Manitowoc

MLC80A-1/MLC90A-1/ MLC100A-1/MLC100-1

Service/Maintenance Manual

Manitowoc®

WARNING

California Proposition 65

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

Always start and operate the engine in a well-ventilated area.

If in an enclosed area, vent the exhaust to the outside.

Do not modify or tamper with the exhaust system.

Do not idle the engine except as necessary.

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

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

California Spark Arrestor

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

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SERVICE/MAINTENANCE MANUAL

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

MLC80A-1/MLC90A-1/MLC100A-1/MLC100-1

Crane Model Number

XXXXXRef

Crane Serial Number

This manual is divided into the following sections:

NOTICE

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

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

Published 10-09-2020, Control # 259-06

THE ORIGINAL LANGUAGE OF THIS PUBLICATION IS ENGLISH

See end of this manual for Alphabetical Index

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SECTION 1
INTRODUCTION

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SECTION 1
INTRODUCTION

CONTINUOUS INNOVATION

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

WARNING

California Proposition 65

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

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
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For more information go to www.P65warnings.ca.gov/diesel.

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

California Spark Arrestor!

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

SAFETY MESSAGES

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

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

Safety Alert Symbol

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

Signal Words

DANGER

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

WARNING

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

CAUTION

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

CAUTION

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

SAFE MAINTENANCE PRACTICES

WARNING

Safety Responsibility!

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

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

Read This Manual

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

Authorized Repair Personnel Only

Crane maintenance and repair must be performed by personnel who by reason of training and experience are thoroughly familiar with the crane's operation and required maintenance. These personnel shall read the Operator Manual and the 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 relevant to the maintenance to be performed.

Before Starting a Maintenance Procedure

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

- Park the crane where it will not interfere with other equipment or operations.
- Lower all loads to ground or otherwise secure them against movement.
- Lower the boom onto blocking at ground level, if possible, or otherwise secure the boom so that it cannot drop unexpectedly.
- Move all controls to OFF and secure all functions against movement by applying or engaging all brakes, pawls, or other locking devices.
- Stop the engine and render the starter inoperative. This must be done according to your organization's lockout-tagout procedure.
- Place a warning sign at the start controls to alert other personnel that the crane is being serviced and the engine must not be started. Do not remove the sign until it is safe to return the crane to service.
- Wear clothing that is relatively tight and belted.
- Wear appropriate eye protection and an approved hard hat.
- Do not attempt to maintain or repair any part of the crane while the engine is running, unless it is absolutely necessary.

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

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

Precautions While Working on the Crane

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

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

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

Stored Energy Safety Precautions

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

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

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

Chemical Handling Precautions

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

Fire Hazard Precautions

- Stop the engine before refueling the crane.
- Do not smoke or allow open flames in the refueling area.
- When using a fuel can, use a safety-type can with an automatic closing cap and flame arrestor.
- Hydraulic oil can also be flammable. Do not smoke or allow open flames in the area when filling hydraulic tanks.
- Only use cleaning solvents which are nonvolatile and nonflammable.
- Do not store flammable materials on the crane.
- Use care while welding or torching on the crane. Cover all hoses and components with nonflammable shields or blankets to prevent a fire and other damage.
- Keep the crane clean. Accumulations of dirt, grease, oil, rags, paper, and other waste will not only interfere with safe operation and maintenance but also create a fire hazard.

Welding Hazard Avoidance

- Welding—To prevent damage to the crane parts (for example, bearings, cylinders, swivels, slewing ring, and computers), perform the following steps before welding on the crane.

  a. Turn the battery disconnect switch to the OFF position.

  b. Disconnect all the cables from the batteries. Make sure to disconnect the negative cable first.

  c. Disconnect the output cables at the engine junction box.

  d. Disconnect all cable connectors from nearby control modules.

  e. Attach a ground cable from the welder directly to the part being welded and as close to the weld as possible.

  Do not weld on the engine or the engine-mounted parts (per engine manufacturer).

- Disconnect and lock out the power supply switch before attempting to service high-voltage electrical components and before entering tight areas (such as carbody openings) containing high-voltage components.

Maintaining Structural Integrity of the Crane

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

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

Returning the Crane to Service

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

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.

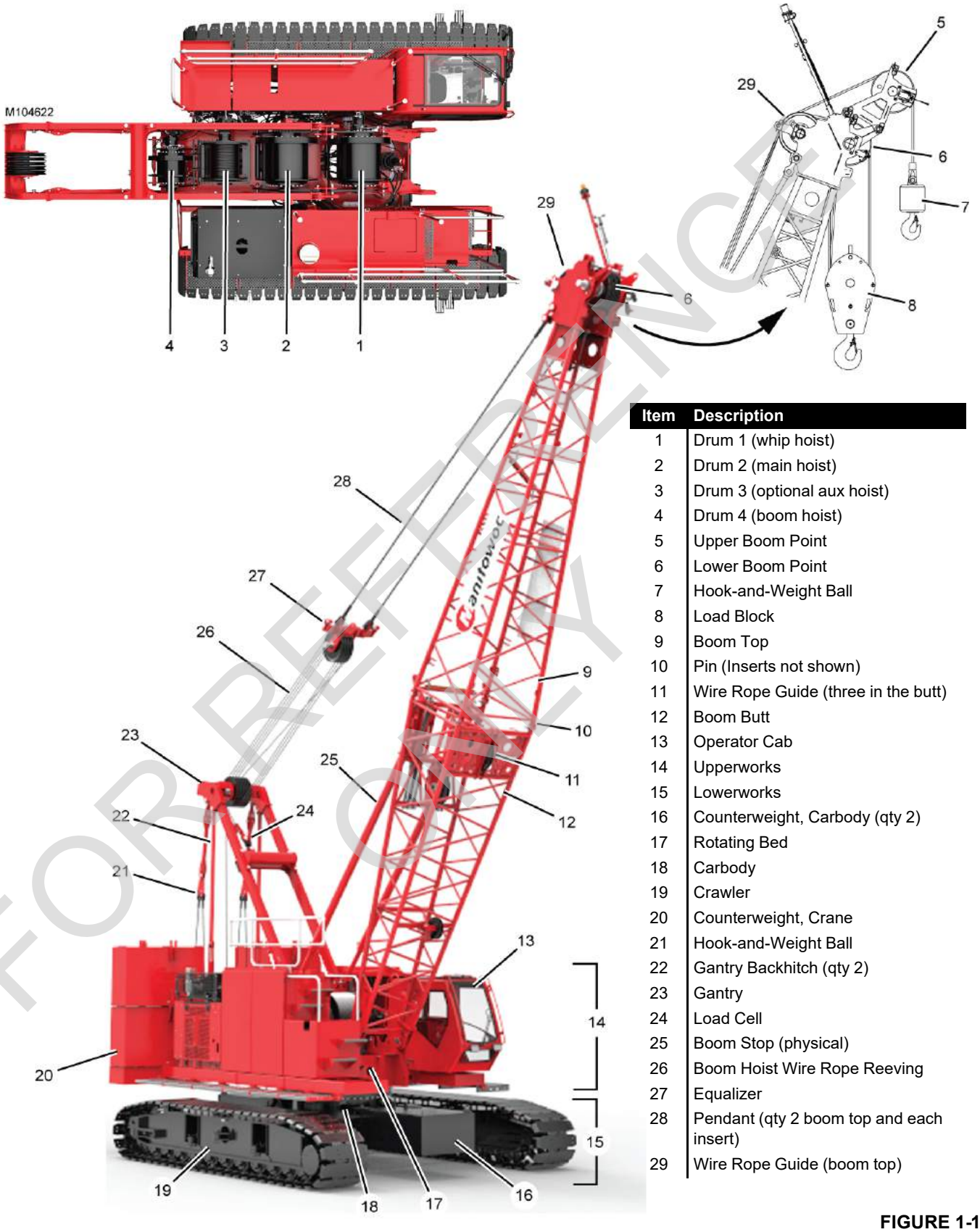
IDENTIFICATION AND LOCATION OF MAJOR COMPONENTS

See Figure 1-1 and Figure 1-2 for locations of the crane's major components.

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

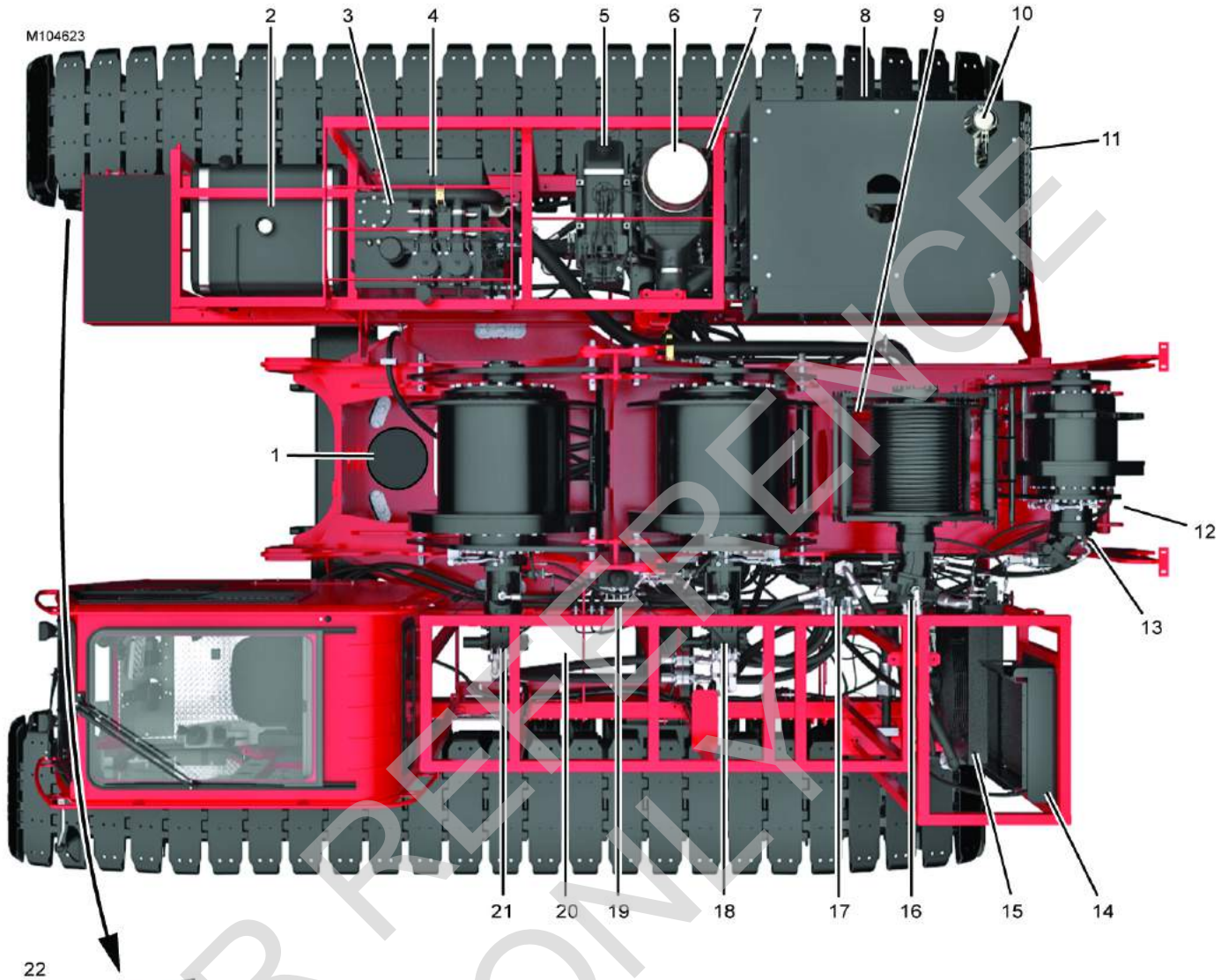
- Hydraulic pumps
- Hydraulic motors
- Transducers
- Hydraulic valve assemblies

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



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

FIGURE 1-1



Item	Description
1	Swing Drive
2	Fuel Tank
3	Hydraulic Tank
4	Battery Box
5	Diesel Exhaust Fluid (DEF) Tank
6	Engine Air Cleaner
7	Pump Drive with Pumps
8	Engine
9	High Pressure Accessory Valve
10	Engine Exhaust System
11	Radiator/Cooler Assembly

Item	Description
12	Counterweight Pins (crane)
13	Drum 4 (boom hoist) (drive)
14	A/C Condenser
15	Hydraulic Oil Cooler
16	Drum 3 (optional aux hoist) (drive)
17	Main Control valve
18	Drum 2 (main hoist) (drive)
19	Low Pressure Accessory Valve
20	Crawler Extend and Retract Cylinder
21	Drum 1 (whip hoist) (drive)
22	Crawler Drive

FIGURE 1-2

SECTION 2
HYDRAULIC SYSTEM

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SECTION 2
HYDRAULIC SYSTEM

HYDRAULIC SCHEMATIC

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

HYDRAULIC SYSTEM OVERVIEW

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

.

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

Hydraulic Pump Locations

There are five hydraulic pumps driven by the engine. Figure 2-1 illustrates the location of these pumps and the circuits they supply.

Pump	Supplies Oil To
1	Main Pumps: Side A = High Pressure Accessories (gantry and crawler cylinders), Drum 2 Primary, Left Crawler, Drum 1 Secondary, and Drum 3 Side B = Right Crawler, Drum 2 Secondary, Drum 1 Primary, sand Drum 4
2	Swing
3	Fan
4	Low Pressure Accessories: Counterweight Pins, Boom Hoist Brake and Pawl, Travel Brake and 2-Speed, Drum 1, 2, 3 Brakes
5	Free Fall Drum 1 and 2 (engine mounted if equipped)

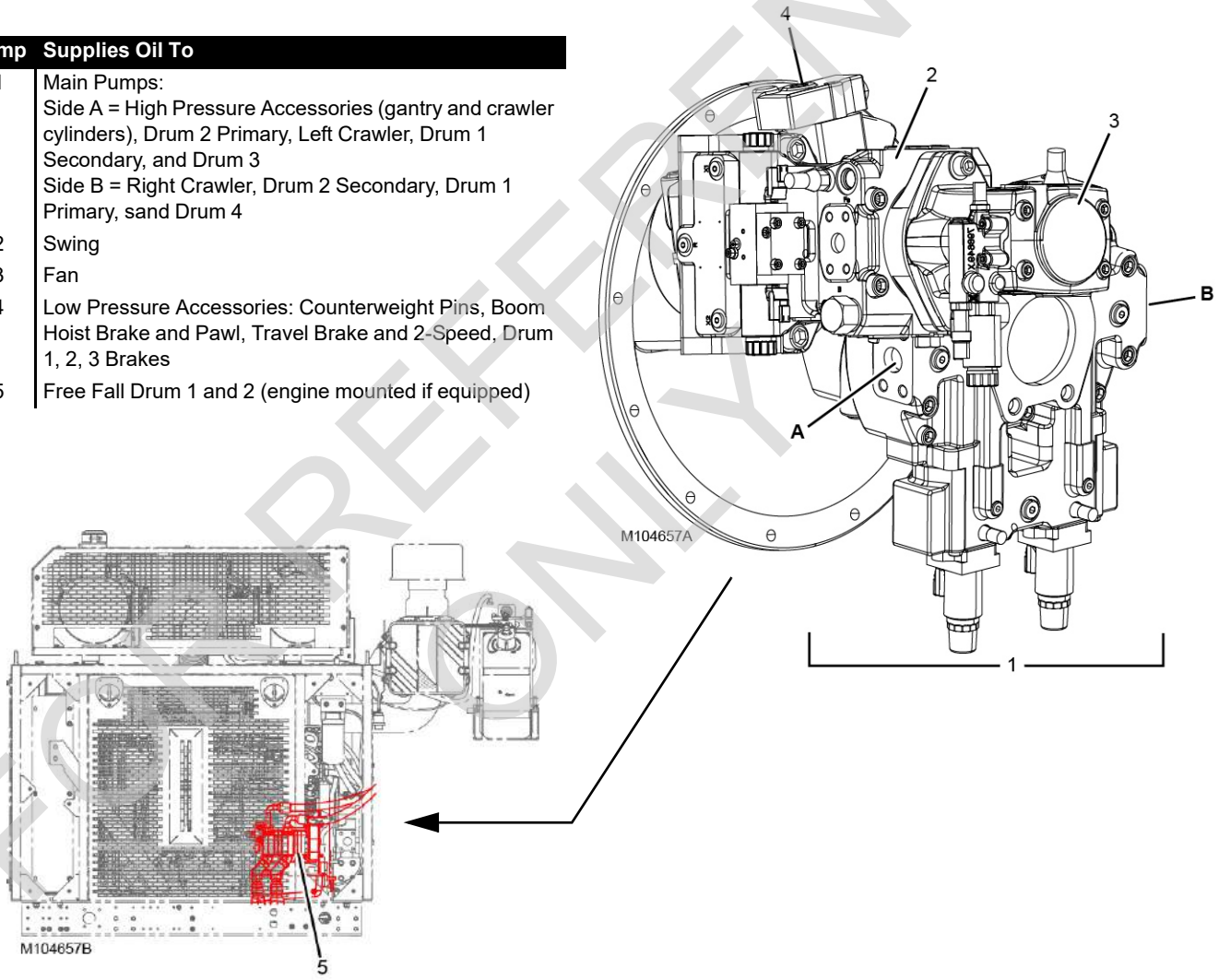
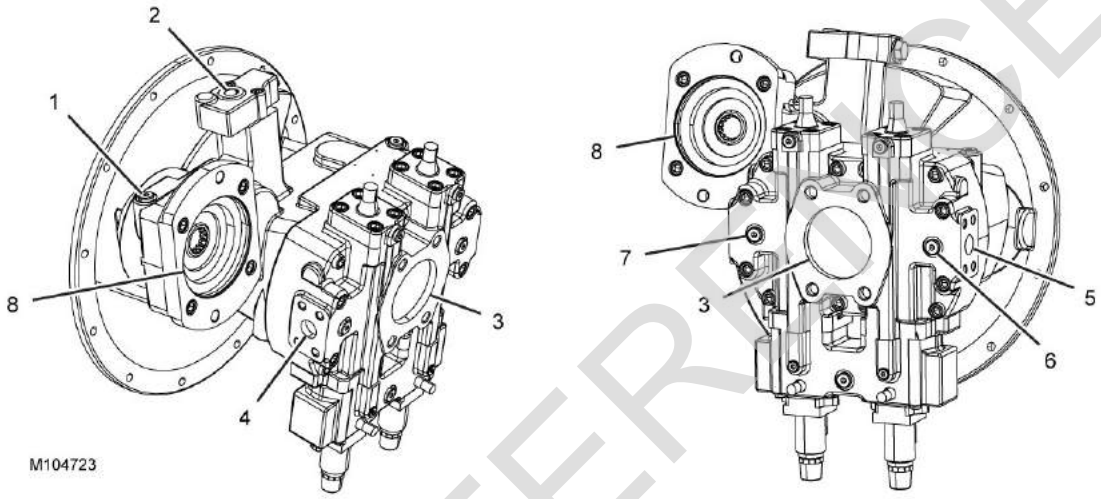


FIGURE 2-1

Pump 1

Pump 1 (Figure 2-2) is a dual 107 cc, variable-displacement pump. Displacement is controlled by an electronic displacement control (EDC).

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



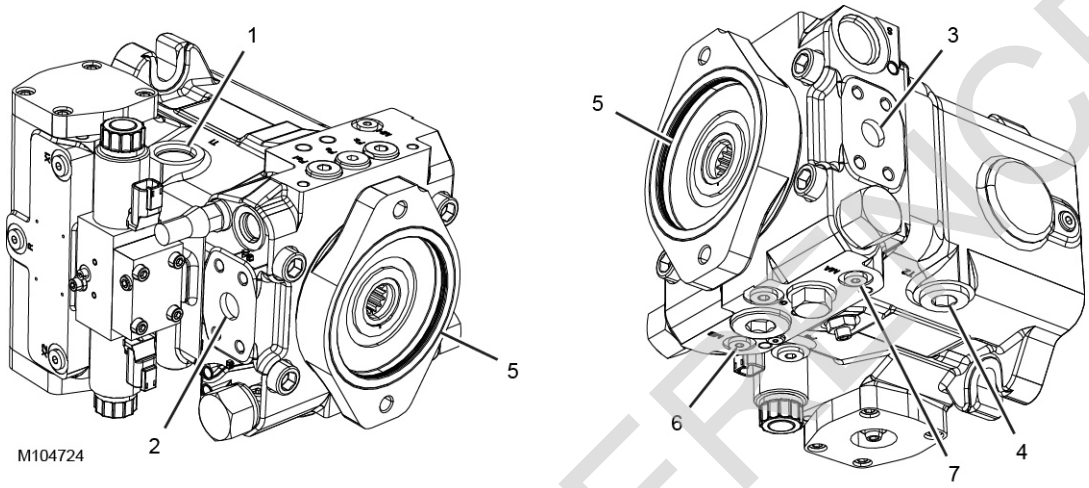
Item	Description
1	Priming Port R3 (start up)
2	Pump 4 Low Pressure Port A3
3	Suction Port S
4	Pressure Port A1
5	Pressure Port A2
6	Pressure Port M2
7	Pressure Port M1
8	Pump 2 Drive

FIGURE 2-2

Pump 2

Pump 2 (Figure 2-3) is a 56 cc, variable-displacement pump. The pump's direction and displacement are controlled by an electronic displacement control (EDC).

The pump has a maximum operating pressure of 320 bar (4640 psi).



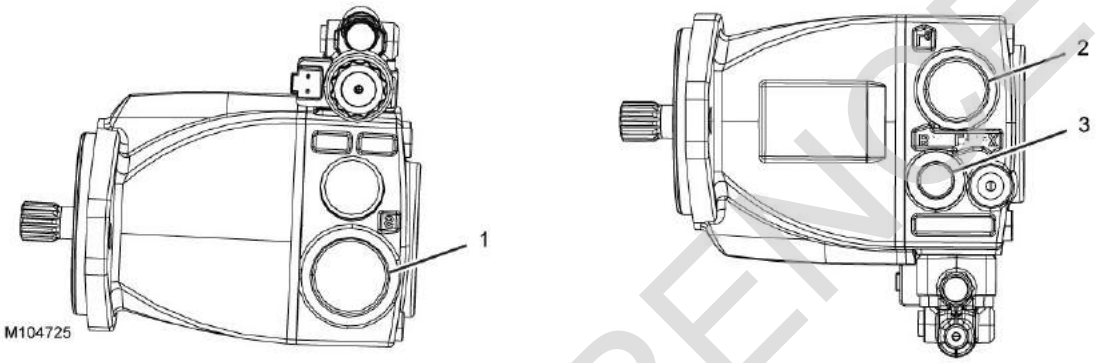
Item	Description
1	Tank T1
2	Pressure Port B
3	Pressure Port A
4	Tank T2
5	Pump 3 Drive
6	Test Port Mb
7	Test Port Ma

FIGURE 2-3

Pump 3

Pump 3 (Figure 2-4) is a 18 cc, variable-displacement pump. Displacement is controlled by an electronic displacement control (EDC).

The pump has a maximum operating pressure of 145 bar (2100 psi).



Item	Description
1	Suction Port
2	Pressure Port
3	Tank Port

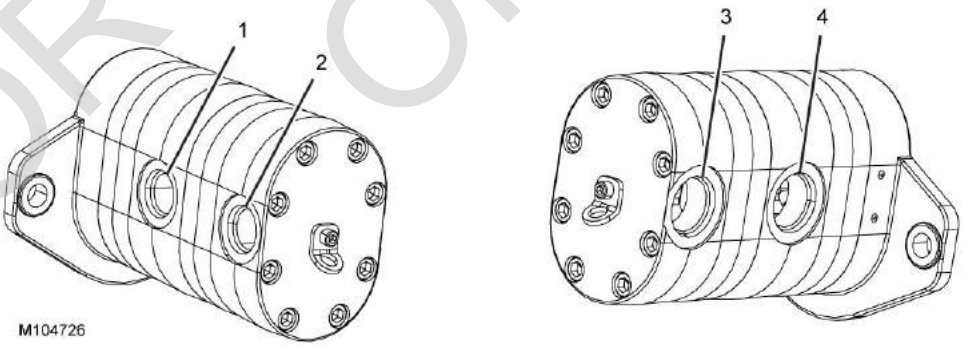
FIGURE 2-4

Pump 4

See item 2 in Figure 2-2, page 2.

Pump 5

Pump 5 (Figure 2-5) is a 32 cc fixed-displacement gear pump that is mounted to the engine for drum 1 and/or 2 free fall operation (if equipped). They have a maximum operating pressure of 75 bar (1087 psi). Its pressure is limited to 4.7 bar (68 psi) by a relief valve.



Item	Description
1	Pressure Port
2	Pressure Port
3	Suction Port
4	Suction Port

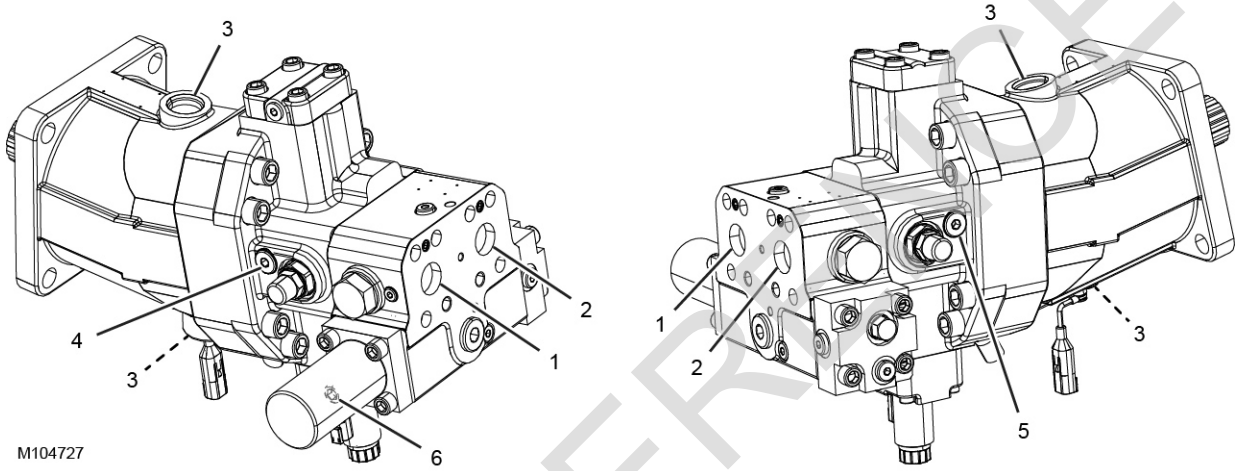
FIGURE 2-5

Motor Identification

Drum 1 and 2 Motors

Each drum 1 and 2 motor (Figure 2-6) is a bidirectional, 170 cc variable-displacement, bent-axis piston motor. Each motor's displacement is controlled by an electronic motor controller.

Each 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	Pressure Port A
2	Pressure Port B
3	Tank Port
4	Test Port Ma
5	Test Port Mb
6	Pilot Pressure Port G

FIGURE 2-6

Drum 3 Motor

Drum 3 motor (Figure 2-6) is a bidirectional, 107 cc variable-displacement, bent-axis piston 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	Pressure Port A
2	Pressure Port B (opposite side)
3	Tank Port
4	Test Port G1
5	Pilot Pressure Port G

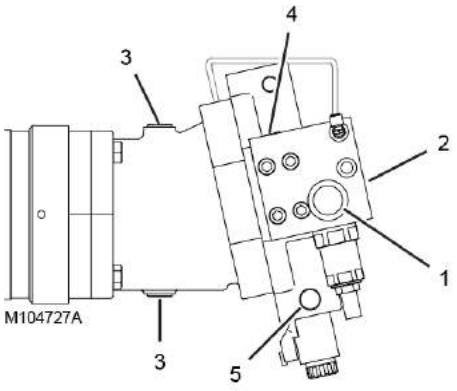
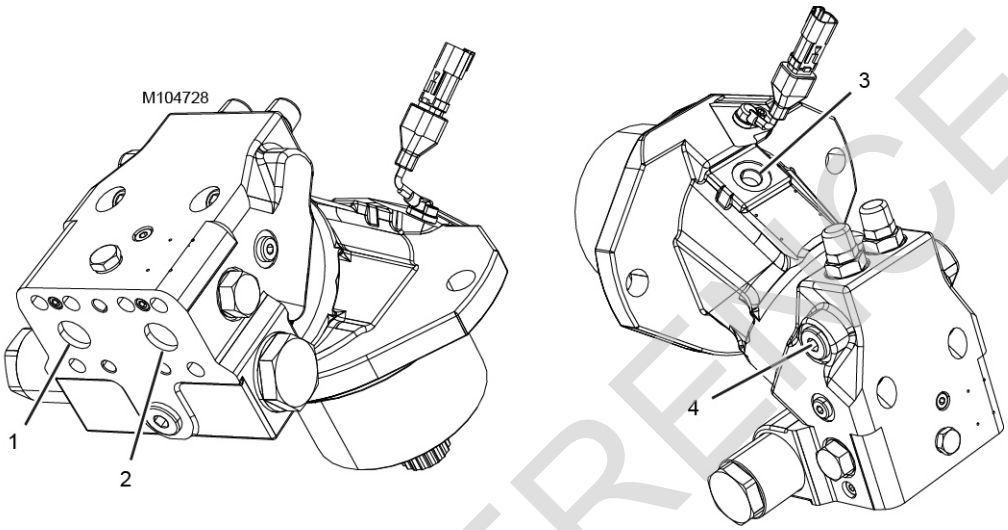


FIGURE 2-7

Drum 4 Motor

Drum 4 motor (Figure 2-8) is an 80 cc bidirectional, fixed-displacement motor.

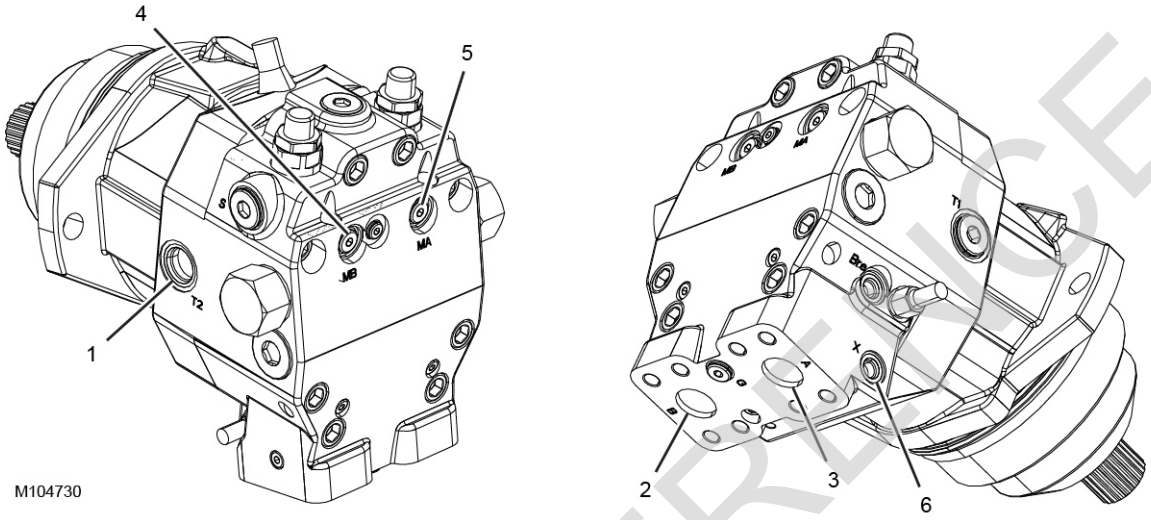


Item	Description
1	Pressure Port A
2	Pressure Port B
3	Tank Port
4	Pilot Pressure Port S

FIGURE 2-8

Travel Motors

The travel motors (Figure 2-9) are 160 cc (max), 70 cc (min) bidirectional, variable-displacement motors. Motor displacement is controlled by the two-speed signal and pressure override.

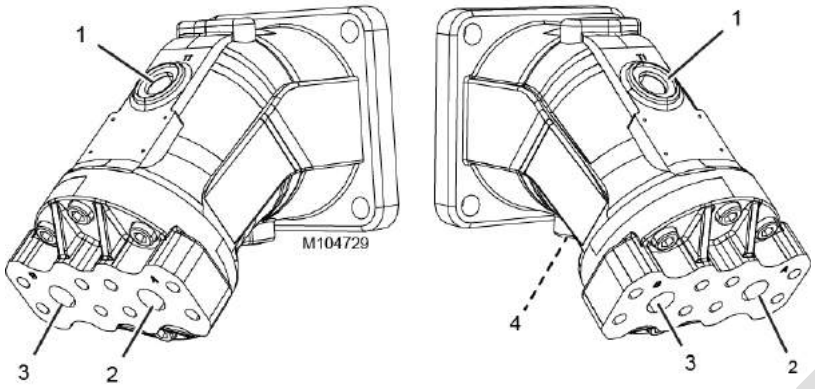


Item	Description
1	Tank Port T2
2	Pressure Port B
3	Pressure Port A
4	Test Port Ma
5	Test Port Mb
6	2-Speed Port X

FIGURE 2-9

Swing Motors

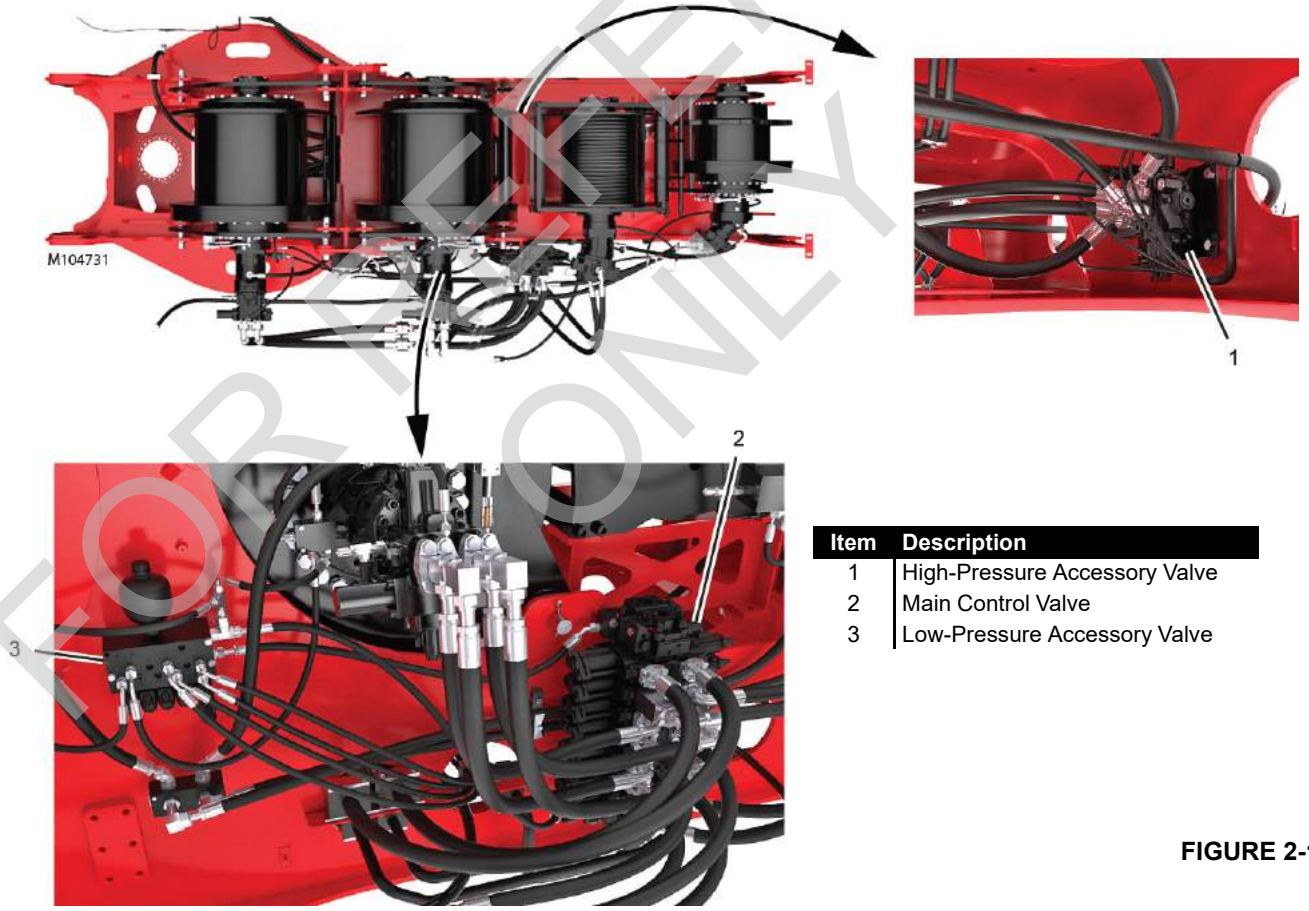
The swing motor (Figure 2-10) is a 56 cc, bidirectional, fixed-displacement motor.



