LUBRICATION GUIDE

Model MLC650

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LUBRICATION SYMBOLS

The symbols in Figure 1 are used in decals on the crane to identify lubrication points.

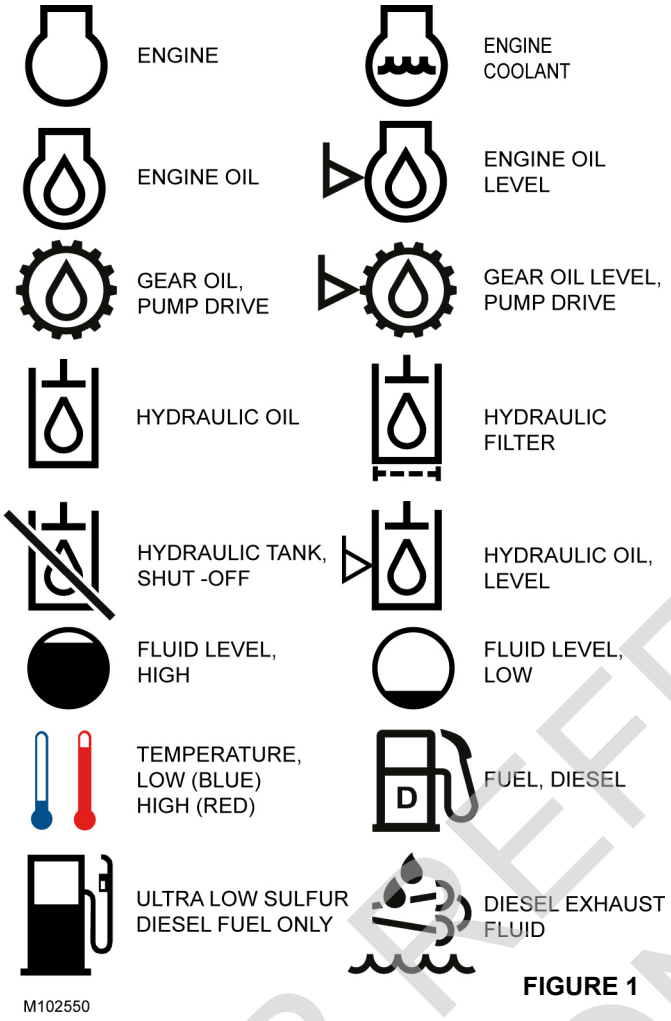


FIGURE 1

WARNING

Personal Injury Hazard!

Personal injury can occur if the following safety precautions are not taken before and after servicing machinery:

- Stop the engine and wait until all moving parts have completely stopped (if necessary, position any grease fittings on moving parts at the access point and then stop the engine).
- Attach a WARNING "**OUT-OF-ORDER**" sign to the engine start control in the operator's cab to warn all personnel that the crane is being serviced.
- Do not operate the crane until all safety guards and covers have been securely reinstalled and all maintenance equipment has been removed.

GENERAL LUBRICATION

This publication describes the major lubrication considerations for this crane. Some points requiring lubrication (for example, the linkage in control members not equipped with grease fittings) have been omitted, but they should be lubricated in accordance with good maintenance practices (see "Oil Can Points" on page 3).

The lubrication intervals for vendor-supplied parts have also been omitted from this Lubrication Guide. ***Service vendor-supplied parts according to the original equipment manufacturers' manuals.***

Depending on the options your crane is equipped with, some lubrication points given in this Lubrication Guide may not apply to your crane.

LUBRICATION INTERVALS

The intervals listed in this Lubrication Guide are for ***average operating conditions*** based on experience gained by testing lubricants at the factory and on recommendations given by the lubricant suppliers. Severe operating conditions (such as excessively dusty or corrosive atmosphere, unusually high or low outside temperature, extreme loadings, uncommonly frequent or long operating cycles) may require shortening the lubrication intervals. Follow the intervals given in this Lubrication Guide until adequate experience is obtained to establish intervals which meet your operating conditions.

Bearings and bushings that are too warm, excessive play in moving parts, binding in moving parts, excessive or abnormal wear in gears and chains, and rust accumulation indicate a lack of lubrication. If these conditions are found during regular inspection, the lubrication interval for the faulty parts should be shortened.

CAUTION

Machinery Damage!

Before lengthening lubrication intervals, check that all parts are receiving an adequate supply of clean lubricant. Otherwise, parts will be damaged from a lack of lubrication. Contact your Manitowoc Cranes dealer or Manitowoc Crane Care Lattice Team for recommendations on lengthening lubrication intervals.

Perform an oil analysis at regular intervals of each fluid used in the crane to determine oil-change intervals. Oil sample kits are provided in the Parts Box of current production cranes.

It is assumed that the maintenance intervals are cumulative, that is, daily maintenance tasks will be performed together with weekly tasks. Daily and weekly tasks will be performed together with monthly tasks.

Intervals are based on engine hour meter or individual component hours of operation readings, as required. Individual component hours of operation can be viewed on the display in the cab (see the MLC650 Main Display Manual for instructions).

OVER-LUBRICATION

Over-lubrication is not only wasteful, but also harmful:

- Excess lubrication can work its way onto friction surfaces and result in faulty operation.
- Oil or grease that drips onto walkways can cause personnel to slip and be hurt.
- Too high of an oil level can cause churning and foaming of the oil, and result in excessive heat and over-flow from the reservoir.
- An extra shot of grease, if too stiff or under too much pressure, can pop out a bearing seal.

LUBRICATION TIPS

Use the following tips during lubrication:

- Check all oil levels before start-up so the oil has had a chance to run down from the reservoir walls and moving parts.
- Avoid introducing dirt into reservoirs. Carefully clean the area around dipsticks, level plugs, fill plugs, and breathers before removing them.
- Replace level plugs, fill plugs, drain plugs, and breathers snugly and wipe up any spillage.
- Keep oil and grease dispensers and containers tightly closed and store in a dirt and moisture-free location.
- Clean grease fittings before and after applying grease.
- Apply grease until the bushing or bearing is purged so dirt and water cannot enter. Wipe up excess grease.
- Protect the environment. Dispose of waste fluids, filters, and batteries properly. See “Environmental Protection” on page 5.

WATER IN HYDRAULIC OIL

Prevent damage that can occur when water mixes with hydraulic oil. Drain any accumulated water from the bottom of the hydraulic tank at the **start of each work day**. Crack open the drain valve at the bottom of the hydraulic tank. Securely close the drain valve as soon as the water stops draining and a steady stream of oil appears.

OIL CAN POINTS

Oil ***all pins*** not equipped with grease fittings with engine oil every 40 hours of operation or once a week, whichever comes first.

WIRE ROPE LUBRICATION

New wire rope is lubricated during manufacturing, but this lubricant is only adequate for initial storage and the early stages of operation. To prevent the damaging effects of corrosion and to reduce wear, the wire rope must be lubricated at regular intervals.

Contact your wire rope manufacturer/dealer for lubrication recommendations. The lubrication interval and the type of lubricant used depends on the type of wire rope, the severity of duty, and the type of corrosive elements the wire ropes is subjected to:

- The wire rope must be properly protected at all times.
- The lubricant must be fluid enough to fully penetrate the strands and rope core. Use one of the methods shown in Figure 2, to lubricate the wire rope.
- For maximum penetration, apply lubricant where the wire rope “opens up” as it travels around a sheave or winds onto a drum.
- The wire rope must be clean and dry before applying lubricant. An air jet or wire brush may be used.

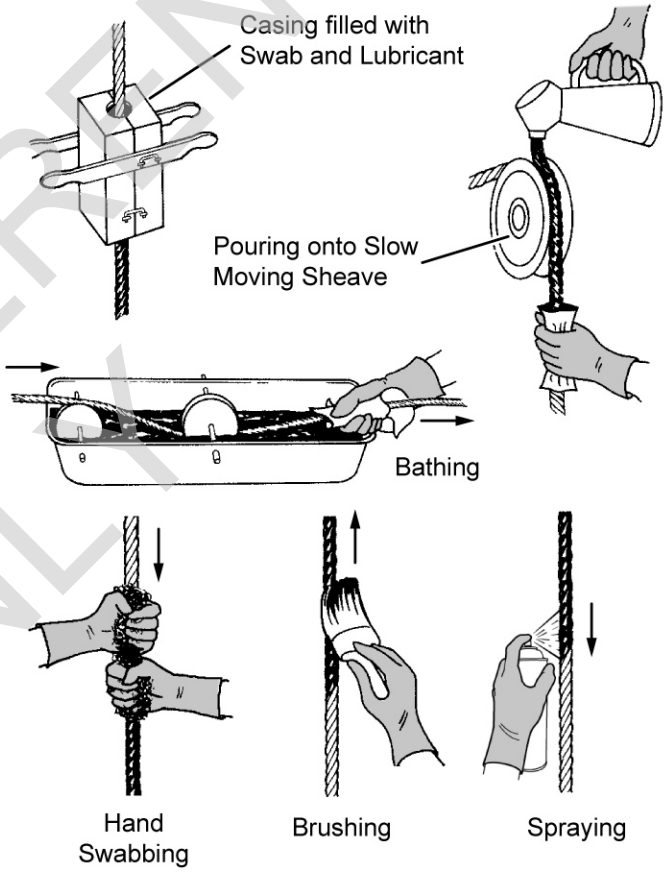


FIGURE 2

WARNING

Moving Rope Hazard!

Take every precaution to protect hands from injury when rope is moving. Wear heavy gloves and move rope as slowly as possible.

Do not use grease to lubricate wire rope. Grease will not penetrate rope properly and will buildup in valleys

between wires and strands. This buildup will inhibit rope inspection and could trap moisture in the rope's interior. A high-quality wire rope lubricant is available from the Manitowoc Crane Care Lattice Team.

CYLINDER ROD LUBRICATION

General

The cylinder rods on Manitowoc Cranes have a layer of chrome plating on their surfaces, to help protect them from corrosion.

However, the chrome plating has cracks in its structure which can allow moisture to corrode underlying steel. Depending on ambient temperature and the frequency of cylinder operation, the crane's hydraulic oil may not penetrate these cracks and protect the rods. Even if the cylinders are operated on a regular basis, many cylinders have portions of exposed rod, even when the cylinders are fully retracted.

Exposed cylinder rods on cranes that are stored, transported, or used in inclement environments (high humidity, rain, snow, and salt air) are at a high risk of corrosion.

Protecting Cylinder Rods

All exposed cylinder rods must be protected by applying a thorough coat of cylinder-rod protectant available from the Manitowoc Crane Care Lattice Team in 12 oz. aerosol cans—order part number 9999101803.

The cylinder-rod protectant contains solvents and lubricants that penetrate metal pores, displace moisture, dissolve existing corrosion, and then dry to a resilient waxy coating. Cylinder operation and weather will remove the protectant over time. Therefore, inspect all cylinder rods weekly and reapply protectant to exposed rods.

HYDRAULIC QUICK DISCONNECT LUBRICATION

All hydraulic quick disconnects must be protected by applying LPS-2 Aerosol Lubricant. Lubricant must be applied while connecting and disconnecting the hydraulic quick disconnects during crane assembly and disassembly.

1. All Quick Disconnects must be fully screwed together until there is metal to metal contact during crane assembly.
2. All plugs, regardless of location, must be fully screwed together into their corresponding caps until there is metal to metal contact, during crane assembly.

Examples of locations of caps and plugs:

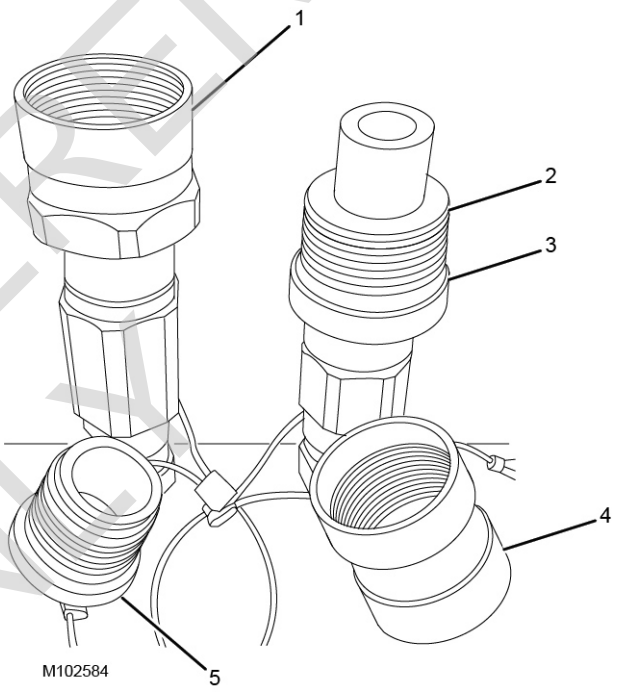
- Hanging lanyards
- Storage brackets
- Job box

3. All Quick Disconnects must be fully screwed together with their corresponding cap and plug until there is metal to metal contact during crane disassembly.

