner (LCC)	Figure 9-1	D	As necessary	See Service Manual	TEST and ADD **See NOTE 7.**
3	Engine Crankcase CUMMINS QSBT4F-275 HP, with Filter	Figure 9-1	F	20 L (5.3 gal)	Every 10 hours of service, or daily, whichever interval comes first	CHECK oil level ADD oil to FULL on DIPSTICK (3A) **See NOTE 8.**
					Every 500 hours of service	DRAIN crankcase REPLACE filter (3B) FILL oil to FULL (3C) **See NOTE 8.**
	Engine Crankcase CUMMINS QSBT3-275 HP, with Filter		F	20 L (5.3 gal)	Every 10 hours of service, or daily, whichever interval comes first	CHECK oil level ADD oil to FULL **See NOTE 8.**
					Every 500 hours of service **See NOTE 9** when using sulfur fuel that is >5000 ppm (it is not recommended)	DRAIN crankcase REPLACE filter **See NOTE 9.** FILL oil to FULL **See NOTE 8.**

NOTE 1: REMOVE decking side cover to access Engine Air Cleaner Filter element.

NOTE 2: **CUMMINS QSBT3-275 HP** – REPLACE Air Cleaner Primary Element when Indicator shows Red (25″ H_2O).

NOTE 3: **CUMMINS QSBT4F-275 HP** – REPLACE Air Cleaner Primary Element when engine fault comes on in the Crane Vitals Area of the Operator Display Module (ODM).

NOTE 4: Anti-Freeze Coolant (AFC) capacities indicated are for a fully formulated mixture of 50% AFC and 50% water.

NOTE 5: CHECK Coolant level using sight gauge (2A) visible through radiator grille at rear of crane. FILL Surge Tank to bottom of filler neck. OPERATE engine through two (2) thermal cycles. CHECK coolant level and FILL as necessary.

NOTE 6: See your GRT8120 *Service Manual* for specified coolant fill instructions.

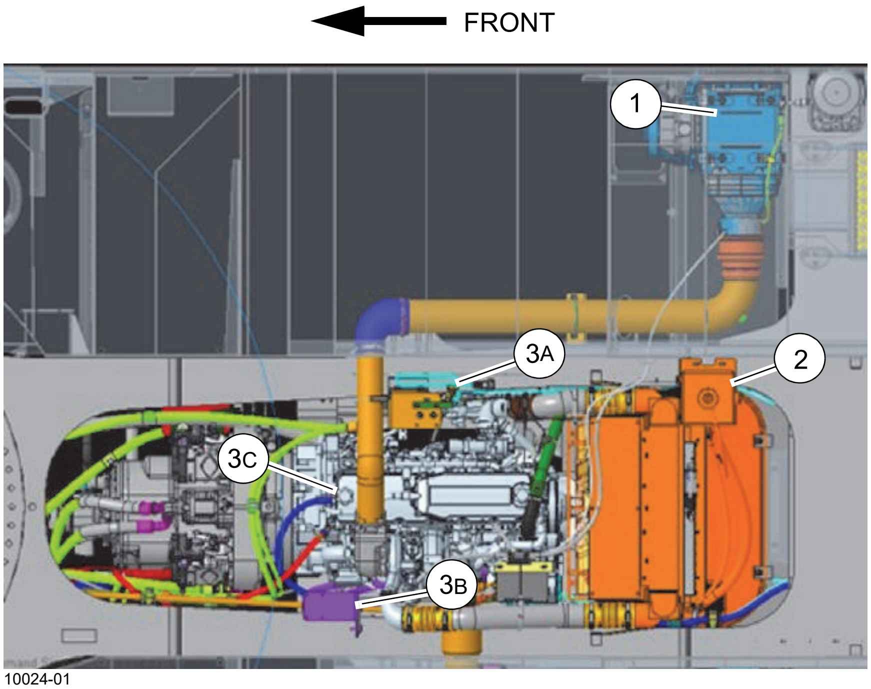
NOTE 7: See your GRT8120 *Service Manual* for information about Liquid Cooling Conditioner (LCC) levels and testing.

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application

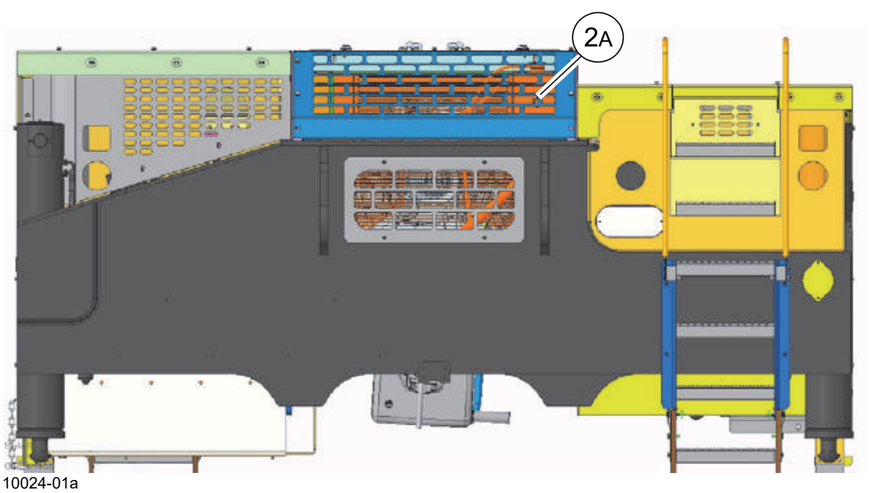
NOTE 8: Engine Oil Fill (3C) is on top of the valve cover. Engine Oil Filter (3B) is located on inside left side of the frame, adjacent to the engine. Engine Oil Dipstick (3A) is on the top right side of the crankcase near Engine Oil Fill.

NOTE 9: Frequency for Engine Oil Filter (3B) service intervals will increase in special circumstance when using sulfur fuel that is >500 ppm. To keep your crane running smoothly, without causing engine damage, it is important to drain the engine crankcase and replace your engine oil filter (3B), using the following time line as your guide:

- If using 500–5000 ppm sulfur fuel in the engine, then drain the crankcase and replace your engine oil filter every 400 hours of service.
- If using >5000 ppm sulfur fuel in the engine, then drain the crankcase and replace your engine oil filter every 250 hours of service. Grove **does not recommend** using >5000 ppm sulfur fuel in the engine.



TOP VIEW OF CARRIER



REAR VIEW OF CARRIER (COOLANT SITE GAUGE)

FIGURE 9-1

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Drive Train (Continued)						
4	Fuel Filter	Figure 9-2	—	—	**PERFORM** every 500 hours of service, or 6 months, whichever interval is first	REPLACE fuel filter **See NOTE 10.**
5	Transmission and Torque Converter	Figure 9-2	E	41.6 L (11 gal)	**PERFORM** every 10 hours of service, or daily, whichever interval comes first	CHECK fluid level **See NOTE 11.** **See NOTE 12.** FILL transmission sump to FULL on DIPSTICK **See NOTE 15.**
					PERFORM after first 50 hours of service, and **REPEAT** after another 50 hours for a total of 100 hours of service	DRAIN transmission sump **See NOTE 13.** REPLACE transmission and torque converter filter **See NOTE 14.** CLEAN magnetic drain plug INSTALL magnetic plug in drain port FILL transmission sump to FULL on DIPSTICK **See NOTE 15.**
					Thereafter **PERFORM** DRAIN procedure, to include REPLACING transmission and torque converter filter, every 500 hours of service, or 3 months, whichever interval comes first	DRAIN transmission sump **See NOTE 13.** REPLACE filter **See NOTE 14.** FILL transmission sump to FULL on DIPSTICK **See NOTE 15.**

NOTE 10: The Fuel Filter is located on the inside right side of the frame adjacent to the engine.

NOTE 11: Check Transmission Fluid level using the dipstick (6A) that is located on the right side of the carrier, behind the steps, adjacent to the hydraulic tank. Check fluid level with boom fully retracted and lowered, and all outrigger cylinders retracted.

NOTE 12: Level should be checked with engine running at 850 rpm idle and torque converter fluid temp at 65°C to 93°C (150°F to 200°F). To bring fluid temperature to this range, it is necessary to work the crane or stall the converter.

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application

CAUTION

Possible Equipment Damage!

Do not operate torque converter at stall condition for longer than 30 seconds at one time.

Shift to neutral for 15 seconds, and repeat procedure until desired fluid temperature is reached.

Excessive fluid temperature [120°C (250°F) maximum] will damage transmission clutches, transmission fluid, torque converter, and seals.

Failure to follow this instruction may cause damage to equipment.

NOTE 13: Follow these specified Transmission and Torque Converter Fluid DRAIN instructions:

a. DRAIN Transmission and Torque Converter Fluid at a temperature of 65°C to 93°C (150°F to 200°F).

b. CLEAN magnetic drain plug when changing lubricant.

NOTE 14: Transmission and Torque Converter filter is located on the outside left side of the frame adjacent to the fuel tank and behind the battery box.

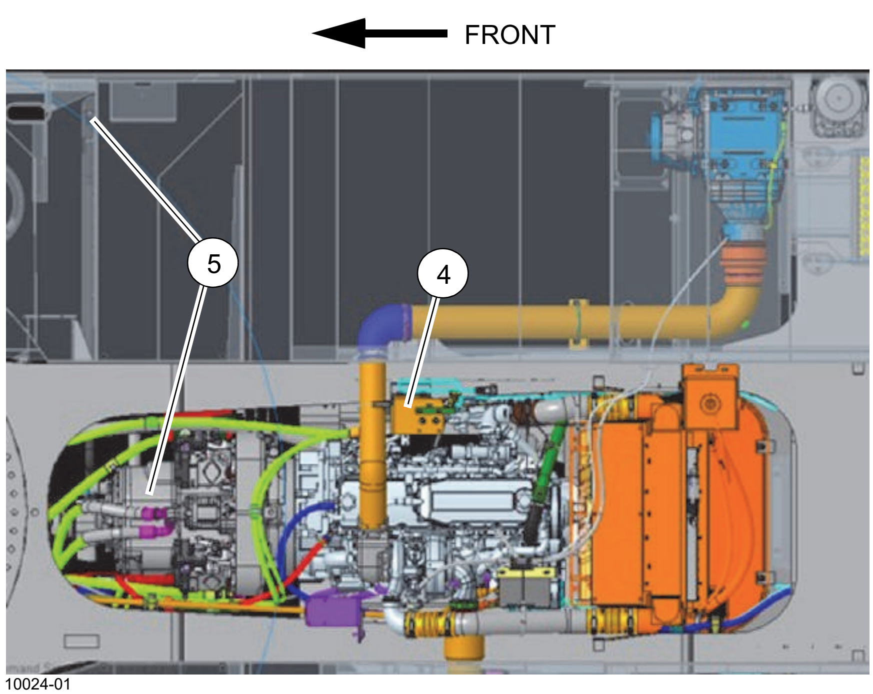
NOTE 15: Follow these specified Transmission and Torque Converter Sump Fluid FILL instructions:

a. Dipstick (6A) is used to FILL the Transmission and Torque Converter Sump, and is located on the right side of the carrier, behind the steps, adjacent to the hydraulic tank. Open cap on the DIPSTICK for the Transmission and Torque Converter sump, and FILL with transmission fluid through the DIPSTICK opening. FILL to FULL on DIPSTICK.

b. OPERATE engine at 850 rpm to prime torque converter and lines.

c. CHECK fluid LEVEL with engine running at 850 rpm and torque converter fluid at 65°C to 93°C (150°F to 200°F).

d. ADD transmission fluid, as necessary. FILL to FULL on DIPSTICK.