Item	Description
1	Tank Port T1
2	Pressure Port A
3	Pressure Port B
4	Tank Port T2

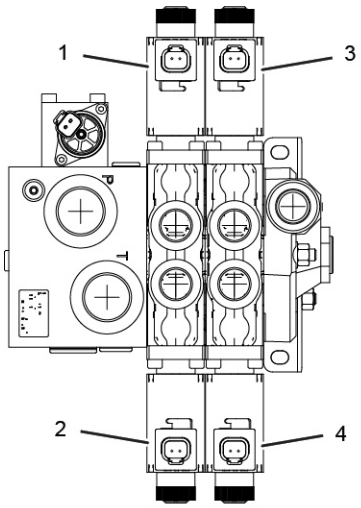
FIGURE 2-10

Rotating Bed Hydraulic Valves

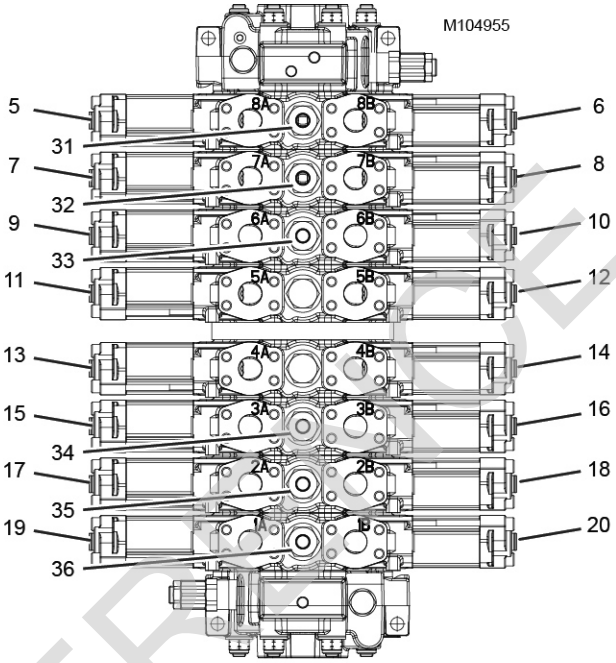


Item	Description
1	High-Pressure Accessory Valve
2	Main Control Valve
3	Low-Pressure Accessory Valve

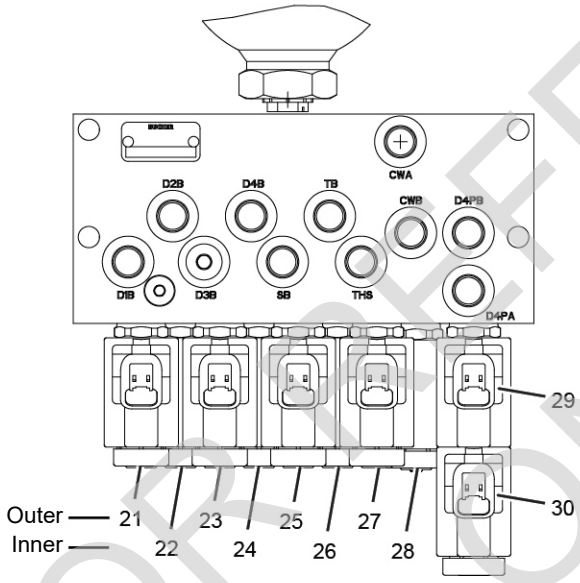
FIGURE 2-11



High Pressure Accessory Valve



Main Control Valve



Low Pressure Accessory Valve

Item	Valve
1	Crawler Extend
2	Crawler Retract
3	Gantry Extend
4	Gantry Retract
5	Right Travel Side A
6	Right Travel Side B
7	Drum 4 Side A
8	Drum 4 Side B
9	Drum 1 Primary Side A
10	Drum 1 Primary Side B
11	Drum 2 Secondary Side A
12	Drum 2 Secondary Side B

Item	Valve
13	Drum 1 Secondary Side A
14	Drum 1 Secondary Side B
15	Drum 2 Primary Side A
16	Drum 2 Primary Side B
17	Drum 3 Side A
18	Drum 3 Side B
19	Left Travel Side A
20	Left Travel Side B
21	Drum 1 Brake
22	Drum 2 Brake
23	Drum 3 Brake
24	Drum 4 Brake
25	Swing Brake
26	Travel Brake
27	Travel 2-Speed
28	Counterweight Pin Puller
29	Drum 4 Pawl In
30	Drum 4 Pawl Out

Item	Pressure Switch
31	Right Travel
32	Drum 4
33	Drum 1 Primary
34	Drum 2 Primary
35	Drum 3
36	Left Travel

FIGURE 2-11 continued

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Table 2-1. Closed-Loop Circuit Hydraulic Specifications

Function[1]	Speed[1] RPM	Pump Port	Motor Port	Pressure[3] Bar (PSI)	Charge Pressure Bar (PSI)
Swing Left Swing Right	1.8 to 2	B A	B A	320 (4,640)	30 (435)

[1] See Figure 2-1 on page 1 for pump identification.

[2] Speeds are based on high engine idle and handles moved fully forward or back. Speeds can vary plus or minus 5%.

[3] Pressures are controlled by relief valves in each pump.

Table 2-2. Open-Loop Circuit Hydraulic Specifications

Function[1]	Speed[2] RPM	Valve Port	Motor Port	Pressure Bar (PSI)
Drum 1 and 2 Hoist	41 to 45	A	A	375 (5,440)
Drum 1 and 2 Lower	See [3]	B	B	
Drum 3 Hoist	34 to 38	A	A	
Drum 3 Lower	See [3]	B	B	
Drum 4 Hoist	17 to 19	A	A	320 (4,641)
Drum 4 Lower	See [3]	B	B	
Right Travel Reverse	5.5 to 6.9 at Tumbler	B	A	
Right Travel Forward		A	B	
Left Travel Reverse		A	A	
Left Travel Forward		B	B	
Accessories	NA	NA		315 (4,568)

[1] See Figure 2-11, page 8 for valve identification.

[2] 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%.

[3] Lowering speeds may be up to 10% slower than hoist speeds.

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 Main Display Operation Manual.

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

Safety

Lower or securely block hydraulically operated attachments and loads before servicing. Do not rely on controls to support attachments or loads.

Stop the engine and relieve all hydraulic pressure before servicing or disconnecting any part of the hydraulic system. After stopping the engine, operate the controls in both directions to relieve pressure.

Before servicing the hydraulic system, attach a warning sign to the engine start controls to warn other personnel not to start the engine.

Do not perform hydraulic system maintenance, adjustment, or repair procedures unless authorized to do so. Make sure all applicable instructions have been read and are thoroughly understood.

Do not alter specified pressure settings. Higher-than-specified pressures can cause structural or hydraulic failure. Lower-than-specified pressures can cause loss of control.

Never check for hydraulic leaks with your hands. Pressurized oil can penetrate the skin, causing serious injury. Oil escaping from a small hole can be nearly invisible. Check for leaks with a piece of cardboard or wood.

Storing and Handling Oil

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

Storing and Handling Parts

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

Disposing of Hydraulic Oil and Parts

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

Inspecting the Hydraulic System

See Figure 2-12, page 15 for referenced item numbers.

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 (2).
- Fill the tank through the fill plug opening (12). Always filter the oil through an owner-supplied 10-micron filter.
- Only use approved hydraulic oil in the system (see Section 9).
- Replace the breather (5) when indicated (see Replacing Breather on page 2-15).
- Replace the hydraulic filter elements (7) when indicated (see Replacing Hydraulic Filters on page 2-16).
- 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 (10) 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

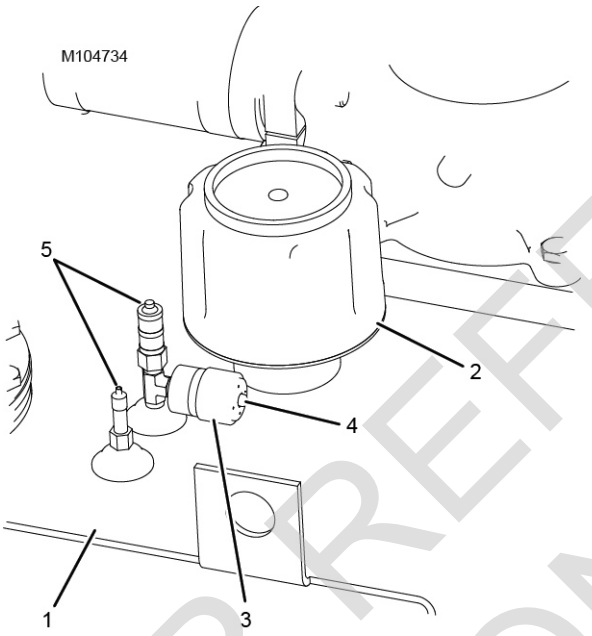
Replacing Breather

WARNING

Burn Hazard!

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

- Allow the hydraulic system to cool before replacing the breather or the hydraulic filters.
- Before opening the tank, relieve any pressure from the tank using either vent valve (4, Figure 2-12).



Item	Description
1	Hydraulic Tank
2	Breather
3	Service Indicator
4	Reset Button
5	Vent Valves

FIGURE 2-12

See Figure 2-12 for the following.

1. Check the breather service indicator daily or every 8 hours of engine operation, whichever occurs first.
2. Replace the breather (2) when the red flag in the service indicator (3) rises to the top and locks in place.

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

Replacing Hydraulic Filters

CAUTION

Avoid Hydraulic System Damage!

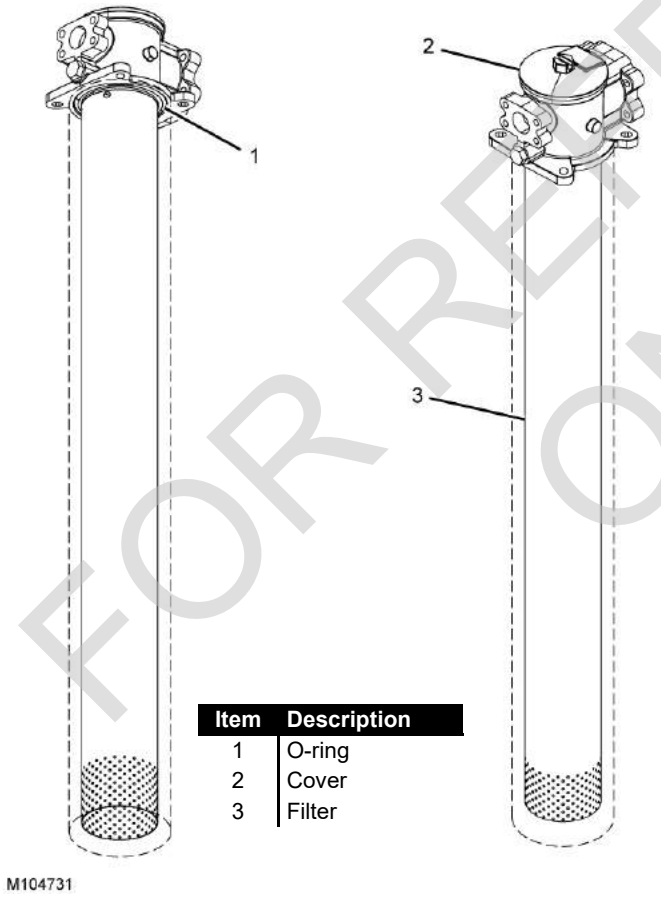
Original equipment manufacturers' filter elements, available from the Manitowoc Crane Care Lattice Team, must be used on this crane. Substituting with any other brand or type of filter element is not allowed.

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



Item	Description
1	O-ring
2	Cover
3	Filter

FIGURE 2-13

An in-tank filter (3, Figure 2-13) 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.

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 the hydraulic filter, proceed as follows (see Figure 2-13).

1. Stop the engine.
2. Vent the hydraulic tank using either of the vent valves (see Figure 2-12, page 15).
3. Take precautions to prevent being burned by hot oil.
4. Disconnect the electric cable from the pressure switch.
5. Clean the cover (2) and the area around the filter cover. Do not allow contaminants to enter the hydraulic tank.
6. Remove the cover.
7. Remove the spring.
8. Lift the filter element out of the hydraulic tank using the handle provided and discard it according to local environmental regulations.
9. Install a new filter element so it is fully seated in the hydraulic tank.
10. Replace the O-ring (1) with a new one.
11. Install the cover.
12. Connect the electric cable to the pressure switch.
13. Install the guard.
14. Start the engine and allow the hydraulic system to reach its normal operating temperature.
15. Check the filter cover for leaks and service as required.
16. Stop the engine.
17. Check the hydraulic tank level and fill as required.

Servicing Suction Strainer

The suction line to the pumps is equipped with a suction strainer located inside the hydraulic tank.

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

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

See Figure 2-14 for the following procedure.

1. Stop the engine and allow the hydraulic oil to cool.
2. Drain the hydraulic oil into a suitable container capable of holding 302 L (80 gal).
3. Disconnect the suction tube (1) and the split flange assembly (2) from the shut-off valve (3).
4. Remove the screws attaching the valve mounting plate (4) to the hydraulic tank.
5. Remove the shut-off valve (3), the valve mounting plate (4), and the suction strainer (6) as an assembled unit from the hydraulic tank.
6. Remove the suction strainer (6) from the valve mounting plate (4).
7. Either replace the strainer with a new one or (if the strainer is not damaged) clean it as follows:
   a. Soak the suction strainer in a clean, nonflammable solvent.
   b. Brush off the outer surface.
   c. Flush the strainer with solvent from the inside out.
8. Remove the access cover (7) and thoroughly clean the inside of the hydraulic tank.
9. Fasten the suction strainer (6) to the valve mounting plate (4).
10. Lubricate and install a new O-ring (5).
11. Fasten the shut-off valve (3), the valve mounting plate (4), and the suction strainer (6) as an assembled unit to the hydraulic tank.
12. Reconnect the suction tube (1) and split flange assembly (2) to the shut-off valve (3). Lubricate and install a new flange O-ring.
13. Reinstall the access cover (7).
14. Start the engine and check for leaks. Correct as needed.

Item	Description
1	Suction Tube
2	Split Flange Assembly
3	Shut-Off Valve
4	Valve Mounting Plate
5	O-Ring
6	Suction Strainer
7	Access Cover

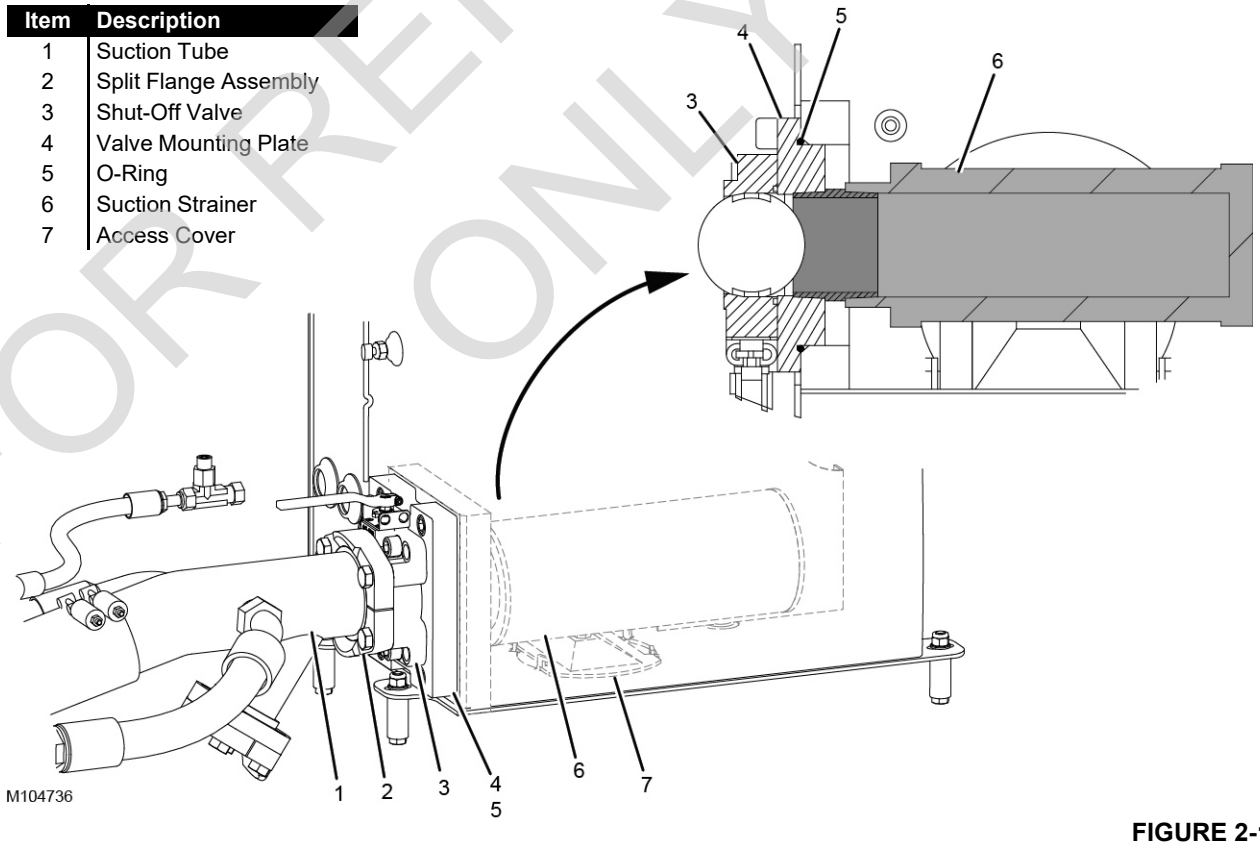
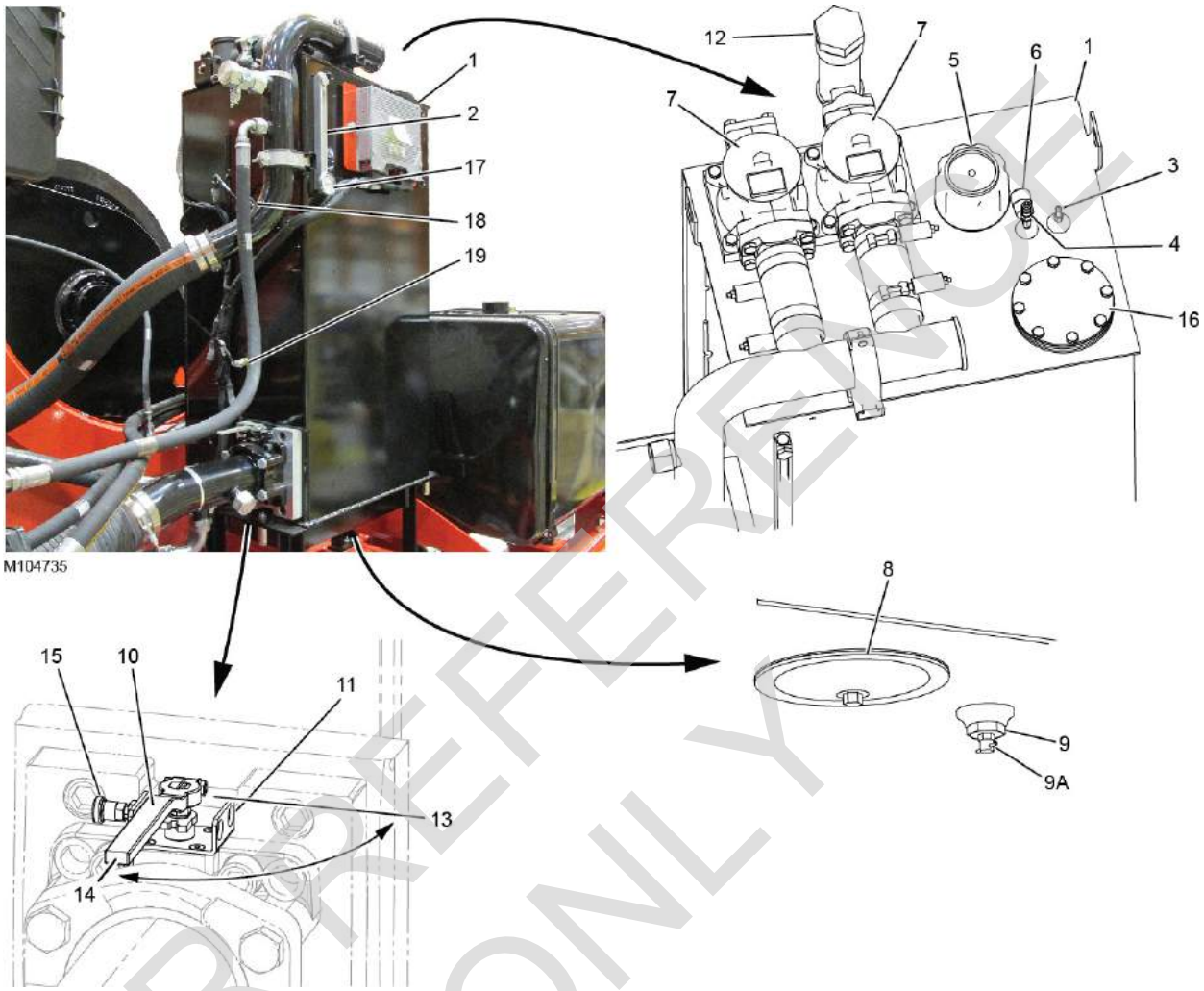


FIGURE 2-14



Item	Description
1	Hydraulic Tank
2	Oil Level Sight Gauge
3	Schrader Valve
4	Vent Valve (requires a mating coupler)
5	Desiccant Breather
6	Level Sensor
7	Pipe Nipple
8	Access Cover
9	Drain Plug (with Vent Valve)
9A	Vent Plug (for draining water)

Item	Description
10	Shut-Off Valve
11	Padlock Holes
12	Fill Plug
13	Shut-Off Closed Position
14	Shut-Off Open Position
15	Locking Knob
16	Hydraulic Tank Heater (not shown)
17	Temperature Gauge
18	Oil Level Switch
19	Temperature Sensor

FIGURE 2-15

Changing Hydraulic Oil

Unless otherwise specified, refer to Figure 2-12 for the following procedure.

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

1. Operate the crane until the hydraulic oil is at its normal operating temperature. This helps remove impurities from the system.
2. Stop the engine.
3. Vent the tank using either the Schrader valve (3) or the vent valve (4).
4. Verify the shut-off valve (10) is open.
5. Place a suitable container capable of holding 302 L (80 gal) under the hydraulic tank.
6. Remove the drain plug (9) and completely drain the hydraulic tank.
7. Discard the hydraulic oil according to local environmental regulations.
8. Remove the access cover (8) 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 strainer if needed (see Servicing Suction Strainer on page 2-17).
11. Replace the filter elements (see Replacing Hydraulic Filters on page 2-16).
12. Replace the breather (see Replacing Breather on page 2-15).
13. Using a new seal, securely fasten the access cover to the hydraulic tank.
14. Securely install the drain plug. Make sure the vent valve in the plug is closed.

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.

15. Fill the hydraulic tank to the Full Cold Level mark on the oil level sight gauge (2). Use the proper hydraulic oil listed in the Lubrication Guide.

    Fill the tank through the fill plug (12) opening. Filter the oil through an owner-supplied 10-micron filter.
16. Close the Schrader valve (3) and the vent valve (4).
17. Crack open the priming port (1, Figure 2-2, page 2). Close the port as soon as oil appears after the engine is started.
18. Start the engine and allow the hydraulic system to reach its normal operating temperature.
19. Check for leaks and correct them as required.
20. Stop the engine.
21. Check the hydraulic tank level and fill as required.

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

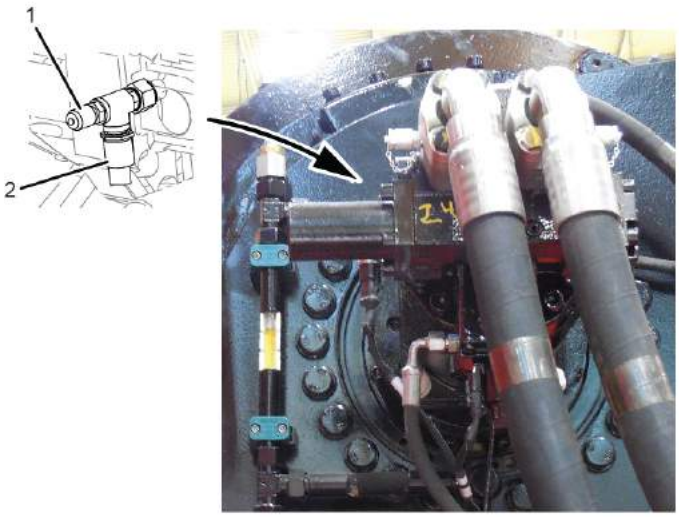
Servicing Pumps

It is not necessary to drain the hydraulic tank when servicing the hydraulic pumps. To service the pumps, close the hydraulic tank shut-off valve (10, Figure 2-12).

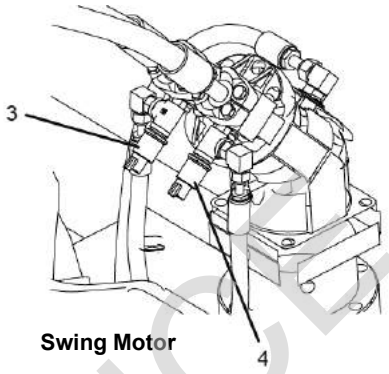
CAUTION

Avoid Damage to Pumps!

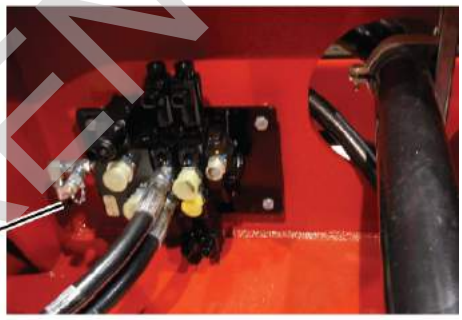
Open the hydraulic tank shut-off valves before starting the engine. Failing to perform this step will result in damage to the pumps from cavitation.



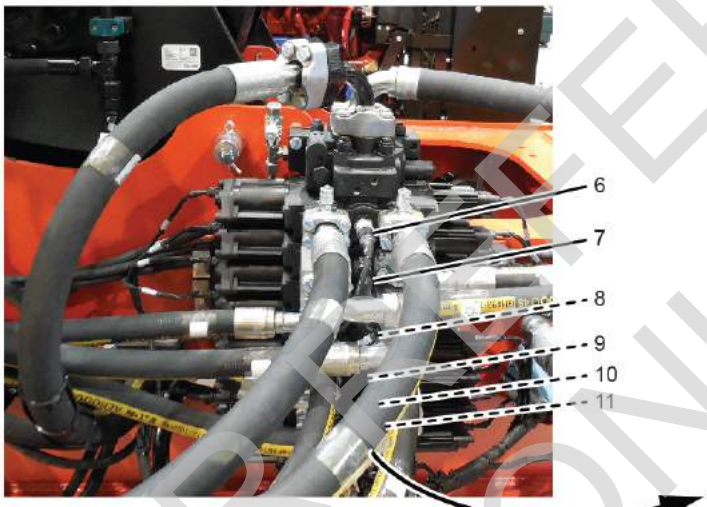
Typical Drum Motor



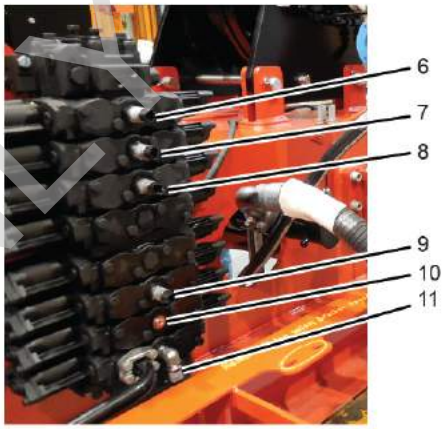
Swing Motor



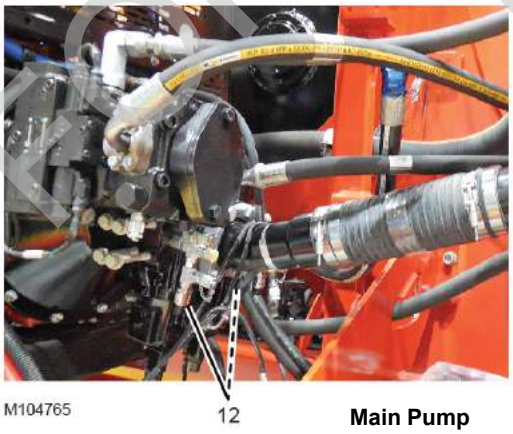
High Pressure Accessory Valve



Main Valve



Main Valve Hoses Removed



Main Pump

Item	Description
1	Gauge Coupler with Dust Cap-18 UNF x -6 PRESSURE TRANSDUCER ID
2	Drum Motor (similar all drums)
3	Swing Right
4	Swing Left
5	High Pressure Accessory
6	Right Travel
7	Drum 4
8	Drum 1 Primary
9	Drum 2 Primary
10	Drum 3 (optional)
11	Travel Left
12	Main Pump

FIGURE 2-16

REPLACING PRESSURE TRANSDUCERS

Testing a Pressure Transducer

See Figure 2-16 for the following procedure.

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

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

Replacing a Pressure Transducer

WARNING

High Pressure Oil Hazard!

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

Hot Oil Hazard!

Take precautions to prevent being burned by hot oil.

To replace a pressure transducer, perform the following procedure.

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

SHOP PROCEDURES

Initial Hydraulic Oil Fill

WARNING

Burn Hazard!

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

Before opening the tank for any reason, relieve any pressure from the tank using the Schrader valve or the vent valve (see Figure 2-12, page 15).

See Figure 2-12, page 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 valve (10).
2. Open the Schrader valve (3) or the vent valve (4) located on top of the tank (1). Failure to do this will result in over pressurizing the tank. Fill hydraulic tank to the appropriate level depending on cylinder position using the manual fill port.

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

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

3. Bleed the port (1, Figure 2-2) on the main hydraulic pump. This will lubricate the front bearing prior to engine startup.

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.

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

CAUTION

Equipment Damage!

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

4. Install bleed line shut off valves into the test ports on the swing pump and utilize them to bleed the air once you have started the engine at a low idle.
5. While running the engine at a low idle retract and extend the counterweight pin puller ten times to remove air from the cylinder.

NOTE: Remove the pin and support the cylinder to prevent it from striking anything during operation.

6. While running the engine at low engine idle, park and unpark drum 4 to operate the pawl cylinder a total of 10 times.
7. While running the engine at a low idle, retract and extend the gantry cylinders to remove air from the cylinders in the following manner:
   a. Extend cylinders 50% out (6”), pause for 2-4 seconds before changing direction, then fully retract. Pause for 2-4 seconds. Repeat.
   b. Extend cylinders 75% out (9”), pause for 2-4 seconds before changing direction, then fully retract. Pause for 2-4 seconds. Repeat.
   c. Extend cylinders 100% out, pause for 2-4 seconds before changing direction, then fully retract. Repeat four times.

NOTE: Remove the pin and support the cylinders to prevent them from striking anything during operation.

8. While running the engine at a low idle, retract and extend the crawler extension cylinders to remove air from the cylinders in the following manner:
   a. Extend cylinders 50% out (44”), pause for 2-4 seconds before changing direction, then fully retract. Pause for 2-4 seconds. Repeat.
   b. Extend cylinders 75% out (65”), pause for 2-4 seconds before changing direction, then fully retract. Pause for 2-4 seconds. Repeat.
   c. Extend cylinders 100% out, pause for 2-4 seconds before changing direction, then fully retract. Repeat four times.
9. While running the engine at a low idle speed, bleed the air out of drums 1, 2, 3 (if equipped), and 4 in the following manner:
   a. Ramp the handle command from 0% to 25% (hoist up) and hold for 15 seconds then ramp to 100% and hold for 30 seconds.
   b. Ramp from 100% hoist up and then down to 0%.
   c. Ramp the handle command from 0% to 25% (hoist down) and hold for 15 seconds, then ramp to 100% and hold for 30 seconds.
   d. Ramp from 100% hoist up and then down to 0%.
   e. Repeat steps a—d three times.

NOTE: This step will be done as the machine is being driven out to test. When you are first moving the machine out of the building, follow these steps to ensure that all air is bled from the circuit.

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

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

HYDRAULIC TESTS AND CALIBRATIONS

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

Controls Calibration

See the Main Display Operation Manual.

Charge Pressure Test

See the Main Display Operation Manual.

High Pressure Test

See the Main Display Operation Manual.

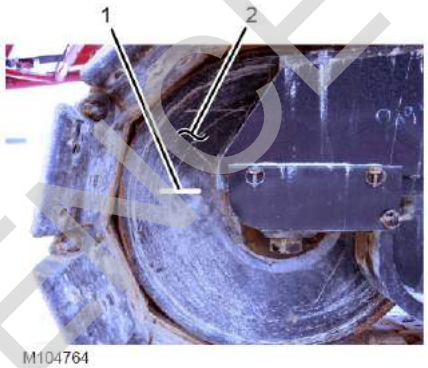
Travel Speed Test

See Figure 2-17 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 2-17

Swing Speed Test

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

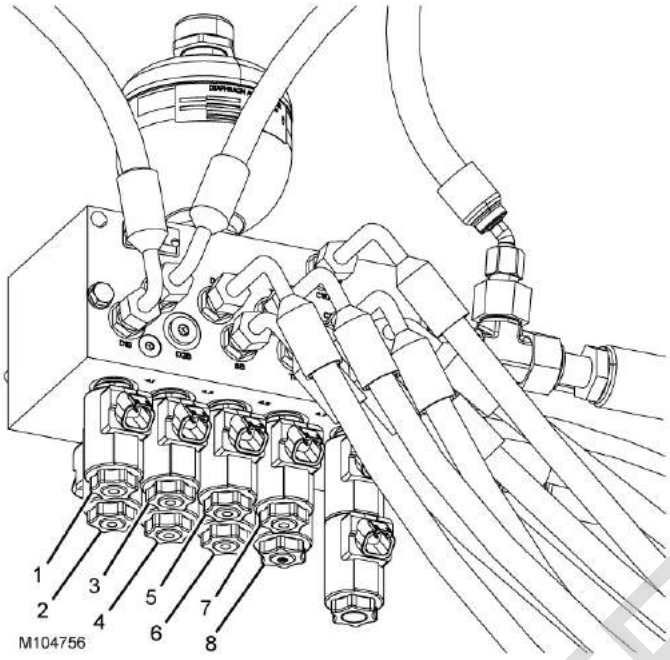
1. Navigate to the Swing Control Information screen in the main display.
2. Start the engine and run it at high idle.
3. Operate the swing fully left and then fully right.
4. Verify that the swing speed shown in the main display is within the limits in Table 2-1.

Drum Speed Test

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

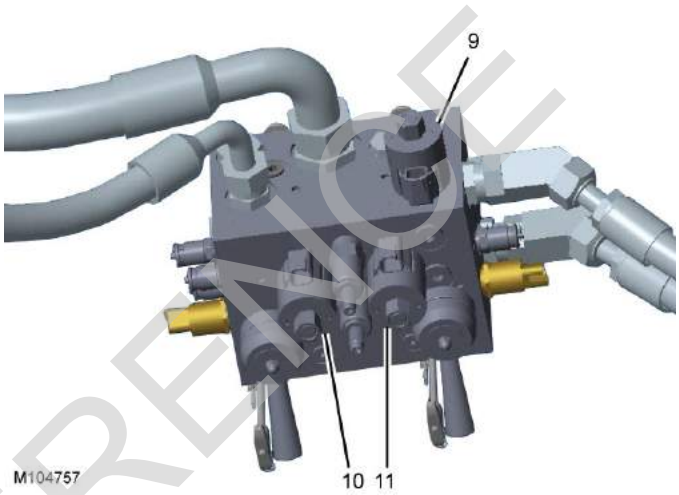
1. Navigate to the Drum Control Information screen (Drum 1, 2, 3, or 4) in the main display.
2. Start the engine and run it at high idle.
3. Move the selected drum handle fully forward and then fully back.
4. Verify that the drum speed shown in the main display is within the limits in Table 2-1 and Table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

Located on Rotating Bed



Low-Pressure Hydraulic Valve

Right Side Enclosure above Pumps



Free Fall Hydraulic Valve

Item	Description
1	Drum 1 Brake
2	Drum 2 Brake
3	Drum 3 Brake
4	Drum 4 Brake
5	Swing Brake
6	Travel Brake
7	2-Speed Travel
8	Counterweight Pin Puller
9	Free Fall Enable
10	Proportional Brake Command Drum 1
11	Proportional Brake Command Drum 2

FIGURE 2-18

DISC BRAKE OPERATIONAL TEST

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

- Travel
- Drums 1-4
- Swing

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

CAUTION

Overheating Hazard!

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

WARNING

Falling Load/Moving Crane Hazard!

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

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

See Figure 2-18 for the location of the brake solenoid valves.

See the system pressure specifications in Table 2-1 and Table 2-2. Perform the free fall 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 Main Display Operation Manual).

NOTE: For the load drums equipped with Free Fall, make sure Free Fall is off.

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

5. Slowly move the control handle for the brake being checked and verify the following:
   - The specified system pressure is reached before 50% pump command is reached.
   - The brake does not slip.

   If the brake fails this test, it must be repaired or replaced and retested before placing the crane back into operation.
6. Turn on the Park switch on the control console for the function being checked.
7. Stop the engine.
8. Connect the electrical connector to the solenoid valve for the brake being checked.

Free Fall Brake Operational Test

DANGER

Falling Load Hazard!

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

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

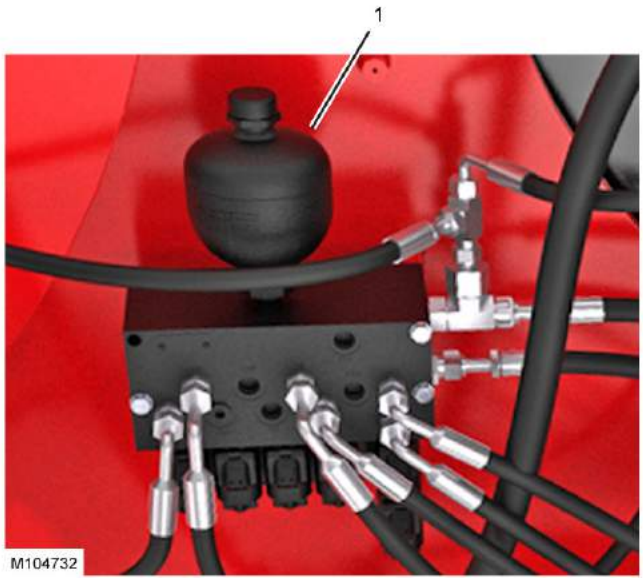
Do not operate a drum in free fall if the brake is not operating properly.

Do not attempt to lower the single-line pull load given in step 2 of the free fall brake operational test procedure using the free fall brake. Brake damage could occur. The free fall lowering is limited to 6 260 kg (13,800 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 Operator Manual for the procedure.
2. Lift a single-line pull load of 12,520 kg (27,600 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	Pre-Charge
1	Accumulator Diaphragm Type	21.7 bar (315 psi)

FIGURE 2-19

This crane is equipped with one accumulator, which is located on the low-pressure accessory valve and identified in Figure 2-19.

WARNING

Explosion Hazard!

The accumulator is precharged with dry nitrogen gas.

Do not tamper with the accumulator unless authorized and trained to do so.

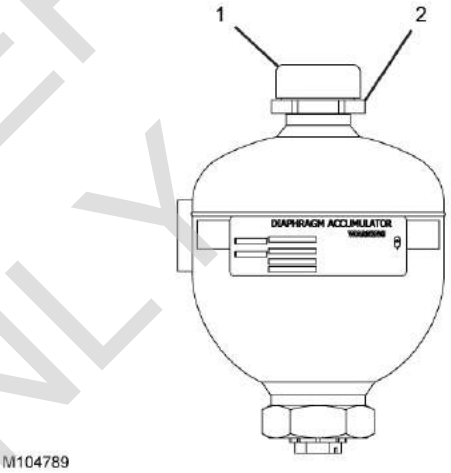
Contact the Manitowoc Crane Care Lattice Team for assistance if needed.

The accumulator must be tested yearly to verify they have retained the specified precharge.

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

- Precharge 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 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 2-20).