The following threaded areas of the quick disconnects, caps, and plugs must be lubricated during crane assembly and disassembly (see Figure 3):

- Threaded surface of male quick disconnect
- Threaded surface of female quick disconnect
- Threaded surface of aluminum caps and plugs
- O-rings

NOTE If the crane is stored without operating for long duration, the hydraulic quick disconnects, caps, and plugs must be lubricated every six months.



Item	Description
1	Female Quick Disconnect
2	Male Quick Disconnect
3	O-ring
4	Aluminum Cap
5	Aluminum Plug

FIGURE 3

ENVIRONMENTAL PROTECTION

WARNING

Environmental Damage!

Dispose of waste properly! Improperly disposing of waste can threaten the environment.

Potentially harmful waste used in Manitowoc Cranes includes—but is not limited to—oil, fuel, grease, coolant, air conditioning refrigerant, filters, batteries, and cloths which have come into contact with these environmentally harmful substances.

Handle and dispose of waste according to local, state, and federal environmental regulations.

When filling and draining crane components, do not pour waste fluids onto the ground, down any drain, or into any source of water:

- Always drain waste fluids into leak-proof containers that are clearly marked with what they contain.
- Always fill or add fluids with a funnel or a filling pump.
- Immediately wipe up any spills.

REFERENCE INSTRUCTIONS

See the MLC650 Service/Maintenance Manual for detailed information on specific maintenance checks and procedures.

CraneLUBE

Manitowoc Cranes highly recommends the use of CraneLUBE lubricants to increase your crane's reliability and performance. Contact your Manitowoc dealer for detailed information about our CraneLUBE lubrication program.

VPC AND VPC-MAX

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LUBRICATION POINTS

Use the following figures to find locations for lubrication points:

- See Figure 4 through Figure 7 for locations of lubrication points for the crane.
- See Figure 8 and Figure 9 for locations of engine components.
- See Figure 10 through Figure 15 for locations of the lubrication points for the boom and other attachments.
- See Figure 16 for locations of the lubrication points for the automatic lubrication systems.

The letters before the item numbers in the illustrations correspond to the intervals that should be inspected:

- A—At Assembly
- D—Daily
- W—Weekly
- M—Monthly
- Q—Quarterly
- S—Semiannually
- O—At Overhaul
- Y—Yearly

APPROVED LUBRICANTS FOR NORMAL OPERATION

For operation below 0°F (-18°C) also see "Approved Lubricants for Arctic Operation" on page 8.

For operation above 122°F (50°C) also see "Approved Lubricants for High Temperature Operation" on page 9.

Grease

Manitowoc Cranes Factory Fill

For the Manitowoc Cranes Factory Fill, see Table 1.

Table 1 Grease

Turntable Bearing and Crawlers	Temperature Range	Application
CraneLUBE XHP 320 Mine	-40°C (-40°F) and above	Automatic Lubrication Systems
CraneLUBE XHP 321 Mine	4°C (40°F)	
CraneLUBE XHP 322 Mine	-18°C (0°F) and above	Manual Lubrication

Other Grease Points	Temperature Range	Application
CraneLUBE E.P. # 2 (MCC Part No. 471197)	-18°C (0°F) and above	Manual Lubrication

NOTE For all operation below -18°C (0°F) use arctic grease specified in the Approved Lubricants for Arctic Operation topic.

Open Gear Oil

This type of oil requires heating or thinning for proper application to gear teeth. Apply a light film of oil to each gear tooth. ***Do not rely on gear rotation to distribute the oil***.

Manitowoc Cranes Factory Fill

- CraneLUBE 375 NC (MCC Part No. 471178)

Gear Oil

Manitowoc Cranes Factory Fill

- CraneLUBE 75W-90 (MCC Part No. 549515) for all gearboxes except the crawler gearboxes
- CraneLUBE 80W-140 (MCC Part No. A13890) for the crawler gearboxes

For specific product recommendations, contact the Manitowoc Crane Care Lattice Team.

Hydraulic Oil

Use a shear, stable anti-wear hydraulic oil that meets the following viscosity targets:

- Cold Start Viscosity—<1600 cST
- Operating Temperature Viscosity—>12 cST (the operating temperature is 38°C [100°F] over ambient temperature)

Manitowoc Factory Fill

- Phillips 66 Trans XP (MCC Spec No. 6829006444)

The factory fill hydraulic oil is a zinc-based multigrade hydraulic oil that may not be compatible with certain ash-less (metal-free) hydraulic oils. Consult with your oil supplier to make sure the oil you select meets the above specification.

Filter new oil through a 10 micron portable filter.

The factory fill hydraulic oil is an all-weather hydraulic oil suitable for use in ambient temperatures from -18°C to 43°C (0°F to 110°F).

The factory fill hydraulic oil can cloud up (form wax crystals) at ambient temperatures below -18°C (0°F). *This condition can result in damage to hydraulic components during start-up.*

When the expected ambient temperature will be below -18°C (0°F), the hydraulic oil must be heated to at least -18°C (0°F) prior to start-up. Tank heaters are available from Manitowoc.

The cloud point of oil selected must be equal to or less than the expected ambient temperature.

CAUTION

Hydraulic Pump Damage!

To prevent damage to hydraulic pumps, warm hydraulic oil to at least 16°C (60°F) before operating the crane functions.

Field Make-Up

Do not dilute the oil in the hydraulic tank with more than 25% of another brand of oil. ***Dilution beyond the 25% maximum could effect the crane's operating performance at certain temperatures.***

If in doubt as to how much make-up oil has been added to the tank on your crane, Manitowoc recommends that a laboratory viscosity test be performed to determine if the oil still meets the viscosity targets given above OR that the system should be completely drained and refilled.

HYDRAULIC FILTER REPLACEMENT

For instructions, refer to Section 2 of the MLC650 Service/ Maintenance Manual.

Hydraulic filter elements on this crane are specially designed to withstand high pressure as the elements fill with dirt. This feature prevents the elements from collapsing.

See Table 2 for the Manitowoc Cranes part numbers of replacement filter elements. See the lubrication charts for identification and location of the filter elements.

Table 2 Replacement Filter Elements

MCC No.	System
A17924	Charge Pumps and In-Tank Return

CAUTION

Hydraulic System Damage!

Original Equipment Manufacturers filter elements—available from the Manitowoc Crane Care Lattice Team — must be used on this crane. Substituting with any other brand or type filter element is prohibited.

Filter elements made by other manufacturers may collapse under pressure. This action will allow unfiltered oil to be drawn into the hydraulic system and pumps, motors, and valves can be destroyed.

The Manitowoc Crane Care Lattice Team will reject warranty claims for damaged hydraulic components if the proper hydraulic filter elements are not used.

APPROVED LUBRICANTS FOR ARCTIC OPERATION

The lubricants listed in Table 3 are recommended for use in Manitowoc's line of hydraulic cranes when operating in an arctic-type climate—***climates with an outside temperature continuously between -18°C (0°F) and -40°C (-40°F)***.

Use these lubricants in place of the lubricants listed for normal operation.

It is recommended the crane have hydraulic tank heaters available from Manitowoc Crane Care Lattice Team.

CAUTION

Machinery Damage!

Do not operate the main crane functions (swing, travel, drums, boom hoist) with approved arctic lubricants when the ambient temperature is above 16°C (60°F). Crane machinery will be damaged.

When the ambient temperature is above 16°C (60°F), limit operation to the crane setup functions (that is, jacking cylinders).

When the ambient temperature is expected to remain above 16°C (60°F), drain the arctic lubricants and refill with the lubricants recommended for normal operation.

Structural Damage!

Cold weather can affect the structural integrity of the crane and attachment. Before operating in cold weather, read the Cold Weather Operation —Crane Limitations topic in Section 3 of the Crane Operator Manual.

Table 3 Lubricant for Arctic Operation

System	Approved Arctic Lubricants
Grease Points	Chevron RPM Arctic Grease NLGI 1
All Gear Cases, Pump Drives, and Gear Boxes	Mobil SHC 626 Gear Oil
Hydraulic System	Petro-Canada Hydrex MV Arctic 15
Engine Oil System (see **NOTE**)	Duron XL Synthetic 0W-30 **OR** Mobil Delvac 1
Engine Fuel (see **NOTE**)	No. 1 Diesel
Engine Cooling System (see **NOTE**)	Mix anti-freeze (Ethylene Glycol) and water 60/40 by volume. This mixture will provide coolant protection to -54°C (-65°F). ***Pure antifreeze freezes at -23°C (-10°F).***
NOTE See the engine manufacturer's manual for specifications and cold weather operating guidelines.	

APPROVED LUBRICANTS FOR HIGH TEMPERATURE OPERATION

The lubricants listed in Table 4 are approved for use in Manitowoc's line of hydraulic cranes when operating in a high temperature climate— **climates with an outside temperature between 38°C (100°F) and 50°C (122°F).**

Use these lubricants in place of the standard lubricants listed in the Lubrication Guide.

CAUTION

Machinery Damage!

To avoid damage to crane machinery, switch back to the standard lubricants listed in the lubrication guide when the ambient temperature will be below 0°C (32°F).

Table 4 Lubricant for High Temperature Operation

System	Approved Lubricants (or Equivalent)
All Grease Points	Mobil CM-S
All Gear Boxes and Pump Drive	Mobil Delvac Synthetic (80W-140)
Hydraulic System	Shell Tellus 100T
Engine Oil System (see NOTE)	Shell Rotella T (15W-40)
Engine Fuel (see NOTE)	Diesel
Engine Cooling System (see NOTE)	Mix anti-freeze (Ethylene Glycol) and water 50/50 by volume.
NOTE	Refer to the engine manufacturer's manual for specifications and high temperature operating guidelines.

FLUID CAPACITIES

Fluid capacities are approximate and should be used only as a guide for ordering sufficient fluid at oil change intervals.

Always fill each system to the level plug opening or to the specified point on the sight gauge or dipstick.

System	Capacity		Approved Lubricant
	Liters	Gallons	
Cooling System—Tier 3	98.4	26	See NOTE 1
Cooling System—Tier 4F	98.4	26	See NOTE 1
Crawler Gearboxes—Input/Output (Both Gearboxes in each Crawler)	110	30	Gear Oil
Crawler Grease Pump Reservoir (Option 3)	4	1	Grease
DEF Tank (Tier 4F)	95	25	See NOTE 1
Dual Input Gearbox each (Carbody Assembly)	12.5	3.5	Gear Oil
Drum 1 (Main Load Hoist—Standard)	104	27.5	Gear Oil
Drum 2 (Main Load Hoist—Optional)	104	27.5	Gear Oil
Drum 3 (Whip Hoist)	75.7	20	Gear Oil
Drum 4 (Boom Hoist—Standard)	153	40.5	Gear Oil
Drum 4 (Mast Hoist—VPC-MAX)			Gear Oil
Drum 5 (Boom Hoist—VPC-MAX)	121	32	Gear Oil
Drum 6 (Luffing Hoist)	102	27	Gear Oil
Fuel Tank	1117	295	See NOTE 1
Hydraulic Tank	946	250	Hydraulic Oil
Pump Drive	6.5	2	Gear Oil
Swing Drive (each Gearbox)	16	4.23	Gear Oil
Turntable Bearing Grease Pump Reservoir	4	1	Grease
VPC Drive (each Gearbox)	5	1.32	Gear Oil

NOTE 1 See the engine manual for DEF, fuel, antifreeze, and engine oil specifications.

NOTE 2 Brake housings for the swing, boom hoist, and load drums are filled automatically with oil from the gear boxes.

Brake housings for the crawlers are flushed with cooling oil from the hydraulic system.