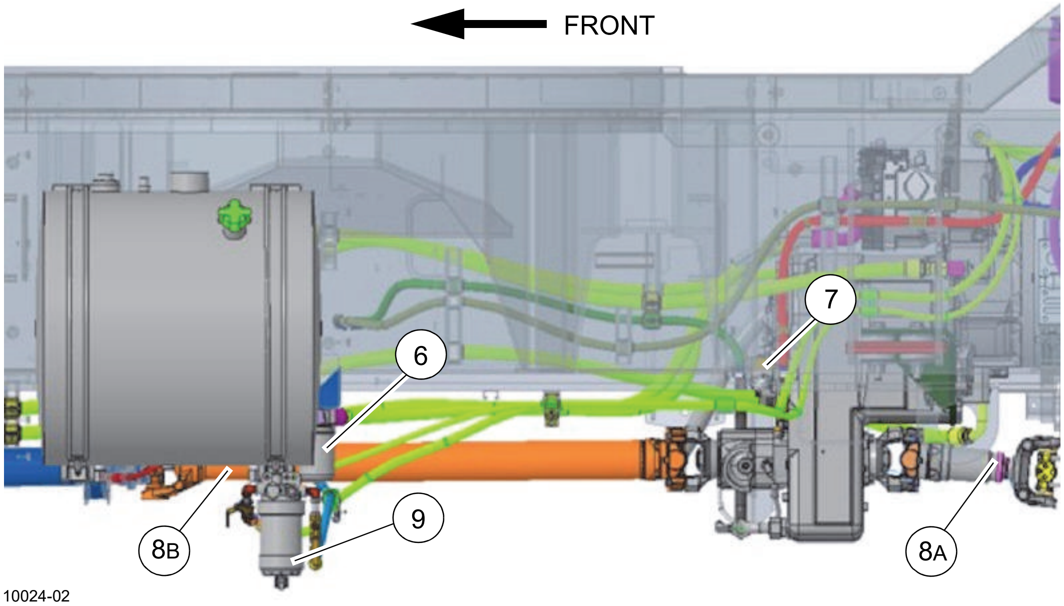
TOP VIEW OF CARRIER

FIGURE 9-2

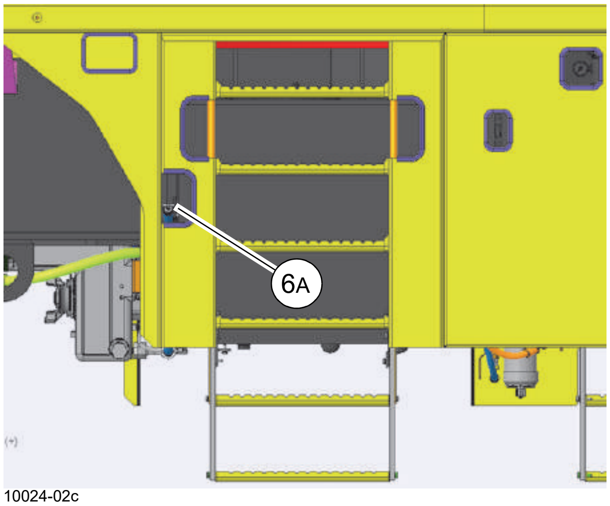
Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Drive Train (Continued)						
6	Transmission and Torque Converter Filter	Figure 9-3	—	—	**PERFORM** after first 50 hours of service	REPLACE filter **See NOTE 14.**
					REPEAT after another 50 hours of service for a total of 100 hours of service	REPLACE filter **See NOTE 14.**
					REPEAT every 500 hours of service or 3 months thereafter, whichever interval comes first	REPLACE filter **See NOTE 14.**
6A	Transmission and Torque Converter Dipstick Location	Figure 9-3	E	41.6 L (11 gal)	As necessary, in DRAIN and FILL routines	FILL transmission sump to FULL on DIPSTICK **See NOTE 15.** **See NOTE 16.**
7	Engine Cooling System – Coolant Strainer for Cab Heater	Figure 9-3	—	—	**PERFORM** after first 100 hours of service	CLEAN strainer
					Then, every 2000 hours of service or 1 year thereafter	REPLACE strainer
8A	Driveline – Slip	Figure 9-3	A	Brush on	Every 500 hours of service, or 3 months, whichever interval comes first	BRUSH ON grease to coat the driveline slip surface
8B	Driveline – Slip	Figure 9-3	A	Brush on	Every 500 hours of service, or 3 months, whichever interval comes first	BRUSH ON grease to coat the driveline slip surface
9	Fuel/Water Separator	Figure 9-3	—	—	Every 10 hours/daily	DRAIN water trap
10	DEF Supply Module Filter (Tier4)	Figure 9-4	—	—	Every 4500 hours or 3 years, whichever interval comes first	CHECK DEF Supply Module filter
11	DEF Tank (Tier 4)	Figure 9-4	K	37.9 L (10 gal)	Every 10 hours/daily	CHECK DEF Tank Level and FILL **See NOTE 17.**
12	DEF Tank Filter	Figure 9-4	—	—	Every 2000 hours or 1 year, whichever interval comes first	CHECK DEF Tank filter

NOTE 16: The Transmission Fluid FILL and DIPSTICK is located on the right side of the carrier, behind the steps, adjacent to the hydraulic tank for ease in servicing the transmission and torque converter.

NOTE 17: The Diesel Exhaust Fluid (DEF) Level Indicator in the Crane Vitals Area of the Operator Display Module (ODM) comes on YELLOW when the DEF tank is 4%–10% FULL, and RED when the tank is <5% FULL.

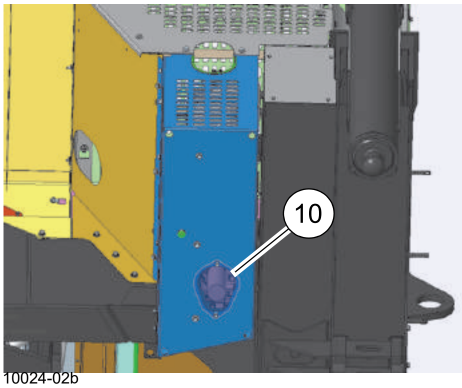


SIDE VIEW OF CARRIER

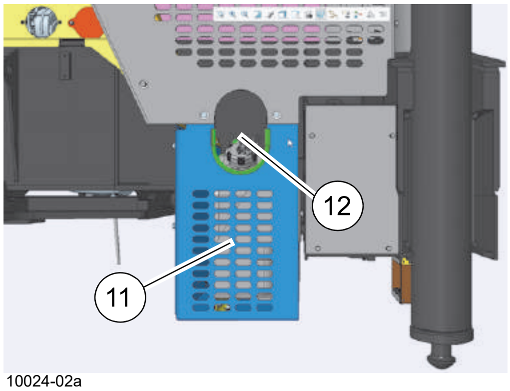


RIGHT SIDE OF CARRIER (TRANSMISSION DIPSTICK)

FIGURE 9-3



LEFT UNDERSIDE OF CARRIER



LEFT REAR SIDE OF CARRIER

FIGURE 9-4

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Steering and Suspension – Meritor Axles						
20	Lockout Cylinder Pivot Pins **See NOTE 18.**	Figure 9-5	A	Until grease extrudes	Every 500 hours, or 3 months, whichever interval comes first	LUBRICATE 2 fittings per axle, 4 service points
21	Steering Cylinder Pivot Pins **See NOTE 18.**	Figure 9-5	A	Until grease extrudes	Every 500 hours, or 3 months, whichever interval comes first	LUBRICATE 4 fittings per axle, 8 service points
22	Tie Rod Pivot Pins **See NOTE 18.**	Figure 9-5	A	Until grease extrudes	Every 500 hours, or 3 months, whichever interval comes first	LUBRICATE 2 fittings per axle, 4 service points
23	King Pins (upper and lower) **See NOTE 18.**	Figure 9-5	A	Until grease extrudes	Every 500 hours, or 3 months, whichever interval comes first	LUBRICATE 4 fittings per axle, 8 service points
Steering and Suspension – Kessler Axles						
24	Lockout Cylinder Pivot Pins **See NOTE 18.**	Figure 9-6	A	Until grease extrudes	Every 500 hours, or 3 months, whichever interval comes first	LUBRICATE 2 fittings per axle, 4 service points
25	Steering Cylinder Pivot Pins **See NOTE 18.**	Figure 9-6	A	Until grease extrudes	Every 50 hours, or weekly, whichever interval comes first	LUBRICATE 4 fittings per axle, 8 service points
26	Tie Rod Pivot Pins	Figure 9-6	—	—	Maintenance Free	NO SERVICE
27	King Pins (upper and lower) **See NOTE 18.**	Figure 9-6	A	Until grease extrudes	**PERFORM** after first 100 hours of service	LUBRICATE 4 fittings per axle, 8 service points
				Until grease extrudes	**REPEAT** every 500 hours of service, or 3 months, thereafter, whichever interval comes first	LUBRICATE 4 fittings per axle, 8 service points

CAUTION

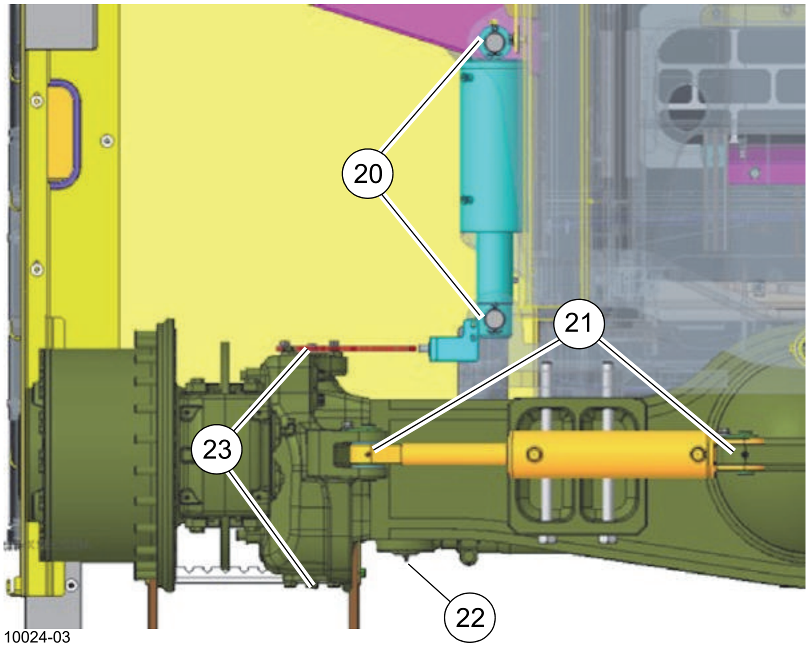
Possible Equipment Damage!

Use specified semi-synthetic or synthetic lubricants as listed in this section of your GRT8120 *Operator Manual*. See also your GRT8120 *Service Manual* for maintenance and lubrication instructions.

Use of non-approved, non semi-synthetic lubricant may damage components and/or invalidate published lubricant intervals.

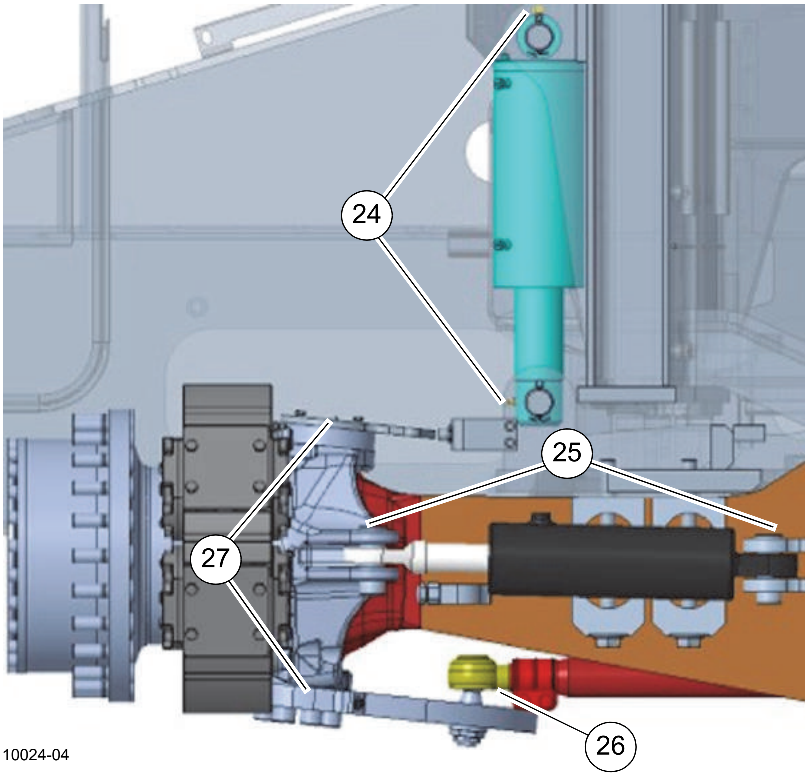
Failure to follow this instruction may cause damage to equipment.

NOTE 18: Use grease fittings provided. **DO NOT USE non semi-synthetic lubricant**. Use of non-approved lubricant may damage components.



MERITOR AXLE

FIGURE 9-5



KESSLER AXLE

FIGURE 9-6

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Steering and Suspension – Fifth Wheel Pivots						
28	Fifth Wheel Pivot Pins	Figure 9-7	A	Until grease extrudes	Every 500 hours, or 3 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 19.**

NOTE 19: Use grease fittings provided.

CAUTION

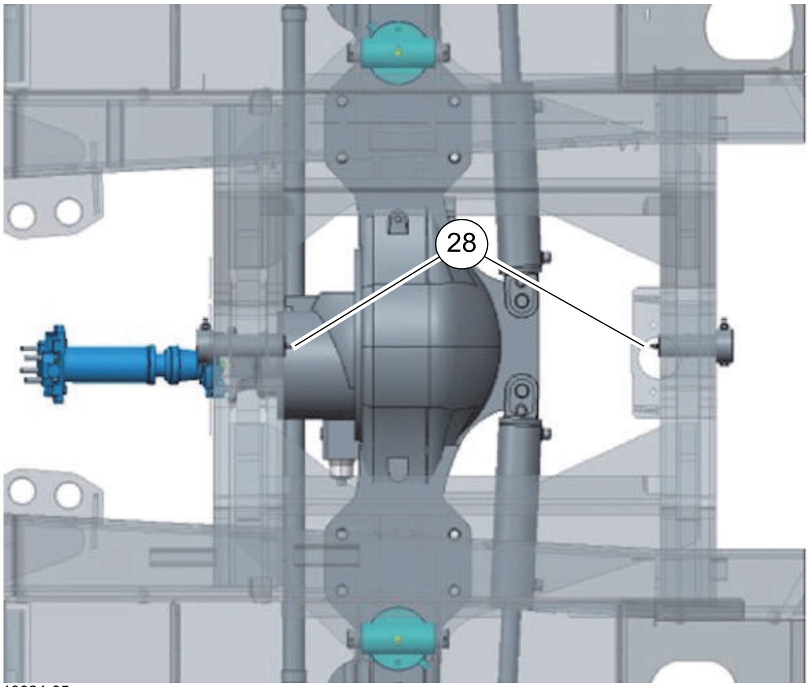
Possible Equipment Damage!

Use specified semi-synthetic or synthetic lubricants as listed in this section of your GRT8120 *Operator Manual*. See also your GRT8120 *Service Manual* for maintenance and lubrication instructions.

Use of non-approved, non semi-synthetic lubricant may damage components and/or invalidate published lubricant intervals.

Failure to follow this instruction may cause damage to equipment.

DO NOT USE non semi-synthetic lubricant. Use of non-approved lubricant may damage components.