Item	Description
1	Protective Cap
2	M28 x 1.5 Male Thread

FIGURE 2-20

SECTION 3
ELECTRICAL SYSTEM

TABLE OF CONTENTS

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Published 10-09-2020, Control # 259-06

SECTION 3
ELECTRICAL SYSTEM

ELECTRICAL SCHEMATIC

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

ELECTRICAL POWER SEQUENCE

Battery Power

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

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

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

Battery Power Disconnect

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

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 CB41:

- Display modules (via CB4)
- Relays K4 and K6 (normally open contacts)
- Relay K5 (via CB1)
- Horn, dome light, and service lights switches (via CB5)
- Radio clock and preset memory (via CB5)
- Relay K7 (normally open contacts) (via CB2)
- Remote battery positive terminal (unfused)

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	IOSA22
CCM-10	IOLC30
CCMC11	IOLC31

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: When energized, relay K4 provides power to the following:
  - Engine ECM (via CB4)
- Relay K5: When energized, relay K5 provides power from circuit breaker CB3 to terminal +UE on the following control modules:

SCM-00	IOSA22
CCM-10	IOLC30
CCMC11	IOLC31

- Relay K6: When energized, relay K6 provides power to terminal +UB on all crane CAN Bus control modules. Relay K6 also provides power to terminals KL15 and +UE on the following control modules:
  - SCMD01—KL15
  - IOSB22—KL15 and +UE
  - CCMC11—KL15 and +UE

  Relay K6 also provides power to the following components and circuits:
  - Jog dial and joysticks (via CB40)
  - Climate controls (via CB33)
  - Wiper controls (via CB34)
  - Work lights and panel lights (via CB36)
  - 24 V_{DC}-to-12 V_{DC} converter (powers the radio and seat motor switches) (via CB10)

Crane Electrical System Ground Points

General

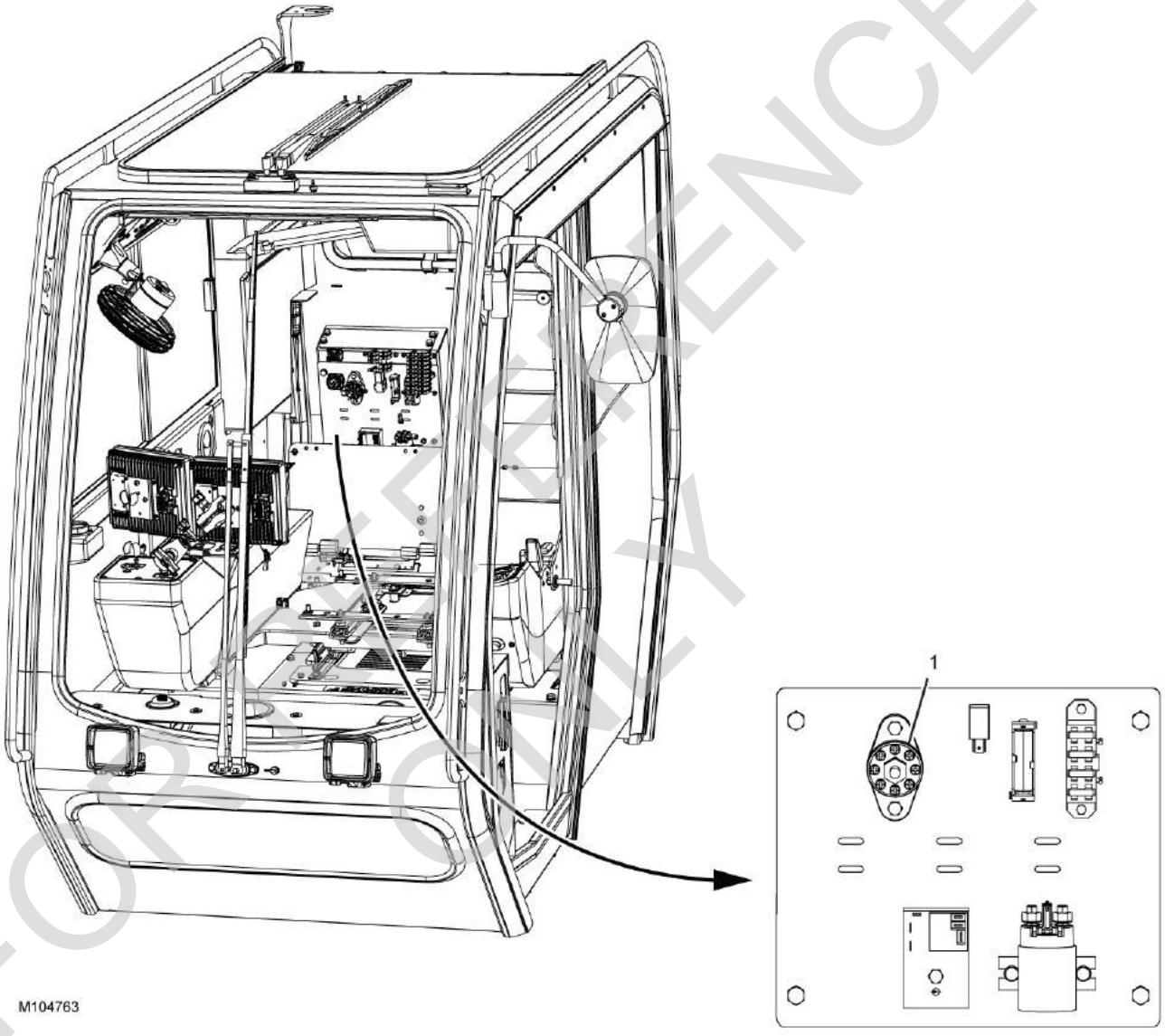
The crane electrical system has several frame ground connection (point) locations on the rotating bed.

Cab Right Console Ground Points

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

The cab right console contains the following point ground locations:

- Ground bus bar (1)



Item	Description
1	Ground Bus Bar

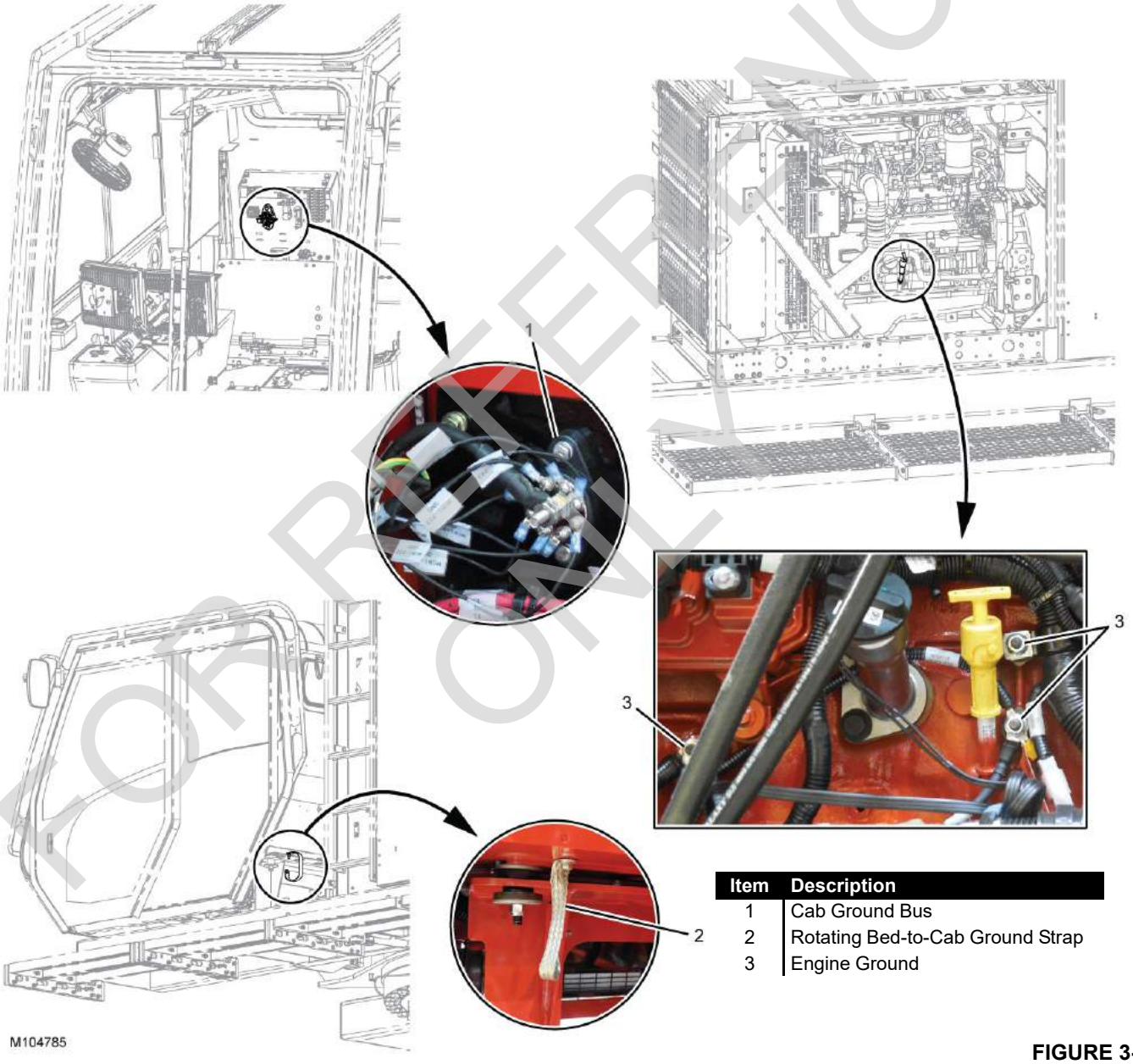
FIGURE 3-1

Rotating Bed and Cab Mount Ground Points

See Figure 3-2 for the following items.

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.
- Rotating Bed Main Ground Point—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.



Item	Description
1	Cab Ground Bus
2	Rotating Bed-to-Cab Ground Strap
3	Engine Ground

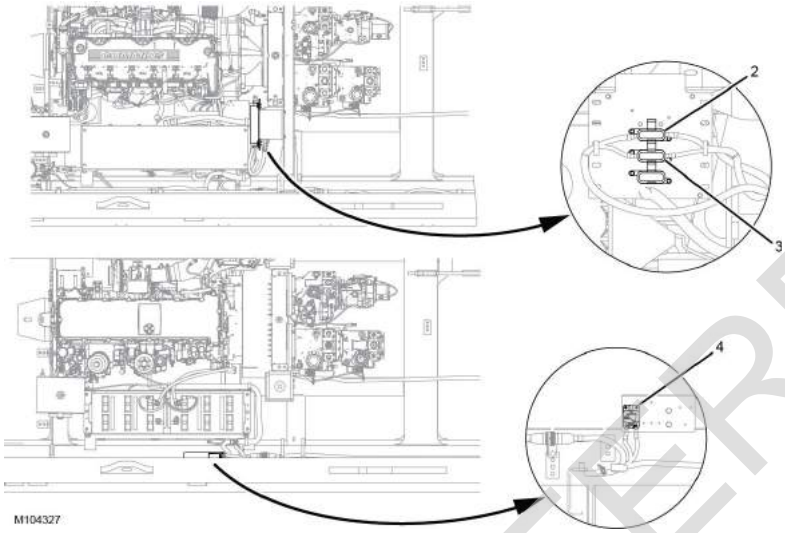
FIGURE 3-2

CIRCUIT BREAKERS, FUSES, AND RELAYS

Most circuit breakers, fuses, and relays are located in the cab.

The following fuses and circuit breaker are not located in fuse box:

- TCU CraneStar® (if equipped) 5A fuse F5 is mounted on the battery disconnect switch bracket.
- Alternator 250A fuse F0 (2) is mounted on a panel at the front of the battery box.
- Intake air heater 150A fuse F6 (3) is mounted on a panel at the front of the battery box.



Engine Compartment

Item	Description
1	CraneStar® 5A Fuse (F5)
2	Alternator 250A Fuse (F0)
3	Intake Air Heater 150A Fuse (F6)

FIGURE 3-3

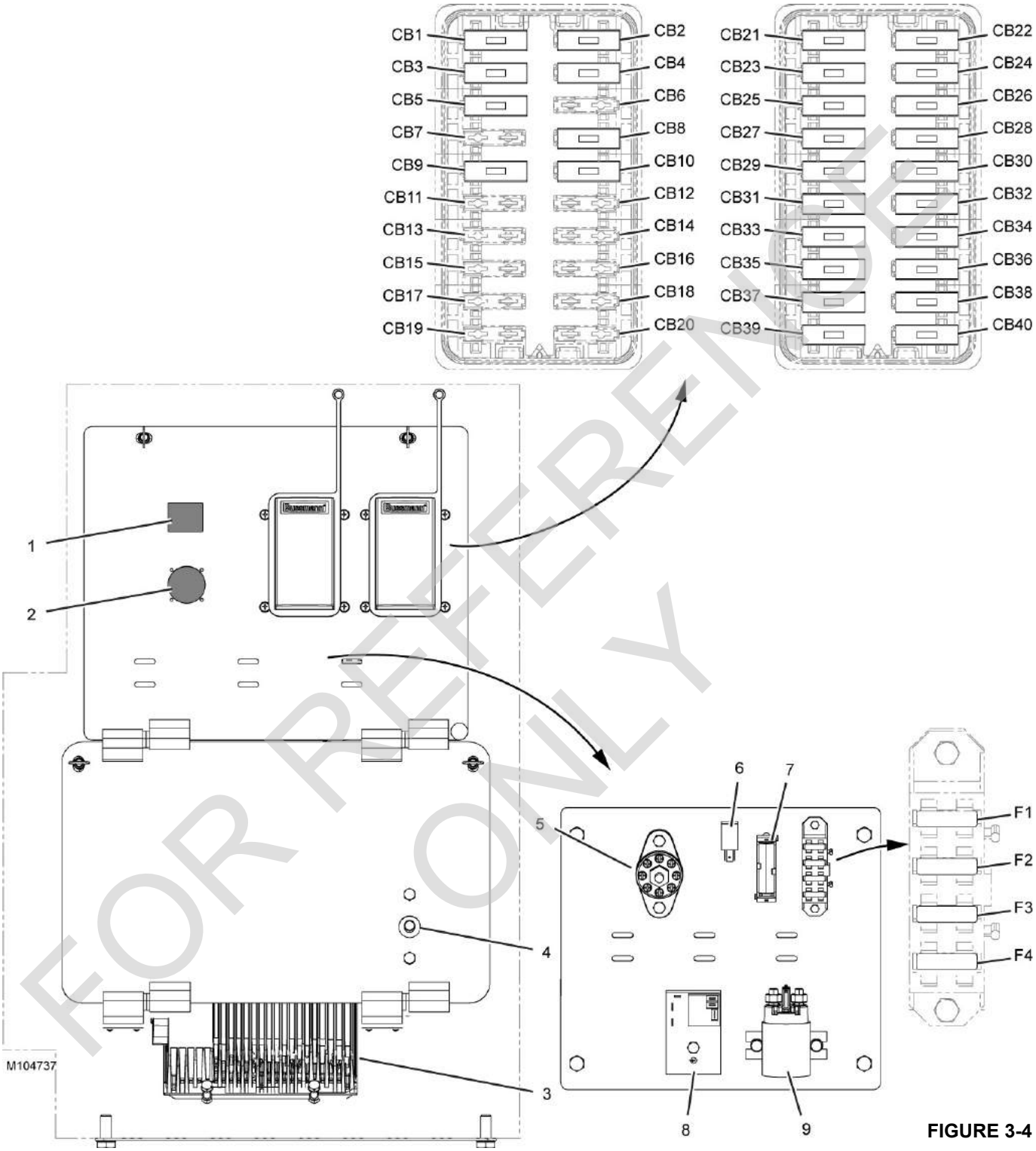


FIGURE 3-4

Item	Description	Item	Description
1	Programing Plug	6	Relay 24/12VDC, 30A
2	J1939 Diagnostic Plug	7	Battery, SCM 3.6V lithium AA
3	Converter (24/12VDC)	8	Time Delay Relay, SCM and CCM Backup—24V
4	Main Fuse (CB41)	9	Relay Contactor—28V
5	Ground Bus Bar		

Circuit Breaker	Amps	Description of Item Protected	Circuit Breaker	Amps	Description of Item Protected
CB1	15	Crane Bus	CB29	15	CCMC11 (+UB input supply)
CB2	15	Boom Positioning Light	CB30	15	CCMC11 (+UB input supply)
CB3	15	ECM Key Power	CB31	15	SCM00 (+UB input supply)
CB4	15	External Key Switch, Setup Remote Receiver, and Displays	CB32	15	IOSA22 (+UB input supply)
CB5	15	Radio, Dome Light, Horn, Radio, Bed Service Lights	CB33	25	Cab A/C Heat
CB8	15	Cab Accessories	CB34	15	Wipers
CB9	15	Cab CCS Display	CB35	15	Switch Back Lights
CB10	25	DC/DC Converter	CB36	15	Cab Front Lights
CB21	15	IOLC30 (+UB input supply)	CB37	15	J1939 Diagnostic
CB22	15	IOLC30 (+UB input supply)	CB38	15	CAM Monitor Power
CB23	15	IOLC31 (+UB input supply)	CB39	15	Radio Switched Power (if equipped)
CB24	15	IOLC31 (+UB input supply)	CB40	15	Joysticks
CB25	15	CCM-10 (+UB input supply)	F1	15	Accessory Socket (right console)
CB26	15	CCM-10 (+UB input supply)	F2	20	Seat Riser
CB27	15	CCM-10 (+UB input supply)	F3	15	Accessory Socket (left console)
CB28	15	CCM-10 (+UB input supply)	F4	15	Not Used

NOTE: Sockets for circuit breakers CB6, CB7, and CB11—CB20 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 C (rotating bed)
- CAN Bus D (gantry)
- 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 3-14.)

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

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

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

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

CAN Bus System Chart

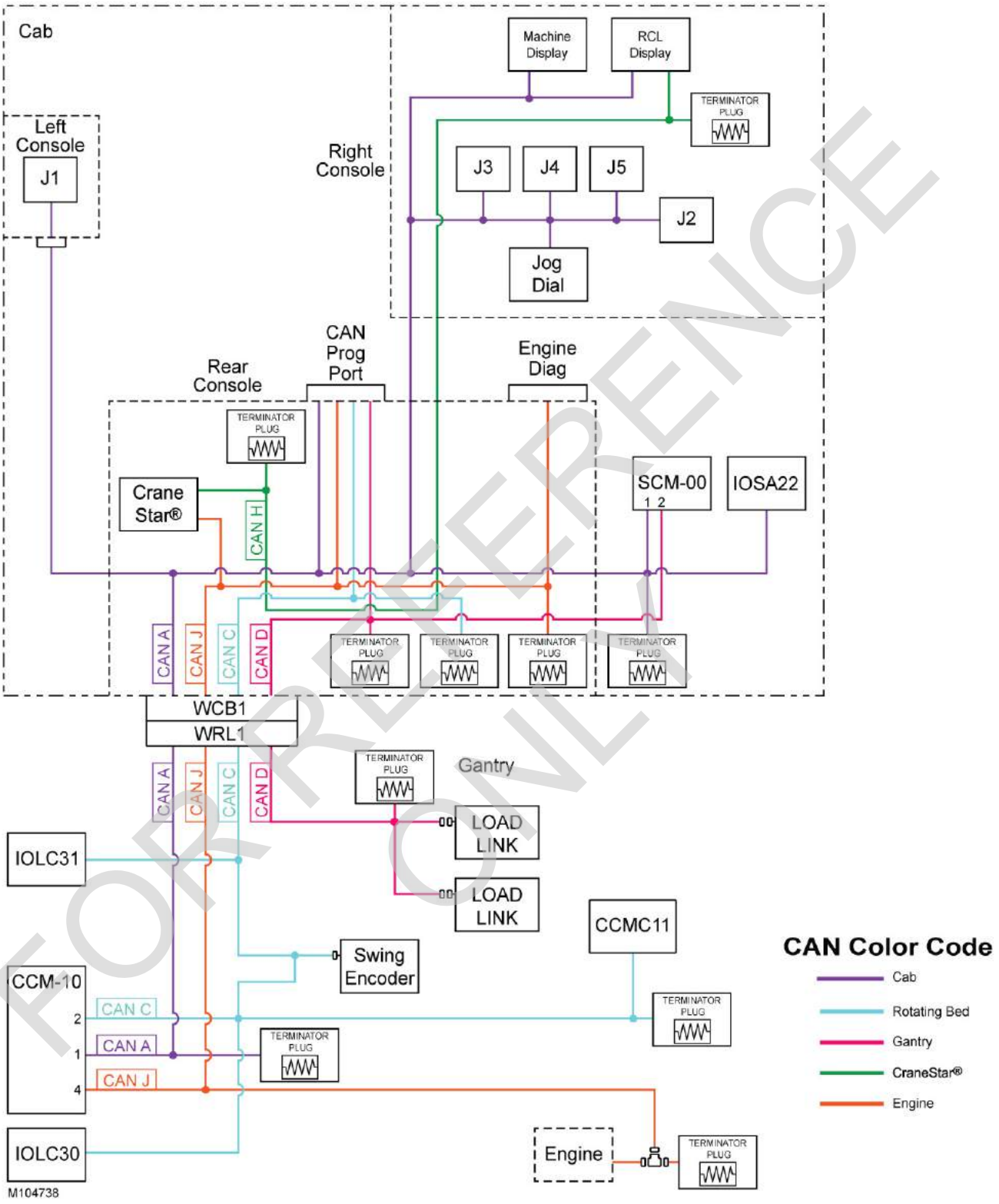


FIGURE 3-5

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 four types of control modules in the CAN Bus system:

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

Control modules are named in the format MWXXXABC. Table 3-2 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 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

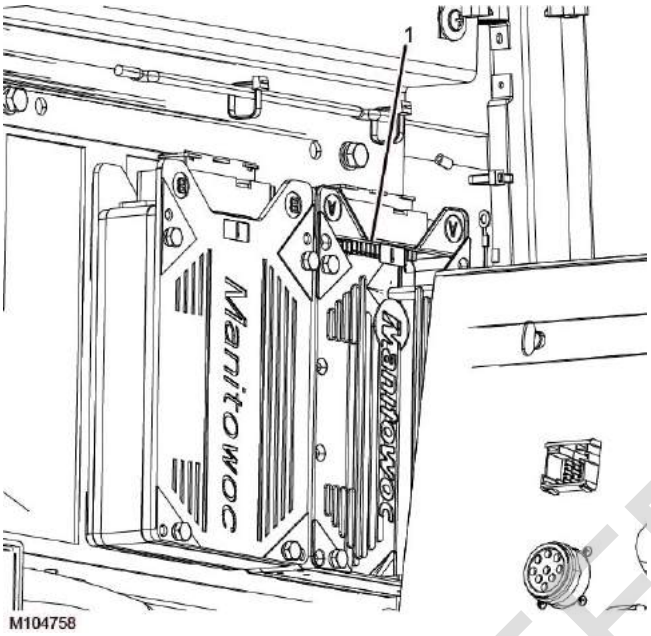
Table 3-3 defines the terms used in the schematics for the I/O types used by the control modules.

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
ODHxA	Digital Output, where “x” is the current in Amps
OPHxA	PWM Output High Side, where “x” is the current in Amps
OPLxA	PWM Output Low Side, where “x” is the current in Amps
OS85H	8.5 V_{DC} Supply Power
OS85L	8.5 V_{DC} Supply Ground
+UB	Battery Supply
+UE	Electronic Supply

Safety Control Module (SCM)

SCM is a controller that runs 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.



Right Side Console

Item	Description
1	SCM-00

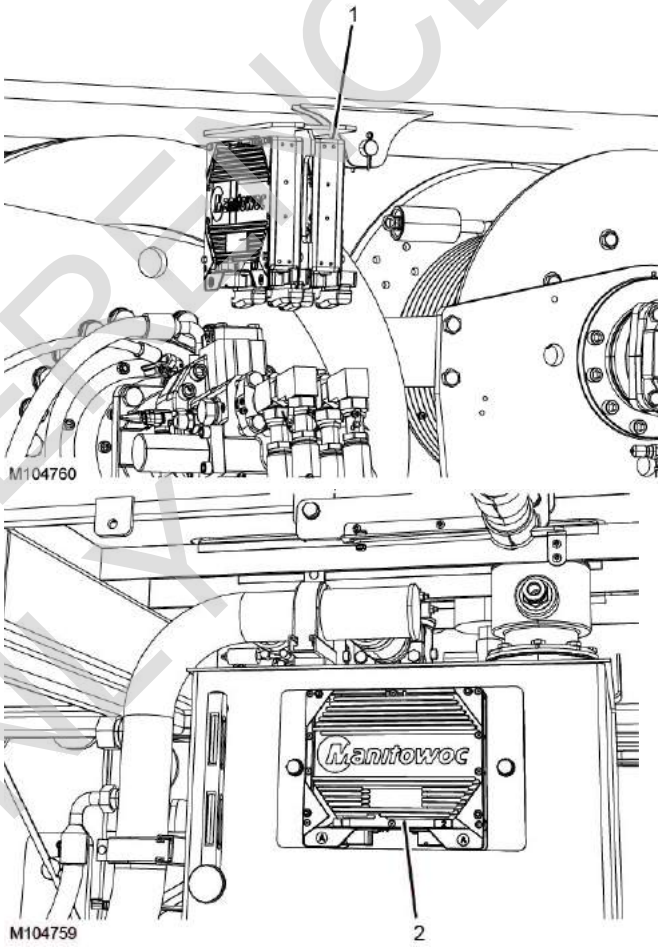
FIGURE 3-6

Crane Control Module (CCM)

CCM controllers run the software programs governing the crane operations. 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 two CCMs mounted on the crane (see Figure 3-7):

- CCM-10 (1) (rotating bed—master)
- CCMC11 (2) (rotating bed—slave)



Item	Description
1	CCM-10
2	CCMC11

Rotating Bed

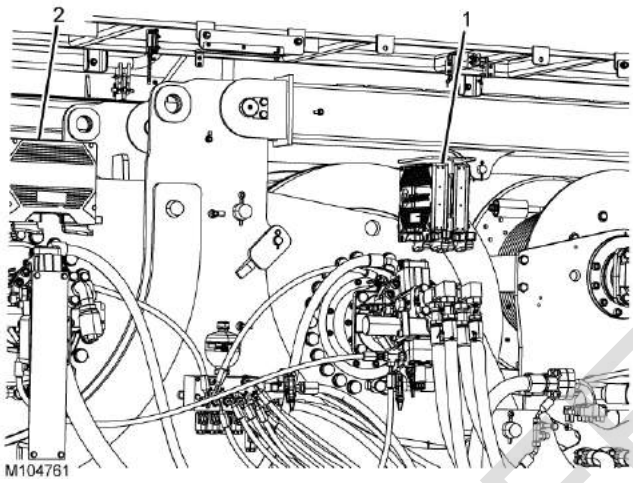
FIGURE 3-7

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 two IOL modules mounted on the rotating bed (see Figure 3-8):

- IOLC30 (1)
- IOLC31 (2)



Item	Description
1	IOLC30
2	IOLC31

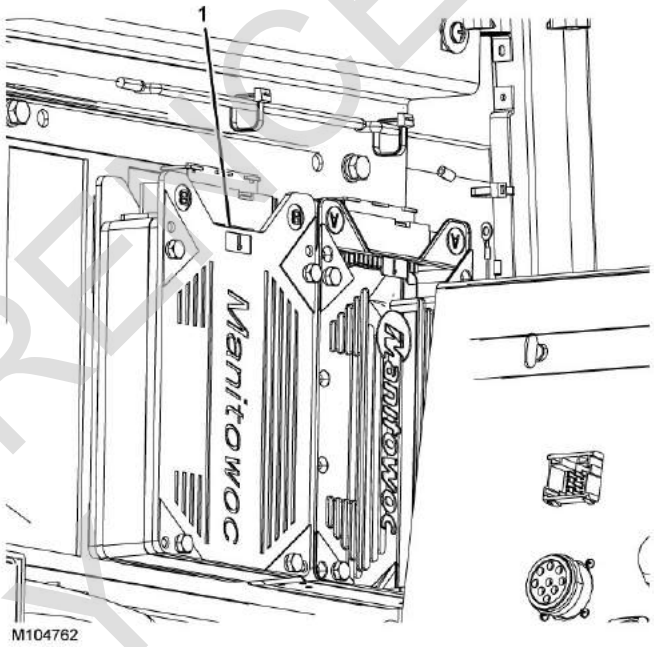
FIGURE 3-8

Input/Output—Small (IOS) Module

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

There is one IOS modules on the crane (see Figure 3-9):

- MWIOSA22 (1) (cab)



Behind Operator Seat

Item	Description
1	IOSA22

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:

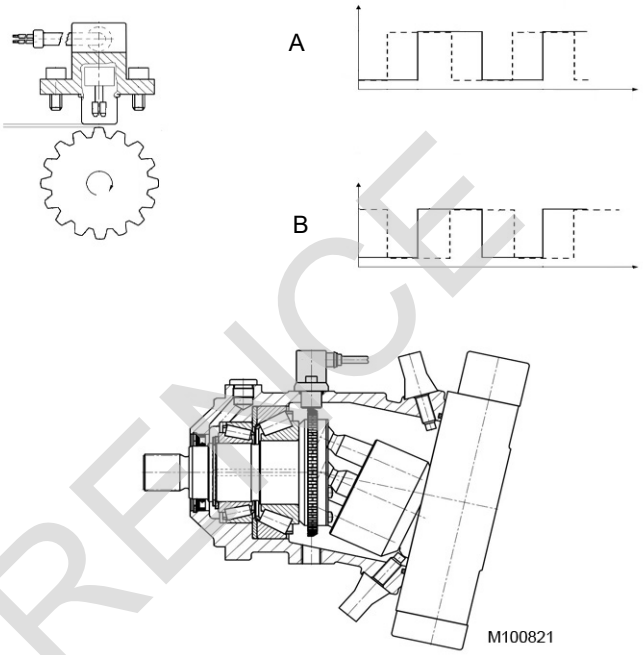
- Drum system pressure
- Swing system pressure
- Accessory system pressure
- Track pressure
- Cooler fan pressure

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

Limit Switches—Single Contact

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

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

- Lower boom point block-up limit
- Upper boom point 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	System valves
Drum pawl cylinders	Pin pusher/puller cylinders
Gantry cylinders	Cooler fan pump

Angle Sensors

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

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

Alarms

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

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

Load Link Sensors

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

- Right and left links

Temperature Sensors

A controller digital output provides power to the temperature sensor.

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

Fuel Level Sensor

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

Hydraulic Fluid Level Switch

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

Pressure and Vacuum Switches

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

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

Relays

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

Hand Throttle

A controller provides an 8.5 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

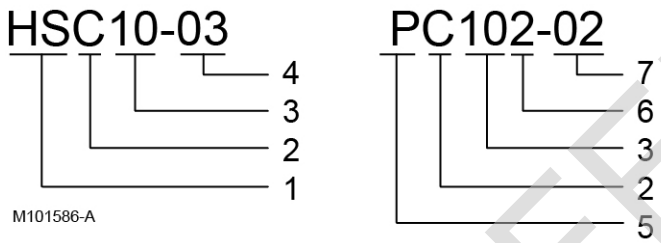
Device	Controller
Alarms	IOLC31
Air Conditioning Clutch	CCMC11
Block-Up Limit and Slow Down Switches	SCM00, IOLC31
Boom Angle Limit Switch	IOLC31
Boom Angle Limit Sensor	IOLC31
Boom Top Components	IOLC31
Cab Switches and Controls	SCM-00, IOSA22
Camera Lights	IOLC30
Drum 1 Components	CCM-10, IOLC31, IOSA22
Drum 2 Components	CCM-10, IOLC31, IOSA22
Drum 3 Components	CCM-10, IOSA22
Drum 4 Components	CCM-10, IOSA22
ECM Start Relay	IOLC31
Engine Components	CCMC11, IOLC30, IOSA22
Fuel Level Sensor	CCMC11
Gantry Components	CCMC11, IOSA22
Hydraulic-Charge Filter Alarm Switch	CCMC11
Hydraulic Fluid Level and Temperature Sensor	CCMC11
Hydraulic Vacuum Switch	CCMC11
Level Sensor—Rotating Bed	CCMC11
Pin Pullers	CCM10, IOLC30, IOSA22
Pin Pushers	CCM10, IOLC30, IOSA22
Pressure Transducers	CCM-10, CCMC11, IOLC30, IOLC31
Pumps 1 to 4	CCMC11,IOLC31
RCL Beacon	SCM-00, IOSA22
Starter Motor Relays	CCMC11
Swing Components	IOLC30, IOLC31
Throttle (Hand and Foot)	SCM-00
Travel Components	CCM-10, CCMC11, IOSB22, SCM-00
Wind Speed Indicators—Boom and Upper Boom Point	IOLC31

SOLENOID VALVE IDENTIFICATION

Each hydraulic valve solenoid is assigned a solenoid number used in Manitowoc Cranes training classes (see Table 3-6). The pin number corresponds to the control module connector pin number, as represented in the electrical schematics.

The control module information contained in each solenoid or pin number is illustrated in Figure 3-11. In this example, for the swing brake release solenoid, the following information is contained:

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



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

FIGURE 3-11

Table 3-6. Hydraulic Solenoid Identification

Solenoid Number	Description	Pin Number
HSC10-03	Swing Brake Release	PC102-02
HSC10-04	Travel Brake Release	PC102-22
HSC10-05	Drum 1 Brake Release	PC102-05
HSC10-06	Drum 2 Brake Release	PC102-15
HSC10-07	Drum 3 Brake Release	PC102-14
HSC10-08	Drum 4 Brake Release	PC102-04
HSC10-09	Drum 4 Pawl In	PC102-03
HSC10-11	Drum 4 Pawl Out	PC102-24
HSC10-12	Travel High Speed	PC102-25
HSC10-13	Counterweight Pin Pullers	PC102-06
HSC10-23	Left Travel Side A	PC101-01
HSC10-24	Left Travel Side B	PC102-12
HSC10-25	Right Travel Side A	PC101-15
HSC10-26	Right Travel Side B	PC101-42
HSC10-27	Drum 4 Side A	PC101-28
HSC10-28	Drum 4 Side B	PC101-02
HSC11-04	Drum 1 and 2 Free fall Enable	PC112-22
HSC11-10	Crawler Extend	PC112-23
HSC11-11	Crawler Retract	PC112-24
HSC11-12	Gantry Extend	PC112-25
HSC11-13	Gantry Retract	PC112-06
HSC11-23	Swing Pump A	PC111-01
HSC11-24	Swing Pump B	PC112-12
HSC11-25	Pump 1	PC111-15
HSC11-26	Pump 2	PC111-42
HSC11-27	Drum 1 Free Fall Proportion Valve	PC111-28
HSC11-28	Drum 2 Free Fall Proportion Valve	PC111-02
HSC30-14	Drum 1 Primary A	PC302-18
HSC30-15	Drum 2 Primary A	PC302-10
HSC30-16	Drum 2 Primary B	PC302-29
HSC30-17	Drum 1 Primary B	PC302-19
HSC30-18	Drum 1 Secondary Side A	PC301-05
HSC30-19	Drum 1 Secondary Side B	PC301-06
HSC30-20	Drum 2 Secondary Side A	PC301-07
HSC30-21	Drum 2 Secondary Side B	PC301-08
HSC31-18	Drum 3 Side A	PC311-5
HSC31-19	Drum 3 Side B	PC311-6
HSC31-17	Hydraulic Fan Control	PC312-19
HSC31-21	Accessory Enable	PC311-08

TEST VOLTAGES

Table 3-7. CCM-10 Test Voltages

Pin	Net	Function	Voltages
P1-1	OPH3A23	Left Travel Side A	0 to 24 V_{DC}
P1-2	OPH3A28	Drum 4 Side B	0 to 24 V_{DC}
P1-3	ID21	Drum 4 Pawl Limit Switch N.C.	0 V_{DC} Open, 24 V_{DC} Closed
P1-4	IDF09	Drum 2 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V_{DC}
P1-5	IDF10	Drum 2 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V_{DC}
P1-7	IDF01	Drum 4 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V_{DC}
P1-8	IDF04	Drum 3 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V_{DC}
P1-9	IDF06	Drum 1 Flange Encoder	0 V_{DC} or 24 V_{DC}
P1-11	IACV16	Right Travel Motor PSI	4 to 20 mA
P1-12	IACV18	Drum 2 Motor PSI	4 to 20 mA
P1-13	IACV14	Drum 3 Motor PSI	4 to 20 mA
P1-14	8C48 (+UE)	Control Module Battery Power	24 V_{DC}
P1-15	OPH3A25	Right Side Travel Side A	0 to 24 V_{DC}
P1-21	IDF03	Drum 3 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V_{DC}
P1-22	IDF05	Drum 1 Flange Encoder	0 V_{DC} or 24 V_{DC}
P1-24	IACV14	Drum 4 Motor PSI	4 to 20 mA
P1-25	IACV11	Left Side Travel Motor PSI	4 to 20 mA
P1-27	KL15	Control Module Ignition Power (from engine RUN switch)	0 V_{DC} Open, 24 V_{DC} Closed
P1-28	OPH3A27	Drum 4 Side A	0 to 24 V_{DC}
P1-29	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
P1-35	IDF02	Drum 4 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V_{DC}
P1-36	IDF07	Drum 2 Flange Encoder	6% (low) to 70% (high) of 8.5 V_{DC}
P1-37	IDF08	Drum 2 Flange Encoder	6% (low) to 70% (high) of 8.5 V_{DC}
P1-38	IACV15	Drum 4 Motor PSI	4 to 20 mA
P1-39	IACV13	Drum 2 Motor PSI	4 to 20 mA
P1-40	IACV12	Drum 1 Motor PSI	4 to 20 mA
P1-42	OPH3A26	Right Side Travel Side B	0 to 24 V_{DC}
P2-2	ODH3A03	Swing Brake Release	0 V_{DC} Off, 24 V_{DC} On
P2-3	ODH3A03	Drum 4 Pawl In	0 V_{DC} Off, 24 V_{DC} On
P2-4	ODH3A03	Drum 4 Brake Release	0 V_{DC} Off, 24 V_{DC} On
P2-5	ODH3A03	Drum 1 Brake Release	0 V_{DC} Off, 24 V_{DC} On
P2-6	ODH3A03	Counterweight Pin Pull	0 V_{DC} Off, 24 V_{DC} On
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	ODH3A10	Left Travel Side B	0 to 24 V_{DC}
P2-13	ODH3A01	Drum 4 Motor Speed Sensor and Pressure	24 V_{DC}
P2-14	ODH3A07	Drum 3 Brake Release	0 to 24 V_{DC}
P2-15	ODH3A06	Drum 2 Brake Release	0 to 24 V_{DC}

Pin	Net	Function	Voltages
P2-18	8C32 (+UB)	Battery Power for Control Module Outputs	24 V_{DC}
P2-20	8C33 (+UB)	Battery Power for Control Module Outputs	24 V_{DC}
P2-21	ODH3A02	Drum 4 Motor Speed Sensor and Pressure	24 V_{DC}
P2-22	ODH3A04	Travel Brake Release	0 to 24 V_{DC}
P2-23	ODH3A10	Drum 4 Pawl Out	0 to 24 V_{DC}
P2-27	OPL3A21	Travel High Speed	0 to 24 V_{DC}
P2-29	8C34 (+UB)	Battery Power for Control Module Outputs	24 V_{DC}

