

# Manitowoc MLC150-1

## Service/Maintenance 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](http://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](http://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.





# SERVICE/MAINTENANCE MANUAL

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

**MLC150-1**

Crane Model Number

**XXXXXRef**

Crane Serial Number

This manual is divided into the following sections:

<b>SECTION 1</b>	<b>INTRODUCTION</b>
<b>SECTION 2</b>	<b>HYDRAULIC SYSTEM</b>
<b>SECTION 3</b>	<b>ELECTRICAL SYSTEM</b>
<b>SECTION 4</b>	<b>BOOM</b>
<b>SECTION 5</b>	<b>HOISTS</b>
<b>SECTION 6</b>	<b>SWING SYSTEM</b>
<b>SECTION 7</b>	<b>POWER TRAIN</b>
<b>SECTION 8</b>	<b>UNDERCARRIAGE</b>
<b>SECTION 9</b>	<b>LUBRICATION</b>
<b>SECTION 10</b>	<b>ACCESSORIES</b>

## NOTICE

The serial number of the crane is the only method your Manitowoc dealer or the Manitowoc Crane Care Lattice Team has of providing you with correct parts and service information.

The serial number is located on a crane identification plate attached to the operator's cab.

**Always furnish serial number of crane** when ordering parts or discussing service problems with your Manitowoc dealer or the Manitowoc Crane Care Lattice Team.



## **WARNING**

### To prevent death or serious injury:

- Avoid unsafe operation and maintenance.  
Crane and attachments must be operated and maintained by trained and experienced personnel. Manitowoc is not responsible for qualifying these personnel.
- Do not operate or work on crane or attachments without first reading and understanding instructions contained in Operator Information Manual and Service Manual supplied with crane and applicable attachments.
- Store Operator Information Manual and Service Manual in operator's cab.  
If Operator Information Manual or Service Manual is missing from cab, contact your Manitowoc dealer for a new one.



REFERENCE  
ONLY

***THE ORIGINAL LANGUAGE OF THIS PUBLICATION IS ENGLISH***

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# SECTION 1 INTRODUCTION

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## SECTION 1 INTRODUCTION

### CONTINUOUS INNOVATION

Due to continuing product innovation, the information in this manual is subject to change without notice. If you are in doubt about any procedure, contact your Manitowoc Cranes dealer or the Manitowoc Crane Care Lattice Team.



#### 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](http://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](http://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.

### SAFETY MESSAGES

The importance of safe operation and maintenance cannot be overemphasized. Carelessness or neglect on the part of operators, job supervisors and planners, rigging personnel, and job site workers can result in their death or injury and costly damage to the crane and property.

To alert personnel to hazardous operating practices and maintenance procedures, safety messages are used throughout the manual. Each safety message contains a safety alert symbol and a signal word to identify the hazard's degree of seriousness.

### Safety Alert Symbol



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible death or injury.

### Signal Words



#### DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



#### WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.



#### CAUTION

Used with the safety alert symbol. Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

#### CAUTION

The signal word CAUTION without the safety alert symbol identifies a hazardous situation which, if not avoided, could result in property damage.

## SAFE MAINTENANCE PRACTICES



### WARNING

#### Safety Responsibility!

The importance of safe maintenance cannot be overemphasized. Carelessness and neglect on the part of maintenance personnel can result in their death or injury and costly damage to the crane or property.

Safety information in this publication is intended only as a guide to assist qualified maintenance personnel in safe maintenance. Manitowoc Cranes cannot foresee all hazards that will arise in the field. Safety remains the responsibility of maintenance personnel and the crane owner.

### Read This Manual

To ensure safe and proper operation of Manitowoc cranes, they must be maintained according to the instructions contained in this manual.

### Authorized Repair Personnel Only

Crane maintenance and repair must be performed by personnel who by reason of training and experience are thoroughly familiar with the crane's operation and required maintenance. These personnel shall read the MLC150-1 Operator Manual and the MLC150-1 Service/Maintenance Manual before attempting any maintenance procedure. If there is any question regarding maintenance procedures or specifications, contact your Manitowoc dealer for assistance.

Training/qualification of maintenance personnel is the responsibility of the crane owner.

### Basic Crane Maintenance Safety

The following precautions are basic practices. Detailed precautions and warnings are in the relevant procedures in this manual. Be sure to read all information in this manual relevant to the maintenance to be performed.

#### Before Starting a Maintenance Procedure

Perform the following actions (as applicable) before starting a maintenance procedure:

- Park the crane where it will not interfere with other equipment or operations.
- Lower all loads to ground or otherwise secure them against movement.
- Lower the boom onto blocking at ground level, if possible, or otherwise secure the boom so that it cannot drop unexpectedly.

- Move all controls to OFF and secure all functions against movement by applying or engaging all brakes, pawls, or other locking devices.
- Stop the engine and render the starter inoperative. This must be done according to your organization's lockout-tagout procedure.
- Place a warning sign at the start controls to alert other personnel that the crane is being serviced and the engine must not be started. Do not remove the sign until it is safe to return the crane to service.
- Wear clothing that is relatively tight and belted.
- Wear appropriate eye protection and an approved hard hat.
- Do not attempt to maintain or repair any part of the crane while the engine is running, unless it is absolutely necessary.

If the engine must be running while the crane is being serviced, observe the following:

- Maintain constant verbal communication between the person at the controls and the person performing the maintenance or repair procedure.
- Keep your clothing and all parts of your body away from moving parts.

#### Precautions While Working on the Crane

- Never climb onto or off a moving crane. Climb onto and off the crane only when it is parked and only with the operator's permission.

To climb onto and off the crane, use both of your hands and also use the handrails, steps, and ladders that are provided.

Use hand lines or hoists to lift tools and other equipment that cannot be carried in pockets or tool belts.

- The boom and gantry are not intended as ladders. Do not attempt to climb the lattice work of the boom or gantry. If the boom or gantry is not equipped with an approved ladder, lower it before performing maintenance or repair procedures.
- Store tools, oil cans, spare parts, and other necessary equipment in tool boxes. Do not allow these items to lie around loose in the operator's cab or on the walkways and stairs.
- Pinch points are impossible to eliminate. Watch for them closely.
- Do not attempt to lift heavy components by hand. Use a hoist, jacks, or blocking to lift components.
- Never handle the wire rope with bare hands. Always wear heavy-duty gloves to prevent being cut by broken wires.

**Stored Energy Safety Precautions**

- Do not remove an actuating cylinder until the actuated part has been securely restrained against movement.
- Pressurized air, coolant, and hydraulic oil can cause serious injury. Make sure all air, coolant, and hydraulic lines, fittings, and components are tight and serviceable.

Do not use your hands to check for air or hydraulic oil leaks:

- Use a soap-and-water solution to check for air leaks (apply to fittings and lines and watch for bubbles).
- Use a piece of cardboard or wood to check for coolant and hydraulic oil leaks.
- Relieve pressure before disconnecting air, coolant, and hydraulic lines and fittings.
- Use extreme care when handling coiled pendants. Stored energy can cause coiled pendants to uncoil quickly with considerable force.
- When inflating tires, use a tire cage, a clip-on inflater, and an extension hose which enables standing well away from the tire.
- Do not remove the radiator cap while the coolant is hot or under pressure. Stop the engine, wait until the pressure drops and coolant cools, then slowly remove the cap.
- Avoid a battery explosion—do not smoke while performing battery maintenance and do not short across the battery terminals to check its charge.
- Read the safety information in the battery manufacturer's instructions before attempting to charge a battery.

**Chemical Handling Precautions**

- Avoid battery acid contact with skin and eyes. If contact occurs, flush the area with water and immediately consult a doctor.

**Fire Hazard Precautions**

- Stop the engine before refueling the crane.
- Do not smoke or allow open flames in the refueling area.
- When using a fuel can, use a safety-type can with an automatic closing cap and flame arrestor.
- Hydraulic oil can also be flammable. Do not smoke or allow open flames in the area when filling hydraulic tanks.
- Only use cleaning solvents which are nonvolatile and nonflammable.

- Do not store flammable materials on the crane.
- Use care while welding or torching on the crane. Cover all hoses and components with nonflammable shields or blankets to prevent a fire and other damage.
- Keep the crane clean. Accumulations of dirt, grease, oil, rags, paper, and other waste will not only interfere with safe operation and maintenance but also create a fire hazard.

**Welding Hazard Avoidance**

- Welding—To prevent damage to the crane parts (for example, bearings, cylinders, swivels, slewing ring, and computers), perform the following steps before welding on the crane.
  - a. Turn the battery disconnect switch to the OFF position.
  - b. Disconnect all the cables from the batteries. Make sure to disconnect the negative cable first.
  - c. Disconnect the output cables at the engine junction box.
  - d. Disconnect all cable connectors from nearby control modules.
  - e. Attach a ground cable from the welder directly to the part being welded and as close to the weld as possible.
- Do not weld on the engine or the engine-mounted parts (per engine manufacturer).
- Disconnect and lock out the power supply switch before attempting to service high-voltage electrical components and before entering tight areas (such as carbody openings) containing high-voltage components.

**Maintaining Structural Integrity of the Crane**

- When assembling and disassembling booms, jibs, or masts on the ground (with or without the support of boom rigging pendants), securely block each section to provide adequate support and alignment.

Do not go under the boom, jib, or mast sections while connecting bolts or pins are being removed.

- Unless authorized in writing by Manitowoc Cranes, do not alter the crane in any way that affects the crane's performance (to include welding, cutting, or burning of structural members or changing pressures and flows of air/hydraulic components). Doing so will invalidate all warranties and capacity charts and make the crane owner/user liable for any resultant accidents.

**Returning the Crane to Service**

- Do not return the crane to service until:
  - All guards and covers have been installed.
  - Trapped air has been bled from hydraulic systems.
  - Safety devices have been reactivated.
  - All tools and maintenance equipment have been removed.
- Perform a function check to ensure proper operation at the completion of the maintenance or repair.

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.

**PROTECTION OF THE ENVIRONMENT****WARNING****Environmental Damage!**

Dispose of waste properly! Improperly disposing of waste can cause environmental damage.

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

**IDENTIFICATION AND LOCATION OF MAJOR COMPONENTS**

See [Figure 1-1](#) and [Figure 1-2](#) for locations of the crane's major components.

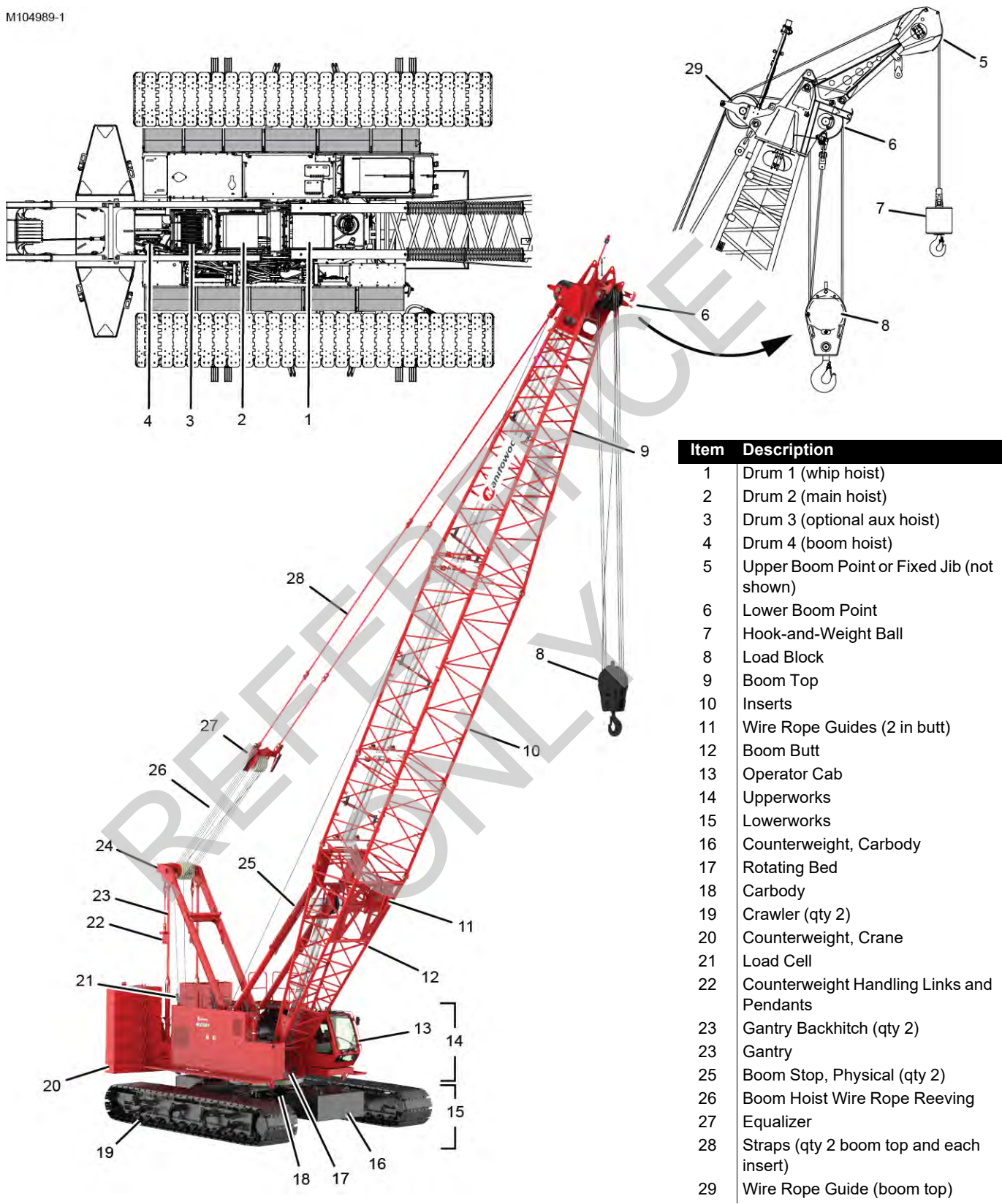
See Section 2 of this manual for locations of the following:

- Hydraulic pumps
- Hydraulic motors
- Transducers
- Hydraulic valve assemblies

See Section 3 of this manual for locations of the electronic control modules.



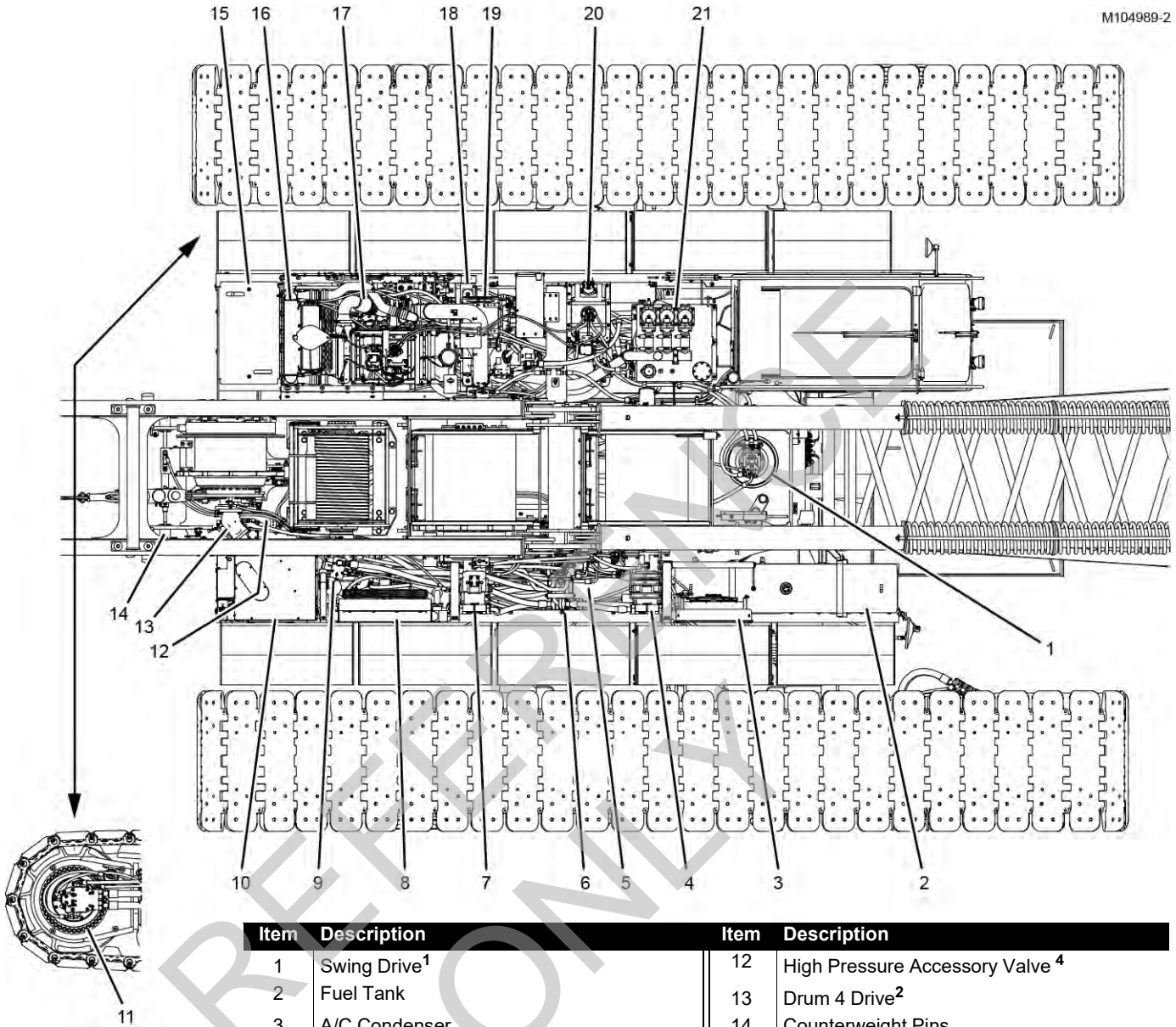
M104989-1



Item	Description
1	Drum 1 (whip hoist)
2	Drum 2 (main hoist)
3	Drum 3 (optional aux hoist)
4	Drum 4 (boom hoist)
5	Upper Boom Point or Fixed Jib (not shown)
6	Lower Boom Point
7	Hook-and-Weight Ball
8	Load Block
9	Boom Top
10	Inserts
11	Wire Rope Guides (2 in butt)
12	Boom Butt
13	Operator Cab
14	Upperworks
15	Lowerworks
16	Counterweight, Carbody
17	Rotating Bed
18	Carbody
19	Crawler (qty 2)
20	Counterweight, Crane
21	Load Cell
22	Counterweight Handling Links and Pendants
23	Gantry Backhitch (qty 2)
23	Gantry
25	Boom Stop, Physical (qty 2)
26	Boom Hoist Wire Rope Reeving
27	Equalizer
28	Straps (qty 2 boom top and each insert)
29	Wire Rope Guide (boom top)

FIGURE 1-1

M104989-2



Item	Description	Item	Description
1	Swing Drive <sup>1</sup>	12	High Pressure Accessory Valve <sup>4</sup>
2	Fuel Tank	13	Drum 4 Drive <sup>2</sup>
3	A/C Condenser	14	Counterweight Pins
4	Drum 1 Drive <sup>2</sup>	15	Battery Box
5	Low Pressure Accessory Valve	16	Radiator
6	Main Control Valve	17	Engine
7	Drum 2 Drive <sup>2</sup>	18	Pump Drive and Pump
8	Hydraulic Oil Cooler	19	Engine Air Cleaner
9	Drum 3 Drive <sup>2</sup>	20	Tier 4 DEF Tank
10	Generator Set	21	Hydraulic Tank
11	Crawler Drive (inboard side both crawlers) <sup>3</sup>		

<sup>1</sup> Swing drive includes a planetary gearbox with swing pinion, a spring-applied brake, and a motor.

<sup>2</sup> Each drum drive includes a drum, a planetary gearbox, a spring applied brake, and a motor.

<sup>3</sup> Each crawler drive includes a planetary gearbox, a drive tumbler, a spring applied brake, and a motor.

<sup>4</sup> Inside rotating bed. Accessible from under rotating bed.

FIGURE 1-2

## SECTION 2

### HYDRAULIC SYSTEM

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## SECTION 2 HYDRAULIC SYSTEM

### HYDRAULIC SCHEMATIC

The hydraulic schematic for this crane is located at the end of this section.

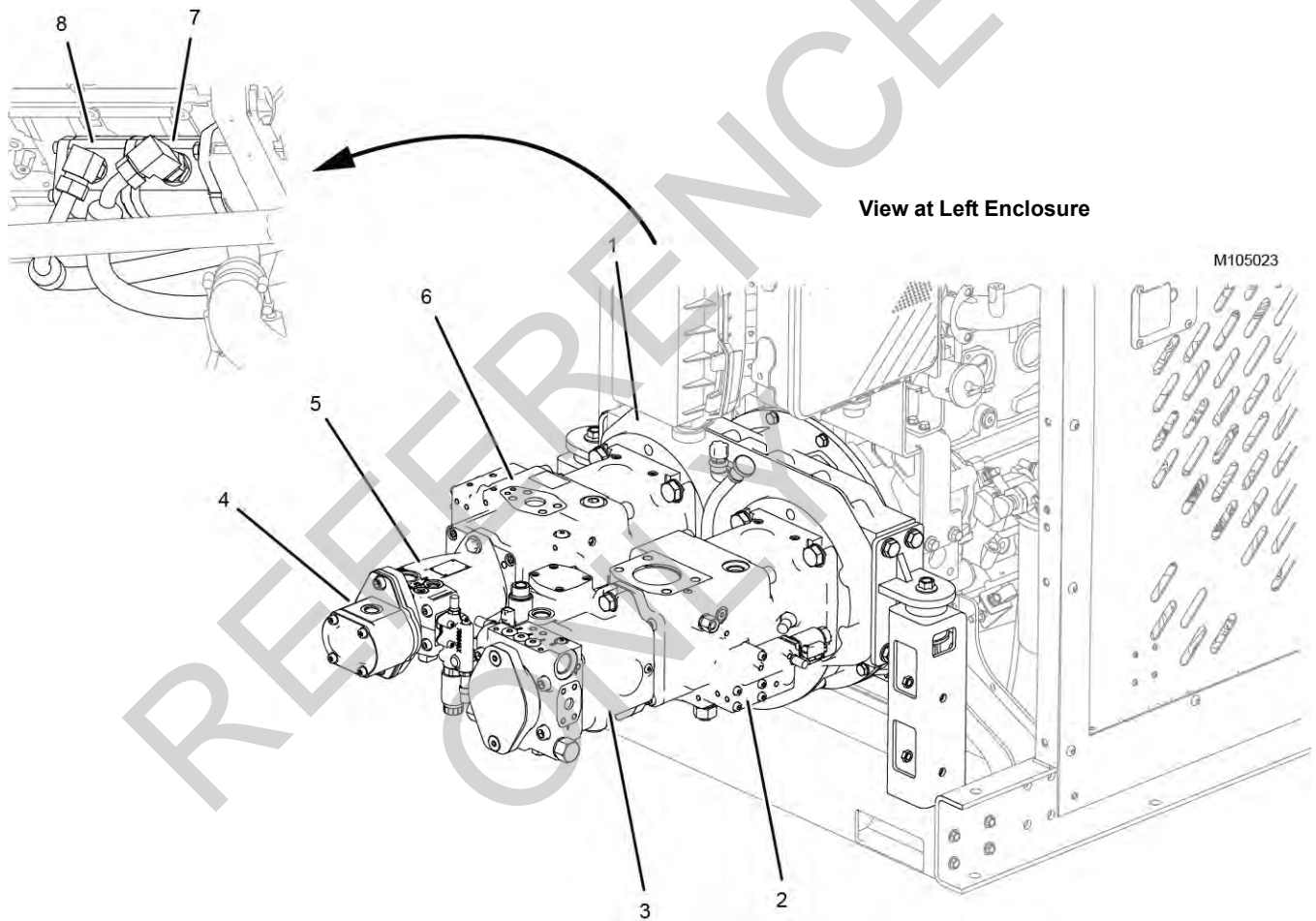
### HYDRAULIC SYSTEM OVERVIEW

This section provides a physical description and general functional overview of the major hydraulic components.

Detailed descriptions of the controls and operations using these components to form working circuits can be found in the appropriate sections of this manual.

### HYDRAULIC PUMP IDENTIFICATION

There are seven hydraulic pumps driven by the engine. See [Figure 2-1](#).



Pump	Supplies Oil To
1	Pump Drive
2	Open Loop B (OLB): Right Travel Drum 1, Drum 3, High Pressure Accessories Valve
3	Swing
4	Pilot: OLA, OLB, and Low Pressure Accessories Valve
5	Fan
6	Open Loop A (OLA): Left Travel, Drum 2, Drum 4
7	Free Fall Cooling
8	Free Fall Pilot

**FIGURE 2-1**

### OLA Pump

The **Open Loop A** pump (Figure 2-2) is an axial piston, 130 cc/rev, variable-displacement pump with an electronic displacement control (EDC).

The pump has a maximum operating pressure of 350 bar (5075 psi).

M105134

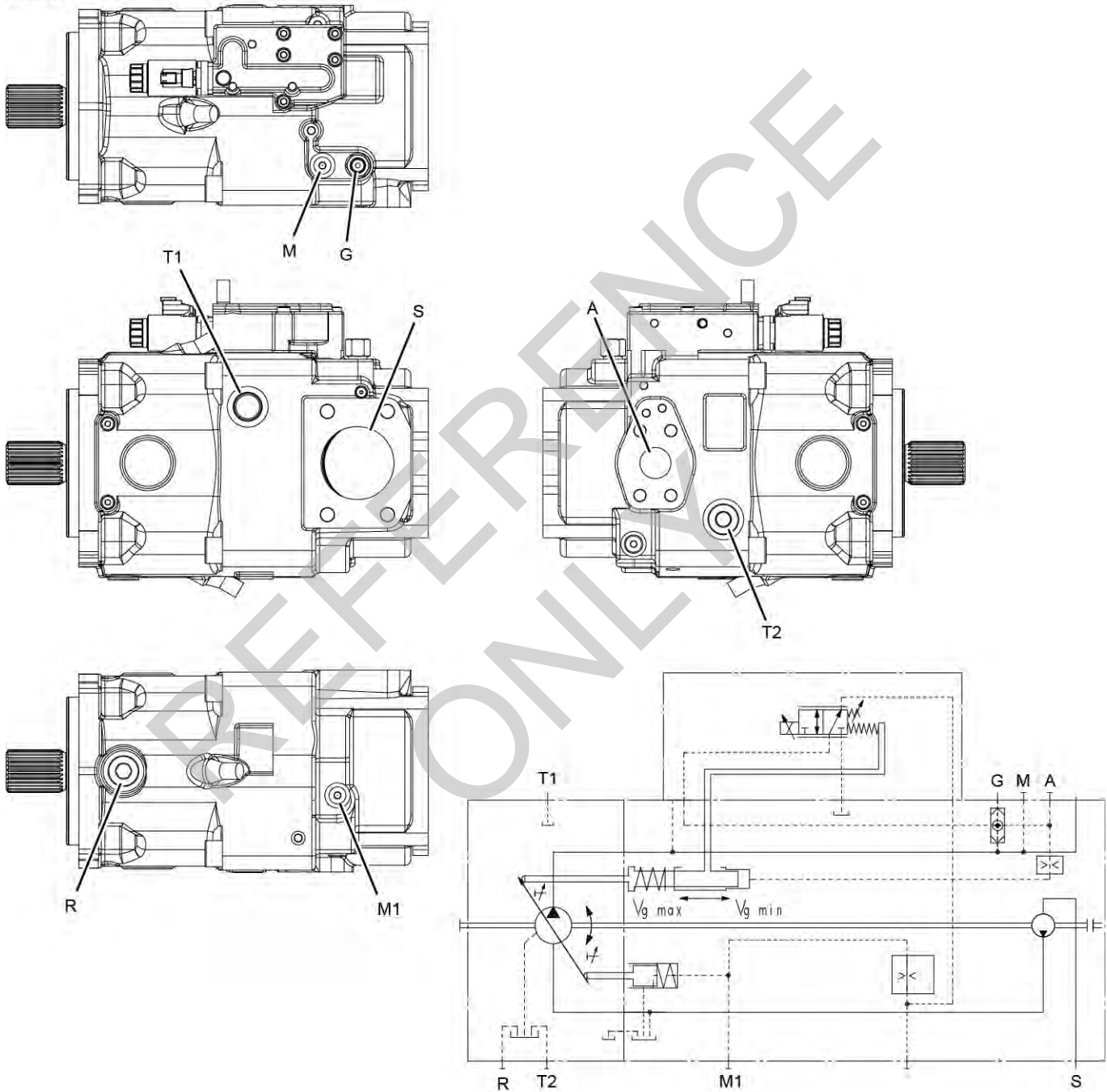


FIGURE 2-2

### OLB Pump

The **Open Loop B** pump (Figure 2-3) is an axial piston, 130 cc/rev, variable-displacement pump with an electronic displacement control (EDC).

The pump has a maximum operating pressure of 350 bar (5075 psi).

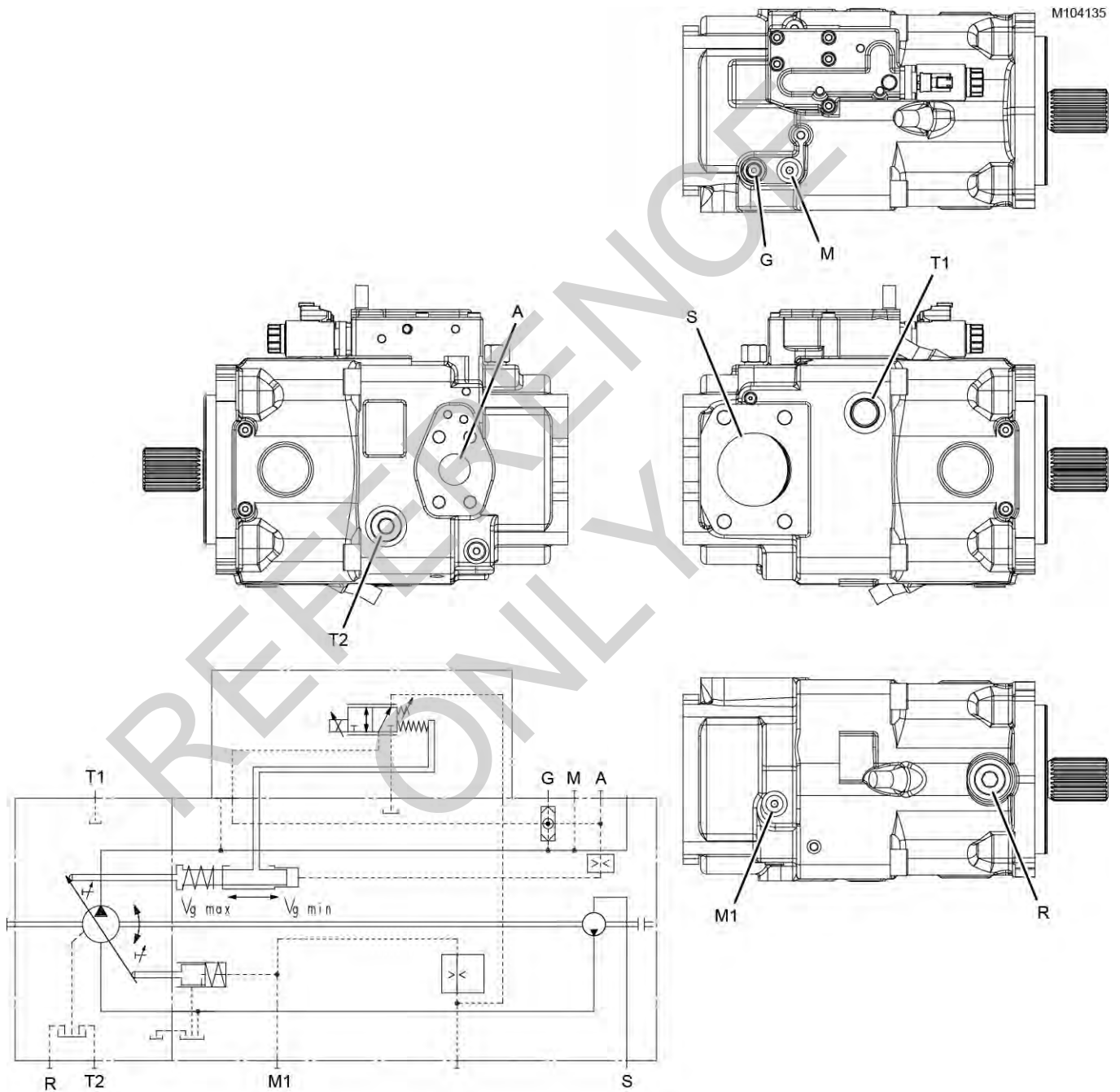


FIGURE 2-3

### Swing Pump

The **Swing** pump (Figure 2-4) is an axial piston, 56 cc/rev, variable-displacement pump with an electronic displacement control (EDC).

The pump has a maximum operating pressure of 420 bar (6,096 psi).

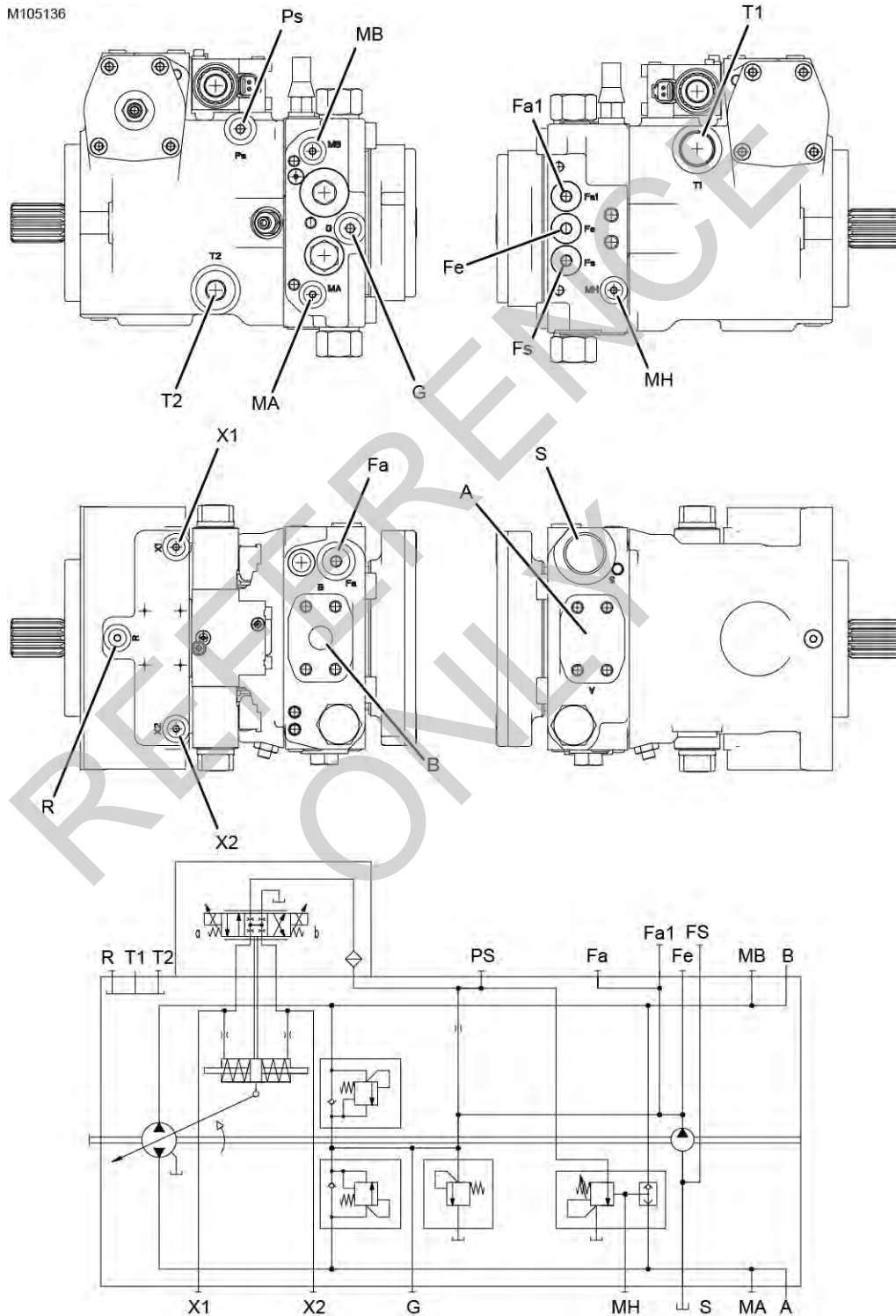


FIGURE 2-4



### Fan Pump

The Fan pump (Figure 2-4) is an axial piston, 18 cc/rev, variable-displacement pump with an electronic displacement control (EDC).

The pump has a maximum operating pressure of 152 bar (2,200 psi).

M104138

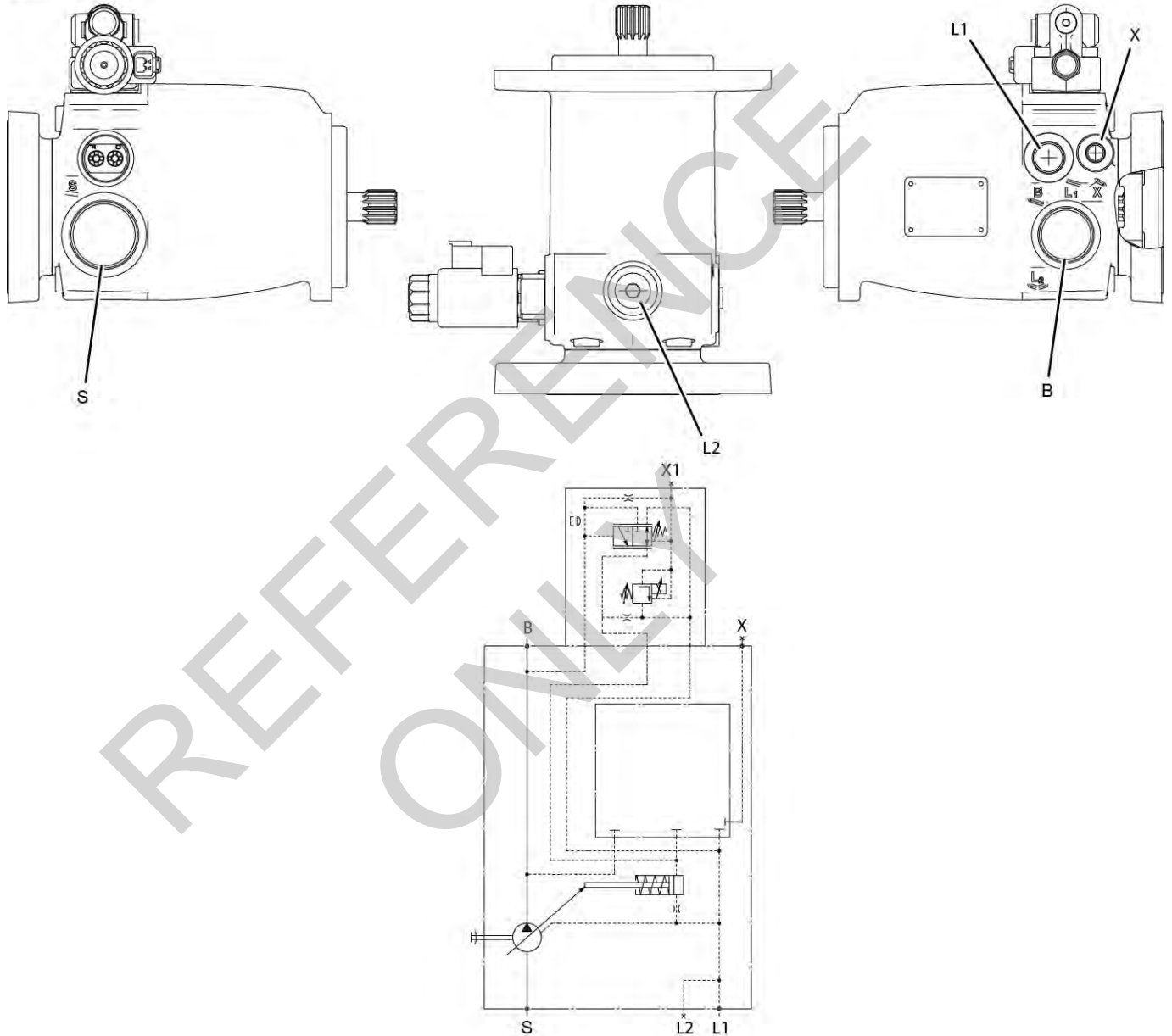


FIGURE 2-5

### Pilot Pump

The **Pilot** pump (Figure 2-6) is a 16 cc/rev, fixed-displacement gear pump.

The pump has a maximum operating pressure of 55 bar (800 psi).

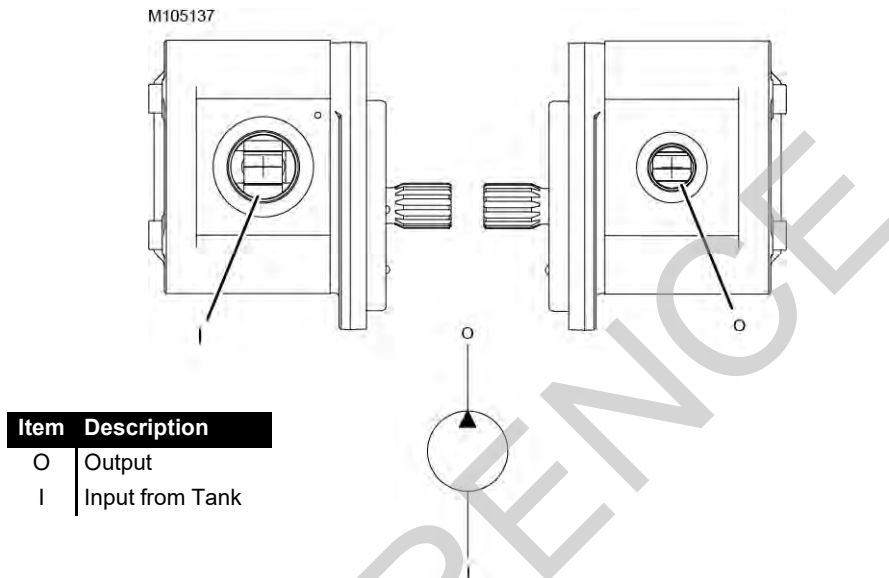


FIGURE 2-6

### Free Fall Pump

The **Freefall** pump (Figure 2-7) is a fixed-displacement dual gear pump. Output 1 (O1) displacement is 32 cc/rev. Output 2 (O2) displacement is 22,5 cc/rev.

The pump has a maximum operating pressure of: O1=5 bar (73 psi); O2=75 bar (1,090 psi).

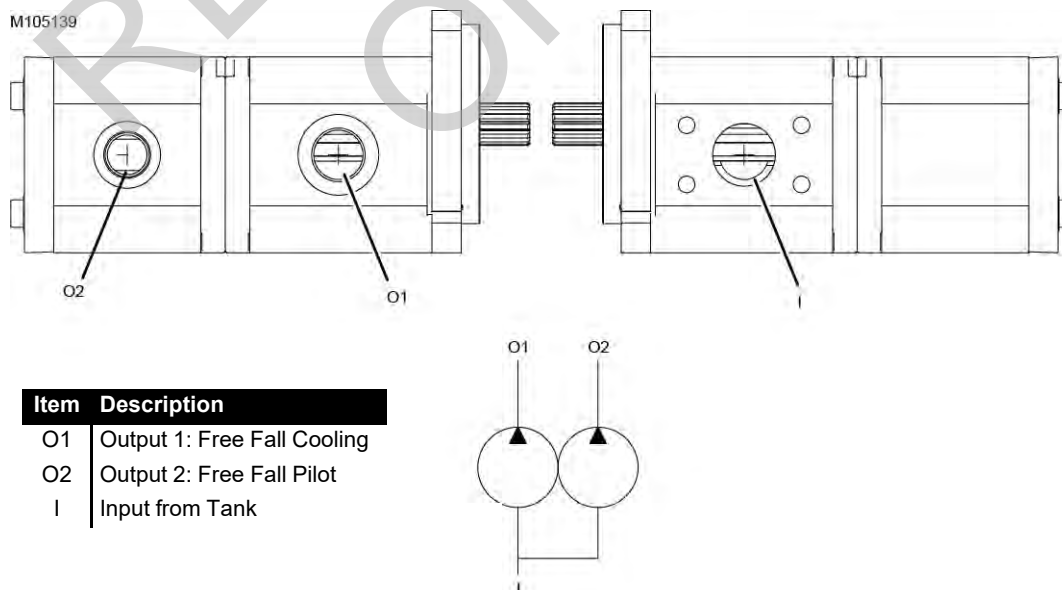


FIGURE 2-7

## HYDRAULIC MOTOR IDENTIFICATION

### Drum 1 and 2 Motors

Each Drum 1 and 2 motor (Figure 2-8) is a bidirectional, variable-displacement, bent-axis piston motor. Each motor's displacement is controlled by an electric-over-hydraulic

proportional displacement control. Displacement is 171,8 cc/rev maximum and 36 cc/rev minimum

Each motor has an external loop flushing circuit that removes a small volume of oil from the motor loop to provide cooling and oil purification.

Motor Shaft Rotation (viewed from shaft end)	Flow Direction		Drum Operation
	Port A	Port B	
Clockwise	IN	OUT	Lower Load
Counterclockwise	OUT	IN	Hoist Load

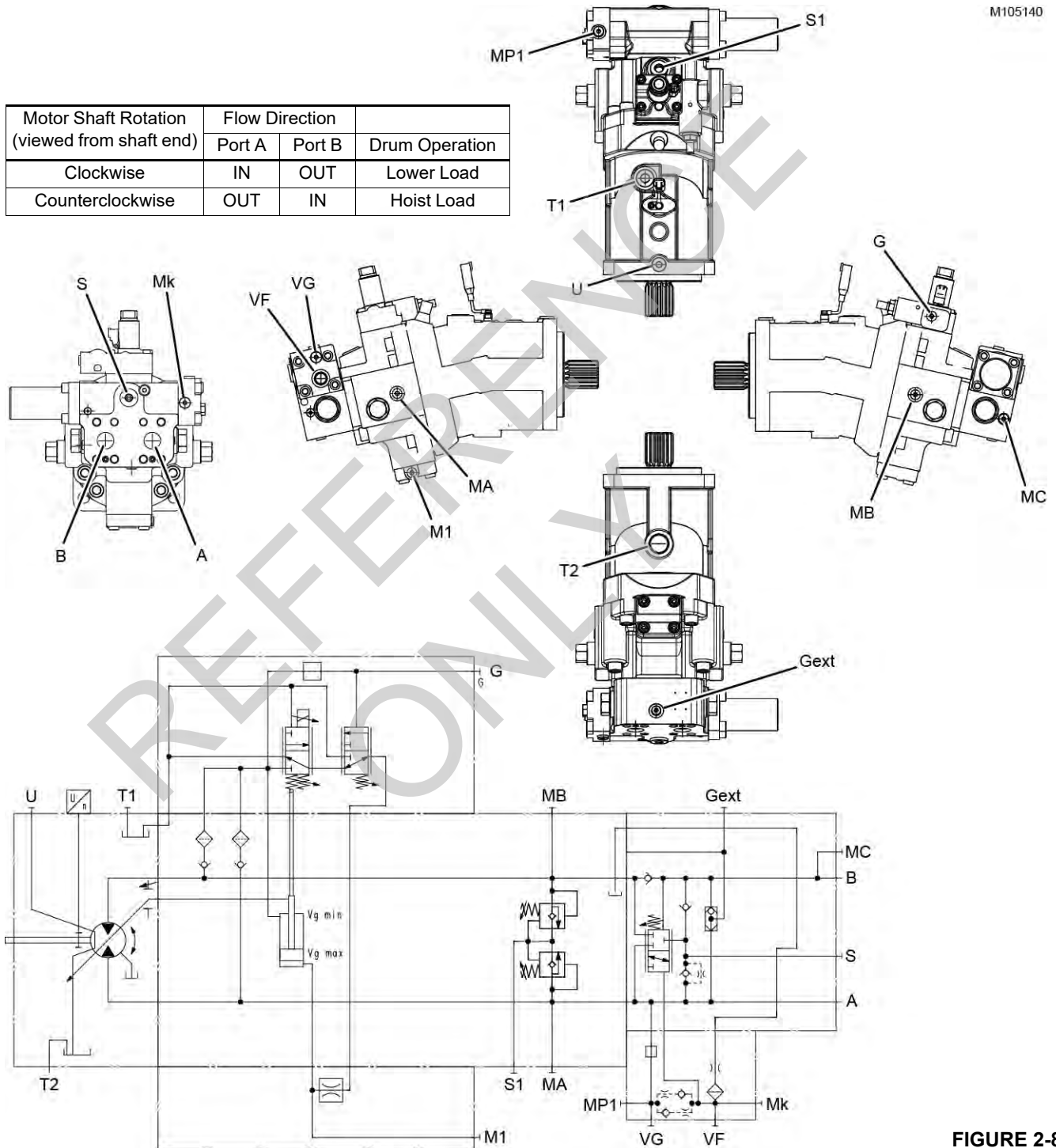


FIGURE 2-8

### Drum 3 Motor

The Drum 3 motor (Figure 2-9) is a bidirectional, variable-displacement, bent-axis piston motor. Motor displacement is controlled by an electric-over-hydraulic proportional displacement control. Displacement is 107 cc/rev maximum

and 36 cc/rev minimum.

The motor has an external loop flushing circuit that removes a small volume of oil from the motor loop to provide cooling and oil purification.

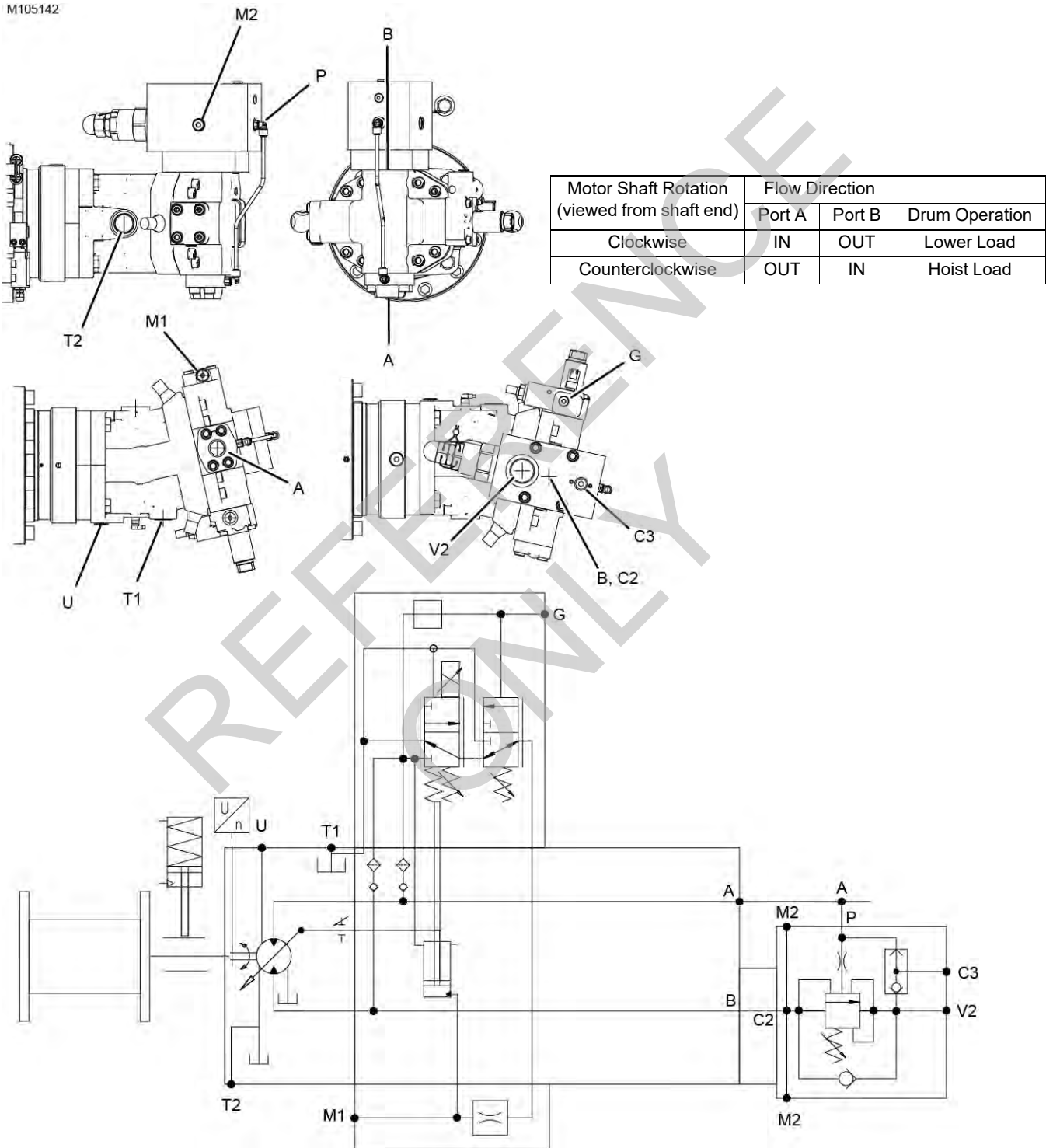
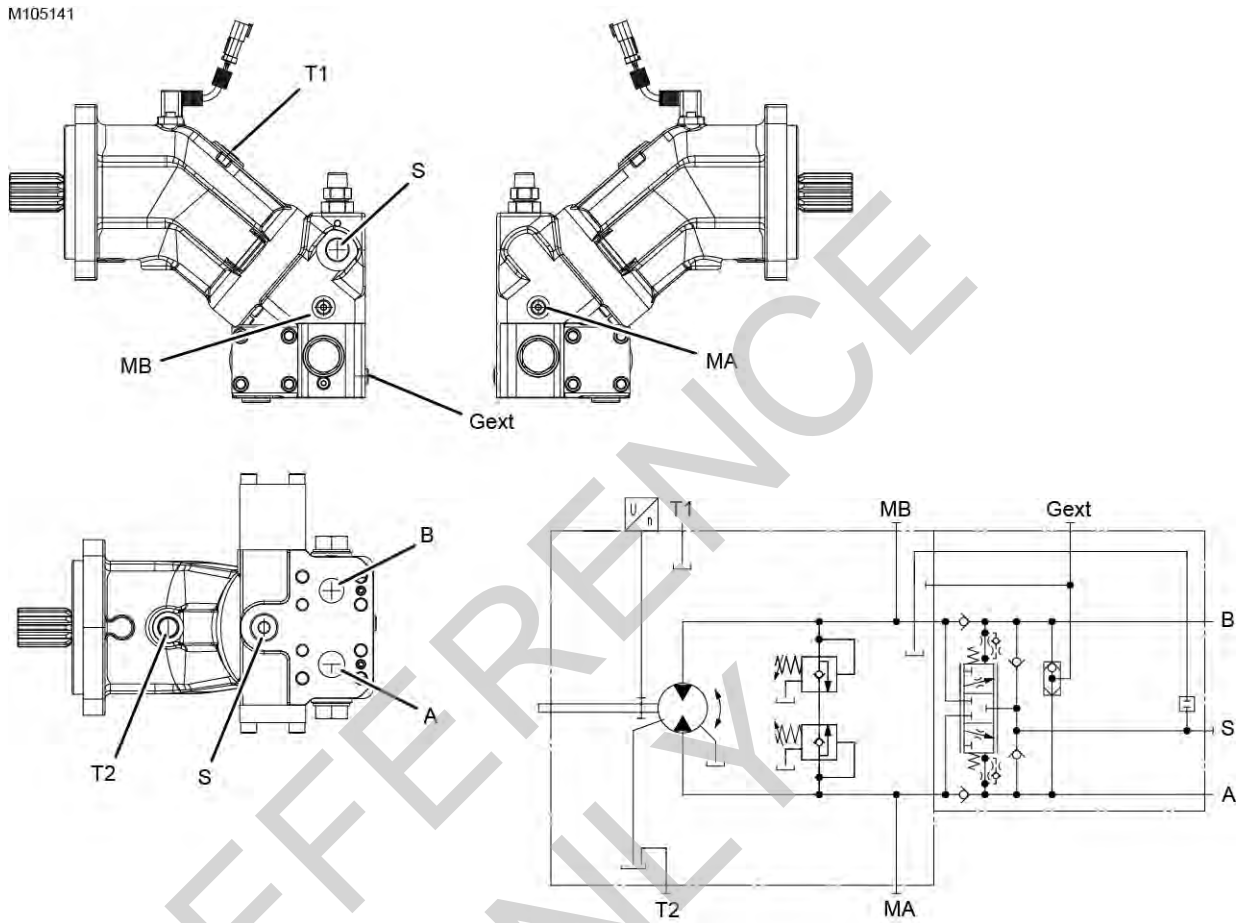


FIGURE 2-9

### Drum 4 Motor

The Drum 4 motor (Figure 2-10) is an bidirectional, bent-axis fixed-displacement motor. Displacement is 107 cc/rev.



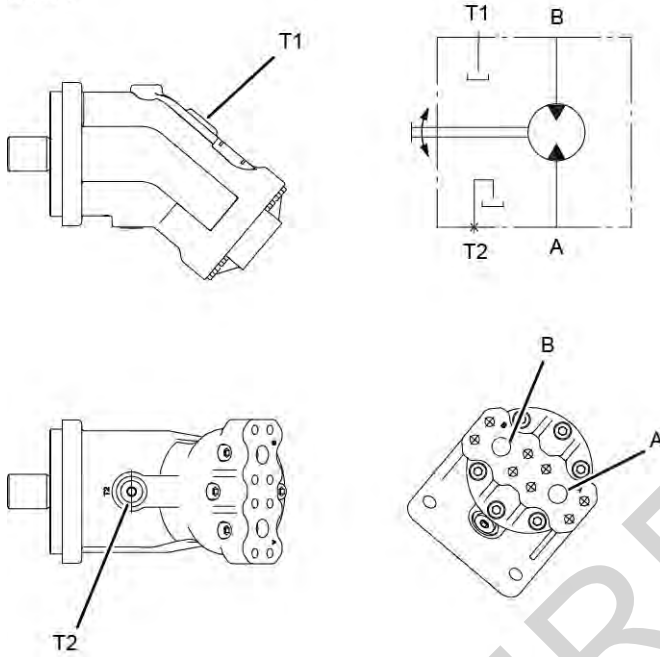
Motor Shaft Rotation (viewed from shaft end)	Flow Direction		Drum Operation
	Port A	Port B	
Clockwise	IN	OUT	Lower Boom
Counterclockwise	OUT	IN	Raise Boom

FIGURE 2-10

### Swing Motor

The swing motor ([Figure 2-12](#)) is a 56.1 cc/rev, bidirectional, fixed-displacement motor, bent-axis piston motor.

M105143



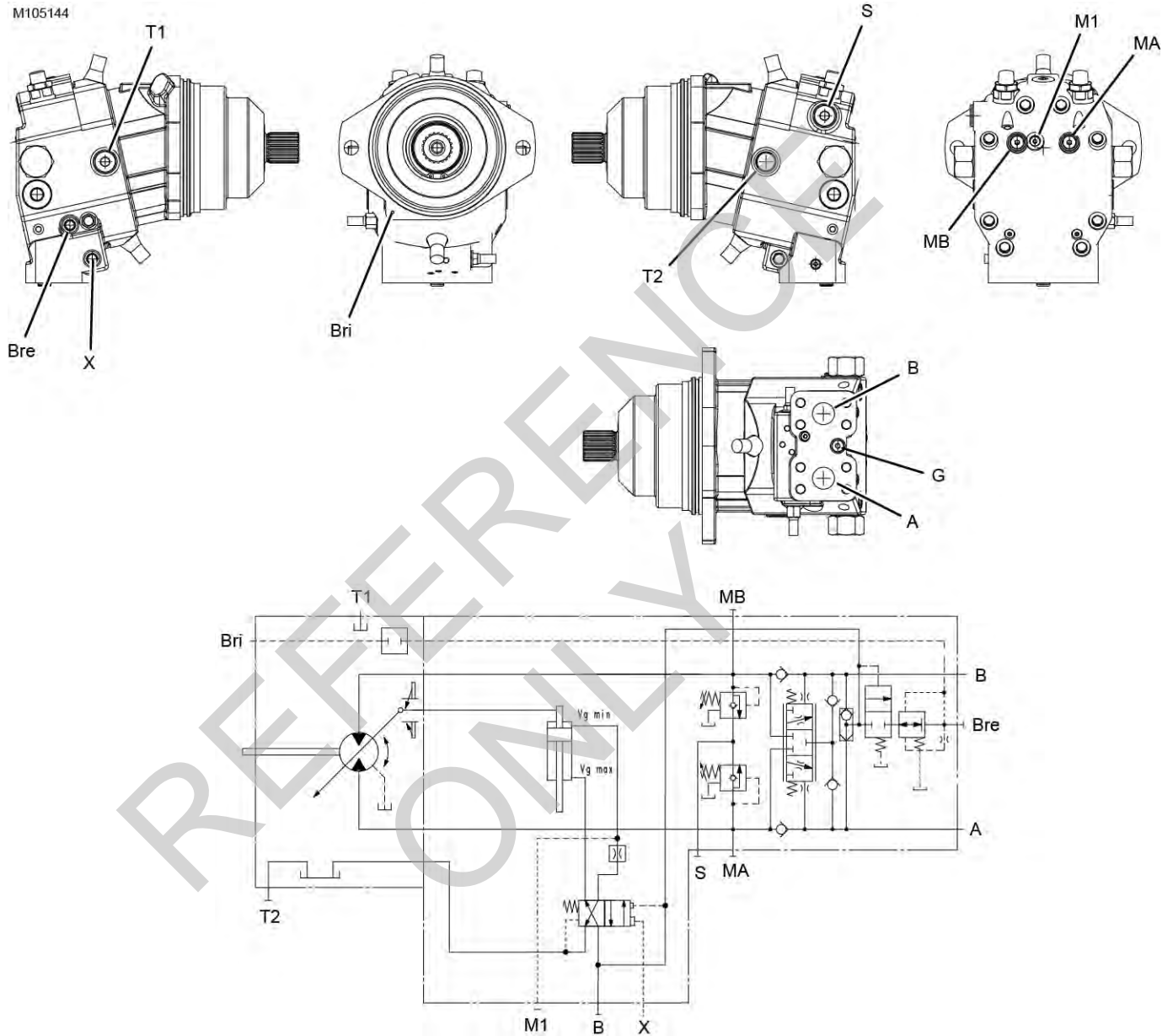
Motor Shaft Rotation (viewed from shaft end)	Flow Direction		Crane Rotation (viewed from top)
	Port A	Port B	
Clockwise	IN	OUT	Clockwise
Counterclockwise	OUT	IN	Counterclockwise

FIGURE 2-11

### Travel Motors

The travel motors (Figure 2-11) are bidirectional, variable-displacement, bent-axis piston motors. Motor displacement is controlled by a hydraulic two-speed signal and pressure override.