FIFTH WHEEL PIVOTS

FIGURE 9-7

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Axle Lubrication – Meritor Axles						
30	Differentials	Figure 9-8	B	40L (10.6 gal) ea **NOTE 20. NOTE 21. NOTE 22. NOTE 23.**	Every 250 hours, or 1 month, whichever interval comes first	CHECK and FILL 2 service points
					Every 3000 hours, or 2 years, whichever interval comes first	DRAIN and FILL 2 service points CLEAN magnetic drain plug INSTALL magnetic plug in drain port
31	Planetary Hubs & Wheel Bearings	Figure 9-9	B	9.8 L (10.4 qt) ea Wheel End **NOTE 20. NOTE 21. NOTE 22.**	Every 250 hours, or 1 month, whichever interval comes first	CHECK and FILL 4 service points **See NOTE 23.**
	Side View, Planetary DRAIN and FILL ports	Figure 9-9			Every 3000 hours, or 2 years, whichever interval comes first	DRAIN and FILL 4 service points **See NOTE 23.**

NOTE 20: Planetary Hubs and Wheel Bearings must be filled to oil fill level indicated on axle hub. To provide sufficient lubrication, final fluid level MUST BE LEVEL with the filler plug hole at the Wheel End, with fluid even slightly dripping from the hole. CLEAN magnetic plug, then INSTALL magnetic plug in drain port.

NOTE 21: Before operating crane in cold weather (arctic) ambient temperatures below -9°C (+15°F), Standard bearing lubricant must be fully purged and replaced with Cold Weather lubricant meeting Grove U.S. L.L.C. specifications as shown in Table 9-4*: Approved Lubricant Reference Table*, page 9-11 in this *Operator Manual*. See also your GRT8120 *Service Manual* for maintenance and lubrication instructions.

NOTE 22: **If the makeup amount of fluid is substantially more than 0.23 L (0.5 pt)**, CHECK for leaks.

CAUTION

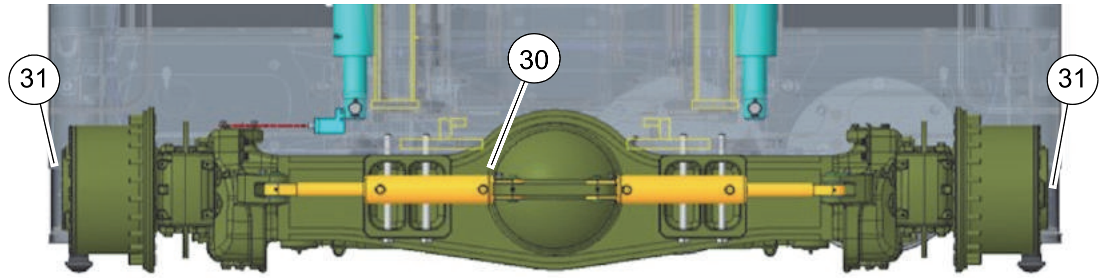
Possible Equipment Damage!

Use specified semi-synthetic or synthetic lubricants as listed in this section of your GRT8120 *Operator Manual*. See also your GRT8120 *Service Manual* for maintenance and lubrication instructions.

Use of non-approved, non semi-synthetic lubricant may damage components and/or invalidate published lubricant intervals.

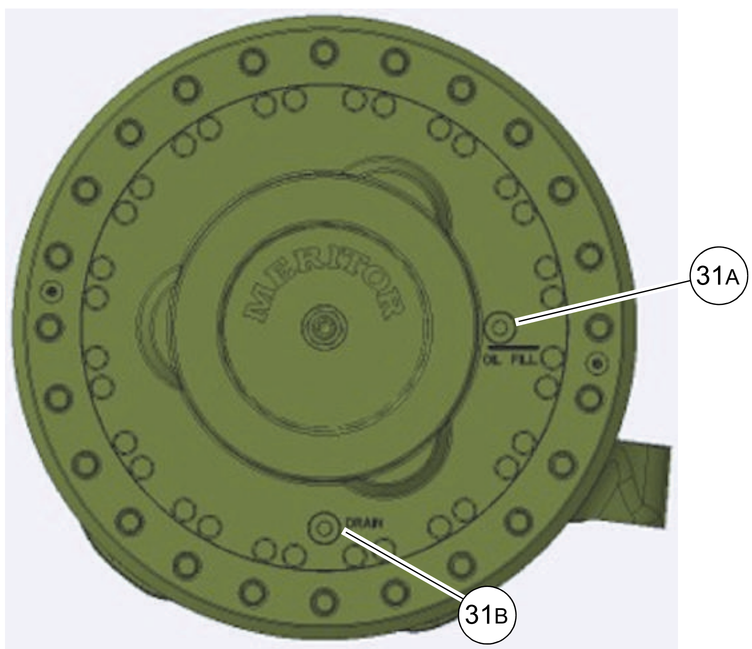
Failure to follow this instruction may cause damage to equipment.

NOTE 23: **DO NOT USE non semi-synthetic lubricant**. Use of non-approved lubricant may damage components.



MERITOR DRIVE AXLE – FRONT VIEW

FIGURE 9-8



LEGEND

31A - OIL FILL 31B - OIL DRAIN

MERITOR AXLE SIDE VIEW – AXLE HUB – PLANETARY DRAIN AND FILL PORTS

FIGURE 9-9

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Axle Lubrication – Kessler Axles						
32	Differentials	Figure 9-10	B	37L (9.8 gal) ea **NOTE 25.** **NOTE 26.** **NOTE 27.**	Every 100 hours, or 1 month, whichever interval comes first	CHECK and FILL 2 service points
					PERFORM after first 100 hours of service **REPEAT** every 1000 hours of service, or 1 year, thereafter, whichever interval comes first	DRAIN and FILL 2 service points CLEAN magnetic drain plug INSTALL magnetic plug in drain port
33	Planetary Hubs & Wheel Bearings	Figure 9-10	B	2.8 L (2.9 qt) ea Wheel End **NOTE 25.** **NOTE 26.** **NOTE 27.**	Every 250 hours, or 1 month, whichever interval comes first	CHECK and FILL 4 service points **See NOTE 24.**
	Detail View, Planetary DRAIN and FILL ports	Figure 9-10			Every 3000 hours, or 2 years, whichever interval comes first	DRAIN and FILL 4 service points **See NOTE 24.**

NOTE 24: Planetary Hubs and Wheel Bearings must be filled to oil fill level indicated on axle hub. To provide sufficient lubrication, final fluid level MUST BE LEVEL with the filler plug hole at the Wheel End, with fluid even slightly dripping from the hole. CLEAN magnetic plug, then INSTALL magnetic plug in drain port.

NOTE 25: Before operating crane in cold weather (arctic) ambient temperatures below -9°C (+15°F), Standard bearing lubricant must be fully purged and replaced with Cold Weather lubricant meeting Grove U.S. L.L.C. specifications as shown in Table 9-4*: Approved Lubricant Reference Table*, page 9-11 in this *Operator Manual*. See also your GRT8120 *Service Manual* for maintenance and lubrication instructions.

NOTE 26: **If the makeup amount of fluid is substantially more than 0.23 L (0.5 pt)**, CHECK for leaks.

CAUTION

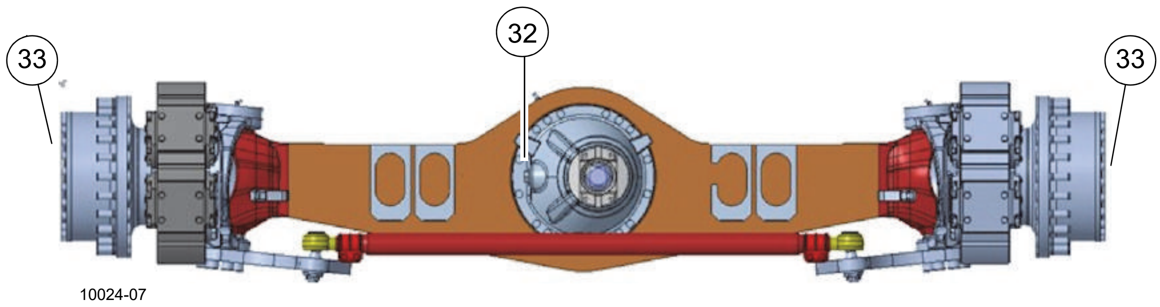
Possible Equipment Damage!

Use specified semi-synthetic or synthetic lubricants as listed in this section of your GRT8120 *Operator Manual*. See also your GRT8120 *Service Manual* for maintenance and lubrication instructions.

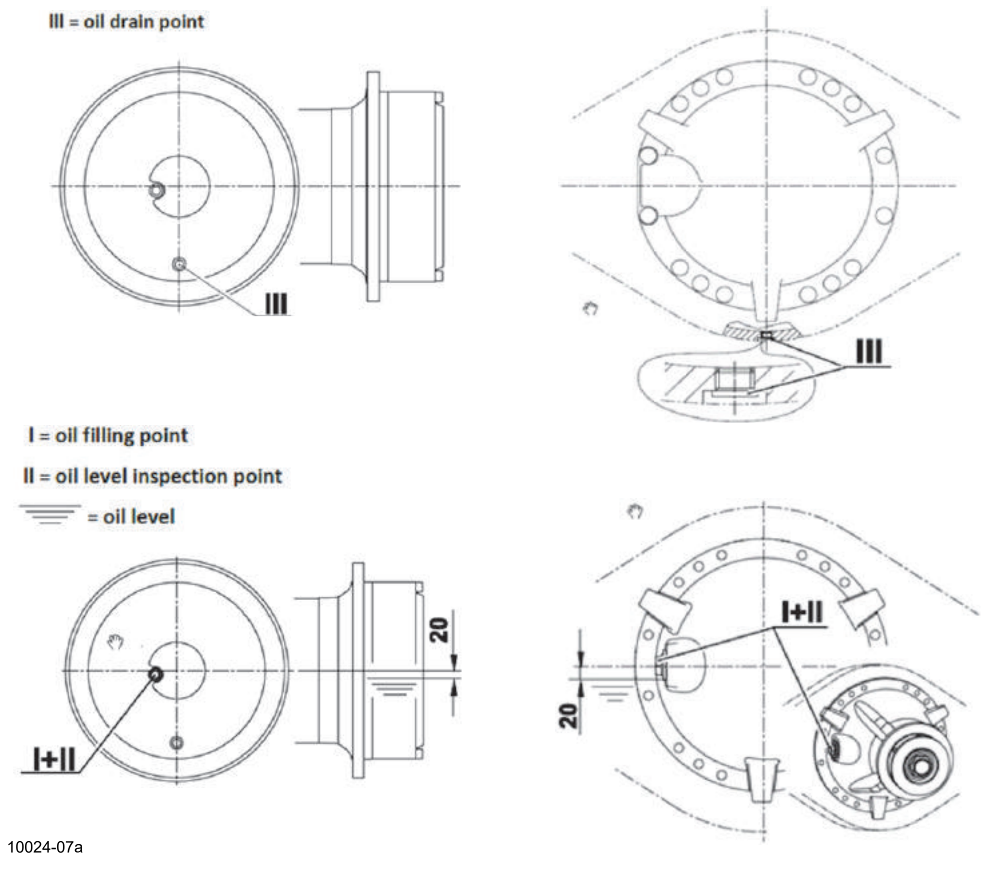
Use of non-approved, non semi-synthetic lubricant may damage components and/or invalidate published lubricant intervals.

Failure to follow this instruction may cause damage to equipment.

NOTE 27: **DO NOT USE non semi-synthetic lubricant**. Use of non-approved lubricant may damage components.



KESSLER DRIVE AXLE – FRONT VIEW



KESSLER DRIVE AXLE DETAIL VIEW

FIGURE 9-10

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Turntable (Swing Drive) and Cab Tilt Lubrication						
40	Turntable (Swing Drive) Gearbox – Brake Assembly	Figure 9-11	H	0.3 L (0.63 pt) each gearbox	**After first 50 hours of service** **Thereafter**, every 50 hours of service, or 1 week, whichever interval comes first	CHECK oil level FILL swing drive gearbox brake assembly to TOP of ELBOW 1 service point **See NOTE 28.**
					After first 50 hours of service **Thereafter**, every 1000 hours, or 12 months, whichever interval comes first	DRAIN swing drive gearbox FILL swing drive gearbox brake assembly to TOP of ELBOW 1 service point **See NOTE 28.**
41	Turntable (Swing Drive) Gearbox	Figure 9-11	B	4.14 L (4.4 qt)	**After first 50 hours of service** **Thereafter**, every 50 hours of service, or 1 week, whichever interval comes first	CHECK oil level FILL swing drive gearbox to BOTTOM of FILL HOLE 1 service point **See NOTE 29.**
					After first 50 hours of service **Thereafter**, every 1000 hours, or 12 months, which-ever comes first	DRAIN swing drive gearbox FILL to BOTTOM of FILL HOLE 1 service point **See NOTE 29.**
42	Turntable Bearing	Figure 9-11	A	**ROTATE** the S/S 90° then grease again **REPEAT** until the S/S has made one full rotation	Every 500 hours, or 6 months, whichever interval comes first	LUBRICATE 6 grease fittings at front of super-structure (S/S) 6 service points **See NOTE 30.** **See NOTE 31.**
43	Turntable (Swing Drive) Gear and Drive Pinion	Figure 9-11	G	SPRAY ON	Every 500 hours, or 6 months of service, whichever interval comes first	SPRAY ON LUBRICATION swing drive gear and drive pinions COAT ALL TEETH 2 service points **See NOTE 32.**
NOTE 28: Check level in Swing Drive Gearbox Brake Assembly, and FILL to TOP of ELBOW.						
NOTE 29: Check level in Swing Drive Gearbox, and FILL to BOTTOM of FILL HOLE.						

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Turntable (Swing Drive) and Cab Tilt Lubrication – Continued						

NOTE 30: Apply grease to six (6) fittings at front of superstructure. Then rotate superstructure 90° and apply grease to fittings once more. Repeat rotating the superstructure in 90° increments and applying grease to the fittings until the entire superstructure has made a full rotation.