Table 3-8. CCMC11 Test Voltages

Pin	Net	Function	Voltages
P1-1	OPH3A23	Swing Pump C1	0 or 24 V_{DC}
P1-2	OPH3A28	Drum 2 Free Fall Brake	0 or 24 V_{DC}
P1-3	ID21	Hydraulic Filter Alarm	0 V_{DC} Open, 24 V_{DC} Closed
P1-6	ID22	Hydraulic Fluid Level	0 V_{DC} Open, 24 V_{DC} Closed
P1-11	IACV16	Pump 1B (2) PSI	4 to 40 mA
P1-12	IACV18	Hydraulic Vacuum Switch	2 to 20 mA
P1-13	IACV14	Drum 1 Free Fall PSI	4 to 20 mA
P1-14	8C48 (+UE)	Control Module Battery Power	24 V_{DC}
P1-15	OPH3A25	Pump 1A (1) Solenoid	0 or 24 V_{DC}
P1-24	IACV17	Accessory Enable PSI	4 to 20 mA
P1-25	IACV11	Engine Fuel Level Sensor	4 to 20 mA
P1-26	OS85L	Engine Fuel Level Sensor	8.54 V_{DC}
P1-27	KL15	Control Module Ignition Power (from engine RUN switch)	0 V_{DC} Open, 24 V_{DC} Closed
P1-28	OPH3A27	Drum 1 Free Fall Brake	0 or 24 V_{DC}
P1-29	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
P1-38	IACV15	Pump 1A (1) PSI	4 to 20 mA
P1-39	IACV13	Drum 2 Free Fall PSI	4 to 20 mA
P1-40	IACV12	Hydraulic Fluid Temperature Sensor	4 to 20 mA
P1-41	OS85H	Hydraulic Fluid and Fuel Sensors	8.5 V_{DC}
P1-42	OPH3A26	Pump 1B (2) Solenoid	0 or 24 V_{DC}
P2-1	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
P2-2	ODH3A03	Drum 1 and 2 Free Fall Brake PSI	24 V_{DC}
P2-3	ODH3A09	Pump 1A, 1B PSI	0 V_{DC} Off, 24 V_{DC} On
P2-4	ODH3A08	Accessory Enable PSI	24 V_{DC}
P2-6	ODH3A13	Gantry Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
P2-10	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
P2-11	8C39 (+UB)	Battery Power for Control Module Outputs (from CB29)	24 V_{DC}
P2-12	OPH3A24	Swing Pump (CL) Solenoid	0 or 24 V_{DC}
P2-13	ODH3A01	Hydraulic Alarm and Hydraulic Vacuum Switch	24 V_{DC}
P2-14	ODH3A07	Starter Relay	0 V_{DC} Off, 24 V_{DC} On
P2-15	ODH306	A/C Clutch	0 V_{DC} Off, 24 V_{DC} On
P2-18	8C40 (+UB)	Battery Power for Control Module Outputs (from CB30)	24 V_{DC}
P2-20	8C39 (+UB)	Battery Power for Control Module Outputs (from CB29)	24 V_{DC}
P2-22	ODH3A04	Drum 1 and 2 Free Fall Enable Solenoid (if equipped)	0 V_{DC} Off, 24 V_{DC} On
P2-23	ODH3A10	Crawler Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
P2-24	ODH3A11	Crawler Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
P2-25	ODH3A12	Gantry Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
P2-29	8C40 (+UB)	Battery Power for Control Module Outputs (from CB30)	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	Freon PSI	0 V_{DC} Open, 24 V_{DC} Closed
P1-4	ID02	Counterweight UP Limit	0 V_{DC} Disconnected, 24 V_{DC} Connected
P1-5	OPH6A18	Drum 1 Side B Solenoid	0 or 24 V_{DC}
P1-6	OPH6A19	Drum 1 Side A Solenoid	0 or 24 V_{DC}
P1-7	OPH6A20	Drum 2 Side A Solenoid	0 or 24 V_{DC}
P1-8	OPH6A21	Drum 2 Side B Solenoid	0 or 24 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}
P1-20	8C22 (+UB)	Battery Power for Control Module Outputs (from CB21)	24 V_{DC}
P1-21	ID07	Rotating Bed Level Sensor	0 V_{DC} Disconnected, 24 V_{DC} Connected
P2-4	IACV18	Drum 1 PSI	4 to 20 mA
P2-7	ODH3A07	Rotating Bed Level Sensor	0.15 V_{DC} to 9.85 V_{DC}
P2-11	8C23 (+UB)	Battery Power for Control Module Outputs (from CB22)	24 V_{DC}
P2-15	ODH3A01	Counterweight Up Limit Switch	24 V_{DC}
P2-20	8C24 (+UB)	Battery Power for Control Module Outputs (from CB22)	24 V_{DC}
P2-21	OS85L	8.5 V_{DC} Ground	0 V_{DC}
P2-22	IACV21	Rotating Bed Level Sensor	0.15 V_{DC} to 9.85 V_{DC}
P2-23	IACV22	Rotating Bed Level Sensor	0.15 V_{DC} to 9.85 V_{DC}
P2-28	ODH3A13	ECM Start	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 1 Minimum Bail Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-4	ID02	Drum 2 Minimum Bail Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-7	OPH6A20	A/C Condenser	0 or 24 V_{DC}
P1-11	8C35 (+UB)	Battery Power for Control Module Outputs (from CB23)	24 V_{DC}
P1-12	8C48 (+UE)	Control Module Battery Power (from K5)	24 V_{DC}
P1-13	ID03	Anti Two Block Lower Point Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-14	ID04	Upper Boom Point Connect	0 V_{DC} Open, 24 V_{DC} Closed
P1-15	ID05	Maximum Boom Angle Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-16	ID06	Fixed Jib Connect	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}
P1-20	8C36 (+UB)	Battery Power for Control Module Outputs (from CB23)	24 V_{DC}
P1-21	ID07	Anti Two Block Upper Boom Point Fixed Jib Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-26	IDF16	Drum 1 Motor Speed Sensor	6% (low) to 70% (high) of 8.5 V_{DC}
P2-4	IACV18	Drum 2 Motor PSI	4 to 20 mA
P2-5	ODH3A02	Drum 2 and 3 Motor PSI	0 V_{DC} Off, 24 V_{DC} On
P2-6	ODH3A04	Alarm Switch Swing and Travel Limit	0 V_{DC} Off, 24 V_{DC} On
P2-10	OPH3A15	Drum 2 Motor Control	0 to 24 V_{DC}
P2-11	8C37 (+UB)	Battery Power for Control Module Outputs (from CB24)	24 V_{DC}
P2-13	IACV19	Swing Left PSI	4 to 20 mA
P2-14	IACV20	Swing Right PSI	4 to 20 mA
P2-15	ODH3A01	Drum 1 Minimum Bail PSI, Drum 1 Motor Speed	24 V_{DC}
P2-16	ODH3A06	Boom Angle Sensor	24 V_{DC}
P2-17	OPH3A09	Anti Two Block UBP/FJ LWR PNT Wind Speed Sensors	0 or 24 V_{DC}
P2-18	OPH3A14	Drum 1 Motor Control	0 to 24 V_{DC}
P2-19	OPH3A17	Hydraulic Fan Control	0 to 24 V_{DC}
P2-20	8C38 (+UB)	Battery Power for Control Module Outputs (from CB24)	24 V_{DC}
P2-22	IACV21	Boom Angle Sensor	4 to 20 mA
P2-23	IACV22	Wind Speed Sensor	4 to 20 mA
P2-25	ODH3A05	Alarm	0 V_{DC} Off, 24 V_{DC} On
P2-26	OPH3A08	Max Boom Angle Limit	0 or 24 V_{DC}
P2-28	ODH3A13	Left and Right Swing PSI	0 V_{DC} Off, 24 V_{DC} On
P2-29	OPH3A16	Drum 3 Motor Control	0 to 24 V_{DC}

Table 3-11. IOSA22 Test Voltages

Pin	Net	Function	Voltages
P1-1	GND	Ground (from cab ground bus-bar)	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: • Free Fall Enable • Crawler Extend Cylinder • Gantry Raise and Lower Cylinder • Drum High Speed	24 V_{DC}
P1-6	OPH6A02	Heater Valve Motor Power	0 V_{DC} Open, 24 V_{DC} Closed
P1-9	IMID1	Module Identifier Input (from cab ground bus-bar)	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 CB32)	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	Crawler Extend	0 V_{DC} Open, 24 V_{DC} Closed
P1-15	ID05	Crawler Retract	0 V_{DC} Open, 24 V_{DC} Closed
P1-16	ID06	Raise Gantry	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 CB32)	24 V_{DC}
P1-21	IDO7	Lower Gantry	0 V_{DC} Open, 24 V_{DC} Closed
P1-22	ID08	Drum High Speed	0 V_{DC} Open, 24 V_{DC} Closed
P1-23	ID09	Drum High Speed	0 V_{DC} Open, 24 V_{DC} Closed
P1-24	ID10	Drum 1 Free Fall Enabled	0 V_{DC} Open, 24 V_{DC} Closed
P1-25	ID11	Drum 2 Free Fall Enabled	0 V_{DC} Open, 24 V_{DC} Closed
P1-26	IDF13	Not Used	0 V_{DC}
P1-27	ID11	Drum 2 Free Fall Control	0 V_{DC} Open, 24 V_{DC} Closed
P1-28	ID11	Drum 2 Free Fall Control	0 V_{DC} Open, 24 V_{DC} Closed
P1-29	IMID3	Module Identifier Input (from cab ground bus bar)	0 V_{DC}

Table 3-12. SCM-00 Test Voltages

Pin	Net	Function	Voltages
P1-1	8C45 (+UB)	Battery Power for Control Module Outputs (from CB31)	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	Not Used	0 V_{DC}
P1-5	ODH1A4	24 V_{DC} Power Bus: • Travel Speed Switch • Seat Safety Switch	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	Not Used	0 V_{DC}
P1-11	IDF3	Not Used	0 V_{DC}
P1-12	IDF4	Not Used	0 V_{DC}
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 Load Link	N/A
P1-17	CAN_D—H	CAN Bus D—High Load Link	N/A
P1-20	IMID1	Module Identifier Input (from cab ground bus bar)	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 Hand Throttle	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 bus bar)	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 bus bar)	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
P1-37	IACV14	Drum 1 Free Fall Pedal	1.5 to 8.5 V_{DC}
P1-38	IACV16	Cab A/C Thermostat	0 V_{DC} Open, 24 V_{DC} Closed
P1-39	IACV16	Not Used	0 V_{DC}
P1-40	RTCP	3.6 V_{DC} Real Time Clock Battery Power (positive)	3.6 V_{DC}

Pin	Net	Function	Voltages
P1-41	0S85H	8.5 V_{DC} Power Bus Hand Throttle	8.5 V_{DC}
P1-42	ID10	Not Used	0 V_{DC}

SECTION 4
BOOM

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Published 10-09-2020, Control # 259-06

SECTION 4
BOOM

GENERAL MAINTENANCE

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

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

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

ROTATING BED LEVEL SENSOR

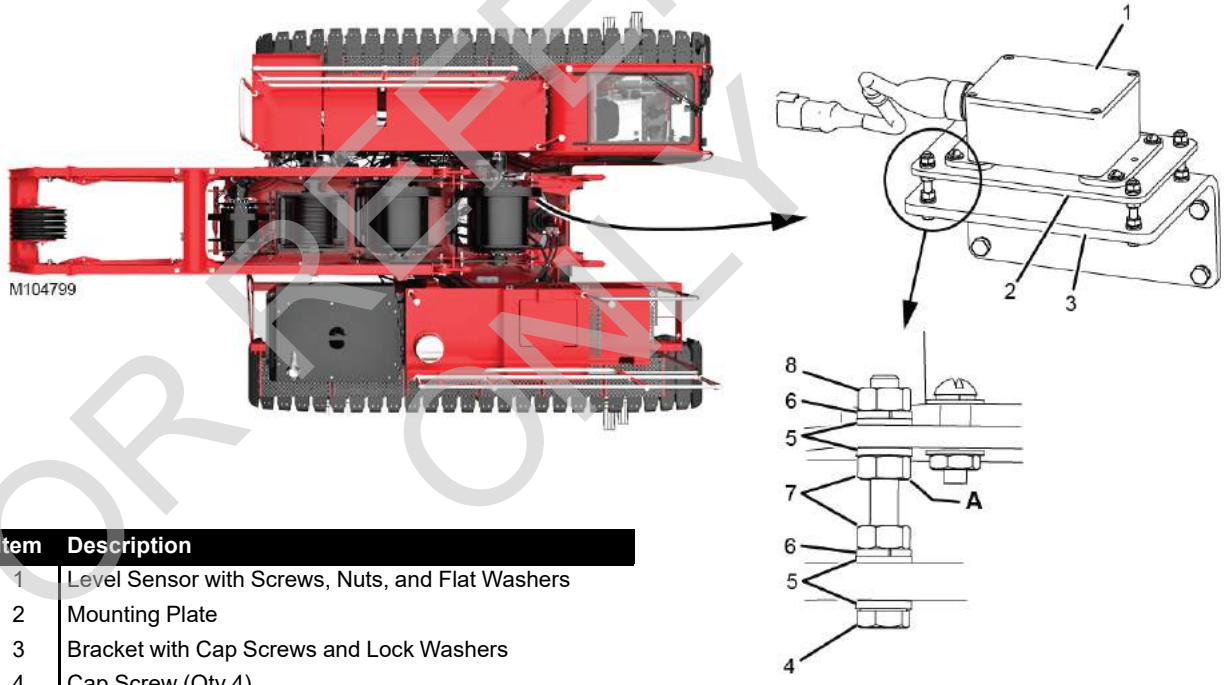
See Figure 4-1.

The rotating bed level sensor (1) is located inside the rotating bed beside the swing motor. The sensor measures the angle of the rotating bed and communicates the information to the crane's control system through the IOLC30 control module.

The angles are viewable in the Crane Status Bar of the Main Display Working Screen.

To adjust the level sensor:

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



Item	Description
1	Level Sensor with Screws, Nuts, and Flat Washers
2	Mounting Plate
3	Bracket with Cap Screws and Lock Washers
4	Cap Screw (Qty 4)
5	Flat Washer (Qty 16)
6	Lock Washer (Qty 8)
7	Nut (Qty 8)
8	Nut (Qty 4)

FIGURE 4-1

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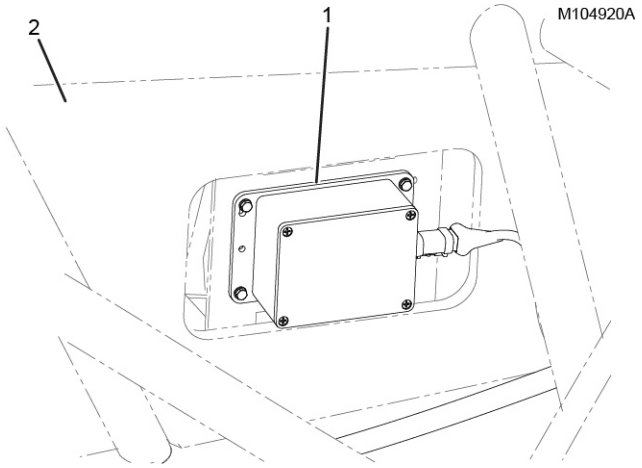


Item	Description
1	Angle Sensor
2	Boom Butt

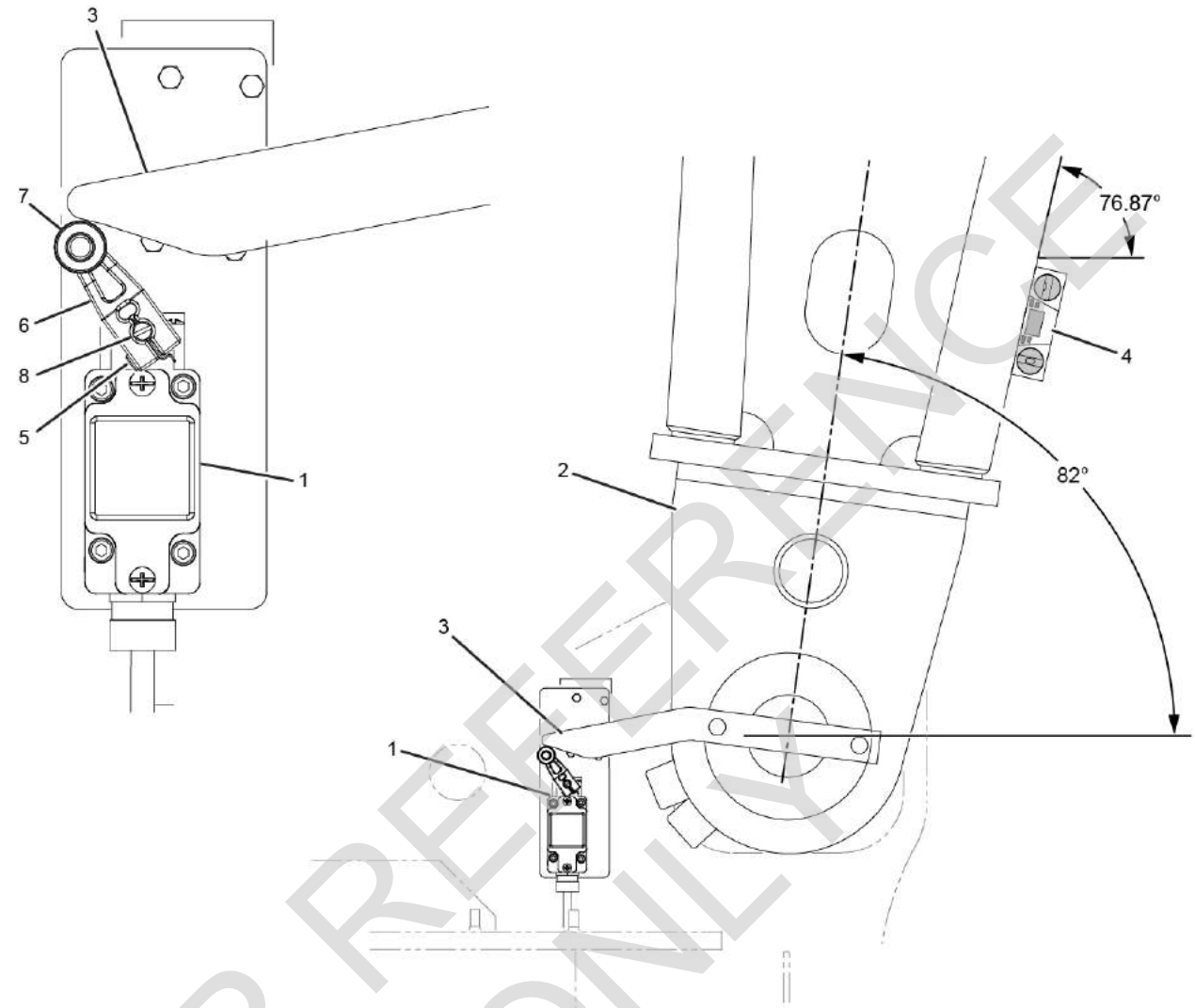
FIGURE 4-2

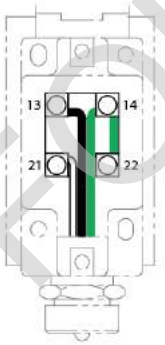
BOOM ANGLE INDICATOR

An BOOM angle sensor (see Figure 4-2) is located inside the boom butt.

The sensor measures the angle of the boom and communicates the information to the crane's control system through the IOLC31 control module.

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





Limit Switch Wiring

Wire Color	Switch Terminals		Function
Green	14	22	Maximum Angle
Black	13		Ground
White	21		24 VDC Supply

Item	Description
1	Limit Switch
2	Boom Butt
3	Actuator
4	Smart Level
5	Set Screw
6	Lever
7	Roller
8	Shaft

M104801

FIGURE 4-3

AUTOMATIC BOOM STOP LIMIT SWITCH

See Figure 4-3.

The automatic boom stop limit switch (1) is mounted on the left inboard leg of the boom butt (2).

When the boom is below the 82° maximum angle, the limit switch is closed, providing a continuous 24 VDC signal to the input on the IOLC31 control module.

When the boom is raised to the 82° maximum angle, the actuator (3) trips the limit switch (1) open (voltage at the ID01 input drops to 0 VDC), signaling the crane's control system to stop the boom hoist and apply its brake.

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

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

Automatic Boom Stop Maintenance

At least once a week, check that the automatic boom stop stops the boom at 82°. If it doesn't, replace any worn or damaged parts and/or adjust the automatic boom stop.

Automatic Boom Stop Adjustment

WARNING

Falling Attachment Hazard!

Do not operate the crane unless the automatic 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.

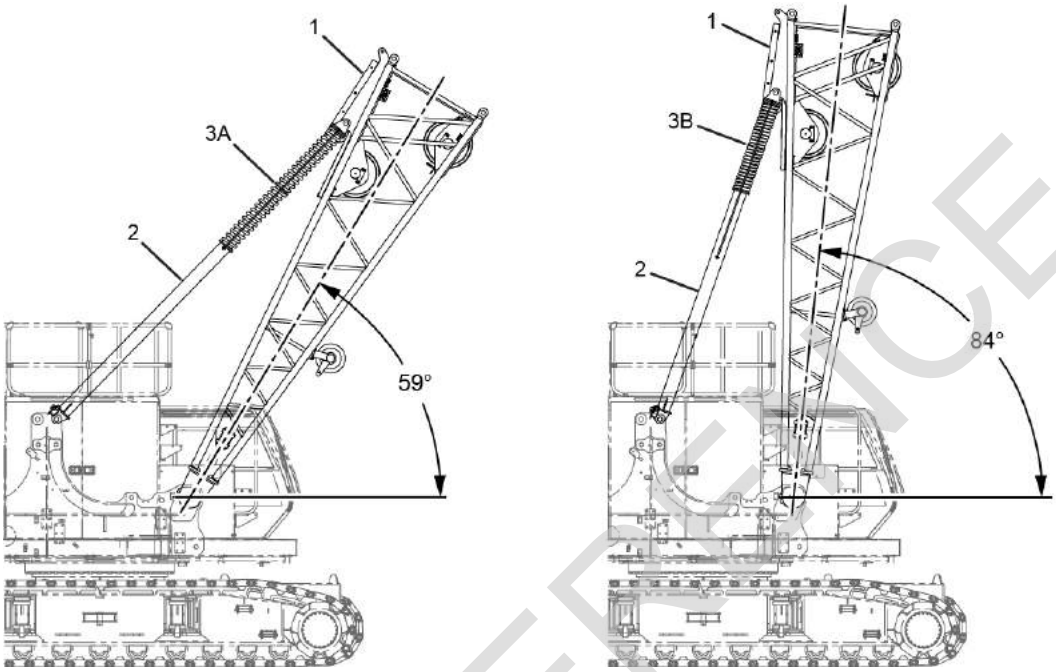
The limit switch for the automatic boom stop was set at the factory and should not require periodic adjustment. Adjustment is necessary when:

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

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

During the following procedure, the boom angle is monitored on the Working Screen of the RCL/RCI Display and on a smart level (4).

1. Park the crane on a firm level surface or level the crane by blocking under the crawlers.
2. Loosen setscrew (5) in the limit switch lever (6) so the lever is free to rotate.
3. Slowly raise the boom while monitoring the boom angle on the RCL/RCI working screen.
4. Stop when the boom reaches 82°.
5. Verify the boom angle with an accurate smart level (4) placed on the boom butt bottom chord. The smart level angle should read 76.87°, which corresponds to an 82° boom angle.
6. Hold the roller (7) on the limit switch lever (6) against the the actuator (3).
7. Turn the limit switch shaft (8) CLOCKWISE (when viewing shaft) ***only enough to click limit switch open and hold***.
8. Securely tighten the setscrew (5) to lock the lever in place.
9. Boom down and then boom back up. The boom must stop at the 82° maximum boom angle.
10. If necessary, repeat the adjustment.



View A
Start of Cushioning

View B
Physical Stop

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

FIGURE 4-4

PHYSICAL BOOM STOP

See Figure 4-5

WARNING

Collapsing Boom Hazard!

Physical boom stops must be installed for all crane operations.

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

Automatic boom stop must be installed and properly adjusted.

Physical Boom Stop Angles

Physical boom stops (2) serve the following purposes:

- Assist in stopping the boom smoothly at any angle above 59°
- Assist in preventing the boom rigging from pulling the boom back when traveling or setting loads with the boom at any angle above 59°
- Assist in moving the boom forward when lowering the boom from any angle above 59°
- Provide a physical stop at 84°

Physical Boom Stop Operation

- When the boom is raised to 59°, the springs start to compress (View A).
- As the boom is raised higher, spring compression increases to exert greater force against the boom.
- If for any reason the boom is raised to 84°, the springs fully compress to provide a physical stop (View B).

Physical Boom Stop Adjustment

The physical boom stops do not require adjustment.

LATTICE SECTION INSPECTION AND LACING REPLACEMENT

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

BOOM ELECTRICAL DIAGRAM

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

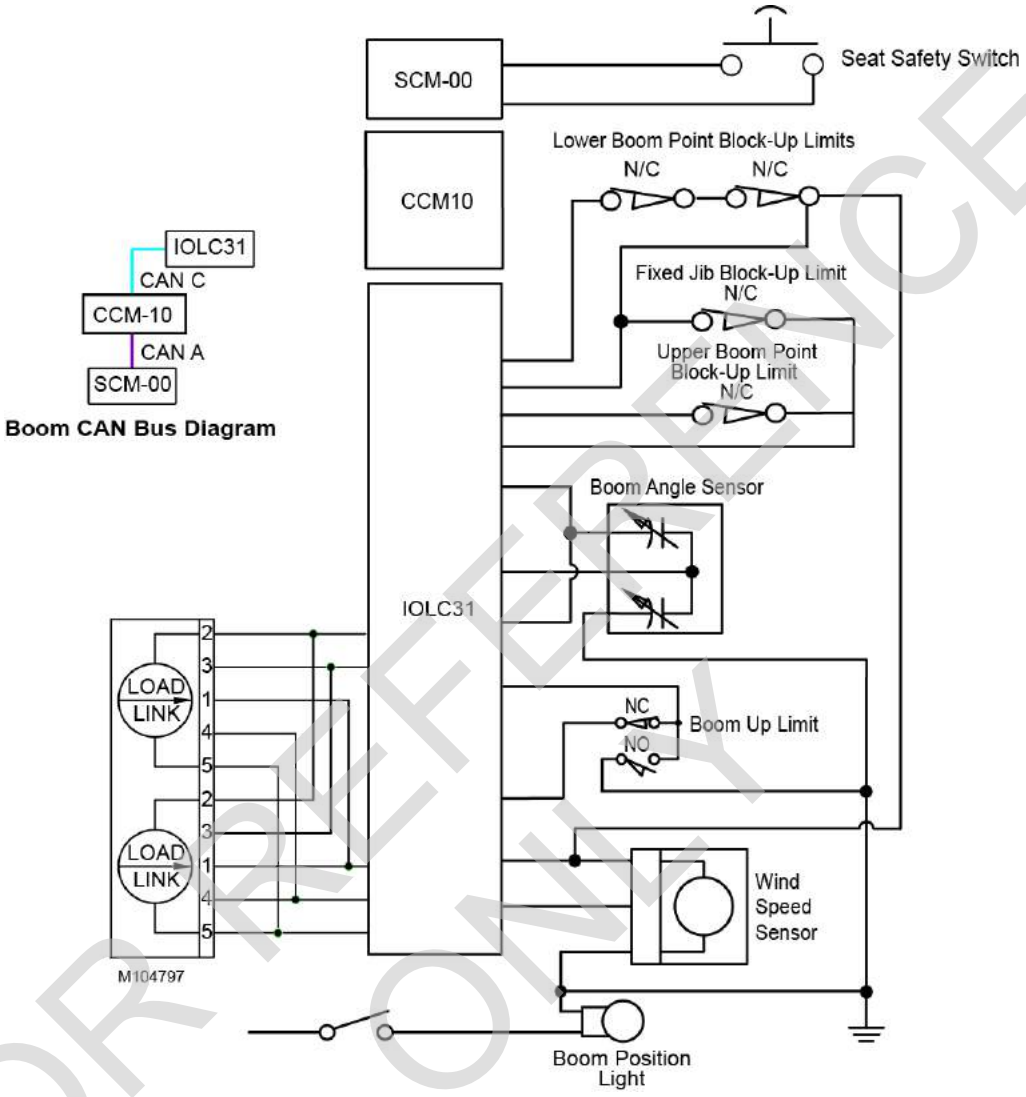


FIGURE 4-5

SECTION 5
HOISTS

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SECTION 5
HOISTS

GENERAL

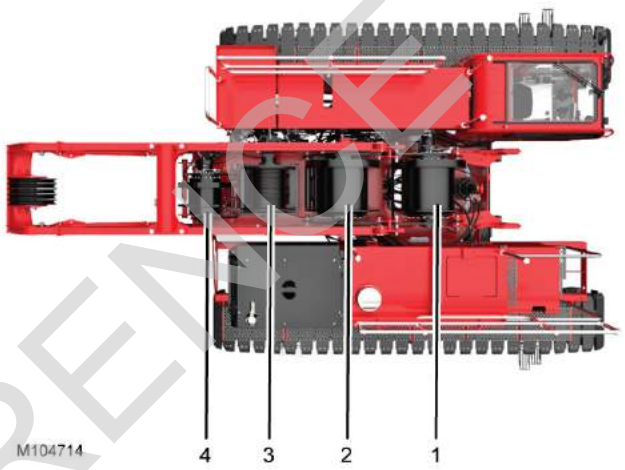
This section provides operational information for the Hoist Systems (Drums 1-4).

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

- Section 2: Hydraulics
- Section 3: Electrical

This section also provides maintenance and adjustment procedures for the hoists and wire rope.

DRUM IDENTIFICATION



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

FIGURE 5-1

5

NOTE: In the following instructions, **CCS** stands for **C**rane **C**ontrol **S**ystem.

ALL DRUMS

See Figure 5-2 through Figure 5-9.

Seat Switch

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

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

Drum Brake

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

The park switch for the desired drum must be switched to the un-park position before the drum can be operated.

The CCS disables the drum control handle and prevents the drum brake from being released (spring applied) or the pawl from being disengaged (Drum 4) until the park switch is closed.

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

Brake Release

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

Speed Sensor

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

DRUMS 1 AND 2

See Figure 5-2 through Figure 5-5.

Overview

Drums 1 and 2 are identically constructed. The hydraulic circuit for each drum consists of the main pump which contains (2) independently controlled 107cc rotary groups, a primary and secondary electrically-operated directional control valve, and a 171cc variable displacement motor with single-sided holding valve and internal relief valve.

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

Each drum has the ability to use the flow from both rotary groups in the main pump if certain conditions are met. In order to use this secondary flow, only one of the two drums can be active, Drum High-Speed mode must be enabled, and the handle command for that drum must be greater than 80%. When these conditions are met, the flow from the secondary pump is proportionally applied to the motor through the secondary section of the main control valve.

Drum 1: Primary pump = B and Secondary Pump = A

Drum 2: Primary pump = A and Secondary Pump = B

In the clam mode, secondary flow is not available to either hoist motor in order to maintain drum synchronization.

Holding Valve

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

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

The valve functions differently in each direction:

Lowering Load

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

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

As the control handle is moved off center in the **down** direction, the working pressure begins to act on the valve,

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

Pilot-Operated Relief Valve

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

Raising Load

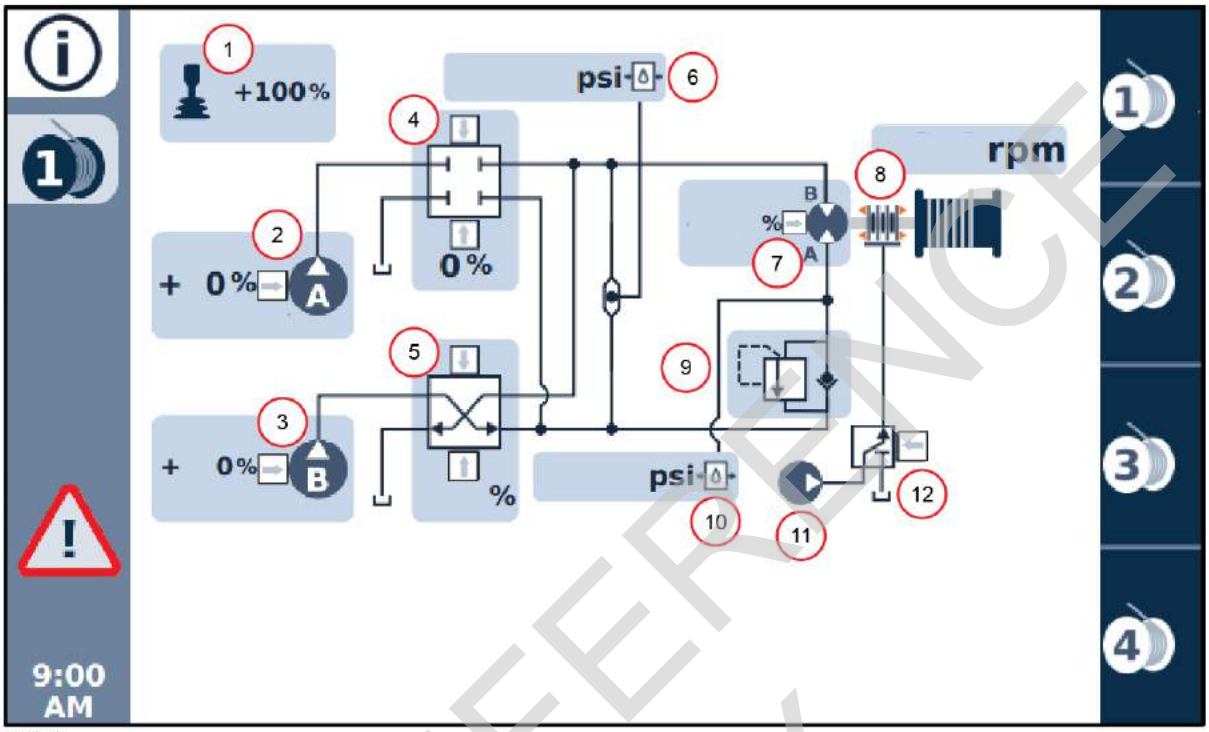
When system flow is in the **up** direction, the holding valve remains in the unchecked position and has no effect on operation.