Displacement is 142 cc/rev maximum and 68 cc/rev minimum.



Motor Shaft Rotation (viewed from shaft end)	Flow Direction		Travel Direction
	Port A	Port B	
Clockwise	IN	OUT	Forward
Counterclockwise	OUT	IN	Reverse

Motor Shaft Rotation (viewed from shaft end)	Flow Direction		Travel Direction
	Port A	Port B	
Clockwise	IN	OUT	Reverse
Counterclockwise	OUT	IN	Forward

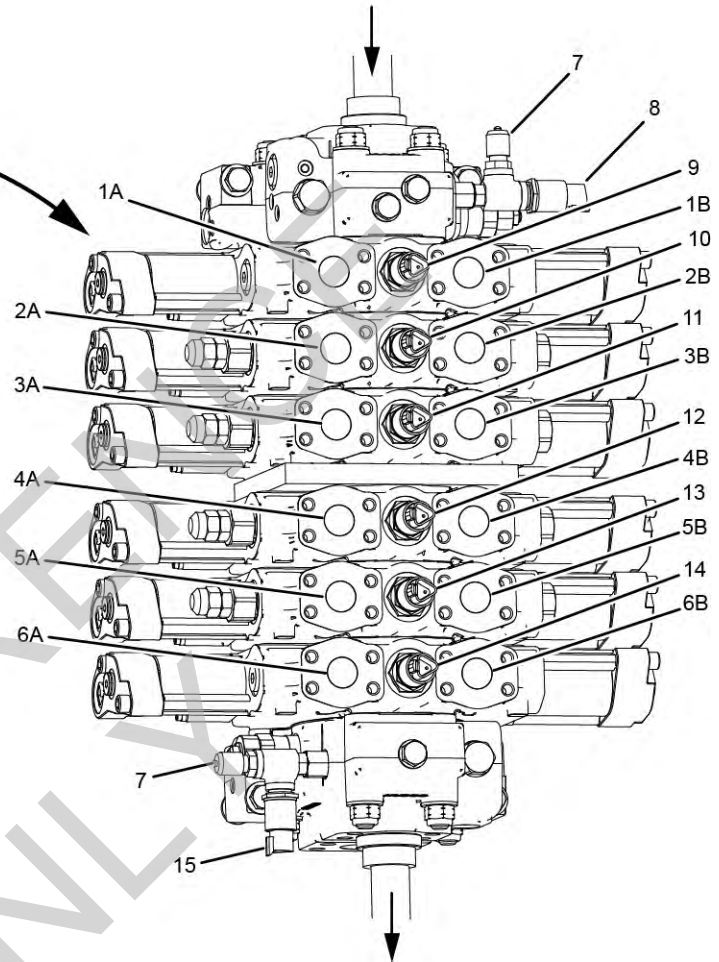
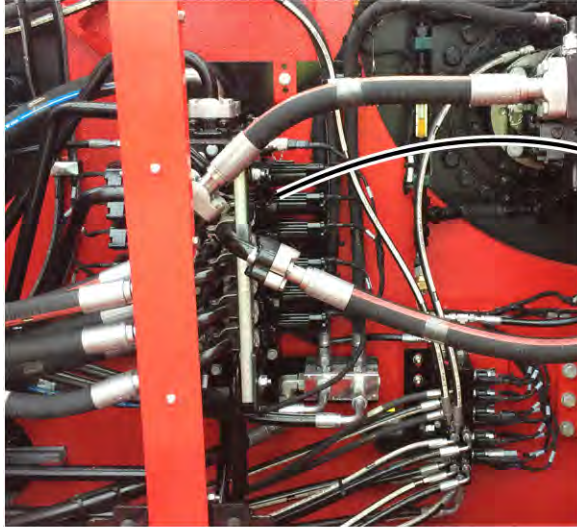
FIGURE 2-12

## HYDRAULIC VALVE IDENTIFICATION

### Main Control Valve

M105145

Right Side Enclosure



Item	Description
1A	Right Travel Reverse
1B	Right Travel Forward
2A	Drum 1 Lower
2B	Drum 1 Hoist
3A	Drum 3 Lower
3B	Drum 3 Hoist
4A	Drum 4 Lower
4B	Drum 4 Raise
5A	Drum 2 Lower
5B	Drum 2 Hoist
6A	Left Travel Reverse
6B	Left Travel Forward
7	Gauge Coupler
8	OLB Pump Pressure Transducer
9	Right Travel Pressure Transducer
10	Drum 1 Pressure Transducer
11	Drum 3 Pressure Transducer
12	Drum 4 Pressure Transducer
13	Drum 2 Pressure Transducer
14	Left Travel Pressure Transducer
15	OLA Pump Pressure Transducer

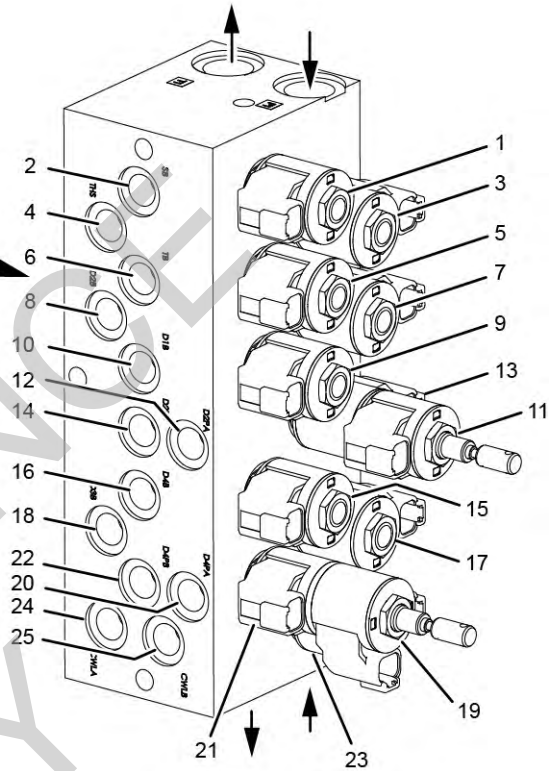
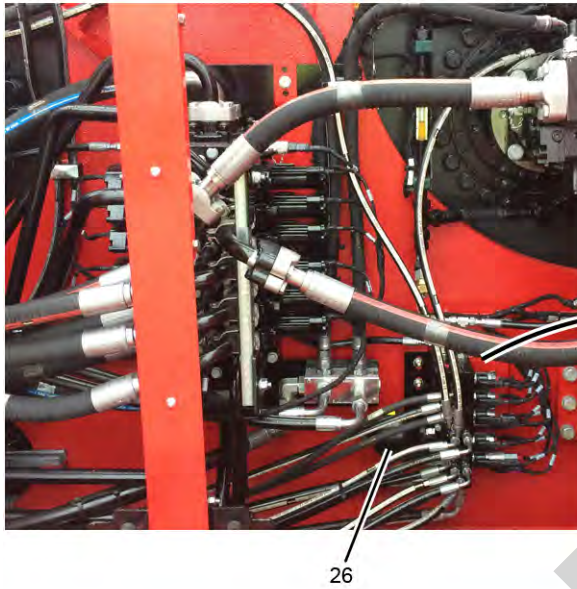
FIGURE 2-13



### Low Pressure Accessory Control Valve

M105146

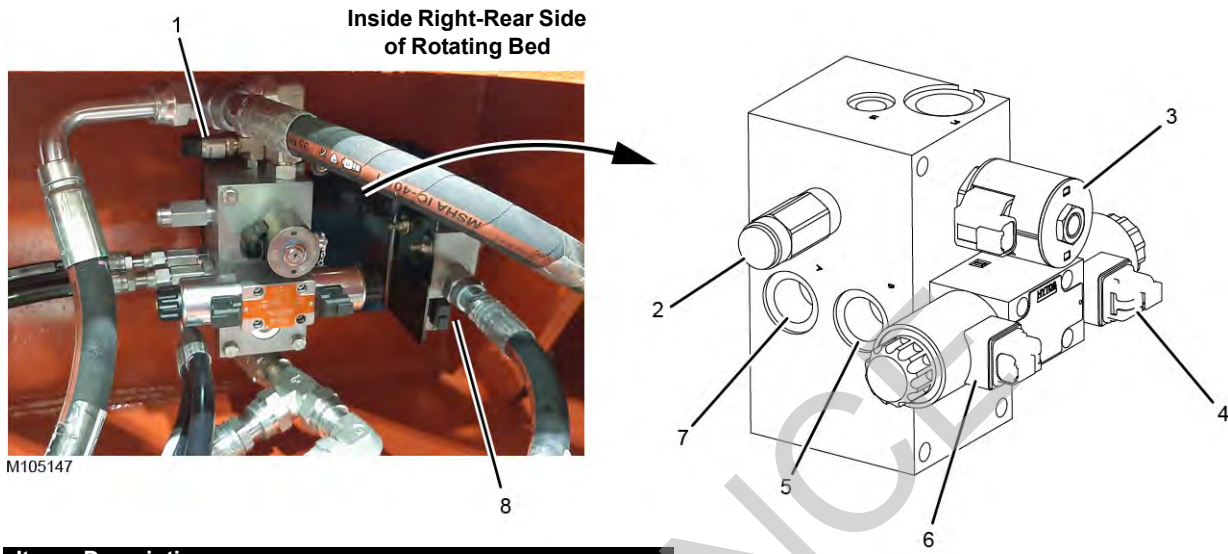
Right Side Enclosure



Item	Description
1	Swing Brake Solenoid Valve
2	SB = To Swing Brake
3	Travel High Speed Solenoid Valve
4	THS = To Travel High Speed Motor Command
5	Travel Brake Solenoid Valve
6	TB = To Travel Brake
7	Drum 2 Brake Solenoid Valve
8	D2B = To Drum 2 Brake
9	Drum 1 Brake Solenoid Valve
10	D1B = To Drum 1 Brake
11	Drum 2 Pawl IN Solenoid Valve
12	D2PA = To Drum 1 Pawl Cylinder IN Port
13	Drum 2 Pawl OUT Solenoid Valve
14	D2PB = To Drum 1 Pawl Cylinder OUT Port
15	Drum 4 Brake Solenoid Valve
16	D4B = To Drum 4 Brake
17	Drum 3 Brake Solenoid Valve
18	D3B = To Drum 3 Brake
19	Drum 4 Pawl IN Solenoid Valve
20	D4PA = To Drum 4 Pawl Cylinder IN Port
21	Drum 4 Pawl OUT Solenoid Valve
22	D4PB = To Drum 4 Pawl Cylinder OUT Port
23	Counterweight Pins Retract Solenoid Valve
24	CWLA = To Counterweight Pins Cylinder EXTEND Port
25	CWLB = To Counterweight Pins Cylinder RETRACT Port
26	Accumulator

FIGURE 2-14

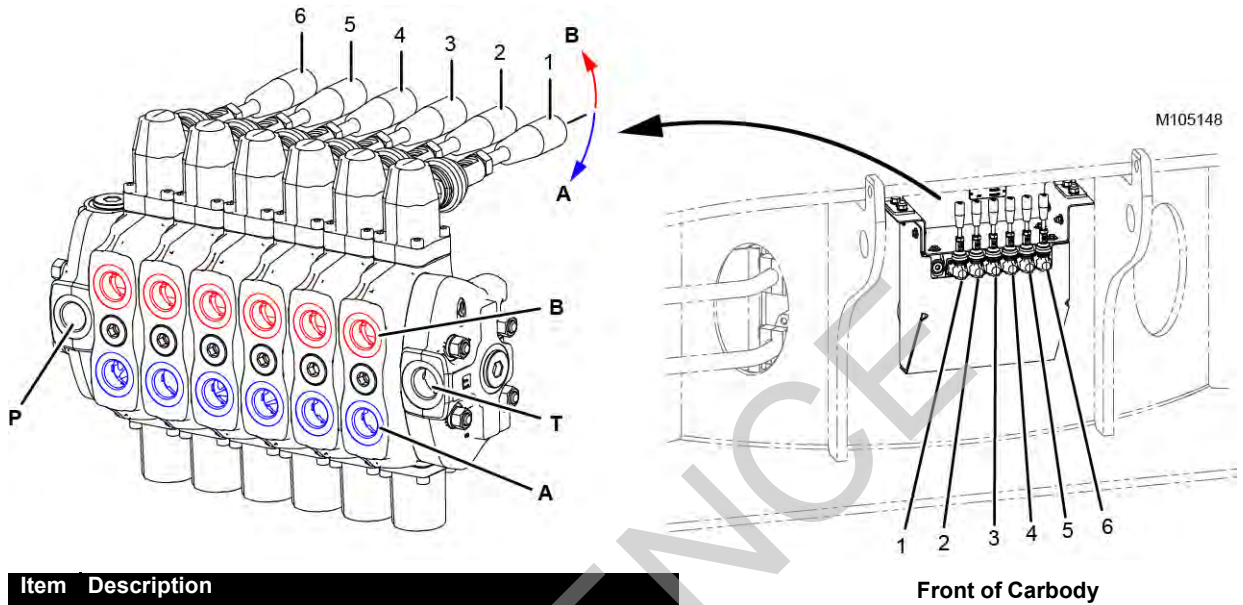
### High Pressure Accessory Control Valve



Item	Description
1	Pressure Transducer
2	Relief Valve
3	Throttle Solenoid Valve
4	Gantry RAISE Solenoid Valve
5	B = To Gantry Cylinders EXTEND Ports
6	Gantry LOWER Solenoid Valve
7	A = To Gantry Cylinders RETRACT Ports
8	Lowerworks Enable Valve

FIGURE 2-15

### Carbody Control Valve



Item	Description
1	Right Front Carbody Jack
1A	Extend Jack
1B	Retract Jack
2	Right Rear Carbody Jack
2A	Extend Jack
2B	Retract Jack
3	Right Crawler Pins
3A	Engage Pins
3B	Disengage Pins
4	Left Crawler Pins
4A	Engage Pins
4B	Disengage Pins
5	Left Rear Carbody Jack
5A	Extend Jack
5B	Retract Jack
6	Left Front Carbody Jack
6A	Extend Jack
6B	Retract Jack
P	Pump Port
T	Tank Port
A	Working Port
B	Working Port

FIGURE 2-16

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Table 2-1. Closed-Loop Circuit Hydraulic Specifications

Function <sup>1</sup>	Speed <sup>1</sup> RPM	Pump Port	Motor Port	Pressure <sup>3</sup> Bar (PSI)	Charge Pressure Bar (PSI)
Swing Left Swing Right	2.1 to 2.3	B A	B A	420 (6,096)	30 (435)

<sup>1</sup> See [Figure 2-1 on page 1](#) for pump identification.

<sup>2</sup> Speeds are based on high engine idle and handles moved fully forward or back. Speeds can vary plus or minus 5%.

<sup>3</sup> Pressures are controlled by relief valves in each pump.

Table 2-2. Open-Loop Circuit Hydraulic Specifications

Function <sup>1</sup>	Speed <sup>2</sup> RPM	Valve Port	Motor Port	Pressure Bar (PSI)
Drum 1 and 2 Hoist	42 to 49	B	B	Raising: 350 (5,075)
Drum 1 and 2 Lower	See <sup>3</sup>	A	A	Lowering: 103 (1,500)
Drum 3 Hoist	53 to 62	B	B	Raising: 350 (5,075)
Drum 3 Lower	See <sup>3</sup>	A	A	Lowering: 180 (2,600)
Drum 4 Hoist	18 to 22	A	A	Raising: 350 (5,075)
Drum 4 Lower	See <sup>3</sup>	B	B	Lowering: 103 (1,500)
Right Travel Reverse	10.8 to 12.7 at Tumbler	A	A	350 (5,075)
Right Travel Forward		B	B	
Left Travel Reverse		A	B	
Left Travel Forward		B	A	
Accessories	NA	NA		295 (4,280)

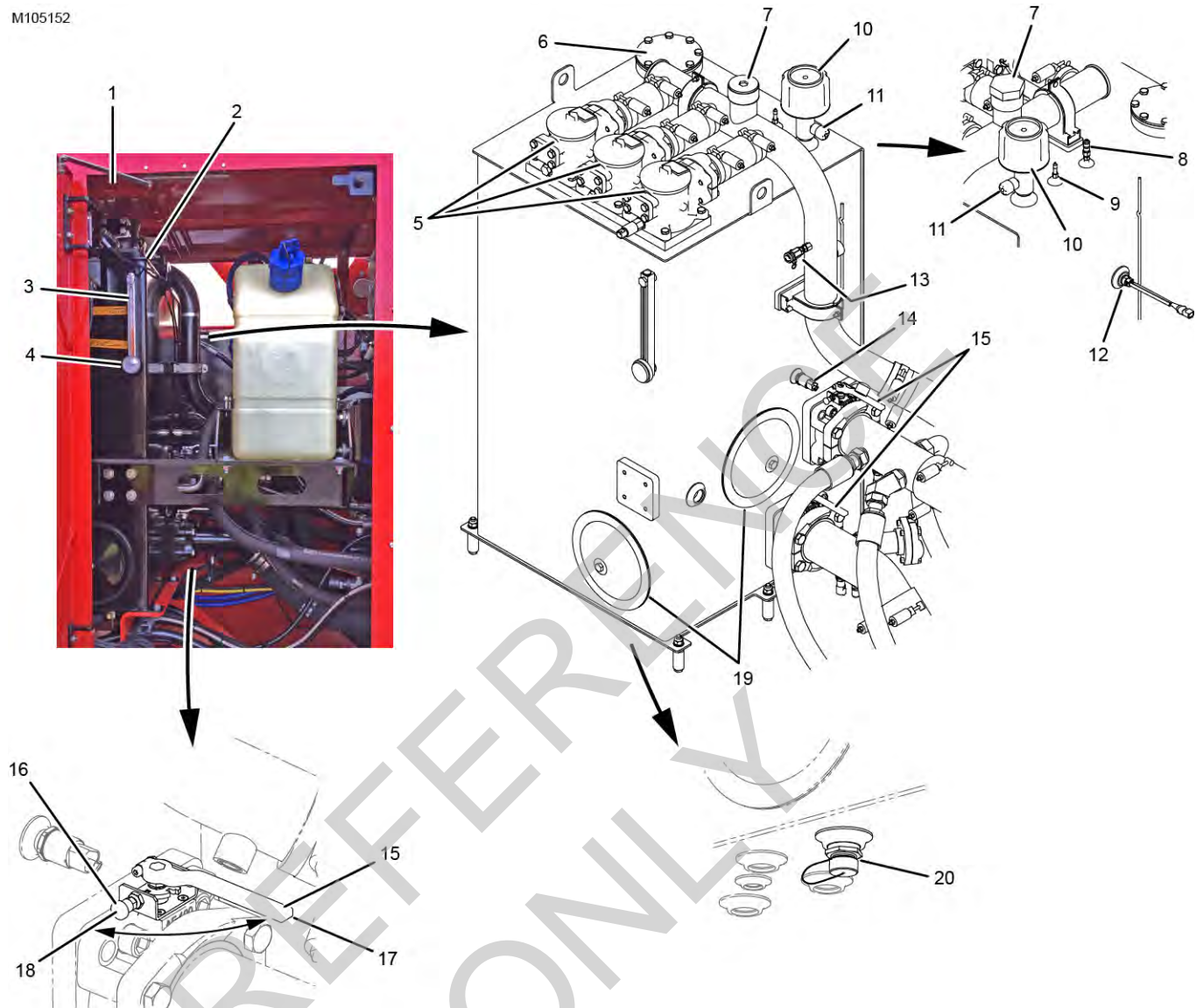
<sup>1</sup> See [Figure 2-13, page 12](#) for valve identification.

<sup>2</sup> Speeds are based on high engine idle, no rope on drums, and handles moved fully forward or back. Speeds can vary plus or minus 5%.

<sup>3</sup> Lowering speeds may be up to 10% slower than hoist speeds.

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M105152



Item	Description	Item	Description
1	Access Doors in Top of Enclosure	11	Service Indicator
2	Hydraulic Tank	12	Oil Level Switch
3	Oil Level Sight Gauge	13	Oil Sample Valve
4	Temperature Gauge	14	Temperature Sensor Transmitter
5	Hydraulic Filter (Qty 3)	15	Shut-Off Valve
6	Hydraulic Tank Heater (not shown)	16	Locking Knob
7	Fill Plug	17	OPEN Position
8	Vent Valve (requires a mating coupler)	18	CLOSED Position
9	Schrader Valve	19	Access Cover (Qty 2)
10	Desiccant Breather	20	Quick-Drain Valve

FIGURE 2-17

## HYDRAULIC SYSTEM MAINTENANCE

### CAUTION

#### Hydraulic Component Damage!

Do not alter the hydraulic system pressures or flows without approval from the Manitowoc Crane Care Lattice Team.

Damage to hydraulic components and improper operation of the crane can occur if pressures and flows are altered.

Only experienced technicians trained in the operation of this crane and its hydraulic system shall perform the procedures described in this section. The technicians shall read, understand, and comply with the instructions in this section and the instructions in the Manitowoc MLC150-1 Main Display Operation Manual.

Contact your Manitowoc Cranes dealer for an explanation of any procedure not fully understood.

### Safety

- Lower or securely block hydraulically operated attachments and loads before servicing. Do not rely on controls to support attachments or loads.
- Stop the engine and relieve all hydraulic pressure before servicing or disconnecting any part of the hydraulic system. After stopping the engine, operate the controls in both directions to relieve pressure.
- Before servicing the hydraulic system, attach a warning sign to the engine start controls to warn other personnel not to start the engine.
- Do not perform hydraulic system maintenance, adjustment, or repair procedures unless authorized to do so. Make sure all applicable instructions have been read and are thoroughly understood.
- Do not alter specified pressure settings. Higher-than-specified pressures can cause structural or hydraulic failure. Lower-than-specified pressures can cause loss of control.
- Never check for hydraulic leaks with your hands. Pressurized oil can penetrate the skin, causing serious injury. Oil escaping from a small hole can be nearly invisible. Check for leaks with a piece of cardboard or wood.

### Storing and Handling Oil

- Store oil drums in a clean, cool, dry location. Avoid outdoor storage.
- Store oil drums on their side and cover them to prevent water and dirt from collecting on them.

- When handling drums and transfer containers, use care to avoid damage that can cause leaks and entry of dirt or water into the oil.
- Before opening a drum, carefully clean the top of it. Clean the faucet or pump to remove oil from the drum.
- Only use clean transfer containers.
- Do not take oil from storage until the oil is needed. If the oil cannot be used immediately, keep the transfer container tightly covered.

### Storing and Handling Parts

- Store new parts (valves, pumps, motors, hoses, and tubes) in a clean, dry, indoor location.
- Do not unpack parts or remove port plugs until the parts are needed.
- Once unpacked, carefully inspect each part for damage that may have occurred during shipping. Remove all shipping material from the ports of parts before installing them.
- Fittings, hoses, and tubes that are not equipped with shipping caps or plugs must be carefully cleaned before they are used. Flush the fittings, hoses, and tubes with clean hydraulic oil and seal all openings until use at assembly.
- Do not use rags to plug openings. Use clean plastic shipping plugs and caps.

### Disposing of Hydraulic Oil and Parts

Dispose of waste oil and used or non-serviceable parts according to local, state, and federal environmental regulations.

### Inspecting Hydraulic System

See [Figure 2-17, page 18](#) for the referenced item numbers in the following steps.

The damaging effects of dirt, heat, air, and water in the hydraulic system can only be prevented by regular, thorough inspection of the system.

The frequency of inspection depends on operating conditions and experience with the system. However, the more often the system is inspected and deficiencies corrected, the less likely the system will malfunction.

A good inspection program will include the following procedures:

- Keep accurate records so future maintenance needs can be projected.
- Check the hydraulic oil level daily prior to startup when the oil is cold. The oil level should be at the full cold mark on the decal next to the sight gauge (3).

- Fill the tank through the fill plug opening (7). Always filter the oil through an owner-supplied 10-micron filter.
- Only use approved hydraulic oil in the system (see Section 9).
- Replace the breather (10) when indicated (see [Replacing Breather on page 2-22](#)).
- Replace the hydraulic filter elements (5) when indicated (see [Replacing Hydraulic Filters on page 2-22](#)).
- Clean the exterior of the system often. Do not let dirt accumulate on or around any part of the system.
- Check for external leaks. Leaks not only are unsafe but also attract dirt and sometimes allow air and water into the system. Do not return leakage oil back to the hydraulic tank.

Never check for hydraulic leaks with your hands. Check for leaks with a piece of cardboard or wood.

- Look for oil leaks at fittings and between parts that are bolted together. Tighten loose fittings and attaching bolts to the proper torque and do not over-tighten.

If leakage persists at these points, replace the seals or gaskets.

- Look for oil leaking from pump and motor shaft ends, from valve spool ends, and from cylinder shaft ends. Replace the seal if leakage is found at any of these points.
- Replace tubes that are cracked, kinked, or bent.
- Replace hoses that are cracked, split, or abraded.
- Listen to the pumps and motors for unusual noises. A high-pitched whine or scream can indicate that air is being drawn into the pump or motor.

An air leak can be pinpointed by flooding the inlet fitting, hose, or tube with oil. If there is an air leak, the oil will cause a noticeable reduction in noise.

Correct the cause of any air leak, or the pump or motor will be ruined.

**NOTE:** A high-pitched whine or scream from a pump can also indicate cavitation (pump being starved of oil). This condition may be caused by one or more of the following:

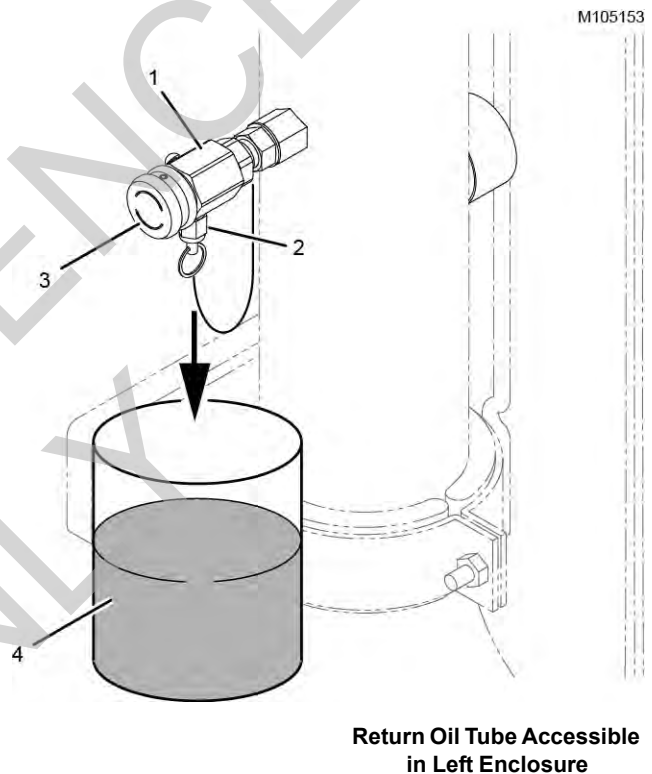
- Shut-off valves (15) closed. Open immediately.
- Collapsed or plugged suction line. Inspect suction screen inside tank.
- Wrong oil being used (viscosity too high). Change to specified oil. See Section 9.
- Look for signs of overheating such as heat-peeled parts, burned and scorched oil odor, and darkening and thickening of oil.

**NOTE:** If the oil temperature in the tank rises above 85°C (185°F), the fault alarm comes on and the Hydraulic Fluid Temperature icon appears in the Fault Bar of the main display.



- Have the hydraulic oil analyzed at regular intervals to determine the condition of the oil and the extent of system contamination. By having the oil analyzed on a regular basis, an oil change interval meeting your operating conditions can be established.

Contact your oil supplier for the availability of oil analysis services and the steps that should be taken to obtain these services.



Return Oil Tube Accessible in Left Enclosure

Item	Description
1	Oil Sample Valve
2	Dust Cover
3	Control Knob
4	Oil Sample Bottle

FIGURE 2-18

### Taking Hydraulic Oil Sample

An oil sample valve (1, [Figure 2-18](#)) is provided in the hydraulic tank return line.



**WARNING****Burn Hazard!**

Oil in the hydraulic system is extremely hot.

Wear appropriate gloves before operating the oil sample valve during the following steps.

1. Operate the hydraulic system until the oil is at the normal operating temperature.
2. Remove the dust cover (2) from the discharge port.
3. Hold a container under the discharge port.
4. Discharge approximately 200 ml (6.7 oz) of oil to flush the valve by turning the control knob (3) 1/4 turn to the right.
5. Release the control knob to off and dispose of the flushed sample in the appropriate manner.
6. Hold a clean oil sample bottle (4) under the discharge port (sample bottles are usually supplied by the oil analysis lab).
7. Turn the control knob (3) 1/4 turn to the right until the bottle is filled to the desired level. Use the knob to control the rate of flow.
8. When the sample bottle is filled, release the control knob (3) to off. The valve will close automatically.
9. Replace the dust cover (2) wrench tight.

**Inspecting and Replacing Hydraulic Hoses****WARNING****Burn Hazard!**

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

Before loosening any hydraulic fitting or hose, perform the following:

- Wait until the hydraulic oil is cold.
- Vent the hydraulic tank and crack open fittings and hoses slowly to allow pressure to vent.

**Periodic Inspection**

Visually inspect all hydraulic hose assemblies every month or at 200 hours of service life for the following:

- Leaks at hose fittings or in the 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 the hose
- Other signs of significant deterioration

If any of these conditions exist, evaluate the hose assemblies for correction or replacement.

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 hose assemblies

If any of these conditions exist, address them appropriately.

**Periodic Replacement**

See [Table 2-3](#) for the following.

Hydraulic hose assemblies operating in Zone C should be replaced after 8,000 hours of service life.

Hydraulic hose assemblies operating in Zones A and B with high ambient temperatures and high-duty circuits could see hose service life reduced by 40% to 50%. High-duty circuits can include, but are not limited to hoist(s), boom lift, swing, travel, pump suction and discharge to directional valves, and directional valve return to reservoir. Replace hoses operating in Zones A and B after 4,000 to 5,000 hours of service life.

Hydraulic hose assemblies operating in Zones D and E should expect a degrade of mechanical properties. Long-term exposure to these cold temperatures will negatively impact service life. Cold temperatures shorten hose life. Therefore, frequent inspection is required.

**Table 2-3. Climate Zone Classifications**

Zone	Description
A	Tropical Moist: All months average above 18°C (65°F) at a Latitude of 15° to 25° N and S
B	Dry or Arid: Deficient precipitation most of the year at a Latitude of 20° to 35° N and S
C	Moist Mid-Latitude: Temperate with mild winters at a Latitude of 30° to 50° N and S
D	Moist Mid-Latitude—Cold winters at a Latitude of 50° to 70° N and S
E	Polar—Extremely cold winters and summers at a Latitude of 60° to 75° N and S

## Replacing Breather



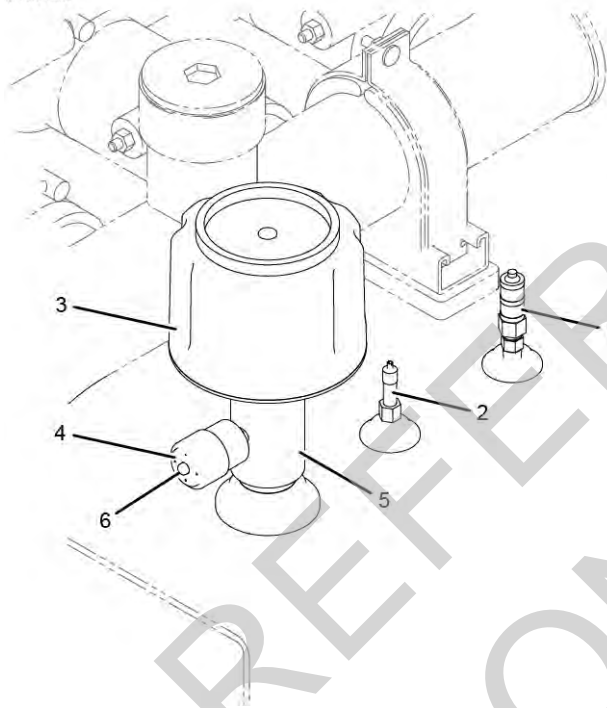
### WARNING

#### Burn Hazard!

The oil in the hydraulic tank may be under pressure and extremely hot. Hot oil can escape when servicing components.

- Allow the hydraulic system to cool before replacing the breather or the hydraulic filters.
- Before opening the tank, relieve any pressure from the tank using either vent valve (8 or 9, [Figure 2-19](#)).

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Item	Description
1	Vent Valve (requires mating coupler)
2	Schrader Valve
3	Breather
4	Service Indicator
5	Indicator Coupling
6	Reset Button

FIGURE 2-19

See [Figure 2-19](#) for the following procedure.

**NOTE:** The breather is accessible through the door in the top of the left enclosure.

1. Check the breather service indicator (4) daily or every 8 hours of engine operation, whichever occurs first.
2. Replace the breather (3) when the red flag in the service indicator (4) rises to the top and locks in place.  
When locked in place, the red flag will remain out after the engine is stopped (pressure exhausted).
3. Stop the engine.
4. Vent the hydraulic tank using either of the vent valves (1 or 2). **Take precautions to prevent being burned by hot oil.**
5. Unscrew the breather (3) and dispose of it according to local environmental regulations. **The breather is not serviceable.**
6. Remove any shipping material from the new breather.
7. Apply pipe tread sealant to the breather threads and securely attach the breather to the indicator coupling (5).
8. Push in the reset button (6) in the end of the service indicator (4).

## Replacing Hydraulic Filters



### WARNING

#### Burn Hazard!

The oil in the hydraulic tank may be under pressure and extremely hot. Hot oil can escape when servicing components.

- Allow the hydraulic system to cool before replacing the breather or the hydraulic filters.
- Before opening the tank, relieve any pressure from the tank using either vent valve (8 or 9, [Figure 2-19](#)).

### CAUTION

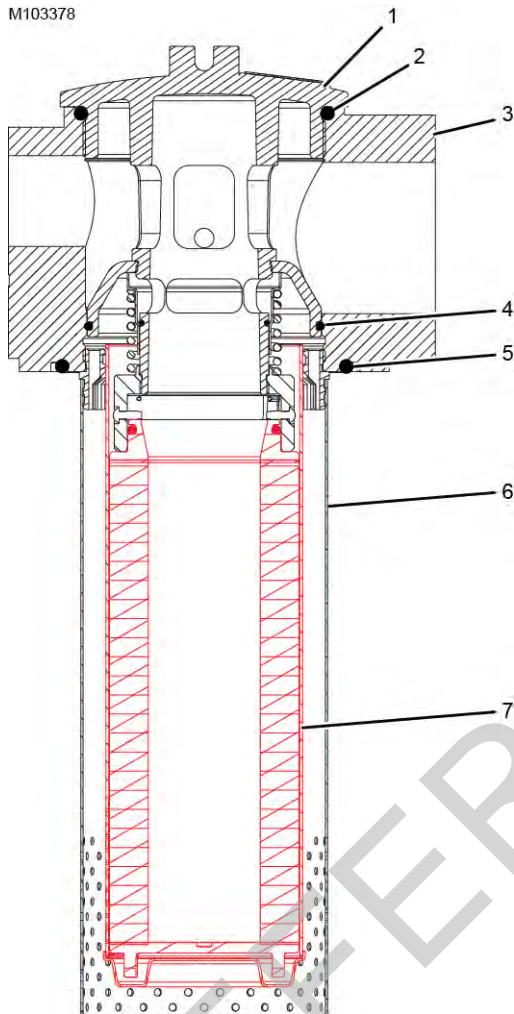
#### Avoid Hydraulic System Damage!

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 of filter element is not allowed.

Non-OEM filter elements may collapse under pressure. This will allow unfiltered oil to be drawn into the hydraulic system. Pumps, motors, and valves can be destroyed.

Manitowoc Cranes will reject warranty claims for damaged hydraulic components if proper hydraulic filter elements are not used.

- Do not attempt to clean or reuse elements.
- Do not operate the crane without filter elements installed.



Item	Description
1	Cover Assembly
2	O-Ring
3	Head Assembly
4	O-Ring
5	O-Ring
6	Shroud-Shell Assembly
7	Filter Element

Three in-tank, return oil filters (5, [Figure 2-17, page 18](#)) are located in the top of the hydraulic tank. The filters are accessible through an access door in the top of the left enclosure.

FIGURE 2-20

Replace the filter elements when the fault alarm comes on and the Filter 1 icon appears in the Fault Bar of the main display.

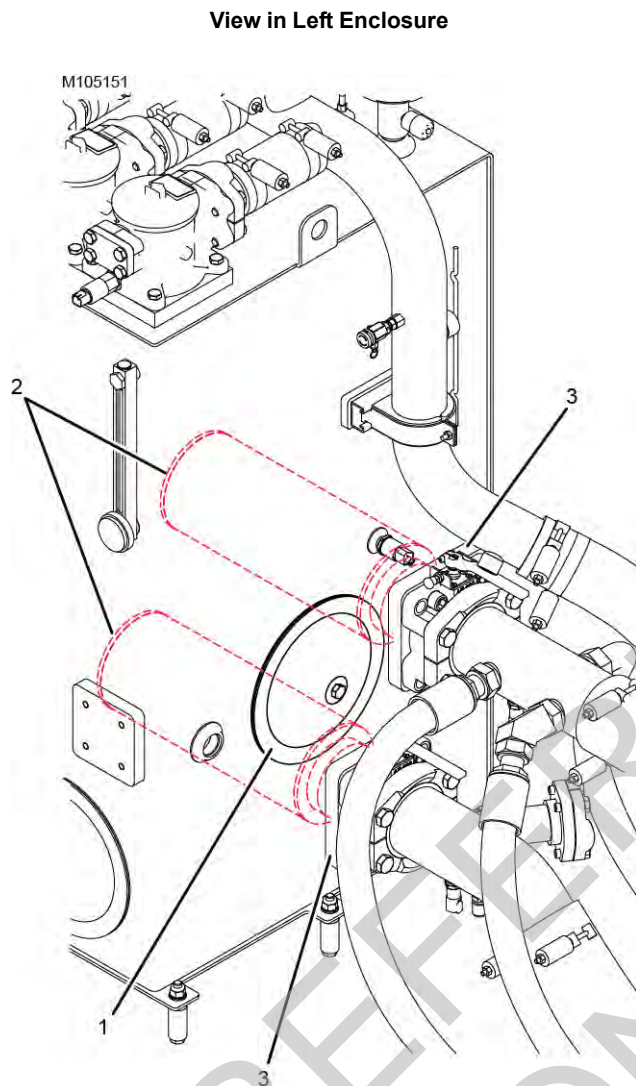


Also replace the filter elements at each oil change interval.

**NOTE:** It is normal for the fault alarm to come on at startup when the oil is cold. The fault alarm should turn off after the hydraulic oil warms up.

See [Figure 2-20](#) for the following procedure.

1. Stop the engine.
2. Vent the hydraulic tank using either of the vent valves (see [Figure 2-19, page 22](#)).
3. Take precautions to prevent being burned by hot oil.
4. Clean the cover assembly (1) and the area around it. Do not allow contaminants to enter the hydraulic tank.
5. Unscrew and remove cover assembly (1) from head assembly (3) (turn counterclockwise when viewed from above).
6. Use a correct size wrench on the hexagon on the cover assembly (2) to loosen the cover assembly.
7. Check that the O-rings are not damaged. If so, replace.
8. Remove filter element (7) and carefully inspect the surface for visible contamination. Normally no dirt should show, but visible dirt or particles can be an early warning of system component failure.
9. Discard both the filter element and its O-rings. The filter element is not CLEANABLE. Any attempt to clean the filter element can cause degradation of the filter medium and allow contaminated fluid to pass through the filter element.
10. Do not run the system without a filter element installed.
11. Lubricate the element O-rings with clean system fluid and install the element in the shroud-shell assembly (6).
12. Reinstall the cover assembly (1). Hand tighten ONLY.
13. Start the engine and allow the hydraulic system to reach its normal operating temperature.
  - Check the filter cover for leaks and service as required.
  - Check that the filter fault has not been activated.
14. Stop the engine.
15. Check the hydraulic tank level and fill as required.



Item	Description
1	Access Cover
2	Suction Strainer (Qty 2)
3	Valve Mounting Plate (Qty 2)

FIGURE 2-21

## Servicing Suction Strainer

Each pump suction line is equipped with a suction strainer located inside the hydraulic tank ([Figure 2-21](#)).

Service the suction strainers when the fault alarm comes on and the Suction Pressure icon appears in the Fault Bar of the main display.



To service the suction strainers, the hydraulic tank must be drained.

See [Figure 2-21](#) for the following procedure.

1. Stop the engine and allow the hydraulic oil to cool.
2. Drain the hydraulic oil into a suitable container capable of holding 416 L (110 gal).
3. Remove the access cover (1) from the hydraulic tank.
4. Using a pipe wrench, remove the suction strainers (2) from the valve mounting plate (3).
5. Either replace the strainers with new ones or, if the strainers are not damaged, clean them as follows:
  - a. Soak the suction strainers in a clean, nonflammable solvent.
  - b. Brush off the outer surfaces.
  - c. Flush the strainers with solvent from the inside out.
6. Apply thread sealant to the suction strainer threads.
7. Thread the suction strainers into the valve mounting plates, and tighten with a pipe wrench.
8. Reinstall the access cover (1).
9. Fill the hydraulic tank with clean oil as instructed in [step 18](#) on [page 2-25](#).
10. Start the engine and check for leaks. Correct as needed.

## Changing Hydraulic Oil

Unless otherwise specified, refer to [Figure 2-17, page 18](#) for the following procedure.

Drain and refill the hydraulic system semiannually or every 1,000 hours of engine operation, whichever comes first, unless an alternate interval has been established through an oil analysis program.

1. Operate the crane until the hydraulic oil is at its normal operating temperature. This helps remove impurities from the system.
2. Stop the engine.
3. Vent the tank using either the vent valve (8) or the schrader valve (9).
4. Verify the shut-off valves (17) are open.
5. Place a suitable container capable of holding 416 L (110 gal) under the hydraulic tank.
6. Remove the dust cap from the quick-drain valve (20).
7. Insert the end of the hose from the quick-drain drainer assembly ([Figure 2-22](#)) in the container.
8. Connect the quick-drain drainer to the quick-drain valve and completely drain the hydraulic tank. The quick-drain drainer assembly is stored in the crane's parts box.

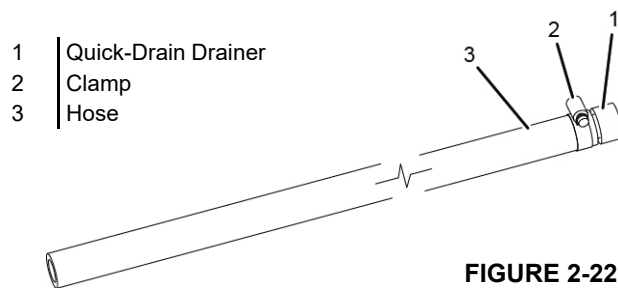


FIGURE 2-22

9. Discard the hydraulic oil according to local environmental regulations.
10. Remove the access covers (19) from the hydraulic tank. Take care to prevent dust and wind-blown dirt from entering the tank while the access covers are off.
11. Clean out any sediment from inside the hydraulic tank.
12. Service the suction strainer if needed (see [Servicing Suction Strainer on page 2-24](#)).
13. Replace the filter elements (see [Replacing Hydraulic Filters on page 2-22](#)).
14. Replace the breather (see [Replacing Breather on page 2-22](#)).
15. Using a new seal, securely fasten the access covers to the hydraulic tank.
16. Remove the quick-drain drainer assembly and attach the dust cap to the quick-drain valve.

---

### CAUTION

#### Contamination Hazard!

Do not fill the hydraulic tank through the breather opening. Harmful contaminants will enter the hydraulic system. Damage to pumps and motors can occur.

---

17. Check that all pump and motor cases are filled with fresh oil filtered through an owner-supplied 10-micron filter.

18. Fill the hydraulic tank to the Full Cold Level mark on the oil level sight gauge (3). Use the proper hydraulic oil listed in the Lubrication Guide.

Fill the tank through the fill plug (7) opening. Filter the oil through an owner-supplied 10-micron filter.

19. Close the Schrader valve (3) and the vent valve (4).

20. Start the engine and allow the hydraulic system to reach its normal operating temperature.

21. Check for leaks and correct them as required.

22. Stop the engine.

23. Check the hydraulic tank level and fill as required.

**NOTE:** If the hydraulic system was extremely dirty (gum or lacquer formation on parts indicated by erratic, jerky, or sluggish operation), repeat the procedure after 48 hours of operation.

### Servicing Pumps

It is not necessary to drain the hydraulic tank when servicing the hydraulic pumps. To service the pumps, close the hydraulic tank shut-off valves (17, [Figure 2-17, page 18](#)).

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### CAUTION

#### Avoid Damage to Pumps!

Open the hydraulic tank shut-off valves before starting the engine. Failing to perform this step will result in damage to the pumps from cavitation.

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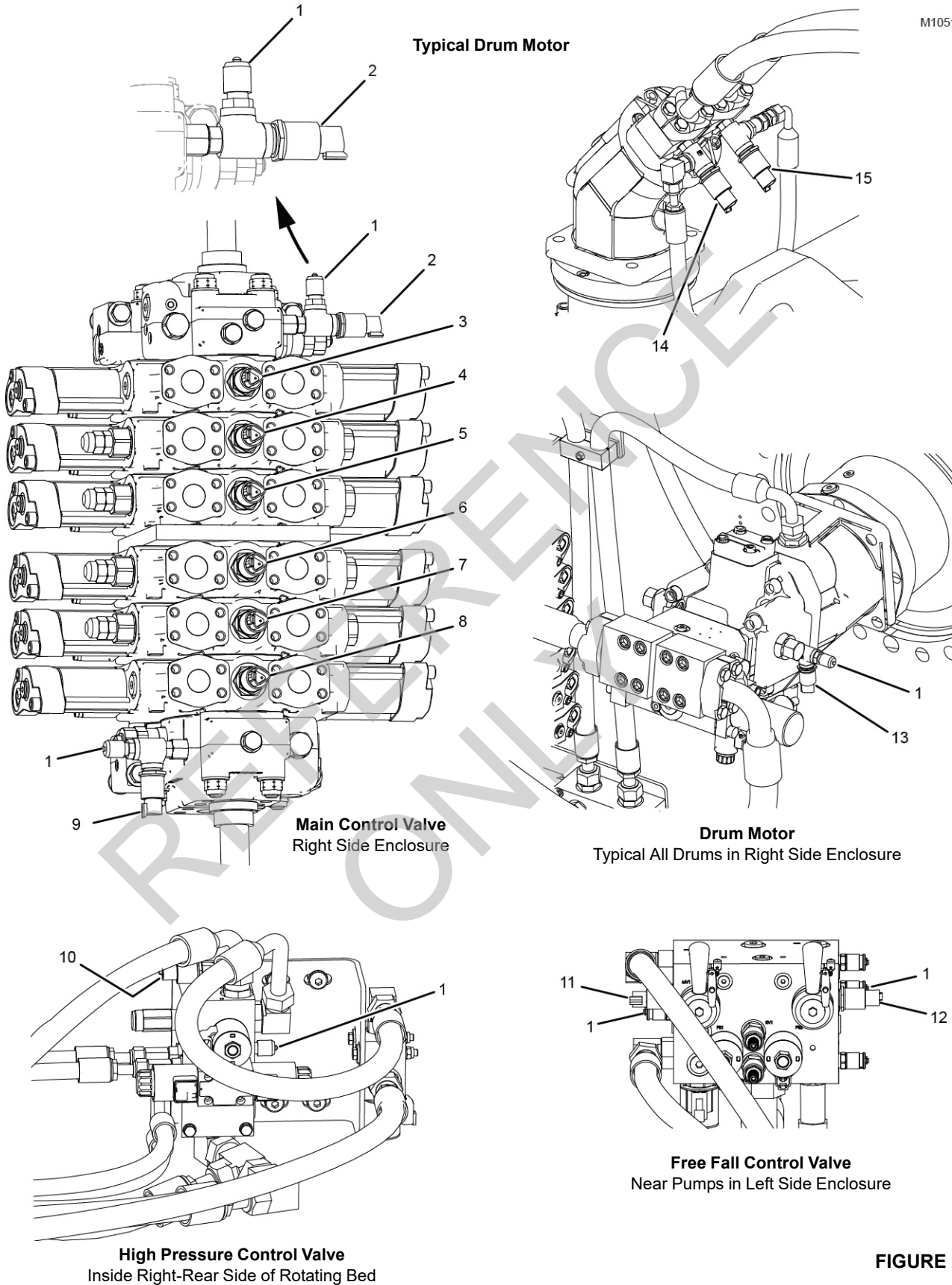


FIGURE 2-23

Item	Description
1	Gauge Coupler with Dust Cap-18 UNF x -6 PRESSURE TRANSDUCER ID
2	OLB Pump Pressure Transducer
3	Right Travel Pressure Transducer
4	Drum 1 Pressure Transducer
5	Drum 3 Pressure Transducer
6	Drum 4 Pressure Transducer
7	Drum 2 Pressure Transducer
8	Left Travel Pressure Transducer
9	OLA Pump Pressure Transducer
10	High Pressure Accessory
11	Front Drum Free Fall
12	Rear Drum Free Fall
13	Drum Motor (similar all drums)
14	Swing Left
15	Swing Right

## SERVICING PRESSURE TRANSDUCERS

The status of the pressure transducers and the corresponding pressure readings can be monitored in the Control Information Screens in the MLC150-1 Main Display Operation Manual.

### Testing a Pressure Transducer

See [Figure 2-23](#) for the following procedure.

Before replacing a pressure transducer, perform the following test steps to verify the suspect pressure transducer is faulty.

1. Perform a pressure transducer calibration as instructed in the MLC150-1 Main Display Operation Manual.
2. Stop the engine and turn the ignition switch to the RUN position.
3. Attach an accurate hydraulic pressure gauge to the gauge coupler at the suspect pressure transducer.
4. If pressure appears on the gauge, bleed the corresponding system so the gauge reads zero pressure (see [step 9](#)).
5. Repeat the pressure transducer calibration and check the pressure on the calibration display with the engine running at idle. The display reading and the gauge reading should be the same.
6. Before replacing a pressure sender, check the electric signal voltage at the sender. It should be 4 mA at zero pressure.

## Replacing a Pressure Transducer



### WARNING High Pressure Oil Hazard!

Do not attempt to remove a pressure transducer until the following steps are performed. High pressure oil will exhaust from the pressure transducer ports.

### Hot Oil Hazard!

Take precautions to prevent being burned by hot oil.

To replace a pressure transducer, perform the following procedure.

1. Lower all loads to the ground.
2. Move all control handles to OFF and park all crane functions.
3. Stop the engine.
4. Place a suitable container under the faulty pressure transducer to catch hydraulic oil leakage.
5. Disconnect the electrical connector from the pressure transducer.
6. Slowly loosen the pressure transducer only enough to relieve the pressure.
7. Remove the pressure transducer and discard it and the oil leakage according to local environmental regulations.
8. Install the new pressure transducer and connect the electrical connector.
9. Bleed the pressure transducer circuit as follows.
  - a. Connect a bleed line with a shut-off valve to the pressure transducer gauge coupler and place the end of the hose into a suitable container.
  - b. Open the shut-off valve.
  - c. With all control handles off, start and run the engine at low idle.
  - d. When clear oil flows from the bleed line (no air bubbles in the oil), close the shut-off valve.
  - e. Stop the engine.
  - f. Remove the bleed line from the gauge coupler at the pressure transducer.
  - g. Repeat the above steps for each new pressure transducer.
10. Perform the pressure transducer calibration.

## SHOP PROCEDURES

The pressures, pump and commands, and handle commands can be monitored in the Control Information Screens in the MLC150-1 Main Display Operation Manual.

### Initial Hydraulic Oil Fill



#### WARNING

##### Burn Hazard!

The oil in the hydraulic tank may be under pressure and extremely hot. Hot oil can escape when servicing components.

Before opening the tank for any reason, relieve any pressure from the tank using the schrader valve or the vent valve (see [Figure 2-17, page 18](#)).

See [Figure 2-17, page 18](#) for the following procedure.

The following procedure is used at the factory to fill the hydraulic system on a new crane. It is necessary to use this procedure in the field only if the entire hydraulic system has been drained.

1. Open the hydraulic tank shut-off valves (17).
2. Open the vent valve (8) or the schrader valve (9) on top of the tank (2). Failure to do this will result in over pressurizing the tank.
3. Fill the hydraulic tank to the appropriate level depending on cylinder position through the fill plug (7) opening.

Do not fill the hydraulic tank through the breather (10) port or through the top of the filters (5). The hydraulic system could be contaminated from unfiltered oil.

**NOTE:** It is extremely important to perform the following bleed procedure in the field anytime the system is drained completely.

4. Check that all pump and motor cases are filled with fresh oil filtered through an owner-supplied 10-micron filter.

#### CAUTION

##### Avoid Damage to the Hydraulic System!

If the Hydraulic Oil Low alarm comes on at any time during the startup procedure, add oil to the tank.



**NOTE:** Ensure all lines cracked during the bleeding procedure are tightened to specification.

#### CAUTION

##### Equipment Damage!

Check pump pressures during the first two minutes of operation. If the pressure for any pump is not within the specified range, stop the engine immediately to prevent pump damage. Troubleshoot to determine the cause of the problem.

5. Install bleed line shut off valves into the test ports on the swing pump and utilize them to bleed the air once you have started the engine at a low idle.
  6. While running the engine at a low idle retract and extend the counterweight pin puller ten times to remove air from the cylinder.
  7. While running the engine at low engine idle, park and un-park Drum 4 and Drum 2 (if equipped with a pawl) to operate the pawl cylinders a total of 10 times.
  8. While running the engine at a low idle, retract and extend the gantry cylinders to remove air from the cylinders in the following manner:
    - a. Extend cylinders 50% out 229 mm (9"), pause for 2-4 seconds before changing direction, then fully retract. Pause for 2-4 seconds. Repeat.
    - b. Extend cylinders 75% out 330 mm (13"), pause for 2-4 seconds before changing direction, then fully retract. Pause for 2-4 seconds. Repeat.
    - c. Extend cylinders 100% out, pause for 2-4 seconds before changing direction, then fully retract. Repeat four times.
- NOTE:** Remove the pin and support the cylinders to prevent them from striking anything during operation.
9. While running the engine at a low idle speed, bleed the air out of drums 1, 2, 3 (if equipped), and 4 in the following manner:
    - a. Ramp the handle command from 0% to 25% (hoist up) and hold for 15 seconds then ramp to 100% and hold for 30 seconds.
    - b. Ramp from 100% hoist up and then down to 0%.
    - c. Ramp the handle command from 0% to 25% (hoist down) and hold for 15 seconds, then ramp to 100% and hold for 30 seconds.
    - d. Ramp from 100% hoist up and then down to 0%.
    - e. Repeat steps a—d three times.

**NOTE:** This step will be done as the machine is being driven out to test. When you are first moving the



machine out of the building, follow these steps to ensure that all air is bled from the circuit.

**NOTE:** Depending on how the machine is parked in the building, you may start by driving forward or in reverse.

10. While running the engine at a low idle speed, bleed the air out of the travel motors in the following manner:
  - a. Ramp the handle from 0 to 100% command and run the tracks so that the tumbler rotates minimally twice.
  - b. Ramp the command down to 0% and repeat step a only in the opposite direction.
11. Check for hydraulic leaks and correct any that are found.
12. Stop the engine and fill the hydraulic tank to the proper level.

## Hydraulic Tests and Calibrations

Only experienced technicians trained in the operation of this crane and its hydraulic system shall perform the procedures described in this section. The technicians shall read, understand, and comply with the instructions in this section and the instructions in the MLC150-1 Main Display Operation Manual.

Contact your Manitowoc dealer for an explanation of any procedure not fully understood.

The calibration and test procedures described in this section were performed before the crane shipped from the factory. These procedures must be performed by field personnel when parts are replaced or when instructed by a Manitowoc Dealer.

Perform the following calibrations and tests as instructed in the MLC150-1 Main Display Operation Manual:

- Pressure Sender Calibration
- Controls Calibration
- Charge Pressure Test
- High Pressure Test

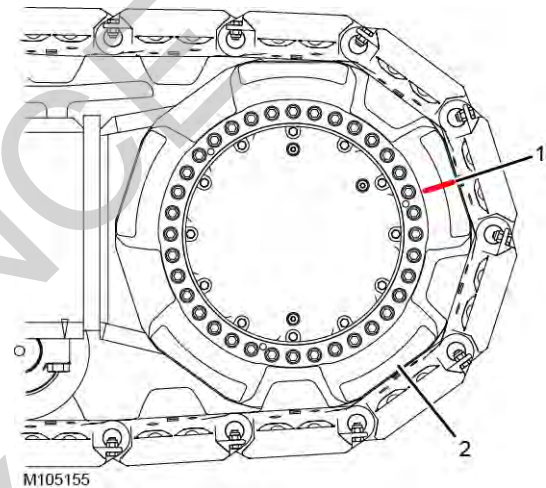
### Travel Speed Test

See [Figure 2-24](#) for the following procedure.

**NOTE:** Perform this test in an area where the crane can be traveled without interference.

1. Apply a timing mark (1) on the tumblers (2).
2. Start the engine and run it at high idle.
3. Using the travel speed selection switch, select high-speed travel.
4. Travel the crane forward at full speed for one minute and count the timing mark revolutions.

5. Verify the counted revolutions are within the limits specified in [Table 2-2 on page 2-17](#). If the counted rotations are not within the specified range, contact the Manitowoc Crane Care Lattice Team.
6. Travel the crane in reverse at full speed for one minute and counts the timing mark revolutions.
7. Verify the counted revolutions are within the limits specified in [Table 2-2 on page 2-17](#). If the counted rotations are not within the specified range, contact the Manitowoc Crane Care Lattice Team.



- 1 Timing Mark
- 2 Tumbler (qty 2)

**FIGURE 2-24**

### Swing Speed Test

**NOTE:** Perform this test in an area where the crane can be swung without interference.

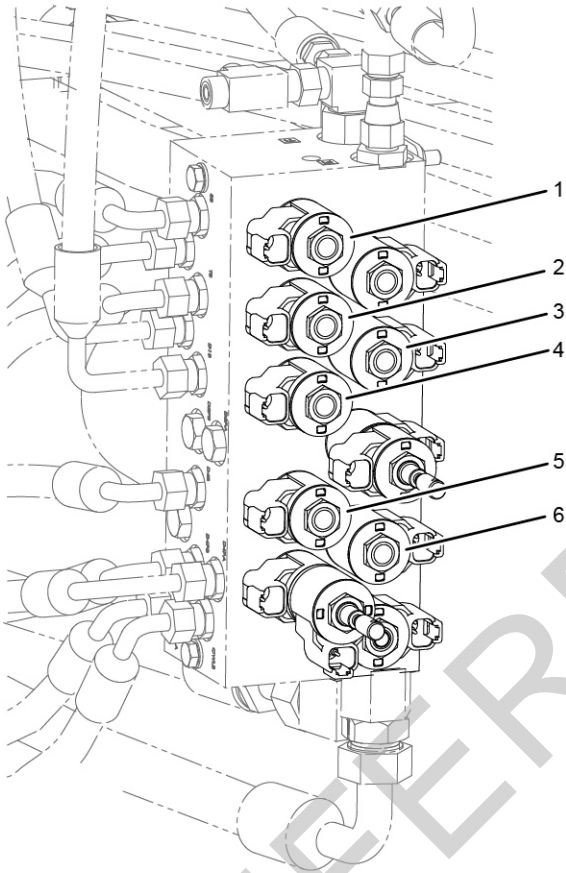
1. Go to the Swing Control Information screen in the main display.
2. Start the engine and run it at high idle.
3. Operate the swing fully left and then fully right.
4. Verify that the swing speed shown in the main display is within the limits in [Table 2-1 on page 2-17](#).

### Drum Speed Test

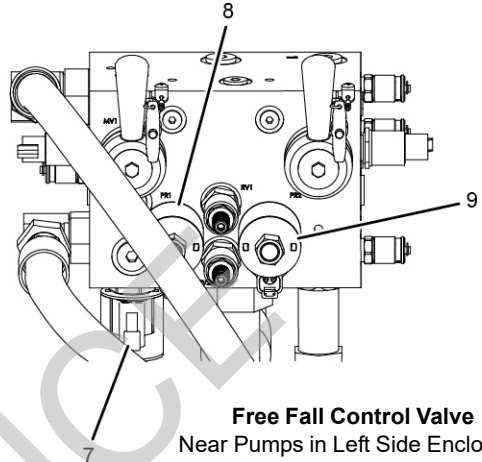
**NOTE:** Perform this test in an area where the crane can be operated without interference.

1. Navigate to the Drum Control Information screen (Drum 1, 2, 3, or 4) in the main display.
2. Start the engine and run it at high idle.
3. Move the selected drum handle fully forward and then fully back.
4. Verify that the drum speed shown in the main display is within the limits in [Table 2-2 on page 2-17](#).

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**Low Pressure Accessory Control Valve**  
Right Side Enclosure



**Free Fall Control Valve**  
Near Pumps in Left Side Enclosure

Item	Description
1	Swing Brake
2	Travel Brake
3	Drum 2 Brake
4	Drum 1 Brake
5	Drum 4 Brake
6	Drum 3 Brake
7	Free Fall Enable
8	Proportional Brake Command Drum 1
9	Proportional Brake Command Drum 2

**FIGURE 2-25**

## DISC BRAKE OPERATIONAL TEST

There is no physical way to check the disc brakes for any of the following:

- Travel
- Drums 1-4
- Swing

An operational test of each brake must be performed weekly. Perform this test in an area where the crane can operate without interference.

### CAUTION

#### Overheating Hazard!

Do not stall any function for more than five seconds. Damage from overheating can occur to the system components.



### WARNING

#### Falling Load/Moving Crane Hazard!

If a disc brake slips when the disc brake operational test is performed, repair or replace it before placing the crane back into service. Loads could fall or the corresponding crane functions could move uncontrolled if the brakes are not operating properly.

See the corresponding motor or gearbox manufacturer's manual for disc brake repair instructions.

See [Figure 2-25](#) for the location of the brake solenoid valves.

See the system pressure specifications in [Table 2-1](#) and [Table 2-2 on page 2-17](#).

