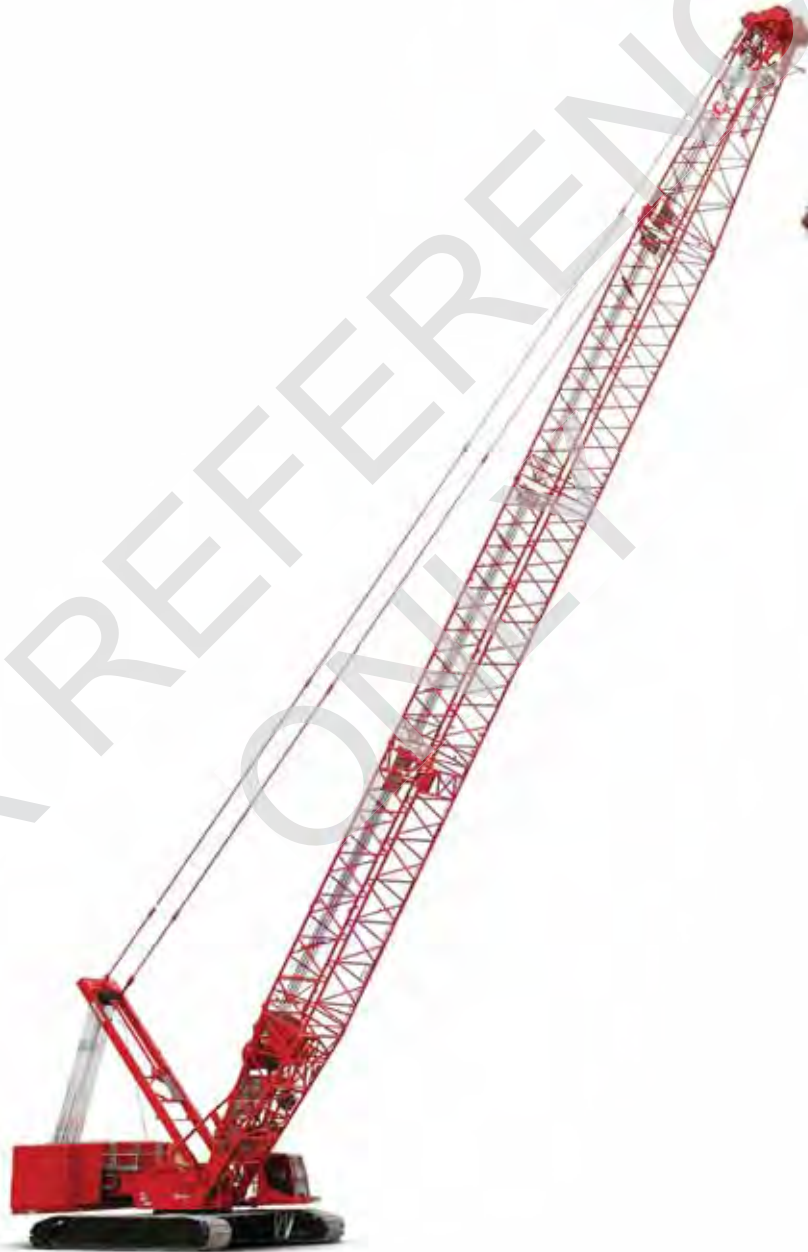


Manitowoc MLC300

with Fixed Position Counterweight

Service/Maintenance Manual



FOR REFERENCE
ONLY



SERVICE/MAINTENANCE MANUAL

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

MLC300

Crane Model Number

XXXXXRef

Crane Serial Number

This manual is divided into the following sections:

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

NOTICE

The serial number of the crane and applicable attachments (luffing jib, VPC-MAX™) 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 and each attachment. Refer to the Nameplate and Decal Assembly Drawing in Section 2 of this manual for the exact location of the crane identification plate.

Always furnish serial number of crane and its attachments 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.

THE ORIGINAL LANGUAGE OF THIS PUBLICATION IS ENGLISH

See end of this manual for Alphabetical Index

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FOR REFERENCE ONLY

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FOR REFERENCE ONLY

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.

Battery posts, terminals, and related accessories contain chemical lead and lead compounds, chemicals known to the State of California to cause cancer, birth defects, and other reproductive harm. Wash hands after handling.

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 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 MLC300 Operator Manual and the MLC300 Service/Maintenance Manual before attempting any maintenance procedure. If there is any question regarding maintenance procedures or specifications, contact your Manitowoc Cranes 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 that is 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 starting means 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 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 and 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 permits standing well away from 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 burning on the crane. Cover all hoses and components with nonflammable shields or blankets to prevent a fire or 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, computers), perform the following steps before welding on the crane:

- Turn the battery disconnect switch to the OFF position.
- Disconnect all the cables from the batteries. Make sure to disconnect the negative cable first.
- Disconnect the output cables at the engine junction box.
- Disconnect all cable connectors from nearby control modules.
- 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.

Maintain 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 or straps), 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 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.

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.

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.

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: Hydraulics in this service manual for locations of the following:

- Hydraulic pumps
- Hydraulic motors
- Transducer manifold
- Hydraulic valve assemblies

See Section 3: Electrical in this service manual for locations of the electronic control modules.

Item	Description
0	Drum 0 (rigging winch)
1	Drum 1 (main hoist)
2	Drum 2 (aux hoist)
3	Drum 3 (aux hoist)
4	Drum 4 (boom hoist)
5	Boom Butt
6	Drum 6 (luffing or auxiliary hoist)
7	Drum 7 (tagline)
8	Upperworks
9	Lowerworks
10	Counterweight
11	Live Mast
12	Boom Stop (physical)
13	Boom Straps
14	Wire Rope Guide
15	Boom Insert (varying lengths)
16	Boom Top
17	Load Cell (1 each side of top)
18	Wire Rope Guide
19	Upper Boom Point
20	Lower Boom Point
21	Hook-and-Weight Ball
22	Load Block

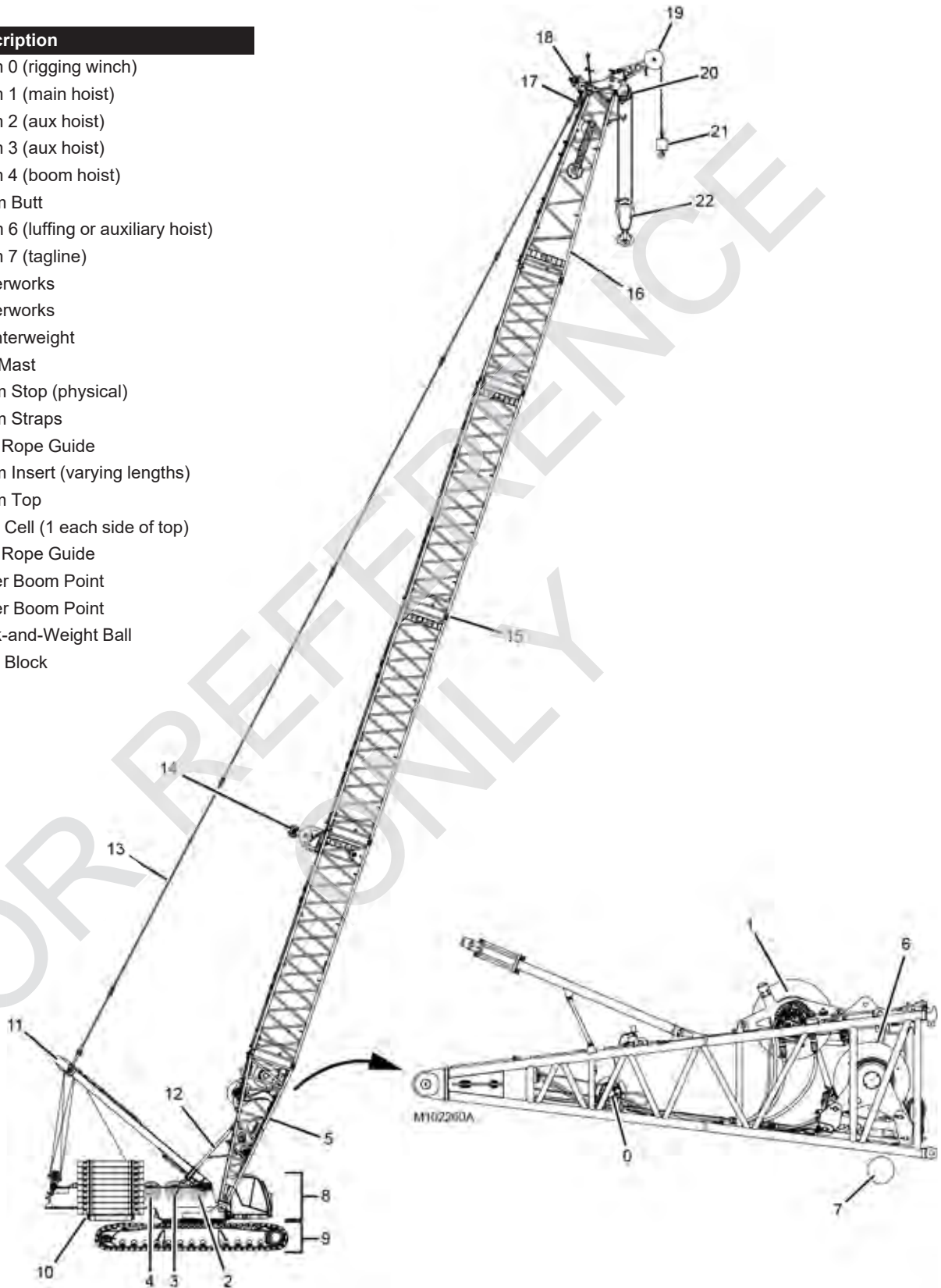


FIGURE 1-1

Item	Description	Item	Description
1	Operator Cab	10	Counterweight Tray Retainer (qty 2)
2	Swing Drive (1 or 2 optional)	11	Batteries (inboard right side)
3	Crawler	12	Fuel Tank
4	Crawler Drive	13	Mast Equalizer
5	Intermediate Roller	14	Load Pin (right side only)
6	Turntable Bearing	15	Live Mast
7	Crawler Roller	16	Live Mast Sheaves
8	Counterweight Tray	17	Self-Erect Cylinder
9	Counterweight Box (quantity varies with Series 0, 1, 2, or 3)	18	Live Mast Straps

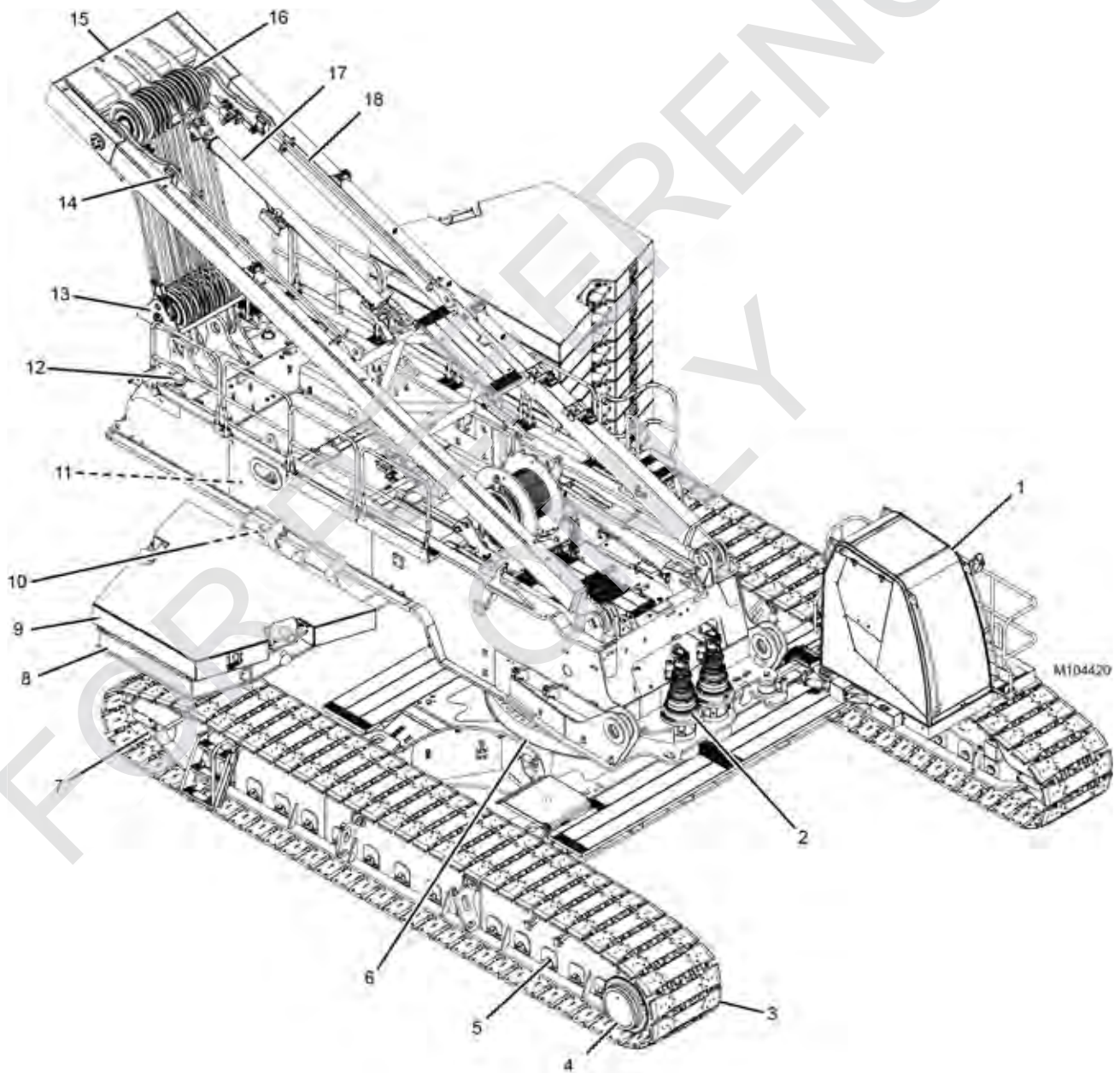


FIGURE 1-2

Item	Description
19	Drum 2 (aux hoist)
20	Mast-Assist Arm and Cylinder (qty 2)
21	Drum 3 (aux hoist)
22	Drum 4 (boom hoist)
23	Hydraulic Tank
24	Pump Drive with Pumps (under guards)
25	Cooler Assembly (under guards)
26	Engine (under guards)
27	Exhaust Aftertreatment Components (inboard left side)
28	DEF Tank (inboard left side)
29	Engine Air Cleaner (inboard left side)
30	Crawler Pin Puller (qty 4)
31	Carbody Jack (qty 2)
32	Jack Pad (qty 4)

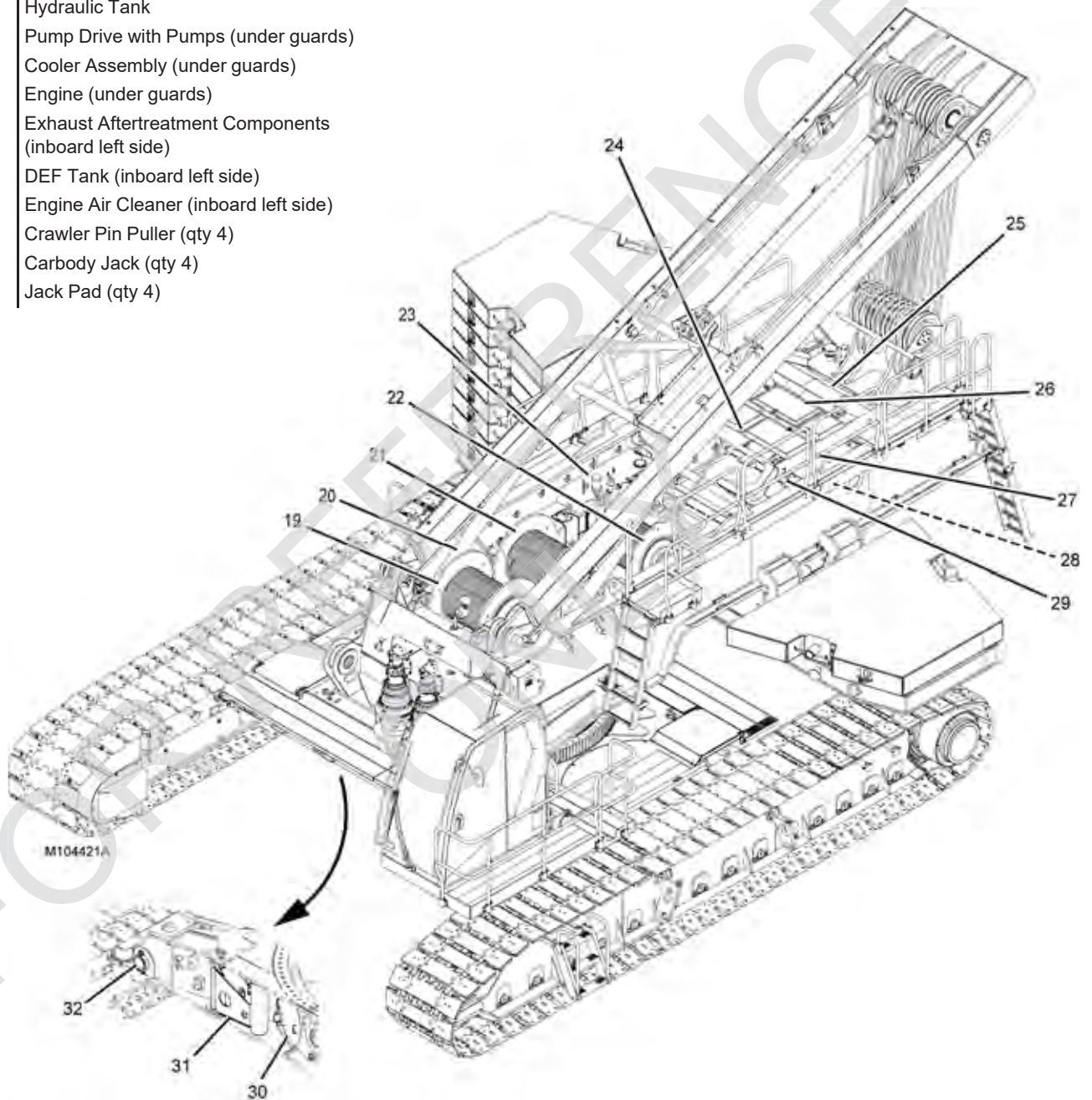


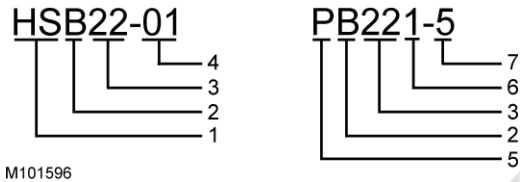
FIGURE 1-2 continued

Solenoid Valve Identification

Each hydraulic valve solenoid is assigned a solenoid number used in Manitowoc Cranes training classes (see [Table 1-1](#)). 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 1-3](#). In this example, for the right rear carbody jack raise solenoid, the following information is contained:

- Control module resides on CAN Bus B
- Control module index is 22
- Control module digital output is ODH3A-01
- Control module output signal is at pin 5 of connector KS-1



M101596

Item	Description
1	Hydraulic Solenoid Reference Designator
2	CAN Bus (- = controller resides on multiple buses)
3	Control Module Index
4	Digital Output Number
5	Connector Reference Designator
6	Connector Number (1 = KS1, 2 = KS2)
7	Pin Number

FIGURE 1-3

Table 1-1. Hydraulic Solenoid Identification

Solenoid Number	Description	Pin Number
HSB11-04	Left Crawler/Carbody Pin Puller Extend	PB112-22
HSB11-05	Left Crawler/Carbody Pin Puller Retract	PB112-5
HSB11-06	Right Crawler/Carbody Pin Puller Extend	PB112-15
HSB11-07	Right Crawler/Carbody Pin Puller Retract	PB112-14
HSB11-08	Travel Brake Release	PB112-4
HSB11-11	Left Crawler Tension Retract	PB112-24
HSB11-12	Left Crawler Tension Extend	PB112-25
HSB11-13	Right Crawler Tension Retract	PB112-6
HSB11-14	Right Crawler Tension Extend	PB112-16
HSB11-23	Left Front Carbody Jack Raise	PB111-1
HSB11-24	Left Front Carbody Jack Lower	PB112-12
HSB11-25	Right Front Carbody Jack Raise	PB111-15
HSB11-26	Right Front Carbody Jack Lower	PB111-42
HSB11-27	Left Rear Carbody Jack Raise	PB111-28
HSB11-28	Left Rear Carbody Jack Lower	PB111-2
HSB22-01	Right Rear Carbody Jack Raise	PB221-5
HSB22-02	Right Rear Carbody Jack Lower	PB221-6
HSC11-05	Drum 2 Left Brake Release	PC112-5
HSC11-07	Drum 3 Park Brake Release	PC112-14
HSC11-11	Drum 0 (Rigging Winch) Spool In	PC112-24
HSC11-12	Drum 0 (Rigging Winch) Spool Out	PC112-25
HSC11-13	Swing Brake Release	PC112-6
HSC11-14	Drum 1/Drum 3 Diverter	PC112-16
HSC12-06	Not Used	PC122-15
HSC12-07	Not Used	PC122-14
HSC12-11	Not Used	PC122-24
HSC12-12	Not Used	PC122-25
HSC12-13	Not Used	PC122-6
HSC13-13	Not Used	PC132-6

Solenoid Number	Description	Pin Number
HSC30-03	Boom Pin Pusher Extend	PC112-7
HSC30-04	Boom Pin Pusher Retract	PC112-26
HSC30-05	Left Mast Cylinder Directional Control	PC302-25
HSC30-06	Not Used	PC302-16
HSC30-07	Not Used	PC302-7
HSC30-08	Not Used	PC302-26
HSC30-11	Right Mast Cylinder Directional Control	PC302-27
HSC30-14	RH Isolation/Accessory Side B	PC302-18
HSC30-15	RH Isolation/Accessory Side A	PC302-10
HSC30-18	Self-Assembly Cylinder Extend	PC301-5
HSC30-19	Self-Assembly Cylinder Retract	PC301-6
HSC31-02	Drum 4 Right Brake Release	PC312-5
HSC31-03	Drum 4 Pawls In	PC312-24
HSC31-05	Free Fall Enable	PC312-25
HSC31-08	Drum 2 Free-Fall Brake Hold	PC312-26
HSC31-09	Drum 3 Free-Fall Brake Hold	PC312-17
HSC31-15	Cooler Fan Pump	PC312-10
HSC31-19	Drum 2 Free-Fall Brake	PC311-6
HSC31-20	Drum 3 Free-Fall Brake	PC311-7
HSC31-24	Drum 4 Pawls Out	PC312-6
HSC32-02	Drum 1 Left Brake Release	PC322-5
HSC32-03	Cab Tilt Down	PC322-24
HSC32-04	Cab Tilt Up	PC322-27
HSC32-11	Mast Pin Puller Extend	PC322-28
HSC32-13	Mast Pin Puller Retract	PC312-17
HSC32-15	Mast Lower	PC322-29
HSC32-16	Mast Raise	PC322-6
HSC32-18	Spotter Circuit Extend	PC321-5
HSC32-19	Spotter Circuit Retract	PC321-6
HSC33-03	Drum 7 Park Brake	PC322-24
HSC33-04	Drum 6 Brake Release	PC322-6
HSC33-06	Drum 6 Pawls In	PC322-16
HSC33-07	Drum 6 Pawls Out	PC322-7
HSC33-20	LH Isolation/Accessory Side B	PC331-7
HSC33-21	LH Isolation/Accessory Side A	PC331-8

Solenoid Number	Description	Pin Number
HSC34-11	Gantry Pin Puller Extend	PC342-27
HSC34-13	Gantry Pin Puller Retract	PC342-28
HSC34-20	Left Mast Cylinder PSI Reducing	PC341-7
HSC34-21	Right Mast Cylinder PSI Reducing	PC341-8

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SECTION 2

HYDRAULIC SYSTEM

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FOR REFERENCE ONLY

SECTION 2

HYDRAULIC SYSTEM

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 Locations

There are eight hydraulic pumps driven by the engine. [Figure 2-1](#) illustrates the location of these pumps and the motors and cylinders that each drive. Diverter valves allow some pumps to drive multiple functions as well as combine pump flows from multiple pumps to drive a single function.

2

Pump Supplies Oil To

1	Drum 2 and Drum 2 Anti-Cavitation
2	Drum 1, Drum 3 Anti-Cavitation, Drum 1 and 3 Selector Valve, Swing Brake, and Crawler Brakes
3	System B—Drum 4, Drum 6, Right Travel, Carbody Jacking Cylinders, Crawler Pins, Rigging Winch, Boom Butt Pins, and Self-Assembly Cylinder
4	System A—Drum 4, Left Travel, Live Mast Raising Cylinders, Live Mast Pins, Gantry Equalizer Pins, Cab Tilt, Warning Circuit
5	Swing
6	Fan
7	Cooler Circuit
8	Travel Motor Case Cooling, Drums 4 and 6 Brakes, and Pawls

NOTE: The pump numbers given above correspond to the pump numbers in the electrical schematic and the wiring diagram located at the end of Section 3.

System A corresponds to solenoid valve bank on left side of rotating bed.

System B corresponds to solenoid valve bank on right side of rotating bed.

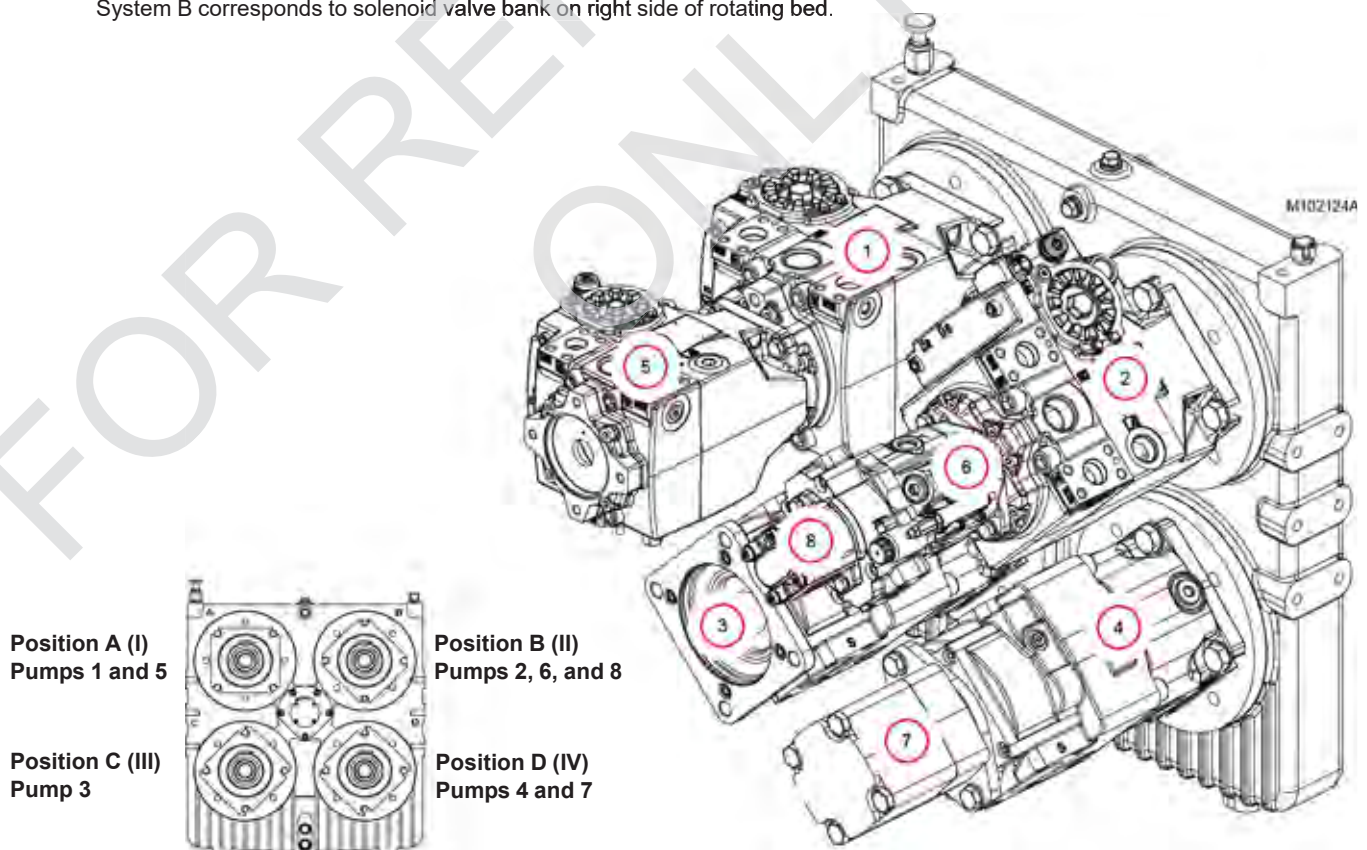


FIGURE 2-1

Pumps 1 and 2

Pumps 1 and 2 (Figure 2-2) are 165cc, variable-displacement, axial piston pumps. Each pump's direction and displacement are controlled by an electronic displacement control (EDC).

Both pumps have a maximum operating pressure of 420 bar (6,090 psi).

Item	Description
1	Case Pressure Port L1
2	Servo Gauge Port M4
3	System Port B
4	Charge Inlet Port
5	System Port A
6	Case Drain L4
7	Charge Pressure Port
8	Servo Gauge Port M5
9	Case Pressure Port L3
10	Case Drain Port L2
11	Charge Gauge Port M3
12	System A Gauge Port MA
13	Charge Filtration Port E
14	Charge Pressure
15	System B Gauge Port MB
16	Charge Filtration Port B

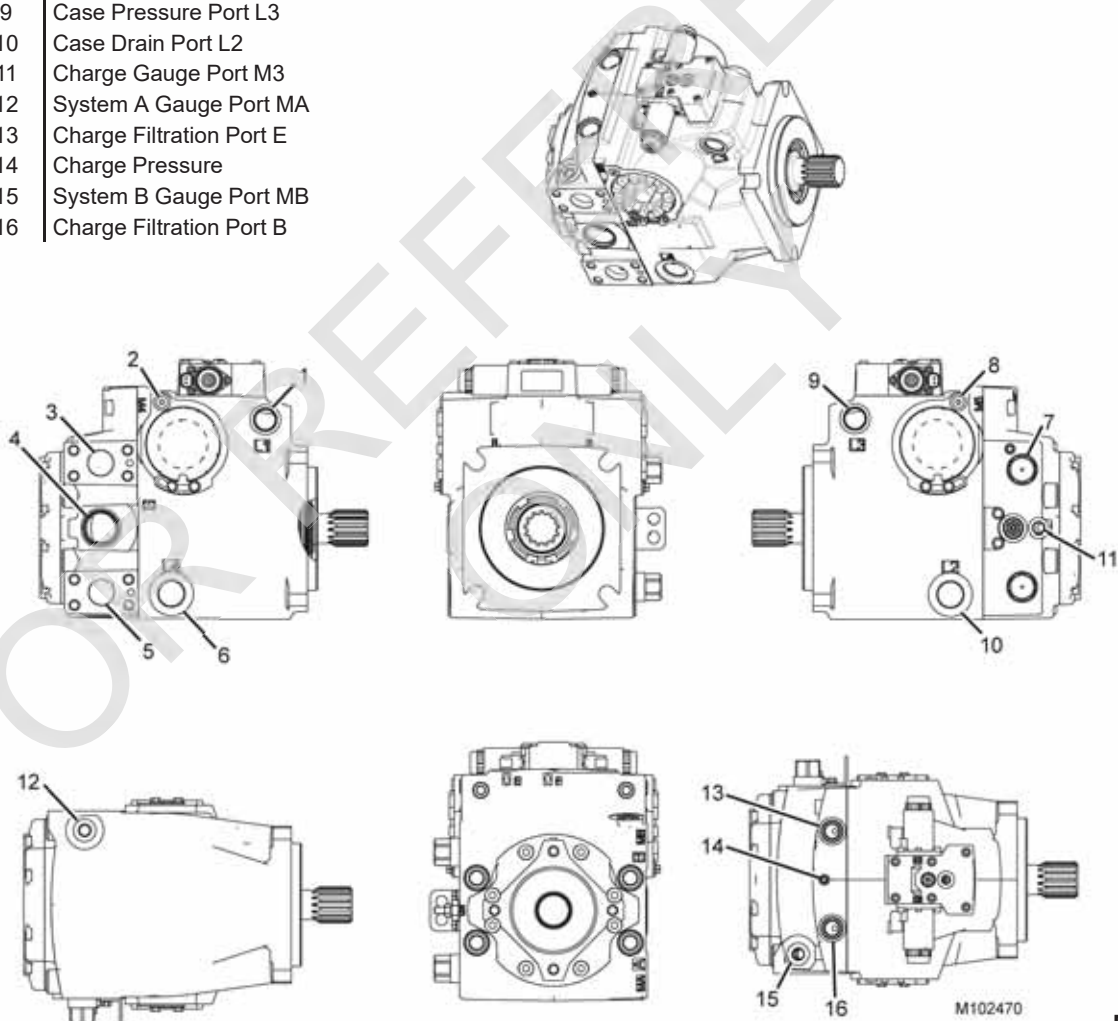
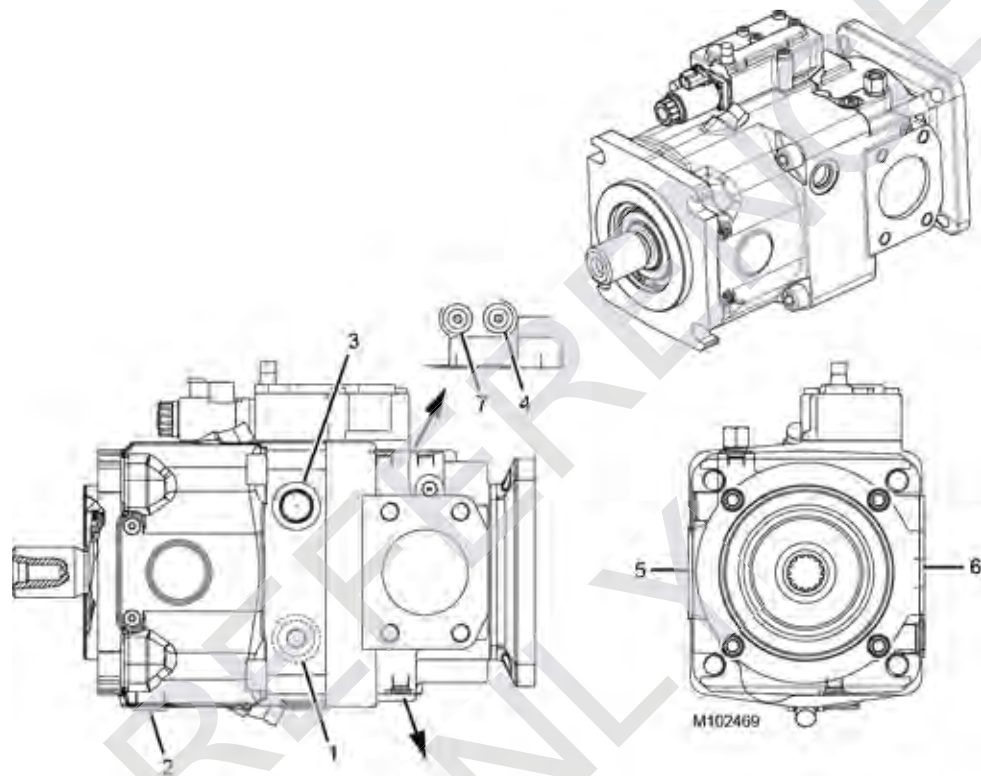


FIGURE 2-2

Pumps 3 and 4

Pumps 3 and 4 ([Figure 2-3](#)) are 145cc, variable-displacement, axial piston pumps. Each pump's direction and displacement are controlled by an electronic displacement control (EDC).

Both pumps have a maximum operating pressure of 355 bar (5,149 psi).



Item	Description
1	Tank T1
2	Air Bleed
3	Tank T2
4	Control Pressure Port G
5	Inlet S
6	Outlet A
7	Measuring Service Line M

FIGURE 2-3

Pump 5

Pump 5 (Figure 2-4) is a 100cc, variable-displacement, axial piston pump. Pump direction and displacement are controlled by an electronic displacement control (EDC).

The pump has a maximum operating pressure of 420 bar (6,090 psi).

Item	Description
1	Case Pressure Port L1
2	Servo Gauge Port M4
3	System Port B
4	Charge Inlet Port
5	System Port A
6	Case Drain L4
7	Charge Pressure Port
8	Servo Gauge Port M5
9	Case Pressure Port L3
10	Case Drain Port L2
11	Charge Gauge Port M3
12	System A Gauge Port MA
13	Charge Filtration Port E
14	Charge Pressure
15	System B Gauge Port MB
16	Charge Filtration Port B

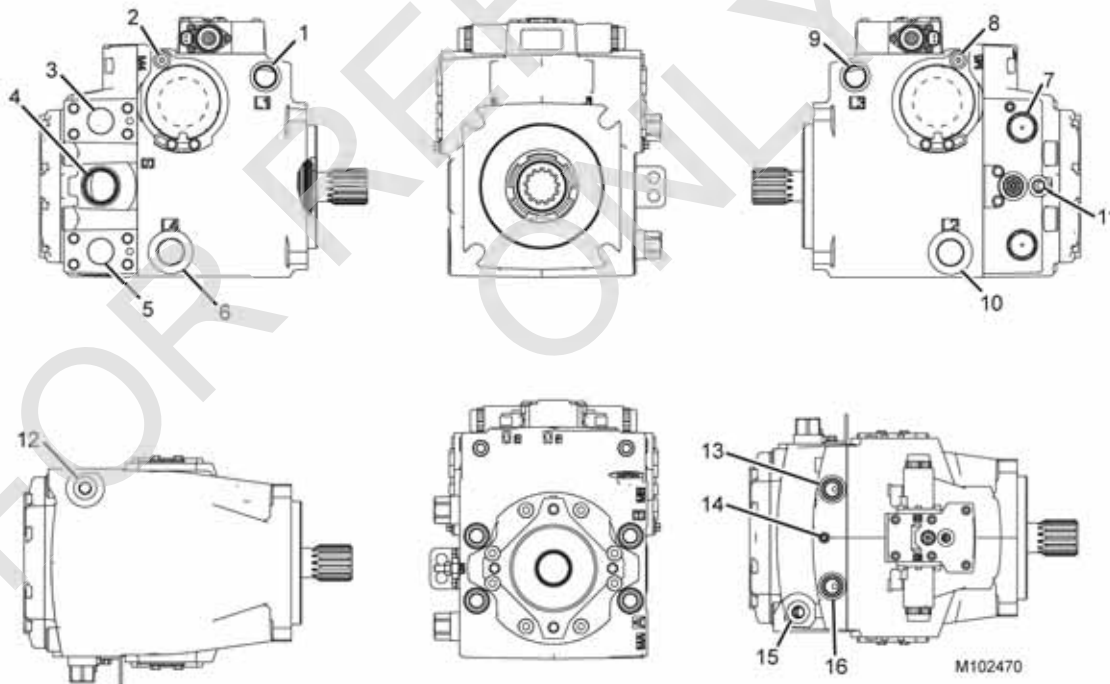
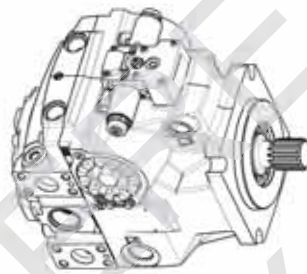
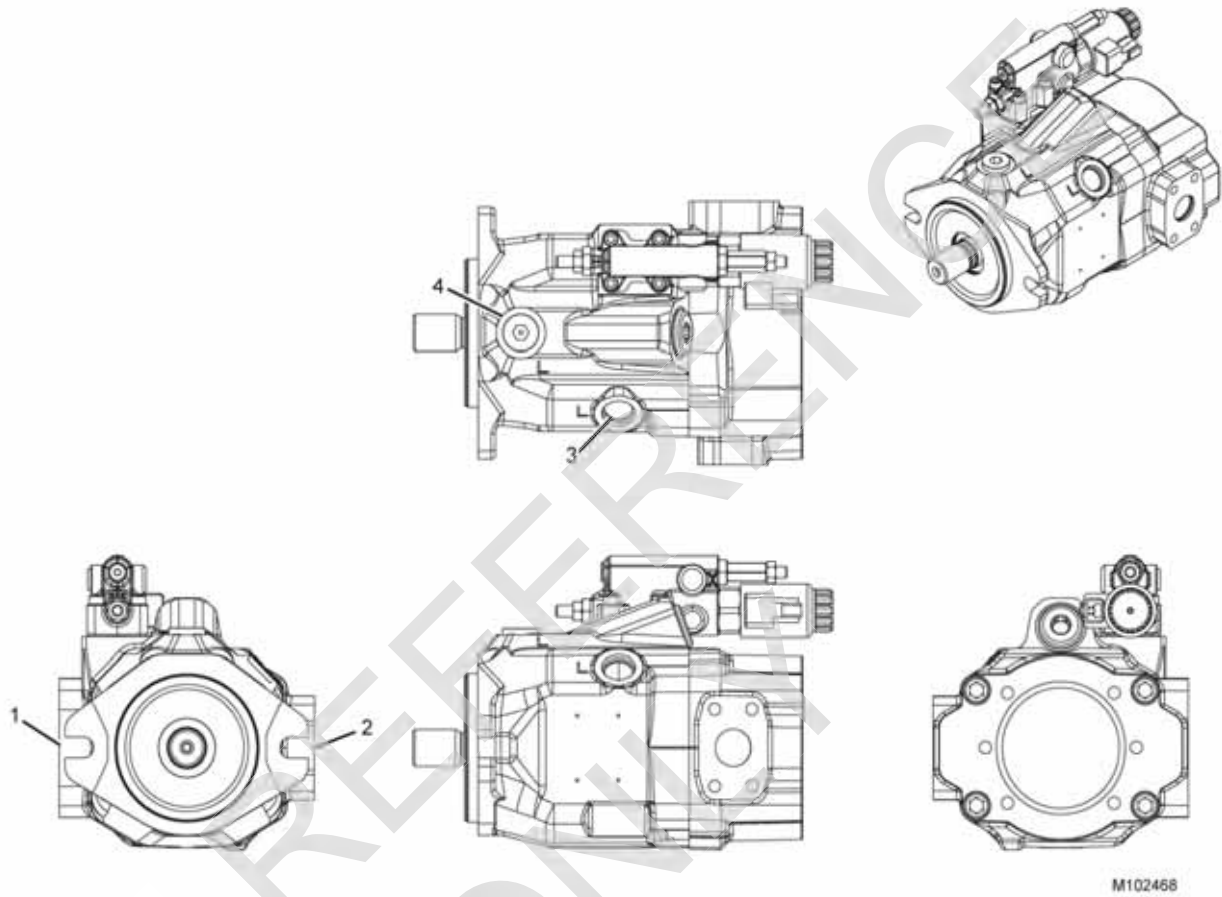


FIGURE 2-4

Pump 6

Pump 6 (Figure 2-5) is a 45cc, variable-displacement, axial piston pump. It has a maximum operating pressure of 250 bar (3,600 PSI).



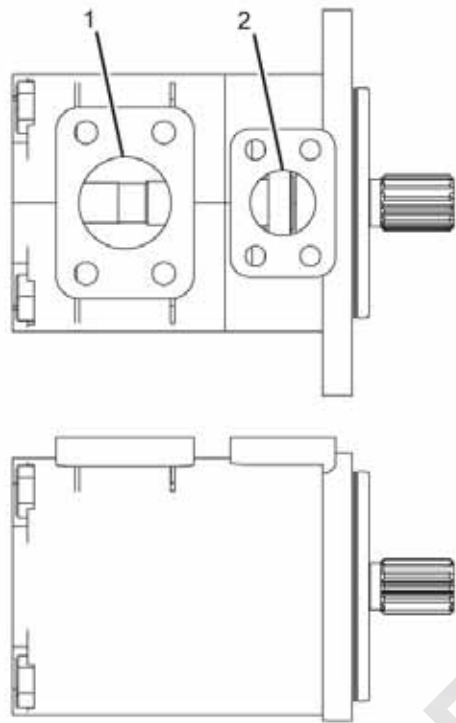
M102468

Item	Description
1	Inlet Port S
2	Outlet Port B
3	Case Drain L
4	Case Drain L1

FIGURE 2-5

Pump 7

Pump 7 (Figure 2-6) is a 122cc, fixed-displacement, vane pump. Its pressure is limited to 25 bar (350 psi) by a relief valve.



Item	Description
1	Inlet Port S
2	Outlet Port P

M102471

FIGURE 2-6

Pump 8

Pump 8 (Figure 2-7) is a 19.66cc, fixed-displacement, gear pump. Its pressure is limited to 9 bar (130 psi) by a relief valve.

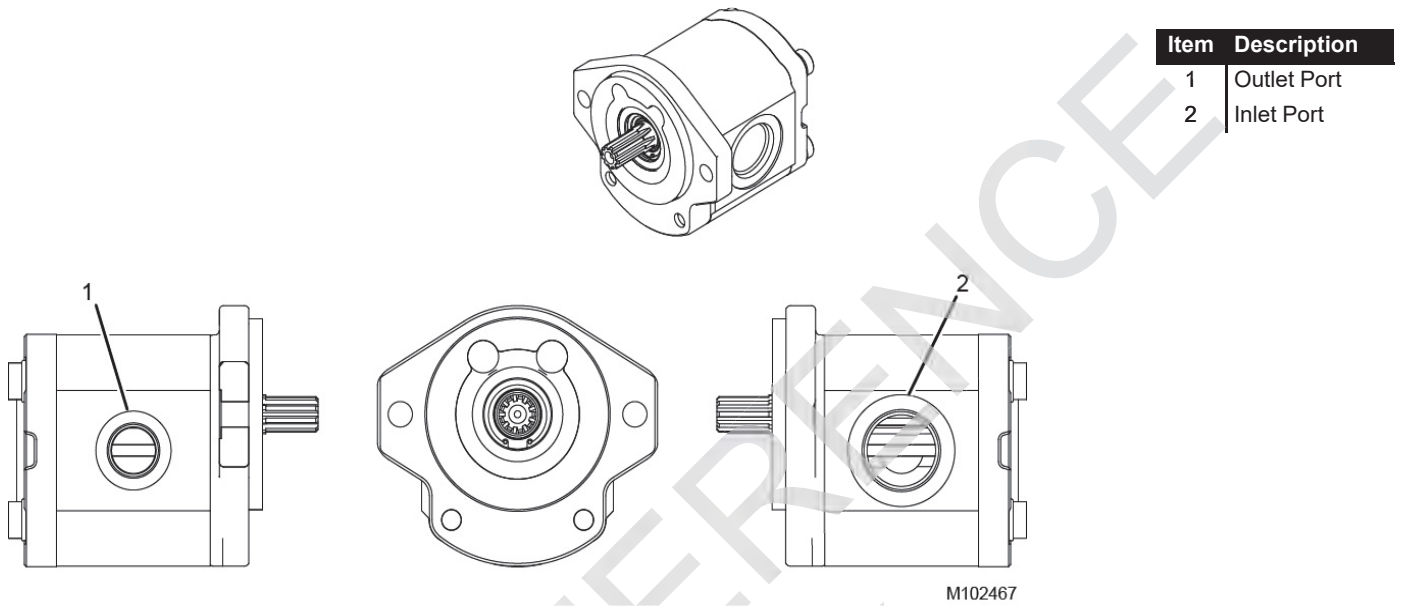


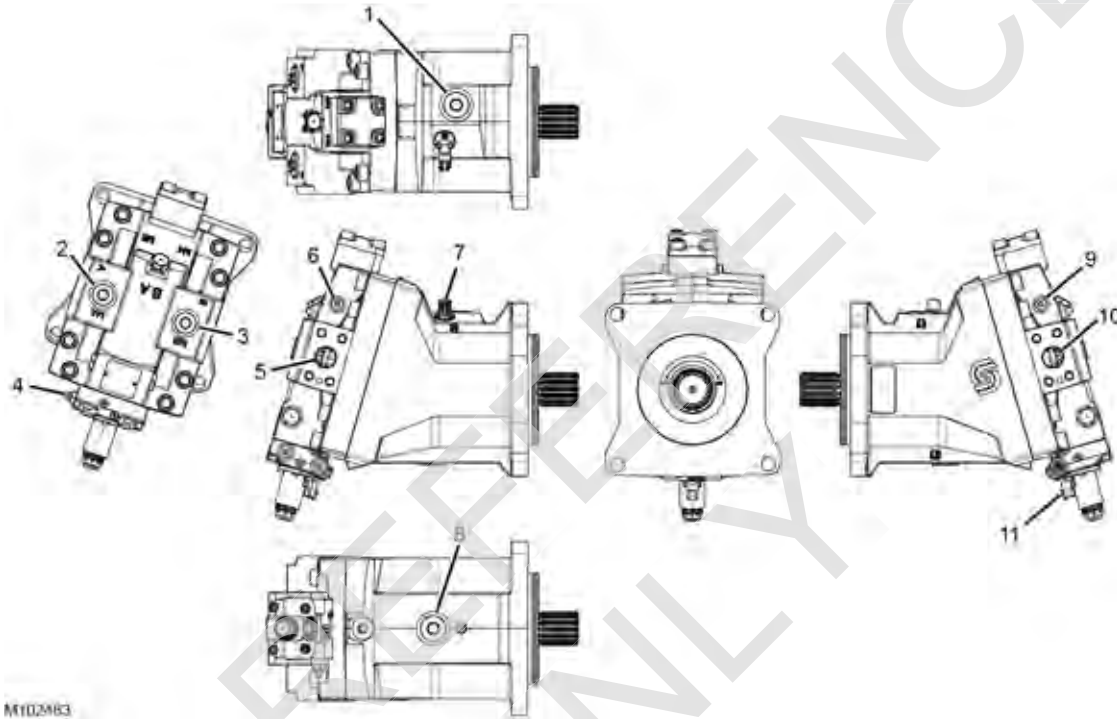
FIGURE 2-7

Motor Locations

Drum 1 Motor

Drum 1 motor ([Figure 2-8](#)) is a bidirectional, variable-displacement motor. Motor displacement is controlled by an electronic motor controller.

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

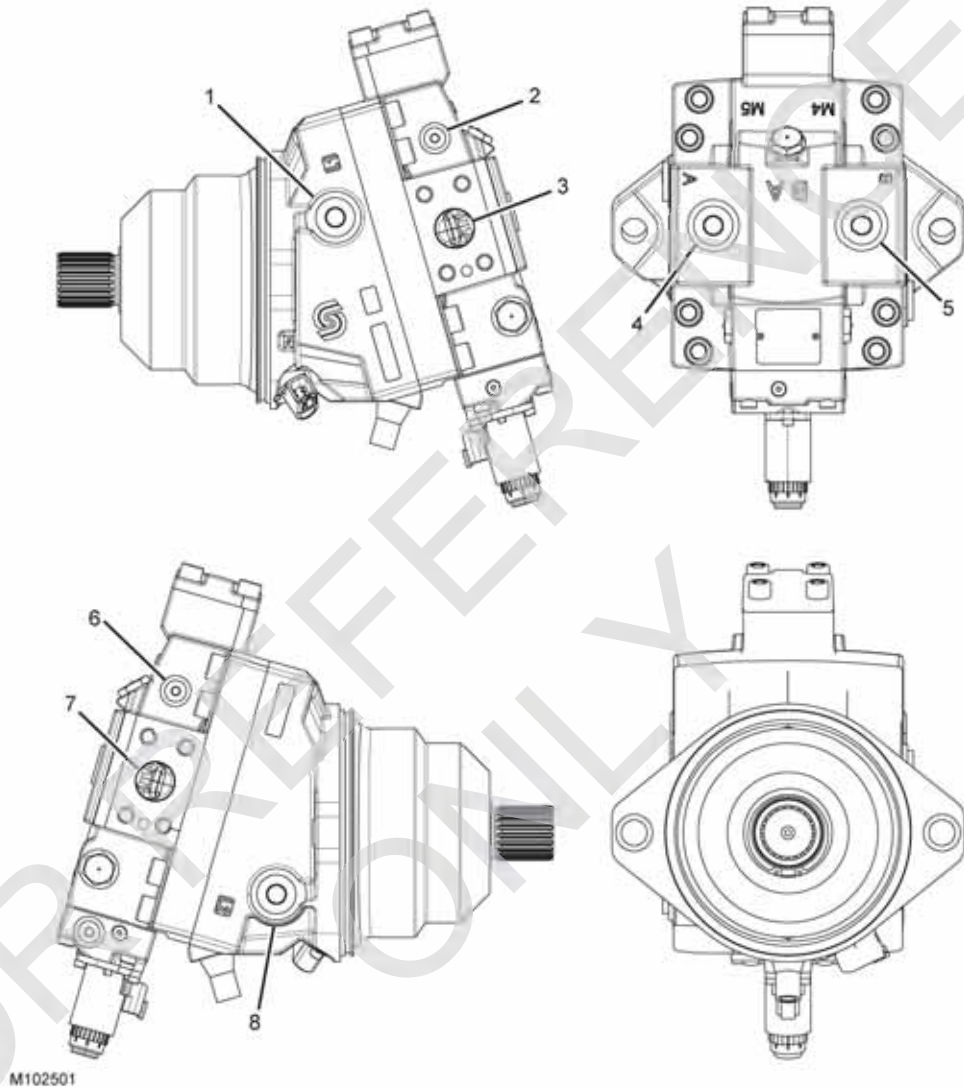


Item	Description
1	Case Drain Port L1
2	System A Pressure Gauge Port MA
3	System B Pressure Gauge Port MB
4	PCOR Adjustment
5	System Port B
6	Servo Pressure Gauge Port M4
7	Speed Sensor N
8	Case Drain Port L2
9	Servo Pressure Gauge Port M5
10	System Port A
11	Elect. Prop. Displacement Control

FIGURE 2-8

Drums 2, 3, 4, and 6 Motors

Drums 2, 3, 4, and 6 motors (Figure 2-9) are bidirectional, variable-displacement motors. Motor displacements are controlled by electronic motor controllers.

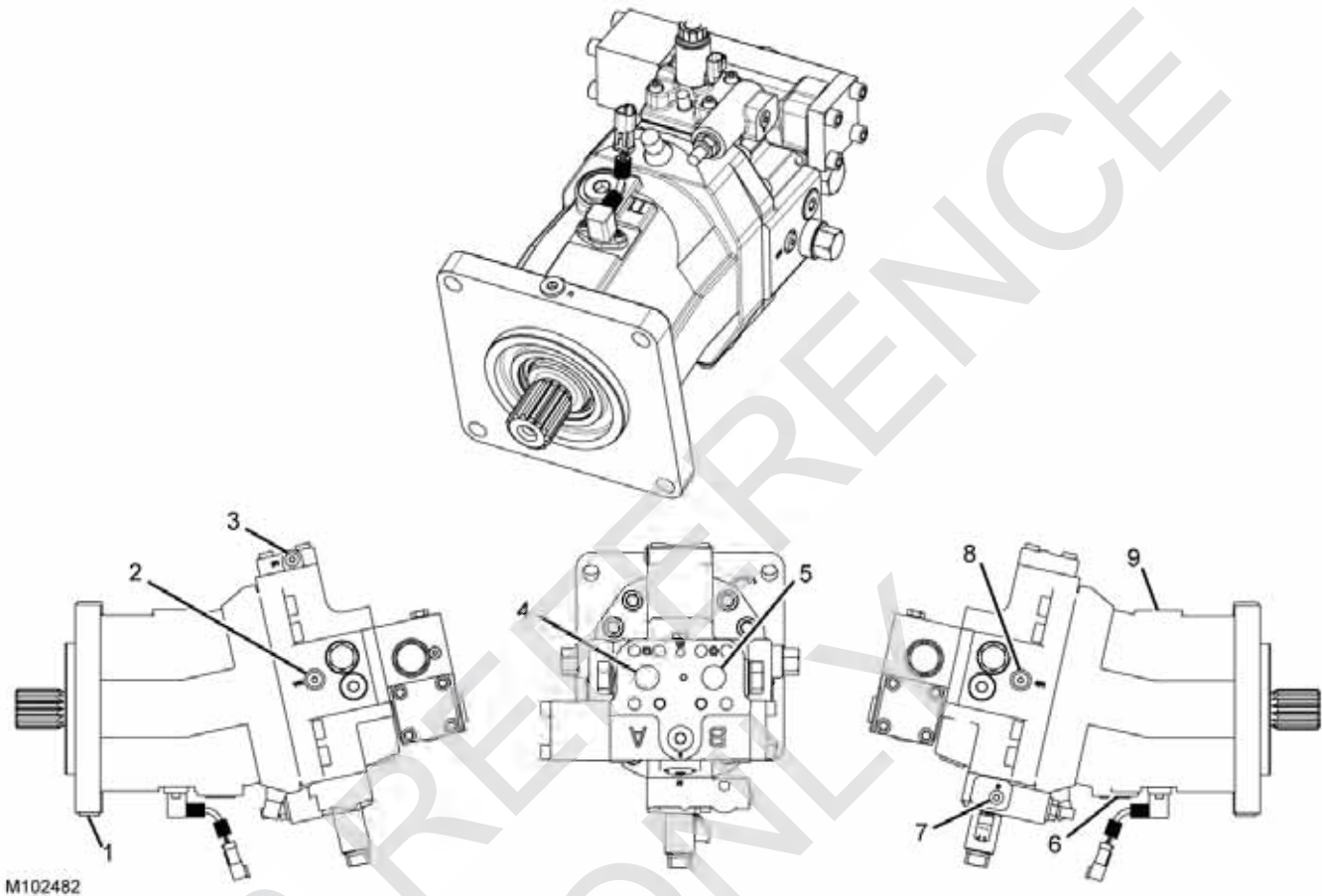


Item	Description
1	Case Drain Port L1
2	Gauge Port M5
3	System Pressure A
4	Gauge Port MA
5	Gauge Port MB
6	Gauge Port M4
7	System Pressure B
8	Case Drain Port L2

FIGURE 2-9

Travel Motors

The travel motors (Figure 2-10) are bidirectional, variable-displacement motors. Motor displacements are controlled by electronic motor controllers.



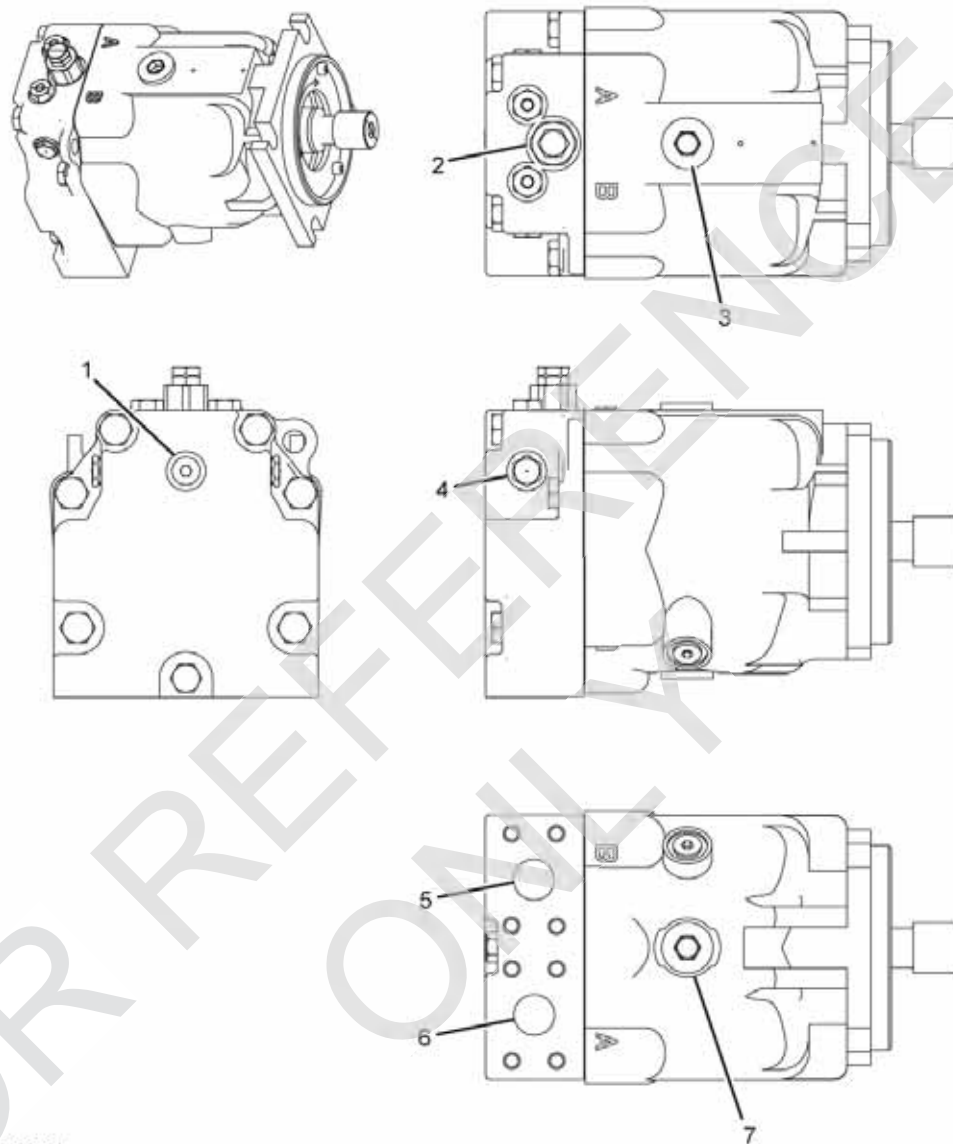
M102482

Item	Description
1	Bearing Flushing U
2	Measuring Pressure MA
3	Measuring Stroking Chamber M1
4	System Pressure A
5	System Pressure B
6	Tank T1
7	Synchronous Control G
8	Measuring Pressure MB
9	Tank T2

FIGURE 2-10

Swing Motors

The swing motors ([Figure 2-11](#)) are bidirectional, fixed-displacement motors.

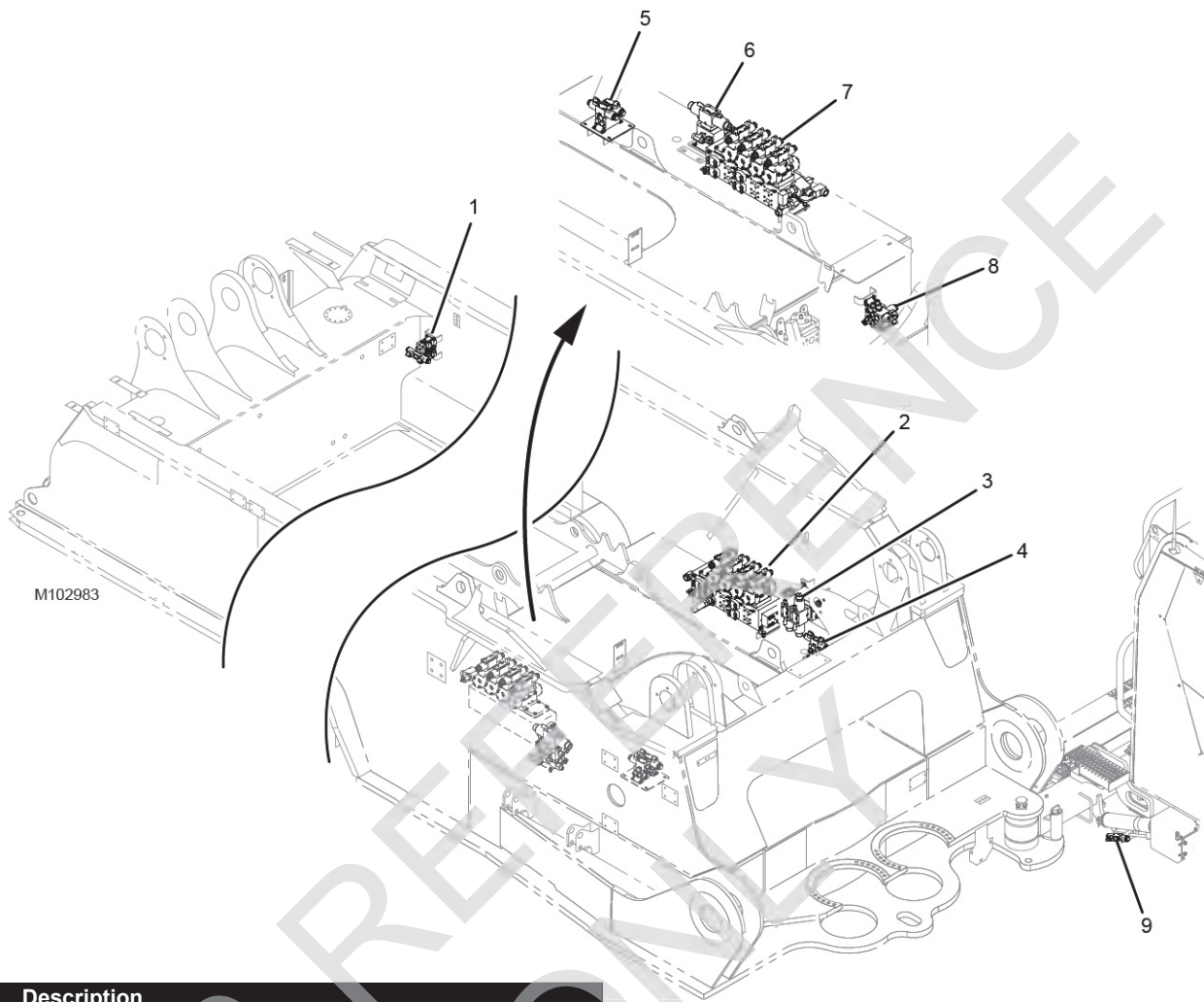


M102481

Item	Description
1	Charge Pressure Gauge Port
2	Loop Flush Relief Valve
3	Case Outlet
4	Loop Flushing Shuttle Valve
5	System Port B
6	System Port A
7	Case Outlet

FIGURE 2-11

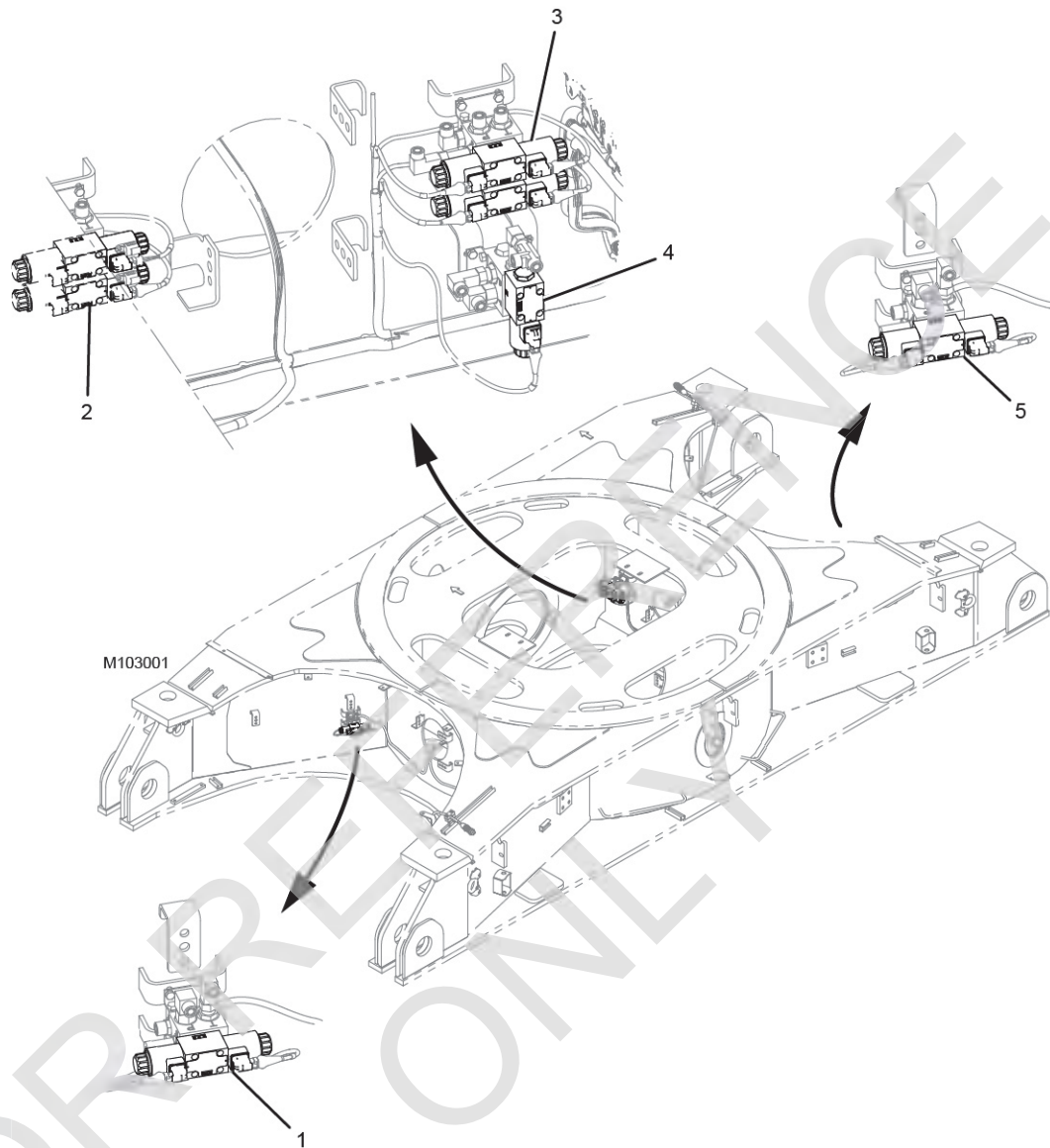
Rotating Bed Hydraulic Valves



Item	Description
1	Gantry Equalizer Pin Puller Valve
2	System A—Left Valve Manifold (from left to right): <ul style="list-style-type: none"> • Accessory System Valve • Drum 4 Valve • Drum 5 Valve (not used) • Left Travel Valve
3	Live Mast Raise/Lower Valve (right valve is a spare)
4	Live Mast Pin Puller Valve
5	Boom Butt Pin Puller Valve (bottom valve is a spare)
6	Drum 0 (rigging winch) Valve
7	System B—Right Valve Manifold (from left to right): <ul style="list-style-type: none"> • Drum 4 Valve • Right Travel Valve • Drum 6 Valve • Accessory System Valve
8	Swing Brake Valve (top) Drum 1/3 Selector Valve (bottom)
9	Cab Tilt Valve

FIGURE 2-12

Carbody Hydraulic Valves

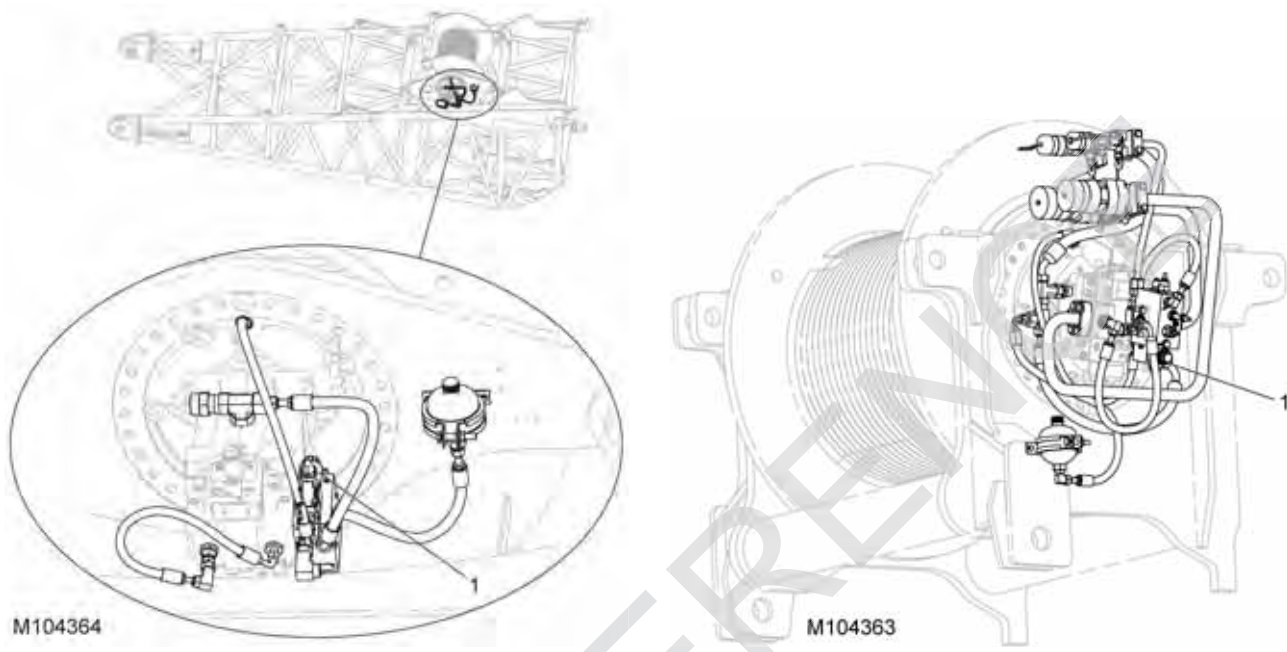


2

Item	Description
1	Left Crawler Pin Puller Valve
2	Jacking Cylinder Valves (from top to bottom): <ul style="list-style-type: none"> • Right Front Jack Raise/Lower Valve • Left Front Jack Raise/Lower Valve
3	Jacking Cylinder Valves (from top to bottom): <ul style="list-style-type: none"> • Left Rear Jack Raise/Lower Valve • Right Rear Jack Raise/Lower Valve
4	Travel Brakes Valve
5	Right Crawler Pin Puller Valve

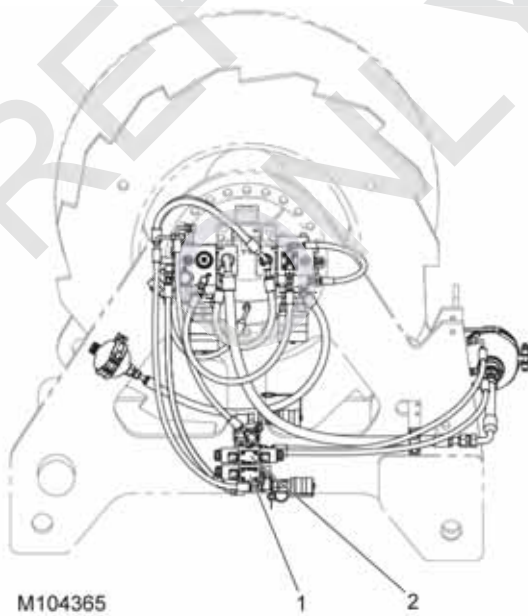
FIGURE 2-13

Drum Pawl and Brake Valve Locations



Drum 1

Drums 2 and 3



Typical for Drums 4 and 6

Item	Description
1	Brake Valve Solenoid
2	Pawl Valve Solenoid

FIGURE 2-14

Table 2-1. Closed-Loop Circuit Hydraulic Specifications

Function	Speed ¹ RPM	Pump Number	Pump Port	Pressure ² Bar (PSI)	Charge Pressure Bar (PSI)
Drum 1 Hoist Up	42 to 46	2	A	420 (6,090)	24 (350)
Drum 1 Hoist Down	37 to 44		B		
Drum 2 Hoist Up	34 to 38	1	B		
Drum 2 Hoist Down	30 to 36		A		
Drum 3 Hoist Up	34 to 38	2	B		
Drum 3 Hoist Down	30 to 36		A		
Swing Left	1.8 to 2 (one drive)	5	B		
Swing Right			A		

¹ 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%.

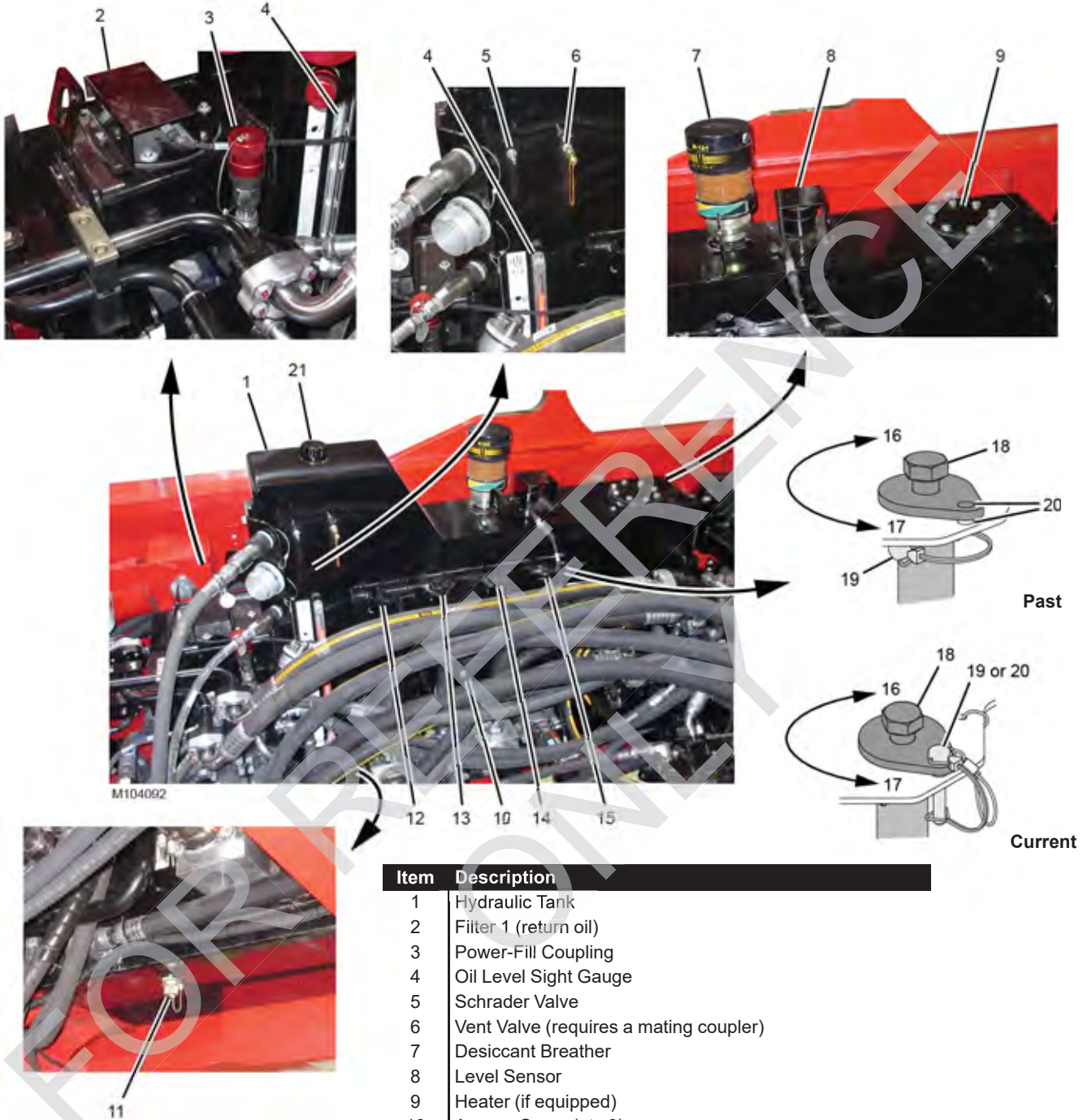
² Pressures are controlled by relief valves in each pump.

Table 2-2. Open-Loop Circuit Hydraulic Specifications

Function	Speed ¹ RPM	Pump Number	Pump Port	Pressure ² Bar (PSI)	Charge Pressure Bar (PSI)
Drum 4 Hoist Up	17 to 19	3 and 4	B	320 (4,641)	NA
Drum 4 Hoist Down	16 to 18		A		
Drum 6 Hoist Up and Down	28 to 34	3	A Up		
			B Down		
Right Travel Reverse	5.5 to 6.9 at tumbler	3	A		
Right Travel Forward			B		
Left Travel Reverse		4	A		
Left Travel Forward			B		
Accessories		NA	3 and 4	NA	315 (4,568)

¹ 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%.

² The load sensing pressure is limited to 320 bar (4,641 psi). The pump compensator pressure is limited to 355 bar (5,148 psi).



Item	Description
1	Hydraulic Tank
2	Filter 1 (return oil)
3	Power-Fill Coupling
4	Oil Level Sight Gauge
5	Schrader Valve
6	Vent Valve (requires a mating coupler)
7	Desiccant Breather
8	Level Sensor
9	Heater (if equipped)
10	Access Cover (qty 3)
11	Quick-Drain Valve (qty 2)
12	Shut-Off Valve Operator: Pump 5
13	Shut-Off Valve Operator: Pumps 2, 7, and 8
14	Shut-Off Valve Operator: Pumps 4 and 6
15	Shut-Off Valve Operator: Pumps 1 and 3
16	Shut-Off Valve Closed Position (must remove safety pin)
17	Shut-Off Valve Open Position
18	Valve Operator (M16 hex)
19	Safety Pin
20	Padlock Holes (for owner-furnished padlock)
21	Fill Cap (past production only)

FIGURE 2-15

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 MLC300 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. And then, 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, also.
- 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, 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 the Hydraulic System

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 (4, [Figure 2-15](#)).

The oil level can also be checked during operation by looking at the hydraulic oil level display in the Crane Systems Bar of the main display in the cab.

NOTE: The full levels given are for an assembled crane with the cylinders in their ready-to-work positions.

- Full Cold Level: 90% at approximately 16°C (60°F)
- Full Hot Level: 100% at approximately 85°C (185°F)
- Do not fill the tank to 100%. Oil will flow out of the breather.
- If the oil level drops to 80%, the fault alarm comes on and the Hydraulic Fluid Low icon appears in the Alert Bar of the main display. **Fill the tank immediately.**



- Fill the tank by using one of the following two methods:
 - Pump oil through the power-fill coupling (3, [Figure 2-15](#)). The oil is filtered by Filter 1 (2).
 - On past production cranes only, fill the tank through the fill cap (21, [Figure 2-15](#)). If this method is used, the oil must be filtered through an owner-supplied 10-micron filter.
- Only use approved hydraulic oil in the system (see Section 9).
- Replace the desiccant breather (7) cartridge when indicated (see [Replacing the Desiccant Breather Cartridge on page 2-20](#)).
- Replace the hydraulic filter elements when indicated (see [Replacing Hydraulic Filters on page 2-20](#)).
- 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:

- The shut-off valve (12, 13, 14, or 15, [Figure 2-15](#)) is closed. Open immediately.
- There is a collapsed or plugged suction line (inspect suction screen inside tank).
- The wrong oil (viscosity too high) is used.
- 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.