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UPPERWORKS AND LOWERWORKS LUBRICATION

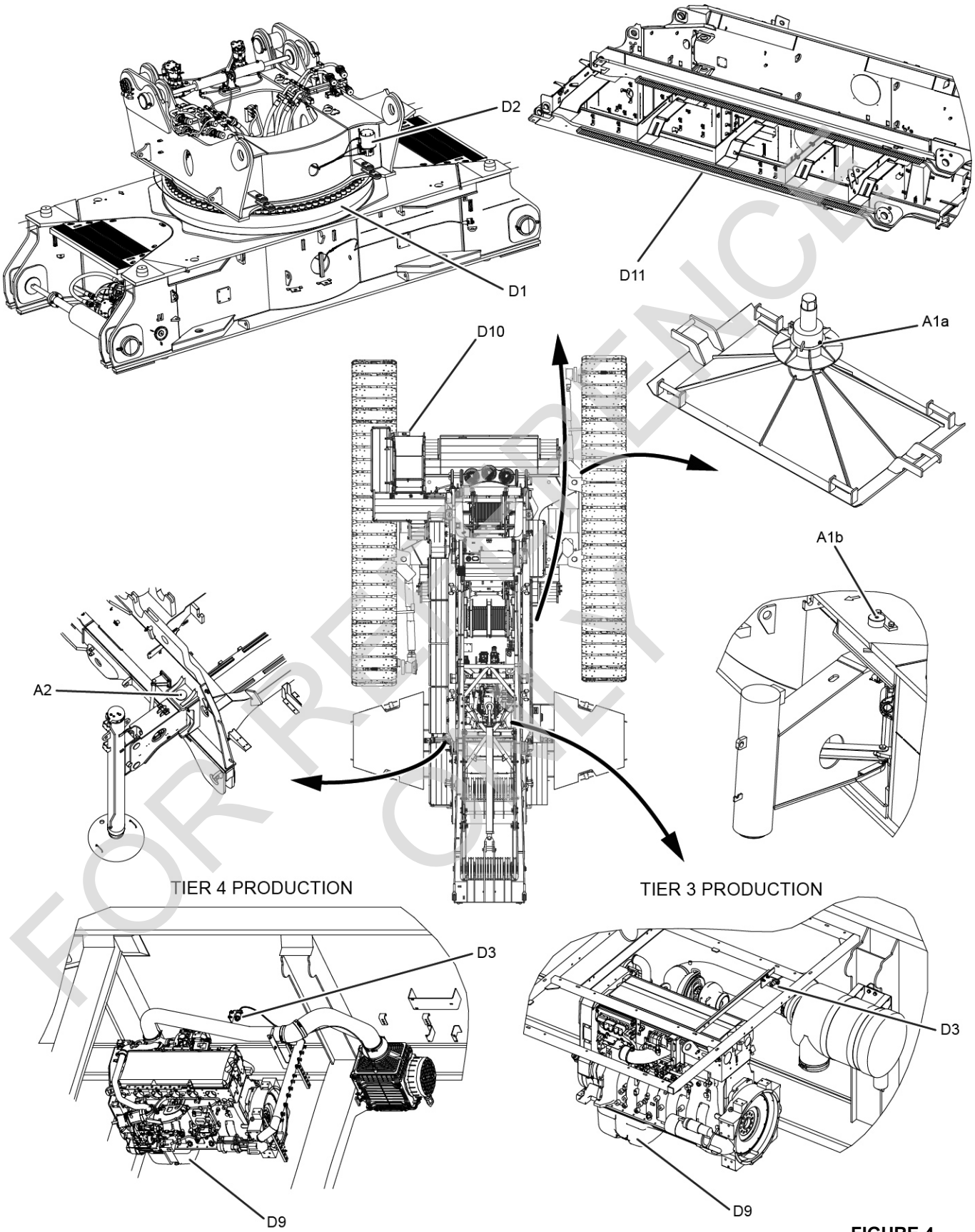


FIGURE 4

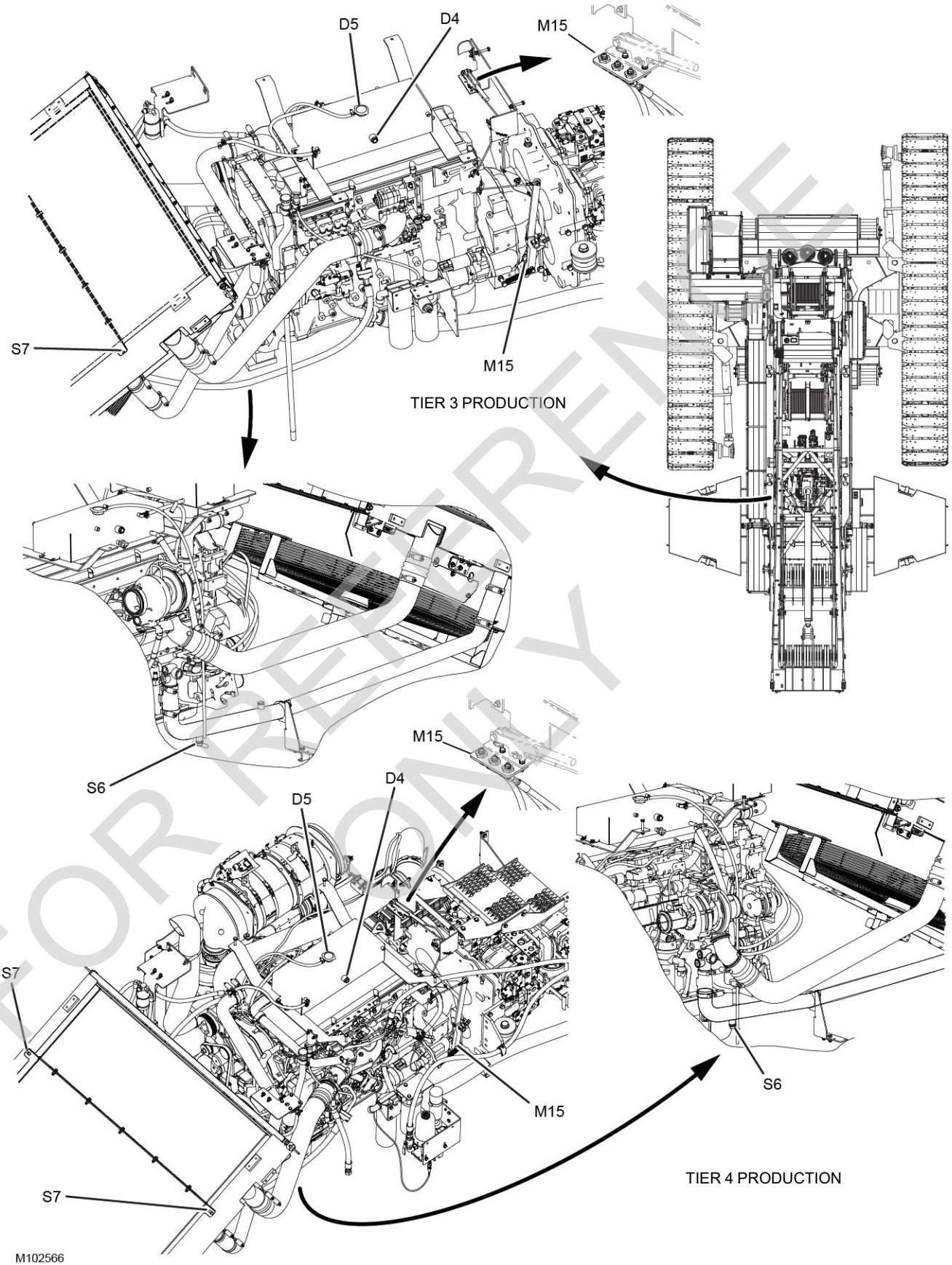


FIGURE 5

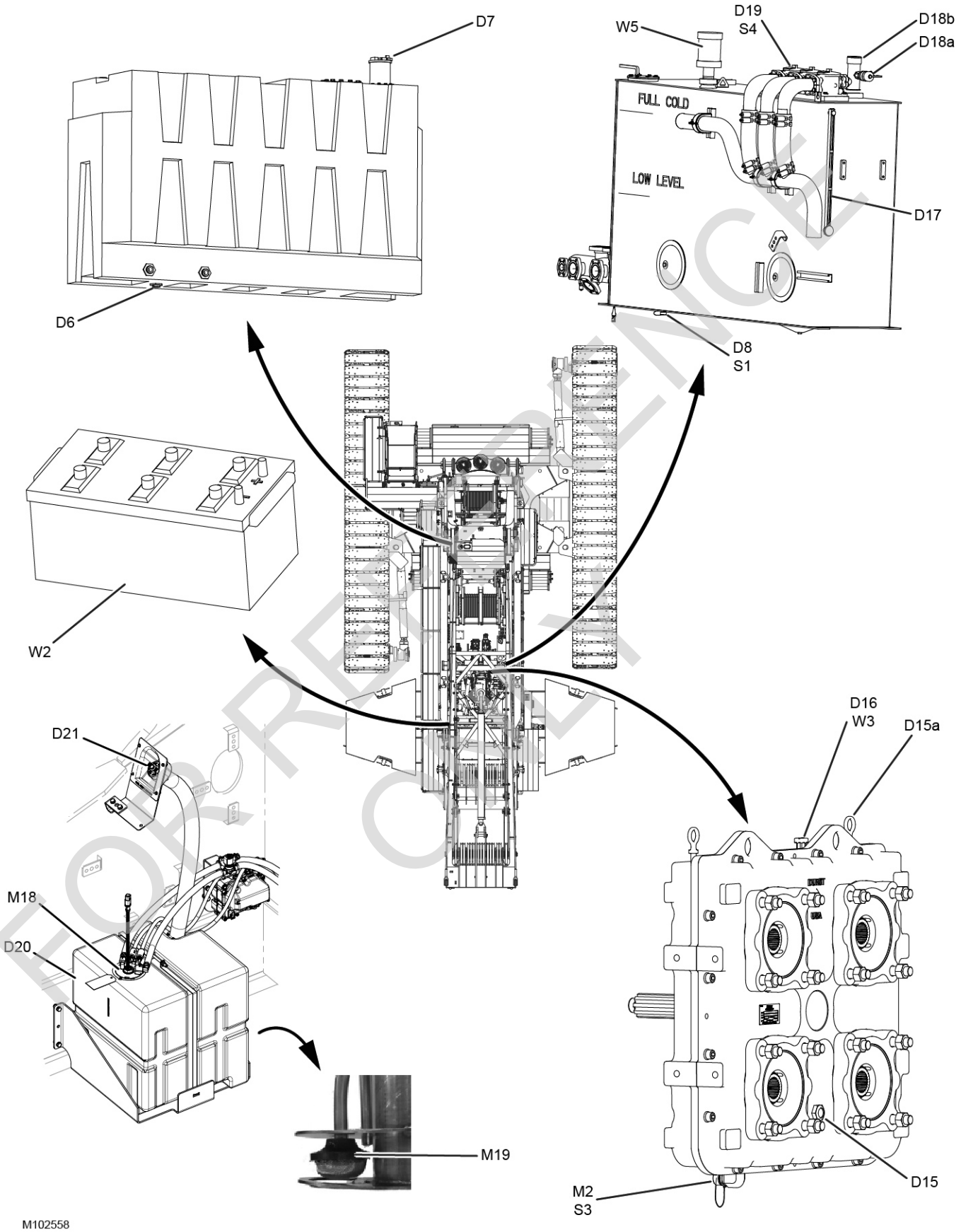


FIGURE 6

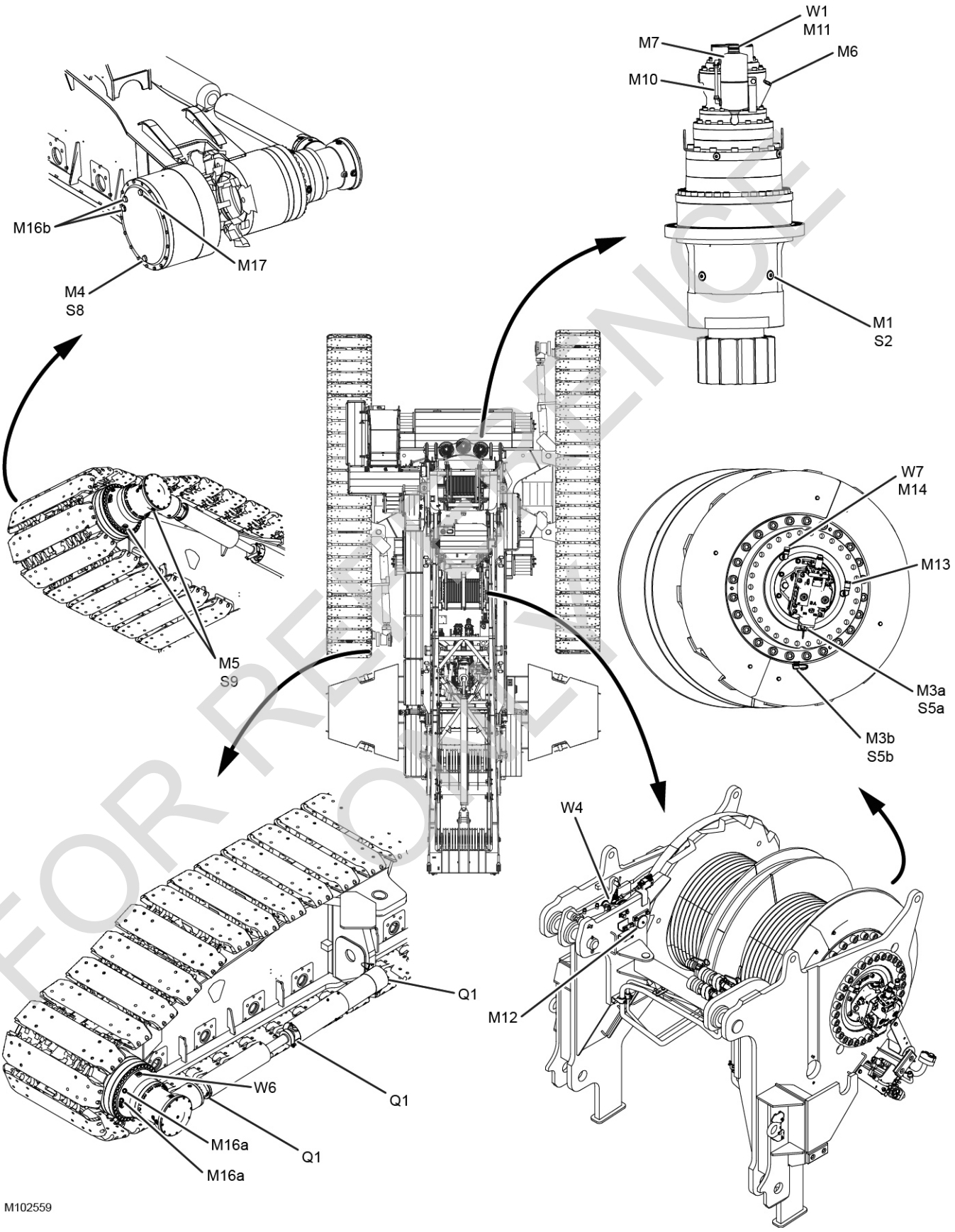
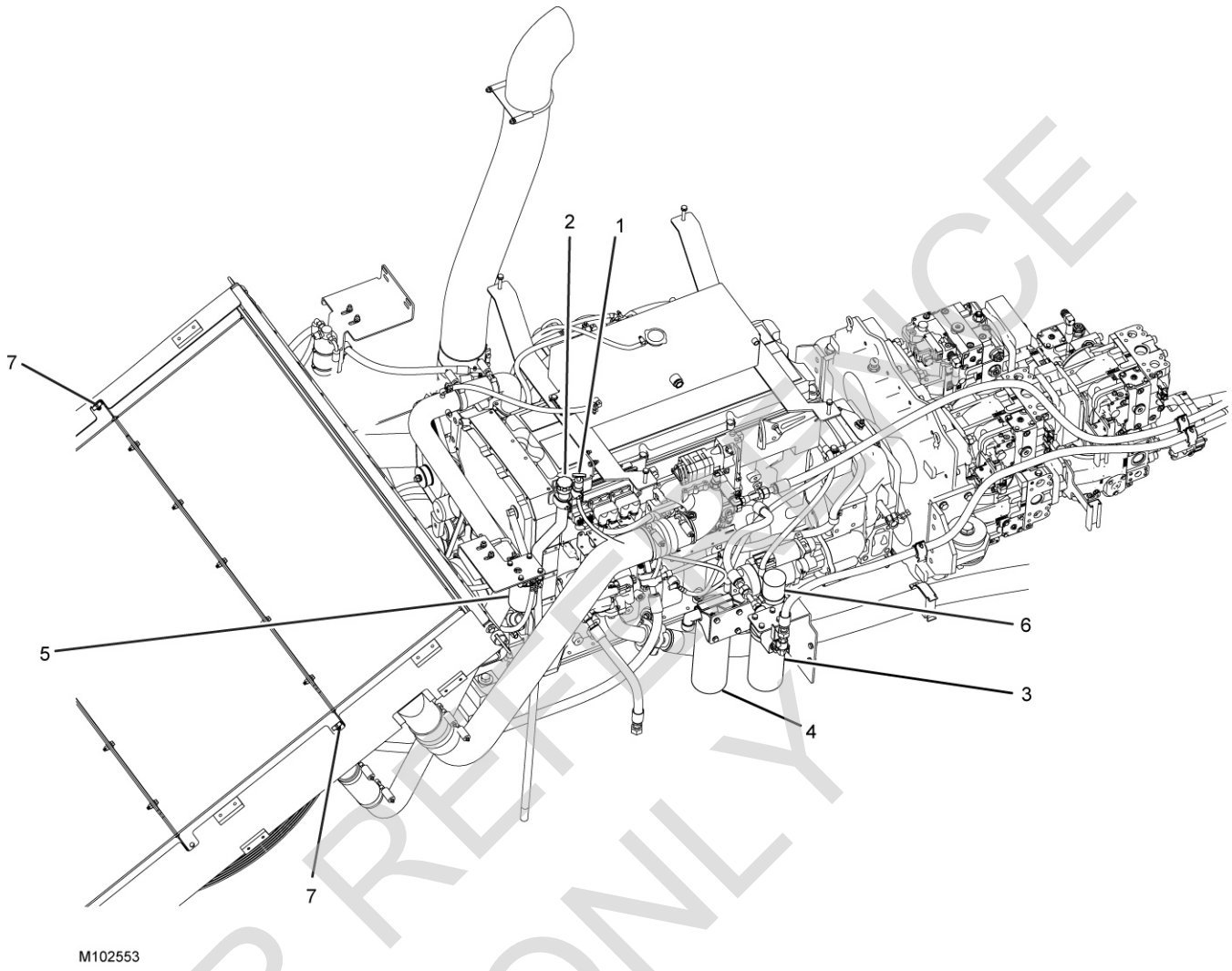


FIGURE 7

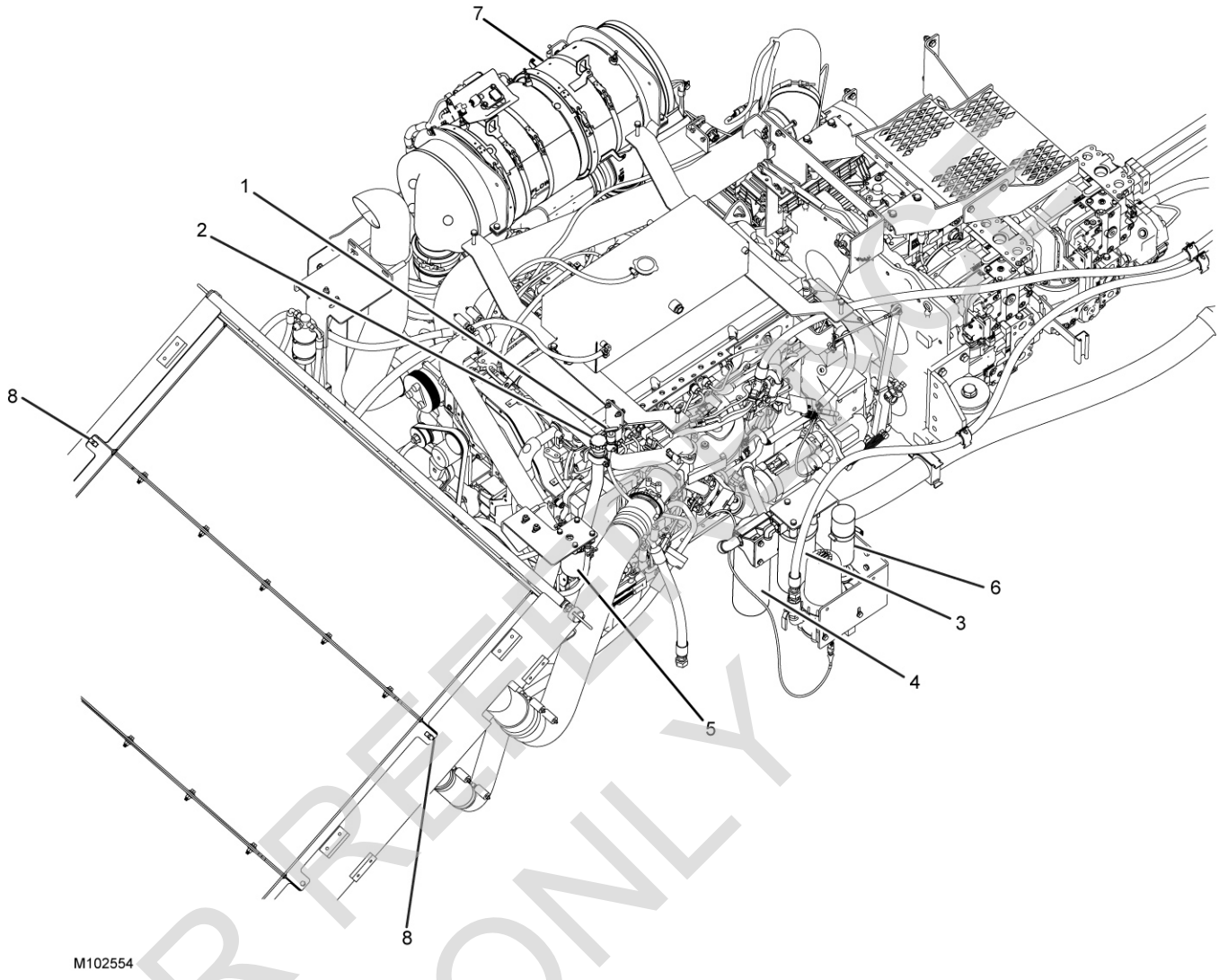
Engine Components – Tier 3



Item	Description	Required Service
1	Dipstick	Service according to the engine manufacturer's instructions.
2	Fill Cap	
3	Fuel Filter	
4	Oil Filter	
5	Coolant Filter	
6	Remote Starting Aid	
7	Vent Valve	

FIGURE 8

Engine Components – Tier 4F



Item	Description	Required Service
1	Dipstick	Service according to the engine manufacturer's instructions.
2	Fill Cap	
3	Fuel Filter	
4	Oil Filter	
5	Coolant Filter	
6	Remote Starting Aid	
7	Diesel Particulate Filter	
8	Vent Valve	

FIGURE 9

Upper and Lower Lubrication — Identification

Item	Description	Required Service
	Prior to Use When the Crane is Assembled	
A1a	Carbody Pedestal (1 Fitting, 4 Places) (Lowerworks Support Pedestals Option)	Grease each fitting
A1b	Carbody Jack Connecting Pin (1 Fitting, Top and Bottom of each Pin, 4 Places) (Lowerworks Jacking Option)	Grease each fitting
A2	Jacking Cylinders Connecting Pin (1 Fitting, Top and Bottom of each Pin, 4 Places) (Upperworks Jacking Option)	Grease each fitting
	Every 8 Hours of Operation or Daily (Whichever Comes First) **(See NOTE 1)**	
D1	Ring Gear	Check for proper lubrication. Coat with open gear oil if needed.
D2	Grease Pump Reservoir (3 Places, 1 for Turntable Bearing and 1 for each Crawler)	Check reservoir level. Fill to the proper level with approved grease (see NOTE 2).
D3	Air Cleaner Service Indicator	Check. Replace element when indicated.
D4	Coolant Surge Tank Sight Gauge (Tier 3 and Tier 4F)	Check level. Should be at full cold mark (see NOTE 4).
D5	Coolant Surge Tank Fill (Tier 3 and Tier 4F)	Fill to the proper level with coolant.
D6	Fuel Tank Quick Drain Plug	Drain water (see NOTE 3).
D7	Fuel Tank Fill Cap	Fill to the proper level with fuel oil.
D8	Hydraulic Tank Quick Drain Plug	Drain water (see NOTE 3).
D9	Engine (For Tier 3, see Figure 8. For Tier 4F, see Figure 9)	Service according to the engine manufacturer's instructions.
D10	Windshield Washer Reservoir	Check level. Fill to base of opening with windshield washer fluid.
D11	VPC Gear Rack (both sides of crane)	Check for proper lubrication. Coat with open gear oil if needed. Clean all debris from roller path.

Items D12-D14 Not Used