1. Disconnect the electrical connector from the solenoid valve for the brake being checked.
2. Turn off the park switch on the control console for the brake being checked.
3. Start and run the engine at low idle.
4. At the main display, navigate to the Control Information Screen for the function being checked (see the MLC150-1 Main Display Operation Manual).

**NOTE:** For the load drums equipped with free fall, make sure free fall is off.

Monitor system pressure and pump command on the corresponding control information screen while moving the control handle.

5. Slowly move the control handle for the brake being checked and verify the following:

- The specified system pressure is reached before 50% pump command is reached.
- The brake does not slip.

If the brake fails this test, it must be repaired or replaced and retested before placing the crane back into operation.

6. Turn on the park switch on the control console for the function being checked.
7. Stop the engine.
8. Connect the electrical connector to the solenoid valve for the brake being checked.

## Free Fall Brake Operational Test



### DANGER

#### Falling Load Hazard!

The free fall brake will not hold the load if the brake discs are worn. To prevent the load from falling, perform an operational test of each free fall brake weekly and service the brake if needed.

If any deterioration in the free fall brake performance is observed by the operator, have the corresponding brake repaired or replaced immediately.

Do not operate a drum in free fall if the brake is not operating properly.

Do not attempt to lower the single-line pull load given in [step 2](#) of the free fall brake operational test procedure using the free fall brake. Brake damage could occur. The free fall lowering is limited to 6 710 kg (14,800 lb) per single part of line when lowering the load.

Perform this test in an area where the crane can be operated without interference.

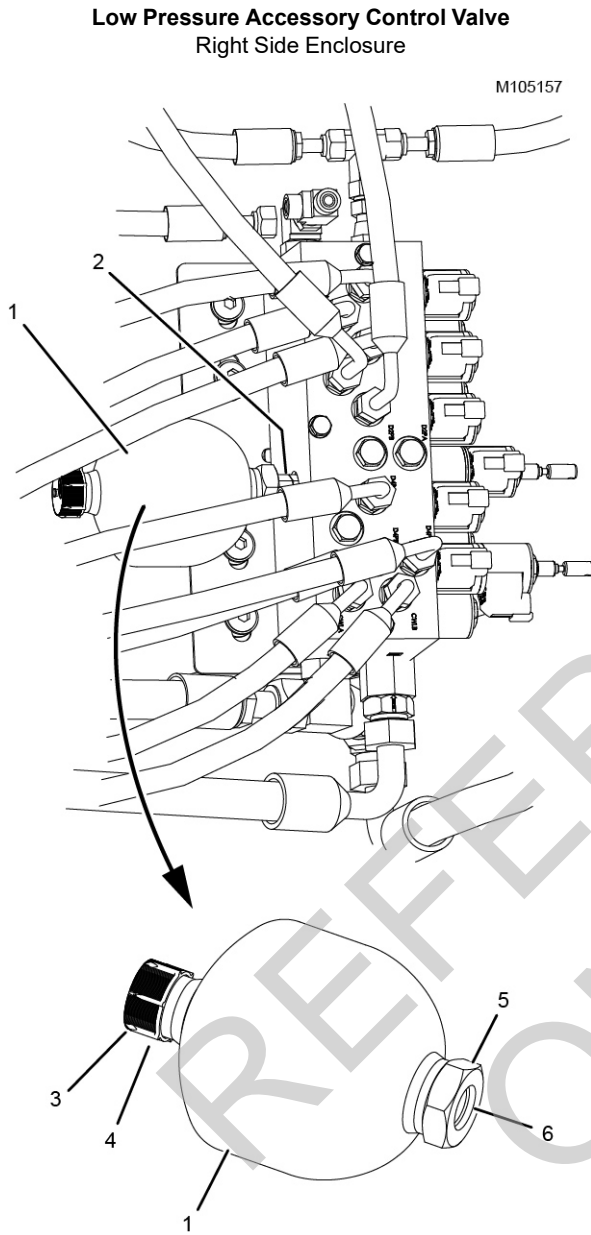
1. Turn on free fall for the drum being tested. See the MLC150-1 Operator Manual for the procedure.
2. Lift a single-line pull load of 6,710 kg (14,800 lb) approximately 305 mm (12 in) off the ground.
3. Apply the free fall brake pedal and watch the load for one minute.
4. The load must not lower.
5. If the load lowers, the brake must be repaired or replaced by a qualified technician.

**ACCUMULATOR MAINTENANCE**

**Table 2-4. Precharge Pressure**

Bar (psi)	°C (°F)
Pressures are proportional to ambient temperature	
20.3 (295)	-1 (30)
20.8 (301)	4 (40)
21.2 (308)	10 (50)
21.7 (314)	16 (60)
22.0 (319)	20 (70)
22.5 (327)	27 (80)
23.0 (333)	32 (90)
23.4 (339)	38 (100)

This crane is equipped with one accumulator, which is located on the low pressure accessory control valve [Figure 2-26](#).



**! WARNING**  
**Explosion Hazard!**

The accumulator is precharged with dry nitrogen gas. Do not tamper with the accumulator unless authorized and trained to do so. Contact the Manitowoc Crane Care Lattice Team for assistance if needed.

The accumulator must be tested yearly to verify it has retained the specified precharge.

The test must be performed by a qualified technician who is trained in the operation and maintenance of gas-filled accumulators. Observe the following:

- Precharge the accumulator with dry nitrogen gas only.
- Never operate the accumulator without the specified precharge.
- Release all system pressure (hydraulic and gas) before disassembling
- Use only approved charging and gauging equipment.
- Do not operate accumulators above the specified maximum pressure.
- Stop the engine when reading the gauge to check the pressure.

The accumulator is not equipped with a gauge port. The technician shall install test equipment in the fitting under the protective cap in the top of the accumulator. The fitting size is M28 x 1.5 male thread.

**FIGURE 2-26**

Item	Description
1	Accumulator (Diaphragm Type) 0,5 L (17 oz); 21.7 bar (315 psi)
2	Straight Fitting (08 ORB)
3	Protective Cap
4	M28 x 1,5 Charge Port
5	M36 Hex
6	08 ORB Port

## SECTION 3

### ELECTRICAL SYSTEM

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## SECTION 3

### ELECTRICAL SYSTEM

#### ELECTRICAL SCHEMATIC

The electrical schematic for this crane is located at the end of this section.

#### ELECTRICAL POWER SEQUENCE

##### Battery Power

Power for the crane's electrical system is provided by two 12-volt batteries connected in series to produce 24 volts.

The following devices are connected to the battery positive terminal at all times:

- Alternator and intake air heater (via 250A alternator fuse or circuit breaker)
- Starter solenoid
- Battery disconnect switch
- CraneStar® TCU (via 5A fuse F5)

##### Battery Power Disconnect

When in the OFF position (contacts open), the battery disconnect switch disconnects the battery positive terminal from the crane's electrical systems.

The battery disconnect switch is turned to the OFF position for the following situations:

- Whenever the electrical system is being serviced
- During extended downtime to help save battery life
- For security reasons

The battery disconnect switch must be in the ON (contacts closed) position for machine operation. When the switch is closed, battery power becomes available to the following circuits and devices, via the main circuit breaker CB41:

- Display modules (via CB9)
- Relays K4 and K6 (normally open contacts)
- Relay K5 (via CB1)
- Horn (via CB3), dome light (via CB8), and service lights switch (via CB36)
- Radio clock and preset memory (via CB5)
- Relay K7 (normally open contacts) (via CB4)
- Remote battery positive terminal (unfused)

---

#### CAUTION

##### Avoid Electronic Control Module Malfunction!

Before turning the battery disconnect switch to the OFF position, make sure the engine run switch has been off for at least five minutes. This will avoid engine fault codes and undesirable operation.

---

## Crane Electrical Power Distribution

When the battery disconnect switch is closed and battery power is available, turning the engine run switch S3 to the RUN position provides power to terminal KL15 on the following control modules:

SCM-00	IOLC30
IOSA22	IOLC31
CCM-10	IOLC32

When in the RUN position, the engine run switch also provides power to the following components:

- Main (ODM) display
- RCL/RCI (RDM) display
- CraneStar® TCU

When in the RUN position, the engine run switch provides power from circuit breaker CB3 to relays K3 to K6, closing the normally open contacts of the relays and providing power to the engine control modules and the crane's CAN Bus control modules as follows:

- Relay K4: When energized, relay K4 provides power to the following:
  - Engine ECM (via CB4)

- Relay K5: When energized, relay K5 provides power from circuit breaker CB3 to terminal +UE on the following control modules:

SCM-00	IOLC30
IOSA22	IOLC31
CCM-10	IOLC32

- Relay K6: When energized, relay K6 provides power to terminal +UB on all crane CAN Bus control modules. Relay K6 also provides power to terminals KL15 and +UE on the following control modules:

- SCMD01—KL15
- IOSB22—KL15 and +UE
- CCMC11—KL15 and +UE

Relay K6 also provides power to the following components and circuits:

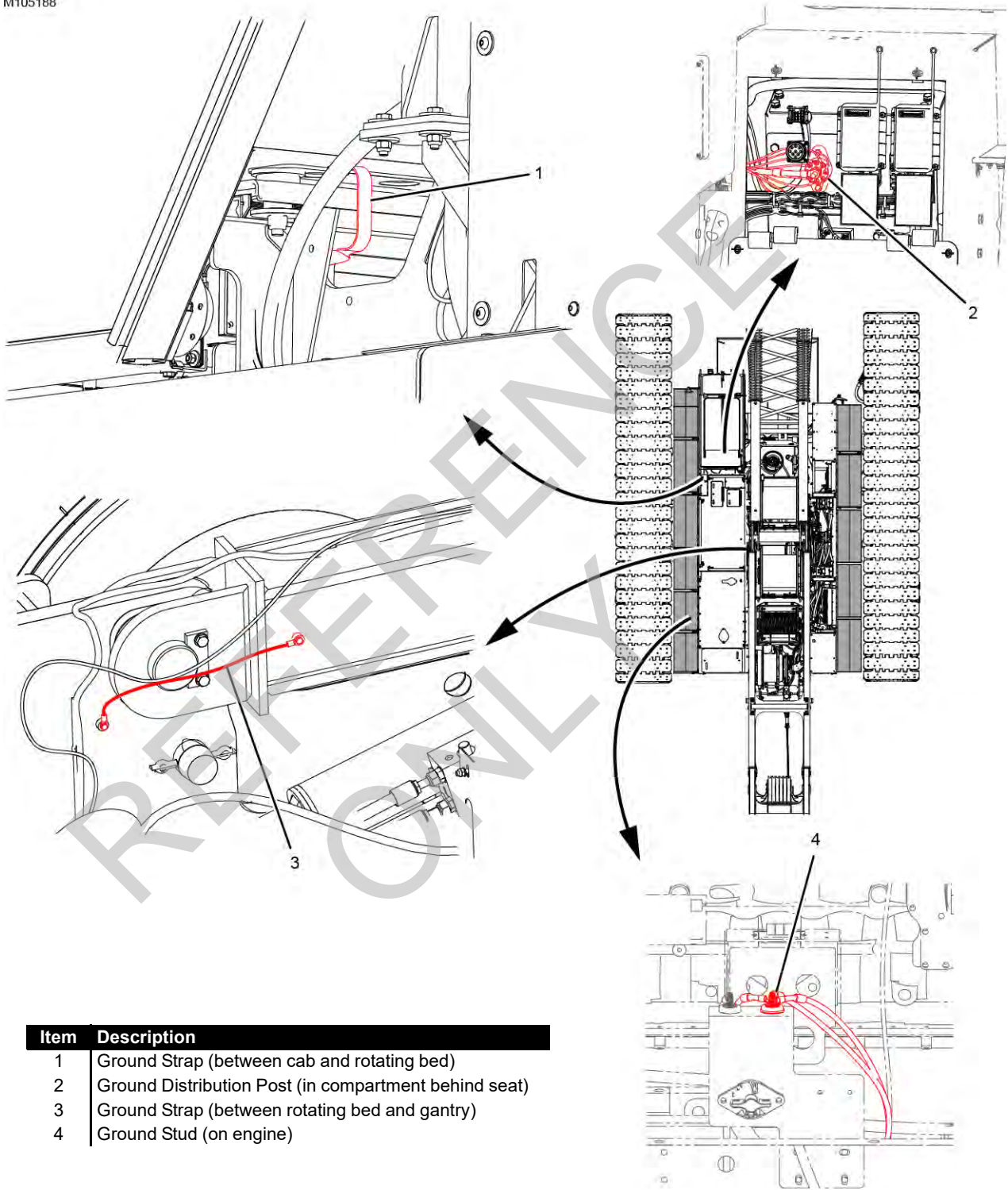
- Jog dial and joysticks (via CB40)
- Climate controls (via CB33)
- Wiper controls (via CB34)
- Work lights and panel lights (via CB36)
- 24 VDC to 12 VDC converter (powers the radio and seat motor switches) (via CB10)



### ELECTRICAL SYSTEM GROUND POINTS

See [Figure 3-1](#)

M105188



Item	Description
1	Ground Strap (between cab and rotating bed)
2	Ground Distribution Post (in compartment behind seat)
3	Ground Strap (between rotating bed and gantry)
4	Ground Stud (on engine)

FIGURE 3-1

### FUSES AND CIRCUIT BREAKERS — ENGINE

See [Figure 3-2](#) and [Figure 3-3](#).

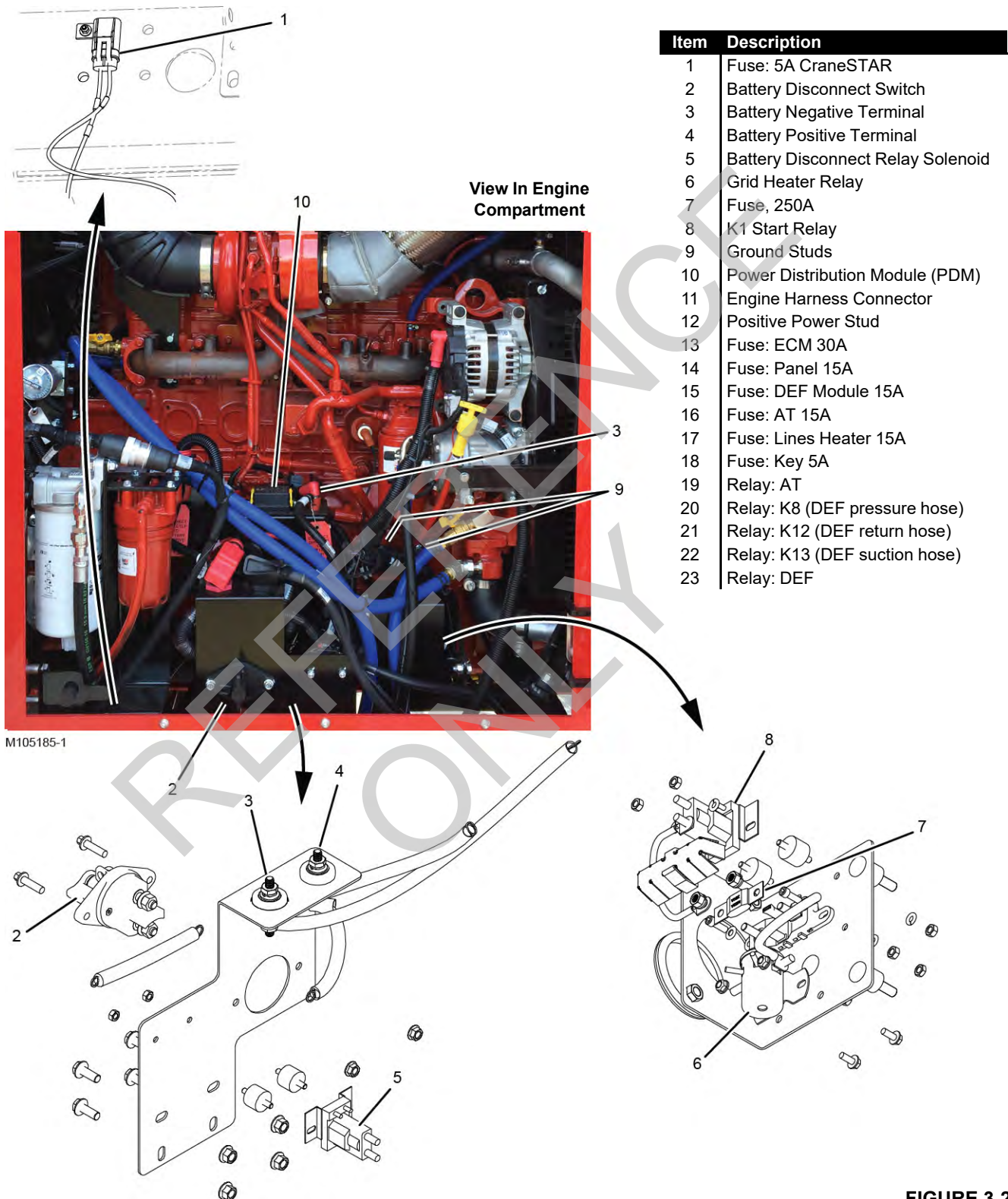


FIGURE 3-2

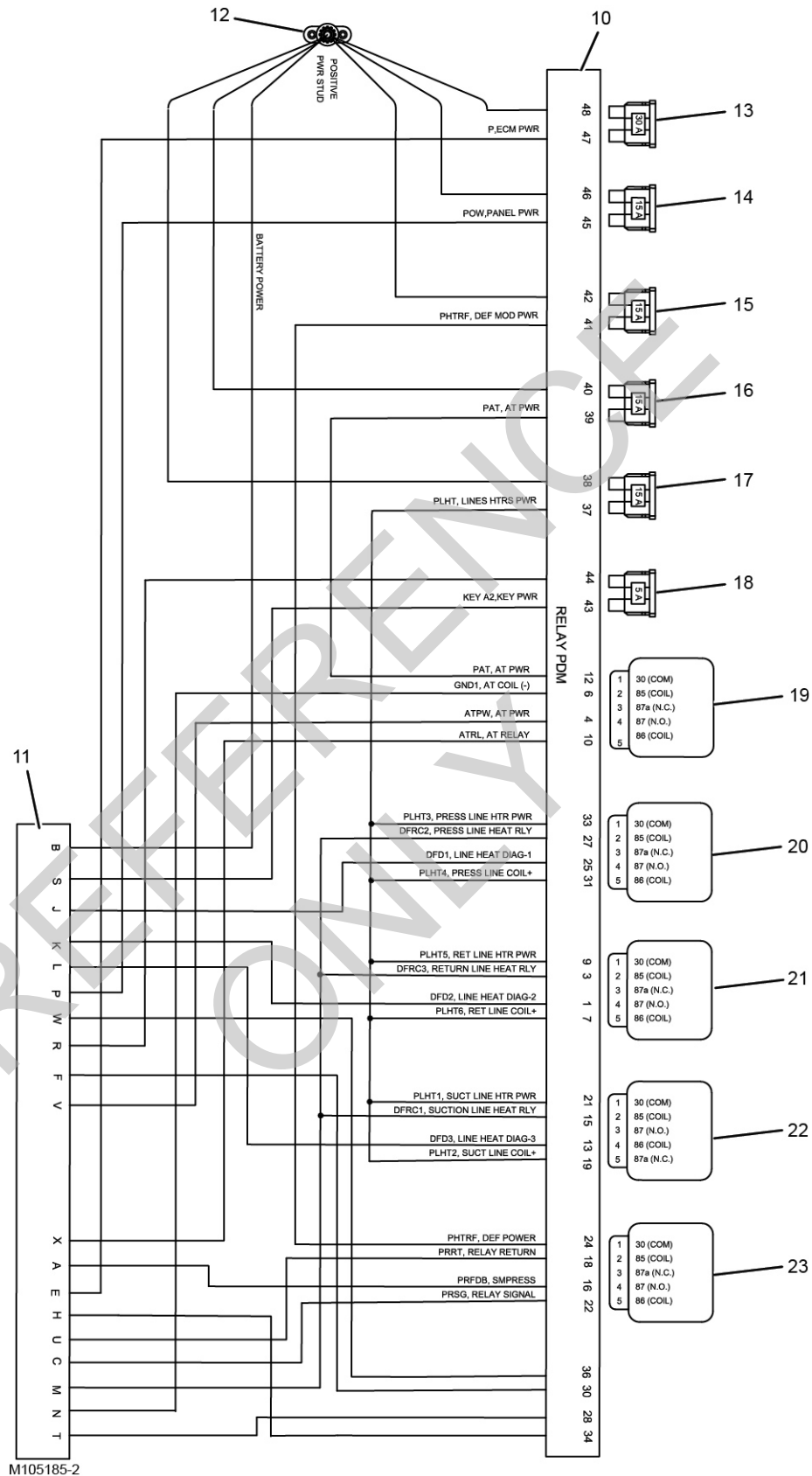
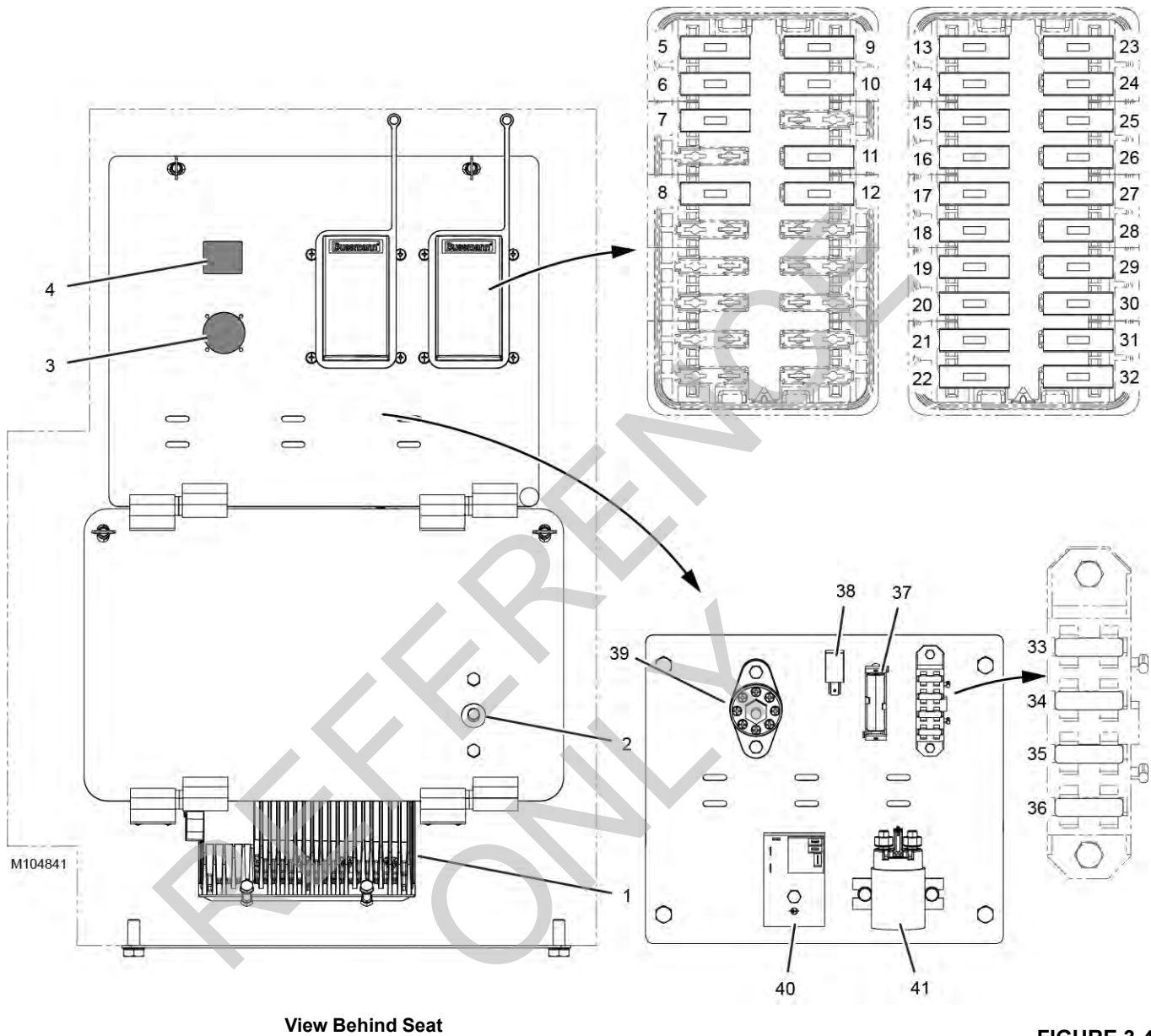


FIGURE 3-3

FUSES AND CIRCUIT BREAKERS — CRANE CAB

See [Figure 3-4](#).



Legend for [Figure 3-4](#).

Item	Description
1	Power Supply Converter — 24/12VDC, 30A
2	Main Circuit Breaker — 120A
3	Diagnostic Receptacle
4	Program Receptacle
5	Crane Bus — 15A Circuit Breaker 6C1
6	Key — 15A Circuit Breaker 6C3 (includes horn and USB accessory socket)
7	Radio — 15A Circuit Breaker 6C5
8	Cab Main and RCL Displays — 15A Circuit Breaker 6C9
9	Boom Position Light — 10A Circuit Breaker 6C2
10	ECM Key — 15A Circuit Breaker 6C4
11	Cab Accessories — 15A Circuit Breaker 6C8
12	DC/DC Converter — 25A Circuit Breaker 6C10
13	IOLC30 UB— 15A Circuit Breaker 8C21
14	IOLC31 UB— 15A Circuit Breaker 8C23 (includes SCMD01 UB)
15	IOLC32 UB— 15A Circuit Breaker 8C25
16	CCM10 UB— 15A Circuit Breaker 8C27
17	CCM10 UB — 15A Circuit Breaker 8C29
18	SCM00 UB — 15A Circuit Breaker 8C31
19	Cab A/C Heat— 25A Circuit Breaker 8C33
20	Switch Back Lights — 15A Circuit Breaker 8C35
21	J1939 Diagnostics— 15A Circuit Breaker 8C37
22	Radio Illumination — 15A Circuit Breaker 8C39
23	IOLC30 UB— 15A Circuit Breaker 8C22
24	IOLC31 UB— 15A Circuit Breaker 8C24
25	IOLC32 UB— 15A Circuit Breaker 8C26
26	CCM10 UB— 15A Circuit Breaker 8C28
27	CCM10 UB — 15A Circuit Breaker 8C30
28	IOSA22 UB — 15A Circuit Breaker 8C32
29	Wipers — 15A Circuit Breaker 8C34
30	Cab Work Lights — 15A Circuit Breaker 8C36
31	Camera Monitor Power — 15A Circuit Breaker 8C38
32	Joysticks — 15A Circuit Breaker 8C40
33	12VDC Accessory Socket (right console) — 15A Fuse 12VF1
34	Seat Riser — 20A Fuse 12VF2
35	12VDC Accessory Socket (left console) — 15A Fuse 12VF3
36	Spare — 15A Fuse
37	Battery, SCM Controller Real-Time Clock — 3.6V Lithium AA, 2400 mAh
38	Relay — 24V, 10A ECM Power
39	Ground Distribution Post
40	Time Delay Relay, SCM and CCM Controller Backup — 24V
41	Relay Contactor — 28V, 120A Cab Switch Power

- The circuit breaker numbers (for example, 6C1 and 8C21) correspond to the circuit breaker numbers in the MLC150-1 Electrical Schematic located at the end of this section.

## CAN BUS CONTROL SYSTEM

### CAN Bus System Overview

The CAN Bus control system consists of the following components:

- CAN Bus
- Control modules
- CAN Bus devices
- CAN Bus terminator plugs

**CAN Bus**—The CAN Bus is the crane's serial communication network consisting of a shielded twisted pair of wires—one wire is designated CAN High (+), and the other wire is CAN Low (-). The twisted pair and shielding helps prevent spurious signals and noise from being introduced into the CAN Bus.

The crane contains six separate CAN Buses (see [Figure 3-5](#)):

- CAN Bus A (cab)
- CAN Bus C (rotating bed)
- CAN Bus D (RCL)
- CAN Bus H (CraneStar®)
- CAN Bus J (engine)

**Control Modules**—The CAN Bus control system contains control modules that use the CAN Bus to communicate with each other and with other CAN Bus devices. (For more information, see [Control Modules on page 3-10](#).)

The control modules receive inputs from components such as switches, sensors, and transducers.

The control modules drive outputs to components such as motors, relays, and solenoids. The control module components are hardwired separately to the control modules. (For more information, see [Control Module Devices on page 3-12](#).)

**CAN Bus Devices**—Besides control modules, the CAN Bus also contains the following devices:

- |                         |                         |
|-------------------------|-------------------------|
| • Main (ODM) display    | • Travel handles        |
| • RCL/RCI (RDM) display | • Swing encoder         |
| • Jog dial              | • Setup remote receiver |
| • Joysticks             | • CAN Bus program port  |
| • Drum encoder          | • Limit switches        |

**CAN Bus Terminator Plugs**—Terminator plugs reduce electrical noise pickup. The terminator plugs are added to each end of the CAN Bus to match the impedance of the CAN line, which prevents line reflection.

The terminator plugs may also provide a load for the control module drivers.

CAN Bus System Diagram

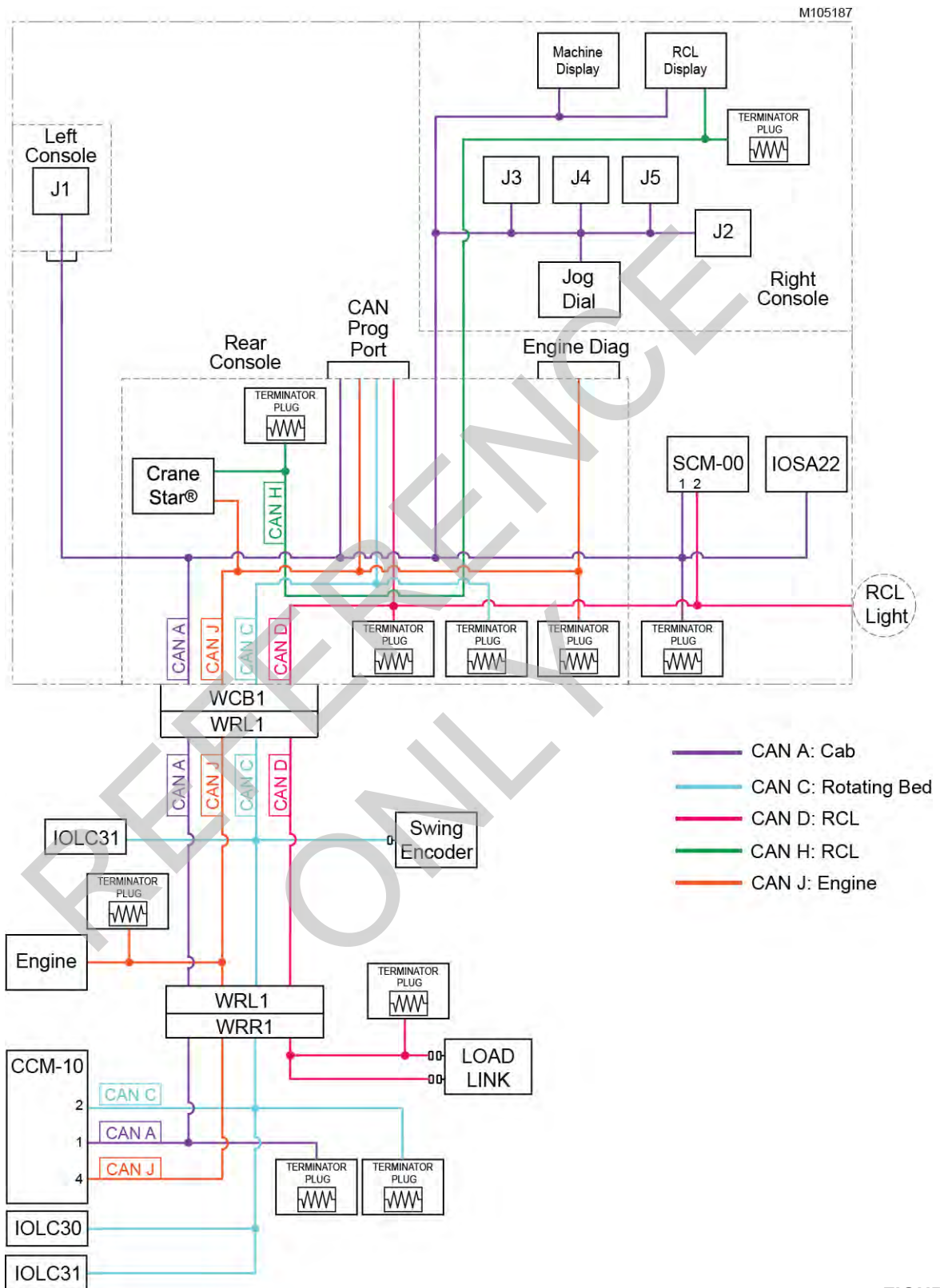


FIGURE 3-5

## Control Module Identification

See [Figure 3-6](#)

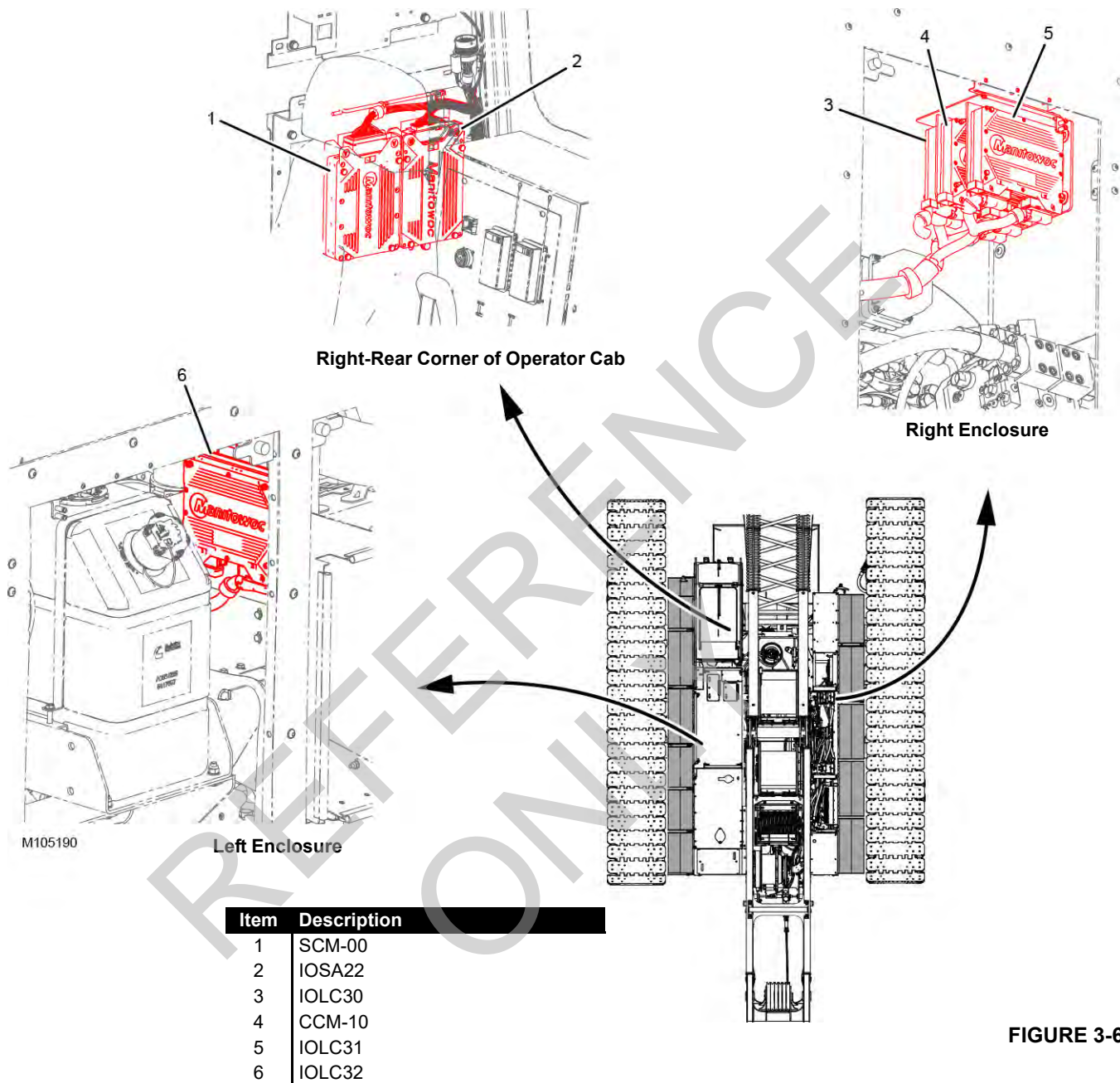


FIGURE 3-6

## Control Modules

Control modules perform several functions:

- Run the software control programs
- Communicate with each other over the CAN Bus
- Read input devices
- Command output devices

## Control Module Naming Conventions

There are four types of control modules in the CAN Bus system:

- Safety Control Module (SCM)
- Crane Control Module (CCM)
- Input/Output—Large (IOL)



- Input/Output—Small (IOS)

Control modules are named in the format MWXXXABC. [Table 3-1](#) defines the variables used to build the name.

**Table 3-1. Control Module Naming Definitions**

Identifier	Definition
XXX	Module Type: SCM CCM IOL IOS
A	CAN Bus ID: - = Multiple Buses A = CAN Bus A C = CAN Bus C D = CAN Bus D J = CAN Bus J H = CAN Bus H
B	Module Hardware ID: 0 = SCM 1 = CCM 2 = IOS 3 = IOL
C	Module Index

### Control Module Input/Output (I/O) Types

[Table 3-2](#) defines the terms used in the schematics for the I/O types used by the control modules.

**Table 3-2. Control Module I/O Types**

Schematic Term	Definition
IAC	Analog Current Input
IACV	Analog Current/Voltage Input
IBRTC <sub>n</sub>	IN Battery RTC Negative Input
IBRTC <sub>p</sub>	IN Battery RTC Positive Input
ID	Digital Input
IDF	Digital Frequency Input
IMID1	Module Identifier Input
KL15	Key Switch Power
ODHxA	Digital Output, where “x” is the current in Amps

Schematic Term	Definition
OPHxA	PWM Output High Side, where “x” is the current in Amps
OPLxA	PWM Output Low Side, where “x” is the current in Amps
OS85H	8.5 VDC Supply Power
OS85L	8.5 VDC Supply Ground to Voltage Regulator
+UB	Battery Supply
+UE	Electronic Supply

### Safety Control Module (SCM)

The SCM controller runs the software programs to interface with the cab controls and to govern boom and jib load safety. The software running in the SCM controls the I/O devices connected directly to the SCM and any I/O modules connected to its bus.

There is one SCM mounted on the crane (see [Figure 3-6](#)):

- SCM-00 located in the right operator cab.

### Crane Control Module (CCM)

The CCM controller runs the software programs governing the crane operations. The software running in the CCM controls the I/O devices connected directly to the CCM and any I/O modules connected to its bus.

There is one CCM mounted on the crane (see [Figure 3-6](#)):

- CCM-10 located in the right enclosure on the rotating bed.

### Input/Output—Large (IOL) Module

IOLs control the devices connected to them and communicate with the SCM or CCM connected to their bus. IOLs have twice the device capacity as the input/output—small (IOS) modules.

There are three IOL modules mounted on the crane (see [Figure 3-6](#)):

- IOLC30, IOLC31, and IOLC32 located in the right and left enclosures on the rotating bed.

### Input/Output—Small (IOS) Module

IOSs control the devices connected to them and communicate with CSMs or CCMs connected to their bus. IOSs have half the device capacity as the input/output—large (IOL) modules.

There is one IOS module on the crane (see [Figure 3-6](#)):

- IOSA22 located in the operator cab.

## Control Module Devices

The control modules communicate with output devices to control crane movement and with input devices to read crane status. The following sections detail the operation of these devices.

### Pressure Transducers

A controller provides power to a pressure transducer. The pressure transducers produce an analog input signal to the controller that is proportional to the hydraulic pressure at the transducer connection. The controllers monitor hydraulic pressures to use as feedback in control algorithms and to provide status information to the operator. Pressure transducers are used to monitor the following:

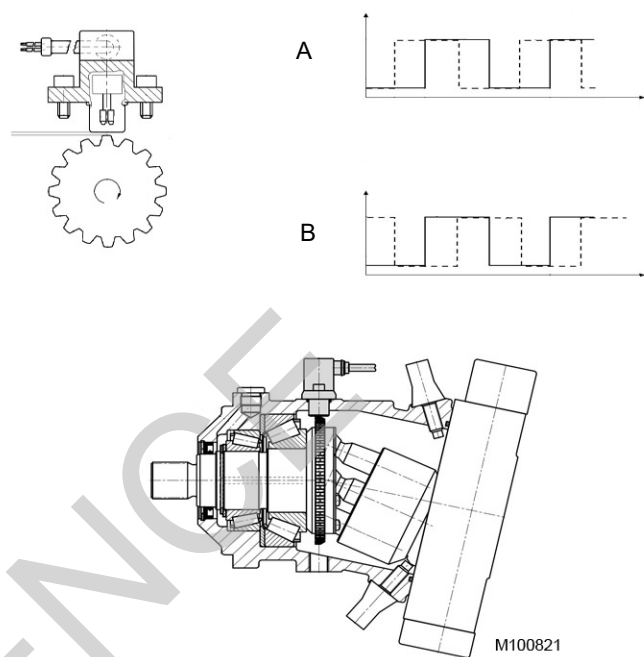
- Drum system pressure
- Swing system pressure
- Accessory system pressure
- Track pressure
- Cooler fan pressure

### Motor Speed Sensors

See [Figure 3-7](#) for the following.

A controller provides power to Hall-effect speed sensors within the hydraulic motors that drive the drums, rotating bed, and crawlers. A gear wheel within the motor has teeth that move past the speed sensor as a motor shaft spins, causing the sensor to produce two square-wave signals that are offset with a 90° phase delay. These signals are read at frequency inputs of the controller.

The frequency of the square waves is determined by the number of teeth on the circumference of the gear wheel and shaft speed. The rotational direction is determined by which signal phase leads the other. Software uses the square-wave frequency and phase information to calculate the rotational speed and direction of the motor.



Item	Description
A	Clockwise Rotation Signals
B	Counterclockwise Rotation Signals

FIGURE 3-7

**Limit Switches—Dual Contact**

In the non-tripped state, a controller provides power to the normally closed contact and grounds the normally open contact. A controller digital input reads the applied power through the normally closed contact back through the common center terminal as a logic high. When the switch is tripped, the normally closed contact opens, breaking the current path through the common terminal. At the same time, the normally open contact closes, grounding the common terminal and sending a controller digital input a logic low signal.

Dual contact limit switches are used to sense the travel limits of the following crane functions:

- Drums 1 and 2 minimum bail limit
- Drums 4 pawl limit
- Counterweight up limit
- Boom up limit
- Luffing jib up limit

**Limit Switches—Single Contact**

In the non-tripped state, a controller provides power to the normally closed contact. A controller digital input reads the applied power back through the normally closed contact as a logic high. When the switch is tripped, the normally closed contact opens, breaking the current path through the common terminal. The controller digital input reads this as a logic low.

Single contact limit switches are used for the following crane functions:

- Block-up limits: boom points and jib points

**Solenoids**

Solenoids are driven by controller digital outputs and activate hydraulic valves and provide control of the following cylinders, valves, and pumps:

Brake release cylinders	System valves
Drum pawl cylinders	Pin pusher cylinders
Gantry cylinders	Cooler fan pump

**Angle Sensors**

A controller provides power to the angle sensor. The sensor outputs an analog signal that is proportional to the sensor angle. A controller analog input reads this output voltage, and the controller software determines the mast angle based upon the signal level. The angle sensors are used to measure the following items:

- Gantry angle
- Boom angle
- Rotating bed pitch and roll

**Alarms**

A controller digital output drives the applicable alarm during various operational states:

- Swing motion
- Travel motion
- Load approaching or exceeding capacity

**Load Link Sensors**

A controller digital output provides power to the load pin sensors. A strain gauge within the load pin produces an analog output current that is proportional to the load. A controller analog input reads this output current, and the controller software determines the value of the load based upon the current level. The load pin sensors monitor the following loads:

- Right and left links

**Temperature Sensors**

A controller digital output provides power to the temperature sensor.

The sensor produces an analog output voltage that is proportional to temperature. A controller analog input reads this output voltage, and software determines the value of the load based upon the current level.

**Fuel Level Sensor**

A controller digital output provides power to the fuel level sensor. The sensor sends a signal through a resistor that is proportional to the fuel level.

**Hydraulic Fluid Level Switch**

A controller digital output provides power to the hydraulic fluid level sensor. The sensor sends a signal that is proportional to the fluid level and sends this to a controller analog input.

**Pressure and Vacuum Switches**

The pressure and vacuum switches are normally closed. They open when the vacuum or pressure level exceeds the setting of the switch. In the non-tripped state, a controller digital output provides power to the normally closed contact.

A controller digital input reads the applied power through the normally closed contact back through the center terminal as a logic high. When the switch is tripped, the normally closed contact opens, breaking the path of power through the center terminal, and the controller reads this as a logic low.

### Relays

A controller digital output drives the relay coil. The coil energizes, creating a magnetic field that closes the relay contacts. Relays use a small control signal to control the flow of a large current.

### Hand Throttle

A controller provides an 8.5 VDC supply to a potentiometer that is connected to the hand throttle. Power is applied across the potentiometer windings to ground. Moving the hand throttle moves a wiper across the potentiometer windings. The voltage provided at the wiper when referenced to ground is proportional to the hand throttle position and is sent to a controller analog input.

### Foot Throttle

A controller provides a digital output to a potentiometer that is connected to the foot throttle. Power is applied across the potentiometer windings to ground. Moving the foot throttle moves a wiper across the potentiometer windings. The voltage provided at the wiper when referenced to ground is proportional to the foot throttle position and is sent to a controller analog input.

### Travel and Free-Fall Brake Pedals

A controller digital output provides power to a potentiometer that is connected to the pedal. Power is applied across the potentiometer windings to ground. Moving the pedal moves a wiper across the potentiometer windings. The voltage provided at the wiper when referenced to ground is proportional to the pedal position and is sent to a controller analog input.

### Pump Displacement Controls

Pump flow is both directional and variable, determined by position and stroke of a proportional solenoid valve. A controller sends two pulse-width modulated (PWM) output signals to two coils that actuate the solenoid valve in opposite directions. As a PWM duty cycle increases at one coil, more fluid is ported to the swashplate servo pistons through the solenoid valve, increasing the swashplate angle in the direction commanded. As the swashplate angle increases, so does the piston stroke within the pump, increasing the pump output volume.

### RCL Beacon

A controller provides a digital output to each indicator in the RCL beacon (red, amber, and green).

### Wind Speed Indicators

A controller digital output provides power to the wind speed sensor. The sensor outputs an analog signal that is proportional to the wind speed. A controller analog input reads this output voltage, and controller software determines the wind speed based upon the signal level.

### Proximity Sensors

Proximity sensors sense metal objects by generating magnetic fields. When no metal object is close to the sensor, the solid state switch within the sensor is open and there is no output signal. When a metal object is close to the sensor, the switch within the sensor closes and outputs a signal that is 1.8 VDC less than the sensor supply voltage.

A yellow LED on the sensor displays the switch state.

## Control Module Test Voltages

### Pump and Motor Voltages and Currents

[Table 3-3](#) shows the voltages and currents of the pumps, hoists, and travel motor.

**Table 3-3. Pump and Motor Voltages and Currents**

Pumps	1.6 or 8.8 VDC nominal
	200 to 600 mA <sup>1, 2</sup>
Hoist Motors	4.5 to 10 VDC
	180 mA to 450 mA <sup>1, 2</sup>
Travel Motors	0 or 24 VDC nominal
	0 or 600 mA nominal <sup>1</sup>
<p><b>Note 1:</b> Resistance increases as the temperature rises on the pump or motor solenoid coil, resulting in decreased current values when measured with a meter. The listing in the table is the current range for a 21°C (68.9°F) coil.</p>	
<p><b>Note 2:</b> The node regulates displacement of the pump or motor with a PWM output. The values represent the beginning and end of the control range.</p>	

**Alphabetical Index of Controller Devices**

Find the device of interest and associated controller in [Table 3-4](#), then refer to the applicable test voltage table for that controller.

**Table 3-4. Controller Components**

Device	Controller
Alarms (Swing, Travel, RCL)	IOLC31
Air Conditioning	SCM-00, IOLC31, IOLC32
Block-Up Limit and Slow Down Switches	IOLC31
Boom Up Limit Switch	IOLC31
Boom Angle Sensor	CCM-S-10, IOLC31
Boom Top Components	IOLC30, IOLC31
Cab Switches and Controls	SCM-00, IOSA22
Camera Lights	IOLC30, IOSA22
Counterweight Limit Switch	CCM-S-10
Counterweight Pin Puller	CCM-10
Drum 1 Components	CCM-10, CCM-S-10, IOLC31
Drum 2 Components	CCM-10, CCM-S-10, IOLC31
Drum 3 Components	CCM-10, CCM-S-10
Drum 4 Components	CCM-10, CCM-S-10
ECM Start Relay	IOLC32
Engine Components	SCM-00, CCMC11, IOLC30, IOLC32, IOSA22

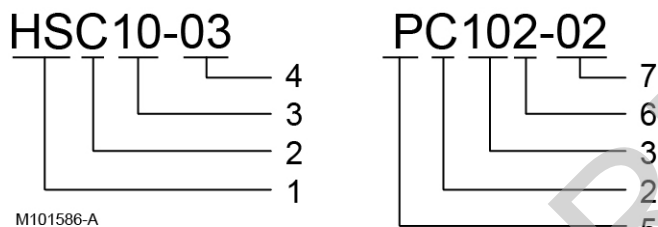
Device	Controller
Free Fall Components	SCM-00, IOLC32, IOSA22
Fuel Level Sensor	IOLC30
Gantry Components	IOLC30
Hydraulic Filter Alarm Switch	IOLC32
Hydraulic Fluid Level and Temperature Sensor	IOLC32
Hydraulic Pressure Accessory Enable	IOLC31, IOLC32
Hydraulic Vacuum Switch	IOLC32
Level Sensor—Rotating Bed	IOLC30
Load Link	IOLC31
Luffing Jib Up Limit	IOLC30
Pressure Transducers	CCM-10, CCM-S010, IOLC30, IOLC31, IOLC32
Pump Controls	IOLC32
RCL Beacon	SCM-00, IOSA22
Rotating Bed Level	IOLC30
Seat Switch	SCM-00, IOSA22
Setup Remote	IOLC32
Starter Motor Relay	IOLC32
Swing Components	CCM-10, IOLC32
Throttle (Hand and Foot)	SCM-00
Travel Components	CCM-10, SCM-00
Wind Speed Indicators—Boom and Upper Boom Point	IOLC30

## SOLENOID VALVE IDENTIFICATION

Each hydraulic valve solenoid is assigned a solenoid number used in Manitowoc Cranes training classes (see [Table 3-5](#)). The pin number corresponds to the control module connector pin number, as represented in the electrical schematics.

The control module information contained in each solenoid or pin number is illustrated in [Figure 3-8](#). In this example, for the swing brake release solenoid, the following information is contained:

- Control module resides on CAN Bus C
- Control module index is 22
- Control module digital output is ODH3A-03
- Control module output signal is at pin 2 of connector KS-2



Item	Description
1	Hydraulic Solenoid Reference Designator
2	CAN Bus
3	Control Module Index
4	Digital Output Number
5	Connector Reference Designator
6	Connector Number
7	Pin Number

FIGURE 3-8

Table 3-5. Hydraulic Solenoid Identification

Solenoid Number	Description	Pin Number
HSC10-03	Swing Brake Release	PC102-02
HSC10-04	Travel Brake Release	PC102-22
HSC10-05	Drum 1 Brake Release	PC102-05

Solenoid Number	Description	Pin Number
HSC10-06	Drum 2 Brake Release	PC102-15
HSC10-07	Drum 3 Brake Release	PC102-14
HSC10-08	Drum 4 Brake Release	PC102-04
HSC10-09	Drum 4 Pawl In	PC102-03
HSC10-11	Drum 4 Pawl Out	PC102-24
HSC10-12	Travel High Speed	PC102-25
HSC10-13	Counterweight Pin Pullers	PC102-06
HSC 10-15	Carbody Accessory Enable	PC102-07
HSC10-23	Left Travel Side A	PC101-01
HSC10-24	Left Travel Side B	PC102-12
HSC10-25	Right Travel Side A	PC101-15
HSC10-26	Right Travel Side B	PC101-42
HSC10-27	Drum 4 Valve A	PC101-28
HSC10-28	Drum 4 Valve B	PC101-02
HSC30-10	Gantry Retract	PC302-08
HSC30-12	Gantry Extend	PC302-09
HSC30-18	Drum 2 Valve A	PC301-05
HSC30-19	Drum 2 Valve B	PC301-06
HSC30-20	Drum 1 Valve A	PC301-07
HSC30-21	Drum 1 Valve B	PC301-08
HSC31-18	Drum 3 Valve A	PC311-5
HSC31-19	Drum 3 Valve B	PC311-6
HSC31-21	Accessory Enable	PC311-08
HSC32-04	Drum 1 and 2 Free fall Enable	PC322-06
HSC32-14	Swing Pump B	PC322-10
HSC32-15	Swing Pump A	PC322-18
HSC32-17	Hydraulic Fan Control	PC322-19
HSC32-18	Drum 1 Free Fall Proportion Valve	PC321-05
HSC32-19	Drum 2 Free Fall Proportion Valve	PC321-06
HSC32-20	Open Loop A Pump	PC321-07
HSC32-21	Open Loop B Pump	PC321-08

REFERENCE  
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## TEST VOLTAGES

Table 3-6. SCM-00 Test Voltages

Pin	Net	Function	Voltages
P1-1	8C31 (+UB)	Battery Power for Control Module Outputs (from CB31)	24 VDC
P1-4	ODH1A5	Seat Safety Switch	0 VDC Open, 24 VDC Closed
P1-6	ODH1A3	RCL Light Red	0 VDC Off, 24 VDC On
P1-7	ODH1A2	24VDC Power Bus: • DPF Regen Switch • Camera Lights Switch	24 VDC
P1-8	ODH1A1	Limit Bypass Switch	0 VDC Open, 24 VDC Closed
P1-9	IDF1	Drum 1 Un-Park	
P1-10	IDF2	Drum 1 Park	
P1-11	IDF3	Drum 2 Un-Park	
P1-12	IDF4	Drum 2 Park	
P1-13	ID5	Swing Un-Park	
P1-14	6C1A (+UE)	Control Module Battery Power (from K5)	24 VDC
P1-16	CAN_D-L	CAN Bus D—Low	N/A
P1-17	CAN_D-H	CAN Bus D—High	N/A
P1-20	IMID1	Module Identifier Input (from cab ground bus bar)	0 VDC
P1-21	ID6	Engine Start Input	0 VDC Open, 24 VDC Closed
P1-22	IACV11	Hand Throttle Input	0.5 VDC Low Idle 4.5 VDC High Idle
P1-23	IACV12	Engine Foot Throttle Input	0.90 to 1.00 VDC High Idle 2.90 to 3.00 VDC Low Idle
P1-24	IACV13	Drum 2 Free Fall Pedal Input	1.5 to 8.5 VDC
P1-25	RTCN	3.6 VDC Real Time Clock Battery Power (negative)	0 VDC
P1-26	0S85L	8.5 VDC Ground Bus Hand Throttle	8.5 VDC
P1-27	KL15	Control Module Ignition Power (from engine RUN switch)	24 VDC
P1-28	ID9	Seat Safety Switch	0 VDC Open, 24 VDC Closed
P1-29	GND	Ground (from cab ground bus bar)	0 VDC
P1-30	CAN_A-L	CAN Bus A-Low	N/A
P1-31	CAN_A-H	CAN Bus A-High	N/A
P1-34	IMID2	Module Identifier Input (from cab ground bus bar)	0 VDC
P1-35	ID7	Engine Run Input	0 VDC Open, 24 VDC Closed
P1-36	ID8-1	Travel Un-Park	
P1-37	IACV14	Drum 1 Free Fall Pedal	1.5 to 8.5 VDC
P1-38	IACV16	Cab A/C Thermostat	0 VDC Open, 24 VDC Closed
P1-39	IACV15	Travel Park	0 VDC
P1-40	RTCP	3.6 VDC Real Time Clock Battery Power (positive)	3.6 VDC
P1-41	0S85H	8.5 VDC Power Bus Hand Throttle	8.5 VDC
P1-42	ID10	Drum 4 Park	



Table 3-7. IOSA22 Test Voltages

Pin	Net	Function	Voltages
P1-1	GND	Ground (from cab ground bus-bar)	0 VDC
P1-2	KL15	Control Module Ignition Power (from engine RUN switch)	24 VDC
P1-3	ID01	DPF Regen Initiate	0 VDC Open, 24 VDC Closed
P1-4	ID02	DPF Regen Disable	0 VDC Open, 24 VDC Closed
P1-5	OPH6A01	24 VDC Power Bus: • Free Fall Enable • Gantry Raise and Lower Cylinder	24 VDC
P1-6	OPH6A02	Heater Valve Motor Power	0 VDC Open, 24 VDC Closed
P1-9	IMID1	Module Identifier Input (from cab ground bus-bar)	0 VDC
P1-10	CAN_A—H	CAN Bus A—High	N/A
P1-11	8C32 (+UB)	Battery Power for Control Module Outputs (from CB32)	24 VDC
P1-12	6C1A (+UE)	Control Module Battery Power (from K5)	24 VDC
P1-13	ID03	Limit Bypass Switch	0 VDC Open, 24 VDC Closed
P1-14	ID04	Limit Bypass Switch	0 VDC Open, 24 VDC Closed
P1-15	ID05	RCL Override Switch	0 VDC Open, 24 VDC Closed
P1-16	ID06	RCL Override Switch	0 VDC Open, 24 VDC Closed
P1-17	IDF12	Drum 3 Un-Park	0 VDC
P1-19	CAN_A—L	CAN Bus A—Low	N/A
P1-20	8C45 (+UB)	Battery Power for Control Module Outputs (from CB32)	24 VDC
P1-21	ID07	Lower Gantry	0 VDC Open, 24 VDC Closed
P1-23	ID09	Seat Safety Switch (N.C)	0 VDC Open, 24 VDC Closed
P1-24	ID10	Swing Un-Park	0 VDC Open, 24 VDC Closed
P1-25	ID11	E-Stop (N.O.)	0 VDC Open, 24 VDC Closed
P1-26	IDF13	Not Used	0 VDC
P1-28	ID15	A/C Thermostat	0 VDC Open, 24 VDC Closed
P1-29	IMID3	Module Identifier Input (from cab ground bus bar)	0 VDC

Table 3-8. CCM-10 Test Voltages

Pin	Net	Function	Voltages
P1-1	OPH3A23	Left Travel Valve A	0 to 24 VDC
P1-2	OPH3A28	Drum 4 Valve B	0 to 24 VDC
P1-3	ID21	Drum 4 Pawl Limit Switch N.C.	0 VDC Open, 24 VDC Closed
P1-4	IDF09	Drum 2 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 VDC
P1-5	IDF10	Drum 2 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 VDC
P1-7	IDF01	Drum 4 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 VDC
P1-8	IDF04	Drum 3 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 VDC
P1-9	IDF06	Drum 1 Flange Encoder	0 VDC or 24 VDC
P1-10	IACV20	Boom Angle Sensor	24 VDC
P1-11	IACV16	Right Travel Motor PSI	4 to 20 mA
P1-12	IACV18	Drum 2 Motor PSI	4 to 20 mA
P1-13	IACV14	Drum 3 Motor PSI	4 to 20 mA
P1-14	6C1A (+UE)	Control Module Battery Power	24 VDC
P1-15	OPH3A25	Right Travel Valve A	0 to 24 VDC
P1-21	IDF03	Drum 3 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 VDC
P1-22	IDF05	Drum 1 Flange Encoder	0 VDC or 24 VDC
P1-24	IACV17	Drum 4 Motor PSI	4 to 20 mA
P1-25	IACV11	Left Side Travel Motor PSI	4 to 20 mA
P1-27	KL15	Control Module Ignition Power (from engine RUN switch)	0 VDC Open, 24 VDC Closed
P1-28	OPH3A27	Drum 4 Valve A	0 to 24 VDC
P1-29	GND	Ground (from ground stud on rotating bed)	0 VDC
P1-35	IDF02	Drum 4 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 VDC
P1-36	IDF07	Drum 2 Flange Encoder	6% (low) to 70% (high) of 8.5 VDC
P1-37	IDF08	Drum 2 Flange Encoder	6% (low) to 70% (high) of 8.5 VDC
P1-38	IACV15	Drum 4 Motor PSI	4 to 20 mA
P1-39	IACV13	Drum 2 Motor PSI	4 to 20 mA
P1-40	IACV12	Drum 1 Motor PSI	4 to 20 mA
P1-42	OPH3A26	Right Side Travel Valve B	0 to 24 VDC
P2-2	ODH3A09	Swing Brake Release	0 VDC Off, 24 VDC On
P2-3	ODH3A08	Drum 4 Pawl Retract	0 VDC Off, 24 VDC On
P2-4	ODH3A05	Drum 4 Brake Release	0 VDC Off, 24 VDC On
P2-5	ODH3A03	Drum 1 Brake Release	0 VDC Off, 24 VDC On
P2-6	ODH3A13	Counterweight Pin Puller	0 VDC Off, 24 VDC On
P2-7	ODH3A15	Carbody Accessory Enable Solenoid	
P2-8	OPL3A17	Drum 2 Valve A	0 to 24 VDC
P2-9	OPL3A18	Drum 1 Valve B	0 to 24 VDC
P2-10	GND	Ground (from ground stud on rotating bed)	0 VDC
P2-11	8C27 (+UB)	Battery Power for Control Module Outputs	24 VDC
P2-12	OPH3A10	Left Travel Valve B	0 to 24 VDC
P2-13	ODH3A01	Drum 4 Motor Speed Sensor and Pressure	24 VDC
P2-14	ODH3A07	Drum 3 Brake Release	0 to 24 VDC
P2-15	ODH3A06	Drum 2 Brake Release	0 to 24 VDC
P2-16	ODH3A14	Drum 2 Pawl Extend	0 VDC Off, 24 VDC On