NOTE 31: The turntable bearing in this crane is lubricated with *Cold Weather* (arctic) bearing grease capable of ambient temperatures between -40°C and +49°C (-40°F to +120°F). If operating the crane in regions expecting sustained winter/cold season temperatures below 15°F, top off bearing grease using Table 9-2, *Cold Weather Lubricants in Arctic Conditions [Down to -29°C (-20°F)]*. If temperatures below -9°C (15°F) are rare and intermittent, then greases from Table 9-1, *Standard Lubricants [Down to -9°C (+15°F)],* are acceptable.

CAUTION

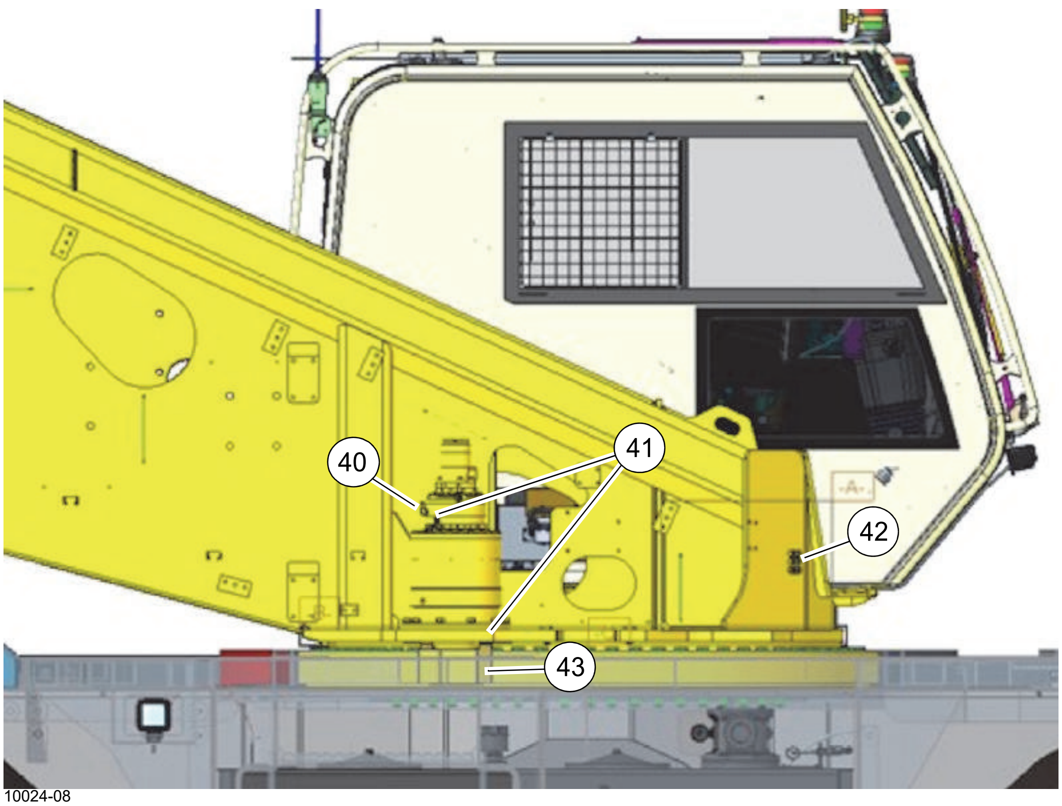
Possible Equipment Damage!

Use specified semi-synthetic or synthetic lubricants as listed in this section of your GRT8120 *Operator Manual*. See also your GRT8120 *Service Manual* for maintenance and lubrication instructions.

Use of non-approved, non semi-synthetic lubricant may damage components and/or invalidate published lubricant intervals.

Failure to follow this instruction may cause damage to equipment.

NOTE 32: **DO NOT USE non semi-synthetic lubricant**. Use of non-approved lubricant may damage components.



SIDE VIEW – SUPERSTRUCTURE

FIGURE 9-11

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Turntable (Swing Drive) and Cab Tilt Lubrication – Continued						
44	Turntable Swivel Lock Pin	Figure 9-12	G	SPRAY ON	Every 500 hours, or 6 months of service, whichever interval comes first	SPRAY ON LUBRICATION 1 service point **See NOTE 34.**
50	Cab Tilt Cylinder Pivot Pins	Figure 9-12	A		Every 500 hours, or 3 months, whichever interval comes first	LUBRICATE 4 service points **See NOTE 33.**
51	Pillow Block	Figure 9-12	A		Every 500 hours, or 3 months, whichever interval comes first	LUBRICATE 4 service points **See NOTE 33.**
52	Cab Door Track and Rollers	Figure 9-13	Light Oil		Every 6 months	LUBRICATE top and bottom door track and rollers 2 service points
53	Air Conditioner Condenser Filter	Figure 9-14	–		Every 1000 hours, or 6 months, whichever interval comes first	CHECK and CLEAN condenser filter 1 service point

NOTE 33: USE grease fittings provided.

CAUTION

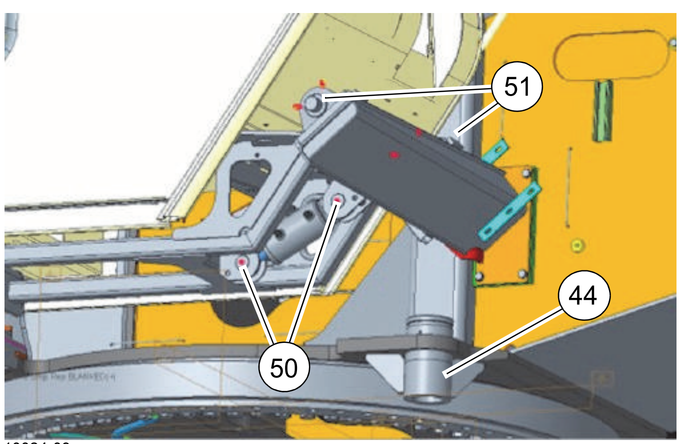
Possible Equipment Damage!

Use specified semi-synthetic or synthetic lubricants as listed in this section of your GRT8120 *Operator Manual*. See also your *Service Manual* for maintenance and lubrication instructions.

Use of non-approved, non semi-synthetic lubricant may damage components and/or invalidate published lubricant intervals.

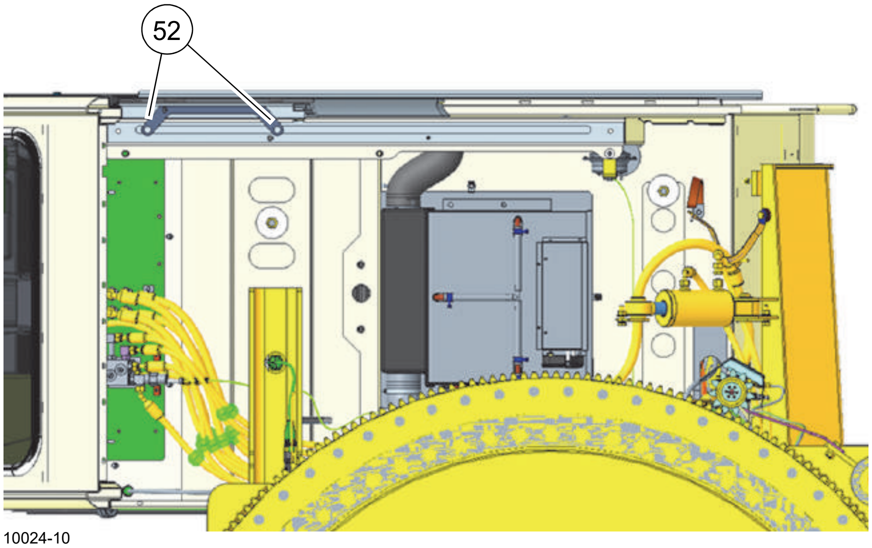
Failure to follow this instruction may cause damage to equipment.

NOTE 34: **DO NOT USE non semi-synthetic lubricant**. Use of non-approved lubricant may damage components.



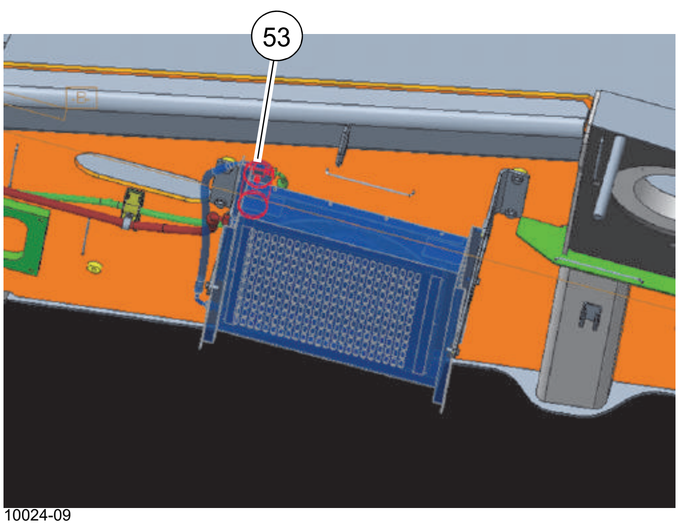
SIDE VIEW – SUPERSTRUCTURE

FIGURE 9-12



UNDERSIDE OPERATOR CAB DOOR TRACK AND ROLLERS

FIGURE 9-13



REAR OF OPERATOR CAB – AIR CONDITIONER CONDENSER FILTER

FIGURE 9-14

9

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Outrigger Lubrication						
60	Outrigger Beams –Top Plates	Figure 9-15	L	Brush on	Every 50 hours, or 1 week of service, whichever interval comes first	BRUSH ON beam top plate as beam is fully extended. **See NOTE 35.** **See NOTE 37.** **See NOTE 38.** **See NOTE 39.**
	Outrigger Beams –Bump-outs **See NOTE 35.** **See NOTE 37.** **See NOTE 38.** **See NOTE 39.**	Figure 9-15	L	Brush on	Every 50 hours, or 1 week of service, whichever interval comes first	BRUSH ON 3 TOP, and 3 BOTTOM bump-outs on each side of outrigger beam 12 service points each beam
61	Wear Pads **See NOTE 35.** **See NOTE 37.**	Figure 9-15	L	Brush on	Every 50 hours, or 1 week of service, whichever interval comes first	BRUSH ON 2 TOP wear pads (rectangular–rear), and 2 BOTTOM wear pads (circular–front) of ea outrigger beam 4 service points each beam
62	Jack Cylinder Support Tubes	Figure 9-15	L	Brush on I.D. of each cylinder support tube and wear bands	Every 50 hours, or 1 week of service, whichever interval comes first	BRUSH ON I.D. of 4 service points **See NOTE 35.** **See NOTE 36.**
63	Jack Cylinder Barrels	Figure 9-15	L	Brush on	Every 50 hours, or 1 week of service, whichever interval comes first	BRUSH ON 4 service points **See NOTE 35.** **See NOTE 36.**
64	Extend Cylinder Supports	Figure 9-15	L	Brush on	Every 50 hours, or 1 week of service, whichever interval comes first	BRUSH ON 8 service points **See NOTE 35.** **See NOTE 37.** **See NOTE 38.**

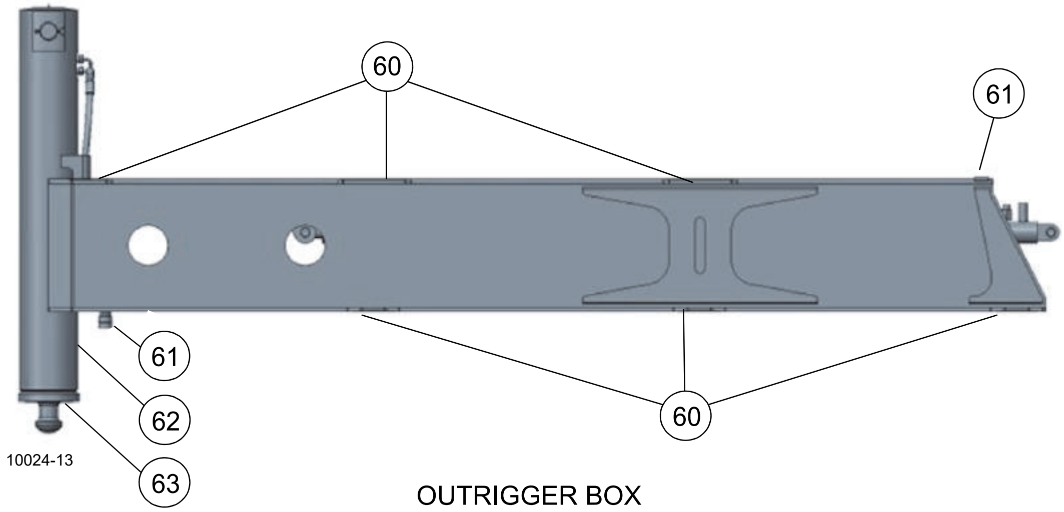
NOTE 35: **DO NOT USE non semi-synthetic lubricant**. Use of non-approved lubricant may damage components.

NOTE 36: Brush lubricant in I.D. of Jack Cylinder Support Tubes and Wear Bands before installing Jack Cylinders.

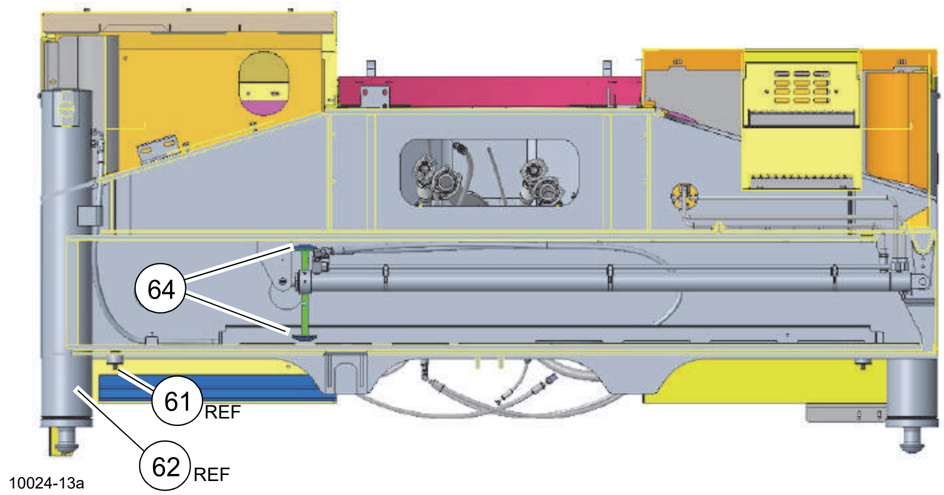
NOTE 37: Brush lubricant on TOP wear pads (rectangular–rear), and BOTTOM wear pads (circular–front) of Outrigger Beams and Extend Cylinder Supports.