NOTE 1 Inspect the crane daily for leaks. If a leak is found, determine the cause, take corrective action, and refill the applicable component with proper fluid.

NOTE 2 Fill through the fitting in the base of the reservoir using a hand-operated grease gun or pump. Refill the reservoir when the grease reaches the MIN mark. Fill the reservoir to the MAX mark.

The crawlers and turntable bearing are greased automatically by electric pumps when the ignition switch is on.

NOTE 3 Drain any accumulated water from the fuel and hydraulic tanks at the ***start of each work day***.

Crack open the drain valves. Securely close the drain valves as soon as water stops draining and a steady stream of fuel or hydraulic oil appears.

NOTE 4 Check the coolant level when the ***coolant is cold***.

Item	Description	Required Service
	Every 8 Hours of Operation or Daily Continued	
D15	Pump Drive Oil Level Sight Gauge	Check level, full at middle of gauge
D15a	Pump Drive Dipstick and Tube (Tier 3 and Tier 4F)	Check level, full at mark on dipstick
D16	Pump Drive Breather (Tier 3 and Tier 4F)	Fill to the proper level with gear oil
D17	Hydraulic Tank Level (Display Screens in Operator's Cab)	Check level (see NOTE 1)
D18a	Hydraulic Tank Fill (Power Fill Coupling)	Fill to the proper level with hydraulic oil (see NOTE 1)
D18b	Hydraulic Tank Fill (Manual Fill)	Fill to the proper level with hydraulic oil (see NOTE 1)
D19	Hydraulic Tank Return Filter (3 each Mounted in Tank)	Replace **ALL** elements when indicated and at each oil change interval (see NOTE 2)
D20	Diesel Exhaust Fluid (DEF) Tank (Tier 4F Engine only)	Check level (see NOTE 3)
D21	DEF Tank Fill Cap (Tier 4F Engine only)	Fill to proper level with approved DEF (see Engine Manufacturer's Manual for Specifications

NOTE 1 Check the hydraulic tank display in the Crane Status Bar of the Main Display Working Screen in the cab (see MLC650 Main Display Manual):

- ***FULL COLD LEVEL***
  The screen should read 92%.
- ***FULL HOT LEVEL***
  The screen should read 100%.

  Do not fill the tank to 100%. Oil will flow out of the breather.

If the oil level drops to 53%, the fault alarm will come on and the fault symbol will appear in the active display screen. The HYDRAULIC FLUID LOW icon will appear in the alerts bar of the working screen. ***Fill the tank immediately.***

Fill the tank either through the power fill coupling (D18a) or manual fill (D18b). ***Do not fill the tank through the breather cap port or through the top of either filter.***

See Section 2 in the MLC650 Service/ Maintenance Manual for the fill procedure.