Pin	Net	Function	Voltages
P2-17	OPLA3	Drum 3 Valve B	0 to 24 VDC
P2-18	8C28 (+UB)	Battery Power for Control Module Outputs	24 VDC
P2-19	OPL3A	Left Travel Valve B	0 to 24 VDC
P2-20	8C29 (+UB)	Battery Power for Control Module Outputs	24 VDC
P2-21	ODH3A02	Drum 3 Motor Speed Sensor and Pressure	24 VDC
P2-22	ODH3A04	Travel Brake Release	0 to 24 VDC
P2-23	ODH3A10	Right Travel Pressure	0 to 24 VDC
P2-24	ODH3A11	Drum 4 Pawl Extend	0 VDC Off, 24 VDC On
P2-25	ODH3A12	Travel High Speed	0 to 24 VDC
P2-26	ODH3A16	Drum 2 Pawl Extend	0 VDC Off, 24 VDC On
P2-27	OPL3A21	Right Travel Valve B	0 to 24 VDC
P2-28	OPL3A	Drum 4 Valve B	0 to 24 VDC
P2-29	8C30 (+UB)	Battery Power for Control Module Outputs	24 VDC

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Table 3-9. IOLC30 Test Voltages

Pin	Net	Function	Voltages
P1-1	GND	Ground (from ground stud on rotating bed)	0 VDC
P1-2	KL15	Control Module Ignition Power (from engine RUN switch)	0 VDC Open, 24 VDC Closed
P1-3	ID01	Freon PSI	0 VDC Open, 24 VDC Closed
P1-4	ID02	Counterweight UP Limit	0 VDC Disconnected, 24 VDC Connected
P1-5	OPH6A18	Drum 2 Valve A Solenoid	0 or 24 VDC
P1-6	OPH6A19	Drum 2 Valve B Solenoid	0 or 24 VDC
P1-7	OPH6A20	Drum 1 Valve A Solenoid	0 or 24 VDC
P1-8	OPH6A21	Drum 1 Valve B Solenoid	0 or 24 VDC
P1-9	IMID1	GND	NA
P1-10	CAN1H	CAN_C-H	N/A
P1-11	8C21 (+UB)	Battery Power for Control Module Outputs (from CB21)	24 VDC
P1-12	8C48 (+UE)	Control Module Battery Power (from K5)	24 VDC
P1-13	ID03	Luffing Jib Boom Up Limit (NO)	0 V <sub>DC</sub> Open, 24 V <sub>DC</sub> Closed
P1-14	ID04	Luffing Jib Boom Up Limit (NC)	0 V <sub>DC</sub> Open, 24 V <sub>DC</sub> Closed
P1-15	ID05	Upper Boom Point Connect	0 VDC Open, 24 VDC Closed
P1-16	ID06	Fixed Jib Connect	0 VDC Open, 24 VDC Closed
P1-17	IDF15	Drum 1 Flange Encoder (EU)	0 or 24 VDC
P1-18	IMID2	GND	NA
P1-19	CAN1L	CAN_C-L	NA
P1-20	8C22 (+UB)	Battery Power for Control Module Outputs (from CB21)	24 VDC
P1-21	ID07	Rotating Bed Level Sensor	0 VDC Disconnected, 24 VDC Connected
P1-26	IDF16	Drum 1 Flange Encoder (EU)	0 or 24 VDC
P1-27	IACV17	Wind Speed Indicator	24 VDC
P1-28	IMID3	GND	NA
P1-29	IMID4	GND	NA
P2-1	ID12	Drum 3 Min Bail Limit	0 VDC Open, 24 VDC Closed
P2-2	ID13	Drum 3 Min Bail Limit	0 VDC Open, 24 VDC Closed
P2-6	ODH3A04	Drum 3 Min Bail Limit	0 VDC Open, 24 VDC Closed
P2-4	IACV18	Drum 1 PSI	4 to 20 mA
P2-7	ODH3A07	Rotating Bed Level Sensor	0.15 VDC to 9.85 VDC
P2-8	ODH3A10	Gantry Extend	0 or 24 VDC
P2-9	ODH3A12	Gantry Retract	0 or 24 VDC
P2-11	8C22 (+UB)	Battery Power for Control Module Outputs (from CB22)	24 VDC
P2-12	OS85H	Fuel Level Sensor	8.54 VDC
P2-13	IACV19	Fuel Level Sensor	?4 to 20 mA
P2-15	ODH3A01	Counterweight Up Limit Switch	24 VDC
P2-20	8C22 (+UB)	Battery Power for Control Module Outputs (from CB22)	24 VDC
P2-21	OS85L	Fuel Level Sensor Resistor	0 VDC
P2-22	IACV21	Rotating Bed Level Sensor	0.15 VDC to 9.85 VDC

Pin	Net	Function	Voltages
P2-23	IACV22	Rotating Bed Level Sensor	0.15 VDC to 9.85 VDC
P2-28	ODH3A13	ECM Start	24 VDC

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Table 3-10. IOLC31 Test Voltages

Pin	Net	Function	Voltages
P1-1	GND	Ground (from ground stud on rotating bed)	0 VDC
P1-2	KL15	Control Module Ignition Power (from engine RUN switch)	0 VDC Open, 24 VDC Closed
P1-3	ID01	Drum 1 Flange Encoder and Minimum Bail Limit Switch	0 VDC Open, 24 VDC Closed
P1-4	ID02	Drum 2 Minimum Bail Limit Switch	0 VDC Open, 24 VDC Closed
P1-5	OPH6A18	Drum 3 Valve A	
P1-6	OPH6A19	Drum 3 Valve B	
P1-7	OPH6A20	A/C Condenser	0 or 24 VDC
P1-8	OPH6A21	High Pressure Acc Enable	
P1-11	8C23 (+UB)	Battery Power for Control Module Outputs (from CB23)	24 VDC
P1-12	8C24 (+UE)	Control Module Battery Power (from K5)	24 VDC
P1-13	ID03	Drum 1 Flange Encoder and Minimum Bail Limit Switch	0 VDC Open, 24 VDC Closed
P1-15	ID05	Boom Up Limit	
P1-16	ID06	Block Up Limits (all)	0 VDC Open, 24 VDC Closed
P1-17	IDF15	Drum 1 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 VDC
P1-20	8C36 (+UB)	Battery Power for Control Module Outputs (from CB23)	24 VDC
P1-26	IDF16	Drum 1 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 VDC
P2-3	ID14	Boom Up Limit	
P2-4	IACV18	Drum 2 Motor PSI	4 to 20 mA
P2-5	ODH3A02	Drum 2 and 3 Motor PSI	0 VDC Off, 24 VDC On
P2-6	ODH3A04	Alarm Switch Swing and Travel Limit	0 VDC Off, 24 VDC On
P2-7	ODH3A07	Pump 1 and Pump 2 Pressure	
P2-10	OPH3A15	25VDC Drum 2 Sensors	
P2-11	8C24 (+UB)	Battery Power for Control Module Outputs (from CB24)	24 VDC
P2-13	IACV19	Swing Left PSI	4 to 20 mA
P2-14	IACV20	Swing Right PSI	4 to 20 mA
P2-15	ODH3A01	Drum 1 Minimum Bail PSI, Drum 1 Motor Speed	24 VDC
P2-16	ODH3A06	Boom Angle Sensor	24 VDC
P2-17	OPH3A09	28VDC Power to Boom	
P2-18	OPH3A14	Drum 1 Motor Control	0 to 24 VDC
P2-20	8C23 (+UB)	Battery Power for Control Module Outputs (from CB24)	24 VDC
P2-22	IACV21	Pump 1 Pressure	
P2-23	IACV22	Pump 2 Pressure	
P2-24	OPH3A03	28VDC Power Luffing Jib Up Limit	
P2-25	ODH3A05	Alarm	0 VDC Off, 24 VDC On
P2-26	ODH3A08	Boom Up Limit	
P2-27	ODH3A11	Load Link	
P2-28	ODH3A13	Left and Right Swing PSI	0 VDC Off, 24 VDC On
P2-29	OPH3A16	Drum 3 Motor Control	0 to 24 VDC

Table 3-11. IOLC32 Test Voltages

Pin	Net	Function	Voltages
P1-1	GND	Ground at Remote Battery Negative Terminal	0VDC
P1-2	KL15	Control Module Ignition Power (from engine run switch)	0 VDC Open, 24 VDC Closed
P1-3	ID01	Hydraulic Filter Switch	0 VDC Open, 24 VDC Closed
P1-5	OPH6A18	Drum 1 Free Fall Proportional Solenoid Valve	0 VDC Open, 24 VDC Closed
P1-6	OPH6A19	Drum 2 Free Fall Proportional Solenoid Valve	0 VDC Open, 24 VDC Closed
P1-7	OPH6A20	Open Loop Pump A Control	0 or 24 VDC
P1-8	OPH6A21	Open Loop Pump B Control	0 or 24 VDC
P1-10	CAN_C-H	CAN Bus C - High	N/A
P1-11	8C25 (+UB)	Battery Power for Control Module Outputs (from CB25)	24VDC
P1-12	6C1A (+UE)	Control Module Battery Power (from K5)	24VDC
P1-13	ID03	Hydraulic Vacuum Switch Open Loop Pump A	2 to 20 mA
P1-14	ID04	Hydraulic Vacuum Switch Open Loop Pump B	2 to 20 mA
P1-15	ID05	Hydraulic Level Switch	0 VDC Open, 24 VDC Closed
P1-17	IDF15	Drum 2 Free Fall Encoder (EU)	
P1-19	CAN_C-L	CAN Bus C - Low	N/A
P1-20	8C25 (+UB)	Battery Power for Control Module Outputs (from CB25)	24VDC
P1-21	ID07	Remote Control Gantry Cylinder Boom Hoist Sync Switch	
P1-22	ID08	Remote Control E-Stop Switch	
P1-23	ID09	Remote Control Counterweight Pins Disengage Switch	
P1-24	ID10	Remote Control Gantry Cylinder Extend Switch	
P1-25	ID11	Remote Control Gantry Cylinder Retract Switch	
P1-26	IDF16	Drum 2 Free Fall Encoder (EU)	
P1-27	IACV17	Remote Control Drum 4 Pay Out/Haul In Switch	
P2-1	ID12	Freon Switch	0 VDC Open, 24 VDC Closed
P2-4	IACV18	ATB Diag	
P2-5	ODH3A09	Camera Light	
P2-6	ODH3A04	Free Fall System Enable Solenoid	0 VDC Off, 24 VDC On
P2-7	ODH3A07	Swing Encoder	0 or 24 VDC
P2-8	ODH3A10	ECM Key Switch	
P2-9	ODH3A12	Freon Switch	
P2-10	OPH3A15	Swing Pump A Control	0 or 24 VDC
P2-11	8C26 (+UB)	Battery Power for Control Module Outputs (from CB26)	24VDC
P2-12	OS85H	Remote Control Power Switch	
P2-13	IACV19	Drum 1 Free Fall Brake Hydraulic PSI	4 to 20 mA
P2-14	IACV20	Drum 2 Free Fall Brake Hydraulic PSI	4 to 20 mA
P2-15	ODH3A01	Alarm: Hydraulic Level, Filter and Vacuum	0 VDC Open, 24 VDC Closed
P2-17	ODH3A09	Camera Lights	
P2-16	ODH3A06	Remote Control Power Switch	
P2-18	OPH3A14	Swing Pump B Control	0 or 24 VDC
P2-19	OPH3A17	Fan Pump Control	0 or 24 VDC
P2-20	8C26 (+UB)	Battery Power for Control Module Outputs (from CB26)	24VDC

Pin	Net	Function	Voltages
P2-21	OS85L	Remote Control Drum 4 Pay Out/Haul In Switch	?
P2-25	ODH3A05	A/C Compressor	0 VDC Off, 24 VDC On
P2-23	IAVC22	Hydraulic Fluid Temperature Sender	4 to 20VDC
P2-24	ODH3A03	Drum 1 and 2 Free Fall Brake Hydraulic PSI	4 to 20VDC
P2-27	ODH3A11	Starter Motor Relay	0 VDC Off, 24 VDC On

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## INSPECT ELECTRICAL COMPONENTS



### DANGER

#### Electric Shock Hazard!

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

### Every Month or 200 Hours

1. Visually inspect all electrical harnesses and cables 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, or flattened harnesses or cables
  - Blistered, soft, or 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 for repair or replacement.

2. 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 boxes
  - Loose junction box mounting hardware

If any of these conditions exist, address them appropriately.

### Degradation Due to Severe Environment

Table 3-12. Climate Zone Classification

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

#### Zones A and B

Replace harnesses and battery cables operating in these climate zones after 8,000 hours of service life. Their electrical service life is reduced by 25% to 40%.

#### Zone C

Replace harnesses and battery cables operating in this climate zone after 10,000 hours of service life.

#### Zones D and E

Cold temperatures will negatively impact service life. Regularly inspect electrical harnesses and cable assemblies per [step 1](#).

#### Salt Environment

Harness and cable assemblies operating in salt water climates could see a significant reduction in service life. Regularly inspect electrical harnesses and cable assemblies per [step 1](#).

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# SECTION 4 BOOM

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## SECTION 4 BOOM

### GENERAL MAINTENANCE

This section contains maintenance and adjustment instructions for the limit devices used with the boom.

For maintenance and inspection of the following components, see Section 5 of this manual:

- Wire rope
- Load block and weight ball
- Boom and jib

### ROTATING BED LEVEL SENSOR

See [Figure 4-1](#).

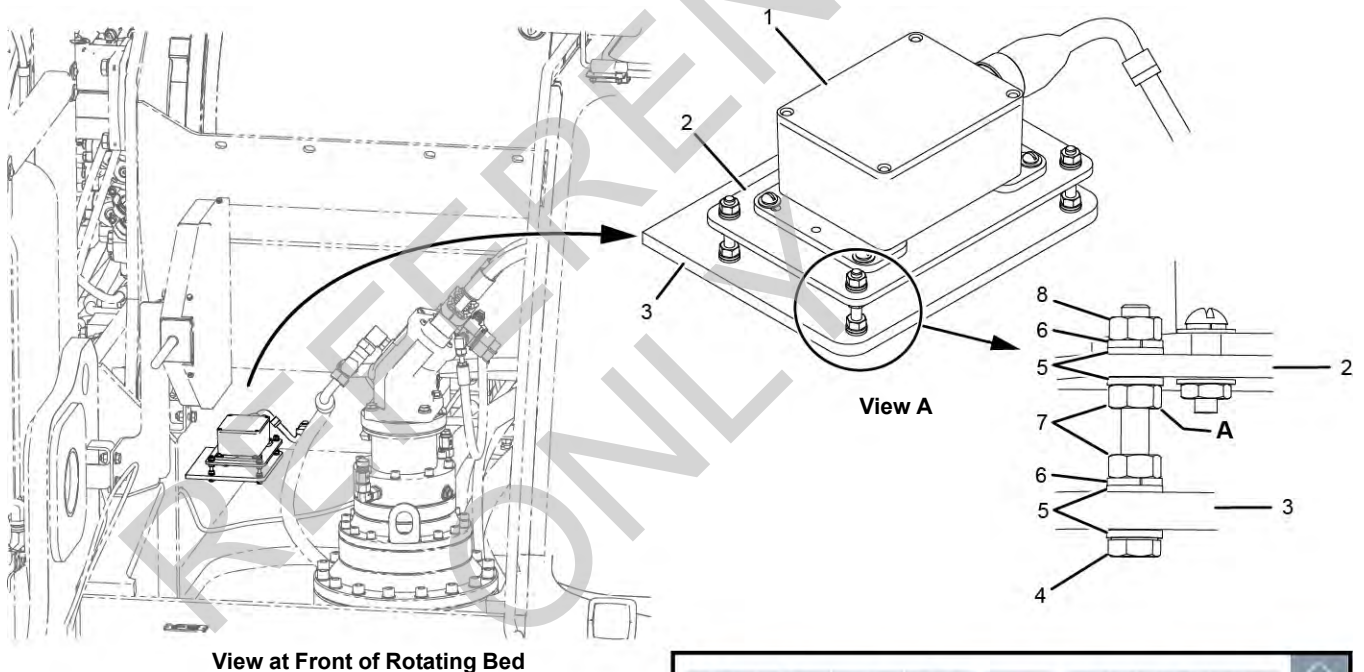
The rotating bed level sensor (1) measures the angle of the rotating bed and communicates the information to the

crane's control system through the IOLC30 control module.

The angles are viewable in the Crane Status Bar of the Main Display Working Screen (View B).

To adjust the level sensor:

1. Move the crane onto a level surface.
2. Using a smart level, measure the crane's roll and pitch at the turntable bearing.
3. Securely fasten the level sensor (1) and the mounting plate (2) to the bracket (3) with the screws, nuts, and washers.
4. Loosen the nuts (8) and adjust nuts (7) at location **A** so the roll and pitch shown in the main display match the roll and pitch measured with the smart level.
5. Securely tighten the nuts (8).



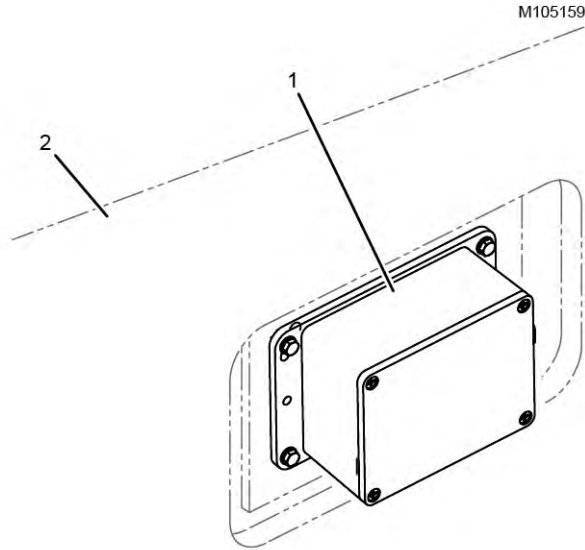
Item	Description
1	Level Sensor with Screws, Nuts, and Flat Washers
2	Mounting Plate
3	Bracket with Cap Screws and Lock Washers
4	Cap Screw (Qty 4)
5	Flat Washer (Qty 16)
6	Lock Washer (Qty 8)
7	Nut (Qty 8)
8	Nut (Qty 4)
9	Crane Roll Indicator
10	Crane Pitch Indicator
11	Crane Bubble Level Indicator



FIGURE 4-1

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### BOOM ANGLE INDICATOR

An boom angle sensor (Figure 4-2) is located on the right inboard side the boom butt.

The sensor measures the angle of the boom and communicates the information to the crane's control system through the CCM-S-10 control module.

The boom angle appears in the various screens of the RCL/RCI Display.

For sensor installation and calibration instructions, refer to the Performing Boom Calibration topic in the RCL/RCI Operation Manual supplied with the crane.

4

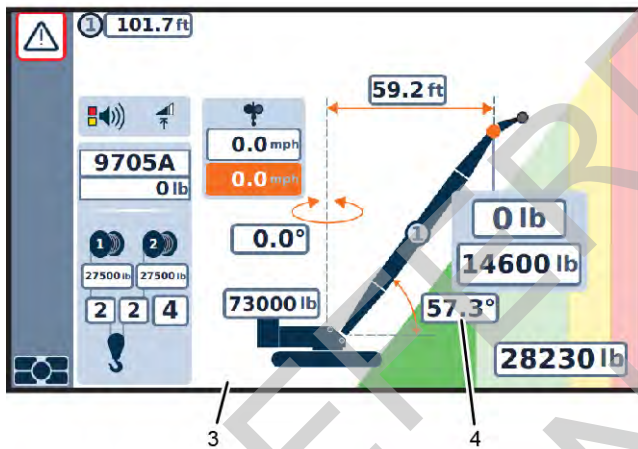
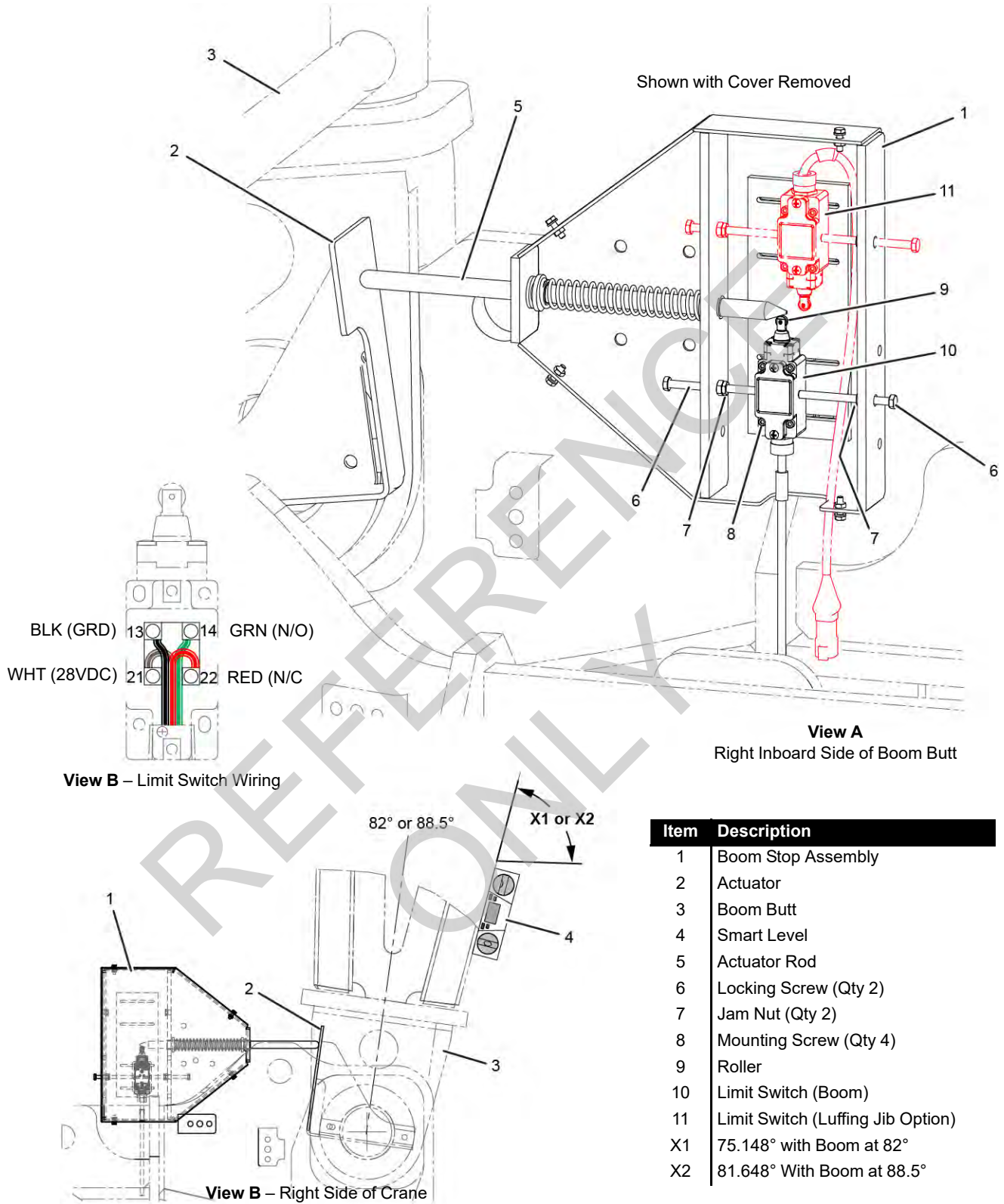


FIGURE 4-2

Item	Description
1	Angle Sensor
2	Boom Butt
3	RCL/RCI Working Screen
4	Boom Angle



M105160-1

FIGURE 4-3



## AUTOMATIC BOOM STOP ASSEMBLY

See [Figure 4-3](#).

The automatic boom stop assembly (1, View A and C) is mounted on the right-front inboard side of the rotating bed.

The assembly consists of one or two limit switches (10 and 11, View A) depending on how the crane is equipped. The limit switches stop the boom at the following maximum angles:

- Limit switch (10): 82° for Boom only or Boom with Fixed Jib
- Limit switch (11): 88.5° for Boom with Luffing Jib

***The limit switch angles are greater than the maximum Capacity Chart angles in order to reach to the minimum chart radii with load on the hook and the boom deflected.***

When the boom is below the maximum angle, the corresponding limit switch is closed, providing a continuous 28 VDC signal to the crane's control system.

When the boom is raised to the maximum angle, the actuator (2, View A) depresses the actuator rod (5) and the actuator rod trips the corresponding limit switch open. Voltage drops to 0 VDC, signaling the crane's control system to stop the boom hoist and apply its brake.

When the maximum boom angle is reached, the fault alarm comes on and the boom maximum up icon appears in the Alerts Bar of the Main Display Working Screen.



To correct the fault once it is activated, lower the boom. The fault cannot be bypassed.

### Automatic Boom Stop Maintenance

At least once a week, check that the automatic boom stop stops the boom at corresponding angle: 82° or 88.5 depending on how the crane is equipped. If it doesn't, replace any worn or damaged parts and/or adjust the automatic boom stop.



#### WARNING

##### Falling Attachment Hazard!

Do not operate the crane unless the automatic boom stop limit switches are properly adjusted and operational. Do not adjust the maximum operating angle higher than specified. The boom could be pulled over backward or collapse, causing death or serious injury.

### Automatic Boom Stop Adjustment — without Luffing Jib

The limit switch (10) for the automatic boom stop with boom

only or boom with fixed jib was set at the factory and should not require periodic adjustment. Adjustment is necessary when:

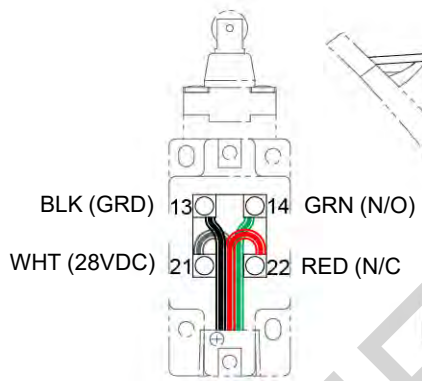
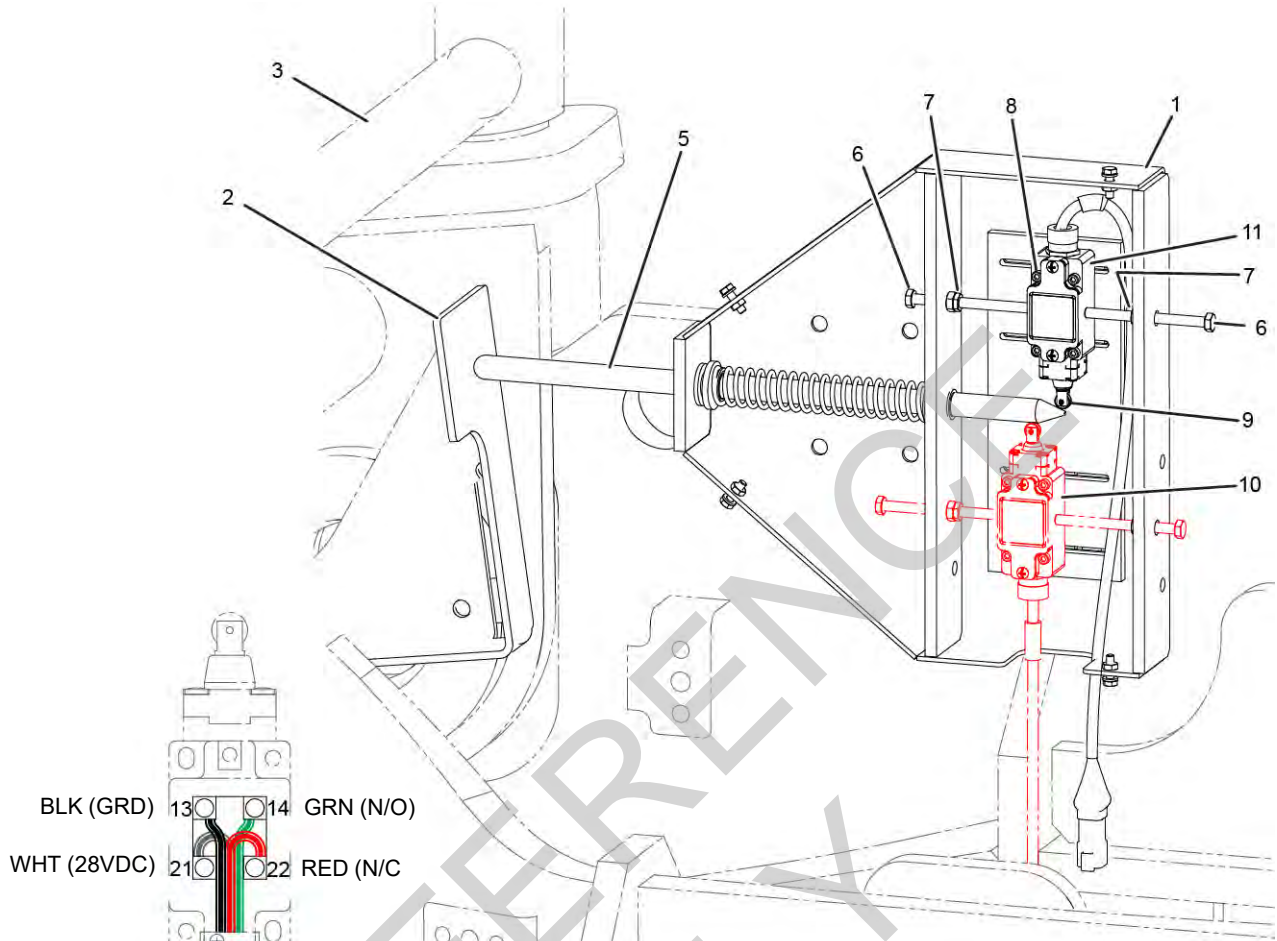
- Parts are replaced
- The wrong angle is displayed in the RCL/RCI

The following instructions assume that the RCL/RCI is installed and properly calibrated.

During the following procedure, the boom angle is monitored on the Working Screen of the RCL/RCI Display ([Figure 4-2 on page 4-3](#)) and on a smart level (4, View B, [Figure 4-3](#)).

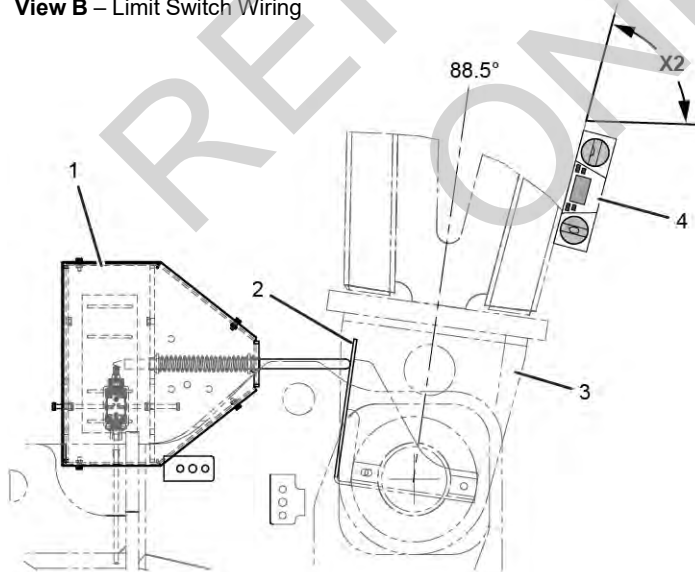
Unless other wise indicated refer to View A, [Figure 4-3](#) for the following procedure.

1. Park the crane on a firm level surface or level the crane by blocking under the crawlers.
2. Slowly raise the boom while monitoring the boom angle on the RCL/RCI working screen.
3. The boom must stop at 82°.
4. If the boom does not stop at the specified angle, proceed as follows:
  - a. Remove the cover from the boom stop assembly.
  - b. Lower the boom to approximately 80°.
  - c. Loosen the jam nuts (7), the adjusting screws (6), and the mounting screws (8).
  - d. Slide the limit switch (10) rearward approximately 52,4 mm (1 in).
  - e. Raise the boom to 82° and verify the boom angle with an accurate smart level (4, View B) placed on the boom butt bottom chord. The smart level angle should read angle X1.
  - f. Slide the limit switch (10) forward in the mounting slots until the roller (9) is contacting the sloped edge of the actuator rod (5).
  - g. Turn the rear adjusting screw (6) clockwise to move the limit switch forward in the mounting slots **only enough to click the limit switch open and stop**.
  - h. Securely tighten the mounting screws (8), both adjusting screws (6) against the limit switch (10), and the jam nuts (7).
  - i. Boom down and then boom back up. The boom must stop at the 82° maximum boom angle.
  - j. If necessary, loosen the jam nuts (7) and mounting screws (8) and fine tune the adjustment using the adjusting screws (6).
  - k. When done, securely tighten the mounting screws (8), both adjusting screws (6) against the limit switch (10), and the jam nuts (7).
  - l. Reinstall the cover on the boom stop assembly.



View B – Limit Switch Wiring

View A  
Right Inboard Side of Boom Butt



M105160-2

View B – Right Side of Crane

Item	Description
1	Boom Stop Assembly
2	Actuator
3	Boom Butt
4	Smart Level
5	Actuator Rod
6	Locking Screw (Qty 2)
7	Jam Nut (Qty 2)
8	Mounting Screw (Qty 4)
9	Roller
10	Limit Switch (Boom only)
11	Limit Switch (Luffing Jib Option)
X2	81.648° With Boom at 88.5°

FIGURE 4-4

## Automatic Boom Stop Adjustment — with Luffing Jib

Unless otherwise indicated, refer to View A, [Figure 4-4](#) for the following procedure.

The limit switch (10) is disabled by the control system when the RCL/RCI is configured for boom with luffing jib.

The limit switch (11) for the automatic boom stop with boom and luffing jib was set at the factory and should not require periodic adjustment. Adjustment is necessary when:

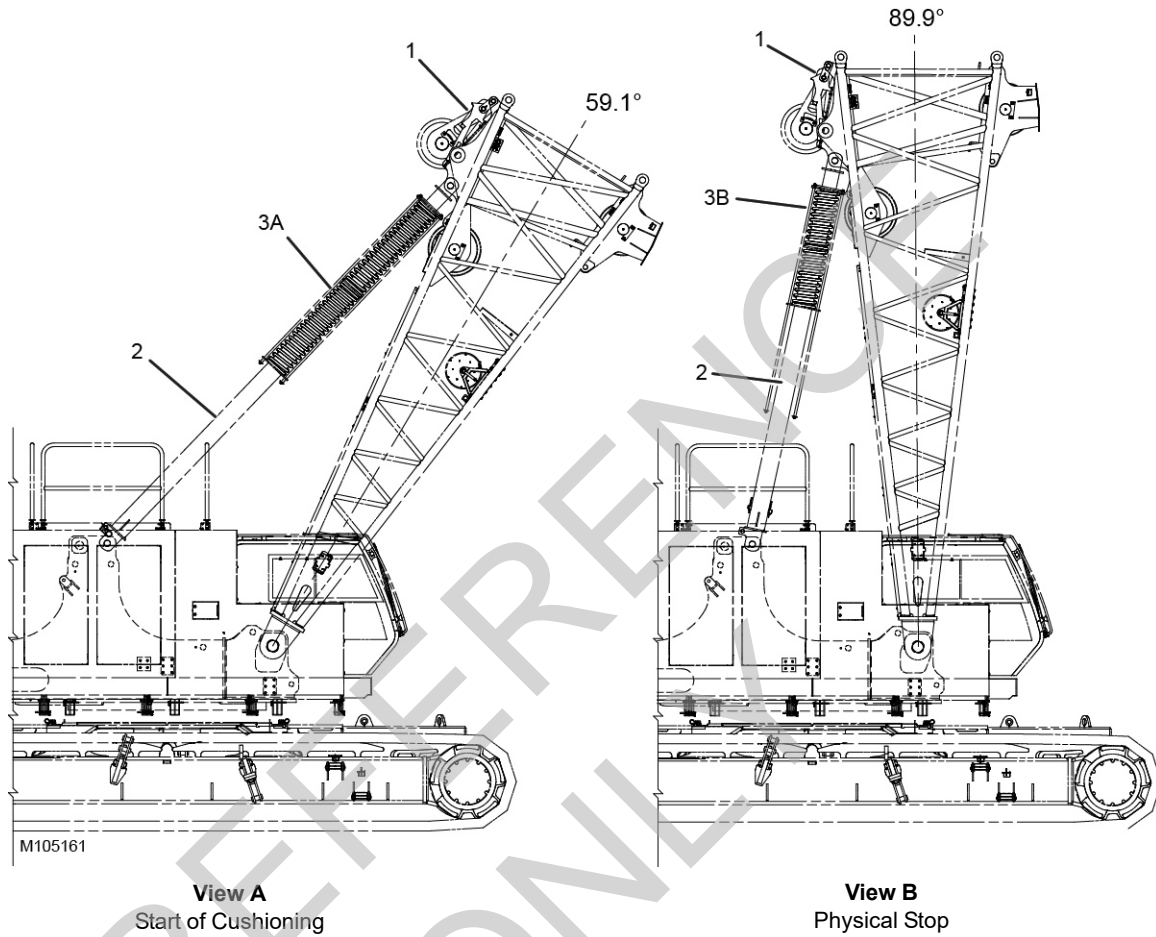
- Parts are replaced
- The wrong angle is displayed in the RCL/RCI

The following instructions assume that the RCL/RCI is installed and properly calibrated.

During the following procedure, the boom angle is monitored on the Working Screen of the RCL/RCI Display ([Figure 4-2 on page 4-3](#)) and on a smart level (4, View B, [Figure 4-4](#)).

1. Park the crane on a firm level surface or level the crane by blocking under the crawlers.
2. Slowly raise the boom while monitoring the boom angle on the RCL/RCI working screen.
3. The boom must stop at 88.5°.
4. If the boom does not stop at the specified angle, proceed as follows:
  - a. Remove the cover from the boom stop assembly.
  - b. Lower the boom to approximately 80°.
    - c. Loosen the jam nuts (7), the adjusting screws (6), and the mounting screws (8).
    - d. Slide the limit switch (11) rearward approximately 52,4 mm (1 in).
    - e. Raise the boom to 88.5° and verify the boom angle with an accurate smart level (4, View B) placed on the boom butt bottom chord. The smart level angle should read angle **X2**.
    - f. Slide the limit switch (11) forward in the mounting slots until the roller (9) is contacting the sloped edge of the actuator rod (5).
    - g. Turn the rear adjusting screw (6) clockwise to move the limit switch forward in the mounting slots **only enough to click the limit switch open and stop**.
    - h. Securely tighten the mounting screws (8), both adjusting screws (6) against the limit switch (11), and the jam nuts (7).
      - i. Boom down and then boom back up. The boom must stop at the 88.5° maximum boom angle.
      - j. If necessary, loosen the jam nuts (7) and the mounting screws (8) and fine tune the adjustment using the adjusting screws (6).
      - k. When done, securely tighten the mounting screws (8), both adjusting screws (6) against the limit switch (11), and the jam nuts (7).
        - l. Reinstall the cover on the boom stop assembly.

REFER ONLY



Item	Description
1	Boom Butt
2	Physical Boom Stop (2)
3A	Springs (fully relaxed)
3B	Springs (fully compressed)

FIGURE 4-5

## PHYSICAL BOOM STOP

See [Figure 4-5](#)



### WARNING

#### Collapsing Boom Hazard!

Physical boom stops must be installed for all crane operations.

Physical boom stops do not automatically stop boom at maximum operating angle.

Automatic boom stop must be installed and properly adjusted.

---

### Physical Boom Stop Angles

Physical boom stops (2) serve the following purposes:

- Assist in stopping the boom smoothly at any angle above 59.1°
- Assist in preventing the boom rigging from pulling the boom back when traveling or setting loads with the boom at any angle above 59.1°
- Assist in moving the boom forward when lowering the boom from any angle above 59.1°
- Provide a physical stop at 89.9°

### Physical Boom Stop Operation

- When the boom is raised to 59.1°, the springs start to compress (View A).
- As the boom is raised higher, spring compression increases to exert greater force against the boom.
- If for any reason the boom is raised to 89.9°, the springs fully compress to provide a physical stop (View B).

### Physical Boom Stop Adjustment

The physical boom stops do not require adjustment.

## LATTICE SECTION INSPECTION AND LACING REPLACEMENT

Refer to Folio 1316 at the end of this section for lattice section inspection and lacing replacement instructions.

## BOOM ELECTRICAL DIAGRAM

A detailed electrical schematic is provided at the end of Section 3 in this Service Manual.

REFERENCE ONLY

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## SECTION 5 HOISTS

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## SECTION 5 HOISTS

### GENERAL

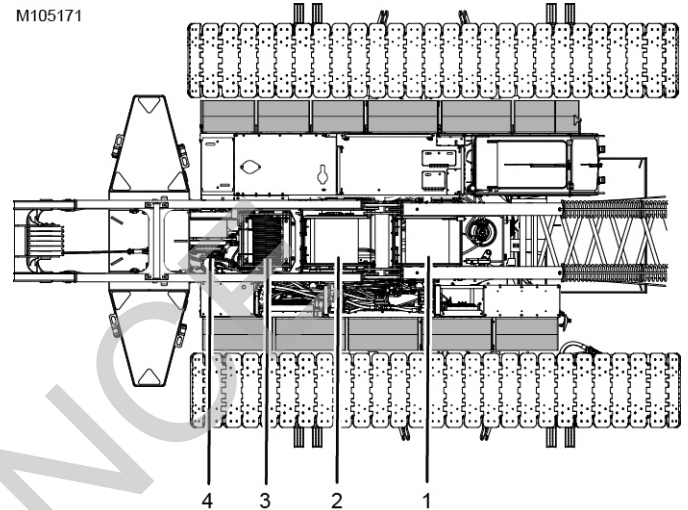
This section contains maintenance and adjustment procedures for the hoists, wire rope, and rigging.

Additional component information for the Hoist Systems can be found in the following sections of this Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

### DRUM IDENTIFICATION

See [Figure 5-1](#).



Drum	Description
1	Front Drum (main hoist)
2	Rear Drum (whip or luffing hoist)
3	Auxiliary Drum (optional)
4	Boom Hoist

FIGURE 5-1

REFERENCE ONLY

**NOTE:** In the following instructions, **CCS** stands for **Crane Control System**.

## ALL DRUMS

See [Figure 5-2](#) through [Figure 5-9](#).

### Seat Switch

The operator must be seated to close the seat switch before the drums can be operated.

The CCS disables the drum control handles and prevents the drum brakes from being released (spring applied) until the seat switch is closed.

### Drum Brake

Each drum is equipped with a spring-applied, hydraulically-released disc brake located between the motor and the drum gear box. The brakes are controlled by 2-position solenoid valves that receive oil flow from the pilot pump.

The un-parked switch for the desired drum must be pressed before the drum can be operated.

The CCS disables the drum control handle and prevents the drum brake from being released (spring applied) or the pawl from being disengaged (Drums 2 and 4) until the un-parked switch is closed.

The point at which a drum brake releases or applies in response to control handle movement is determined by the CCS. When the control handle is moved off center, a signal is sent to the brake solenoid. The solenoid then opens a hydraulic valve to allow pressure to release the brake. When the control handle is moved back to center and the controller sees zero pressure for a set amount of time, the brake applies.

### Brake Release

All load hoists utilize a pressure memory routine to control drum brake release in order to provide smooth brake release without any load droop. The CCS remembers the load-induced pressure from the last hoist cycle and operates the pump and control valve such that the pressure in on the raising side of the hoist is increased to nearly this stored value before releasing the drum brake and starting drum movement.

### Speed Sensor

When a drum motor rotates, a sensor mounted on the motor sends an input voltage to the designated controller. The controller in turn sends corresponding voltage pulses to the rotation indicator (thumper solenoid) in the drum control handle. The rotation indicator pulsates with a varying frequency to indicate drum rotational speed. The direction of rotation is also displayed on the main display via an arrow on the corresponding drum icon.

## DRUMS 1 AND 2

See [Figure 5-2](#) through [Figure 5-5](#).

### Overview

The hydraulic circuit for each drum consist of an open loop pump which contains a 130 cc rotary group, an electrically operated directional control valve, and a 171,8 cc variable displacement motor with holding valve and internal relief valve.

The control signals to these hydraulic elements are determined by the CCS, which uses a number of inputs to determine speed, direction, and brake release commands.

### Drum 2 Pawl

The Drum 2 pawl is controlled by a 3-position solenoid valve that receives oil flow from the pilot pump.

When the Drum 2 park switch is in the parked position, the CCS shifts the pawl valve to the position that extends the pawl cylinder (rotates cam away from pawl), allowing the pawl to spring engage the drum ratchet.

When the Drum 2 park switch is in the un-parked position, the CCS shifts the pawl valve to the position that retracts the pawl cylinder, allowing the cam to disengage the pawl from the drum ratchet.

### Holding Valve

A holding valve is attached to each motor. The purpose of the valve is to:

- Ensure that the hoist powers down properly
- Hold the load when the control handle is in center
- Ensure smooth starts, stops, and changes in hoist speed
- Relieve momentary excess pressure that may occur when bringing a heavy load to a quick stop.

The valve functions differently in each direction:

#### Lowering Load

When flow is in the **down** direction, the holding valve functions as a hydraulically operated proportional spool valve which checks motor outflow in one position and in the other position allows motor outflow.

When there is no working pressure (handle in center), a check valve stops hydraulic flow in the return side of the **down** circuit. This prevents the hoist motor from turning in the **down** direction.

As the control handle is moved off center in the **down** direction, the working pressure begins to act on the valve, which begins to shift to the unchecked position to allow motor outflow. When the control handle is moved toward

center, the holding valve begins to close, slowing the load. At center, the check valve is again closed, preventing motor outflow and downward movement of the load. An orifice in the unchecked circuit prevents abruptness in starting and changes in hoist speed.

#### ***Pilot-Operated Relief Valve***

The relief valve in the motor protects the motor from excessive pressure, such as might occur when bringing a heavy load to a quick stop when lowering.

#### ***Raising Load***

When system flow is in the **up** direction, the holding valve remains in the unchecked position and has no effect on operation.

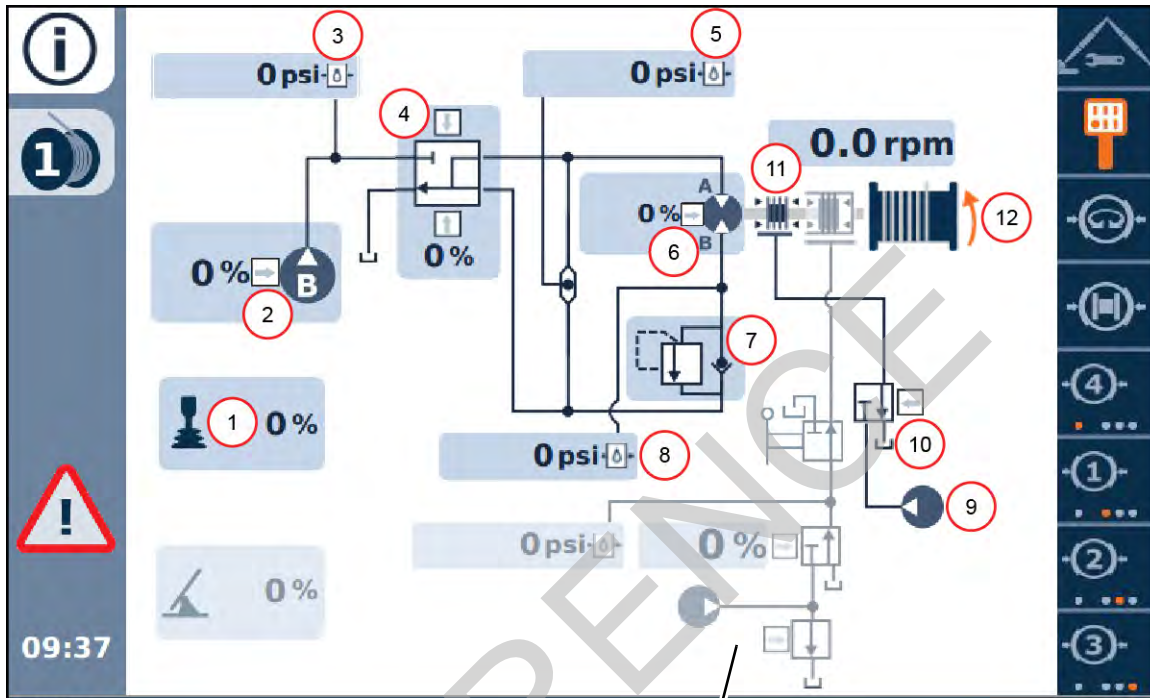
#### **Motor displacement**

Each motor contains an electronic displacement control. The motor will stay at maximum displacement until the drum begins to turn. The motor will shift towards minimum displacement in proportion to the position of the control handle. Each motor is also equipped with an electronic pressure compensator that will shift the motor back towards maximum displacement if pressure in the circuit rises above a set pressure to ensure that the drum has sufficient torque to reach full line pull in all conditions.

REFERENCE ONLY

### Drum 1 Hydraulic Diagram (without Free Fall)

A detailed hydraulic schematic is provided at the end of Section 2 in this Service Manual.



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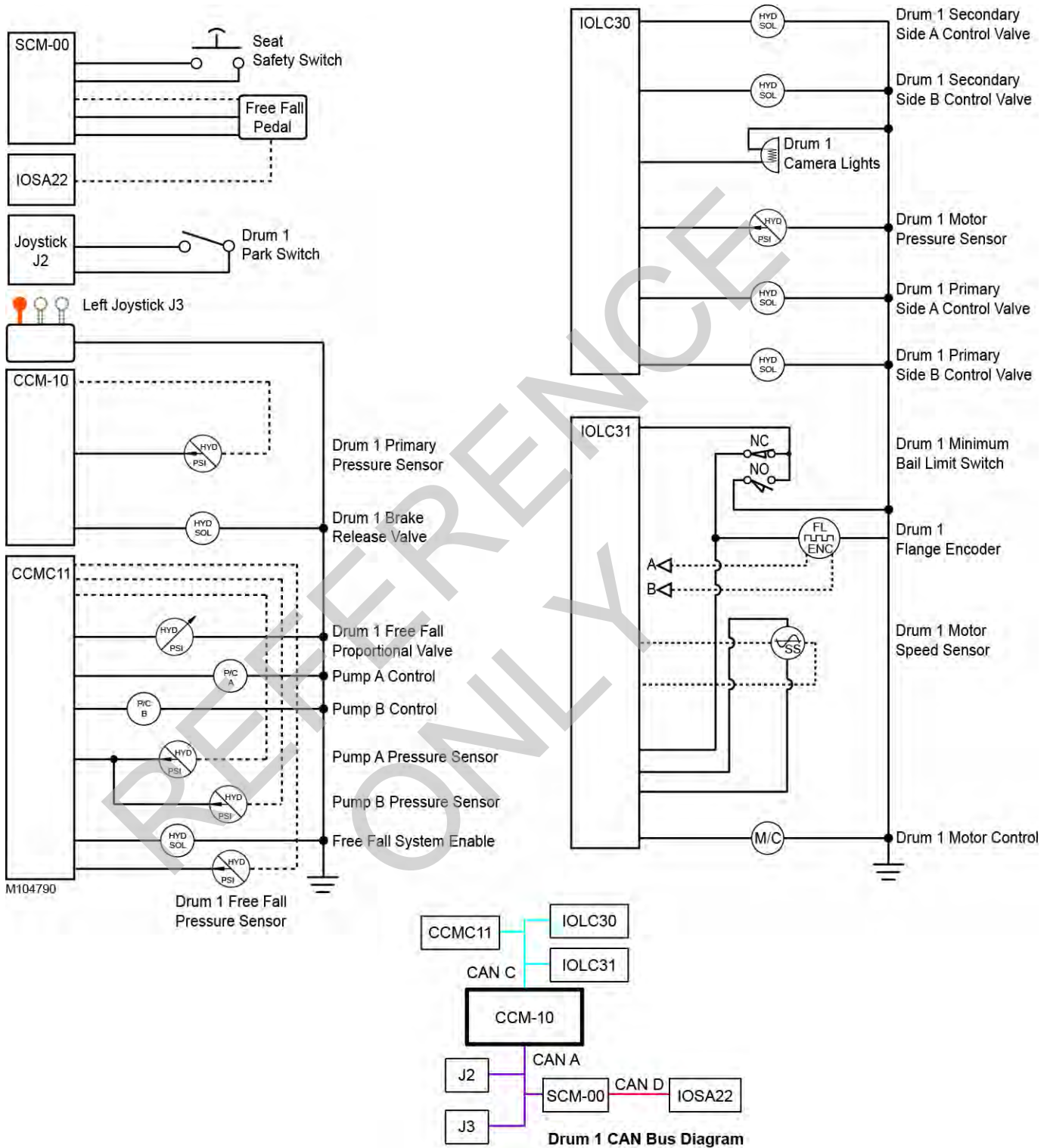
For Free Fall, see [Figure 5-10 on page 5-16](#)

Drum 1 Components			
1	Handle (command -100 to 100%: + number = raise, - number = lower)	7	Load Holding Valve
2	Open Loop B Pump (command 0 to 100%)	8	Motor Pressure Transducer
3	Open Loop B Pump Pressure Transducer	9	Pilot Pump
4	Control Valve (command -100 to 100%: + number = raise, - number = lower)	10	Brake Valve
5	System Pressure Transducer	11	Brake (motor end)
6	Motor (command: 0 = max displacement, 100% = min displacement)	12	Drum

FIGURE 5-2

### Drum 1 Electrical Diagram

A detailed electrical schematic is provided at the end of Section 3 in this Service Manual.

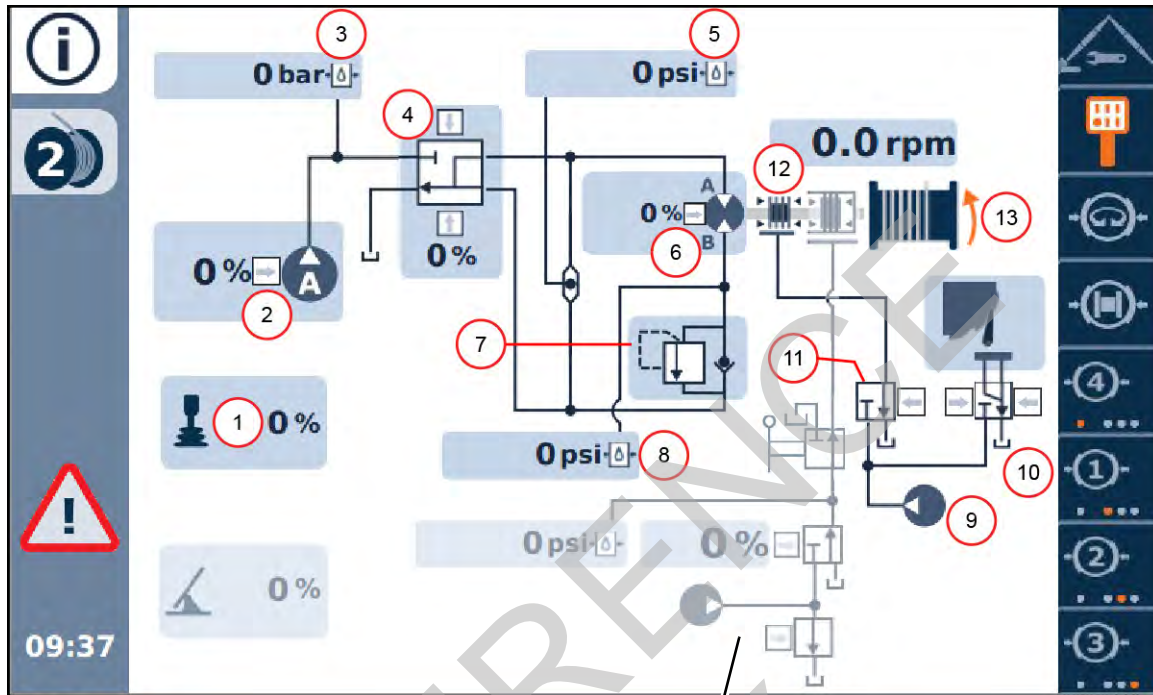


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FIGURE 5-3

### Drum 2 Hydraulic Diagram

A detailed hydraulic schematic is provided at the end of Section 2 in this Service Manual.



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For Free Fall, see [Figure 5-11 on page 5-17](#)

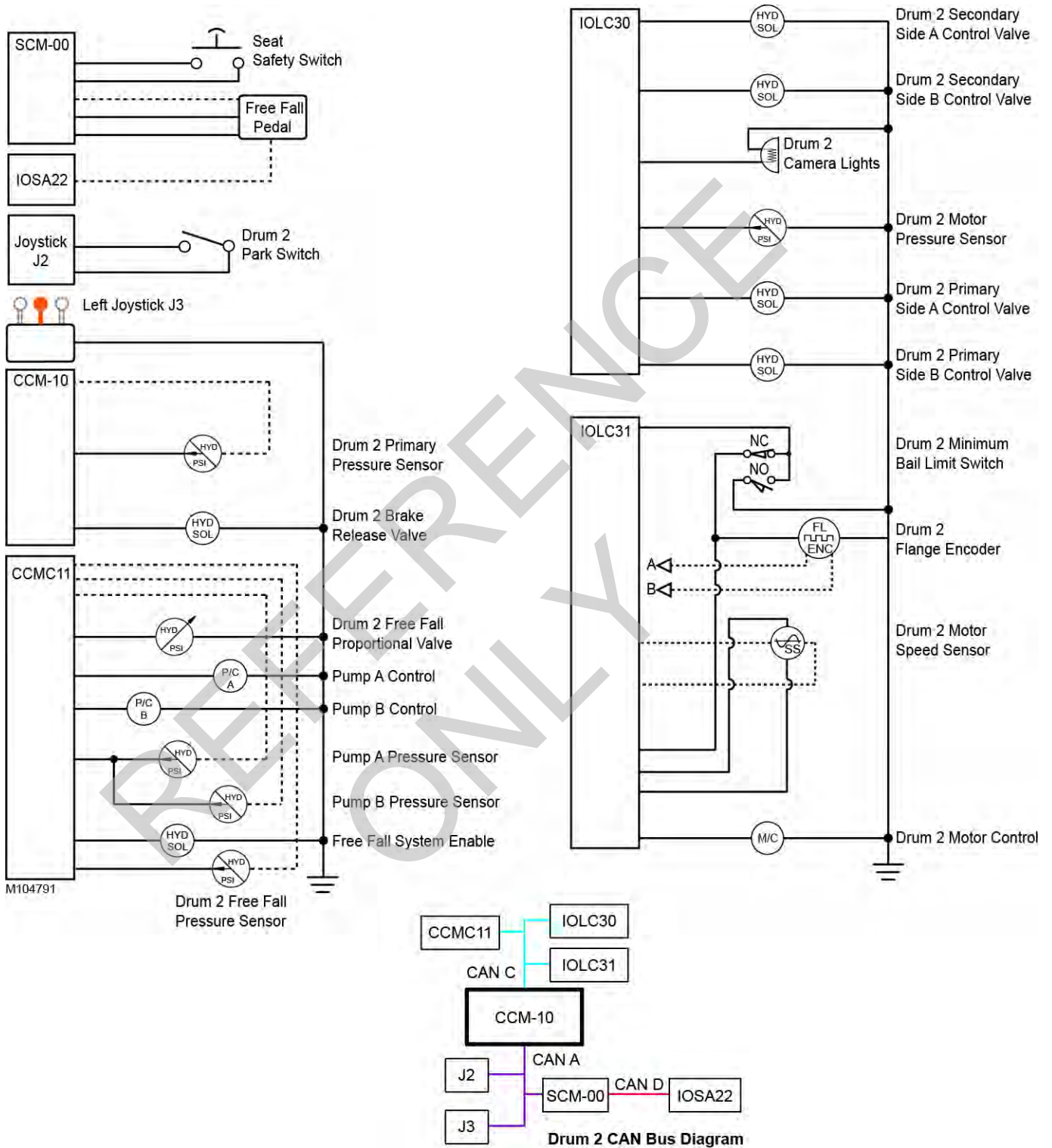
Drum 2 Components			
1	Handle (command -100 to 100%: + number = raise, - number = lower)	8	Motor Pressure Transducer
2	Open Loop A Pump (command 0 to 100%)	9	Pilot Pump
3	Open Loop A Pump Pressure Transducer	10	Pawl Valve
4	Control Valve (command -100 to 100%: + number = raise, - number = lower)	11	Brake Valve
5	System Pressure Transducer	12	Brake (motor end)
6	Motor (command: 0 = max displacement, 100% = min displacement)	13	Drum
7	Load Holding Valve		

FIGURE 5-4



### Drum 2 Electrical Diagram

A detailed electrical schematic is provided at the end of Section 3 in this Service Manual.



5

FIGURE 5-5

REFERENCE  
ONLY

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## DRUM 3

See [Figure 5-6](#) and [Figure 5-7](#).

### Overview

The hydraulic circuit for Drum 3 consist of an open loop pump which contains a 130 cc rotary group, an electrically operated directional control valve, and a 107 cc variable displacement motor with holding valve and internal relief valve.

The control signals to these hydraulic elements are determined by the CCS, which uses a number of inputs to determine speed, direction, and brake release commands.

### Holding Valve

A holding valve is attached to the motor. The purpose of the valve is to:

- Ensure that the hoist powers down properly
- Hold the load when the control handle is in center
- Ensure smooth starts, stops, and changes in hoist speed
- Relieve momentary excess pressure that may occur when bringing a heavy load to a quick stop.

The valve functions differently in each direction:

#### **Lowering load**

When flow is in the **down** direction, the holding valve functions as a hydraulically operated proportional spool valve which checks motor outflow in one position and in the other position allows motor outflow.

When there is no working pressure (handle in center), a check valve stops hydraulic flow in the return side of the **down** circuit. This prevents the hoist motor from turning in the **down** direction.

As the control handle is moved off center in the **down** direction, the working pressure begins to act on the valve, which begins to shift to the unchecked position to allow motor outflow. When the control handle is moved toward center, the holding valve begins to close, slowing the load. At center, the check valve is again closed, preventing motor outflow and downward movement of the load. An orifice in the unchecked circuit prevents abruptness in starting and changes in hoist speed.

#### **Pilot-Operated Relief Valve**

The relief valve in the motor protects the motor from excessive pressure, such as might occur when bringing a heavy load to a quick stop when lowering.