Motor displacement

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

Drum 1 Hydraulic Diagram (without Free Fall)

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



Item	Drum 1 Components		
1	Handle (Command -100 to 100%) + number = raise, – number = lower	7	Motor (Command 0=max displacement, 100%= min displacement)
2	Pump A (secondary) (Command 0 to 100%)	8	Brake
3	Pump B (primary) (Command 0 to 100%)	9	Load Holding Valve
4	Pump A Control Valve (Command -100 to 100%) + number = raise, – number = lower	10	Motor Pressure Sensor
5	Pump B Control Valve (Command -100 to 100%) + number = raise, – number = lower	11	Accessory Pump
6	System Pressure Sensor	12	Brake Valve

FIGURE 5-2

Drum 1 Electrical Diagram

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

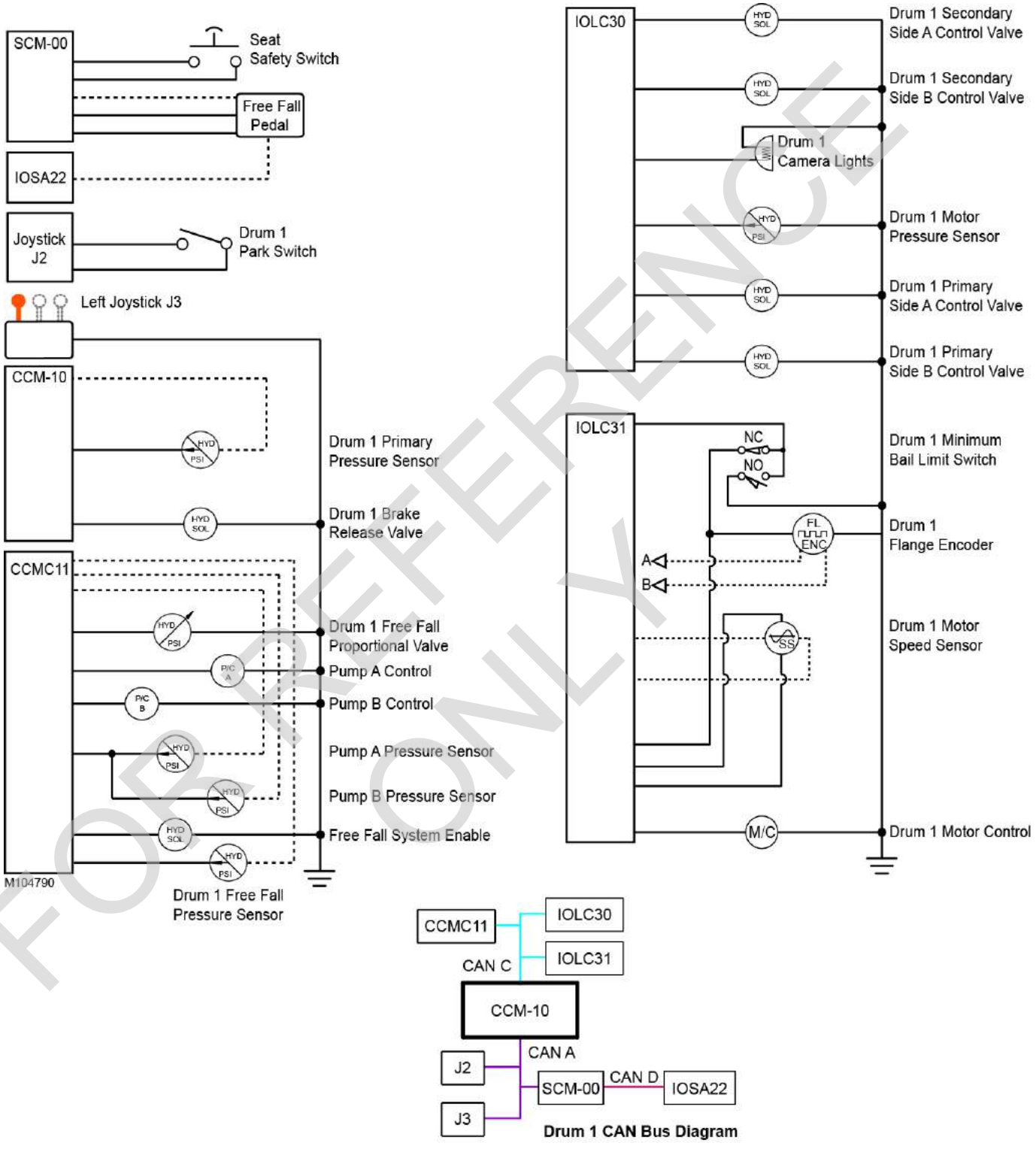
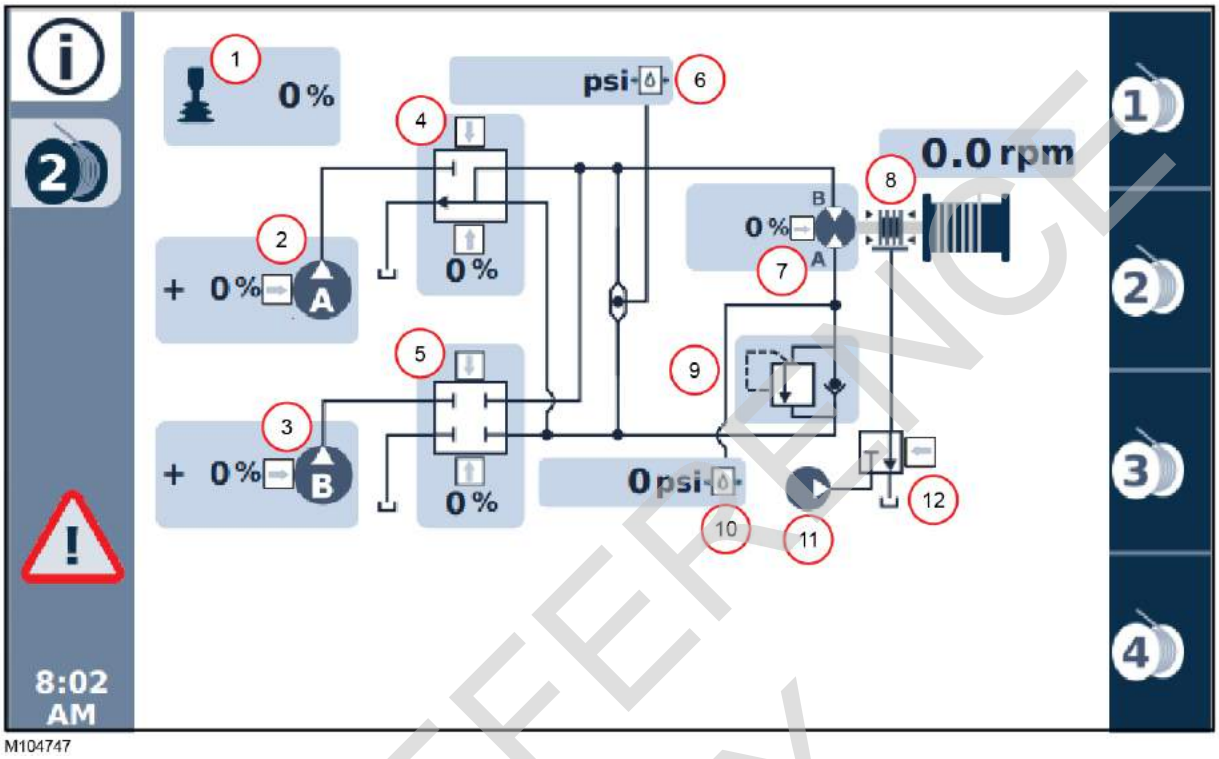


FIGURE 5-3

Drum 2 Hydraulic Diagram (without Free Fall)

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



Item	Drum 2 Components		
1	Handle (Command -100 to 100%) + number = raise, – number = lower	7	Motor (Command 0=max displacement, 100%= min displacement)
2	Pump A (primary) (Command 0 to 100%)	8	Brake
3	Pump B (primary) (Command 0 to 100%)	9	Load Holding Valve
4	Pump A Control Valve (Command -100 to 100%) + number = raise, – number = lower	10	Motor Pressure Sensor
5	Pump B Control Valve (Command -100 to 100%) + number = raise, – number = lower	11	Accessory Pump
6	System Pressure Sensor	12	Brake Valve

FIGURE 5-4

Drum 2 Electrical Diagram

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

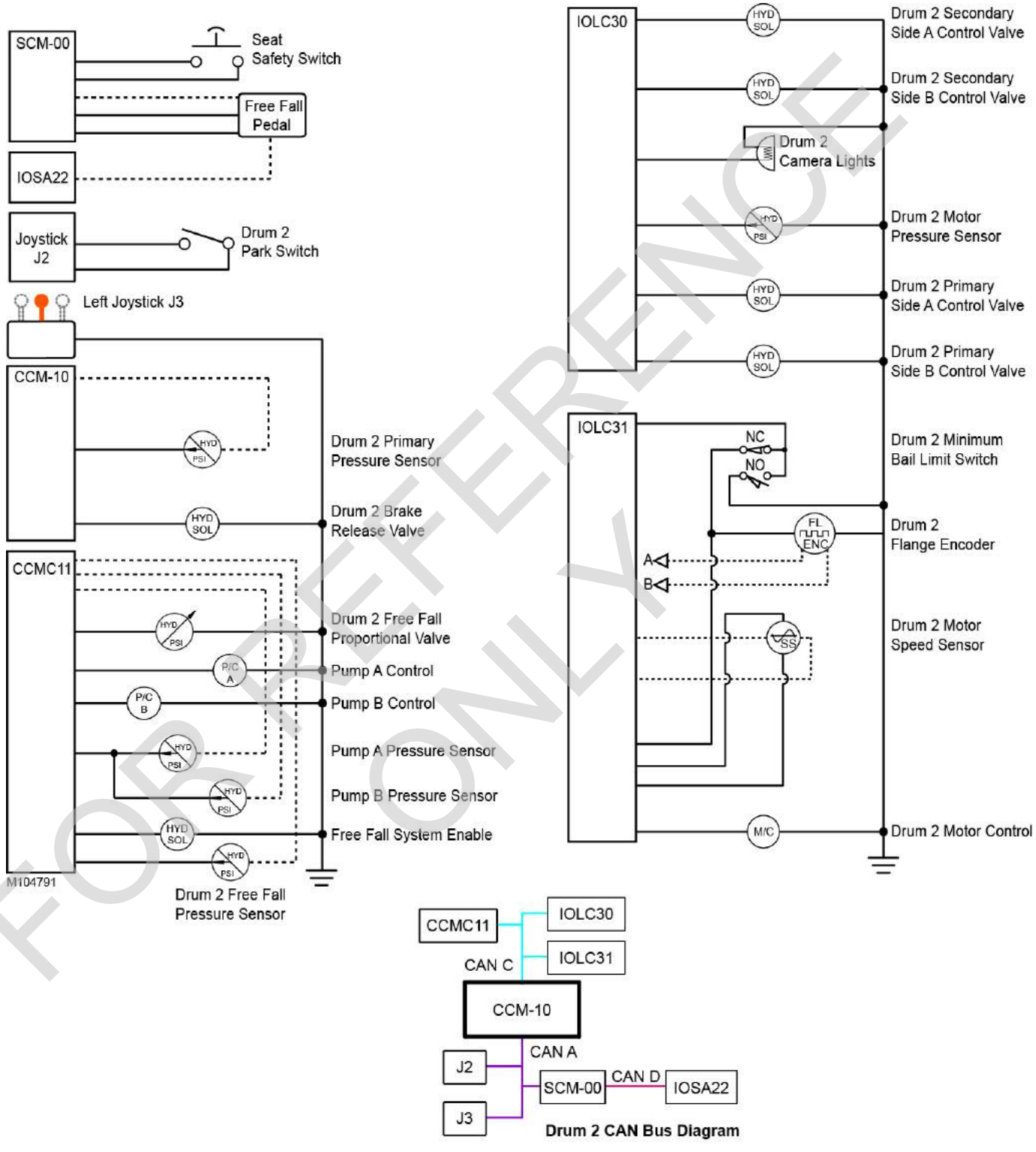


FIGURE 5-5

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DRUM 3

See Figure 5-6 and Figure 5-7.

Overview

The hydraulic circuit for Drum 3 consists of one independently controlled 107cc rotary group (Pump A) of the main pump, an electrically-operated directional control valve, and a 107cc variable displacement motor with a single-sided holding valve and internal relief valve.

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

Holding Valve

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

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

The valve functions differently in each direction:

Lowering load

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

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

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

Pilot-Operated Relief Valve

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

Raising Load

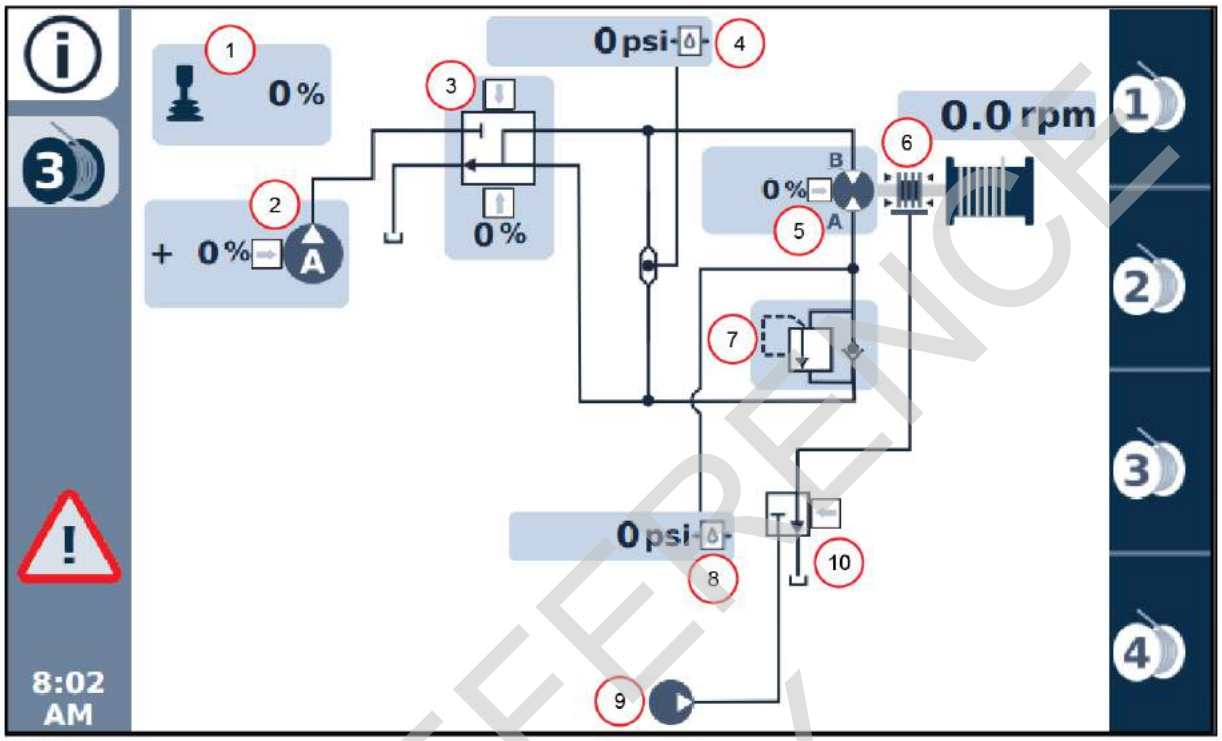
When system flow is in the **up** direction, the holding valve remains in the unchecked position and has no effect on operation.

Motor displacement

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

Drum 3 Hydraulic Schematic

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



Item	Drum 3 Components		
1	Handle (Command -100 to 100%) + number = raise, – number = lower	6	Brake
2	Pump A (Command 0 to 100%)	7	Load Holding Valve
3	Pump A Control Valve (Command -100 to 100%) + number = raise, – number = lower	8	Motor Pressure Sensor
4	System Pressure Sensor	9	Accessory Pump
5	Motor (Command 0=max displacement, 100%= min displacement)	10	Brake Valve

FIGURE 5-6

Drum 3 Electrical Diagram

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

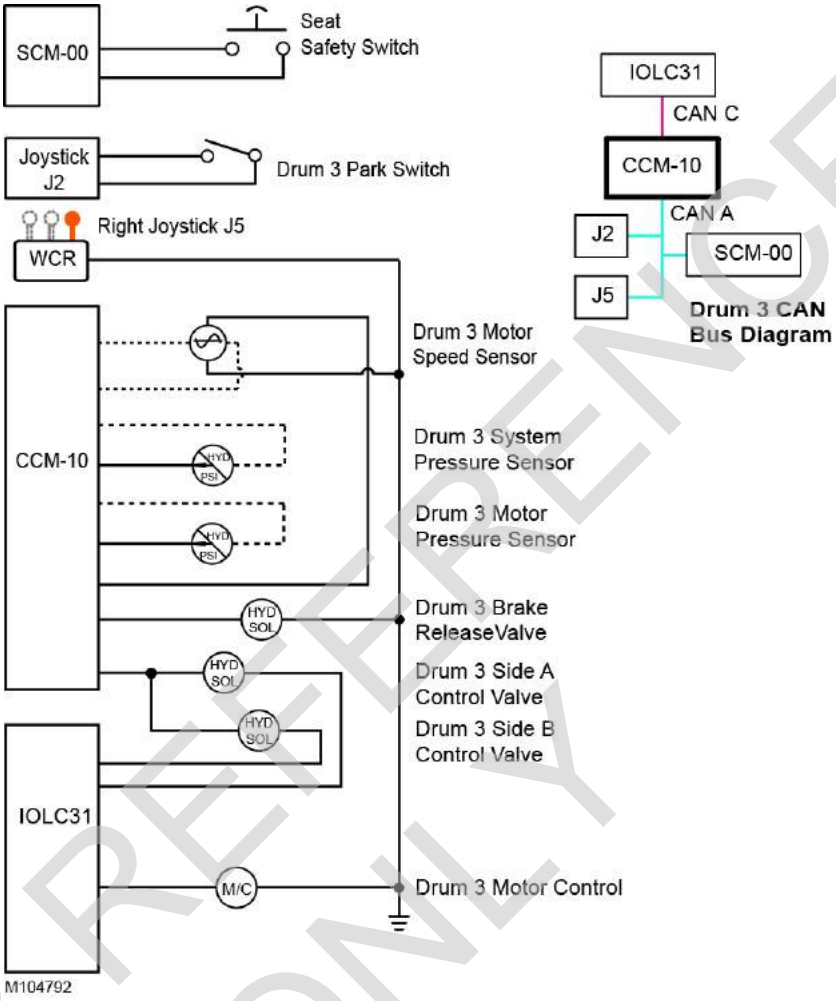


FIGURE 5-7

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DRUM 4

See Figure 5-8 and Figure 5-9.

The hydraulic circuit for Drum 4 consists of an independently controlled 107cc rotary group (Pump B) of the main pump, an electrically-operated directional control valve, and an 80cc fixed displacement motor with dual-sided holding valve to allow for additional charge pressure to be supplied from the pilot circuit for travel on grade. The control signals to these hydraulic elements are determined by the CCS, which uses a number of inputs and to determine speed, direction, and brake release commands.

Drum 4 Pawl

See Figure 5-16.

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

When the Drum 4 park switch is in the parked position, the CCS shifts the pawl valve to the position that extends the pawl cylinder (rotates cam away from pawl), allowing the pawl to spring engage the drum ratchet.

When the Drum 4 park switch is in the un-parked position, the CCS shifts the pawl valve to the position that retracts the pawl cylinder, allowing the cam to disengage the pawl from the drum ratchet.

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

Holding Valve

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

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

The valve functions differently in each direction:

Lowering and Holding a Load

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

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

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

Pilot-Operated Relief Valve

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

Raising a Load

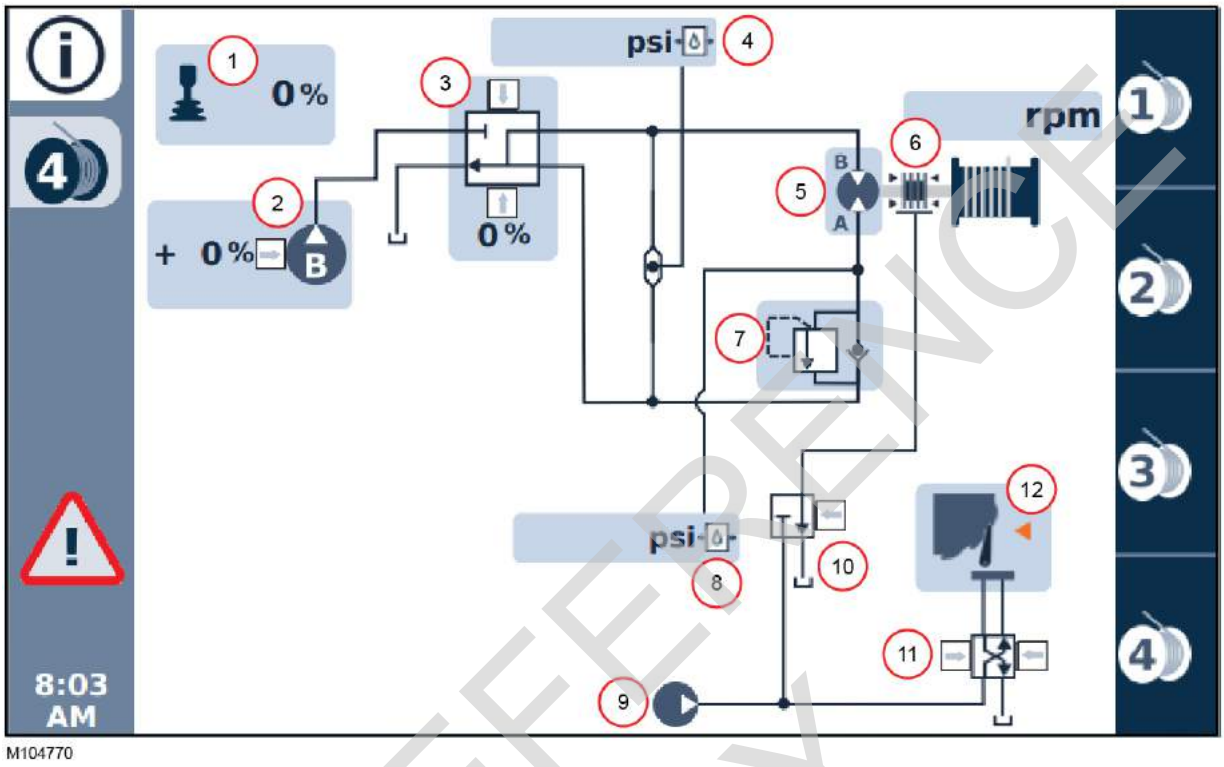
When system flow is in the raising direction, the holding valve functions as a hydraulically operated proportional spool valve which checks motor outflow in one position and in the other position allows motor outflow.

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

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

Drum 4 Hydraulic Diagram

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



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Item	Drum 4 Components		
1	Handle (Command -100 to 100%) + number = raise, – number = lower	7	Load Holding Valve
2	Pump B (Command 0 to 100%)	8	Motor Pressure Sensor
3	Pump B Control Valve (Command -100 to 100%) + number = raise, – number = lower	9	Accessory Pump
4	System Pressure Sensor	10	Brake Valve
5	Motor	11	Pawl Valve
6	Brake	12	Pawl Cylinder

FIGURE 5-8

Drum 4 Electrical Diagram

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

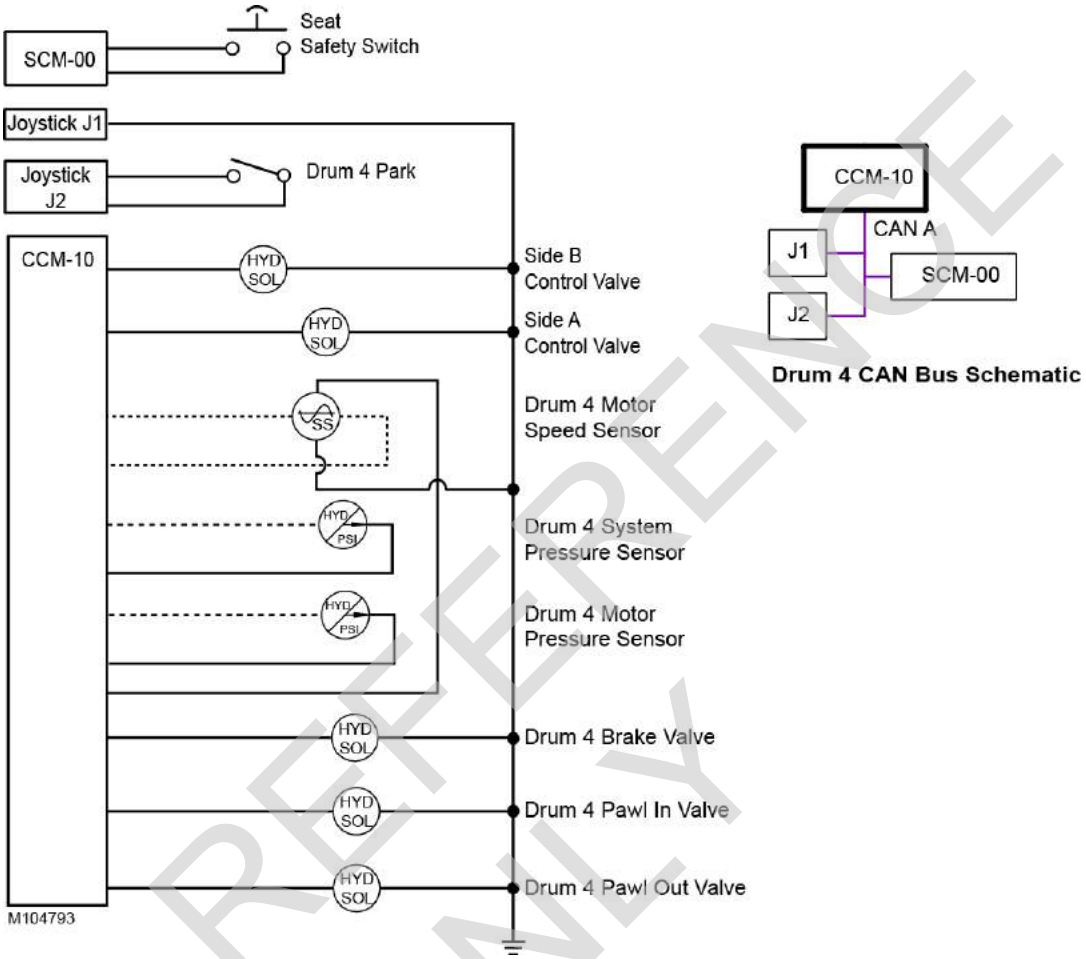
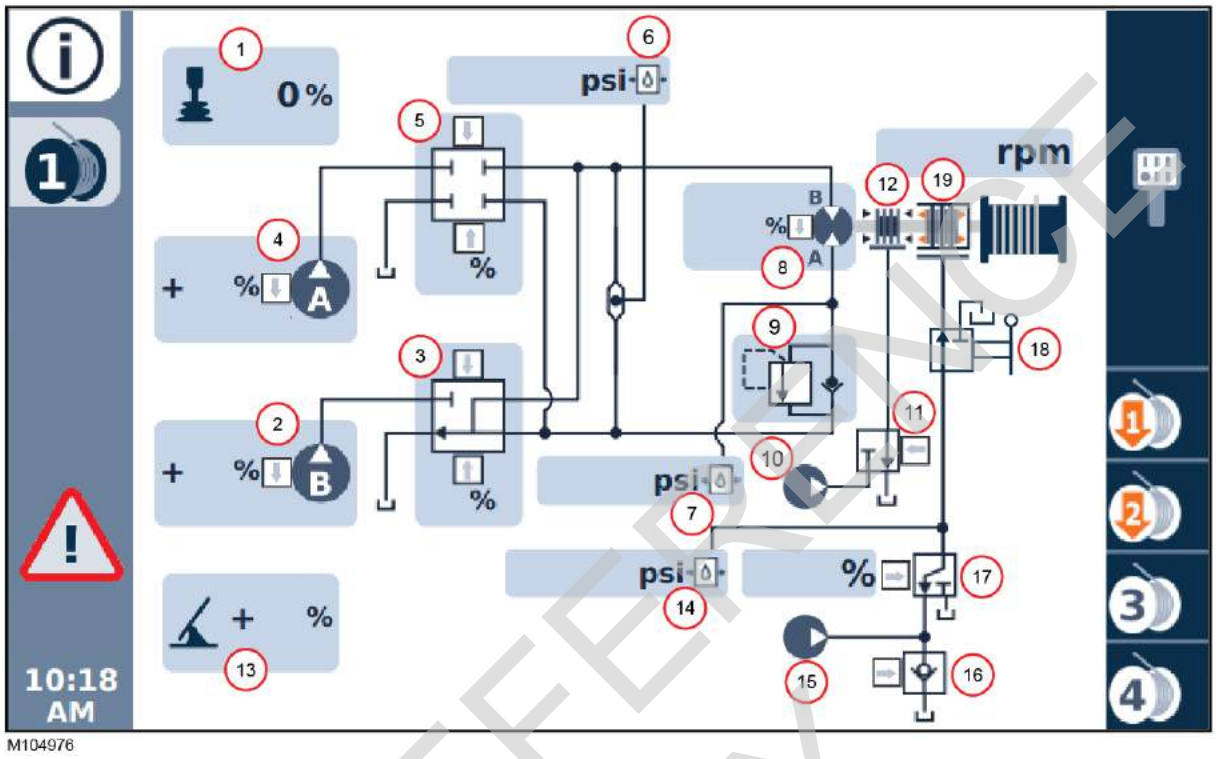


FIGURE 5-9

5

Drum 1 Hydraulic Diagram (with Free Fall

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

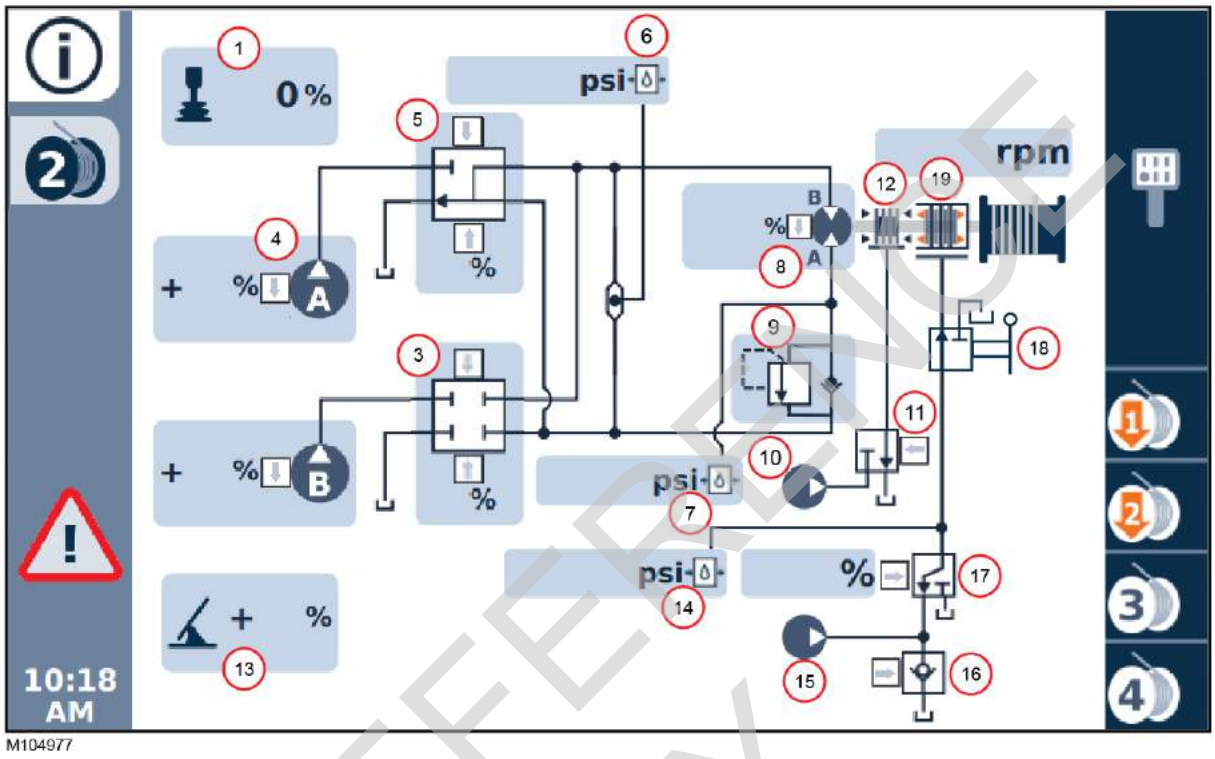


Item	Drum 1 Components		
1	Handle (Command -100 to 100%) + number = raise, – number = lower	11	Brake Valve (motor end)
2	Pump B (primary) Command (0 to 100%)	12	Brake (motor end)
3	Pump B Control Valve (Command -100 to 100%) + number = raise, – number = lower	13	Free Fall Brake Pedal (Command 0-100%) 0% = pedal down, 100% = pedal up
4	Pump A (secondary) (Command 0 to 100%)	14	Free Fall Brake Pressure Sensor 0 bar/psi = pedal down (applied), 70 bar (1000 psi) pedal up (fully released)
5	Pump A Control Valve (Command -100 to 100%) + number = raise, – number = lower	15	Free Fall Pump
6	System Pressure Sensor	16	Free Fall System Enable Valve
7	Motor Pressure Sensor	17	Free Fall Brake Valve (Command 0-100%) 0% = pedal down, 100% = pedal up
8	Motor (command 0% = max displacement, 100% = min displacement)	18	Free Fall Selector Valve (On-Off)
9	Load Holding Valve	19	Free Valve Brake
10	Accessory Pump		

FIGURE 5-10

Drum 2 Hydraulic Diagram (with Free Fall

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



Item	Drum 1 Components		
1	Handle (Command -100 to 100%) + number = raise, – number = lower	11	Brake Valve (motor end)
2	Pump B (secondary) Command (0 to 100%)	12	Brake (motor end)
3	Pump B Control Valve (Command -100 to 100%) + number = raise, – number = lower	13	Free Fall Brake Pedal (Command 0-100%) 0% = pedal down, 100% = pedal up
4	Pump A (primary) (Command 0 to 100%)	14	Free Fall Brake Pressure Sensor 0 bar/psi = pedal down (applied), 70 bar (1000 psi) pedal up (fully released)
5	Pump A Control Valve (Command -100 to 100%) + number = raise, – number = lower	15	Free Fall Pump
6	System Pressure Sensor	16	Free Fall System Enable Valve
7	Motor Pressure Sensor	17	Free Fall Brake Valve (Command 0-100%) 0% = pedal down, 100% = pedal up
8	Motor (command 0% = max displacement, 100% = min displacement)	18	Free Fall Selector Valve (On-Off)
9	Load Holding Valve	19	Free Valve Brake
10	Accessory Pump		

FIGURE 5-11

Free Fall System (Optional)

See Figure 5-10 and Figure 5-11.

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

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

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

When equipped with free fall, the CCS determines whether drum speed is taken from the motor speed sensor (Figure 5-18 on page 5-25) or from the free fall speed sensor (Figure 5-19 on page 5-26).

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

Cooling oil flow through the brake is continuous whether or not the free fall mode is enabled. Cooling oil flow at 3.5 bar (70 psi) is provided by the free fall cooling pump, which is dedicated for this purpose.

Brake release pressure is provided by a the free fall pump which is relief-valve limited to 66 bar (950 psi). The CCS receives a position signal from the free fall brake pedal and uses this information to proportionally adjust the brake release pressure in order to allow the drum to free fall.

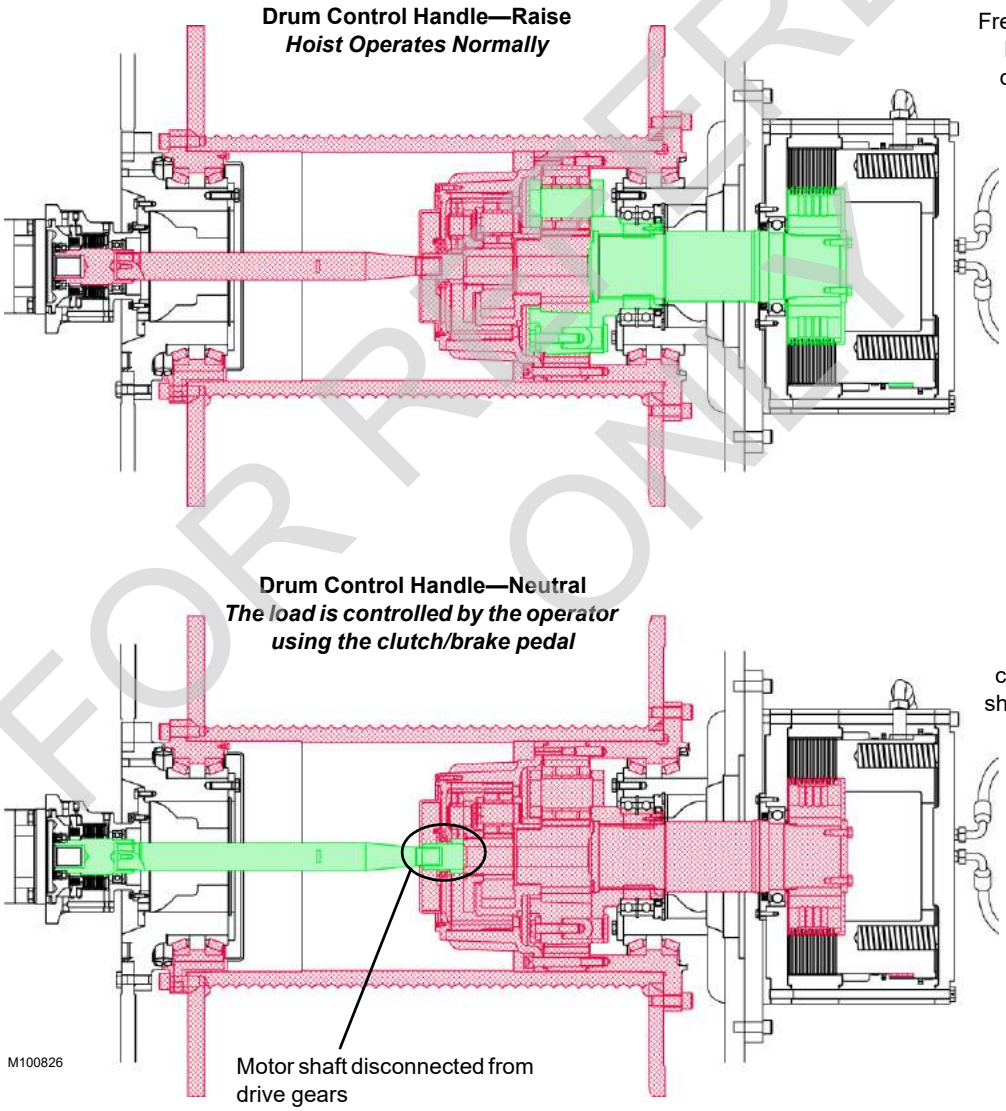
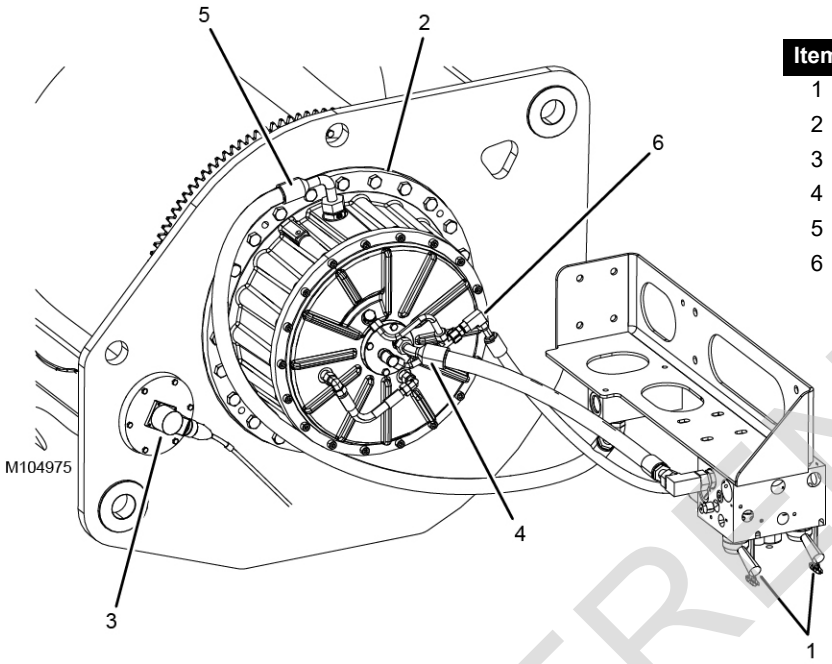


FIGURE 5-12



Item	Description
1	Free Fall Selector Valves
2	Free Fall Brake (Drum 2 shown)
3	Free Fall Speed Senor
4	Cooling Flow In
5	Cooling Flow Out
6	Brake Release Pressure

FIGURE 5-13

WARNING

Falling Load Hazard

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

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

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

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

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

- Operator seated (seat switch closed)
- Brake pedal latched down
- Free fall selector valve rotated to **ON**
- Free fall enable/disable key switch (on control console) toggled to the Drum 1 and/or Drum 2 position

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

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

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

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

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

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

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

When free fall is enabled, the drum control handle will operate in the same manner as normal (non-free fall) operation, but the operator must remember to use the free fall brake pedal to control lowering while the control handle is in center. Optionally, if the operator pulls back on the drum control handle, the CCS will use this input as a proportional control to apply the free fall brakes. See Section 3 of the Operator Manual for free fall operating procedures.