NOTE 2 When a filter needs replacement, the fault alarm will come on and the fault symbol will appear on the active display screen. The FILTER FAULT icon and corresponding filter number will appear on the fault display. ***Replace ALL THREE filter elements if the fault appears and at each oil change interval. This crane has three filters that filter all oil returning to tank.***

See Section 2 of the MLC650 Service/ Maintenance Manual for the filter replacement procedure.

It is normal for this fault alert to come on at start-up when the hydraulic oil is cold. The alert should shut off as the oil warms up.

WARNING

Burn Hazard!

Oil in the hydraulic tank may be under pressure and extremely hot.

Hot oil can escape when you remove either filter cover.

Relieve pressure through the air valve on top of the hydraulic tank before servicing.

NOTE 3 Check the DEF tank display in the Crane Status Bar of the Main Display Working Screen in the cab (see MLC650 Main Display Manual).

If the DEF level drops to 10%, the fault alarm will come on and the fault symbol will appear in the active display screen. The DEF LEVEL icon will come on in the crane status bar. ***Fill the tank immediately.***

If the DEF level drops to 5%, the DEF LEVEL icon will flash in the crane status bar. ***Fill the tank immediately.***

Item	Description	Required Service
Every 40 Hours of Operation or Weekly (Whichever Comes First)		
W1	Swing Gear Box Oil Fill and Breather Plug (2 Places)	Clean each (see NOTE 1)
W2	Batteries (Tier 3 and Tier 4F)	Check the electrolyte level
W3	Pump Drive Breather (Tier 3 and Tier 4F)	Clean (see NOTE 1)
W4	Drum Pawl and Lever (Mast Hoist - Drum 4 and Luffing Hoist - Drum 6)	Apply open gear oil to sliding surfaces
W5	Hydraulic Tank Breather	Clean (see NOTE 1 and NOTE 2)
W6	Crawler Right Angle Gearbox Breather and Oil Fill Plug (1 each Crawler)	Clean each (see NOTE 1)
W7	Drum Gearbox Oil Filling and Breather Plug (1 each Drum)	Clean each (see NOTE 1)

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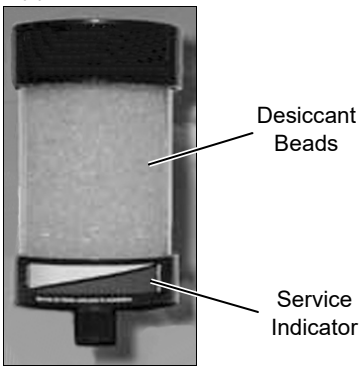

Desiccant Breather

NOTE 1 Soak breathers in non-flammable solvent and blow dry them with compressed air. For the hydraulic tank, this service applies only to the past production metal-type breather.

NOTE 2 The hydraulic tank on current production cranes has a desiccant breather. The breather does not require servicing until indicated.

Inspect the desiccant breather weekly. Replace the cartridge with a new one, when all of the desiccant beads turn dark green. The desiccant beads are gold when new).

Item	Description	Required Service
After First 200 Hours of Operation (See NOTE 1)		
M1	Swing Gear Box Drain Plug (4 Places in each Gearbox)	Drain and refill each with gear oil (see NOTE 4)
M2	Pump Drive Drain Plug (Option 1 and 2)	Drain and refill with gear oil
M3a	Drum Gear Box Primary Drain Valve (1 each Drum)	Drain and refill each with gear oil (see NOTE 2)
M3b	Drum Gear Box Secondary Drain Plug (1 each Drum)	Drain remaining oil from bottom of drum barrel (see NOTE 2)
M4	Crawler Output Right Angle Gearbox Magnetic Drain Plug (1 each Crawler)	Drain and refill each with gear oil (see NOTE 3)
M5	Crawler Input Right Angle Gearbox Magnetic Drain Plug (2 each Crawler)	Drain and refill each with gear oil
M6	Swing Gear Box Oil Level and Filling Plug	Drain and refill each with gear oil (see NOTE 4)
M7	Swing Gear Box Oil Expansion Tank	Drain and refill each with gear oil (see NOTE 4)
Items M8 and M9 Not Used		

NOTE 1 Service after first 200 hours of operation is required, to remove metal particles and other impurities collected during the initial run-in of the gear boxes.

NOTE 2 Lower the boom so drums are horizontal when changing the oil.

NOTE 3 Input and output gear box drives are common. Standard fill level allows for travel up to 10% grade. For travel on grades between 10% and 30% grade, oil to be filled to high fill level.

NOTE 4 Refer to Figure 7 for the following procedure.

Remove the drain plug (M1) and drain the oil into an appropriate container. Re-install the drain plug (M1). Remove the oil fill and breather plug (M11) of the expansion tank (M7) and the oil level plug (M6). Fill the gearbox with oil through the oil fill and breather plug (M11). Allow oil to settle. Check the oil level on the level sight tube (M10) of the expansion tank (M7). Confirm oil level with temperature decal. Add oil as required. Re-install the oil level plug (M6) and the oil fill and breather plug (M11).

Item	Description	Required Service
Every 200 Hours of Operation or Monthly (Whichever Comes First)		
M10	Swing Gear Box Level Sight Tube (2 Places)	Check that level is up to plug opening
M11	Swing Gear Box Oil Fill and Breather Plug (2 Places)	Fill each to proper level with gear oil
M12	Drum Pawl Pin (1 pin each in Mast Hoist - Drum 4 and Luffing Hoist - Drum 6)	Grease each 1/2 shot
M13	Drum Gear Box Transparent Oil Level Plug (1 each in Main Hoist – Drum 1, Main Hoist (Optional) – Drum 2 and Whip Hoist – Drum3)	Check level, which should be at middle of gauge (see NOTE 2)
M14	Drum Gear Box Oil Filling and Breather Plug (1 each Drum)	Fill each to proper level with gear oil
M15	Engine Clutch Lever and Bearing (Tier 3 and Tier 4F)	Grease 1 each side and 1 on bottom (see NOTE 5)
M16a	Crawler Input Right Angle Gearbox Level Plug (2 each Crawler - Standard Level and High Level)	Check level, which oil should be up to plug opening. Fill each as required with gear oil (see NOTE 3 and NOTE 4)
M16b	Crawler Output Right Angle Gearbox Level Plug (2 each Crawler - Standard Level and High Level)	Check level, which oil should be up to plug opening. Fill each as required with gear oil (see NOTE 3 and NOTE 4)
M17	Crawler Output Right Angle Gearbox Fill Plug (1 each Crawler)	Fill each to proper level with gear oil (see NOTE 3 and NOTE 4)
M18	Dosing Module Filter (Tier 4F Engine only)	Inspect and replace as needed according to Cummins engine manuals
M19	DEF Tank Filter (40 Micron Suction Filtration) (Tier 4F Engine only)	Inspect and replace as needed according to Cummins engine manuals

NOTE 1 This grease fitting is removed if Drum 2 has the high speed option.

NOTE 2 Before raising the boom each time the crane is assembled, check the level of drums in the horizontal position.

Mast Hoist – Drum 4 has a dipstick to check oil level on the left and right side.

NOTE 3 Input and output gear box drives are common. Remove the breather from the input gear boxes to vent air while filling.

NOTE 4 Standard fill level allows for travel up to 10% grade. For travel on grades between 10% and 30% grade, oil to be filled to high fill level.

NOTE 5 Grease fittings (M15) are located either on the clutch housing (3 places) or on a grease panel accessible from above the engine clutch.

Item	Description	Required Service
Every 500 Hours of Operation or Quarterly (Whichever Comes First)		
Q1	Crawler Drive Shafts (4 Fittings both Crawlers)	Grease (see NOTE 1).

NOTE 1 See the manufacturer's instructions for proper greasing.

Slide the guards clear of drive shafts to expose the grease fittings. ***Be sure to securely reattach the ends of the guards in the operating position after greasing.***

Item	Description	Required Service
Every 1000 Hours of Operation or Semiannually (Whichever Comes First)		
S1	Hydraulic Tank Quick Drain Plug	Drain and refill with hydraulic oil
S2	Swing Gear Box Drain Plug (4 Places in each Gearbox)	Drain and refill each with gear oil. (see NOTE 1)
S3	Pump Drive Drain Plug	Drain and refill with gear oil
S4	Hydraulic Filters (in Tank Return Filters)	Replace **ALL** elements, when indicated on screen
S5a	Drum Gear Box Primary Quick Drain Plug (1 each Drum)	Drain and refill each with gear oil
S5b	Drum Gear Box Secondary Quick Drain Plug (1 each Drum)	Drain remaining oil from bottom of drum barrel
S6	Radiator Drain Plug (Tier 3 and Tier 4F)	Drain and refill with coolant
S7	Radiator Vent Valve (Tier 3 and Tier 4F)	Open when filling radiator and close when coolant appears
S8	Crawler Output Right Angle Gearbox Magnetic Drain Plug (1 each Crawler)	Drain and refill each with gear oil (see NOTE 2)
S9	Crawler Input Right Angle Gearbox Magnetic Drain Plug (2 each Crawler)	Drain and refill each with gear oil

NOTE 1 Refer to Figure 7 for the following procedure.

Remove the drain plug (S2) and drain the oil into an appropriate container. Re-install the drain plug (S2). Remove the oil fill and breather plug (M11) of the expansion tank (M7) and the oil level plug (M6). Fill the gearbox with oil through the oil fill and breather plug (M11). Allow oil to settle. Check the oil level on the level sight tube (M10) of the expansion tank (M7). Confirm oil level with temperature decal. Add oil as required. Re-install the oil level plug (M6) and the oil fill and breather plug (M11).

NOTE 2 Input and output gear box drives are common.