#### **Raising Load**

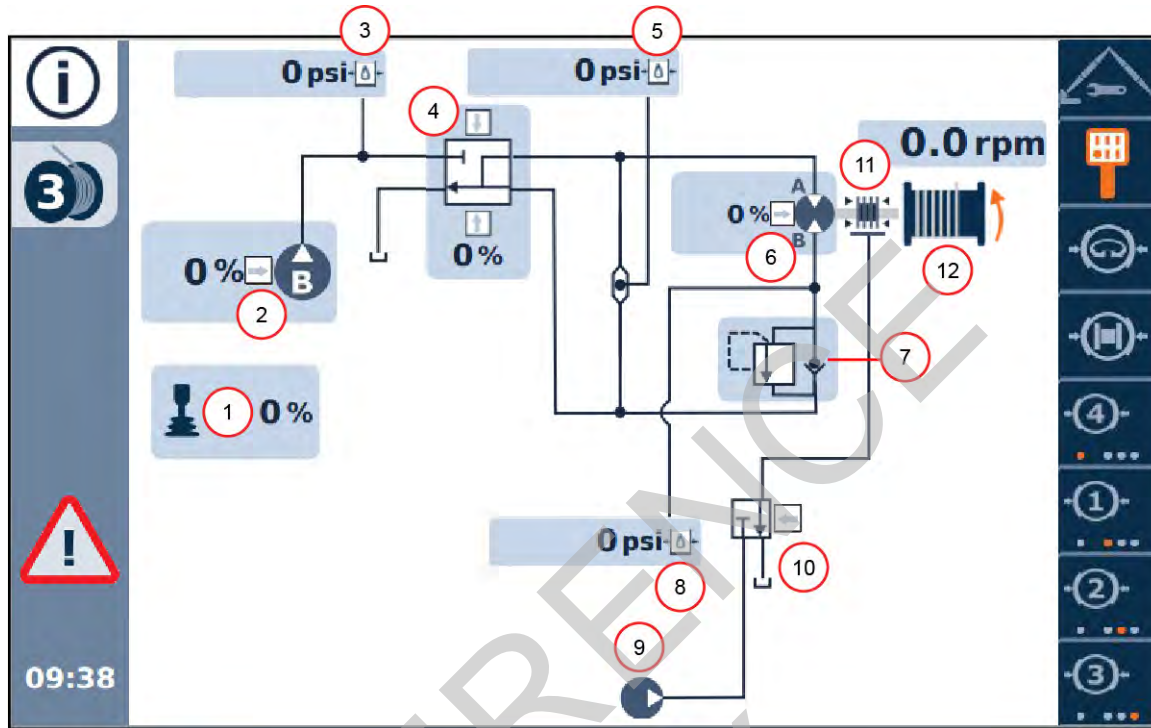
When system flow is in the **up** direction, the holding valve remains in the unchecked position and has no effect on operation.

### Motor displacement

The motor contains an electronic displacement control. The motor will stay at maximum displacement until the drum begins to turn. The motor will shift towards minimum displacement in proportion to the position of the control handle. Each motor is also equipped with an electronic pressure compensator that will shift the motor back towards maximum displacement if pressure in the circuit rises above a set pressure to ensure that the drum has sufficient torque to reach full line pull in all conditions.

### Drum 3 Hydraulic Schematic

A detailed hydraulic schematic is provided at the end of Section 2 in this Service Manual.



M105069-1

Drum 3 Components			
1	Handle (command -100 to 100%: + number = raise, - number = lower)	7	Load Holding Valve
2	Open Loop B Pump (command 0 to 100%)	8	Motor Pressure Transducer
3	Open Loop B Pump Pressure Transducer	9	Pilot Pump
4	Control Valve (command -100 to 100%: + number = raise, - number = lower)	10	Brake Valve
5	System Pressure Transducer	11	Brake
6	Motor (command: 0 = max displacement, 100% = min displacement)	12	Drum

FIGURE 5-6

### Drum 3 Electrical Diagram

A detailed electrical schematic is provided at the end of Section 3 in this Service Manual.

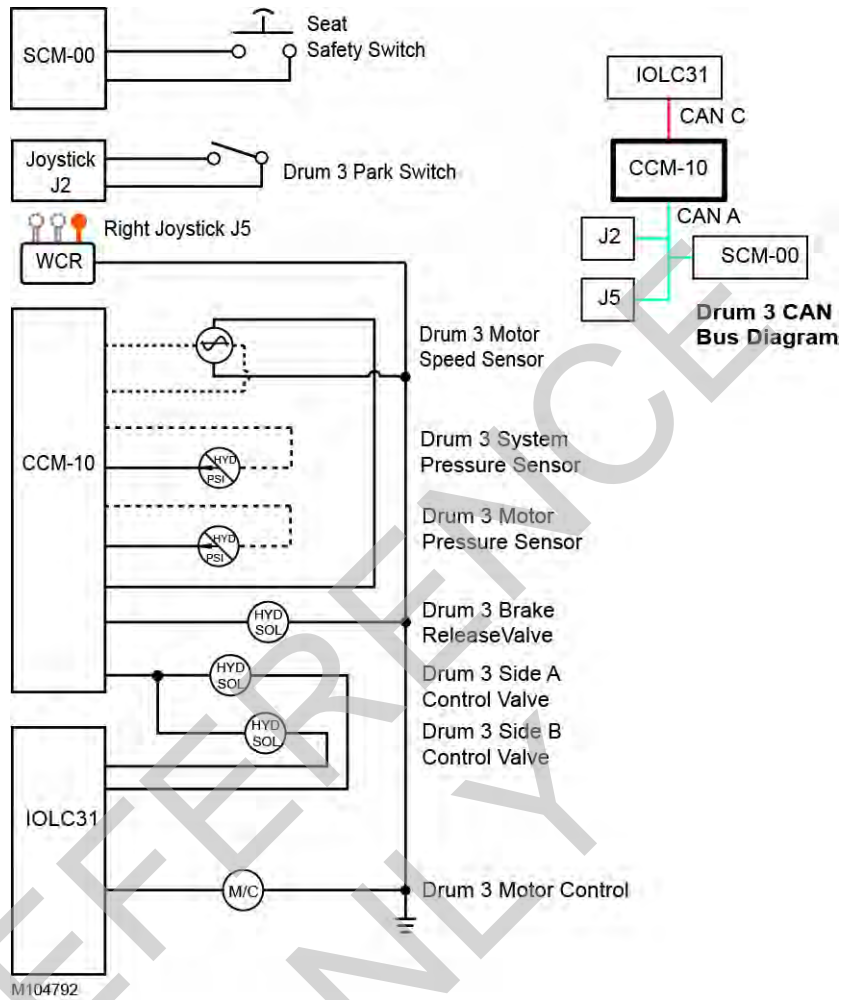


FIGURE 5-7

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## DRUM 4

See [Figure 5-8](#) and [Figure 5-9](#).

The hydraulic circuit for Drum 4 consist of an open loop pump which contains a 130 cc rotary group, an electrically-operated directional control valve, and an 107 cc fixed displacement motor with dual-sided holding valve to allow for additional charge pressure to be supplied from the pilot circuit for travel on grade. The control signals to these hydraulic elements are determined by the CCS, which uses a number of inputs and to determine speed, direction, and brake release commands.

### Drum 4 Pawl

See [Figure 5-15](#).

The Drum 4 pawl is controlled by a 3-position solenoid valve that receives oil flow from the pilot pump.

The CCS shifts the pawl valve to the position that extends the pawl cylinder (rotates cam away from pawl), allowing the pawl to spring engage the drum ratchet.

The CCS shifts the pawl valve to the position that retracts the pawl cylinder, allowing the cam to disengage the pawl from the drum ratchet.

The limit switch signals the CCS that the pawl is disengaged.

### Holding Valve

A holding valve is attached to the motor. The purpose of the valve is to:

- Ensure that the hoist powers down properly
- Hold the load when the control handle is in center
- Ensure smooth starts, stops, and changes in hoist speed
- Relieve momentary excess pressure that may occur when bringing a heavy load to a quick stop.

The valve functions differently in each direction:

### Lowering and Holding a Load

When flow is in the lowering direction, the holding valve functions as a hydraulically operated proportional spool valve which checks motor outflow in one position and in the other position allows motor outflow.

When there is no working pressure (handle in center), a check valve halts hydraulic flow in the return side of the **down** circuit. This prevents the hoist motor from turning in the **down** direction. As the control handle is moved off center in the **down** direction, the working pressure begins to act on the valve, which begins to shift to the lowering unchecked position to allow motor outflow.

When the control handle is moved toward center, the holding valve begins to close, slowing the load. At center, the check valve is again closed, preventing motor outflow and downward movement of the load. An orifice in the circuit prevents abruptness in starting and changes in hoist speed.

### Pilot-Operated Relief Valve

The relief valve in the motor protects the motor from excessive pressure, such as might occur when bringing a heavy load to a quick stop when lowering.

### Raising a Load

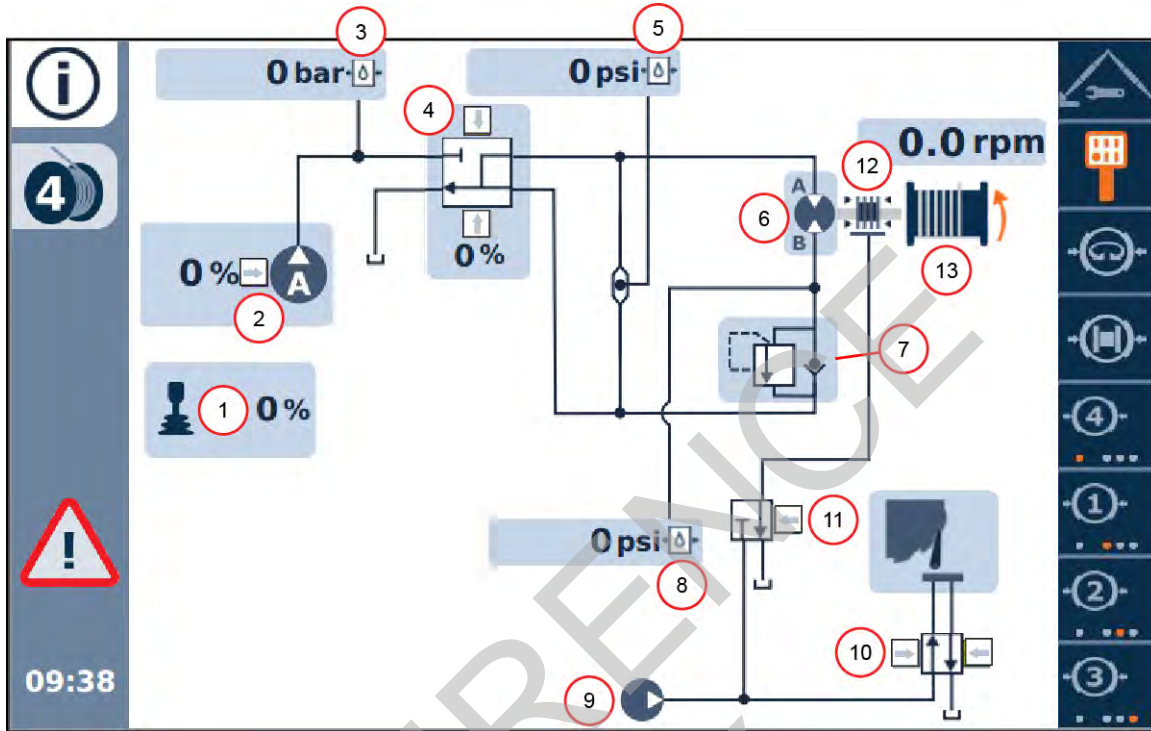
When system flow is in the raising direction, the holding valve functions as a hydraulically operated proportional spool valve which checks motor outflow in one position and in the other position allows motor outflow.

When there is no working pressure (handle in center), a check valve halts hydraulic flow in the return side of the **down** circuit. This prevents the hoist motor from turning in the **down** direction. As the control handle is moved off center in the **up** direction, the working pressure begins to act on the valve, which begins to shift to the raising unchecked position to allow motor outflow. When the control handle is moved toward center, the holding valve begins to close, slowing the load. At center, the check valve is again closed, preventing motor outflow and downward movement of the load.

An orifice in the circuit prevents abruptness in starting and changes in hoist speed.

### Drum 4 Hydraulic Diagram

A detailed hydraulic schematic is provided at the end of Section 2 in this Service Manual.



M105070-1

Drum 4 Components			
1	Handle (command -100 to 100%: + number = raise, - number = lower)	8	Motor Pressure Transducer
2	Open Loop A Pump (command 0 to 100%)	9	Pilot Pump
3	Open Loop A Pump Pressure Transducer	10	Pawl Valve
4	Control Valve (command -100 to 100%: + number = raise, - number = lower)	11	Brake Valve
5	System Pressure Transducer	12	Brake
6	Motor (command: 0 = max displacement, 100% = min displacement)	13	Drum
7	Load Holding Valve		

FIGURE 5-8



### Drum 4 Electrical Diagram

A detailed electrical schematic is provided at the end of Section 3 in this Service Manual.

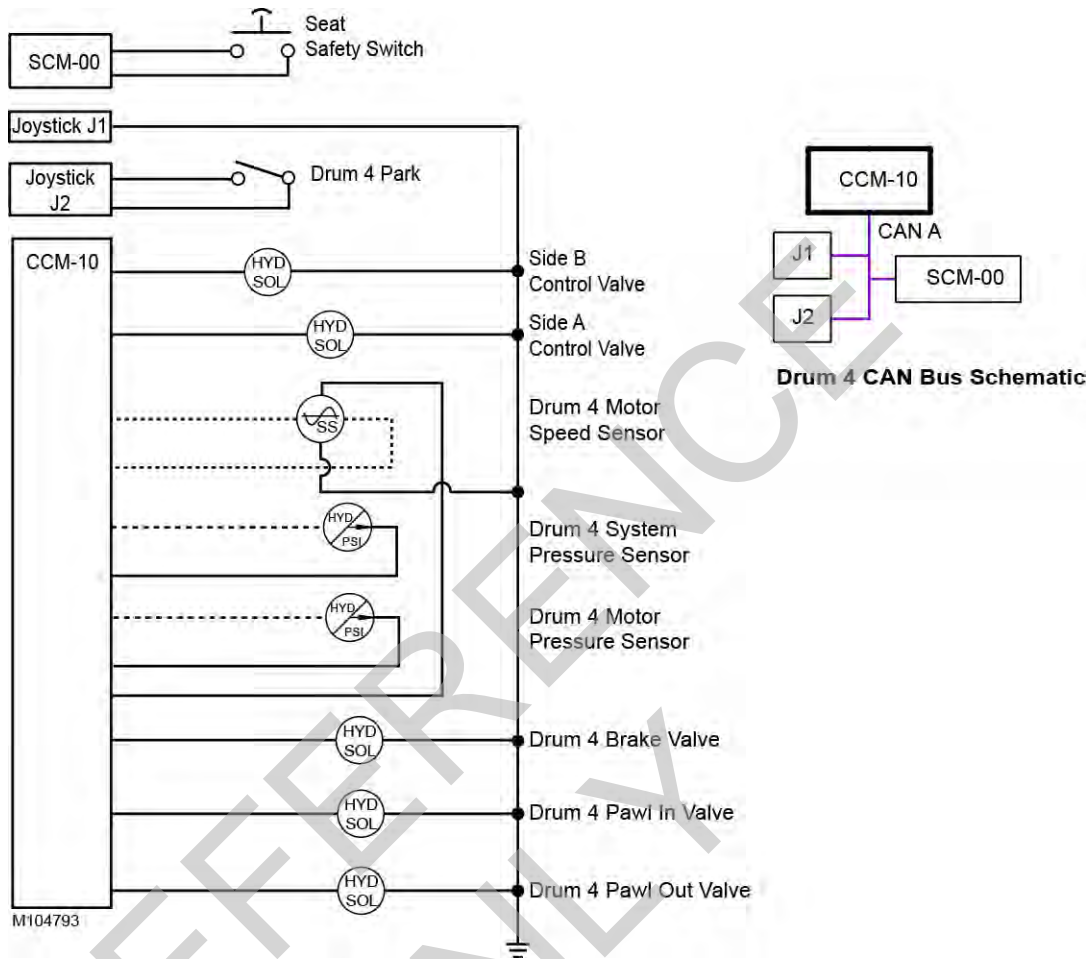
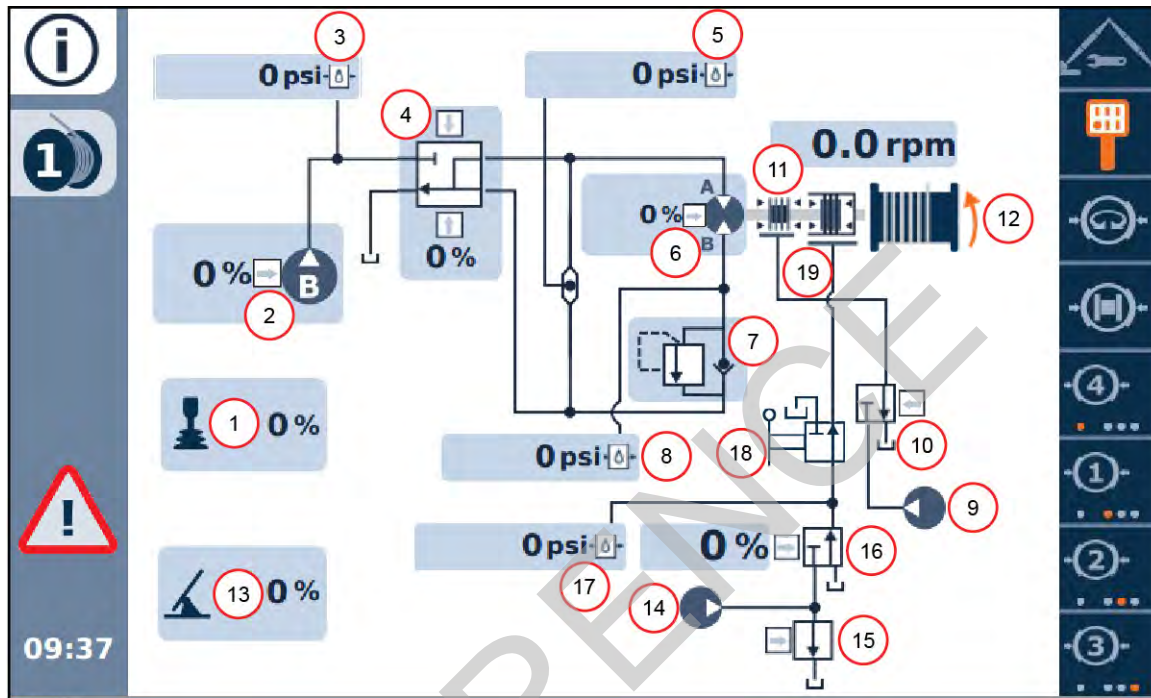


FIGURE 5-9

### Drum 1 Hydraulic Diagram (with Free Fall)

A detailed hydraulic schematic is provided at the end of Section 2 in this Service Manual.



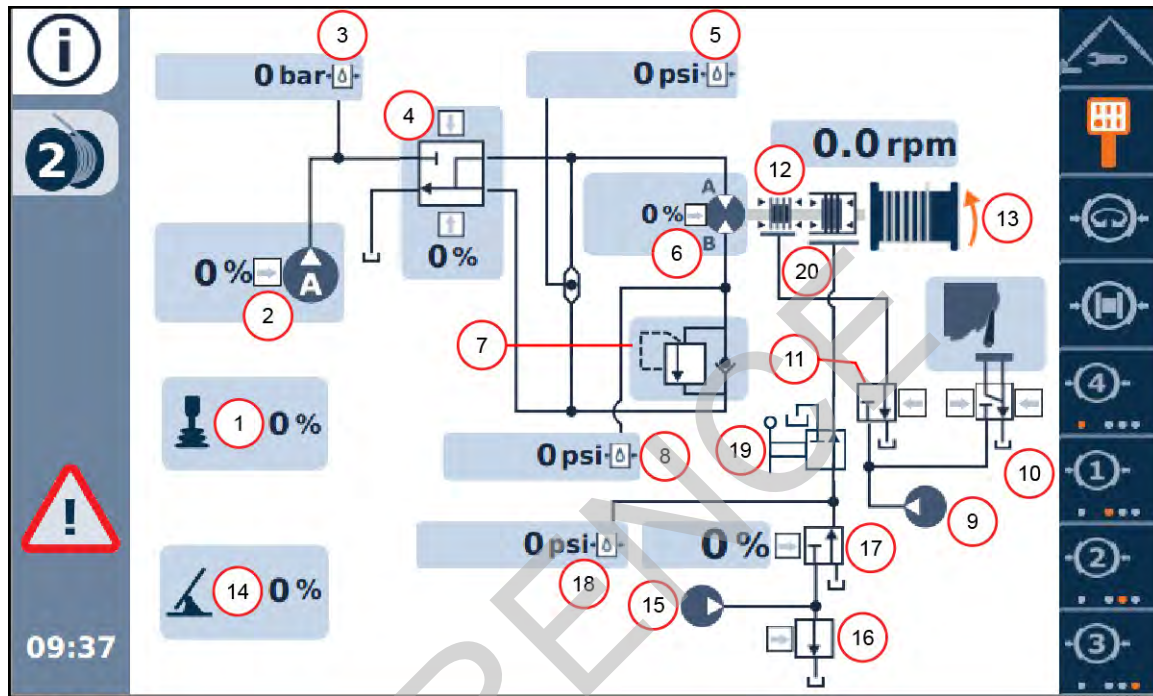
M105066-2

Drum 1 Components			
1	Handle (command -100 to 100%: + number = raise, - number = lower)	11	Brake (motor end)
2	Open Loop B Pump (command 0 to 100%)	12	Drum
3	Open Loop B Pump Pressure Transducer	13	Free Fall Brake Pedal (command 0 to 100%: 0% = pedal down, 100% = pedal up)
4	Control Valve (command -100 to 100%: + number = raise, - number = lower)	14	Free Fall Pilot Pump
5	System Pressure Transducer	15	Free Fall System Enable Valve
6	Motor (command: 0 = max displacement, 100% = min displacement)	16	Free Fall Brake Valve (command 0 to 100%: 0% = pedal down, 100% = pedal up)
7	Load Holding Valve	17	Free Fall Brake Pressure Transducer
8	Motor Pressure Transducer	18	Free Fall On-Off Selector Valve
9	Pilot Pump	19	Free Fall Brake
10	Brake Valve		

FIGURE 5-10

### Drum 2 Hydraulic Diagram (with Free Fall)

A detailed hydraulic schematic is provided at the end of Section 2 in this Service Manual.



M105067-2

5

Drum 1 Components			
1	Handle (command -100 to 100%: + number = raise, - number = lower)	11	Brake Valve
2	Open Loop A Pump (command 0 to 100%)	12	Brake (motor end)
3	Open Loop A Pump Pressure Transducer	13	Drum
4	Control Valve (command -100 to 100%: + number = raise, - number = lower)	14	Free Fall Brake Pedal (command 0 to 100%: 0% = pedal down, 100% = pedal up)
5	System Pressure Transducer	15	Free Fall Pilot Pump
6	Motor (command: 0 = max displacement, 100% = min displacement)	16	Free Fall System Enable Valve
7	Load Holding Valve	17	Free Fall Brake Valve (command 0 to 100%: 0% = pedal down, 100% = pedal up)
8	Motor Pressure Transducer	18	Free Fall Brake Pressure Transducer
9	Pilot Pump	19	Free Fall On-Off Selector Valve
10	Pawl Valve	20	Free Fall Brake

FIGURE 5-11

### Free Fall System (Optional)

See [Figure 5-10](#) and [Figure 5-11](#).

Drum 1, Drum 2, or both drums can be equipped with the free fall option. When free fall is enabled, the large spring-applied, hydraulically-released disc brake on the end of drum is used to control the lowering of a load. Raising a load when free fall is enabled works the same as in normal operation.

**NOTE** When the crane is not in free fall mode, depressing the free fall brake pedal has no effect on hoist operation.

The motor and the disc brake on the motor end of the drum used on the free fall drum are the same as those used on the non-free fall drum.

When equipped with free fall, the CCS determines whether drum speed is taken from the motor speed sensor

([Figure 5-20 on page 5-30](#)) or from the free fall speed sensor ([Figure 5-21 on page 5-32](#)).

The speed sensor sends a signal to the rotation indicator (thumper solenoid) in the control handle. The rotation indicator pulsates with a varying frequency to indicate drum rotational speed. The direction of rotation is also displayed on the main display via an arrow on the corresponding drum icon.

Cooling oil flow through the brake is continuous whether or not the free fall mode is enabled. Cooling oil flow at 5 bar (73 psi) is provided by the free fall cooling pump, which is dedicated for this purpose.

Brake release pressure is provided by the free fall pump which is relief-valve limited to 75 bar (1090 psi). The CCS receives a position signal from the free fall brake pedal and uses this information to proportionally adjust the brake release pressure in order to allow the drum to free fall.

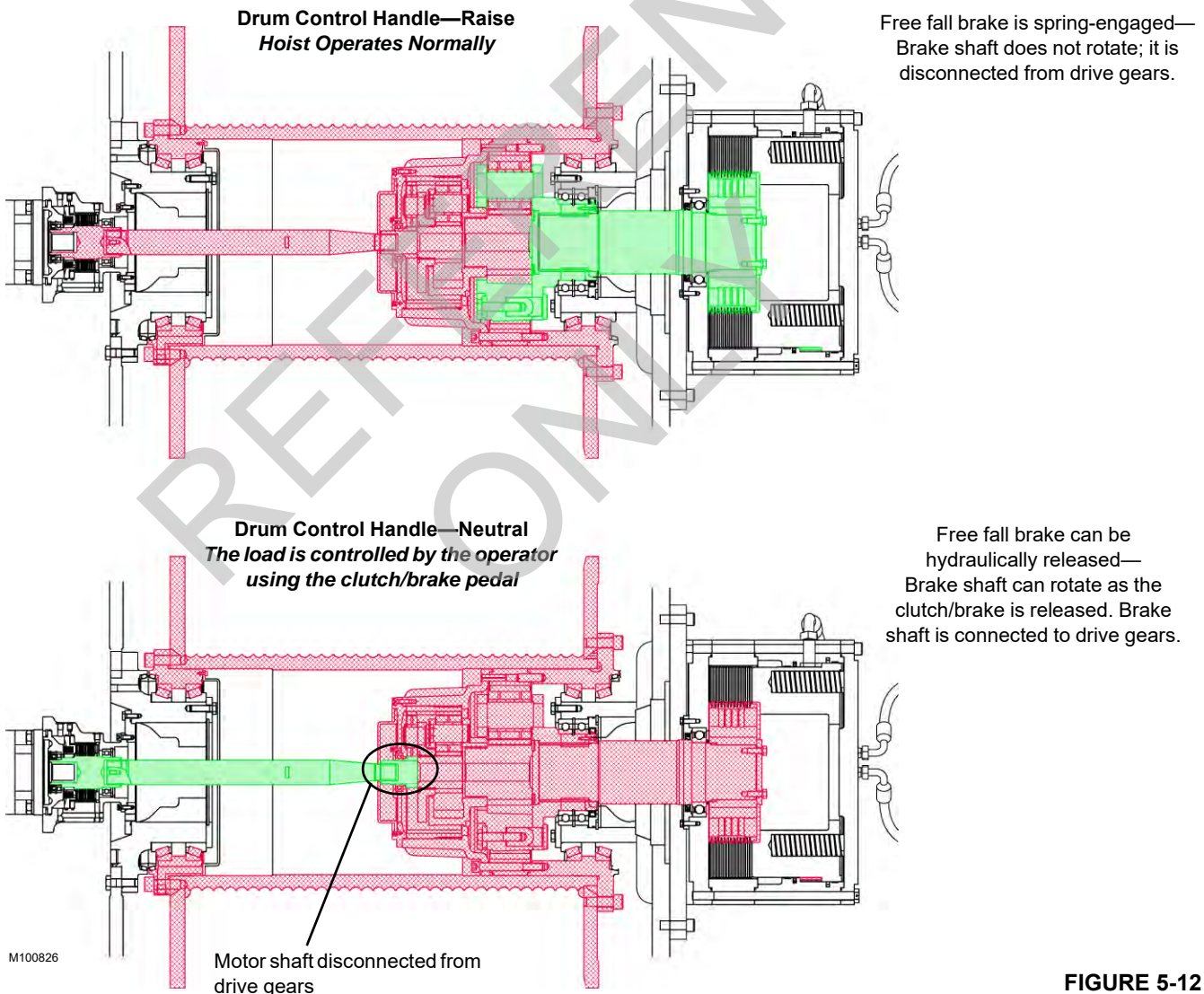
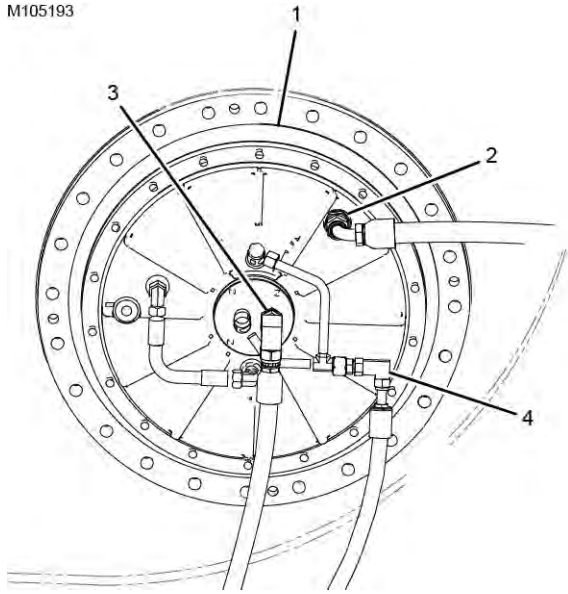
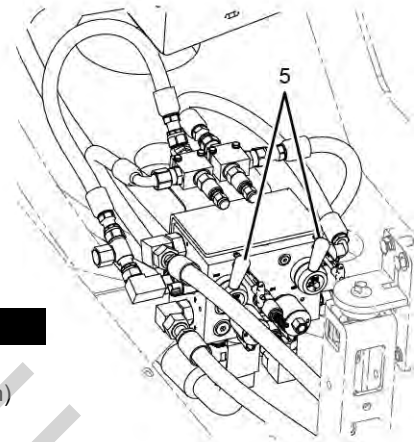


FIGURE 5-12

M105193



Typical View Left End of Drums 1 and 2



View in Left Enclosure  
Near Pump Drive

Item	Description
1	Free Fall Selector Valves
1	Free Fall Brake (Drum 1 shown)
3	Free Fall Speed Sensor
4	Cooling Flow In
5	Cooling Flow Out
6	Brake Release Pressure

FIGURE 5-13

**! WARNING**  
**Falling Load Hazard**

When the free fall mode is fully enabled, the load will fall uncontrolled unless the brake pedal is applied.

Always be ready to apply the brake pedal so lowering speed can be controlled.

If this is not done, the load can fall, possibly resulting in injury or death.

To prevent the load from falling when free fall is selected for a drum, latch down the free fall brake pedal.

To enable free fall, the following conditions must be met:

- Operator seated
- Brake pedal latched down
- Free fall enable/disable key momentarily turned to the Drum 1 and/or Drum 2 position

To release the free fall brake, the following conditions must be met:

- Free fall enabled
- Operator seated
- Free fall selector valve rotated to ON

For specific operating instructions, see Section 3 of the MLC150-1 Operator Manual.

For the remaining instructions, operation applies only to the selected drum.

When the brake pedal is latched down, flow from the free fall pump to the brake pedals is routed to tank via the free fall enable valve, and pressure in the circuit drops below 7 bar (100 psi).

In the on position, the free fall selector valve allows oil flow from the free fall brake valve to the free fall brake.

If all other conditions are met and the free fall enable key is turned on, the control system activates the free fall brake valve, allowing pressure to reach the free fall brake via the free fall selector valve.

As the operator allows the brake pedal to rise, the CCS will close the free fall enable valve (block flow to tank) and then increase brake release pressure proportionally to the brake pedal position via the free fall brake valve. The free fall brake will release and the load will lower. Full brake release occurs at 60 bar (870 psi).

Adjusting the slip setting in the main display will limit the maximum pressure available to the brake from the free fall pump.

When free fall is enabled, the drum control handle will operate in the same manner as normal (non-free fall) operation, but the operator must remember to use the free fall brake pedal to control lowering while the control handle is in center. Optionally, if the operator pulls back on the drum control handle, the CCS will use this input as a proportional control to apply the free fall brakes.

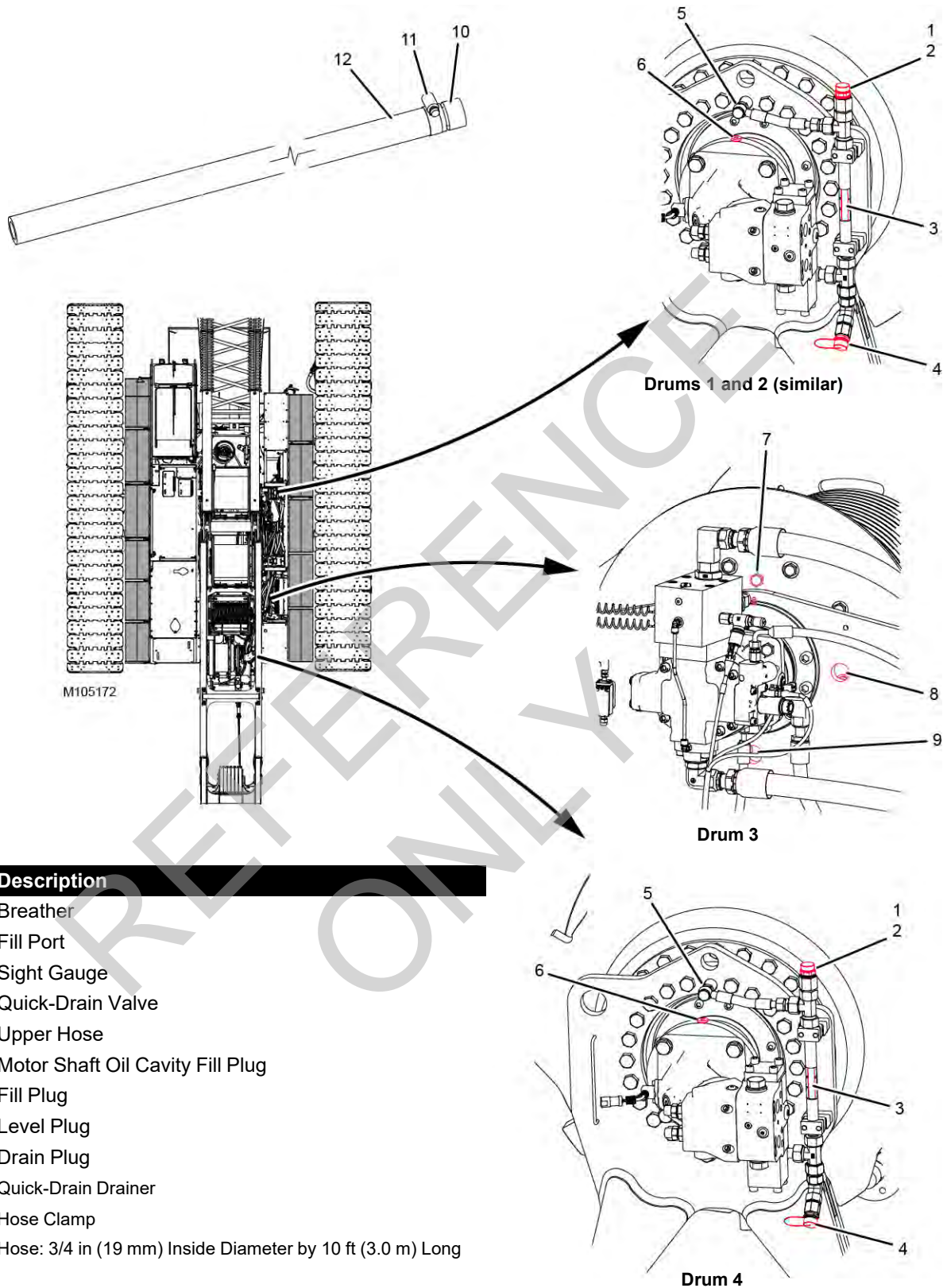


FIGURE 5-14

## DRUM GEARBOX OIL CHANGE

Drum gearbox maintenance consists of periodically checking the level and changing the oil in each drum gearbox.

### Gear Oil Specifications

For gear oil specifications and gearbox capacities, see the Lubrication Guide supplied with the crane.

### Oil Analysis

An oil analysis program is the best way to determine the optimum oil change interval and the condition of the drum gearboxes.

### Periodic Maintenance

#### Initial Operation

Drain and refill each drum gearbox after the first 200 hours of engine operation.

#### Monthly

Check the oil level in each drum gearbox monthly **or** every 200 hours of engine operation, whichever occurs first.

#### Yearly

Drain and refill each drum gearbox yearly **or** every 400 hours of function operation **or** every 2000 hours of engine operation, whichever occurs first, unless an alternate interval has been established through an oil analysis program.

### Quick-Drain Valve

Each gearbox for Drums 1, 2, and 4 is equipped with a quick-drain valve that requires use of the quick-drain drainer assembly (see [Figure 5-14](#)). The quick-drain drainer assembly is stored in the parts box supplied with the crane.

**To prevent oil contamination, thoroughly clean the quick-drain drainer assembly before and after each use.**

### Oil Change Procedure

The oil change interval may be adjusted according to the results of an oil analysis program.

Change the oil when the gearbox is warm, not hot.

**NOTE:** To prevent harmful contaminants from entering a gearbox, thoroughly clean components before disconnecting or connecting them.

See [Figure 5-14](#) for the following procedures.

#### Drums 1, 2, and 4

1. Stop the engine and lockout-tagout the ignition switch.
2. Remove the dust cap from the quick-drain valve (4).
3. Place the hose from the quick-drain drainer assembly into a 23 L (6 gal) container under the drum.

4. Remove the breather (1) and fill plug for faster draining.
5. Thread the quick-drain drainer assembly to the quick-drain valve. The poppet inside the valve will open allowing the oil to drain from the gearbox.
6. Once the gearbox has finished draining, remove the quick-drain drainer assembly.
7. Fasten the dust cap to the quick-drain valve (4).
8. Fill the gearbox with specified oil:
  - a. Remove the breather (1) from the fill port (2).
  - b. Disconnect the upper hose (5) to allow trapped air to vent.
  - c. Add oil through the fill port (2) using a suitable funnel until the oil level is halfway up the sight gauge (3). **Do not overfill.**
  - d. Install and securely tighten the upper hose.
9. Clean the breather (1) in non-flammable solvent, blow it dry with compressed air, and reinstall it with the fill plug.
10. Allow the oil to settle and recheck the oil level, as required, after operating the drum.
11. Thoroughly clean the quick-drain drainer assembly and store it in the parts box.

#### Drum 3

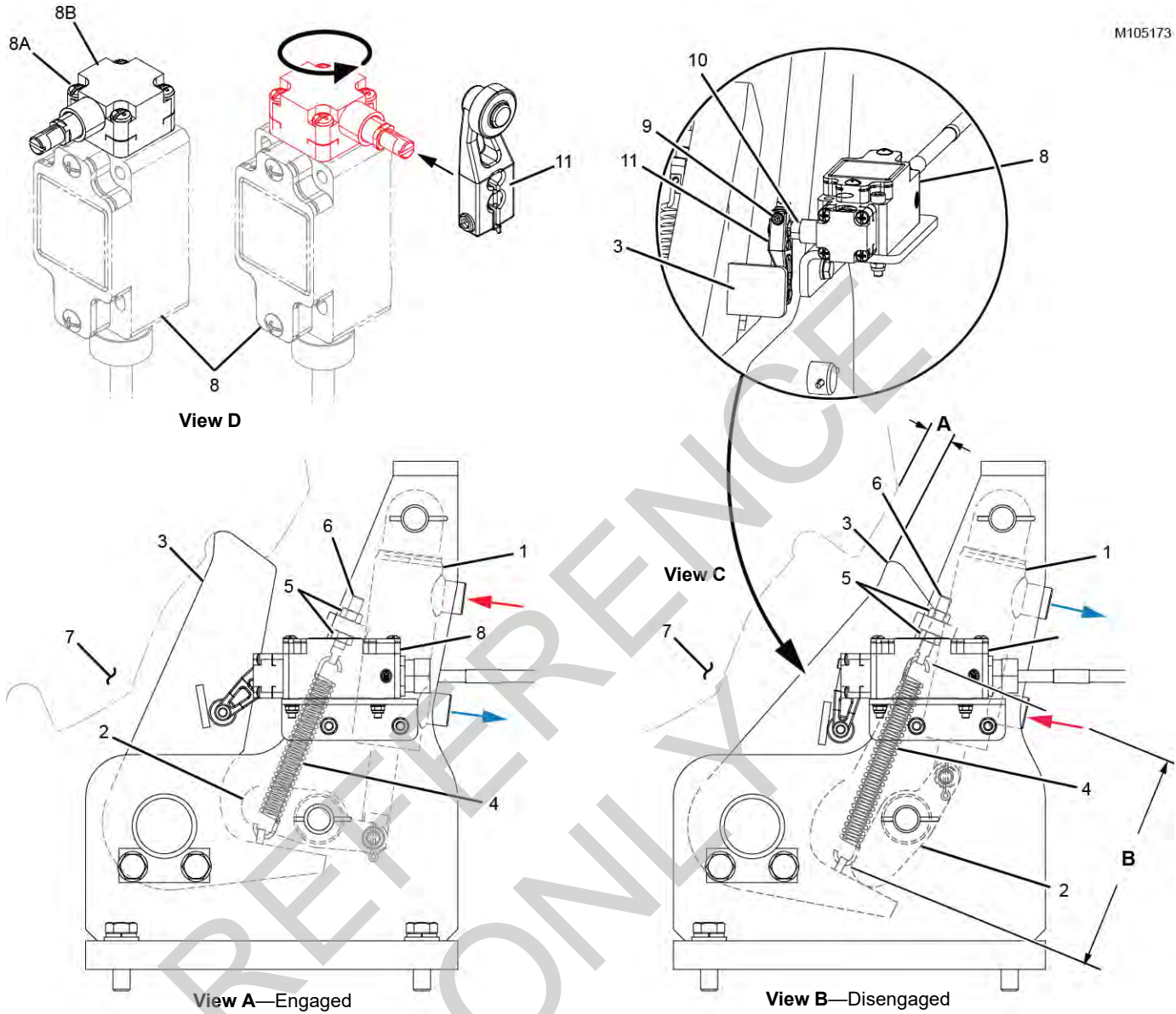
1. Rotate the drum so the fill, level, and drain plugs (7-9) are aligned with the holes in the drum frame.
2. Lock out-tag out the crane.
3. Place a 23 L (6 gal) container under the drum.
4. Remove the fill, level, and drain plugs (7-9) and drain the gearbox.
5. Once the gearbox has finished draining, securely reinstall the drain plug (9).
6. Fill the gearbox with specified oil through the fill plug port (7) until the oil is just up to the bottom of the level plug port (8).
7. Securely reinstall the fill and level plugs (7 and 8).
8. Allow the oil to settle and recheck the oil level, as required, after operating the drum.
9. Thoroughly clean up any spilled oil.

### Motor Shaft Oil Cavity

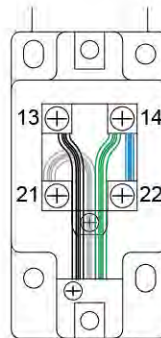
If the motor for Drum 1, 2, or 4 is removed for servicing, the motor shaft oil cavity must be filled with gear oil after the motor is reinstalled.

1. Remove the fill plug (6).
2. Fill the cavity to the top with gear oil.
3. The oil level will equalize with the gearbox.
4. Securely reinstall the fill plug.

M105173



Item	Description	Item	Description
1	Hydraulic Cylinder	8A	Screw (Qty 4)
2	Cam	8B	Head
3	Pawl	9	Setscrew
4	Spring	10	Limit Switch Shaft
5	Adjusting Nut (qty 2)	11	Limit Switch Lever
6	Eye Bolt	A	11-20 mm (7/16-25/32 in)
7	Ratchet	B	150 mm (5-29/32 in)
8	Limit Switch		



Wire Color	Switch Terminals	Function
Black	13	Normally Open
Green	14	Input
White	21	Normally Closed
Blue	14 22	Jumper

FIGURE 5-15



## DRUM 4 PAWL



### WARNING

#### Falling Boom Hazard

Before performing the following steps, land the loads and lower the boom onto blocking at ground level. There is no positive means of holding the boom up when the pawl is being serviced.

See [Figure 5-15](#) for the following procedures.

### Operation

The pawl is controlled by the Drum 4 park switch in the operator cab. See Section 3 of the Crane Operator Manual.

#### Drum 4 Parked

See View A—Engaged.

The hydraulic cylinder (1) extends and rotates the cam (2) away from the pawl (3). This allows the spring (4) to rotate the pawl into engagement with the drum ratchet (7).

#### Drum 4 Un-Parked

See View B—Disengaged.

The hydraulic cylinder (1) retracts and rotates the cam (2) against the pawl (3). This action rotates the pawl out of engagement with the drum ratchet (7). It may be necessary to operate the drum slightly in the raise direction to fully disengage the pawl from the ratchet.

### Maintenance

#### Daily

Visually check the pawl for proper operation as described under Operation.

#### Weekly

Apply open gear lube to the sliding surfaces between the cam (2) and pawl (3).

### Spring Adjustment

If the spring tension becomes insufficient, perform the following.

1. Visually check the position of the pawl and make sure it is fully engaged with the ratchet.

If the pawl is not fully engaged, perform the following.

- a. Start the engine and operate the drum slightly in the up direction.
- b. Check the pawl again and make sure it is fully engaged with the ratchet.

**NOTE:** In some cases, the pawl may come to rest on the top of a ratchet tooth. There must be enough spring tension to pull the pawl into the root of a ratchet tooth if the drum starts to turn in the down direction.

2. Stop the engine and lockout-tagout the ignition switch.
3. Adjust the eye bolt (6) adjusting nuts (5) so there is enough spring (4) tension to engage the pawl.
4. When new at the factory, the spring is adjusted to Dimension B
5. Start the engine and check the pawl for proper operation and engagement.

### Limit Switch Head Orientation

If a new limit switch is being installed, orient the head (8B, View D) as follows:

1. Remove the screws (8A).
2. Rotate the head (8B) 90° counterclockwise.
3. Install and securely tighten the screws (8A).
4. Install the lever (11).

### Limit Switch Adjustment

The limit switch (8) signals the crane's control system when the Drum 4 pawl is fully disengaged.

1. Disengage the pawl by moving the Drum 4 park switch to the UN-PARK position. It may be necessary to boom up slightly before the pawl will disengage the ratchet.
2. Stop the engine and lockout-tagout the ignition switch.
3. Loosen the setscrew (9) so the limit switch lever (11) is free to rotate on the limit switch shaft (10).
4. Rotate the limit switch lever up and hold it so the roller is against the pawl (3).
5. Turn the limit switch shaft counterclockwise until the limit switch clicks open and hold.
6. Make sure the roller is against the actuator plate on the pawl (3) and tighten the setscrew to lock the adjustment.
7. Start the engine and check for proper operation:
  - Engage the pawl by moving the Drum 4 park switch to the PARK position and try to boom down. The drum should not operate in the down direction. The fault alert should come on and the pawl engaged fault icon should appear in the fault bar of the Main Display Working Screen.
  - Disengage the pawl by moving the Drum 4 park switch to the UN-PARK position and try to boom down. The drum should operate in the down direction.
8. Readjust the limit switch if required.



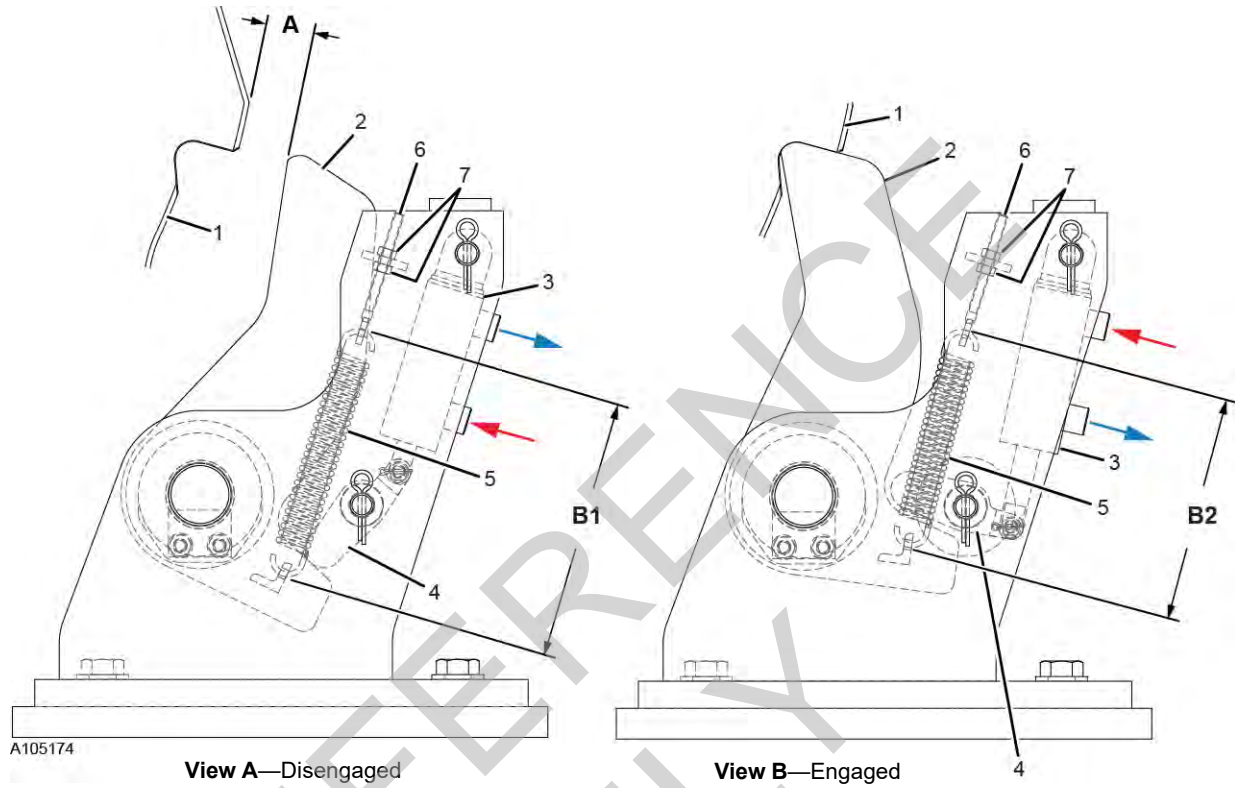


FIGURE 5-16

Item	Description	Item	Description
1	Ratchet	6	Eye Bolt
2	Pawl	7	Adjusting Nut (qty 2)
3	Hydraulic Cylinder	<b>A</b>	35 mm (1-3/8 in)
4	Cam	<b>B1</b>	211 mm (8-5/16 in)
5	Spring	<b>B2</b>	182 mm (7-5/32 in)

## DRUM 2 PAWL

See [Figure 5-16](#) for the following procedures.

### Operation

The pawl is controlled by the Drum 2 park switch in the operator cab. See Section 3 of the Crane Operator Manual.

#### **Drum 2 Un-Parked**

See View A—Disengaged.

The hydraulic cylinder (3) retracts and rotates the cam (4) against the pawl (2). This action rotates the pawl out of engagement with the drum ratchet (1). It may be necessary to operate the drum slightly in the raise direction to fully disengage the pawl from the ratchet.

#### **Drum 2 Parked**

See View A—Engaged.

The hydraulic cylinder (3) extends and rotates the cam (4) away from the pawl (2). This allows the spring (5) to rotate the pawl into engagement with the drum ratchet (2).

### Maintenance

#### **Daily**

Visually check the pawl for proper operation as described under Operation.

#### **Weekly**

Apply open gear lube to the sliding surfaces between the cam (4) and pawl (2).

### Spring Adjustment

If the spring tension becomes insufficient, perform the following steps:

1. Visually check the position of the pawl and make sure it is fully engaged with the ratchet.

If the pawl is not fully engaged, perform the following.

- a. Start the engine and operate the drum slightly in the up direction.
- b. Check the pawl again and make sure it is fully engaged with the ratchet.

**NOTE:** In some cases, the pawl may come to rest on the top of a ratchet tooth. There must be enough spring tension to pull the pawl into the root of a ratchet tooth if the drum starts to turn in the down direction.

2. Stop the engine and lockout-tagout the ignition switch.
3. Adjust the eye bolt (6) adjusting nuts (7) so there is enough spring (5) tension to engage the pawl.
4. When new at the factory, the spring is adjusted to Dimension B1 and B2
5. Start the engine and check the pawl for proper operation and engagement.

REFERENCED ONLY

## DRUM 1 AND 2 MINIMUM BAIL LIMIT



### **WARNING** Falling Load Hazard!

When lowering a load below the minimum bail limit, do so slowly with extreme caution. Do not lower the load to the point where less than three full wraps of wire rope are on the drum. The wire rope could be pulled out of the drum, allowing the load to fall.

### Non-Free Fall Drum

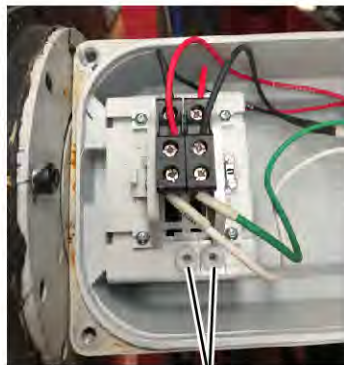
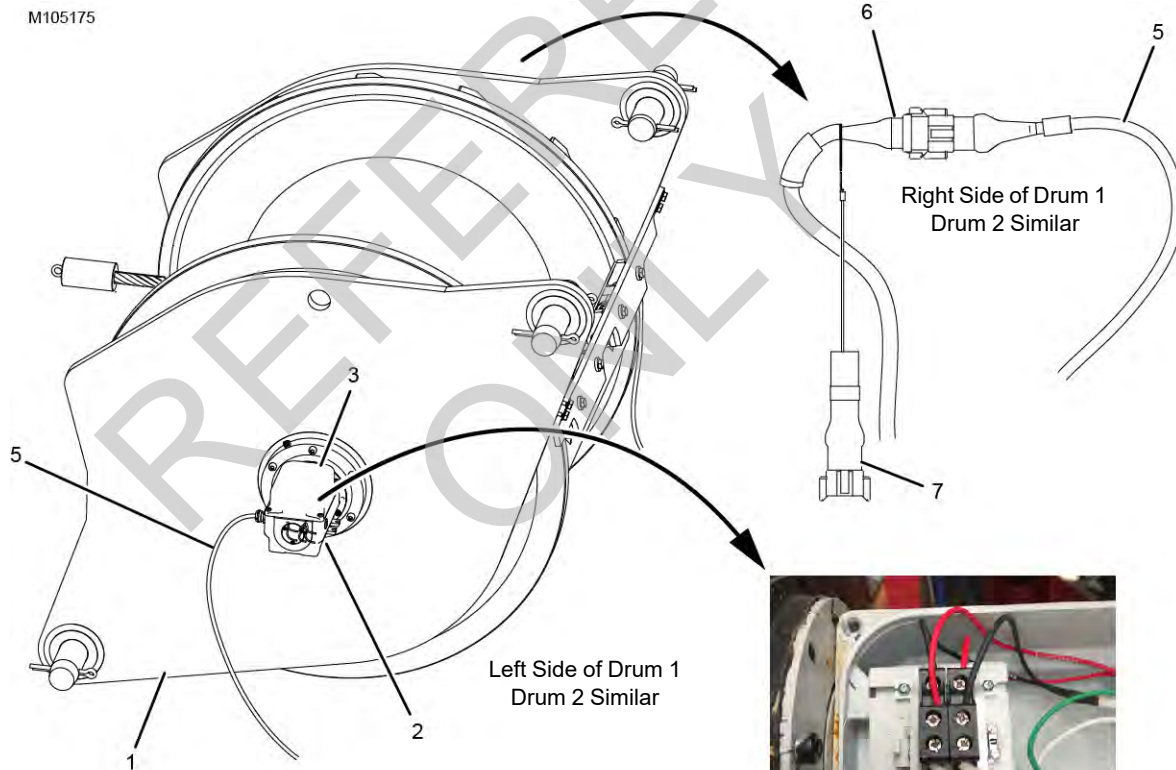
See [Figure 5-18](#) for the following procedures.

The minimum bail limit stops the corresponding Drum 1 or 2 from lowering when there are three to four wraps of wire rope remaining on the first layer of the drum.



When the limit is reached, the operating limit fault is activated and the fault icon appears in the fault bar of the Main Display Working Screen.

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4

FIGURE 5-17

- The drum can be operated in the hoist direction after the limit is contacted.
- The limit can only be bypassed by disconnecting the electric cable (5) from the electric cable (6) and connecting the supplied shorting plug (7) to the electric cable 6.

### Limit Switch Adjustment

1. Pay out the wire rope from the desired Drum 1 or Drum 2 until there are three to four wraps of rope on the first layer of the drum.
2. Remove the cover (3).
3. Turn either adjusting screw (4) counterclockwise until you hear the switch "click".  
Repeat this step for the other adjusting screw (4).
4. Operate the drum to make sure it stops with three to four wraps of wire rope on the first layer of the drum.
5. Readjust the limit switch as needed.
6. Install the cover with a new gasket (if required).

Item	Description	Item	Description
1	Drum 1 or 2	5	Electric Cable from Limit Switch
2	Limit Switch	6	Electric Cable from Wire Harness
3	Cover	7	Shorting Plug
4	Adjusting Screw (Qty 2)		

### Free Fall Drum

See [Figure 5-18](#) for the following procedures.

The minimum bail limit stops the corresponding Drum 1 or 2 from lowering when there are three to four wraps of wire rope remaining on the first layer of the drum.

When the limit is reached, the operating limit fault is activated and the fault icon appears in the fault bar of the Main Display Working Screen.



- The drum can be operated in the hoist direction after the limit is contacted.
- The limit can only be bypassed by disconnecting the electric cable (5) from the electric cable (6) and connecting the supplied shorting plug (7) to the electric cable (6).

### Limit Switch Adjustment

1. Pay out the wire rope from the desired Drum 1 or Drum 2 until there are three to four wraps of rope on the first layer of the drum.
2. Remove the cover (3).
3. Turn either WHITE adjusting screw (4) counterclockwise until you hear the switch “click”.

Repeat this step for the other WHITE adjusting screw (4).

The black adjusting screw has no function for this application and does not require adjustment.

4. Operate the drum to make sure it stops with three to four wraps of wire rope on the first layer of the drum.
5. Readjust the limit switch as needed.
6. Install the cover with a new gasket (if required).

Item	Description	Item	Description
1	Drum 1 or 2	5	Electric Cable from Limit Switch
2	Limit Switch	6	Electric Cable from Wire Harness
3	Cover	7	Shorting Plug
4	Adjusting Screw (Qty 2)		

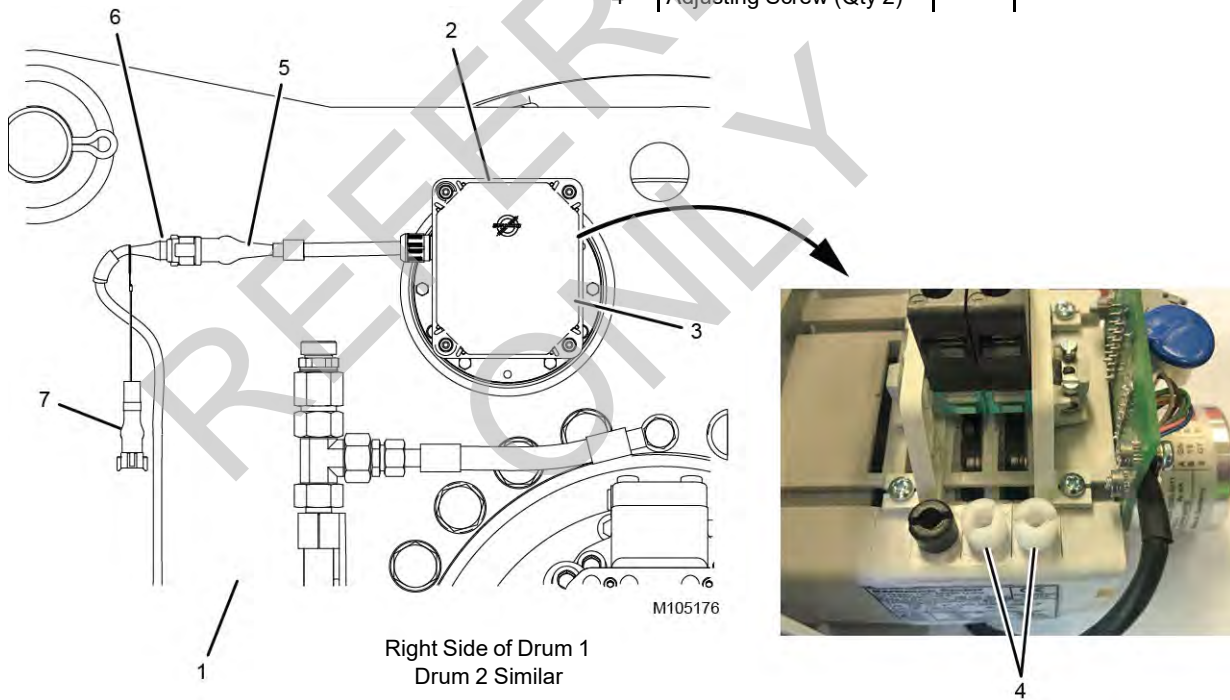


FIGURE 5-18

5

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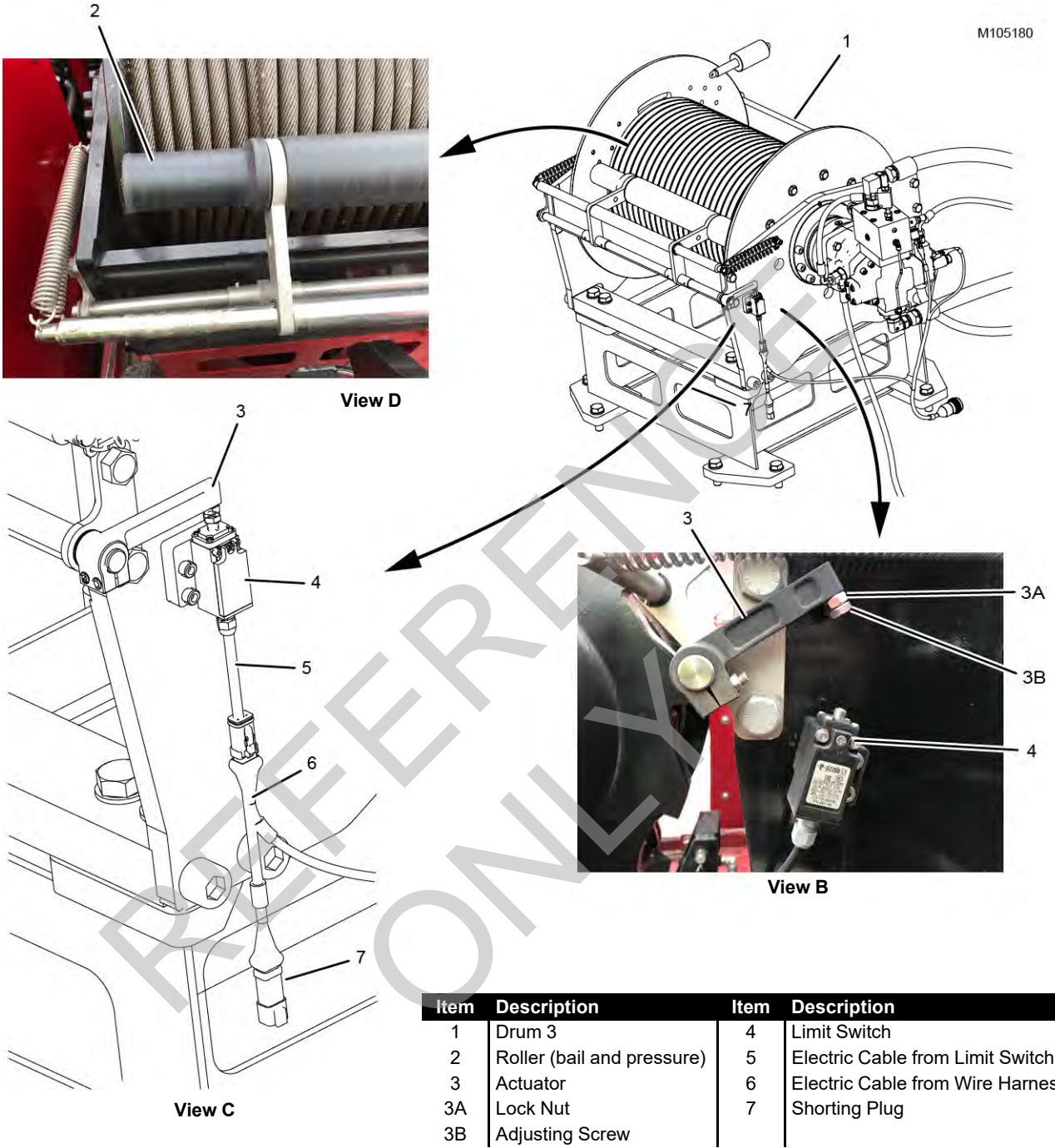


FIGURE 5-19

## DRUM 3 MINIMUM BAIL LIMIT



### WARNING

#### Falling Load Hazard!

When lowering a load below the minimum bail limit, do so slowly with extreme caution. Do not lower the load to the point where less than three full wraps of wire rope are on the drum. The wire rope could be pulled out of the drum, allowing the load to fall.