Inspecting and Replacing Hydraulic Hoses



CAUTION

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) Latitude—15° to 25° N and S
B	Dry or Arid—Deficient precipitation most of the year Latitude—20° to 35° N and S
C	Moist Mid-Latitude—Temperate with mild winters Latitude—30° to 50° N and S
D	Moist Mid-Latitude—Cold winters Latitude—50° to 70° N and S
E	Polar—Extremely cold winters and summers Latitude—60° to 75° N and S

Replacing the Desiccant Breather Cartridge

! 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 (see [Figure 2-15](#)).



Item	Description
1	Reusable Cap
2	Breather Cartridge
3	Adapter Fitting
4	Hydraulic Tank

FIGURE 2-16

See [Figure 2-16](#) for the following.

1. Replace the breather cartridge when the gold desiccant beads turn dark green.

2. Vent the hydraulic tank (4) using either of the vent valves (see [Figure 2-15](#)).
3. Take precautions to prevent being burned by hot oil.
4. Unscrew the breather cartridge (2) from the adapter fitting (3).
5. Unscrew the reusable cap (1) from the breather cartridge and dispose of the used breather cartridge according to local environmental regulations.
6. Do not discard the cap.
7. Remove the protective caps from the top and bottom of the new cartridge.
8. Securely attach the reusable cap to the breather cartridge. Tighten the cap by hand only.
9. Securely attach the breather cartridge to the adapter fitting. Tighten the cartridge by hand only.

Replacing Hydraulic Filters

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.

Filter 1

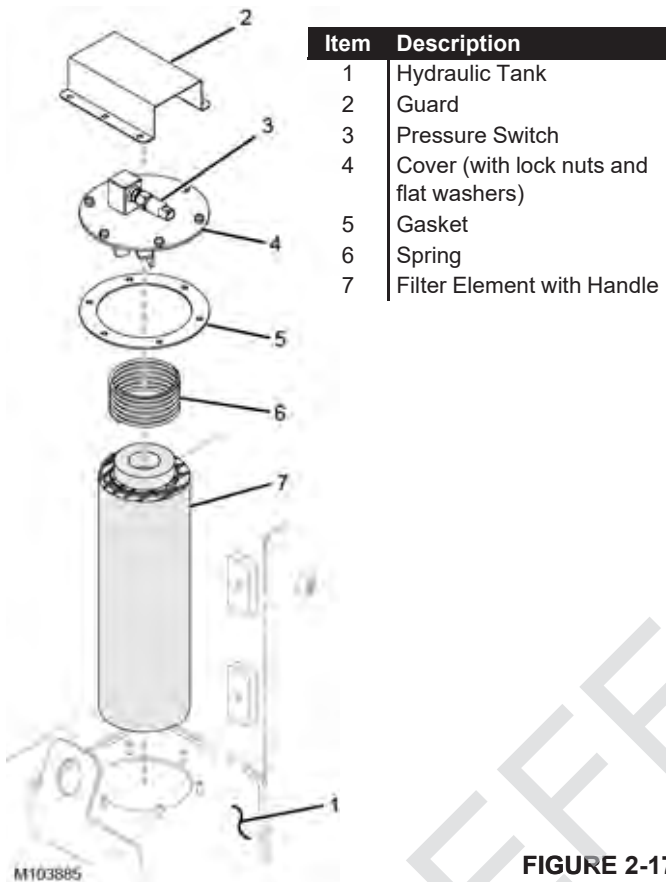


FIGURE 2-17

An in-tank filter—Filter 1 (see [Figure 2-17](#))—filters return oil.

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



Replace the filter element at each oil change interval, also.

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.

To replace Filter 1, proceed as follows (see [Figure 2-17](#)).

1. Stop the engine.
2. Vent the hydraulic tank using either of the vent valves (see [Figure 2-15](#)).
3. Take precautions to prevent being burned by hot oil.
4. Remove the guard (2).
5. Disconnect the electric cable from the pressure switch (3).
6. Clean the cover (4) and the area around the filter cover. Do not allow contaminants to enter the hydraulic tank.

7. Remove the lock nuts and washers and remove the cover.
8. Remove the spring (6).
9. Lift the filter element (7) out of the hydraulic tank using the handle provided and discard it according to local environmental regulations.
10. Install a new filter element so it is fully seated in the hydraulic tank.
11. Replace the gasket (5) with a new one.
12. Install the cover.
13. Connect the electric cable to the pressure switch.
14. Install the guard.
15. Start the engine and allow the hydraulic system to reach its normal operating temperature.
16. Check the filter cover for leaks and service as required.
17. Stop the engine.
18. Check the hydraulic tank level and fill as required.

Filter 2

Filter 2 (see [Figure 2-18](#)) filters the oil to the cooler circuit.

Replace both filter elements when the fault alarm comes on and the Filter 2 icon appears in the Fault Bar of the main display.



Replace both filter elements at each oil change interval, also.

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.

Below Engine on Right Inboard Side of Rotating Bed



M103888

Item	Description
1	Filter Head
2	Filter Element

FIGURE 2-18

To replace Filter 2, proceed as follows (see [Figure 2-18](#)).

1. Stop the engine.
2. Close the Pump 5 shut-off valve (see [Figure 2-15](#)).
3. Take precautions to prevent being burned by hot oil.
4. Place a container below the filter elements to catch hydraulic oil leakage.
5. Clean the outside of the filter elements and the area around the filter head.
6. Using a filter wrench, loosen the filter elements.
7. Remove the filter elements and discard them and the oil leakage according to local environmental regulations.
8. Make sure the seal is securely attached to each new element.
9. Lubricate the seal on the new elements with clean hydraulic oil. Do not use grease.
10. Do not fill the new element with oil.
11. Screw the new elements onto the filter housing until the seals are snug against the head.
12. Tighten each element by hand 1/2 turn more so the seal is properly seated and the element does not leak.
13. Start the engine and allow the hydraulic system to return to its normal operating pressure and temperature.
14. Check the filter elements for leaks. Tighten the elements as required to stop leakage.
15. Open the Pump 5 shut-off valve.

Filter 3

Below Center Section of Rotating Bed



M103889

Item	Description
1	Filter Head
2	Filter Element

FIGURE 2-19

Filter 3 (see [Figure 2-19](#)) filters the oil in the flushing circuit for each travel motor.

On past production cranes, replace the filter element when the service indicator in the filter head turns red.

On current production cranes, replace the filter element when the fault alarm comes on and the Filter 3 icon appears in the Fault Bar of the main display.



Replace the filter element at each oil change interval, also.

To replace Filter 3, proceed as follows (see [Figure 2-19](#)).

1. Stop the engine.
2. Take precautions to prevent being burned by hot oil.
3. Place a suitable container under the filter element to catch hydraulic oil leakage.
4. Clean the outside of filter element and the area around the filter head.
5. Using a filter wrench, loosen the filter element.
6. Remove the filter element and discard it and the oil leakage according to local environmental regulations.
7. Make sure the seal is securely attached to the new element.
8. Lubricate the seal on the new element with clean hydraulic oil. Do not use grease.
9. Do not fill the new element with oil.
10. Screw the new element onto the filter housing until the seal is snug against the head.
11. Tighten the element by hand 1/2 turn more so the seal is properly seated and the filter element does not leak.
12. Start the engine and allow the hydraulic system to return to its operating pressure and temperature.
13. Check the filter element for leaks. Tighten the element as required to stop leakage.
14. Check the filter element for leaks. Tighten the element as required to stop leakage.

Filter 4 and 5

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

Filter 4 (Drum 2) and Filter 5 (Drum 3) filter the oil to the free fall brakes.

Replace the filter element when the fault alarm comes on and the corresponding filter icon, Filter 4 or 5, appears in the Fault Bar of the main display.



Replace the filter elements at each oil change interval, also.

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.

On Left End of Free Fall Drums 2 and 3

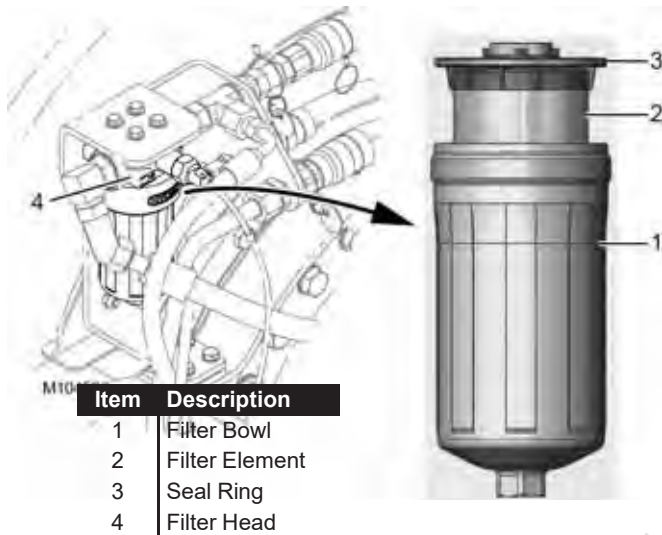


FIGURE 2-20

To replace Filter 4 or 5, proceed as follows:

1. Stop the engine.
2. Unscrew the filter bowl (1) from the head (4).
3. Drain the oil from the filter bowl and discard the oil according to local environmental regulations.
4. Remove the filter element (2) with seal ring (3). Examine the surface of the element for contamination residue and larger particles. These can be an indication of possible component damage.
5. Discard the filter element according to local environmental regulations.
6. Clean the filter bowl (1) and the head (4).
7. Make sure the new filter element (2) and seal ring are (3) not damaged.
8. Wet the sealing ring and the sealing surfaces on the head and bowl with clean hydraulic oil.
9. Apply anti-seize compound to the threads of the filter bowl.
10. Install the new filter element (2) with seal ring (3) in the filter bowl.
11. Screw the filter bowl onto the filter head and tighten to 40 Nm (30 ft-lb).

12. Start the engine and check for leaks.
13. If needed, add oil to the hydraulic tank.

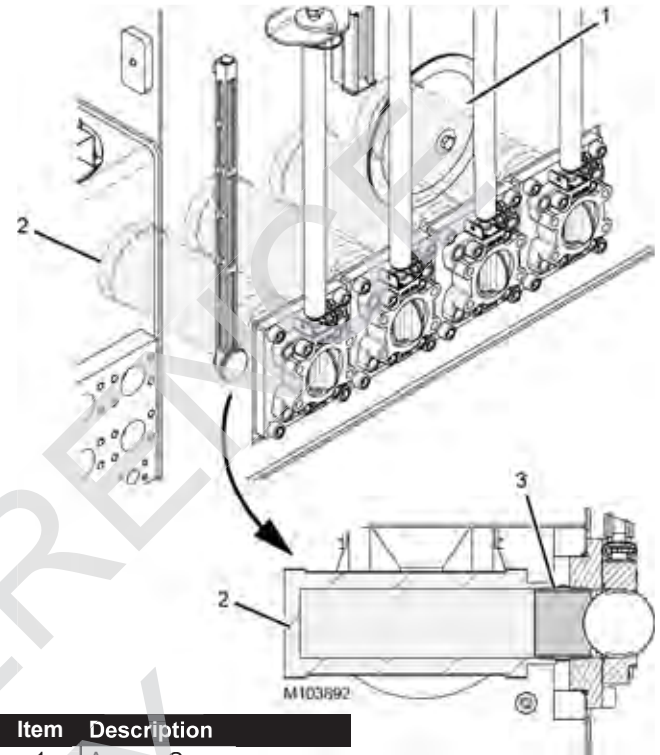


FIGURE 2-21

Servicing Suction Strainers

Each of the four suction lines to the pumps is equipped with a suction strainer located inside the hydraulic tank.

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 a suction screen, the hydraulic tank must be drained.

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

1. Remove the access cover (1).
2. Using a wrench, remove the suction strainer (2) from the pipe nipple (3).
3. Soak the suction strainer in a clean, nonflammable solvent. Brush off the outer surface, and flush the strainer from the inside out.
4. Replace the suction strainer if it is damaged.
5. Reinstall the suction strainer.

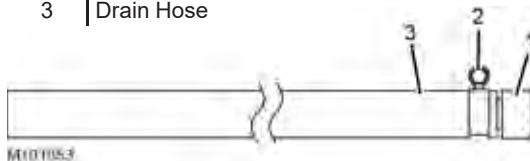
Changing Hydraulic Oil

See [Figure 2-15](#) for the following procedure.

Drain and refill the hydraulic system every 1,000 hours or semiannually, 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 Schrader valve (5) or the vent valve (6).

Item	Description
1	Quick-Drain Drainer
2	Hose Clamp
3	Drain Hose



Stored in Parts Box Supplied with Crane

FIGURE 2-22

4. Put the free end of the drain hose (3, [Figure 2-22](#)) into a suitable container to catch the hydraulic oil. See the Lubrication Guide (Section 9 in this manual) for the hydraulic system capacity.
5. Verify the shut-off valves (12, 13, 14, and 15) are open.
6. Screw the quick-drain drainer (1, [Figure 2-22](#)) onto either of the quick-drain valves (11) on the bottom of the hydraulic tank.
7. Completely drain the hydraulic tank and discard the hydraulic oil according to local environmental regulations.
8. Remove the access cover (10) from the hydraulic tank. Take care to prevent dust and wind-blown dirt from entering the tank while the access covers are off.
9. Clean out any sediment from inside the hydraulic tank.
10. Service the suction strainers (see [Servicing Suction Strainers on page 2-23](#)).
11. Replace the filter elements (see [Replacing Hydraulic Filters on page 2-20](#)).
12. Replace the desiccant breather cartridge (see [Replacing the Desiccant Breather Cartridge on page 2-20](#)).

13. Using a new seal, securely fasten the access cover to the hydraulic tank.

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.

14. Fill the hydraulic tank to the Full Cold Level mark on the oil level sight gauge (4). Use the proper hydraulic oil listed in the Lubrication Guide.

Do not fill the hydraulic tank to 100% as indicated in the Crane Systems Bar of the main display. Oil will flow out of the breather.

Fill the tank using one of the following methods:

- Pump oil through the power-fill coupling (3). The oil will be filtered by Filter 1.
- On past production cranes only, fill the tank through the fill cap (21). If this method is used, the oil must be filtered through an owner-supplied 10-micron filter.

15. Close the Schrader valve (5) and vent valve (6).
16. Start the engine and allow the hydraulic system to reach its normal operating temperature.
17. Check for leaks and correct them as required.
18. Stop the engine.
19. 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 corresponding hydraulic tank shut-off valve (12, 13, 14, or 15, [Figure 2-15](#)).

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.

FOR REFERENCE ONLY

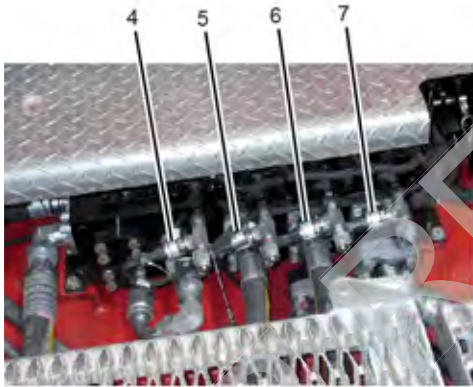
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M104457



Front of Rotating Bed

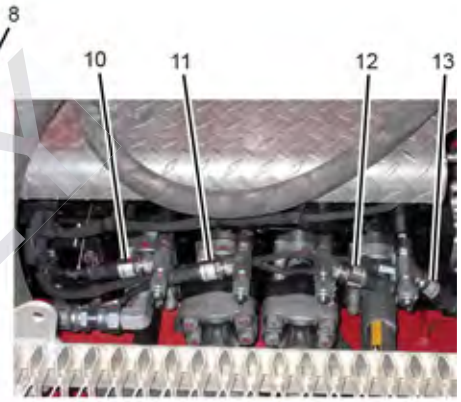
Item	Description
1	Gauge Coupler with Dust Cap -18 UNF x -6
PRESSURE TRANSDUCER ID	
2	Swing Right
3	Swing Left
4	Accessory System 1 (see Main Display Operation Manual)
5	Drum 4
6	Drum 5 (not used)
7	Left Travel
8	Typical Drum 4 or 6
9	Typical Pump 1, 2, 3, or 4
10	Drum 4
11	Right Travel
12	Drum 6
13	Accessory System 2 (see Main Display Operation Manual)
14	Fan Motor



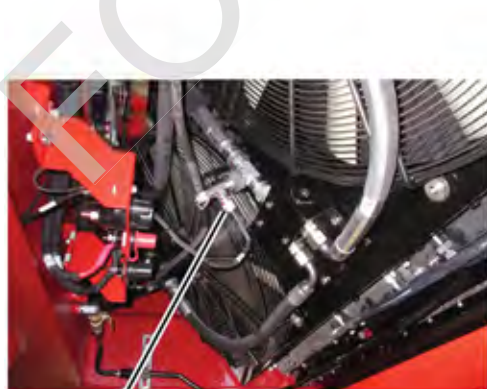
Left Inboard Side of Rotating Bed



Typical at Drums 4 and 6



Right Inboard Side of Rotating Bed



Under Rear of Rotating Bed

14



Right Inboard Side of Rotating Bed

FIGURE 2-23

REPLACING PRESSURE TRANSDUCERS

Testing a Pressure Transducer

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

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

1. Perform a pressure transducer calibration as instructed in the MLC300 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](#) on [page 2-27](#)).
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

Initial Hydraulic Oil Fill

See [Figure 2-15](#) 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 (12, 13, 14, and 15).
2. Make sure the hydraulic tank quick-drain valves (11) are closed.
3. At the engine, disengage the engine clutch (see [Figure 2-24](#)).
4. Stop the engine after disengaging the engine clutch.

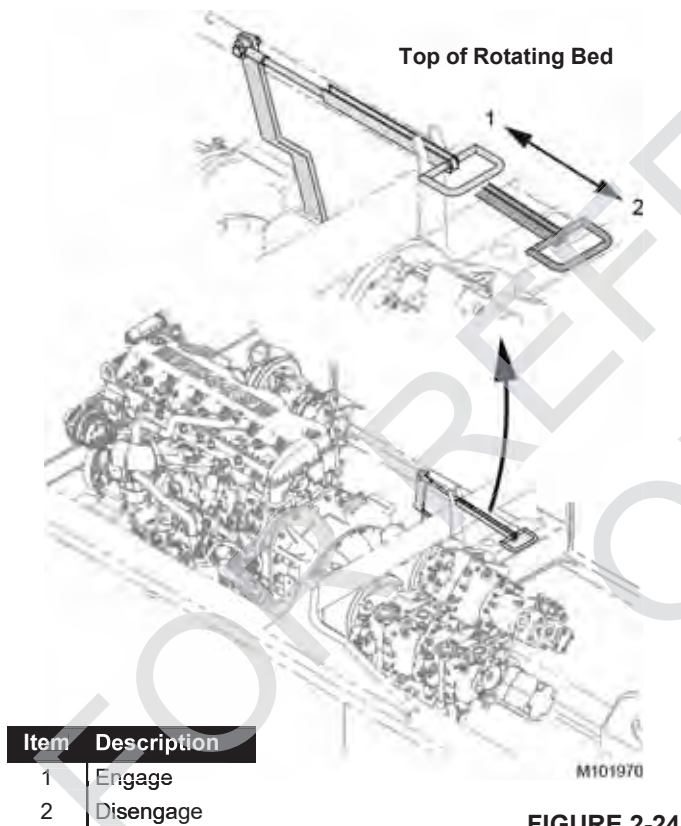


FIGURE 2-24

CAUTION

Avoid Engine Clutch Damage!

Observe the following precautions for the engine clutch:

- Decrease the engine speed to idle before engaging or disengaging the engine clutch.
- Do not run the engine longer than 20 minutes with the engine clutch disengaged.

5. Open the Schrader valve (5) or the vent valve (6) on the hydraulic tank to release pressure when filling the hydraulic tank through the power-fill coupling (3).
6. Fill the hydraulic tank by pumping oil through the power-fill coupling with an owner-supplied portable pump. Use new hydraulic oil filtered through a 10-micron filter.

Do not fill the hydraulic tank through the desiccant breather (7) or the top of Filter 1 (2). The hydraulic system could be contaminated from unfiltered oil.

7. Fill the hydraulic tank to the Full Cold level on the oil level sight gauge (4).
8. Fill all motor cases with new hydraulic oil filtered through a 10-micron filter as follows.
 - a. Disconnect the fitting from the highest case drain port of each motor.
 - b. Fill each motor case to the level of the case drain port.
 - c. Reconnect the fittings.
9. Apply 0.20 to 0.34 bar (3 to 5 psi) of owner-supplied air pressure to the air vent on the hydraulic tank.

The tank breather allows 0.21 bar (3 psi) of pressure to remain in the tank to force hydraulic oil into the charge system of the closed circuit lines.

10. Bleed the closed-loop motor cases (Drums 1, 2, and 3) by cracking open the MA or MB port to release trapped air.

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

11. Check for hydraulic leaks and correct any that are found.

Initial Hydraulic System Startup

The following procedure is used at the factory to start a new crane engine for the first time. It is necessary to use this procedure in the field only if the entire hydraulic system has been drained.

The procedure requires two people—one to start the engine and monitor pressures on the diagnostic screens, and one to monitor gauge pressure and check for leaks.



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 2-15](#)).

CAUTION

Avoid Damage to the Hydraulic System!

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

1. Before starting the engine, calibrate the pressure transducers (see the procedure in the MLC300 Main Display Operation Manual).
2. Make sure the hydraulic tank shut-off valves are fully open. The pumps can be damaged from cavitation if this step is not performed.
3. At the engine, disengage the engine clutch (see [Figure 2-24](#)).

CAUTION

Avoid Engine Clutch Damage!

Observe the following precautions for the engine clutch:

- Decrease the engine speed to idle before engaging or disengaging the engine clutch.
 - Do not run the engine longer than 20 minutes with the engine clutch disengaged.
4. Start the engine at the lowest possible speed and make necessary adjustments before engaging the engine clutch.
 5. Slowly engage and disengage the engine clutch and check for charge pressure in closed-loop circuits.

6. Fully engage the engine clutch.
7. Purge air from the open-loop circuit work lines for the Drum 4, Left Travel, and Right Travel as follows.
 - a. Activate Drum 4 with no more than 20% handle command at low engine idle speed for 1 to 2 minutes.
 - b. Repeat step [a](#) for all remaining open-loop circuit work lines.

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.

8. Calibrate the controls and perform the charge pressure and high pressure checks as instructed in the MLC300 Main Display Operation Manual.
 - a. Make sure the pressure reading for each pump is at 30 bar (440 psi) standby pressure in the open-loop circuits.
 - b. Make sure the pressure reading for each pump is 22 to 25.5 bar (250 to 370 psi) in the closed-loop circuits.
 - c. If the pump pressures are not within the specified range, stop the engine immediately. Determine the cause of the faulty pressure and correct.
9. With the engine at low idle, extend and retract all cylinders three times (gantry cylinders, mast cylinders, backhitch pins, cab tilt, boom hinge pins, carbody jacks, and crawler pins).

If the oil level drops to 80%, the fault alarm comes on and the Hydraulic Fluid Low icon appears in the Alert Bar of the main display. Fill the tank immediately.
10. With the engine running at low idle, slowly cycle each crane function in both directions for at least five minutes to vent any remaining air from the hydraulic system.
11. Be sure all crane functions operate in the proper direction with relation to control handle movement.
12. Check for hydraulic leaks and correct the cause, if found.
13. Stop the engine and fill the hydraulic tank to the proper level.
14. Perform the hydraulic tests and calibrations (see [Hydraulic Tests and Calibrations on page 2-30](#)).

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 MLC300 Main Display Operation Manual.

Contact your Manitowoc Cranes 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 only when parts are replaced or when instructed by a Manitowoc Cranes dealer.

Pressure Sender Calibration

See the MLC300 Main Display Operation Manual.

Controls Calibration

See the MLC300 Main Display Operation Manual.

Charge Pressure Test

See the MLC300 Main Display Operation Manual.

High Pressure Test

See the MLC300 Main Display Operation Manual.

Travel Speed Test

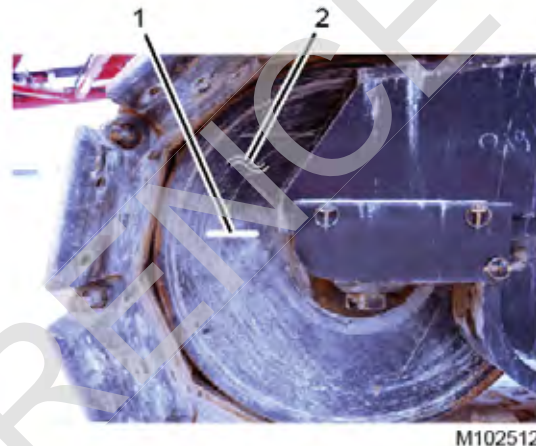
See [Figure 2-25](#) for the following procedure.

NOTE: Perform this test in an area where the crane can travel without interference.

An assistant is needed to count the rotations of the crawler rollers.

1. Apply a timing mark (1) on the inside faces of the front crawler rollers (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 while the assistant walks alongside the crane and counts the timing mark revolutions.
5. Verify the counted revolutions are within the limits specified in [Table 2-2](#). 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 while the assistant walks alongside the crane and counts the timing mark revolutions.
7. Verify the counted revolutions are within the limits specified in [Table 2-2](#). If the counted rotations are not within the specified range, contact the Manitowoc Crane Care Lattice Team.



Item	Description
1	Timing Mark
2	Front Crawler Roller (qty 2)

FIGURE 2-25

Swing Speed Test

NOTE: Perform this test in an area where the crane can swing without interference.

1. Navigate 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](#).

Drum Speed Test

NOTE: Perform this test in an area where the crane can operate without interference.

1. Navigate to the Drum Control Information screen (Drum 1, 2, 3, 4, 5, or 6) 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 2-1](#) and [Table 2-2](#).

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DISC BRAKE OPERATIONAL TEST

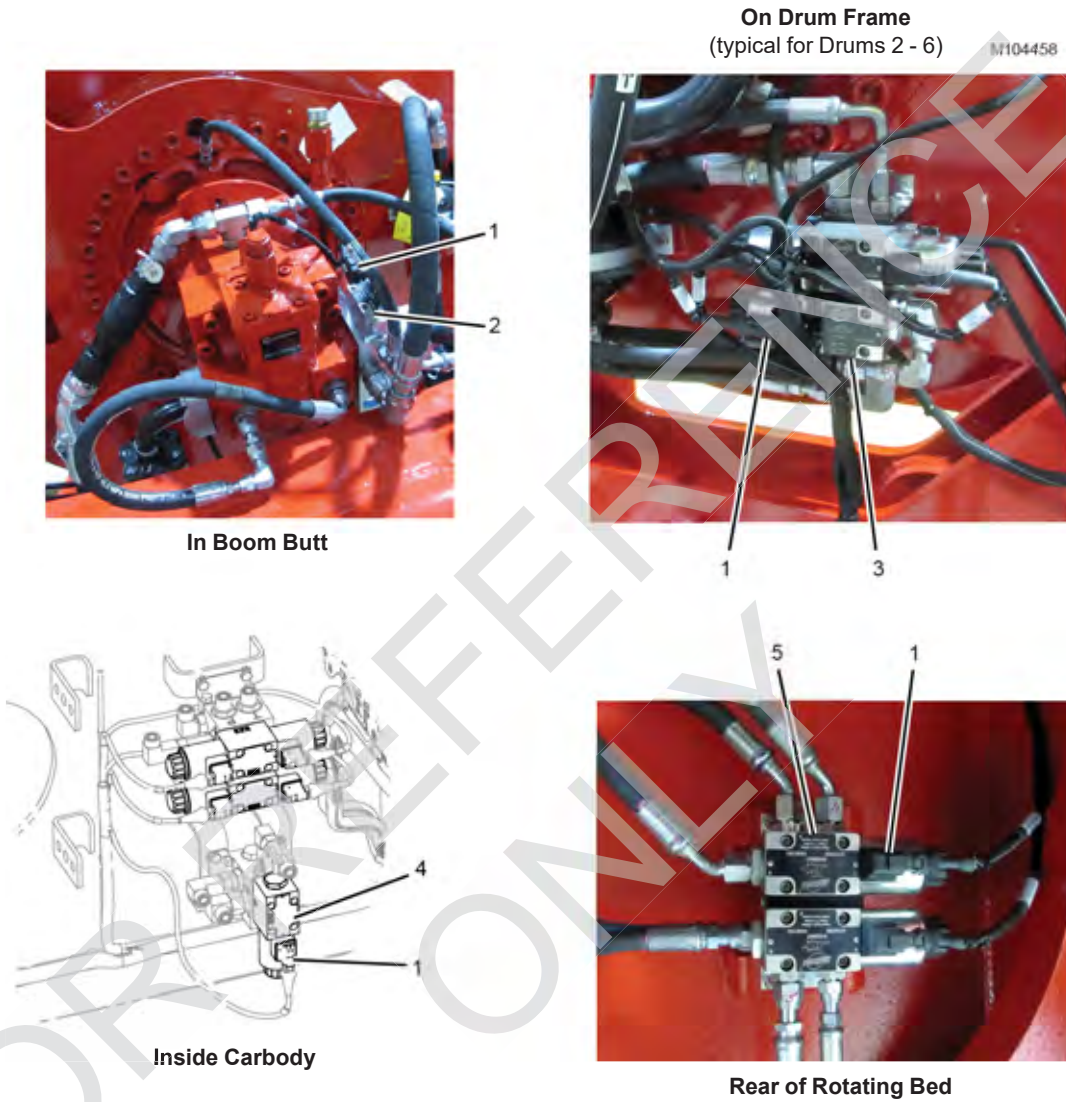


FIGURE 2-26

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

- Travel
- Drums 1, 2, 3, 4, and 6
- 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 5 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 2-26](#) for the location of the brake solenoid valves.

See the system pressure specifications in [Table 2-1](#) and [Table 2-2](#). Perform the disc brake operational test as follows.

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 MLC300 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 free fall brake performance is observed by the operator, have the corresponding brake repaired or replaced immediately.

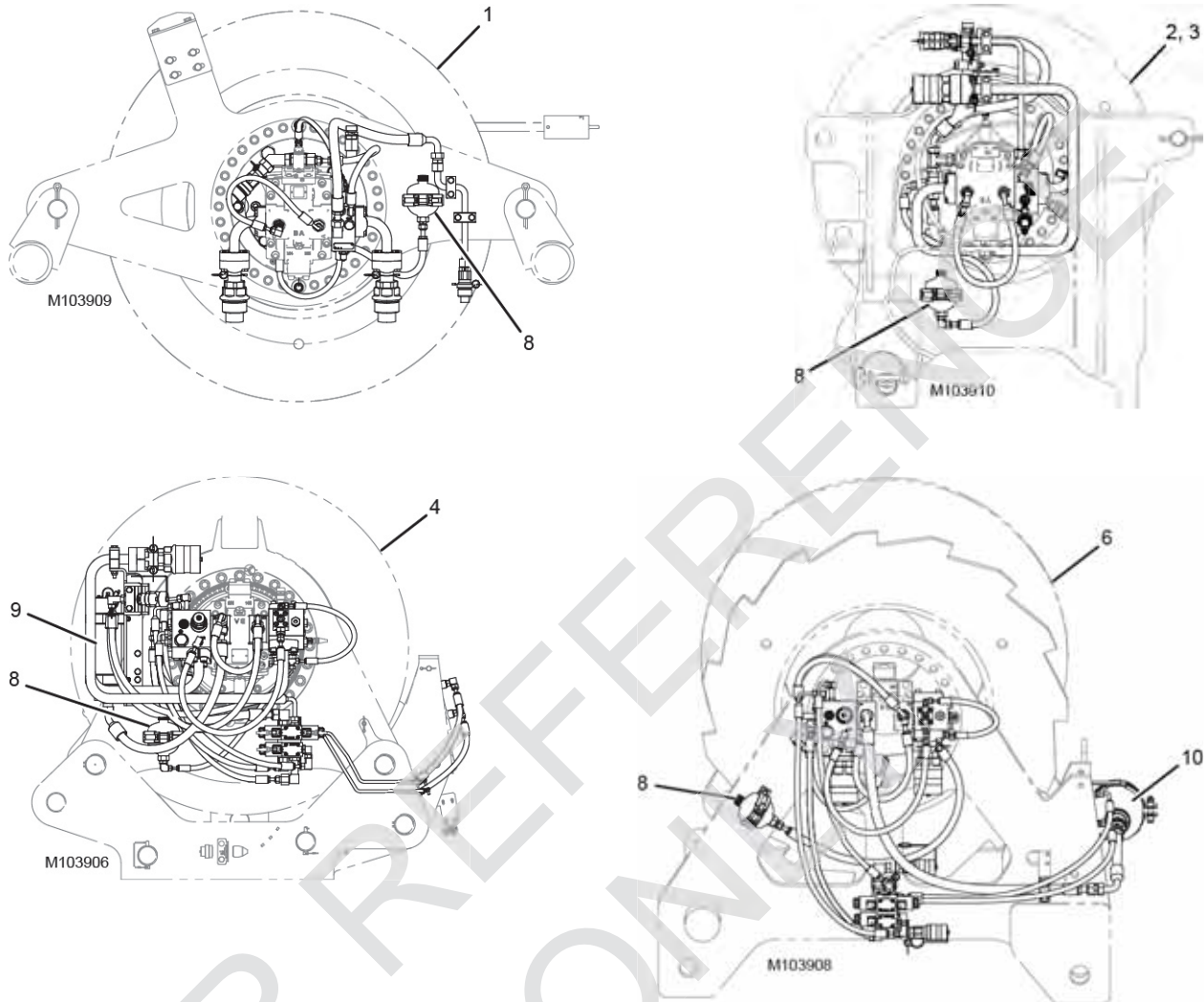
Do not operate a drum in free fall if the brake is not operating properly.

Do not attempt to lower the single line pull load given in [step 2](#) below using the free fall brake. Brake damage could occur. Free fall lowering is limited to 8 165 kg (18,000 lb) per the capacity chart.

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 MLC300 Operator Manual for the procedure.
2. Lift a single line pull load of 16 674 kg (36,760 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



Item	Description	Size	Pre-Charge	Max Pressure	Purpose
1	Drum 1 (in boom butt)				
2, 3	Drum 2 and 3 (in rotating bed)				
4	Drum 4 (in rotating bed)				
6	Drum 6 (in boom butt)				
8	Accumulator: Diaphragm Type	0,5 L (0.13 gal)	1,4 bar (20 psi)	160 bar (2,300 psi)	Thermal Expansion
9	Accumulator: Piston Type	1,1 L (0.29 gal)	5,5 bar (80 psi)	207 bar (3,000 psi)	Anti-Cavitation
10	Accumulator: Diaphragm Type	3,8 L (1 gal)	8,3 bar (120 psi)	207 bar (3,000 psi)	Anti-Cavitation

FIGURE 2-27

This crane is equipped with accumulators, which are identified in [Figure 2-27](#).

An accurate tire pressure gauge can be attached to the Schrader valve to check pressure.

! WARNING
Explosion Hazard!

The accumulators are pre-charged with dry nitrogen gas. Do not tamper with the accumulators unless authorized and trained to do so. Contact the Manitowoc Crane Care Lattice Team for assistance if needed.

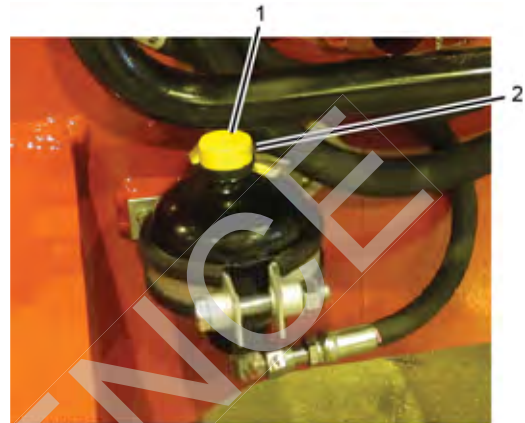
The accumulators must be tested yearly to verify they have retained the specified pre-charge.

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

- Pre-charge accumulators with dry nitrogen gas only.
- Never operate accumulators without the specified pre-charge.
- 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 (8, [Figure 2-27](#)) 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 (2, [Figure 2-28](#))

Accumulators (9 and 10, [Figure 2-27](#)) are equipped with a Schrader valve (tire inflation valve) located under the protective cap (3, [Figure 2-29](#)) on the top of the accumulator.



Item	Description
1	Protective Cap
2	M28 x 1,5 Male Thread

FIGURE 2-28



Item	Description
1	Pressure Gauge
2	Schrader Valve
3	Protective Cap

FIGURE 2-29

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SECTION 3

ELECTRICAL SYSTEM

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SECTION 3 ELECTRICAL SYSTEM

ELECTRICAL DRAWINGS AND SCHEMATICS

Electrical schematics are 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 (via 150 A alternator fuse or circuit breaker)
 - Alternator fuse (F0)—Cummins engine
 - Alternator circuit breaker (CB0)—MTU engine
- Intake air heater (Cummins engine)
- Remote battery positive terminal
- Starter solenoid
- Battery disconnect switch
- CraneStar® TCU (via fuse F5)

Battery Power Disconnect

When in the OFF position (contacts open), the battery disconnect switch S1 disconnects the battery positive terminal from the crane's electrical systems.

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.

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 CB61:

- Engine run switch S3 (via CB6)
- Display modules (via CB4)
- Relay K3 and external run switch S33 (via CB4)
- Relays K4 and K6 (normally open contacts)
- Relay K5 (via CB8)
- Horn, dome light, and service lights switches (via CB5)
- Radio clock and preset memory (via CB5)
- Boom top warning light switch (via CB6)
- Setup remote battery charger (via CB4)
- Diesel heater (via CB9)
- Relay K7 (normally open contacts) (via CB2)

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	IOLC31
CCM-10	IOLC32
CCMC11	IOLC33
IOSA22	IOLC34
IOLC30	

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 CB4 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 (Cummins engine): When energized, relay K4 provides power to the following:
 - Engine ECM (via CB17)
 - DEF hose heater relays (via CB19)
- Relay K4 (MTU engine): When energized, relay K4 provides power to the following engine control modules:
 - MCM (via CB17)
 - CPC4 (via CB16)

- ACM (via CB26)

- Relay K5: When energized, relay K5 provides power from circuit breaker CB8 to terminal +UE on the following control modules:

SCM-00	IOLC32
CCM-10	IOLC33
CCMC11	IOLC34
IOSA22	SCMD01
IOLC30	SCMD02
IOLC31	

Relay K5 also provides power to terminals KL15 and +UB of SCMD02.

- Relay K6: When energized, relay K6 provides power to terminal +UB on all crane CAN Bus control modules except SCMD02. Relay K6 also provides power to terminals KL15 and +UE on the following control modules:

- SCMD01—KL15
- IOSB22—KL15 and +UE
- CCMB11—KL15 and +UE

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

- Jog dial and joysticks (via CB46)
- Climate controls (via CB42)
- Wiper controls (via CB43)
- Work lights and panel lights (via CB44)
- 24 V_{DC}-to-12 V_{DC} converter (powers the radio and seat motor switches) (via CB41)

Crane Electrical System Ground Points

General

The crane electrical system has several frame ground connection (point) locations. They are located on the following components:

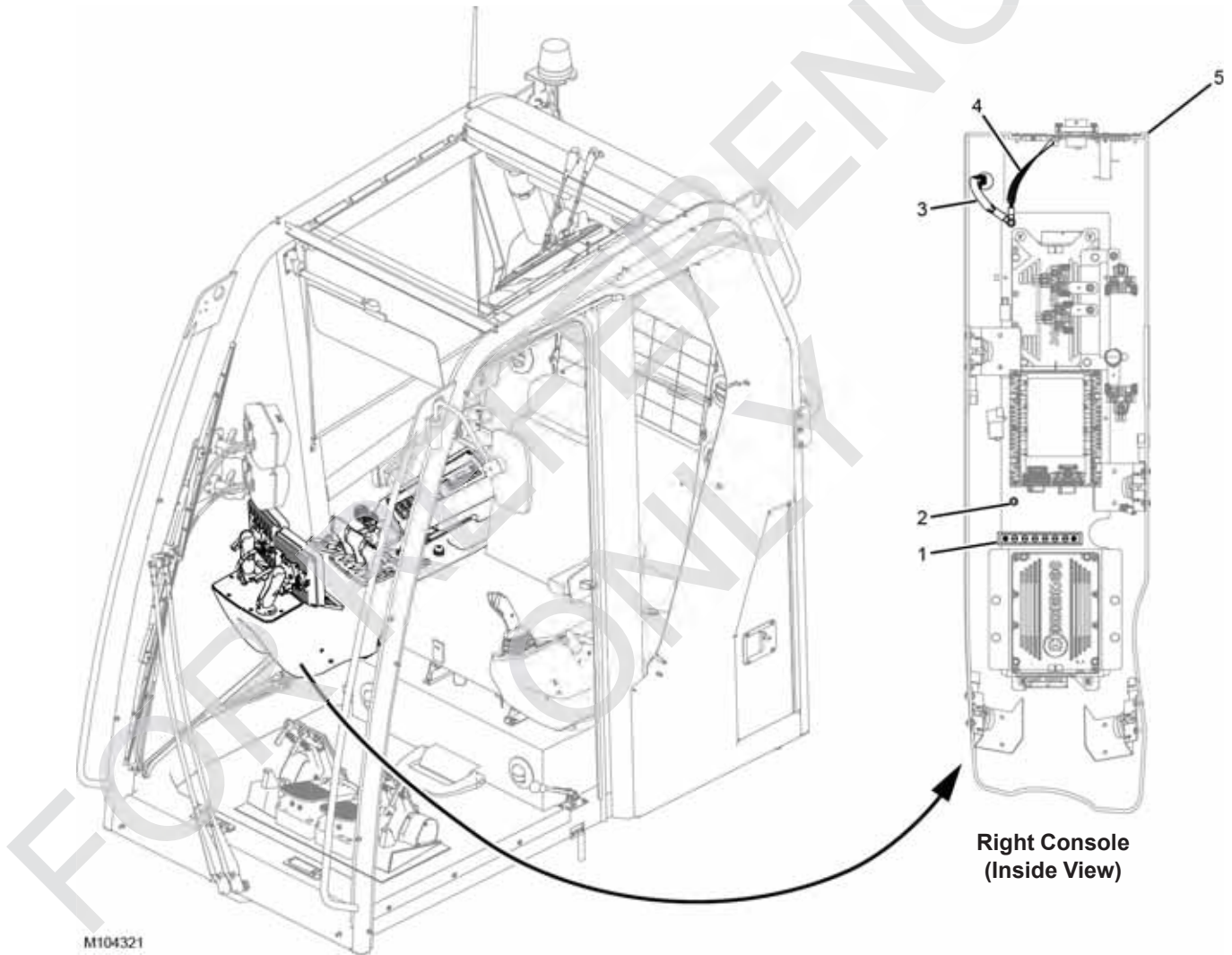
- Cab right console
- Rotating bed
- Cab mount/arm

Cab Right Console Ground Points

The cab ground points are at the following locations (see [Figure 3-1](#)):

The cab right console (5) contains the following point ground locations:

- Right console ground bus bar (1)
- Right console chassis ground stud (2)
- Right console chassis-to-cab ground strap (3)
- Right console chassis-to-rear panel ground strap (4)



Item	Description
1	Right Console Ground Bus Bar
2	Right Console Chassis Ground Stud
3	Right Console Chassis-to-Cab Ground Strap
4	Right Console Chassis-to-Rear Panel Ground Strap
5	Cab Right Console

FIGURE 3-1

Rotating Bed and Cab Mount /Arm Ground Points

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

The rotating bed ground points are as follows:

- Negative Remote Ground Terminal (1)—The negative remote ground terminal is located on the battery disconnect switch panel.
- Rotating Bed-to-Cab Arm Ground Strap (2)—Ensures an electrical path to ground between the rotating bed and the cab arm.
- Cab Arm-to-Cab Mount Ground Strap (3)—Ensures an electrical path to ground between the cab arm and the cab mount.
- Live Mast-to-Rotating Bed Ground Point (4)—Ensures an electrical path to ground for electrical components on the live mast frame. It electrically connects the left arm of the live mast to the rotating bed frame. A ground cap assembly (5) provides connector protection when the live mast is not attached to the rotating bed.
- Rotating Bed Main Ground Point (6)—The rotating bed main ground point is a ground stud located at the inside right frame of the rotating bed. The ground stud provides a single connection point for the ground circuit of all the electrical devices located on the rotating bed and the carbody. A ground cable connects the ground stud to the negative battery terminal.

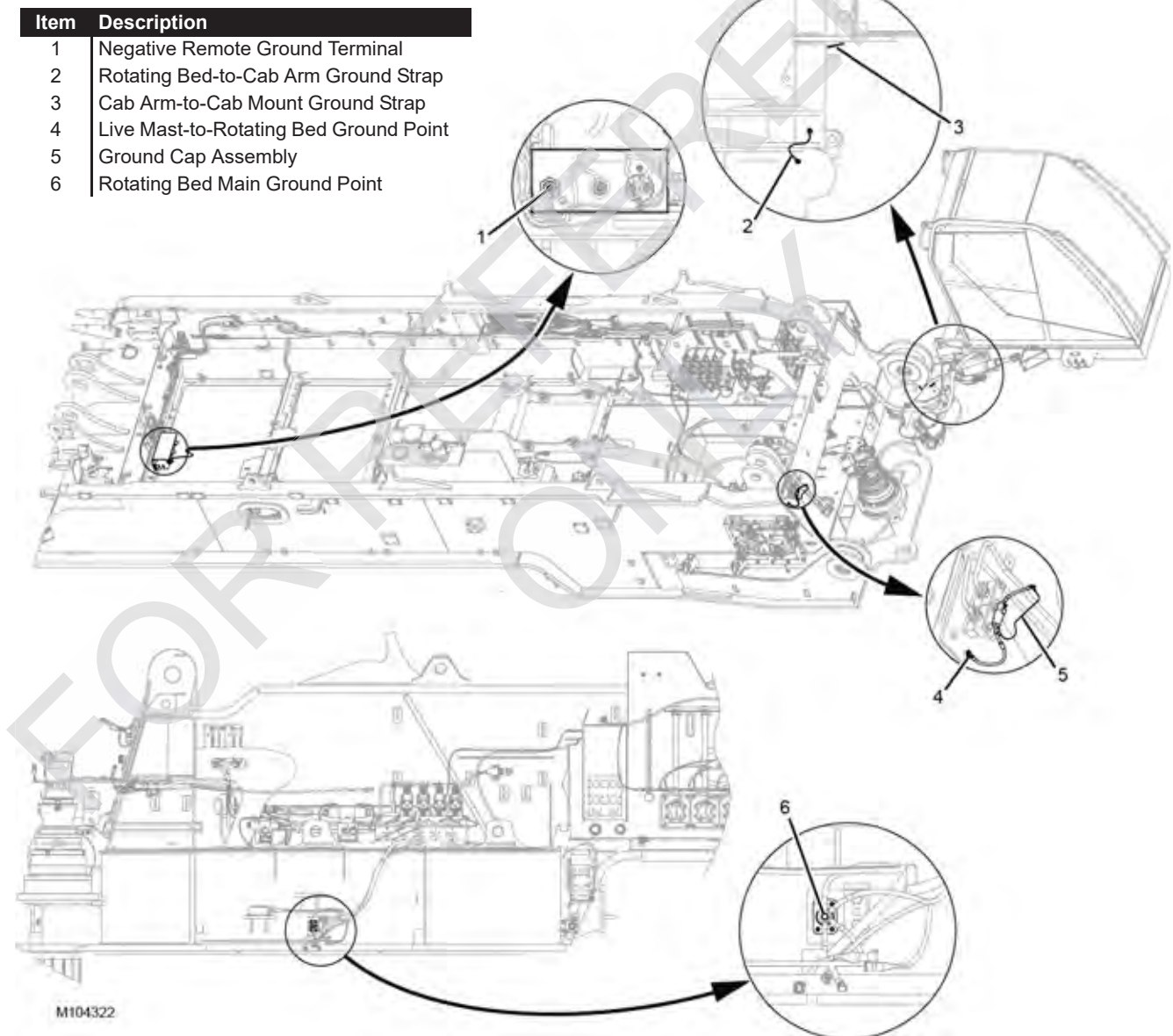


FIGURE 3-2

CIRCUIT BREAKERS, FUSES, AND RELAYS

Most circuit breakers, fuses, and relays are located in the DC load center junction box (see [Figure 3-4](#)).

The following fuses and circuit breaker are not located in the DC load center (see [Figure 3-3](#)):

- TCU CraneStar 5 A fuse F5 (1)—Fuse F5 is mounted on the battery disconnect switch bracket.
- Alternator 150 A fuse F0 (2) (Cummins engine)—Fuse F0 is mounted on a panel at the front of the battery box.
- Alternator 150 A circuit breaker CB0 (4) (MTU engine)—Circuit breaker CB0 is mounted on a panel at the right side of the battery box.
- Intake air heater 150 A fuse F6 (3) (Cummins engine)—Fuse F6 is mounted on a panel at the front of the battery box.

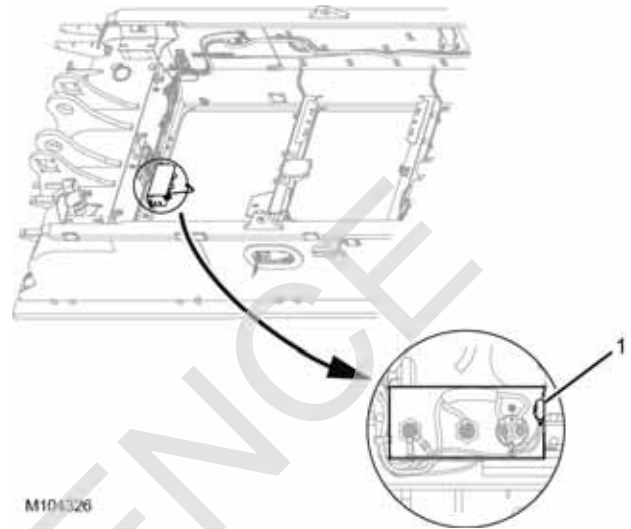


FIGURE 3-3

Item	Description
1	CraneStar 5 A Fuse (F5)
2	Alternator 150 A Fuse (F0) (Cummins engine)
3	Intake Air Heater 150 A Fuse (F6) (Cummins engine)
4	Alternator 150 A Circuit Breaker (CB0) (MTU engine)

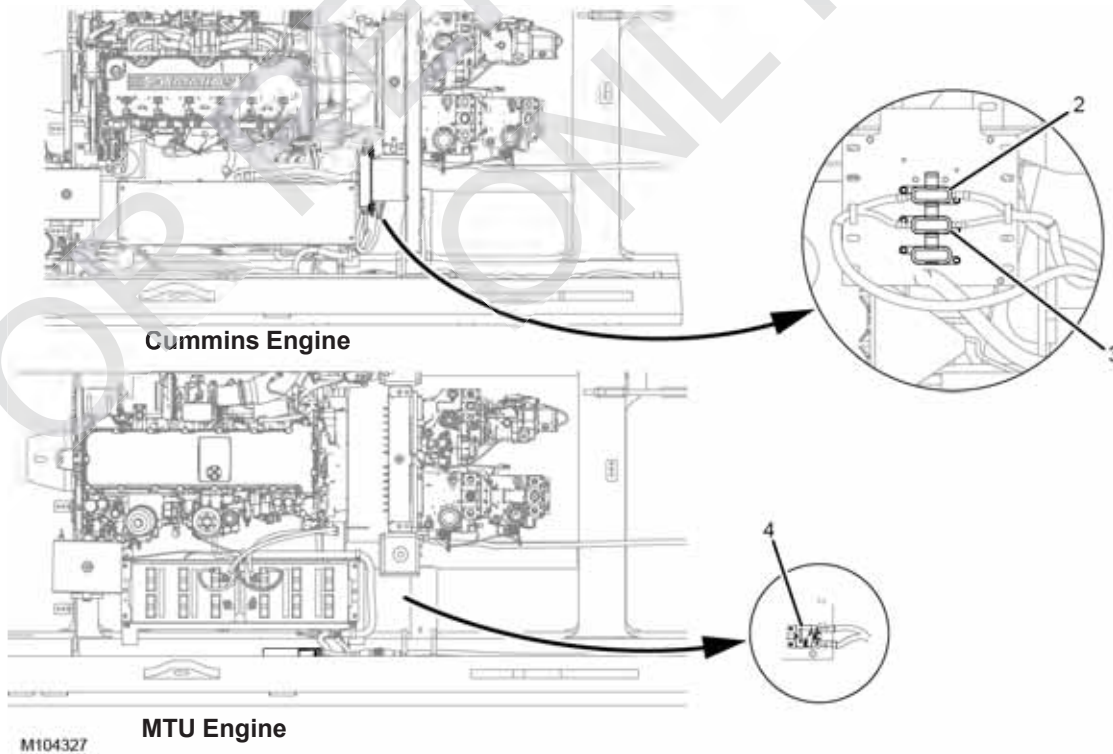
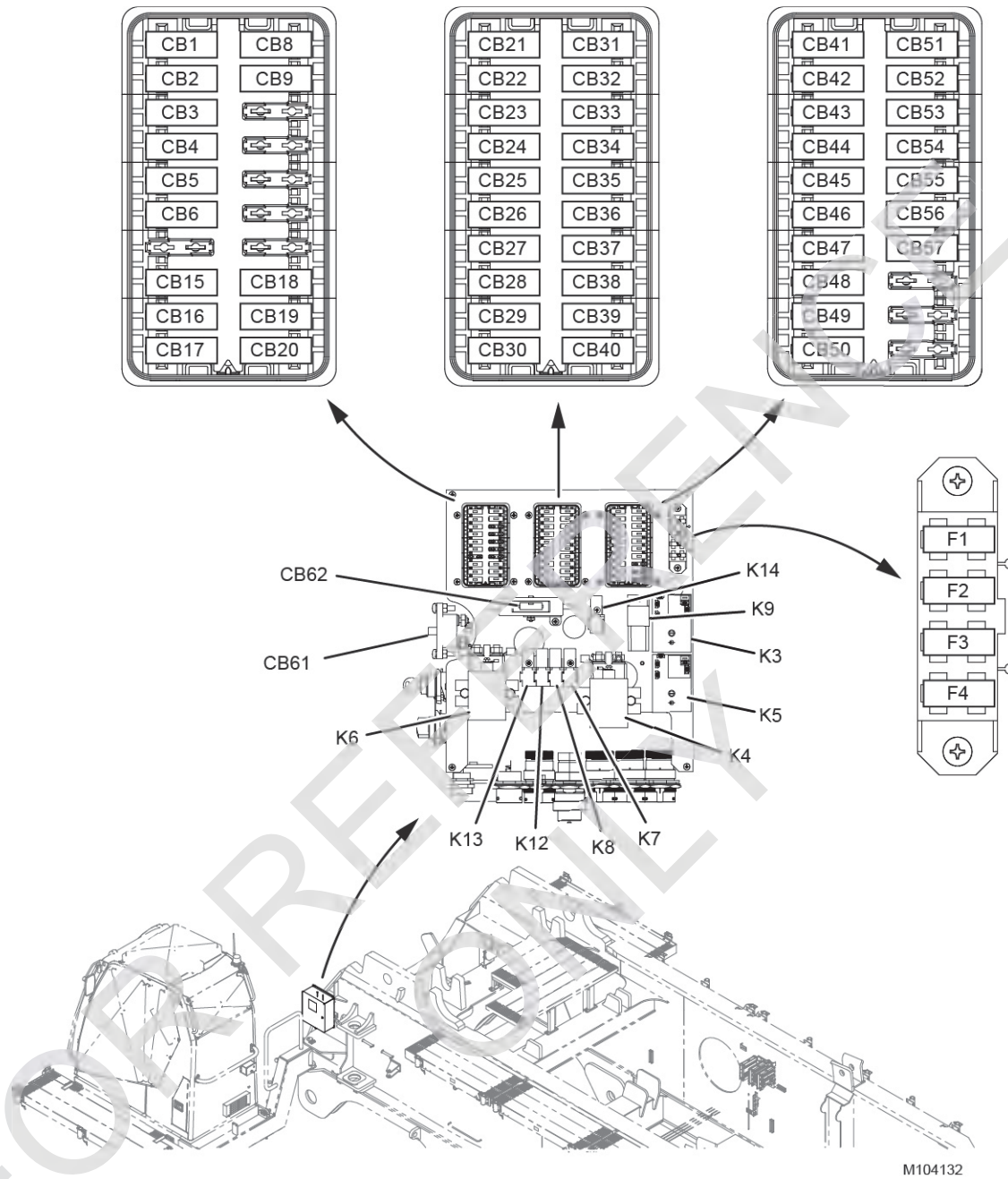


FIGURE 3-3 continued



M104132

FIGURE 3-4

Relay	Description	Relay	Description
K1	Starter Motor Relay (not shown)	K8	Diesel Exhaust Fluid (DEF) Hose Heater (Cummins)
K3	ECM Bus (time delay)	K9	Not Used
K4	ECM Bus	K12	Diesel Exhaust Fluid (DEF) Hose Heater (Cummins)
K5	Ignition Bus (time delay)	K13	Diesel Exhaust Fluid (DEF) Hose Heater (Cummins)
K6	Crane Bus	K14	DEF Supply Module (Cummins)
K7	ECM Key (start)		

Circuit Breaker	Amps	Description of Item Protected	Circuit Breaker	Amps	Description of Item Protected
CB1	15	Does not leave the Junction Box	CB36	15	IOLC31 (+UB input supply)
CB2	10	ECM Start Relay (K7)	CB37	15	IOLC31 (+UB input supply)
CB3	15	Spare	CB38	15	IOLC31 (+UB input supply)
CB4	15	External Key Switch, Setup Remote Receiver, and Displays	CB39	15	CCMC11 (+UB input supply)
CB5	15	Dome Light, Horn, Radio, Bed Service Lights	CB40	15	CCMC11 (+UB input supply)
CB6	15	Ignition Switch Circuits and Boom Top Warning Light	CB41	25	24 V _{DC} -to-12 V _{DC} Converter (seat motors and power points)
CB8	15	Control Modules +UE Power Supply	CB42	15	Heater/AC, ECU Power Interface
CB9	15	Diesel Heater	CB43	15	Wipers
CB15	10	Spare	CB44	15	Back Panel Lights, Diagnostic Port, Cameras, and Work Lights
CB16	10	Engine CPC4 (MTU engine)	CB45	15	SCM-00, IOSA22 (+UB input supply)
CB17	30	Engine ECM (Cummins engine) Engine MCM (MTU engine)	CB46	15	Joysticks, Jog Dial, Park Switches
CB18	10	Spare	CB47	15	Spare
CB19	15	DEF Heater Relays (K8, K12, K13) (Cummins engine)	CB48	15	Diesel Heater
CB20	15	Spare	CB49	15	IOLC33 (+UB input supply)
CB21	15	IOLC30 (+UB input supply)	CB50	15	IOLC33 (+UB input supply)
CB22	15	IOLC30 (+UB input supply)	CB51	15	IOLC34 (+UB input supply)
CB23	15	IOLC30 (+UB input supply)	CB52	15	IOLC34 (+UB input supply)
CB24	15	IOLC30 (+UB input supply)	CB53	15	IOLC34 (+UB input supply)
CB25	15	IOLC32 (+UB input supply)	CB54	15	Not Used
CB26	15	IOLC32 (+UB input supply)	CB55	15	Spare
CB27	15	IOLC32 (+UB input supply)	CB56	15	Spare
CB28	15	IOLC32 (+UB input supply)	CB57	15	CCMB11 and IOSB22 (+UB, UE, KL15 input supply)
CB29	15	SCMD01 (+UB, KL15)	CB61	120	Main Circuit Breaker
CB30	15	Spare	CB62	40	Engine ACM (MTU engine)
CB31	15	CCM-10 (+UB input supply)	F1	10	Power Point (right 12 V outlet)
CB32	15	CCM-10 (+UB input supply)	F2	10	Power Point (left 12 V outlet)
CB33	15	CCM-10 (+UB input supply)	F3	10	Radio
CB34	15	CCM-10 (+UB input supply)	F4	10	Spare
CB35	15	IOLC31 (+UB input supply)			

NOTE: Sockets for circuit breakers CB7, CB10—CB14, and CB58—CB60 are not used.

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 3-1. 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](#).

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 B (carbody)
- CAN Bus C (rotating bed)
- CAN Bus D (RCL/boom)
- 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 3-11](#).)

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 3-16](#).)

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 |

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 Chart

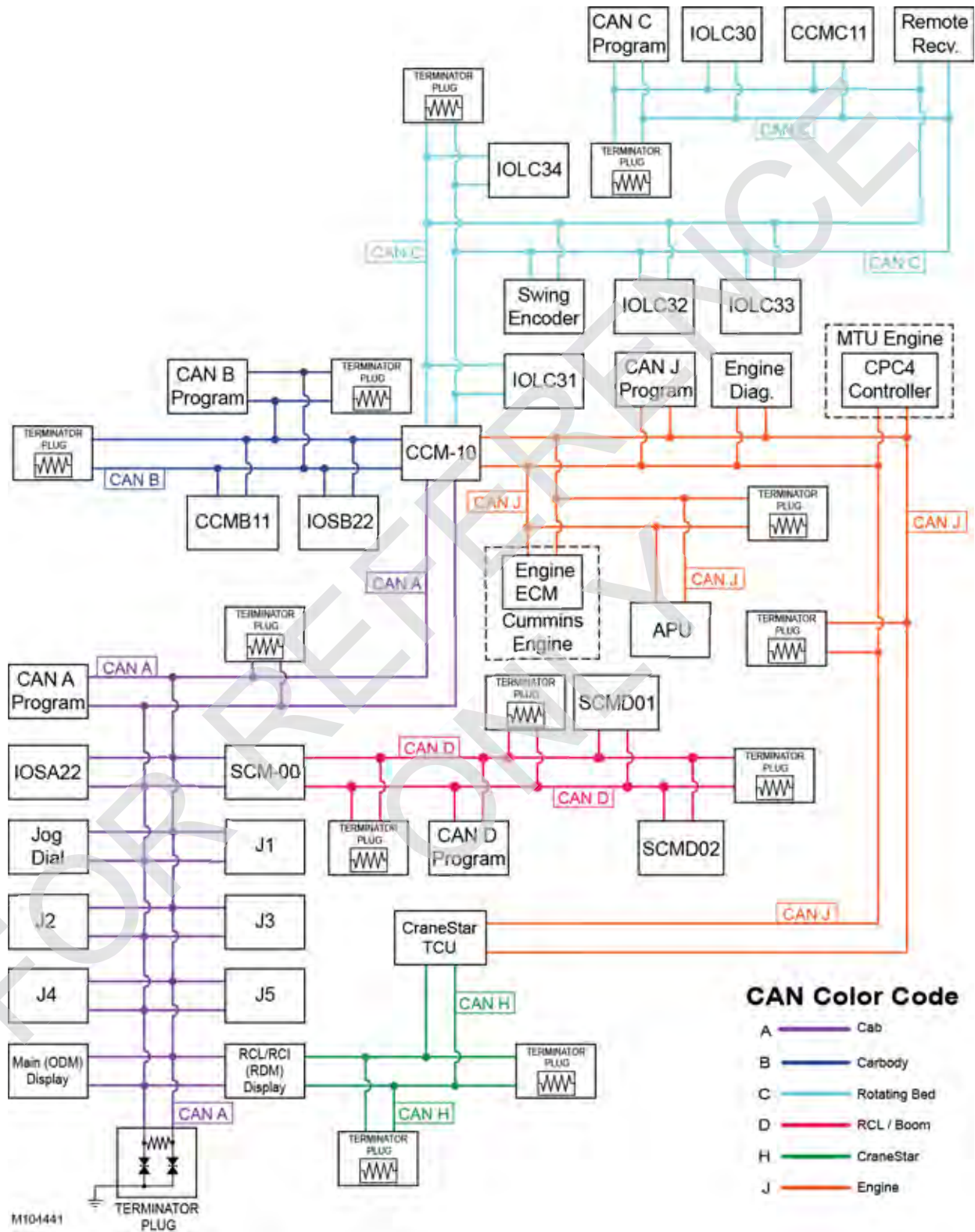


FIGURE 3-5

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 three 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 3-2](#) defines the variables used to build the name.

Table 3-2. Control Module Naming Definitions

Identifier	Definition
XXX	Module Type: SCM CCM IOL IOS
A	CAN Bus ID: - = Multiple Buses A = CAN Bus A B = CAN Bus B 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 3-3](#) defines the terms used in the schematics for the I/O types used by the control modules.

Table 3-3. Control Module I/O Types

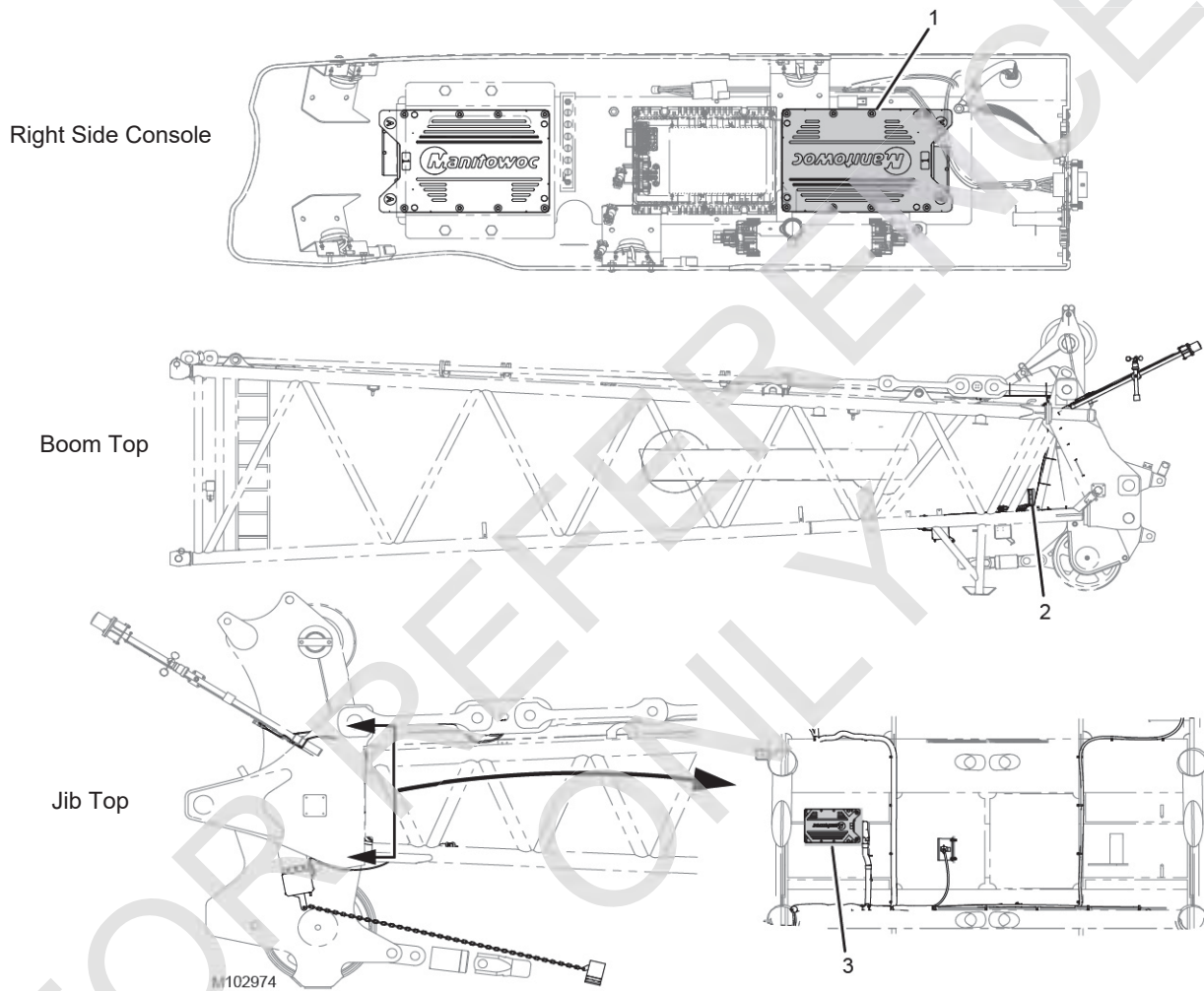
Schematic Term	Definition
IAC	Analog Current Input
IACV	Analog Current/Voltage Input
IBRTC _n	IN Battery RTC Negative Input
IBRTC _p	IN Battery RTC Positive Input
ID	Digital Input
IDF	Digital Frequency Input
IMID1	Module Identifier Input
KL15	Key Switch Power
ODH _x A	Digital Output, where "x" is the current in Amps
OPH _x A	PWM Output High Side, where "x" is the current in Amps
OPL _x A	PWM Output Low Side, where "x" is the current in Amps
OS85H	8.5 V _{DC} Supply Power
OS85L	8.5 V _{DC} Supply Ground
+UB	Battery Supply
+UE	Electronic Supply

Safety Control Module (SCM)

SCMs are controllers that run the software programs to interface with the cab controls and to govern boom and jib load safety. The software running in each SCM controls the I/O devices connected directly to the SCM and any I/O modules connected to its bus.

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

- MWSCM-00 (1) (cab)
- MWSCMD01 (2) (boom top)
- MWSCMD02 (3) (jib)



Item	Description
1	MWSCM-00
2	MWSCMD01
3	MWSCMD02

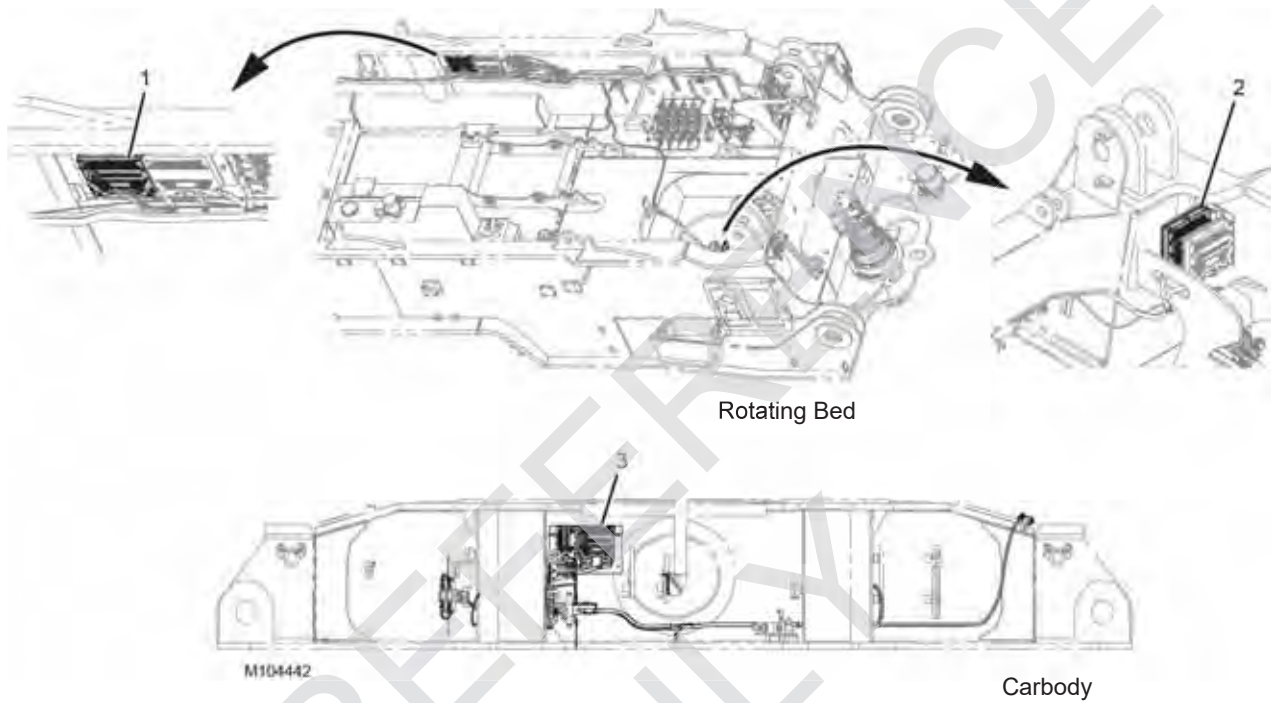
FIGURE 3-6

Crane Control Module (CCM)

CCMs are controllers that run the software programs governing crane operations in the rotating bed and car body. The software running in each CCM controls the I/O devices connected directly to the CCM and any I/O modules connected to its bus.

There are three CCMs mounted on the crane (see [Figure 3-7](#)):

- MWCCM-10 (1) (rotating bed—master)
- MWCCMC11 (2) (rotating bed—slave)
- MWCCMB11 (3) (carbody)



Item	Description
1	MWCCM-10
2	MWCCMC11
3	MWCCMB11

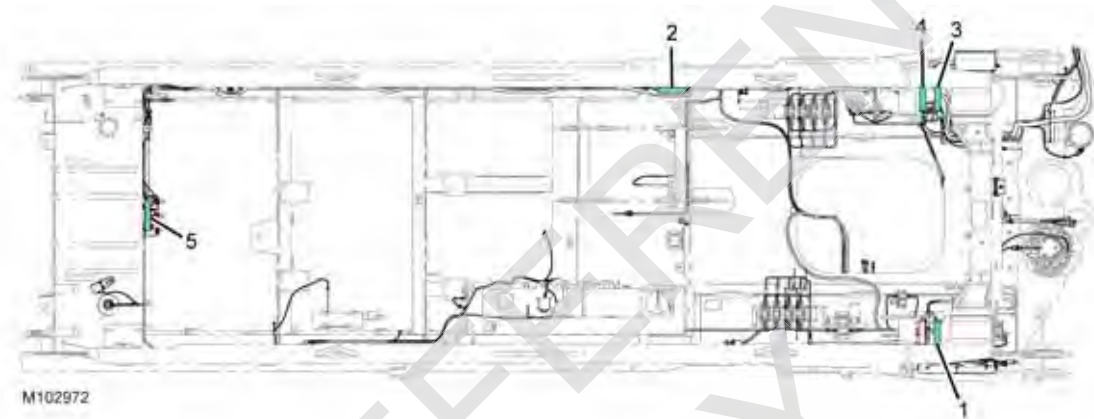
FIGURE 3-7

Input/Output—Large (IOL) Module

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

There are five IOL modules mounted on the rotating bed (see [Figure 3-8](#)):

- MWIOLC30 (1)
- MWIOLC31 (2)
- MWIOLC32 (3)
- MWIOLC33 (4)
- MWIOLC34 (5)



Item	Description
1	MWIOLC30
2	MWIOLC31
3	MWIOLC32
4	MWIOLC33
5	MWIOLC34

FIGURE 3-8

Input/Output—Small (IOS) Module

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

There are two IOS modules on the crane (see [Figure 3-9](#)):

- MWIOSB22 (1) (carbody)
- MWIOSA22 (2) (cab)

Item	Description
1	MWIOSB22
2	MWIOSA22

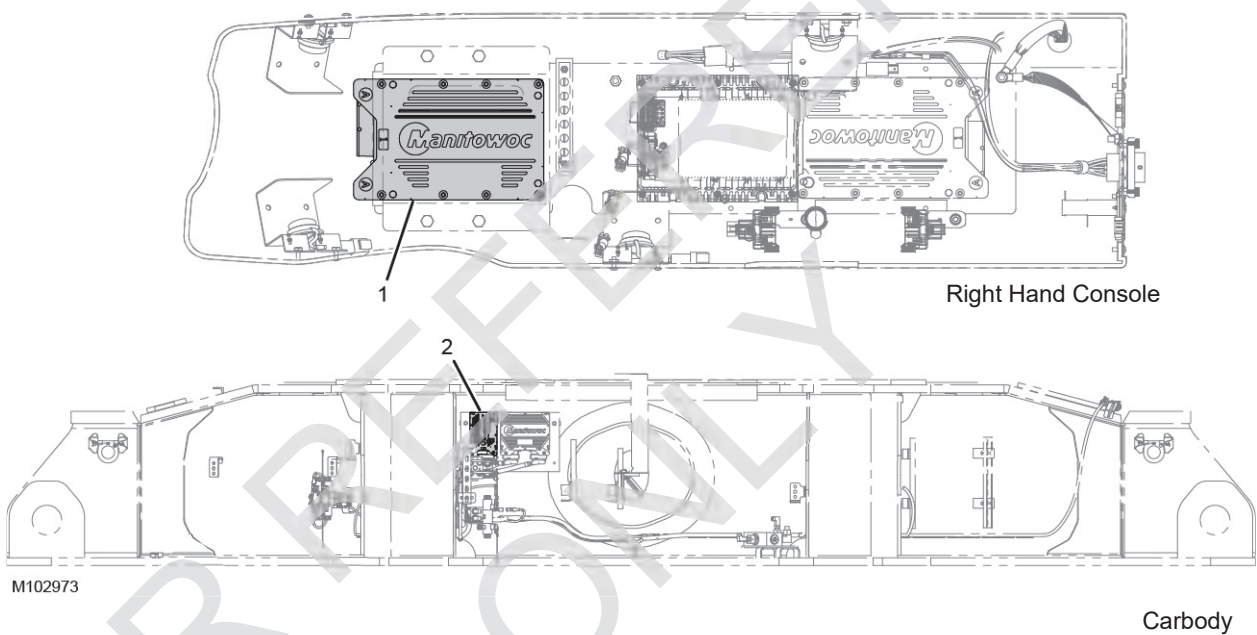


FIGURE 3-9

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:

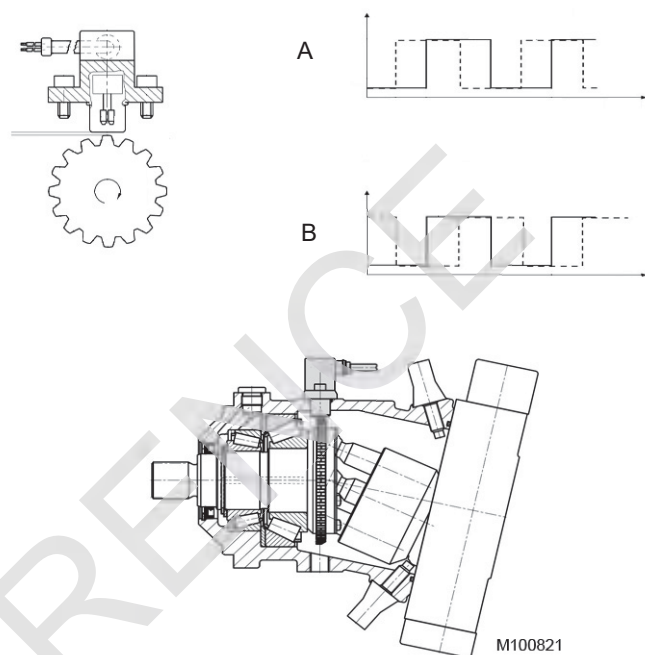
- Drum system pressures
- Swing system pressure
- Accessory system pressure
- Track pressure
- Cooler fan pressure

Motor Speed Sensors

See [Figure 3-10](#) 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 3-10

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, 2, 3, and 6 minimum bail limit
- Drums 4 and 6 pawl limit
- Maximum boom angle limit
- Mast position limit
- Swing 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:

- Lower boom point block-up limit
- Lower boom point block-up slow down
- Upper boom point block-up limit
- Upper boom point block-up slow down
- Luffing jib minimum angle
- Luffing jib maximum angle
- Fixed jib block-up slow down
- Fixed jib block-up limit

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	Diverter valves
Drum pawl cylinders	Jack cylinders
Mast cylinders	Pin pusher/puller cylinders
Cab tilt cylinders	Cooler fan pump
Self-assembly cylinder	Left and right system valves
Cylinder stowage	Crawler tensioner cylinders
Rigging winch (drum 0)	

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:

- Live mast angle
- Jib butt angle
- Boom angle
- Boom top 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 Pin 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:

- Mast strap
- Right and left strap links
- Upper boom point light fixed jib

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 transducer produces an ultrasonic pulse that reflects off the fuel surface and bottom of the fuel tank.

A micro-controller in the fuel sensor uses the echo return times to calculate the distance from the fuel surface to the bottom of the tank and sends a controller analog input a voltage that is proportional to the fuel level.

Hydraulic Fluid Level Sensor

A controller digital output provides power to the hydraulic fluid level sensor. The sensor has a capacitive probe that is immersed in the hydraulic fluid. The level of hydraulic fluid determines the capacitance of the probe.

A micro-controller in the probe translates the probe capacitance to an analog output voltage that is proportional to the fluid level and sends this to a controller analog input.

Pressure and Vacuum Switches

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 V_{DC} 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 $1.8 V_{DC}$ 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 3-4 shows the voltages and currents of the pumps, hoists, and travel motor.

Table 3-4. Pump and Motor Voltages and Currents

Pumps
1.6 or 8.8 V_{DC} nominal
200 to 600 mA ^{1, 2}
Hoist Motors
4.5 to 10 V_{DC}
180 mA to 450 mA ^{1, 2}
Travel Motors
0 or 24 V_{DC} nominal
0 or 600 mA nominal ¹
Note 1: 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.
Note 2: The node regulates displacement of the pump or motor with a PWM output. The values represent the beginning and end of the control range.

Alphabetical Index of Controller Devices

Find the device of interest and associated controller in [Table 3-5](#), then refer to the applicable test voltage table for that controller.