NOTE 38: Brush lubricant on three (3) TOP and three (3) BOTTOM bump-outs found on each side of the outrigger beam where top and bottom plates contact the sides of the outrigger box. Lubricate 6 points each side, per outrigger, when the beam is fully extended.

NOTE 39: Perform same service for each of four (4) Outrigger Beams, for a total of 48 service points.



OUTRIGGER BOX



OUTRIGGER BOX INTERIOR

FIGURE 9-15

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Lift Cylinder Lubrication						
70	Lower Lift Cylinder Pivot Pin	Figure 9-16	L	Until grease extrudes	Every 500 hours, or 3 months, whichever interval comes first	LUBRICATE 1 grease fitting, 1 service point **See NOTE 40. See NOTE 41.**

CAUTION

Possible Equipment Damage!

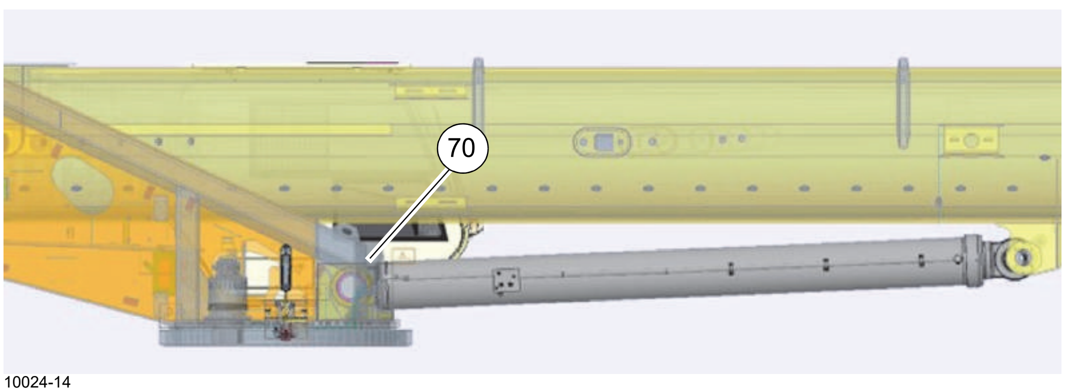
Use specified semi-synthetic or synthetic lubricants as listed in this section of your GRT8120 *Operator Manual*. See also your GRT8120 *Service Manual* for maintenance and lubrication instructions.

Use of non-approved, non semi-synthetic lubricant may damage components and/or invalidate published lubricant intervals.

Failure to follow this instruction may cause damage to equipment.

NOTE 40: **DO NOT USE non semi-synthetic lubricant**. Use of non-approved lubricant may damage components.

NOTE 41: Before operating crane in cold weather (arctic) ambient temperatures below -9°C (+15°F), Standard grease must be fully purged and replaced with Cold Weather grease meeting Grove U.S. L.L.C. specifications as shown in Table 9-4*: Approved Lubricant Reference Table*, page 9-11 in this *Operator Manual*. See also your GRT8120 *Service Manual* for specified maintenance and lubrication instructions.



LIFT CYLINDER

FIGURE 9-16

Boom Lubrication

READ FIRST! IMPORTANT CRANE SET-UP INFORMATION!

1. With crane set on a firm level surface and a minimum 29,200-lb counterweight installed, fully extend the outriggers, and level the crane.
2. Center the boom over the front of the crane, engage the turntable swing lock pin, and disable the swing function.
3. Fully retract the boom and set boom angle to 70°.
4. Limit rigging to an overhaul ball or a hook block of no more than 2000 lb.
5. Program the RCL to Rigging Code 0001. Do Not Override the RCL with the Limit Bypass Switch to service the boom.
6. Use the Manual Telescope Mode in the ODM to extend and retract the Telescope Sections in the sequences given.
7. To grease rear upper wear pads, front wear pads, and locking pins **on each Tele Section**, extend boom to the sequences given in the following chart.
8. Start with Tele Section 6 (Tele 6).

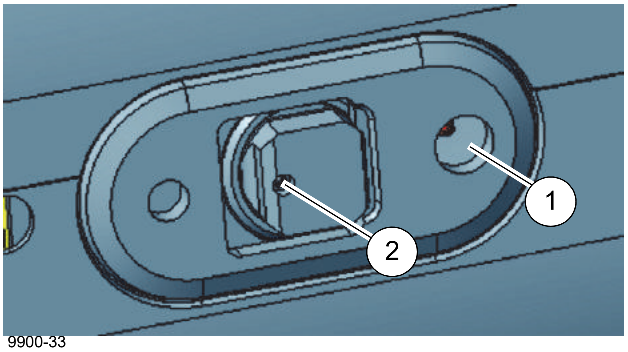
	To Grease Tele 6	To Grease Tele 5	To Grease Tele 4	To Grease Tele 3	To Grease Tele 2	To Grease Tele 1
Tele 1	0	0	0	0	50	100
Tele 2	0	0	0	50	100	0
Tele 3	0	0	50	100	0	0
Tele 4	0	50	100	0	0	0
Tele5	50	100	0	0	0	0
Tele 6	100	0	0	0	0	0

If necessary, refer to the following detailed procedures to lubricate the boom in Manual Telescope Mode.

Telescope Section 6 (Tele 6)

1. Select the Manual Telescope Mode function icon in the Operator Display Module (ODM) to enter Manual Telescope Mode.
2. Make sure that the tele cylinder is locked to Tele 6.
3. Extend and lock Tele 6 to the 100% pinning location.
4. Extend and lock Tele 5 to the 50% pinning location.
5. Lower the boom to 0° and perform the following greasing in this position:
   a. Grease outer sides of Tele 6 in the areas that touch the front wear pads of Tele 5.
   b. Grease the rear upper wear pads of Tele 6 on both sides, at the grease fittings (1, Figure 9-17), through the openings in Tele 5.
   c. Grease locking pins on both sides (2, Figure 9-17).

NOTE: To grease the rear upper wear pads of Tele 56 at the 50% or 89% pinning locations, extend and lock Tele 6 to these pinning locations and repeat **Step 5b** greasing.



9900-33

BOOM SERVICE LOCATIONS –
REAR UPPER WEAR PADS AND LOCKING PINS

FIGURE 9-17

6. While in the horizontal position, first retract Tele 5, and then retract and extend Tele 6 several times to make sure that grease is properly distributed.
7. When Tele 6 greasing is complete, retract and lock Tele 6 to the 0% pinning location.
8. Raise boom to 70°.

Telescope Section 5 (Tele 5)

1. Make sure that the tele cylinder is locked to Tele 5.
2. Extend and lock Tele 5 to the 100% pinning location.
3. Extend and lock Tele 4 to the 50% pinning location.
4. Lower the boom to 0° and perform the following greasing in this position:
   a. Grease outer sides of Tele 5 in the areas that touch the front wear pads of Tele 4.
   b. Grease the rear upper wear pads of Tele 5 on both sides, at the grease fittings (1, Figure 9-17), through the openings in Tele 4.
   c. Grease locking pins on both sides (2, Figure 9-17).

NOTE: To grease the rear upper wear pads of Tele 5 at the 50% or 89% pinning locations, extend and lock Tele 5 to these pinning locations and repeat **Step 5b** greasing.

5. While in the horizontal position, first retract Tele 4, and then retract and extend Tele 5 several times to make sure that grease is properly distributed.
6. When Tele 5 greasing is complete, retract and lock Tele 5 to the 0% pinning location.
7. Raise boom to 70°.

Telescope Section 4 (Tele 4)

1. Make sure that the tele cylinder is locked to Tele 4.
2. Extend and lock Tele 4 to the 100% pinning location.
3. Extend and lock Tele 3 to the 50% pinning location.
4. Lower the boom to 0° and perform the following greasing in this position:
   a. Grease outer sides of Tele 4 in the areas that touch the front wear pads of Tele 3.
   b. Grease the rear upper wear pads of Tele 4 on both sides, at the grease fittings (1, Figure 9-17), through the openings in Tele 3.
   c. Grease locking pins on both sides (2, Figure 9-17).

NOTE: To grease the rear upper wear pads of Tele 4 at the 50% or 89% pinning locations, extend and lock Tele 4 to these pinning locations and repeat **Step 4b** greasing.

5. While in the horizontal position, first retract Tele 3, and then retract and extend Tele 4 several times to make sure that grease is properly distributed.
6. When Tele 4 greasing is complete, retract and lock Tele 4 to the 0% pinning location.
7. Raise boom to 70°.

Telescope Section 3 (Tele 3)

1. Make sure that the tele cylinder is locked to Tele 3.
2. Extend and lock Tele 3 to the 100% pinning location.
3. Extend and lock Tele 2 to the 50% pinning location.
4. Lower the boom to 0° and perform the following greasing in this position:
   a. Grease outer sides of Tele 3 in the areas that touch the front wear pads of Tele 2.
   b. Grease the rear upper wear pads of Tele 3 on both sides, at the grease fittings (1, Figure 9-17), through the openings in Tele 2.
   c. Grease locking pins on both sides (2, Figure 9-17).

NOTE: To grease the rear upper wear pads of Tele 3 at the 50% or 89% pinning locations, extend and lock Tele 3 to these pinning locations and repeat **Step 4b** greasing.

5. While in the horizontal position, first retract Tele 2, and then retract and extend Tele 3 several times to make sure that grease is properly distributed.
6. When Tele 3 greasing is complete, retract and lock Tele 3 to the 0% pinning locations.
7. Raise boom to 70°.

Telescope Section 2 (Tele 2)

1. Make sure that the tele cylinder is locked to Tele 2.
2. Extend and lock Tele 2 to the 100% pinning location.
3. Extend and lock Tele 1 to the 50% pinning location.
4. Lower the boom to 0° and perform the following greasing in this position:
   a. Grease outer sides of Tele 2 in the areas that touch the front wear pads of Tele 1.
   b. Grease the rear upper wear pads of Tele 2 on both sides, at the grease fittings (1, Figure 9-17), through the openings in Tele 1.
   c. Grease locking pins on both sides (2, Figure 9-17).

NOTE: To grease the rear upper wear pads of Tele 2 at the 50% or 89% pinning locations, extend and lock Tele 2 to these pinning locations and repeat **Step 4b** greasing.

5. While in the horizontal position, first retract Tele 1, and then retract and extend Tele 2 several times to make sure that grease is properly distributed.
6. When Tele 2 greasing is complete, retract and lock Tele 2 to the 0% pinning location.
7. Raise boom to 70°.

Telescope Section 1 (Tele 1)

1. Make sure that the tele cylinder is locked to Tele 1.
2. Extend and lock Tele 1 to the 100% pinning location.
3. Lower the boom to 0° and perform the following greasing in this position:
   a. Grease outer sides of Tele 1 in the areas that touch the front wear pads of the base section.
   b. Grease the rear upper wear pads of Tele 1 on both sides, at the grease fittings (1, Figure 9-17), through the openings in the base section.
   c. Grease locking pins on both sides (2, Figure 9-17).

NOTE: To grease the rear upper wear pads of Tele 1 at the or 89% pinning locations, extend and lock Tele 1 to these pinning locations and repeat **Step 3b** greasing.

4. While in the horizontal position, extend and retract Tele 1 several times to make sure that grease is properly distributed.
5. When Tele 1 greasing is complete, retract and lock Tele 1 to the 0% pinning location.

Boom Tele Section Lubrication procedures are complete.

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Boom Lubrication (Continued)						
80	Hook Block, 1 Sheave, Swivel Bearing – 26MT	Figure 9-18	A	Use grease fittings provided Apply until grease extrudes	Every 250 hours, or 3 months of service, whichever interval comes first	CHECK sheaves on each of four (4) hook blocks listed CHECK sheaves for dry points of operation CHECK sheaves for grease leaks GREASE swivel bearing(s) at service points, as shown Each hook block has 3 service points The overhaul ball and cylinder each have 1 service point **See NOTE 42.** **See NOTE 44.**
81	Hook Block, 3 Sheave, Swivel Bearing – 45MT					
82	Hook Block, 5 Sheave, Swivel Bearing – 75MT					
83	Hook Block, 7 Sheave, Swivel Bearing – 100MT					
84	Overhaul Ball/Cylinder					
85	Telescopic Slide Faces	Figure 9-19	M	Brush on	Every 500 hours, or 6 months, whichever interval comes first	BRUSH ON front faces in a thin line 12 service points **See NOTE 42.** **See NOTE 43.**

CAUTION

Possible Equipment Damage!

Use specified semi-synthetic or synthetic lubricants as listed in this section of your GRT8120 *Operator Manual*. See also your GRT8120 *Service Manual* for maintenance and lubrication instructions.