Drum	Description
1	Breather
2	Fill Port
3	Sight Gauge
4	Quick-Drain Valve
5	Upper Hose
6	Fill Plug
7	Level Plug
8	Drain Plug
9	Fill Plug – Motor Shaft Oil Cavity

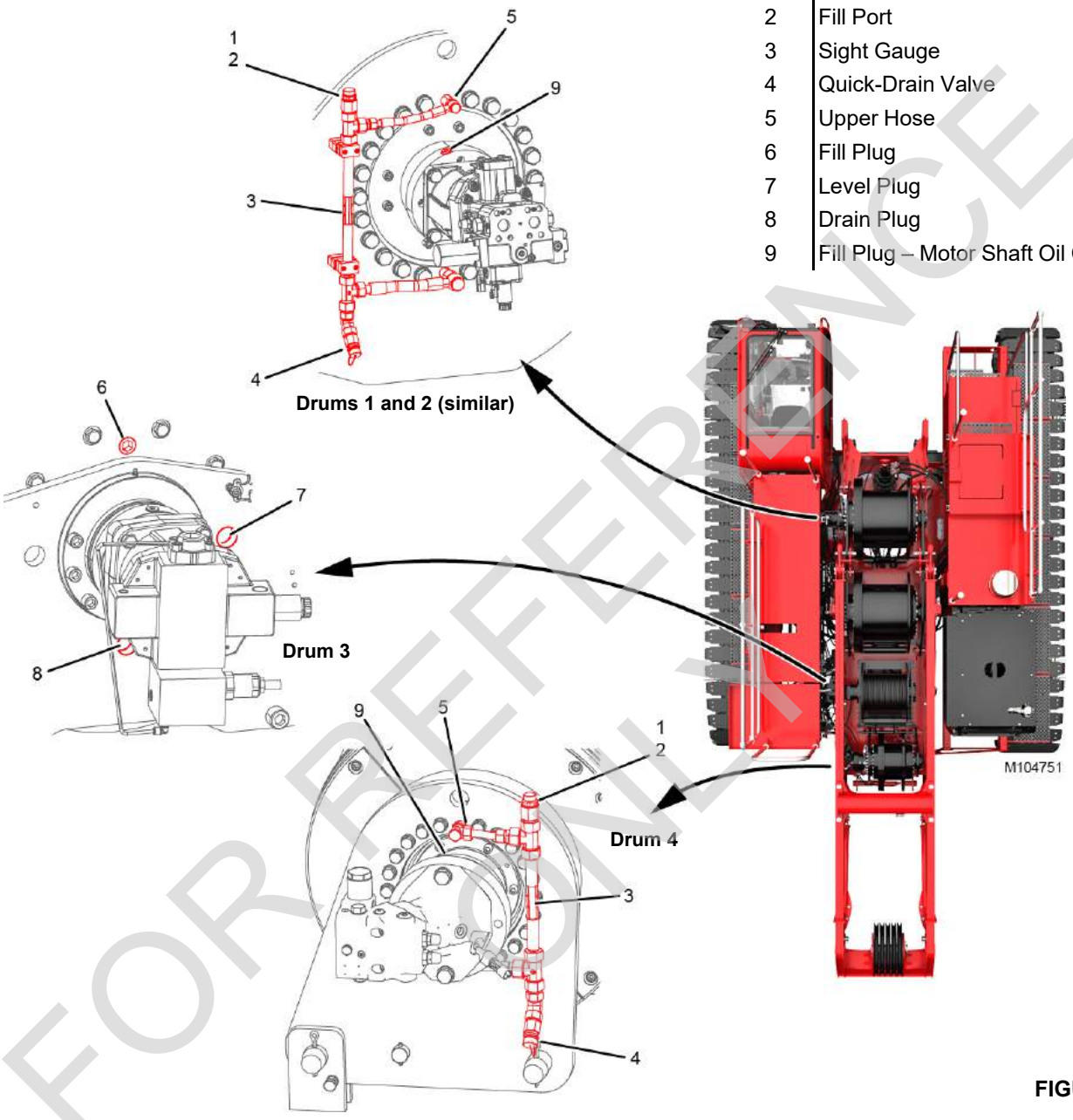
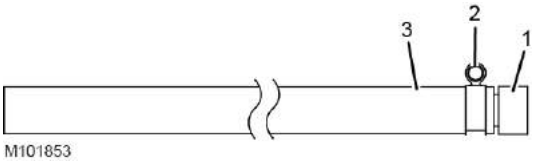


FIGURE 5-14



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 5-15

DRUM GEARBOX OIL CHANGE

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

Gear Oil Specifications

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

Oil Analysis

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

Periodic Maintenance

Initial Operation

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

Monthly

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

Yearly

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

Quick-Drain Valve

Each gearbox for Drums 1, 2, and 4 is equipped with a quick-drain valve that requires use of the quick-drain drainer assembly (see Figure 5-15). The quick-drain drainer assembly is stored in the parts box supplied with the crane.

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

Oil Change Procedure

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

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

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

See Figure 5-14 for the following procedures.

Drums 1, 2, and 4

1. Lockout-tagout the crane.
2. Remove the dust cap from the quick-drain valve (4).
3. Place the hose from the quick-drain drainer assembly into an suitable container for collecting the drained oil. Refer to the Lubrication Guide for oil capacities.
4. Thread the quick-drain drainer assembly to the quick-drain valve. The poppet inside the valve will open allowing the oil to drain from the gearbox.
5. Once the gearbox has finished draining, remove the quick-drain drainer assembly.
6. Fasten the dust cap to the quick-drain valve.
7. Fill the gearbox with specified oil:
   a. Remove the breather (1) from the fill port (2).
   b. Disconnect the upper hose (6) to allow trapped air to vent.
   c. Add oil through the fill port using a suitable funnel until the oil level is halfway up the sight gauge (5). ***Do not overfill***.
   d. Securely reinstall the breather.
   e. Install and securely tighten the upper hose.
8. Allow the oil to settle and recheck the oil level, as required, after operating the drum.
9. Thoroughly clean the quick-drain drainer assembly and store it in the parts box.

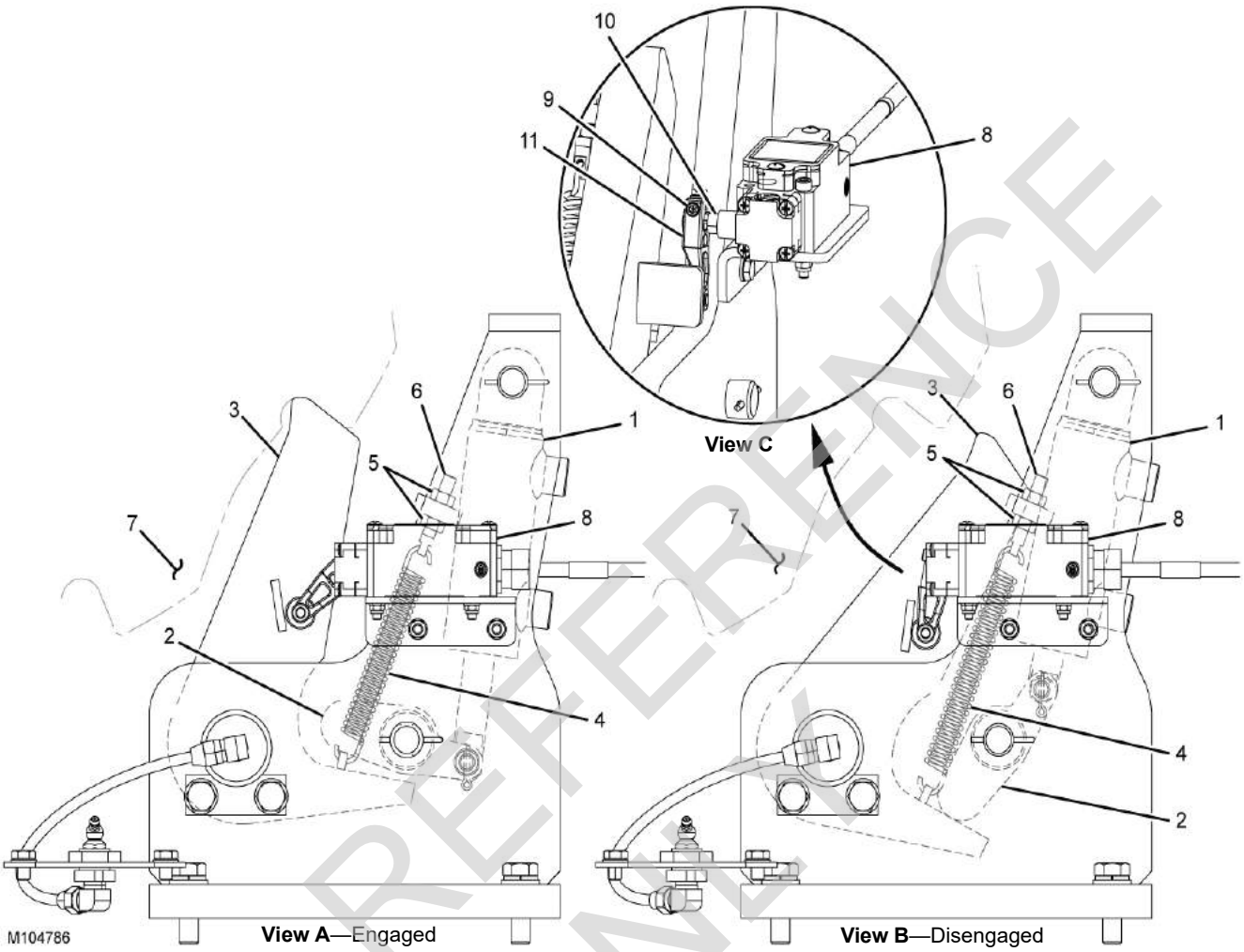
Drum 3

1. Rotate the drum so the fill, level, and drain plugs (6-8) are aligned with the holes in the drum frame.
2. Lock out-tag out the crane.
3. Place a 26 L (7 gal) container under the drum.
4. Remove the fill, level, and drain plugs (6-8) and drain the gearbox.
5. Once the gearbox has finished draining, securely reinstall the drain plug (8).
6. Fill the gearbox with specified oil through the fill plug port until the oil is just up to the bottom of the level plug port.
7. Securely reinstall the level and fill plugs (6 and 7).
8. Allow the oil to settle and recheck the oil level, as required, after operating the drum.
9. Thoroughly clean up any spilled oil.

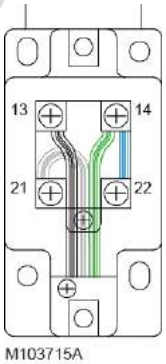
Motor Shaft Oil Cavity

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

1. Remove the fill plug (9).
2. Fill the cavity to the top with gear oil.
3. The oil level with equalizer with the gearbox.
4. Securely reinstall the fill plug.



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



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 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 eye bolt 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.

DRUM 1 AND 2 MINIMUM BAIL LIMIT

See Figure 5-17 for the following procedures.

The minimum bail limit stops the corresponding drum 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 1 or Drum 2 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 (1) with gasket.
2. Turn the limit switch screw (2) until you hear the switch activate.
3. Start the engine and check for proper operation. 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

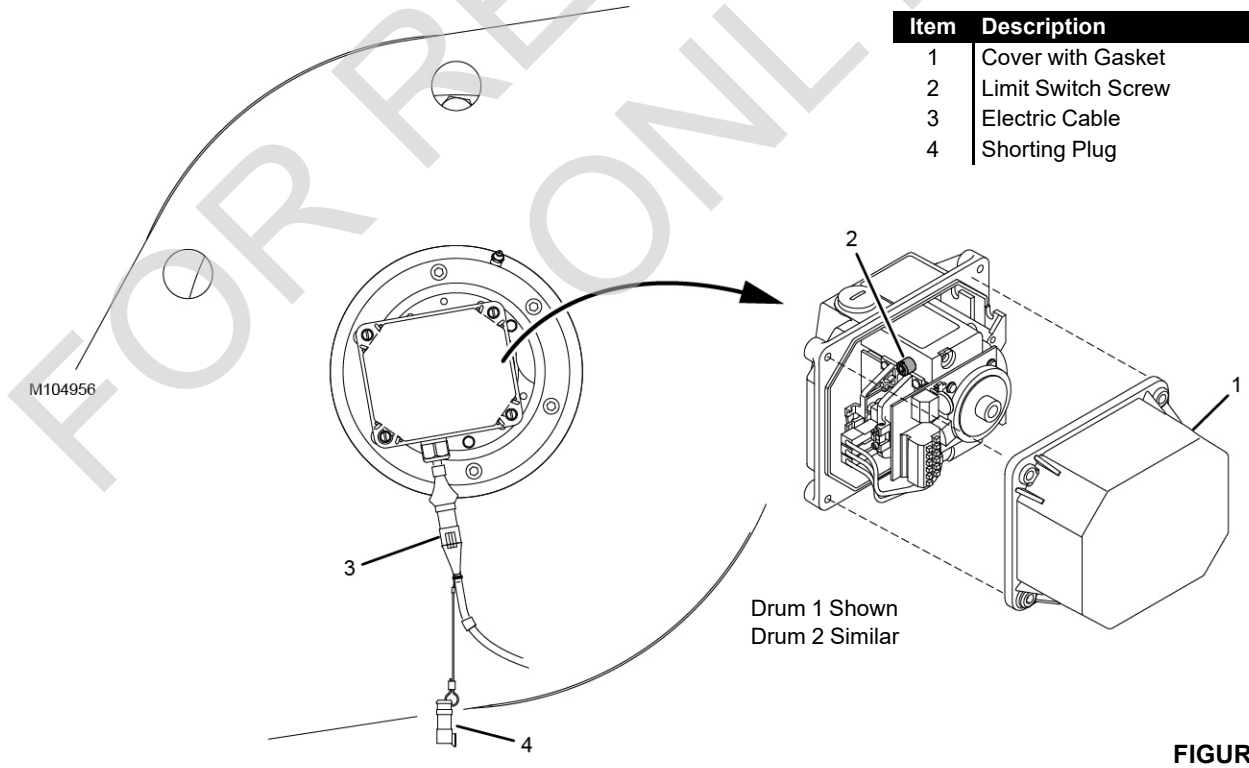


FIGURE 5-17

SPEED SENSOR—HOIST MOTORS

See Figure 5-18 for the following procedure.

A speed sensor (1) is installed in the drum motor (2) for each drum. 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

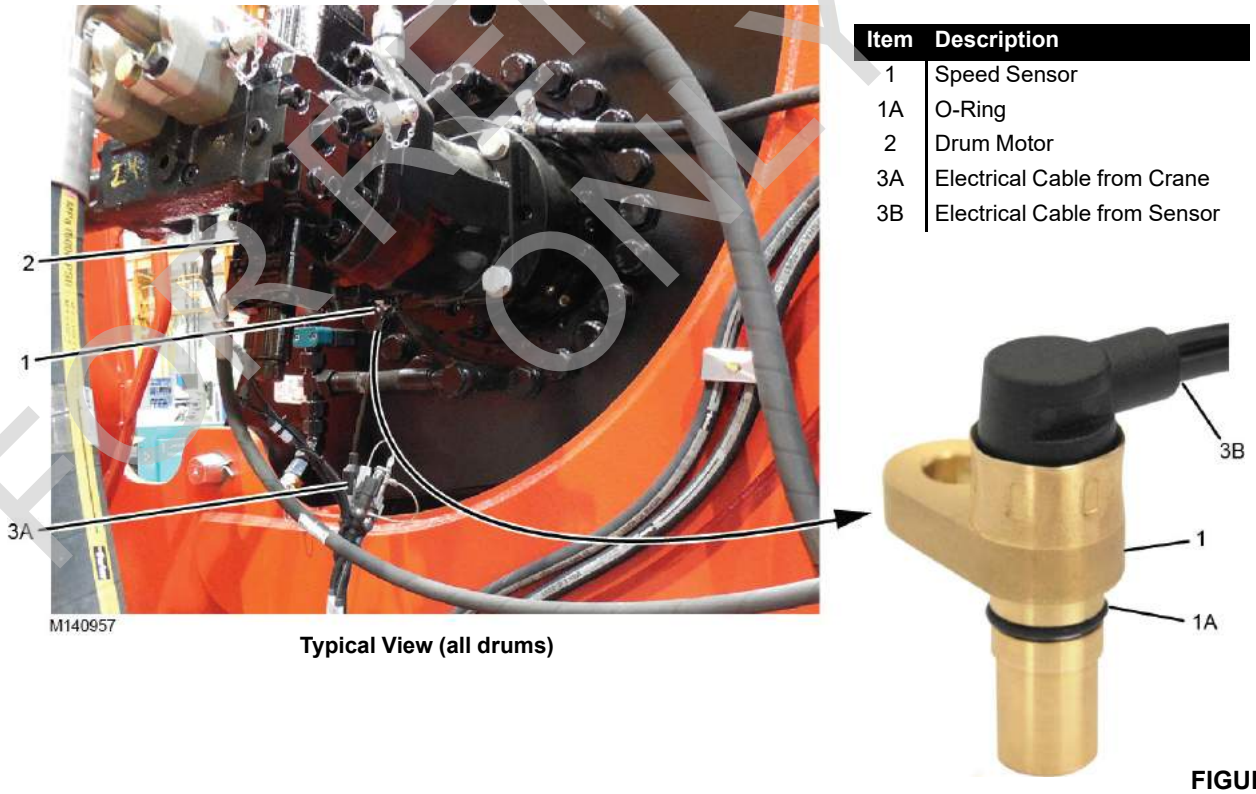
Replacement is required if a speed sensor is suspected of sending faulty information to the corresponding control module.

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.

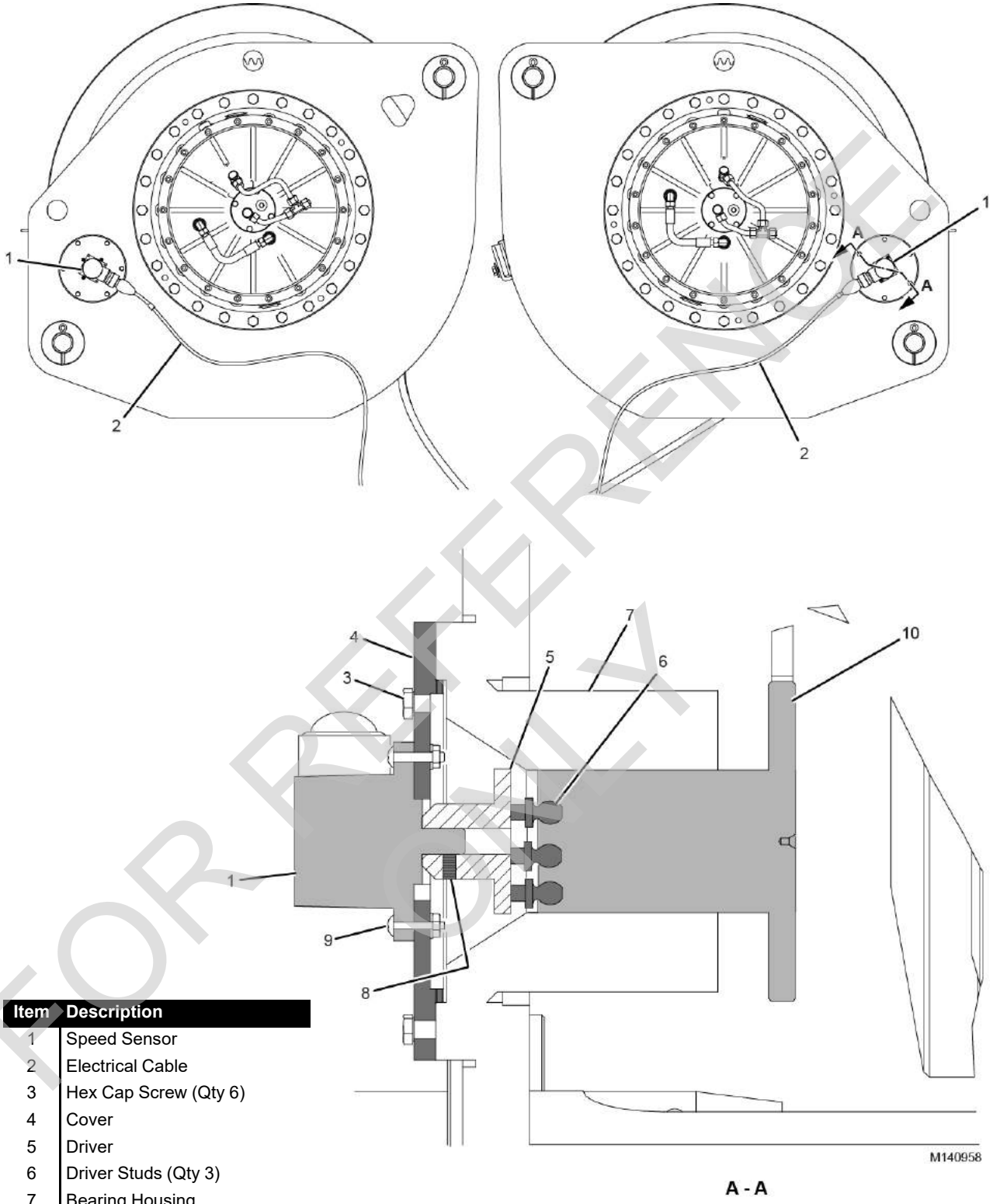
1. Lockout-tagout the crane.
2. Disconnect the electrical cable (3A) from the electric cable (3B).
3. Thoroughly clean the area around the speed sensor to prevent dirt from entering the hydraulic system.
4. Place an appropriate container under the motor to catch any oil leakage.
5. Work quickly to prevent excess oil leakage.
6. Make sure the O-ring (1A) is installed on the new speed sensor (1).
7. Remove the speed sensor mounting screw and the faulty speed sensor.
8. Clean the mating surfaces and install the new speed sensor and O-ring.
9. Install the mounting screw and tighten it to 8 ±2 Nm (6 ± 1.5 ft-lb).
10. Connect the electrical cables (3A and 3B).
11. Operate the drum and check for a steady drum speed (rpm) and direction signal in the corresponding drum's Control Information Screen in the main display.
12. Make sure there is no oil leakage.



Typical View (all drums)

Item	Description
1	Speed Sensor
1A	O-Ring
2	Drum Motor
3A	Electrical Cable from Crane
3B	Electrical Cable from Sensor

FIGURE 5-18



A - A

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

FIGURE 5-19

SPEED SENSOR—FREE FALL

See Figure 5-19 for the following procedure.

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

There is no adjustment for the speed sensor.

Replacement

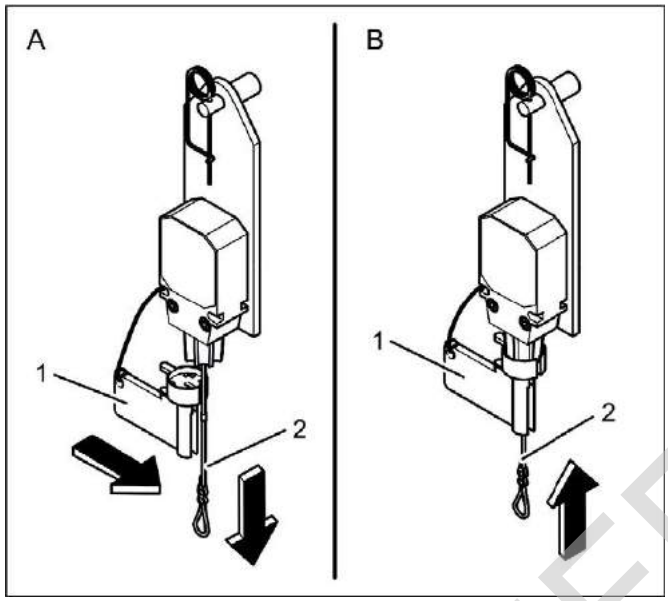
Replacement is required if a speed sensor is suspected of sending faulty information to the corresponding control module.

1. Lockout-tagout the crane.
2. Disconnect the electrical cable (2) from the speed sensor (1).
3. Thoroughly clean the area around the speed sensor.
4. Note the orientation of the speed sensor (1) and the cover (4) with the drum flange.
5. Remove the hex cap screws (3) and pull out the speed sensor (1), the cover (4), the driver (5) with driver studs (6) as an assembled unit.
6. Loosen the set screw (8) and remove the driver (5) with drive studs (6) from the speed sensor shaft.
7. Note the orientation of the speed sensor (1) on the cover (4).
8. Disassemble the speed sensor (1) from the cover (4) and discard the speed sensor.
9. Assemble the new speed sensor (1) in the original orientation to the cover (4) with the phillips head screws, flat washers, and nuts (9). Apply Loctite 243 to the screw threads and torque the nuts to 48 Nm (35 ft-lb).
10. Assemble the driver (5) with drive studs (6) to the speed sensor shaft so the driver is snug against the sensor. ***Do not tamper with the position of the drive studs***.
11. Clean the mating surfaces of the cover (4) and the drum flange.
12. Assemble the cover (4), the sensor (1), and the driver (5) in its original orientation to the drum flange.
13. Rotate the unit as needed to align the drive studs (6) with the holes in the drive pinion (10).
14. Install and securely tighten the hex screws (3)
15. Connect the electrical cable (2) to the speed sensor (1).
16. Operate the drum and check for a steady drum speed (rpm) and direction signal in the corresponding drum's Control Information Screen in the main display.

ANTI TWO BLOCK (A2B) SWITCH

If a hoist rope has been reeved and two A2B switches are installed, the unused A2B switch must be locked (disabled) to allow all crane operations.

Locking

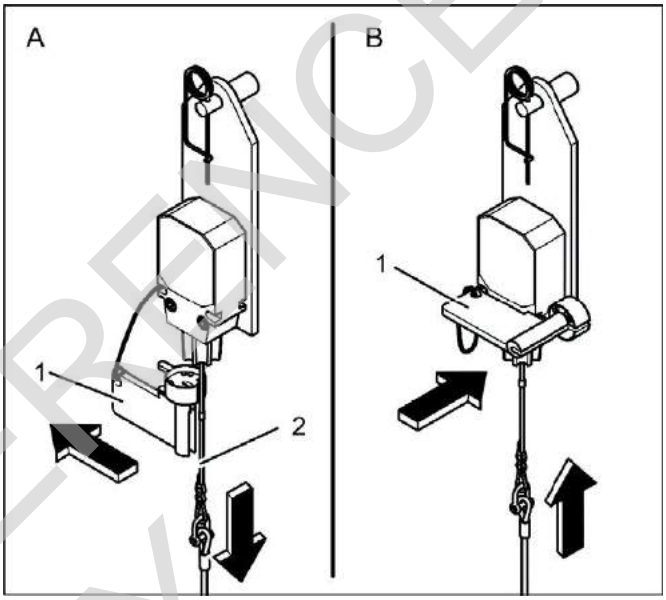


CAUTION

If the A2B switch is locked (disabled), the hook block could hit the main boom head or extension, and hoist rope. Never lock an A2B switch with a switch weight attached.

1. Remove A2B weight.
2. (A) Remove the cap (1) from switch.
3. Pull lanyard (2) down.
4. (B) Secure the lanyard (2) in this position using the cap (1).The A2B switch is locked (disabled).

Unlocking



NOTE: Always remove the switch lock (enable) before installing an A2B weight around the hoist rope.

1. (A) Pull the down lanyard (2) and remove the cap (1). The switch is unlocked (enabled).
2. (B) Install the cap (1) on the A2B switch.

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.

Failure to reposition the A2B weight will prevent the A2B system from functioning properly. No weight shall be mounted on the A2B switch of the main boom when working with the extension/top section.

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 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.

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

Cranes with Main Hoist Only

If the crane is operated with a main boom extension or top section, the connecting cable must be mounted between the distributor socket on the extension or insert, and the distributor socket on the main boom. The main boom A2B switch weight must be disconnected and mounted on the extension or fly section A2B switch.

Item	Description
1	Limit Switch (Qty 1-3)
2	Actuator Cable (Qty 1-3)
3	Chain with Shackles and Pins (Qty 1-3)
4	Weight with Chain and Link (Qty 1-3)

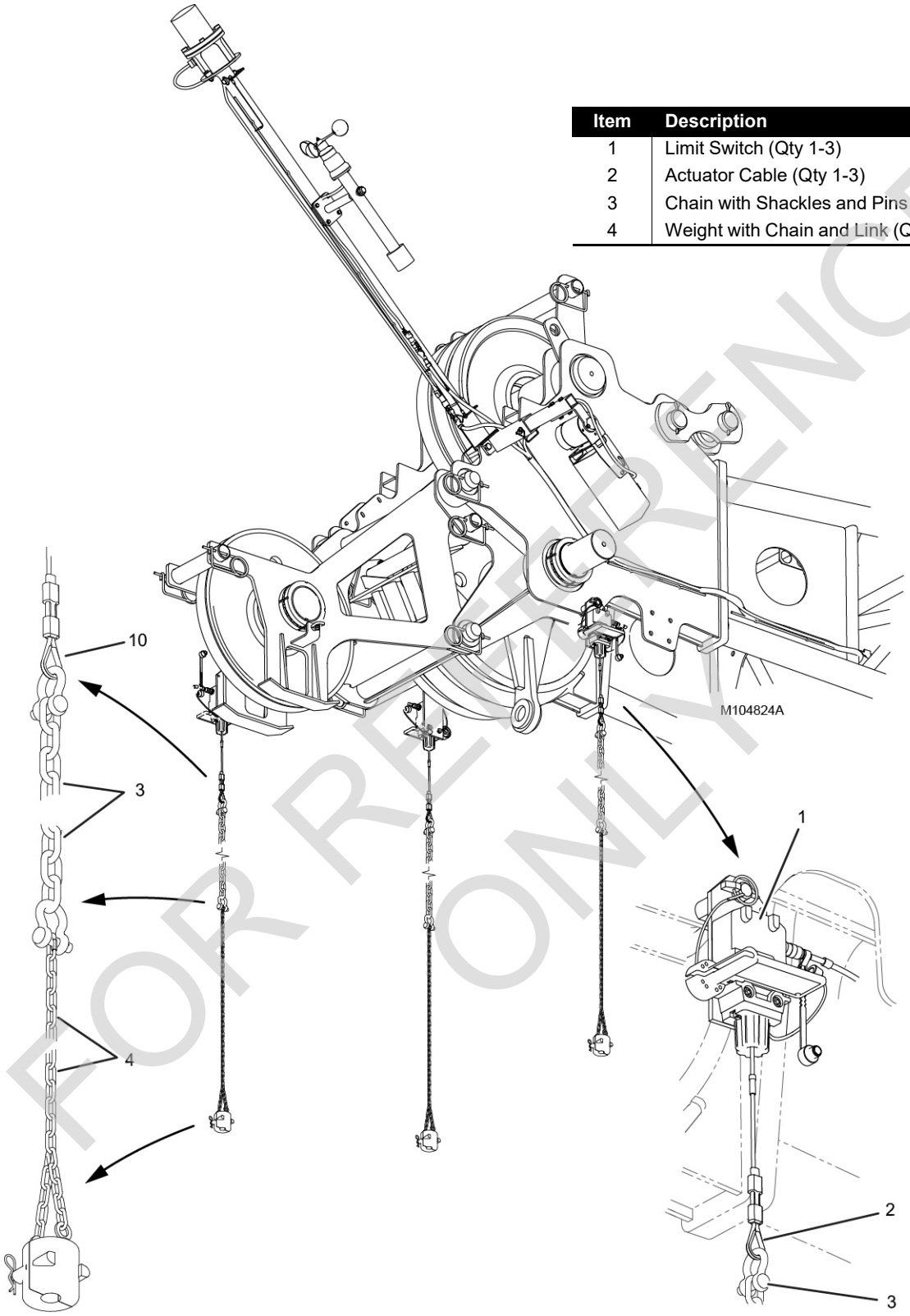


FIGURE 5-20

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 a week, inspect and test the A2B switches as follows.

1. Lower the boom and jib onto blocking at ground level and carefully inspect the following items.
   a. Inspect each switch for freedom of movement.
   b. Inspect each weight for freedom of movement on the load line.
   c. Inspect each weight, each chain, each shackle, and each connecting pin 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.

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 5-22).

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 5-38) and
- Yearly (at minimum) (see Periodic Comprehensive Inspection on page 5-33)

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:

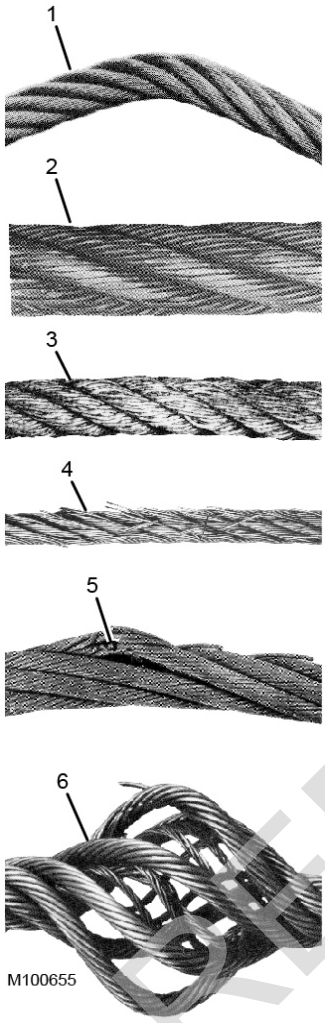
- Lockout-tagout the crane when removing or installing the wire rope assemblies.
- Use safety glasses for eye protection.
- Wear protective clothing, gloves, and safety shoes as appropriate.
- Use supports and clamps to prevent uncontrolled movement of the wire rope, parts, and equipment.

- 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 5-21)
  - Loss of rope diameter (see Reduction in the Rope Diameter on page 5-34)
  - 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 5-34)
  - Internal wear or broken wires for ropes operating on nylon 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 is 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 5-21

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 5-32
- Inspection of the rope diameter (see Reduction in the Rope Diameter on page 5-34)
- Comprehensive examination for broken wires (see Broken Rope Wires on page 5-34)
- 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 5-34).

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:

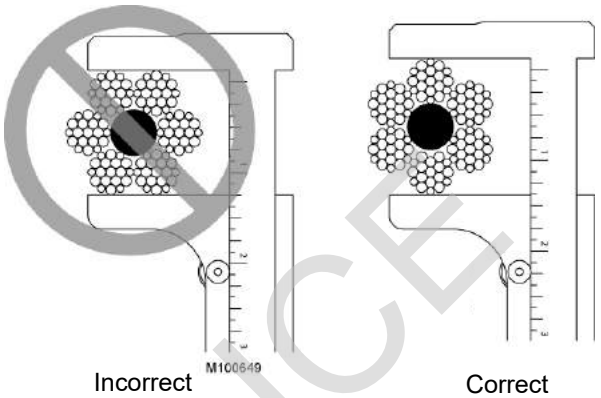
- Reduction in the rope diameter and excessive broken wires (see Reduction in the Rope Diameter on page 5-34 and Broken Rope Wires on page 5-34)
- Wear of one-third of the original diameter of outside individual wires
- Kinking, crushing, birdcaging, or any other damage resulting in distortion of the 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 5-31).

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



Measuring Technique

FIGURE 5-22

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***.

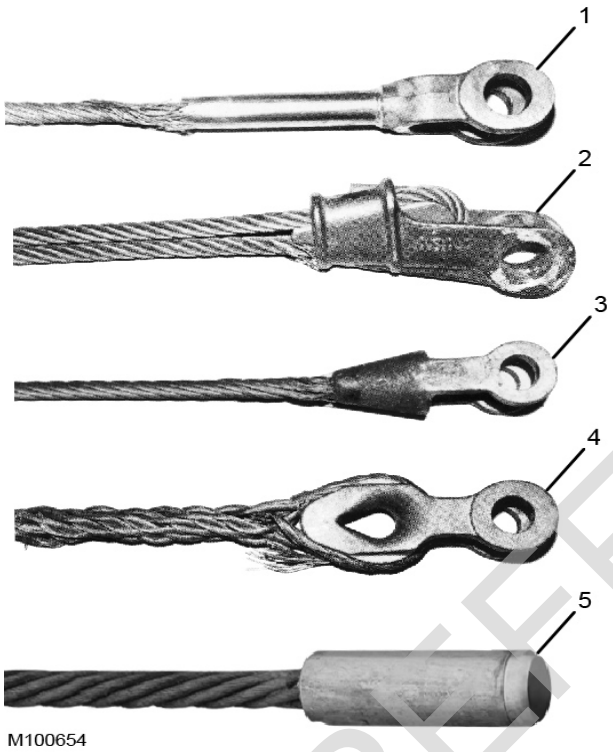
Wire breaks are typically at the crown of the strands—the area that contacts the sheave or drum when a load is picked up. Breaks at the crown will appear as small gaps in a wire. In comparison, when wires in the valley of a strand break, the broken ends will rise up and are easier to notice.

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 5-24 for an explanation of lay length):

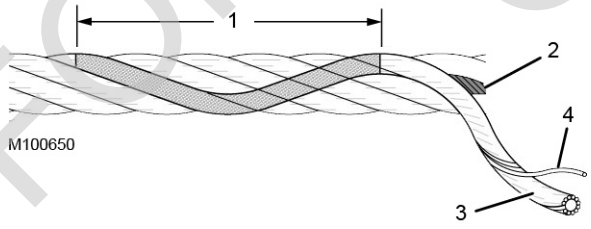
- Running Ropes—Six randomly broken wires in one lay length or three broken wires in one strand in one lay length.
- Standing Ropes (pendants)—More than two broken wires in one lay length in sections beyond the end attachment, or more than one broken wire at the end attachment (see Figure 5-23).
- Rotation-resistant 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 5-23)—When more than one broken wire appears at the attachment, replace the rope or cut off the affected area and reattach the fitting.



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

FIGURE 5-23



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

FIGURE 5-24

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

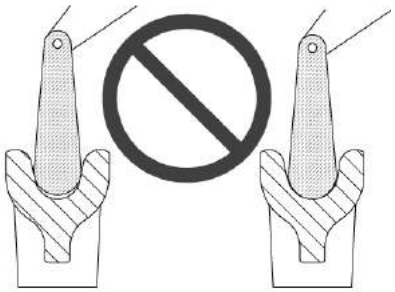
Wire rope wear at the “critical wear points” can be reduced and the life of the wire rope extended by moving the rope at regular intervals so that different sections of the rope are subjected to the wear points. This practice can also help correct spooling problems and rope vibration.

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.

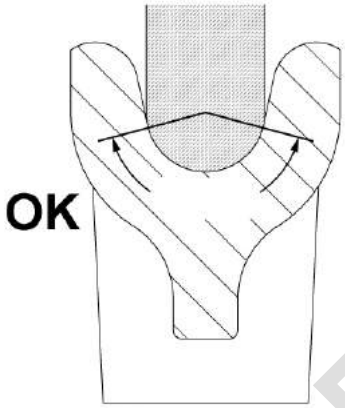
5

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



Groove Too Small Groove Too Large

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



M100656

FIGURE 5-25

M100657

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

FIGURE 5-26

SHEAVE, ROLLER, AND DRUM INSPECTION

Perform the following inspections weekly:

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

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

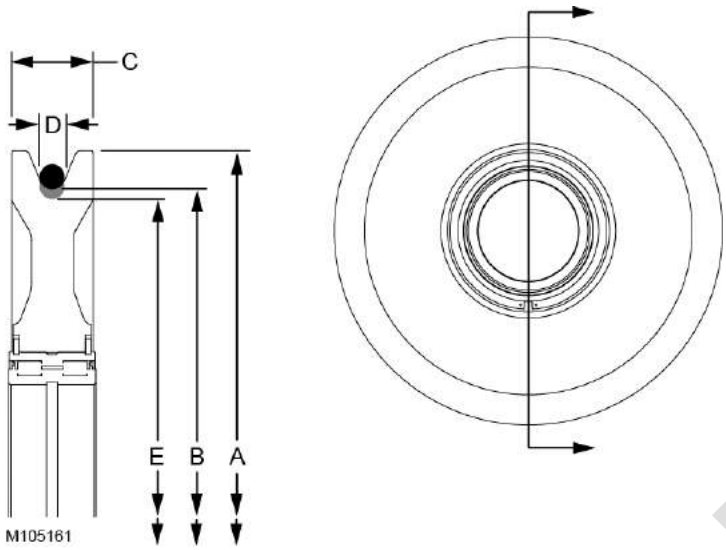
  For sheaves not equipped with grease fittings, be sure to pack the new bearings with grease at assembly.
- For steel sheaves, check the depth, width, and contour of each sheave using a groove gauge (see Figure 5-25). Replace the sheaves that have oversized or undersized grooves.
- Replace any grooved 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 5-26).

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.



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

PLASTIC SHEAVE DATA					
Sheave Part No.	**A Outside Diameter**	**B Tread Diameter**	**C Width**	**D Rope Diameter**	**E Worn Diameter**
	mm (inch)	mm (inch)	mm (inch)	mm (inch)	mm (inch)
80118232	580,00 (22.83)	510,00 (20.08)	75,00 (2.95)	22,00 (0.87)	575,00 (22.64)

FIGURE 5-27

- Measure the nylon sheaves in the gantry and the equalizer for excessive tread wear (see Figure 5-27). To check for uneven wear, measure at three places.