Table 3-5. Controller Components

Device	Controller
Alarms	IOLC34
Air Conditioning Clutch	IOLC34
Ambient Air Temperature Sensor	IOLC32
Auto Lube Components—Crawler	CCMB11
Auto Lube Components—Swing	IOLC32
Block-Up Limit & Slow Down Switches	SCMD01, SCMD02
Boom Angle Limit Switch	IOLC30, IOLC32
Boom Angle Limit Sensor	IOLC30, IOLC32
Boom Butt and Insert Components	CCMC11, IOLC32
Boom Top Components	SCMD01
Cab Switches and Controls	SCM-00, IOSA22
Cab Tilt	IOLC32, IOSA22
Camera Lights	CCM-10, IOLC30, IOLC32
Drum Diverter Valves	CCMC11
Drum 0 Components	CCMC11
Drum 1 Components	CCMC11, CCM-10, IOLC32
Drum 2 Components	CCMC11, IOLC30, IOLC31, IOLC32
Drum 3 Components	CCMC11, IOLC30, IOLC31, IOLC32
Drum 4 Components	CCM-10, CCMC11, IOLC33
Drum 6 Components	CCM-10, CCMC11, IOLC32, IOLC33
ECM Start Relay	IOLC31
Engine Components	IOLC32, IOLC34
Fixed Jib Confirm	SCMD01
Fuel Level Sensor	IOLC34
Hydraulic-Charge Filter Alarm Switch	IOLC34

Device	Controller
Hydraulic Fluid Level and Temperature Sensor	IOLC34
Hydraulic Vacuum Switch	IOLC34
Jacks—Carbody	CCMB11, IOSB22
Jib Components	SCMD01, SCMD02
Level Sensor—Rotating Bed	CCMC11
Live Mast Components	SCM-00, CCMC11, IOLC30, IOLC32
Load Pins	SCMD01, SCMD02, CCMC11
Luffing Jib Limit Switches	SCMD01, SCMD02
Pin Pullers	CCMB11, CCMC11, IOLC32, IOLC34
Pin Pushers	CCMC12
Pressure Transducers	CCM-10, CCMC11, IOLC30, IOLC31, IOLC32, IOLC33, IOLC34
Proximity Sensors	SCMD01
Pumps 1 to 7	CCM-10
Pumps 5 to 8	IOLC31
RCL Beacon	SCM-00
Self-Assembly Cylinder	IOLC30
Starter Motor Relays	IOLC34
Swing Components	IOLC30, IOLC32, CCMC11
Throttle (Hand and Foot)	SCM-00
Travel Components	CCM-10, CCMB11, CCMC11, IOLC33, CCMB11, IOSB22, SCM-00
Upper Boom Point Confirm	SCMD01
Wind Speed Indicators—Boom and Upper Boom Point	SCMD01
Wind Speed Indicator (Luffing Jib)	SCMD02

Table 3-6. CCM-10 Test Voltages

Pin	Net	Function	Voltages
P1-1	OPH3A23	Pump 4 Travel System A	0 to 24 V _{DC}
P1-2	OPH3A28	Pump 1 Drum 2 FF	0 to 24 V _{DC}
P1-7	IDF01	Drum 6 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V _{DC}
P1-13	IACV14	Pump 3 System B PSI	4 to 20 mA
P1-14	8C48 (+UE)	Control Module Battery Power	24 V _{DC}
P1-15	OPH3A25	Drums 1/2 Pump C2	0 to 24 V _{DC}
P1-20	IMID1	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-25	IACV11	Pump 2 Drums 1/3 PSI	4 to 20 mA
P1-27	KL15	Control Module Ignition Power (from engine RUN switch)	0 V _{DC} Open, 24 V _{DC} Closed
P1-28	OPH3A27	Pump 1 Drum 2 FF	0 to 24 V _{DC}
P1-29	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P1-34	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-35	IDF02	Drum 6 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V _{DC}
P1-38	IACV15	Pump 7 System C PSI	4 to 20 mA
P1-39	IACV13	Pump 4 System A PSI	4 to 20 mA
P1-40	IACV12	Pump 1 Drum 2 PSI	4 to 20 mA
P1-42	OPH3A26	Pump 2 Drum 1/3 C1	0 to 24 V _{DC}
P2-1	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P2-2	ODH3A03	Drum 4 Camera Lights	0 V _{DC} Off, 24 V _{DC} On
P2-8	OPL3A17	Ground Circuit for Pump 5	0 V _{DC}
P2-9	OPL3A18	Ground Circuit for Pump 7	0 V _{DC}
P2-10	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P2-11	8C31 (+UB)	Battery Power for Control Module Outputs	24 V _{DC}
P2-12	OPH3A24	Pump 3 Travel System B	0 to 24 V _{DC}
P2-13	ODH3A01	24 V _{DC} Power Bus for Pump 2 and Drums 1/3 PSI	24 V _{DC}
P2-17	OPL3A19	Ground for Isolation Valve—System A Valve Assembly	0 V _{DC}
P2-18	8C32 (+UB)	Battery Power for Control Module Outputs	24 V _{DC}
P2-19	OPL3A20	Ground for Left Travel Valve—System A Valve Assembly	0 V _{DC}
P2-20	8C33 (+UB)	Battery Power for Control Module Outputs	24 V _{DC}
P2-21	ODH3A02	Not Used	0 V _{DC}
P2-22	ODH3A04	Not Used	0 V _{DC}
P2-23	ODH3A10	Not Used	0 V _{DC}
P2-27	OPL3A21	Not Used	0 V _{DC}
P2-28	OPL3A22	Ground for Drum 4 Valve—System A Valve Assembly	0 V _{DC}
P2-29	8C34 (+UB)	Battery Power for Control Module Outputs	24 V _{DC}
P2-30	CAN_A—L	CAN_A—Low	N/A
P2-31	CAN_A—H	CAN_A—High	N/A
P2-32	CAN_B—L	CAN_B—Low	N/A
P2-33	CAN_B—H	CAN_B—High	N/A

Table 3-7. CCMB11 Test Voltages

Pin	Net	Function	Voltages
P1-1	OPH3A23	Carbody Left Front Jack Raise Solenoid	0 or 24 V _{DC}
P1-2	OPH3A28	Carbody Left Front Jack Lower Solenoid	0 or 24 V _{DC}
P1-3	ID21	Crawler Left Grease Switch (3500 PSI)	0 V _{DC} Open, 24 V _{DC} Closed
P1-4	IDF09	Digital Input (not used)	0 V _{DC}
P1-5	IDF10	Digital Input (not used)	0 V _{DC}
P1-6	ID22	Crawler Right Grease Switch (3500 PSI)	4 to 20 mA
P1-7	IDF01	Travel Left Motor Speed Sensor	< 2 V _{DC} (low) to 95% of 24 V _{DC} (high)
P1-8	IDF04	Travel Right Motor Speed Sensor	< 2 V _{DC} (low) to 95% of 24 V _{DC} (high)
P1-9	IDF06	Digital Frequency Input (not used)	0 V _{DC}
P1-11	IACV16	Not Used	0 V _{DC}
P1-12	IACV18	Not Used	0 V _{DC}
P1-13	IACV14	Analog Input (not used)	0 V _{DC}
P1-14	8C57 (+UE)	Control Module Battery Power	24 V _{DC}
P1-15	OPH3A25	Carbody Right Front Jack Raise Solenoid	0 or 24 V _{DC}
P1-21	IDF03	Travel Right Motor Speed Sensor	< 2 V _{DC} (low) to 95% of 24 V _{DC} (high)
P1-23	IACV19	Not Used	0 V _{DC}
P1-24	IACV17	Not Used	0 V _{DC}
P1-25	IACV11	Analog Input (not used)	0 V _{DC}
P1-26	OS85L	Not Used	0 V _{DC}
P1-27	KL15	Control Module Ignition Power (from CB57)	24 V _{DC}
P1-28	OPH3A27	Carbody Left Rear Jack Raise Solenoid	0 or 24 V _{DC}
P1-29	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P1-30	CAN_B—L	CAN_B—Low	N/A
P1-31	CAN_B—H	CAN_B—High	N/A
P1-34	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-35	IDF02	Travel Left Motor Speed Sensor	< 2 V _{DC} (low) to 95% of 24 V _{DC} (high)
P1-36	IDF07	Digital Frequency Input (not used)	0 V _{DC}
P1-37	IDF08	Digital Frequency Input (not used)	0 V _{DC}
P1-38	IACV15	Analog Input (not used)	0 V _{DC}
P1-39	IACV13	Analog Input (not used)	0 V _{DC}
P1-40	IACV12	Analog Input (not used)	0 V _{DC}
P1-41	OS85H	Not Used	8.5 V _{DC}
P1-42	OPH3A26	Carbody Right Front Jack Lower Solenoid	0 or 24 V _{DC}
P2-1	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P2-2	ODH3A03	Crawler Right Tracks Auto Lube	0 V _{DC} Off, 24 V _{DC} On
P2-3	ODH3A09	Digital Output (not used)	0 V _{DC}
P2-4	ODH3A08	Travel Brake Release Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-5	ODH3A05	Crawler/Carbody Left Pin Puller Retract Solenoid	0 V _{DC} Off, 24 V _{DC} On

Pin	Net	Function	Voltages
P2-6	ODH3A13	Crawler Right Tension Retract Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-7	ODH3A15	Digital Output (not used)	24 V _{DC}
P2-10	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P2-11	8C57 (+UB)	Battery Power for Control Module Outputs	24 V _{DC}
P2-12	OPH3A24	Carbody Left Front Jack Lower Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-13	ODH3A01	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • Left Crawler Grease • Left Travel Motor Speed Sensor 	24 V _{DC}
P2-14	ODH3A07	Crawler/Carbody Right Pin Puller Retract Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-15	ODH3A06	Crawler/Carbody Right Pin Puller Extend Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-16	ODH3A14	Crawler Right Tension (extend) Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-18	8C57 (+UB)	Battery Power for Control Module Outputs	24 V _{DC}
P2-20	8C57 (+UB)	Battery Power for Control Module Outputs	24 V _{DC}
P2-21	ODH3A02	Crawler Left Tracks Auto Lube	0 V _{DC} Off, 24 V _{DC} On
P2-22	ODH3A04	Crawler/Carbody Left Pin Puller Extend Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-23	ODH3A10	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • Right Crawler Grease • Right Crawler Connected 	24 V _{DC}
P2-24	ODH3A11	Crawler Left Tension Retract Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-25	ODH3A12	Crawler Left Tension Extend Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-26	ODH3A16	Digital Output (not used)	0 V _{DC}
P2-29	8C57 (+UB)	Battery Power for Control Module Outputs	24 V _{DC}

Table 3-8. CCMC11 Test Voltages

Pin	Net	Function	Voltages
P1-1	OPH3A23	Drum 6 Valve—System B Valve Assembly—Side B	0 or 24 V _{DC}
P1-2	OPH3A28	Drum 4 Valve—System B Valve Assembly—Side A	0 or 24 V _{DC}
P1-3	ID21	Drum 2 Minimum Bail Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-4	IDF09	Drum 3 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V _{DC}
P1-5	IDF10	Drum 3 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V _{DC}
P1-6	ID22	Drum 3 Minimum Bail Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-7	IDF01	Swing Speed Sensor	6% (low) to 70% (high) of 24 V _{DC}
P1-8	IDF04	Drum 2 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V _{DC}
P1-9	IDF06	Drum 2 Flange Encoder	0 V _{DC} or 24 V _{DC}
P1-10	IACV20	Rotating Bed Level Sensor	0.15 V _{DC} to 9.85 V _{DC}
P1-11	IACV16	Swing Right PSI	4 to 40 mA
P1-12	IACV18	Live Mast Angle Sensor	2 to 20 mA
P1-13	IACV14	Isolation B PSI	4 to 20 mA
P1-14	8C48 (+UE)	Control Module Battery Power	24 V _{DC}
P1-15	OPH3A25	Travel Right Valve—System B Valve Assembly—Side B	0 or 24 V _{DC}
P1-21	IDF03	Drum 2 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V _{DC}
P1-22	IDF05	Drum 2 Flange Encoder	0 V _{DC} or 24 V _{DC}
P1-23	IACV19	Rotating Bed Level Sensor	0.15 V _{DC} to 9.85 V _{DC}
P1-24	IACV17	Live Mast Load Pin	2 to 20 mA
P1-25	IACV11	Drum 6 PSI	4 to 20 mA
P1-27	KL15	Control Module Ignition Power (from engine RUN switch)	0 V _{DC} Open, 24 V _{DC} Closed
P1-28	OPH3A27	Drum 4 Valve—System B Control Valve—Side B	0 or 24 V _{DC}
P1-29	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P1-30	CAN_C—L	CAN_C—Low	N/A
P1-31	CAN_C—H	CAN_C—High	N/A
P1-34	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-35	IDF02	Swing Speed Sensor	6% (low) to 70% (high) of 24 V _{DC}
P1-36	IDF07	Drum 3 Flange Encoder	0 V _{DC} or 24 V _{DC}
P1-37	IDF08	Drum 3 Flange Encoder	0 V _{DC} or 24 V _{DC}
P1-38	IACV15	Swing Left PSI	4 to 20 mA
P1-39	IACV13	Drum 4 PSI	4 to 20 mA
P1-40	IACV12	Travel Right PSI	4 to 20 mA
P1-41	OS85H	8.5 V _{DC} Power (not used)	8.5 V _{DC}
P1-42	OPH3A26	Travel Right Valve—System B Valve Assembly—Side A	0 or 24 V _{DC}
P2-1	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P2-2	ODH3A03	24 V _{DC} Power Bus: • Live Mast Angle Sensor • Mast Strap Load Pin	24 V _{DC}
P2-3	ODH3A09	Front Alarm (positive)	0 V _{DC} Off, 24 V _{DC} On

Pin	Net	Function	Voltages
P2-4	ODH3A08	24 V _{DC} Power to Rotating Bed Level Sensor	24 V _{DC}
P2-5	ODH3A05	Drum 2 Park Brake Release Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-6	ODH3A13	Swing Brake Release Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-7	ODH3A15	Boom Pin Pusher Extend Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-8	OPL3A17	Ground for Isolation Valve—System B Valve Assembly	0 V _{DC}
P2-10	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P2-11	8C39 (+UB)	Battery Power for Control Module Outputs (from CB39)	24 V _{DC}
P2-12	OPH3A24	Drum 6 Valve—System B Valve Assembly—Side A	0 or 24 V _{DC}
P2-13	ODH3A01	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • Drum 6 PSI • Right Travel PSI • Drum 4 PSI Manifold B • Isolation B PSI 	24 V _{DC}
P2-14	ODH3A07	Drum 3 Park Brake Release Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-15	ODH306	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • Drum 3 Motor Speed Sensor • Drum 3 Flange Encoder • Drum 3 Minimum Bail Switch 	24 V _{DC}
P2-16	ODH3A14	Drum 1/3 Selector (Diverter) Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-18	8C40 (+UB)	Battery Power for Control Module Outputs (from CB40)	24 V _{DC}
P2-20	8C39 (+UB)	Battery Power for Control Module Outputs (from CB39)	24 V _{DC}
P2-21	ODH3A02	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • Swing Left PSI • Swing Right PSI • Swing Motor Speed Sensor 	24 V _{DC}
P2-22	ODH3A04	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • Drum 2 Flange Encoder • Drum 2 Minimum Bail Switch 	24 V _{DC}
P2-23	ODH3A10	Front Alarm (warble)	0 V _{DC} Off, 24 V _{DC} On
P2-24	ODH3A11	Drum 0 In Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-25	ODH3A12	Drum 0 Out Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-26	ODH3A16	Boom Pin Pusher Retract Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-29	8C40 (+UB)	Battery Power for Control Module Outputs (from CB40)	24 V _{DC}

Table 3-9. IOLC30 Test Voltages

Pin	Net	Function	Voltages
P1-1	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P1-2	KL15	Control Module Ignition Power (from engine RUN switch)	0 V _{DC} Open, 24 V _{DC} Closed
P1-3	ID01	Max Boom Angle Limit	0 V _{DC} Open, 24 V _{DC} Closed
P1-4	ID02	APU Connect	0 V _{DC} Disconnected, 24 V _{DC} Connected
P1-5	OPH6A18	Self-Assembly Cylinder Side A (extend) Solenoid	0 or 24 V _{DC}
P1-6	OPH6A19	Self-Assembly Cylinder Side B (retract) Solenoid	0 or 24 V _{DC}
P1-7	OPH6A20	Not Used	0 V _{DC}
P1-8	OPH6A21	Not Used	0 V _{DC}
P1-9	IMID1	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-10	CAN_C—H	CAN Bus C—High	N/A
P1-11	8C21 (+UB)	Battery Power for Control Module Outputs (from CB21)	24 V _{DC}
P1-12	8C48 (+UE)	Control Module Battery Power (from K5)	24 V _{DC}
P1-13	ID03	Mast Position Limit Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-14	ID04	Not Used	0 V _{DC}
P1-15	ID05	Drum Pawl Limit Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-16	ID06	Not Used	0 V _{DC}
P1-17	IDF15	Not Used	0 V _{DC}
P1-18	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-19	CAN_C—L	CAN Bus C—Low	N/A
P1-20	8C22 (+UB)	Battery Power for Control Module Outputs (from CB22)	24 V _{DC}
P1-21	ID07	Drum 2 Connect	0 V _{DC} Disconnected, 24 V _{DC} Connected
P1-22	ID08	Drum 3 Connect	0 V _{DC} Disconnected, 24 V _{DC} Connected
P1-23	ID09	Swing Limit	0 V _{DC} Open, 24 V _{DC} Closed
P1-26	IDF16	Not Used	0 V _{DC}
P1-28	IMID4	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-29	IMID3	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P2-1	ID12	Drum 2 Freefall Filter	0 V _{DC} Open, 24 V _{DC} Closed
P2-2	ID13	Drum 3 Freefall Filter	0 V _{DC} Open, 24 V _{DC} Closed
P2-4	IACV18	Not Used	0 V _{DC}
P2-5	ODH3A02	24 V _{DC} Power to Mast Position Limit Switch	24 V _{DC}
P2-6	ODH3A04	Not Used	0 V _{DC}
P2-7	ODH3A07	Not Used	0 V _{DC}
P2-8	ODH3A10	APU Key Switch	0 V _{DC} Open, 24 V _{DC} Closed
P2-9	ODH3A12	APU 24 V _{DC}	24 V _{DC}
P2-10	OPH3A15	Isolation Valve—System B Valve Assembly—Side A	0 to 24 V _{DC}
P2-11	8C23 (+UB)	Battery Power for Control Module Outputs (from CB23)	24 V _{DC}
P2-12	OS85H	8.5 V _{DC} Power	8.5 V _{DC}
P2-13	IACV19	Not Used	0 V _{DC}

Pin	Net	Function	Voltages
P2-14	IACV20	Not Used	0 V _{DC}
P2-15	ODH3A01	24 V _{DC} Power to Max Boom Angle Limit Switch	24 V _{DC}
P2-16	ODH3A06	Not Used	0 V _{DC}
P2-17	ODH3A09	24 V _{DC} Power to Swing Encoder	24 V _{DC}
P2-18	OPH3A14	Isolation Valve—System B Valve Assembly—Side B	0 to 24 V _{DC}
P2-19	OPH3A17	Drum 3 Motor Control	0 or 24 V _{DC}
P2-20	8C24 (+UB)	Battery Power for Control Module Outputs (from CB24)	24 V _{DC}
P2-21	OS85L	8.5 V _{DC} Ground	0 V _{DC}
P2-22	IACV21	Not Used	0 V _{DC}
P2-23	IACV22	Not Used	0 V _{DC}
P2-24	ODH3A03	24 V _{DC} Power Bus (not used)	24 V _{DC}
P2-25	ODH3A05	Not Used	0 V _{DC}
P2-26	ODH3A08	Not Used	0 V _{DC}
P2-27	ODH3A05	Not Used	0 V _{DC}
P2-28	ODH3A13	24 V _{DC} Power to Swing Limit Switch	24 V _{DC}
P2-29	OPH3A16	Drum 2 Motor Control	0 or 24 V _{DC}

Table 3-10. IOLC31 Test Voltages

Pin	Net	Function	Voltages
P1-1	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P1-2	KL15	Control Module Ignition Power (from engine RUN switch)	0 V _{DC} Open, 24 V _{DC} Closed
P1-3	ID01	Drum 4 Pawl Limit Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-5	OPH6A18	Drum 4 Motor Control	0 V _{DC} Off, 24 V _{DC} On
P1-6	OPH6A19	Drum 2 Free-Fall Brake Solenoid	0 or 24 V _{DC}
P1-7	OPH6A20	Drum 3 Free-Fall Brake Solenoid	0 or 24 V _{DC}
P1-10	CAN_C—H	CAN Bus C—High	N/A
P1-11	8C35 (+UB)	Battery Power for Control Module Outputs (from CB35)	24 V _{DC}
P1-12	8C48 (+UE)	Control Module Battery Power (from K5)	24 V _{DC}
P1-17	IDF15	Drum 4 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V _{DC}
P1-18	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-19	CAN_C—L	CAN Bus C—Low	N/A
P1-20	8C36 (+UB)	Battery Power for Control Module Outputs (from CB36)	24 V _{DC}
P1-23	ID09	Crawler Cooler Filter	0 V _{DC} Open, 24 V _{DC} Closed
P1-26	IDF16	Drum 4 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V _{DC}
P1-27	IACV17	Drum 2 Free-Fall Brake PSI	4 to 20 mA
P1-28	IMID4	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-29	IMID3	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P2-2	ID13	Freefall Connect	0 V _{DC} Disconnected, 24 V _{DC} Connected
P2-5	ODH3A02	Drum 4 Brake Release Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-6	ODH304	Drum 4 Pawls Out Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-7	ODH3A07	24 V _{DC} Power to Crawler Cooler Filter	24 V _{DC}
P2-10	OPH3A15	Pump 6—Cooler Fan	0 to 24 V _{DC}
P2-11	8C37 (+UB)	Battery Power for Control Module Outputs (from CB37)	24 V _{DC}
P2-12	OS85H	8.5 V _{DC} Power to Drum 4 Motor Speed Sensor	8.5 V _{DC}
P2-15	ODH3A01	24 V _{DC} Power Bus: • Drum 4 Motor PSI • Drum 4 Pawl Limit Switch	24 V _{DC}
P2-16	ODH3A06	24 V _{DC} Power Bus: • Free-Fall Connect • Drums 2 & 3 Free-Fall Brake PSI	24 V _{DC}
P2-17	OPH3A09	Drum 3 Free-Fall Brake Hold Solenoid	0 or 24 V _{DC}
P2-18	OPH3A14	Pump 7—System C	0 to 24 V _{DC}
P2-19	OPH3A17	Pump 5—Swing C2	0 to 24 V _{DC}
P2-20	8C38 (+UB)	Battery Power for Control Module Outputs (from CB38)	24 V _{DC}
P2-21	OS85L	8.5 V _{DC} Ground	0 V _{DC}
P2-22	IACV18	Drum 3 Free-Fall Brake PSI	4 to 20 mA
P2-23	IACV22	Drum 4 Motor PSI	4 to 20 mA
P2-24	ODH3A03	Drum 4 Pawls In Solenoid	0 V _{DC} Off, 24 V _{DC} On

Pin	Net	Function	Voltages
P2-25	ODH3A05	Free-Fall Enable	0 V _{DC} Off, 24 V _{DC} On
P2-26	OPH3A08	Drum 2 Freefall Brake Hold Solenoid	0 or 24 V _{DC}
P2-28	ODH3A13	ECM Start Relay	0 V _{DC} Off, 24 V _{DC} On
P2-29	OPH3A15	Pump 5—Swing C1	0 to 24 V _{DC}

Table 3-11. IOLC32 Test Voltages

Pin	Net	Function	Voltages
P1-1	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P1-2	KL15	Control Module Ignition Power (from engine RUN switch)	0 V _{DC} Open, 24 V _{DC} Closed
P1-3	ID01	Drum 1 Minimum Bail	0 V _{DC} Open, 24 V _{DC} Closed
P1-4	ID02	Boom Butt Connect	0 V _{DC} Disconnected, 24 V _{DC} Connected
P1-5	OPH6A18	Spotter Circuit Extend Solenoid	0 or 24 V _{DC}
P1-6	OPH6A19	Spotter Circuit Retract Solenoid	0 or 24 V _{DC}
P1-9	IMID1	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-10	CAN_C—H	CAN Bus C—High	N/A
P1-11	8C25 (+UB)	Battery Power for Control Module Outputs (from CB25)	24 V _{DC}
P1-12	8C48 (+UE)	Control Module Battery Power (from K5)	24 V _{DC}
P1-13	ID03	Swing Grease Switch (3500 PSI)	0 V _{DC} Open, 24 V _{DC} Closed
P1-15	ID05	Live Mast Limit Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-17	IDF15	Drum 1 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V _{DC}
P1-19	CAN_C—L	CAN Bus C—Low	N/A
P1-20	8C26 (+UB)	Battery Power for Control Module Outputs (from CB26)	24 V _{DC}
P1-26	IDF16	Drum 1 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V _{DC}
P1-27	IACV17	Boom Angle Sensor	0.5 to 4.5 V _{DC}
P1-28	IMID4	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-29	IMID3	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P2-3	ID14	Air Temp Sensor Connect	0 V _{DC} Disconnected, 24 V _{DC} Connected
P2-5	ODH3A02	Drum 1 Brake Release Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-6	ODH3A04	Cab Tilt Up Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-7	ODH3A07	Drum 2 & 3 Camera Lights	0 V _{DC} Off, 24 V _{DC} On
P2-8	ODH3A10	24 V _{DC} Power to Live Mast Limit Switch	24 V _{DC}
P2-9	ODH3A12	24 V _{DC} Power to Ambient Air Sensor	24 V _{DC}
P2-10	OPH3A15	Mast Raise/Lower—Lower Solenoid	0 or 24 V _{DC}
P2-11	8C27 (+UB)	Battery Power for Control Module Outputs (from CB27)	24 V _{DC}
P2-12	OS85H	8.5 V _{DC} Power to Drum 1 Motor Speed Sensor	8.5 V _{DC}
P2-13	IACV19	Air Temperature Sensor	4 to 20 mA
P2-15	ODH3A01	24 V _{DC} Power Bus: • Boom Angle Sensor • Boom Butt Connect • Drum 1 Minimum Bail Switch	24 V _{DC}
P2-16	ODH3A06	24 V _{DC} Power to Swing Grease Switch	24 V _{DC}
P2-18	OPH3A14	Drum 1 Motor Control	0 to 24 V _{DC}
P2-19	OPH3A17	Drum 6 Motor Control	0 to 24 V _{DC}
P2-20	8C28 (+UB)	Battery Power for Control Module Outputs (from CB28)	24 V _{DC}
P2-21	OS85L	8.5 V _{DC} Ground to Drum 1 Motor Speed Sensor	0 V _{DC}
P2-22	IACV21	Drum 6 Motor PSI	4 to 20 mA

Pin	Net	Function	Voltages
P2-24	ODH3A03	Cab Tilt Down Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-25	ODH3A05	Swing Bearing Auto Lube	0 V _{DC} Off, 24 V _{DC} On
P2-26	ODH3A08	Drums 1 and 6 Camera Lights	0 V _{DC} Off, 24 V _{DC} On
P2-27	ODH3A11	Mast Pin Puller Extend Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-28	ODH3A13	Mast Pin Puller Retract Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-29	OPH3A16	Mast Raise/Lower—Raise Solenoid	0 or 24 V _{DC}

Table 3-12. IOLC33 Test Voltages

Pin	Net	Function	Voltages
P1-1	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P1-2	KL15	Control Module Ignition Power (from engine RUN switch)	0 V _{DC} Open, 24 V _{DC} Closed
P1-3	ID01	Drum 6 Minimum Bail Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-4	ID02	Drum 6 Pawl Limit Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-5	OPH6A18	Drum 4 Valve—System A Valve Assembly—Side B	0 or 24 V _{DC}
P1-6	OPH6A19	Drum 4 Valve—System A Valve Assembly—Side A	0 or 24 V _{DC}
P1-7	OPH6A20	Isolation Valve—System A Valve Assembly—Side B	0 or 24 V _{DC}
P1-8	OPH6A21	Isolation Valve—System A Valve Assembly—Side A	0 or 24 V _{DC}
P1-10	CAN_C—H	CAN Bus C—High	N/A
P1-11	8C49 (+UB)	Battery Power for Control Module Outputs (from CB49)	24 V _{DC}
P1-12	8C48 (+UE)	Control Module Battery Power (from K5)	24 V _{DC}
P1-14	ID04	Drum 7 Connect	0 V _{DC} Disconnected, 24 V _{DC} Connected
P1-17	IDF15	Drum 7 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V _{DC}
P1-19	CAN_C—L	CAN Bus C—Low	N/A
P1-20	8C49 (+UB)	Battery Power for Control Module Outputs (from CB49)	24 V _{DC}
P1-26	IDF16	Drum 7 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V _{DC}
P1-27	IACV17	Travel Left PSI	4 to 20 mA
P1-28	IMID4	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-29	IMID3	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P2-4	IACV18	Drum 4 PSI	4 to 20 mA
P2-6	ODH3A04	Drum 6 Brake Release Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-7	ODH3A07	Drum 6 Pawls Out Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-10	OPH3A15	Travel Left Valve—System A Valve Assembly—Side A	0 or 24 V _{DC}
P2-11	8C50 (+UB)	Battery Power for Control Module Outputs (from CB50)	24 V _{DC}
P2-13	IACV19	Drum 4 PSI (system A)	4 to 20 mA
P2-14	IACV20	Isolation A PSI	4 to 20 mA
P2-15	ODH3A01	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • Drum 4 PSI • Left Travel PSI • Isolation A PSI 	24 V _{DC}
P2-16	ODH3A06	Drum 6 Pawls In Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-18	OPH3A14	Travel Left Valve—System A Valve Assembly—Side B	0 or 24 V _{DC}
P2-19	OPH3A17	Not Used	0 V _{DC}
P2-20	8C50 (+UB)	Battery Power for Control Module Outputs (from CB50)	24 V _{DC}
P2-24	ODH3A03	Drum 7 Park Brake Release Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-25	ODH3A05	24 V Power Bus: <ul style="list-style-type: none"> • Drum 6 Minimum Bail Switch • Drum 6 Pawl Limit Switch 	24 V _{DC}
P2-29	OPH3A16	Not Used	0 V _{DC}

Table 3-13. IOLC34 Test Voltages

Pin	Net	Function	Voltages
P1-1	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P1-2	KL15	Control Module Ignition Power (from engine RUN switch)	0 V _{DC} Open, 24 V _{DC} Closed
P1-3	ID01	System Circulation Filter Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-4	ID02	Hydraulic Vacuum Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-5	OPH6A18	Digital Pulse Output (not used)	0 V _{DC}
P1-6	OPH6A19	Digital Pulse Output (not used)	0 V _{DC}
P1-7	OPH6A20	Not Used	0 V _{DC}
P1-8	OPH6A21	Not Used	0 V _{DC}
P1-9	IMID1	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-10	CAN_C—H	CAN Bus C—High	N/A
P1-11	8C51 (+UB)	Battery Power for Control Module Outputs (from CB51)	24 V _{DC}
P1-12	8C48 (+UE)	Control Module Battery Power (from K5)	24 V _{DC}
P1-13	ID03	Hydraulic Charge Filter Alarm Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-14	ID04	Not Used	0 V _{DC}
P1-15	ID05	Not Used	0 V _{DC}
P1-16	ID06	Not Used	0 V _{DC}
P1-17	IDF15	Digital Frequency Input (not used)	0 V _{DC}
P1-18	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-19	CAN_C—L	CAN Bus C—Low	N/A
P1-20	8C52 (+UB)	Battery Power for Control Module Outputs (from CB52)	24 V _{DC}
P1-21	ID07	Not Used	0 V _{DC}
P1-22	ID08	Digital Input (not used)	0 V _{DC}
P1-23	ID09	Hydraulic Vacuum 2 Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-24	ID10	Hydraulic Vacuum 3 Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-25	ID11	Hydraulic Vacuum 4 Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-26	IDF16	Digital Frequency Input (not used)	0 V _{DC}
P1-27	IACV17	Engine Fuel Level	0.5 to 4.5 V _{DC}
P1-28	IMID4	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P2-1	ID12	Not Used	0 V _{DC}
P2-2	ID13	Digital Input (not used)	0 V _{DC}
P2-3	ID14	Digital Input (not used)	0 V _{DC}
P2-4	IACV18	Cooler Fan PSI	4 to 20 mA
P2-5	ODH3A02	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • Flow Sensor • Hydraulic Level Sensor • Hydraulic Charge Filter Alarm Switch • Hydraulic Vacuum Switch 	24 V _{DC}
P2-6	ODH3A04	Rear Alarm (warble)	0 V _{DC} Off, 24 V _{DC} On
P2-7	ODH3A07	Starter Motor Relay	0 V _{DC} Off, 24 V _{DC} On

Pin	Net	Function	Voltages
P2-8	ODH3A10	24 V _{DC} Power to Hydraulic Vacuum Switches 2, 3, & 4	24 V _{DC}
P2-9	ODH3A12	Digital Output (not used)	0 V _{DC}
P2-10	OPH3A15	Digital Pulse Output (not used)	0 V _{DC}
P2-11	8C53 (+UB)	Battery Power for Control Module Outputs (from CB53)	24 V _{DC}
P2-12	OS85H	8.5 V _{DC} Power to Hydraulic Temperature Sensor	8.5 V _{DC}
P2-13	IACV19	Hydraulic Fluid Level Sensor	0.5 to 4.5 V _{DC}
P2-14	IACV20	Hydraulic Fluid Temp Sensor	0.5 to 4.5 V _{DC}
P2-15	ODH3A01	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • System Circulation Filter • Cooler Fan PSI • Engine Fuel Level Sensor 	24 V _{DC}
P2-17	ODH3A09	24 V _{DC} Power Bus (not used)	24 V _{DC}
P2-18	OPH3A14	Digital Pulse Output (not used)	0 V _{DC}
P2-19	OPH3A17	Digital Pulse Output (not used)	0 V _{DC}
P2-20	8C54 (+UB)	Battery Power for Control Module Outputs (from CB54)	24 V _{DC}
P2-22	IACV21	Flow Sensor Switch	0 V _{DC} Off, 24 V _{DC} On
P2-23	IACV22	Analog Input (not used)	0 V _{DC}
P2-24	ODH3A03	Rear Alarm (positive)	24 VDC
P2-25	ODH3A05	Diesel Heater 28 V _{DC} Switched	0 V _{DC} Off, 24 V _{DC} On
P2-26	ODH3A08	A/C Clutch	0 V _{DC} Off, 24 V _{DC} On
P2-27	ODH3A11	Gantry Pin Puller Extend Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-28	ODH3A13	Gantry Pin Puller Retract Solenoid	0 V _{DC} Off, 24 V _{DC} On
P2-29	OPH3A16	Digital Pulse Output (not used)	0 V _{DC}

Table 3-14. IOSA22 Test Voltages

Pin	Net	Function	Voltages
P1-1	GND	Ground (from cab ground busbar)	0 V _{DC}
P1-2	KL15	Control Module Ignition Power (from engine RUN switch)	24 V _{DC}
P1-3	ID01	DPF Regen Initiate	0 V _{DC} Open, 24 V _{DC} Closed
P1-4	ID02	DPF Regen Disable	0 V _{DC} Open, 24 V _{DC} Closed
P1-5	OPH6A01	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • DPF Regen Switch • Limit Bypass Switch • Cab Tilt Switch • APU Switch • Camera Light 	24 V _{DC}
P1-6	OPH6A02	Horn Power (switched)	0 V _{DC} Open, 24 V _{DC} Closed
P1-9	IMID1	Module Identifier Input (from cab ground busbar)	0 V _{DC}
P1-10	CAN_A—H	CAN Bus A—High	N/A
P1-11	8C45 (+UB)	Battery Power for Control Module Outputs (from CB45)	24 V _{DC}
P1-12	6C8A (+UE)	Control Module Battery Power (from K5)	24 V _{DC}
P1-13	ID03	Limit Bypass	0 V _{DC} Open, 24 V _{DC} Closed
P1-14	ID04	Cab Tilt Up	0 V _{DC} Open, 24 V _{DC} Closed
P1-15	ID05	Cab Tilt Down	0 V _{DC} Open, 24 V _{DC} Closed
P1-16	ID06	Camera Light Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-17	IDF12	Not Used	0 V _{DC}
P1-19	CAN_A—L	CAN Bus A—Low	N/A
P1-20	8C45 (+UB)	Battery Power for Control Module Outputs (from CB45)	24 V _{DC}
P1-21	ID07	Not Used	0 V _{DC}
P1-22	ID08	Not Used	0 V _{DC}
P1-23	ID09	APU Run	0 V _{DC} Open, 24 V _{DC} Closed
P1-24	ID10	APU Start	0 V _{DC} Open, 24 V _{DC} Closed
P1-25	ID11	Heater Command Input	0 V _{DC} Open, 24 V _{DC} Closed
P1-26	IDF13	Not Used	0 V _{DC}
P1-29	IMID3	Module Identifier Input (from cab ground busbar)	0 V _{DC}

Table 3-15. IOSB22 Test Voltages

Pin	Net	Function	Voltages
P1-1	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P1-2	KL15	Control Module Ignition Power (from CB57)	24 V _{DC}
P1-3	ID01	Digital Input (not used)	0 V _{DC}
P1-4	ID02	Digital Input (not used)	0 V _{DC}
P1-5	OPH6A01	Carbody Right Rear Jack—Raise Solenoid	0 or 24 V _{DC}
P1-6	OPH6A02	Carbody Right Rear Jack—Lower Solenoid	0 or 24 V _{DC}
P1-7	OPH6A03	Travel Motor—Left	0 to 24 V _{DC}
P1-8	OPH6A04	Travel Motor—Right	0 to 24 V _{DC}
P1-9	IMID1	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-10	CAN_B—H	CAN Bus B—High	N/A
P1-11	8C57 (+UB)	Battery Power for Control Module Outputs (from CB57)	24 V _{DC}
P1-12	8C57 (+UE)	Control Module Battery Power (from CB57)	24 V _{DC}
P1-13	ID03	Digital Input (not used)	0 V _{DC}
P1-14	ID04	Digital Input (not used)	0 V _{DC}
P1-15	ID05	Digital Input (not used)	0 V _{DC}
P1-19	CAN_B—L	CAN Bus B—Low	N/A
P1-20	8C57 (+UB)	Battery Power for Control Module Outputs (from CB57)	24 V _{DC}
P1-21	ID07	Crawler Left Connected	0 V _{DC} Disconnected, 24 V _{DC} Connected
P1-22	ID08	Crawler Right Connected	0 V _{DC} Disconnected, 24 V _{DC} Connected
P1-29	GND	Ground (from ground stud on rotating bed)	0 V _{DC}

Table 3-16. SCM-00 Test Voltages

Pin	Net	Function	Voltages
P1-1	8C45 (+UB)	Battery Power for Control Module Outputs (from CB45)	24 V _{DC}
P1-2	ODH1A17	RCL Light Amber	0 V _{DC} Off, 24 V _{DC} On
P1-3	ODH1A6	RCL Light Green	0 V _{DC} Off, 24 V _{DC} On
P1-4	ODH1A5	24 V _{DC} Power to RCL Override Switch	24 V _{DC}
P1-5	ODH1A4	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • Travel Speed Switch • Seat Safety Switch • Drum 7 Park Switch • Mast Arm Cylinder Switches 	24 V _{DC}
P1-6	ODH1A3	RCL Light Red	0 V _{DC} Off, 24 V _{DC} On
P1-8	ODH1A1	24 V _{DC} Power to Foot Throttle	24 V _{DC}
P1-9	IDF1	Not Used	0 V _{DC}
P1-10	IDF2	Drum 7 Park Input	0 V _{DC} Open, 24 V _{DC} Closed
P1-11	IDF3	Mast Cylinder Extend Input	0 V _{DC} Open, 24 V _{DC} Closed
P1-12	IDF4	Mast Cylinder Retract Input	0 V _{DC} Open, 24 V _{DC} Closed
P1-13	ID51	A/C Compressor Enable Input	0 V _{DC} Open, 24 V _{DC} Closed
P1-14	6C8A (+UE)	Control Module Battery Power (from K5)	24 V _{DC}
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 busbar)	0 V _{DC}
P1-21	ID6	Engine Start Input	0 V _{DC} Open, 24 V _{DC} Closed
P1-22	IACV11	Hand Throttle Input	0.5 V _{DC} Low Idle 4.5 V _{DC} High Idle
P1-23	IACV12	Engine Foot Throttle Input	0.90 to 1.00 V _{DC} High Idle 2.90 to 3.00 V _{DC} Low Idle
P1-24	IACV13	Drum 2 Free-Fall Pedal Input	1.5 to 8.5 V _{DC}
P1-25	RTCN	3.6 V _{DC} Real Time Clock Battery Power (negative)	0 V _{DC}
P1-26	0S85L	8.5 V _{DC} Ground Bus: <ul style="list-style-type: none"> • Hand Throttle • Travel Pedals • Drums 2 and 3 Free-Fall Brake Pedals 	8.5 V _{DC}
P1-27	KL15	Control Module Ignition Power (from engine RUN switch)	24 V _{DC}
P1-28	ID9	Seat Safety Switch	0 V _{DC} Open, 24 V _{DC} Closed
P1-29	GND	Ground (from cab ground busbar)	0 V _{DC}
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 busbar)	0 V _{DC}
P1-35	ID7	Engine Run Input	0 V _{DC} Open, 24 V _{DC} Closed
P1-36	ID8-1	Travel Speed Input	0 V _{DC} Open, 24 V _{DC} Closed

Pin	Net	Function	Voltages
P1-37	IACV14	Drum 3 Free-Fall Pedal	1.5 to 8.5 V _{DC}
P1-38	IACV16	Travel Pedal—Left	1.5 to 5.0 V _{DC} Reverse 5 to 8.5 V _{DC} Forward
P1-39	IACV16	Travel Pedal—Right	1.5 to 5.0 V _{DC} Reverse 5 to 8.5 V _{DC} Forward
P1-40	RTCP	3.6 V _{DC} Real Time Clock Battery Power (positive)	3.6 V _{DC}
P1-41	0S85H	8.5 V _{DC} Power Bus: <ul style="list-style-type: none"> • Hand Throttle • Travel Pedals • Drums 2 and 3 Free-Fall Brake Pedals 	8.5 V _{DC}
P1-42	ID10	RCL Override Input	0 V _{DC} Open, 24 V _{DC} Closed

Table 3-17. SCMD-01 Test Voltages

Pin	Net	Function	Voltages
P1-1	8C29 (+UB)	Battery Power for Control Module Outputs (from CB29)	24 V _{DC}
P1-2	ODH1A7	Not Used	24 V _{DC}
P1-3	ODH1A6	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • Jib Butt Angle Sensor • Luffing Jib Min and Max Angle Limit Switches • Luffing Jib Latch Left and Right Switches 	24 V _{DC}
P1-4	ODH1A5	24 V _{DC} Power to Drum 1 Proximity A and B Sensors	24 V _{DC}
P1-5	ODH1A4-1	24 V _{DC} Power to Drum 2 Proximity A and B Sensors	24 V _{DC}
P1-6	ODH1A3	24 V _{DC} Power to Lower/Upper Boom Point Slow Down	24 V _{DC}
P1-7	ODH1A2	24 V _{DC} Power to Lower/Upper Boom Point Block-Up Limit	24 V _{DC}
P1-8	ODH1A1	24 V _{DC} Power to Boom Strap Load Cell	24 V _{DC}
P1-9	IDF01	Drum 2 Proximity Sensor (A)	0 V _{DC} Open, 24 V _{DC} Closed
P1-10	IDF02	Drum 2 Proximity Sensor (B)	0 V _{DC} Open, 24 V _{DC} Closed
P1-11	IDF03	Drum 1 Proximity Sensor (A)	0 V _{DC} Open, 24 V _{DC} Closed
P1-12	IDF04	Drum 1 Proximity Sensor (B)	0 V _{DC} Open, 24 V _{DC} Closed
P1-13	ID05	Lower/Upper Boom Point A2B Block-Up Limit Input	0 V _{DC} Open, 24 V _{DC} Closed
P1-14	6C8A (+UE)	Control Module Battery Power (from K5)	24 V _{DC}
P1-15	ODH2A8	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • Boom-Top Angle Sensor • Wind Speed Sensor 	24 V _{DC}
P1-21	ID06	Lower/Upper Boom Point A2B Slow Down Input	0 V _{DC} Open, 24 V _{DC} Closed
P1-22	IACV11	Boom Strap Load Cell Right	2 to 20 mA
P1-23	IACV12	Boom Strap Load Cell Left	2 to 20 mA
P1-24	IACV13	Boom-Top Angle Sensor	4 to 20 mA
P1-27	KL15	Control Module Ignition Power (from CB29)	0 V _{DC} Open, 24 V _{DC} Closed
P1-28	ID9	Upper Boom Point Confirm	0 V _{DC} Disconnected, 24 V _{DC} Connected
P1-29	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P1-30	CAN_D—L	CAN Bus D—Low	N/A
P1-31	CAN_D—H	CAN Bus D—High	N/A
P1-34	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-35	ID07	Luffing Jib Max Stop	0 V _{DC} Open, 24 V _{DC} Closed
P1-36	ID08	Luffing Jib Min Stop	0 V _{DC} Open, 24 V _{DC} Closed
P1-37	IACV14	Wind Speed Sensor	4 to 20 mA
P1-38	IACV15	Luffing Jib Latch—Left and Right	0 V _{DC} Open, 24 V _{DC} Closed
P1-39	IACV16	Jib Butt Angle Sensor	4 to 20 mA

Table 3-18. SCMD-02 Test Voltages

Pin	Net	Function	Voltages
P1-1	6C8A (+UB)	Battery Power for Control Module Outputs (from K5)	24 V _{DC}
P1-3	ODH1A6	24 V _{DC} Power to UBP Load Pin	24 V _{DC}
P1-6	ODH1A3	24 V _{DC} Power to Lower/Upper Boom Point Slow Down	24 V _{DC}
P1-7	ODH1A2	24 V _{DC} Power to Lower/Upper Boom Point Block-Up Limit	24 V _{DC}
P1-8	ODH1A1	24 V _{DC} Power to Boom Strap Load Cells—Left and Right	24 V _{DC}
P1-13	ID05	24 V _{DC} Power to LBP and UBP A2B Block-Up Limit Input	0 V _{DC} Open, 24 V _{DC} Closed
P1-14	6C8A (+UE)	Control Module Battery Power (from K5)	24 V _{DC}
P1-15	ODH2A8	24 V _{DC} Power Bus: <ul style="list-style-type: none"> • Boom-Top Angle Sensor • Wind Speed Sensor 	24 V _{DC}
P1-20	IMID1	Module Identifier Input (from ground stud on rotating bed)	0 V _{DC}
P1-21	ID06	Lower/Upper Boom Point A2B Slow Down Input	0 V _{DC} Open, 24 V _{DC} Closed
P1-22	IACV11	Boom Strap Load Cell Right Input	2 to 20 mA
P1-23	IACV12	Boom Strap Load Cell Left Input	2 to 20 mA
P1-24	IACV13	Boom Angle Sensor	4 to 20 mA
P1-27	KL15	Control Module Ignition Power (from K5)	0 V _{DC} Open, 24 V _{DC} Closed
P1-28	ID9	Upper Boom Point Confirm	0 V _{DC} Disconnected, 24 V _{DC} Connected
P1-29	GND	Ground (from ground stud on rotating bed)	0 V _{DC}
P1-30	CAN_D—L	CAN Bus D—Low	N/A
P1-31	CAN_D—H	CAN Bus D—High	N/A
P1-37	IACV14	Wind Speed Sensor	4 to 20 mA
P1-38	IACV15	Upper Boom Point Load Pin Input	2 to 20 mA

SECTION 4

BOOM

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FOR REFERENCE ONLY

SECTION 4

BOOM

GENERAL MAINTENANCE

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

For maintenance and inspection of the following components, see the Service/Maintenance Manual supplied with your crane:

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

BOOM AND LUFFING JIB ANGLE INDICATOR CALIBRATION

An angle sensor (see [Figure 4-1](#)) is located inside the boom and luffing jib tops. The sensors are calibrated on the rated capacity limiter/rated capacity indicator (RCL/RCI) display and do not require adjustment.



FIGURE 4-1

BOOM STOP LIMIT SWITCH

When the boom is at a position other than the maximum allowable angle, the limit switch in the boom stop switch unit (1, [Figure 4-2](#)) is closed, providing a continuous 24 V_{DC} signal to the ID01 input on the IOLC30 control module.

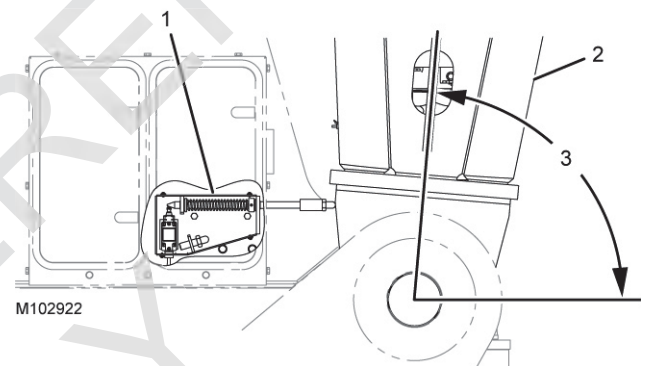
If the boom reaches the maximum allowable angle for your boom/jib configuration, the limit switch will open (voltage at the ID01 input drops to 0 V_{DC}), signaling the control system to stop the boom hoist and apply the hoist brake.

Automatic Boom Stop Overview

See [Figure 4-2](#) for the following.

The boom stop switch unit (1) automatically stops the boom and applies the boom hoist brake if the boom is raised to the maximum switch boom angle (3).

NOTE: The maximum switch boom angle is greater than the maximum boom angle to allow the operator to boom up past the maximum capacity chart angle to get to the minimum chart radius with a load on the hook and the boom deflected.



Item	Description
1	Boom Stop Switch Unit
2	Boom Butt
3	Maximum Switch Boom Angle: 84.5°—Boom with EUBP 86.5°—Boom Only 87.5°—Boom with Luffing Jib

FIGURE 4-2

**WARNING****Falling Attachment Hazard!**

Do not operate the crane unless the automatic boom stop is 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.

When the maximum boom angle is reached, the fault alarm comes on and the boom maximum up icon appears in the information screen of the main display.



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

Maintenance

At least once weekly, check that the automatic boom stop stops the boom at the specified maximum boom angle. If it doesn't, replace any worn or damaged parts and/or adjust the automatic boom stop. See [Adjusting the Automatic Boom Stop on page 4-3](#).

Adjusting the Automatic Boom Stop



WARNING

Falling Attachment Hazard!

Do not operate the crane unless the boom stop limit switch is 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.

See [Figure 4-3](#) for the following procedure.

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

- Parts are replaced
- The boom/luffing jib configuration is changed

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 and on a digital protractor-level (14).

1. Park the crane on a firm level surface or level the crane by blocking under the crawlers.
2. Make sure that the correct adjusting rod (2a or 2b) is installed:
 - Adjusting rod (2a) for 83° or 85° boom angle
 - Adjusting rod (2b) for 86° boom angle
3. Boom up slowly while monitoring the boom angle on the RCL/RCI working screen.
4. Stop boom up when the boom reaches the specified maximum boom angle. (See Maximum Switch Boom Angle table in View C.)

NOTE: The maximum switch boom angle is greater than the maximum boom angle to allow for boom deflection.

5. Verify the boom angle with an accurate digital protractor-level (14) placed on the boom butt bottom chord (15). The corresponding digital level angle (16) should appear on the protractor-level:
 - If the boom stops at the specified angle, further adjustment is not needed.
 - If the boom stops before reaching the specified angle, go to [step 6](#).
 - If the boom reaches the specified angle before it stops, go to [step 7](#).

6. If the boom stops before reaching the specified angle, perform the following procedure.
 - a. Loosen the jam nut (3).
 - b. Turn the adjusting rod (2a or 2b) all the way into the coupling (4).
 - c. Boom up slowly until the boom reaches the specified angle.
 - d. Turn the adjusting rod out against the boom butt (1, View B) until the limit switch (6) clicks open.
 - e. Tighten the jam nut.
7. If the boom reaches the specified angle before it stops, perform the following procedure.
 - a. Loosen the jam nut (3).
 - b. Turn the adjusting rod (2a or 2b) out against the boom butt (1, View B) until the limit switch (6) clicks open.
 - c. Tighten the jam nut.
8. Verify the position of the actuator rod (11) relative to the limit switch roller to ensure there is overtravel (13).
9. Boom down and then boom back up. The boom must stop at the specified maximum switch boom angle.
10. If the boom does not stop at the specified angle, repeat [step 3](#) through [step 9](#).

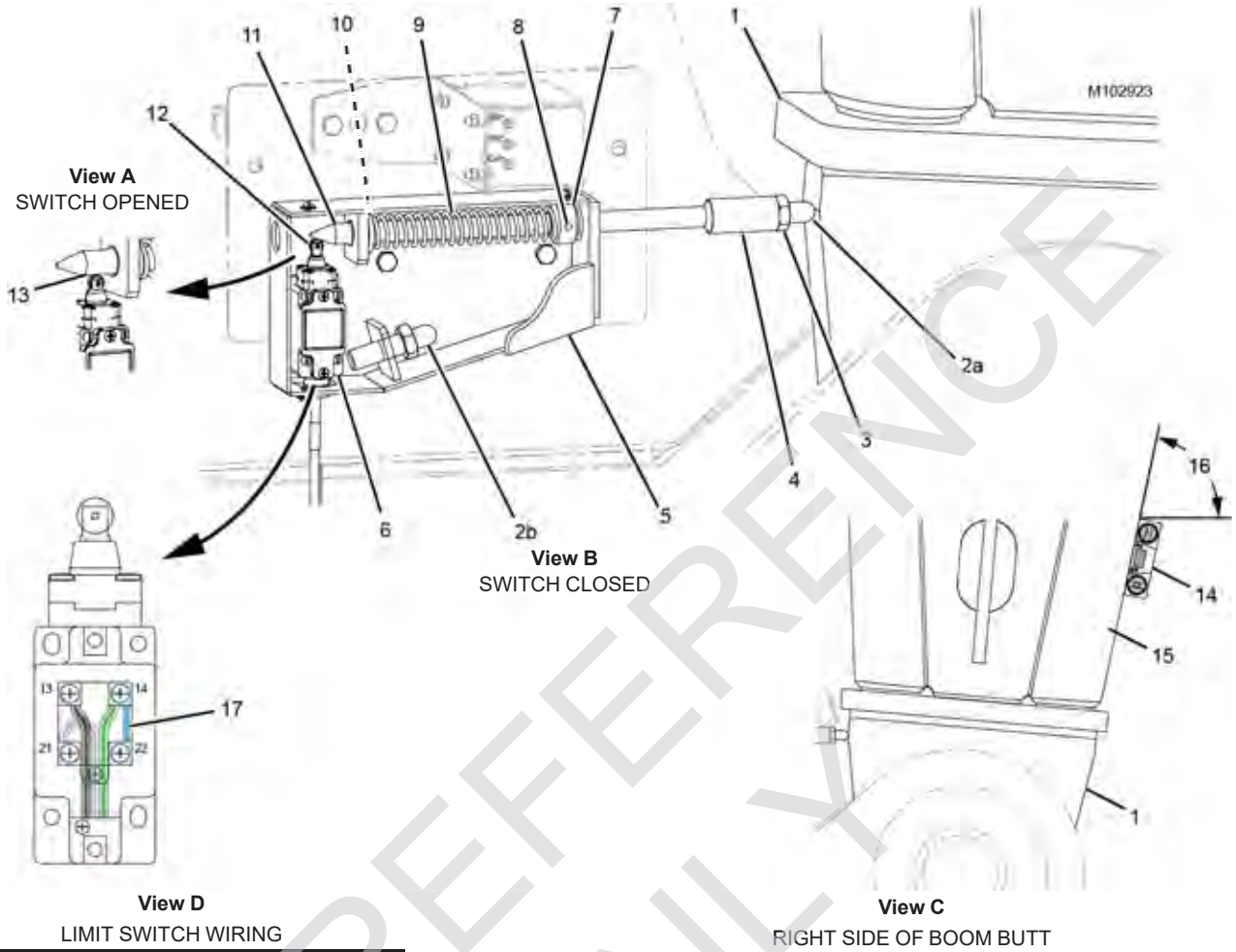
Replacing the Boom Stop Limit Switch Actuator Rod

See [Figure 4-3](#) for the following procedure.

1. Disassemble the boom stop switch unit (5).
2. Assemble the boom stop switch using the following instructions.
 - a. Position the actuator rod (11) so the tapered end just touches the limit switch roller (see View B). The actuator rod must not depress the limit switch.
 - b. Drill a 6,35 mm (1/4 in) hole through the spring washer (7) and actuator rod.
 - c. Install the spring pin (8).
 - d. Push the actuator rod in until the limit switch clicks open. Check the position of the limit switch roller to ensure there is overtravel (13).

AUTOMATIC LUFFING JIB STOP ADJUSTMENT AND MAINTENANCE

See the MLC300 Luffing Jib Operator Manual.



Receptacle	Switch Terminals	Function
Black	13	Ground
Green	14	Maximum Angle
White	21	24 V _{DC} Supply
Blue	14 22	Jumper

Maximum Switch Boom Angle	Digital Level Angle (16)
84.5°—Boom with EUBP	76°
86.5°—Boom Only	78°
87.5°—Boom with Luffing Jib	79°

Maximum Boom Angle
83°—Boom with EUBP
85°—Boom Only
86°—Boom with Luffing Jib

Item	Description	Item	Description
1	Boom Butt	9	Spring
2a	Adjusting Rod for 83° or 85° Boom Angle—89 mm (3.50 in)	10	Spring Washer
2b	Adjusting Rod for 86° Boom Angle—85 mm (3.344 in)	11	Actuator Rod
3	Jam Nut	12	Switch Closed
4	Coupling (part of actuator rod)	13	Overtravel (switch open)
5	Boom Stop Switch Unit	14	Digital Protractor-Level
6	Limit Switch	15	Boom Butt Bottom Chord
7	Spring Washer	16	Digital Level Angle
8	Spring Pin	17	Blue Jumper Wire

FIGURE 4-3

BOOM ELECTRICAL SCHEMATIC

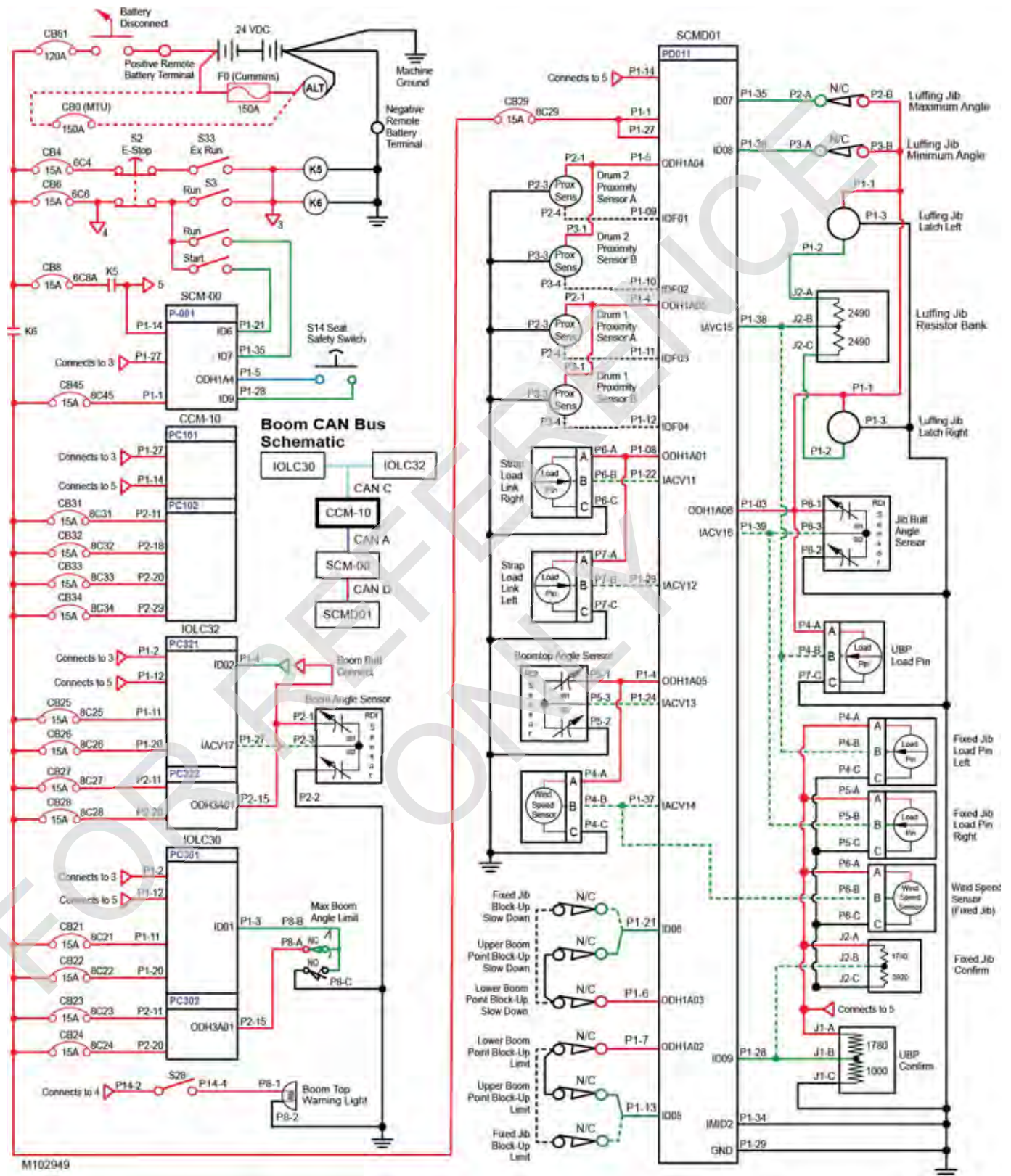


FIGURE 4-4

4

LUFFING JIB ELECTRICAL SCHEMATIC

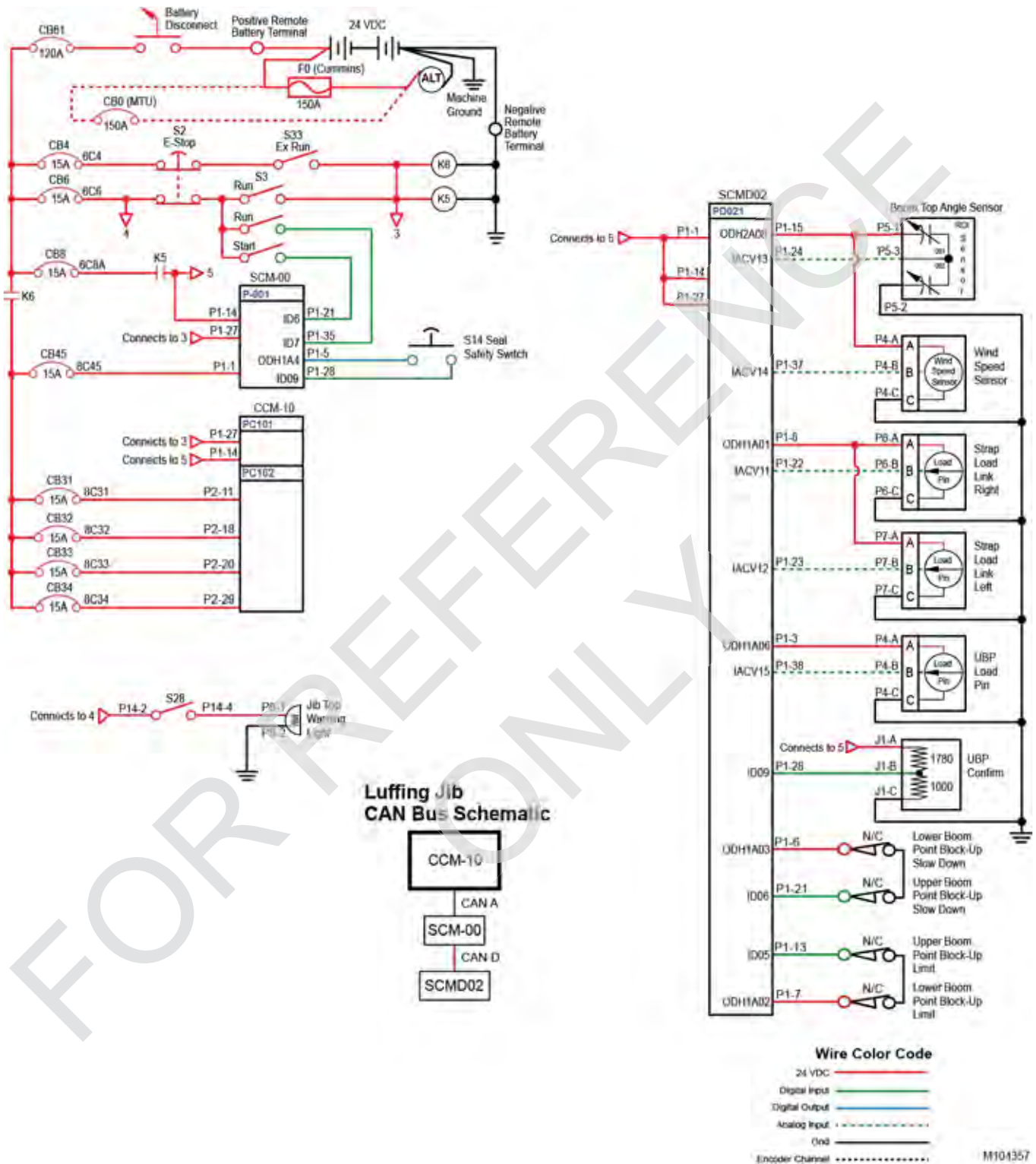


FIGURE 4-5

STRAP INSPECTION AND MAINTENANCE

This section is a guide to crane owners for properly inspecting and maintaining straps in the field. It is impossible to predict whether or when a strap may fail. Frequent and periodic inspections can help reveal potential for failure. Straps are to be inspected regularly by a qualified person as part of the crane's preventive maintenance program. Dated records should also be kept.

Strap repairs are prohibited. Perform only the maintenance indicated in this section. For inspection procedures not covered in this manual, contact your dealer or the Manitowoc Crane Care Lattice Team.

NOTE: If strap damage was caused by overload or shock load or if there is damage to other major structural components, Manitowoc Cranes recommends that a thorough inspection be made by a qualified person. A nondestructive test of all critically stressed members must be made.

Strap connecting links are subject to the same inspection procedures and replacement specifications as those for straps. In this section, "strap" means straps and connecting links.

Inspection

Regular inspection of all straps is necessary to ensure that the crane can lift its rated load. If a strap fails, the boom or other attachment can collapse. All inspections must be performed by a qualified inspector at the following intervals:

- Routinely on a daily (frequent inspection) or monthly (periodic inspection) basis
- Before initial use
- After transport
- After an overload or shock loading has occurred
- If the boom and/or jib has come into contact with another object (for example, power lines, building, another crane)
- If the boom or jib has been struck by lightning

Frequent Inspection

Visually inspect all straps once each work shift for obvious damage that poses an immediate hazard. Pay particular attention to areas where wear and other damage is likely to occur. Look for straps that are disconnected, loose, or sagging excessively and for distortion such as kinking or twisting. If any strap looks like it is damaged, the strap must be checked to make sure it is within the specifications given in this section.

Periodic Inspection

Periodic inspection must be performed at least monthly. During this inspection, the entire length of strap must be inspected to ensure that it is within specifications. Any damage found must be recorded and a determination must be made as to whether continued use of the strap is safe.

NOTE: The strap must be within all specifications identified in this section.

Before beginning an inspection, thoroughly clean the strap of all dirt, grease, oil, etc., so a thorough inspection can be made. Closely examine those areas where paint is chipped, wrinkled, or missing and where faint rust lines or marks appear.

A qualified inspector may modify an interval for periodic inspection depending on the following factors:

- Severity of the environment in which the crane is operated
- Size, nature, and frequency of lifts
- Exposure to shock loading or other abuse

Cranes Not in Regular Use

A qualified inspector should determine the type of inspection required for cranes that have been idle. A frequent inspection (visual observation) should be adequate for a crane that has been idle for less than six months. A periodic inspection is required for cranes that have been idle for more than six months.

Identifying the Straps

To aid in identification, the part number is stamped into both ends of each strap (see [Figure 4-6](#)).

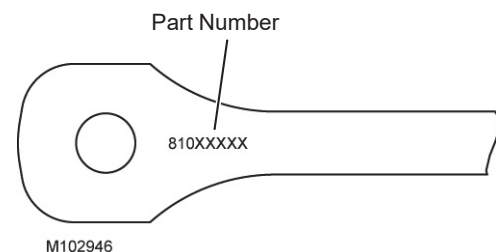


FIGURE 4-6

Replacement Specifications

Any strap not within specifications listed [Table 4-1](#) in must be replaced.



WARNING

Falling Attachment Hazard!

If damage to the strap exceeds that allowed within specification, do not operate the crane until the strap has been replaced.

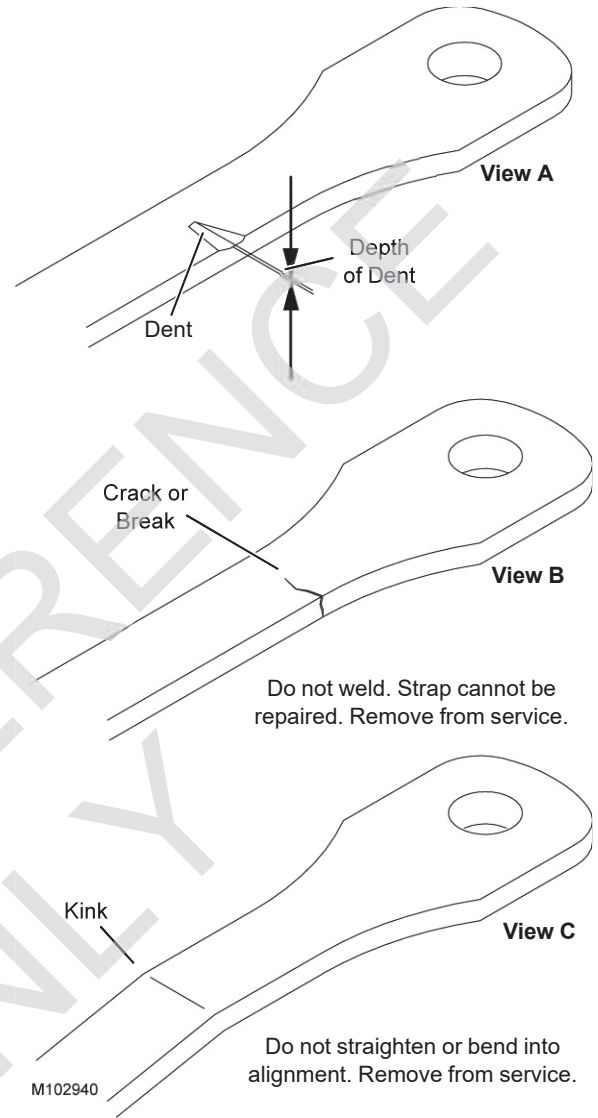
Operating the crane with a damaged strap can cause structural failure or collapse of the boom, jib, mast, or other crane components.

Table 4-1. Strap Specifications

Condition	Reference	Allowable Tolerance or Deviation	Corrective Action
Dent	Figure 4-7 View A	< 3% of strap thickness	Monitor condition
		≥ 3% of strap thickness	Remove strap from service
Crack or Break	Figure 4-7 View B	None	Remove strap from service
Kink	Figure 4-7 View C	None	Remove strap from service
Corrosion or Abrasion	Figure 4-8	<3% of strap cross-sectional area	Sandblast and paint to maintain continuous protective coating
		≥3% of strap cross-sectional area	Remove strap from service
Straightness (gradual or sweeping bend)	Figure 4-9	Table 4-2	Remove strap from service if deviation exceeds maximum allowed
Flatness (includes twisted straps)	Figure 4-10	Table 4-3	Remove strap from service if deviation exceeds maximum allowed
Elongated Holes	Figure 4-11	None	Remove strap from service
Length	Figure 4-12	None	Remove strap from service

< = less than

≥ = equal to or greater than



Do not weld. Strap cannot be repaired. Remove from service.

Do not straighten or bend into alignment. Remove from service.

FIGURE 4-7

Corrosion or Abrasion

See [Figure 4-8](#) for the following procedure.

1. For quick identification by repair workers, clearly mark damaged areas with brightly colored tape.
2. Sandblast to remove corrosion. Do not grind!
3. Determine the reduction in the cross-sectional area.
4. If the reduction is less than 3% of the strap's cross-sectional area, paint the strap to maintain a continuous protective coating.
5. If the reduction is 3% or more of the strap's cross-sectional area, remove the strap from service.

Corrosion or Abrasion

P325



Not Acceptable
Abrasion from handling with chain exceeds allowable limit.

Not Acceptable
Surface is badly pitted, exceeding allowable limit.

P326



Acceptable
Surface is relatively smooth and within allowable limit.

FIGURE 4-8

Straightness

See [Figure 4-9](#) for the following procedure.

1. Stretch a line (string or wire) from the pin storage hole at one end of the strap.
2. Stretch the line as tight as possible and tie it off at the other end.
3. Mark the strap's centerline. Do not use a center punch!
4. If the string does not align with the centerline, measure the distance from the centerline to the line.

If deviation from straight is greater than the maximum allowed in , remove the strap from service.

Table 4-2. Strap Straightness

Strap Length (L)	Maximum Deviation Allowed
1,5 to <3,0 m (5 to <10 ft)	1,5 mm (0.060 in)
3,0 to <6,1 m (10 to <20 ft)	3,2 mm (0.125 in)
6,1 to <9,1 m (20 to <30 ft)	6,4 mm (0.250 in)
9,1 to <12,2 m (30 to <40 ft)	9,5 mm (0.375 in)
12,2 to <15,2 m (40 to <50 ft)	12,7 mm (0.50 in)

< = less than

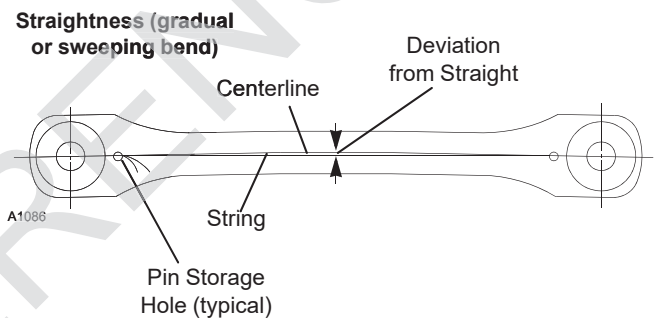


FIGURE 4-9

Flatness

See [Figure 4-10](#) for the following procedure.

1. Lay the strap on a flat surface. Do not put the strap on blocks. This may cause the strap to sag.
2. Stretch a line (string or wire) across the top surface of the strap from the pin storage hole at one end of the strap.
3. Stretch the line as tight as possible and tie it off at the other end.
4. Verify that the line touches the top surface of the strap at all points along its length.
5. If the string does not touch the strap, measure the distance from the line to the strap.

If deviation from flat is greater than the maximum allowed in [Table 4-3](#), remove the strap from service.
6. Remove the line. Turn the strap over.
7. Repeat [step 1](#) through [step 5](#) above.

Flatness (includes twisted straps)

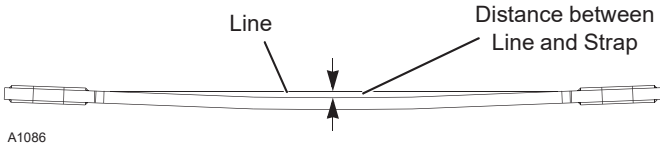


FIGURE 4-10

Table 4-3. Strap Flatness

Strap Length (L) m (ft)	Maximum Deviation Allowed	
	25,4 to <50,8 mm (1 to <2 in) Thick	50,8 to <101,6 mm (2 to <4 in) Thick
<0,9 (<3)	4,3 mm (0.17 in)	12,7 mm (0.50 in)
0,9 to <1,2 (3 to <4)	15,9 mm (0.63 in)	14,3 mm (0.56 in)
1,2 to <1,5 (4 to <5)	19,1 mm (0.75 in)	17,8 mm (0.70 in)
1,5 to <1,8 (5 to <6)	20,6 mm (0.80 in)	19,1 mm (0.75 in)
1,8 to <2,1 (6 to <7)	22,2 mm (0.88 in)	19,1 mm (0.75 in)
2,1 to <2,4 (7 to <8)	23,8 mm (0.94 in)	19,1 mm (0.75 in)
2,4 to <2,7 (8 to <9)	25,4 mm (1.0 in)	19,1 mm (0.75 in)
2,7 to <3,0 (9 to <10)	25,4 mm (1.0 in)	22,2 mm (0.88 in)
3,0 to <3,7 (10 to <12)	25,4 mm (1.0 in)	25,4 mm (1.0 in)
≥3,7 (≥12)	Deviation not to exceed 25,4 mm (1 in) in any 3,7 m (12 ft) length of strap	

< = less than

≥ = equal to or greater than

Elongated Hole

See [Figure 4-11](#) for the following procedure.

1. Insert the pin into the hole.
2. Push the pin tight against the edge of the hole along the horizontal centerline. Measure the dimension between the pin and the hole (see View A).

3. Push the pin tight against the edge of the hole along the vertical centerline. Measure the dimension between the pin and the hole (see View B).

If dimension B is not half of A, the hole is elongated. Remove the strap from service.

If dimension A is greater than 0,8 mm (0.030 in), contact the Manitowoc Crane Care Lattice Team.

Elongated Holes

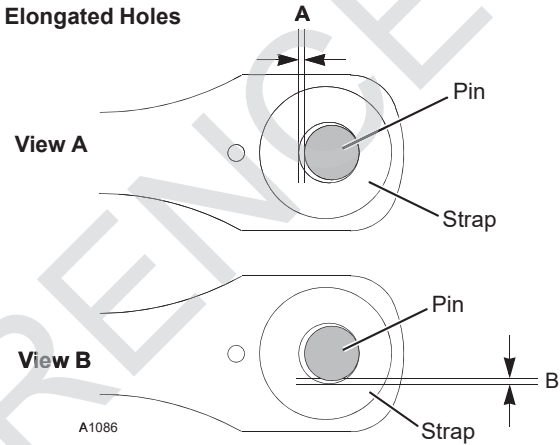


FIGURE 4-11

Strap Length

Check the strap length ([Figure 4-12](#)) by measuring pin hole to pin hole. See the appropriate rigging drawing in the Operator Manual for the original length. Strap length includes the connecting link. If a change in length is detected, remove the strap from service.

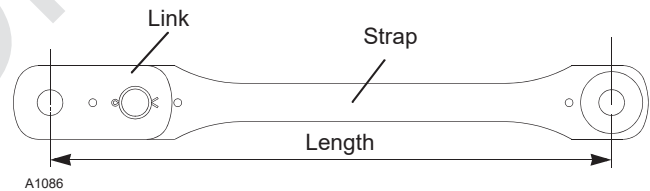


FIGURE 4-12

Storing the Straps

Straps should be stored in a protected area. If stored in the open, a protective covering is recommended, especially in a corrosive environment (chemicals, salt water spray, etc.).

Inspect straps in storage for corrosion monthly. If necessary, sandblast to remove corrosion and repaint to maintain a continuous protective surface. If corrosion is not removed, the strap will need to be removed from service because the reduction in thickness will exceed the maximum allowed.

A full periodic inspection is required for straps returned to service from storage.

Removing the Straps from Service

Straps removed from service should be clearly marked to prevent accidental future use. Rendering the strap useless in some way, such as cutting off an end, is recommended.

Inspection Checklist

The Strap Inspection Checklist is provided at the end of this section. The checklist can be reproduced as needed.

Signed and dated copies of the Strap Inspection Checklist must be kept on file at all times for each strap, since the checklists may be required to verify warranty or product liability claims.

If no damage is found or the damage is within specification, check the box () next to the item to indicate that its specific condition was evaluated and found acceptable. If damage is not within specification, indicate so in the box next to the item (for example, "D" to indicate damage).

STRAP INSPECTION CHECKLIST

Inspector's Name _____ Signature _____ Date _____

Length _____ mm (ft) Part Number _____

Dents Kinks Cracks Breaks Corrosion

Abrasion Length Straightness Flatness Elongated Holes

Other _____

Length _____ mm (ft) Part Number _____

Dents Kinks Cracks Breaks Corrosion

Abrasion Length Straightness Flatness Elongated Holes

Other _____

Length _____ mm (ft) Part Number _____

Dents Kinks Cracks Breaks Corrosion

Abrasion Length Straightness Flatness Elongated Holes

Other _____

Length _____ mm (ft) Part Number _____

Dents Kinks Cracks Breaks Corrosion

Abrasion Length Straightness Flatness Elongated Holes

Other _____

Length _____ mm (ft) Part Number _____

Dents Kinks Cracks Breaks Corrosion

Abrasion Length Straightness Flatness Elongated Holes

Other _____

LATTICE SECTION INSPECTION AND LACING REPLACEMENT

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

FOR REFERENCE ONLY

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SECTION 5

HOISTS

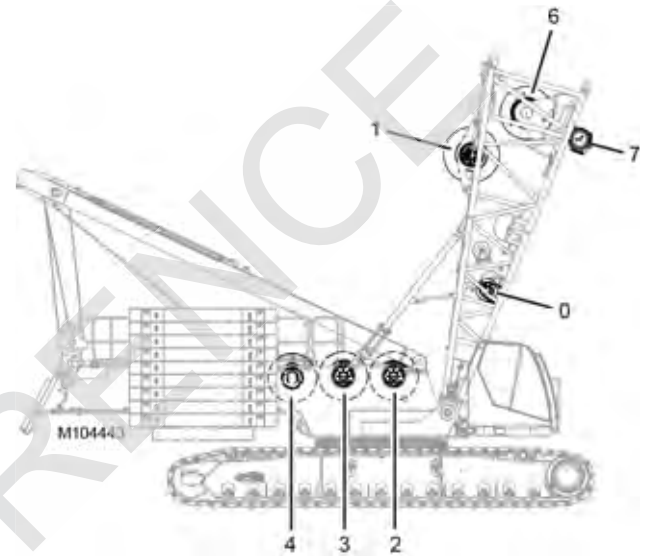
GENERAL

This section provides the electrical and hydraulic crane hoist information. Electrical and hydraulic circuit schematics are provided for each drum system.

Details of individual components are covered later in this section. Component information can also be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

DRUM IDENTIFICATION



Drum	Description
0	Rigging Winch (optional)
1	Main Hoist
2	Auxiliary Front Hoist (optional)
3	Auxiliary Rear Hoist (optional)
4	Boom Hoist
6	Auxiliary Hoist
7	Tagline Winch (optional)

FIGURE 5-1

DRUM 1—MAIN HOIST

See [Figure 5-2](#) and [Figure 5-3](#) for the following descriptions.

Drum 1 Overview

Drum 1 is powered by a closed-loop hydraulic system consisting of a variable displacement hydraulic pump and a variable displacement hydraulic motor. The cross-port orifice between the motor ports A and B assists in providing smooth drum operation.

The system contains a drum brake that applies whenever the drum is not being operated.

Drum 1 Brake Overview

A brake is attached to the input of the drum 1 gearbox located between the gearbox and the motor. The brake is controlled by joystick movement and the drum 1 park brake switch. The brake is applied by spring force and released by hydraulic pressure.

CAUTION

Possible Machine Damage!

When raising or lowering a load, do not use the drum park switch to stop the load movement, since this could cause damage to the boom. Use the joystick for a controlled smooth stop.

The brake must be fully released to allow the drum to rotate for hoisting and lowering operations. To accomplish this, the brake pressure must be above 18 bar (261 psi). Any pressure below this could cause the brakes to remain partially applied, which could damage the drum brake system.

Only when predetermined conditions are met will the control system actively release the drum brake. If hydraulic pressure or electric current is lost, spring force applies the brake, stopping the drum and holding it in position.

Drum 1 Brake Operation

UN-PARK Operation

Joystick J2 sends 24 V_{DC} to the drum 1 park switch. The park switch is closed in the UN-PARK position, causing the park switch to send 24 V_{DC} back to joystick J2. Joystick J2 communicates the un-park command to the CCM-10 control module via the controller area network bus (CAN Bus).

The drum brake remains engaged until drum 1 joystick J3 is moved in either direction to hoist or lower a load. When moved, joystick J3 communicates this information to the CCM-10 control module via the CAN Bus.

When the CCM-10 control module receives both the un-park command from joystick 2 and a hoist/lower command from joystick 3, the CCM-10 control module relays the un-park command to the IOLC32 control module via the CAN Bus.