BOOM RIGGING LUBRICATION

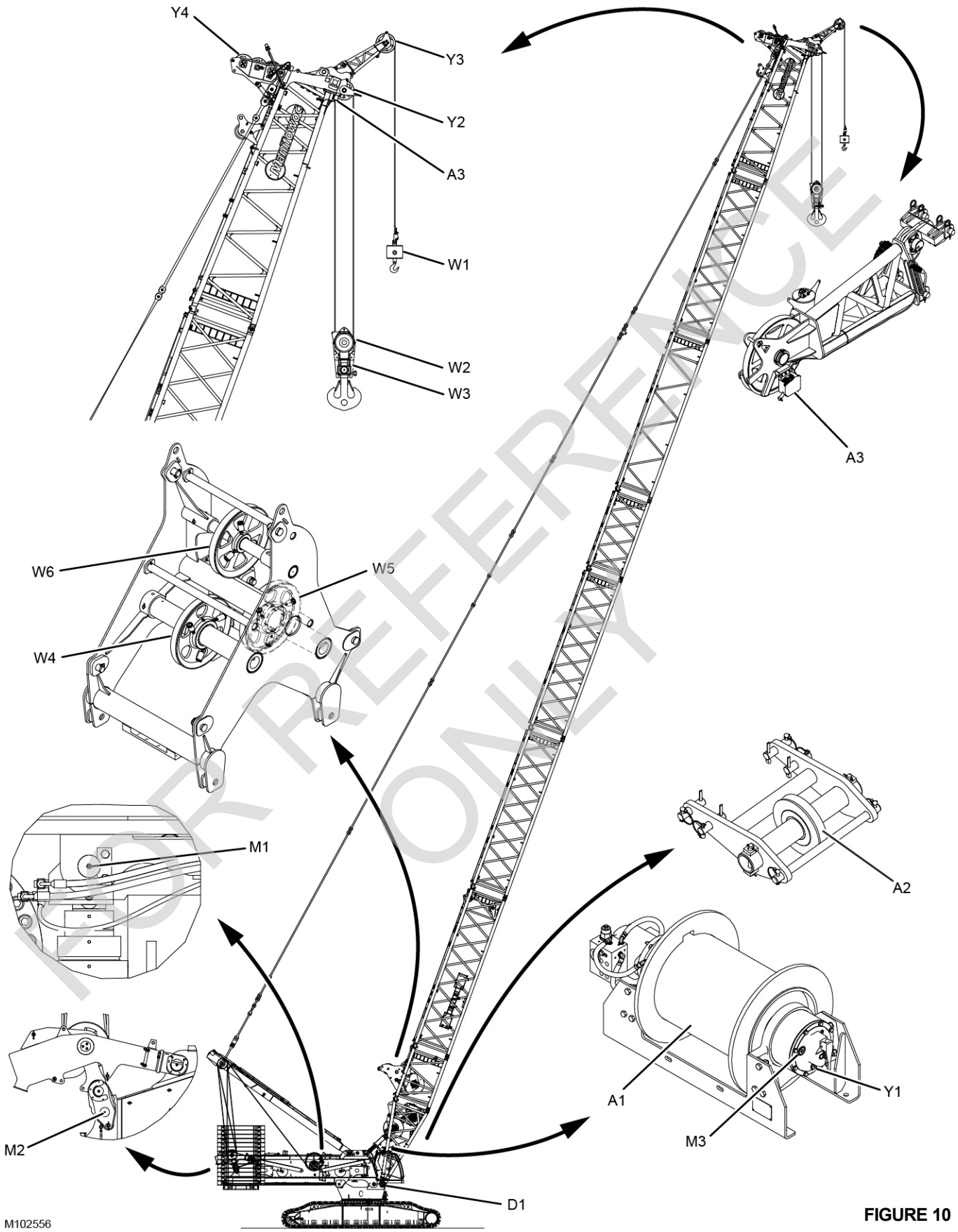

FIGURE 10

Item	Description	Required Service
Prior to Operation		
A1	Rigging Winch	Inspect for oil leaks prior to using. If found, repair and refill unit with gear oil
A2	Boom Butt Fleeting Sheaves (Rigging Winch) (2 Places on Boom Butt)	Grease. Make sure entire length of both shafts is coated with grease
A3	Block-Up Limit Switch (1 Fitting Inside each Switch)	Grease each
Every 8 Hours of Operation or Daily (Whichever Comes First)		
D1	Boom Hinge Pin (1 Fitting, 2 Places)	Grease each
Every 40 Hours of Operation or Weekly (Whichever Comes First)		
W1	Weight Ball Swivel (1 Fitting each)	Grease each
W2	Load Block Sheaves (1 Fitting, each Sheave)	Grease each
W3	Hook Bearing	Grease
W4	Wire Rope Guide Fleeting Sheave (Drum 1)	Check auto greasers located on the sheave and replace if empty. Grease at the grease hole located on the shaft (see NOTE 1)
W5	Wire Rope Guide Fleeting Sheave (Drum 2)	Check auto greasers located on the sheave and replace if empty. Grease at the grease hole located on the shaft (see NOTE 1)
W6	Wire Rope Guide Fleeting Sheave (Drum 3)	Check auto greasers located on the sheave and replace if empty. Grease at the grease hole located on the shaft (see NOTE 1)
Every 200 Hours of Operation or Monthly (Whichever Comes First)		
M1	Mast Cylinder End Pins (1 Fitting each Cylinder)	Grease each
M2	Backhitch Link Pin (1 Fitting each Side of Rotating Bed)	Grease each
M3	Rigging Winch	Check level. If the level is not at least half full, fill with gear oil
Every 2000 Hours of Operation or Annually (Whichever Comes First)		
Y1	Rigging Winch	Drain and refill with 1.9 to 2.3 L (64 to 80 oz) of gear oil. Refer to winch manufacturer operator manual included in the shop reference and maintenance guide for winch lubrication drain and fill procedure
Y2	Lower Point Sheave	Grease each if equipped with grease fittings.
Y3	Upper Point Sheaves	Inspect the sheaves for proper operation yearly or every 2000 hours of crane operation. Overhaul the sheaves and repack them with grease if needed.
Y4	Boom Top Wire Rope Guide Sheaves	If equipped with grease fittings, the sheaves can be greased at a desired interval established by the crane owner/user.

CAUTION

Bearing Damage!

For sheaves with grease fitting in groove of sheave, fitting must be clean and free of debris when greased. Contaminating a bearing with debris while greasing can damage the bearing.

NOTE 1 Before installing the auto greasers, grease the zerk with manual grease gun.

During operation, set the auto greasers to empty contents in 1 to 12 months as required. When not in use, the auto greasers can be turned off.

Auto greasers are for one time use only and not refillable. Dispose once empty.

EXTENDED UPPER BOOM POINT LUBRICATION

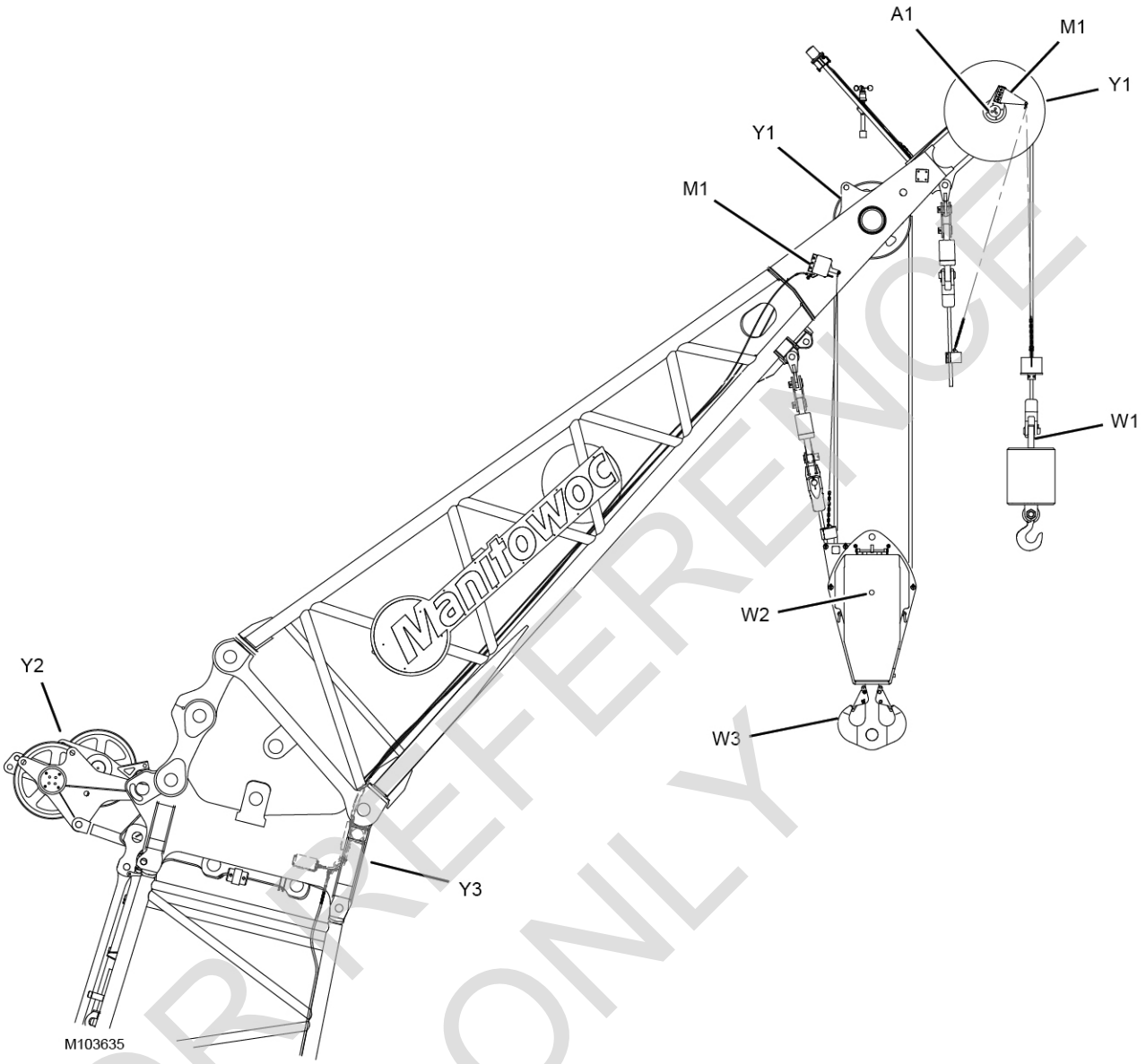

FIGURE 11

Item	Description	Required Service
Before Raising Boom and Luffing Jib		
A1	Upper Point Rollers (1 Fitting each End of Shaft)	Grease prior to raising boom
Every 40 Hours or Weekly (Whichever Comes First)		
W1	Swivel (1 Fitting each)	Grease each
W2	Load Block Sheaves	Grease if equipped with fittings
W3	Load Block Trunnion/Swivel	Grease if equipped with fittings
Every 200 Hours of Operation or Monthly (Whichever Comes First)		
M1	Block-Up Limit Switch (1 Fitting Inside each Switch)	Grease each
Every 2000 Hours of Operation or Annually (Whichever Comes First)		
Y1	Upper Boom Point Sheaves	Grease each if equipped with grease fittings. Inspect the sheaves for proper operation yearly or every 2000 hours of crane operation. Overhaul the sheaves and repack them with grease if needed. If equipped with grease fittings, the sheaves can be greased at a desired interval established by the crane owner/user.
Y2	Lower Boom Point Sheaves (not shown)	
Y3	Wire Rope Guide Sheaves	

LUFFING JIB LUBRICATION

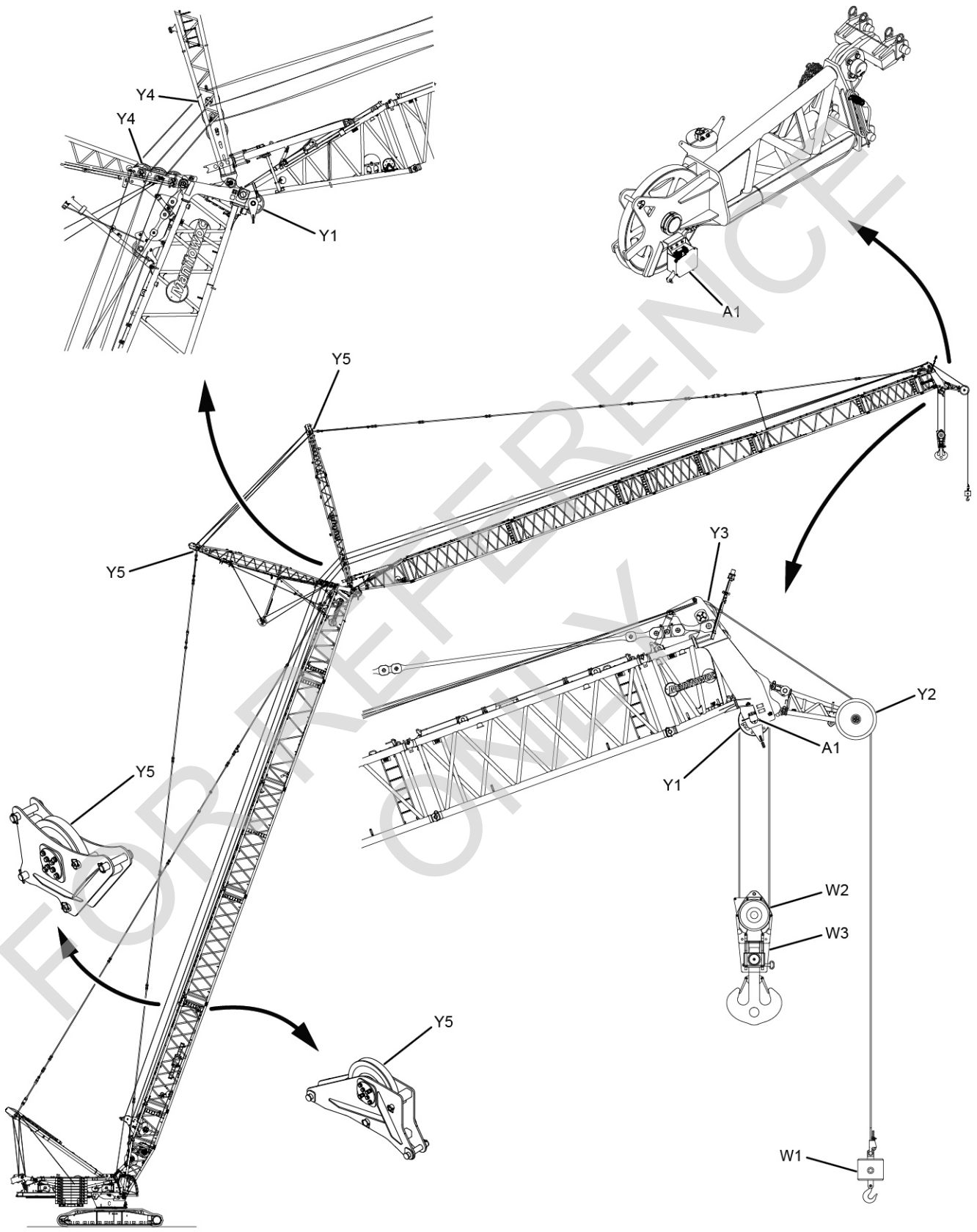

FIGURE 12

Item	Description	Required Service
Prior to Operation		
A1	Block-Up Limit Switch (1 Fitting Inside each Switch)	Grease each
Every 40 Hours of Operation or Weekly (Whichever Comes First)		
W1	Weight Ball Swivel (1 Fitting each)	Grease each
W2	Load Block Sheaves (1 Fitting, each Sheave)	Grease each
W3	Hook Bearing	Grease
Every 2000 Hours of Operation or Annually (Whichever Comes First)		
Y1	Lower Point Sheaves	Grease each if equipped with grease fittings.
Y2	Upper Jib Point Sheaves	Inspect the sheaves for proper operation yearly or every 2000 hours of crane operation. Overhaul the sheaves and repack them with grease if needed.
Y3	Jib Top Wire Rope Guide Sheaves	
Y4	Jib Strut Wire Rope Guide Sheaves	If equipped with grease fittings, the sheaves can be greased at a desired interval established by the crane owner/user.
Y5	Luffing Hoist Sheave (1 Fitting, each Sheave)	Grease each

CAUTION

Bearing Damage!