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

  - Depending on the type of wire rope used, it is normal for nylon sheaves to show the wire rope print. Do not remachine the nylon sheaves.
  - Nylon sheaves cannot be accurately inspected using conventional methods such as sheave gauges.
  - Due to the characteristics of nylon sheaves, the nylon material will actually move to better support the wire rope as the sheave wears normally.
  - Nylon sheave properties will be degraded in temperatures above 60°C (140°F).

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 5-28) that is attached to the load blocks and hook-and-weight balls.
- See Section 4 of the Operator Manual for recommended sling angles and capacity restrictions when the load block has a duplex or a quadruplex hook.

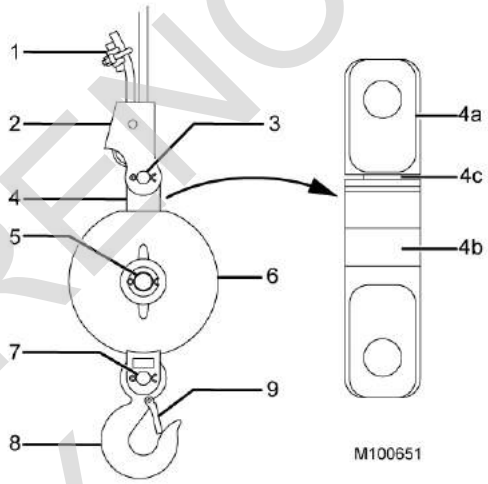
Item	Description
1	Working Load Limit in Tons (US and metric)
2	Wire Rope Diameter (in and mm)
3	Block Weight (lb and kg)
4	Block Serial Number
5	Block Part Number (OEM and Manitowoc)
6	Design Factor

FIGURE 5-28

Daily Inspection

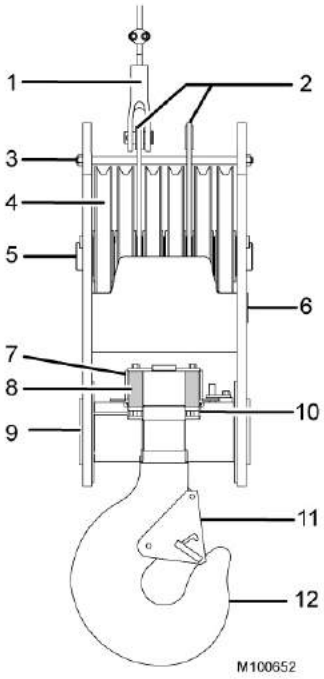
The operating condition of the load block and the hook-and-weight ball can change daily with use and therefore must be inspected daily (at start of each shift). During operation, observe for any defects which could affect their safe operation. Correct all defects before using the load block or the hook-and-weight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

Daily inspection and maintenance will include the following points (see Figure 5-29 and Figure 5-30):



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

FIGURE 5-29



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

FIGURE 5-30

- 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 5-29) 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.

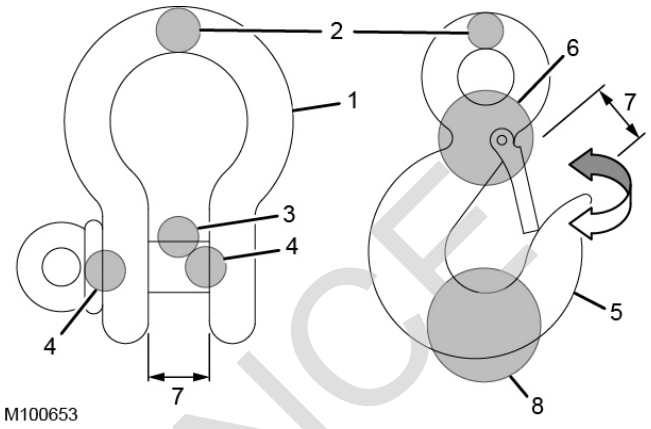
WARNING

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).

- Inspect each hook and shackle for damage (see Figure 5-31).
- 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.



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 5-31

Yearly Inspection

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

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

SECTION 6
SWING SYSTEM

TABLE OF CONTENTS

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Published 10-09-2020, Control # 259-06

SECTION 6
SWING SYSTEM

GENERAL

This section provides operational information for the Swing System.

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

- Section 2: Hydraulics
- Section 3: Electrical

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

NOTE: In the following instructions, **CCS** stands for **C**rane **C**ontrol **S**ystem.

SWING SYSTEM OVERVIEW

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

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

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

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

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

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

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

SWING BRAKE OPERATION

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

The swing brake release system uses pilot pressure from the accessory pump supplied to the swing brake via the swing brake solenoid valve. The brake release pressure must be at least 25 bar (363 psi) to fully release the brake.

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

Park Switch Control

In the UN-PARK position, the swing park brake switch is closed. This causes the CCS to open the swing brake solenoid valve which then allows pressure from the accessory pump to release the swing brake.

In the PARK position, the swing park brake switch is open. This causes the CCS to close the swing brake solenoid valve which then blocks hydraulic oil from the accessory pump and vents the brake pressure to tank. The reduced hydraulic pressure allows the swing brake to spring apply.

Holding Brake Switch Control

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

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

SWING OPERATION

Swing Pump Control

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

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

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

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Swing Left

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

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

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

Cross Port Orifice

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

Swing Right

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

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

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

Coasting

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

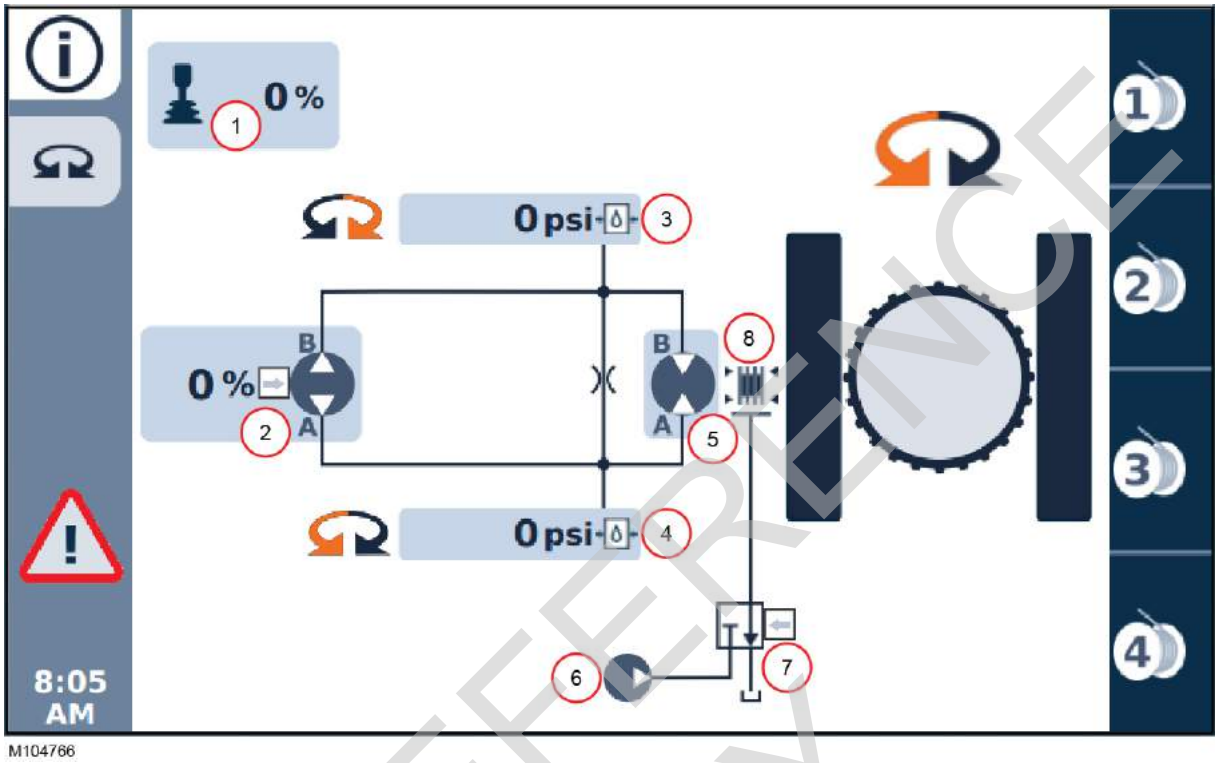
With joystick J1 in the neutral position and the swing brake released, the crane is allowed to coast because of an orifice located across the A and B sides of the closed loop. The orifice is connected in parallel with ports A and B of the swing motor, allowing a restricted amount of hydraulic fluid to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

Swing Alarm

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

Swing Hydraulic Diagram

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



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

FIGURE 6-1

Swing Electrical Diagram

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

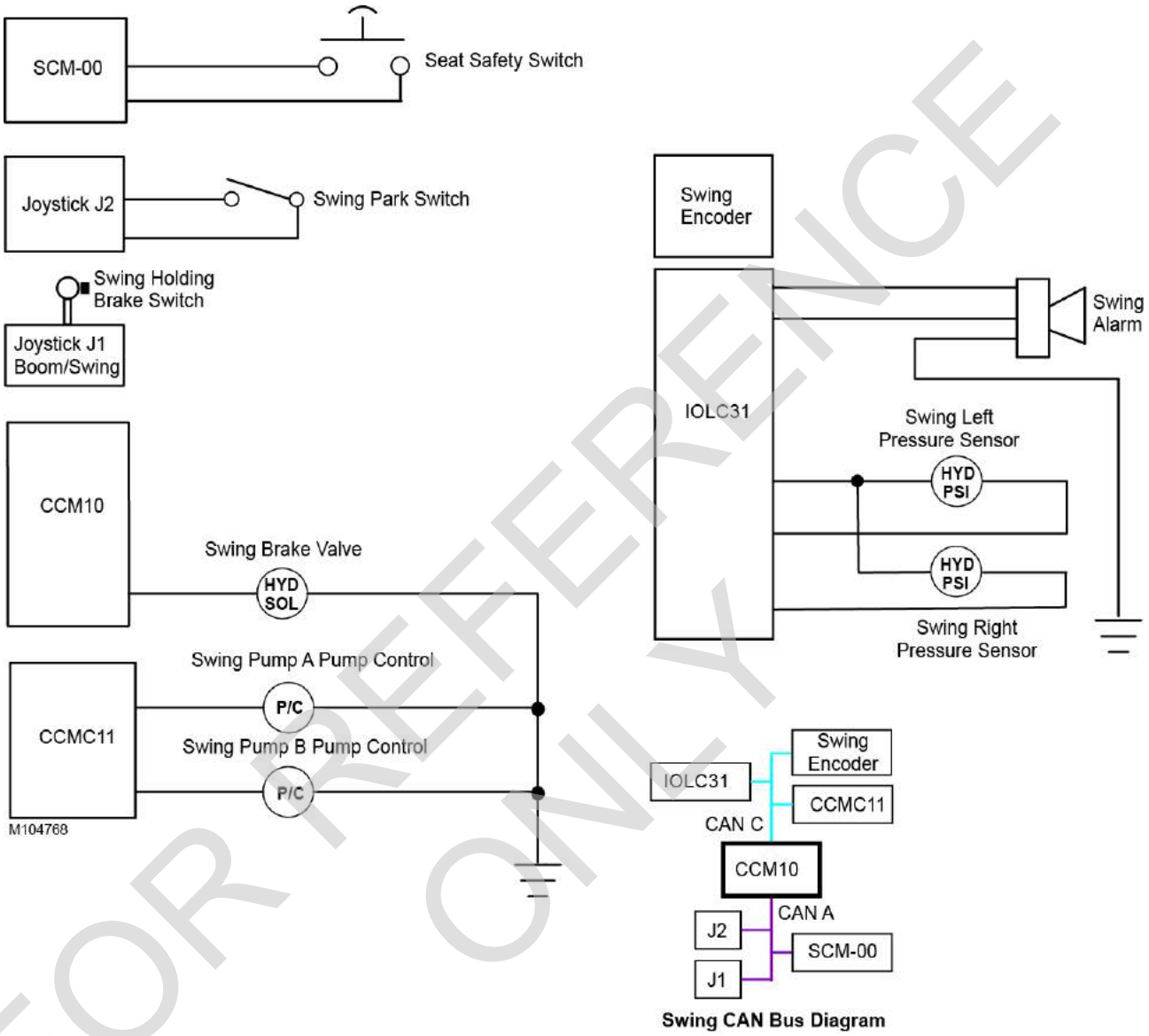


FIGURE 6-2

6

SWING BRAKE MANUAL RELEASE

See Figure 6-3 for the following procedure.

The crane has one swing drive.

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

WARNING

Unexpected Crane Movement!

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

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

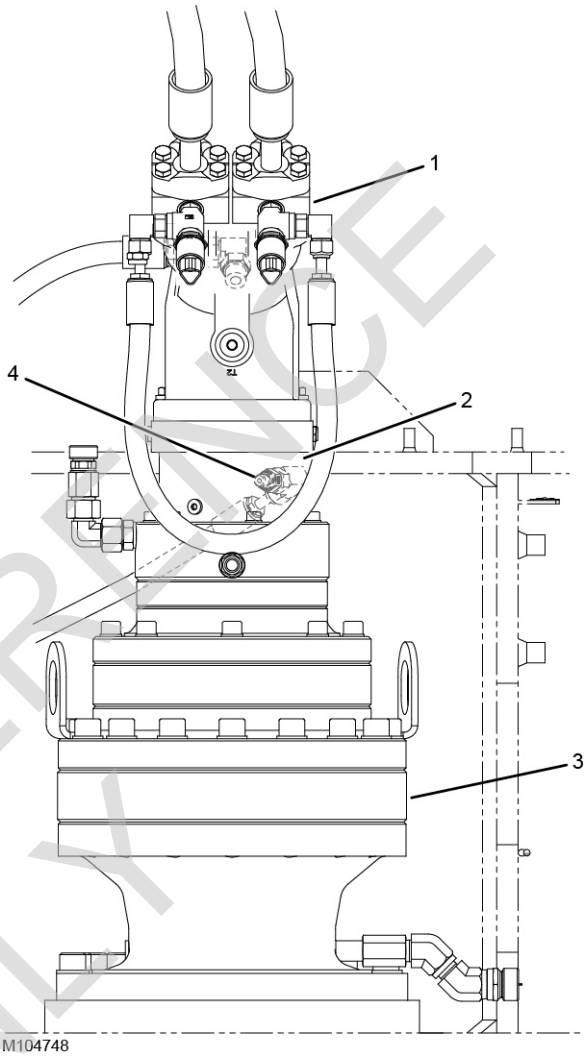
NOTE: A hydraulic hand pump with a pressure gauge is needed to manually release the swing brake.

CAUTION

Avoid Damage to Parts!

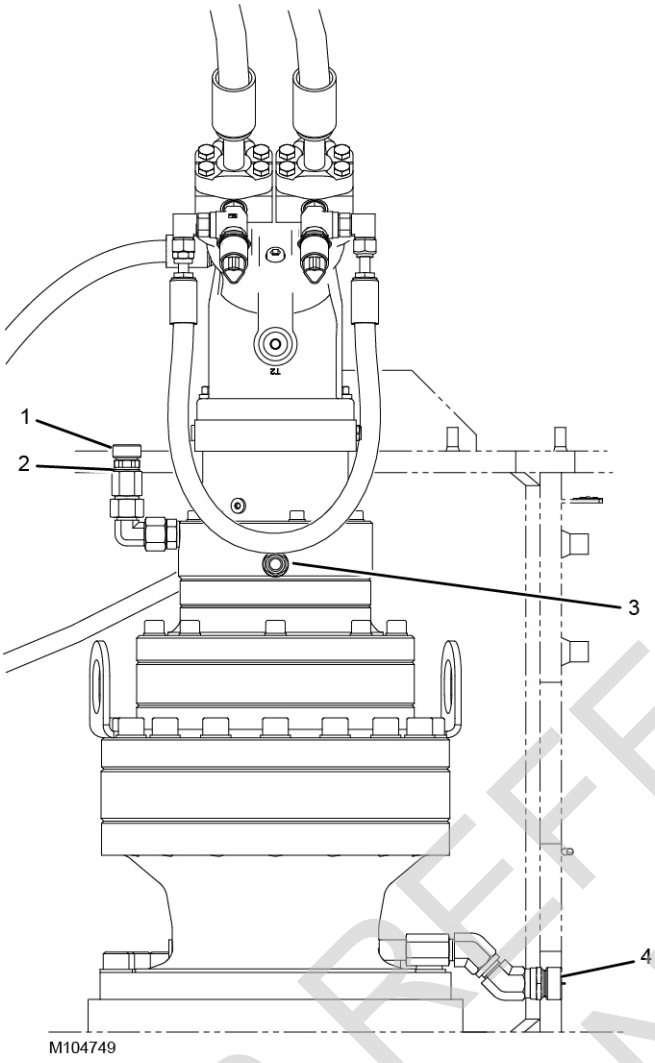
When releasing the swing brake with the hand pump, do not exceed 21 bar (300 psi) of pressure.

1. Stop the engine and lock out tag out the crane.
2. Disconnect the brake hose from the existing elbow in the brake release port (4).
3. Connect the hand pump hose to the existing elbow with user-supplied 06 ORFS fittings.
4. To release the brake, pressurize it to 25 bar (363 psi) with the hydraulic hand pump.
5. Service the swing drive as required.
6. At the completion of servicing, perform the following procedure:
   a. Apply the swing brake by relieving the pressure with the hand pump.
   b. Disconnect the hand pump hose from the existing elbow in the brake release port.
   c. Connect the brake hose to the existing elbow in the brake release port.
7. Clean up any spilled oil.



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

FIGURE 6-3



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

FIGURE 6-4

SWING GEARBOX OIL CHANGE

See Figure 6-4.

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

Gear Oil Specifications

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

Oil Analysis

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

Periodic Maintenance

Initial Drain Interval

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

Oil Level Interval

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

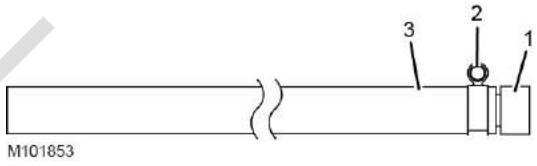
Remove the fill cap/breather (1) and fill the swing gearbox through the fill port (2) to middle of the sight gauge (3).

Oil Change Interval

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

Quick-Drain Valve

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



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

FIGURE 6-5

Oil Change Procedure

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

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

See Figure 6-4.

1. Lock out tag out the crane.
2. Remove the dust cap from the quick-drain valve (4).

3. Place the hose from the quick-drain drainer assembly (Figure 6-5) into an suitable container for collecting the drained oil: 5 L (1.3 gal) of oil is required to fill a dry gearbox.
4. Thread the quick-drain drainer assembly hose to the quick-drain valve. The poppet inside the valve will open allowing the oil to drain from the gearbox.
5. Once the gearbox has finished draining, remove the quick-drain drainer assembly.
6. Fasten the dust cap to the quick-drain valve.
7. Fill the gearbox with specified oil:

   Manual Fill Procedure

   a. Remove the fill cap/breather (1) from the fill port (2).
   b. Add oil through the fill port (2) using a suitable funnel until the oil level is halfway up the sight gauge (3). Do not overfill.
   c. Reinstall the fill cap/breather in the fill port.

   Power Fill Procedure

   a. Remove the dust cap from the quick-drain valve (4).
   b. Thoroughly clean the inside of the hose for the existing quick-drain drainer assembly.
   c. Thread the quick-drain drainer assembly all the way onto the quick drain valve. The poppet inside the valve will open.
   d. Connect the hose from the quick-drain drainer assembly to a portable pump, either hydraulically powered or hand powered.
   e. Slowly pump oil into the gearbox until the oil level is halfway up the sight gauge (3). Do not overfill.
   f. Once the gearbox is filled, remove the quick-drain drainer assembly.
   g. Fasten the dust cap to the quick-drain valve.
8. Recheck the oil level, as required, after operating the swing drive.
9. Thoroughly clean the quick-drain drainer assembly and store it in the parts box.

SECTION 7
POWER TRAIN

TABLE OF CONTENTS

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SECTION 7
POWER TRAIN

BATTERY INFORMATION

Battery Safety

WARNING

Explosion Hazard!

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

Chemical Burn Hazard!

Battery electrolyte can cause severe burns. If electrolyte comes in contact with eyes, skin, or clothing, the area must be immediately flushed with large amounts of water.

Seek medical attention in the event of an electrolyte burn.

Always wear eye protection when servicing batteries.

Battery Gases Are Explosive

Avoid sparks while charging batteries. Do not disturb the connection between the batteries until the charger is turned off.

Another source of explosion lies in the reverse connection of the charging equipment. This hazard is present with all types of chargers, but particularly in the case of high-rate equipment. Carefully check the connections before turning on the charger.

Jump-Starting a Battery

Improper use of a booster battery to start a crane presents an explosion hazard. To minimize this hazard, the following procedure is suggested.

1. Connect one end of each jumper cable to the proper battery terminals on the crane to be started. Do not allow the cable ends to touch.
2. Connect the positive cable to the positive terminal of the booster battery.
3. Connect the remaining cable to the frame or block of the starting vehicle. Never connect it to the grounded terminal of the starting vehicle.

Causes of Battery Failure

A battery should never be left in a discharged state. When discharged, it rapidly sulfates and, unless recharged within hours, will permanently lose capacity.

Overcharging

Overcharging is one cause of battery failure and is most often caused by a malfunctioning voltage regulator.

Excessive heat is the result of overcharging. Overheating causes the plates to warp, which can damage the separators and cause a short circuit within a cell. This bubbling and gassing of the electrolyte can wash the active material from the plates, reducing the battery's capacity or causing an internal short.

Undercharging

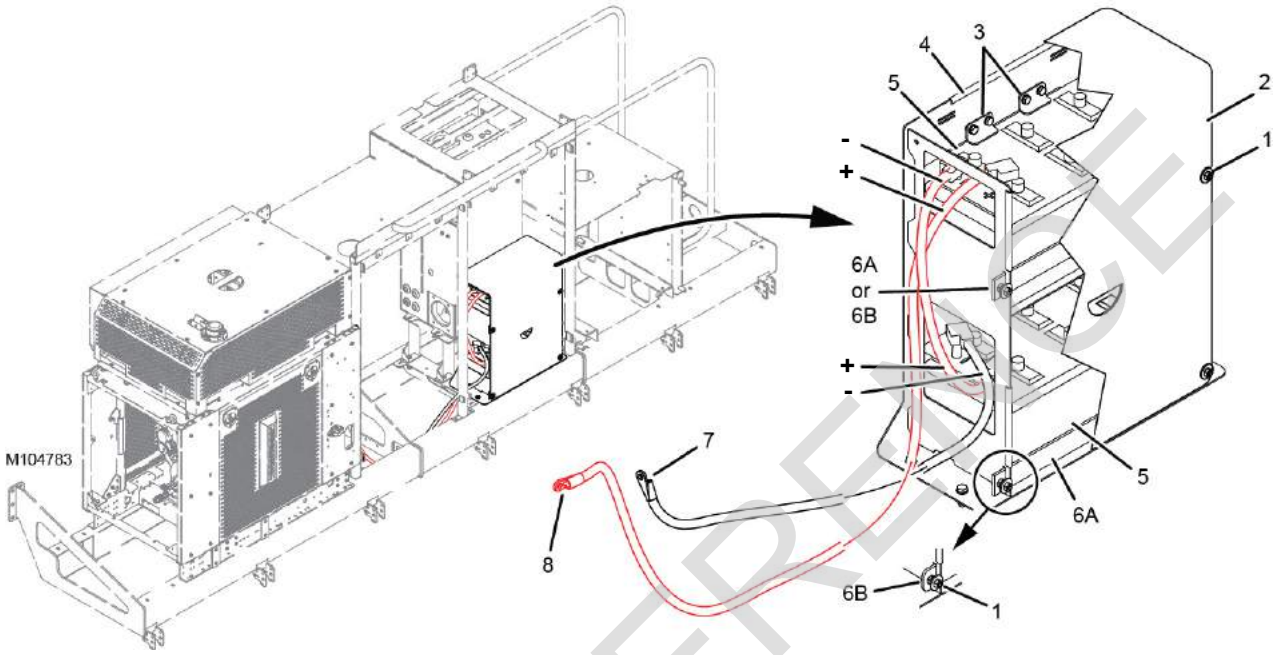
Undercharging can cause a type of sulfate to develop on the plates. The sulfate reduces the battery capacity and causes strains in the positive plates, which cause plate buckling. Buckled plates can pinch the separators and cause a short circuit. An undercharged battery is not only unable to deliver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

Table 7-1. Battery Freeze Points

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

Lack of Water

The plates must be completely covered with electrolyte. If the plates are exposed, the high acid concentration will char and disintegrate the separators. The plates cannot take a full charge if they are not completely covered by the electrolyte.



Item	Description
1	Cover Mounting Cap Screws, Nuts, and Washers (4 places)
2	Cover
3	Hold-Down Plates with Cap Screws and Washers (Qty 4)
4	Battery Box
5	Battery: 12V, 1,375 CCA, Size 8D (Qty 2)
6A	Retaining Bar (Qty 4, past)
6B	Tab (Qty 4, current)
7	To Remote Terminal at Engine
8	To Battery Disconnect Switch

FIGURE 7-1

Loose Hold-Downs

Loose hold-downs allow the battery to vibrate in the battery box. 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).

Connect the battery cables as indicated. 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.

WARNING

Personal Injury Hazard!

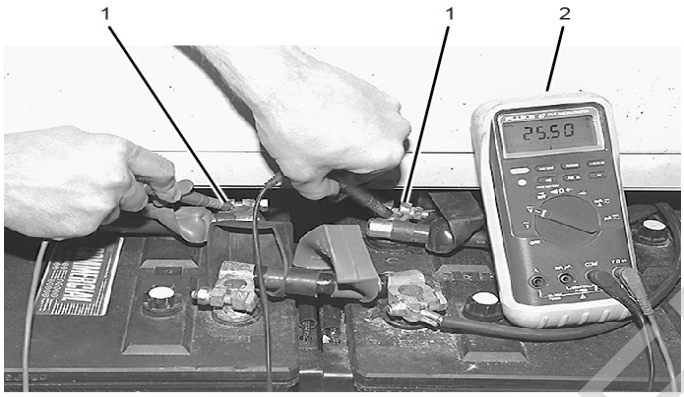
Each battery weighs about 59 kg (130 lb). Use proper lifting procedures.

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).

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.



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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.

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 gases violently, temporarily halt charging or reduce the charging current.

Storage

When the crane is left idle for prolonged periods, the batteries should be periodically charged.

When storing batteries, make sure they are fully charged to prevent sulfation and the possibility of freezing.

Follow your battery dealer's recommendations.

BATTERY MAINTENANCE

Quarterly or Every 500 Hours of Engine Operation (whichever occurs first)

- Thoroughly clean the batteries with a baking soda/water solution.
- Clean the posts and terminals. The posts can be lightly coated with petroleum jelly to prevent corrosion.
- Check the electrolyte levels. If required, add additional electrolyte to bring all levels to the bottom of the vent wells. DO NOT OVERFILL. If the batteries require topping off while in service, add distilled water — DO NOT ADD ACID.
- Replace frayed, broken, or corroded cables.
- Replace the batteries if their containers are cracked or worn to the point that they leak.
- Ensure there is tight contact between the clamp terminals and battery posts.
- Make sure that the hold-downs are in good condition. Replace any faulty parts.
- Make sure the hold-downs are tight enough to prevent battery movement, but not so tight as to cause distortion.
- Make sure the battery retaining bars are installed.
- Makes sure the battery box cover is installed.

BATTERY DISCONNECT SWITCH

CAUTION

Engine Damage

To avoid possible engine fault codes and undesirable operation, make sure engine ignition switch has been off five minutes before disconnecting batteries.

Do not rely on this switch to protect crane's electronic systems when welding. Disconnect battery cables at batteries before welding.

The battery disconnect switch (Figure 7-3) is located on the engine enclosure on the right side 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 clockwise to connect (turn on) the batteries to the electrical control system.

Turn the switch handle counterclockwise to disconnect (turn off) the batteries from the electrical control system.

Use the disconnect switch for the following situations:

- When servicing the crane's electrical control system
- To help prevent the batteries from discharging when the crane is stored for extended periods of time
- To prevent the crane from being started by unauthorized personnel

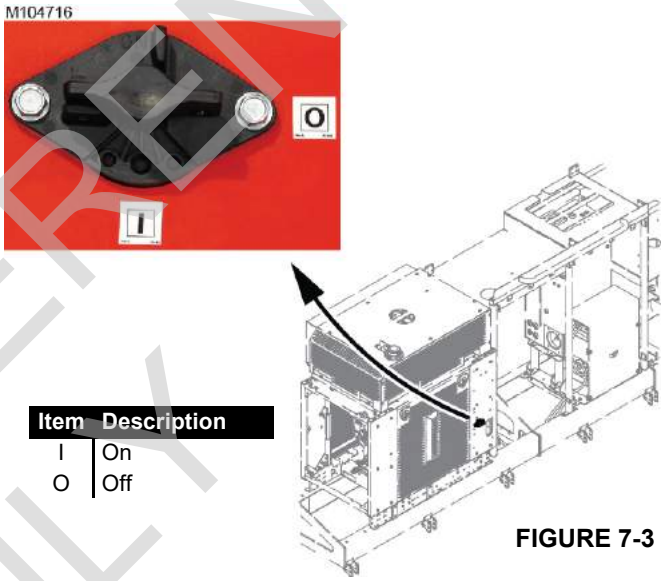
CAUTION

Avoid Control System Damage!

Before welding:

- Disconnect the battery cables at the batteries.
- Disconnect the cabling from any control modules that are in the vicinity of the welding.

Do not rely on the battery disconnect switch to protect the crane's electronic control systems when welding.



Item	Description
I	On
O	Off

FIGURE 7-3

BATTERY CHARGER (OPTIONAL)

See Figure 7-4 for the following procedure.

An optional auxiliary power unit (APU) equipped with a 5 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:

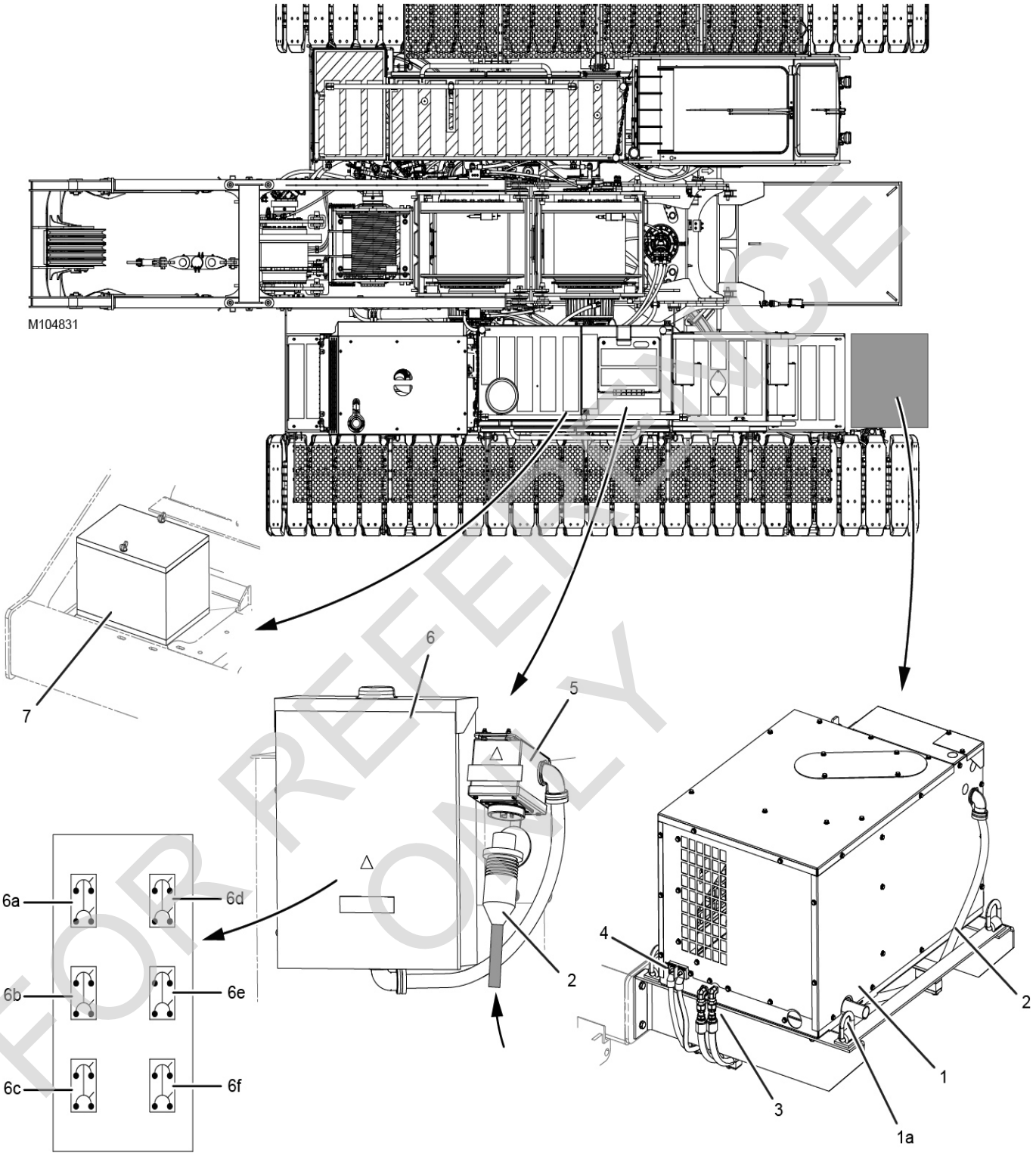
- To charge the crane batteries
- To power the cold weather heaters
- To power any AC lighting on the crane.

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 outside the 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	Generator (5 kw,120/240VAC)
1a	Lifting Ring (Qty 4)
2	Power Supply Cable with Plug
3	Fuel Lines
4	Battery Cables
5	Receptacle (120/240VAC, 50A)
6	Load Center (120/240VAC)

Item	Description
6a	Circuit Breaker — 50A Main
6b	Circuit Breaker — 15A, 300W Rotating Bed Lights
6c	Circuit Breaker — 15A, 900W Boom Lights
6d	Circuit Breaker — 15A,150W Battery Pads 300W Engine Oil heater

Item	Description
6e	Circuit Breaker — 15A, 2000W Hydraulic Tank Heater
6f	Circuit Breaker — 15A, 1500W Engine Coolant Heater
7	Battery (12V, 660 CCA)

FIGURE 7-4

ENGINE CONTROLS

See the engine start procedure in Section 3 of the 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 ACCESS PANELS

The engine enclosure has two access panels that can be removed to allow access for engine service.

The grating over the radiator and the covers over the exhaust aftertreatment assembly can also be removed.

WARNING

Personal Injury or Equipment Damage Hazard!

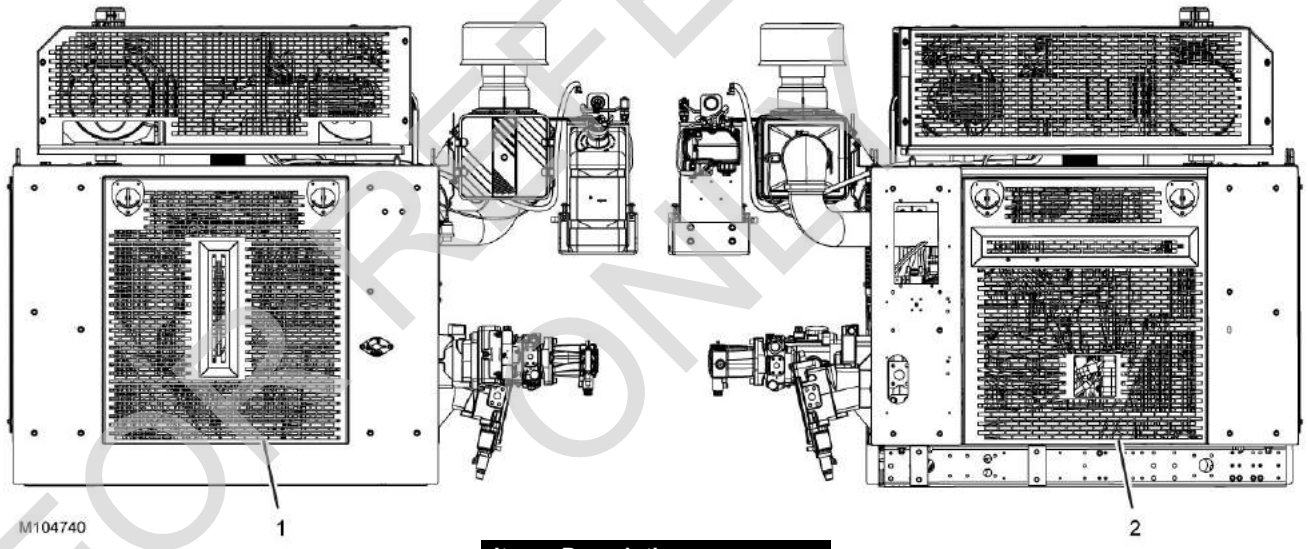
Personal injury can occur from contact with moving engine components. Equipment damage can occur if all components are not tightened securely.

Do not operate the crane without the access panels, grating, and covers in place and all the fasteners secure.

WARNING

Personal Injury Hazard—Heavy Objects!