Upon receiving the un-park command, the IOLC32 control module sends 24 V_{DC} to the drum 1 brake release solenoid valve, energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the drum brake cylinder, releasing the brake.

ON-PARK Operation

When the brake switch is in the ON-PARK position, the drum 1 park switch is open, sending 0 V_{DC} back to joystick J2. Joystick J2 communicates the park command to the CCM-10 control module via the CAN Bus, which then relays the command to the IOLC32 control module.

Upon receiving the park command, the IOLC32 control module sends 0 V_{DC} voltage to the drum 1 brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake cylinder to flow through the drum 1 brake release valve, then back to the tank. The reduced hydraulic pressure allows spring force to apply the drum brake.

When the drum 1 park switch is in the ON-PARK position, drum 1 joystick J3 is inoperable.

Drum 1/3 Diverting

NOTE: Drums 1 and 3 cannot be operated at the same time. The unused drum must always be parked.

The hydraulic circuits of drum 1 and drum 3 use three hydraulic valves to divert the hydraulic fluid to the motor of the selected drum. The valves are as follows:

- Drum 1/3 selector solenoid valve
- Drum 1/3 single diverter valve
- Drum 1/3 double diverter valve

When drum 3 is parked and drum 1 is un-parked, the CCMC11 control module de-energizes the drum 1/3 selector solenoid valve.

When the drum 1/3 selector solenoid valve is de-energized, the following occurs:

- The drum 1/3 selector solenoid valve routes hydraulic fluid from pump 2 to the drum 1 pilot control of the single and double drum 1/3 diverter valves, causing these valves to shift to the drum 1 position.
- With the drum 1/3 double diverter valve shifted to the drum 1 position, hydraulic fluid from the main pump of pump 2 is routed to the drum 1 motor. Return flow from the motor is routed back to the pump via the double diverter valve.
- With the drum 1/3 single diverter valve shifted to the drum 1 position, the single diverter valve routes hydraulic fluid from the charge pump of pump 2 to the makeup check valve for motor anti-cavitation purposes.

Drum 1 Hoisting Operation

The following conditions must be met to operate drum 1:

- Seat safety switch must be closed
- Drum 3 must be parked
- Drum 1 must be un-parked

When drum 1 joystick J3 is pulled back to hoist a load, CCM-10 control module sends a pulse-width modulated (PWM) signal to the pump 2 electronic displacement control (EDC). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the B-side of the pump. From the pump, hydraulic flow is routed through the drum 1/3 diverter valve, to the B-side of the drum 1 motor.

At the same time, the IOLC32 control module shifts the drum 1 brake release valve, allowing hydraulic fluid to flow through the valve to the brake cylinder, releasing the drum brake.

The CCM-10 control module then sends a signal to the IOLC32 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 1 motor controller. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The drum 1 motor speed sensor and the pump 2 pressure transducer provide closed-loop feedback to the controllers. The control system uses this feedback to adjust the pump and motor flow to maintain the speeds commanded by the joystick.

Neutral

When drum 1 joystick J3 is moved back to neutral, the pump swashplate shifts to neutral, stopping hydraulic flow in the closed-loop circuit. The motor swashplate then shifts to maximum displacement, and the drum 1 brake release

solenoid valve is de-energized. The de-energized solenoid valve vents hydraulic brake pressure back to the tank, allowing spring force to apply the drum brake.

Drum 1 Lowering Operation

The following conditions must be met to operate drum 1:

- Seat safety switch must be closed
- Drum 3 must be parked
- Drum 1 must be un-parked

When drum 1 joystick J3 is pushed forward to lower a load, the CCM-10 control module sends a pulse-width modulated (PWM) signal to the pump 2 electronic displacement control (EDC). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the A-side of the pump. From the pump, hydraulic flow is routed through the drum 1/3 diverter valve to the A-side of the drum 1 motor.

At the same time, the IOLC32 control module shifts the drum 1 brake release valve, allowing hydraulic fluid to flow through the valve to the brake cylinder, releasing the drum brake.

The CCM-10 control module then sends a signal to the IOLC32 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 1 motor controller. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The drum 1 motor speed sensor and the pump 2 pressure transducer provide closed-loop feedback to the controllers. The control system uses this feedback to adjust the pump and motor flow to maintain the speeds commanded by the joystick.

When needed, the makeup check valve opens to allow charge pressure fluid to enter the low pressure side of the loop, thereby maintaining a positive pressure at the motor port.

Drum 1 Loop Flushing

Loop flushing (cooling) is achieved by the continuous exchange of hydraulic fluid through the loop flushing valve. When the drum is operated in either direction, the sequence valve opens at 21 bar (300 psi), allowing hydraulic fluid from the loop to flow through the normally open poppet valve to the flow control valve. The flow control valve removes approximately 38 L/min (10 gpm) of hot hydraulic fluid from the system by discharging the exhausted hydraulic fluid into the motor case where the hydraulic fluid returns to the tank.

The accumulator in the loop flushing circuit protects the drum motor from damage due to thermal expansion during boom butt storage/transport. If the pressure in the motor increases, the pressure is captured in the accumulator.

Drum 1 Hydraulic Schematic—Hoisting

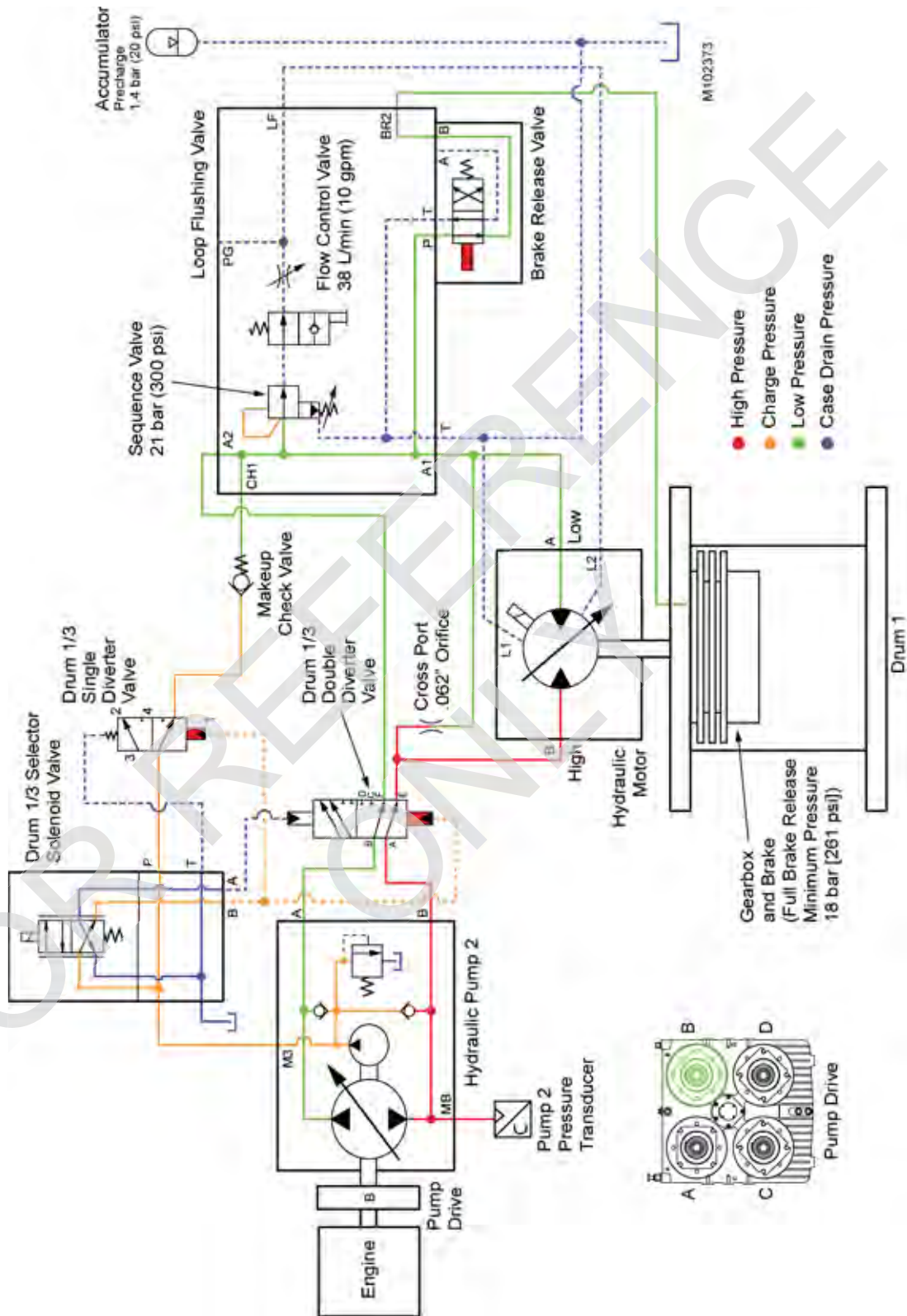
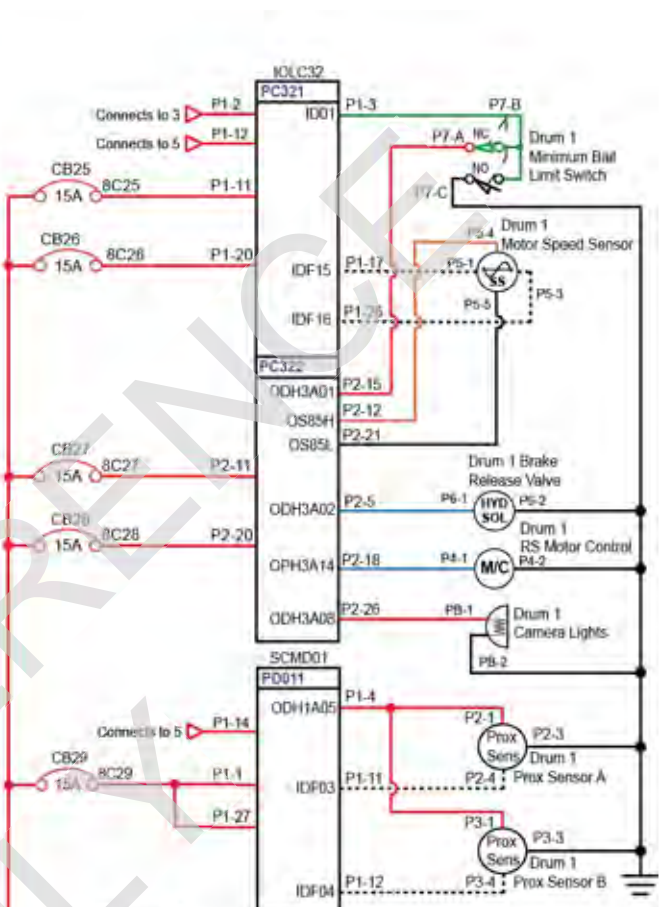
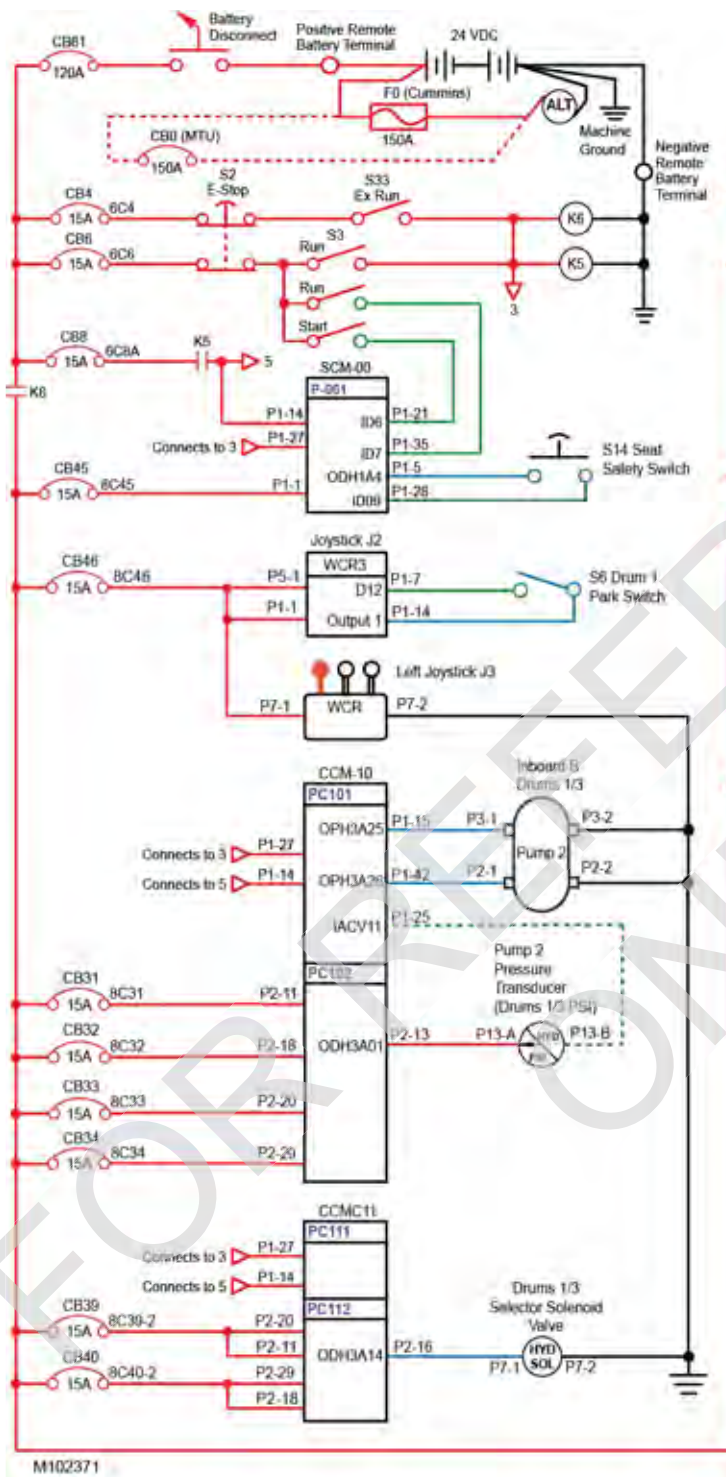


FIGURE 5-2

Drum 1 Electrical Schematic



Drum 1 CAN Bus Schematic

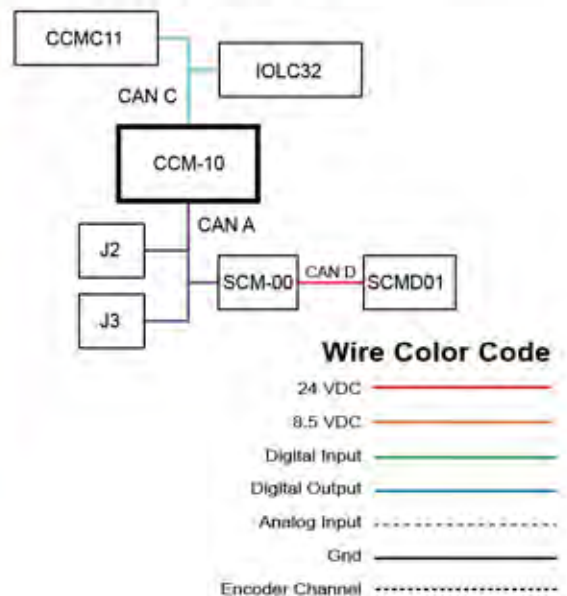


FIGURE 5-3

DRUM 2—AUXILIARY FRONT HOIST

See [Figure 5-4](#) and [Figure 5-5](#) for the following descriptions.

Drum 2 Overview

Drum 2 is powered by a closed-loop hydraulic system consisting of a variable displacement hydraulic pump and a variable displacement hydraulic motor. The cross-port orifice between the motor ports A and B assists in providing smooth drum operation.

The system contains a drum brake that applies whenever the drum is not being operated.

Drum 2 Brake Overview

A brake is attached to the input of the drum 2 gearbox located between the gearbox and the motor. The brake is controlled by joystick movement and the drum 2 park brake switch. The brake is applied by spring force and released by hydraulic pressure.

CAUTION

Possible Machine Damage!

When raising or lowering a load, do not use the drum park switch to stop the load movement, since this could cause damage to the boom. Use the joystick for a controlled smooth stop.

The brake must be fully released to allow the drum to rotate for hoisting and lowering operations. To accomplish this, the brake pressure must be above 16 bar (232 psi). Any pressure below this could cause the brakes to remain partially applied, which could damage the drum brake system.

Only when predetermined conditions are met will the control system actively release the drum brake. If hydraulic pressure or electric current is lost, spring force applies the brake, stopping the drum and holding it in position.

Drum 2 Brake Operation

UN-PARK Operation

Joystick J2 sends 24 V_{DC} to the drum 2 park switch. The park switch is closed in the UN-PARK position, causing the switch to send 24 V_{DC} back to joystick J2. Joystick J2 communicates the un-park command to the CCM-10 control module via the controller area network bus (CAN Bus).

The drum brake remains engaged until drum 2 joystick J4 is moved in either direction to hoist or lower a load. When moved, the joystick J4 communicates this information to the CCM-10 control module via the CAN Bus. When the CCM-10 control module receives both the un-park command from joystick 2 and a hoist/lower command from joystick 4, the CCM-10 control module relays the un-park command to the CCMC11 control module via the CAN Bus.

Upon receiving the un-park command, the CCMC11 control module sends 24 V_{DC} to the drum 2 brake release solenoid valve, energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the drum brake cylinder, releasing the brake.

ON-PARK Operation

When the drum 2 park switch is in the ON-PARK position, the park switch is open, sending 0 V_{DC} back to joystick J2. Joystick J2 communicates the park command to the CCM-10 control module via the CAN Bus, which then relays the command to the CCMC11 control module.

Upon receiving the park command, the CCMC11 control module sends 0 V_{DC} voltage to the drum 2 brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake cylinder to flow through the drum 2 brake release valve, then back to the tank. The reduced hydraulic pressure allows spring force to apply the drum brake.

When the drum 2 park switch is in the ON-PARK position, drum 2 joystick J4 is inoperable.

Drum 2 Hoisting Operation

The following conditions must be met to operate drum 2:

- Seat safety switch must be closed
- Drum 2 must be un-parked

When drum 2 joystick J4 is pulled back to hoist a load, the CCM-10 control module sends a pulse-width modulated (PWM) signal to the pump 1 electronic displacement control (EDC). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the B-side of the pump. From the pump, hydraulic flow is routed to the B-side of the drum 2 motor.

At the same time, the CCMC11 control module shifts the drum 2 brake release valve, allowing hydraulic fluid to flow through the valve to the brake cylinder, releasing the drum brake.

The CCM-10 control module then sends a signal to the IOLC30 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 2 motor controller. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The drum 2 motor speed sensor and the pump 1 pressure transducer provide closed-loop feedback to the controllers. The control system uses this feedback to adjust the pump and motor flows to maintain the speeds commanded by the joystick.

Neutral

When drum 2 joystick J4 is moved back to neutral, the pump swashplate shifts to neutral, stopping hydraulic flow in the closed-loop circuit.

The motor swashplate then shifts to maximum displacement and the drum 2 brake release solenoid valve is de-energized. The de-energized solenoid valve vents hydraulic brake pressure back to the tank, allowing spring force to apply the drum brake.

Drum 2 Lowering Operation

The following conditions must be met to operate drum 2:

- Seat safety switch must be closed
- Drum 2 must be un-parked

When drum 2 joystick J4 is pushed forward to lower a load, the CCM-10 control module sends a pulse-width modulated (PWM) signal to the pump 1 electronic displacement control (EDC). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the A-side of the pump. From the pump, hydraulic flow is routed to the A-side of the drum 2 motor.

At the same time, the CCMC11 control module shifts the drum 2 brake release valve, allowing hydraulic fluid to flow through the valve to the brake cylinder, releasing the drum brake.

The CCM-10 control module then sends a signal to the IOLC30 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 2 motor controller. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The drum 2 motor speed sensor and the pump 1 pressure transducer provide closed-loop feedback to the controllers. The control system uses this feedback to adjust the pump and motor flows to maintain the speeds commanded by the joystick.

When needed, the makeup check valve opens to allow charge pressure fluid to enter the low pressure side of the loop, thereby maintaining a positive pressure at the motor port.

Drum 2 Loop Flushing

Loop flushing (cooling) is achieved by the continuous exchange of hydraulic fluid through the loop flushing valve. When the drum is operated in either direction, the sequence valve opens at 21 bar (300 psi), allowing hydraulic fluid from the loop to flow through the normally open poppet valve to the flow control valve. The flow control valve removes approximately 38 L/min (10 gpm) of hot hydraulic fluid from the system by discharging the exhausted hydraulic fluid into the motor case where the hydraulic fluid returns to the tank.

The accumulator in the loop flushing circuit protects the drum motor from damage due to thermal expansion during storage/transport. If the pressure in the motor increases, the pressure is captured in the accumulator.

Drum 2 Hydraulic Schematic—Hoisting

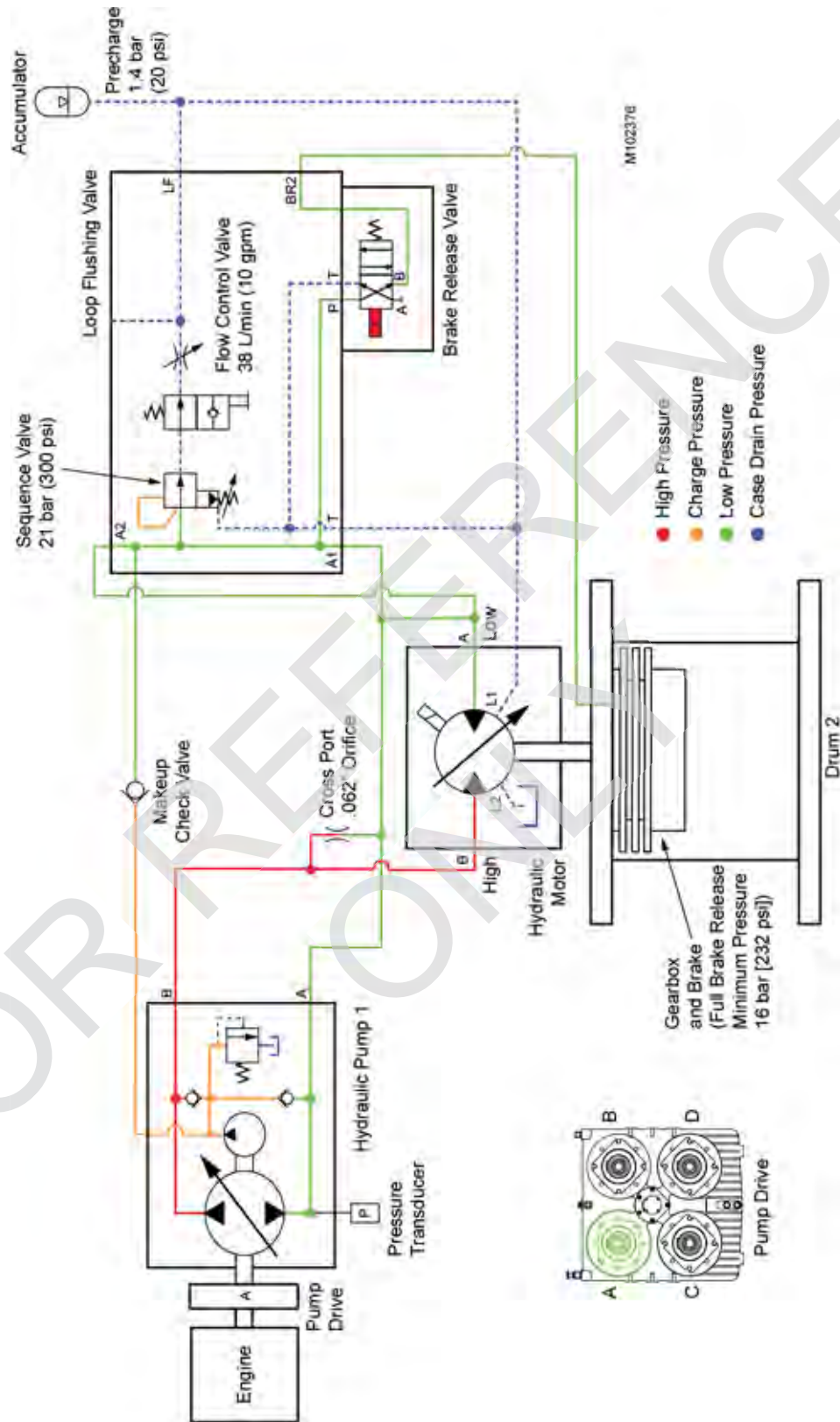
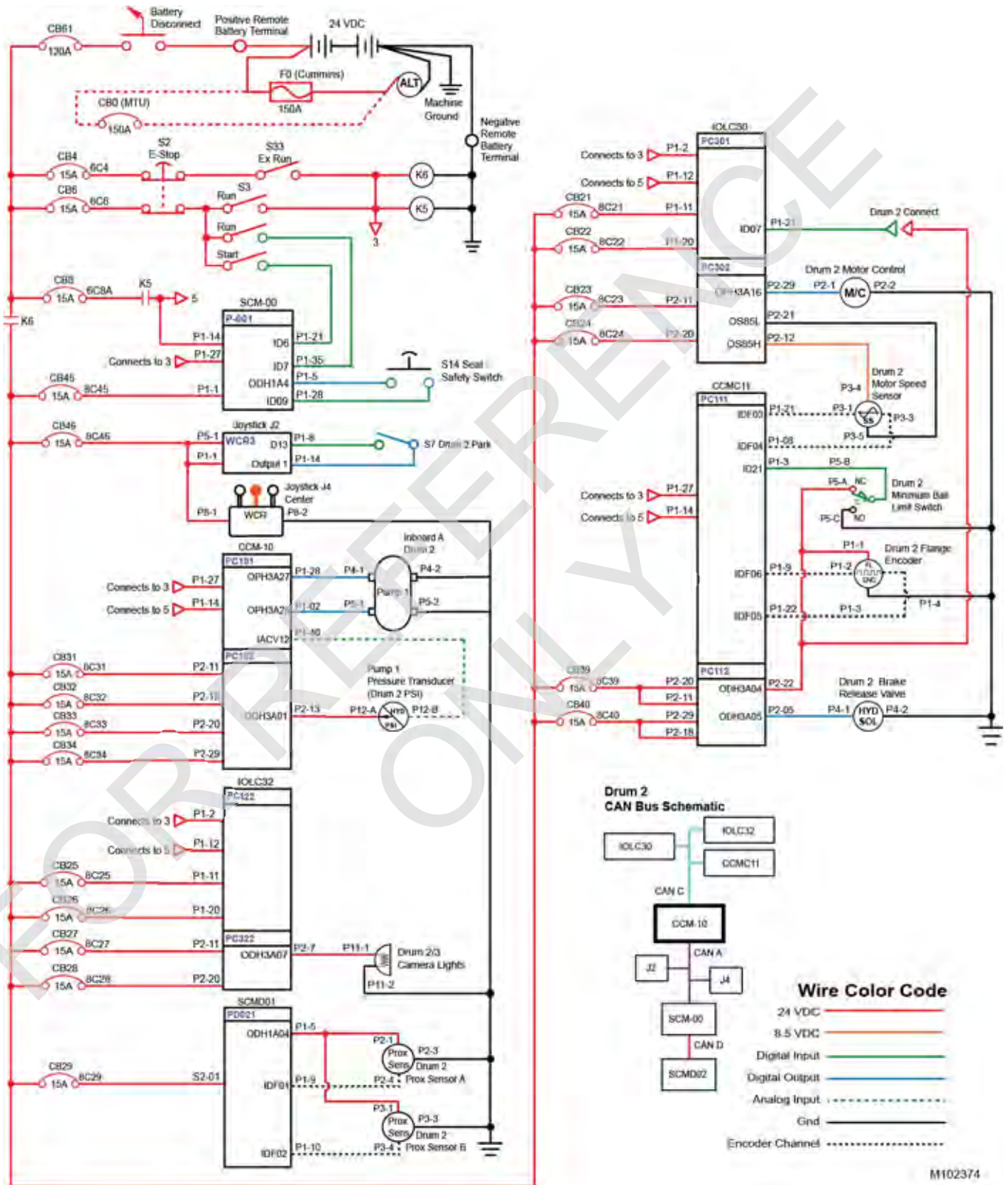


FIGURE 5-4

Drum 2 Electrical Schematic



M102374

FIGURE 5-5

DRUM 3—AUXILIARY REAR HOIST

See [Figure 5-6](#) and [Figure 5-7](#) for the following descriptions.

Drum 3 Overview

Drum 3 is powered by a closed-loop hydraulic system consisting of a variable displacement hydraulic pump and a variable displacement hydraulic motor. The cross-port orifice between the motor ports A and B assists in providing smooth drum operation.

The system contains a drum brake that applies whenever the drum is not being operated.

Drum 3 Brake Overview

A brake is attached to the input of the drum 3 gearbox located between the gearbox and the motor. The brake is controlled by joystick movement and the drum 3 park brake switch. The brake is applied by spring force and released by hydraulic pressure.

CAUTION

Possible Machine Damage!

When raising or lowering a load, do not use the drum park switch to stop the load movement, since this could cause damage to the boom. Use the joystick for a controlled smooth stop.

The brake must be fully released to allow the drum to rotate for hoisting and lowering operations. To accomplish this, the brake pressure must be above 16 bar (232 psi). Any pressure below this could cause the brakes to remain partially applied, which could damage the drum brake system.

Only when predetermined conditions are met will the control system actively release the drum brake. If hydraulic pressure or electric current is lost, spring force applies the brake, stopping the drum and holding it in position.

Drum 3 Brake Operation

UN-PARK Operation

Joystick J2 sends 24 V_{DC} to the drum 3 park switch. The park switch is closed in the UN-PARK position, causing the switch to send 24 V_{DC} back to joystick J2. Joystick J2 communicates the un-park command to the CCM-10 control module via the controller area network bus (CAN Bus).

The drum brake remains engaged until drum 3 joystick J5 is moved in either direction to hoist or lower a load.

When moved, joystick J5 communicates this information to the CCM-10 control module via the CAN Bus.

When the CCM-10 control module receives both the un-park command from joystick 2 and a hoist/lower command from joystick 5, the CCM-10 control module relays the un-park command to the CCMC11 control module via the CAN Bus.

Upon receiving the un-park command, the CCMC11 control module sends 24 V_{DC} to the drum 3 brake release solenoid valve, energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the drum brake cylinder, releasing the brake.

ON-PARK Operation

When the drum 3 park switch is in the ON-PARK position, the park switch is open, sending 0 V_{DC} back to joystick J2. Joystick J2 communicates the park command to the CCM-10 control module via the CAN Bus, which then relays the command to the CCMC11 control module.

Upon receiving the park command, the CCMC11 control module sends 0 V_{DC} voltage to the drum 3 brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake cylinder to flow through the drum 3 brake release valve, then back to the tank. The reduced hydraulic pressure allows spring force to apply the drum brake.

When the drum 3 park switch is in the ON-PARK position, joystick J5 is inoperable.

Drum 1/3 Diverting

NOTE: Drums 1 and 3 cannot be operated at the same time. The unused drum must always be parked.

The hydraulic circuits of drum 1 and drum 3 use three hydraulic valves to divert the hydraulic fluid to the motor of the selected drum. The valves are as follows:

- Drum 1/3 selector solenoid valve
- Drum 1/3 single diverter valve
- Drum 1/3 double diverter valve

When drum 1 is parked and drum 3 is un-parked, the CCMC11 control module energizes the drum 1/3 selector solenoid valve.

When the drum 1/3 selector solenoid valve is energized, the following occurs:

- The drum 1/3 selector solenoid valve routes hydraulic fluid from pump 2 to the drum 3 pilot control of the single and double drum 1/3 diverter valves, causing these valves to shift to the drum 3 position.
- With the drum 1/3 double diverter valve shifted to the drum 3 position, hydraulic fluid from the main pump of pump 2 is routed to the drum 3 motor. Return flow from the motor is routed back to the pump via the double diverter valve.
- With the drum 1/3 single diverter valve shifted to the drum 3 position, the single diverter valve routes hydraulic fluid from the charge pump of pump 2 to the makeup check valve for motor anti-cavitation purposes.

Drum 3 Hoisting Operation

The following conditions must be met to operate drum 3:

- Seat safety switch must be closed
- Drum 1 must be parked
- Drum 3 must be un-parked

When drum 3 joystick J5 is pulled back to hoist a load, the CCM-10 control module sends a pulse-width modulated (PWM) signal to the pump 2 electronic displacement control (EDC). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the B-side of the pump. From the pump, hydraulic flow is routed through the drum 1/3 diverter valve, to the B-side of the drum 3 motor.

At the same time, the CCMC11 control module shifts the drum 3 brake release valve, allowing hydraulic fluid to flow through the valve to the brake cylinder, releasing the drum brake.

The CCM-10 control module then sends a signal to the IOLC30 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 3 motor controller. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The drum 3 motor speed sensor and the pump 2 pressure transducer provide closed-loop feedback to the controllers. The control system uses this feedback to adjust the pump and motor flow to maintain the speeds commanded by the joystick.

Neutral

When drum 3 joystick J5 is moved back to neutral, the pump swashplate shifts to neutral, stopping hydraulic flow in the closed-loop circuit. The drum 3 brake release solenoid valve

is then de-energized. The de-energized solenoid valve vents hydraulic brake pressure back to tank, allowing spring force to apply the drum brake.

Drum 3 Lowering Operation

The following conditions must be met to operate drum 3:

- Seat safety switch must be closed
- Drum 1 must be parked
- Drum 3 must be un-parked

When drum 3 joystick J5 is pushed forward to lower a load, CCM-10 control module sends a PWM signal to the pump 2 EDC. The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the A-side of the pump. From the pump, hydraulic flow is routed through the drum 1/3 diverter valve, to the A-side of the drum 3 motor.

At the same time, the CCMC11 control module shifts the drum 3 brake release valve, allowing hydraulic fluid to flow through the valve to the brake cylinder, releasing the drum brake.

The CCM-10 control module then sends a signal to the IOLC30 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 3 motor controller. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The drum 3 motor speed sensor and the pump 2 pressure transducer provide closed-loop feedback to the controllers. The control system uses this feedback to adjust the pump and motor flow to maintain the speeds commanded by the joystick.

When needed, the makeup check valve opens to allow charge pressure fluid to enter the low pressure side of the loop, thereby maintaining a positive pressure at the motor port.

Drum 3 Loop Flushing

Loop flushing (cooling) is achieved by the continuous exchange of hydraulic fluid through the loop flushing valve. When the drum is operated in either direction, the sequence valve opens at 21 bar (300 psi), allowing hydraulic fluid from the loop to flow through the normally open poppet valve to the flow control valve. The flow control valve removes approximately 38 L/min (10 gpm) of hot hydraulic fluid from the system by discharging the exhausted hydraulic fluid into the motor case where the hydraulic fluid returns to the tank.

The accumulator in the loop flushing circuit protects the drum motor from damage due to thermal expansion during storage/transport. If the pressure in the motor increases, the pressure is captured in the accumulator.

Drum 3 Hydraulic Schematic—Hoisting

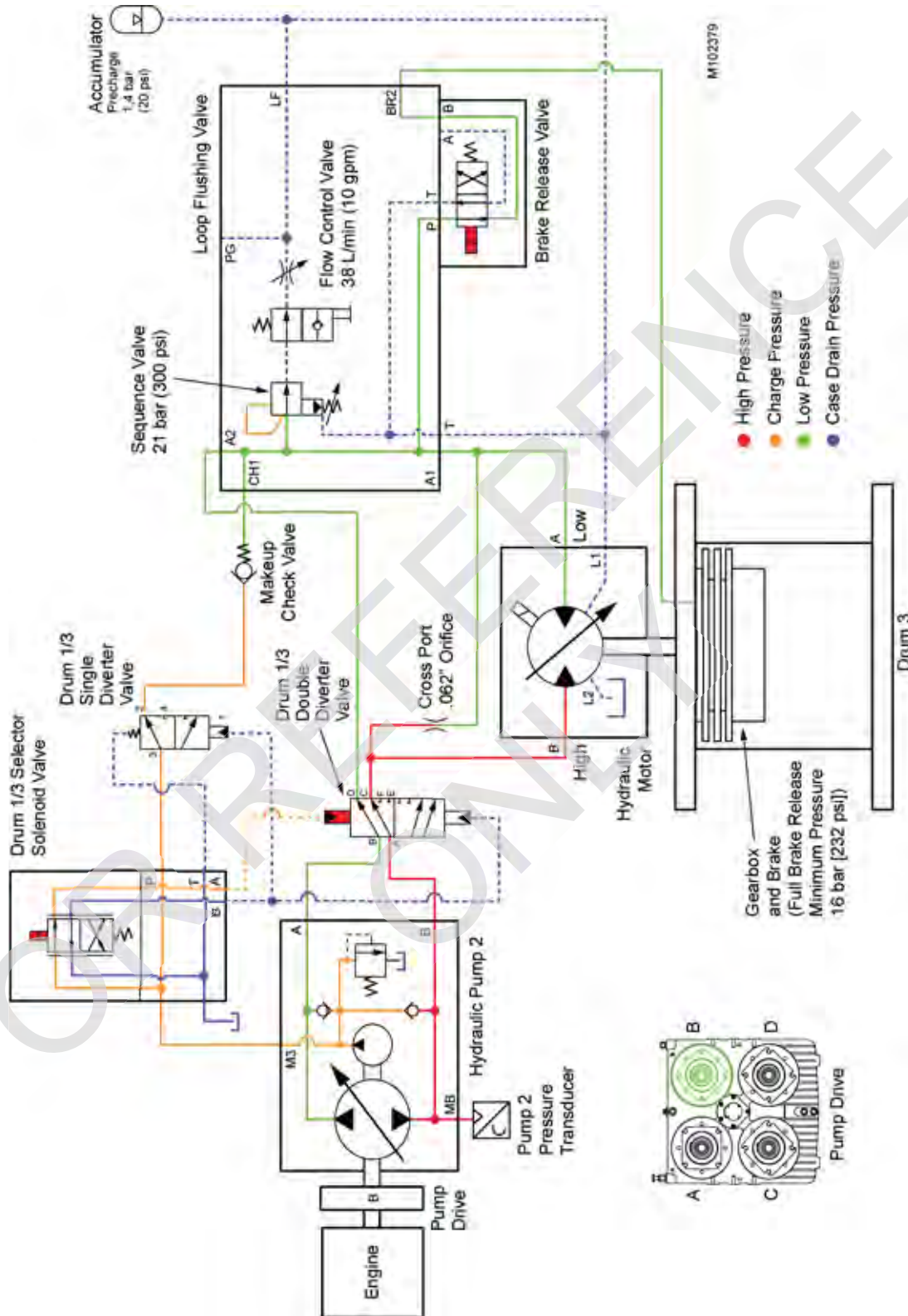


FIGURE 5-6

Drum 3 Electrical Schematic

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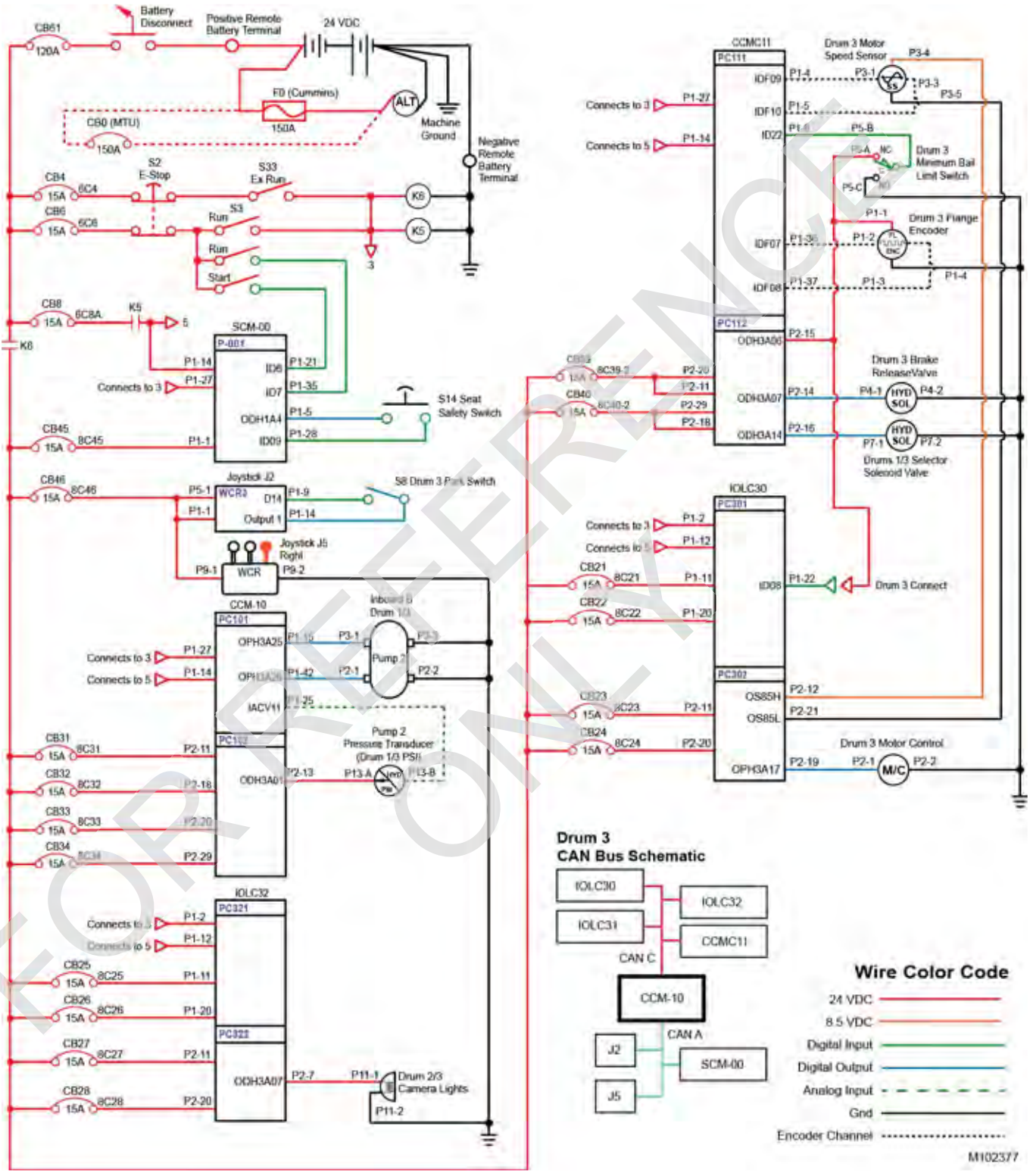


FIGURE 5-7

DRUM 4—BOOM HOIST

See [Figure 5-8](#), [Figure 5-9](#), and [Figure 5-10](#) for the following descriptions.

NOTE: The terms inboard A, inboard C, and inboard D indicate the pump locations on the pump drive (2).

System A refers to the systems controlled by the valve bank on the left side of the rotating bed. System A is also referred to as Pump System A in the MLC300 Main Display Manual.

System B refers to the systems controlled by the valve bank on the right side of the rotating bed. System B is also referred to as Pump System B in the MLC300 Main Display Manual.

Drum 4 Overview

Drum 4 (16) is powered by an open-loop hydraulic system consisting of two variable displacement hydraulic pumps (3 and 4) and one variable displacement hydraulic motor (18).

The drum 4 system contains a drum brake that applies whenever the drum is not being operated.

Drum 4 also uses a pawl that provides a mechanical stop when engaged. Pawl engagement occurs whenever the drum 4 park switch is in the PARK position.

Joystick Control

Depending on crane configuration, drum 4 can be controlled by joystick J1 on the left console or by joystick J5 on the right console. For more information, see Drum and Control Handle Identification in Section 3 of the MLC300 Operator Manual.

The following operational procedures describe joystick J1 as the controlling joystick.

Drum 4 Brake Overview

A brake is attached to the input of the drum 4 gearbox located between the gearbox and the motor. The brake is applied by spring force and released by hydraulic pressure.

The brake is controlled by joystick movement and the drum 4 park brake switch.

CAUTION

Possible Machine Damage!

When raising or lowering the boom, do not use the drum park switch to stop the boom movement, since this could cause damage to the boom. Use the joystick for a controlled smooth stop.

The pump 1 charge pump (6) provides the hydraulic pressure to release the drum brake.

The brake must be fully released to allow the drum to rotate for hoisting and lowering operations. To accomplish this, the brake pressure must be above 10.5 bar (152 psi). Any pressure below this could cause the brakes to remain partially applied, which could damage the drum brake system.

Only when predetermined conditions are met will the control system actively release the drum brake. If hydraulic pressure or electric current is lost, spring force applies the brake, stopping the drum and holding it in position.

Drum 4 Brake Operation

UN-PARK Operation

Joystick J2 sends 24 V_{DC} to the drum 4 park switch. The park switch is closed in the UN-PARK position, causing the switch to send 24 V_{DC} back to joystick J2. Joystick J2 communicates the un-park command to the CCM-10 control module via the controller area network bus (CAN Bus).

The drum brake remains engaged until drum 4 joystick J1 is moved in either direction to hoist or lower a load. When moved, joystick J1 communicates this information to the CCM-10 control module via the CAN Bus.

When the CCM-10 control module receives both the un-park command from joystick J2 and a hoist/lower command from joystick J1, the CCM-10 control module relays the un-park command to the IOLC31 control module via the CAN Bus.

Upon receiving the un-park command, the IOLC31 control module sends 24 V_{DC} to the drum 4 brake release solenoid valve (14), energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the drum brake (17) via the brake defeat valve (22), releasing the brake.

ON-PARK Operation

When the drum 4 park switch is in the ON-PARK position, the park switch is open, sending 0 V_{DC} back to joystick J2. Joystick J2 communicates the park command to the CCM-10 control module via the CAN Bus, which then relays the command to the IOLC31 control module.

Upon receiving the park command, the IOLC31 control module sends 0 V_{DC} voltage to the drum 4 brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the drum brake (17) to return to the tank via the brake defeat valve (22) and the drum 4 brake release solenoid valve (14). The reduced hydraulic pressure allows spring force to apply the drum brake.

When the drum 4 park switch is in the ON-PARK position, drum 4 joystick J1 is inoperable.

Drum 4 Pawl Control

Pawl Disengagement

When the drum 4 park switch is in the UN-PARK position, the CCM-10 control module communicates the un-park command to the IOLC31 control module via the controller area network bus (CAN Bus).

The IOLC31 control module then sends $24 V_{DC}$ to the pawl-out solenoid on the pawl valve (13), energizing the solenoid. The pawl valve shifts to the position that routes hydraulic fluid from the pump 1 charge pump (6) to the rod side of the drum pawl cylinder (15). The cylinder retracts, causing a cam to rotate and disengage the pawl from the ratchet. For more information, see [Drum 4 Pawl on page 5-30](#).

The drum 4 pawl limit switch signals the control system when the pawl is disengaged by sending $0 V_{DC}$ to the IOLC31 control module.

Pawl Engagement

When the drum 4 park switch is in the PARK position, the CCM-10 control module communicates the park command to the IOLC31 control module via the CAN Bus.

The IOLC31 control module then sends $24 V_{DC}$ to the pawl-in solenoid on the pawl solenoid valve (13), energizing the solenoid. The pawl valve shifts to the position that routes hydraulic fluid from the pump 1 charge pump (6) to the barrel side of the drum pawl cylinder (15). The cylinder extends, causing the cam to rotate in the opposite direction, allowing a spring to engage the pawl with the ratchet. For more information, see [Drum 4 Pawl on page 5-30](#).

The drum 4 pawl limit switch signals the control system when the pawl is engaged by sending $24 V_{DC}$ to the IOLC31 control module.

Drum 4 Hoisting Operation

The following conditions must be met to operate drum 4:

- Seat safety switch must be closed
- Drum 4 must be un-parked

When drum 4 joystick J1 is pulled back to raise the boom, the CCM-10 control module sends an electrical signal to the drum 4 system A control valve (8), and the CCMC11 control module sends an electrical signal to the drum 4 system B control valve (9). The control valves shift to a position that routes hydraulic fluid to the raise side of the system.

At the same time, the CCM-10 control module sends a pulse-width modulated (PWM) signal to the electronic displacement controls (EDC) on pumps 3 and 4 (3 and 4). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pumps' swashplate angle, which increases the hydraulic flow from the pumps through the B ports of the system A and system B control valves (8 and 9), then to the load-holding valve (12) on the B side of the hydraulic motor (18).

In the holding valve, the hydraulic fluid flows through a check valve, then to the B port on the motor, causing the motor to attempt to turn the drum.

At the same time, the IOLC31 control module sends $24 V_{DC}$ to the brake release solenoid valve (14), energizing the solenoid. The brake valve shifts to a position that routes hydraulic fluid from the pump 1 charge pump (6) to the brake defeat valve (22). Hydraulic pressure created by the pressure-reducing valve (23) on the A side of the motor shifts the brake defeat valve (22). This allows the hydraulic fluid from the brake release solenoid valve to flow to the drum brake (17), releasing the brake.

As the motor starts to rotate, hydraulic pressure on the A side of the motor opens the sequence valve (25), allowing return hydraulic fluid to flow back to the tank via the drum 4 system A and system B control valves. This allows the drum to turn in the direction that raises the boom.

The CCM-10 control module then sends a signal to the IOLC31 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 4 motor controller. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The following sensors provide feedback to the controllers:

- Drum 4 Motor Speed Sensor
- Pump 3 Pressure Transducer (pump 3 system B psi)
- Pump 4 Pressure Transducer (pump 4 system A psi)
- Drum 4 Motor Pressure Transducer (drum 4 motor psi)
- Drum 4 System A Pressure Transducer (system A manifold psi)
- Drum 4 System B Pressure Transducer (system B manifold psi)

The control system uses this feedback to adjust the pump and motor flow to maintain the speeds commanded by drum 4 joystick J1.

Neutral

When drum 4 joystick J1 is moved back to neutral, the pump swashplate shifts to neutral, stopping hydraulic flow in the open-loop circuit.

The motor swashplate will then go to minimum displacement, and the drum 4 brake release solenoid valve (14) de-energizes, opening a return path to the tank. The brake pressure vents to the tank via the brake defeat valve (22) and the brake release solenoid valve, allowing spring force to apply the drum brake (17).

When in neutral, the load-holding valve (12) closes to block oil flow from the hydraulic motor (18).

If hydraulic pressure is lost on the low-pressure side of the hydraulic motor during operation, the brake defeat valve closes, venting the drum brake pressure directly to the tank. This allows the drum brake to immediately apply to stop the drum.

Drum 4 Lowering Operation

The following conditions must be met to operate drum 4:

- Seat safety switch must be closed
- Drum 4 must be un-parked

When the drum 4 joystick J1 is pushed forward to lower the boom, the CCM-10 control module sends an electrical signal to the drum 4 system A control valve (8), and the CCMC11 control module sends an electrical signal to the drum 4 system B control valve (9). The control valves shift to a position that routes hydraulic fluid to the lower hoist side of the system.

The CCM-10 control module then sends a pulse-width modulated (PWM) signal to the electronic displacement controls (EDC) on pumps 3 and 4 (3 and 4). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pumps' swashplate angle, which increases the hydraulic flow from the pumps through the A ports of the system A and system B control valves (8 and 9), then to the sequence valve (25) on the A side of the hydraulic motor (18).

The oil flows through the check valve in the sequence valve to the A port of the hydraulic motor, causing the motor to attempt to turn the drum.

At the same time, the IOLC31 control module sends 24 V_{DC} to the brake release solenoid valve (14), energizing the solenoid. The brake valve shifts to a position that routes hydraulic fluid from the pump 1 charge pump (6) to the brake defeat valve (22). Hydraulic pressure on the A side of the motor shifts the brake defeat valve. This allows the hydraulic fluid from the brake release solenoid valve to flow to the drum brake (17), releasing the brake.

As the motor starts to rotate, hydraulic pressure on the B side of the motor shifts the load holding-valve (12) to the open position, which meters the return hydraulic fluid as it flows back to the tank via the drum 4 system A and system B control valves. This allows the drum to turn in the direction that lowers the boom.

The CCM-10 control module then sends a signal to the IOLC31 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 4 motor controller. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The following sensors provide feedback to the controllers:

- Drum 4 Motor Speed Sensor
- Pump 3 Pressure Transducer (pump 3 system B psi)
- Pump 4 Pressure Transducer (pump 4 system A psi)
- Drum 4 Motor Pressure Transducer (drum 4 motor psi)
- Drum 4 System A Pressure Transducer (system A manifold psi)
- Drum 4 System B Pressure Transducer (system B manifold psi)

The control system uses this feedback to adjust the pump and motor flow to maintain the speeds commanded by drum 4 joystick J1.

Brake Defeat Valve

When the hydraulic system is operating properly, the pressure on the A side of the motor should always be above 5 bar (73 psi).

The brake defeat valve (22) overrides the brake release solenoid valve (14) to do the following:

- Prevent the brake from releasing (when applied) if pressure on the A side of the motor is below 5 bar (73 psi)
- Apply the brake (when released) if pressure on the A side of the motor drops below 5 bar (73 psi)

High Pressure Protection

The relief valve (10) protects the hydraulic pump (3) and motor (18) from a pressure spike such as might occur when bringing the boom to a sudden stop. The relief valve is factory set at the specified pressure.

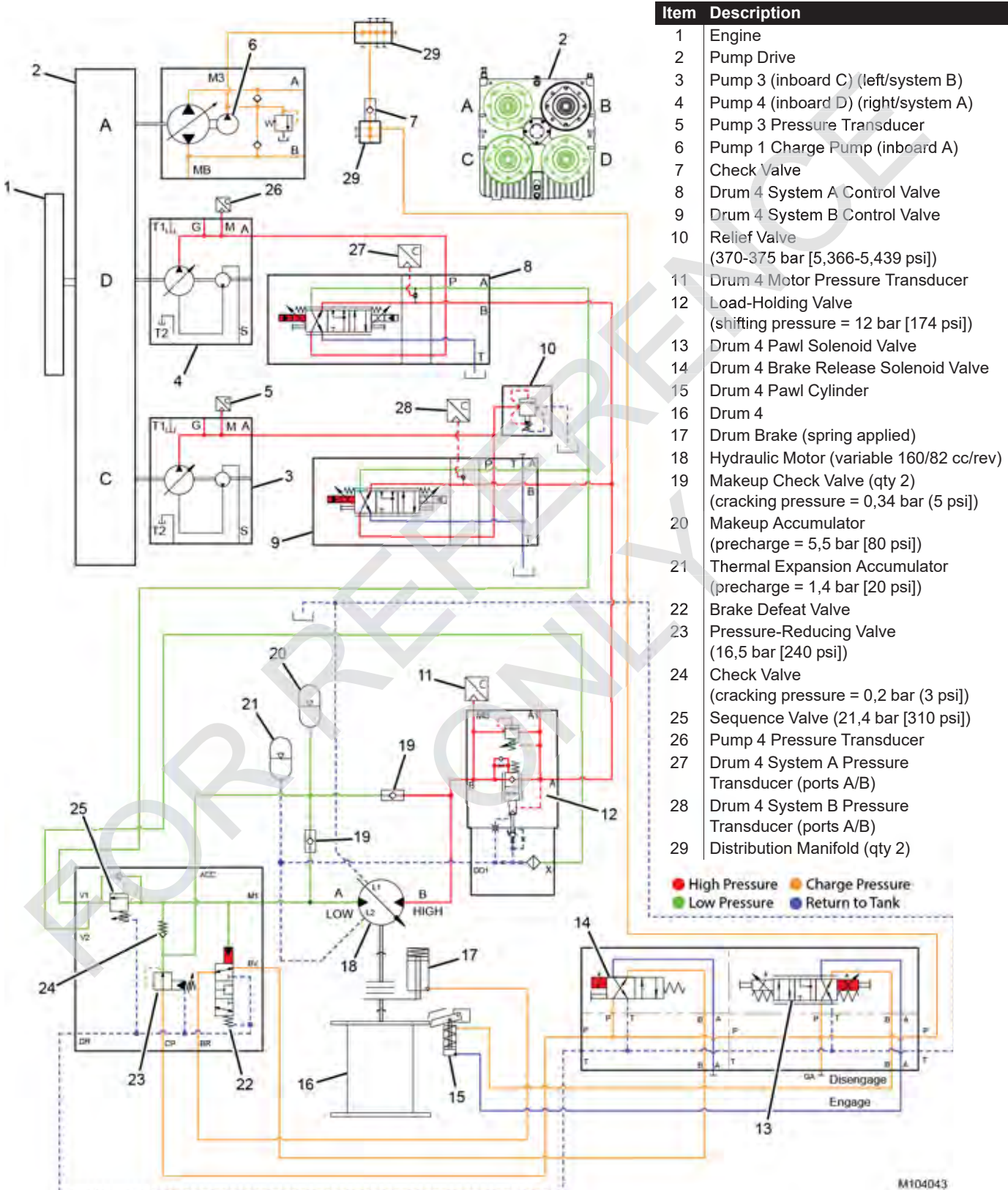
Drum 4 Cavitation Protection

When needed, the makeup check valves (19) open to allow fluid stored in the makeup accumulator (20) to enter the low-pressure side of the system, thereby maintaining a positive pressure at the motor A port.

Drum 4 Motor Case Protection

The thermal expansion accumulator (21) connected to the motor case protects the motor from damage due to thermal expansion during drum storage/transport. If the pressure in the motor increases, the pressure is captured in the accumulator.

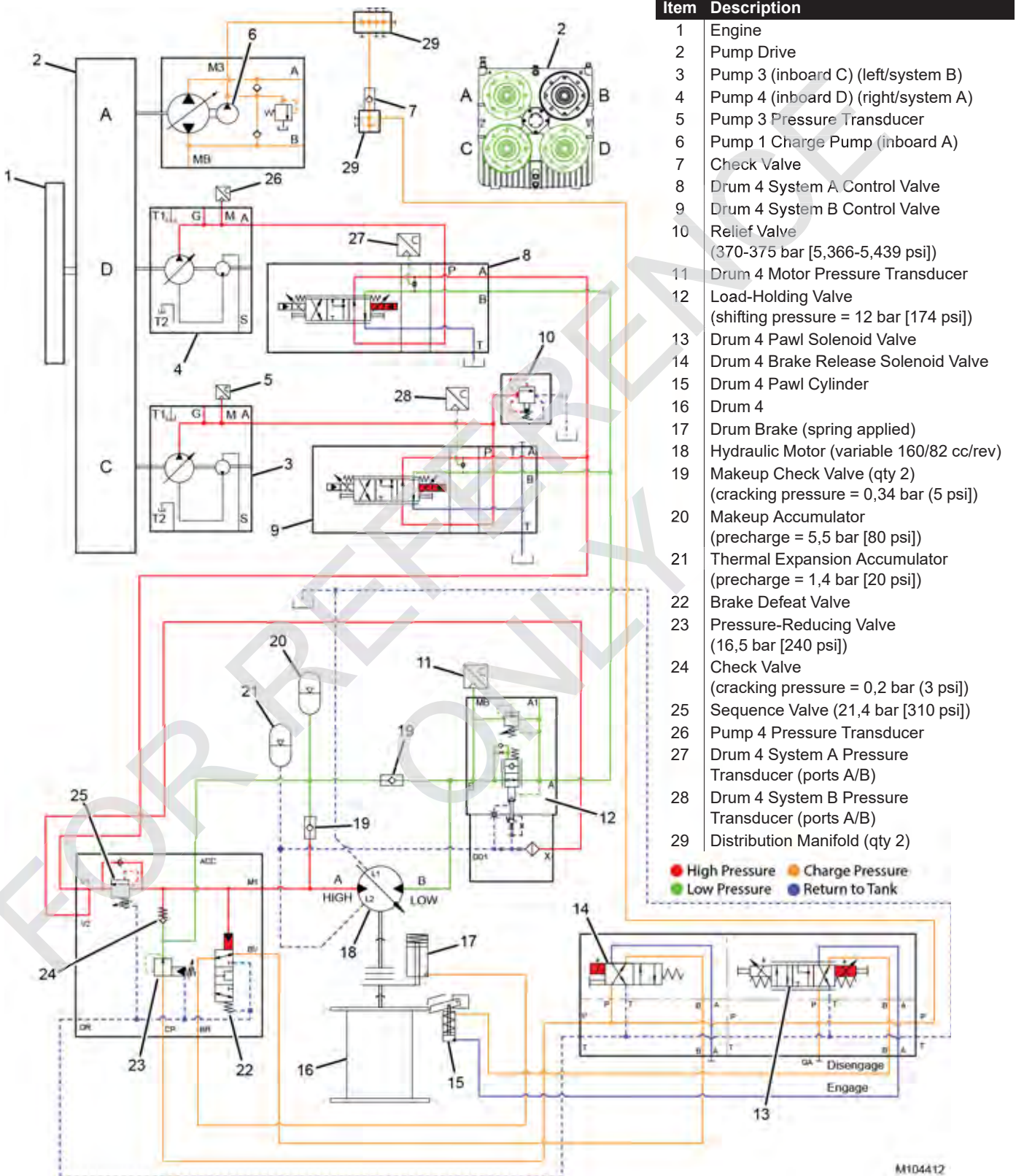
Drum 4 Hydraulic Schematic—Hoisting



Item	Description
1	Engine
2	Pump Drive
3	Pump 3 (inboard C) (left/system B)
4	Pump 4 (inboard D) (right/system A)
5	Pump 3 Pressure Transducer
6	Pump 1 Charge Pump (inboard A)
7	Check Valve
8	Drum 4 System A Control Valve
9	Drum 4 System B Control Valve
10	Relief Valve (370-375 bar [5,366-5,439 psi])
11	Drum 4 Motor Pressure Transducer
12	Load-Holding Valve (shifting pressure = 12 bar [174 psi])
13	Drum 4 Pawl Solenoid Valve
14	Drum 4 Brake Release Solenoid Valve
15	Drum 4 Pawl Cylinder
16	Drum 4
17	Drum Brake (spring applied)
18	Hydraulic Motor (variable 160/82 cc/rev)
19	Makeup Check Valve (qty 2) (cracking pressure = 0,34 bar (5 psi))
20	Makeup Accumulator (precharge = 5,5 bar [80 psi])
21	Thermal Expansion Accumulator (precharge = 1,4 bar [20 psi])
22	Brake Defeat Valve
23	Pressure-Reducing Valve (16,5 bar [240 psi])
24	Check Valve (cracking pressure = 0,2 bar (3 psi))
25	Sequence Valve (21,4 bar [310 psi])
26	Pump 4 Pressure Transducer
27	Drum 4 System A Pressure Transducer (ports A/B)
28	Drum 4 System B Pressure Transducer (ports A/B)
29	Distribution Manifold (qty 2)

M104043
FIGURE 5-8

Drum 4 Hydraulic Schematic—Lowering



Item	Description
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- 1 Engine
- 2 Pump Drive
- 3 Pump 3 (inboard C) (left/system B)
- 4 Pump 4 (inboard D) (right/system A)
- 5 Pump 3 Pressure Transducer
- 6 Pump 1 Charge Pump (inboard A)
- 7 Check Valve
- 8 Drum 4 System A Control Valve
- 9 Drum 4 System B Control Valve
- 10 Relief Valve (370-375 bar [5,366-5,439 psi])
- 11 Drum 4 Motor Pressure Transducer
- 12 Load-Holding Valve (shifting pressure = 12 bar [174 psi])
- 13 Drum 4 Pawl Solenoid Valve
- 14 Drum 4 Brake Release Solenoid Valve
- 15 Drum 4 Pawl Cylinder
- 16 Drum 4
- 17 Drum Brake (spring applied)
- 18 Hydraulic Motor (variable 160/82 cc/rev)
- 19 Makeup Check Valve (qty 2) (cracking pressure = 0,34 bar (5 psi))
- 20 Makeup Accumulator (precharge = 5,5 bar [80 psi])
- 21 Thermal Expansion Accumulator (precharge = 1,4 bar [20 psi])
- 22 Brake Defeat Valve
- 23 Pressure-Reducing Valve (16,5 bar [240 psi])
- 24 Check Valve (cracking pressure = 0,2 bar (3 psi))
- 25 Sequence Valve (21,4 bar [310 psi])
- 26 Pump 4 Pressure Transducer
- 27 Drum 4 System A Pressure Transducer (ports A/B)
- 28 Drum 4 System B Pressure Transducer (ports A/B)
- 29 Distribution Manifold (qty 2)

● High Pressure ● Charge Pressure
● Low Pressure ● Return to Tank

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FIGURE 5-9

Drum 4 Electrical Schematic

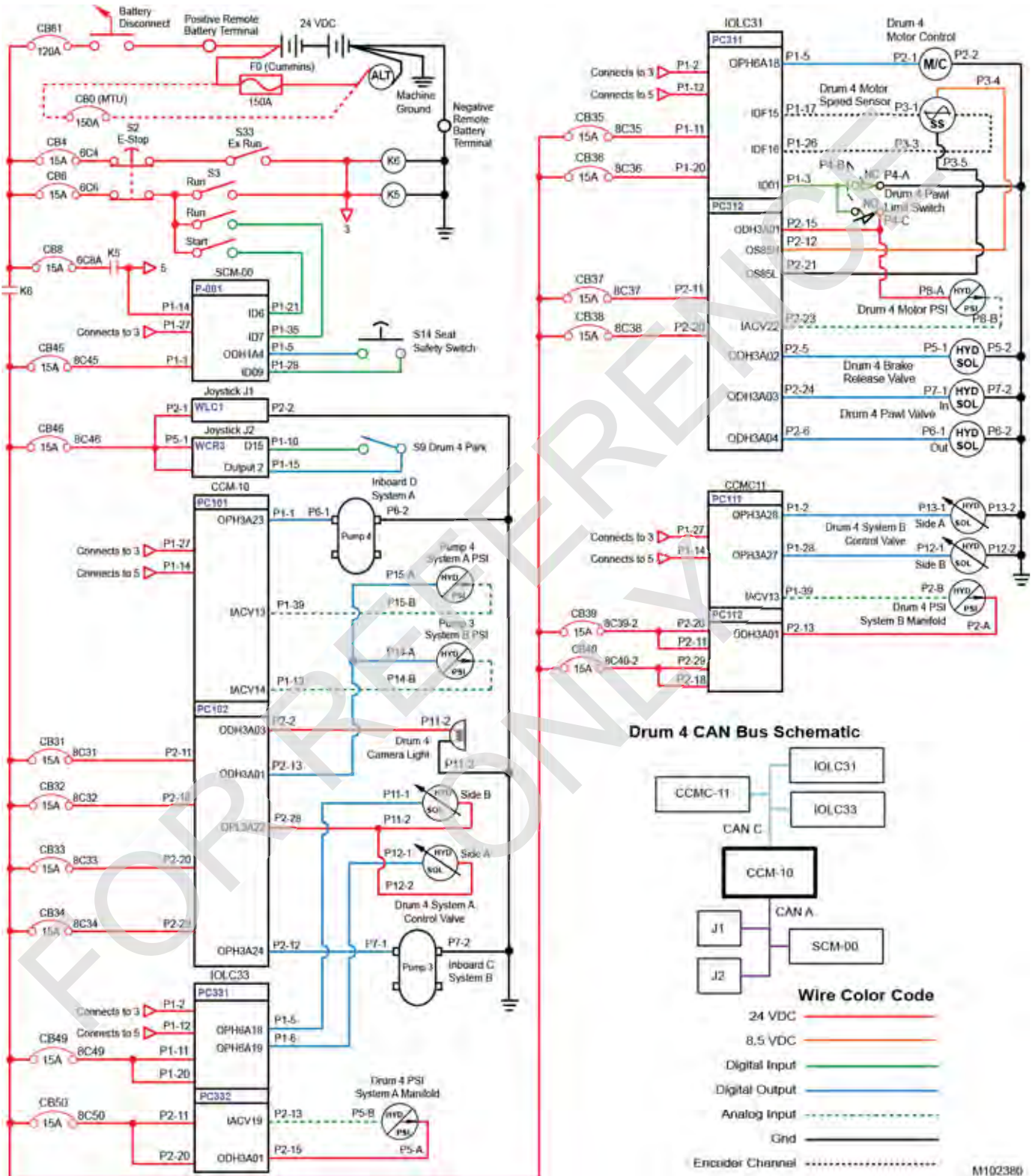


FIGURE 5-10

DRUM 6—AUXILIARY HOIST

See [Figure 5-11](#), [Figure 5-12](#), and [Figure 5-13](#) for the following descriptions.

NOTE: The terms inboard C and inboard A indicate the pump locations on the pump drive (2).

System B refers to the systems controlled by the valve bank on the right side of the rotating bed. System B is also referred to as Pump System B in the MLC300 Main Display Manual.

Drum 6 is primarily used as the luffing jib hoist, but it can be used as an auxiliary load hoist.

Drum 6 Overview

Drum 6 (13) is powered by an open-loop hydraulic system consisting of one variable displacement hydraulic pump (3) and one variable displacement hydraulic motor (15).

The drum 6 system contains a drum brake that applies whenever the drum is not being operated.

Drum 6 also uses a pawl that provides a mechanical stop when engaged. Pawl engagement occurs whenever the drum 6 park switch is in the PARK position.

Joystick Control

Depending on crane configuration, drum 6 can be controlled by joystick J1 on the left console or by joystick J5 on the right console. For more information, see Drum and Control Handle Identification in Section 3 of the MLC300 Operator Manual.

The following operational procedures describe joystick J1 as the controlling joystick.

Drum 6 Brake Overview

A brake is attached to the input of the drum 6 gearbox located between the gearbox and the motor. The brake is applied by spring force and released by hydraulic pressure.

The brake is controlled by joystick movement and the drum 6 park brake switch.

CAUTION

Possible Machine Damage!

When raising or lowering the boom, do not use the drum park switch to stop the boom movement, since this could cause damage to the boom. Use the joystick for a controlled smooth stop.

The charge pressure from the pump 1 charge pump (5) provides the hydraulic pressure to release the drum brake.

The brake must be fully released to allow the drum to rotate for hoisting and lowering operations. To accomplish this, the brake pressure must be above 10.5 bar (152 psi). Any pressure below this could cause the brakes to remain partially applied, which could damage the drum brake system.

Only when predetermined conditions are met will the control system actively release the drum brake. If hydraulic pressure or electric current is lost, spring force applies the brake, stopping the drum and holding it in position.

Drum 6 Brake Operation

UN-PARK Operation

Joystick J2 sends 24 V_{DC} to the drum 6 park switch. The park switch is closed in the UN-PARK position, causing the switch to send 24 V_{DC} back to joystick J2. Joystick J2 communicates the un-park command to the CCM-10 control module via the controller area network bus (CAN Bus).

The drum brake remains engaged until drum 6 joystick J1 is moved in either direction to hoist or lower a load. When moved, joystick J1 communicates this information to the CCM-10 control module via the CAN Bus.

When the CCM-10 control module receives both the un-park command from joystick 2 and a hoist/lower command from joystick 1, the CCM-10 control module relays the un-park command to the IOLC33 control module via the CAN Bus.

Upon receiving the un-park command, the IOLC33 control module sends 24 V_{DC} to the drum 6 brake release solenoid valve (11), energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the drum brake (14) via the brake defeat valve (19), releasing the brake.

ON-PARK Operation

When the drum 6 park switch is in the ON-PARK position, the park switch is open, sending 0 V_{DC} back to joystick J2. Joystick J2 communicates the park command to the CCM-10 control module via the CAN Bus, which then relays the command to the IOLC33 control module.

Upon receiving the park command, the IOLC33 control module sends 0 V_{DC} to the drum 6 brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the drum brake (14) to return to the tank via the brake defeat valve (19) and the drum 6 brake release solenoid valve (11). The reduced hydraulic pressure allows spring force to apply the drum brake.

When the drum 6 park switch is in the ON-PARK position, drum 6 joystick J1 is inoperable.

Drum 6 Pawl Control

Pawl Disengagement

When the drum 6 park switch is in the UN-PARK position, the CCM-10 control module communicates the un-park command to the IOLC33 control module via the controller area network bus (CAN Bus).

The IOLC33 control module then sends $24 V_{DC}$ to the pawl-out solenoid on the pawl valve (10), energizing the solenoid. The pawl valve shifts to the position that routes hydraulic fluid from the pump 1 charge pump (5) to the rod side of the drum pawl cylinder (12). The cylinder retracts, causing a cam to rotate and disengage the pawl from the ratchet. For more information, see [Drum 6 Pawl on page 5-32](#).

The drum 6 pawl limit switch signals the control system when the pawl is disengaged by sending $0 V_{DC}$ to the IOLC33 control module.

Pawl Engagement

When the drum 6 park switch is in the PARK position, the CCM-10 control module communicates the park command to the IOLC33 control module via the CAN Bus.

The IOLC33 control module then sends $24 V_{DC}$ to the pawl-in solenoid on the pawl valve (10), energizing the solenoid. The pawl valve shifts to the position that routes hydraulic fluid from the pump 1 charge pump (5) to the barrel side of the drum pawl cylinder (12). The cylinder extends, causing the cam to rotate in the opposite direction, allowing a spring to engage the pawl with the ratchet. For more information, see [Drum 6 Pawl on page 5-32](#).

The drum 6 pawl limit switch signals the control system when the pawl is engaged by sending $24 V_{DC}$ to the IOLC33 control module.

Drum 6 Hoisting Operation

The following conditions must be met to operate drum 6:

- Seat safety switch must be closed
- Drum 6 must be un-parked

When drum 6 joystick J1 is pulled back to raise the luffing jib, the CCMC11 control module sends an electrical signal to the drum 6 system B control valve (7). The control valve shifts to a position that routes hydraulic fluid to the raise side of the system.

The CCM-10 control module then sends a pulse-width modulated (PWM) signal to the electronic displacement control (EDC) on pump 3 (3). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump's swashplate angle, which increases the hydraulic flow from the pump through the A port of the drum 6 system B control valve (7), then to the load-holding valve (9) on the B side of the hydraulic motor (15).

In the load-holding valve, the hydraulic fluid flows through a check valve, then to the B port on the motor, causing the motor to attempt to turn the drum.

At the same time, the IOLC33 control module sends $24 V_{DC}$ to the brake release solenoid valve (11), energizing the solenoid. The brake valve shifts to a position that routes hydraulic fluid from the pump 1 charge pump (5) to the brake defeat valve (19). Hydraulic pressure created by the pressure-reducing valve (20) on the A side of the motor shifts the brake defeat valve (19). This allows the hydraulic fluid from the brake release solenoid valve to flow to the drum brake (14), releasing the brake.

As the motor starts to rotate, pressure on the A side of the motor opens the sequence valve (22), allowing return hydraulic fluid to flow back to the tank via the drum 6 system B control valve. This allows the drum to turn in the direction that raises the luffing jib.

The CCM-10 control module then sends a signal to the IOLC32 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 6 motor controller. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The following sensors provide feedback to the controllers:

- Drum 6 Motor Speed Sensor
- Pump 3 Pressure Transducer (pump 3 system B psi)
- Drum 6 Motor Pressure Transducer (drum 6 motor psi)
- Drum 6 System B Pressure Transducer (system B manifold psi)

The control system uses this feedback to adjust the pump and motor flow to maintain the speeds commanded by drum 6 joystick J1.

Neutral

When drum 6 joystick J1 is moved back to neutral, the pump swashplate shifts to neutral, stopping hydraulic flow in the open-loop circuit. The motor swashplate then goes to maximum displacement, and the drum 6 brake release solenoid valve (11) de-energizes, opening a return path to the tank. The brake pressure vents to the tank via the brake defeat valve (19) and the brake release solenoid valve, allowing spring force to apply the drum brake (14).

When in neutral, the load-holding valve (9) closes to block oil flow from the hydraulic motor (15).

If hydraulic pressure is lost on the low-pressure side of the hydraulic motor during operation, the brake defeat valve closes, venting the drum brake pressure directly to the tank. This allows the drum brake to immediately apply to stop the drum.

Drum 6 Lowering Operation

The following conditions must be met to operate drum 6:

- Seat safety switch must be closed
- Drum 6 must be un-parked

When drum 6 joystick J1 is pushed forward to lower the luffing jib, the CCMC11 control module sends an electrical signal to the drum 6 system B control valve (7). The control valve shifts to a position that routes hydraulic fluid to the lower side of the system.

The CCM-10 control module then sends a pulse-width modulated (PWM) signal to the electronic displacement control (EDC) on pump 3 (3). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump's swashplate angle, which increases the hydraulic flow from the pump through the B port of the drum 6 system B control valve (7), then to the sequence valve (22) on the A side of the hydraulic motor (15).

The oil flows through the check valve in the sequence valve to the A port of the hydraulic motor, causing the motor to attempt to turn the drum.

At the same time, the IOLC33 control module sends 24 V_{DC} to the brake release solenoid valve (11), energizing the solenoid. The brake valve shifts to a position that routes hydraulic fluid from the pump 1 charge pump (5) to the brake defeat valve (19). Hydraulic pressure on the A side of the motor shifts the brake defeat valve (19). This allows the hydraulic fluid to flow from the brake release solenoid valve to the drum brake (14), releasing the brake.

As the motor starts to rotate, hydraulic pressure on the B side of the motor shifts the load-holding valve (9) to the open position, allowing the load-holding valve to meter the return hydraulic fluid as it flows back to the tank via the drum 6

system B control valve. This allows the drum to turn in the direction that lowers the luffing jib.

The CCM-10 control module then sends a signal to the IOLC32 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 6 motor controller. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The following sensors provide feedback to the controllers:

- Drum 6 Motor Speed Sensor
- Pump 3 Pressure Transducer (pump 3 system B psi)
- Drum 6 Motor Pressure Transducer (drum 6 motor psi)
- Drum 6 System B Pressure Transducer (system B manifold psi)

The control system uses this feedback to adjust the pump and motor flow to maintain the speeds commanded by drum 6 joystick J1.

Brake Defeat Valve

When the hydraulic system is operating properly, the pressure on the A side of the motor should always be above 5 bar (73 psi).

The brake defeat valve (19) overrides the brake release solenoid valve (11) to do the following:

- Prevent the brake from releasing (when applied) if pressure on the A side of the motor is below 5 bar (73 psi)
- Apply the brake (when released) if pressure on the A side of the motor drops below 5 bar (73 psi)

High Pressure Protection

The relief valve (8) protects the hydraulic pump 3 (3) and motor (15) from a pressure spike such as might occur when bringing the boom to a sudden stop. The valve is factory set at the specified pressure.

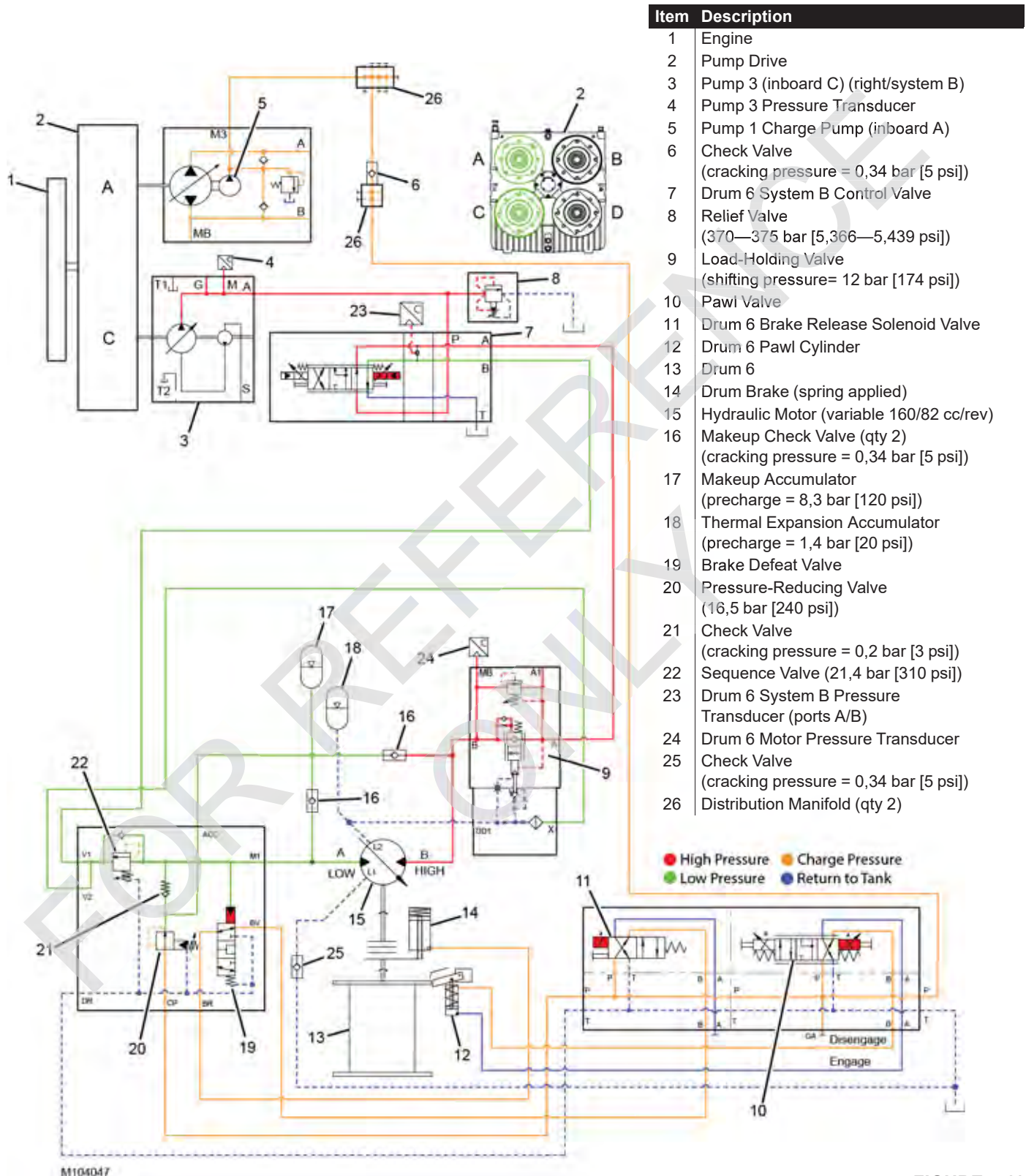
Drum 6 Cavitation Protection

When needed, the makeup check valves (16) open to allow fluid stored in the makeup accumulator (17) to enter the low-pressure side of the system, thereby maintaining a positive pressure at the motor A port.

Drum 6 Motor Case Protection

The accumulator (18) connected to the motor case protects the motor from damage due to thermal expansion during drum storage/transport. If the pressure in the motor increases, the pressure is captured in the accumulator.