See [Figure 5-19](#) for the following procedures.

Optionally, Drum 3 has a combination minimum bail limit and pressure roller.

During normal operation with more than three to four wraps of wire rope on the first layer of the drum, springs hold the roller (2, View D) firmly against the wire rope to assist in proper spooling.

When there are three to four wraps of wire rope on the first layer of the drum, the small diameter end of the roller (2, View D) contacts the drum. This action activates the bail limit fault by rotating the actuator (3, View B) down against the limit switch (4, View C).

When the fault is activated, the drum stops lowering and the fault icon appears in the fault bar of the Main Display Working Screen.

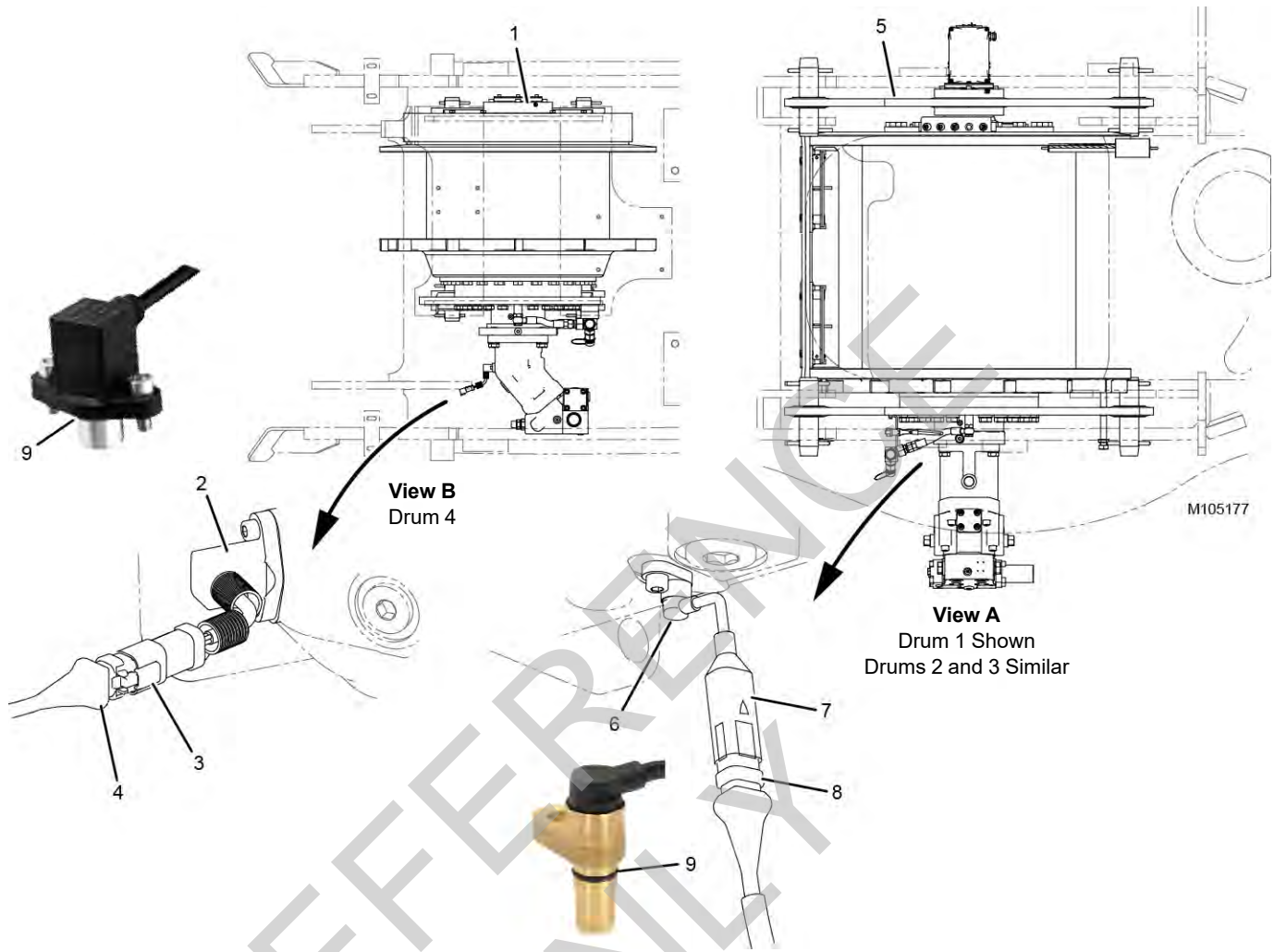


- The drum can be operated in the hoist direction after the limit is contacted.
- The limit can only be bypassed by disconnecting the electric cable (5, View C) from the electric cable (6) and connecting the supplied shorting plug (7) to the electric cable (6).

### Limit Switch Adjustment

1. Pay out the wire rope from Drum 3 until there are three to four wraps of rope on the first layer of the drum.
2. If necessary, loosen the lock nut (3A, View B) and turn the adjusting screw (3B):
  - OUT to stop the drum SOONER
  - IN to stop the drum LATER
3. Operate the drum to make sure it stops with three to four wraps of wire rope on the first layer of the drum.
4. Readjust the limit switch as needed.

REFERENCED ONLY



Item	Description	Item	Description
1	Drum 4	5	Drum 1
2	Speed Sensor	6	Speed Sensor
3	Electric Cable from Sensor	7	Electric Cable from Sensor
4	Electric Cable WRR1-P23 from Harness	8	Electric Cable WRR1-P2 from Harness
		9	O-Ring

FIGURE 5-20



## SPEED SENSOR

See [Figure 5-20](#) for the following procedure.

A speed sensor (2 or 6) is installed in the motor of each drum. The sensors send rotational speed and direction information to the corresponding control module to be used by the crane's control functions.

[Figure 5-20](#) shows the speed sensor for Drums 4 and 1. The speed sensor for Drums 2 and 3 are similar to Drum 1.

The speed sensors are not adjustable. They must be replaced if they are not working properly

### Replacement

Replacement is required if a speed sensor is suspected of sending faulty information to the corresponding control module.



### WARNING

#### Burn Hazard!

Hydraulic fluid will drain from the port when the speed sensor is removed. Wait for the hydraulic fluid to cool before removing the speed sensor.

#### **Drum 4 (View B)**

1. Stop the engine and lockout-tagout the ignition switch.
2. Disconnect the electrical cable (4) from the electric cable (3).
3. Thoroughly clean the area around the speed sensor (2) to prevent dirt from entering the hydraulic system.
4. Place an appropriate container under the motor to catch any oil leakage.
5. Work quickly to prevent excess oil leakage.
6. Make sure the O-ring (9) is installed on the new speed sensor (2).

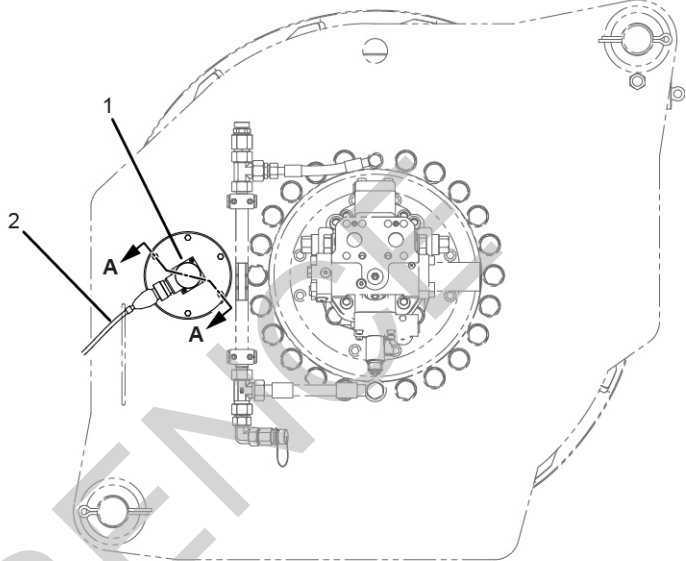
7. Remove the speed sensor (2) mounting screws and the faulty speed sensor.
8. Clean the mating surfaces and install the new speed sensor (2) and O-Ring (9).
9. Install the mounting screws and tighten them to 10 Nm (7.4 ft-lb).
10. Connect the electrical cables (3 and 4).
11. Operate the drum and check for a steady drum speed (rpm) and direction signal in the corresponding drum's Control Information Screen in the main display.
12. Make sure there is no oil leakage.

#### **Drum 1, 2, or 3 (View A)**

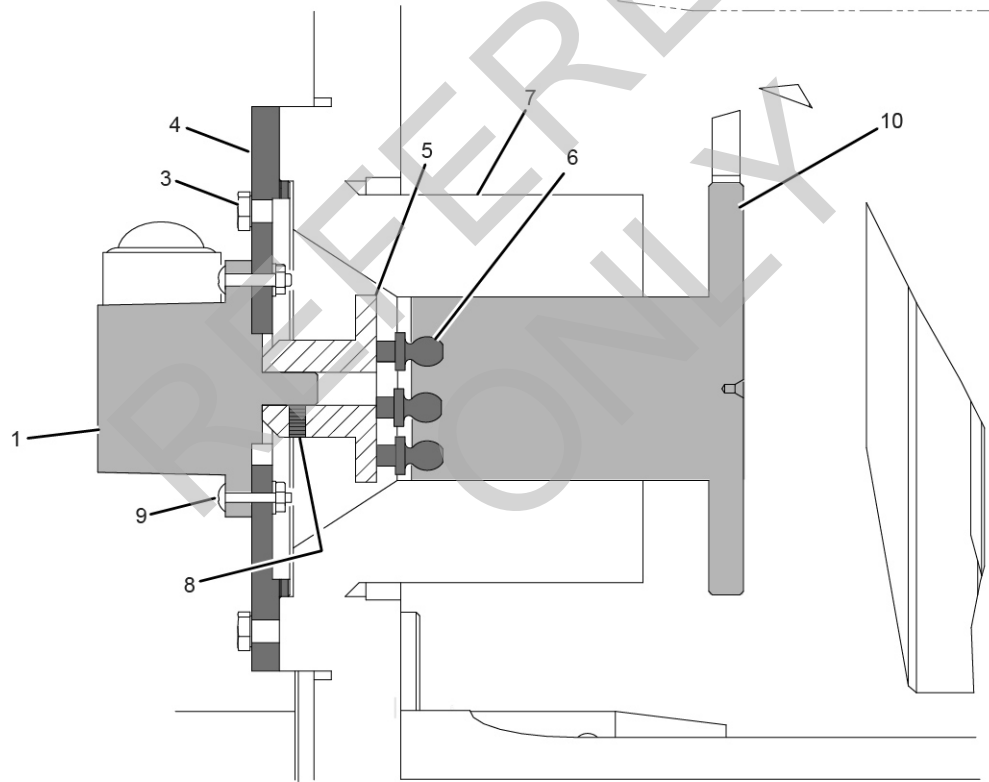
1. Stop the engine and lockout-tagout the ignition switch.
2. Disconnect the electrical cable (8) from the electric cable (7).
3. Thoroughly clean the area around the speed sensor (6) to prevent dirt from entering the hydraulic system.
4. Place an appropriate container under the motor to catch any oil leakage.
5. Work quickly to prevent excess oil leakage.
6. Make sure the O-ring (9) is installed on the new speed sensor (6).
7. Remove the speed sensor (6) mounting screw and the faulty speed sensor.
8. Clean the mating surfaces and install the new speed sensor (6) and O-Ring (9).
9. Install the mounting screw and tighten it to 8 Nm (6 ft-lb).
10. Connect the electrical cables (7 and 8).
11. Operate the drum and check for a steady drum speed (rpm) and direction signal in the corresponding drum's Control Information Screen in the main display.
12. Make sure there is no oil leakage.

M105178

Item	Description
1	Speed Sensor
2	Electrical Cable
3	Hex Cap Screw (Qty 6)
4	Cover
5	Driver
6	Driver Studs (Qty 3)
7	Bearing Housing
8	Set Screw
9	Phillips Head Screw, Flat Washer and Nut (Qty 4)
10	Drive Pinion



Drum 2 Shown  
Drum 1 Similar



A - A

FIGURE 5-21

## SPEED SENSOR — FREE FALL

See [Figure 5-21](#) for the following procedure.

A speed sensor (1) is installed on the right end of each free fall equipped drum. The sensor sends rotational speed and direction information to the corresponding control module to be used by the crane's control functions when operating in free fall.

There is no adjustment for the speed sensor.

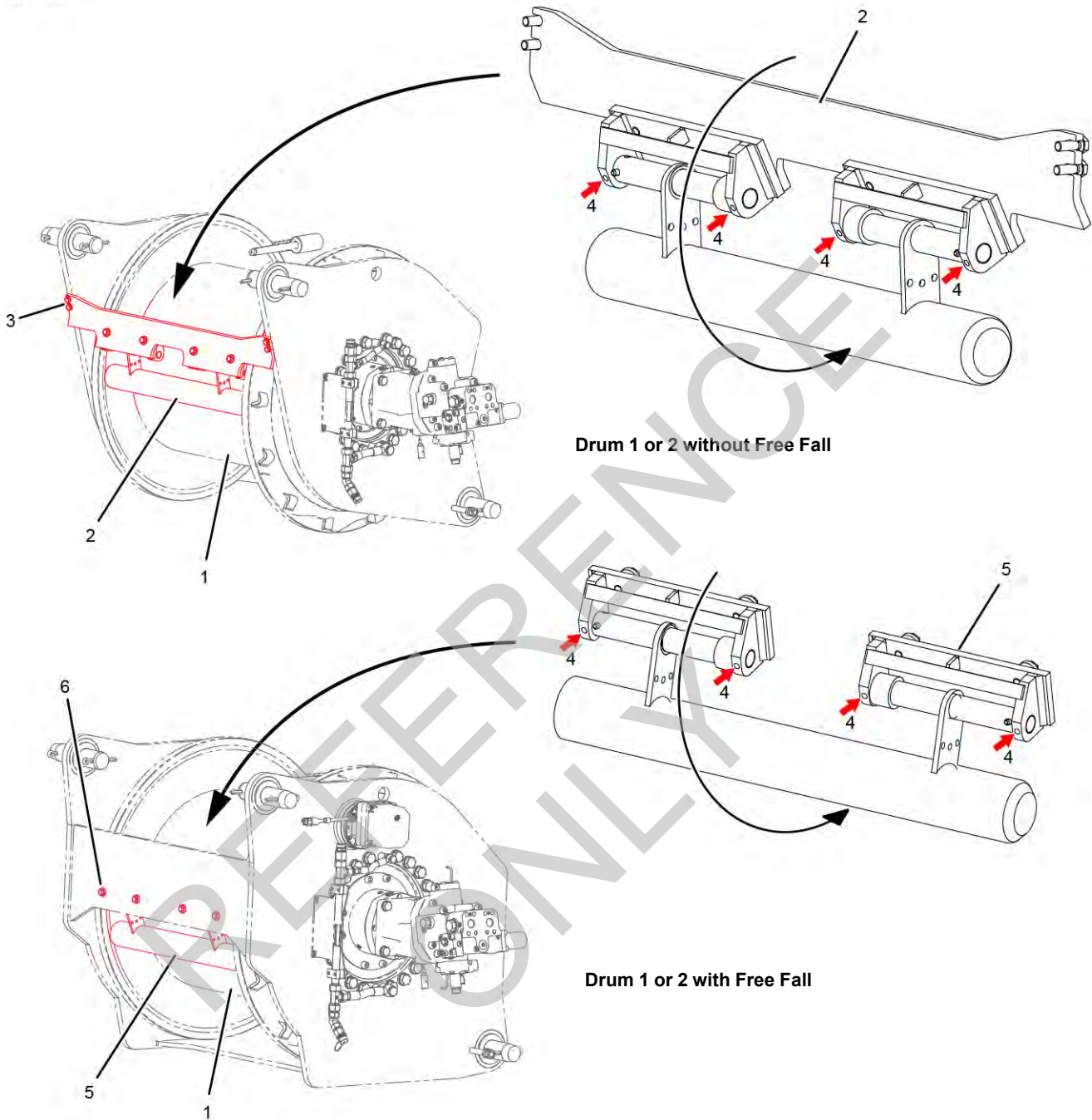
### Replacement

Replacement is required if a speed sensor is suspected of sending faulty information to the corresponding control module.

1. Stop the engine and lockout-tagout the ignition switch.
2. Disconnect the electrical cable (2) from the speed sensor (1).
3. Thoroughly clean the area around the speed sensor.
4. Note the orientation of the speed sensor (1) and the cover (4) with the drum flange.
5. Remove the hex cap screws (3) and pull out the speed sensor (1), the cover (4), the driver (5) with driver studs (6) as an assembled unit.
6. Loosen the set screw (8) and remove the driver (5) with drive studs (6) from the speed sensor shaft.
7. Note the orientation of the speed sensor (1) on the cover (4).
8. Disassemble the speed sensor (1) from the cover (4) and discard the speed sensor.
9. Assemble the new speed sensor (1) in the original orientation to the cover (4) with the phillips head screws, flat washers, and nuts (9). Apply Loctite® 222 to the screw threads and securely tighten them.
10. Assemble the driver (5) with drive studs (6) to the speed sensor shaft so the driver is snug against the sensor. **Do not tamper with the position of the drive studs.**
11. Clean the mating surfaces of the cover (4) and the drum flange.
12. Assemble the cover (4) with gasket, the sensor (1), and the driver (5) in its original orientation to the drum flange.
13. Rotate the unit as needed to align the drive studs (6) with the holes in the drive pinion (10).
14. Install and securely tighten the hex screws (3)
15. Connect the electrical cable (2) to the speed sensor (1).
16. Operate the drum and check for a steady drum speed (rpm) and direction signal in the corresponding drum's Control Information Screen in the main display.

REFERENCED ONLY

M105179



Drum 1 or 2 without Free Fall

Drum 1 or 2 with Free Fall

Item	Description
1	Drum 1
2	Pressure Roller Assembly without Free Fall — 40 kg (88 lb)
3	Mounting Screws with Washers (Qty 4)
4	M10 x 12 mm or Longer Socket Head Screw (Qty 4)(Owner Furnished)
5	Pressure Roller Assembly with Free Fall — 27 kg (60 lb)
6	Mounting Screws with Washers (Qty 4)

FIGURE 5-22

## PRESSURE ROLLERS

Optional pressure rollers (Figure 5-22) are available to assist in maintaining proper wire rope spooling on the Drums 1 and 2 during dynamic operations, like clamshell.

### CAUTION

#### Avoid Pressure Roller Damage!

The pressure rollers are designed for use on drums with 1 to 3 layers of wire rope only.

To avoid damage, remove the pressure rollers for applications requiring more than 3 layers of wire rope.

The pressure rollers provide the following forces:

**Table 5-1. Pressure Roller Force**

Layer	Force
Without Free Fall	
1	45,4 kg (100 lb)
3	79,4 kg (175 lb)
With Free Fall	
1	72,6 kg (160 lb)
3	99,8 kg (220 lb)



### WARNING

#### Crush Hazard!

The pressure roller is spring pre-loaded.

During removal and installation, keep all body parts clear from between the roller and the drum.

The roller will spring into engagement against the drum if you let go of the roller while the M10 socket head screws are being installed or removed.

## Removing Pressure Roller Assembly

1. Pre-load the pressure roller (2 or 5) by pulling the roller rearward as far as it will go and securely holding it in place.
2. Install the M10 socket head screws (4) in the four holes indicated.

This step will hold the pressure roller in the pre-loaded position.

3. Support the pressure roller assembly so it cannot fall and remove the mounting screws (3 or 6).
4. Remove the pressure roller assembly from the drum and store it for future use.
5. Store the mounting screws and washers with the pressure roller assembly.
6. Relieve the spring pre-load for storage:
  - a. Pull back on the pressure roller and hold it securely in place.
  - b. Remove the M10 socket head screws (4) and store them.
  - c. Slowly release the roller to relieve the pre-load.

## Installing Pressure Roller Assembly

1. Make sure there are no more than 3 layers of wire rope on the drum.
2. If necessary, pre-load the pressure roller (2 or 5) by pulling the roller rearward as far as it will go and securely holding it in place.
3. Install the M10 socket head screws (4) in the four holes indicated.

This step will hold the pressure roller in the pre-loaded position.

4. Lift the pressure roller assembly (2 or 5) into position at the rear of the drum.
5. Apply Loctite® 243 to the mounting screw threads.
6. Align the connecting holes and install the mounting screws (3 or 6).
7. Torque the screws to 83 Nm (60 ft-lb).
8. Pull back on the pressure roller and hold it securely in place.
9. Remove the M10 socket head screws (4) and store them.
10. Slowly release the roller until the roller is firmly against the wire rope on the drum.

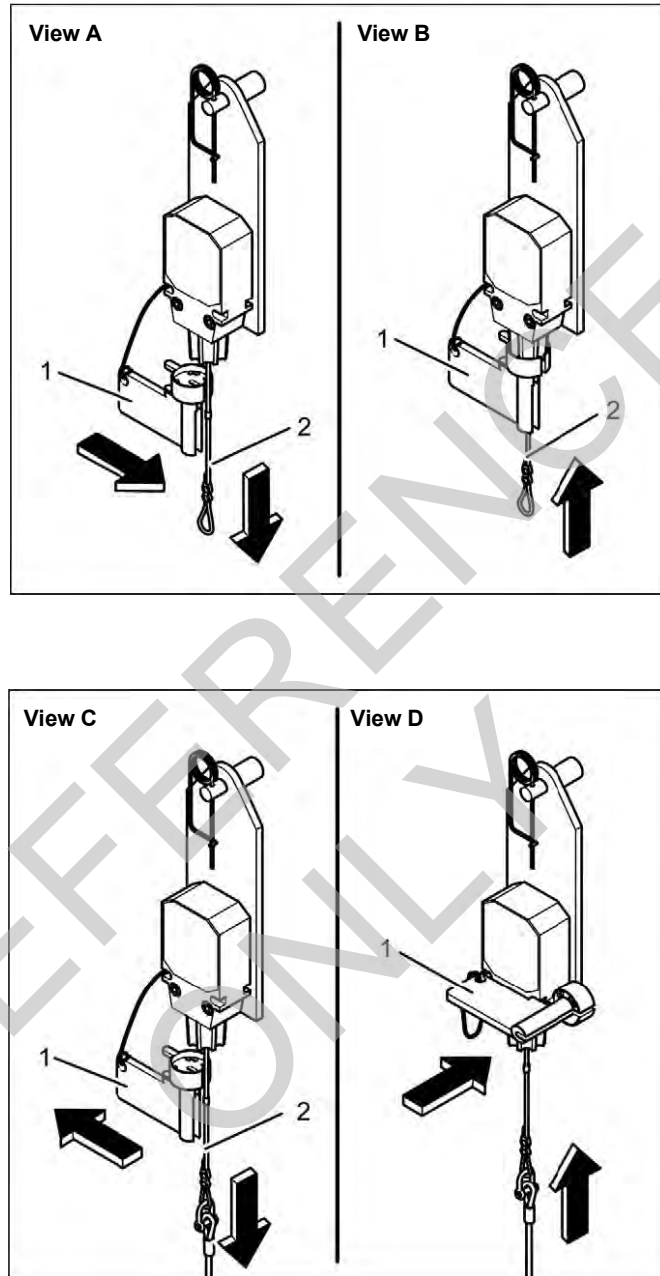


FIGURE 5-23

**WARNING****Two-Blocking Hazard**

Two-blocking is the condition in which the load block or the hook-and-weight ball runs into the boom or jib point sheaves.

**Two-blocking can result in failure of the sheaves and wire rope, possibly causing the load to fall.**

The operator shall determine the fastest line speed that allows the block-up limit to function properly and thereafter not exceed that line speed.

**If the load block or the hook-and-weight ball approaches the boom sheaves too fast, the block-up limit may not prevent two-blocking.**

**BLOCK-UP LIMIT DEVICE****General**

A block-up limit (also called anti-two-block device) is a two-blocking prevention device that stops the corresponding load drum from hoisting and the boom (or luffing jib) from lowering when a load block or the hook-and-weight ball is too close to the sheaves in the boom or jib point.

**NOTE** The block-up limit is a protective device designed only to assist the operator in preventing a two-blocking condition. Any other use is neither intended nor approved.

If the load block or the hook-and-weight ball is raised to high, the limit switch stops the drum from hoisting, the fault alarm comes on, and the block-up fault icon appears in the fault bar of the Main Display Working Screen.



The block-up limit device consists of the components shown in [Figure 5-24 on page 5-38](#):

**Locking/Unlocking Block-Up Limit Switch**

See [Figure 5-23](#) for the following procedures.

If any block-up limit switch is not used, it must be locked (disabled) to allow all hoist operations.

**Locking a Block-Up Limit Switch****CAUTION**

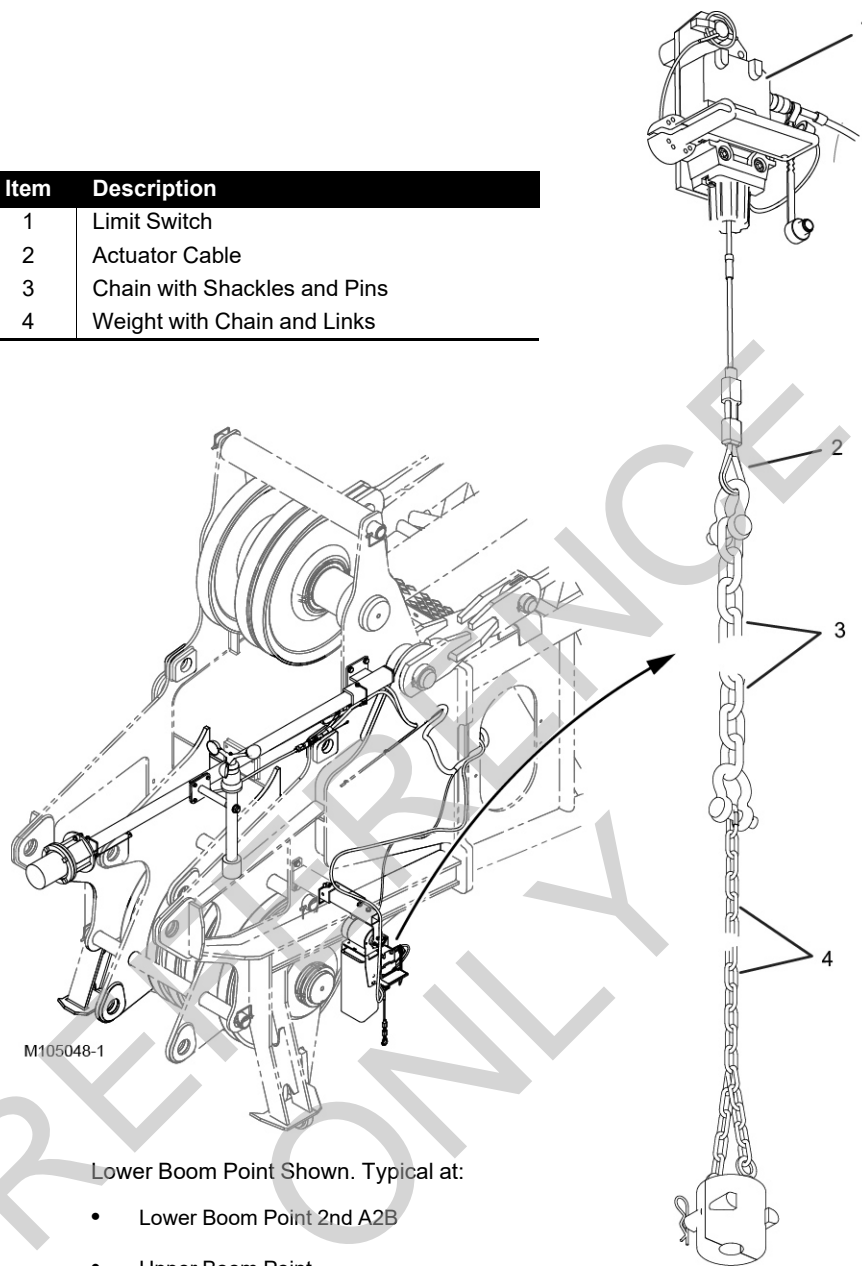
Never lock a block-up limit switch at a boom or jib point that is in use. Two-blocking could occur.

1. Remove the block-up limit chains and weight from the limit switch lanyard (2, View A).
2. Remove the cap (1, View A) from limit switch.
3. Pull the lanyard (2) down.
4. Install the cap (1, View B) to secure the lanyard (2) in the locked (disabled) position.

**Unlocking a Block-Up Limit Switch**

1. Attach the block-up limit chains and weight to the lanyard (2, View C).
2. Remove the cap (1, View C). The switch is now unlocked (enabled).
3. Store the cap (1, View D) in the limit switch slots.

Item	Description
1	Limit Switch
2	Actuator Cable
3	Chain with Shackles and Pins
4	Weight with Chain and Links



Lower Boom Point Shown. Typical at:

- Lower Boom Point 2nd A2B
- Upper Boom Point

FIGURE 5-24

## Maintenance

### CAUTION Prevent Damage!

If inspection reveals a problem with the block-up limit components, do not operate the crane until the block-up limit has been repaired to proper working order.

See [Figure 5-24](#) for the following procedure.

Inspect and test the block-up limits **weekly or every 40 hours of operation**, as follows:

1. Lower the boom (and the jib, if equipped) onto blocking at ground level.
2. Carefully inspect the following items:
  - a. Inspect each weight for freedom of movement on the load line.
  - b. Inspect each weight, chain, shackle and connecting pin for excessive or abnormal wear. Make sure the cotter pins for the shackles are installed and spread.
  - c. Inspect the entire length of each electric cable for damage.



- d. Check that the electric cables are clear of all moving parts on the boom (and the jib, if equipped).
  - e. Make sure that the cables are securely fastened to the boom (and the jib, if equipped) with nylon straps.
  - f. Check that all electric cable connections are securely fastened.
3. Test the block-up limit switches for proper operation using **either** of the two following methods:

- **Boom Lowered Method—**

While the boom is lowered and with the engine running:

Test each block-up limit switch by manually lifting weight. Try to operate the drum. The corresponding load drum should not operate in the up direction and the boom hoist drum should not operate in the down direction.

---

### CAUTION

#### Avoid Sheave Damage

Use extreme care when testing the block-up limits when the boom is raised. If a block-up limit fails to stop the load, immediately stop the hoist.

- **Boom Raised Method—**

Test each block-up limit switch by slowly hoisting one of the load blocks or the hook-and-weight ball against the weight. When the chain goes slack, the corresponding load drum should stop and the boom hoist should not operate in the down direction.

Test each block-up limit switch this way.

---

### CAUTION

#### Avoid Sheave Damage

Do not lengthen or shorten the chains that hold the block limit weights. Proper chain length and weight is necessary for proper switch activation.

If replacement is needed, replace with the same length, size, and material specified in the Parts Manual.

---

## WIRE ROPE INSPECTION AND REPLACEMENT

The following 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 Cranes.

### Wire Rope Lubrication

Refer to the lube folio for lubrication techniques.

---

### CAUTION

#### Prevent Wire Rope Damage!

Do not use grease to lubricate the wire rope. Grease will not penetrate the rope properly and will build up in the valleys between the 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 Manitowoc Crane Care Lattice Team. Otherwise, consult your wire rope supplier.

### Maintain a Wire Rope Condition Report

Always keep a signed and dated periodic inspection report of the wire rope's condition on file. The report must cover all inspection points discussed in this section. The information in the reports can then be used to determine when a wire rope should be replaced.

After initial loading of a new rope, measure and record its diameter for comparison with future inspections. Measure the rope's diameter across the crowns of the strands so the true diameter is measured (see [Figure 5-26](#)).

Wire rope removed from service should be examined and a corresponding report kept. This information can be used to establish a relationship between visual inspection and the rope's actual internal condition at the time of its removal from service. See Replacement Criteria for inspection guidelines.

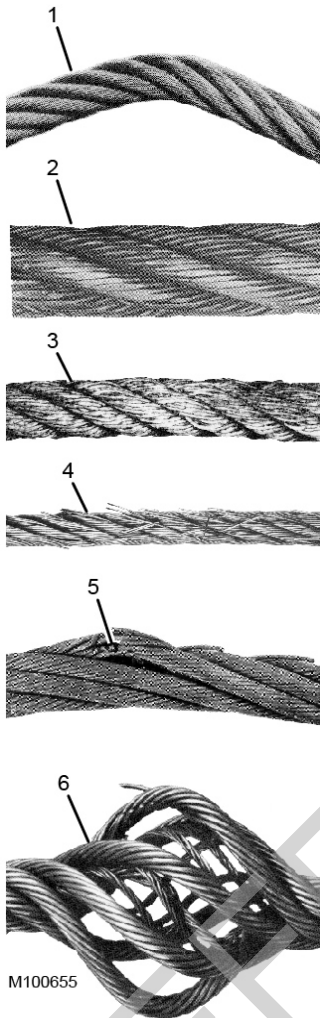
### Required Inspection Intervals

The frequency of wire rope inspection must be:

- Daily (see [Daily Inspection on page 5-40](#)) and
- Yearly (at minimum) (see [Periodic Comprehensive Inspection on page 5-41](#))

### Wire Rope Care and Replacement Guidelines

- When replacing fixed-length wire rope assemblies (such as pendants) having permanently attached end fittings, use only pre-assembled lengths of wire rope as supplied from Manitowoc Cranes. Do not build lengths from individual components.
- Replace an entire wire rope assembly. Do not attempt to rework damaged wire rope or wire rope ends.
- Never electroplate a wire rope assembly.
- Do not weld any wire rope assembly or component unless welding is recommended by the wire rope manufacturer.



M100655

Item	Description
1	Dog-Leg or Kink
2	Drum Abrasion
3	Drum Crushing
4	Sheaves Too Small
5	Corrosion
6	Bird Cage (sudden release of load)

FIGURE 5-25

- Welding spatter must 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.
- Wire ropes are manufactured from special steels. If heating a wire rope assembly is absolutely necessary for removal, the entire wire rope assembly must be discarded.
- On systems equipped with two or more wire rope assemblies operating as a matched set, they must be replaced as an entire set.

- Do not paint or coat wire ropes with any substance except approved lubricants.

## Daily Inspection

Wire rope should be inspected in accordance with ANSI/ASME B30.5 and OSHA 29 CFR 1926.1413. A running record of the condition of each wire rope should be noted in the equipment inspection log.



### WARNING

#### Personal Injury Hazard!

Prior to conducting an inspection of wire rope:

- Stop the engine and lockout-tagout the ignition switch when removing or installing the wire rope assemblies.
- Use safety glasses for eye protection.
- Wear protective clothing, gloves, and safety shoes as appropriate.
- Use supports and clamps to prevent uncontrolled movement of the wire rope, parts, and equipment.

**NOTE:** Daily inspection does not require that the rope be cleaned or probed.

- Each workday, prior to crane work, visually inspect all rope that can reasonably be expected to be used that day. Check for obvious damage, including the following:
  - Rope defects (see [Figure 5-25](#))
  - Loss of rope diameter (see [Reduction in the Rope Diameter on page 5-42](#))
  - Distortion to the uniform structure of the rope
  - Broken wires—Record the number, distribution, and type of broken wires (see [Broken Rope Wires on page 5-42](#))
  - Internal wear or broken wires for ropes operating on synthetic sheaves. Common indicators of internal deterioration include localized reduction in the rope diameter, corrosion between the strands, localized lengthening of lay, wire displacement, or wire distortion.
  - Gross damage, deterioration, or corrosion to the end connections
  - Evidence of heat, electrical, or lightning damage
  - Localized change in lubrication condition
  - Minor or general corrosion
  - Areas that deteriorate more rapidly, such as the flange points, the crossover points, and the repetitive pickup points on the drums

- Take special care to observe the boom hoist ropes and rotation-resistant ropes for evidence of core failure or other deterioration (remove from service)
- Internal deterioration of rotation-resistant ropes may not be readily observable
- Throughout the day, observe the wire rope during operation, particularly at the following locations:
  - a. Repetitive wear points, such as the following:
    - Flange step-up, crossover, repetitive pickup points on drums
    - Reverse bends in the reeving systems
    - Equalizer sheaves
    - End connections
    - Sheave or drum groove wear or corrugation
  - b. Known wear areas based on previous experience or inspections
  - c. Locations where rope vibrations are reduced, such as the following:
    - Sections in contact with equalizer or other sheaves where rope travel is limited
    - Sections of the rope at or near end connections where corroded or broken wires may protrude
    - Rope at the reverse bends in the boom hoist or luffing hoist reeving
    - Repetitive pickup points, crossovers, and change of layers at flanges on the drums
    - Fleeting or deflector sheaves

### Periodic Comprehensive Inspection

The comprehensive inspection must be done by a qualified person. The inspection must include pulling all the rope off the drum and carefully inspecting the entire length.

The inspection must include the following:

- All points listed under [Daily Inspection on page 5-40](#)
- Inspection of the rope diameter (see [Reduction in the Rope Diameter on page 5-42](#))
- Comprehensive examination for broken wires (see [Broken Rope Wires on page 5-42](#))
- End connections. Check for broken wires or severely corroded, cracked, bent, worn, or improperly applied end connections
- Areas subjected to rapid deterioration are as follows:
  - Sections in contact with the saddles, equalizer sheaves, or other sheaves where the wire rope travel is limited
  - Sections of the wire rope at or near the terminal ends where corroded or broken wires may protrude
- Inspection of the boom sheaves, hook block sheaves, gantry/mast sheaves, boom extension/jib sheaves, jib strut sheaves, and hoist drums for wear

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

Any damage of the wire rope found must be recorded and a determination made as to whether continued use of the rope is safe (refer to [Replacement Criteria on page 5-42](#)).



### WARNING

#### Falling Load Hazard!

All wire rope will eventually deteriorate to a point where it is no longer usable.

- As a wire rope approaches the end of its useful life, do inspections more frequently.
- A comprehensive inspection of each wire rope must be performed at least once a year.

### Determining the Frequency of Inspection

Intervals for comprehensive inspections may vary from machine to machine. The inspection interval must be determined by a qualified person and must be based on such factors as the following:

- Expected rope life as determined by experience on the particular installation or similar installations
- Size, nature, and frequency of lifts
- Rope maintenance practices
- Severity of the environment, such as the following:
  - Variation in the temperature
  - Continuous excessive moisture levels
  - Exposure to corrosive chemicals or vapors
  - Subjecting the wire rope to abrasive material
  - Power line contact
- Exposure to abuse and shock loads, such as:
  - High-velocity movement, such as hoisting or swinging a load followed by abrupt stops
  - Suspending loads while traveling over irregular surfaces such as railroad tracks, potholes, and rough terrain
  - Moving a load that is beyond the rated capacity of the lifting mechanism (overloading)

**NOTE:** Inspection intervals may also be predetermined by state and local regulatory agencies.

## Replacement Criteria

### **WARNING** Falling Load Hazard!

Replacement wire rope can break if it does not meet Manitowoc Cranes specifications given in the following publications supplied with your crane:

- Wire Rope Specifications Chart located in the Capacity Chart Manual (for load lines)
- Boom or Jib Assembly drawings located in the Operator Manual (for boom or luffing hoist)
- Mast Assembly drawing located in the Parts Manual

Deciding when a wire rope should be replaced is the responsibility of the qualified person who is appointed to review rope inspection records and evaluate rope condition.

The following are indications that the rope needs to be replaced:

- Reduction in the rope diameter and excessive broken wires (see [Reduction in the Rope Diameter on page 5-42](#) and [Broken Rope Wires on page 5-42](#))
- Wear of one-third of the original diameter of outside individual wires
- Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure
- Evidence of any heat damage from any cause
- Severe corrosion as evidenced by pitting
- Independent wire rope core (IWRC) or strand core protrusion between outer strands
- Obvious damage existing from any heat source including—but not limited to—welding, power line strike, or lightning

### Reduction in the Rope Diameter

A reduction in rope diameter is often the first outward sign that the rope core is damaged. Reduction in the rope diameter can be caused by loss of core support, internal or external corrosion, or wear of the outside wires.

**New Wire Rope**—After initial loading, measure (see [Figure 5-26](#)) and record the diameter of any new wire rope for comparison to future inspections (see [Maintain a Wire Rope Condition Report on page 5-39](#)).

The wire rope must be taken out of service when the reduction from its nominal diameter is more than 5 percent.

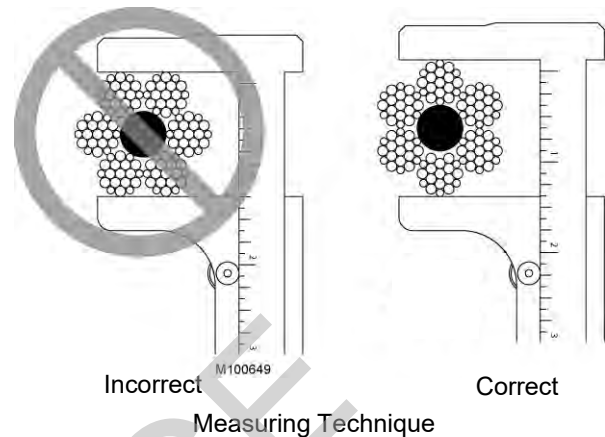


FIGURE 5-26

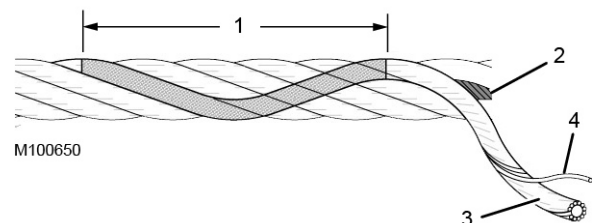
### Broken Rope Wires

### **WARNING** Falling Load Hazard!

A broken wire indicates a weakened wire rope. Replace wire rope when more than one broken wire appears.

When conducting the periodic comprehensive inspection, thoroughly clean the wire rope so breaks can be seen. Relax the rope, move it off “pick-up points,” and flex it as much as possible to uncover damage. Use a sharp awl to lift any wire which appears loose. **Do not attempt to open the rope.**

Wire breaks are typically at the crown of the strands—the area that contacts the sheave or drum when a load is picked up. Breaks at the crown will appear as small gaps in a wire. In comparison, when wires in the valley of a strand break, the broken ends will rise up and are easier to notice.



Item	Description
1	Lay Length: distance in which one strand makes one complete revolution around core
2	Core
3	Strand
4	Wire

FIGURE 5-27

The wire rope must be taken out of service when it has the following number of broken wires (see [Figure 5-27](#) for an explanation of lay length):

- Running Ropes—Six randomly broken wires in one lay length or three broken wires in one strand in one lay length.
- Standing Ropes (pendants)—More than two broken wires in one lay length in sections beyond the end attachment, or more than one broken wire at the end attachment (see [Figure 5-28](#)).
- Rotation-resistant rope—Two randomly distributed broken wires in six-rope diameters or four randomly distributed broken wires in 30-rope diameters.
- All ropes—One outer wire broken at the point of contact with the core and protruding or looping out of the rope structure. Additional inspection is required.
- End attachments (see [Figure 5-28](#))—When more than one broken wire appears at the attachment (indicated by red arrow), replace the rope or cut off the affected area and reattach the fitting.

### Rope That Has Been Idle a Month or More

Wire rope must be given a complete inspection if it has been idle for a month or more. The inspection must be performed by a qualified inspector looking for the damage identified under both daily and periodic comprehensive inspection.

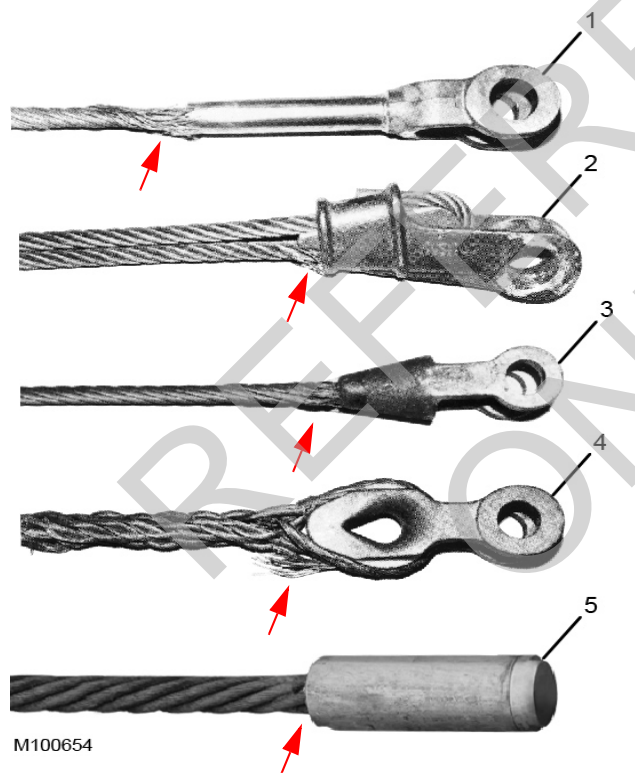
**NOTE:** Wire rope may be purchased through Manitowoc Crane Care Lattice Team.

### Distributing Wire Rope Wear

Wire rope wear at the “critical wear points” can be reduced and the life of the wire rope extended by moving the rope at regular intervals so that different sections of the rope are subjected to the wear points. This practice can also help correct spooling problems and rope vibration.

To move the wire rope, cut off a piece of the rope at the worn end and refasten. The piece should be long enough to move the wire rope at least one full drum wrap.

If the wire rope is too short to allow cutting off a piece, reverse the rope end for end and refasten it.



Item	Description
1	Swagged Socket
2	Wedge Socket
3	Poured Zinc Socket
4	Hand-Spliced Socket
5	Button Socket

FIGURE 5-28

## Seizing and Cutting Wire Rope

Apply tight seizings of annealed wire to the ends of all wire rope. If not done, the rope wires and strands may slacken. This will result in overloading of some strands and underloading of others. Bird-caging and breakage of the wire rope can occur.

Before cutting the wire rope, apply seizings on both sides of the point where the cut will be made. If desired, heavy-duty hose clamps can be used. Then cut the wire rope with a torch, rope cutter, or abrasive cut-off wheel.

See [Figure 5-29 on page 5-44](#) for:

- The number of seizings to be applied to the ends of the wire rope and to both sides of the point where a cut will be made.
- The proper application method. Each seizing should be one rope diameter long.

**NOTE** Per the wire rope manufacturer, rotation resistant stranded ropes should be regarded as non-preformed rope even though the strands may have been partially (lightly) preformed during the closing process.

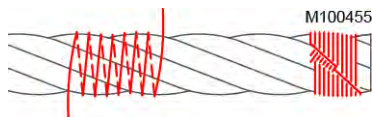
Wire Rope Type	Seizings Required
Preformed	1
Non-preformed	3

Place the free end of the seizing wire in the valley between two strands (view A). Then wind the seizing wire over the free end as shown. Finally, twist and pull the two ends of seizing wire together until the seizing is tight.



**View A**—Rope Diameter 1 in (26 mm) and Larger

Wind the seizing wire around the wire rope (View B). Then twist the two ends of seizing wire together at the center of the seizing. Alternately twist and pull the ends until the seizing is tight.



**View B**—Rope Diameter Smaller than 1 in (26 mm)

**FIGURE 5-29**

## SHEAVE, ROLLER, AND DRUM INSPECTION

Perform the following inspections weekly:

- Check the drum clutches and the brakes for proper adjustment.
- Check all sheaves, rollers, and drums for the following conditions:
  - Unusual noises
  - Freedom of movement—Must turn freely by hand. Wire rope may need to be loosened to perform this inspection.
  - Wobble—Must turn true with very little side-to-side or up-and-down play.
  - Signs of rust (indicating that water may have entered the bearing).
  - Grease leaks (indicating a faulty seal or water in the grease).

The above problems indicate bearing damage. If found, the corresponding sheave, roller, or drum should be disassembled for further inspection. New bearings should be installed.

- Many current production sheaves are not equipped with grease fittings, but are packed with grease at assembly. Repack the bearings of these sheaves with CraneLUBE EP #2 grease when the sheaves are overhauled.

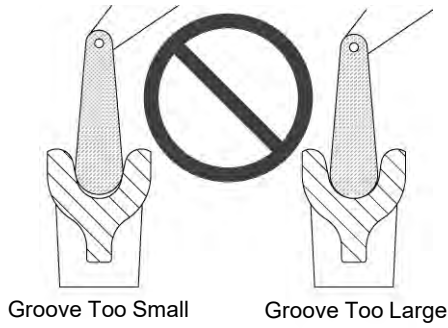
Due to application and design variations, it is not possible to give specific grease repacking intervals or the life expectancy of the components.

Make sure the sheaves, drums, and rollers are properly lubricated according to the instructions in the lubrication guide provided with the crane.

For some sheaves, the seals are an integral part of the bearing. Therefore, if a seal is damaged during repacking, the complete bearing may need to be replaced.

- For steel sheaves, check the depth, width, and contour of each sheave using a groove gauge (see [Figure 5-30](#)). Replace the sheaves that have oversized or undersized grooves.
- Replace any grooved drums that allow one wrap of the wire rope to contact the next wrap as the rope spools onto the drum.
- Inspect the sheaves to verify they do not contact another sheave or structural plate work. There should be uniform clearance between sheaves in a cluster. Repair or replace worn or damaged sheaves.
- Remachine or replace steel sheaves, drums, or rollers that have been corrugated by the wire rope's print (see [Figure 5-31](#)).
- For nylon sheaves see [page 5-47](#).

Observe the groove to see if the contour of the gauge matches the contour at the bottom of the sheave groove.



Proper fitting sheave groove should support the wire rope or 135–150° of rope circumference.

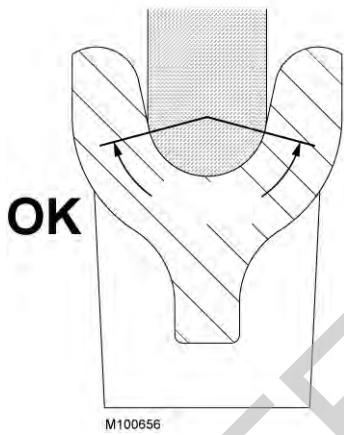
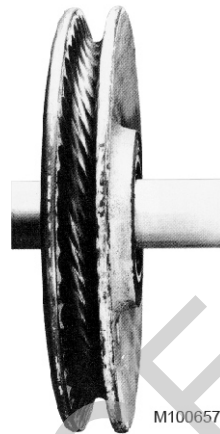


FIGURE 5-30



“Corrugated” steel sheave, roller, or drum will cause the wire rope to wear rapidly.

FIGURE 5-31

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- Measure the nylon sheaves identified in [Figure 5-32](#) for excessive tread wear:
  - 80103997 in gantry and equalizer
  - 171693 in luffing jib main and jib struts

To check for uneven wear, measure at three places.

Wear must not exceed the limit given. Replace worn or damaged sheaves.

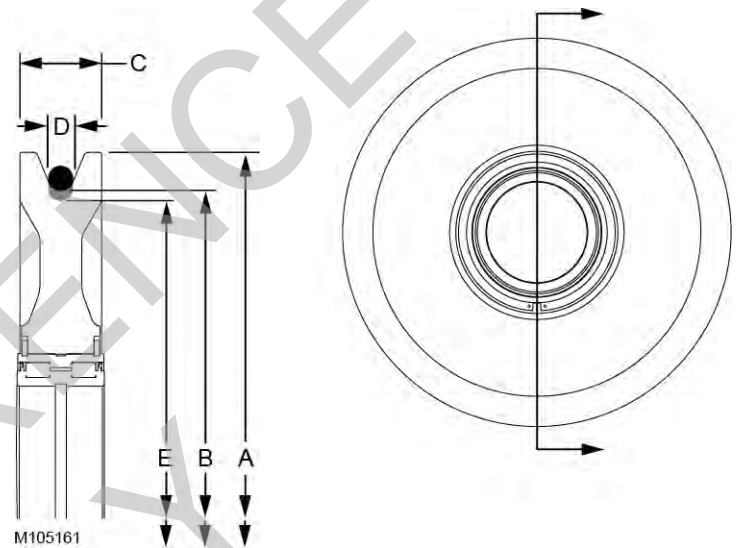
- Depending on the type of wire rope used, it is normal for nylon sheaves to show the wire rope print. Do not remachine the nylon sheaves.

- Nylon sheaves cannot be accurately inspected using conventional methods such as sheave gauges.
- Due to the characteristics of nylon sheaves, the nylon material will actually move to better support the wire rope as the sheave wears normally.
- Nylon sheave properties can be degraded in temperatures above 60°C (140°F).

E = replacement dimension

E = B minus 5 mm (3/16 in) maximum

If a tread print exists in the root of the sheave groove, measure to the maximum tread diameter.



5

PLASTIC SHEAVE DATA				
Sheave Part No.	A Outside Diameter	B Tread Diameter NEW	C Width	D Rope Diameter
	mm (inch)	mm (inch)	mm (inch)	mm (inch)
80103997 Gantry and Equalizer	580,00 (22.83)	510,00 (20.08)	75,00 (2.95)	22,00 (0.87)
171693 Luffing Jib Main and Jib Struts	685,80 (27.00)	584,20 (23.00)	76,20 (3.00)	25,40 (1.00)

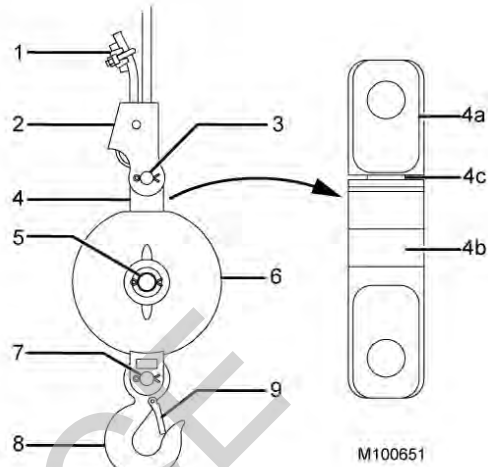
FIGURE 5-32

# LOAD BLOCK AND HOOK-AND-WEIGHT BALL INSPECTION

**WARNING**  
**Falling Load Hazard!**

To prevent the load from dropping due to structural failure of the load block or the hook-and-weight ball, observe the following:

- Only use a load block or a hook-and-weight ball which has the capacity equal to or greater than the load to be handled.
- Do not remove or deface the nameplate (see [Figure 5-33](#)) that is attached to the load blocks and hook-and-weight balls.
- See Section 4 of the Operator Manual for recommended sling angles and capacity restrictions when the load block has a duplex or a quadruplex hook.



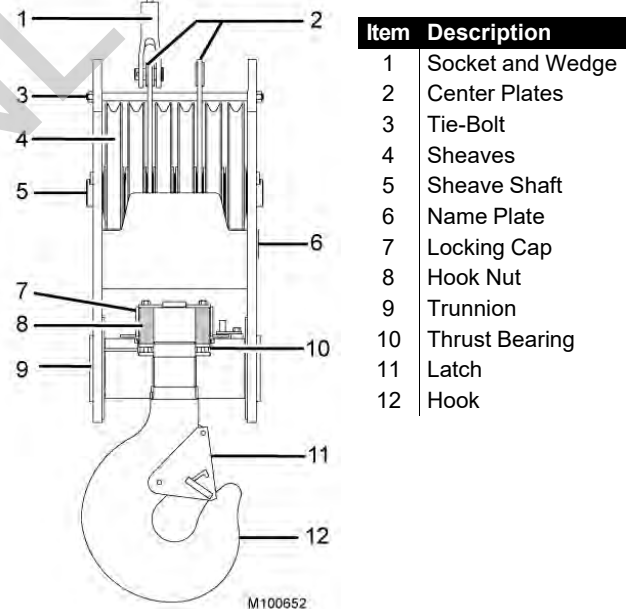
Item	Description	Item	Description
1	Dead-End Clip	4c	Check Gap Here
2	Socket and Wedge	5	Bolt or Pin
3	Bolt or Pin	6	Weight Ball
4	Swivel	7	Bolt or Pin
4a	Swivel Shank	8	Hook
4b	Swivel Barrel	9	Latch

FIGURE 5-34



Item	Description
1	Working Load Limit in Tons (US and metric)
2	Wire Rope Diameter (in and mm)
3	Block Weight (lb and kg)
4	Block Serial Number
5	Block Part Number (OEM and Manitowoc)
6	Design Factor

FIGURE 5-33



Item	Description
1	Socket and Wedge
2	Center Plates
3	Tie-Bolt
4	Sheaves
5	Sheave Shaft
6	Name Plate
7	Locking Cap
8	Hook Nut
9	Trunnion
10	Thrust Bearing
11	Latch
12	Hook

FIGURE 5-35

## Daily Inspection

The operating condition of the load block and the hook-and-weight ball can change daily with use and therefore must be inspected daily (at start of each shift). During operation, observe for any defects which could affect their safe operation. Correct all defects before using the load block or the hook-and-weight ball.

Daily inspection and maintenance will include the following points (see [Figure 5-34](#) and [Figure 5-35](#)):

- Clean the load block or the hook-and-weight ball.
- Lubricate the sheaves (if fittings provided), the hook trunnion, the hook swivel, and any other part equipped with a grease fitting at the intervals specified in the "Lubrication Guide."
- Tighten any loose tie-bolts, cap screws, and setscrews. Check that all the cotter pins are installed with the legs opened and trimmed.
- Check the sheaves for uneven wear in the grooves and on the flanges. Check for loose or wobbly sheaves. These conditions indicate faulty bearings or bushings.
- Check the fit of the wire rope in the groove of each sheave.
  - An oversize wire rope can crack the lip of the sheave flange, causing rapid wear of the wire rope and sheave.
  - The groove must be larger than the wire rope, and the groove must be free of rough edges and burrs.
- Check that the hook, the trunnion, and the swivel rotate freely without excessive play. Faulty operation indicates faulty bushings or bearings or inadequate lubrication.

- Check the swivel of the hook-and-weight ball for the following conditions:

- Overloading—Spin the swivel by hand. If the motion is rough or has a ratchet-like effect, the swivel bearings are damaged.
- Side loading—This can cause the swivel to turn freely in one spot and lock up in another.

This condition can also be checked by checking the gap (see 4c, [Figure 5-34](#)) between the barrel and shank (to check, swivel must be removed from weight ball).

If the gap is wide on one side and closed on the other side, damage is present.

**NOTE:** The gap between the barrel and the shank is normally 0.5 mm (0.02 in) to 1.3 mm (0.05 in). If the gap increases, swivel-bearing failure is indicated.

- Check the load block for signs of overloading:
  - Spread side plates
  - Elongated holes
  - Bent or elongated tie-bolts
  - Cracks
- Check all of the welds for defects and cracks.
- Check the wire rope for wear and broken wires at the point where the wire rope enters the dead-end socket. Check the socket for cracks. Tighten the wire-rope clips located at the dead end of the wire rope.
- Make sure that each hook has a latch and that the hook latch operates properly.

*Continued on next page.*

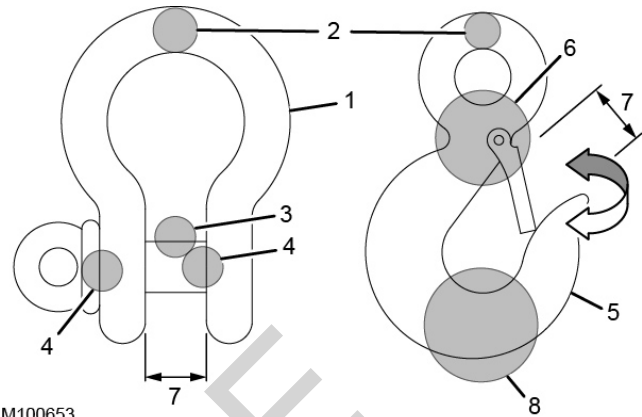
## **! WARNING**

### **Falling Load Hazard!**

To prevent the load from dropping due to a hook or shackle failure, do not attempt to repair any cracks in hooks and shackles by welding.

Do not weld on any load-bearing component unless proper welding methods are used (contact Manitowoc Crane Care Lattice Team for material and welding specifications).

- Inspect each hook and shackle for damage (see [Figure 5-36](#)).
- See the ASME B30-10 Standard for specific hook replacement guidelines. The standards are available as follows:
  - Mail—ASME, 22 Law Drive, Fairfield, New Jersey, 07004-2900
  - Toll-free phone—US & Canada 800-843-2763, Mexico 95-800-843-2763, Universal 973-882-1167
  - Fax—973-882-1717 or 973-882-515
  - E-mail—[infocentral@asme.org](mailto:infocentral@asme.org)
- Contact the supplier of your hooks, shackles, blocks, and other rigging for repair instructions.