For sheaves with grease fitting in groove of sheave, fitting must be clean and free of debris, when greased. Contaminating a bearing with debris, while greasing, can damage the bearing.

MAST ASSEMBLY LUBRICATION

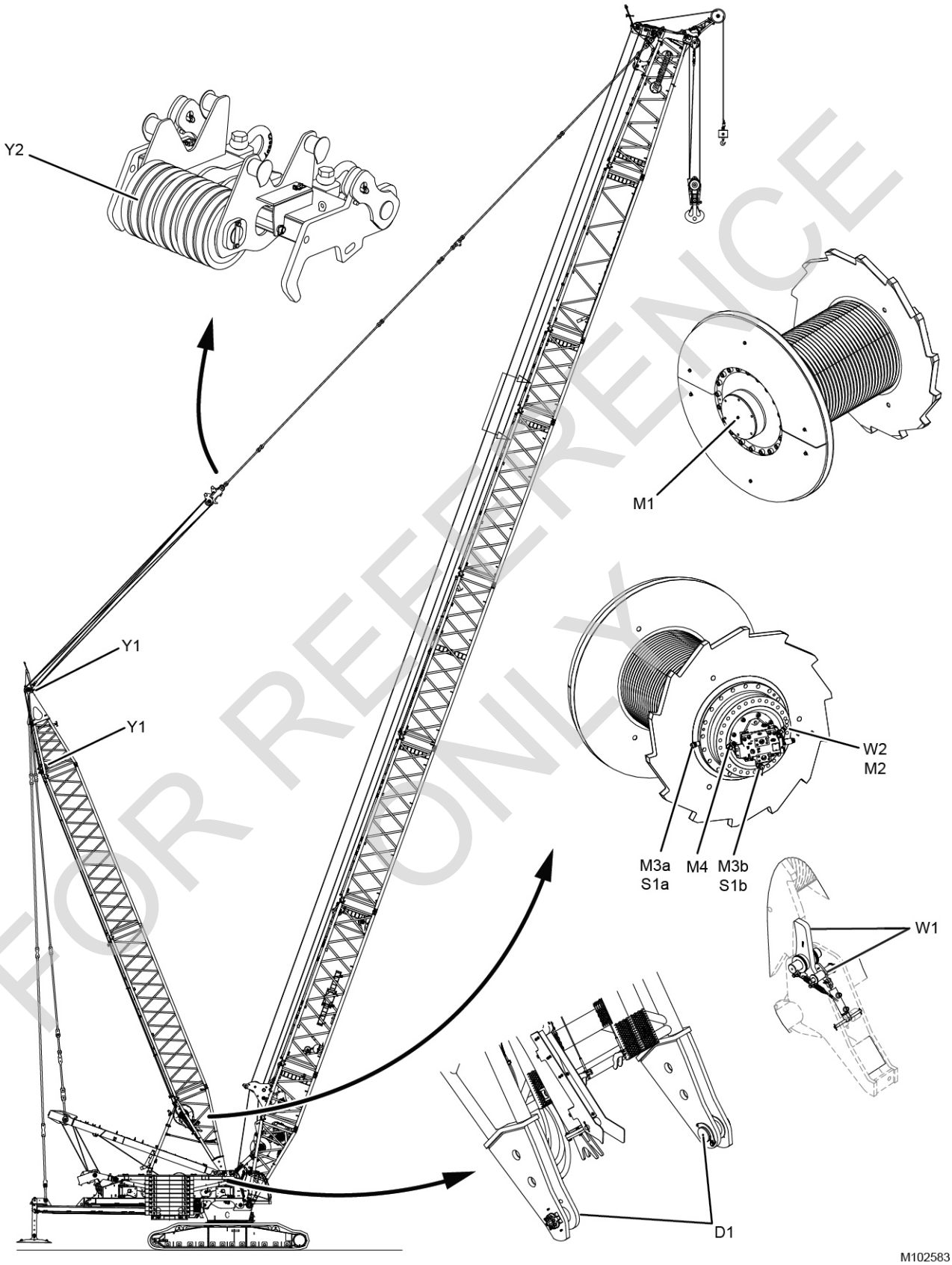

FIGURE 13

Item	Description	Required Service
Every 8 Hours of Operation or Daily (Whichever Comes First)		
D1	Mast Hinge Pin (1 Fitting, 2 Places)	Grease each
Every 40 Hours of Operation or Weekly (Whichever Comes First)		
W1	Boom Hoist Drum Pawl and Lever	Apply open gear oil to sliding surfaces to Pawl and Lever
W2	Boom Hoist Drum Oil Filling and Breather Plug	Clean each
Every 200 Hours of Operation or Monthly (Whichever Comes First)		
M1	Boom Hoist Drum Bearing Retainer	Grease
M2	Boom Hoist Drum Oil Filling and Breather Plug	Fill each to proper level with gear oil
M3a	Boom Hoist Drum Gearbox Drain Valve	Drain and refill with gear oil (see NOTE 1)
M3b	Boom Hoist Drum Gearbox Drain Valve	Drain and refill with gear oil (see NOTE 1)
M4	Boom Hoist Drum Transparent Oil Level Plug	Check level (see NOTE 2)
Every 1000 Hours of Operation or Semiannually (Whichever Comes First		
S1a	Boom Hoist Drum Gearbox Drain Valve	Drain and refill with gear oil
S1b	Boom Hoist Drum Gearbox Drain Valve	Drain and refill with gear oil
Every 2000 Hours of Operation or Annually (Whichever Comes First)		
Y1	Mast Top Assy Sheave (1 Fitting, each Sheave)	Grease each.
Y2	Mast Equalizer Sheave (1 Fitting, each Sheave)	Inspect the sheaves for proper operation yearly or every 2000 hours of crane operation. Overhaul the sheaves and repack them with grease if needed. The sheaves can be greased at a desired interval established by the crane owner/user.

NOTE 1 Lower the mast assembly so the drum is horizontal when changing oil.

NOTE 2 Before raising the mast assembly each time the crane is assembled, check the level of drums in the horizontal position.

VPC LUBRICATION

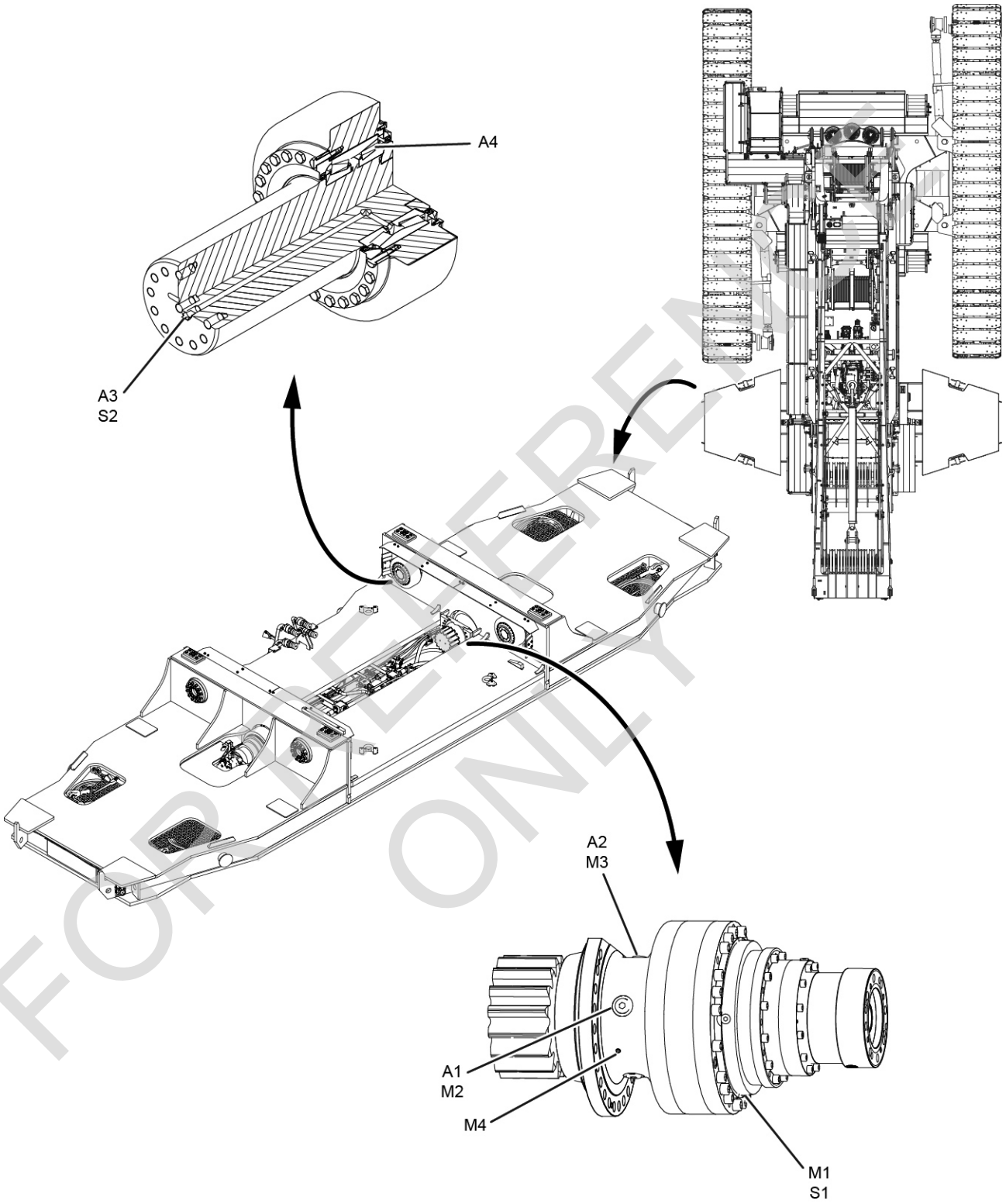

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FIGURE 14

Item	Description	Required Service
Prior to Operation		
A1	VPC Gearbox Oil Level Plug	Check the level, fill with gear oil through fill plug
A2	VPC Gearbox Oil Fill Plug	Fill to the proper level with gear oil
A3	VPC Roller Assy (each Roller)	Grease each fitting (see NOTE 2)
A4	VPC Roller Bearing (each Roller)	Grease each (see NOTE 3)
After First 200 Hours of Operation (See NOTE 1)		
M1	VPC Gearbox Oil Drain Plug	Drain and refill with gear oil through fill plug
Every 200 Hours of Operation or Monthly (Whichever Comes First)		
M2	VPC Gearbox Oil Level Plug	Check the level, fill with gear oil through fill plug
M3	VPC Gearbox Oil Fill Plug	Fill to the proper level with gear oil
M4	VPC Drive (each Gearbox)	Grease each fitting
Every 1000 Hours of Operation or Semiannually (Whichever Comes First)		
S1	VPC Gearbox Oil Drain Plug	Drain and refill with gear oil through fill plug
S2	VPC Roller Assy (each Roller)	Grease each fitting (see NOTE 2)

NOTE 1 Service after first 200 hours of operation is required to remove metal particles and other impurities collected during the initial run-in of the gearboxes.

NOTE 2 Before assembly, make sure that all the grease holes are open.

NOTE 3 Before assembling the bearing, hand pack the bearing with grease.