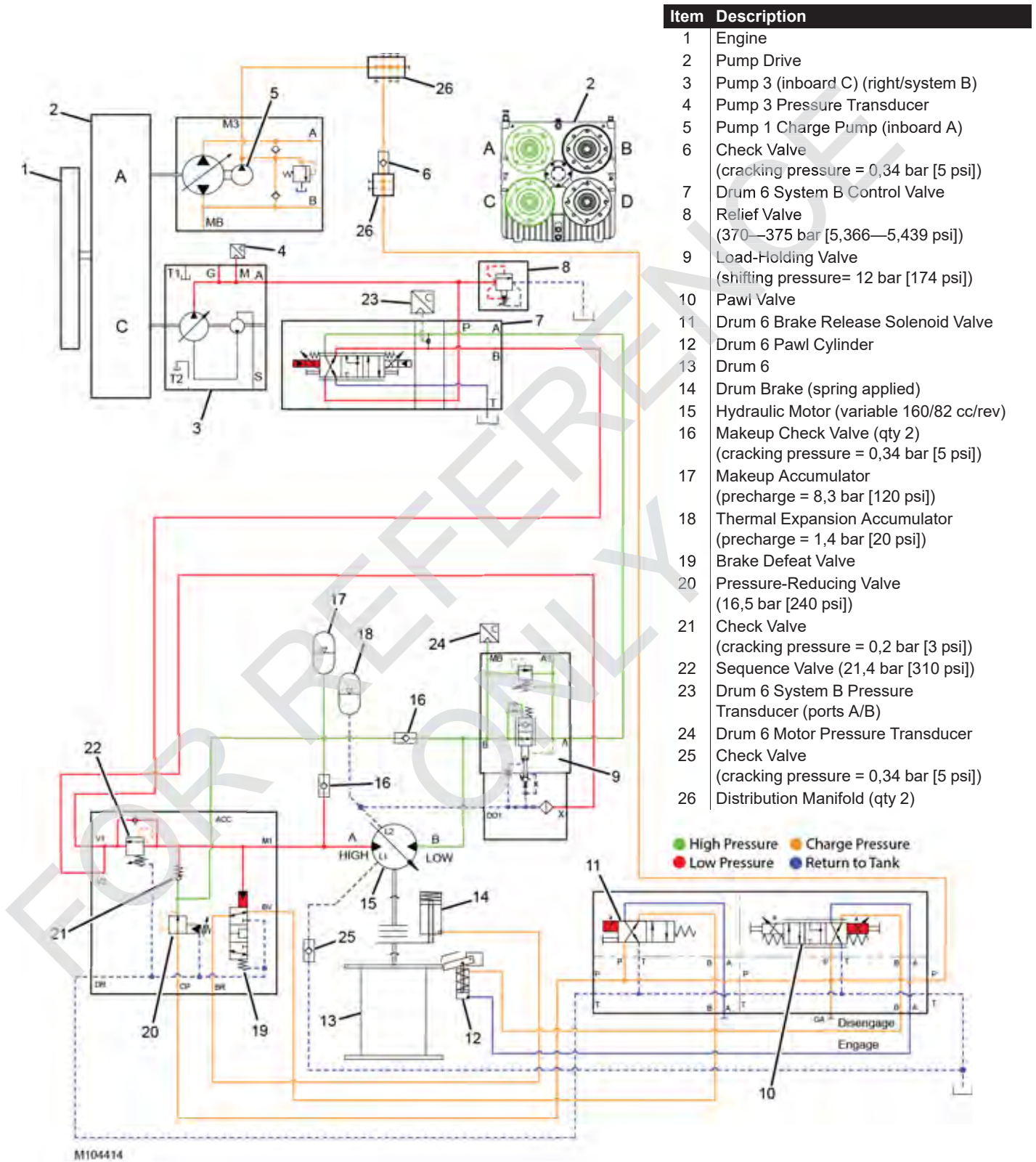
Drum 6 Hydraulic Schematic—Hoisting



Item	Description
1	Engine
2	Pump Drive
3	Pump 3 (inboard C) (right/system B)
4	Pump 3 Pressure Transducer
5	Pump 1 Charge Pump (inboard A)
6	Check Valve (cracking pressure = 0,34 bar [5 psi])
7	Drum 6 System B Control Valve
8	Relief Valve (370—375 bar [5,366—5,439 psi])
9	Load-Holding Valve (shifting pressure= 12 bar [174 psi])
10	Pawl Valve
11	Drum 6 Brake Release Solenoid Valve
12	Drum 6 Pawl Cylinder
13	Drum 6
14	Drum Brake (spring applied)
15	Hydraulic Motor (variable 160/82 cc/rev)
16	Makeup Check Valve (qty 2) (cracking pressure = 0,34 bar [5 psi])
17	Makeup Accumulator (precharge = 8,3 bar [120 psi])
18	Thermal Expansion Accumulator (precharge = 1,4 bar [20 psi])
19	Brake Defeat Valve
20	Pressure-Reducing Valve (16,5 bar [240 psi])
21	Check Valve (cracking pressure = 0,2 bar [3 psi])
22	Sequence Valve (21,4 bar [310 psi])
23	Drum 6 System B Pressure Transducer (ports A/B)
24	Drum 6 Motor Pressure Transducer
25	Check Valve (cracking pressure = 0,34 bar [5 psi])
26	Distribution Manifold (qty 2)

FIGURE 5-11

Drum 6 Hydraulic Schematic—Lowering

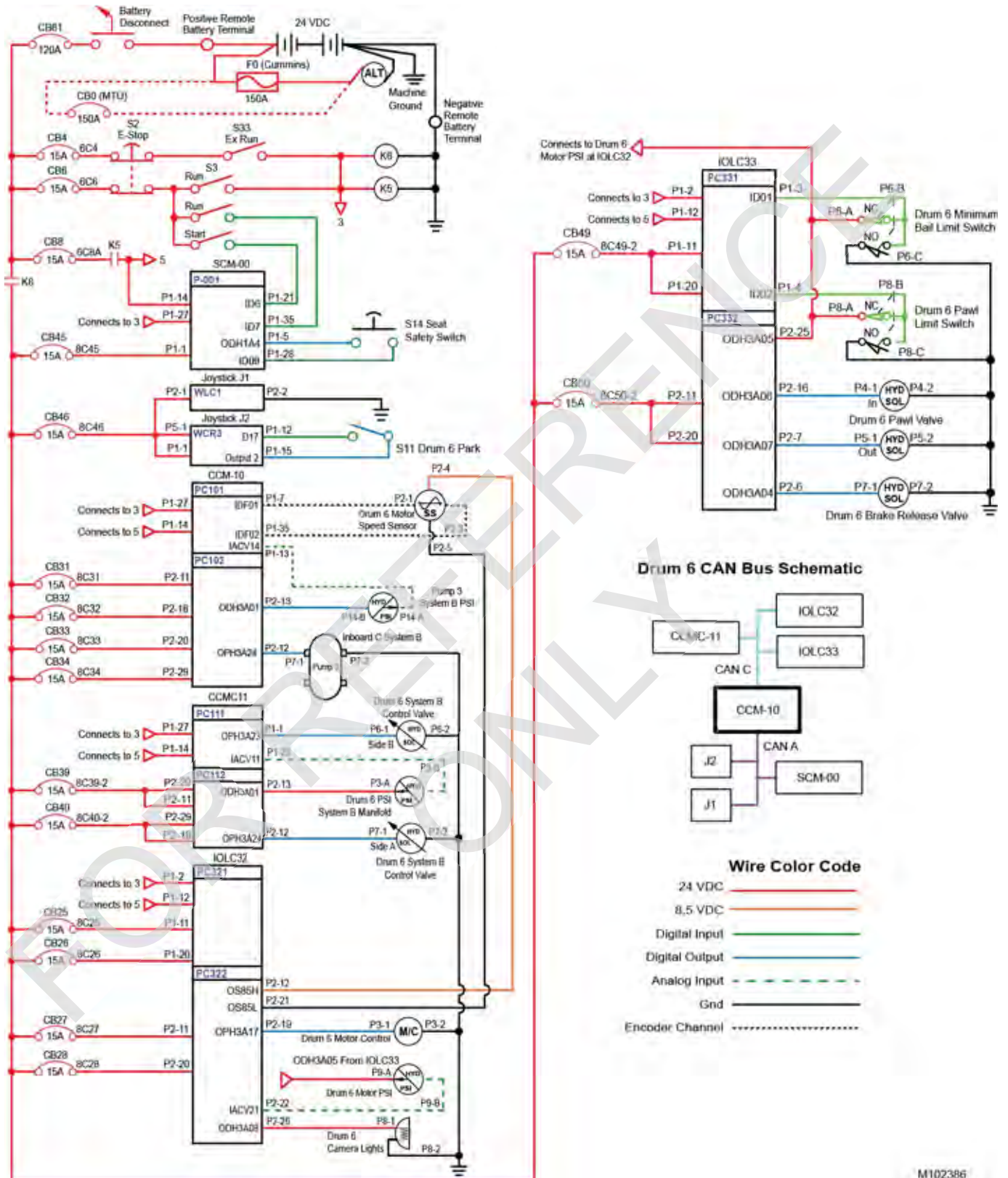


Item	Description
1	Engine
2	Pump Drive
3	Pump 3 (inboard C) (right/system B)
4	Pump 3 Pressure Transducer
5	Pump 1 Charge Pump (inboard A)
6	Check Valve (cracking pressure = 0,34 bar [5 psi])
7	Drum 6 System B Control Valve
8	Relief Valve (370—375 bar [5,366—5,439 psi])
9	Load-Holding Valve (shifting pressure= 12 bar [174 psi])
10	Pawl Valve
11	Drum 6 Brake Release Solenoid Valve
12	Drum 6 Pawl Cylinder
13	Drum 6
14	Drum Brake (spring applied)
15	Hydraulic Motor (variable 160/82 cc/rev)
16	Makeup Check Valve (qty 2) (cracking pressure = 0,34 bar [5 psi])
17	Makeup Accumulator (precharge = 8,3 bar [120 psi])
18	Thermal Expansion Accumulator (precharge = 1,4 bar [20 psi])
19	Brake Defeat Valve
20	Pressure-Reducing Valve (16,5 bar [240 psi])
21	Check Valve (cracking pressure = 0,2 bar [3 psi])
22	Sequence Valve (21,4 bar [310 psi])
23	Drum 6 System B Pressure Transducer (ports A/B)
24	Drum 6 Motor Pressure Transducer
25	Check Valve (cracking pressure = 0,34 bar [5 psi])
26	Distribution Manifold (qty 2)

● High Pressure ● Charge Pressure
● Low Pressure ● Return to Tank

FIGURE 5-12

Drum 6 Electrical Schematic



M102386

FIGURE 5-13

DRUM GEARBOX OIL CHANGE

Drum gearbox maintenance consists of periodically checking the level and changing the oil in the gearboxes for drums 1, 2, 3, 4, 5, and 6.

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

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

Initial Operation

Drain and refill the gearboxes after the first 200 hours of operation.

Monthly or 200 Hours

Check the oil level in the drum gearboxes every 200 hours of operation or monthly, whichever occurs first.

Fill each drum gearbox through the fill port (3) to the middle of the sight gauge (5).

Every 6 Months or 1,000 Hours

Drain and refill the drum gearboxes every 1,000 hours of operation or every 6 months, whichever occurs first, unless an alternate interval has been established through an oil analysis program.

Quick-Drain Valve

Each drum gearbox 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.



Item	Description
1	Quick-Drain Drainer
2	Hose Clamp
3	Hose: 3/4 in (19 mm) Inside Diameter by 10 ft (3,0 m) Long

FIGURE 5-14

Oil Change Procedure

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

Change the oil when the gearboxes are warm.

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

1. Lockout-tagout the crane.
2. Remove the plug (2) to vent the gearbox.
3. Remove the dust cap from the quick-drain valve (4).
4. Place the hose from the quick-drain drainer assembly (see [Figure 5-14](#)) into an appropriate container for collecting the drained oil.
5. Connect the quick-drain drainer assembly hose to the quick-drain valve. Make sure the fitting is all the way on, so that the poppet inside the valve opens and allows 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.

8. Fill the gearbox with specified oil:

Manual Fill Procedure

- a. If not already done, remove the plug (2).
- b. Using an appropriate funnel, add oil through the fill port (3) until the oil level is halfway up the sight gauge (5). Do not overfill.
- c. Install the plug.

Power Fill Procedure

- a. Remove the plug (2) to vent the gearbox.
- b. Remove the dust cap from the quick-drain valve (4).
- c. Thoroughly clean the inside of the hose for the existing quick-drain drainer assembly or use a new quick-drain drainer assembly for filling the gearbox.

NOTE: Additional quick-drain drainer assemblies can be purchased from your Manitowoc Cranes dealer.

- d. Connect the quick-drain drainer assembly hose to the quick-drain valve. Make sure the fitting is all the way on, so that the poppet inside the valve opens.
- e. Connect the hose from the quick-drain drainer assembly to a portable pump, either hydraulically powered or hand powered.
- f. Slowly pump oil into the gearbox until the oil level is halfway up the sight gauge (5). Do not overfill.
- g. Once the gearbox is filled, remove the quick-drain drainer assembly.
- h. Fasten the dust cap to the quick-drain valve.
- i. Install the plug.
9. Adjust the oil level, as required, after operating the drum.
10. Thoroughly clean the quick-drain drainer assembly and store it in the parts box.

Item	Description
1	Breather
2	Plug
3	Fill Port (elbow opening)
4	Quick-Drain Valve
5	Sight Gauge

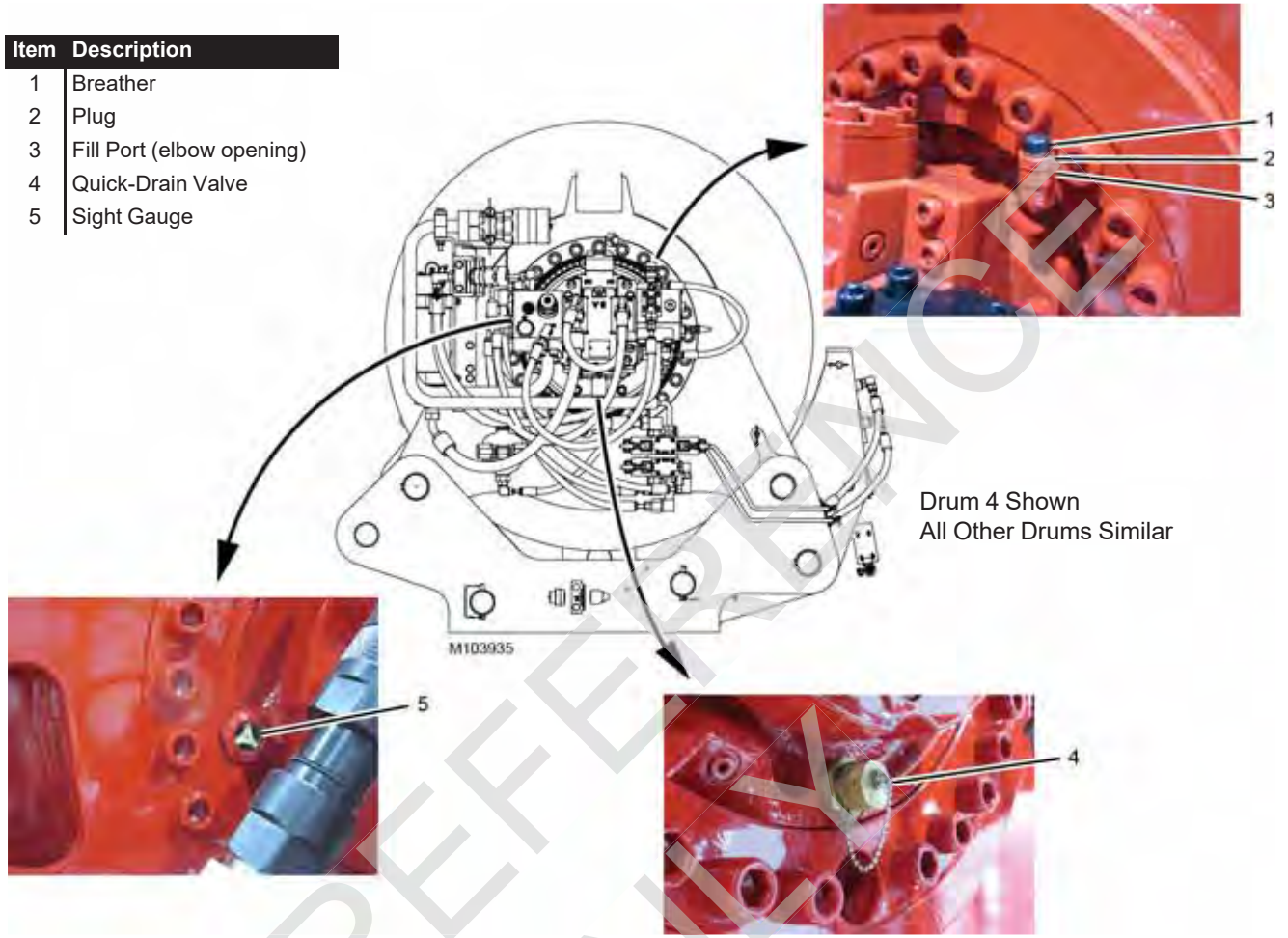


FIGURE 5-15

5

DRUM 4 PAWL

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

Operation

The pawl is controlled by the drum 4 park switch in the operator cab.

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, then stop the engine.
- b. Check the pawl again and make sure it is fully engaged with the ratchet.

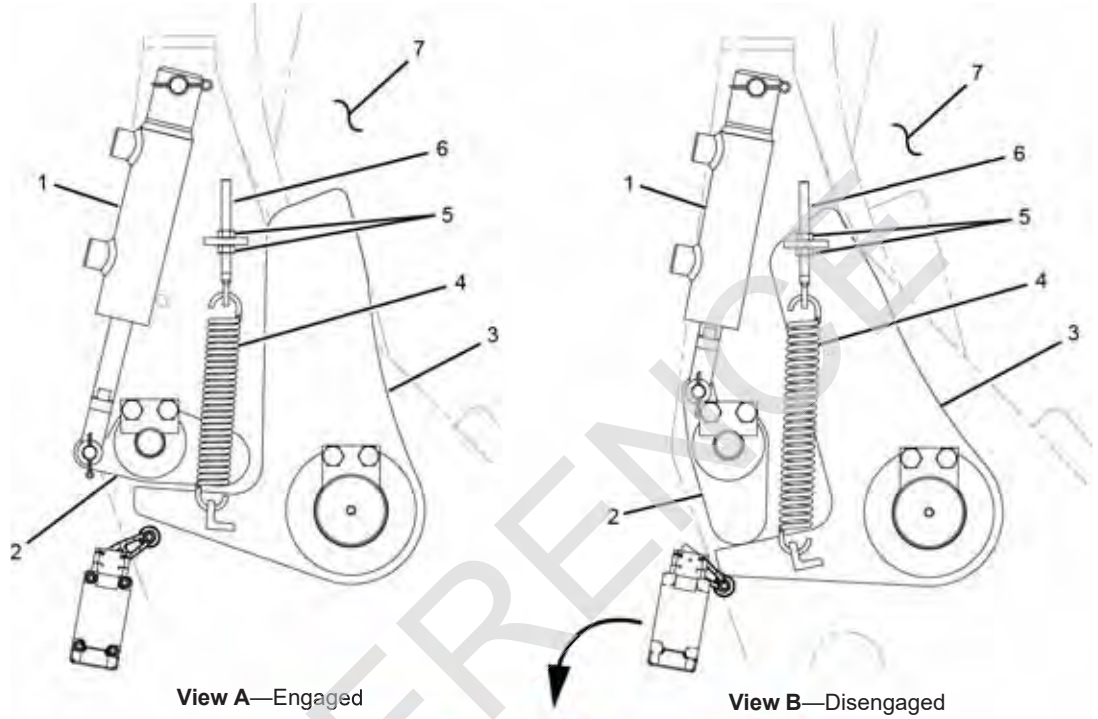
NOTE: In some cases, the pawl may come to rest on the top of a ratchet tooth. There must be enough spring tension to pull the pawl into the root of a ratchet tooth if the drum starts to turn in the down direction.

2. Lockout-tagout the crane.
3. Adjust the eyebolt adjusting nuts (5) to increase the spring (4) tension.
4. Start the engine and check the pawl for proper operation and engagement.

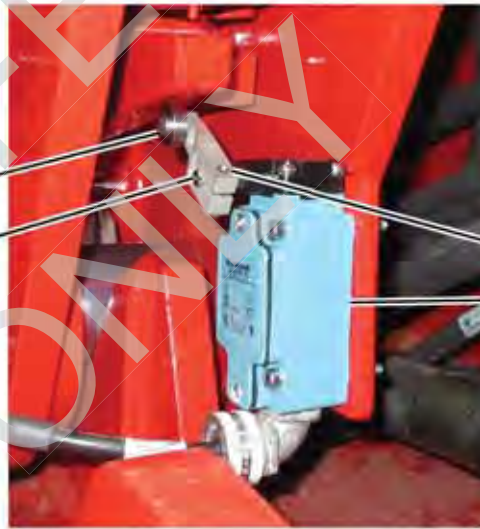
Limit Switch Adjustment

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

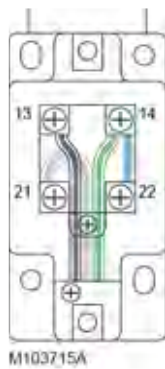
1. Disengage the pawl by moving the drum 4 park switch to the UN-PARK position. It may be necessary to boom up slightly before the pawl will disengage the ratchet.
2. Lockout-tagout the crane.
3. Loosen the setscrew (9) so the limit switch lever (11) is free to rotate on the limit switch shaft (10).
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 pawl and tighten the setscrew to lock 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.
 - 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.



Item	Description
1	Hydraulic Cylinder
2	Cam
3	Pawl
4	Spring
5	Adjusting Nut (qty 2)
6	Eyebolt
7	Ratchet
8	Limit Switch
9	Setscrew
10	Limit Switch Shaft
11	Limit Switch Lever



M102523 View C



M103715A

Limit Switch Wiring

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

FIGURE 5-16

DRUM 6 PAWL

See [Figure 5-17](#) for the following procedures.

Operation

The pawl is controlled by the drum 6 park switch in the operator cab.

Drum 6 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 6 Un-Parked

See View B—Disengaged.

The hydraulic cylinder (1) retracts and rotates the cam (2) against the pawl (3). This 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 procedure.

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, then stop the engine.
- b. Check the pawl again and make sure it is fully engaged with the ratchet.

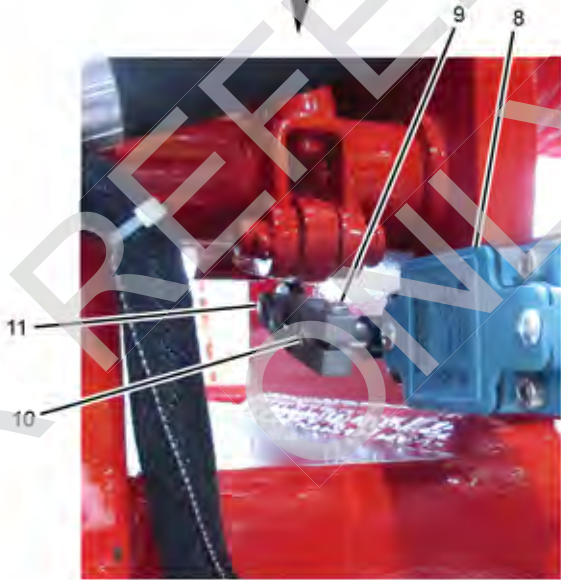
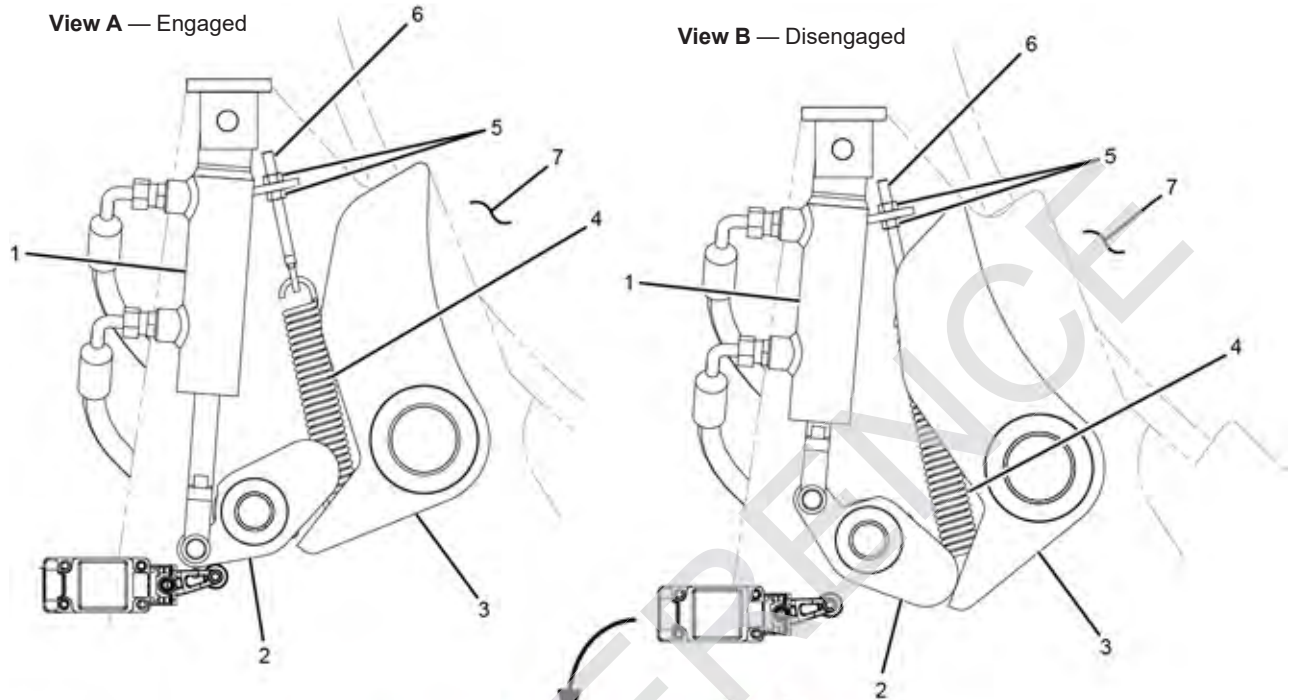
NOTE: In some cases, the pawl may come to rest on the top of a ratchet tooth. There must be enough spring tension to pull the pawl into the root of a ratchet tooth if the drum starts to turn in the down direction.

2. Lockout-tagout the crane.
3. Adjust the eyebolt adjusting nuts (5) to increase the spring (4) tension.
4. Start the engine and check the pawl for proper operation and engagement.

Limit Switch Adjustment

The limit switch (8) signals the crane's control system when the drum 6 pawl is fully disengaged.

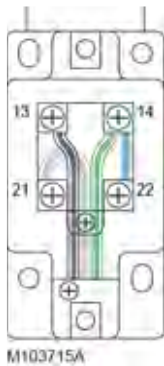
1. Disengage the pawl by moving the drum 6 park switch to the UN-PARK position. It may be necessary to luff up slightly before the pawl will disengage the ratchet.
2. Lockout-tagout the crane.
3. Loosen the setscrew (9) so the limit switch lever (11) is free to rotate on the limit switch shaft (10).
4. Rotate the limit switch lever up and hold it so the roller is against the cam (2).
5. Turn the limit switch shaft counterclockwise until the limit switch clicks open and hold.
6. Make sure the roller is against the cam and tighten the setscrew (9) to lock adjustment.
7. Start the engine and check for proper operation:
 - Engage the pawl by moving the drum 6 park switch to the PARK position, then try to luff down. The drum should not operate in the down direction.
 - Disengage the pawl by moving the drum 6 park switch to the UN-PARK position and try to luff down. The drum should operate in the down direction.
8. Readjust the limit switch if required.



M103936

View C

Item	Description
1	Hydraulic Cylinder
2	Cam
3	Pawl
4	Spring
5	Adjusting Nut (qty 2)
6	Eyebolt
7	Ratchet
8	Limit Switch
9	Setscrew
10	Limit Switch Shaft
11	Limit Switch Lever



M103715A

Limit Switch Wiring

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

FIGURE 5-17

5

DRUM 1 MINIMUM BAIL LIMIT

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

The minimum bail limit stops drum 1 from lowering when there are three to four wraps of wire rope remaining on 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 from the limit switch and connecting the supplied shorting plug (9).



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.

Pre-Adjustment

1. Pay out the wire rope from drum 1 until there are three to four wraps of wire rope on the first layer of the drum and the rollers (2) are against the bare drum barrel.
2. Lockout-tagout the crane.

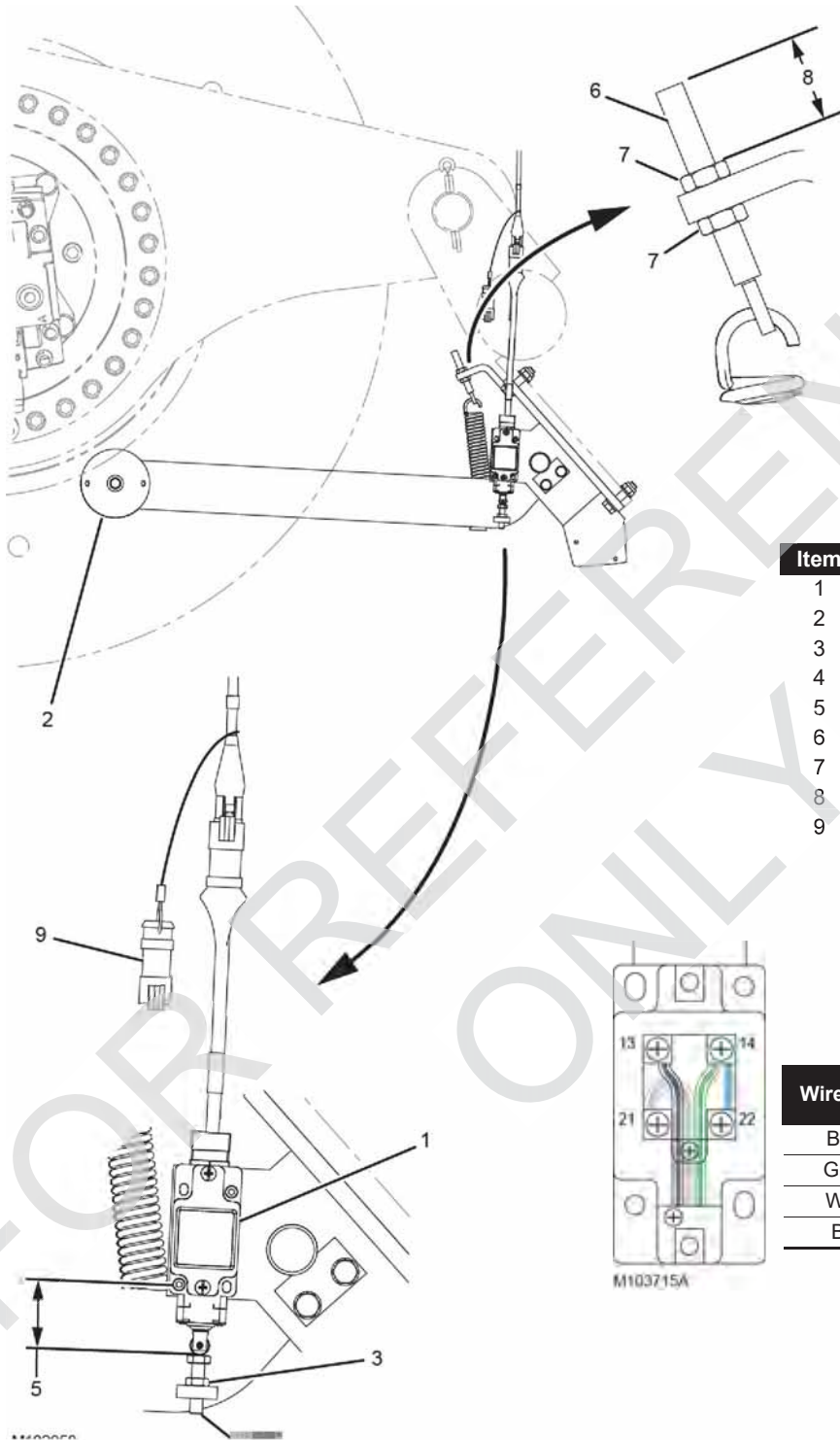
Spring Adjustment

Adjust the eyebolt jam nuts (7) so there is enough spring tension to hold the rollers (2) firmly against the bare drum barrel.

NOTE: The eyebolts were initially adjusted to the dimension (8).

Limit Switch Adjustment

1. With the rollers (2) contacting the bare drum barrel, loosen the jam nut (3).
2. Adjust the bolt (4) until it depresses the limit switch plunger to the dimension (5).
3. Hold the bolt in place and tighten the jam nut.
4. Start the engine and check for proper operation.



Item	Description
1	Limit Switch
2	Rollers
3	Jam Nut
4	Bolt
5	Dimension: 44 mm (1.7 in)
6	Eyebolt (qty 3)
7	Jam Nut (qty 6)
8	Dimension: 35 mm (1.4 in)
9	Shoring Plug

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

5

FIGURE 5-18

DRUM 2/3 MINIMUM BAIL LIMIT (NON-FREE FALL DRUM)

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

The minimum bail limit stops drum 2 or drum 3 from lowering when there are three to four wraps of wire rope remaining on 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 from the limit switch and connecting the supplied shorting plug (4).

WARNING

Falling Load Hazard!

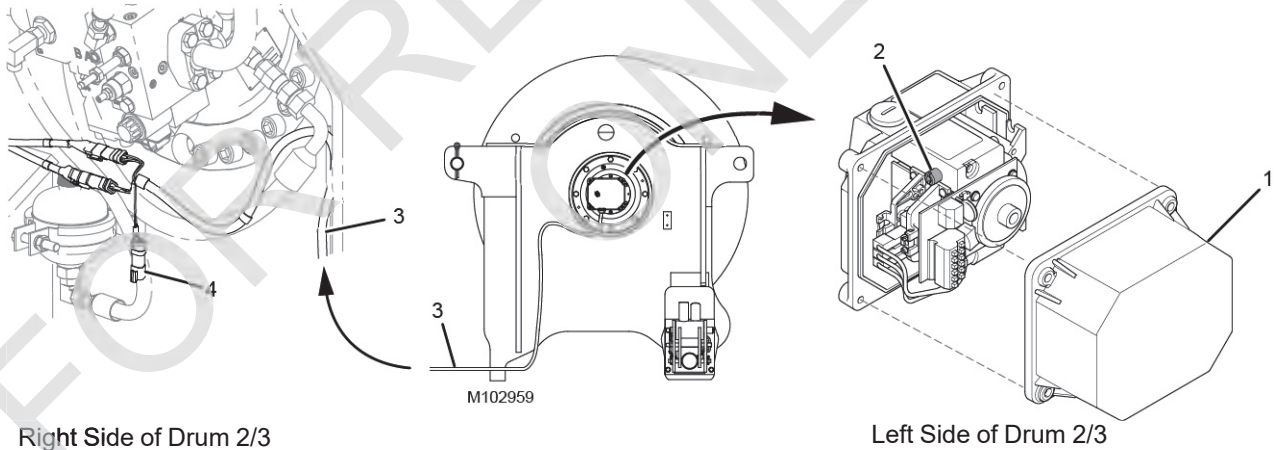
When lowering a load below the minimum bail limit, do so slowly with extreme caution. Do not lower the load to the point where less than three full wraps of wire rope are on the drum. The wire rope could be pulled out of the drum, allowing the load to fall.

Pre-Adjustment

1. Pay out the wire rope from the desired drum 2 or drum 3 until there are three to four wraps of rope on the first layer of the drum.
2. Lockout-tagout the crane.

Limit Switch Adjustment

1. Remove the cover with gasket (1).
2. Turn the limit switch screw (2) until you hear the switch activate (click). Also, you can verify the state of the limit switch in the digital input screen of the main display.
3. Start the engine and check for proper operation, as follows:
 - a. Haul in wire rope on the drum until there are 6-7 wraps on the first layer of the drum.
 - b. Pay out wire rope from the drum. The drum must stop and the operating limit alert must come on when there are 3-4 wraps on the first layer of the drum.
 - c. Readjust the limit switch as needed.
4. Install the cover with a new gasket (if required).



Item	Description
1	Cover with Gasket
2	Limit Switch Screw
3	Electric Cable
4	Shorting Plug

FIGURE 5-19

DRUM 2/3 MINIMUM BAIL LIMIT (FREE FALL DRUM)

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

The minimum bail limit stops drum 2 or drum 3 from lowering when there are three to four wraps of wire rope remaining on 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 adjusting the limit switch until the drum can be un-spooled.



WARNING

Falling Load Hazard!

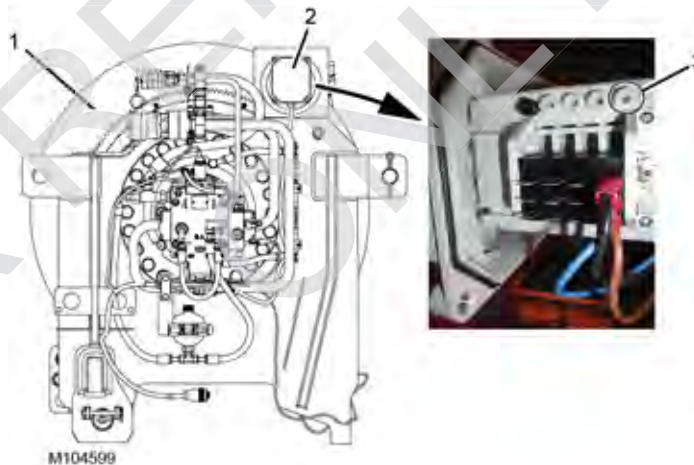
When lowering a load below the minimum bail limit, do so slowly with extreme caution. Do not lower the load to the point where less than three full wraps of wire rope are on the drum. The wire rope could be pulled out of the drum, allowing the load to fall.

Pre-Adjustment

1. Pay out the wire rope from the desired Drum 2 or 3 until there are three to four wraps of rope on the first layer of the drum.
2. Lockout-tagout the crane.

Limit Switch Adjustment

1. Remove the cover with gasket (2).
2. Turn the limit switch screw (3) until you hear the switch activate (click). Also, you can verify the state of the limit switch in the digital input screen of the main display.
3. Start the engine and check for proper operation, as follows:
 - a. Haul in wire rope on the drum until there are 6-7 wraps on the first layer of the drum.
 - b. Pay out wire rope from the drum. The drum must stop and the operating limit alert must come on when there are 3-4 wraps on the first layer of the drum.
 - c. Readjust the limit switch as needed.
4. Install the cover with a new gasket (if required).



Item	Description
1	Drum 2 or 3 with Free Fall
2	Cover with Gasket
3	Limit Switch Screw

FIGURE 5-20

DRUM 6 MINIMUM BAIL LIMIT

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

The minimum bail limit stops drum 6 from lowering when there are three to four wraps of wire rope remaining on 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 from the limit switch and connecting the supplied shorting plug (9).



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.

Pre-Adjustment

1. Pay out the wire rope from drum 6 until there are three to four wraps of rope on the first layer of the drum and the rollers (2) are against the bare drum barrel.
2. Lockout-tagout the crane.

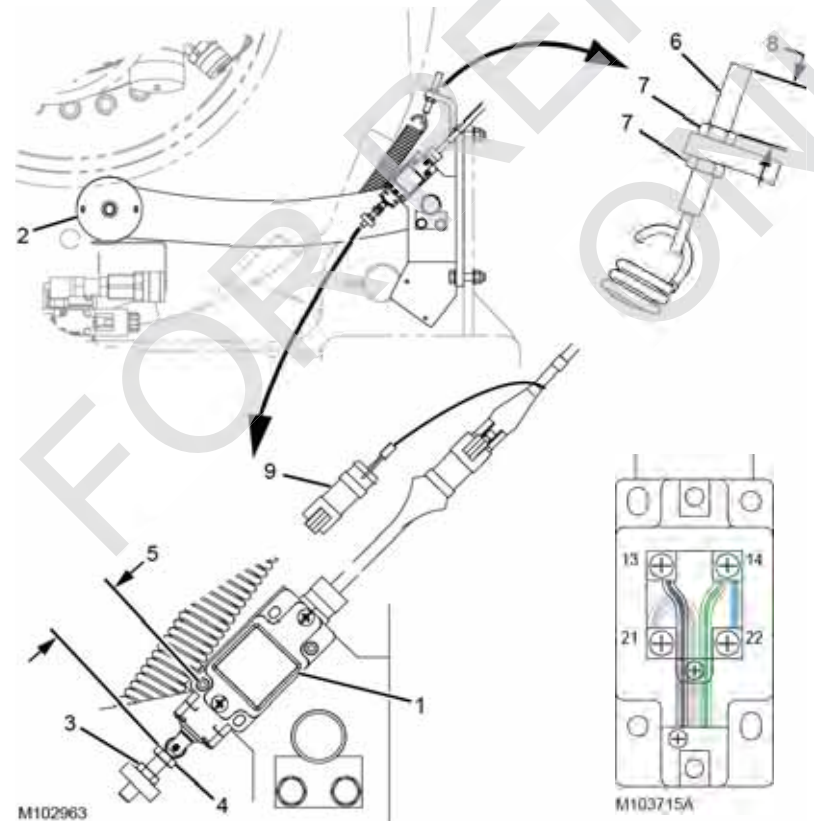
Spring Adjustment

Adjust the eyebolt jam nuts (7) so there is enough spring tension to hold the rollers (2) firmly against the bare drum barrel.

NOTE: The eyebolts were initially adjusted to the dimension (8).

Limit Switch Adjustment

1. With the rollers (2) contacting the bare drum barrel, loosen the jam nut (3).
2. Adjust the bolt (4) until it depresses the limit switch plunger to the dimension (5).
3. Hold the bolt in place and tighten the jam nut.
4. Start the engine and check for proper operation.



Item	Description
1	Limit Switch
2	Rollers
3	Jam Nut
4	Bolt
5	Dimension: 44 mm (1.7 in)
6	Eyebolt (3)
7	Jam Nut (6)
8	Dimension: 35 mm (1.4 in)
9	Shorting Plug

Limit Switch Wiring

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

FIGURE 5-21

SPEED SENSOR—HOIST MOTORS

See [Figure 5-22](#) for the following procedure.

For non-free-fall drums only, a speed sensor (1) is installed in the drum motor (2) for each drum, 1 through 6. The sensor sends rotational speed and direction information to the corresponding control module to be used by the crane control functions.

There is no adjustment for the speed sensors.

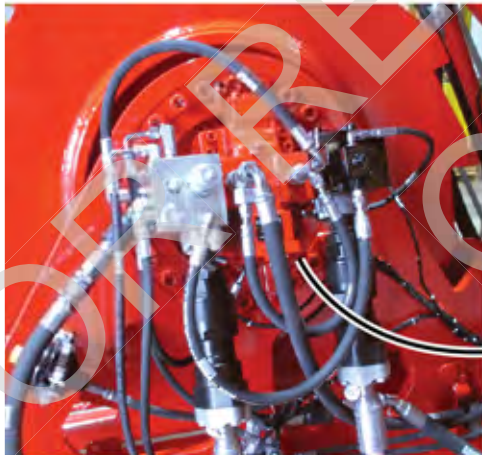
Replacement

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.

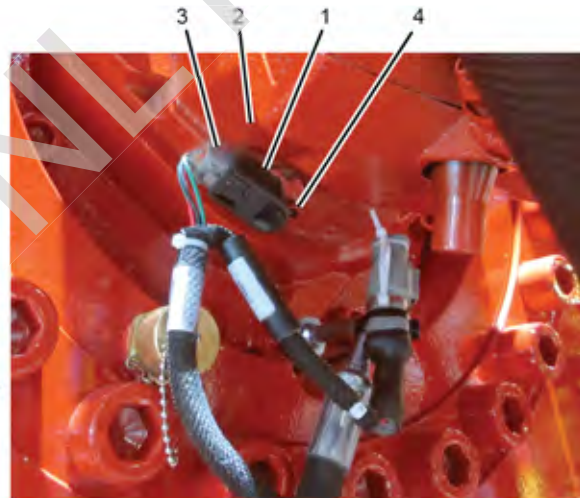
1. Lockout-tagout the crane.
2. Disconnect the electrical cable (3) from the speed sensor (1).
3. Thoroughly clean the area around the speed sensor to prevent dirt from entering the hydraulic system.
4. For drums 1, 4, 5, and 6, place an appropriate container under the motor to catch any oil leakage.
5. Work quickly to prevent excess oil leakage.
6. Make sure the O-ring is installed on the new speed sensor.
7. Remove the speed sensor mounting screw (4).
8. Remove the faulty speed sensor.
9. Clean the mating surfaces and install the new speed sensor and O-ring.
10. Install the mounting screw and tighten the screw to 11,1 Nm (8.2 ft-lb).
11. Connect the electrical cable to the new speed sensor.
12. 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.
13. Make sure there is no oil leakage.



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Typical View (all drums)

Note: For drums 2 and 3, the sensor is mounted in the top of the motor.



Item	Description
1	Speed Sensor
2	Drum Motor
3	Electrical Cable
4	Screw (M6 x 1 x 12 mm long)

FIGURE 5-22

BLOCK LEVEL

Proximity Sensor Operation

The block level proximity sensors ensure that the load block remains level when two load lines—drums 2 and 3—are routed to the load block. Located on the boom top, the proximity sensors monitor sheave rotation speed and direction.

The proximity sensors detect sheave rotation by detecting the slotted holes in the sheave as it rotates past the sensor. To determine direction of sheave rotation, two proximity sensors are used per load line.

Each proximity sensor contains a green LED and a yellow LED. The green LED illuminates when the sensor is powered up. The yellow LED illuminates when the sensor provides an output signal to the control module.

The crane's control modules use the signals from the proximity sensors to equalize the rotation speed of the drums so the load block remains level.

The proximity sensors are adjusted at the factory and need to be adjusted only when a new sensor is installed or the position of a sensor is reconfigured.

Proximity Sensor Replacement and Adjustment

Drum 2 Block Level Proximity Sensors

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

1. Lower the boom onto the blocking at the ground level.
2. Lockout-tagout the crane.
3. Remove the nuts (12), washers (13 and 14), and bolts (17). Remove the shim (16) (if used) and the mounting bracket (18) containing the drum 2 proximity sensors (10 and 11).

NOTE: Some configurations may use a shim located between the mounting bracket (18) and the guide frame bracket (15) to obtain proper sensor-to-sheave clearance.

4. Disconnect the electrical cable from the proximity sensor to be replaced.
5. Remove the screws (7) and the old proximity sensor from the mounting bracket.
6. Install the new proximity sensor and secure the sensor with the screws (7).
7. Connect the electrical cable to the proximity sensor.

8. Install the mounting bracket and shim (if used with old sensor). Secure with the nuts (12), washers (13 and 14), and bolts (17).
9. Check the clearance between sensors and the drum 2 sheave (8). The nominal distance between the sensors and sheave is 5,3 mm (0.21 in).
10. Check for proper operation without load. Drums must operate at the same speed, and the load block must remain level.
11. If the system does not operate correctly, adjust sensors by adding or removing the shim between the mounting bracket and the guide frame bracket as necessary.

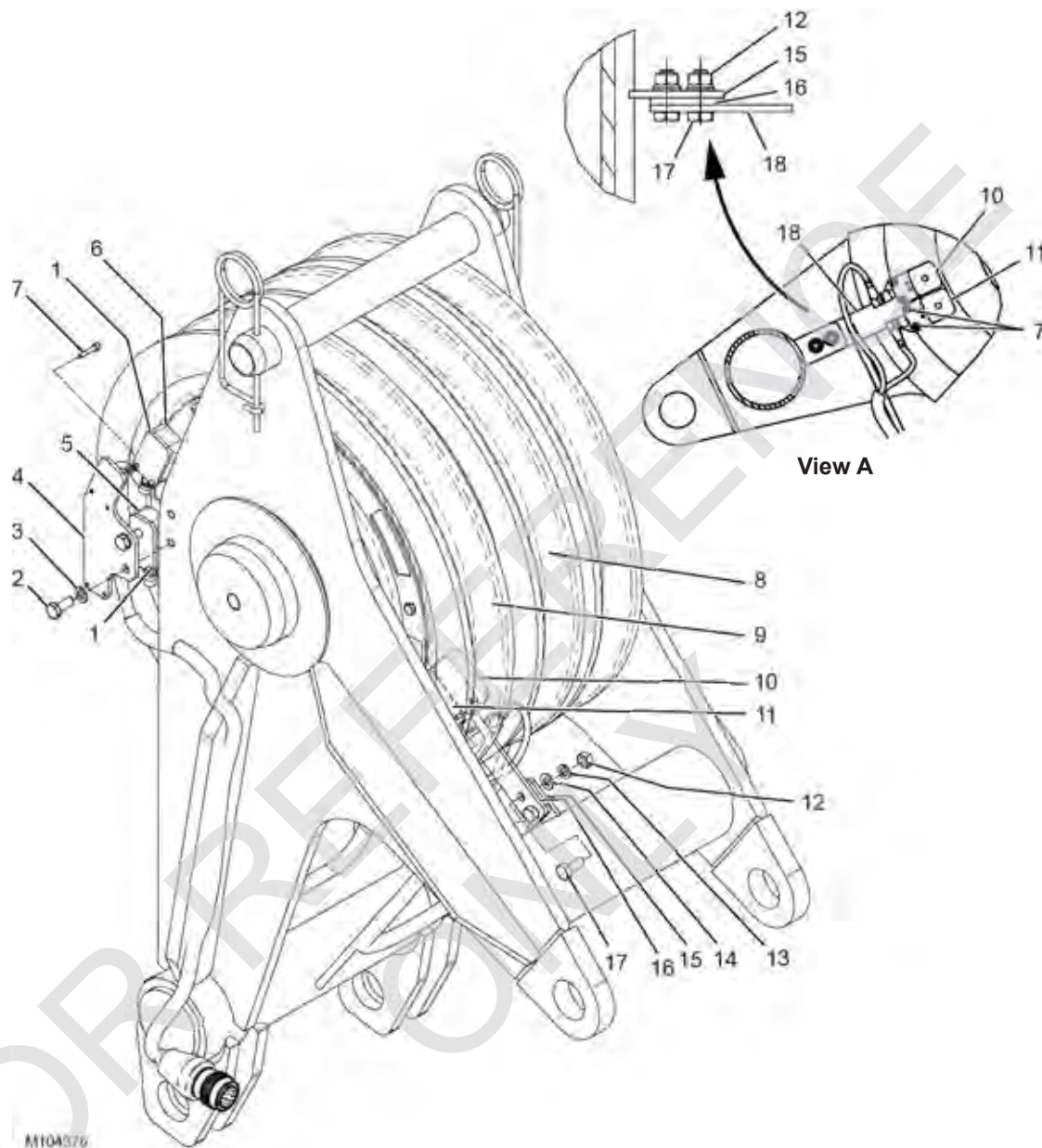
Drum 3 Block Level Proximity Sensors

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

1. Lower the boom onto the blocking at the ground level.
2. Lockout-tagout the crane.
3. Remove the bolts (2) and lock washers (3). Remove the mounting bracket (4) containing the drum 3 proximity sensors (5 and 6).
4. Disconnect the electrical cable from the proximity sensor to be replaced.
5. Remove the screws (7), shim (1) (if used), and the old proximity sensor from the mounting bracket.
6. Install the new proximity sensor and the shim (if used with old sensor). Secure with the screws (7).
7. Connect the electrical cable to the proximity sensor.
8. Install the mounting bracket. Secure with the bolts (2) and lock washers (3).
9. Check the clearance between the sensors and the drum 3 sheave (9). The nominal distance between the sensors and sheave is 5,3 mm (0.21 in).
10. Check for proper operation without load. The drums must operate at the same speed, and the load block must remain level.
11. If the system does not operate correctly, remove the mounting bracket and adjust the proximity sensors by removing the screws (7) and adding or removing the shim (1) between the mounting bracket and sensors as necessary.

Weekly Maintenance

1. Thoroughly clean the accumulated air dust on the proximity sensor.
2. Make sure all proximity sensor assembly parts, wiring, and connections are secure and undamaged.



5

Item	Description	Item	Description
1	Shim (5 mm [0.2 in]) (as necessary)	10	Drum 2 Proximity Sensor B
2	Bolt (qty 2)	11	Drum 2 Proximity Sensor A
3	Lock Washer (qty 2)	12	Nut (qty 2)
4	Mounting Bracket	13	Lock Washer
5	Drum 3 Proximity Sensor B	14	Flat Washer (qty 4)
6	Drum 3 Proximity Sensor A	15	Guide Frame Bracket
7	Screw (qty 2 per sensor)	16	Shim (5 mm [0.2 in]) (as necessary)
8	Drum 2 Sheave	17	Bolt (qty 2)
9	Drum 3 Sheave	18	Mounting Bracket

FIGURE 5-23

BLOCK-UP LIMIT INSTALLATION AND ADJUSTMENT



WARNING

Two-Blocking Hazard!

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

The block-up limit control may not prevent two-blocking when the load is hoisted at the maximum single line speed. The operator shall determine the fastest line speed that allows the block-up limit control to function properly and, thereafter, not exceed that line speed.

General

The block-up limit control (also called anti-two-block device) is a two-blocking prevention device which automatically stops the load drum from hoisting and the luffing jib (and boom) from lowering when a load is hoisted a predetermined distance from either jib point.

Two-Blocking Definition

Two-blocking is the unsafe condition in which the load block or the weight ball contacts the sheave assembly from which either is suspended.

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

The luffing jib block-up limit system consists of the following components (see [Figure 5-24](#)):

- A normally closed limit switch assembly fastened at either or both of the following locations:
 - Lower jib point
 - Upper jib point
- A weight freely suspended by the chain from each limit switch actuating lever (weight encircles load line as shown)
- A lift block fastened to the load line or a lift plate fastened to the load block

For identification and location of the block-up limit components in the boom, see the Operator and Service Manuals supplied with the crane.

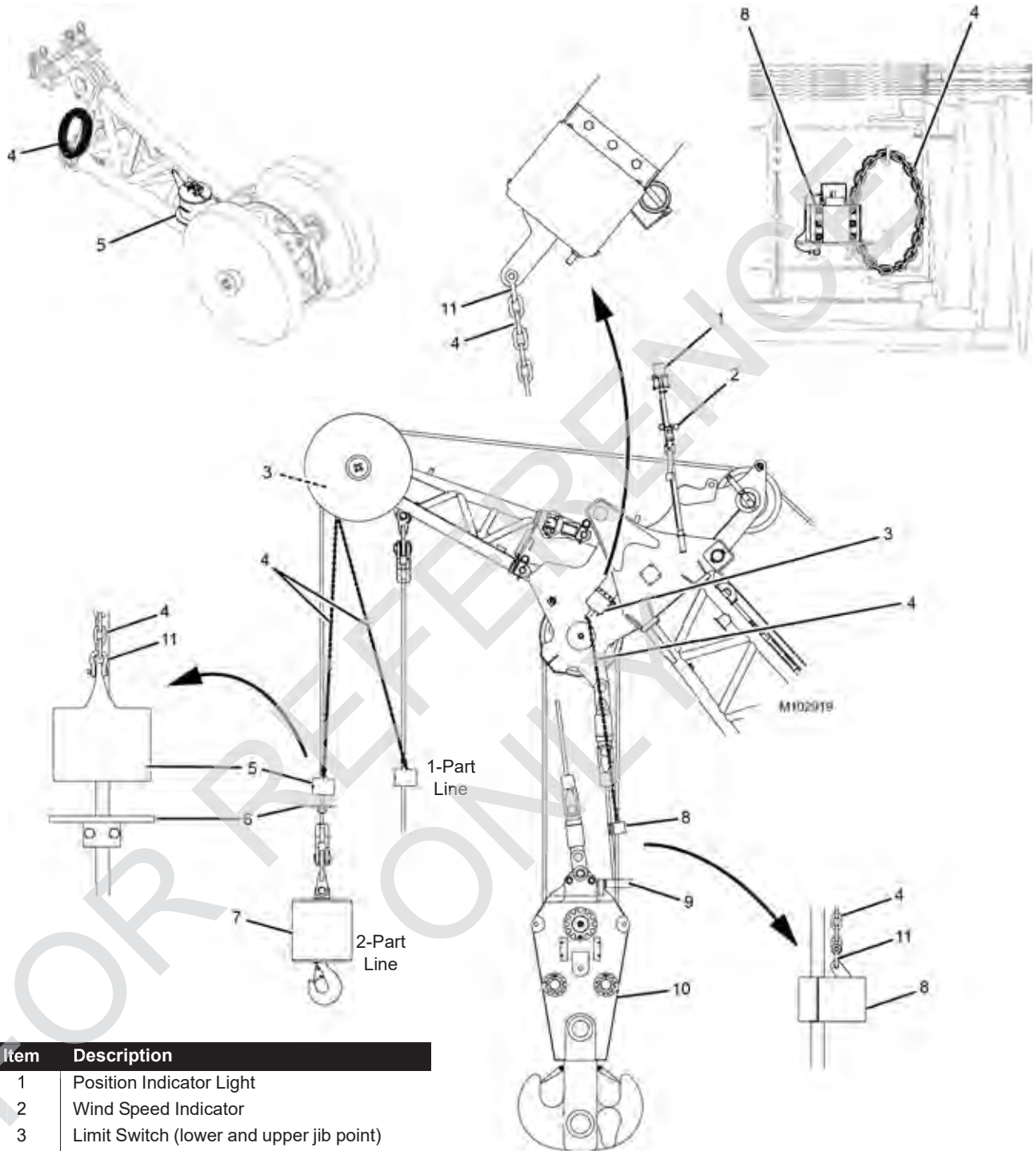
Removing the Luffing Jib

When removing the luffing jib, it is necessary to disconnect the electric cables from the jib at the electric cables in the boom top.

Be sure to do the following.

1. Thoroughly clean all cable connectors and dust caps.
2. Connect the dust caps to the cable connectors.
3. Connect the terminators to the cables on the boom top.

Failing to perform this step will result in faulty operation. Also, the fault alarm will come on in the main display.



Item	Description
1	Position Indicator Light
2	Wind Speed Indicator
3	Limit Switch (lower and upper jib point)
4	Chain
5	Weight with 2-Chain Attachments
6	Lift Plate
7	Hook-and-Weight Ball
8	Weight with 1-Chain Attachment
9	Lift Block
10	Load Block
11	Shackle

FIGURE 5-24

5

Maintenance

CAUTION

Prevent Damage!

To prevent two-blocking from occurring, do not operate the crane until cause for improper operation and all hazardous conditions have been found and corrected.

At least once weekly, inspect and test the block-up limit switches as follows.

1. Lower the boom and jib onto blocking at ground level and carefully inspect the following items.
 - a. Inspect each limit switch lever and actuating lever (see [Figure 5-25](#)) for freedom of movement. Apply one-half shot of grease to the fitting on the actuating lever. Wipe away any excess grease.
 - b. Inspect each weight (see [Figure 5-24](#)) for freedom of movement on the load line.
 - c. Inspect each weight, each chain, each shackle, and each connecting pin (see [Figure 5-24](#)) for excessive or abnormal wear. Make sure the cotter pins for the shackles are installed and spread.
 - d. Inspect the entire length of the electric cables for damage.
 - e. Make sure that the electric cables are clear of all moving parts in the boom and jib and that the cables are securely fastened to the boom and jib.
 - f. Make sure that all cables and terminating plugs are securely fastened.

CAUTION

Avoid Sheave Damage!

Use extreme care testing the block-up limit controls when the boom and jib are raised. If the block-up limit control fails to stop the load, immediately stop the load by moving the drum control handle to OFF or by applying the drum working brake. Otherwise, two-blocking may occur.

2. Test the block-up limit controls for proper operation with the engine running using either of the following methods:
 - Boom and Jib Lowered: Manually lift each weight—one at a time. The corresponding load drum must not operate in the up direction, and the boom/luffing hoist must not operate in the down direction.
 - Boom and Jib Raised: Slowly hoist each load block and weight ball—one at a time—against the weight. When the chain goes slack, the corresponding load drum must stop hoisting, and the boom/luffing hoist must not operate in the down direction.

Adjustment

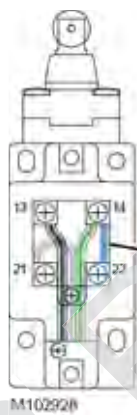
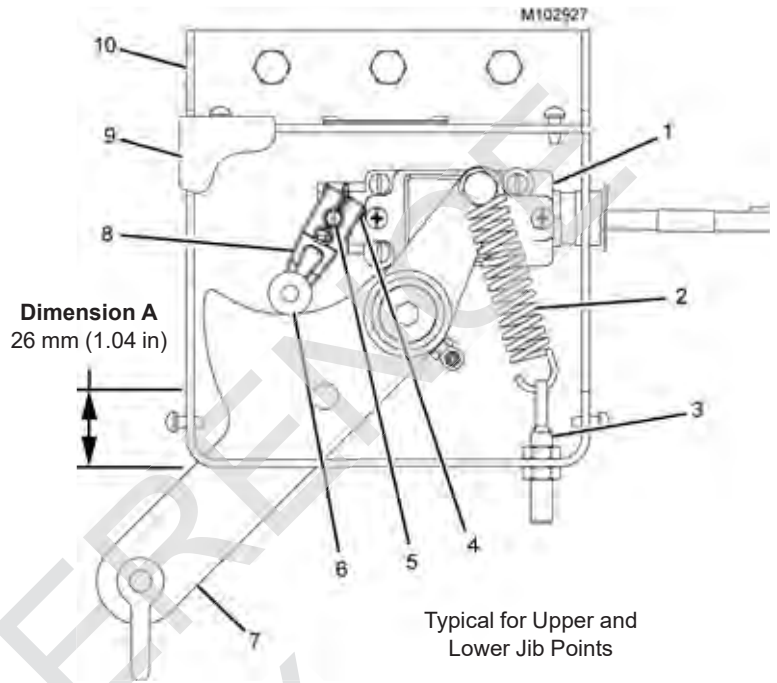
See [Figure 5-25](#) for the following procedure.

Lower the boom and jib onto blocking at ground level and adjust each limit switch as follows.

1. Adjust the tension of the spring (2) by adjusting the eyebolt and nuts (3). The spring tension must be just enough to lift the weight of the chain and rotate the actuating lever (7) up when the weight is lifted.
2. Loosen the setscrew (4) in the limit switch lever (8) so the lever is free to rotate.
3. Manually lift the weight to allow the actuating lever to rotate up.
4. Hold the actuating lever at Dimension A.
5. Hold the limit switch roller (6) against the actuating lever while performing [step 6](#).
6. Slowly turn the limit switch shaft (5) clockwise until the limit switch clicks open and hold.
7. Securely tighten the setscrew in the limit switch lever.
8. Test the limit switch for correct operation. Repeat the adjustment steps until the block-up limit operates correctly.

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Item	Description
1	Limit Switch
2	Spring
3	Eyebolt and Nuts
4	Setscrew
5	Shaft
6	Roller
7	Actuating Lever
8	Limit Switch Lever
9	Cover
10	Bracket
11	Jumper Wire (blue)



Limit Switch Wiring

Receptacle	Switch Terminals	Function
Black	13	Ground
Green	14	Maximum Angle
White	21	24 V _{DC} Supply
Blue	14 22	Jumper

FIGURE 5-25

5

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 5-27](#)).

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 5-53](#)) and
- Yearly (at minimum) (see [Periodic Comprehensive Inspection on page 5-47](#))

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.
- 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.



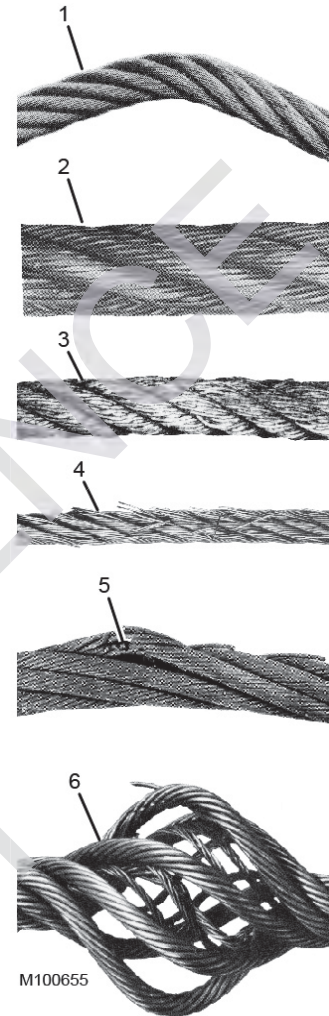
WARNING

Personal Injury Hazard!

Prior to conducting an inspection of wire rope:

- Lockout-tagout the crane 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.
-
- 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 5-26](#))
 - Loss of rope diameter (see [Reduction in the Rope Diameter on page 5-48](#))

- 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 5-49](#))
 - 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



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 5-26

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 5-46](#)
- Inspection of the rope diameter (see [Reduction in the Rope Diameter on page 5-48](#))

- Comprehensive examination for broken wires (see [Broken Rope Wires on page 5-49](#))
- 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 5-48](#)).

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

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 5-48](#) and [Broken Rope Wires on page 5-49](#))
- Wear of one-third of the original diameter of outside individual wires
- Kinking, crushing, birdcaging, 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 and record the diameter of any new wire rope for comparison to future inspections (see [Maintain a Wire Rope Condition Report on page 5-46](#)).

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

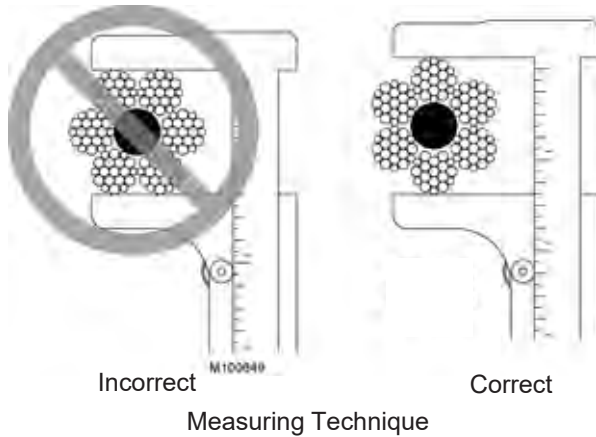


FIGURE 5-27

- 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, replace the rope or cut off the affected area and reattach the fitting.

NOTE: For galvanized bridle strand wire rope pendants, United States Steel states, “Replacement criteria for galvanized strand boom suspension pendants are 25 percent of the outer wires fractured, or 10 percent of the total numbers, whichever comes first.”

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.

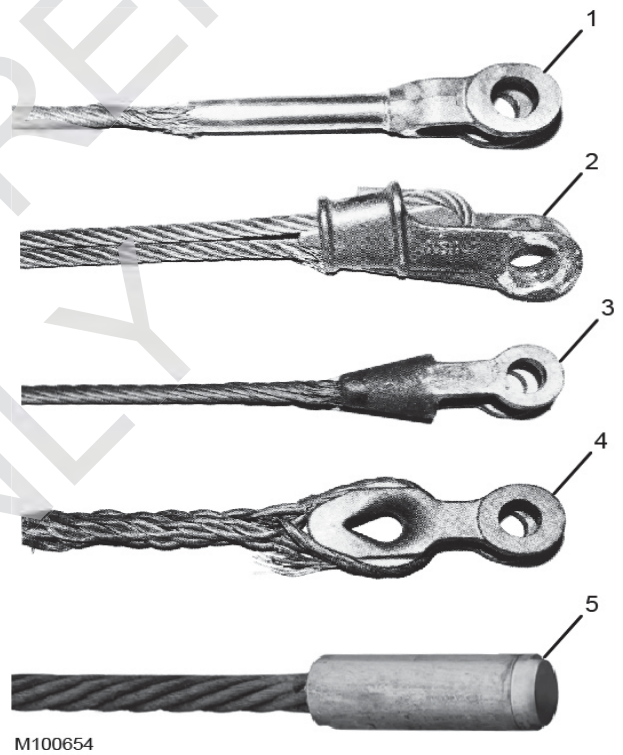
When conducting the periodic comprehensive inspection, thoroughly clean the wire rope so breaks can be seen. Relax the rope, move it off “pick-up points,” and flex it as much as possible to uncover damage. Use a sharp awl to lift any wire which appears loose. **Do not attempt to open the rope.**

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.

NOTE: The daily inspection does not require that the rope be cleaned or probed.

The wire rope must be taken out of service when it has the following number of broken wires (see [Figure 5-29](#) 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](#)).

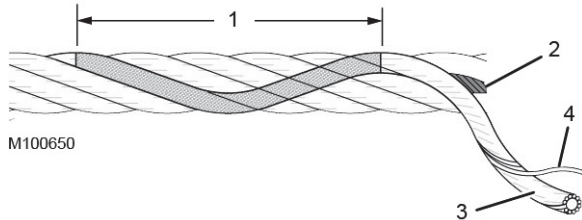


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Item	Description
1	Swagged Socket
2	Wedge Socket
3	Poured Zinc Socket
4	Hand-Spliced Socket
5	Button Socket

FIGURE 5-28

5



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

FIGURE 5-29

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.

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

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.

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 bearing).
 - Grease leaks (indicating a faulty seal or water in grease).

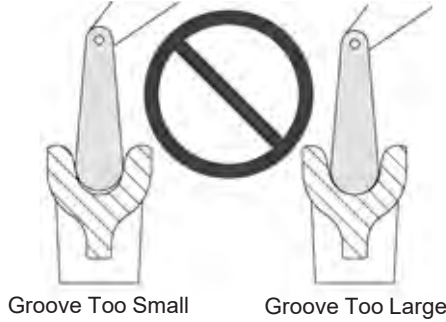
The above problems indicate bearing damage. If found, the corresponding sheave, roller, or drum should be disassembled for further inspection. New bearings should be installed.

For sheaves not equipped with grease fittings, be sure to pack the new bearings with grease at assembly.

- 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](#)).
- Measure the nylon sheaves for excessive tread wear (see [Figure 5-33](#)). To check for uneven wear, measure at three places.

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

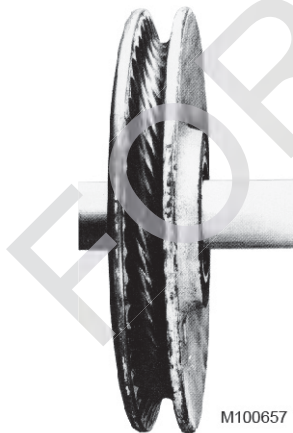
Observe the groove to see if the contour of the gauge matches the contour at the bottom of the sheave groove.



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

- Inspect the nylon sheaves to verify they have not separated and “walked off” the steel inserts or the bearings (see [Figure 5-32](#)).

Maximum sideways displacement is 3 mm (1/8 in). Replace worn or damaged sheaves.

NOTE: Nylon sheaves have the following characteristics:

- 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 will be degraded in temperatures above 60°C (140°F).

NOTE: 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 this manual.

NOTE: 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.

Item	Description
1	Nylon Sheave
2	Improper Snap Ring Engagement
3	Steel Insert of Bearing
4	1/8 in (3 mm) Maximum Sideways Displacement

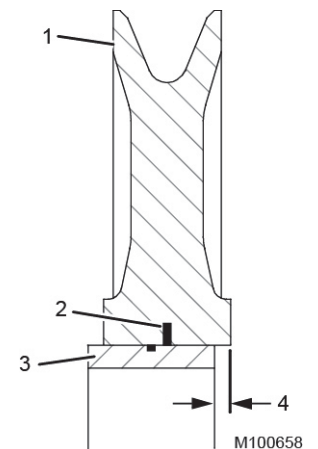
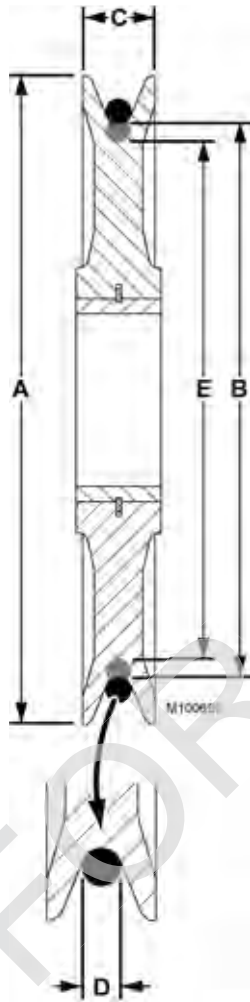


FIGURE 5-32

B = tread diameter, new sheave
E = tread diameter, used sheave
B minus E = total wear

If total wear is 5 mm (3/16 in) or more, the sheave should be replaced.

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



PLASTIC SHEAVE DATA								
Sheave Part No.	A Outside Diameter		B Tread Diameter		C Width		D Rope Diameter	
	mm	inch	mm	inch	mm	inch	mm	inch
912738	335.0	13.19	290.1	11.42	45.0	1.77	16	5/8
631056								
631054	335.0	13.19	290.1	11.42	45.0	1.77	22	7/8
631065	406.4	16.00	339.6	13.37	55.1	2.17	14	9/16
631071	406.4	16.00	352.6	13.88	55.1	2.17	16	5/8
631526	489.0	19.25	422.4	16.63	50.8	1.94	22	7/8
631527	489.0	19.25	422.4	16.63	50.8	1.94	16	5/8
631055	500.1	19.69	447.0	17.60	47.0	1.85	22	7/8
631067	500.1	19.69	450.9	17.75	50.0	1.97	19	3/4
631529	508.0	20.00	431.8	17.00	76.2	3.00	25	1
631519	584.2	23.00	511.0	20.13	57.2	2.25	22	7/8
631520								
631084	584.2	23.00	511.0	20.13	63.5	2.50	22	7/8
A00083								
631102	584.2	23.00	511.0	20.13	63.5	2.50	25	1

FIGURE 5-33

LOAD BLOCK AND HOOK-AND-WEIGHT BALL INSPECTION



WARNING

Falling Load Hazard!

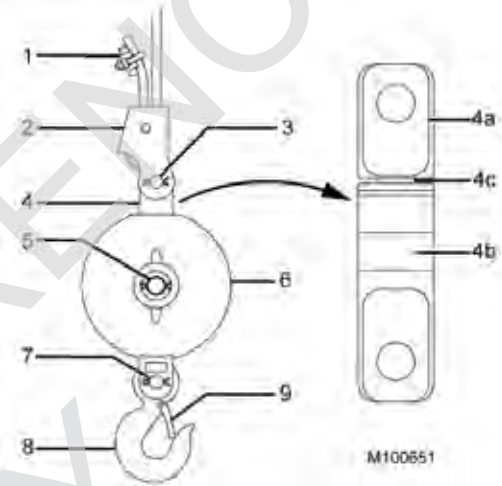
To prevent the load from dropping due to structural failure of the load block or the hook-and-weight ball, observe the following:

- 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 5-34](#)) 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.

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 5-35](#) and [Figure 5-36](#)):



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

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 Maniowoc)
6	Design Factor

FIGURE 5-35

FIGURE 5-34

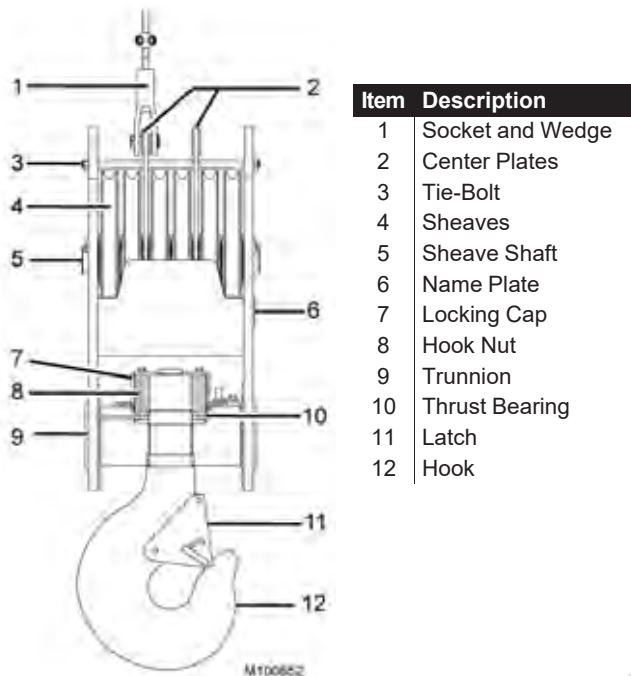


FIGURE 5-36

- 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 5-35](#)) 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.

**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).

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

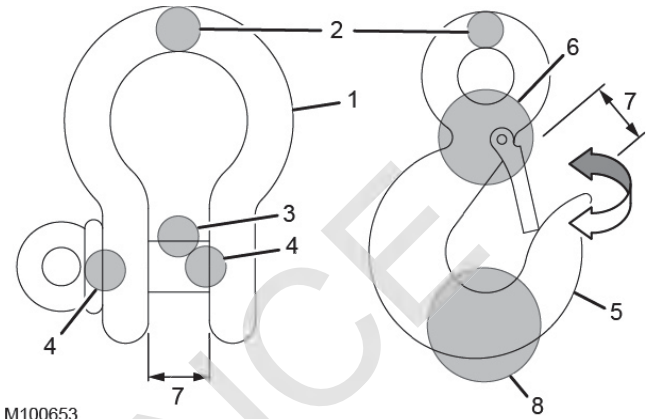
To prevent the load from dropping, make sure that, under slack conditions, the hook latch retains the slings or other rigging in the hook.

The hook latch is not intended as an anti-fouling device. Make sure that the hook latch does not support any part of load.

Make sure that any slings or other rigging are seated in the hook. Rigging must never be in a position to foul the hook latch.

Never attempt to defeat the purpose of the hook latch.

- Inspect each hook and shackle for damage (see [Figure 5-37](#)).
- 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
- Contact the supplier of your hooks, shackles, blocks, and other rigging for repair instructions.



M100653

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 5-37

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

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SECTION 6 SWING SYSTEM

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FOR REFERENCE ONLY

SECTION 6

SWING SYSTEM

GENERAL

This section provides the hydraulic and electrical information for the crane's swing system. Hydraulic and electrical circuit schematics are provided (see [Figure 6-1](#), [Figure 6-2](#), and [Figure 6-3](#)).

Details of individual components are covered later in this section. Component information can also be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

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 joystick J1 left-right position determines the crane's swing direction and speed. Joystick J1 also has a momentary contact holding brake switch to control the swing brake.

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

NOTE: Joystick J1 has no external locations where voltages can be checked.

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 MLC300 Main Display Operation Manual).

SWING BRAKE OPERATION

A spring-applied, hydraulically-released disc brake is located between the swing motor and its planetary drive. The swing brake must be actively released by the control system. If brake hydraulic pressure or electrical control is lost, the swing brake is applied by spring force.

The swing brake release system uses charge pressure from pump 2 that is supplied to the swing brake release solenoid valve. The hydraulic pressure must be above 18 bar (261 psi) to fully release the brake. If the pressure is less than 18 bar (261 psi), the brake could remain partially applied, which could damage the swing brake system.

Park Switch Control

Joystick J2 sends 24 V_{DC} to the swing park switch. When the swing park switch is in the UN-PARK position, the switch is closed, sending 24 V_{DC} back to joystick J2.

Joystick J2 communicates the un-park command to the CCM-10 control module via CAN Bus A. The CCM-10 control module relays the command to CCMC11 control module via CAN Bus C. The CCMC11 control module then sends 24 V_{DC} to the swing brake release solenoid valve, energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the swing brake, releasing the brake.

When the swing park switch is in the ON-PARK position, the swing brake switch is open, sending 0 V_{DC} to joystick J2.

Joystick J2 communicates the on-park command to the CCM-10 control module via CAN Bus A. The CCM-10 control module relays the command to CCMC11 control module via CAN Bus C. The CCMC11 control module then sends 0 V_{DC} to the swing brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake to flow back to the tank. The reduced hydraulic pressure allows spring force to apply the brake.

Holding Brake Switch Control

When the holding brake button on joystick J1 is pressed, joystick J1 sends a brake command to CCMC11 control module via the CAN Bus. The CCMC11 control module then sends 0 V_{DC} to the swing brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake to flow back to the tank. The reduced hydraulic pressure allows spring force to apply the brake.

SWING OPERATION

Swing Pump Control

Swing pump 5 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 a swing command is communicated to the IOLC31 control module via the CAN Bus, the IOLC31 control module sends a pulse-width modulation (PWM) output signal to the EDC. The PWM consists of a 1.6 to 8.8 V_{DC} signal with the current control range starting at 200 mA and ending at 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.

Swing Left

When joystick J1 is moved to the left, the joystick sends a swing left command to CCM-10 control module via CAN Bus A. The CCM-10 control module relays the command to the IOLC31 control module via CAN Bus C. The IOLC31 control module 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 motor speed sensor and swing left psi pressure transducer provide closed-loop feedback to the CCMC11 control module.

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 CCM-10 control module via CAN Bus A. The CCM-10 control module relays the command to the IOLC31 control module via CAN Bus C. The IOLC31 control module 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 motor speed sensor and swing right psi pressure transducer provide closed-loop feedback to the CCMC11 control module.

Coasting

When joystick J1 is moved back to the neutral position, the IOLC31 control module ramps down the PWM signal to the energized A or B solenoid in the pump 5 EDC. This allows the springs to center the spool inside the proportional solenoid valve, causing the pump swashplate to destroke (moves to the center position), stopping hydraulic flow to the motors.

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 EDC on pump 5, the CCMC11 and IOLC34 control modules activate the front and rear alarms.