Item	Description
1	Shackle
2	Check for Wear and Deformation
3	Check for Wear and Straightness
4	Check That Pin Is Always Seated
5	Hook
6	Check That Hook Is Not Twisted
7	Check for Cracks and Twisting
8	Check for Wear and Cracks

**FIGURE 5-36**

### **Yearly Inspection**

Check each hook and shackle at least yearly for cracks using one or more of the following methods:

- Dye penetrant test
- MAG particle test
- Ultrasonic test
- X-ray

# SECTION 6 SWING SYSTEM

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## SECTION 6

# SWING SYSTEM

### GENERAL

This section provides operational information for the Swing System.

Additional component information for the Swing System can be found in the following sections of this Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

This section also provides maintenance and adjustment procedures for the swing system.

**NOTE:** In the following instructions, **CCS** stands for **Crane Control System**.

### SWING SYSTEM OVERVIEW

The swing system is a closed-looped system consisting of a hydraulic pump and a fixed-displacement motor.

The swing pump is an engine-driven, electronically controlled, bi-directional, variable-displacement pump with electronic displacement control (EDC) that provides hydraulic flow to the swing motor.

The swing motor is a bi-directional, fixed-displacement motor mounted on the planetary swing drive. To swing the crane, the swing motor rotates a pinion gear. The pinion gear meshes with a ring gear that is attached to the carbody, causing the rotating bed to rotate relative to the carbody.

The speed of the swing motor is proportional to the output flow volume of the swing pump that is controlled by the position of joystick J1.

The left-right motion of joystick J1 determines the crane's swing direction and speed. Joystick J1 also has a momentary push-button switch that controls the swing brake.

Joystick J1 communicates with the crane's control system using the controller area network bus (CAN Bus).

Swing speed and swing torque can be selected for the type of work being performed in the Speed and Torque Settings Screen of the main display (see the MLC150-1 Main Display Operation Manual).

### SWING BRAKE OPERATION

The swing brake is a spring-applied, hydraulically-released disc brake located between the swing motor and the planetary swing drive.

The swing brake release system uses pilot pressure from the pilot pump supplied to the swing brake via the swing brake solenoid valve. The brake release pressure must be at least 23 bar (334 psi) to fully release the brake.

If brake hydraulic pressure or electrical control is lost, the swing brake is applied by spring force.

### Park Switch Control

In the UN-PARKED state, the CCS opens the swing brake solenoid valve which then allows pressure from the pilot pump to release the swing brake.

In the PARKED state, the CCS closes the swing brake solenoid valve which then blocks hydraulic oil from the pilot pump and vents the brake pressure to tank. The reduced hydraulic pressure allows the swing brake to spring apply.

### Holding Brake Switch Control

When the swing holding brake switch on joystick J1 is not depressed, the swing brake is released in the normal manner described above.

When the holding brake switch on joystick J1 is depressed, the CCS signals the swing brake solenoid valve to close and apply the brake as described above.

### SWING OPERATION

#### Swing Pump Control

The swing pump is controlled by an electronic displacement control (EDC). The EDC is a proportional solenoid valve that determines the swing pump's output volume and flow direction.

When swing joystick is moved in either direction from off, the CCS sends a pulse-width modulation (PWM) output signal to the EDC. The PWM output generates a control current within the range of 200-600 mA.

The PWM signal is proportional to the speed commanded by the position of joystick J1. Increasing the PWM duty cycle routes more hydraulic fluid to the swashplate servo piston, increasing the swashplate angle. As the swashplate angle increases, so does the piston stroke within the pump, increasing pump output volume and swing speed.

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## Swing Left

When joystick J1 is moved to the left, the joystick sends a swing left command to the CCS. The CCS then ramps up the PWM duty cycle to the proportional solenoid A in the swing pump EDC to move the pump swashplate to a position that meets the direction and speed commanded by the joystick position.

The swing pump sends hydraulic fluid out port B on the pump to port B on the motor. Hydraulic fluid then flows from port A on the motor to port A on the pump to complete the closed-loop circuit.

The swing encoder and swing left psi pressure sensor provide closed-loop feedback to the CCS.

## Cross Port Orifice

The orifice across the A and B sides of the closed loop provides smoother hydraulic fluid flow when shifting swing directions.

## Swing Right

When joystick J1 is moved to the right, the joystick sends a swing right command to the CCS. The CCS then ramps up the PWM duty cycle to the proportional solenoid B in the swing pump EDC to move the pump swashplate to a position that meets the direction and speed commanded by the joystick position.

The swing pump sends hydraulic fluid out port A on the pump to port A on the motor. Hydraulic fluid then flows from port B on the motor to port B on the pump to complete the closed-loop circuit.

The swing encoder and swing right psi pressure sensor provide closed-loop feedback to the CCS.

## Coasting

When joystick J1 is moved back to the neutral position, the CCS ramps down the PWM signal to the energized A or B solenoid in the swing pump EDC. This allows the springs to center the spool inside the proportional solenoid valve, causing the pump swashplate to de-stroke (move to the center position) and stop hydraulic flow to the motor.

With joystick J1 in the neutral position and the swing brake released, the crane is allowed to coast because of an orifice located across the A and B sides of the closed loop. The orifice is connected in parallel with ports A and B of the swing motor, allowing a restricted amount of hydraulic fluid to flow from one side of the motor to the other side without having to go through the pump.

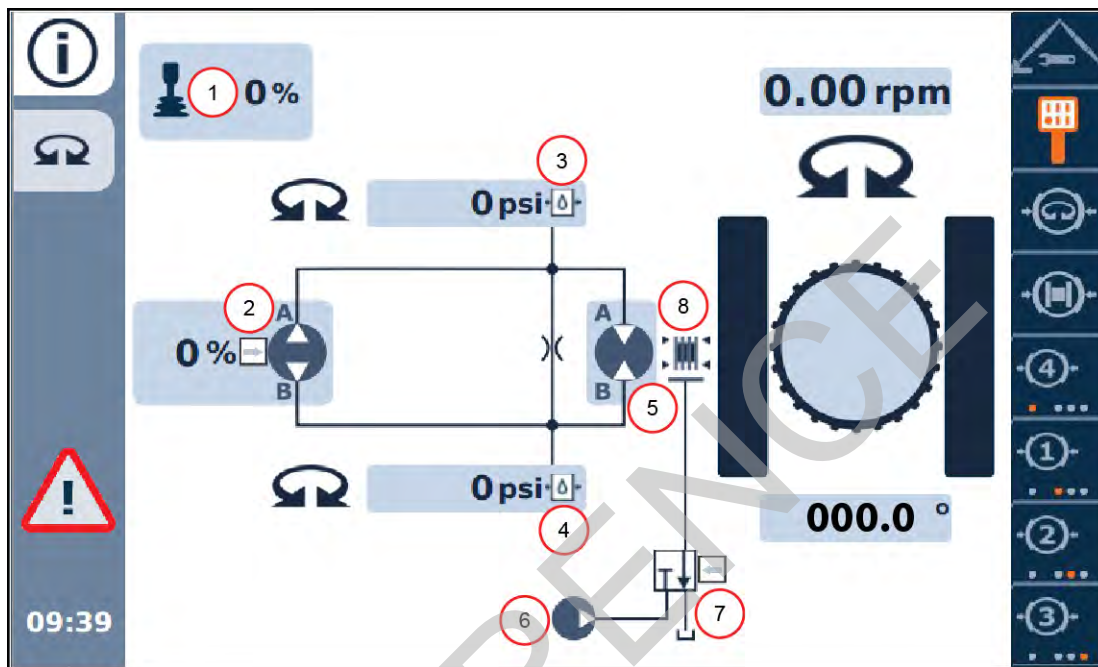
## Swing Alarm

Whenever a PWM signal is sent to the swing pump EDC, the CCS activates the swing alarm.

REFERENCE ONLY

### Swing Hydraulic Diagram

A detailed hydraulic schematic is provided at the end of Section 2 in this Service Manual.



M105071-1

Swing Components			
1	Control Handle (command -100 to 100%: + number = swing right, - number = swing left)	5	Motor
2	Pump (command -100 to 100%: + number = swing right, - number = swing left)	6	Pilot Pump
3	Pressure Sensor (Right Swing)	7	Brake Valve
4	Pressure Sensor (Right Left)	8	Brake

FIGURE 6-1

### Swing Electrical Diagram

A detailed electrical schematic is provided at the end of Section 3 in this Service Manual.

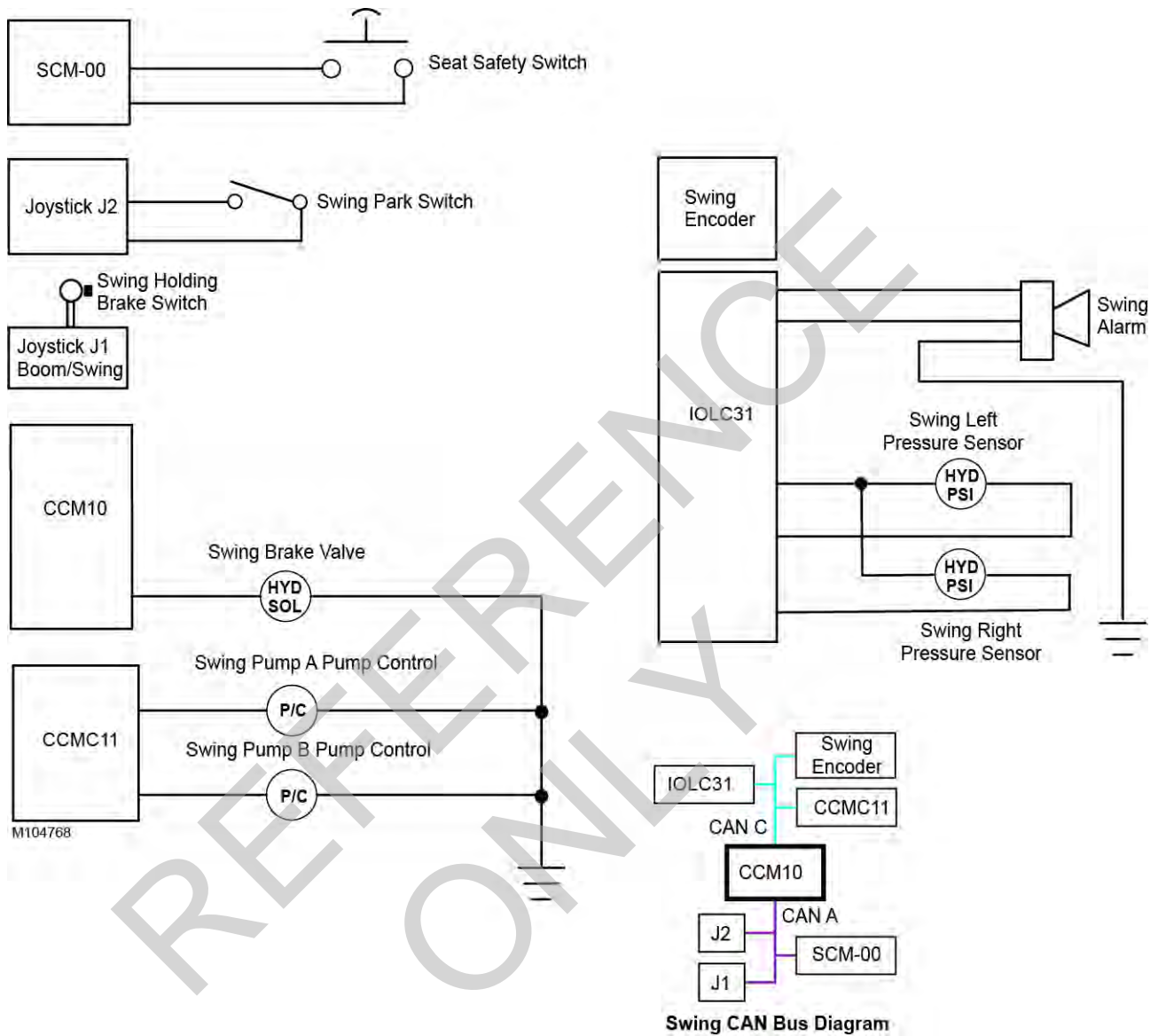
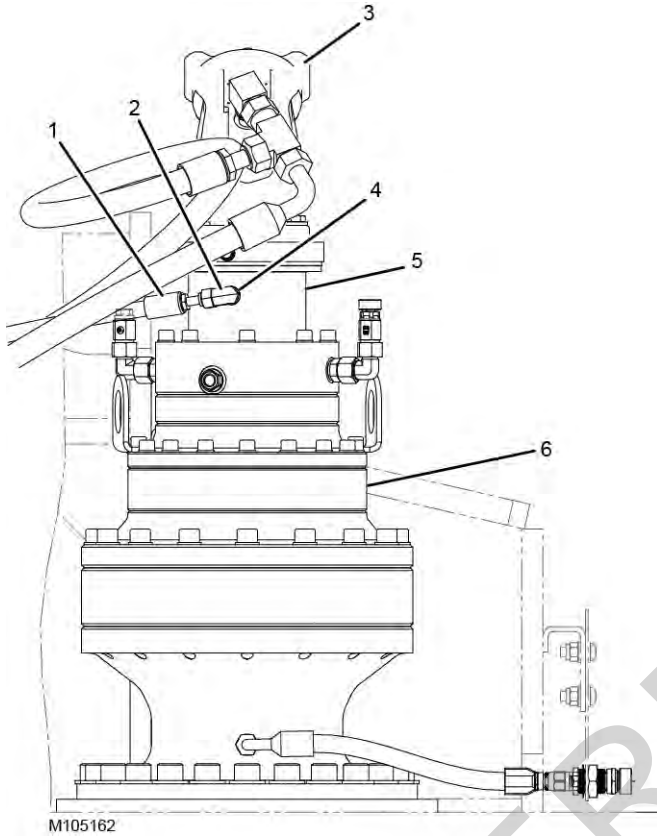


FIGURE 6-2



M105162

Item	Description
1	Swing Brake Release Hose
2	06 ORFS x M12 Elbow
3	Swing Motor
4	M12 Swing Brake Release Port
5	Swing Brake
6	Swing Gearbox

FIGURE 6-3

### SWING BRAKE MANUAL RELEASE

See [Figure 6-3](#) for the following procedure.

The crane has one swing drive.

When removing or installing the swing drive, the swing brake must be released to allow alignment of the swing pinion with the slewing ring gear.



### WARNING

#### Unexpected Crane Movement!

When the swing brake is released, the crane can suddenly swing. Before releasing the swing brake, secure the crane by lowering the boom onto blocking at ground level to prevent sudden uncontrolled swinging.

The swing brake manual release procedure is for servicing purposes only. Do not operate the crane unless the swing brake is fully operational.

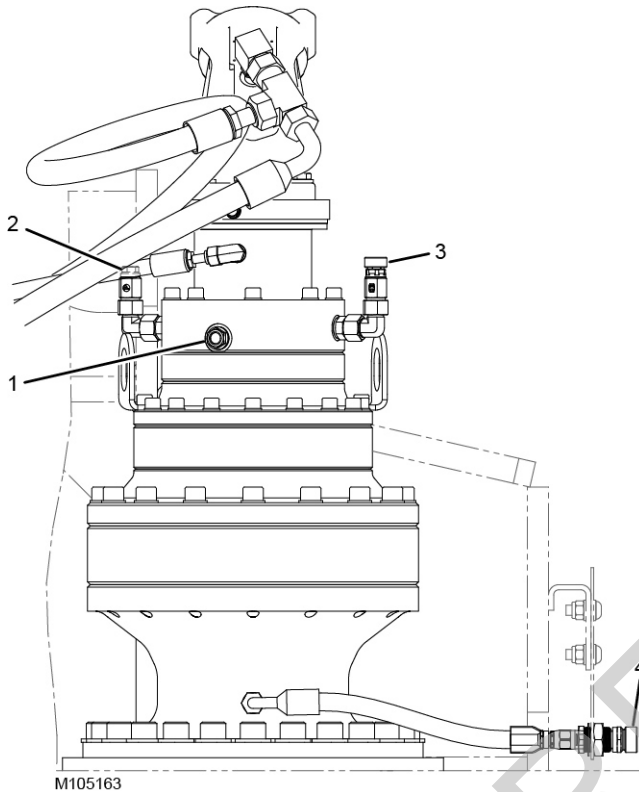
**NOTE:** A hydraulic hand pump with a pressure gauge is needed to manually release the swing brake.

### CAUTION

#### Avoid Damage to Parts!

When releasing the swing brake with the hand pump, do not exceed 40 bar (580 psi) of pressure.

1. Stop the engine and lock out tag out the crane.
2. Disconnect the brake release hose (1) from the elbow (2) in the brake release port (4).
3. Connect the hand pump hose to the elbow (2) with user-supplied 06 ORFS fittings.
4. To release the brake, pressurize it to 23 bar (334 psi) with the hydraulic hand pump.
5. Service the swing drive as required.
6. At the completion of servicing, perform the following procedure:
  - a. Apply the swing brake by relieving the pressure with the hand pump.
  - b. Disconnect the hand pump hose from the elbow (2) in the brake release port (4).
  - c. Connect the brake release hose (1) to the elbow (2).
7. Clean up any spilled oil.



Item	Description
1	Sight Gauge (Qty 2)
2	Fill Cap
3	Breather
4	Quick-Drain Valve

FIGURE 6-4

## SWING GEARBOX OIL CHANGE

See [Figure 6-4](#).

Swing gearbox maintenance consists of periodically checking the level and changing the oil.

### Gear Oil Specifications

For gear oil specifications and the swing gearbox capacity, see the Lubrication Guide supplied with the crane.

### Oil Analysis

An oil analysis program is the best way to determine the optimal oil change interval and the condition of the swing gearbox.

### Periodic Maintenance

#### Oil Level Interval

Check the swing gearbox oil level weekly **or** every 10 hours of swing operation **or** every 20 hours of engine operation, whichever occurs first.

Remove the fill cap (2) and fill the swing gearbox through the fill port to middle of the sight gauge (1).

#### Initial Drain Interval

Drain and refill the swing gearbox after the first 200 hours of engine operation.

#### Breather Cleaning Interval

Clean the swing gearbox breather weekly **or** every 40 hours of engine operation.

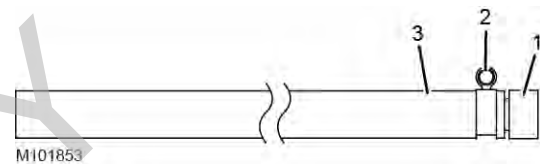
Clean the breather by soaking it in a non-flammable solvent and blowing it thoroughly dry with compressed air.

#### Oil Change Interval

Drain and refill the swing gearbox semiannually **or** every 200 hours of swing operation **or** every 1000 hours of engine operation, whichever occurs first, unless an alternate interval has been established through an oil analysis program.

#### Quick-Drain Valve

The swing gearbox is equipped with a quick-drain valve (4), which requires use of the quick-drain drainer assembly (see [Figure 6-5](#)). The quick-drain drainer assembly is stored in the parts box supplied with the crane.



Item	Description
1	Quick-Drain Drainer
2	Hose Clamp
3	Hose: 19 mm (3/4 in) Inside Diameter by 3.0 m (10 ft) Long

FIGURE 6-5

### Oil Change Procedure

Change the oil when the gearbox is warm, not hot.

**NOTE:** To prevent harmful contaminants from entering the gearbox, thoroughly clean components before disconnecting or connecting them.

See [Figure 6-4](#) for the following procedure.

1. Lock out tag out the crane.
2. Remove the dust cap from the quick-drain valve (4).
3. Place the hose from the quick-drain drainer assembly ([Figure 6-5](#)) into a suitable container for collecting the drained oil: 11 L (2.9 gal) of oil is required to fill a dry gearbox.

4. Thread the quick-drain drainer assembly hose to the quick-drain valve. The poppet inside the valve will open allowing the oil to drain from the gearbox.
5. Once the gearbox has finished draining, remove the quick-drain drainer assembly.
6. Fasten the dust cap to the quick-drain valve.
7. Fill the gearbox with specified oil:
  - Manual Fill Procedure**
    - a. Remove the fill cap (2) from the fill port.
    - b. Add oil through the fill port using a suitable funnel until the oil level is halfway up the sight gauge (1). Do not overfill.
    - c. Reinstall the fill cap (2) in the fill port.
  - Power Fill Procedure**
    - a. Remove the dust cap from the quick-drain valve (4).
      - b. Thoroughly clean the inside of the hose for the existing quick-drain drainer assembly.
      - c. Thread the quick-drain drainer assembly all the way onto the quick drain valve. The poppet inside the valve will open.
      - d. Connect the hose from the quick-drain drainer assembly to a portable pump, either hydraulically powered or hand powered.
      - e. Slowly pump oil into the gearbox until the oil level is halfway up the sight gauge (1). Do not overfill.
      - f. Once the gearbox is filled, remove the quick-drain drainer assembly.
      - g. Fasten the dust cap to the quick-drain valve.
    8. Recheck the oil level, as required, after operating the swing drive.
    9. Thoroughly clean the quick-drain drainer assembly and store it in the parts box.

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## SECTION 7

### POWER TRAIN

#### BATTERY INFORMATION

##### Battery Safety

 **WARNING**  
**Explosion Hazard!**

Batteries can violently explode, spraying acid, if a spark or flame is brought too close. The room or compartment in which batteries are stored must be ventilated and away from flames or sparks.

**Chemical Burn Hazard!**

Battery electrolyte can cause severe burns. If electrolyte comes in contact with eyes, skin, or clothing, the area must be immediately flushed with large amounts of water.

Seek medical attention in the event of an electrolyte burn.

Always wear eye protection when servicing batteries.

##### Battery Gases Are Explosive



Avoid sparks while charging batteries. Do not disturb the connection between the batteries until the charger is turned off.

Another source of explosion lies in the reverse connection of the charging equipment. This hazard is present with all

types of chargers, but particularly in the case of high-rate equipment. Carefully check the connections before turning on the charger.

##### Jump-Starting a Battery

Improper use of a booster battery to start a crane presents an explosion hazard. To minimize this hazard, the following procedure is suggested.

1. Connect one end of each jumper cable to the proper battery terminals on the crane to be started. Do not allow the cable ends to touch.
2. Connect the positive cable to the positive terminal of the booster battery.
3. Connect the remaining cable to the frame or block of the starting vehicle. Never connect it to the grounded terminal of the starting vehicle.

##### Causes of Battery Failure

A battery should never be left in a discharged state. When discharged, it rapidly sulfates and, unless recharged within hours, will permanently lose capacity.

##### Overcharging

Overcharging is one cause of battery failure and is most often caused by a malfunctioning voltage regulator.

Excessive heat is the result of overcharging. Overheating causes the plates to warp, which can damage the separators and cause a short circuit within a cell. This bubbling and gassing of the electrolyte can wash the active material from the plates, reducing the battery's capacity or causing an internal short.

##### Undercharging

Undercharging can cause a type of sulfate to develop on the plates. The sulfate reduces the battery capacity and causes strains in the positive plates, which cause plate buckling. Buckled plates can pinch the separators and cause a short circuit. An undercharged battery is not only unable to deliver power, but also may freeze (see [Table 7-1](#)).

**Table 7-1. Battery Freeze Points**

State of Charge	Specific Gravity	Freeze Point °C (°F)
100%	1.26	-57 (-70)
75%	1.23	-38 (-36)
50%	1.20	-26 (-15)
25%	1.17	-19 (-2)
0%	1.11	-8 (18)

##### Lack of Water

The plates must be completely covered with electrolyte. If the plates are exposed, the high acid concentration will char and disintegrate the separators. The plates cannot take a full charge if they are not completely covered by the electrolyte.

##### Loose Hold-Down Plate

A loose hold-down plate ([Figure 7-2, page 7-3](#)) or mounting brackets will allow the battery to vibrate. This can cause cracks or wear in the battery container and cause the acid to leak. Leaking acid corrodes terminals and cables, causing high resistance at the battery connections, which weakens the battery. Hold-down clamps can also distort or crack the container.

Makes sure all mounting hardware is securely tightened.

##### Overloads

Avoid prolonged cranking or the addition of extra electric devices. These can drain the battery and may cause excessive heat.

M105165

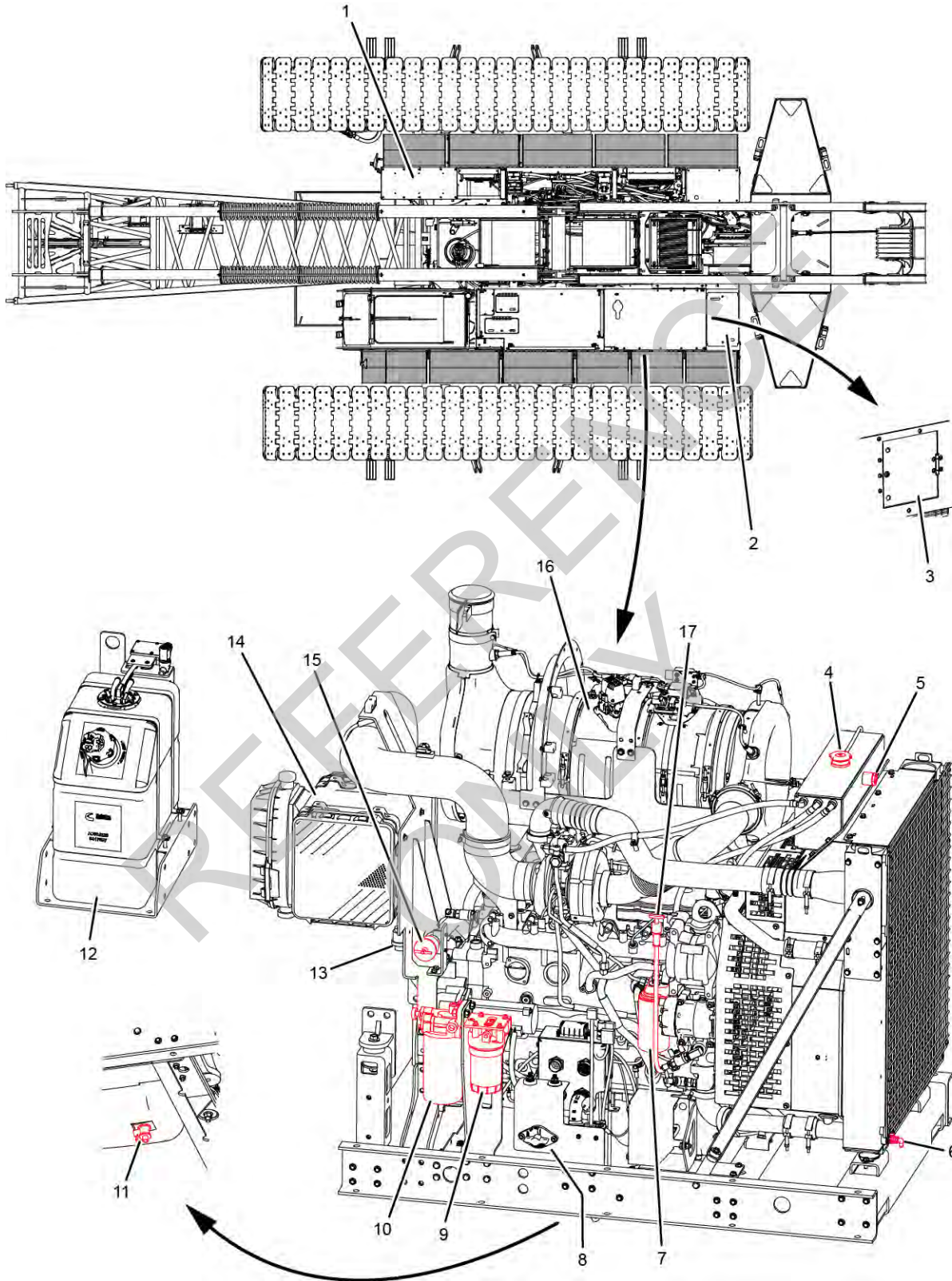
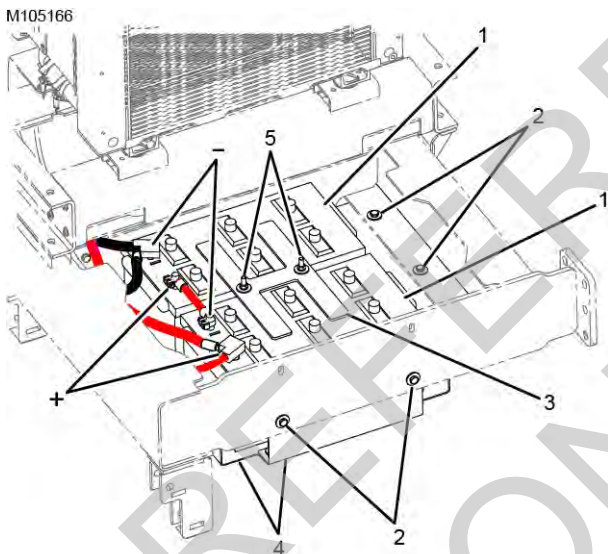


FIGURE 7-1

Legend for [Figure 7-1](#)

Item	Description
1	Fuel Tank
2	Battery Compartment Cover
3	Lockable Access Door (coolant fill cap and sight gauge)
4	Coolant Fill Cap
5	Coolant Level Gauge
6	Coolant Drain Valve
7	Engine Oil Filter
8	Battery Disconnect Switch
9	Primary Fuel Filter
10	Fuel Pre-Filter/Water Separator with Drain Valve
11	Engine Oil Drain Valve
12	DEF Tank
13	Air Cleaner Service Indicator
14	Air Cleaner
15	Engine Oil Fill Cap
16	Exhaust Aftertreatment System
17	Engine Oil Dipstick



Item	Description
1	Battery (Qty 2)
2	Battery Support Mounting Screws, Washers, and Lock Nuts
3	Hold-Down Plate
4	Battery Supports (Qty 2)
5	Hold-Down Rods, Washers, and Nuts
+	Positive Terminal (Qty 2)
-	Negative (Ground) Terminal (Qty 2)

FIGURE 7-2

### Multiple Battery System

The crane's 24 V system is powered by two 12 V batteries connected in series (see [Figure 7-2](#)).

Connect the battery cables as indicated. Be careful not to reverse the battery connections. Installing the batteries with reversed connections will damage not only the batteries but also the crane's electrical system, voltage regulator, and/or alternator.



### WARNING Personal Injury Hazard!

Each battery weighs about 59 kg (130 lb). Use proper lifting procedures.

### Checking Battery State of Charge

Special equipment is required to properly determine the condition of a battery that has been in service. However, a voltmeter can be used to determine a battery's state of charge by checking the voltage between the battery terminals (see [Figure 7-3](#)).

This open-circuit test is the simplest test, but not as accurate in determining a battery's condition as a hydrometer test. The advantage is that the cell covers do not need to be opened, eliminating the possibility of cell contamination and electrolyte spillage.

**NOTE:** Do not use this test method if the battery has been recently charged by a charger or alternator. Recent charging places a high surface charge voltage on the battery, which is not a true indication of actual battery voltage.



V1102428

Item	Description
1	Test Leads on Battery Terminals
2	Voltmeter

FIGURE 7-3

Table 7-2. Open Circuit Voltage

State of Charge	Specific Gravity	Approximate Open-Circuit Voltage (24 V system)
100%	1.260	25.2
75%	1.230	24.8
50%	1.200	24.4
25%	1.170	24.0
0%	1.110	23.6

Consult the manual provided with the test meter for detailed test information.

## Troubleshooting—Slow Cranking

If the starter cranks too slowly and the battery is charged and in good condition, do a voltage-drop test to make sure that the starter connections are good.

When cranking, a voltage drop of more than 0.6 volts between the starting motor cable and ground can cause hard starting regardless of a battery's condition. The voltage drop can be caused by a poor contact between the cable terminal and ground or between the clamp terminal and the battery post. Also, poor start-switch contacts and frayed, broken, or corroded cables can be the cause.

## Charging



### WARNING

#### Personal Injury Hazard!

Exposure to battery electrolyte can cause severe burns. If electrolyte comes in contact with eyes, the area must be immediately flushed with large amounts of water.

Always wear eye protection when servicing batteries.

**NOTE:** If the crane is equipped with the optional charger, see [Engine Operation on page 7-5](#).

1. Remove the battery or disconnect all of the crane wiring from the battery.
2. Read and follow the charger manufacturer's instructions.

**NOTE:** The battery should be at room temperature when recharging. Never attempt to recharge a frozen battery.

3. Clean the top of the battery to help prevent dirt from entering the cells.
4. Remove the vent caps and verify the plates are covered with electrolyte. If the level is low, add distilled water to

bring the level just to the top of the plates. Use a clean funnel. Re-check the electrolyte level after charging.

- The maximum charge rate in amperes should be no more than 1/3 of the battery's reserve capacity minute rating.

**NOTE:** The Deka 908D battery originally supplied with the crane has a reserve capacity rating of 430 minutes.

- Do not exceed 13.8 volts for long periods and 14.4 volts for short periods (8 hours maximum).
- Charge until a 2-hour period results in no increase in voltage or decrease in current.

**NOTE:** Overcharging shortens a battery's life.

If the battery becomes hot to the touch or if it gases violently, temporarily halt charging or reduce the charging current.

## Storage

When the crane is left idle for prolonged periods, the batteries should be periodically charged.

When storing batteries, make sure they are fully charged to prevent sulfation and the possibility of freezing.

Follow your battery dealer's recommendations.

## BATTERY MAINTENANCE

### Quarterly or Every 500 Hours of Engine Operation (whichever occurs first)

See [Figure 7-2, page 7-3](#) for the following procedure.

- Thoroughly clean the batteries with a baking soda/water solution.
- Clean the posts and terminals. The posts can be lightly coated with petroleum jelly to prevent corrosion.
- Check the electrolyte levels. If required, add additional electrolyte to bring all levels to the bottom of the vent wells. DO NOT OVERFILL. If the batteries require topping off while in service, add distilled water — DO NOT ADD ACID.
- Replace frayed, broken, or corroded cables.
- Replace the batteries if their containers are cracked or worn to the point that they leak.
- Ensure there is tight contact between the clamp terminals and battery posts.
- Make sure the hold-down plate and mounting brackets are in good condition. Replace any faulty parts.
- Make sure the hold-down clamp is tight enough to prevent battery movement, but not so tight as to cause distortion.

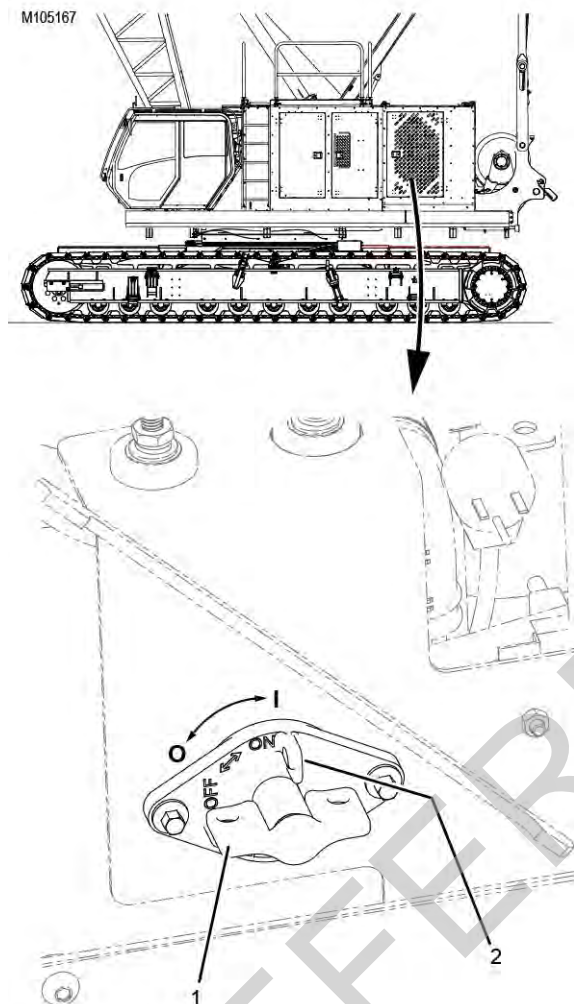


FIGURE 7-4

Item	Description
1	Battery Disconnect Switch
2	Padlock Holes
I	Connect Batteries. (ON)
O	Disconnect Batteries (OFF)

## BATTERY DISCONNECT SWITCH

### CAUTION

#### Engine Damage

To avoid possible engine fault codes and undesirable operation, make sure engine ignition switch has been off five minutes before disconnecting batteries.

Do not rely on this switch to protect crane's electronic systems when welding. Disconnect battery cables at batteries before welding.

The battery disconnect switch (Figure 7-4) is located on the engine enclosure in the left side enclosure. It can be locked with a padlock in either position, ON or OFF.

The switch disconnects the positive side of the batteries from the crane's electrical control system.

Turn the switch handle clockwise to connect (turn on) the batteries to the electrical control system.

Turn the switch handle counterclockwise to disconnect (turn off) the batteries from the electrical control system.

Use the disconnect switch for the following situations:

- When servicing the crane's electrical control system
- To help prevent the batteries from discharging when the crane is stored for extended periods of time
- To prevent the crane from being started by unauthorized personnel

### CAUTION

#### Avoid Control System Damage!

Before welding:

- Disconnect the battery cables at the batteries.
- Disconnect the cabling from any control modules that are in the vicinity of the welding.

Do not rely on the battery disconnect switch to protect the crane's electronic control systems when welding.

## ENGINE OPERATION

For detailed engine startup and shutdown instructions, refer to Section 3 of the MLC150-1 Operator Manual and to Cummins Owner's Manual supplied with the crane.

The engine is started and stopped with the engine key switch on the right control console in the operator cab.

An emergency stop button is provided adjacent to the key switch. The emergency stop button must be pulled up before the engine can be started. When this button is depressed, the crane engine shuts off, the brakes apply, and the currently operated crane functions come to a complete stop. For normal engine shut down, use the engine ignition switch.

An engine hand throttle is located on the left control console in the operator cab and a foot throttle is provided on the cab floor.

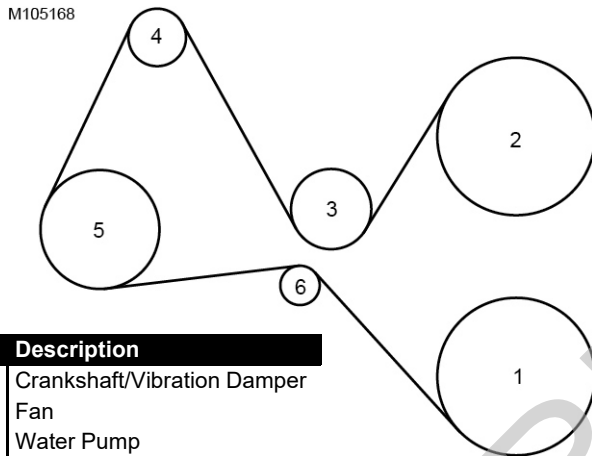
The speed of the crane functions depends on engine speed and function control handle movement. Engine speed must be fast enough to provide sufficient power for the work being done. **The engine can stall under the load if the engine speed is too slow.**

## ENGINE MAINTENANCE

For detailed engine maintenance and service instructions refer to the Cummins Owner's Manual supplied with the crane.

Additionally, refer Cummins QuickServe Online. For access to the online internet site, contact your local Cummins Dealer.

## ENGINE BELT ROUTING



Item	Description
1	Crankshaft/Vibration Damper
2	Fan
3	Water Pump
4	Refrigerant Compressor
5	Alternator
6	Tensioner Idler

FIGURE 7-5

when the yellow stem reaches the red zone of the window.

The yellow stem remains locked in place when the engine is stopped. The reset button (1B) on the top of the indicator can be pressed at any time. When the engine is started, the indicator stem returns to the proper reading.

## Monthly Inspection

### *Monthly or Every 200 Hours of Engine Operation (whichever occurs first)*

- Inspect the rubber reducers, the reducing elbows, and the tubing between the air cleaner and the engine for cracks or other damage that might allow unfiltered air to enter the engine. Replace worn or damaged parts.
- Check for loose clamps. Tighten as required.
- Check the air intake housing (1), the pre-cleaner housing (2) and the air cleaner housing (4) for damage that may allow unfiltered air to enter the engine. Replace damaged parts.
- Inspect the air cleaner cover (6). Make sure it is securely in place.
- Check that the air intake housing seals are not damaged or missing. Replace as needed.
- Make sure the air inlet holes in the left enclosure door are open and free from obstructions.
- Make sure the air inlet housing is clean and free from obstructions.

## AIR CLEANER MAINTENANCE

See [Figure 7-6](#) for the following procedures.

The air cleaner requires periodic maintenance due to the following:

- Clogged air cleaner filters prevent adequate air flow to the engine, causing poor starting and increased exhaust emissions.
- An improperly installed or damaged air cleaner can allow dirty air to be drawn directly into the engine.

Either condition can cause engine damage. To maintain engine protection and air cleaner filter service life, inspect the air cleaner at the following intervals.

### Daily Inspection

#### *Daily or Every 8 Hours of Engine Operation (whichever occurs first)*

Check the service indicator (1) with the engine running. The indicator gives a visual indication when it is time to change the air cleaner filters.

A yellow stem in the indicator window (1A) extends as the air cleaner filters become plugged. Change the air cleaner filters

## CAUTION

### Avoid Engine Damage!

- Stop the engine before servicing the air cleaner. Otherwise, unfiltered air will be drawn directly into the engine. Never operate the engine without the air cleaner or filters.
- Before servicing, clean the fittings, the mounting hardware, and the area around the components to be removed.
- Do not attempt to clean and reuse old filters. Discard them and install new filters. Cleaning filter elements by impact or compressed air voids the warranty and can degrade or damage the filter media, leading to engine damage.

## Changing the Air Cleaner Filters

- Lock out tag out the crane.
- Un-clip and remove the cover (6).
- Remove the primary filters (7) gently to avoid dislodging dust from the filters.

There will be some initial resistance, similar to breaking the seal on a jar. Using the handle (7A) on each filter, move the end of the filter back and forth to break the seal.

4. If required, remove the secondary filter (8) by pulling on the tabs (8A). Take care to avoid dislodging dust from the filter.

**NOTE:** Replace the secondary filter (8) **every third time** the primary filters (7) are replaced.

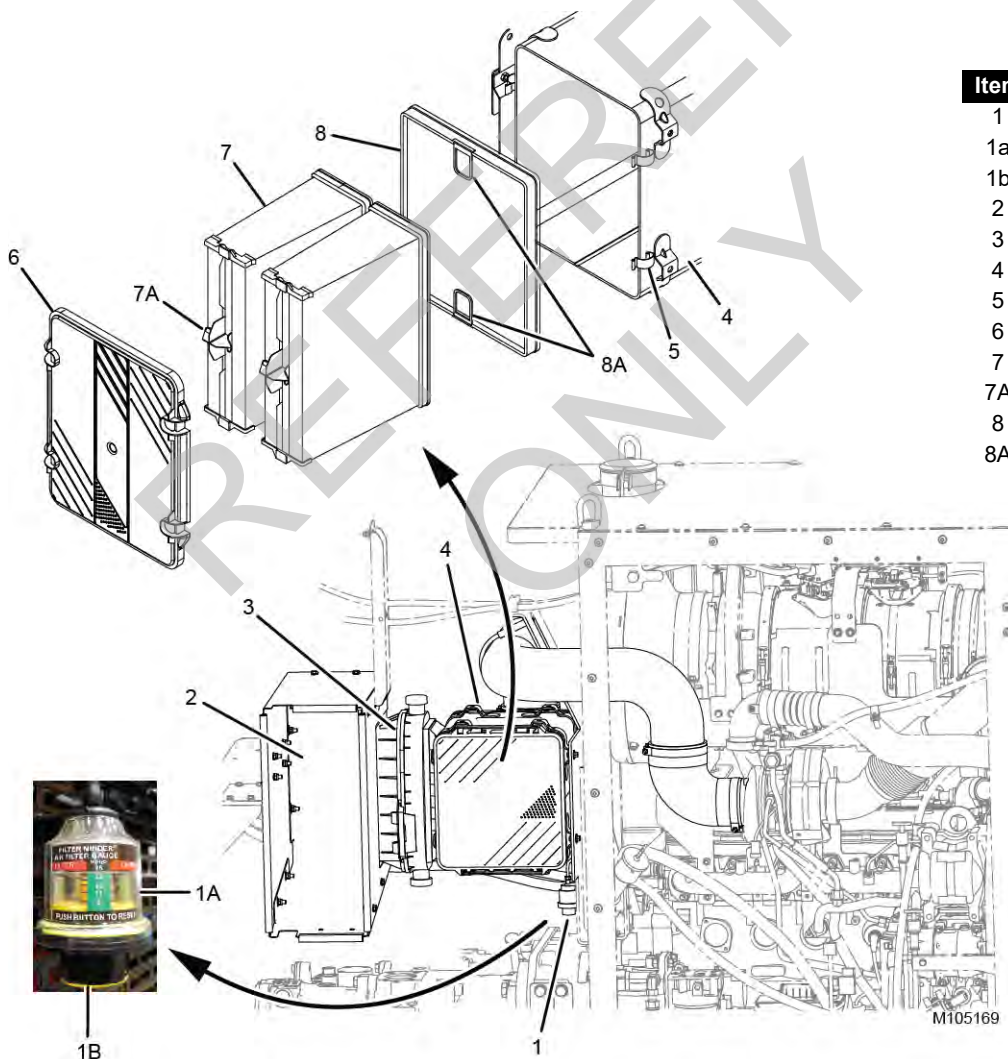
5. **Do not clean or reuse the filters.** Dispose of them according to local environmental regulations.
6. Using a clean damp cloth, wipe clean the inside of the cover, the sealing surfaces, and the inside of the air cleaner housing. These areas must be clean and free of grease and loose contaminants.
7. Inspect the new filters, especially the sealing areas. **Never install damaged filters.**

The filters have O-rings that provide an air-tight seal.

8. If removed, carefully install the new secondary filter (8) – O-ring side first – with the plastic rings and gently push it into the back of the housing. Apply pressure to all four corners to make sure the filter is completely secure in the housing.
9. Carefully install the new primary filters (7) – O-ring side first – using the handles. Make sure all surfaces are sealed inside the housing.
10. Make sure the seal is in place and install the cover (6) with the clips (5). The cover should go on without extra force.

Never use the clips on the cover to force the filters into the air cleaner. It is tempting to assume that the cover will do the job of sealing the filters, but it will not. Using the cover and clips to push the filters into the housing could damage the housing and will void the warranty.

11. Push the reset button (1B) on the service indicator (1).



Item	Description
1	Service Indicator
1a	Indicator Window
1b	Reset Button
2	Air Intake Housing with Seals
3	Pre-Cleaner (not serviceable)
4	Air Cleaner Housing
5	Clip (Qty 4)
6	Cover
7	Primary Filter (Qty 2)
7A	Handle
8	Secondary Filter
8A	Plastic Rings

FIGURE 7-6

M105170

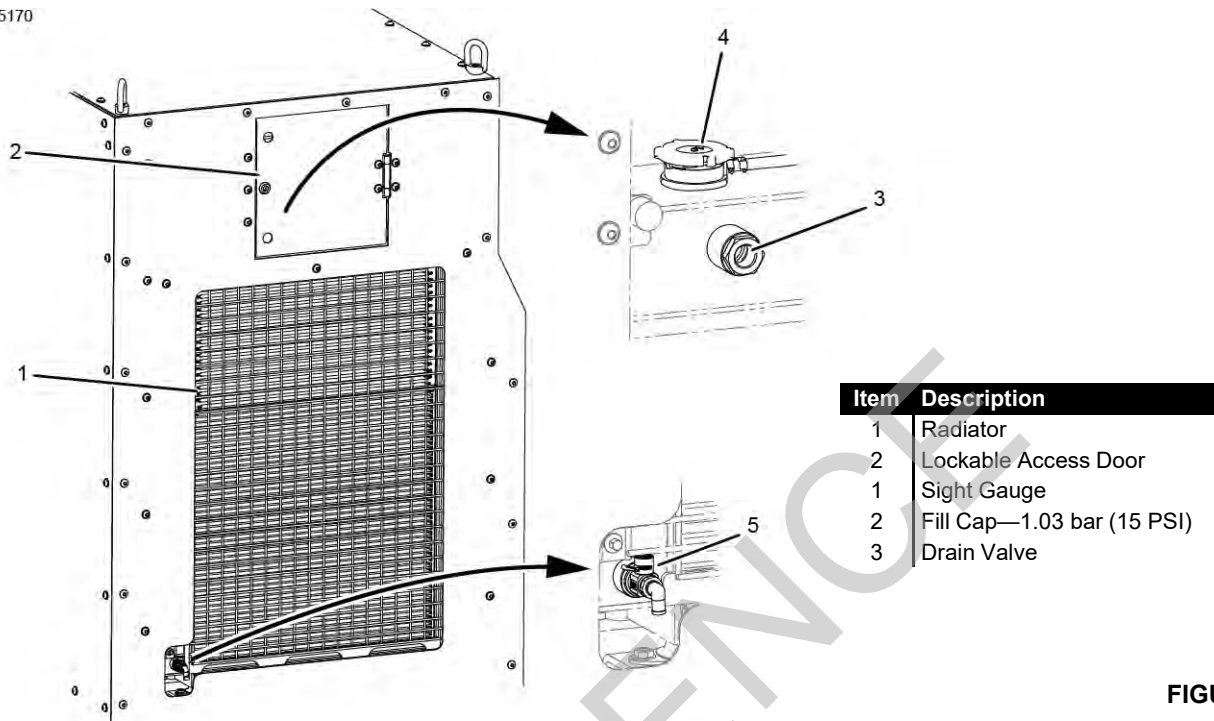


FIGURE 7-7

## ENGINE COOLING SYSTEM

### **! WARNING** Burn Hazard!

Hot and pressurized coolant can burn, causing serious injury. Do not remove the coolant fill cap while the coolant is hot. Wait for it to cool to below 50°C (120°F).

### **Material Hazard!**

Coolant is toxic. Do not ingest. Dispose of in accordance with all local and other applicable environmental regulations.

## Checking Coolant Level

**Daily (at start of shift) or Every 8 Hours of Engine Operation (whichever occurs first) — when coolant is cold**

For service other than checking the coolant level, refer to Cummins' literature/online site for detailed instructions.

See [Figure 7-7](#).

1. Stop the engine and lockout-tagout the ignition switch.
2. Unlock and open the access door (2).
3. The coolant must be at the middle of the sight gauge (3). Add coolant if necessary.

4. To prevent engine damage, stop the engine and wait until the coolant temperature is below 50°C (122°F).
5. Take care to prevent being burned by hot coolant as follows.
  - a. Place a heavy cloth over the fill cap (4).
  - b. Turn the fill cap counterclockwise until the pressure starts to release (indicated by a hissing sound).
  - c. Wait for the pressure to escape completely.
  - d. Turn the fill cap fully counterclockwise and remove it.
6. Slowly add a 50/50 coolant mixture of water and ethylene glycol until the coolant is at the middle of the sight gauge (3).
7. Securely install the fill cap (4).
8. Close and lock the access door (2).

## Changing Coolant

**Every Other Year or Every 2000 Hours of Engine Operation (whichever occurs first)**

See [Figure 7-7](#).

### Draining

1. Stop the engine and the ignition switch.
2. Attach a drain hose to the drain valve (5). Place the other end of the drain hose into a suitable container that



can hold 30 L (8 gal) of coolant.

3. Take care to prevent being burned by hot coolant as follows.
  - a. Wait until the coolant temperature is below 50°C (122°F).
  - b. Place a heavy cloth over the fill cap (4).
  - c. Turn the fill cap counterclockwise until the pressure starts to release (indicated by a hissing sound).
  - d. Wait for the pressure to escape completely.
  - e. Turn the fill cap fully counterclockwise and remove it.
4. Open the drain valve (5).
5. Close the drain valve and remove the drain hose once the cooling system has completely drained.
6. Dispose of the drained coolant according to local environmental regulations.
7. Inspect the cooling system:
  - Check for damaged hoses and loose or damaged hose clamps. Replace as required.
  - Check the radiator for leaks, damage, and dirt buildup. Clean and replace as required.

### Flushing

If it is necessary to flush the cooling system, refer to Cummins' literature/online site for detailed instructions.

### Filling

1. The system has a maximum fill rate of 19 L (5 gal) per minute. Fill the system slowly to allow air to vent.
2. While allowing air to vent, slowly add supplemental coolant additive (SCA) and a 50-50 coolant mixture to the radiator through the fill cap opening.  
  
Refer to the Cummins' literature/online site for specific SCA and coolant recommendations.
3. Once coolant is visible in the middle of the sight gauge (3), wait 2 to 3 minutes before starting the engine to

allow the system to naturally purge entrained air and to allow the coolant level to stabilize.

4. Add a 50/50 coolant mixture to bring the coolant to the middle the sight gauge (2).



## WARNING

### Chemical and Burn Hazard!

Coolant could spray from an open radiator cap while the engine is running. Do not stand near the radiator while operating the engine with the pressure cap removed.

5. Check that both cab heater valves on the engine are open.
6. In the cab, place the heat control to maximum.
7. With the fill cap removed:
  - Start the engine and operate it at low idle for 2-3 minutes.
  - Stop the engine and add a 50/50 coolant mixture to bring the coolant to the middle the sight gauge (3).

**NOTE:** After starting a cold engine, increase engine speed slowly to provide adequate bearing lubrication and to allow oil pressure to stabilize.

8. With the radiator fill cap removed, start the engine and run it at high idle until the thermostat opens.

**Engine damage can occur if the temperature rises above 93°C (200°F).**

9. Reduce engine speed to low idle for 2 minutes to cool down the internal engine components, then stop the engine.
10. Once the engine has cooled to 50°C (122°F), add a 50/50 coolant mixture to bring the coolant to the middle the sight gauge (3).
11. Install the fill cap (4).
12. Close and lock the access door (2).
13. Operate the engine until it is at its normal operating temperature and check for coolant leaks. Repair as needed.

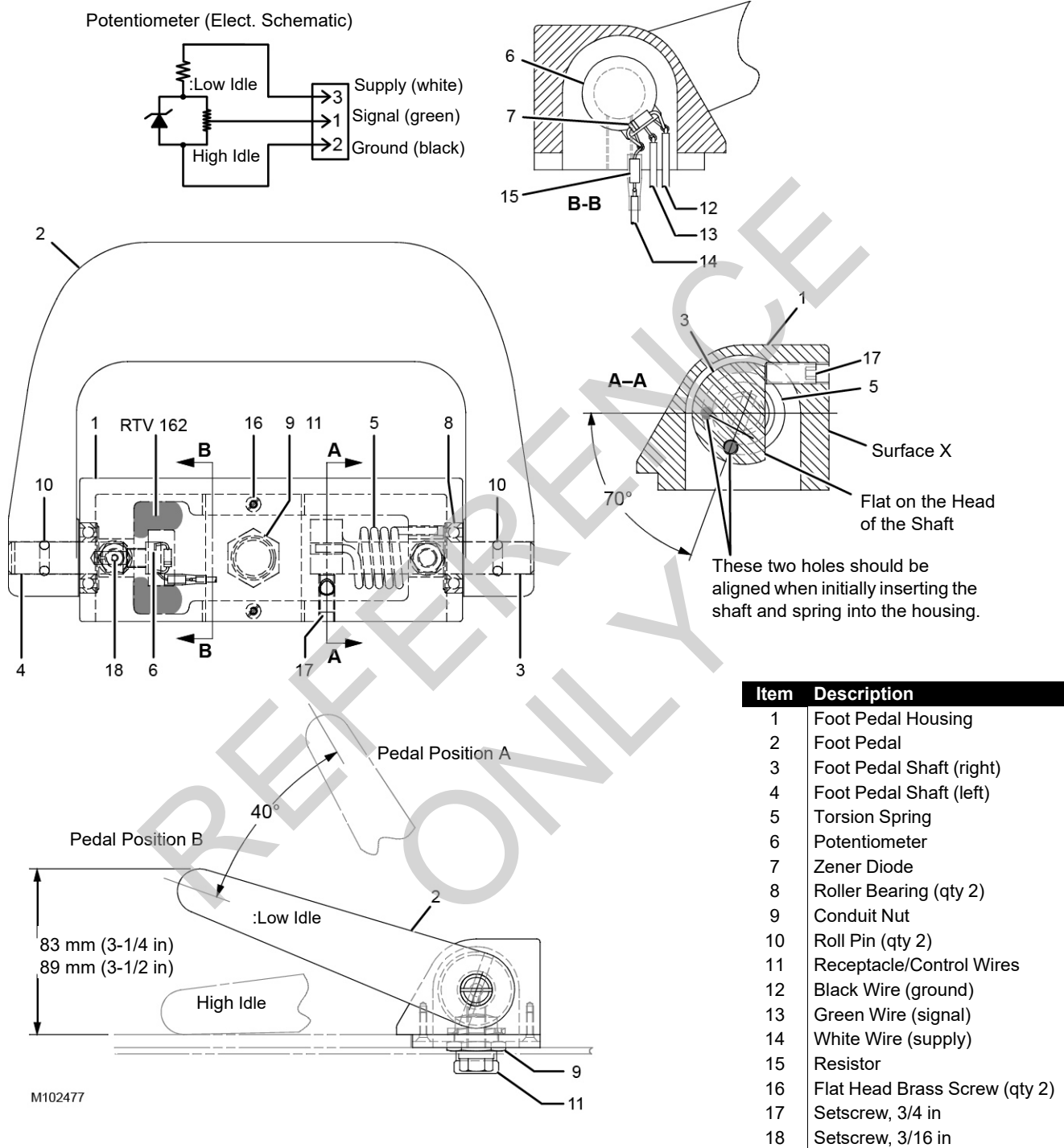


FIGURE 7-8

## ADJUSTING THE ENGINE THROTTLE

The engine throttle assembly consists of an electronic hand throttle control in the left console and an electronic foot throttle control on the cab floor. There is no mechanical linkage between the throttle controls.

Electronic signals from the throttle controls are transmitted to the crane control system, and the control system increases and decreases engine speed accordingly.

### Hand Throttle Control

The hand throttle control does not require adjustment and is not repairable.

### Foot Throttle Control

See [Figure 7-8](#) for the following procedure.

If there is a problem with the foot throttle, it is best to either replace it or send the unit to your Manitowoc Dealer for repair.

However, if field disassembly was done, use the following procedure to re-assemble and calibrate the throttle control.

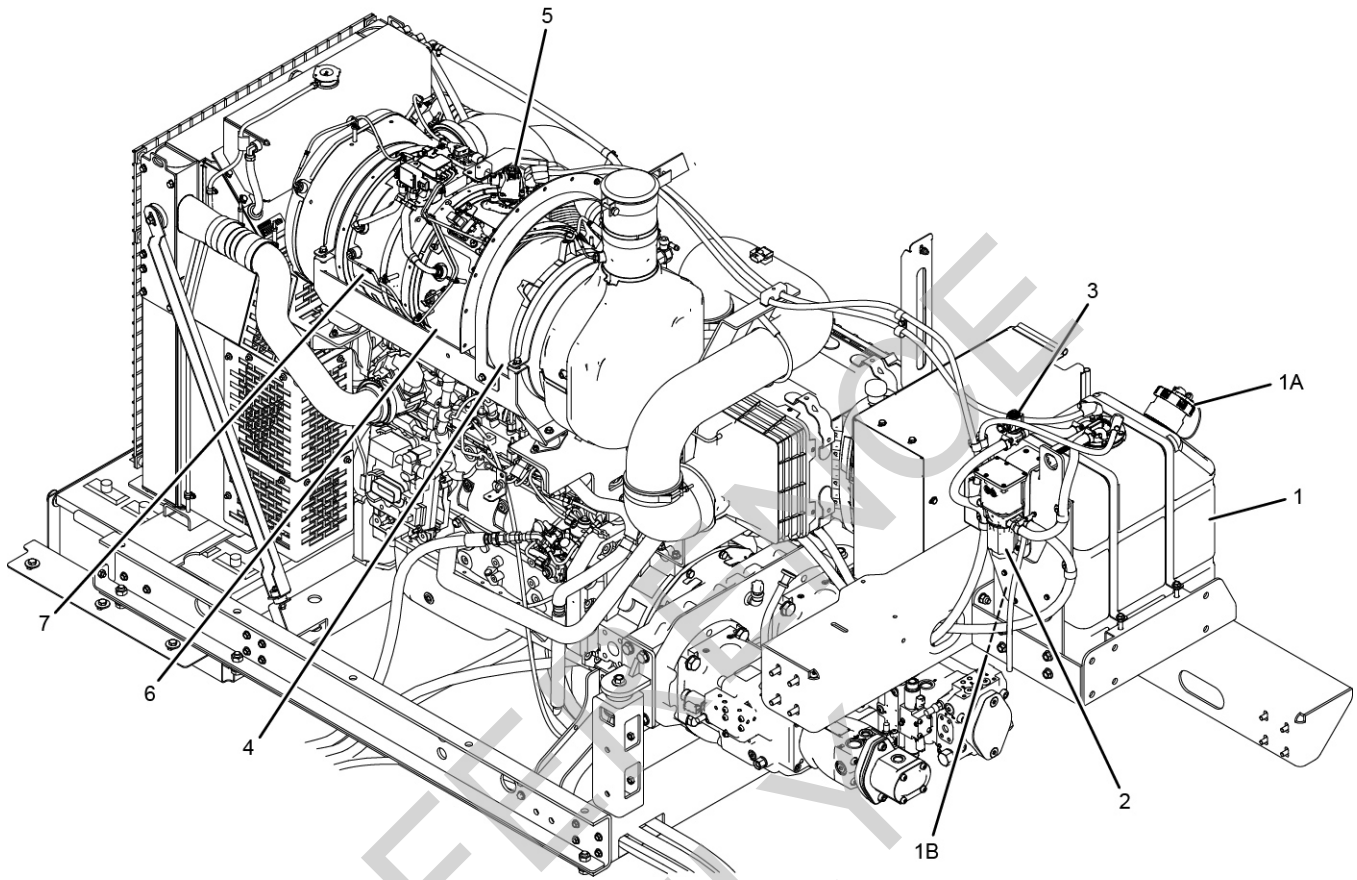
**NOTE:** The foot throttle control was properly assembled and calibrated at initial installation and should not require further attention.

Steps 1 through 8 must be done on a clean work bench.

1. To assemble the right foot pedal shaft (3) and the torsion spring (5) into the foot pedal housing (1), first assemble the spring onto the shaft by inserting the lug on one end of the spring into the hole in the head of the shaft.
2. Insert the shaft into the cavity in the bottom of the housing, through the roller bearing (8), and into the foot pedal (2).  
The lug on the outboard end of the torsion spring must engage the hole in the housing (see A-A).
3. Insert the left foot pedal shaft (4) into the cavity in the bottom of the foot pedal housing, through the roller bearing, and into the foot pedal.
4. Rotate the foot pedal as needed and install the roll pins (10) through the holes in the foot pedal and the foot pedal shafts (see Pedal Position A).
5. Install the setscrew (17) only partway into the threaded hole. Do not allow the setscrew to contact the right foot pedal shaft at this time.