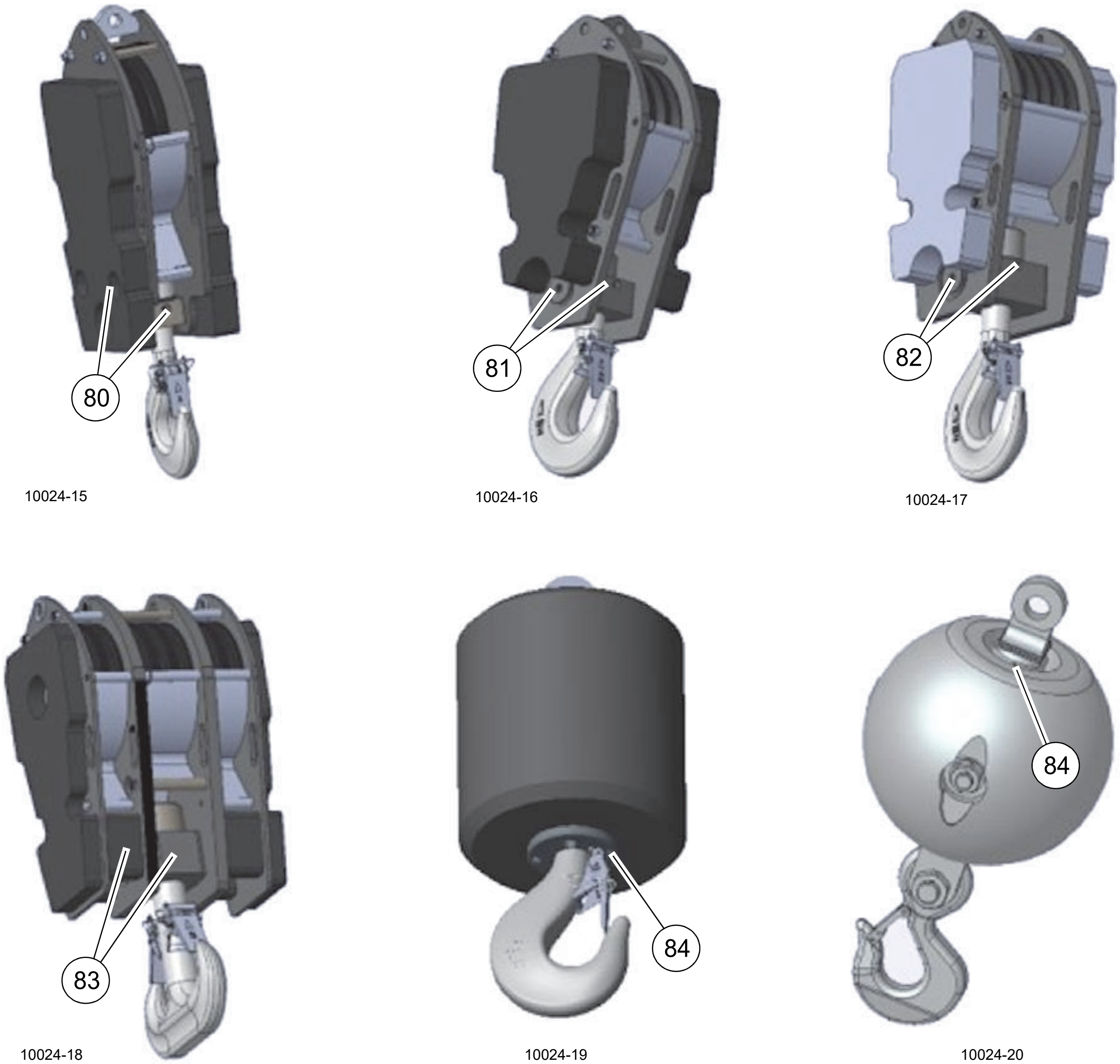
Use of non-approved, non semi-synthetic lubricant may damage components and/or invalidate published lubricant intervals.

Failure to follow this instruction may cause damage to equipment.

NOTE 42: **DO NOT USE non semi-synthetic lubricant**. Use of non-approved lubricant may damage components.

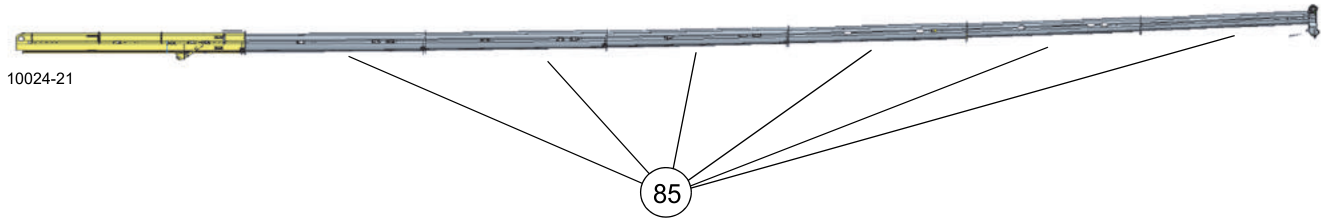
NOTE 43: Extend boom for **access to telescopic slide front faces** that contact wear pads inside the boom. Follow the Tele Section positioning and lubrication instruction given in the section titled *READ FIRST! IMPORTANT CRANE SET-UP INFORMATION!*, page 9-33. If the weather is very bad or operating conditions are poor, then more frequent intervals are necessary. Monitor the service points and adjust lubrication intervals, as necessary.

NOTE 44: Slowly turn the sheave, and **examine it for rough or dry points** of operation and **grease leaks**. If rough or dry points of operation are found, then **replace the sheave**. If grease leaks are found, then **replace the sheave**.



HOOK BLOCKS, OVERHAUL BALL, OVERHAUL CYLINDER

FIGURE 9-18



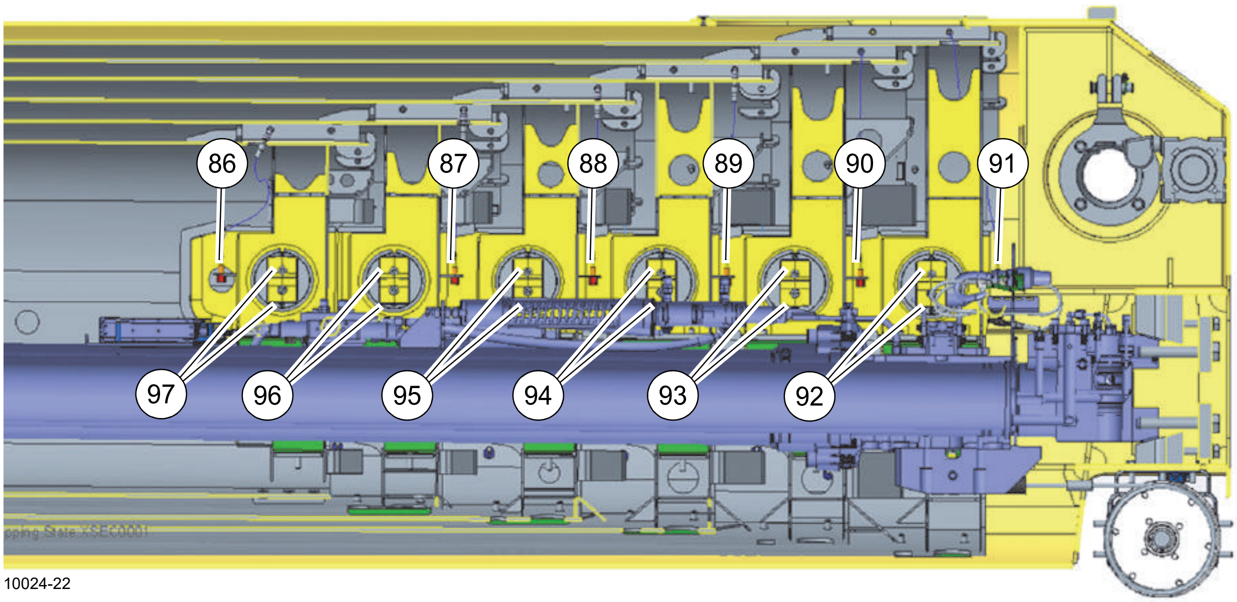
TELESCOPIC SECTION SLIDE FRONT FACES

FIGURE 9-19

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Boom Lubrication (Continued)						
86	Tele 6 Rear Upper Wear Pad	Figure 9-20	M	Only until resistance is felt	Every 500 hours, or 6 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 45.**
87	Tele 5 Rear Upper Wear Pad	Figure 9-20	M	Only until resistance is felt	Every 500 hours, or 6 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 45.**
88	Tele 4 Rear Upper Wear Pad	Figure 9-20	M	Only until resistance is felt	Every 500 hours, or 6 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 45.**
89	Tele 3 Rear Upper Wear Pad	Figure 9-20	M	Only until resistance is felt	Every 500 hours, or 6 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 45.**
90	Tele 2 Rear Upper Wear Pad	Figure 9-20	M	Only until resistance is felt	Every 500 hours, or 6 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 45.**
91	Tele 1 Rear Upper Wear Pad	Figure 9-20	M	Only until resistance is felt	Every 500 hours, or 6 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 45.**
92	Tele 1 Lock Pin	Figure 9-20	N	1 or 2 pumps each fitting	Every 250 hours, or 3 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 46.**
93	Tele 2 Lock Pin	Figure 9-20	N	1 or 2 pumps each fitting	Every 250 hours, or 3 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 46.**
94	Tele 3 Lock Pin	Figure 9-20	N	1 or 2 pumps each fitting	Every 250 hours, or 3 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 46.**
95	Tele 4 Lock Pin	Figure 9-20	N	1 or 2 pumps each fitting	Every 250 hours, or 3 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 46.**
96	Tele 5 Lock Pin	Figure 9-20	N	1 or 2 pumps each fitting	Every 250 hours, or 3 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 46.**
97	Tele 6 Lock Pin	Figure 9-20	N	1 or 2 pumps each fitting	Every 250 hours, or 3 months, whichever interval comes first	LUBRICATE 2 service points **See NOTE 46.**

NOTE 45: **DO NOT apply excessive pressure or force** when greasing wear pads. Applying excessive pressure or force can cause grease fitting to separate from wear pad. **Apply grease only until resistance is felt**.

NOTE 46: To grease rear upper-wear pads, front wear pads, and locking pins on each Tele Section, follow the Tele Section positioning and lubrication instruction given in the section titled *READ FIRST! IMPORTANT CRANE SET-UP INFORMATION!*, page 9-33 of this GRT8120 *Operator Manual*. Start with Tele Section 6 (Tele 6). See also your GRT8120 *Service Manual* for detailed service interval and specified boom lubrication instructions.



LEFT SIDE BOOM – REAR UPPER WEAR PADS AND LOCK PINS

FIGURE 9-20

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Boom Lubrication (Continued)						
98	Tele Cylinder Sled Wear Pad	Figure 9-21	M	Coat areas that the wear pads move on	Every 500 hours, or 6 months of service, whichever interval comes first	BRUSH ON 5 service points
99	Derricking Pivot Pin	Figure 9-21	A	Until grease extrudes	Every 100 hours, or 1 month of service, whichever interval comes first	LUBRICATE 2 service points
100	Boom Extension Sheave	Figure 9-21	A	—	Every 250 hours, or 3 months of service, whichever interval comes first	CHECK 2 service points CHECK sheaves for dry points of operation and grease leaks **See NOTE 47.**
101	Mast Sheave	Figure 9-21	A	—	Every 250 hours, or 3 months of service, whichever interval comes first	CHECK 2 service point CHECK sheave for dry points of operation and grease leaks **See NOTE 47.**
102	Boom Nose Sheaves	Figure 9-21	A	—	Every 250 hours, or 3 months of service, whichever interval comes first	CHECK 7 service points CHECK sheave for dry points of operation and grease leaks **See NOTE 47.**
103	Auxiliary Boom Nose Sheave	Figure 9-21	A	—	Every 250 hours, or 3 months of service, whichever interval comes first	CHECK 1 service point CHECK sheave for dry points of operation and grease leaks **See NOTE 47.**
104	Boom Extension Screw	Figure 9-21	A	Brush on entire screw	BRUSH ON, as necessary	BRUSH ON 1 service point
105	Boom Extension Pivot Pins	Figure 9-21	A	Until grease extrudes	Every 250 hours, or 3 months of service, whichever interval comes first	LUBRICATE 2 service points
NOTE 47: Slowly turn the sheave, and **examine it for rough or dry points** of operation and **grease leaks**. If rough or dry points of operation are found, then **replace the sheave**. If grease leaks are found, then **replace the sheave**.						