Swing Left Hydraulic Schematic

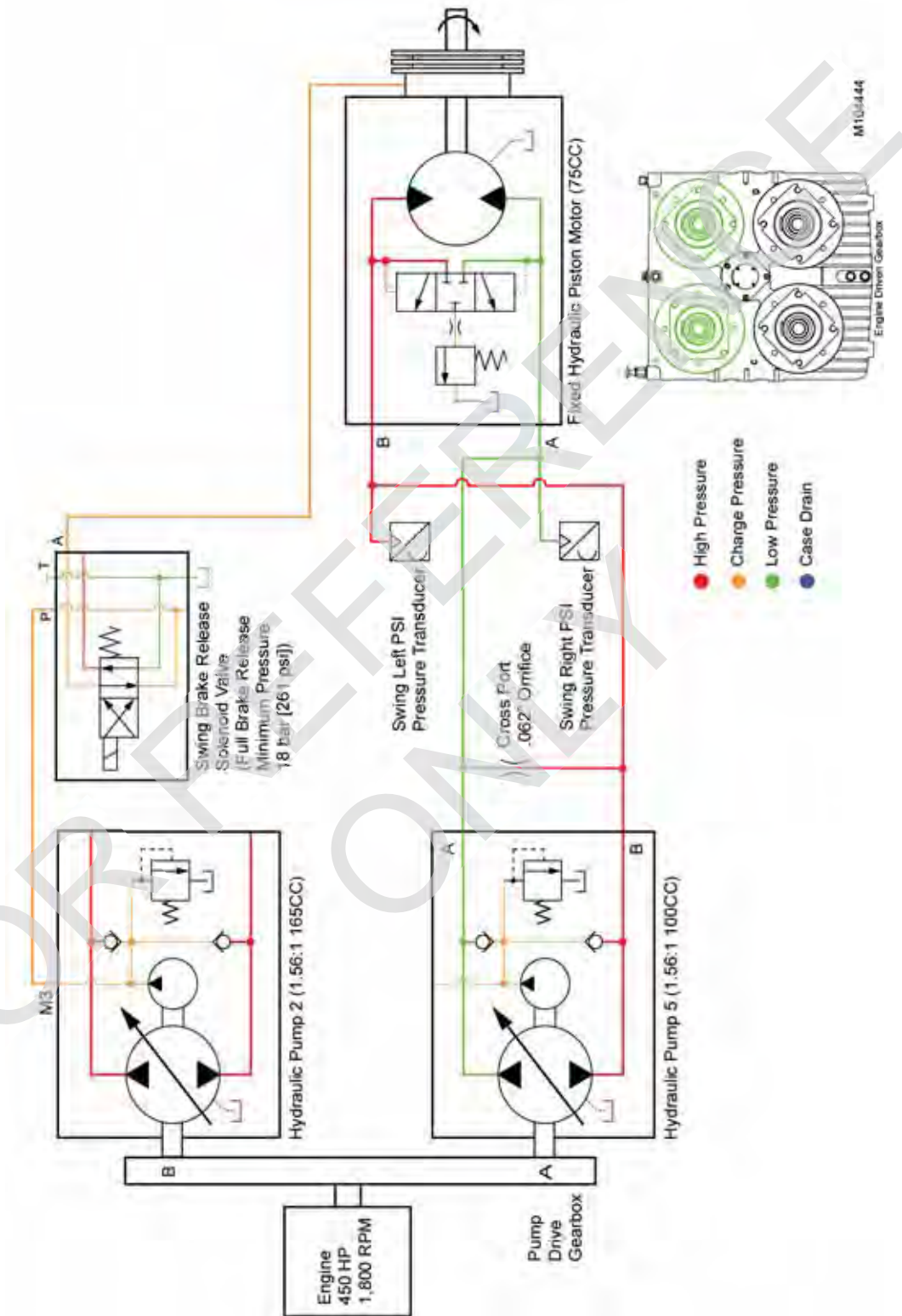


FIGURE 6-1

Swing Right Hydraulic Schematic

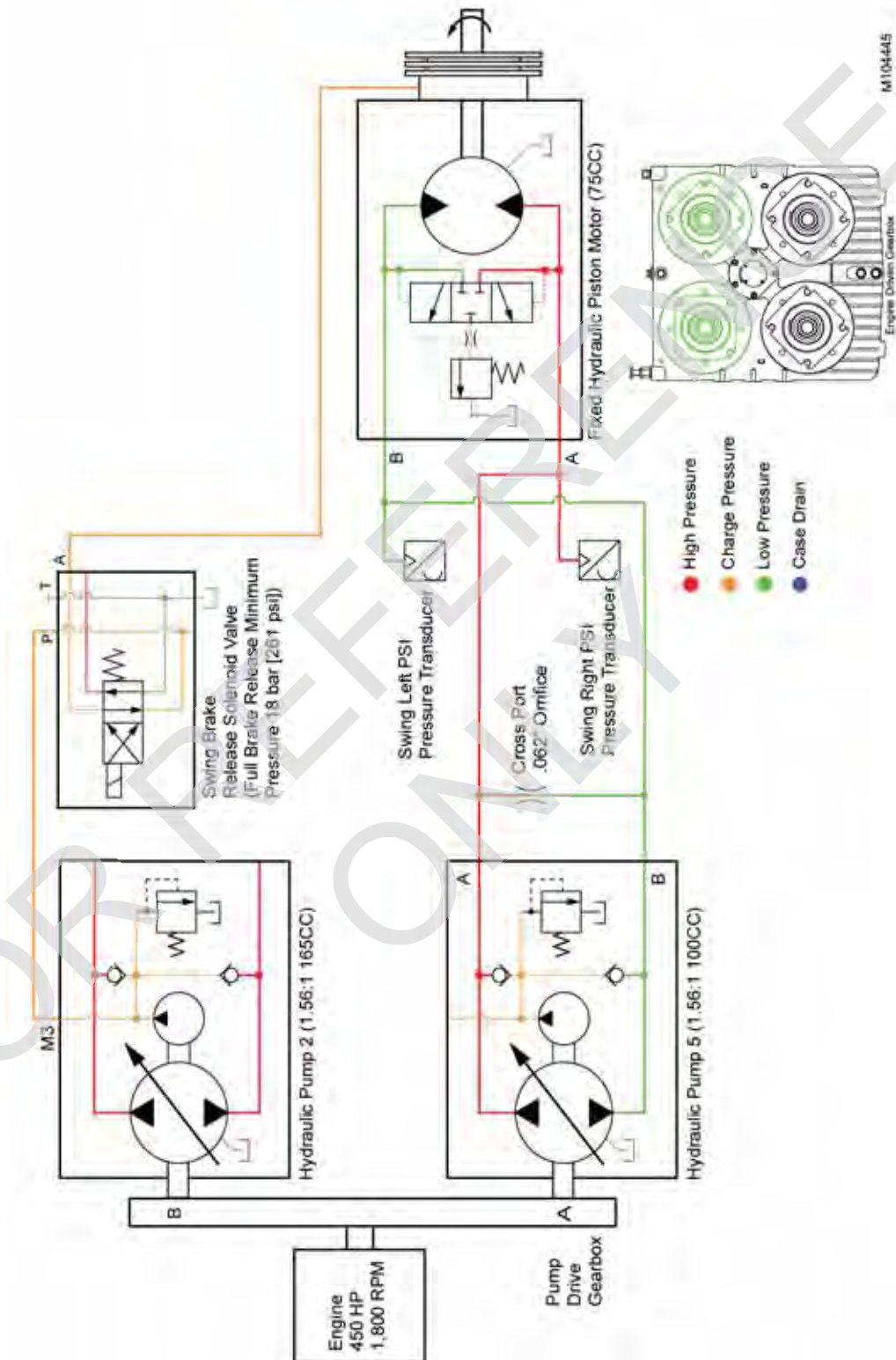


FIGURE 6-2

Swing Electrical Schematic

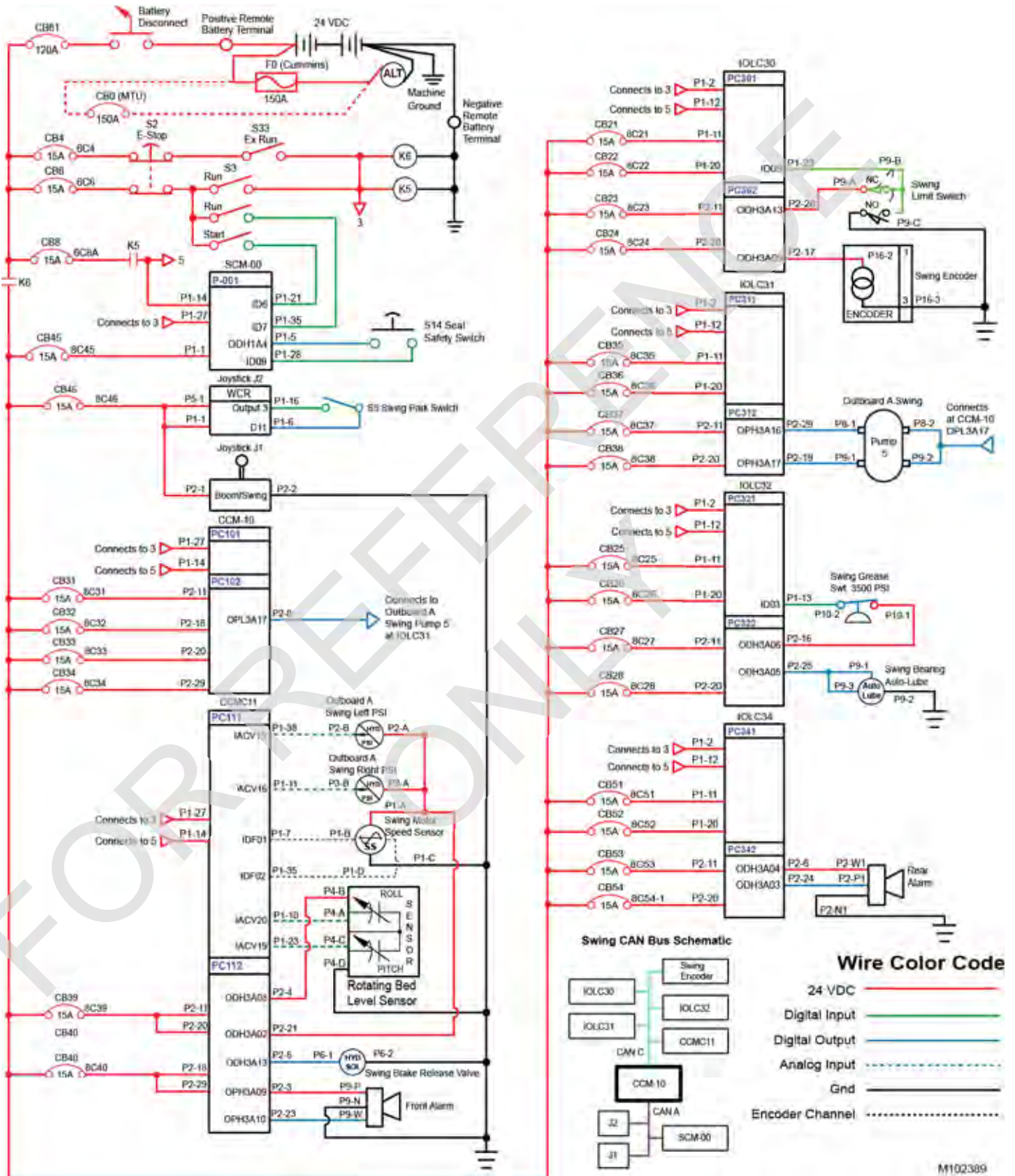


FIGURE 6-3

SWING BRAKE MANUAL RELEASE

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

Depending on your options, the crane has either one or two swing drives.

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.

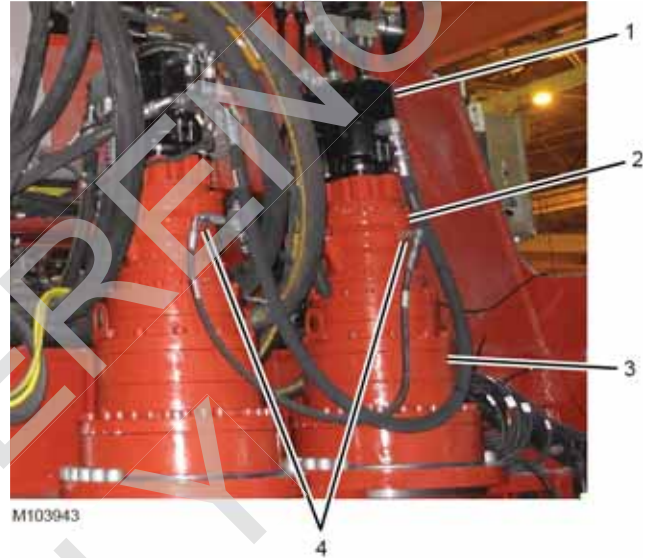
CAUTION

Avoid Damage to Parts!

When releasing the swing brake with the hand pump, do not exceed 21 bar (300 psi) of pressure.

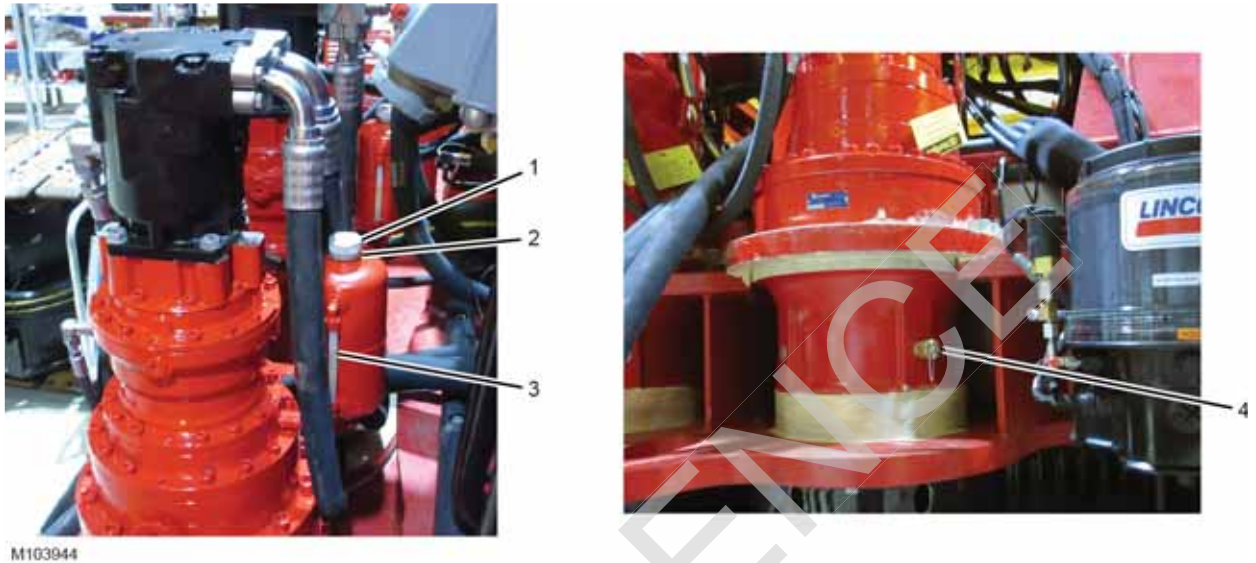
1. Disconnect the existing brake hose and fittings from the adapter fitting in the brake release port (4).
2. Connect the hand pump hose to the adapter fitting with user-supplied 06 ORFS fittings.
3. To release the brake, pressurize it to 21 bar (300 psi) with the hydraulic hand pump.

4. Service the swing drive as required.
5. 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 adapter fitting in the brake release port.
 - c. Connect the existing brake hose and fittings to the adapter fitting in the brake release port.



Item	Description
1	Swing Motor
2	Swing Brake Release Port
3	Swing Gearbox
4	Brake Release Port

FIGURE 6-4



Item	Description
1	Fill Cap/Breather
2	Fill Port (expansion tank)
3	Sight Gauge
4	Quick-Drain Valve

FIGURE 6-5

SWING GEARBOX OIL CHANGE

See [Figure 6-5](#) for the following procedures.

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

Depending on your options, the crane has either one or two swing drives.

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 best oil change interval and the condition of the swing gearbox.

Periodic Maintenance

Initial Operation

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

Monthly or Every 200 Hours

Check each swing gearbox oil level every 200 hours of operation or monthly, whichever occurs first.

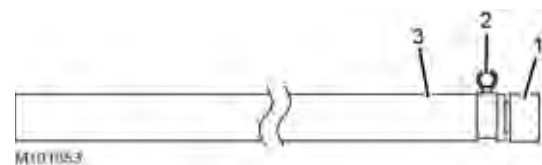
Fill each swing gearbox through the fill cap/breather (1) opening to the level indicated on the decal next to the sight gauge (3).

Every 6 Months or 1,000 Hours

Drain and refill each swing gearbox every 1,000 hours of operation or every 6 months, whichever occurs first, unless an alternate interval has been established through an oil analysis program.

Quick-Drain Valve

Each swing gearbox is equipped with a quick-drain valve (4), which requires use of the quick-drain drainer assembly (see [Figure 6-6](#)). 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 6-6

Oil Change Procedure

See [Figure 6-5](#) for the following procedure.

Change the oil when the swing gearbox is warm.

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

1. Lockout-tagout the crane.
2. Remove the fill cap/breather (1) to vent the swing gearbox.
3. Remove the dust cap from the quick-drain valve (4).
4. Place the non-fitting hose end of the quick-drain drainer assembly (see [Figure 6-6](#)) into an appropriate container for collecting the drained oil.
5. Thread the quick-drain drainer assembly all the way onto the quick-drain valve. The poppet inside the valve will open, allowing the oil to drain from the swing gearbox.
6. Once the swing gearbox is drained, remove the quick-drain drainer assembly.
7. Fasten the dust cap to the quick-drain valve.
8. Fill the swing gearbox with the specified oil by performing one of the following procedures.

Manual Fill Procedure

- a. If not already done, remove the fill cap/breather.
- b. Add oil through the fill port (2) using an appropriate funnel until the oil is at the level indicated on the decal next to the sight gauge (3).

- c. Install the fill cap/breather.

Power Fill Procedure (recommended)

- a. Remove the fill cap/breather to vent the swing gearbox.
- b. Remove the dust cap from the quick-drain valve.
- c. Thoroughly clean the inside of the hose for the existing quick-drain drainer assembly or use a new quick-drain drainer assembly for filling the gearbox.

NOTE: Additional quick-drain drainer assemblies can be purchased from your Manitowoc Cranes dealer.

- d. Thread the quick-drain drainer assembly all the way onto the quick-drain valve. The poppet inside the valve will open.
- e. Connect the hose from the quick-drain drainer assembly to a portable pump, either hydraulically-powered or hand-powered.
- f. Slowly pump oil into the swing gearbox until the oil is at the level indicated on the decal next to the sight gauge. Do not overfill.
- g. Once the swing gearbox is full, remove the quick-drain drainer assembly.
- h. Fasten the dust cap to the quick-drain valve.
- i. Install the fill cap/breather.
9. Adjust the oil level, as required, after operating the swing drive.
10. Thoroughly clean the quick-drain drainer assembly and store it in the parts box.
11. Dispose of the drained oil according to local

SWING MOTOR SPEED SENSOR

The speed sensor sends rotational speed and direction information to the corresponding control module to be used by the crane control functions.

See [Figure 6-7](#) for the following procedures.

Speed Sensor Replacement

WARNING Burn Hazard!

Avoid possible injury. Oil will drain from the port when the sensor is removed. Wait for the hydraulic oil to cool before removing the sensor.

NOTE: When removing the motor speed sensor (1) from the swing motor (2), be careful to contain the hydraulic fluid that will drain from the motor.

1. Loosen the sensor lock nut with an 1-1/16 in hex wrench and remove the sensor.
2. Install and adjust the new sensor. See [Speed Sensor Adjustment, page 6-9](#).
3. Before starting the engine, add clean hydraulic oil of the correct type to the motor's top case drain port.

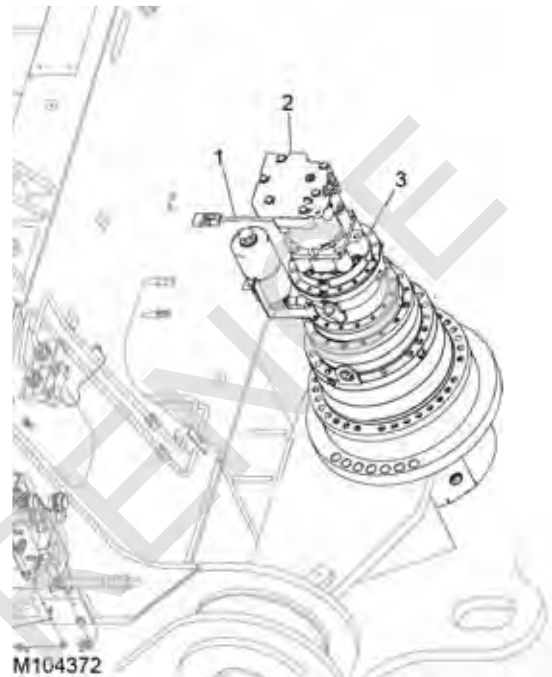
Speed Sensor Adjustment

The swing motor speed sensor is set at the factory and should not need adjustment, unless replaced. When installing or adjusting the speed sensor on the motor, it must be set at a specific distance from the speed ring on the unit's cylinder.

Adjust the speed sensor as follows.

1. Loosen the sensor lock nut with an 1-1/16 in hex wrench.
2. Turn the sensor clockwise by hand until it just contacts the speed ring.
3. Turn the sensor counterclockwise 1/4 turn.
4. Continue to turn the sensor counterclockwise until the flats on the sensor are 22 degrees to either side of the motor shaft centerline. Do not turn the sensor counterclockwise more than 3/4 turn after contacting the speed ring.

5. Hold the sensor in the position with a 1/2 in hex wrench while tightening the lock nut to 13 Nm (10 ft-lb).



Item	Description
1	Motor Speed Sensor
2	Swing Motor
3	Planetary Swing Drive Assembly

FIGURE 6-7

Weekly Periodic Maintenance

1. Check that all the speed sensor assembly parts, wiring, and connections are secure and undamaged.
2. Operate the swing drive to verify that there is a reliable speed readout on the main display. If there is intermittent or no readout, troubleshoot the speed sensor assembly.
3. Thoroughly clean the sensor of any accumulated dust and debris.

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FOR REFERENCE ONLY

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SECTION 7

POWER TRAIN

BATTERIES

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

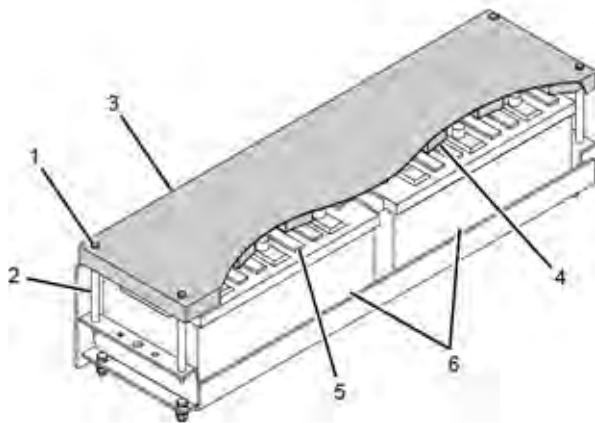
Undercharging can cause a type of sulfate to develop on the plates. The sulfate reduces the battery capacity and causes strains in the positive plates, which cause plate buckling. Buckled plates can pinch the separators and cause a short circuit. An undercharged battery is not only unable to deliver power, but also may freeze (see [Table 7-1](#)).

Table 7-1. Battery Freeze Points

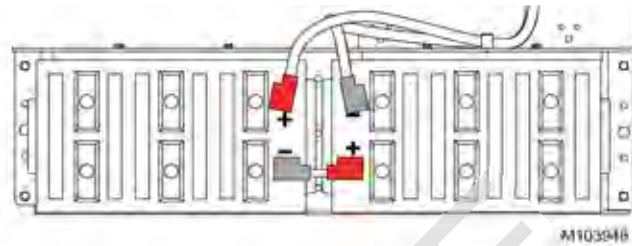
State of Charge	Specific Gravity	Freeze Point °C (°F)
100%	1.26	-57 (-70)
75%	1.23	-38 (-36)
50%	1.20	-26 (-15)
25%	1.17	-19 (-2)
0%	1.11	-8 (18)

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.



Located in Rotating Bed
on Right Side of Engine



Item	Description
1	Hold-Down Screw with Nuts and Washers (qty 4)
2	Hold-Down Tubes
3	Battery Cover
4	Hold-Down Knobs
5	Rubber Strip (qty 10)
6	Battery: 12V, 1,375 CCA, Size 8D (qty 2)

FIGURE 7-1

Loose Hold-Downs

Loose hold-downs allow the battery to vibrate in the holder. This can cause cracks or wear in the 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-downs can also distort or crack the container.

Overloads

Avoid prolonged cranking or the addition of extra electric devices. These can drain the battery and may cause excessive heat.

Multiple Battery System

The crane's 24 V system is powered by two 12 V batteries connected in series (see [Figure 7-1](#)).

Always refer to the wiring diagram for the correct connections. Be careful not to reverse the battery connections. Installing the batteries with electrical connections that are reversed will damage not only the batteries but also the crane's electrical system, voltage regulator, and/or alternator.

Battery Maintenance

CAUTION

Potential Electronic Control Module Malfunction!

Before disconnecting the batteries or opening the battery disconnect, make sure that the engine ignition switch has been off for five minutes. This will avoid engine fault codes and undesirable operation.



WARNING

Personal Injury Hazard!

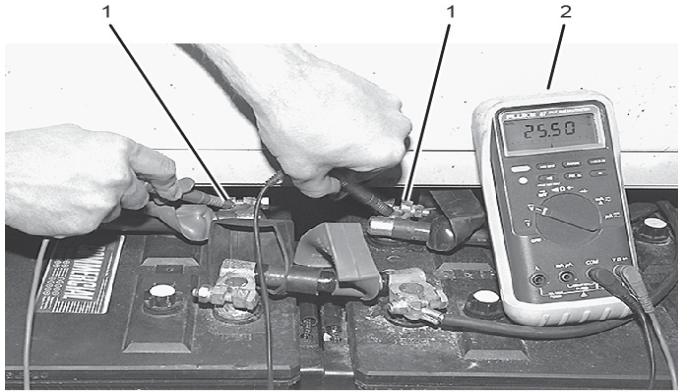
Each battery weighs about 59 kg (130 lb). Use proper lifting procedures.

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 7-2](#) and [Table 7-2](#)).

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 7-2

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.

Quarterly Battery System Maintenance

- Thoroughly clean the batteries and the holder with a baking soda/water solution.
- If provided, make sure the drain holes are open in the holder. If water collects in the holder, drill some drain holes.

- Clean the posts and terminals. The posts can be lightly coated with petroleum jelly to prevent corrosion.
- Make sure that the hold-downs are in good condition. Replace any faulty parts.
- 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-downs are tight enough to prevent battery movement, but not so tight as to cause distortion.

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 [Battery Charger \(optional\) on page 7-4](#).

1. Remove the battery or disconnect all 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. 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 gasses 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 DISCONNECT SWITCH

CAUTION

Avoid Electronic Control Module Malfunction!

Before disconnecting the battery disconnect, make sure the engine ignition switch has been off for five minutes. This will avoid engine fault codes and undesirable operation.

The battery disconnect switch (1, [Figure 7-3](#)) is located on the rear of the rotating bed. 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 counterclockwise to turn off (disconnect) the batteries from the electrical control system.

Turn the switch handle clockwise to turn on (connect) the batteries to the electrical control system.

Use the disconnect switch under the following circumstances:

- 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

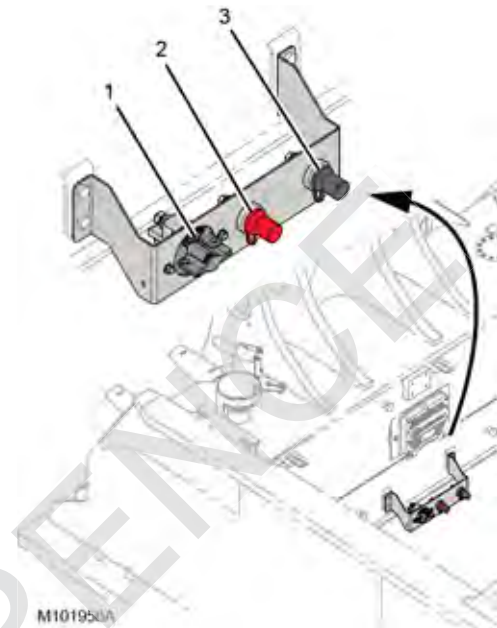
CAUTION

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.



Item	Description
1	Battery Disconnect Switch
2	Remote Positive Battery Terminal
3	Remote Negative Battery Terminal

FIGURE 7-3

BATTERY CHARGER (OPTIONAL)

See [Figure 7-4](#) for the following procedure.

An optional auxiliary power unit (APU) equipped with a 10 KW, continuous duty, 60 HZ AC generator and a DC charging system is available from Manitowoc Cranes for the following operations when the crane engine is off:

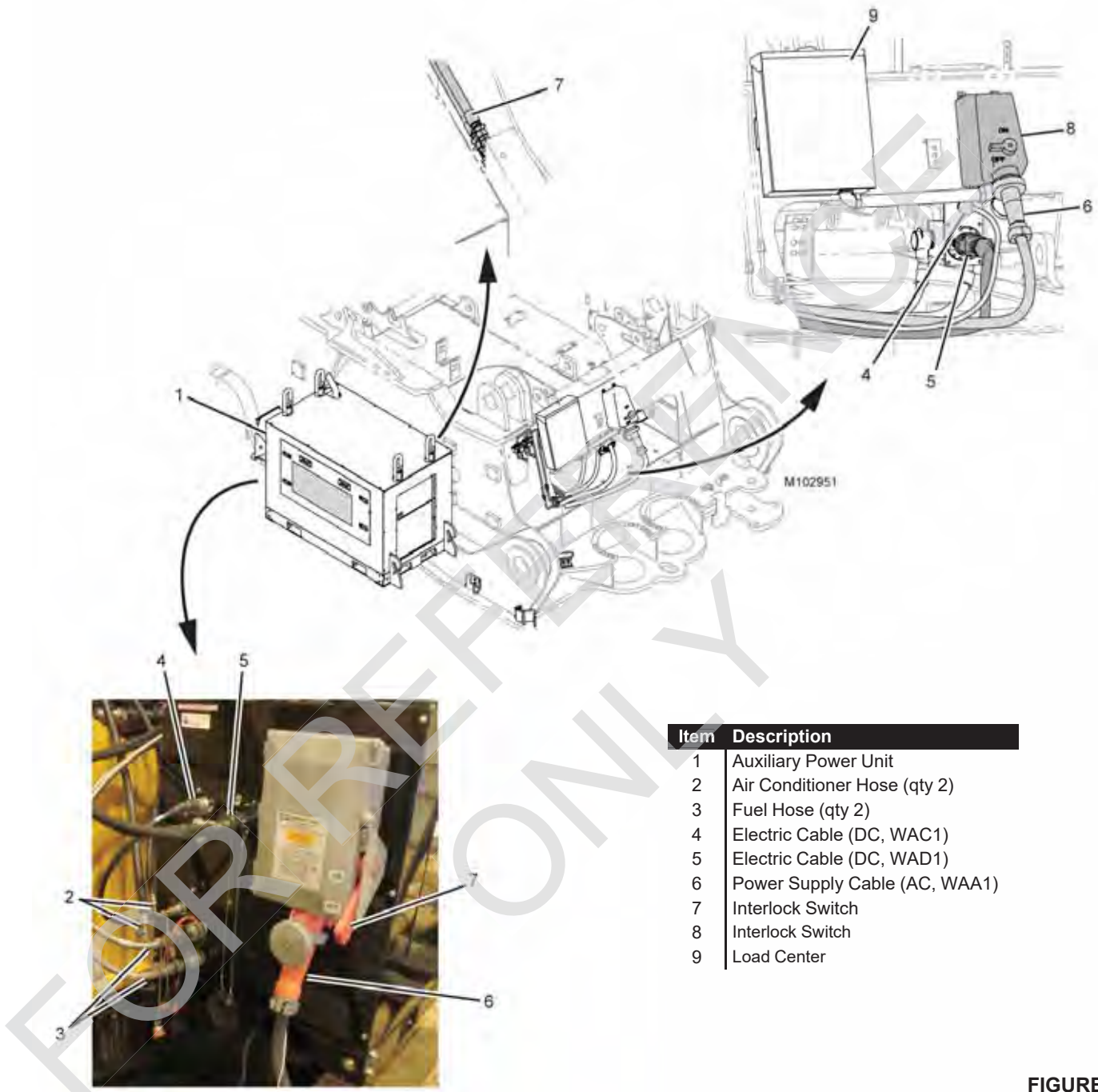
- To power the cab heater and air conditioner
- To charge the crane batteries
- To power the cold weather heaters
- To power any AC lighting the crane is equipped with

If an alternative method of charging is desired, follow the instructions in [Charging on page 7-3](#).

The APU can be started with the switch in the operator cab.

If the crane is not to be used for more than a few days, the charger should be plugged into a 240 V_{AC} source.

There is a 10 A fuse on the DC output. For charger troubleshooting and maintenance information, refer to the manufacturer's service manual.



Item	Description
1	Auxiliary Power Unit
2	Air Conditioner Hose (qty 2)
3	Fuel Hose (qty 2)
4	Electric Cable (DC, WAC1)
5	Electric Cable (DC, WAD1)
6	Power Supply Cable (AC, WAA1)
7	Interlock Switch
8	Interlock Switch
9	Load Center

FIGURE 7-4

ENGINE CONTROLS

See the engine start procedure in Section 3 of the MLC300 Operator Manual for engine startup. See the Cummins engine manual for detailed engine instructions.

The engine is started and stopped with the engine key switch.

The speed of the crane motors and actuating cylinders depends on engine speed and equipment control handle movement. Engine speed is controlled with the hand or foot throttle. Node 1 controller and engine node 0 controller process and control engine information, which is shown on the main display.

The emergency stop push button stops the engine in an emergency. All brakes apply, and any functions stop abruptly.

ENGINE ENCLOSURE

The engine enclosure consists of cover panels that can be removed to allow access for engine service.

WARNING

Personal Injury or Equipment Damage Hazard!

Personal injury can occur from contact with moving engine components. Equipment damage can occur if all components are not tightened securely.

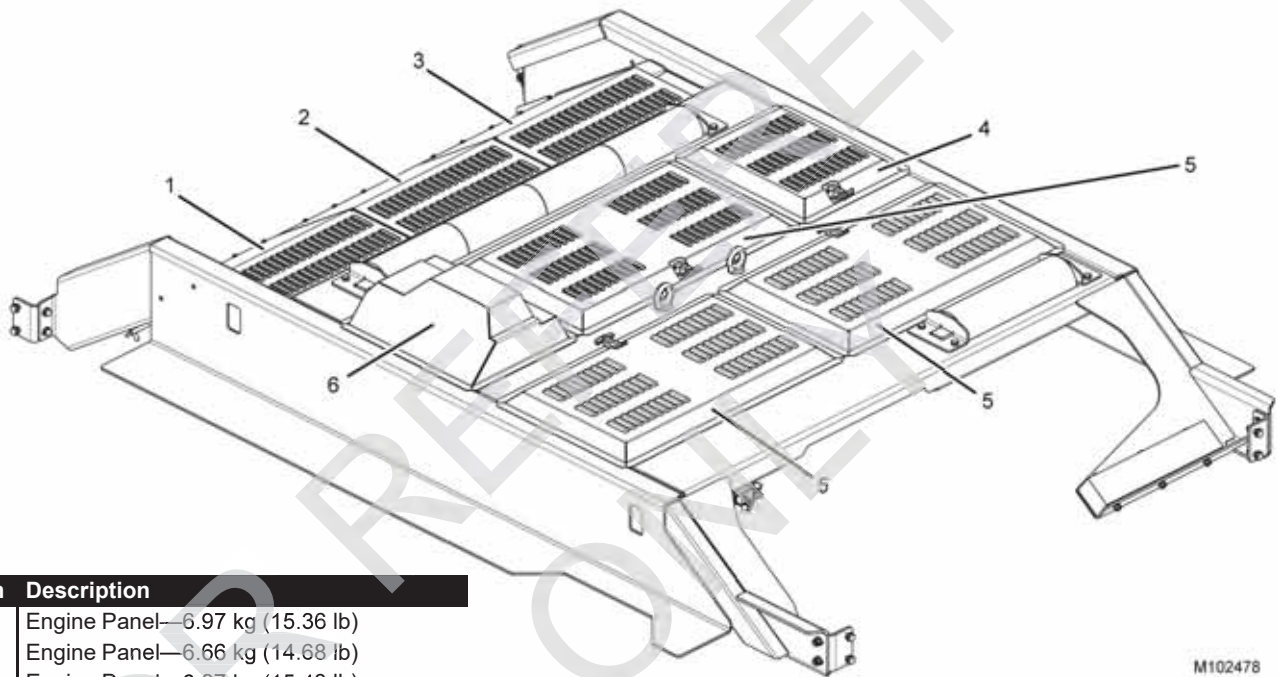
Do not operate the crane without the cover panels in place and all the fasteners secure.

WARNING

Personal Injury Hazard—Heavy Objects!

Engine cover panel weights are listed in the table for [Figure 7-5](#).

To prevent serious injury, use the appropriate lifting equipment when lifting or removing these objects.

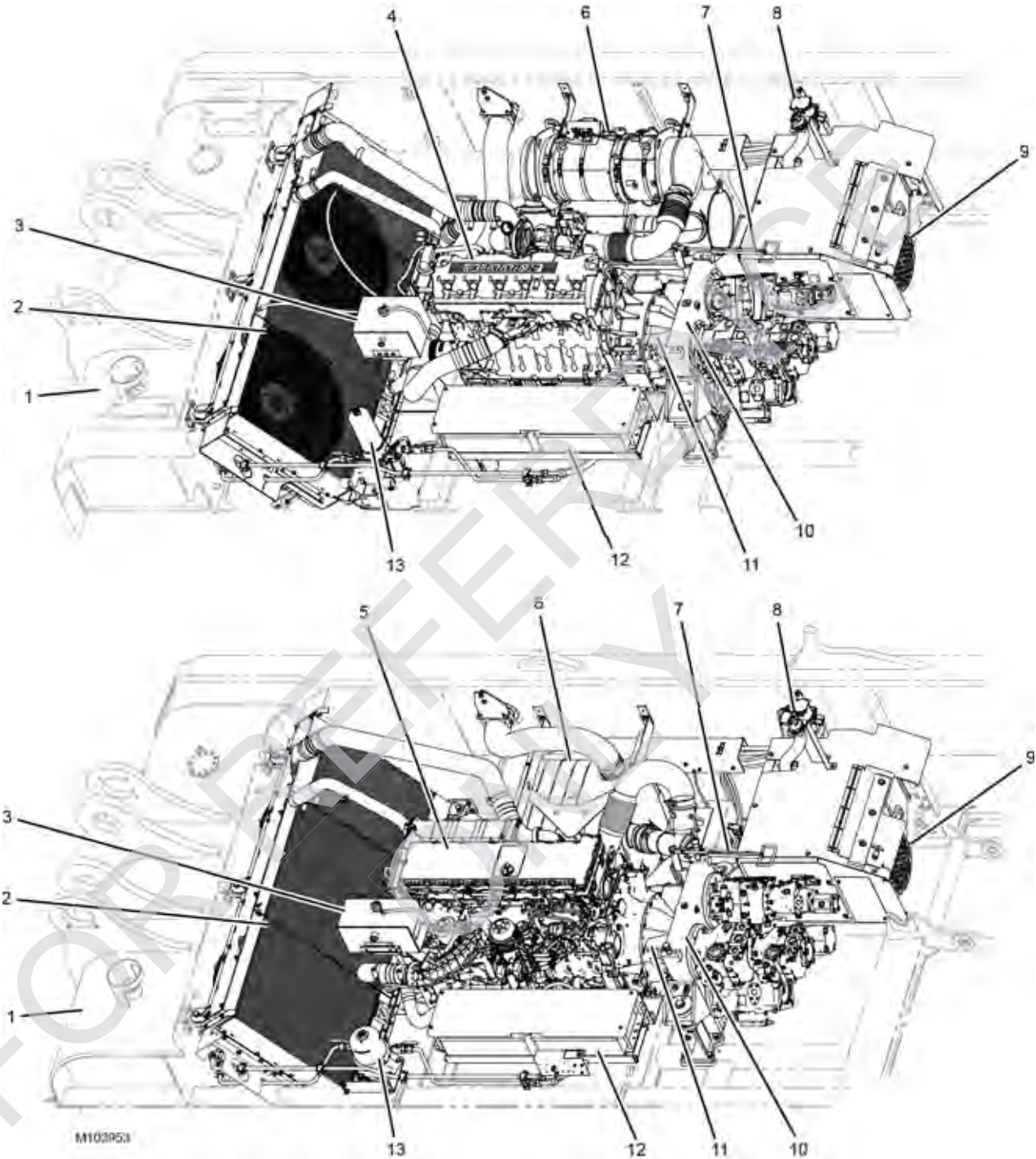


M102478

Item	Description
1	Engine Panel—6.97 kg (15.36 lb)
2	Engine Panel—6.66 kg (14.68 lb)
3	Engine Panel—6.97 kg (15.48 lb)
4	Engine Panel—5.57 kg (12.28 lb)
5	Engine Panel—8.9 kg (19.62 lb)
6	Engine Panel—7.38 kg (16.27 lb)

FIGURE 7-5

ENGINE COMPONENT IDENTIFICATION

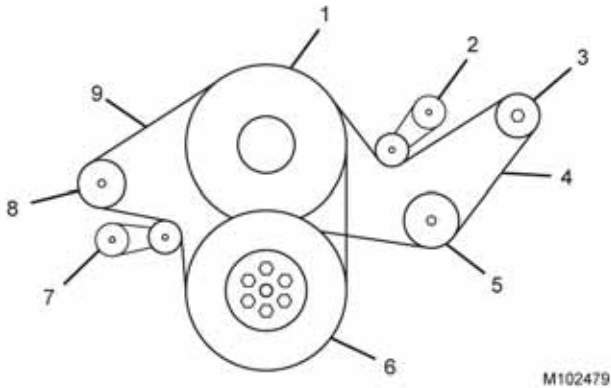


Item	Description	Item	Description	Item	Description
1	Fuel Tank	6	Exhaust Aftertreatment Assembly	10	Pump Drive Assembly
2	Radiator and Coolers	7	Engine Clutch Disconnect Lever	11	Engine Clutch
3	Coolant Expansion Tank	8	DEF Treatment System	12	Batteries
4	Cummins QSG12 Engine	9	Air Cleaner Assembly	13	Fuel Filter
5	MTU 1300 Engine				

FIGURE 7-6

ENGINE BELT ROUTING

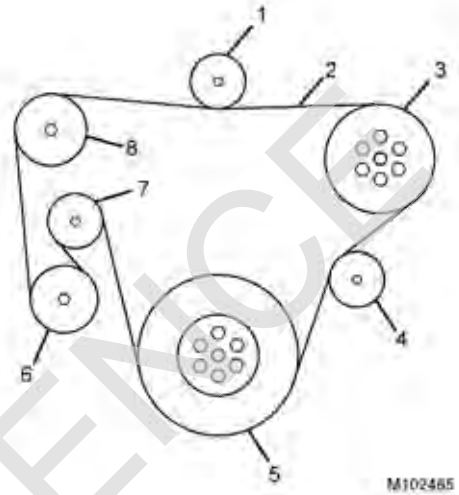
Cummins Engine



Item	Description
1	Fan Pulley
2	Tensioner
3	Alternator
4	Belt 1
5	A/C Compressor
6	Harmonic Balancer
7	Tensioner
8	Water Pump
9	Belt 2

FIGURE 7-7

MTU Engine



Item	Description
1	Idler
2	Belt
3	Water Pump
4	Idler
5	Harmonic Balancer
6	Alternator
7	Tensioner
8	A/C Compressor

FIGURE 7-8

AIR CLEANER MAINTENANCE

See [Figure 7-9](#) for the following procedure.

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

Check the service indicator (5, View B) 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 (5b) extends as the air cleaner filters become plugged. Change the air cleaner filters 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 (5a) 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

- 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 cleaner housing (2, View A) for damage that may allow unfiltered air to enter the engine. Replace the housing if it is damaged.
- Inspect the inlet/pre-cleaner cover (3, View A) for obstructions. Clean the cover as required.
- Inspect the dust ejector (4, View C) for damage. Replace the ejector if necessary.

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.
- Replace the secondary filter as quickly as possible to prevent contaminants from entering the engine intake.
- 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

1. Open the enclosure cover (1, View A).
2. Unlatch and carefully remove the inlet/pre-cleaner cover (3, View A).
3. Remove the primary filters (2a, View D) gently to avoid dislodging dust from the filters.

There will be some initial resistance, similar to breaking the seal on a jar. Using the tab on each filter, move the end of the filter back and forth to break the seal.

NOTE: The secondary filters (2b, View E) should be replaced every third time the primary filters are replaced.

4. Remove the secondary filters by pulling on the plastic rings. Take care to avoid dislodging dust from the filters.
5. Dispose of the old filters 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. Visually inspect the old filters for leaks. A streak of dust on the clean side of a filter is a telltale sign. Remove any causes of leaks before installing new filters.
8. Inspect the new filters, especially the sealing areas. Never install damaged filters.

- 9. Carefully install new secondary filters (2b, View E), if required, and gently push them into the back of the housing. Apply pressure to all four corners and tabs to make sure each filter is completely secure in the housing.
- 10. Repeat the previous step for the primary filters (2a, View D).
- 11. Install the inlet/pre-cleaner cover (3, View A), making sure the seal is in place. Fasten the latches. The cover should go on without extra force.

Never use the latches 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 latches to push the filters into the housing could damage the housing and will void the warranty.

Close and latch the enclosure cover (1, View A).

- 12. Push the reset button on the service indicator (5, View B).

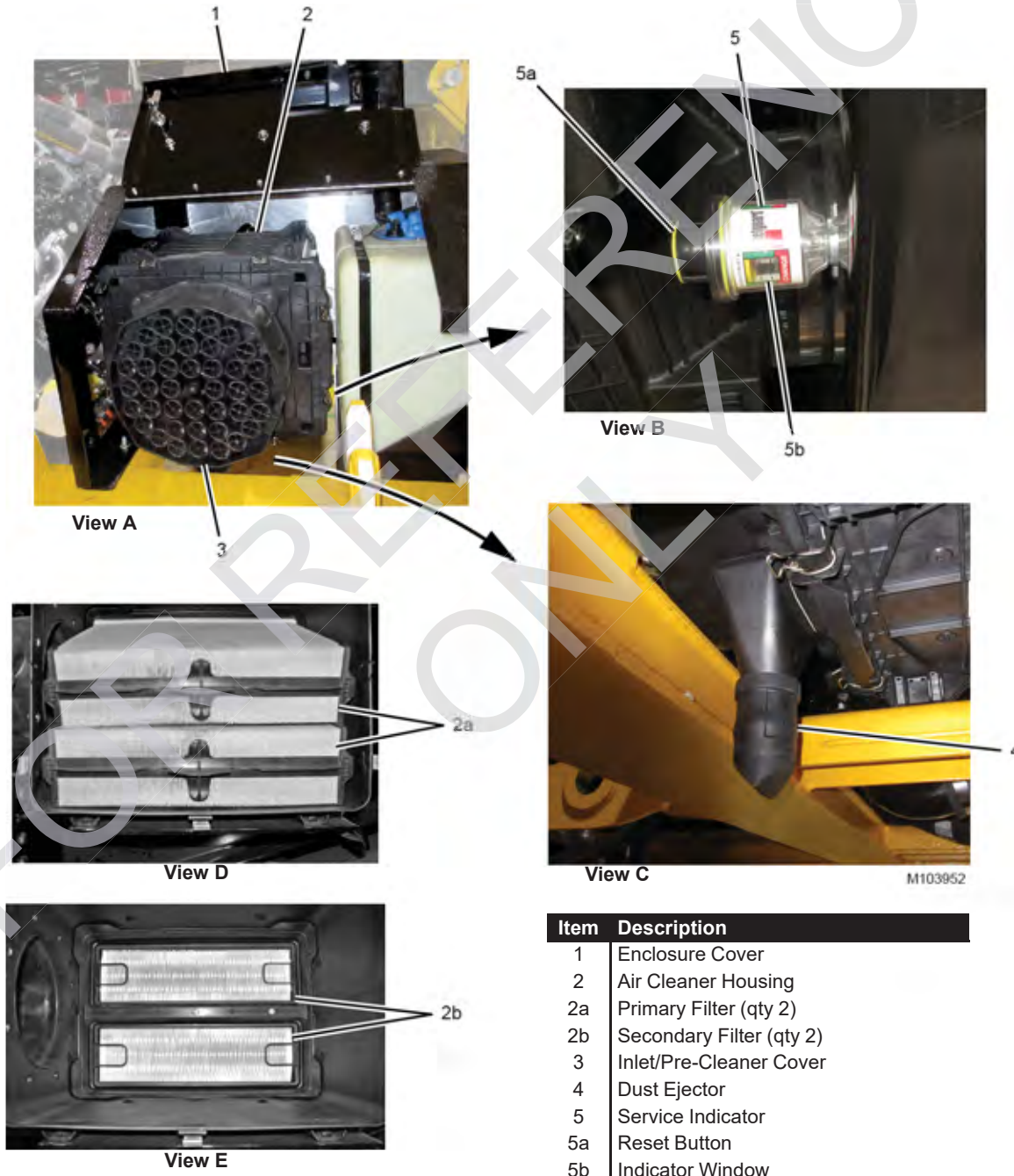


FIGURE 7-9

REPLACING THE FUEL FILTER—MTU

Overview

See [Figure 7-10](#) for the following procedure.

The fuel filter requires periodic maintenance.

- Filters left unchanged make more work for filters closer to the engine, thus increasing the risk of unclean fuel running in the engine.
- An improperly installed or damaged filter can allow dirty fuel to be drawn into the engine.

Either condition can cause engine damage.

Inspecting the Fuel Filter

To maintain engine protection and to prolong filter service life, check the fuel level in the filter daily while the engine is running and observe the following:

- If the fuel level is at the top of the label, watch carefully over the next few weeks for the fuel level to reach the black bar above the label (10).
- If the fuel level has reached the change filter indicator on the black bar above the label, the filter must be changed.

NOTE: If the fuel level is below the label and adding fuel to the fuel tank raises the level in the filter to the black bar, the filter may not need to be replaced. To verify whether the filter needs to be replaced, loosen the vent cap (2) and watch the level of fuel in the filter while the engine runs. The filter does not need to be replaced if the level in the filter decreases.

Replacing the Fuel Filter

1. Close the fuel inlet port (6) and fuel outlet port (7).
2. Loosen the vent cap (2).
3. Place a container below the drain valve (1) to capture draining fuel in the following step.
4. Open the drain valve and drain the filter (4) until the fuel level is just below the housing. Fuel is less likely to spill when the cover (3) is removed if the fuel is just below the housing (5).

The drained fuel can be set aside and reused to prime the filter or can be disposed of.

NOTE: Dispose of used fuel in a way that follows all local, state, and federal environmental regulations.

5. Using the collar wrench (8a), loosen and remove the collar (9) from the cover.
 - a. Loosen the collar two half-twists with the collar wrench (8b).
 - b. Twist the cover with both hands until the cover is completely loose.
 6. Remove the cover, peel the large O-ring off the body, and set the cover aside.
 7. Remove the filter (4) by pulling straight up. Hold the filter over the housing to let excess fuel drip.
 8. Remove the filter grommet from the tube.
 9. Dispose of the old filter according to local environmental regulations.
 10. Remove the vent cap (2) and peel the small O-ring from the vent cap. Wipe the vent cap with a clean towel.
 11. If you have not already done so, peel the large O-ring off the body.
 12. Clean the cover by wiping the rim and outside with a clean towel and install both new O-rings (provided with the new filter).
 13. Manually twist the vent cap (2) onto the top of the cover (3).
 14. Wipe the threads with a clean towel to remove any debris and to ease installation of the collar (9).
 15. Place the filter on the tube and press down to seat the grommet firmly on the base of the tube.
 16. Make sure the spring (11) is on the top inside of the cover (3).
 17. Place the cover (3) over the filter (4), and the collar (9) over the cover.
 18. Apply downward pressure to the cover (3) and tighten the collar (9) with both hands. When the collar is tight against the body, use the collar wrench to twist the collar one notch to ensure proper tightness (8b).
- NOTE:** Tightening the collar past one notch could cause improper filter function and structural damage.
19. Prime the unit by removing the vent cap (2) and filling the clear cover (3) with clean diesel fuel or with the fuel set aside in step 4. Place the vent cap on the cover and tighten the cap by hand.
 20. Open the fuel inlet port (6) and fuel outlet port (7) and run the engine for a minute.
 21. While the engine is running, open the vent cap (2). Close the vent cap when the fuel level is below the label (10).



Item	Description
1	Drain Valve
2	Vent Cap
3	Cover
4	Filter
5	Housing
6	Fuel Inlet Port
7	Fuel Outlet Port
8a	Collar Wrench
8b	Applying Collar Wrench to Collar
9	Collar
10	Label with Black Bar
11	Spring

FIGURE 7-10

REPLACING THE FUEL FILTER—CUMMINS QSG12 ENGINE

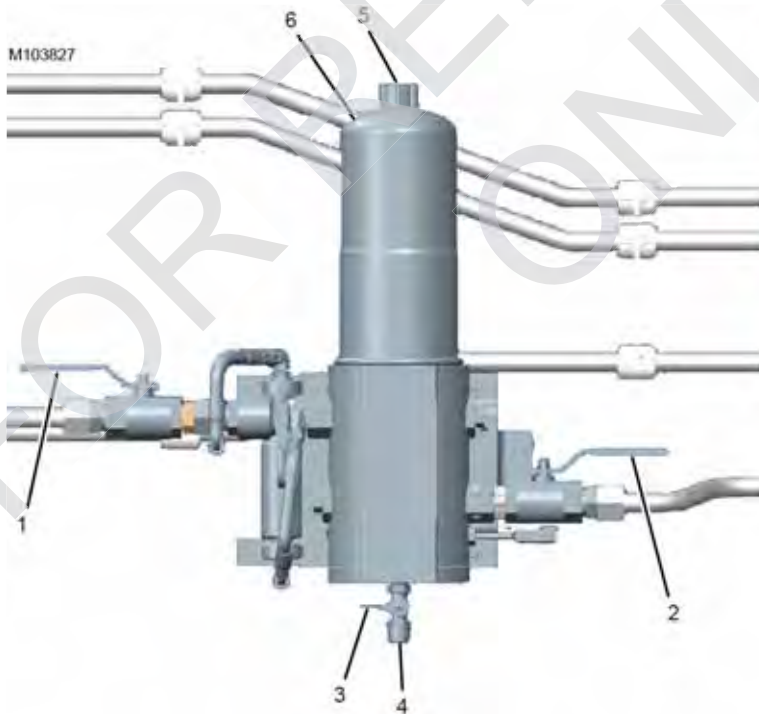
See [Figure 7-11](#) for the following procedure.

Overview

The fuel filter for the Cummins QSG12 engine is a combination fuel filter and water separator. To ensure a clean fuel system and proper engine operation, the fuel filter element must be replaced at the interval specified in the engine manufacturer's operation and maintenance manual.

Replacing the Fuel Filter

1. Stop the engine and leave the ignition switch in the OFF position so the electric fuel primer pump cannot run.
2. Close the outlet shut-off valve (1) and the inlet shut-off valve (2). When shut off, the handles are perpendicular to the fuel lines.
3. Make sure the drain valve (3) is closed. When closed, the handle is perpendicular to the drain valve.
4. Remove the drain plug (4). A small amount of fuel will drain. Catch the fuel with a rag.
5. Connect a 19 mm (3/4 in) I.D. hose to the drain valve to direct the fuel to an approved container with a minimum capacity of 3,8 L (1 gal). Use a hose clamp if needed.
6. Open the drain valve (3) to drain the fuel filter housing.
7. Open the vent (5) on the top of the filter element (6) to drain the fuel.
8. After the fuel is drained, remove the filter element (6) by rotating it counterclockwise (viewed from the top of the filter element).
9. Dispose of the old filter element according to local environmental regulations.
10. Install and securely tighten the new filter element (6) by rotating it clockwise.
11. Close the vent (5).
12. Close the drain valve (3).
13. Remove the hose and install the drain plug (4).
14. Open the outlet shut-off valve (1) and the inlet shut-off valve (2).
15. To prime the fuel system, cycle the ignition switch to ON a few times without starting the engine. The electric fuel primer pump runs for 120 seconds with the key on.



View Inside Rotating Bed to Right Rear of Engine

Item	Description
1	Shut-Off Valve (outlet)
2	Shut-Off Valve (inlet)
3	Drain Valve
4	Drain Plug
5	Vent
6	Filter Element

FIGURE 7-11

ENGINE RADIATOR

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.

Material Hazard!

Coolant is toxic. Do not ingest. Dispose of in accordance with all local and other applicable environmental regulations.

CAUTION **Avoid Engine Damage!**

The required coolant level must be maintained to prevent engine damage.

Checking the Coolant Level

See [Figure 7-13](#) for the following procedure.

For service other than checking the coolant level, refer to the engine manufacturer's manual for instructions.

Check the coolant level daily (at the start of the shift) when the engine is cold.

The coolant should be at the full cold level specified on the level decal (5). If necessary, add coolant as follows:

1. Remove the enclosure cover (4).
2. Take care to prevent being burned from hot coolant as follows.
 - a. Place a heavy cloth over the fill cap (1).
 - 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.

CAUTION

Avoid Engine Damage!

The required supplemental coolant additive (SCA) concentration must be maintained to prevent engine damage.

SCA must be added to the cooling system to prevent liner pitting and for scaling protection.

Check the SCA concentration according to the schedule in the engine manufacturer's operator manual and per the manufacturer's warnings, cautions, and instructions.

3. Slowly add coolant to the expansion tank (2) until the coolant is at the proper level on the sight gauge (3).
4. Securely install the fill cap (1).
5. Install the enclosure cover (4).

Draining and Re-Filling the Cooling System

See [Figure 7-13](#) for the following procedure.

NOTE: The cooling system has a quick-drain valve (7) that requires using the quick-drain drainer assembly (see [Figure 7-12](#)) to drain the coolant. 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	Drain Hose



FIGURE 7-12

Drain the cooling system every 1,000 hours of operation or semi-annually, whichever occurs first.

1. Insert the quick-drain hose into a suitable container that can hold 95 L (25 gal) of coolant.
2. Remove the enclosure cover (4).
3. Take care to prevent being burned from hot coolant as follows.
 - a. Place a heavy cloth over the fill cap (1).
 - 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.

4. Attach the quick-drain drainer to the quick-drain valve (7). The fluid will drain.
5. Once the cooling system has completely drained, refill it.
6. Dispose of the drained coolant according to local environmental regulations.

CAUTION

Maintain Coolant Additive!

A proper concentration of supplemental coolant additive (SCA) must be maintained to prevent engine damage.

Check the SCA concentration according to the schedule in the engine manufacturer's manual and per the manufacturer's warnings, cautions and instructions.

7. Add the supplemental coolant additive (SCA) to the radiator through the fill cap opening.
8. Add a 50-50 mix of water and ethylene glycol to the radiator.

NOTE: The maximum fill rate is 19 L/min (5 GPM).

9. Once coolant is visible at the full cold mark on the level decal (5), wait 2 to 3 minutes, then add coolant again as needed.

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.

10. Check that the cab heater valves under the cab are open.

11. In the cab, place the heat control to maximum.

NOTE: It is not necessary to turn on the heater fan.

12. Start the engine and run it until the thermostat opens at a coolant temperature of 83 to 93°C (181 to 199°F).

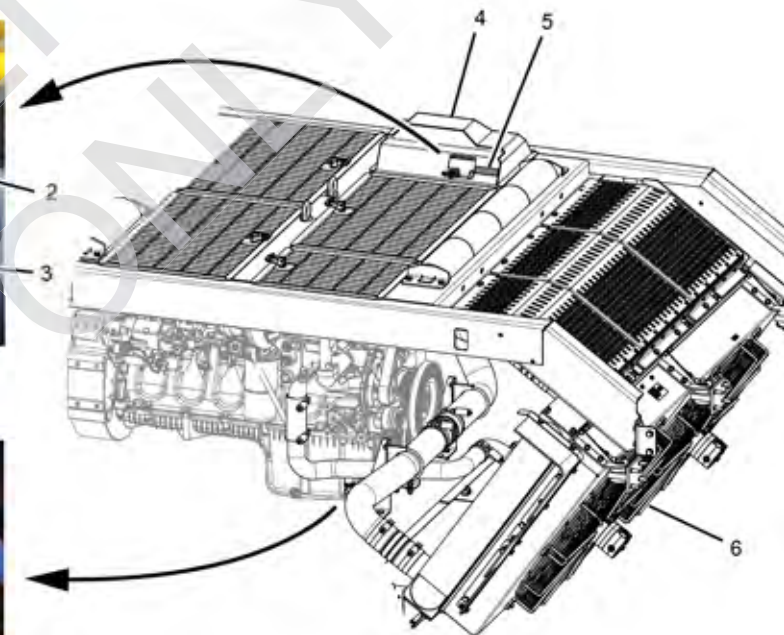
13. Reduce engine speed to low idle for 2 minutes to cool down the engine components, then stop the engine.

14. Once the engine has cooled, add coolant until it is visible at the full cold mark on the level decal (5).

15. Install the fill cap (1) and install the enclosure cover (4).



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Item	Description
1	Fill Cap—1.03 bar (15 PSI)
2	Expansion Tank
3	Sight Gauge
4	Enclosure Cover
5	Level Decal
6	Radiator
7	Quick-Drain Valve

FIGURE 7-13

CHANGING THE PUMP DRIVE OIL

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 best oil change interval and the condition of the pump drive.

Periodic Maintenance

Daily

Check the oil level in the pump drive every 8 hours of operation or daily, whichever occurs first.

Using a suitable funnel, add oil through the fill plug opening so the oil is at the full mark on the dipstick (3). Do not overfill.

Initial Operation

Drain and refill the pump drive after the first 200 hours of operation.

Every 6 Months or 1,000 Hours

Drain and refill the pump drive every 1,000 hours of operation or every 6 months, whichever occurs first, unless an alternate interval has been established through an oil analysis program.

Quick-Drain Valve

The pump drive has a quick-drain valve (4) that requires use of the quick-drain drainer assembly (see [Figure 7-14](#)). 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 7-14

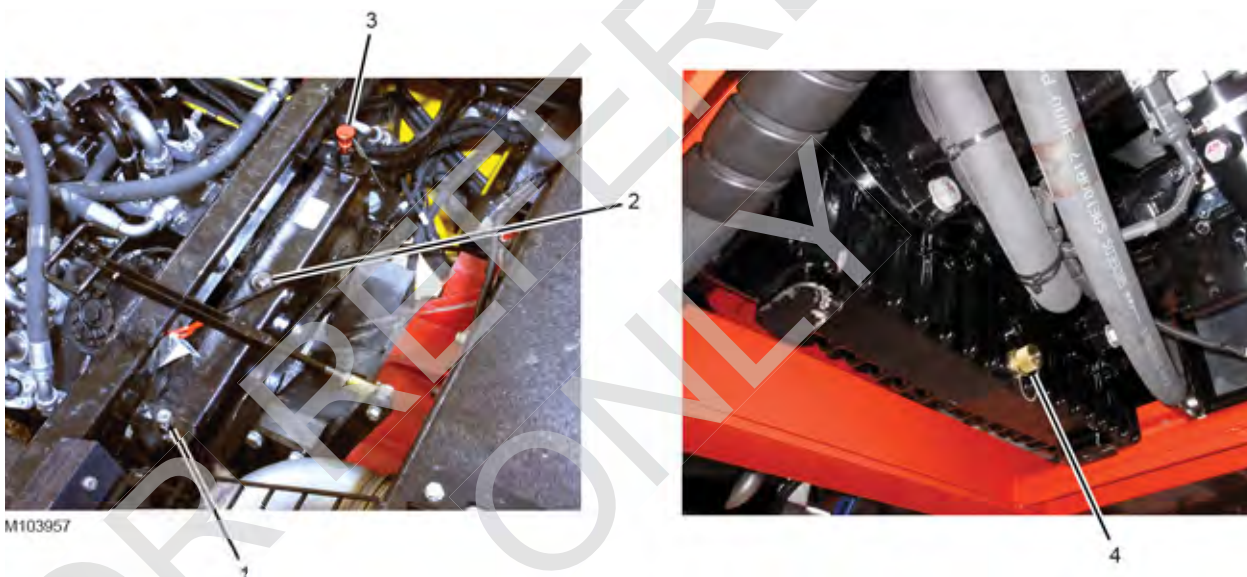
Changing the Oil

See [Figure 7-15](#) for the following procedure.

Change the oil when the pump drive is warm.

NOTE: To prevent harmful contaminants from entering the pump drive, thoroughly clean any components before disconnecting or connecting them.

1. Lockout-tagout the crane.
2. Remove the fill plug (2) to vent the gearbox.
3. Remove the dust cap from the quick-drain valve (4).
4. Place the hose from the quick-drain drainer assembly ([Figure 7-14](#)) into an appropriate container for collecting the drained oil.
5. Thread the quick-drain drainer assembly all the way onto the quick-drain valve (4). 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 the specified oil as follows.
 - a. If not already done, remove the fill plug (2).
 - b. Using an appropriate funnel, add oil through the fill plug opening so the oil is at the full mark on the dipstick (3). Do not overfill.
 - c. Install the fill plug (2).
9. Dispose of the drained oil according to local environmental regulations.



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Item	Description
1	Breather
2	Fill Plug
3	Dipstick
4	Quick-Drain Valve

FIGURE 7-15

ENGINE CLUTCH MAINTENANCE

A disc-type, manually operated clutch (see [Figure 7-16](#)) is mounted between the engine and the pump drive. The clutch allows the pump drive to be disconnected from the engine, thereby reducing engine load and making startup easier in cold weather. The clutch can be engaged or disengaged while the engine is running or off.

CAUTION

Parts Damage!

Do not run the engine longer than 20 minutes with the clutch disengaged. The clutch release bearing can be damaged.

Monthly

- Grease the clutch monthly. See Section 9: Lubrication for more information.

- At least once each month, park all crane functions and disengage and engage the clutch several times with the engine running. This practice cleans the disc surfaces and prevents the discs from seizing.
- When disengaging the clutch, check free travel. Free travel should be 19,1 mm (3/4 in) (see [Figure 7-16](#)). Readjust the clutch when free travel is less than 19,1 mm (3/4 in).

Adjustment



DANGER

Moving Machinery Hazard!

The parts inside the clutch rotate when the engine is running. Stop the engine and lockout-tagout the crane before adjusting the clutch.

The clutch is adjusted internally through the hand hole in the clutch housing. See the manufacturer's manual for adjustment instructions.

Item	Description
1	Pump Drive
2	Engine Clutch
3	Clutch Lever Disengaged
4	Clutch Lever Engaged
5	Free Travel: 19,1 mm (3/4 in)
6	Release Travel: 12,7–14,3 mm (1/2–9/16 in)
7	Free Travel Between Yoke and Wear Pads: 3,2 mm (1/8 in)
8	Yoke

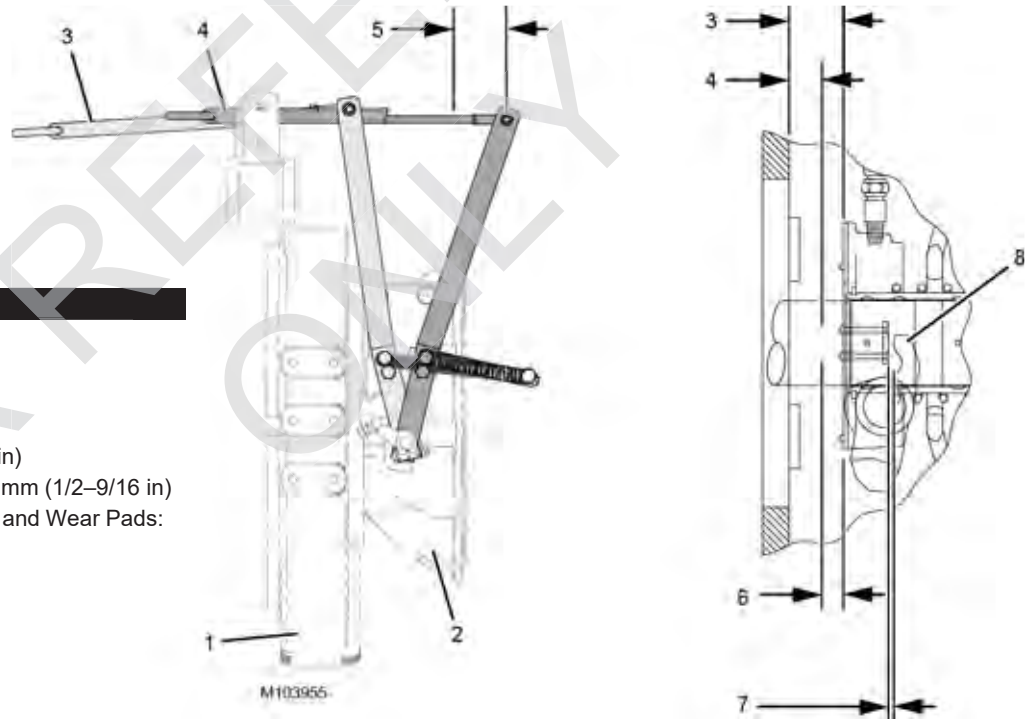


FIGURE 7-16

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 7-17](#) 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 the Manitowoc Crane Care Lattice Team 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.

Foot Throttle Control Assembly and Calibration

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_{DC} to 26 V_{DC} available at the white wire, 0 V_{DC} 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_{DC} to 1.0 V_{DC}.
 - 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_{DC} to 1.0 V_{DC} 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_{DC} to 3.0 V_{DC}.
9. Install the assembly onto the crane.

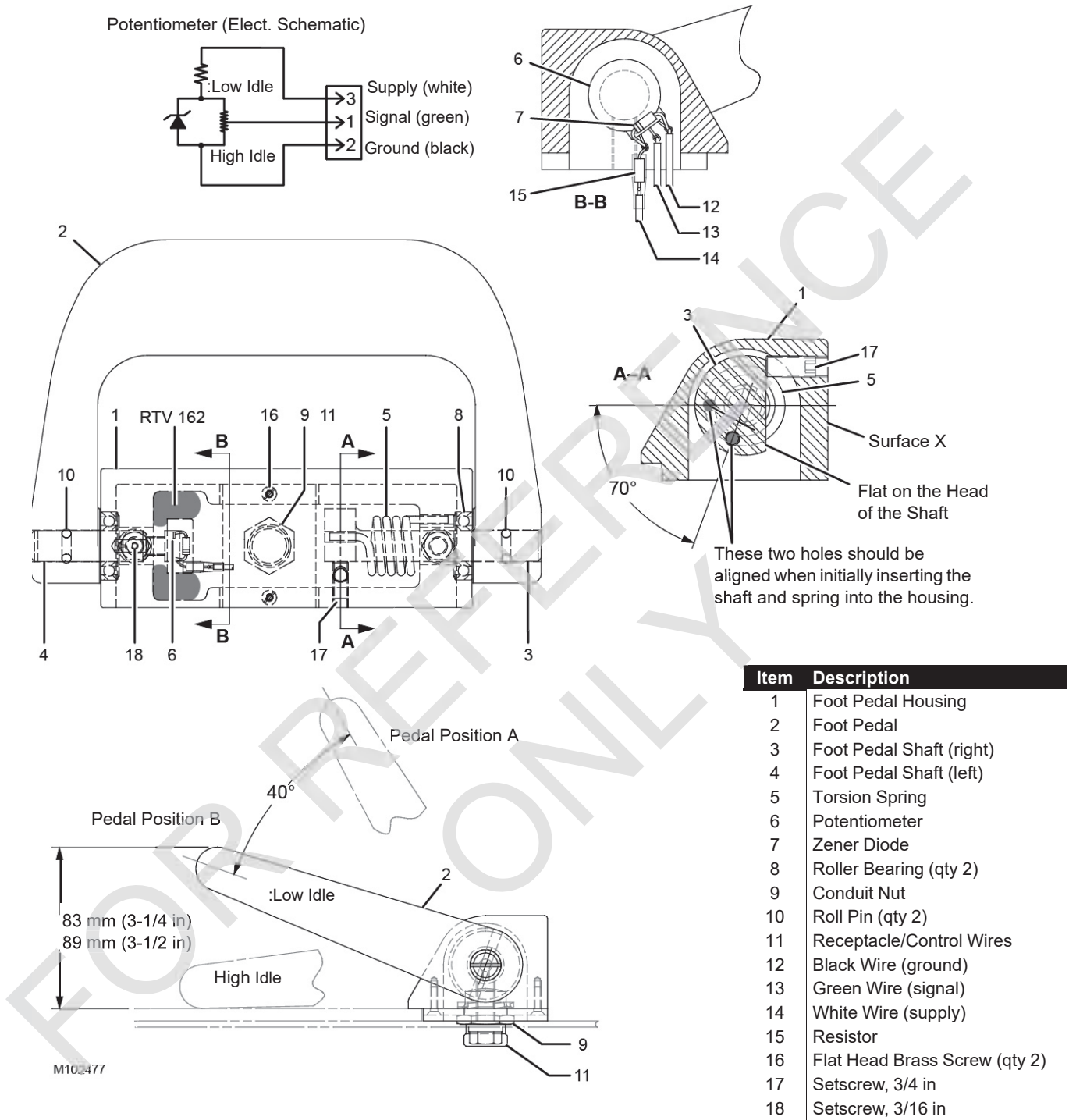


FIGURE 7-17

ENGINE ELECTRICAL SCHEMATIC

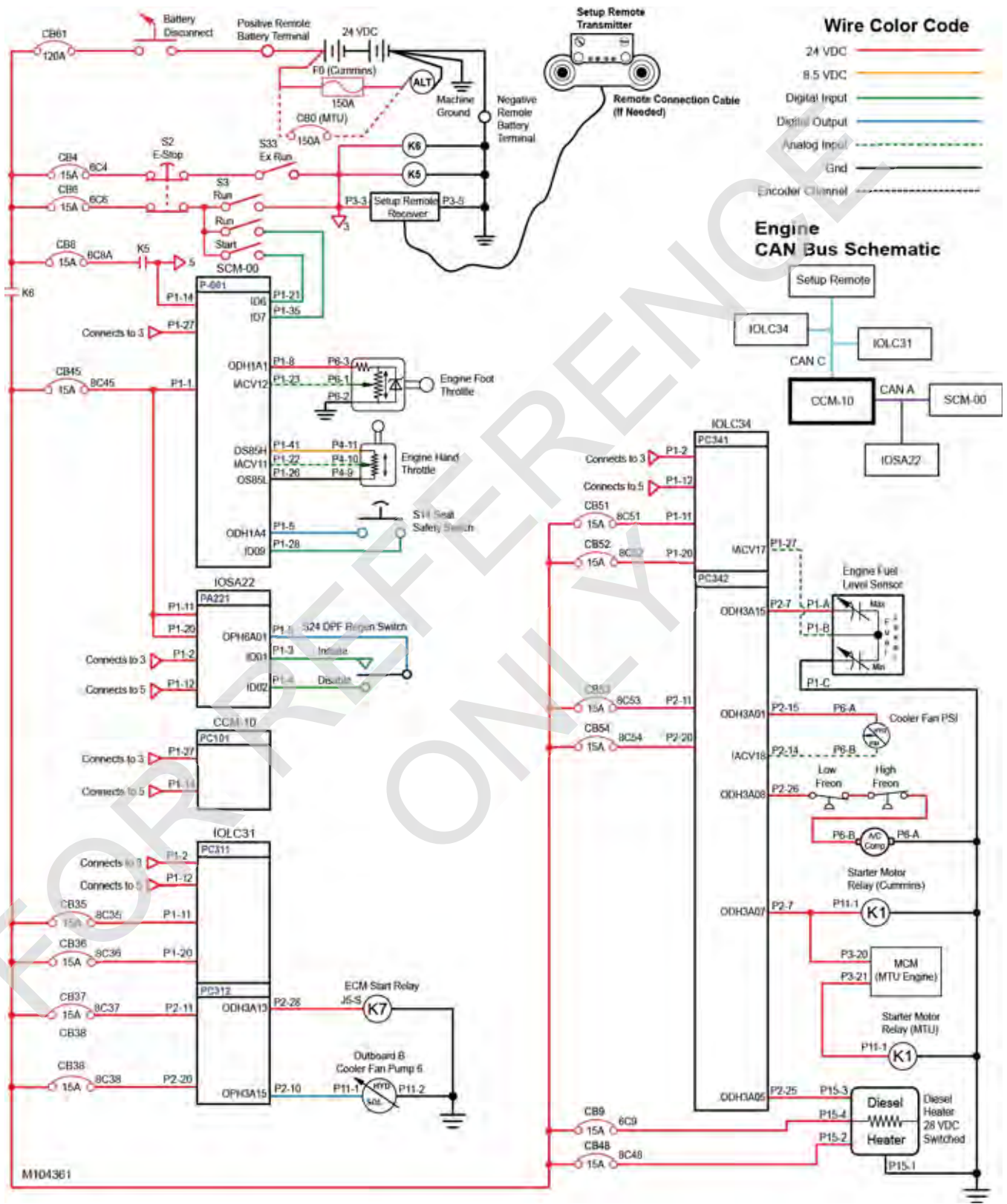


FIGURE 7-18

EXHAUST AFTERTREATMENT SYSTEM

See [Figure 7-19](#) 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
DRP	Decomposition Reactor Pipe
ECM	Engine Control Module
HEST	High Exhaust System Temperature
SCR	Selective Catalytic Reduction
NH ₃	Ammonia
NO _x	Generic term for the mono-nitrogen oxides NO and NO ₂ (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 MLC300 Operator Manual for operation of the Engine Regeneration/Inhibit switch in the operator cab.

Tier 4 Main Display Icons

Refer to MLC300 Main Display Operation Manual for identification of the tier 4 icons that appear in the Crane Systems Status Bar of the main display.

DEF Tank

The DEF tank (1) houses 57 L (15 gal) of DEF. DEF consists of 32% urea and 68% de-ionized water. A metered mist of DEF, approximately equal to 7% of the fuel used, is injected into the DRP (7). This is about 52 L (14 gal) of DEF for one tank of fuel.

There is a 40-micron filter on the DEF suction tube inside the tank. For filter maintenance intervals and procedures, refer to the engine manufacturer's manual.

The DEF level can be monitored in the Crane Systems Status Bar of the main display. See the MLC300 Main Display Operator Manual. When the tank is full, the DEF is at the dimension (1b) measured from the bottom of the tank.

The drain plug (1c) 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, which is mounted on the DRP (7).

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 the engine manufacturer's manual.



WARNING

Personal Injury or Equipment Damage Hazard!

Do not remove hoses from or attempt to service the DEF supply module without first consulting the engine manufacturer's 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°C (25°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 (4) oxidizes the remaining hydrocarbons in the exhaust to carbon dioxide. It incorporates an 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 (6). The flow of DEF through the dosing module also keeps it cool and operable.

SCR Module

The SCR module (6) incorporates a catalyst, two temperature sensors, an NH_3 sensor, and an NO_x sensor.

The SCR module utilizes DEF (urea and deionized water) to reduce NO_x content in the exhaust gas to nitrogen.

The SCR module does not require maintenance.

Excessive NO_x Warning System

CAUTION

Loss of Power or Engine Shutdown Hazard!

If 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 derate 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 NO_x warning is issued, check anything that might cause an elevated 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 NO_x sensor

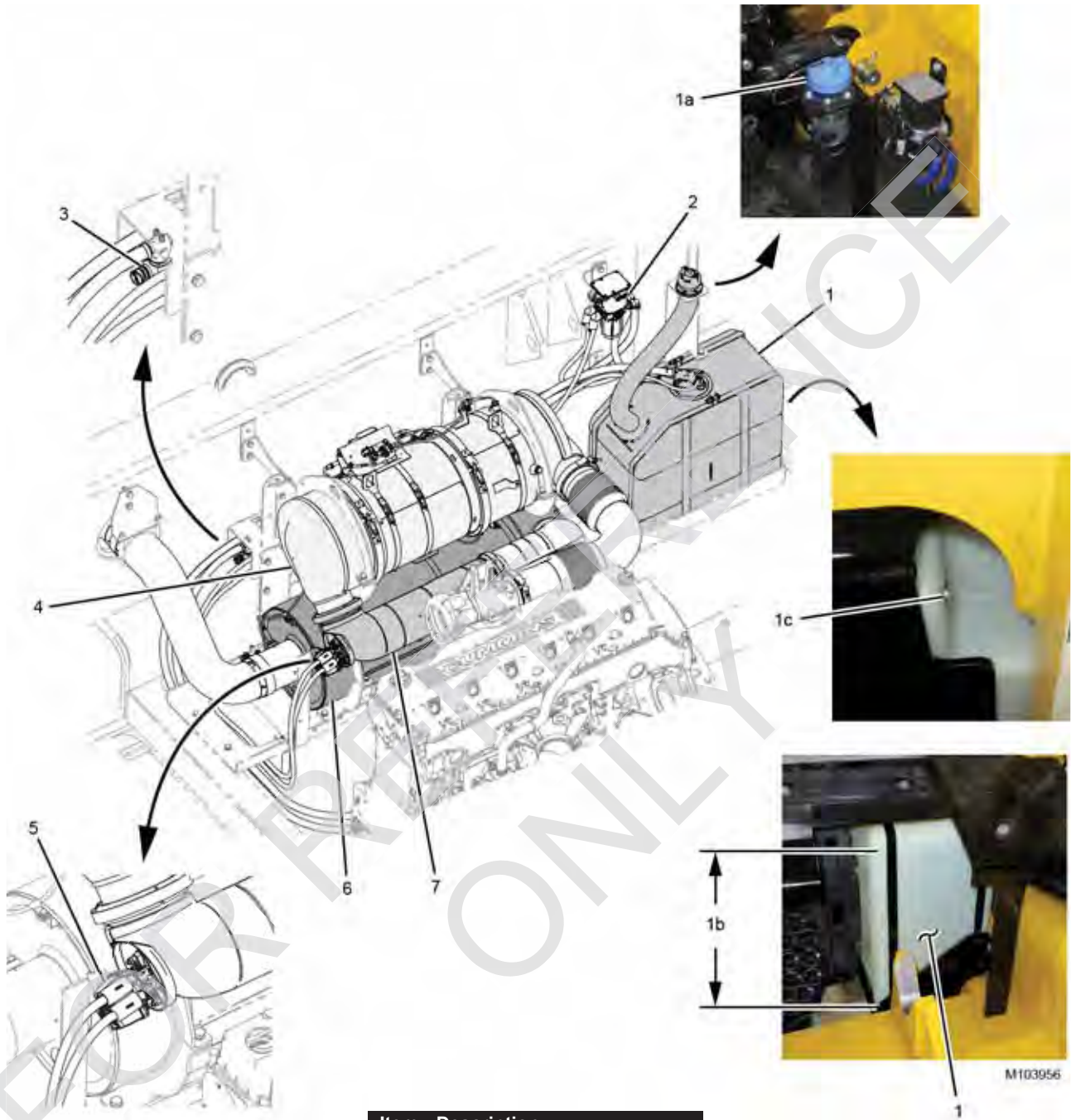
APS

The APS continually monitors exhaust gas temperatures. In the event of excessive exhaust temperatures, the APS activates the HEST icon on the main display.

DRP

The DRP (7) is a pipe mounted between the DOC/DPF module (4) and the SCR module (6).

The DRP does not require maintenance.



Item	Description
1	DEF Tank
1a	Fill Cap
1b	Fill Height—343 mm (13.5 in)
1c	Drain Plug
2	DEF Supply Module
3	Coolant Control Valve
4	DOC/DPF Module
5	DEF Dosing Module
6	SCR Module
7	DRP

FIGURE 7-19

SECTION 8 UNDERCARRIAGE

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FOR REFERENCE ONLY

SECTION 8

UNDERCARRIAGE

GENERAL

This section provides operational information and electrical and hydraulic schematics for the following systems:

- Travel System
- Carbody Jack Cylinders
- Crawler Pin Pullers
- Carbody Track Tension Cylinders

Additional component information for these systems can be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

This section also provides repair, maintenance, and adjustment procedures for the crawler and turntable.

HYDRAULIC TRAVEL SYSTEM

Travel System Overview

The travel system consists of two open-looped hydraulic circuits. One circuit controls the left crawler, and the other circuit controls the right crawler. Each open-looped circuit consists of a directional control valve, one engine-driven hydraulic pump, and one hydraulic motor.