VPC-MAX LUBRICATION

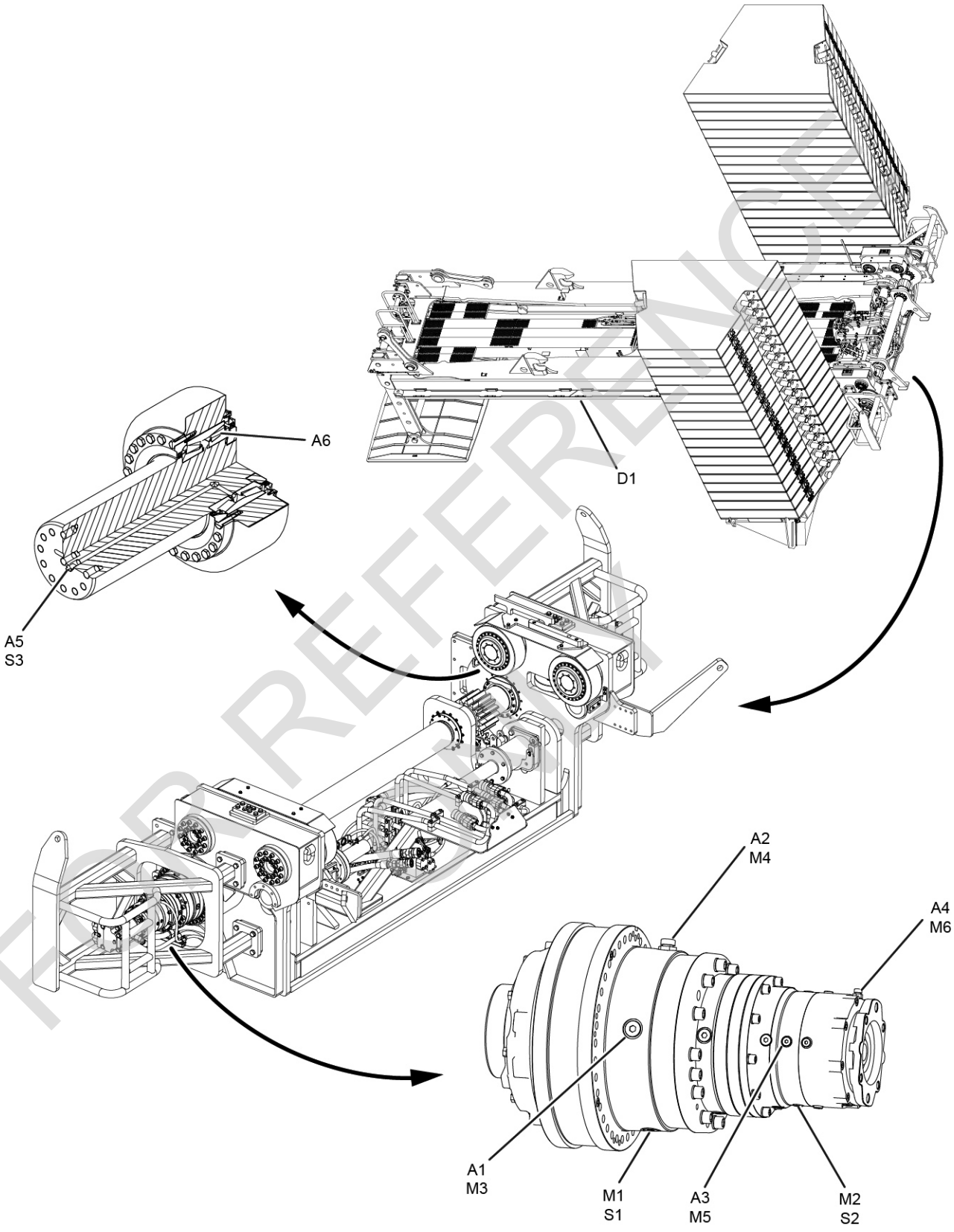


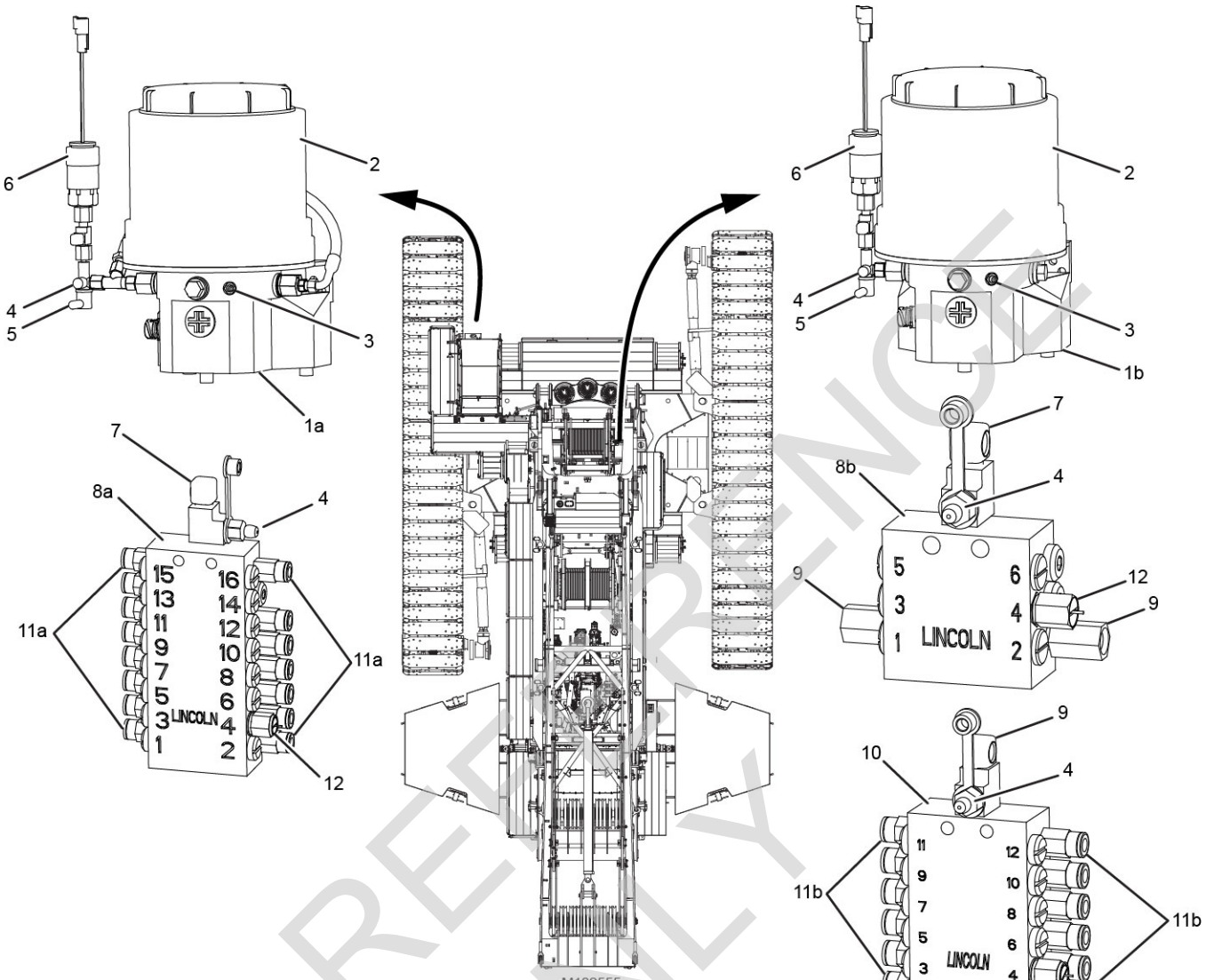
FIGURE 15

Item	Description	Required Service
Prior to Operation		
A1	VPC-MAX Gearbox Sight Glass Level Plug	Check the level, fill with gear oil through fill plug
A2	VPC-MAX Gearbox Breather and Fill Plug	Fill to the proper level with gear oil
A3	VPC-MAX Gearbox Sight Glass Level Plug (Brake)	Check the level, fill with gear oil through fill plug
A4	VPC-MAX Gearbox Breather and Fill Plug (Brake)	Fill to the proper level with gear oil
A5	VPC-MAX Roller Assy (each Roller)	Grease each fitting (see NOTE 2)
A6	VPC-MAX Roller Bearing (each Roller))	Grease each (see NOTE 3)
Every 8 Hours of Operation or Daily (Whichever Comes First)		
D1	VPC-MAX Gear Rack (both sides of crane)	Check for proper lubrication. Coat with open gear oil if needed. Clean all debris from roller path.
After First 200 Hours of Operation (See NOTE 1)		
M1	VPC-MAX Gearbox Magnetic Drain Plug	Drain and refill with gear oil through fill plug
M2	VPC-MAX Gearbox Magnetic Drain Plug (Brake)	Drain and refill with gear oil through fill plug
Every 200 Hours of Operation or Monthly (Whichever Comes First)		
M3	VPC-MAX Gearbox Sight Glass Level Plug	Check the level, fill with gear oil through fill plug
M4	VPC-MAX Gearbox Breather and Fill Plug	Fill to the proper level with gear oil
M5	VPC-MAX Gearbox Sight Glass Level Plug (Brake)	Check the level, fill with gear oil through fill plug
M6	VPC-MAX Gearbox Breather and Fill Plug (Brake)	Fill to the proper level with gear oil
Every 1000 Hours of Operation or Semiannually (Whichever Comes First)		
S1	VPC-MAX Gearbox Magnetic Drain Plug	Drain and refill with gear oil through fill plug
S2	VPC-MAX Gearbox Magnetic Drain Plug (Brake)	Drain and refill with gear oil through fill plug
S3	VPC-MAX Roller Assy (each Roller)	Grease each fitting (see NOTE 2)

NOTE 1 Service after first 200 hours of operation is required to, remove metal particles and other impurities collected during the initial run-in of the gearboxes.

NOTE 2 Before assembly, make sure that all the grease holes are open.

NOTE 3 Before assembling the bearing, hand pack the bearing with grease.



Item	Description
1a	Grease Pump (Crawler - 1 each)
1b	Grease Pump (Turntable Bearing)
2	Grease Reservoir
3	Grease Fitting for Filling Reservoir
4	Grease Fitting for Greasing System Manually
5	Pressure Relief Valve
6	Variable Pressure Switch
7	Grease Line from Pump
8a	Divider Valve (Crawler - 1 each)
8b	Primary Divider Valve (Turntable)
9	Grease Lines to Secondary Divider Valves (Turntable)
10	Secondary Divider Valves (Turntable)
11a	Grease Lines to Lube Points (Crawler)
11b	Grease Lines to Lube Points (Turntable)
12	Indicator Pin

FIGURE 16

AUTOMATIC LUBRICATION SYSTEM

The crane has two grease systems that automatically grease points on the turntable bearing and the rollers on each crawler. Grease is pumped to each point at the intervals given in Table 5 when the ignition switch is on. The grease pumps use 24 VDC power.

Table 5 Automatic Greasing Intervals

Item	Cycle Time	Interval
Turntable Bearing	2 minutes	Every hour
Crawler Roller Bearings	Continuous	While Traveling
Reservoir Capacity	4 L (1 gal)	
Pump Output:		
Turntable Bearing	2.8 cm^3/min	
Crawlers	8.0 cm^3/min	

Operation

See Figure 16 for the following procedure.

The crane's programmable controller controls the grease pumps.

- The pumps push grease to the grease points when the automatic grease system component is operating, usually when the crane is swung or traveled. See Table 5 for greasing intervals.
- The pumps stop pumping, when the automatic grease system is not operating.
- The pumps also stop pumping, if the crane's ignition switch is turned off.
- Each divider valve has an indicator pin (12) that extends and retracts during a lubrication cycle.

Daily Inspection

See Figure 16 for the following procedure.

To ensure maximum reliability and to protect crane components, the ***automatic lubrication systems must be inspected daily***:

1. Check the grease level in each reservoir.
2. When the grease level reaches the MIN mark on the reservoir, fill the reservoir to the MAX mark, with a hand operated grease pump through the grease fitting on the pump housing.

   Use a recommended grease (see Table 1 for the factory fill).
3. Visually inspect the automatic lubrication systems:
   a. Inspect the divider valve inlets, outlets, and lubrication points for leaks.
   b. Inspect for broken or cut grease lines.
   c. Inspect the terminal ends of each grease line to verify there are no leaks.
   d. Tighten any fittings, if grease leakage is detected.
4. With the power on, check that the pumps are working by moving the swing and travel handles.
5. Check to see if the indicator pin on each valve is working, when the system is cycling. The indicator pin on each valve should extend and retract.
6. If grease is pumped out through the pressure relief valve, pressure within system is greater than 276 ± 17 bar (4,000 ± 247 psi). An obstructed grease line or divider valve is indicated. Troubleshoot the system (see the next page).

CAUTION

Crawler/Turntable Bearing Hazard!

In extreme cold weather operation—temperatures down to -40°C (-40°F)—pumps may not pump grease through the automatic lubrication systems. It will be apparent that the lines are obstructed when the pump pushes grease out the relief valve.

If this occurs, ***grease the crawler rollers and the turntable bearing manually*** using the grease fittings (4) on the divider valves.

Manual Greasing

Each divider valve is equipped with a grease fitting (4, Figure 16) so that the crawler rollers and the turntable bearing can be greased manually if the need arises.

Automatic Lubrication System Troubleshooting

Symptom	Probable Cause	Solution
1. Pump will not operate	Not receiving 24-volt DC input	Check fuses and electrical supply Check electrical supply to the pump, by tracing to electrical source. Repair
	Blocked pump cam	If voltage is available to pump, check for blockage. Repair Replace pump motor if blockage is not identified
2. The pump motor is running but there is no grease being discharged	Air pocket at pump element inlet	Disconnect main delivery hose from pump outlet Run pump until solid grease with no bubbles flows from outlet. If solid grease does not discharge after twenty minutes, pump inlet is blocked **NOTE** Depending on operating temperature and grease type, it can take up to ten minutes to obtain full volume at outlet
	Blocked pump inlet	Remove pump element from pump body and check suction inlet port for foreign particles Reassemble pump and element, then test pump. If pump element does not discharge grease, replace element
3. Pump operated with an empty reservoir	Grease in reservoir is low	Fill reservoir and test system with grease gun at system manual grease fitting Disconnect main delivery hose from pump and watch until solid grease with no bubbles flows from outlet Reconnect main delivery hose to pump outlet
4. Grease is discharged at pressure relief valve	There is blockage in meter valves, hose, tubing, or at bearing	Test system with grease gun at system manual grease fitting. Loosen each outlet line at primary valve, one at a time. The blocked outlet line will start flowing grease and indicator pin starts indexing Retighten all outlets at primary valve Trace hose that flowed to its secondary valve Repeat process of loosening each outlet one at a time until blocked line is found Retighten all outlets Repair bearing blockage If a metering valve is causing blockage, replace valve
5. Indicator pin on primary valve does not move	See item 4	See item 4
6. Lubrication point is not receiving grease	Cut in hose or tubing	Replace hose or tubing