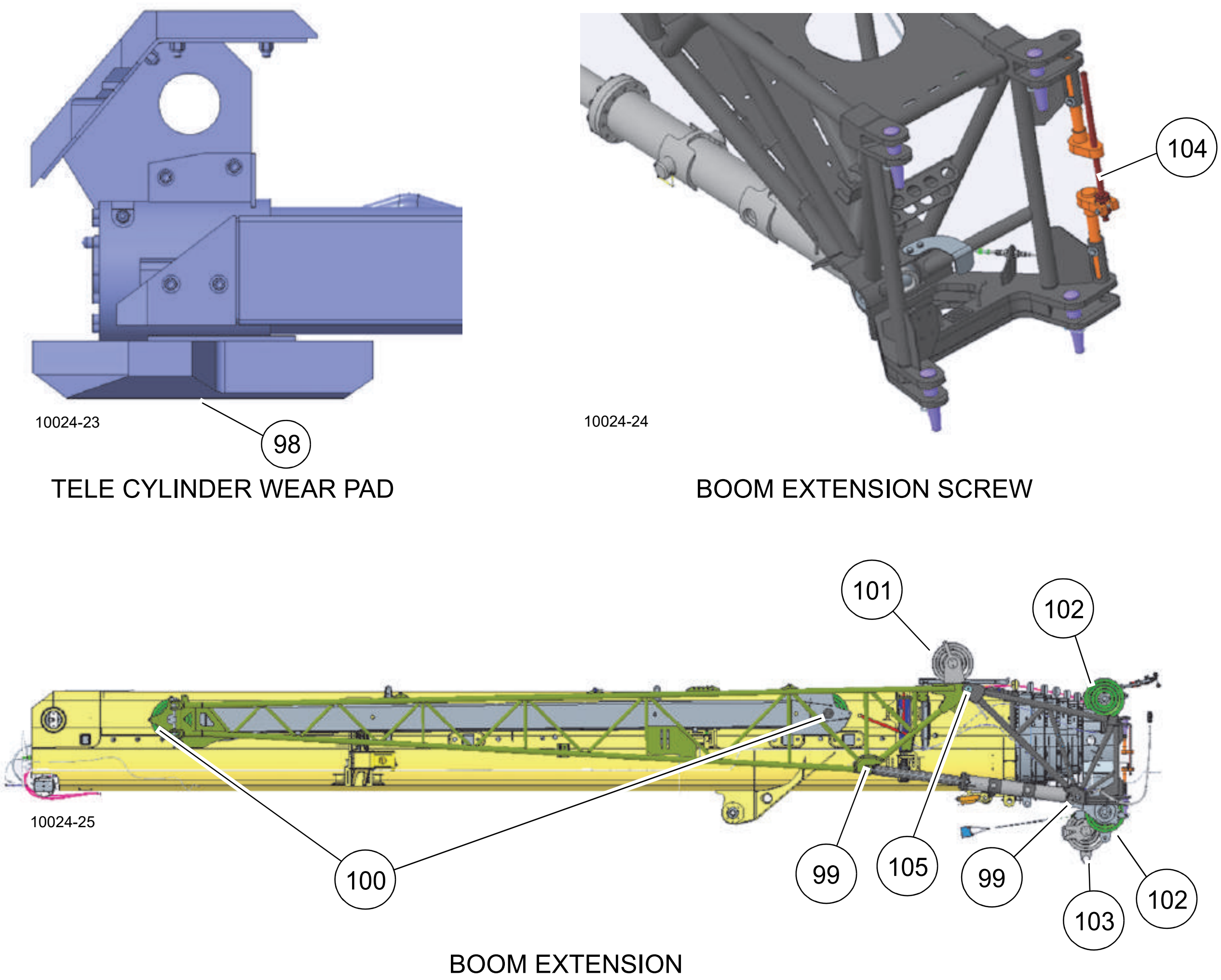
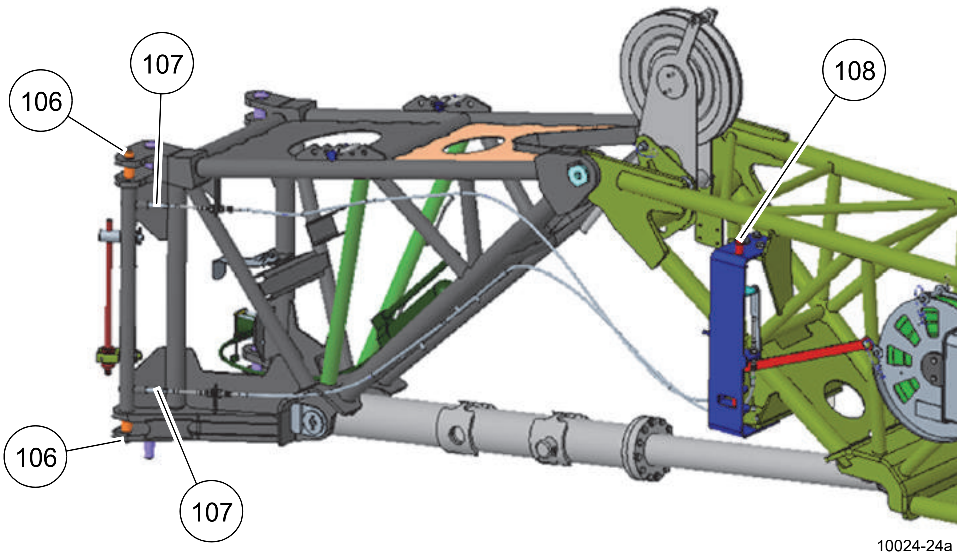

10024-23
98
TELE CYLINDER WEAR PAD
10024-24
104
BOOM EXTENSION SCREW
101
102
10024-25
100
99
105
99
103
102
BOOM EXTENSION

FIGURE 9-21

Item	Lube Point Description	Figure No.	Approved Lubricant	Approximate Capacity	Service Interval	Service Application
Boom Lubrication (Continued)						
106	Boom Extension Attachment Pins	Figure 9-22	A	Brush on	Every 250 hours, or 3 months of service, whichever interval comes first	LUBRICATE 2 service points
107	Interlock Pins	Figure 9-22	A	Brush on	Every 250 hours, or 3 months of service, whichever interval comes first	LUBRICATE 2 service points
108	Boom Extension Swing Pin	Figure 9-22	A	Brush on	Every 250 hours, or 3 months of service, whichever interval comes first	LUBRICATE 1 service point
109	Rear Boom Extension Ramp Pin	Figure 9-22	A	Until grease extrudes	Every 250 hours, or 3 months, whichever interval comes first	LUBRICATE 1 service point



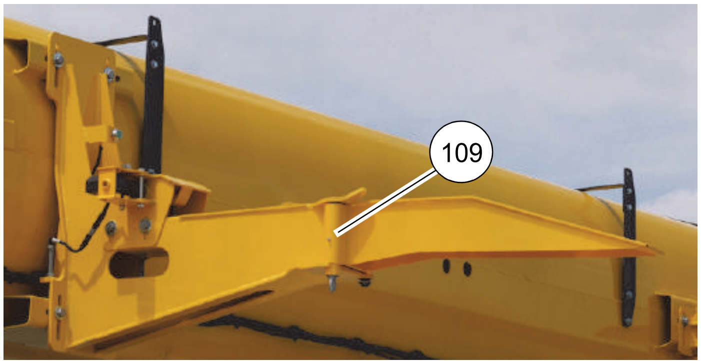


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FIGURE 9-22

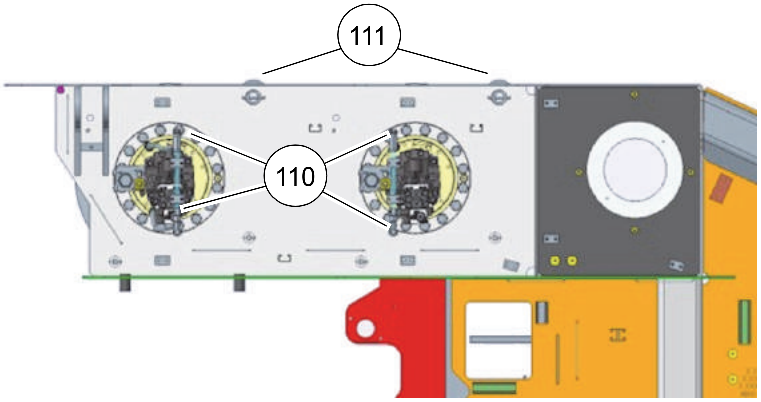
<table>
<tr><th>Item</th><th>Lube Point Description</th><th>Figure No.</th><th>Approved Lubricant</th><th>Approximate Capacity</th><th>Service Interval</th><th>Service Application</th></tr>
<tr><td colspan="7">Hoist Lubrication</td></tr>
<tr><td rowspan="4">110</td><td rowspan="4">Hoist Drums (Main & Auxiliary)</td><td rowspan="4">Figure 9-23</td><td rowspan="4">H</td><td rowspan="4">4 L (1.05 gal)</td><td rowspan="2">Every 50 hours of service, or weekly, whichever interval comes first</td><td>CHECK oil level
2 service points
REMOVE vent or hose from top of the sight glass to FILL
FILL hoist drums to LEVEL visible in sight glass
2 service points
See NOTE 48.
See NOTE 49.
See NOTE 51.</td></tr>
<tr><td>CHECK and CLEAN breather, as needed</td></tr>
<tr><td rowspan="2">Every 1000 hours, or 12 months of service, whichever interval comes first</td><td>REMOVE plug or hose from bottom of sight glass to DRAIN oil
DRAIN hoist drums
2 service points</td></tr>
<tr><td>FILL hoist drums to LEVEL visible in sight glass
See NOTE 48.
See NOTE 49.
See NOTE 51.
CHECK and CLEAN breather, as needed</td></tr>
<tr><td>111</td><td>Hoist Rope Rollers</td><td>Figure 9-23</td><td>A</td><td>Brush on outer surface of roller</td><td>Every 250 hours, or 3 months of service, whichever interval comes first</td><td>BRUSH ON
2 service points
See NOTE 48.
See NOTE 50.</td></tr>
<tr><td>112</td><td>Hoist Bearings</td><td>Figure 9-23</td><td>A</td><td>Until grease extrudes from entire bearing circumference</td><td>Every 250 hours, or 3 months of service, whichever interval comes first</td><td>LUBRICATE
2 service points
See NOTE 48.
See NOTE 51.</td></tr>
</table>

NOTE 48: **DO NOT USE non semi-synthetic lubricant**. Use of non-approved lubricant may damage components.

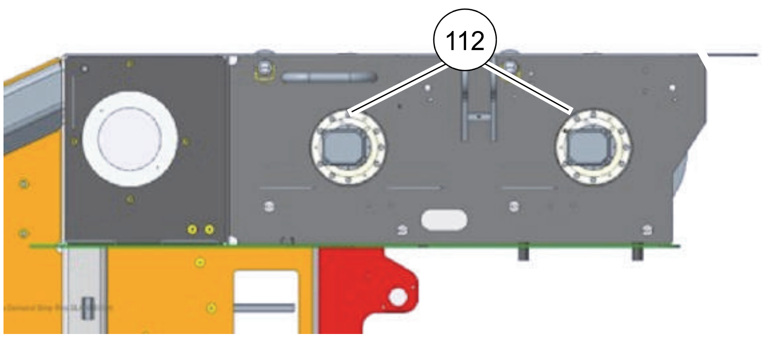
NOTE 49: Check oil level in hoist drum sight glass. Hoist oil level MUST be between the high and low marks on sight glass. If oil is not visible, hoist may be underfilled. If oil is escaping from the vent plug, hoist may be overfilled.

NOTE 50: If the weather is very bad or operating conditions are poor, then more frequent intervals are necessary. Monitor the service points and adjust lubrication intervals, as necessary.

NOTE 51: Before operating crane in cold weather (arctic) ambient temperatures below -9°C (+15°F), Standard bearing grease must be fully purged and replaced with Cold Weather bearing grease meeting Grove U.S. L.L.C. specifications as shown in Table 9-4*: Approved Lubricant Reference Table*, page 9-11 in this *Operator Manual*. See also your GRT8120 *Service Manual* for maintenance and lubrication instructions.



HOIST DRUM – RIGHT SIDE



HOIST DRUM – LEFT SIDE

HOIST DRUMS – (MAIN and AUXILIARY)

FIGURE 9-23

<table>
<tr><th>Item</th><th>Lube Point Description</th><th>Figure No.</th><th>Approved Lubricant</th><th>Lube Capacity</th><th>Lube Interval</th><th>Application</th></tr>
<tr><td colspan="7">Hydraulics Lubrication</td></tr>
<tr><td>114</td><td>Hydraulic Filter</td><td>Figure 9-24</td><td>—</td><td>—</td><td>REPLACE hydraulic filter when restriction indicator gauge on the filter head shows red</td><td>REPLACE hydraulic filter element
See NOTE 53.
See NOTE 56.</td></tr>
<tr><td>115</td><td>Hydraulic Tank SIGHT GLASS
See NOTE 52.</td><td rowspan="3">Figure 9-24</td><td rowspan="3">J</td><td rowspan="3">926.5 L (192.6 gal) Tank only</td><td>Every 10 hours of service, or daily, whichever interval comes first</td><td>CHECK oil level
FILL hydraulic tank to LEVEL in SIGHT GLASS</td></tr>
<tr><td rowspan="2">116</td><td rowspan="2">Hydraulic Tank BREATHER</td><td>PERFORM SERVICE INSPECTION every 3 to 6 months
See NOTE 56.</td><td>PERFORM SERVICE INSPECTION of oil, filters, and breathers
See NOTE 54.
See NOTE 55.</td></tr>
<tr><td>SAMPLE hydraulic oil every 3 to 6 months</td><td>SAMPLE hydraulic oil</td></tr>
</table>

NOTE 52: Check Hydraulic oil level using sight glass on tank with boom fully retracted and lowered, and all outrigger cylinders retracted.

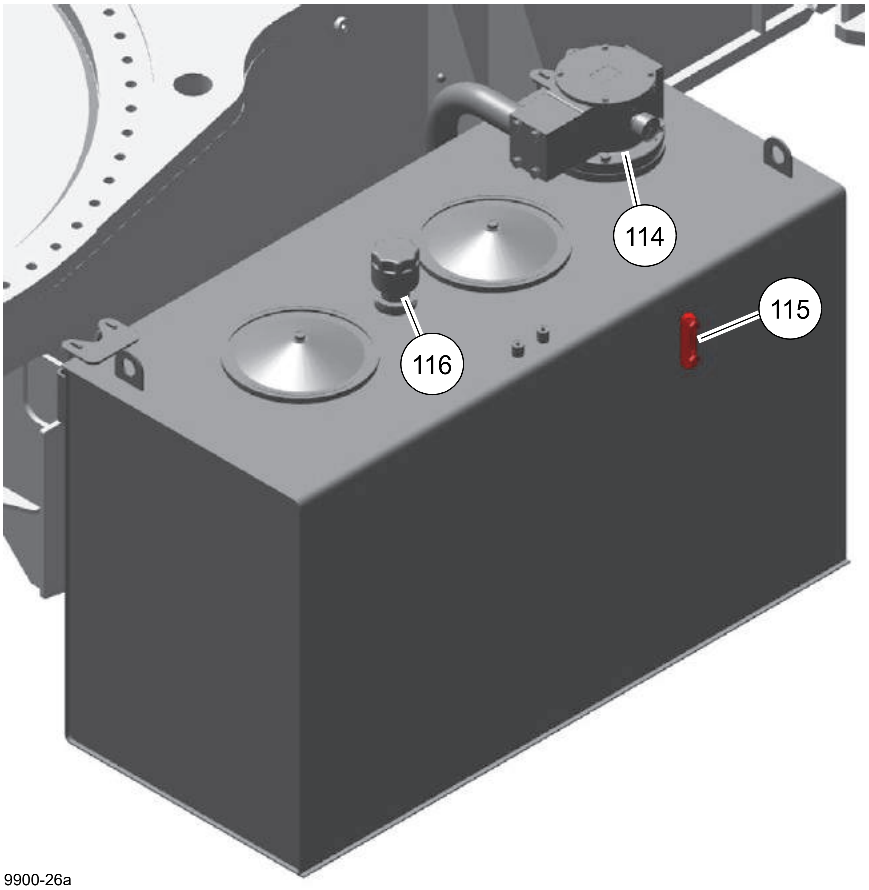
NOTE 53 REPLACE hydraulic filter element when the restriction indicator gauge on the filter head is in the red and oil is at operating temperature.