Hydraulic Pumps

The hydraulic pumps used for the travel system are electronically controlled, bi-directional, variable-displacement type of pumps.

The right travel circuit uses pump 3. The left travel circuit uses pump 4. Pumps 3 and 4 also provide hydraulic flow to other open-loop functions.

Directional Control Valves

The directional control valve is an electronically controlled proportional valve. Each directional control valve contains two solenoids. Depending on which solenoid is energized, the valve spool will move to a position that allows hydraulic fluid from the pump to flow to the travel motor for either forward or reverse travel direction.

When in neutral, the directional control valve spool is held in the center position. When in this position, the forward and reverse hydraulic lines to the travel motor are connected through orifice passages in the valve spool.

Travel Motors

The travel motors are electronically controlled, bi-directional variable-displacement type of motors that provide power to planetary drives. Each travel motor is equipped with a park brake that must be hydraulically released before travel can occur.

The speed and direction of the travel motors are dependent on the output flow volume of the travel pumps, the position of the directional control valve, and the position of the travel motor servo.

Joystick J2 Control

The pumps, directional control valves, and motors are electronically controlled by the position of the corresponding travel control handle (joystick J2) and the travel speed switch located on the right console. Joystick J2 communicates with the crane control system using the controller area network bus (CAN Bus).

The left travel control handle controls pump 4, the left travel control valve, and the left travel motor.

The right travel control handle controls pump 3, the right travel control valve, and the right travel motor.

Travel Brake Operation

See [Figure 8-1](#) and [Figure 8-2](#) for the following information.

The travel brakes are a spring-applied, hydraulically released brake system located between each travel motor and its corresponding planetary drive. The travel brake must be actively released by the control system. If the brake hydraulic pressure or electrical control is lost, the brake is applied by spring force.

The travel brake release system uses charge pressure from pump 2, supplied to the travel brakes via the travel brake release solenoid valve. The brake release pressure must be at least 17 bar (246 psi) to fully release the brakes. If the pressure is less than 17 bar (246 psi), the brakes could remain partially applied, which could damage the brake system.

Travel Park Brake Disengaged

Joystick J2 sends 24 V_{DC} to the travel park switch. The travel park switch is closed in the UN-PARK position, causing the switch to send 24 V_{DC} back to joystick J2. When 24 V_{DC} is detected, joystick J2 activates the travel control handles, but does not allow the travel park brake to disengage until one or both travel control handles are moved.

When a travel control handle is moved, either forward or rearward, joystick J2 sends the disengage park brake command to the CCM-10 control module via CAN Bus A. The CCM-10 control module relays the command to the CCMB11 control module via CAN Bus C. The CCMB11 control module then sends 24 V_{DC} to the travel brake release solenoid valve, energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the travel brakes, releasing the brakes.

Travel Park Brake Engaged

When the travel park switch is moved to the ON-PARK position, the travel park switch is open, sending 0 V_{DC} back to joystick J2. When 0 V_{DC} is detected, joystick J2 deactivates the travel control handles and sends the engage park brake command to the CCM-10 control module via CAN Bus A. The CCM-10 control module relays the command to the CCMB11 control module via CAN Bus C.

The CCMB11 control module then sends 0 V_{DC} to the travel brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake system to flow through the travel brake release solenoid valve, then back to the tank. The reduced hydraulic pressure allows spring force to apply the travel brakes.

Travel Speed Selection

See [Figure 8-1](#) and [Figure 8-2](#) for the following information.

Low Travel Speed

The SCM-00 control module sends 24 V_{DC} to the travel speed switch. When the switch is in the LOW speed position, the switch is open, sending 0 V_{DC} back to the SCM-00 control module. The SCM-00 control module communicates the low-speed command to the CCM-10 control module via CAN Bus A.

The CCM-10 control module then sends a corresponding signal to the IOSB22 control module via CAN Bus B. The IOSB22 control module then decreases the pulse width modulation (PWM) duty cycle to the travel motor control solenoids. The decreased PWM duty cycle increases the angle of the motor swashplate, causing the motor speed to decrease. Motor displacement goes to maximum.

When in low-speed travel mode, the travel motors are kept at maximum displacement and any variation in travel speed is done by varying the PWM duty cycle to the pump control solenoids.

High Travel Speed

When the travel speed switch is in the HIGH speed position, the switch is closed, sending 24 V_{DC} back to the SCM-00 control module. The SCM-00 control module communicates the high-speed command to the CCM-10 control module via CAN Bus A.

The CCM-10 control module then sends a corresponding signal to the IOSB22 control module via the CAN Bus B. The control algorithm commands the CCM-10 and IOSB22 control modules to drive the travel pumps and motors at a higher rate of speed relative to the movement of the travel control handles.

When in high-speed travel mode, the IOSB22 control module varies the PWM duty cycle to the travel motor control solenoids as commanded by the control algorithm. Increasing the PWM duty cycle decreases the angle of the motor swashplate, causing the motor speed to increase.

NOTE: When the load on the travel circuit increases, the control algorithm decreases the PWM signal to the motors. This causes the angle of each motor's swashplate to increase, which increases motor displacement. The motors rotate at a slower speed, but with more torque.

Forward Travel Operation

See [Figure 8-1](#) and [Figure 8-2](#) for the following information.

To enable the travel control system, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Travel park switch in the UN-PARK position

When the travel park switch is placed in the UN-PARK position, the CCMB11 control module energizes the travel brake release solenoid valve, routing hydraulic fluid to the travel brakes, releasing the brakes.

When either control handle of joystick J2 is moved to the forward position, joystick J2 communicates the travel command to the CCM-10 control module via CAN Bus A.

The CCM-10 control module then begins to ramp up the PWM duty cycle to the corresponding pump's electronic displacement control (EDC). The PWM signal is in proportion to the speed commanded by the travel control handle. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the pump.

At the same time, the CCM-10 control module communicates the forward travel command to the IOLC33 and CCMC11 control modules via CAN Bus C:

- If the left joystick handle is moved forward, the IOLC33 control module energizes the left travel control valve, shifting the valve to the position that allows hydraulic fluid to flow to the left travel motor for forward travel.
- If the right joystick handle is moved forward, the CCMC11 control module energizes the right travel control valve, shifting the valve to the position that allows hydraulic fluid to flow to the right travel motor for forward travel.

If high-speed travel mode is selected, the IOSB22 control module ramps up the PWM duty cycle to the corresponding travel motor control solenoid to increase the motor speed until the commanded travel speed is achieved.

The following sensors provide feedback to the control system:

- Pump 3 pressure transducer
- Pump 4 pressure transducer
- Left travel psi pressure transducer
- Right travel psi pressure transducer
- Left travel motor speed sensor
- Right travel motor speed sensor

The control system uses this feedback to adjust the pump and motor flows to maintain the speeds commanded by joystick J2.

Reverse Travel Operation

See [Figure 8-1](#) and [Figure 8-2](#) for the following information.

To enable the travel control system, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Travel park switch in the UN-PARK position

When the travel park switch is placed in the UN-PARK position, the CCMB11 control module energizes the travel brake release solenoid valve, routing hydraulic fluid to the travel brakes, releasing the brakes.

When either control handle of joystick J2 is moved to the rearward position, joystick J2 communicates the travel command to the CCM-10 control module via CAN Bus A.

The CCM-10 control module then begins to ramp up the PWM duty cycle to the corresponding pump's electronic displacement control (EDC). The PWM signal is in proportion to the speed commanded by the travel control handle. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the pump.

At the same time, the CCM-10 control module communicates the reverse travel command to the IOLC33 and CCMC11 control modules via CAN Bus C:

- If the left joystick handle is moved rearward, the IOLC33 control module energizes the left travel control valve, shifting the valve to the position that allows hydraulic fluid to flow to the left travel motor for reverse travel.

- If the right joystick handle is moved rearward, the CCMC11 control module energizes the right travel control valve, shifting the valve to the position that allows hydraulic fluid to flow to the right travel motor for reverse travel.

If high-speed travel mode is selected, the IOSB22 control module ramps up the PWM duty cycle to the corresponding travel motor control solenoid to increase the motor speed until the commanded travel speed is achieved.

The following sensors provide feedback to the control system:

- Pump 3 pressure transducer
- Pump 4 pressure transducer
- Left travel psi pressure transducer
- Right travel psi pressure transducer
- Left travel motor speed sensor
- Right travel motor speed sensor

The control system uses this feedback to adjust the pump and motor flows to maintain the speeds commanded by joystick J2.

No Travel

When joystick J2 handles are in the neutral position, the travel pumps are de-stroked and the left and right travel control valves remain in the center position, blocking hydraulic flow from the pumps to the travel motors. The travel brake release solenoid is deenergized, allowing spring force to apply the travel brakes.

Travel Hydraulic Schematic

Figure 8-1 shows the travel circuit in the neutral position.

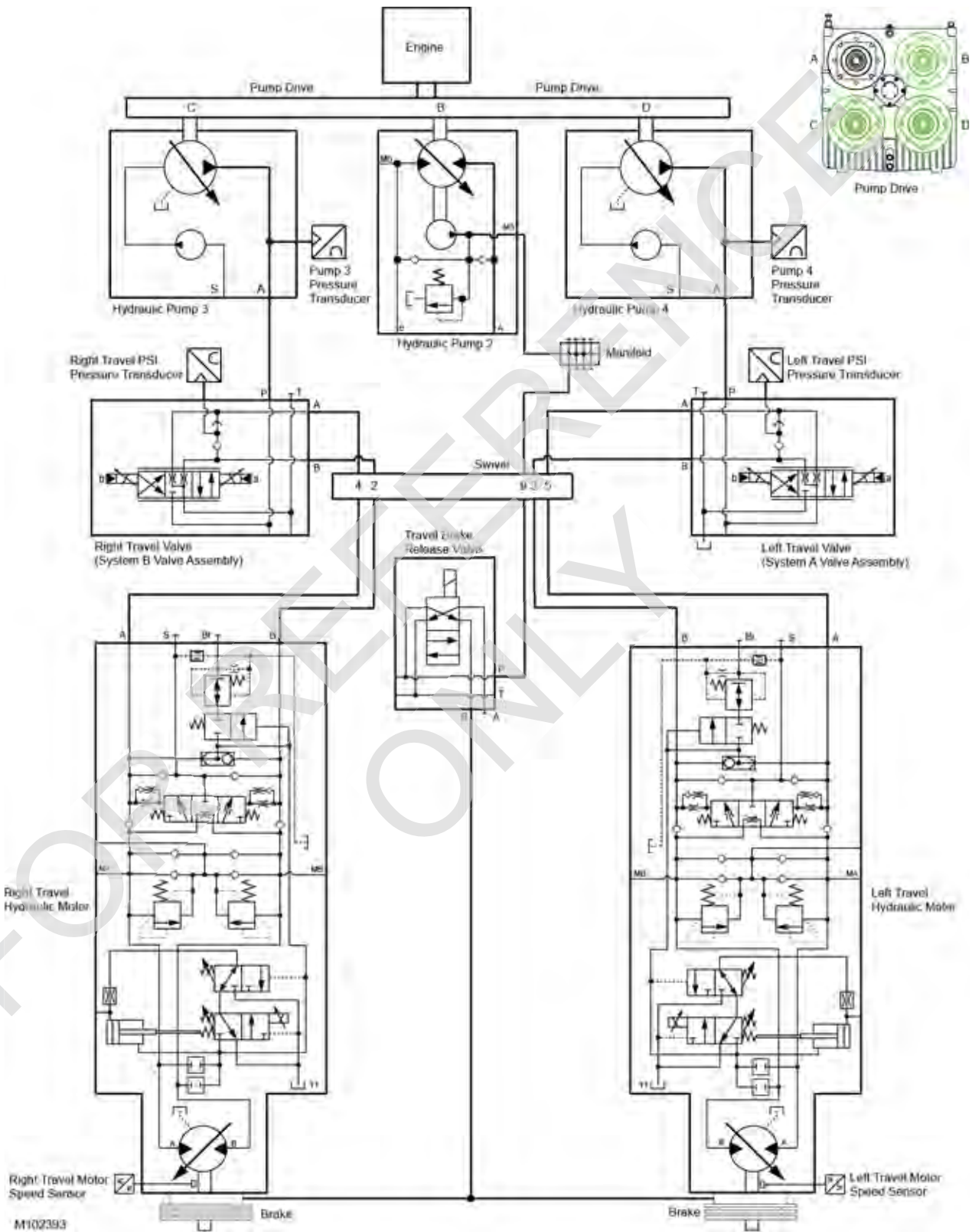


FIGURE 8-1

Travel Electrical Schematic

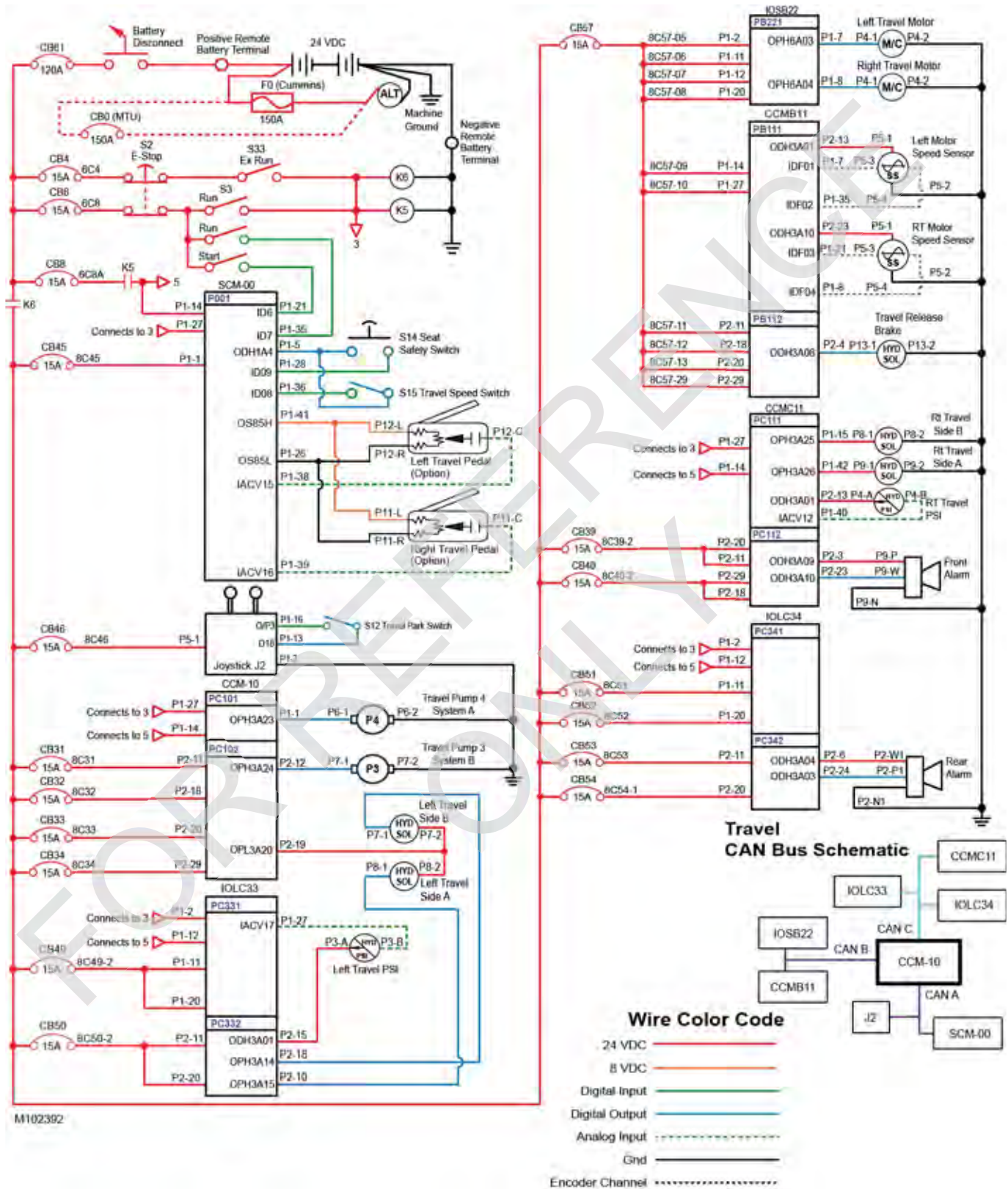


FIGURE 8-2

TRAVEL MOTOR CASE FLUSHING

See [Figure 8-3](#) for the following descriptions.

The purpose of the travel motor case flushing circuit is to provide a continuous flow of cool, filtered make-up oil to the case of both travel motors.

When the engine is running, pump 8 (3) supplies hydraulic fluid to the inlet port (P1) of the valve manifold (1).

The hydraulic fluid is routed to the inlet port of the relief valve (2) and to the pressure-reducing valve (4).

The relief valve (2) limits system pressure in the brake and pawl circuits to 15,2 bar (220 psi).

The pressure-reducing valve (4) reduces pressure in the flushing circuit to 13 bar (289 psi).

The hydraulic fluid exits from the outlet port (CF) of the valve manifold, then flows through the swivel (5), and enters the inlet of the flow divider (6) in the carbody.

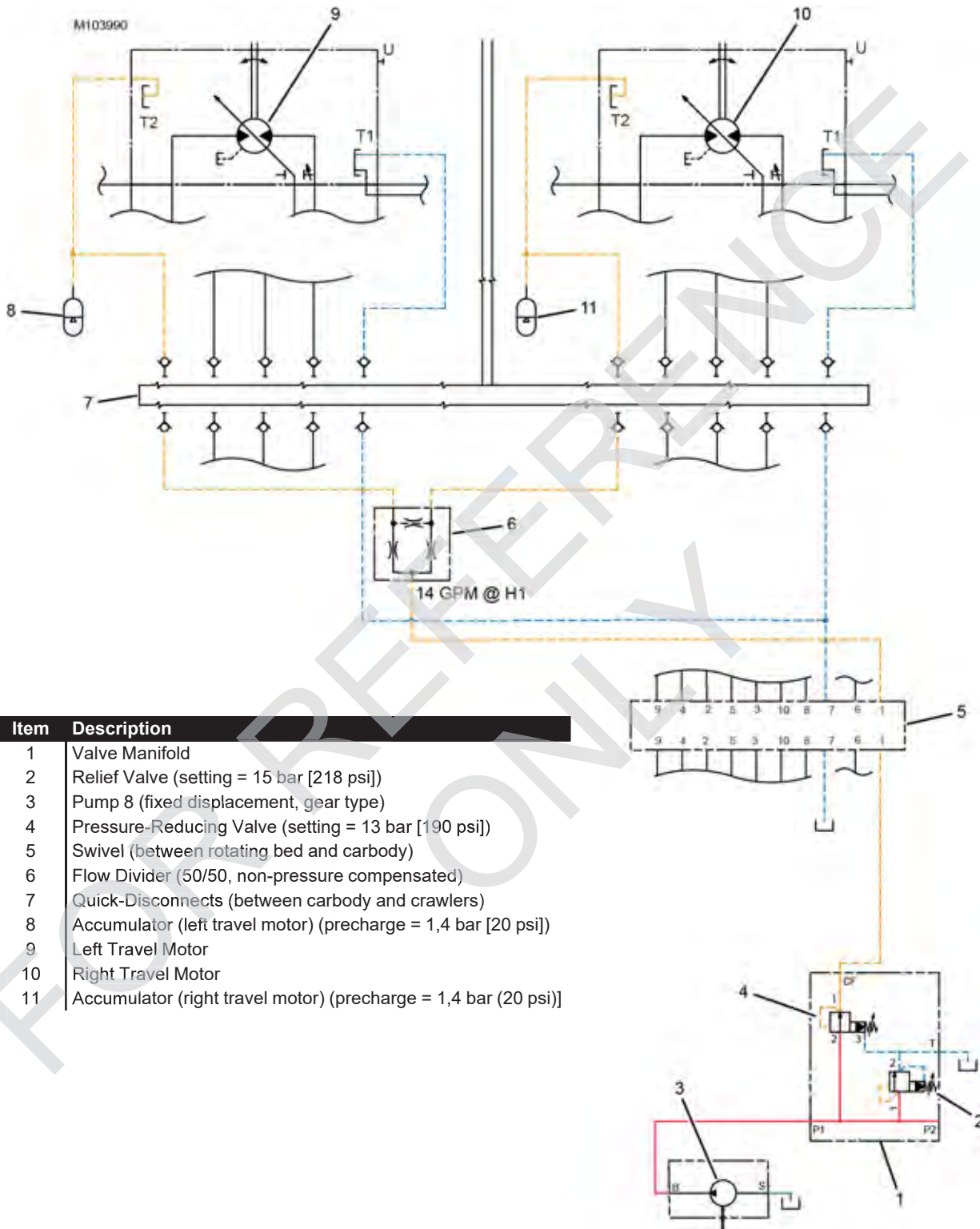
The flow divider divides the hydraulic flow 50/50 and directs the hydraulic fluid to the inlet port (T2) of each travel motor (9 and 10).

The hydraulic fluid exits the outlet port (T1) of each motor and returns to the tank to continue the cycle of filtering and cooling the hydraulic fluid to the travel motor cases.

Accumulators (8 and 11) protect the motor cases from damage during storage or shipping by absorbing pressure increases caused by thermal expansion. This protection is needed because the hydraulic fluid is trapped in the motors by quick disconnects on the hoses.

FOR REFERENCE ONLY

Travel Motor Case Flushing Hydraulic Schematic



Item	Description
1	Valve Manifold
2	Relief Valve (setting = 15 bar [218 psi])
3	Pump 8 (fixed displacement, gear type)
4	Pressure-Reducing Valve (setting = 13 bar [190 psi])
5	Swivel (between rotating bed and carbody)
6	Flow Divider (50/50, non-pressure compensated)
7	Quick-Disconnects (between carbody and crawlers)
8	Accumulator (left travel motor) (precharge = 1,4 bar [20 psi])
9	Left Travel Motor
10	Right Travel Motor
11	Accumulator (right travel motor) (precharge = 1,4 bar (20 psi))

FIGURE 8-3

CARBODY JACKS

See [Figure 8-4](#) and [Figure 8-5](#) for the following descriptions.

The carbody jacks are controlled by the setup remote control.

Setup Remote Control

The setup remote control communicates with the CCM-10 control module via the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

To operate the setup remote, it must be turned on as instructed in the MLC300 Operator Manual.

Neutral

When the setup remote is not transmitting:

- Pump 3 hydraulic flow through system B (right valve assembly) decreases.
- The isolation valve B shifts to neutral to block pump flow to the carbody jack solenoid valves.
- The carbody jack solenoid valves shift to neutral to block pump flow to the carbody jacks.
- The counterbalance valves lock the jacks in position.

Load Holding

If pressure is lost to either end of a jack cylinder, the counterbalance valves shift to the closed position, causing the check valves to trap the oil in the jack cylinder and lock it in position.

Lower (retract jack)

When a lower (retract jack) command is initiated by the setup remote, the setup remote receiver communicates the retract command to the CCM-10 and IOC30 control modules via CAN Bus C. The following then occurs:

- The CCM-10 control module increases the pulse-width modulation (PWM) current to pump 3 to increase system B hydraulic flow.
- The IOLC30 control module sends 24 V_{DC} to the side A solenoid on the system B isolation valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the carbody jack solenoid valves.

- The CCM-10 control module relays the retract command to the CCMB11 and IOSB22 control modules via CAN Bus B. The CCMB11 and IOSB22 control modules then send 24 V_{DC} to the corresponding solenoid on the selected carbody jack valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid through an orifice, then to the rod end of the counterbalance valve.
- At the counterbalance valve, hydraulic fluid flows through the rod end check valve and into the rod end of the jack cylinder. At the same time, pilot pressure opens the valve at the barrel end of the counterbalance valve. As hydraulic fluid fills the rod end of the jack cylinder, the rod retracts. This action forces hydraulic fluid out of the barrel end of the jack cylinder, through the open valve, and back to the tank.

Raise (extend jack)

When a raise (extend jack) command is initiated by the setup remote, the setup remote receiver communicates the extend command to the CCM-10 and IOC30 control modules via CAN Bus C. The following then occurs:

- The CCM-10 control module increases the PWM current to pump 3 to increase system B hydraulic flow.
- The IOLC30 control module sends 24 V_{DC} to the side A solenoid on the system B isolation valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the carbody jack solenoid valves.
- The CCM-10 control module relays the extend command to the CCMB11 and IOSB22 control modules via CAN Bus B. The CCMB11 and IOSB22 control modules then send 24 V_{DC} to the corresponding solenoid on the selected carbody jack valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the barrel end of the counterbalance valve.
- At the counterbalance valve, hydraulic fluid flows through the barrel end check valve and into the barrel end of the jack cylinder. At the same time, pilot pressure opens the valve at the rod end of the jack cylinder. As hydraulic fluid fills the barrel end of the jack cylinder, the rod extends. This action forces hydraulic fluid out the rod end of the jack cylinder, through the open valve, and back to the tank.

Carbody Jacks Hydraulic Schematic

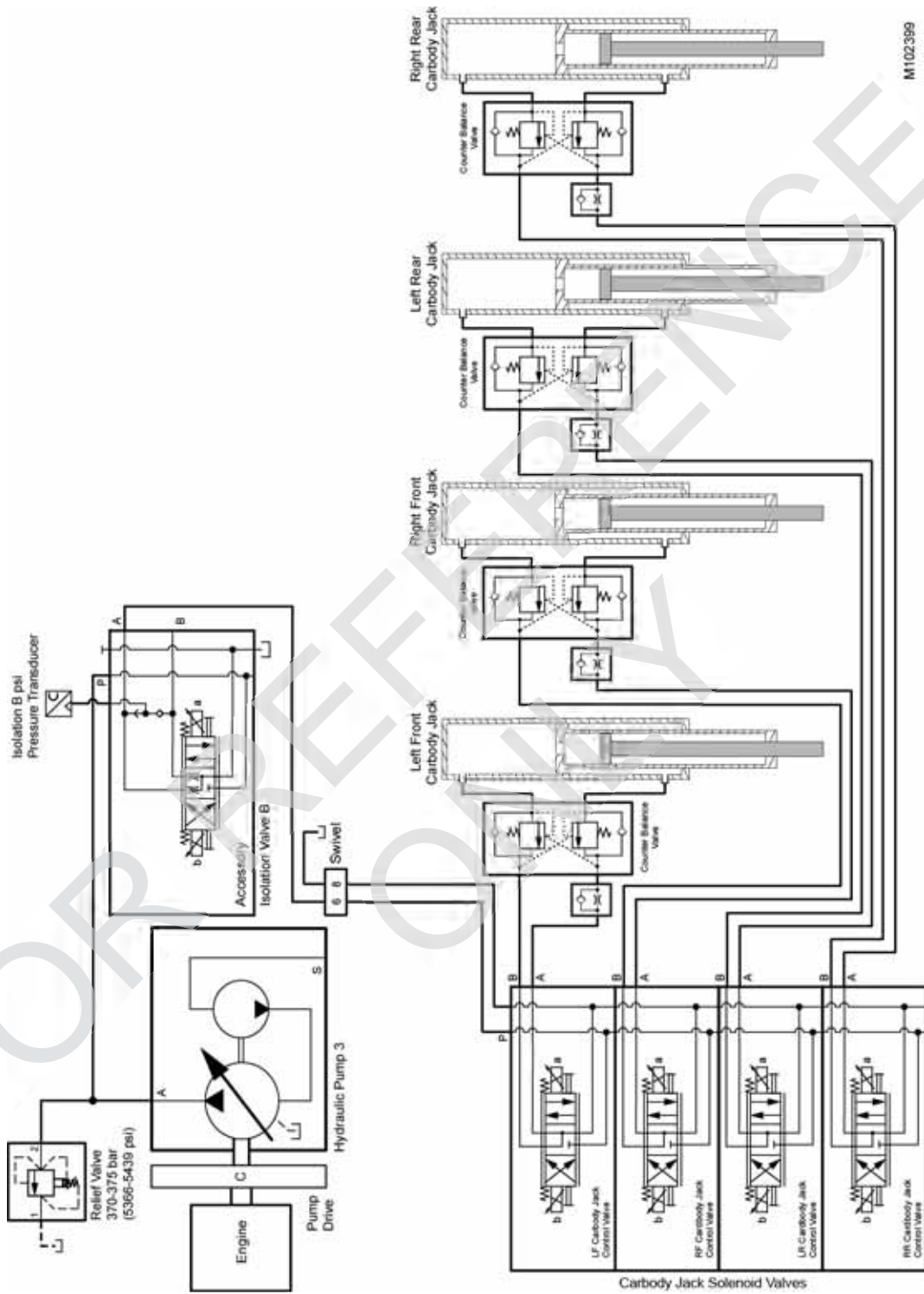


FIGURE 8-4

Carbody Jacks Electrical Schematic

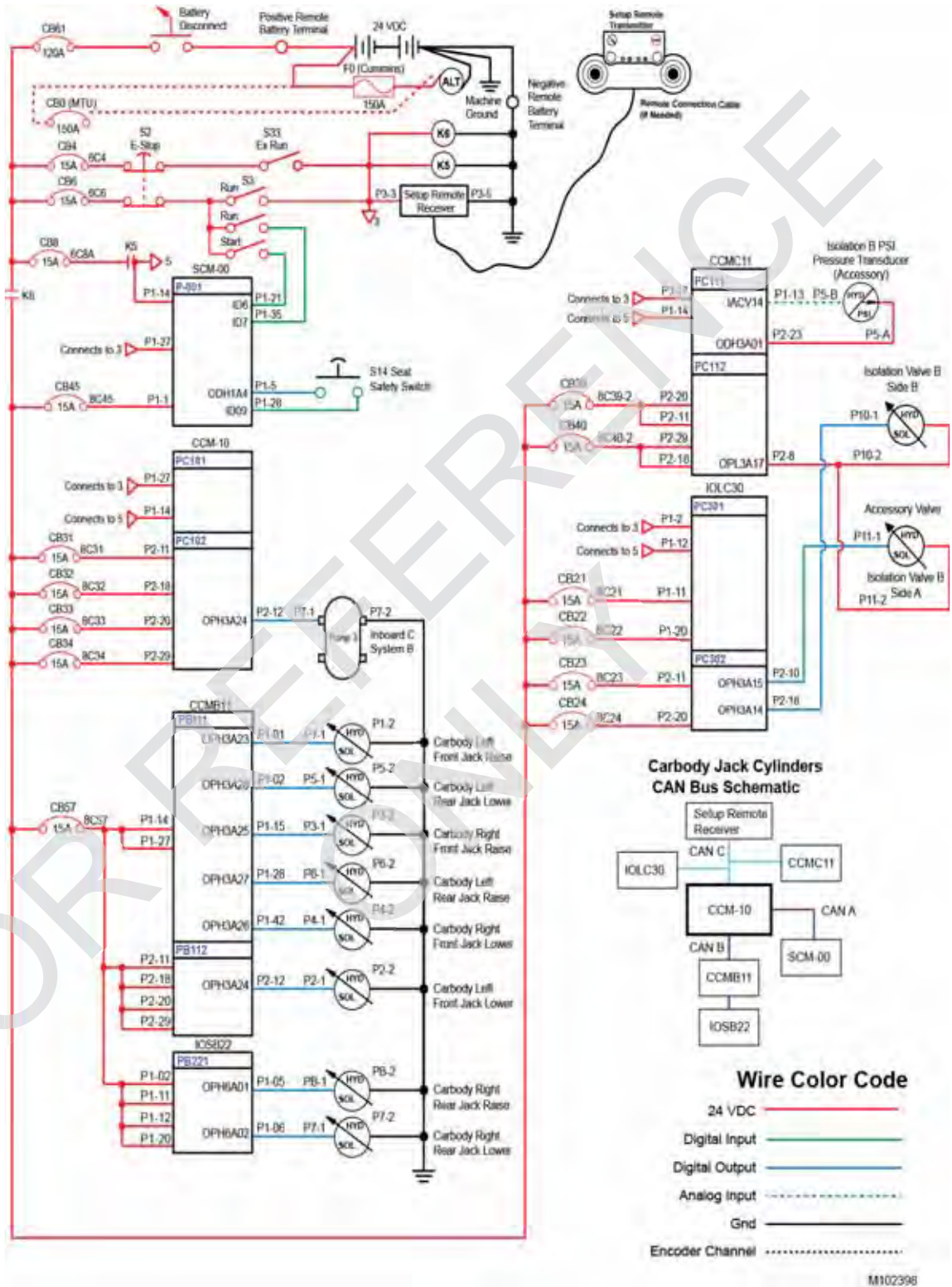


FIGURE 8-5

CRAWLER PINS

See [Figure 8-6](#) and [Figure 8-7](#) for the following descriptions.

The crawler pins are controlled by the setup remote.

Setup Remote Control

The setup remote control communicates with the CCM-10 control module via the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

To operate the setup remote, it must be turned on as instructed in the MLC300 Operator Manual.

Neutral

When the setup remote is not transmitting:

- Pump 3 hydraulic flow through system B (right valve assembly) decreases.
- The isolation valve B shifts to neutral to block pump flow to the crawler pin puller solenoid valves.
- The crawler pin puller solenoid valves shift to neutral to block pump flow to the crawler pin pullers.

Disengage (retract pins)

When a disengage (retract pins) command is initiated by the setup remote, the setup remote receiver communicates the retract command to the CCM-10 and IOC30 control modules via CAN Bus C. The following then occurs:

- The CCM-10 control module increases the pulse-width modulation (PWM) current to pump 3 to increase system B hydraulic flow.
- The IOLC30 control module sends 24 V_{DC} to the side A solenoid on the system B isolation valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the crawler pin puller solenoid valves.

- The CCM-10 control module relays the retract command to the CCMB11 control module via CAN Bus B. The CCMB11 control module then sends 24 V_{DC} to the corresponding solenoid on the selected crawler pin puller valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the rod end of the pin puller cylinder.
- As hydraulic fluid flows into the rod end of the pin puller cylinder, the rod retracts to disengage the corresponding crawler pin. This action forces hydraulic fluid out the barrel end of the pin puller cylinder and back to the tank.

Engage (extend pins)

When an engage (extend pins) command is initiated by the setup remote, the setup remote receiver communicates the extend command to the CCM-10 and IOC30 control modules via CAN Bus C. The following then occurs:

- The CCM-10 control module increases the PWM current to pump 3 to increase system B hydraulic flow.
- The IOLC30 control module sends 24 V_{DC} to the side A solenoid on the system B isolation valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the crawler pin puller solenoid valves.
- The CCM-10 control module relays the extend command to the CCMB11 control module via CAN Bus B. The CCMB11 control module then sends 24 V_{DC} to the corresponding solenoid on the selected crawler pin puller valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the barrel end of the pin puller cylinder.
- As hydraulic fluid flows into the barrel end of the pin puller cylinder, the rod extends to engage the corresponding crawler pin. This action forces hydraulic fluid out the rod end of the pin puller cylinder and back to the tank.

Crawler Pins, Auto Lube, and Track Tension Electrical Schematic

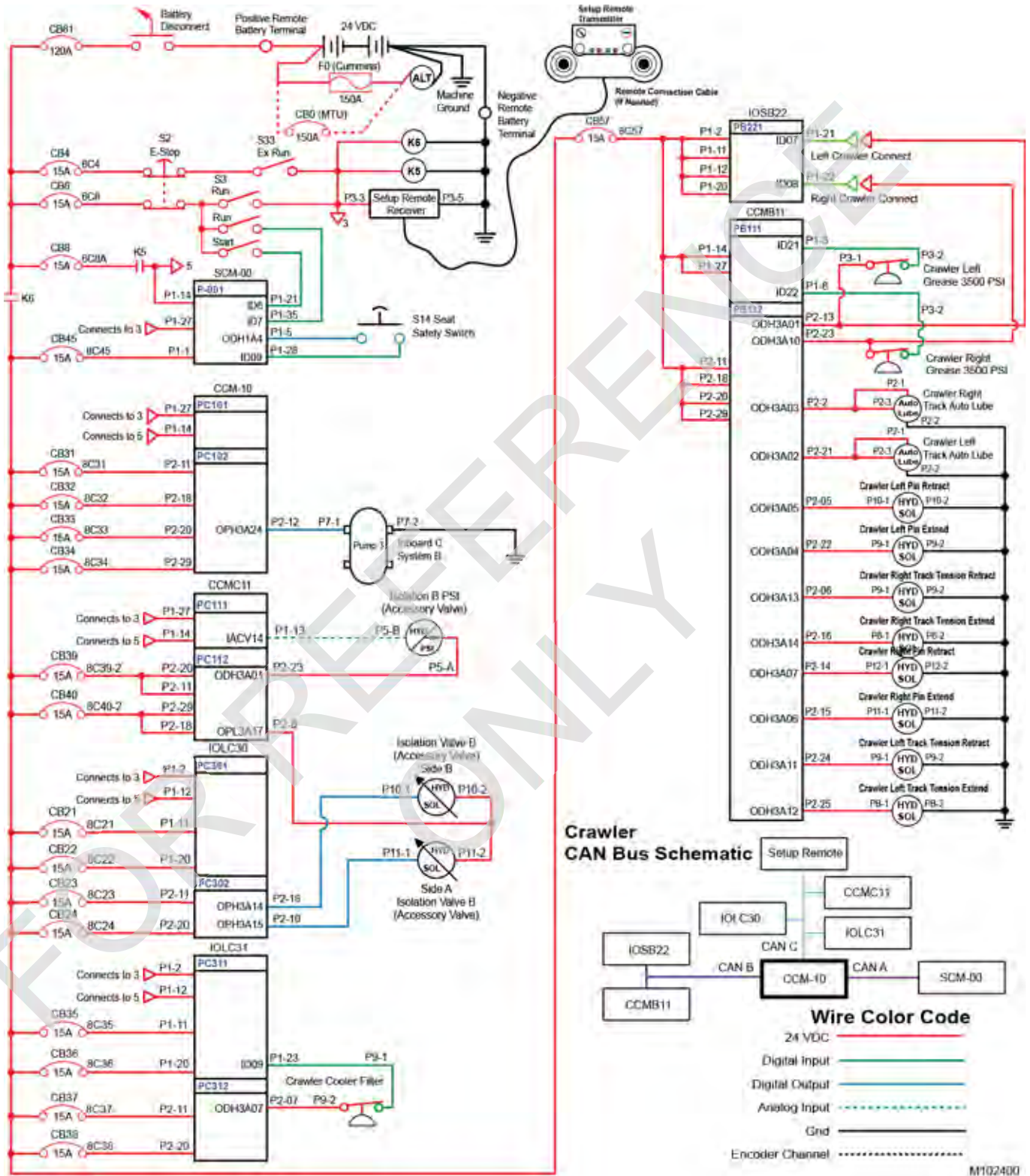


FIGURE 8-6

Crawler Pins Hydraulic Schematic

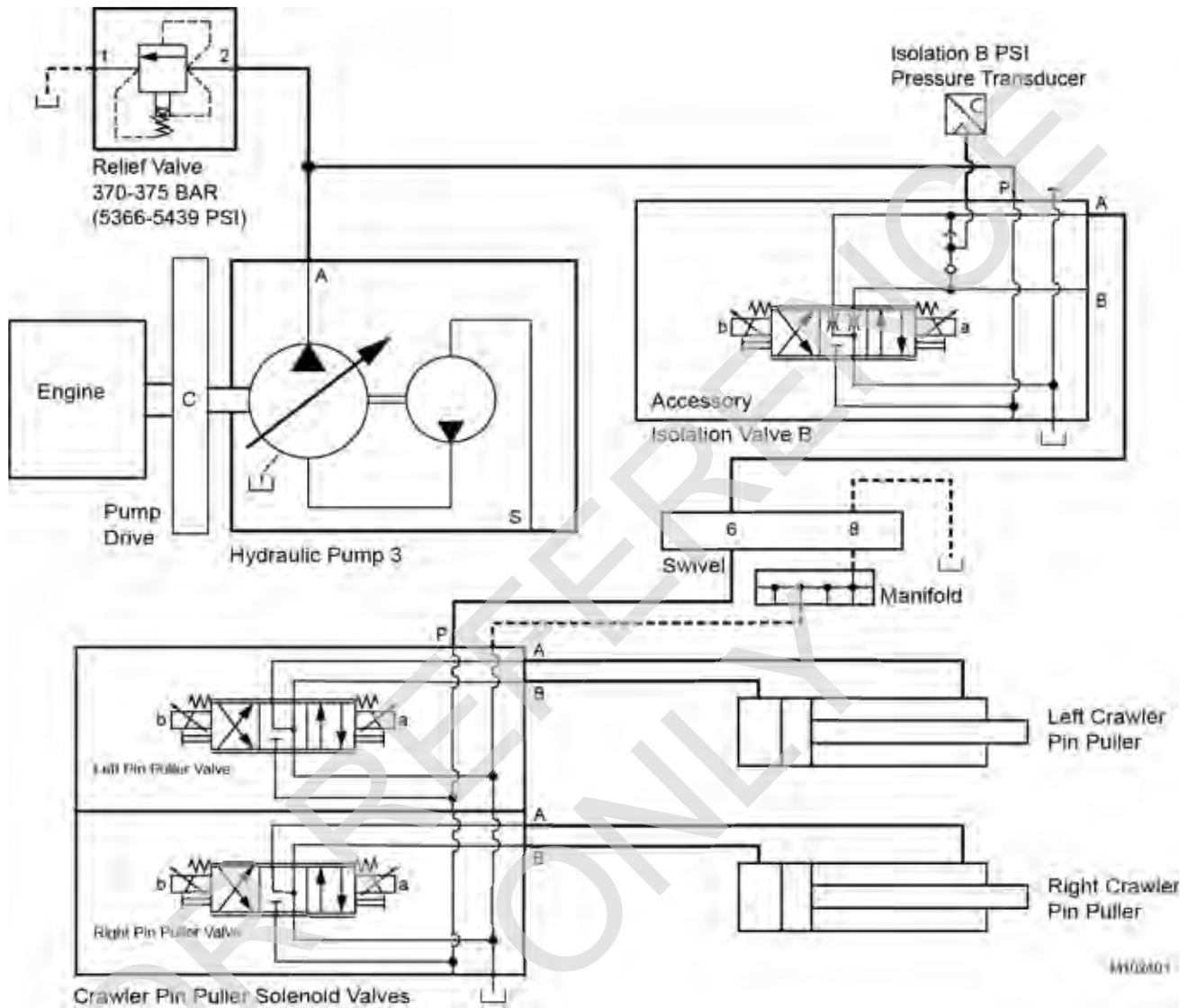


FIGURE 8-7

FOR REFERENCE ONLY

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CARBODY TRACK TENSION CYLINDERS

This topic applies only to past production cranes. Track tension on current production cranes is adjusted manually.

See [Figure 8-6](#) and [Figure 8-8](#) for the following descriptions.

The crawler track tension cylinders are controlled by the setup remote.

Setup Remote Control

The setup remote control communicates with the CCM-10 control module via the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

To operate the setup remote, it must be turned on as instructed in the MLC300 Operator Manual.

Neutral

When the setup remote is not transmitting:

- Pump 3 hydraulic flow through system B (right valve assembly) decreases.
- The isolation valve B shifts to neutral to block pump flow to the crawler track tension solenoid valves.
- The crawler track tension solenoid valves shift to neutral to block pump flow to the crawler track tension cylinders.
- The counterbalance valves lock the crawler track tension cylinders in position.

Retract

When a retract command is initiated by the setup remote, the setup remote receiver communicates the retract command to the CCM-10 and IOC30 control modules via CAN Bus C. The following then occurs:

- The CCM-10 control module increases the pulse-width modulation (PWM) current to pump 3 to increase system B hydraulic flow.
- The IOLC30 control module sends 24 V_{DC} to the side A solenoid on the system B isolation valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the crawler track tension solenoid valves.

- The CCM-10 control module relays the retract command to the CCMB11 control module via CAN Bus B. The CCMB11 control module then sends 24 V_{DC} to the corresponding solenoid on the selected crawler track tension valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the rod end of the crawler track tension cylinder.
- Fluid flows into the rod end of the cylinder. At the same time, pilot pressure opens the counterbalance valve at the barrel end of the cylinder. As hydraulic fluid fills the rod end of the cylinder, the rod retracts. This action forces hydraulic fluid out of the barrel end of the cylinder, through the open counterbalance valve, and back to the tank.

Extend

When an extend command is initiated by the setup remote, the setup remote receiver communicates the retract command to the CCM-10 and IOC30 control modules via CAN Bus C. The following then occurs:

- The CCM-10 control module increases the PWM current to pump 3 to increase system B hydraulic flow.
- The IOLC30 control module sends 24 V_{DC} to the side A solenoid on the system B isolation valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the crawler track tension solenoid valves.
- The CCM-10 control module relays the extend command to the CCMB11 control module via CAN Bus B. The CCMB11 control module then sends 24 V_{DC} to the corresponding solenoid on the selected crawler track tension valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the counterbalance valve at the barrel end of the crawler track tension cylinder.
- At the counterbalance valve, hydraulic fluid flows through the barrel end check valve and into the barrel end of the cylinder. As hydraulic fluid fills the barrel end of the cylinder, the rod extends. This action forces hydraulic fluid out the rod end of the cylinder, through the open crawler track tension valve, and back to the tank.

Carbody Track Tension Hydraulic Schematic

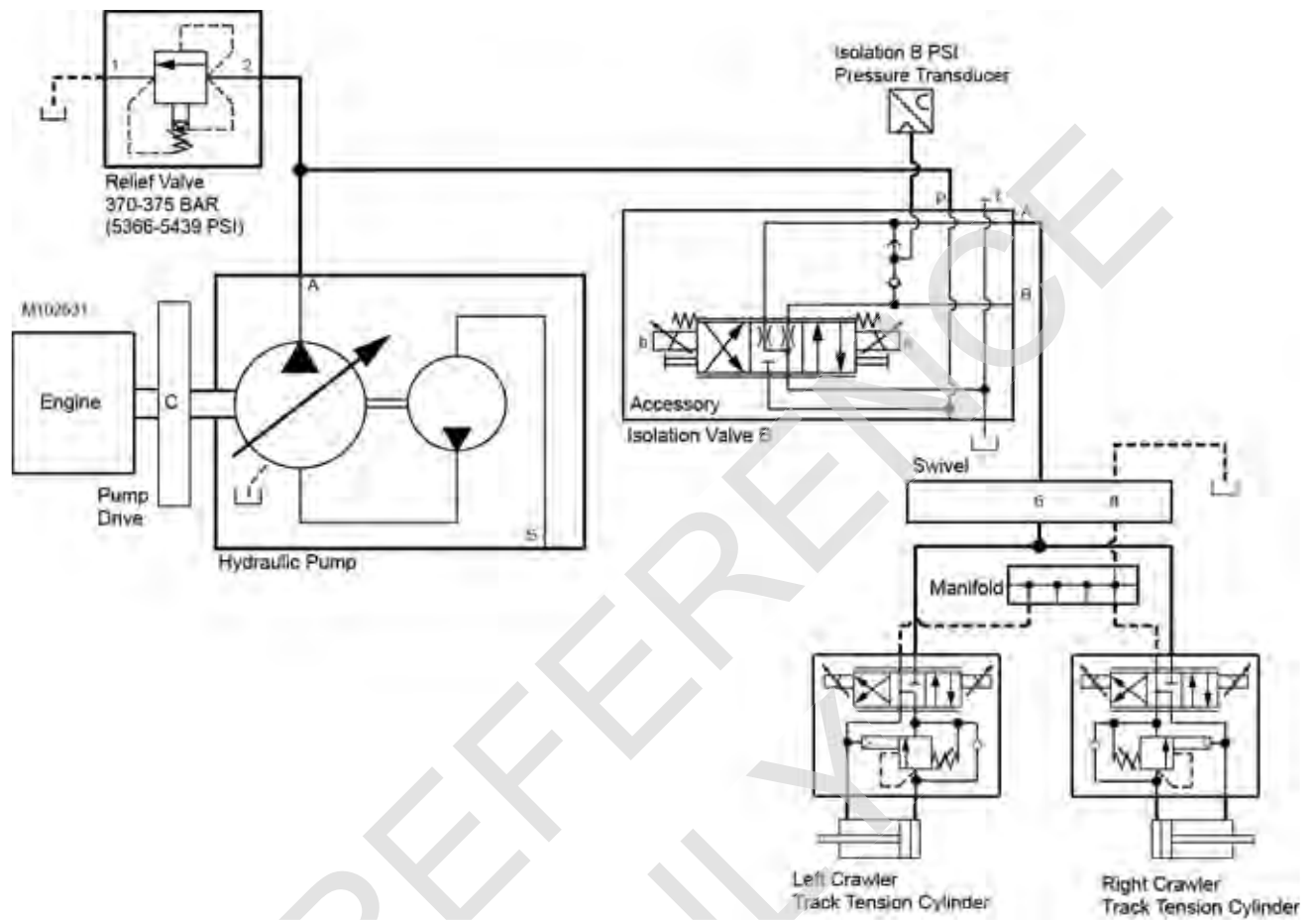
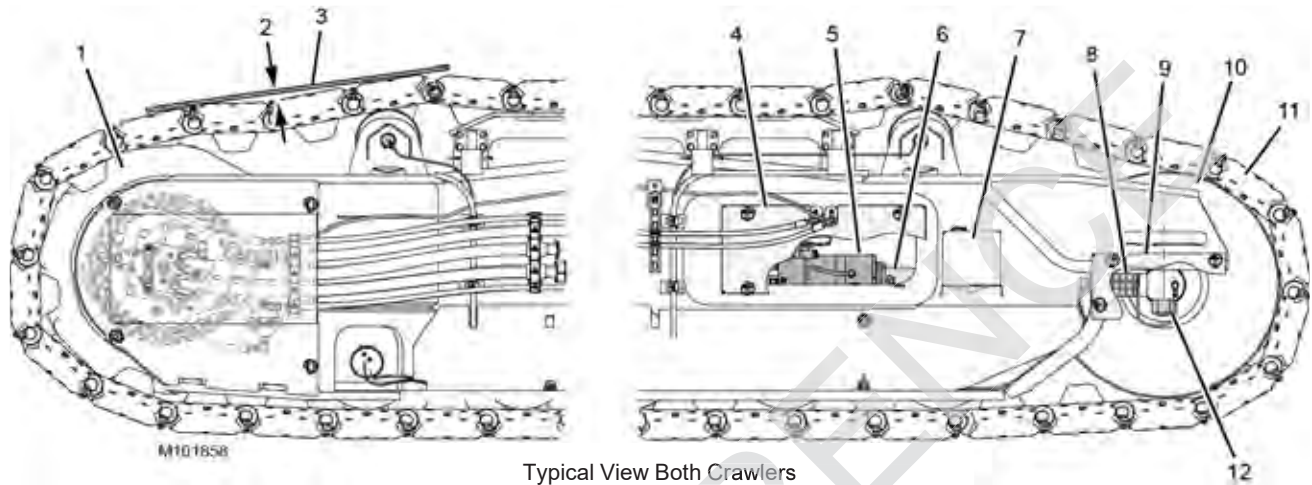


FIGURE 8-8

FOR REFERENCE ONLY



Item	Description	Item	Description
1	Drive Tumbler	7	Shim Storage Compartment
2	Tread Slack Dimension • 38,1 mm (1.5 in)—Tight Limit • 76,2mm (3.0 in)—Loose Limit	8	Shim • 12,7 mm (0.5 in) • 25,4 mm (1.0 in)
3	Straightedge	9	Cover (qty 2)
4	Cover	10	Front Roller
5	Tensioning Cylinder	11	Tread
6	Rod	12	Nut and Bolt

FIGURE 8-9

CRAWLER PREVENTIVE MAINTENANCE

Crawler wear cannot be eliminated, but the rate of wear can be reduced through regular preventive maintenance:

- Lubricate the crawlers as instructed in the Lubrication Guide supplied with the crane.
- Keep the crawlers clean and avoid dirt buildup when cutting.
- Keep all mounting bolts tight.
- Keep the treads properly adjusted.
- Inspect the crawler frames, rollers, and treads on a regular basis.
- 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 8-9](#) for the following procedure.

Check tread slack (2) 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 (3) on top of the treads and measure the tread slack between the straightedge and the top of the tread at the lowest point.
 - Tight limit gap—38,1 mm (1.5 in)
 - Loose limit gap—76,2 mm (3.0 in)
3. If the slack exceeds the tight or loose limit, adjust crawler tread slack see
 - [Crawler Tread Slack Adjustment - Past Production on page 8-19](#) OR
 - [Crawler Tread Slack Adjustment - Current Production on page 8-21](#)

CRAWLER TREAD SLACK ADJUSTMENT - PAST PRODUCTION

See [Figure 8-9](#) for the following procedure.

Tighten the treads when operating on firm ground.

Loosen the treads when operating on soft ground (mud or sand).

:

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.

1. Thoroughly clean the crawler to be adjusted.
2. Remove the cover (4) from the inboard side of the crawler frame.
3. Remove the cover (9) from both sides of the crawler frame.
4. Loosen the nut and bolt (12) on both sides of the front roller (10).
5. Using the setup remote control, extend the crawler tensioning cylinder (5) to push the front roller forward and to loosen the shims (8).

6. Add or remove an equal thickness of shims 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.

7. Using the setup remote control, fully retract the crawler tensioning cylinder.

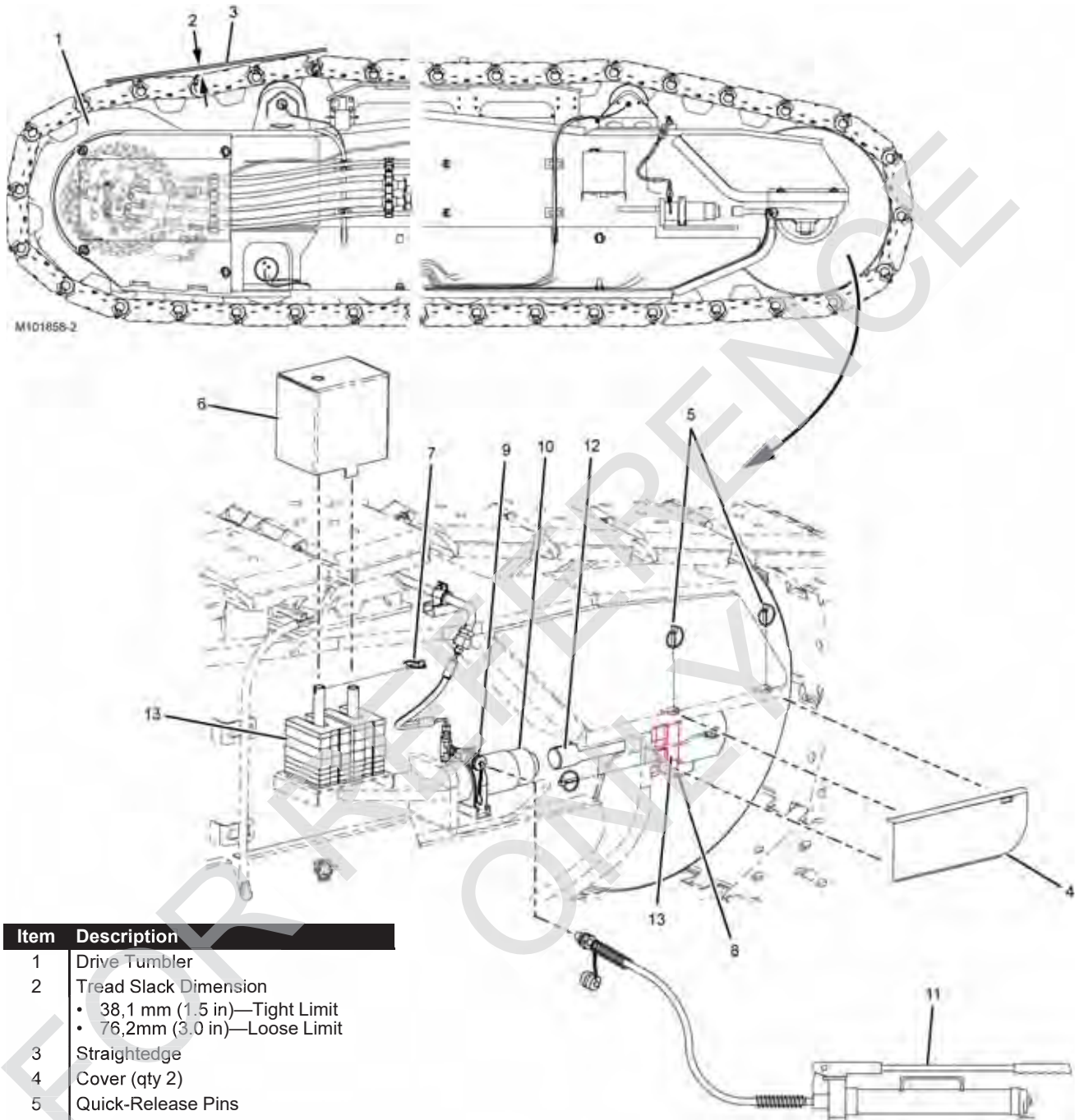
CAUTION

Avoid Cylinder Damage!

The tensioning cylinder can be damaged if it is not fully retracted.

8. Travel the crane forward or reverse to tighten the shims.
9. Check for proper tread slack.
10. Lubricate the nuts and bolts at the front roller with Never-Seez or an equivalent anti-seizing lubricant.
11. Tighten the nut and bolt (12) to 2 710 Nm (2,000 ft-lb).
12. Install the covers on both sides of the crawler frame.
13. Repeat the procedure on 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.



Item	Description
1	Drive Tumbler
2	Tread Slack Dimension <ul style="list-style-type: none"> • 38,1 mm (1.5 in)—Tight Limit • 76,2mm (3.0 in)—Loose Limit
3	Straightedge
4	Cover (qty 2)
5	Quick-Release Pins
6	Shim Storage Cover
7	Quick-Release Pin
8	Nut and Bolt (qty 2)
9	Coupler with Dust Cap
10	Tensioning Cylinder (qty 2)
11	Hand Pump
12	Adjusting Rod (qty 2)
13	Front Roller
14	Shim <ul style="list-style-type: none"> • 12,7 mm (0.5 in) • 25,4 mm (1.0 in)

FIGURE 8-10

CRAWLER TREAD SLACK ADJUSTMENT - CURRENT PRODUCTION

- Tighten the treads when operating on firm ground.
- Loosen the treads when operating on soft ground (mud or sand).

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.

See [Figure 8-10](#) for the following procedure.

1. Thoroughly clean the crawler to be adjusted.
2. Remove the cover (4) from both sides of the crawler frame.
3. Remove the shim storage cover (6) from both sides of the crawler frame.
4. Loosen the nut (8) on both sides of the front roller (13).
5. Remove the dust cap from the coupler (9) at the tensioning cylinder (10) on the outboard side of the crawler. Make sure the coupler is clean.
6. Remove the dust cap from the hand pump (11) hose. Make sure the nipple is clean.
7. Connect the hose from the hand pump to the coupler (9) at the tensioning cylinder (10).
8. Using the hand pump, extend the tensioning cylinders (10) against the adjusting rods (12). This will push the front roller (13) forward and loosen the shims (14).

For hand pump operation, see [Hydraulic Hand Pump on page 8-23](#).

9. Add or remove an equal thickness of shims (14) 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.

10. Using the hand pump, fully retract the tensioning cylinders (10).

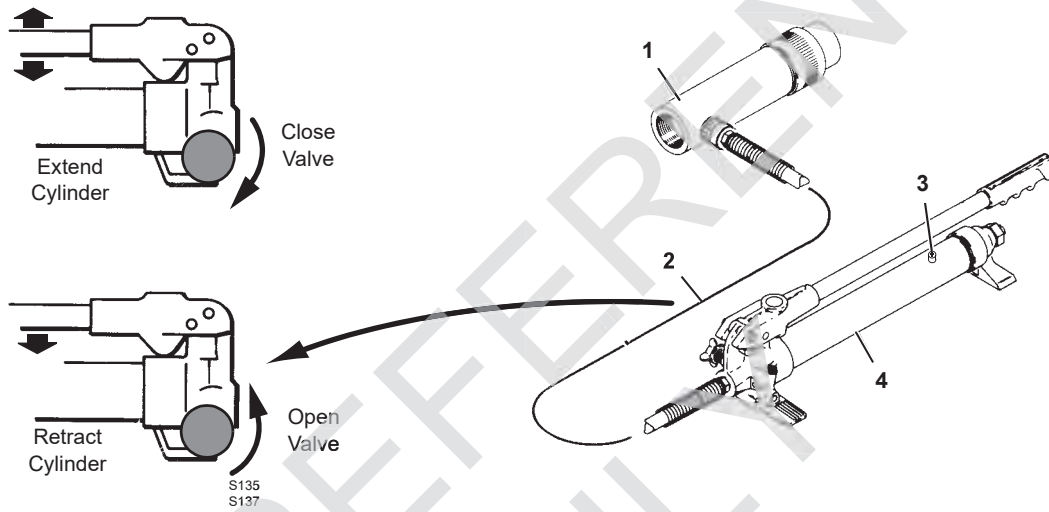
CAUTION

Avoid Cylinder Damage!

The tensioning cylinders can be damaged if not fully retracted.

11. Travel the crane forward or in reverse to tighten the shims.
12. Check for proper tread slack.
13. Lubricate the nuts (8) and bolts at the front roller (13) with Never-Seez or an equivalent anti-seizing lubricant.
14. Tighten the nuts and bolts (8) to 2 710 Nm (2,000 ft-lb).
15. Install the covers (4 and 6) on both sides of the crawler frame.
16. Repeat the procedure at the other crawler.

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.



Item	Description
1	Cylinder
2	Hose
3	Vent.Fill Valve
4	Pump

FIGURE 8-11

HYDRAULIC HAND PUMP

See [FIGURE 8-11](#) for the following procedures.



WARNING

Prevent Possible Death or Serious Injury to Maintenance Personnel

Manitowoc has provided hand pump and cylinder for crawler adjustment only. Any other use is neither intended nor approved.

Wear safety glasses and other personal protective gear when operating hand pump.

Do not exceed maximum pressure rating of components (pump, cylinder, hose) – 10,000 psi (700 bar). Higher pressure can cause components to explode.

Do not set pump relief valve higher than 10,000 psi (700 bar). Higher pressure can cause components to explode.

Pump is not vented. It can explode if subjected to high pressure. Do not attempt to return more oil to pump than it is capable of holding. Do not overfill pump.

In some cases, 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 hose from pump outlet port to cylinder inlet.
2. Use 1-1/2 wraps of a high-grade thread sealant on fittings (for example, Teflon tape).

Do not apply sealant to first complete thread to ensure tape does not shed into hydraulic system and cause malfunctioning or damage.

3. Do not over tighten 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

1. Keep unit clean and stored in a safe place where it cannot be damaged.
2. Keep oil in pump at proper level. Check level as follows:

- a. Open valve and fully retract cylinder rod to return all oil to pump. **Cylinder must be fully retracted or system will contain too much oil.**
- b. Place pump in horizontal position on a flat surface.
- c. Using a screw driver, remove vent/fill cap.
- d. Add hydraulic oil until reservoir is 2/3 full. **Do not overfill.**
- e. Securely reinstall vent/fill cap.
- f. Test operation and remove air from system, if required. Recheck level after removing air.

Air Removal

1. Close valve finger-tight only.
2. Position pump higher than cylinder and position cylinder so rod is down.
3. Operate pump to fully extend cylinder rod.
4. Open valve and retract cylinder rod to force oil and trapped air back into pump.
5. Repeat steps until cylinder operates smoothly. **Erratic operation indicates air in system.**

Operation

1. Before using pump:
 - a. Check that all fittings are tight and leak free.
 - b. Check oil level.
2. To pressurize cylinder and extend rod, close valve by turning clockwise until finger-tight only. Then pump handle up and down.

Pressure will be maintained until valve is opened.

To reduce handle effort at high pressure, use short strokes. Maximum leverage is obtained in last five degrees of stroke.

3. To de-pressurize cylinder, push handle down fully and open valve by turning counterclockwise.
4. Pump can be operated in any position from horizontal to vertical as long as **hose end of pump is down.**

TURNTABLE BEARING ALIGNMENT

See [Figure 8-12](#) for the following.

The outer ring (C) can be installed in any position with relation to the carbody.

The S stamped in each side of the inner ring must be centered on the left and right sides of the rotating bed.

Two dowel pins (A) are installed in the carbody to locate the inner ring with the carbody.

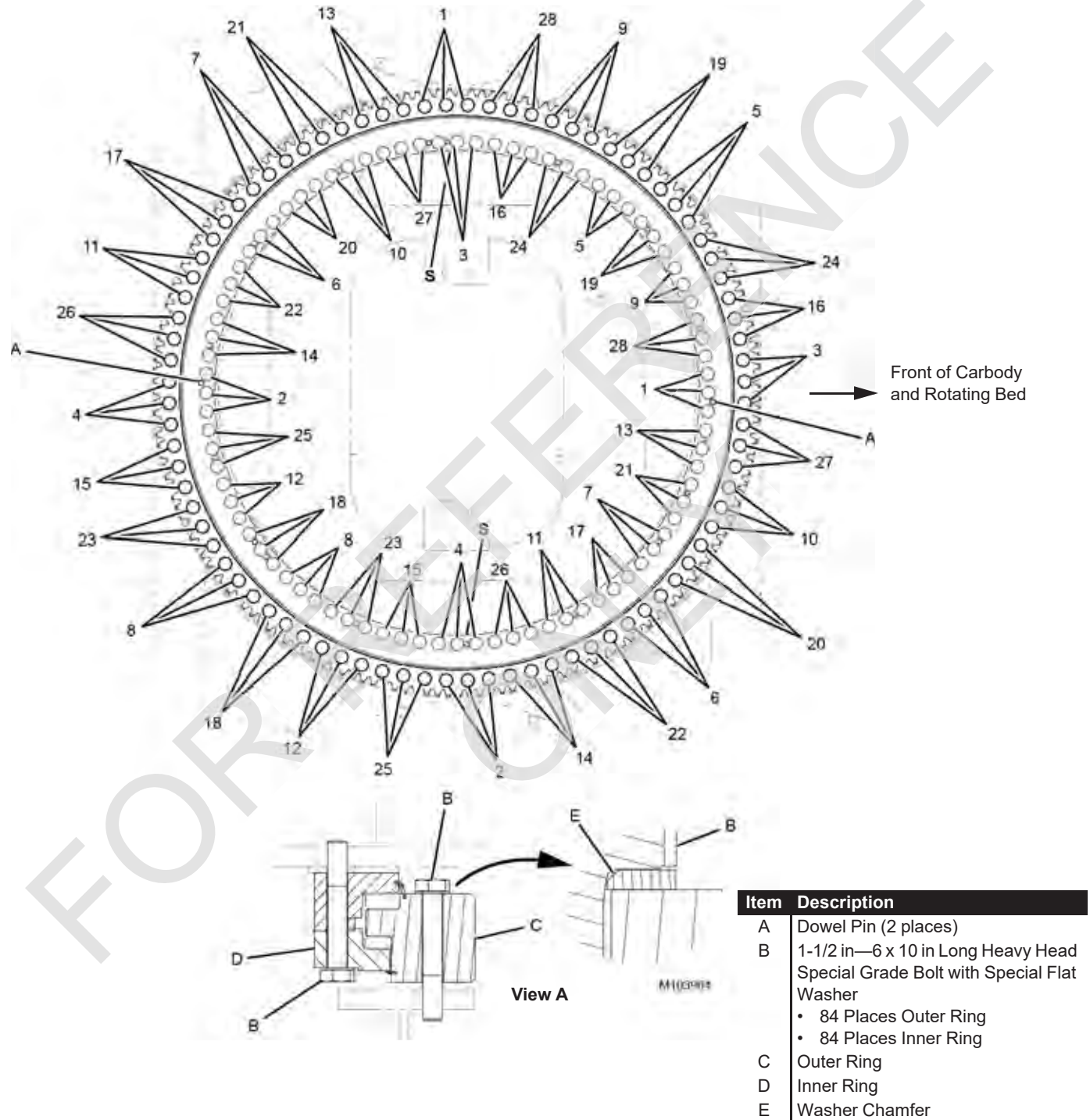


FIGURE 8-12

TIGHTENING TURNTABLE BEARING BOLT

See [Figure 8-12](#) for the following procedures.



DANGER

Crushing Injury Hazard!

Two people are required to install the turntable 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 turntable 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 turntable bearing to fail, possibly allowing the upperworks to break away from the carbody.

After First 50 Hours of Operation

Tighten all bolts, three at a time, in the numbered sequence given to 3 525 Nm (2,600 ft-lb).

Annually or Every 2,000 Hours of Operation (whichever comes first)

Tighten all bolts, three at a time, in the numbered sequence given using two steps:

- First to 1 360 Nm (1,000 ft-lb)
- Final to 3 525 Nm (2,600 ft-lb)

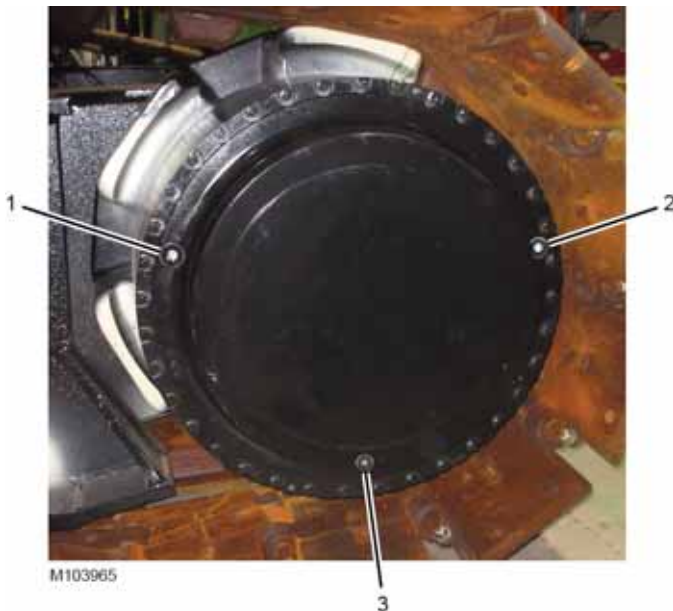
If during the annual interval:

- One or more bolts are found to be tightened to less than 2 820 Nm (2,080 ft-lb), replace each loose bolt and washer as well as one bolt and washer on each side of each loose bolt.
- 17 or more bolts in either ring are found to be tightened to less than 2 820 Nm (2,080 ft-lb), replace all of the bolts and washers for the corresponding ring.
- Replace all of the bolts and washers anytime a new turntable bearing is installed.

REPLACING TURNTABLE BOLTS

1. Apply Never-Seez or an equivalent anti-seizing lubricant to:
 - Bolt threads
 - Underside of bolt heads
 - Both sides of all washers
2. Make sure the chamfer (E) in each washer is toward the bolt head (see View A).
3. Install and tighten the bolts, three at a time, in the numbered sequence to an initial torque of 1 360 Nm (1,000 ft-lb).
4. Tighten the bolts, three at a time, in the numbered sequence to a final torque of 3 525 Nm (2,600 ft-lb).

CRAWLER GEARBOX OIL CHANGE



Item	Description
1	Fill Plug
2	Level Plug
3	Drain Plug

FIGURE 8-13

See [Figure 8-13](#) for the following procedures.

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 operation.

Monthly or Every 200 Hours

Check the oil level in both crawler gearboxes every 200 hours of operation or monthly, whichever occurs first, by performing the following.

1. Travel the crawlers until the plugs are positioned as shown.
2. Lockout-tagout the crane.
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.

Every 6 Months or 1,000 Hours

Drain and refill both crawler gearboxes every 1,000 hours of operation or every 6 months, 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.
2. Lockout-tagout the crane.
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.
6. Remove the drain plug.
7. Once the crawler gearbox is drained, 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.
9. Repeat the procedure for the other crawler gearbox.
10. Dispose of the drained oil according to local environmental regulations.

**SECTION 9
LUBRICATION**

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SECTION 9 LUBRICATION

LUBRICATION

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FOR REFERENCE ONLY

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FOR REFERENCE ONLY

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SECTION 10

ACCESSORIES

WARMING CIRCUIT

See [Figure 10-1](#) and [Figure 10-2](#) for the following descriptions.

At startup, the control system allows the engine water jacket to warm up for approximately two minutes before activating the warming circuit. This is done to prevent the engine from lugging down.

Once activated, the warming circuit maintains a minimum oil temperature in the hydraulic tank of 15,6°C to 18,3°C (60°F to 65°F).

To accomplish this, a temperature sensor (6) in the hydraulic tank (7) sends an electrical signal representing hydraulic fluid temperature to the IOLC34 control module. The IOLC34 control module then relays this information to CCM-10 and IOLC33 control modules via the controller area network bus (CAN Bus) C.

Warming Circuit Operation—Accessory Circuit Not Active

When the hydraulic fluid temperature is less than 15,6°C (60°F) and no accessory circuits are active, the IOLC33 control module sends 24 V_{DC} to the corresponding solenoid on isolation valve A (9), energizing the solenoid. The CCM-10 control module provides the ground for the solenoid.

With the isolation valve A solenoid energized, the isolation valve spool shifts to a position that allows hydraulic fluid from the hydraulic main pump 4 (3) to flow to the valves of accessory circuits (8) and to the warming relief valve (10).

At the same time, the CCM-10 control module increases the pulse width modulation (PWM) current to pump 4 to increase hydraulic flow to the system A (left) valve assembly.

When no accessory circuit is active, the hydraulic fluid is dead headed, causing the hydraulic pressure in the accessory circuit to increase. When the pressure rises to 370—375 bar (5,366—5,439 psi), the warming relief valve opens to divert hydraulic fluid to the hydraulic tank.

With the circuit in relief, the hydraulic fluid temperature increases until the temperature reaches 18,3°C (65°F), at which point, the IOLC33 control module de-energizes the isolation valve A solenoid.

The de-energized solenoid causes the isolation valve spool to shift to neutral, blocking pump flow to the accessory circuits. At the same time, the CCM-10 control module ramps down the PWM current to pump 4.

This causes the hydraulic pressure in the accessory circuit to drop. When the hydraulic pressure drops below the specified relief valve setting, the warming relief valve closes.

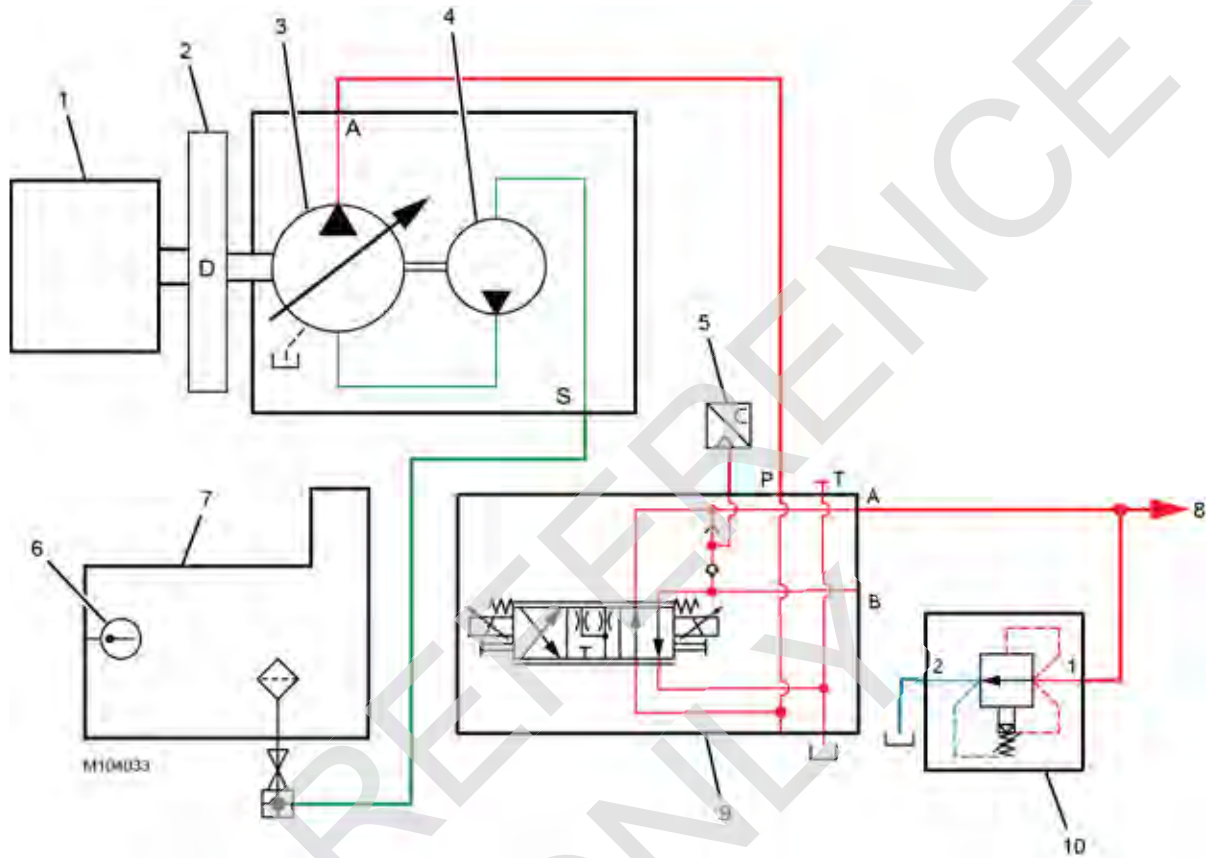
The cycle repeats as needed to maintain the specified minimum temperature.

Warming Circuit Operation—Accessory Circuit Active

When an accessory circuit is activated during the time when the warming relief valve is open, the warming control circuit will stop hydraulic flow by temporarily de-energizing the isolation valve A solenoid. This causes the hydraulic pressure in the accessory circuit to drop, closing the warming relief valve. The warming circuit then re-energizes the isolation valve A solenoid to resume providing hydraulic flow to the activated accessory circuit.

During operation of an accessory circuit, the warming relief valve protects the accessory circuits from pressures above the specified range.

Warming Circuit Hydraulic Schematic



Item	Description
1	Engine
2	Pump Drive (inboard pad D)
3	Hydraulic Main Pump 4
4	Charge Pump
5	Isolation A PSI Pressure Transducer
6	Temperature Sensor
7	Hydraulic Tank
8	To Accessory Circuits: <ul style="list-style-type: none"> • Live Mast Pin Pullers • Gantry Equalizer Pin Pullers • Live Mast Assist Arms • Cab Tilt
9	Isolation Valve A (left side valve bank) (also referred to as accessory valve)
10	Warming Relief Valve

FIGURE 10-1

Warming Circuit Electrical Schematic

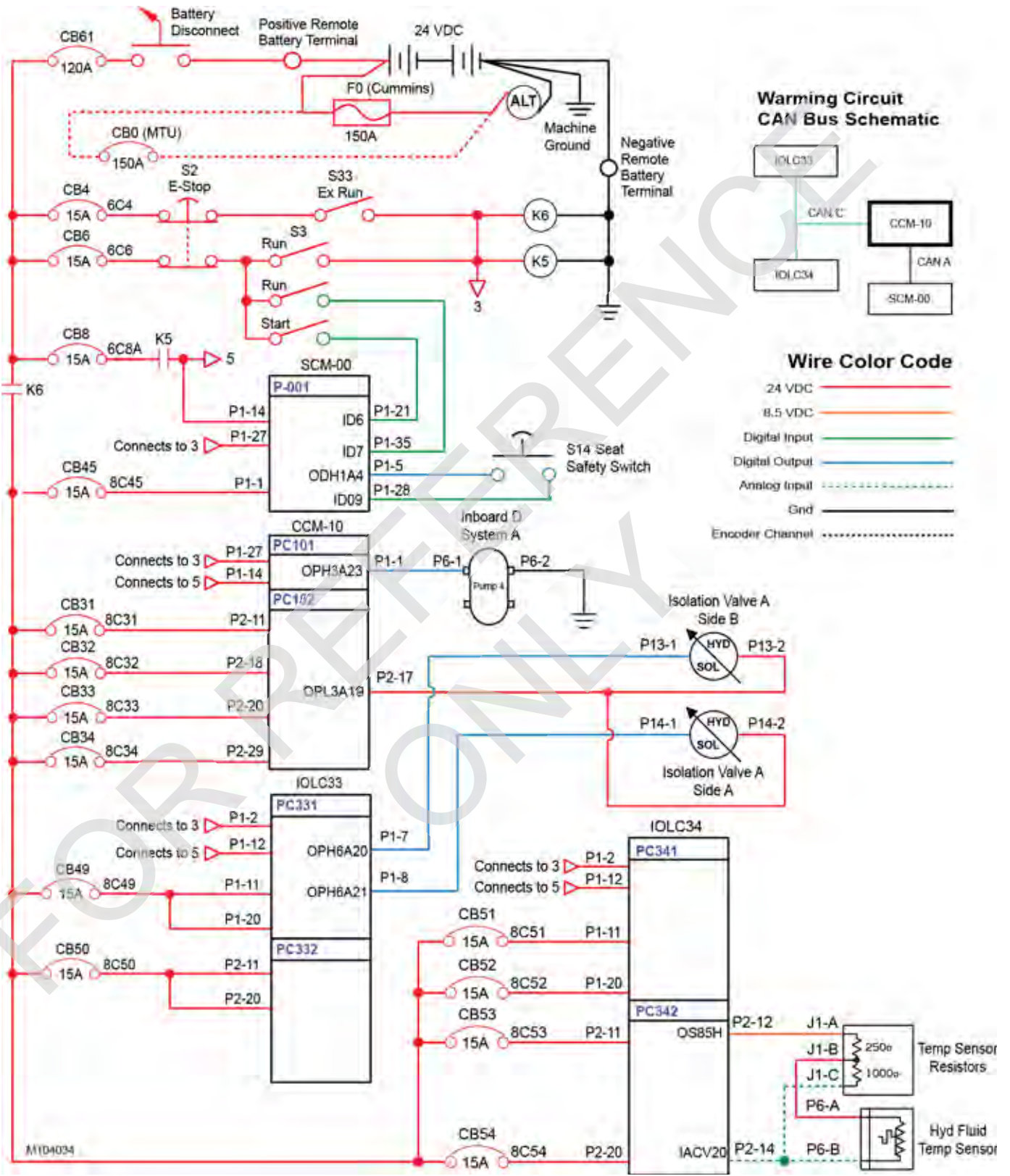


FIGURE 10-2

LIVE MAST PIN PULLERS

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the live mast pin pullers system.

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

- Section 2: Hydraulics
- Section 3: Electrical

The pins that connect the live mast to the rotating bed are controlled by the setup remote.

See [Figure 10-3](#) and [Figure 10-4](#) for the following descriptions.

Setup Remote Control

The setup remote control communicates with the CCM-10 control module via the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

To operate the setup remote, it must be turned on as instructed in the MLC300 Operator Manual.

Neutral

When the setup remote is not transmitting:

- Pump 4 hydraulic flow through system A (left valve assembly) decreases.
- The isolation valve A shifts to neutral to block pump flow to the live mast pin puller valve.
- The live mast pin puller valve shifts to neutral to block pump flow to the live mast pin pullers.