6. Rotate the foot pedal approximately 40° to Pedal Position B (low idle). The flat on the head of the right foot pedal shaft should be parallel with the surface X on the foot pedal housing.
7. Turn in the setscrew until it just contacts the flat on the head of the right foot pedal shaft (see A-A).
8. Install the potentiometer (6) and calibrate the foot throttle as follows.
  - a. Solder the control wires to the potentiometer leads as follows (see B-B):
    - Black wire (12) to the outer lead
    - Green wire (13) to the middle lead
    - White wire (14) to the fixed resistor lead
  - b. Turn the potentiometer shaft fully counterclockwise as viewed from the shaft end.  
With a supply voltage of 25 V<sub>DC</sub> to 26 V<sub>DC</sub> available at the white wire, 0 V<sub>DC</sub> should be present at the potentiometer output (green wire) lead.
  - c. With the pedal at Pedal Position B, insert the potentiometer into the cavity in the bottom of the housing (see B-B). Insert the potentiometer shaft into the end of the left foot pedal shaft (4) and tighten the setscrew (18).
  - d. Rotate the foot pedal to the high idle position and adjust the setscrew (17) to hold the foot pedal at this position.
  - e. Rotate the potentiometer housing to obtain an output of 0.9 V<sub>DC</sub> to 1.0 V<sub>DC</sub>.
  - f. Apply silicone sealant RTV-162 between the housing and potentiometer. Do not get sealant on the shaft. Allow sealant to cure before proceeding to the next step.
  - g. After the sealant has cured, check the potentiometer output for 0.9 V<sub>DC</sub> to 1.0 V<sub>DC</sub> with the foot pedal at the high idle position.
  - h. Remove the setscrew (17) and apply Loctite #243 to the threads. Install and adjust the setscrew to obtain a low idle pedal position output of 2.9 V<sub>DC</sub> to 3.0 V<sub>DC</sub>.
9. Install the assembly onto the crane.

M105164



Item	Description
1	DEF Tank
1A	Fill Cap
1B	Drain Plug
2	DEF Supply Module
3	Coolant Control Valve
4	SCR Module
5	DEF Dosing Module
6	Decomposition Reactor Module
7	DOC/DPF Module

FIGURE 7-9

## EXHAUST AFTERTREATMENT SYSTEM

See [Figure 7-9](#) for the following instructions.

**Table 7-3. Abbreviations**

Abbreviation	Description
APS	Aftertreatment Protection System
DEF	Diesel Exhaust Fluid
DOC	Diesel Oxidation Catalyst
dP	Delta Pressure
DPF	Diesel Particulate Filter
ECM	Engine Control Module
HEST	High Exhaust System Temperature
SCR	Selective Catalytic Reduction
NH <sub>3</sub>	Ammonia
NO <sub>x</sub>	Generic term for the mono-nitrogen oxides NO and NO <sub>2</sub> (nitric oxide and nitrogen dioxide). They are produced from the reaction of nitrogen and oxygen gases in the air during combustion.



### WARNING

#### Hot Exhaust Surfaces and Inhalation Hazards!



Extremely hot surfaces and exhaust gases can cause death or serious injury.

When the HEST fault is activated on the main display (in the cab), warn people to stay at least 1,5 m (5 ft) away from the exhaust pipe. Make sure the exhaust pipe is not directed at anything that can melt, burn, or explode.

Allow the engine and the exhaust system to cool before servicing.

The engine exhaust is treated to significantly reduce the amount of harmful by-products of combustion from contaminating breathable air.

The APS captures soot and ash from the engine exhaust:

- Soot is partially burned fuel particles that occur during normal operation (black smoke).
- Soot is automatically removed by a process called regeneration.
- Ash is partially burned engine oil particles that occur during normal operation.

## Engine Regeneration and Inhibit

See Section 3 of the MLC150-1 Operator Manual for operation of the Engine Regeneration/Inhibit switch in the operator cab.

## Tier 4/Euro Stage 5 Main Display Icons

Refer to MLC150-1 Main Display Operation Manual for identification of the exhaust aftertreatment icons that appear in the Crane Systems Status Bar of the main display.

## DEF Tank

The DEF tank (1) houses 56 L (15 gal) of DEF. DEF consists of 32% urea and 68% de-ionized water. A metered mist of DEF, approximately equal to 10% of the fuel used, is injected into the decomposition reactor module (5).

There is a 40-micron filter on the DEF suction tube inside the tank. For filter maintenance intervals and procedures, refer to the refer to Cummins' literature/online site for detailed instructions.

The DEF level can be monitored in the Crane Systems Status Bar of the main display. See the MLC150-1 Main Display Operator Manual.

The drain plug (1B) is provided in case the tank needs to be emptied of poor-quality DEF.



### WARNING

#### Chemical Hazard!

DEF contains urea. Do not get DEF in your eyes. In case of contact, immediately flush your eyes with large amounts of water for a minimum of 15 minutes. Do not swallow. If DEF is ingested, contact a physician immediately.

**NOTE:** Do not store DEF for long periods of time. DEF deteriorates relative to time and temperature. Low-quality DEF may require the tank to be drained and the system purged.

## CAUTION

### Loss of Power or Engine Shutdown Hazard!

If poor-quality DEF or a low-level condition is sensed, an error code is activated. These conditions can lead to engine power being reduced (derated) by the ECM. If the condition persists, engine low idle lock may occur.

## DEF Supply Module

The DEF supply module (2) is an electronically operated pump and metering system controlled by the ECM. The

module pumps DEF to the dosing module (5), which is mounted on the decomposition reactor module (6).

At engine shutdown, the DEF supply module enters a purge cycle to prevent DEF from being left in the system, and in cold climates from potentially freezing. When it is in the purge cycle, an audible click and pumping sound is heard from the module, and the module pulls out all of the DEF in the system and returns the DEF to the tank.

The DEF supply module is heated electrically and with engine coolant. It has a 10-micron filter that requires periodic cleaning and inspection. For filter maintenance intervals, refer to Cummins' literature/online site for detailed instructions.



## WARNING

### Personal Injury or Equipment Damage Hazard!

Do not remove hoses from or attempt to service the DEF supply module without first consulting the Cummins' literature/online site for detailed instructions. Personal injury and/or equipment damage may result.

## CAUTION

### Use Only Approved Replacement Parts!

The DEF system components are designed to withstand freezing and to be compatible with DEF and the other unique characteristics of the system. Use of non-approved replacement parts may result in system damage.

## Coolant Control Valve

When needed, the DEF is heated by engine coolant, which is circulated through a heat exchanger in the tank. If the tank temperature drops below  $-4^{\circ}\text{C}$  ( $25^{\circ}\text{F}$ ), the ECM opens the coolant control valve (3) to allow coolant to flow through the heat exchanger and the DEF supply module.

## DOC/DPF Module

The DOC/DPF module (7) oxidizes the remaining hydrocarbons in the exhaust to carbon dioxide. It incorporates an  $\text{NO}_x$  sensor, a dP sensor, and two temperature sensors.

The DOC/DPF should be sent to the engine manufacturer for cleaning or exchanged for a clean one at a minimum service interval of 4,500 heavy-duty operating hours (roughly every 2 years of one-shift operation).

**NOTE:** DPF cleaning requires special tools and equipment and should not be attempted by field service personnel.

## DEF Dosing Module

The DEF dosing module (5) injects a liquid mixture of urea and deionized water (called DEF) into the exhaust stream ahead of the inlet to the SCR module (4). The flow of DEF through the dosing module also keeps it cool and operable.

## SCR Module

The SCR module (4) incorporates a catalyst, a temperature sensor, and an  $\text{NO}_x$  sensor.

The SCR module utilizes DEF (urea and deionized water) to reduce  $\text{NO}_x$  content in the exhaust gas to nitrogen.

The SCR module does not require maintenance.

### Excessive $\text{NO}_x$ Warning System

## CAUTION

### Loss of Power or Engine Shutdown Hazard!

If  $\text{NO}_x$  emissions exceed legislated limits, the operator is alerted by warning lights and audible warnings. If the condition is not corrected in a set amount of time, an engine de-rate and shutdown sequence begins.

Refer to the Main Display Operation Manual for identification and location of the engine and exhaust aftertreatment warning lights.

If an excessive  $\text{NO}_x$  warning is issued, check anything that might cause an elevated  $\text{NO}_x$  level, such as:

- Disconnected DEF tank level or quality sensor
- Blocked DEF hose or dosing module
- Disconnected dosing module
- Disconnected supply module
- Disconnected SCR wiring harness
- Disconnected  $\text{NO}_x$  sensor

## APS

The APS continually monitors exhaust gas temperatures. In the event of excessive exhaust temperatures, the APS activates the HEST icon on the main display.

## Decomposition Reaction Module

The decomposition reactor module (6), mounted between the SCR module (4) and the DOC/DPF module (7), does not require maintenance.

## ENGINE ELECTRICAL SCHEMATIC

See the electrical schematic at the end of Section 3.

## SECTION 8 UNDERCARRIAGE

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## SECTION 8

### UNDERCARRIAGE

#### GENERAL

This section provides operational information for the Travel System.

Additional component information for the Travel System can be found in the following sections of this Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

This section also provides maintenance and adjustment procedures for the crawler and turntable.

**NOTE:** In the following instructions, **CCS** stands for **Crane Control System**.

#### HYDRAULIC TRAVEL SYSTEM

See [Figure 8-1](#) and [Figure 8-2](#).

#### Travel System Overview

The travel system consists of two open-loop hydraulic circuits, one for each crawler. Each circuit consists of a joystick, an engine-driven hydraulic pump, a directional control valve, a hydraulic motor, and a disc brake.

##### Hydraulic Pump

The hydraulic pumps (Pump A and Main Pump B) are electronically controlled variable-displacement type pumps.

##### Directional Control Valves

The directional control valves are electronically controlled proportional valves. Each section of the directional control valve is controlled by two solenoids. Depending on which solenoid is energized, the valve spool moves to a position that allows hydraulic oil from the corresponding pump to flow to the selected travel motor for either forward or reverse travel.

In neutral, the directional control valve spools are spring returned to the center position. In this position, pump flow to the travel motors is blocked and the forward and reverse hydraulic lines to the travel motors are connected to tank.

##### Travel Motors

The travel motors are hydraulically pilot operated, bi-directional, variable-displacement motors with pressure override. The motors provide power to the planetary drive at each crawler.

Each travel planetary drive is equipped with a spring-applied, hydraulically-released disc brake that is controlled by a two-position, solenoid controlled, brake valve.

The speed and direction of the travel motors depends on the output flow volume of the travel pumps, the position of the proportional control valves, and the position of the travel motor servos.

##### Joystick Control

The pumps and proportional control valves are electronically controlled by the position of the corresponding travel control handle (joystick J2) and the travel speed switch located on the right console. The joystick communicates with the crane control system via the controller area network bus (CAN Bus).

The left travel control handle controls pump A, the left travel proportional control valve, and the left travel motor.

The right travel control handle controls pump B, the right travel proportional control valve, and the right travel motor.

#### Travel Brake Operation

The travel brakes are a spring-applied, hydraulically-released disc brakes located between each travel motor and its corresponding planetary drive.

The travel brake release system uses pilot pressure from pilot Pump supplied to the travel brakes via the travel brake solenoid valve. The brake release pressure must be at least 22 bar (319 psi) to fully release the brakes.

If brake hydraulic pressure or electrical control is lost, the travel brakes are applied by spring force.

##### Travel Park Brake Released

In the UN-PARKED state, the CCS sends a 24 VDC signal to the joystick J2. When 24 VDC is detected, the joystick J2 activates the travel control handles, but does not allow the travel brakes to release until one or both travel control handles are moved.

When a travel control handle is moved in either direction, it sends a release brake command to the CCS. The CCS then sends 24 VDC to the travel brake solenoid valve. This causes the travel brake solenoid valve to open, allowing hydraulic oil to flow to the travel brakes. The increased pressure releases the travel brakes.

##### Travel Park Brake Engaged

In the PARKED state, the CCS sends a 0 VDC signal to the joystick J2. When 0 VDC is detected, joystick J2 deactivates the travel control handles and sends an apply brake command to the CCS. This causes the travel brake solenoid valve to close, allowing the hydraulic oil in the brake system to flow back to the tank. The reduced hydraulic pressure allows spring force to apply the travel brakes.

## Travel 2-Speed Operation

The travel motors are variable displacement and shift internally with an adjustable spring in each motor P/C (Pressure Compensator) valve that is preset at 270 bar (3,915 psi). The travel speed switch allows the operator to select low speed when smoother starts and precise control over the load is required or high speed when maximum available travel speed is required.

When the 2-speed switch is in the low position, the control system sends an output signal to enable the travel speed solenoid. The valve shifts to direct accessory pressure to the end of the P/C valve. The P/C valve shifts the PCOR spool placing the travel motors in maximum displacement (high torque, low speed). The travel motors remain in this position until the 2-speed switch is placed in the high position and engine speed is more than 1350 rpm.

When the 2-speed switch is in the high position, the travel motors remain in minimum displacement (low torque, high-speed) when starting. If system pressure rises to 270 bar (3915 psi) when the crawlers begin to move, the P/C will shift as required, up to maximum displacement, to maintain 270 bar (3915 psi) so that maximum tractive effort is always available.

The travel motors shift back to minimum displacement automatically if engine speed is above 1350 rpm and system pressure is below 270 bar (3,915 psi).

## Travel Cruise Operation

The travel cruise switch on the left travel handle allows the crawlers to operate in either direction at a selected speed without manually moving the travel handles. Once moving in the desired direction and speed, press and release the cruise switch. The control system locks-in the travel information and the travel direction and speed are maintained when the travel handles are released to the neutral position.

Pressing and releasing the switch again or moving either travel handle in the opposite direction from neutral, opens the travel cruise circuit and returns control of the crawlers to the operator.

## Forward Travel Operation

To enable the travel control system, the operator must be seated (seat safety switch closed) and the travel brakes must be in the UN-PARKED state.

When either control handle is moved to the forward position, the joystick J2 communicates the travel command to the CCS.

At the same time, the CCS communicates the forward travel command to the solenoid at the corresponding proportional control valve.

- If the left control handle is moved forward, the CCS energizes the left travel proportional control valve, shifting the valve to the position that allows hydraulic oil from Pump A to flow to the left travel motor for forward travel.
- If the right control handle is moved forward, the CCS energizes the right travel proportional control valve, shifting the valve to the position that allows hydraulic oil from Pump B to flow to the right travel motor for forward travel.
- Simultaneously, the travel brakes are released to allow travel.

The following sensors provide feedback to the CCS:

- Pump A and Pump B pressure sensors
- Left travel pressure sensor
- Right travel pressure sensor

The control system uses this feedback to adjust the pump and proportional control valves to maintain the speeds commanded by the handles.

## Reverse Travel Operation

To enable the travel control system, the operator must be seated (seat safety switch closed) and the travel brakes must be in the UN-PARKED state.

When either control handle is moved to the rearward position, the joystick J2 communicates the travel command to the CCS.

At the same time, the CCS communicates the reverse travel command to the solenoid at the corresponding proportional control valve.

- If the left control handle is moved rearward, the CCS energizes the left travel proportional control valve, shifting the valve to the position that allows hydraulic oil from Pump A to flow to the left travel motor for reverse travel.
- If the right joystick handle is moved rearward, the CCS energizes the right travel proportional control valve, shifting the valve to the position that allows hydraulic oil from Pump B to flow to the right travel motor for reverse travel.
- Simultaneously, the travel brakes are released to allow travel.

The following pressure transducers provide feedback to the control system:

- Pump A and Pump B
- Left travel
- Right travel

The control system uses this feedback to adjust the pump and proportional control valves to maintain the speeds commanded by the handles.

### No Travel

When the travel control handles are in the neutral position, the travel pumps are de-stroked and the left and right travel proportional control valves remain in the center position, blocking hydraulic flow from the pumps to the travel motors.

The travel brake solenoid is deenergized, allowing spring force to apply the travel brakes.

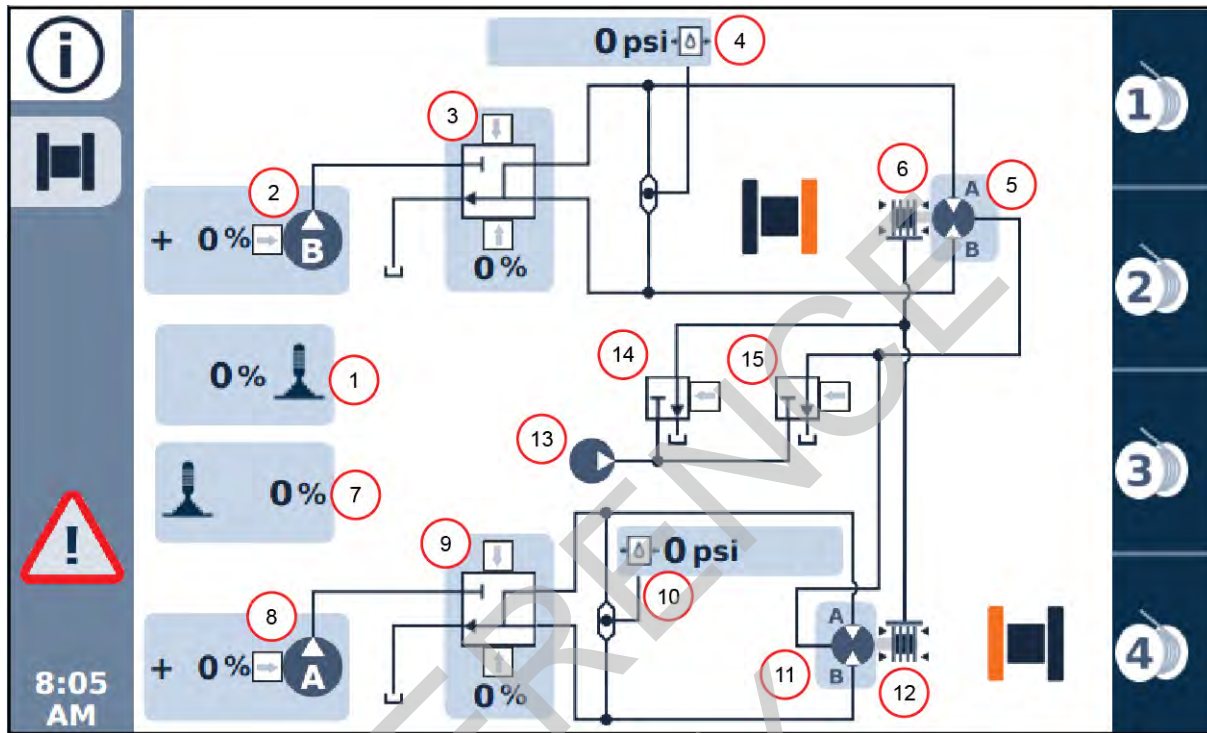
### Travel Motor Cooling

The purpose of the travel motor cooling circuit is to provide a continuous flow of oil to the case of both travel motors. The flow comes from the low side of the hydraulic oil cooler fan motor and is provided at all times, regardless of whether the travel function is active.

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### Travel Hydraulic Diagram

A detailed hydraulic schematic is provided at the end of Section 2 in this Service Manual.



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Item	RIGHT Crawler Components	Item	LEFT Crawler Components
1	Control Handle (command -100 to 100%: + number = forward, - number = reverse)	7	Control Handle (command -100 to 100%: + number = forward, - number = reverse)
2	Open Loop B Pump (command 0 to 100%)	8	Open Loop A Pump (command 0 to 100%)
3	Proportional Control Valve (command -100 to 100%: + number = forward, - number = reverse)	9	Proportional Control Valve (command -100 to 100%: + number = forward, - number = reverse)
4	Pressure Transducer	10	Pressure Transducer
5	Motor	11	Motor
6	Brake	12	Brake
13	Pilot Pump		
14	Brake Valve (right and left)		
15	2-Speed Valve (right and left)		

FIGURE 8-1

### Travel Electrical Diagram

A detailed electrical schematic is provided at the end of Section 3 in this Service Manual.

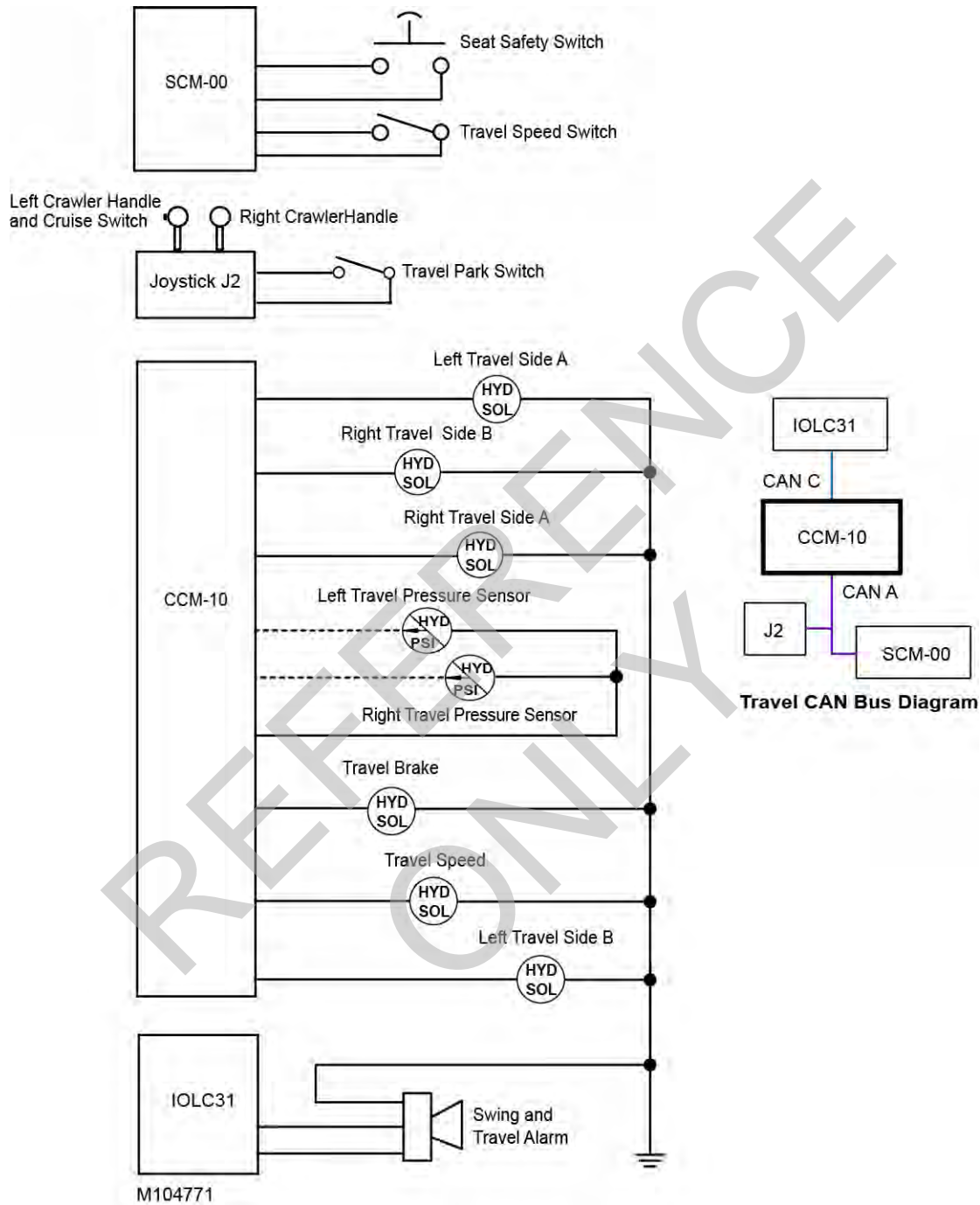
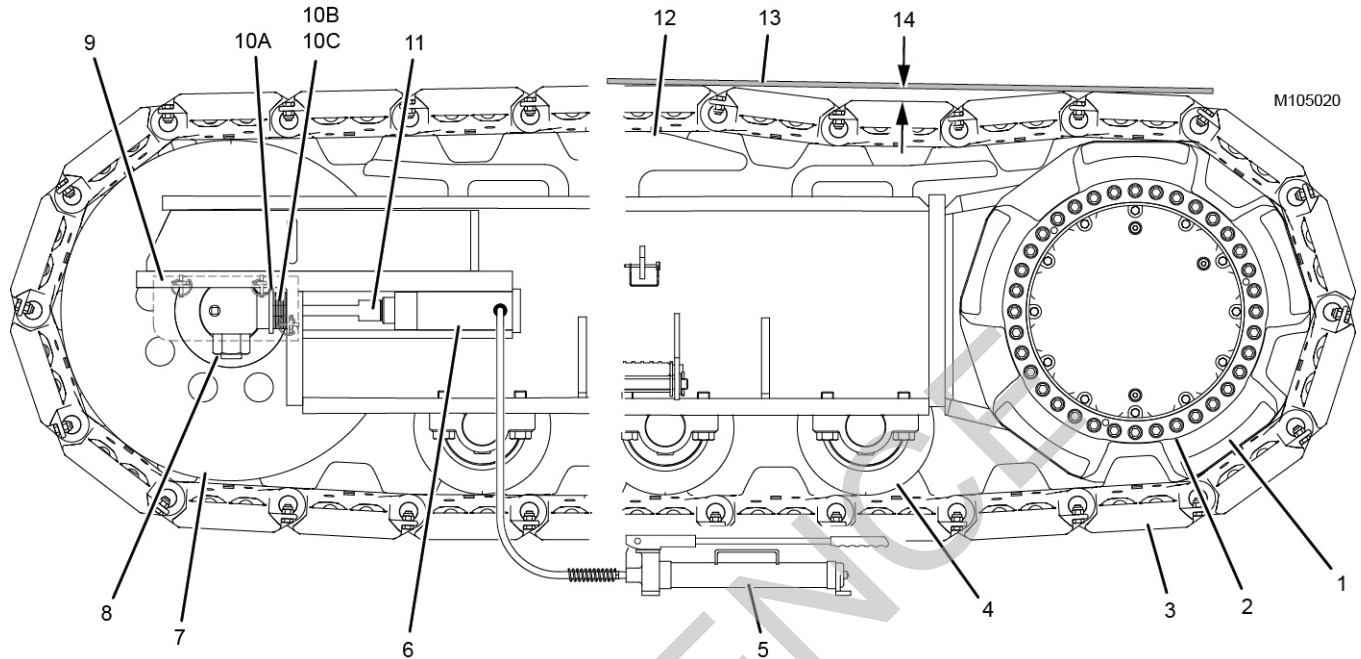


FIGURE 8-2



Quantities are for Each Crawler

Item	Description	Item	Description
1	Drive Tumbler	9	Cover (shown removed) (qty 2)
2	Gearbox	10A	Shim: 10 mm (0.39 in) (qty 1 each side)
3	Tread	10B	Shim: 6.4 mm (0.25 in) thick (qty as required)
4	Intermediate Roller (qty 11)	10C	Shim: 3.4 mm (0.134 in) thick (qty as required)
5	Hand Pump	11	Adjusting Rod
6	Cylinder	12	Guide Bars
7	Front Roller	13	Straightedge
8	Nut and Bolt (qty 2)	14	Tread Slack:
			• 19 mm (0.75 in) — Tight Limit
			• 51 mm (2.0 in) — Loose Limit

FIGURE 8-3

### CRAWLER PREVENTIVE MAINTENANCE

See [Figure 8-3](#).

#### Weekly or Every 40 Hours of Engine Operation

- Lubricate the crawlers as instructed in the Lubrication Guide supplied with the crane.
- Keep the crawlers clean and avoid dirt buildup when cutting.
- Check that all mounting bolts are tight. See [Intermediate Roller Bolt Torque on page 8-7](#).
- Check for proper tread slack.
- Check for oil leaks, excessive wear, cracks, and other damage. Broken or cracked parts can indicate that the treads are adjusted too tightly.
- Repair or replace damaged parts immediately to prevent further damage.

### CRAWLER TREAD SLACK MEASUREMENT

See [Figure 8-3](#).

#### Weekly or Every 40 Hours of Engine Operation

Check tread slack (14) at the drive tumbler (1) end of each crawler. Maintain equal tread slack at both crawlers.

1. Travel forward or reverse on a firm level surface until all tread slack is in the top treads at the drive tumbler end of the crawlers.
2. Place a straightedge (13) on top of the treads (3). **The straightedge must span from the top of the rear guide bars (12) to the top of the drive tumbler (1).**
3. Measure the tread slack between the straightedge and the top of the tread at the lowest point:
  - Tight limit gap—19 mm (0.75 in)
  - Loose limit gap—51 mm (2.0 in)

- If the slack exceeds the tight or loose limit, adjust crawler tread slack.

### CAUTION

#### Avoid Tread Pin Damage!

Do not adjust the treads too tightly or the tread pins will wear rapidly and may break. Dirt buildup will tighten the treads further, increasing the possibility of damage.

Tight treads require more drive torque, resulting in faster wear and increased fuel consumption.

## CRAWLER TREAD SLACK ADJUSTMENT

See [Figure 8-3](#).

- Tighten the treads when operating on firm ground.
- Loosen the treads when operating on soft ground (mud or sand).

- Thoroughly clean the crawler to be adjusted.
- Remove the covers (9) from both sides of the crawler frame.
- Loosen the nut and bolt (8) on both sides of the front roller (7).
- Remove the hand pump (5), the cylinder (6), and the extra shims (10B and 10C) from the parts box. See [Crawler Hand Pump and Cylinder on page 8-8](#) for operating instructions.
- Place the cylinder (6) in position to jack against the adjusting rod (11). Using the hand pump, jack an equal amount on each side until the track is at the desired tension.
- Install or remove an equal number of shims (10B and 10C) on both sides of the crawler frame as needed. One shim (10A) must always be installed on both sides of the crawler frame.

### CAUTION

#### Avoid Parts Wear!

Parts will wear rapidly if an equal thickness of shims is not installed on both sides of the crawler frame.

- Fully retract and remove the cylinder (6).

### CAUTION

#### Avoid Cylinder Damage!

The tensioning cylinder can be damaged if it is not fully retracted.

- Travel the crane forward and/or in reverse to tighten the shims.
- Check for proper tread slack.
- Tighten the nuts (8) to 2712-4067 Nm (2000-4000 ft-lb).
- Install the cover (9) on both sides of the crawler frame.
- Repeat the procedure for the other crawler.

**NOTE** The extreme limit of tread adjustment occurs when the bolts are tight against the front end of the slots in the crawler frame. One crawler tread can be removed when this limit is reached.

- Store the hand pump, the cylinder, and any extra shims in the parts box.

Item	Description
1	Intermediate Roller (qty 11 each crawler)
2	Bolt with Flat Washer (qty 4 each roller)

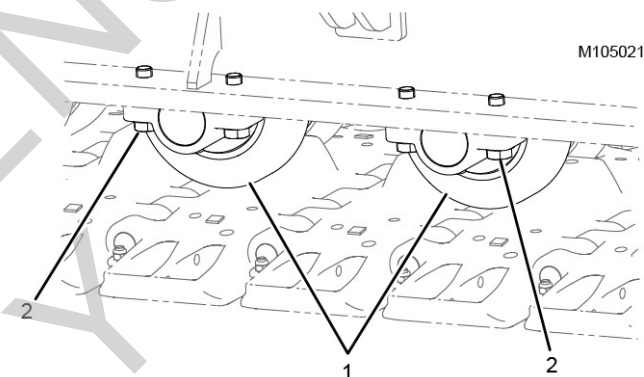


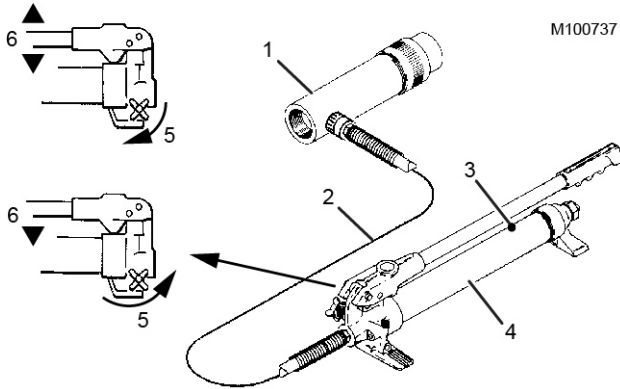
FIGURE 8-4

## INTERMEDIATE ROLLER BOLT TORQUE

See [Figure 8-4](#).

**Annually, Every 2000 Hours of Engine Operation, or Every 250 Hours of Travel Operation, Whichever Occurs First**

- Check the torque of the bolts (2) at each intermediate roller (1). The bolts must be at 1220 Nm (900 ft-lb) torque. **The bolts must not turn.**
- Replace ALL loose bolts with new bolts and torque as follows:
  - Clean threads with solvent/degreaser as needed
  - Apply LOCTITE® 263 to threads
  - Torque bolts to 1627 Nm (1200 ft-lb)



Item	Description
1	Jacking Cylinder
2	Hose
3	Vent Fill Cap
4	Pump
5	Valve
6	Jacking Handle

FIGURE 8-5

## CRAWLER HAND PUMP AND CYLINDER



### WARNING

#### Hand Pump Explosion

The hand pump and cylinder is provided for crawler adjustment only, any other use is neither intended nor approved.

Wear safety glasses and other personal protective gear when operating the hand pump.

Do not set the pump relief valve higher than 10,000 psi (700 bar). Higher pressure can cause components to explode.

The pump is not vented. It can explode if subjected to high pressure. Do not attempt to return more oil to the pump than it is capable of holding. Do not overfill the pump.

In some cases, the pump handle can “kickback.” Always keep your body to side of pump, away from line of handle force.

Do not add extensions to handle. Extensions can cause unstable operation.

## Assembly

1. Connect the hose from the pump outlet port to the cylinder inlet ([Figure 8-5](#)).

## CAUTION

### Hand Pump Damage

Do not apply sealant to the first complete thread to ensure the sealant does not shed into the hydraulic system and cause malfunctioning or damage.

2. Apply 1-1/2 wraps of a high-grade thread sealant (Teflon tape) to the fittings.

## CAUTION

### Leaks and Fitting Damage

Do not over tighten the connections, connections only need to be snug and leak free. Over tightening can cause premature thread failure and may cause fittings or castings to split at lower than their rated pressures.

## Maintenance

See [Figure 8-5](#).

1. Keep the unit clean and stored in a safe place where it cannot be damaged.
2. Assure correct pump oil level. To check the level:
  - a. Turn the pump valve (5) counter-clockwise, push the jacking handle (6) all the way down, and fully retract the jacking cylinder (1) rod to return all oil to the pump. **The cylinder must be fully retracted or the system will contain too much oil after filling.**
  - b. Place the pump (4) horizontally on a flat surface.
  - c. Using a screw driver, remove the vent fill cap (3).
  - d. Add hydraulic oil to the pump until the reservoir is two-thirds full. **Do not overfill.**
  - e. Reinstall the vent fill cap.
  - f. Test pump operation and remove air from system, if required. Recheck oil level after removing the air.

## Air Removal

See [Figure 8-5](#).

1. Rotate the valve (5) clockwise until finger tight.
2. Position the pump (4) so it is higher than the cylinder (1) and position the cylinder so the rod is down.
3. Operate the jacking handle (6) up and down to fully extend the jacking cylinder (1) rod.
4. Rotate the valve (5) counterclockwise, push the jacking handle (6) all the way down, and fully retract the jacking



cylinder (1) rod to force oil and trapped air back into the pump.

5. Repeat this procedure until the cylinder operates smoothly. **Erratic operation indicates air in the system.**

## Operation

See [Figure 8-5](#).

1. Before using the pump:

- Check that all fittings are tight and leak free.
- Check the oil level.

2. To pressurize the jacking cylinder (1) and extend the rod, close the valve (5) by turning it clockwise until finger tight. Pump the jacking handle (6) up and down. Pressure is maintained until the valve is opened.

To reduce the handle effort at high pressure, use short strokes, maximum leverage is obtained in last five degrees of stroke.

3. To de-pressurize the jacking cylinder (1), push the jacking handle down fully and then open the valve (5) by turning it counterclockwise.
4. The pump can be operated in any position from horizontal to vertical as long as the **hose end of the pump is down.**

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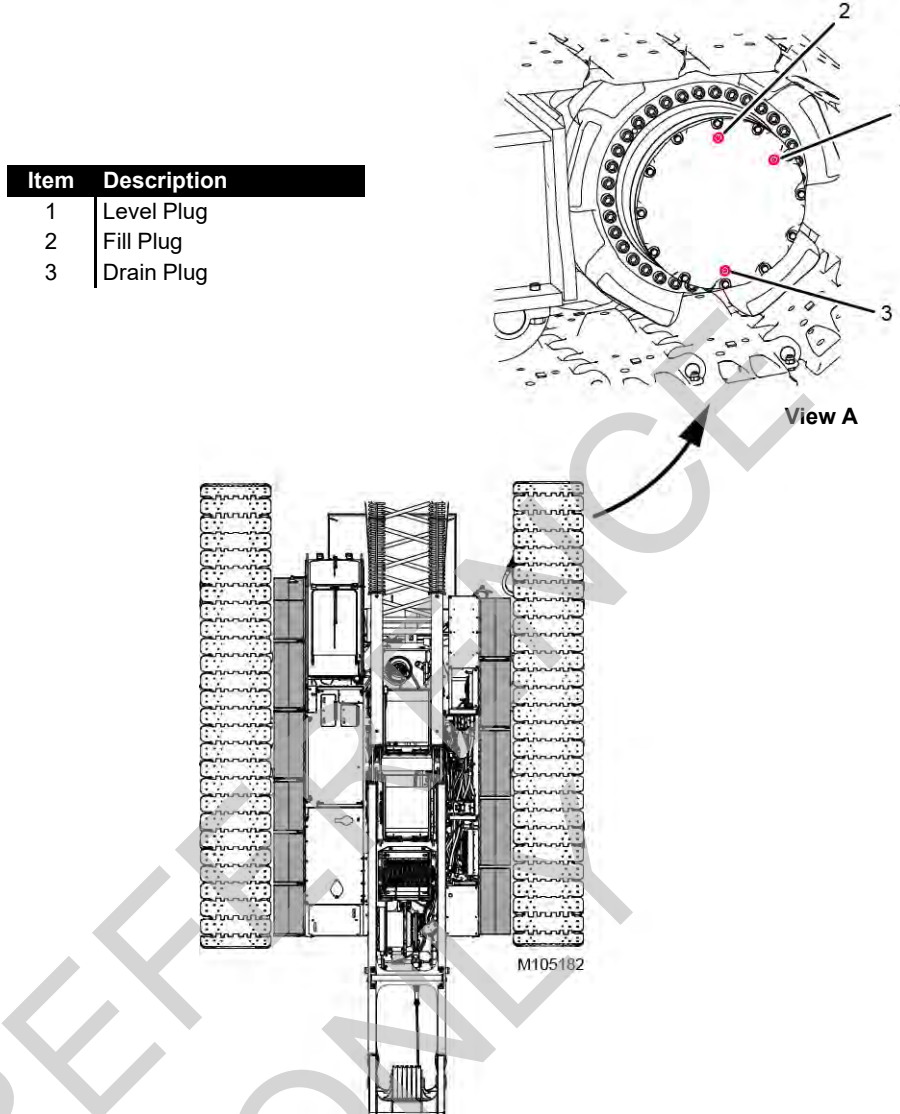


FIGURE 8-6

## CRAWLER GEARBOX OIL CHANGE

See [Figure 8-6](#).

### Gear Oil Specifications

For gear oil specifications and the crawler gearbox capacity, see the Lubrication Guide supplied with the crane.

### Oil Analysis

An oil analysis program is the best way to determine the optimum oil change interval and the condition of the crawler gearboxes.

### Periodic Maintenance

#### Initial Operation

Drain and refill both crawler gearboxes after the first 200 hours of engine operation.

#### Weekly

Check the oil level in both crawler gearboxes weekly **or** every 10 hours of function operation **or** 20 hours of engine operation, whichever occurs first.

1. Travel the crawlers until the plugs are positioned as shown in View A
2. Stop the engine and lockout-tagout the ignition switch.
3. Thoroughly clean the area around the plugs to prevent dirt from entering the gearboxes.
4. Remove the fill plug (1) and the level plug (2) from the gearbox.
5. The oil must be up to the bottom of the level plug opening.
6. If necessary, add the specified oil to the gearbox with a funnel through the fill plug opening.
7. Install the fill and level plugs.
8. Repeat the procedure for the other crawler gearbox.

#### Semi-Annually

Drain and refill both crawler gearboxes semi-annually **or** every 200 hours of function operation **or** every 1000 hours of engine operation, whichever occurs first, unless an alternate interval has been established through an oil analysis program.

### Oil Change Procedure

Change the oil when the crawler gearboxes are warm.

1. Travel the crawlers until the plugs are positioned as shown in View A
2. Stop the engine and lockout-tagout the ignition switch.
3. Thoroughly clean the area around the plugs to prevent dirt from entering the gearboxes.
4. Remove the fill plug (1) and the level plug (2) from the gearbox.
5. Place an appropriate container under the drain plug (3) to catch the oil (approximately 27 L – 7 gal).
6. Remove the drain plug (3).
7. Once the gearbox is drained, clean and securely install the drain plug.
8. Fill the crawler gearbox with specified oil:
  - a. If not already done, remove the fill and level plugs.
  - b. Add the specified oil through the fill plug opening with a funnel until the oil is up to the bottom of the level plug opening.
  - c. Securely install the fill and level plugs (1 and 2).
9. Repeat the procedure for the other crawler gearbox.
10. Dispose of the drained oil according to local environmental regulations.

**Item Description**

- 1 Slewing Ring — Inner Ring
- 2 Slewing Ring — Outer Ring
- 3 1-1/2 in—6 UNC x 8 in Long Grade 8 Bolt
  - 48 Places Outer Ring
  - 48 Places Inner Ring
- 4 Washer
- 5 Shear Pin (2 places)
- 6 Access Slots to Inner Ring Bolts
- 7 Carbody
- 8 Rotating Bed

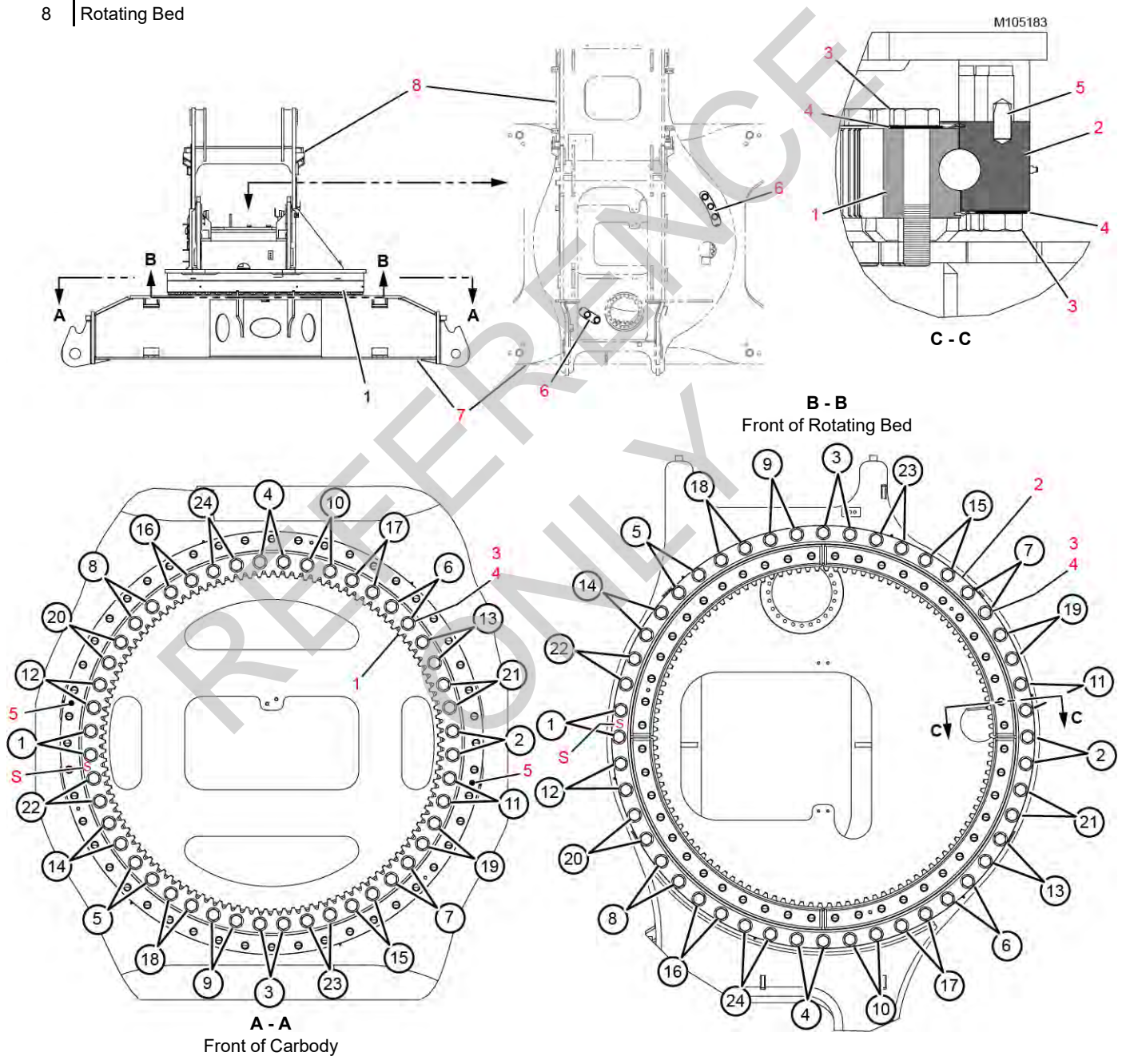


FIGURE 8-7

## SLEWING RING ALIGNMENT

See [Figure 8-7](#) for the following.

Install the inner ring (1) so the S stamp is towards the side of the carbody (7).

Two shear pins (5) are installed in the rotating bed (8) to locate the outer ring (2) with the rotating bed.

Verify the S stamp in the outer ring (2) is toward the side of the rotating bed (8).

## SLEWING RING BOLT

See [Figure 8-7](#) for the following procedures.



### DANGER

#### Crushing Injury Hazard!

Two people are required to install the slewing ring bearing bolts, an operator to operate the swing control and a mechanic to tighten the bolts to the correct torque.

It is necessary for the mechanic to go inside the rotating bed to tighten the inner slewing ring bearing bolts, requiring the following to be complied with:

- Maintain constant communication between the operator and the mechanic while the mechanic is inside the rotating bed.
- The operator shall not swing the upperworks until instructed to do so by the mechanic.
- The mechanic shall stay well clear of moving parts while the upperworks is being swung to position the bolts.



### WARNING

#### Bolt Failure!

Loose or improperly tightened bolts can cause the bolts or the slewing ring bearing to fail, possibly allowing the upperworks to break away from the carbody.

## After First 50 Hours of Operation

Tighten all bolts (3), two at a time, in the numbered sequence given to 2 847 Nm (2,100 ft-lb).

## Annually or Every 2,000 Hours of Operation (whichever comes first)

Tighten all bolts (3), two at a time, in the numbered sequence given using two steps:

- First to 814 Nm (600 ft-lb)
- Final to 2 847 Nm (2,100 ft-lb)

If during the annual interval:

- One or more bolts (3) are found to be tightened to less than 2 278 Nm (1,680 ft-lb), replace each loose bolt (3) and washer (4) as well as one bolt (3) and washer (4) on each side of each loose bolt.
- 10 or more bolts (3) in either ring are found to be tightened to less than 2 278 Nm (1,680 ft-lb), replace all of the bolts (3) and washers (4) for the corresponding ring.

Replace all of the bolts (3) and washers (4) anytime a new slewing ring is installed.

## REPLACING SLEWING RING BOLTS

1. Apply Never-Seez or an equivalent anti-seizing lubricant to:
  - Bolt threads
  - Underside of bolt heads
  - Both sides of all washers
2. Install and tighten the bolts (3), two at a time, in the numbered sequence to an initial torque of 814 Nm (600 ft-lb).
3. Tighten the bolts (3), two at a time, in the numbered sequence to a final torque of 2 847 Nm (2,100 ft-lb).

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**SECTION 9  
LUBRICATION**

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## SECTION 9 LUBRICATION

### LUBRICATION

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## SECTION 10

### ACCESSORIES

This section provides operational information for the crane's accessory hydraulic systems.

Additional component information for this system can be found in the following sections of this Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

**NOTE:** In the following instructions, **CCS** stands for **C**rane **C**ontrol **S**ystem.

#### GANTRY CYLINDERS OPERATION

See [Figure 10-1](#) and [Figure 10-2](#)

##### Gantry Cylinders Overview

The gantry cylinders are controlled by a switch either on the remote control or on the right side cab console.

The system consists of the OLB pump, a 2-position, proportional solenoid-operated accessory enable control valve, a 3-position, solenoid-operated control valve, and two double-acting hydraulic cylinders with holding valves.

The setup remote control communicates with the gantry cylinder solenoid valves via the CCS.

The switch on the cab console communicates with the gantry cylinder solenoid valves via the CCS.

To activate the setup remote control, it must be turned in crane's main display. See the Main Display Operation Manual provided with the crane.

To activate the gantry cylinders switch on the cab console, the Boom Butt Configuration must be selected in the RCL/RCI Display. See the RCL/RCI Operation Manual supplied with the crane.

Both gantry cylinder switches are 3-position momentary switches that are spring returned to the off position when released.

##### Neutral

When there is no command from either gantry cylinders switch, the following occurs:

- The solenoid on the accessory enable valve is deenergized and a spring shifts the valve to block pump A flow to the high pressure accessory valve bank.
- The solenoids on the gantry cylinders control valve are deenergized and springs shift the valve to the neutral position.

- The gantry cylinders are held in their last position by the holding valve on each cylinder.

##### Retract

When a retract command is sent by either gantry cylinders switch, the following occurs:

- The proportional solenoid on the accessory enable valve is energized by a PWM (pulse width modulation) signal from the CCS to adjust the flow rate of oil to the high pressure accessory valve bank.
- At the same time, the retract solenoid on the gantry cylinders control valve is energized by 24 VDC from the CCS.
- The energized solenoid shifts the valve spool to the position that routes hydraulic oil to the rod end of the gantry cylinders.
- Pressure from the rod ends of the cylinders pilots open the load holding valves allowing the oil from the barrel end of the cylinders to flow back to tank via the high pressure accessory valve.
- The cylinder rods retract to lower the gantry.

##### Load Holding

If hydraulic pressure is lost for any reason, the holding valves close and the check valve traps the oil in both ends of each cylinder, preventing the cylinders from extending or retracting.

##### Extend

When an extend command is sent by either gantry cylinders switch, the following occurs:

- The proportional solenoid on the accessory enable valve is energized by a PWM signal from the control system to adjust the flow rate of oil to the high pressure accessory valve bank.
- At the same time, the extend solenoid on the gantry cylinders control valve is energized by 24 VDC from the CCS.
- The energized solenoid shifts the valve spool to the position that routes hydraulic oil to the barrel end of the gantry cylinders.
- The oil flows over the load holding check valves to the barrel end of the cylinders and the cylinders extend to raise the gantry.
- The hydraulic oil in the rod end of the cylinders flows back to tank via the high pressure accessory valve.

## CAB TILT OPERATION

See [Figure 10-1](#) and [Figure 10-2](#)

The system consists of the OLB pump, a 2-position, proportional solenoid-operated accessory enable control valve, a 3-position, solenoid-operated control valve, and a double-acting hydraulic cylinder with holding valve.

### Neutral

In neutral there is no signal to the cab tilt control valve, so the valve is closed and no fluid flows to the cylinder. The holding valve is also in the closed position to prevent cylinder movement and lock the cab in the last position it was moved to.

### Raise

When a raise command is sent by the cab tilt switch, the following occurs:

- The proportional solenoid on the accessory enable valve is energized by a PWM signal from the control system to adjust the flow rate of oil to the high pressure accessory valve bank.
- At the same time, the raise solenoid on the cab tilt control valve is energized by 24 VDC from the CCS.
- The energized solenoid shifts the valve spool to the position that routes hydraulic oil to the barrel end of the cab tilt cylinder.
- The oil flows over the load holding check valve to the barrel end of the cylinder and the cylinder extends to raise the cab.
- The hydraulic oil in the rod end of the cylinder flows back to tank via the high pressure accessory valve.

### Lower

When a lower command is sent by the cab tilt switch, the following occurs:

- The proportional solenoid on the accessory enable valve is energized by a PWM (pulse width modulation) signal from the CCS to adjust the flow rate of oil to the high pressure accessory valve.
- At the same time, the lower solenoid on the cab tilt control valve is energized by 24 VDC from the CCS.
- The energized solenoid shifts the valve spool to the position that routes hydraulic oil to the rod end of the cab tilt cylinder.
- Pressure from the rod end of the cylinder pilots open the load holding valve allowing the oil from the barrel end of the cylinder to flow back to tank via the high pressure accessory valve.

- The cylinder retracts to lower the gantry.

## COUNTERWEIGHT PINS

See [Figure 10-1](#) and [Figure 10-2](#)

### Counterweight Pins Overview

The counterweight pins are controlled by a switch on the remote control. The system consists of the pilot pump, a 2-position, solenoid operated control valve, and a double-acting hydraulic cylinder.

The setup remote control communicates with the counterweight pins solenoid valve via the CCS.

To activate the setup remote, it must be turned in crane's main display. See the Main Display Operation Manual provided with the crane.

The counterweight pins switch on the remote control is a 2-position locking switch. The switch must be unlocked and held in the engage or disengage position.

### Engage (extend)

When the counterweight pins switch is unlocked and moved to the engage position, the following occurs:

- The solenoid on the counterweight pins control valve is deenergized.
- A spring shifts the control valve to the engage position.
- Hydraulic oil from the pilot pump is routed to the piston end of the counterweight pin cylinders.
- The counterweight pin cylinder rods extend to engage the counterweight pins.
- The oil from the rod end of the cylinders flows back to tank via the low pressure accessory valve.

### Disengage (retract)

When the counterweight pins switch is unlocked and moved to the disengage position, the following occurs:

- The solenoid on the counterweight pins control valve is energized by 24 VDC from the CCS.
- The solenoid shifts the control valve to the disengage position.
- Hydraulic oil from the pilot pump is routed to the rod end of the counterweight pin cylinders.
- The counterweight pin cylinder rods retract to disengage the counterweight pins.
- The oil from the piston end of the cylinders flows back to tank via the low pressure accessory valve.

## Counterweight Limit Switch

The counterweight limit switch stops the boom hoist and the gantry from raising the crane counterweights too high during counterweight installation.

## BOOM HOIST OPERATION

The thumbwheel on the remote control operates the boom hoist in the same manner as the control handle in the cab.

The boom hoist park switch in the cab must be unparked to operate the boom hoist.

The sync switch allows the gantry cylinders to follow along with the gantry when the boom hoist thumbwheel is used to raise and lower the gantry during counterweight installation and removal.

## HYDRAULIC COOLING FAN OPERATION

See [Figure 10-1](#) and [Figure 10-2](#)

The system consists of the fan pump, the hydraulic oil cooler and motor, and the hydraulic oil temperature sensor.

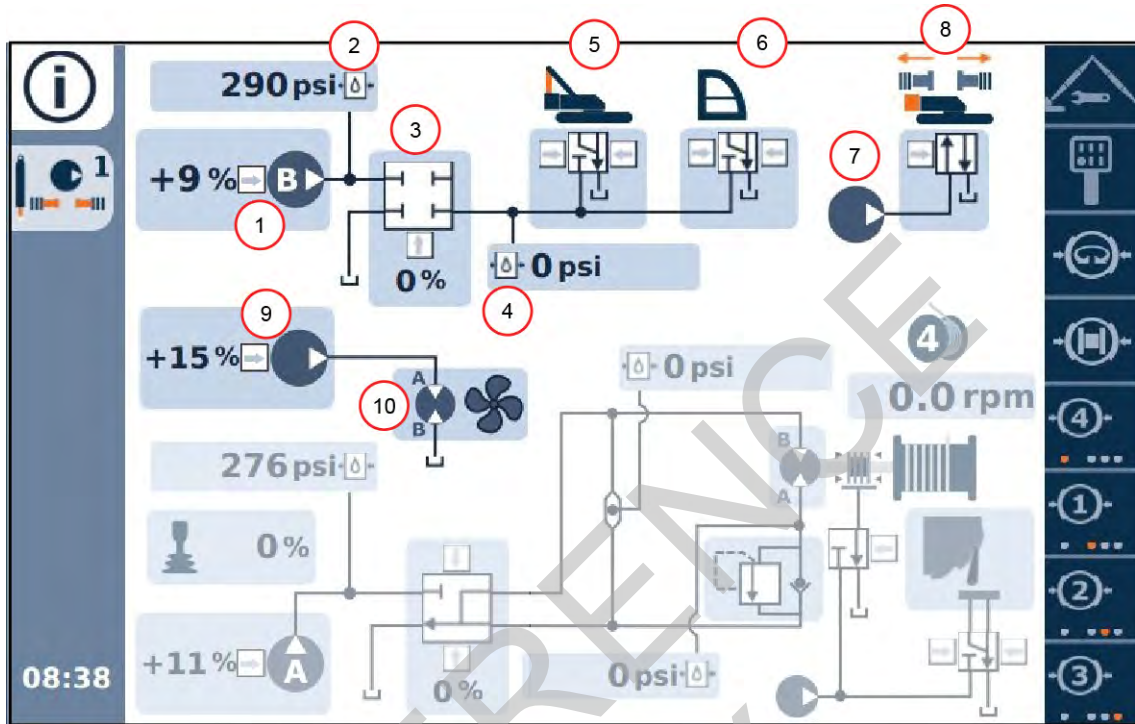
The hydraulic cooling fan is proportionally controlled by the temperature of the hydraulic oil. Increasing hydraulic oil temperature increases fan speed. At 80°C (176°F), the fan operates at maximum speed.

The fan motor is equipped with a check valve that prevents cavitation when the motor is stopped by allowing return oil to flow from the motor outlet to motor inlet until the motor comes to a complete stop.

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### ACCESSORY SYSTEMS HYDRAULIC DIAGRAM

A detailed hydraulic schematic is provided at the end of Section 2 in this Service Manual.



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Item	Accessory Systems Components	Item	Accessory Systems Components
1	Open Loop A Pump (command 0 to 100%)	6	Cab Tilt Control Valve
2	Open Loop A Pump Pressure Transducer	7	Accessory System Pump (low pressure)
3	Accessory System Enable Valve (command 0 to 100%)	8	Counterweight Pins Control Valve
4	Accessory System Pressure Transducer	9	Hydraulic Cooler Fan Pump (command 0 or 100%)
5	Gantry Cylinders Control Valve	10	Hydraulic Cooler Fan Motor

FIGURE 10-1



### ACCESSORY SYSTEMS ELECTRICAL DIAGRAM

A detailed electrical schematic is provided at the end of Section 3 in this Service Manual.

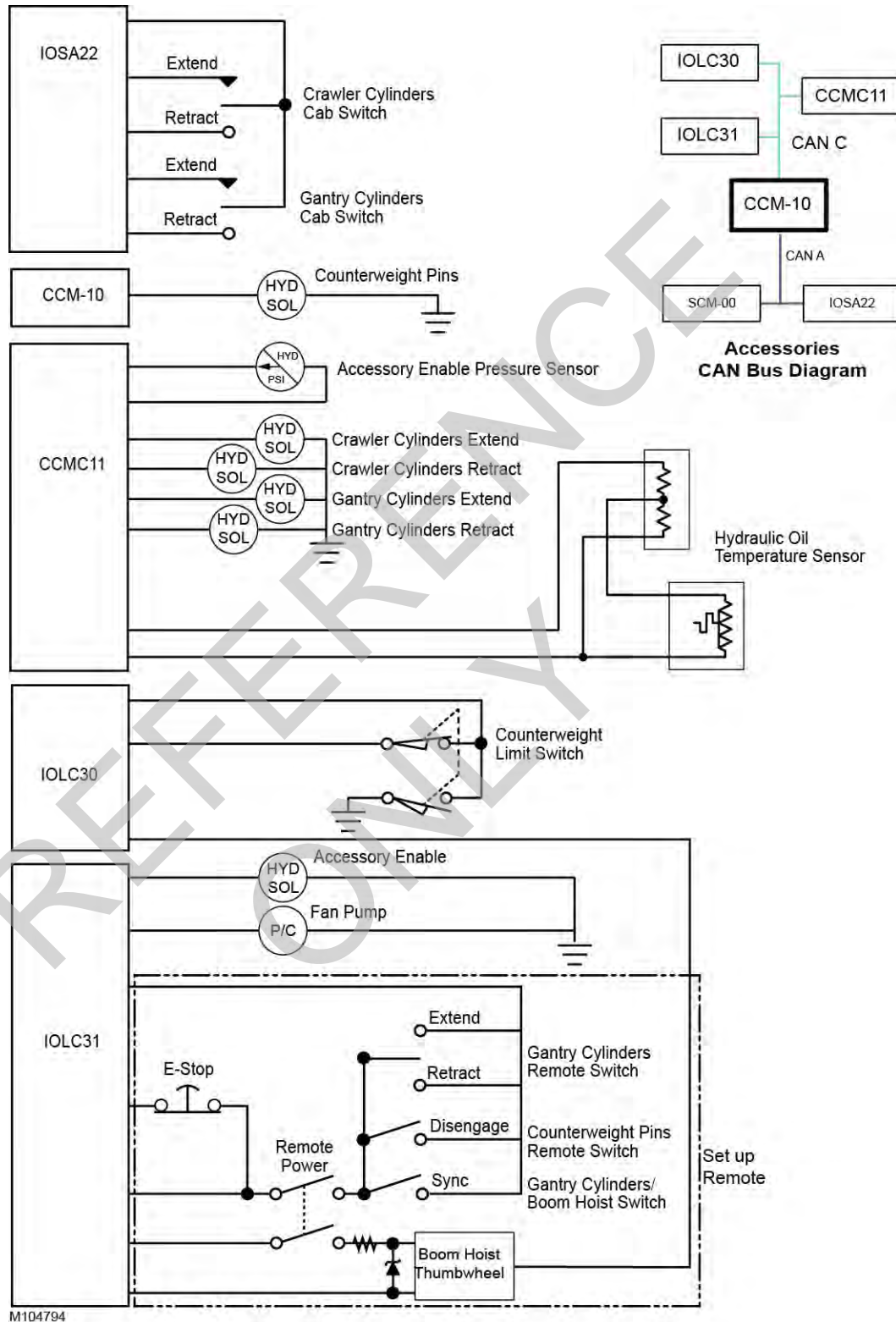


FIGURE 10-2

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