NOTE 54: REPLACE hydraulic filter at **first 50-hours of service** and **repeat after another 50-hours**, for a total of **100 hours of service**, thereafter, at normal intervals.

NOTE 55: Hydraulic oil MUST BE at operating temperature at hydraulic filter and tank inspection and service. Hydraulic oil MUST be drained at a temperature of 65°C to 90°C (150°F to 200°F).

NOTE 56: **Hydraulic oil SHALL MEET or EXCEED ISO 4406 class 17/14 cleanliness level** (reference SAE J1165).

- Working in harsh environmental conditions can dramatically affect the performance and condition of hydraulic oil, filters, and breathers. Therefore, specific intervals for servicing/changing hydraulic oil, filters, and hydraulic tank breathers cannot be set. Thus, it is imperative for the continued satisfactory performance of Grove cranes, that service inspections be performed on the basis of how and where each crane is used.
- Under normal operating conditions, Grove recommends that **hydraulic oil**, **filters**, and **breathers** be serviced, and **hydraulic oil sampled** at least every 3 to 6 months. Service inspections should be for airborne or ingested particles and water that deteriorates and contaminates the hydraulic oil. Contaminated hydraulic 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 the contaminant content is high. If the filter by-pass indicator reaches the red zone or indicates a by-pass condition, the hydraulic oil must be sampled. Perform service to **make sure that the hydraulic oil tank breather does not restrict air flow IN, or air flow OUT of the reservoir**.
- FILL procedure for Hydraulic Tank operation below -9°C (+15°F):
  - **a.** DRAIN existing oil.
  - **b.** FILL tank with oil per 6829101559 and cycle all cylinders.
  - **c.** DRAIN oil.
  - **d.** FILL tank with oil per 6829101559.
- See also your GRT8120 *Service Manual* for further details on Hydraulic Oil Sampling Test. Should you have any questions, please contact your local authorized Grove distributor.



HYDRAULIC TANK

FIGURE 9-24

RUST PROTECTION

Protecting Cranes From Rusting

Grove 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.

Grove cranes are treated with Carwell® T32 (CP-90) rust inhibitor. While a rust inhibitor cannot guarantee that a crane will never rust, this product helps protect against corrosion on Grove cranes.

Carwell® is a treatment, not a coating. It contains no silicones, solvents, chlorofluorocarbons (CFC), or anything that would be classified as hazardous under OSHA Regulation 29CRF 1910.1200. The product is a liquid blend of petroleum derivatives, rust inhibitors, and water-repelling/water-displacing agents.

Special equipment is used to spray a light film on the entire undercarriage and various other areas of each new crane before shipment. When applied, the product has a red tint to allow applicators to view coverage. This red tint turns clear within approximately 24 hours after application.

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

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

In addition to the factory-applied treatment, Grove 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 Grove cranes.

The most common causes of corrosion include the following:

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

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

Exercise special care and increase frequency of cleaning if 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 (for example, 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 Grove cranes, Manitowoc Crane Care recommends washing the crane at least monthly to remove all foreign matter. More frequent cleaning may be needed when operating in harsh environmental conditions. To clean the crane, follow these guidelines:

- High pressure water or steam is effective for cleaning the crane undercarriage and wheel housings. Keeping these areas clean will decrease the rate of corrosion and improve the ability to identify possible issues before they grow into larger problems.

CAUTION

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

- Rinse 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 before washing. Do not use solvents or gasoline.
- Wash the crane only with soaps and detergents recommended for automotive paint finishes.
- Rinse all surfaces thoroughly to prevent streaking caused by soap residue.
- Allow crane to dry thoroughly. You can increase the speed of evaporation by using compressed air to remove excess water.

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

Inspection and Repair

- Immediately following cleaning of the Grove crane, 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.
- Any area scratched through to bare 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 a qualified body repair technician prepare, prime, and paint any major scratch(es) or minor damage.

CAUTION

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

For scratches and marks in highly visible areas:

1. Sand to remove scratch. Feather outward from the mark to blend repair into the original surface. Apply body putty as necessary to hide the defect; then sand smooth.
2. Cover all bare metal with a primer compatible with the original paint finish and allow to dry thoroughly.
3. Prepare surface before applying finish coat of paint.
4. Apply a finish coat using accepted blending techniques. Use of original paint colors is recommended to ensure the best color match possible.

For scratches and marks in areas of low visibility:

- Consider touching up the spots with a brush technique to cover the bare metal. This will decrease the rate of corrosion, and enable you to do the repair later 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 on the environment in which a crane is used and/or stored, initial factory application of Carwell® T32 (CP-90) should help inhibit corrosion for approximately 12 months.

It is recommended the treatment be periodically reapplied by the crane owner, after that time, to help continue protection against corrosion of the crane and its components.

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

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

NOTE: The crane must be completely dry before applying treatment.

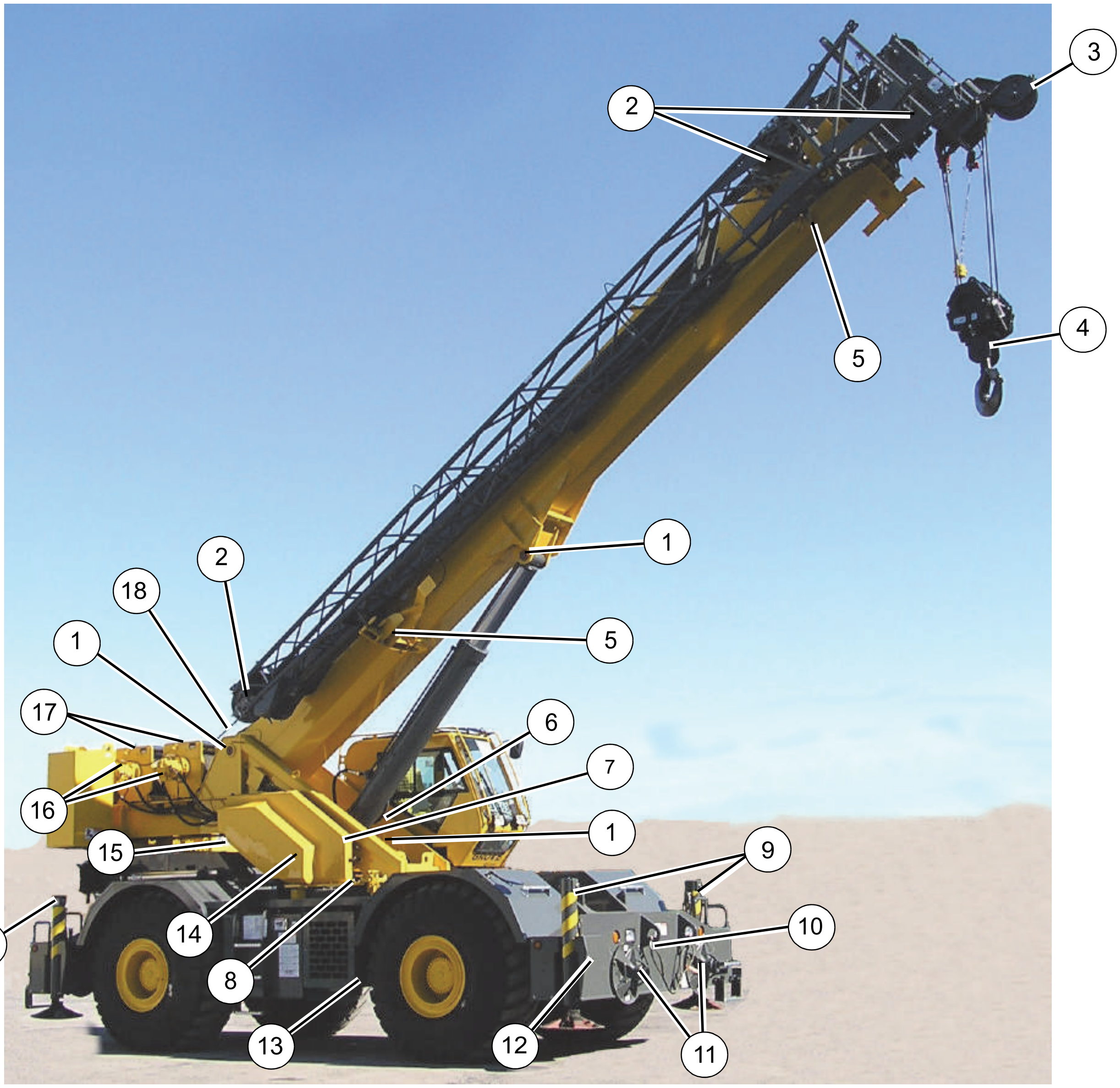
- Do not allow product to puddle or build-up on weather stripping, rubber gaskets, etc. The crane should not have puddles or runs evident anywhere.
- To ensure proper coverage, product needs to be fogged on the crane.
- Use of pressure pots to apply treatment is recommended.
- Carwell® treatment is available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

Contact your local Grove distributor or Manitowoc Crane Care should you have any questions.

Areas of Application

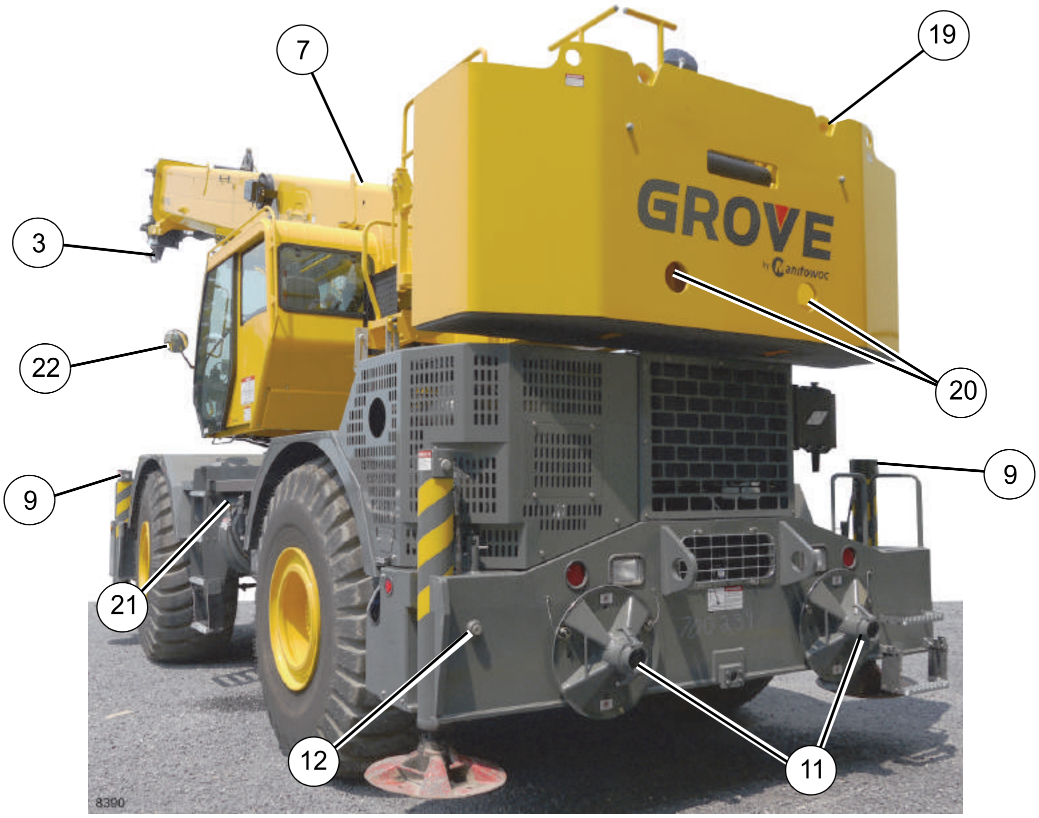
Refer to Figure 9-25 and Figure 9-26 for location of crane components that need periodic application of Carwell® T32 (CP-90) for continued protection against corrosion.

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



Picture may not be same model as your crane, it is for reference only.

Figure 9-25



Picture may not be same model as your crane, it is for reference only.

Figure 9-26

Table 9-1 Rust Inhibitor Application Locations

1	Boom Extension Pins, Clips	12	Entire underside of crane
2	Boom Nose Pins, Clips	13	Turntable Bearing Fasteners
3	Hook Block/Overhaul Ball	14	Powertrain Hardware Inside Compartment
4	Boom Extension Hanger Hardware	15	Valve Bank
5	Pivot Shaft	16	Hoist Hose Connections
6	Hose Connections Inside Turntable	17	Tension Spring
7	All Hardware, Clips, Pins, Hose Connections not painted Outrigger Pins, Clips	18	Wire Rope
8	Outrigger Hose Connections	19	Counterweight Mounting Hardware
9	Hook Block Tiedown Cable	20	Counterweight Pins
10	Outrigger Pins, Clips	21	Hose Connections
11	O/R Beam Wear Pad Adjustment Hardware	22	Mirror Mounting Hardware

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