Engage (extend)

When an engage command is initiated by the setup remote, the setup remote receiver communicates the command to the CCM-10 control module. The CCM-10 control module then communicates the engage command to the IOLC32 and IOLC33 control modules via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 4 to increase system A (left valve assembly) hydraulic flow.

- The IOLC33 control module sends $24 V_{DC}$ to the side A solenoid on isolation valve A. The solenoid energizes because the CCM-10 control module provides a ground for the solenoid. The energized solenoid shifts the valve spool to a position that routes hydraulic fluid to the live mast pin puller valve.
- The IOLC32 control module then sends $24 V_{DC}$ to the corresponding solenoid on the selected live mast pin puller valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the barrel end of the pin puller cylinder.
- As hydraulic fluid flows into the barrel end of the pin puller cylinder, the rod extends to engage the corresponding live mast pin. This action forces hydraulic fluid out the rod end of the pin puller cylinder and back to the tank via the live mast pin puller valve.

Disengage (retract)

When a disengage command is initiated by the setup remote, the setup remote receiver communicates the command to the CCM-10 control module. The CCM-10 control module then communicates the disengage command to the IOLC32 and IOLC33 control modules via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 4 to increase system A (left valve assembly) hydraulic flow.
- The IOLC33 control module sends $24 V_{DC}$ to the side A solenoid on isolation valve A. The solenoid energizes because the CCM-10 control module provides a ground for the solenoid. The energized solenoid shifts the valve spool to a position that routes hydraulic fluid to the live mast pin puller valve.
- The IOLC32 control module then sends $24 V_{DC}$ to the corresponding solenoid on the selected live mast pin puller valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the rod end of the pin puller cylinder.
- As hydraulic fluid flows into the rod end of the pin puller cylinder, the rod retracts to disengage the corresponding live mast pin. This action forces hydraulic fluid out the barrel end of the pin puller cylinder and back to the tank via the live mast pin puller valve.

Live Mast Pin Pullers Hydraulic Schematic

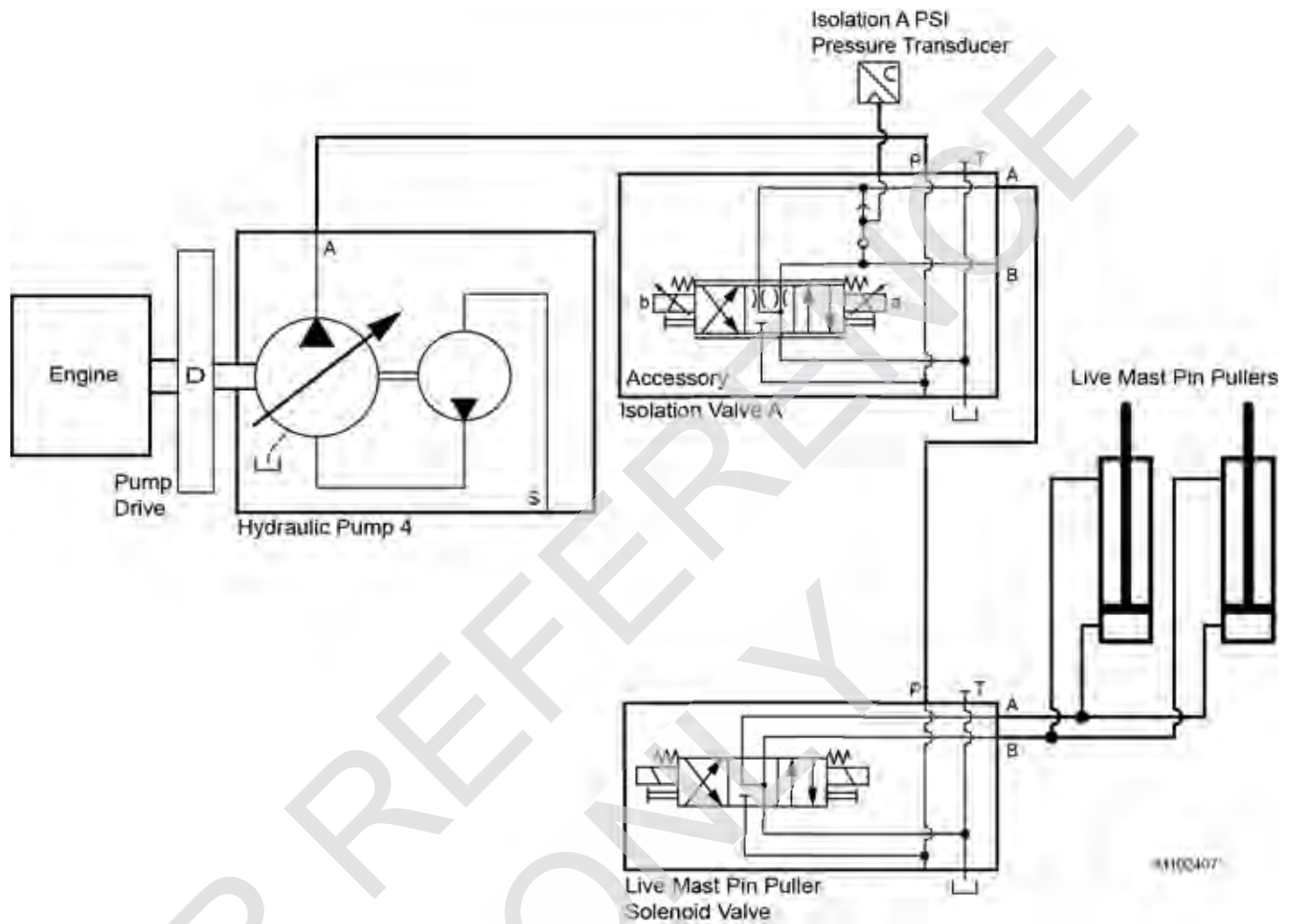


FIGURE 10-3

Live Mast Pin Pullers Electrical Schematic

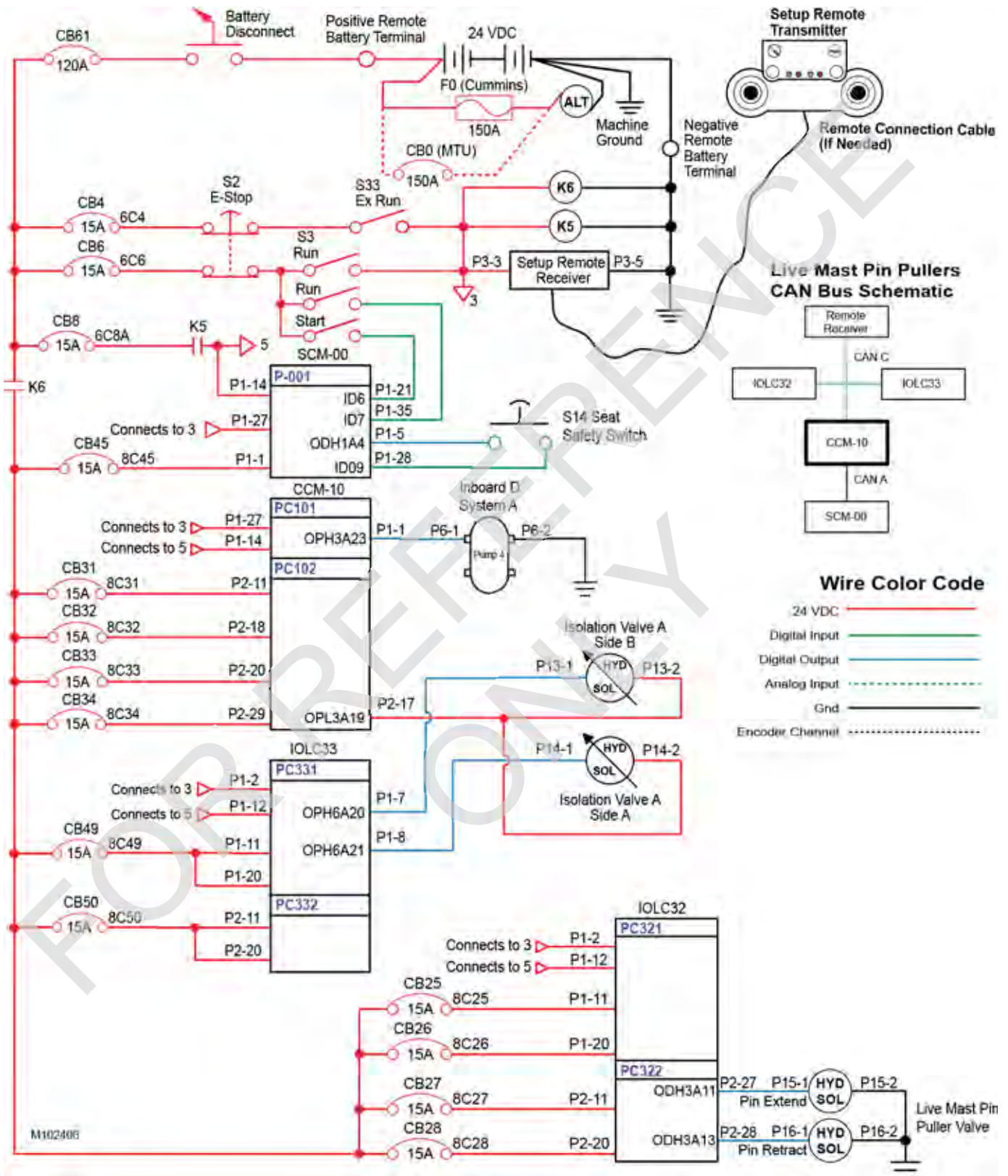


FIGURE 10-4

GANTRY EQUALIZER PIN PULLERS

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the gantry equalizer pin pullers system.

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

- Section 2: Hydraulics
- Section 3: Electrical

The pins that connect the gantry equalizer to the rotating bed are controlled by the setup remote.

See [Figure 10-5](#) and [Figure 10-6](#) for the following descriptions.

Setup Remote Control

The setup remote control communicates with the CCM-10 control module via the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

To operate the setup remote, it must be turned on as instructed in the MLC300 Operator Manual.

Neutral

When there is no command from the setup remote:

- Pump 4 hydraulic flow through system A (left valve assembly) decreases.
- The isolation valve A shifts to neutral to block pump flow to the gantry equalizer pin puller valve.
- The gantry equalizer pin puller valve shifts to neutral to block pump flow to the gantry pin pullers.

Engage (extend)

When an engage command is initiated by the setup remote, the setup remote receiver communicates the command to the CCM-10 control module. The CCM-10 control module then communicates the engage command to the IOLC33 and IOLC34 control modules via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 4 to increase system A (left valve assembly) hydraulic flow.

- The IOLC33 control module sends 24 V_{DC} to the side A solenoid on isolation valve A. The solenoid energizes because the CCM-10 control module provides a ground for the solenoid. The energized solenoid shifts the valve spool to a position that routes hydraulic fluid to the gantry equalizer pin puller valve.
- The IOLC34 control module then sends 24 V_{DC} to the corresponding solenoid on the gantry equalizer pin puller valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the barrel end of the pin puller cylinder.
- As hydraulic fluid flows into the barrel end of the pin puller cylinder, the rod extends to engage the gantry equalizer pins. This action forces hydraulic fluid out the rod end of the pin puller cylinder and back to the tank via the gantry equalizer pin puller valve.

Disengage (retract)

When a disengage command is initiated by the setup remote, the setup remote receiver communicates the command to the CCM-10 control module. The CCM-10 control module then communicates the disengage command to the IOLC33 and IOLC34 control modules via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 4 to increase system A (left valve assembly) hydraulic flow.
- The IOLC33 control module sends 24 V_{DC} to the side A solenoid on isolation valve A. The solenoid energizes because the CCM-10 control module provides a ground for the solenoid. The energized solenoid shifts the valve spool to a position that routes hydraulic fluid to the gantry equalizer pin puller valve.
- The IOLC34 control module then sends 24 V_{DC} to the corresponding solenoid on the gantry equalizer pin puller valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the rod end of the pin puller cylinder.
- As hydraulic fluid flows into the rod end of the pin puller cylinder, the rod retracts to disengage the gantry equalizer pins. This action forces hydraulic fluid out the barrel end of the pin puller cylinder and back to the tank via the gantry equalizer pin puller valve.

Gantry Equalizer Pin Puller Hydraulic Schematic

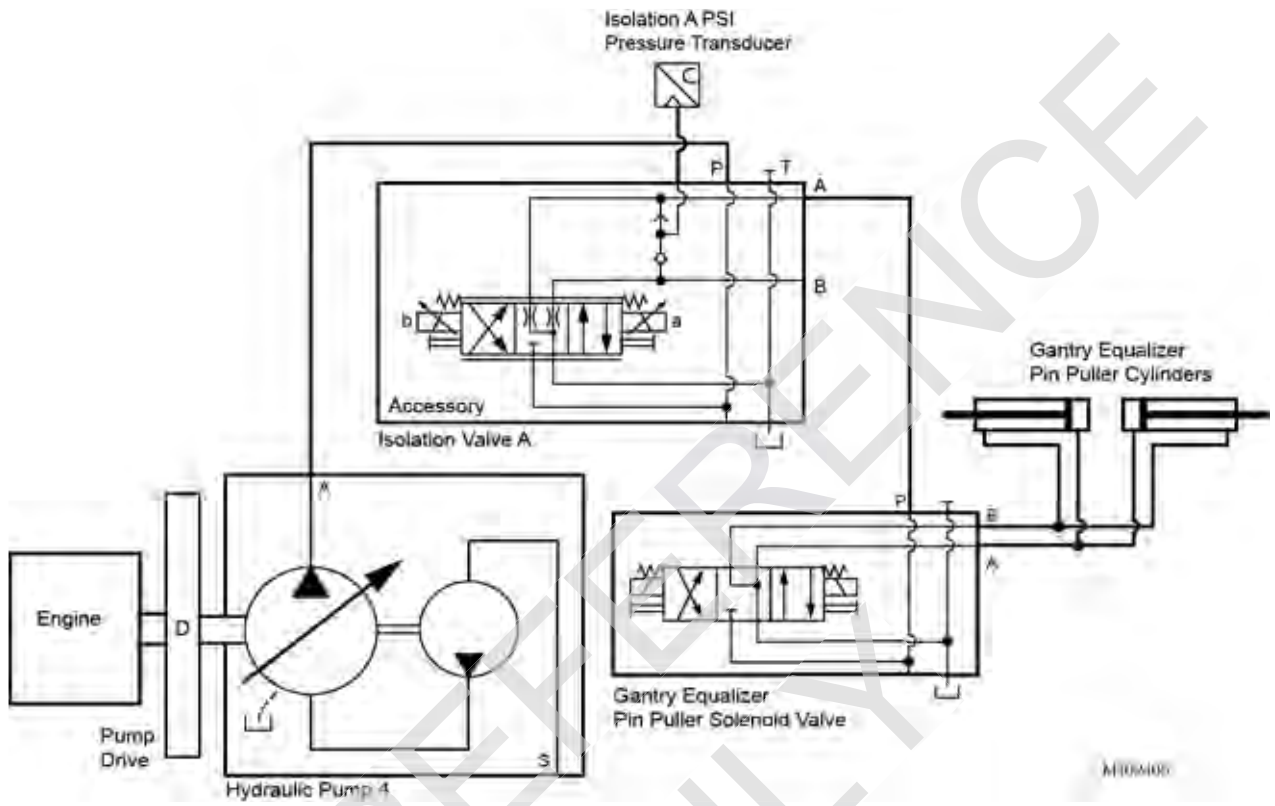
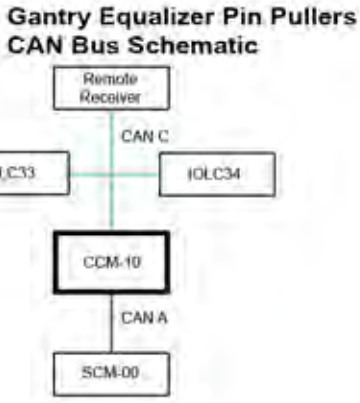
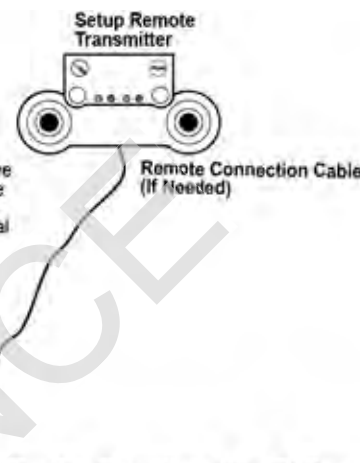
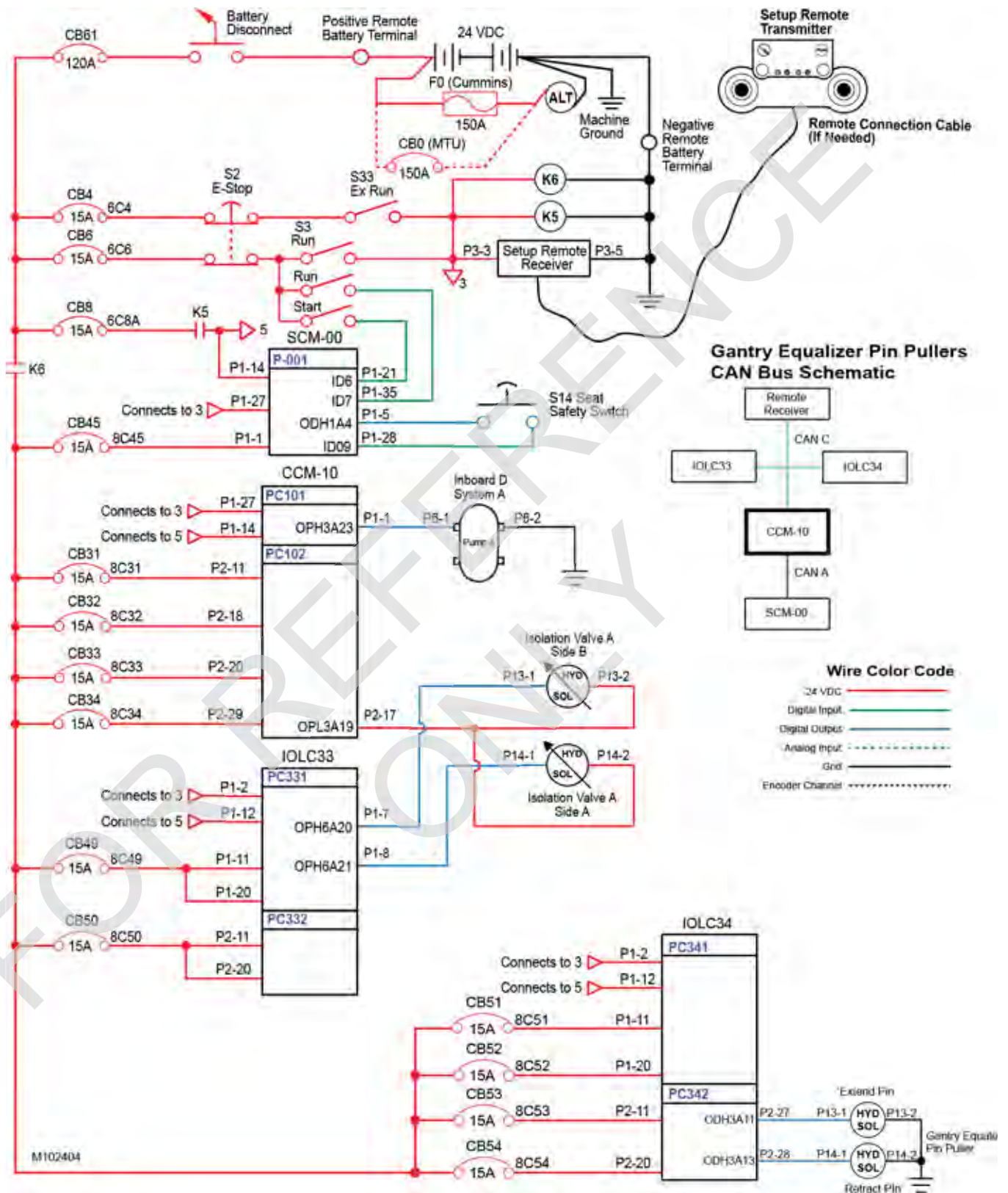


FIGURE 10-5

Gantry Equalizer Pin Puller Electrical Schematic



Wire Color Code

- 24 VDC: Red line
- Digital Input: Green line
- Digital Output: Blue line
- Analog Input: Dashed line
- Ground: Black line
- Encoder Channel: Dotted line

FIGURE 10-6

LIVE MAST ASSIST ARMS

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the live mast assist arms system.

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

- Section 2: Hydraulics
- Section 3: Electrical

NOTE: The mast assist arms are connected to hydraulic cylinders that raise and lower the arms.

The live mast assist arms (and cylinders) are also controlled automatically during live mast raising and lowering (see Section 4 of the MLC300 Crane Operator Manual).

The mast assist arms are manually controlled by the setup remote or by the S31 mast assist arms switch in the cab.

See [Figure 10-7](#) and [Figure 10-10](#) for the following descriptions.

Setup Remote Control

The setup remote control communicates with the CCM-10 control module via the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

To operate the setup remote, it must be turned on as instructed in the MLC300 Operator Manual.

S31 Mast Assist Arms Switch Control

The SCM-00 control module provides 24 V_{DC} to the S31 switch. When in the EXTEND or RETRACT positions, the S31 switch sends a 24 V_{DC} signal back to the SCM-00 control module. The SCM-00 control module then communicates the corresponding command to the CCM-10 control module via CAN Bus A.

Neutral

See [Figure 10-7](#) and [Figure 10-10](#) for the following.

When there is no command from the setup remote or S31 mast assist arms switch:

- Pump 4 hydraulic flow through system A (left valve assembly) decreases.
- The isolation valve A shifts to neutral to block pump flow to the live mast assist arms valve.
- The live mast assist arms valve shifts to neutral to block pump flow to the live mast assist arm cylinders.
- The load-equalizer valves and the counterbalance valves are closed to lock the cylinders in position.

Extend (Raise)

See [Figure 10-8](#) and [Figure 10-10](#) for the following.

When a raise command is initiated by the setup remote or by the S31 switch, the command is sent to the CCM-10 control module. The CCM-10 control module then communicates the raise command to the IOLC32 and IOLC33 control modules via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 4 to increase system A (left valve assembly) hydraulic flow.
- The IOLC33 control module sends 24 V_{DC} to the side A solenoid on isolation valve A. The solenoid energizes because the CCM-10 control module provides a ground for the solenoid. The energized solenoid shifts the valve spool to a position that routes hydraulic fluid to the live mast assist arms valve.
- The IOLC32 control module then sends 24 V_{DC} to the corresponding solenoid on the live mast assist arms valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the load-equalizing valve.
- At the load-equalizing valve, the hydraulic fluid flows through the barrel end check valve to the barrel end counterbalance valves. At the same time, pilot pressure opens the rod end load-equalizing valve.
- At the counterbalance valves, the hydraulic fluid flows through the barrel end check valves into the barrel end of the cylinders. At the same time, pilot pressure opens the rod end counterbalance valves. As hydraulic fluid fills the barrel end of the cylinders, the rods extend to raise the mast assist arms. This action forces hydraulic fluid out the rod ends of the cylinders, through the open counterbalance valves, through the open load-equalizing valve, and back to tank via the live mast assist arms valve.

Retract (Lower)

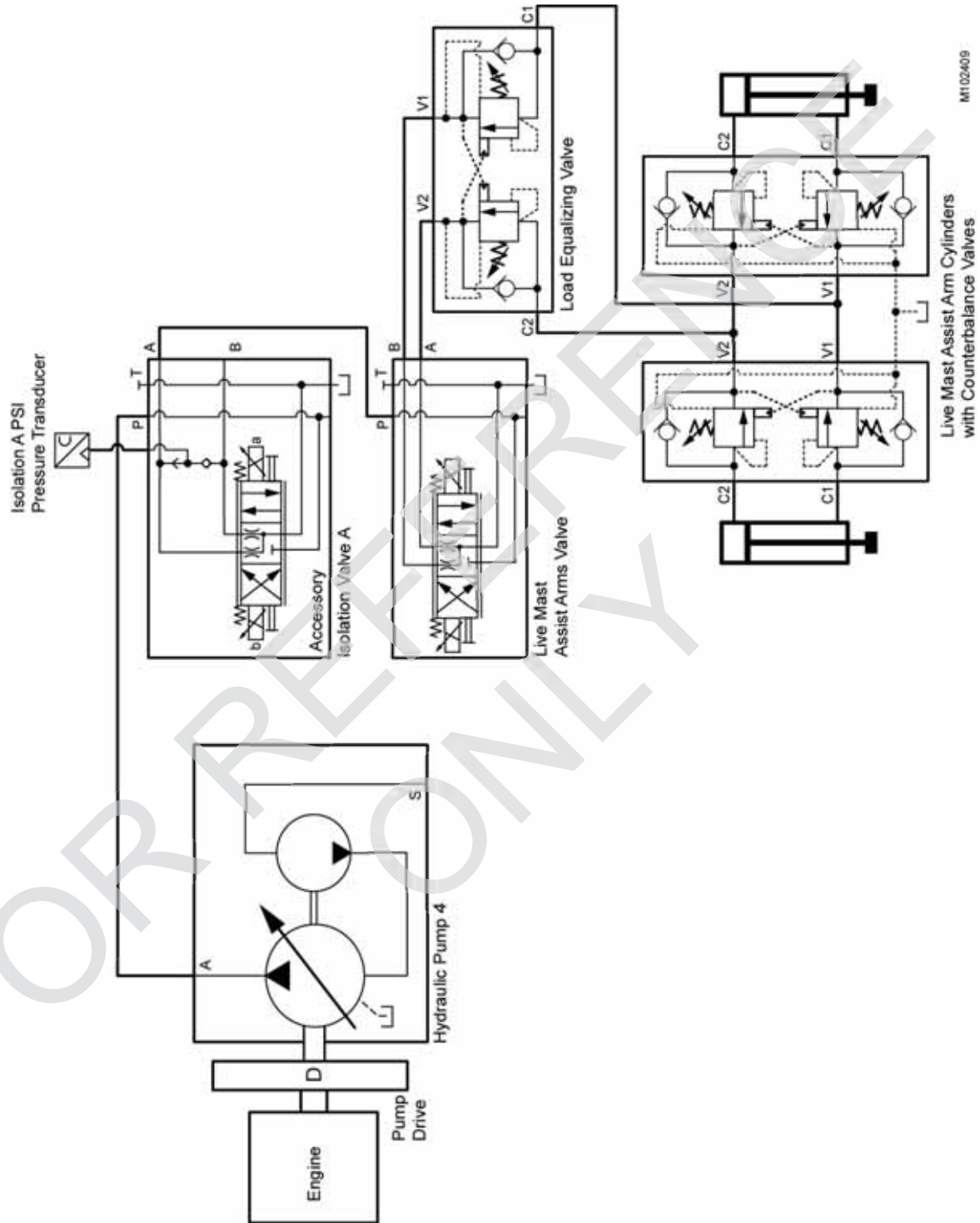
See [Figure 10-9](#) and [Figure 10-10](#) for the following.

When a lower command is initiated by the setup remote or by the S31 switch, the command is sent to the CCM-10 control module. The CCM-10 control module then communicates the lower command to the IOLC32 and IOLC33 control modules via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 4 to increase system A (left valve assembly) hydraulic flow.
- The IOLC33 control module sends 24 V_{DC} to the side A solenoid on isolation valve A. The solenoid energizes because the CCM-10 control module provides a ground for the solenoid. The energized solenoid shifts the valve spool to a position that routes hydraulic fluid to the live mast assist arms valve.
- The IOLC32 control module then sends 24 V_{DC} to the corresponding solenoid on the live mast assist arms valve, energizing the solenoid. The valve shifts to route hydraulic fluid to the rod end side of the load-equalizing valve.
- At the load-equalizing valve, hydraulic fluid flows through the rod end check valve to the rod end counterbalance valves. At the same time, pilot pressure opens the barrel end load-equalizing valve.
- At the counterbalance valves, hydraulic fluid flows through the rod end check valves into the rod end of the cylinders. At the same time, pilot pressure opens the barrel end counterbalance valves. As hydraulic fluid fills the rod end of the cylinders, the rods retract to lower the arms. This action forces hydraulic fluid out the barrel ends of the cylinders, through the open counterbalance valves, through the open load-equalizing valve, and back to tank via the live mast assist arms valve.

Live Mast Assist Arms Hydraulic Schematic—Neutral



M102405

FIGURE 10-7

Live Mast Assist Arms Hydraulic Schematic—Extend Cylinders

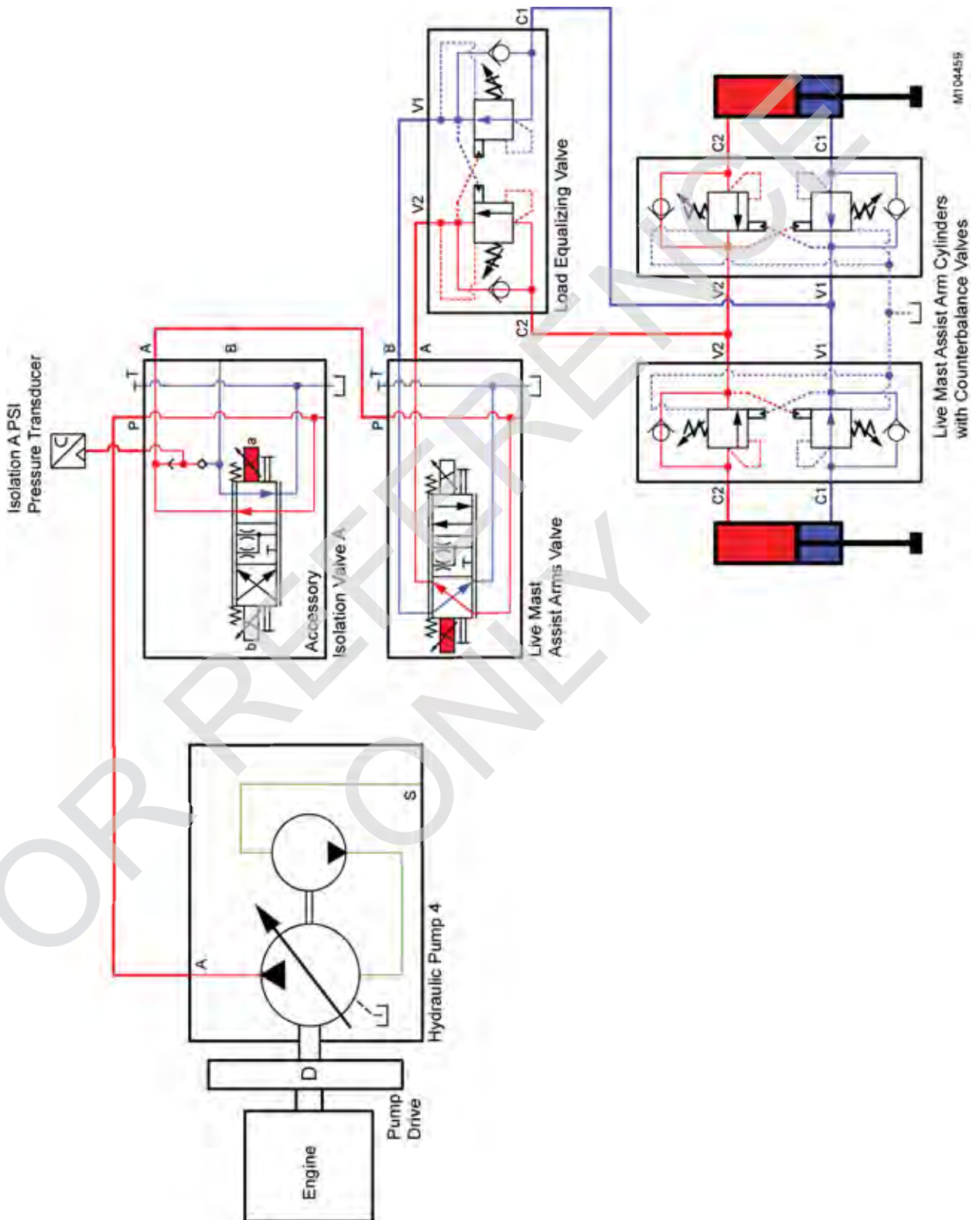


FIGURE 10-8

Live Mast Assist Arms Hydraulic Schematic—Retract Cylinders

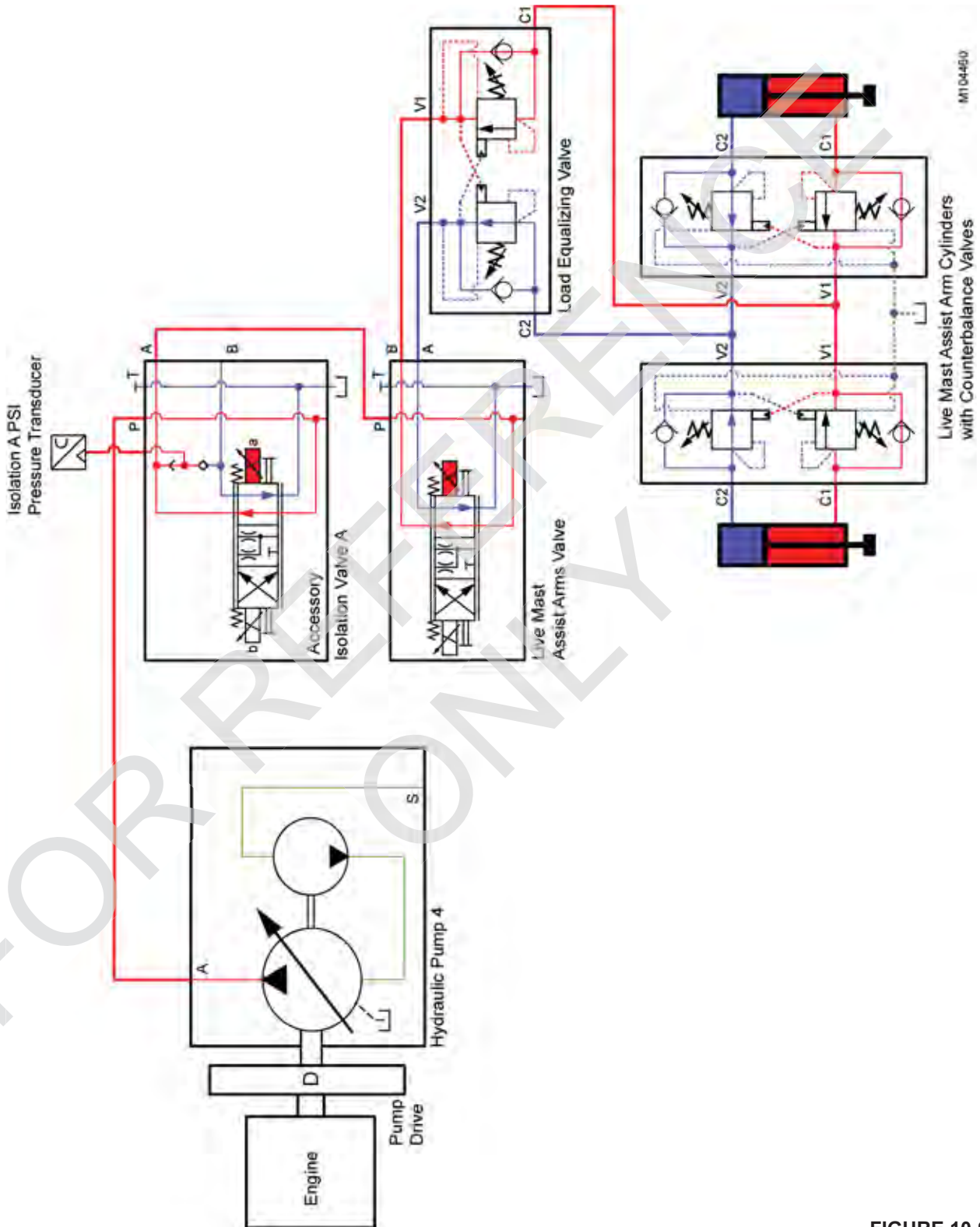


FIGURE 10-9

Live Mast Assist Arms Electrical Schematic

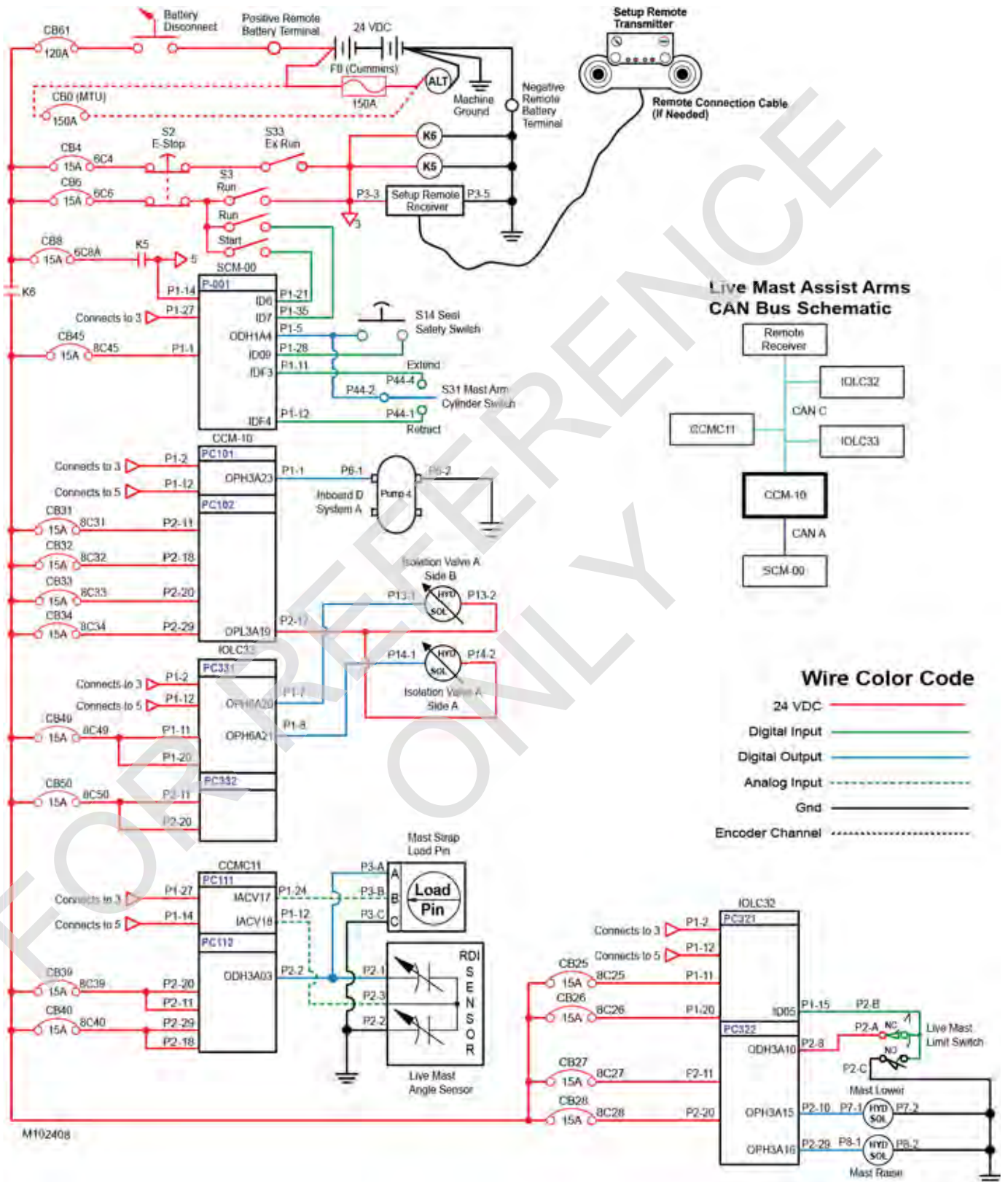


FIGURE 10-10

CAB TILT CYLINDER

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the cab tilt system.

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

- Section 2: Hydraulics
- Section 3: Electrical

The cab tilt cylinder is controlled by the setup remote or by the S23 cab tilt switch in the cab.

See [Figure 10-12](#) and [Figure 10-13](#) for the following descriptions.

Setup Remote Control

The setup remote control communicates with the CCM-10 control module via the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

To operate the setup remote, it must be turned on as instructed in the MLC300 Operator Manual.

S23 Cab Tilt Switch Control

The IOSA22 control module provides 24 V_{DC} to the S23 switch. When the S23 switch is in the cab UP or cab DOWN position, the switch sends a 24 V_{DC} signal back to the IOSA22 control module. The IOSA22 control module then communicates the corresponding command to the CCM-10 control module via CAN Bus A.

Neutral

When there is no command from the setup remote or S23 cab tilt switch:

- Pump 4 hydraulic flow through system A (left valve assembly) decreases.
- The isolation valve A shifts to neutral to block pump flow to the cab tilt valve.
- The cab tilt valve shifts to neutral to block pump flow to the cab tilt cylinder.
- The load holding valve closes to lock the cylinder in position.

Tilt Up

When a tilt up command is initiated by the setup remote or by the S23 cab tilt switch, the command is sent to the CCM-10 control module. The CCM-10 control module then communicates the tilt up command to the IOLC32 and IOLC33 control modules via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 4 to increase system A (left valve assembly) hydraulic flow.
- The IOLC33 control module sends 24 V_{DC} to the side A solenoid on isolation valve A, energizing the solenoid. The CCM-10 control module provides the ground for the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the cab tilt valve via an adjustable pressure compensated flow control valve.
- The IOLC32 control module then sends 24 V_{DC} to the corresponding solenoid on the cab tilt valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the load holding valve at the barrel end of the cab tilt cylinder.
- Hydraulic fluid bypasses the load holding valve by flowing through a check valve, then to the barrel end of the cylinder. As hydraulic fluid fills the barrel end of the cylinder, the rod extends to tilt the cab up. This action forces hydraulic fluid out the rod end of the cylinder and back to tank via the cab tilt valve.

Load Holding

If system pressure is lost, the check valve closes and the load holding valve locks the cab tilt cylinder in position.

Tilt Down

When a tilt down command is initiated by the setup remote or by the S23 cab tilt switch, the command is sent to the CCM-10 control module. The CCM-10 control module then communicates the tilt down command to the IOLC32 and IOLC33 control modules via CAN Bus C. The following then occurs:

- The CCM-10 control module increases the PWM current to pump 4 to increase system A (left valve assembly) hydraulic flow.
- The IOLC33 control module sends 24 V_{DC} to the side A solenoid on isolation valve A, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the cab tilt valve.
- The IOLC32 control module then sends 24 V_{DC} to the corresponding solenoid on the cab tilt valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the rod end of the cab tilt cylinder.
- Rod-end pilot pressure opens the load holding valve. As hydraulic fluid fills the rod end of the cab tilt cylinder, the rod retracts to tilt the cab down. This action forces hydraulic fluid out the barrel end of the cylinder, through the open load holding valve, and back to tank via the cab tilt valve.

Cab Tilt Adjustment

The cab tilt circuit contains a pressure-compensated flow control valve (1) that allows adjustment of the cab tilt speed.

The flow control valve is located near the cab, on the left side of the rotating bed.

See [Figure 10-11](#) for the following procedure.

To adjust the speed at which the cab tilts up and down, perform the following.

1. Loosen the set screw (2).
2. Turn the adjusting knob (3) clockwise to close the valve.
3. Open the valve slightly by turning the adjusting knob counterclockwise.
4. Test the cab tilt operation using the S23 cab tilt switch on the cab control console.
5. Repeat [step 2](#) through [step 4](#) until cab tilt starts and stops smoothly.
6. Securely tighten the set screw.



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Item	Description
1	Flow Control Valve
2	Set Screw
3	Adjusting Knob

FIGURE 10-11

Cab Tilt Hydraulic Schematic

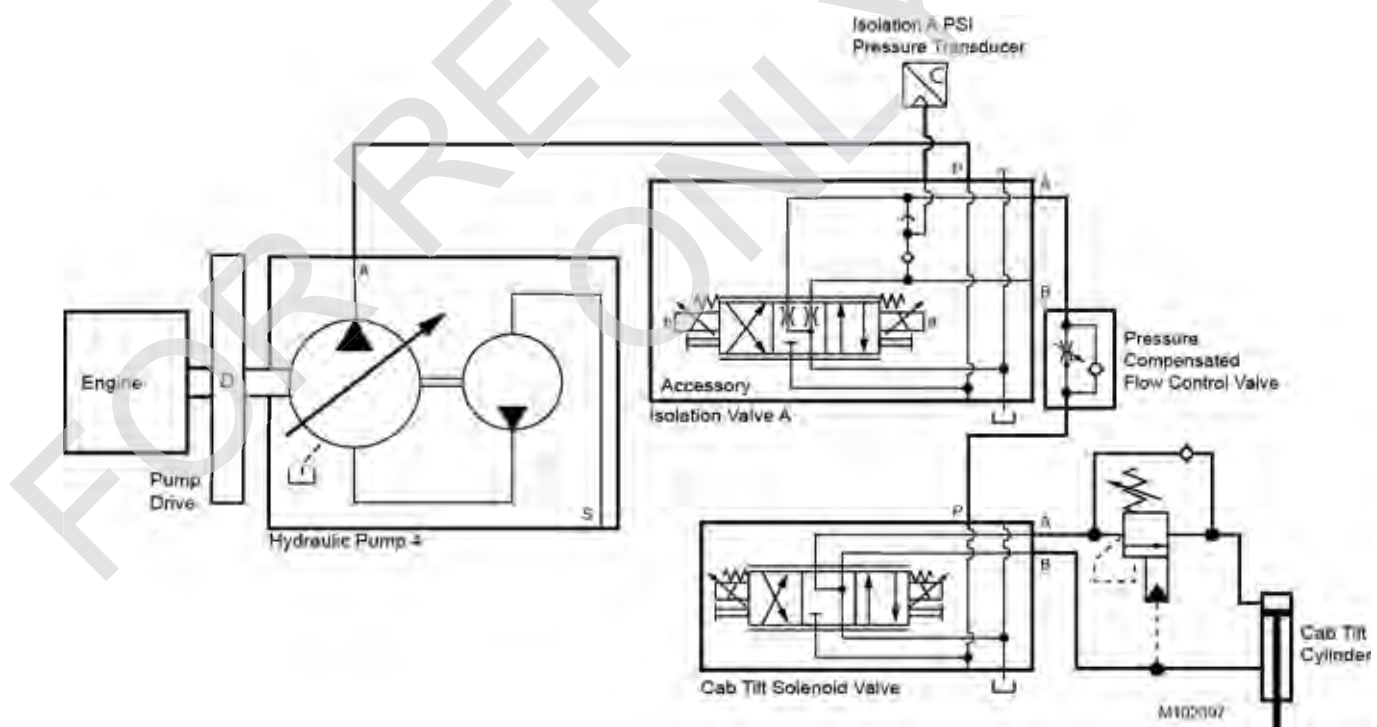


FIGURE 10-12

Cab Tilt Electrical Schematic

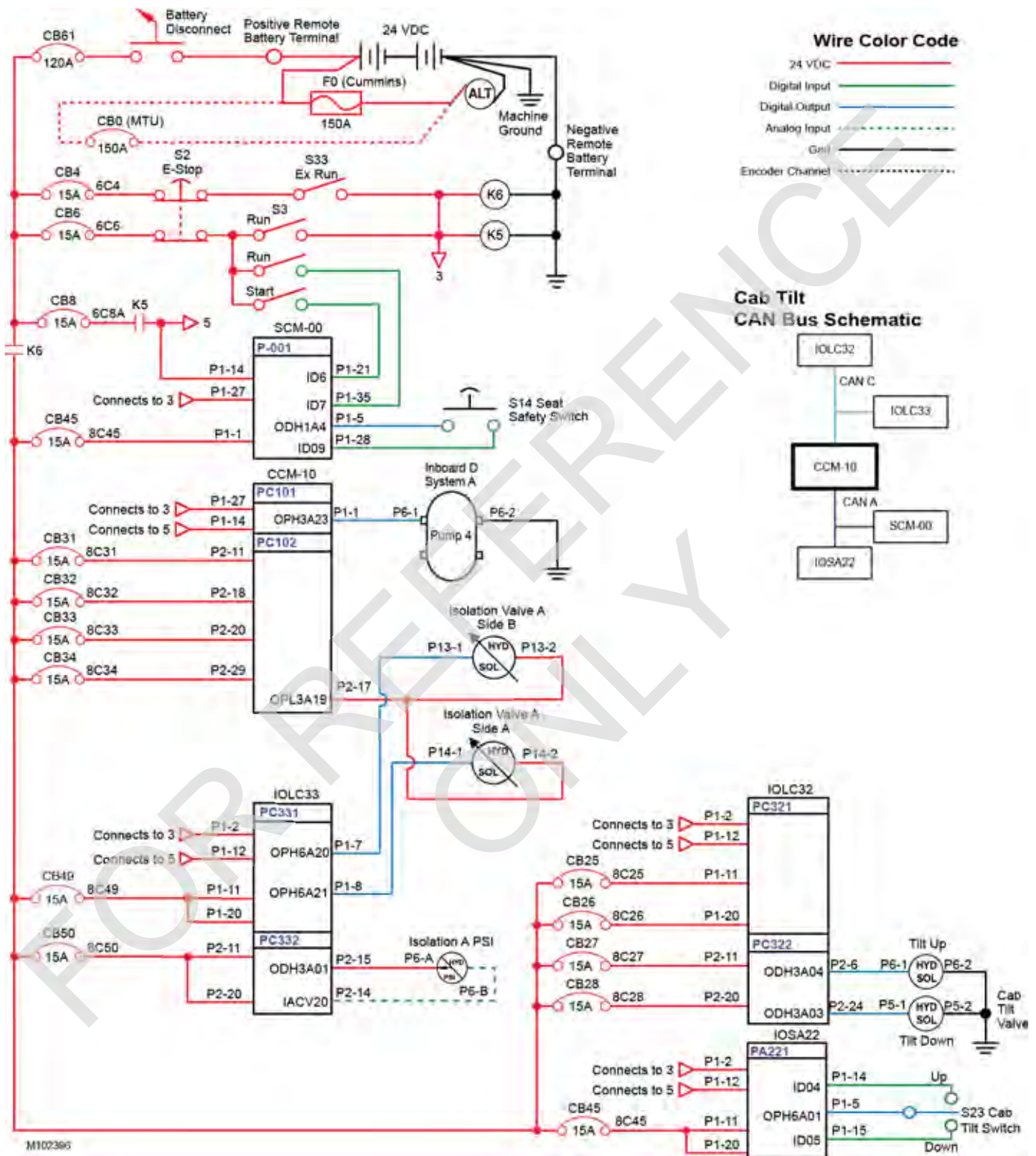


FIGURE 10-13

RIGGING WINCH (DRUM 0)

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the rigging winch system.

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

- Section 2: Hydraulics
- Section 3: Electrical

The rigging winch is controlled by the setup remote.

Setup Remote Control

The setup remote control communicates with the CCM-10 control module via the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

To operate the setup remote, it must be turned on as instructed in the MLC300 Operator Manual.

See [Figure 10-14](#) and [Figure 10-15](#) for the following descriptions.

Neutral

When there is no command from the setup remote:

- Pump 3 hydraulic flow through system B (right valve assembly) decreases.
- The isolation valve B shifts to neutral to block pump flow to the rigging winch valve.
- The rigging winch valve shifts to neutral to block pump flow to the rigging winch.
- The holding valve closes to prevent the winch from paying out. The shuttle valve provides a return flow path from the brake to tank, so the brake spring applies.

Haul In

When a haul in command is initiated by the setup remote, the setup remote receiver communicates the command to the CCM-10 control module. The CCM-10 control module then communicates the haul in command to the CCMC11 and IOLC30 control modules via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 3 to increase system B (right valve assembly) hydraulic flow.
- The IOLC30 control module sends 24 V_{DC} to the side B solenoid on isolation valve B. The solenoid energizes because the CCMC11 control module provides a ground

for the solenoid. The energized solenoid shifts the valve spool to a position that routes hydraulic fluid to the rigging winch valve.

- The CCMC11 control module then sends 24 V_{DC} to the corresponding solenoid on the rigging winch valve, energizing the solenoid. The valve spool shifts to a position that routes hydraulic fluid to the holding valve.
- At the holding valve, hydraulic fluid flows through the check valve to the haul-in port on the hydraulic motor. Hydraulic flow shifts the shuttle valve, and hydraulic pressure releases the winch brake. The hydraulic motor turns the drum in the haul-in direction.
- Hydraulic fluid leaving the opposite side of the motor flows back to tank via the rigging winch control valve.

Pay Out

When a pay out command is initiated by the setup remote, the setup remote receiver communicates the command to the CCM-10 control module. The CCM-10 control module then communicates the pay out command to the CCMC11 and IOLC30 control modules via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 3 to increase system B (right valve assembly) hydraulic flow.
- The IOLC30 control module sends 24 V_{DC} to the side B solenoid on isolation valve B. The solenoid energizes because the CCMC11 control module provides a ground for the solenoid. The energized solenoid shifts the valve spool to a position that routes hydraulic fluid to the rigging winch valve.
- The CCMC11 control module then sends 24 V_{DC} to the corresponding solenoid on the rigging winch valve, energizing the solenoid. The valve shifts to a position that routes hydraulic fluid to the pay-out port on the hydraulic motor.
- At the same time, hydraulic flow shifts the shuttle valve and hydraulic pressure releases the winch brake.
- Pilot pressure from the pay-out side of the hydraulic motor shifts the holding valve open, allowing the motor to turn in the pay-out direction.
- Hydraulic fluid leaving the opposite side of the motor flows through the open holding valve and back to the tank via the rigging winch control valve.

Load Holding

If system pressure is lost, the winch brake spring applies and the holding valve closes to stop the winch and prevent it from paying out.

Rigging Winch (Drum 0) Hydraulic Schematic

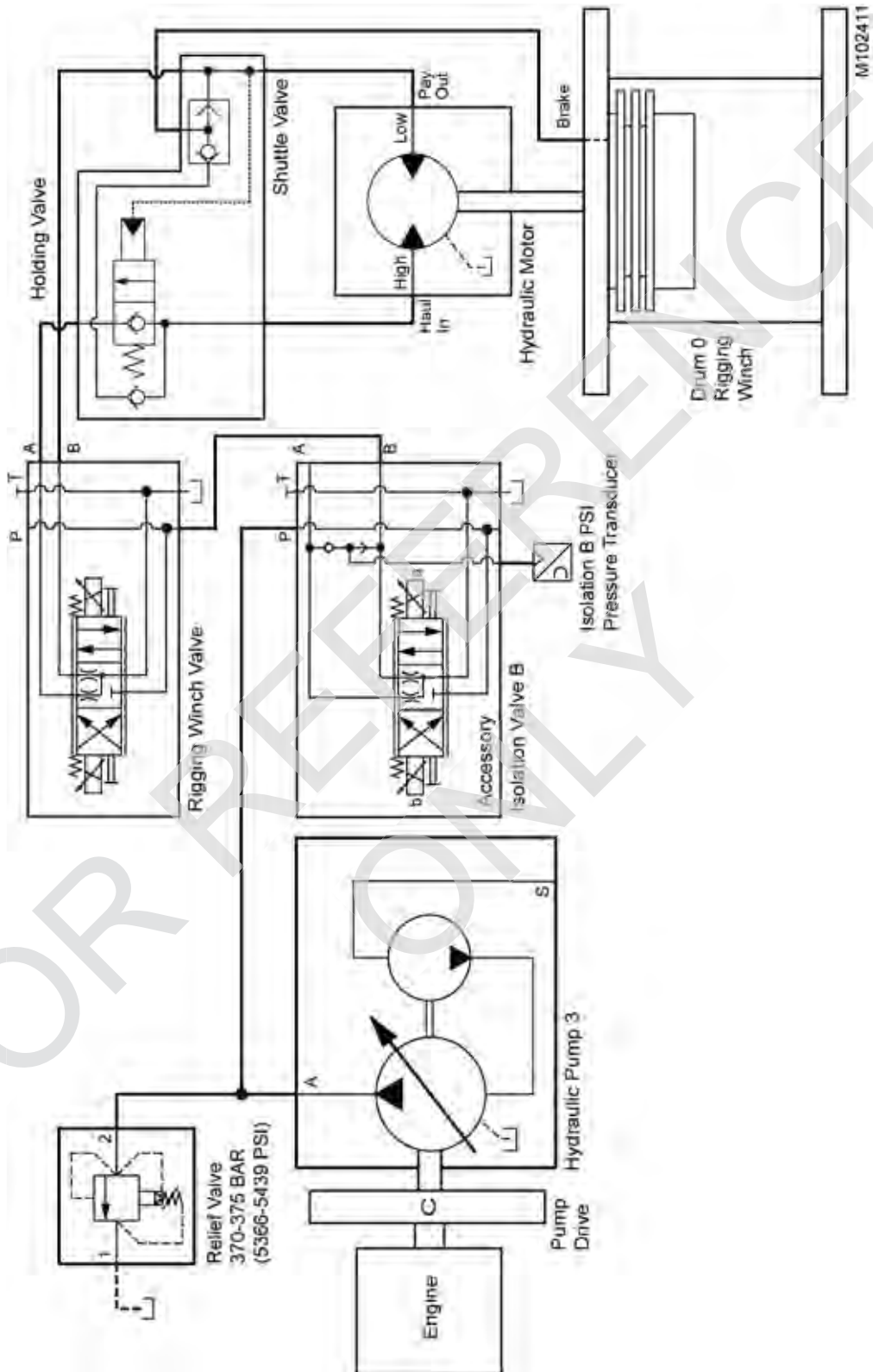


FIGURE 10-14

Rigging Winch (Drum 0) Electrical Schematic

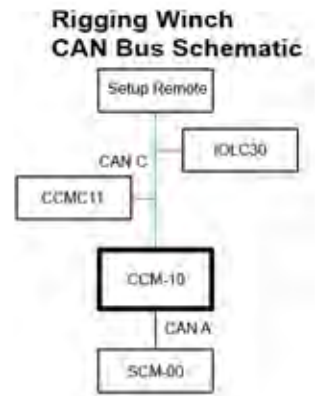
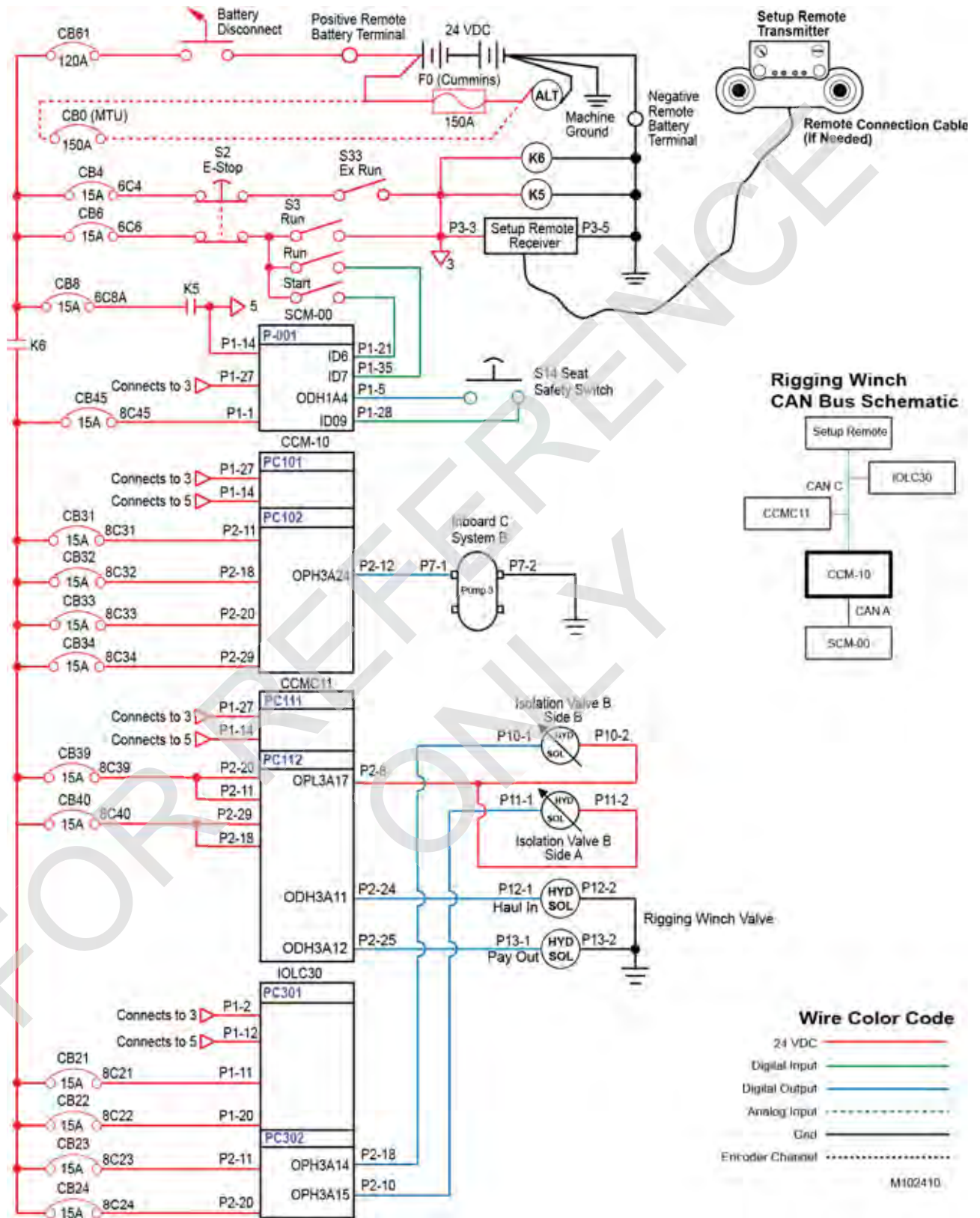


FIGURE 10-15

BOOM BUTT PIN PULLERS

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the boom butt pin pullers system.

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

- Section 2: Hydraulics
- Section 3: Electrical

The pins that connect the boom butt to the rotating bed are controlled by the setup remote.

See [Figure 10-16](#) and [Figure 10-17](#) for the following descriptions.

Setup Remote Control

The setup remote control communicates with the CCM-10 control module via the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

To operate the setup remote, it must be turned on as instructed in the MLC300 Operator Manual.

The mast must be configured for setup by using the RCL/RCI display. For setup instructions, see the RCL/RCI display operation manual (F2269).

Neutral

When there is no command from the setup remote:

- Pump 3 hydraulic flow through system B (right valve assembly) decreases.
- The isolation valve B shifts to neutral to block pump hydraulic flow to the boom butt pin puller valve.
- The boom butt pin puller valve shifts to neutral to block hydraulic flow to the boom butt pin pullers.

Disengage (extend)

When a pin puller engage command is initiated by the setup remote, the setup remote receiver sends the command to CCM-10 control module. The CCM-10 control module then communicates the extend command to the CCMC11 and IOLC30 control modules via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 3 to increase system B (right valve assembly) hydraulic flow.
- The IOLC30 control module sends 24 V_{DC} to the side B solenoid on isolation valve B. The solenoid energizes because the CCMC11 control module provides a ground for the solenoid. The energized solenoid shifts the valve spool to a position that routes hydraulic fluid to the boom butt pin puller valve.
- The CCMC11 control module then sends 24 V_{DC} to the corresponding solenoid on the boom butt pin puller valve, energizing the solenoid. The valve shifts to a position that routes hydraulic fluid to the barrel end of the pin puller cylinders.
- Hydraulic fluid flows into the barrel end of the pin puller cylinders and the rods extend to disengage the boom butt pins. This action forces hydraulic fluid out the rod end of the pin puller cylinders and back to the tank via the boom butt pin puller valve.

Engage (retract)

When a pin puller disengage command is initiated by the setup remote, the setup remote receiver sends the command to CCM-10 control module. The CCM-10 control module then communicates the extend command to the CCMC11 and IOLC30 control modules via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 3 to increase system B (right valve assembly) hydraulic flow.
- The IOLC30 control module sends 24 V_{DC} to the side B solenoid on isolation valve B. The solenoid energizes because the CCMC11 control module provides a ground for the solenoid. The energized solenoid shifts the valve spool to a position that routes hydraulic fluid to the boom butt pin puller valve.
- The CCMC11 control module then sends 24 V_{DC} to the corresponding solenoid on the boom butt pin puller valve, energizing the solenoid. The valve shifts to a position that routes hydraulic fluid to the rod end of the pin puller cylinders.
- Hydraulic fluid flows into the rod end of the pin puller cylinders, and the rods retract to engage the boom butt pins. This action forces hydraulic fluid out the barrel end of the pin puller cylinders and back to the tank via the boom butt pin puller valve.

Boom Butt Pin Pullers Hydraulic Schematic

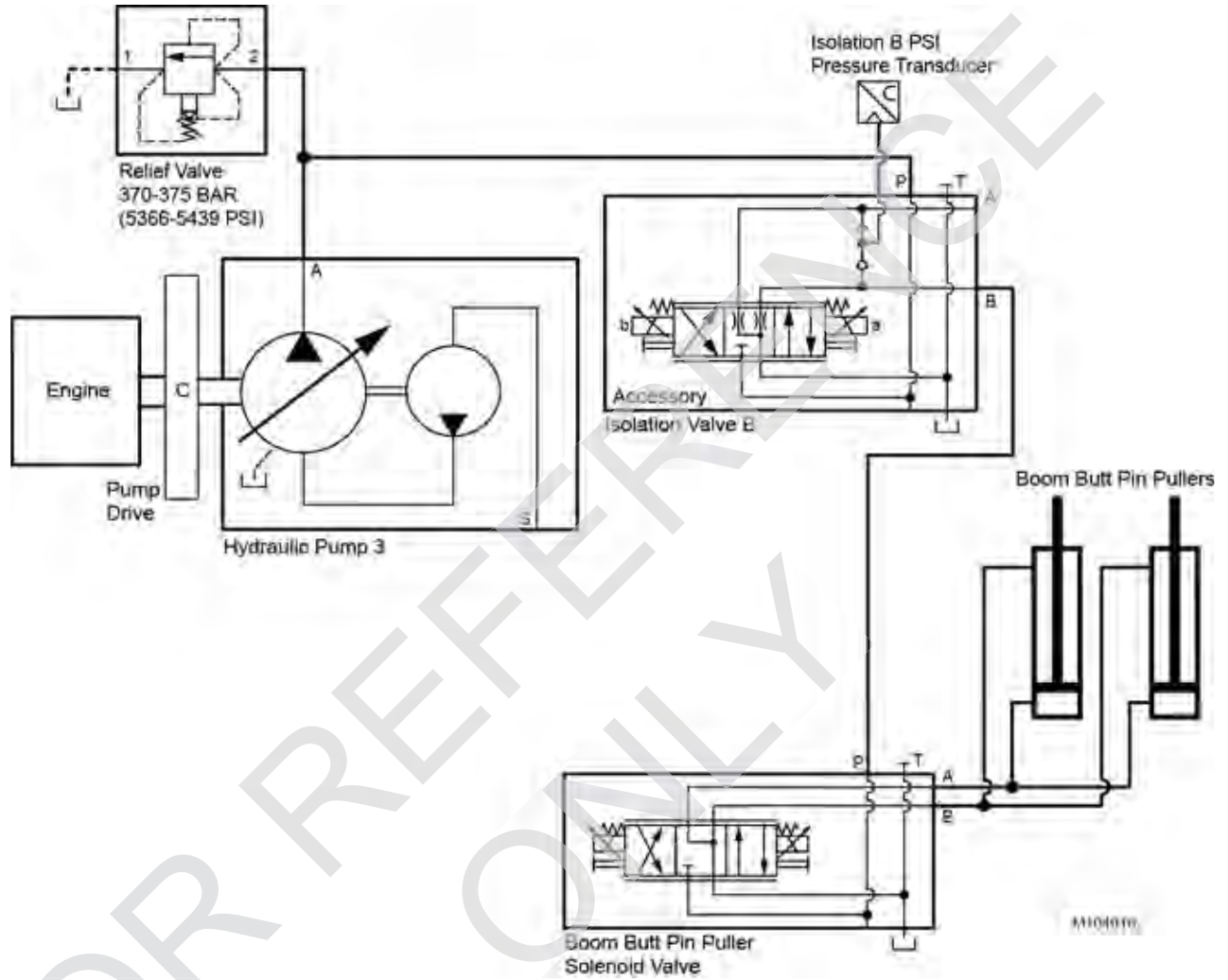


FIGURE 10-16

Boom Butt Pin Pullers Electrical Schematic

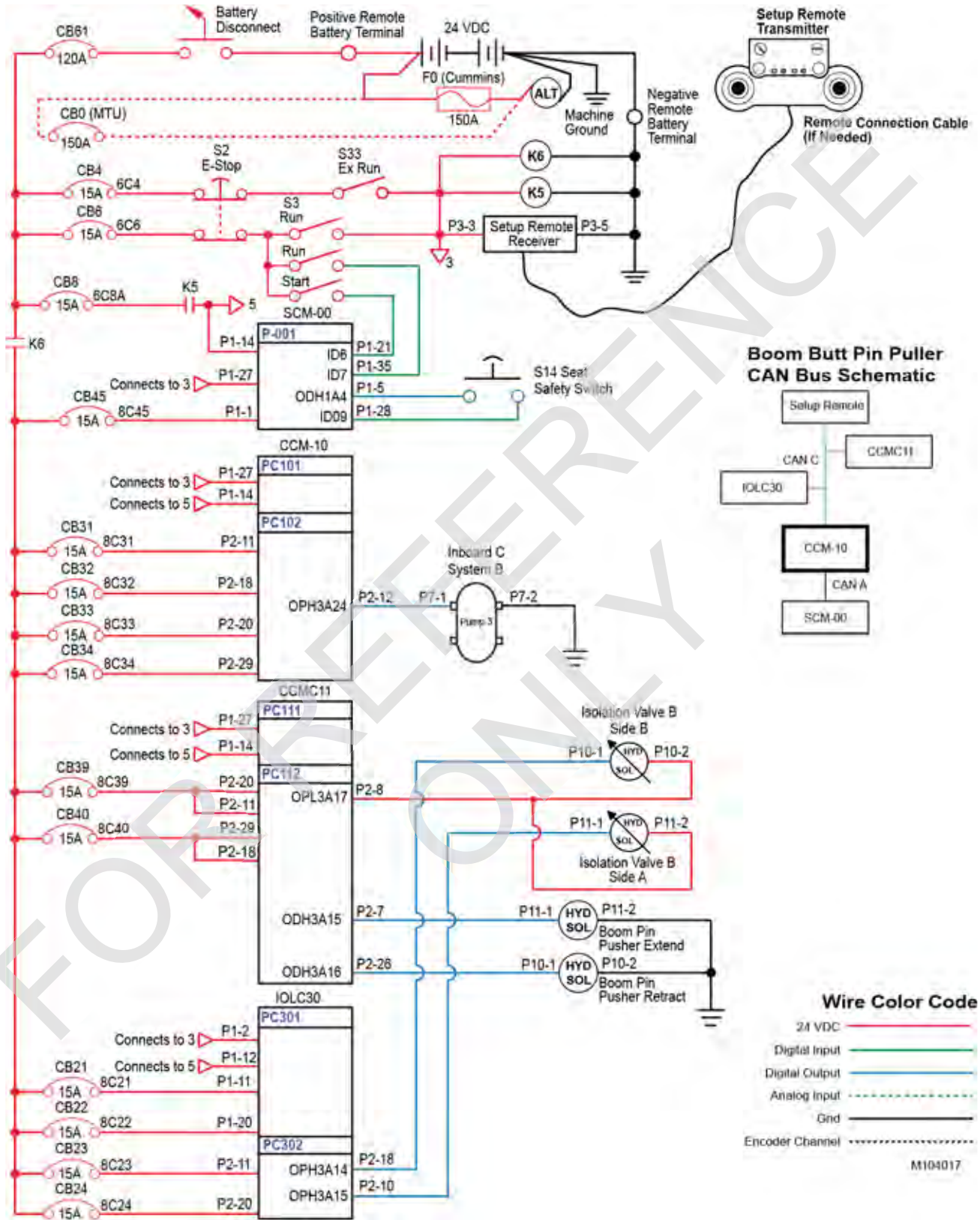


FIGURE 10-17

SELF-ERECT CYLINDER

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the self-erect cylinder system.

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

- Section 2: Hydraulics
- Section 3: Electrical

The self-erect cylinder is controlled by the center control handle on the right console (joystick J4).

See [Figure 10-18](#) and [Figure 10-19](#) for the following descriptions.

Joystick J4 Control

Joystick J4 communicates with the CCM-10 control module via the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

To operate the self-erect cylinder, the setup mode must be turned on as instructed in the MLC300 Operator Manual.

Also, on current production cranes (software version CCM-10 0.022 and newer) the self-erect cylinder must be turned on as instructed in the MLC300 Main Display Manual.

Neutral

When there is no command from joystick J4:

- Pump 3 hydraulic flow through system B (right valve assembly) decreases.
- The isolation valve B shifts to neutral to block pump flow to the self-erect cylinder valve.
- The self-erect valve shifts to neutral to block pump flow to the self-erect cylinder.
- The load holding valve closes to lock the self-erect cylinder in position.

Hoist (retract)

When a hoist command is sent by joystick J4 to CCM-10 control module, the CCM-10 control module communicates the hoist command to the IOLC30 control module via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 3 to increase system B (right valve assembly) hydraulic flow.

- The IOLC30 control module sends 24 V_{DC} to the side B solenoid on isolation valve B. The solenoid energizes because the CCMC11 control module provides a ground for the solenoid. The energized solenoid shifts the valve spool to a position that routes hydraulic fluid to the self-erect cylinder valve.
- The IOLC30 control module then sends 24 V_{DC} to the corresponding solenoid on the self-erect cylinder valve, energizing the solenoid. The valve shifts to a position that routes hydraulic fluid to the load holding valve at the rod end of the self-erect cylinder.
- The hydraulic fluid bypasses the load holding valve by flowing through a check valve, then to the rod end of the self-erect cylinder. The rod retracts to hoist the load. This action forces hydraulic fluid out the barrel end of the self-erect cylinder and back to the tank via the self-erect cylinder valve.

Load Holding

If system pressure is lost, the check valve closes and the load holding valve locks the self-erect cylinder in position.

Lower (extend)

When a lower command is sent by joystick J4 to CCM-10 control module, the CCM-10 control module communicates the lower command to the IOLC30 control module via CAN Bus C.

The following then occurs:

- The CCM-10 control module increases the PWM current to pump 3 to increase system B (right valve assembly) hydraulic flow.
- The IOLC30 control module sends 24 V_{DC} to the side B solenoid on isolation valve B. The solenoid energizes because the CCMC11 control module provides a ground for the solenoid. The energized solenoid shifts the valve spool to a position that routes hydraulic fluid to the self-erect cylinder valve.
- The IOLC30 control module then sends 24 V_{DC} to the corresponding solenoid on the self-erect cylinder valve, energizing the solenoid. The valve shifts to a position that routes hydraulic fluid to the barrel end of the self-erect cylinder.
- Barrel end pilot pressure opens the load holding valve. As hydraulic fluid fills the barrel end of the self-erect cylinder, the rod extends to lower the load. This action forces hydraulic fluid out the rod end of the cylinder, through the open holding valve, and back to the tank via the self-erect cylinder valve.

Self-Erect Cylinder Hydraulic Schematic

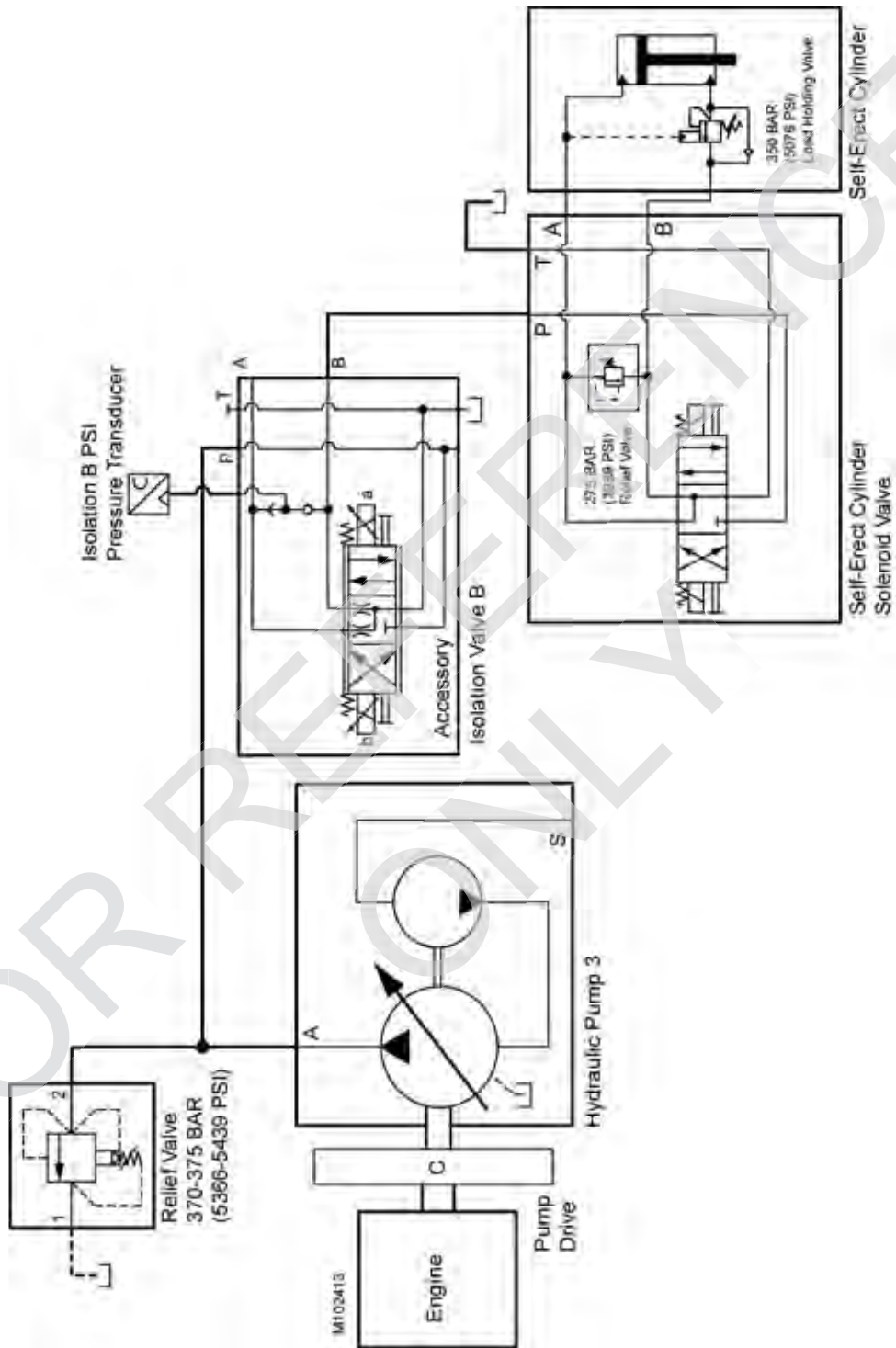
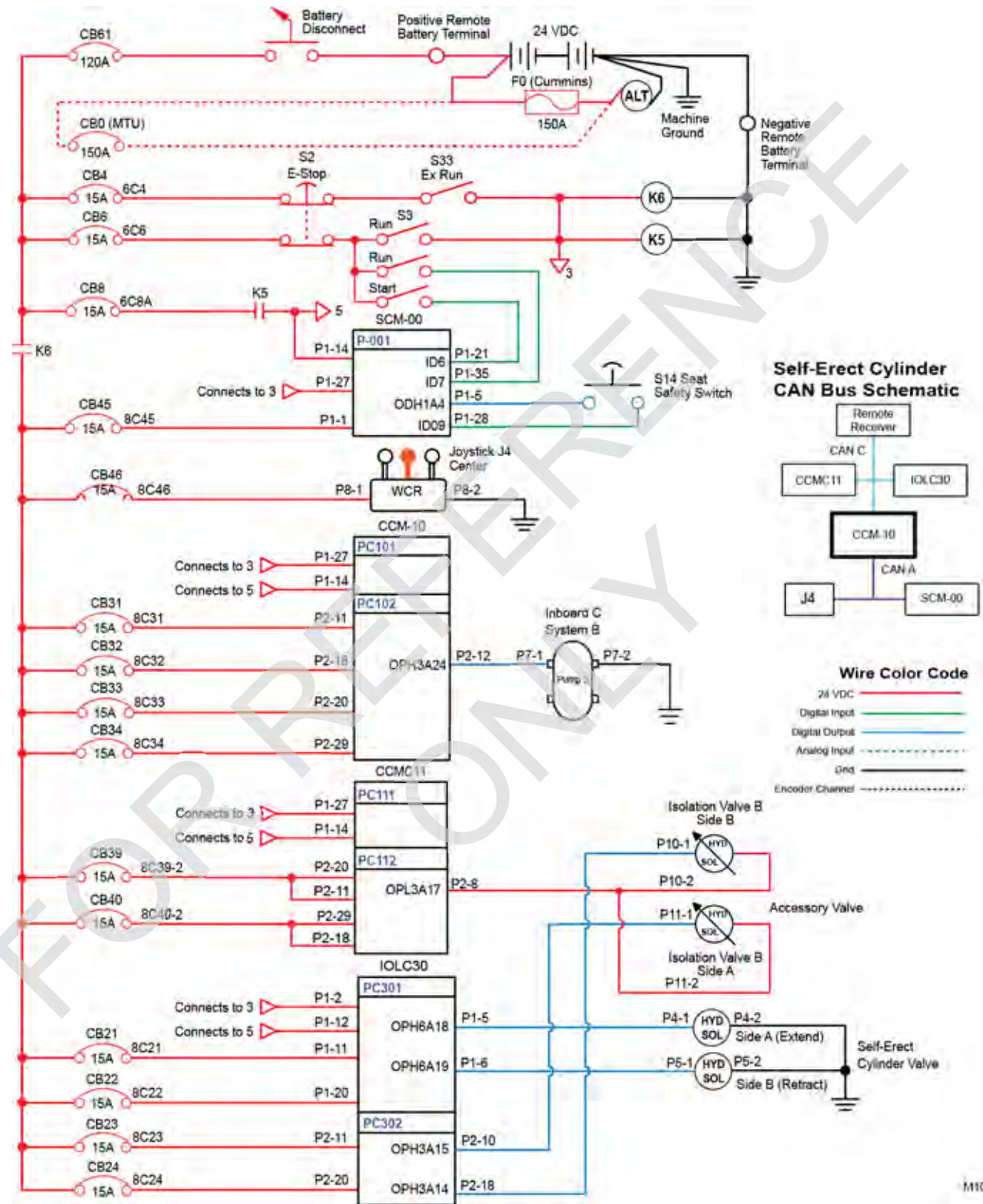


FIGURE 10-18

Self-Erect Cylinder Electrical Schematic



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FIGURE 10-19

10

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Grove

Manitowoc

National Crane

Potain