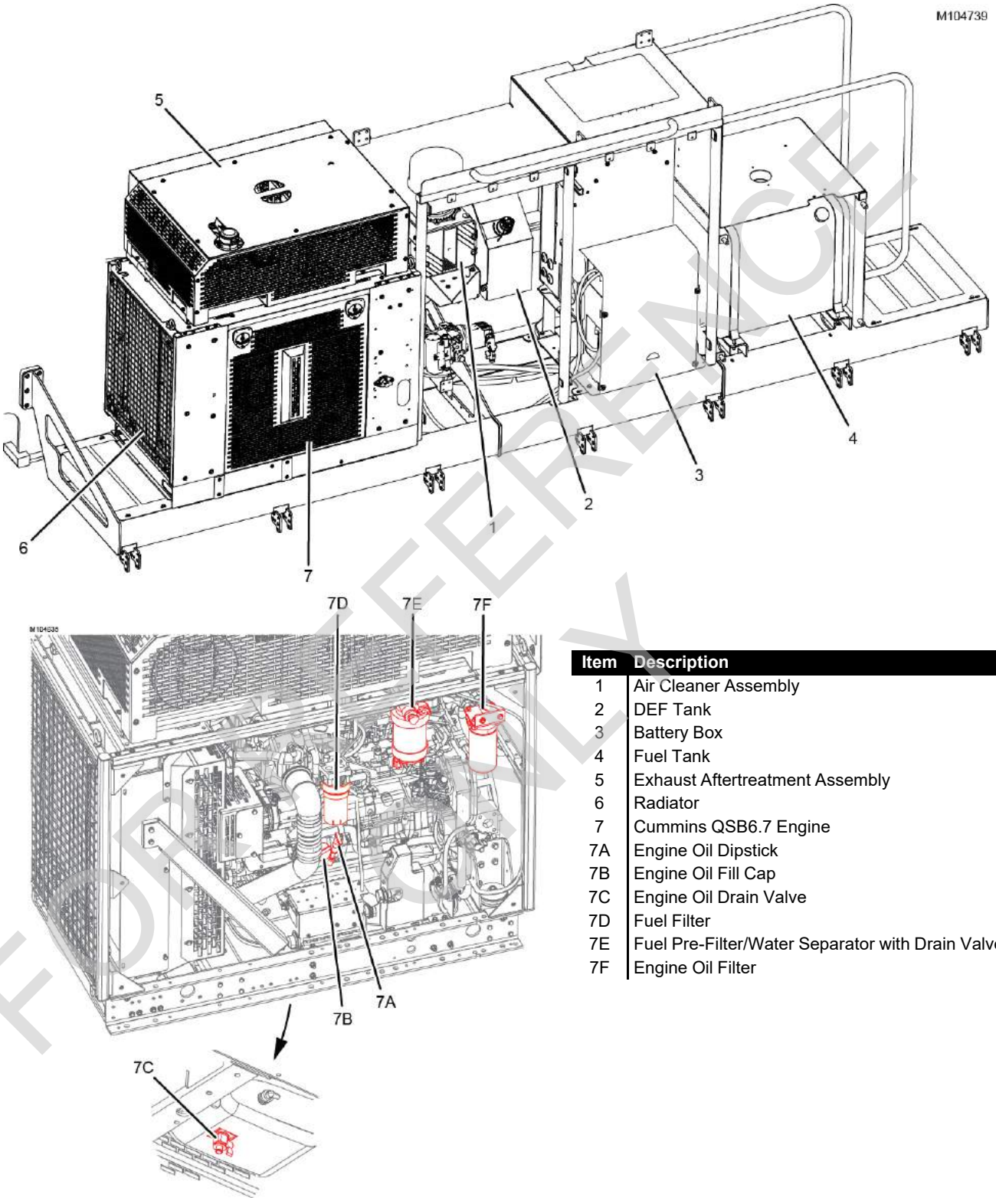
Engine access panels are heavy. To prevent serious injury, use the appropriate lifting equipment when lifting or removing these objects.



Item	Description
1	Outboard Access Panel
2	Inboard Access Panel

FIGURE 7-5

ENGINE COMPONENT IDENTIFICATION



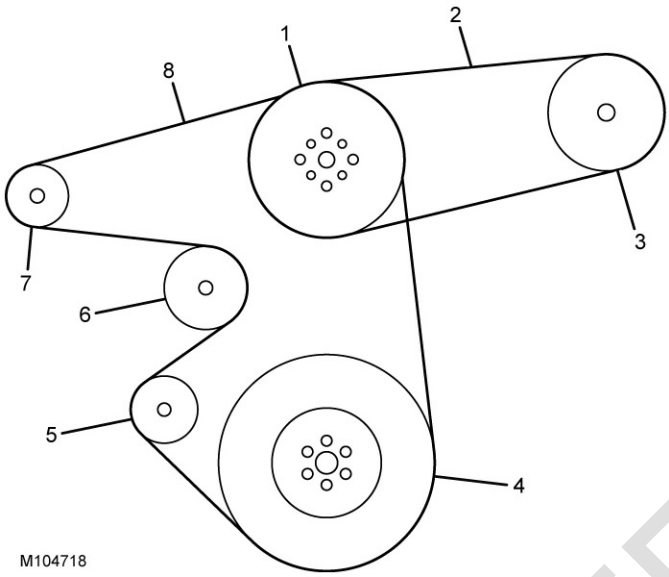
Item	Description
1	Air Cleaner Assembly
2	DEF Tank
3	Battery Box
4	Fuel Tank
5	Exhaust Aftertreatment Assembly
6	Radiator
7	Cummins QSB6.7 Engine
7A	Engine Oil Dipstick
7B	Engine Oil Fill Cap
7C	Engine Oil Drain Valve
7D	Fuel Filter
7E	Fuel Pre-Filter/Water Separator with Drain Valve
7F	Engine Oil Filter

FIGURE 7-6

ENGINE MAINTENANCE

Refer to the Engine Manufacturer's Manual supplied with the crane for engine maintenance intervals and procedures.

ENGINE BELT ROUTING



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

FIGURE 7-7

AIR CLEANER MAINTENANCE

See Figure 7-8 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

Daily or Every 8 Hours of Engine Operation (whichever occurs first)

Check the service indicator (1) with the engine running. The indicator gives a visual indication when it is time to change the air cleaner filters.

A yellow stem in the indicator window (1A) extends as the air cleaner filters become plugged. Change the air cleaner filters when the yellow stem reaches the red zone of the window.

The yellow stem remains locked in place when the engine is stopped. The reset button (1B) on the top of the indicator can be pressed at any time. When the engine is started, the indicator stem returns to the proper reading.

Monthly Inspection

Monthly or Every 200 Hours of Engine Operation (whichever occurs first)

- Inspect the rubber reducers, the reducing elbows, and the tubing between the air cleaner and the engine for cracks or other damage that might allow unfiltered air to enter the engine. Replace worn or damaged parts.
- Check for loose clamps. Tighten as required.
- Check the air cleaner housing (2) for damage that may allow unfiltered air to enter the engine. Replace the housing if it is damaged.
- Inspect the cover (4). Make sure it securely in place.

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. Lock out tag out the crane.
2. Un-clip and remove the cover (4).
3. Remove the primary filters (5) gently to avoid dislodging dust from the filters.

   There will be some initial resistance, similar to breaking the seal on a jar. Using the handle (5A) on each filter,

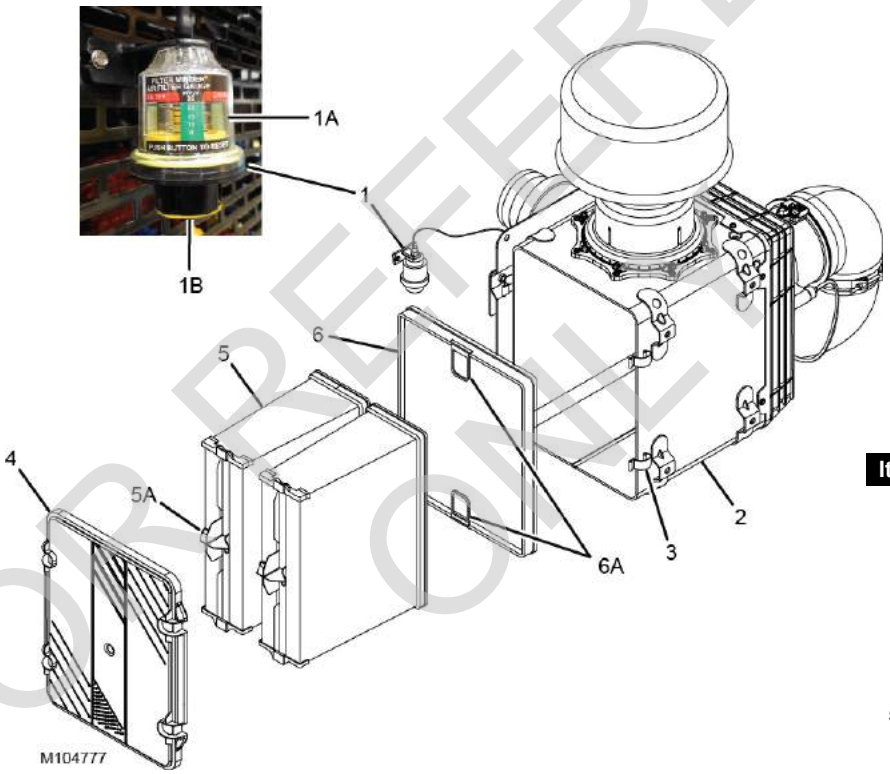
move the end of the filter back and forth to break the seal.

NOTE: The secondary filter (6) should be replaced every third time the primary filters (5) are replaced.

4. If required, remove the secondary filter (6) by pulling on the tabs (6A). Take care to avoid dislodging dust from the filter.
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. Inspect the new filters, especially the sealing areas. Never install damaged filters.

   The filters have O-rings that provide an air-tight seal.
8. If removed, carefully install the new secondary filter (6) – O-ring side first – with the tabs and gently push it into the back of the housing. Apply pressure to all four corners to make sure the filter is completely secure in the housing.
9. Carefully install the new primary filters (5) – O-ring side first – using the handles. Make sure all surfaces are sealed inside the housing.
10. Make sure the seal is in place and install the cover (4) with the clips (3). The cover should go on without extra force.

    Never use the clips on the cover to force the filters into the air cleaner. It is tempting to assume that the cover will do the job of sealing the filters, but it will not. Using the cover and clips to push the filters into the housing could damage the housing and will void the warranty.
11. Push the reset button (1B) on the service indicator (1).



Item	Description
1	Service Indicator
1a	Indicator Window
1b	Reset Button
2	Air Cleaner Housing
3	Clip (Qty 4)
4	Cover
5	Primary Filter (Qty 2)
5A	Handle
5	Plastic Rings
6	Secondary Filter
7	Tab (Qty 2)

FIGURE 7-8

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 to below 50°C (120°F).

Material Hazard!

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

CAUTION

Avoid Engine Damage!

The required coolant level must be maintained to prevent 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.

Checking Coolant Level

Daily (at start of shift) or Every 8 Hours of Engine Operation (whichever occurs first) — when coolant is cold

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

See Figure 7-9.

1. The coolant must be at the middle of the sight gauge (2). Add coolant if necessary.
2. Stop the engine and wait until the coolant temperature is below 50°C (120°F).
3. Remove the access cover.
4. Take care to prevent being burned by 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.
5. Slowly add a 50/50 coolant mixture of water and ethylene glycol until the coolant is at the middle of the sight gauge (2).
6. Securely install the fill cap (1).
7. Install the access cover.

Changing Coolant

Biennially or Every 2000 Hours of Engine Operation (whichever occurs first)

See Figure 7-9.

Draining

1. Stop the engine and lockout-tagout the crane.
2. Attach a drain hose to the drain valve (3). Place the other end of the drain hose into a suitable container that can hold 30 L (8 gal) of coolant.
3. Take care to prevent being burned by hot coolant as follows.
   a. Wait until the coolant temperature is below 50°C (120°F).
   b. Place a heavy cloth over the fill cap (1).
   c. Turn the fill cap counterclockwise until the pressure starts to release (indicated by a hissing sound).
   d. Wait for the pressure to escape completely.
   e. Turn the fill cap fully counterclockwise and remove it.
4. Open the drain valve (3).
5. Close the drain valve once the cooling system has completely drained,
6. Dispose of the drained coolant according to local environmental regulations.
7. Inspect the cooling system
   - Check for damaged hoses and loose or damaged hose clamps. Replace as required.
   - Check the radiator for leaks, damage, and dirt buildup. Clean and replace as required.

Flushing

If it is necessary to flush the cooling system, refer to the Engine Manufacturer's Manual for detailed instructions.

Filling

1. The system has a maximum fill rate of 19 L (5 gal) per minute. Fill the system slowly to allow air to escape.

2. Slowly add supplemental coolant additive (SCA) and a 50-50 coolant mixture to the radiator through the fill cap opening. Refer to the Engine Manufacturer's Manual for specific SCA and coolant recommendations.
3. Once coolant is visible in the middle of the sight gauge (2), wait 2 to 3 minutes before starting the engine to allow the system to naturally purge entrained air and the coolant level to stabilize.
4. Add a 50/50 coolant mixture to bring the coolant to the middle the sight gauge (2).

WARNING

Chemical and Burn Hazard!

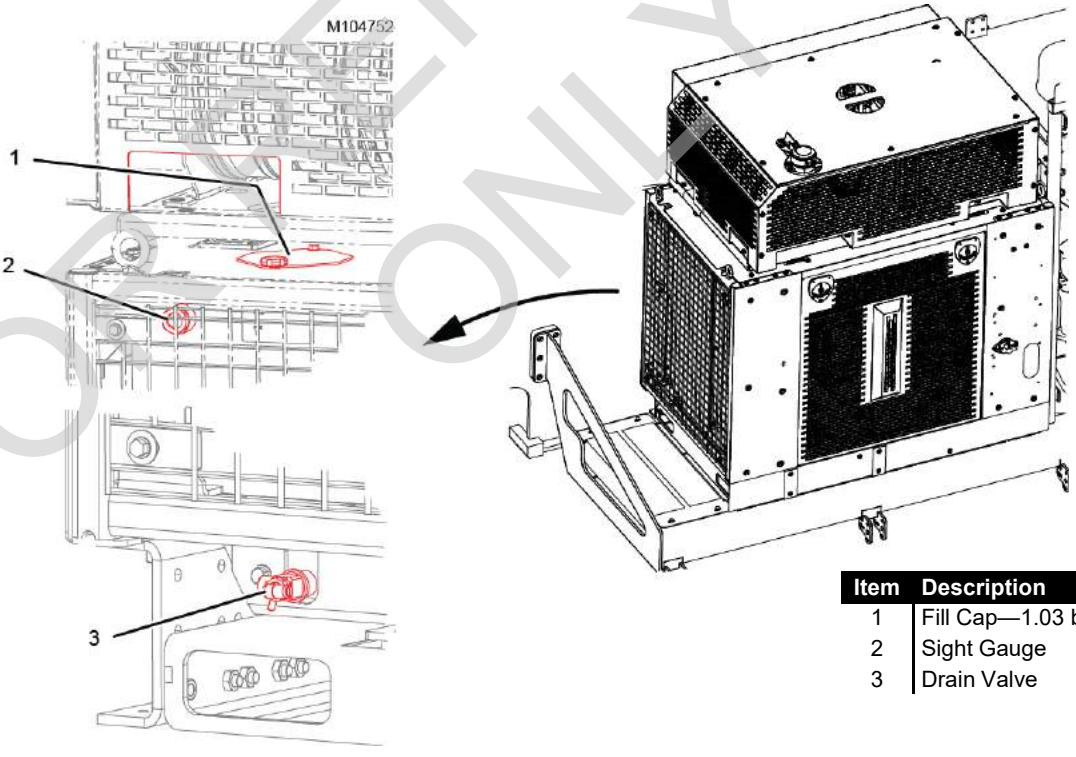
Coolant could spray from an open radiator cap while the engine is running. Do not stand near the radiator while operating the engine with the pressure cap removed.

5. Check that both cab heater valves on the engine are open.
6. In the cab, place the heat control to maximum.
7. With the radiator fill cap removed:
   - Start the engine and operate it a low idle for 2-3 minutes.
   - Stop the engine and add a 50/50 coolant mixture to bring the coolant to the middle the sight gauge (2).

NOTE: After starting a cold engine, increase engine speed slowly to provide adequate bearing lubrication and to allow oil pressure to stabilize.

8. With the radiator fill cap removed:
   - Start the engine and run it at high idle until the thermostat opens.

   Engine damage can occur if the temperature rises above 93°C (200°F).
9. Reduce engine speed to low idle for 2 minutes to cool down the engine components, then stop the engine.
10. Once the engine has cooled to 50°C (120°F), add a 50/50 coolant mixture to bring the coolant to the middle the sight gauge (2).
11. Install the radiator fill cap (1).
12. Install the access cover.
13. Operate the engine until it is at its normal operating temperature and check for coolant leaks Repair as needed.



Item	Description
1	Fill Cap—1.03 bar (15 PSI)
2	Sight Gauge
3	Drain Valve

FIGURE 7-9

7

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 7-10 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.

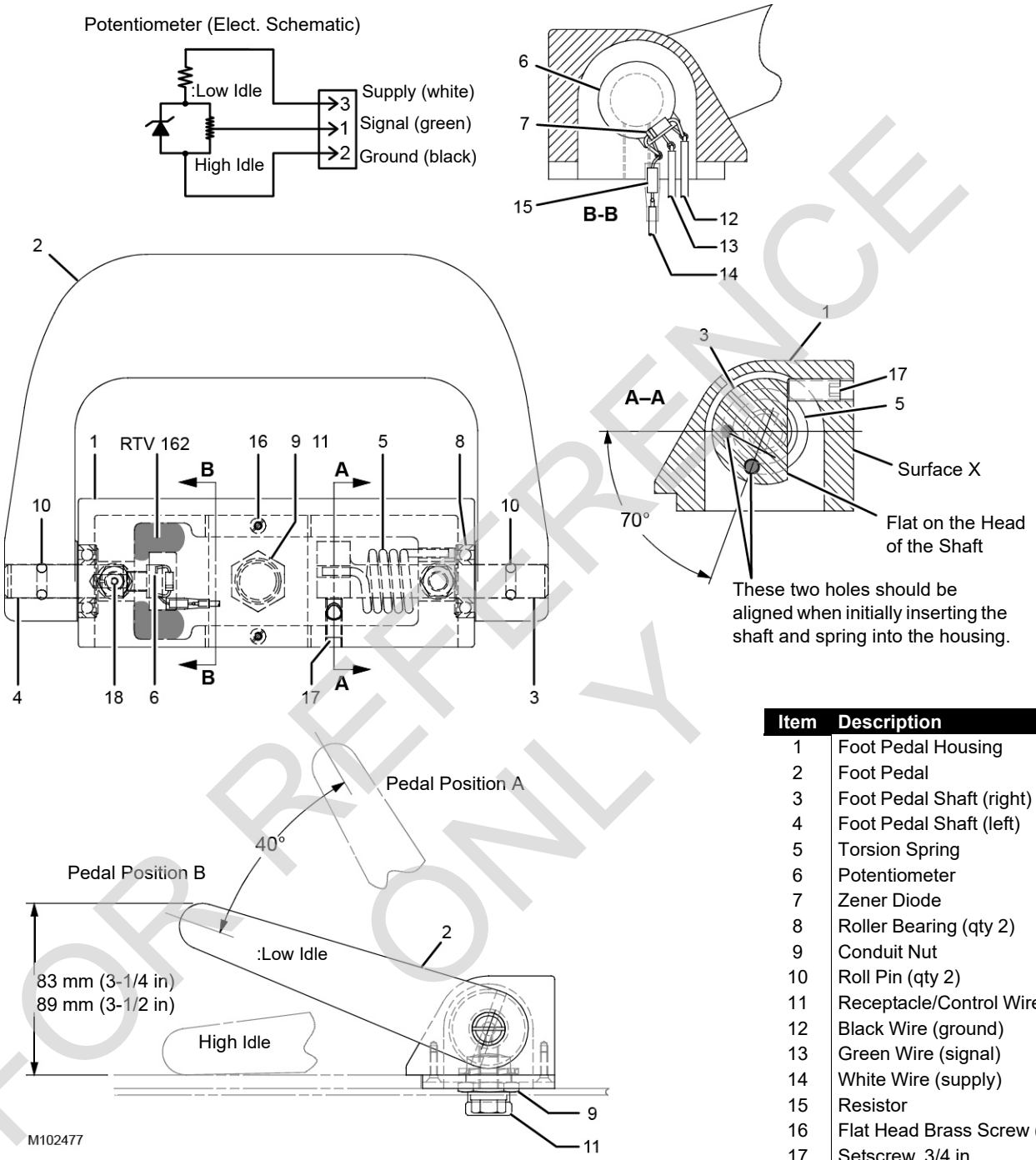
Foot Throttle Control Assembly and Calibration

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.



Item	Description
1	Foot Pedal Housing
2	Foot Pedal
3	Foot Pedal Shaft (right)
4	Foot Pedal Shaft (left)
5	Torsion Spring
6	Potentiometer
7	Zener Diode
8	Roller Bearing (qty 2)
9	Conduit Nut
10	Roll Pin (qty 2)
11	Receptacle/Control Wires
12	Black Wire (ground)
13	Green Wire (signal)
14	White Wire (supply)
15	Resistor
16	Flat Head Brass Screw (qty 2)
17	Setscrew, 3/4 in
18	Setscrew, 3/16 in

FIGURE 7-10

ENGINE ELECTRICAL SCHEMATIC

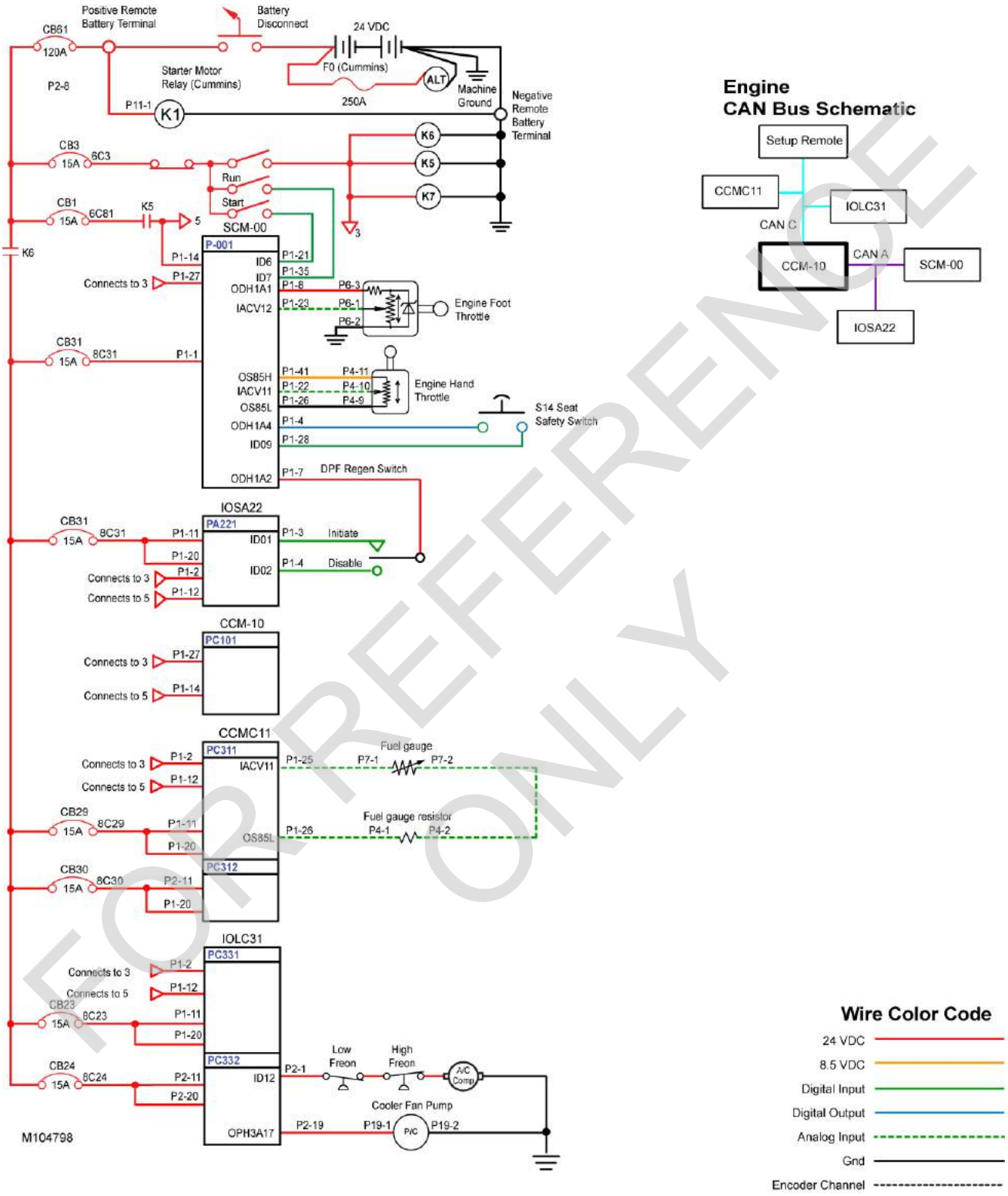


FIGURE 7-11

EXHAUST AFTERTREATMENT SYSTEM

See Figure 7-12 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 NO2 (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 Operator Manual for operation of the Engine Regeneration/Inhibit switch in the operator cab.

Tier 4 Main Display Icons

Refer to 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 38 L (10 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).

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 Main Display Operator Manual.

The drain plug (9) 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

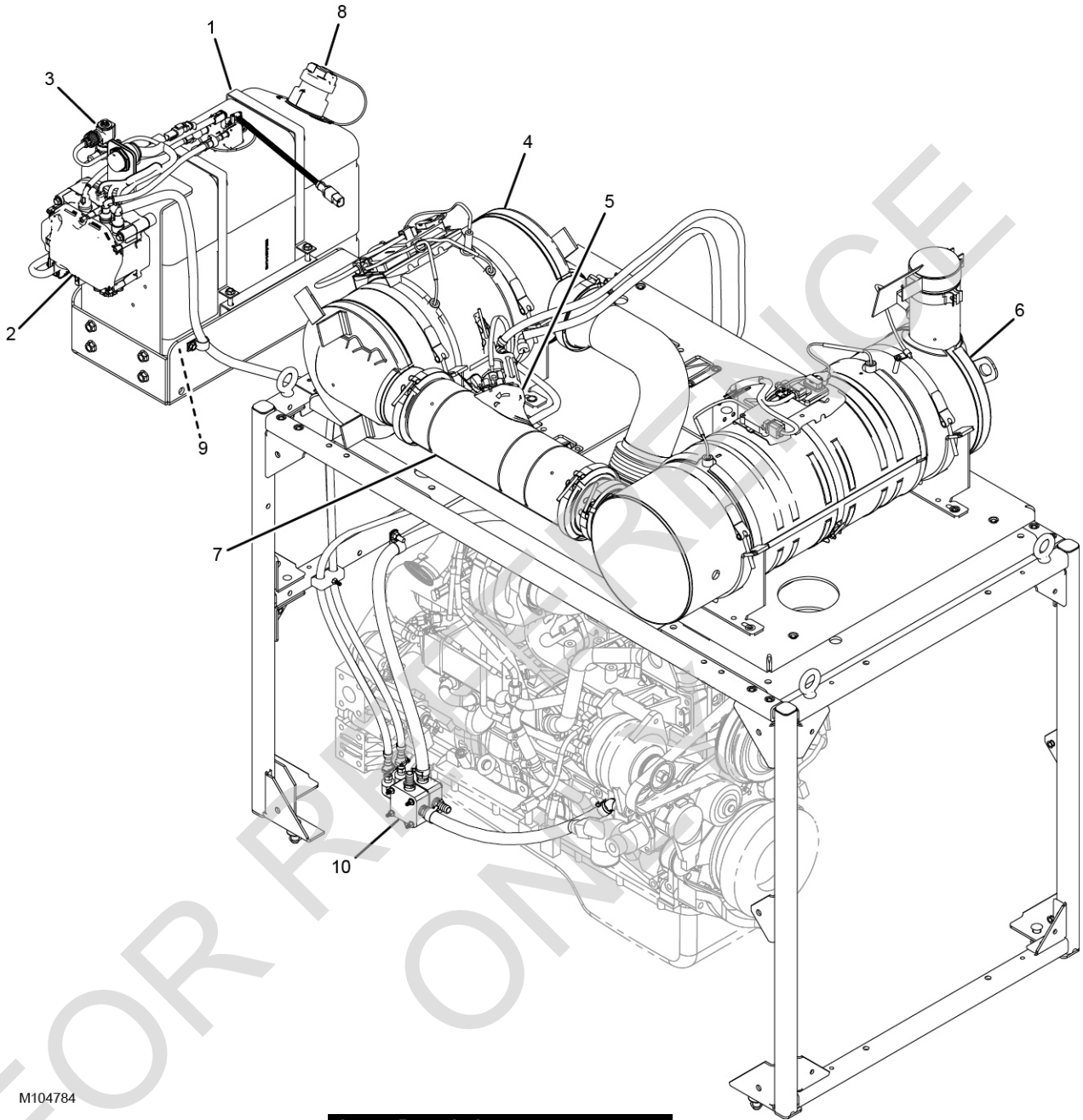
APS

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
2	DEF Supply Module
3	Coolant Control Valve
4	DOC/DPF Module
5	DEF Dosing Module
6	SCR Module
7	DRP
8	Fill Cap
9	Drain Plug
10	Coolant Tee Blocks

FIGURE 7-12

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SECTION 8
UNDERCARRIAGE

TABLE OF CONTENTS

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SECTION 8
UNDERCARRIAGE

GENERAL

This section provides operational information for the Travel System.

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

- Section 2: Hydraulics
- Section 3: Electrical

This section also provides maintenance and adjustment procedures for the crawler and turntable.

NOTE: In the following instructions, **CCS** stands for **C**rane **C**ontrol **S**ystem.

HYDRAULIC TRAVEL SYSTEM

See Figure 8-2 and Figure 8-3.

Travel System Overview

The travel system consists of two open-loop hydraulic circuits, one for each crawler. Each circuit consists of a joystick, an engine-driven hydraulic pump, a directional control valve, a hydraulic motor, and a disc brake.

Hydraulic Pump

The hydraulic pumps (Pump A and Main Pump B) are electronically controlled variable-displacement type pumps.

Directional Control Valves

The directional control valves are electronically controlled proportional valves. Each section of the directional control valve is controlled by two solenoids. Depending on which solenoid is energized, the valve spool moves to a position that allows hydraulic oil from the corresponding pump to flow to the selected travel motor for either forward or reverse travel.

In neutral, the directional control valve spools are spring returned to the center position. In this position, pump flow to the travel motors is blocked and the forward and reverse hydraulic lines to the travel motors are connected to tank.

Travel Motors

The travel motors are hydraulically pilot operated, bi-directional, variable-displacement motors with pressure override. The motors provide power to the planetary drive at each crawler.

Each travel planetary drive is equipped with a spring-applied, hydraulically-released disc brake that is controlled by a two-position, solenoid controlled, brake valve.

The speed and direction of the travel motors depends on the output flow volume of the travel pumps, the position of the proportional control valves, and the position of the travel motor servos.

Joystick Control

The pumps and proportional control valves are electronically controlled by the position of the corresponding travel control handle (joystick J2) and the travel speed switch located on the right console. The joystick communicates with the crane control system via the controller area network bus (CAN Bus).

The left travel control handle controls pump A, the left travel proportional control valve, and the left travel motor.

The right travel control handle controls pump B, the right travel proportional control valve, and the right travel motor.

Travel Brake Operation

The travel brakes are a spring-applied, hydraulically-released disc brakes located between each travel motor and its corresponding planetary drive.

The travel brake release system uses pilot pressure from accessory pump supplied to the travel brakes via the travel brake solenoid valve. The brake release pressure must be at least 22 bar (319 psi) to fully release the brakes.

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

Travel Park Brake Released

In the UN-PARK position, the travel park switch is closed, causing the switch to send 24 V_{DC} back to the joystick (J2). When 24 V_{DC} is detected, joystick J2 activates the travel control handles, but does not allow the travel brakes to release until one or both travel control handles are moved.

When a travel control handle is moved in either direction, it sends a release brake command to the CCS. The CCS then sends 24 V_{DC} to the travel brake solenoid valve. This causes the travel brake solenoid valve to open, allowing hydraulic oil to flow to the travel brakes. The increased pressure releases the travel brakes.

Travel Park Brake Engaged

In the PARK position, the travel park switch is open, causing the switch to send 0 V_{DC} back to the joystick (J2). When 0 V_{DC} is detected, joystick (J2) deactivates the travel control handles and sends an apply brake command to the CCS. This causes the travel brake solenoid valve to close, allowing the hydraulic oil in the brake system to flow back to the tank.

The reduced hydraulic pressure allows spring force to apply the travel brakes.

Travel 2-Speed Operation

The travel motors are variable displacement and shift internally with an adjustable spring in each motor P/C (Pressure Compensator) valve that is preset at 270 bar (3,915 psi). The travel speed switch allows the operator to select low speed when smoother starts and precise control over the load is required or high speed when maximum available travel speed is required.

When the 2-speed switch is in the low position, the control system sends an output signal to enable the travel speed solenoid. The valve shifts to direct accessory pressure to the end of the P/C valve. The P/C valve shifts the PCOR spool placing the travel motors in maximum displacement (high torque, low speed). The travel motors remain in this position until the 2-speed switch is placed in the high position and engine speed is more than 1350 rpm.

When the 2-speed switch is in the high position, the travel motors remain in minimum displacement (low torque, high-speed) when starting. If system pressure rises to 270 bar (3915 psi) when the crawlers begin to move, the P/C will shift toward maximum displacement, as required up to max displacement, to maintain 270 bar (3915 psi) so that maximum tractive effort is always available.

The travel motors shift back to minimum displacement automatically if engine speed is above 1350 rpm and system pressure is below 270 bar (3,915 psi). If engine speed is below 1350 rpm, the travel speed solenoid is enabled even if the 2-speed switch in the high position. The travel speed solenoid is disabled, shifting the valve, and accessory pressure to end of the P/C valve. This action allows the motor to operate in the PCOR mode.

Travel Cruise Operation

The travel cruise switch on the left travel handle allows the crawlers to operate in either direction at a selected speed without manually moving the travel handles. Once moving in the desired direction and speed, press and release the cruise switch. The control system locks-in the travel information and the travel direction and speed are maintained when the travel handles are released to the neutral position.

Pressing and releasing the switch again or moving either travel handle in the opposite direction from neutral, opens the travel cruise circuit and returns control of the crawlers to the operator.

Forward Travel Operation

To enable the travel control system, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Travel park switch in the UN-PARK position

When either control handle is moved to the forward position, the joystick (J2) communicates the travel command to the CCS.

At the same time, the CCS communicates the forward travel command to the solenoid at the corresponding proportional control valve.

- If the left control handle is moved forward, the CCS energizes the left travel proportional control valve, shifting the valve to the position that allows hydraulic oil from Pump A to flow to the left travel motor for forward travel.
- If the right control handle is moved forward, the CCS energizes the right travel proportional control valve, shifting the valve to the position that allows hydraulic oil from Pump B to flow to the right travel motor for forward travel.
- Simultaneously, the travel brakes are released to allow travel.

The following sensors provide feedback to the CCS:

- Pump A and Pump B pressure sensors
- Left travel pressure sensor
- Right travel pressure sensor

The control system uses this feedback to adjust the pump and motor flows to maintain the speeds commanded by the handles.

Reverse Travel Operation

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 either control handle is moved to the rearward position, the joystick (J2) communicates the travel command to the CCS.

At the same time, the CCS communicates the reverse travel command to the solenoid at the corresponding proportional control valve.

- If the left control handle is moved rearward, the CCS energizes the left travel proportional control valve, shifting the valve to the position that allows hydraulic oil from Pump A to flow to the left travel motor for reverse travel.
- If the right joystick handle is moved rearward, the CCS energizes the right travel proportional control valve, shifting the valve to the position that allows hydraulic oil from Pump B to flow to the right travel motor for reverse travel.

- Simultaneously, the travel brakes are released to allow travel.

The following sensors provide feedback to the control system:

- Pump A and Pump B pressure sensors
- Left travel pressure sensor
- Right travel pressure sensor

The control system uses this feedback to adjust the pump and motor flows to maintain the speeds commanded by the handles.

No Travel

When the travel control handles are in the neutral position, the travel pumps are de-stroked and the left and right travel proportional control valves remain in the center position, blocking hydraulic flow from the pumps to the travel motors. The travel brake solenoid is deenergized, allowing spring force to apply the travel brakes.

Travel Motor Flushing

See Figure 8-1.

The purpose of the travel motor flushing circuit is to provide a continuous flow of flushing oil to the case of both travel motors while the crane is traveling.

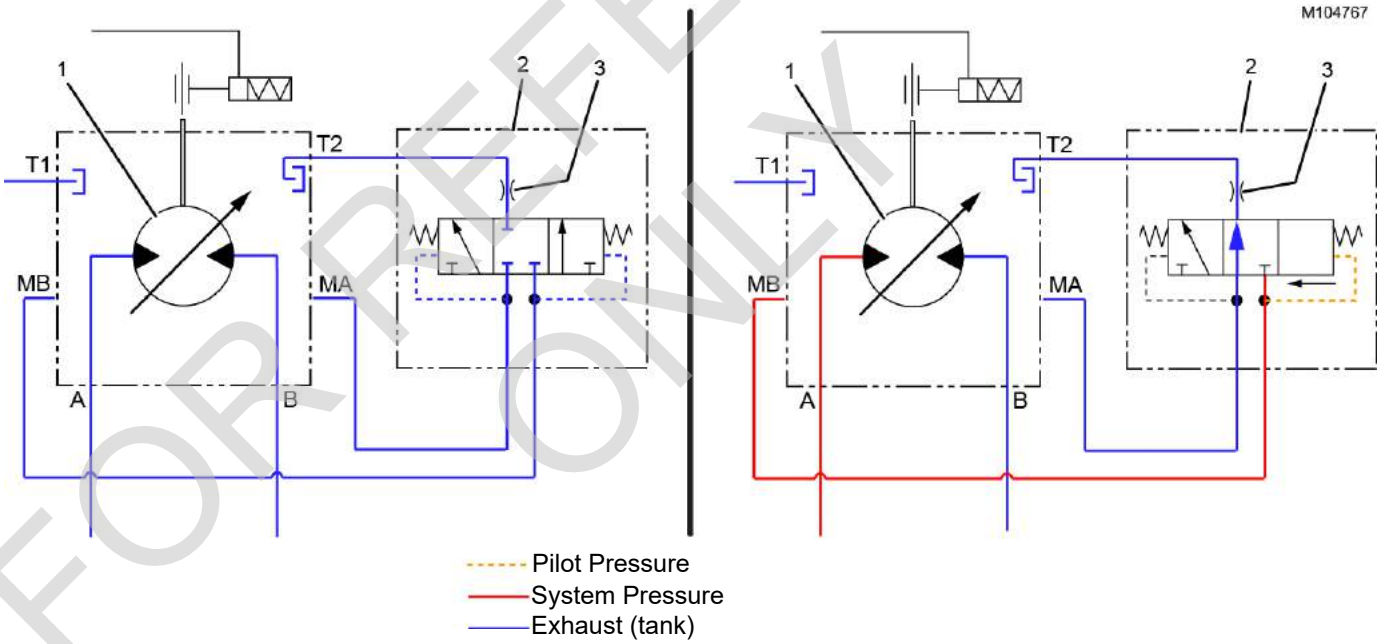
Each travel motor (1) has a 3-position, pilot-operated flushing valve (2) for controlling the flushing circuit.

When the travel system is in neutral (View A), the flushing valve is spring centered to the closed position, and there is no flushing oil flow through the travel motor.

When a crawler is operated (View B), oil from the pump is delivered to the corresponding motor port via the proportional travel control valve. For the example in Figure 8-1, oil is being delivered to motor port A.

In this example, system pressure from motor port MB shifts the flushing valve open allowing return oil from motor port MA to flow through the orifice (3). The orifice meters return oil to the motor case port T2 and the oil returns to tank via the motor case port T1.

When the motor is operated in the opposite direction, pressure from motor port MA shifts the flushing valve (2) in the opposite direction shown, and oil from motor port MB flows through the orifice (3) and back to tank via the motor case ports T2 and T1.



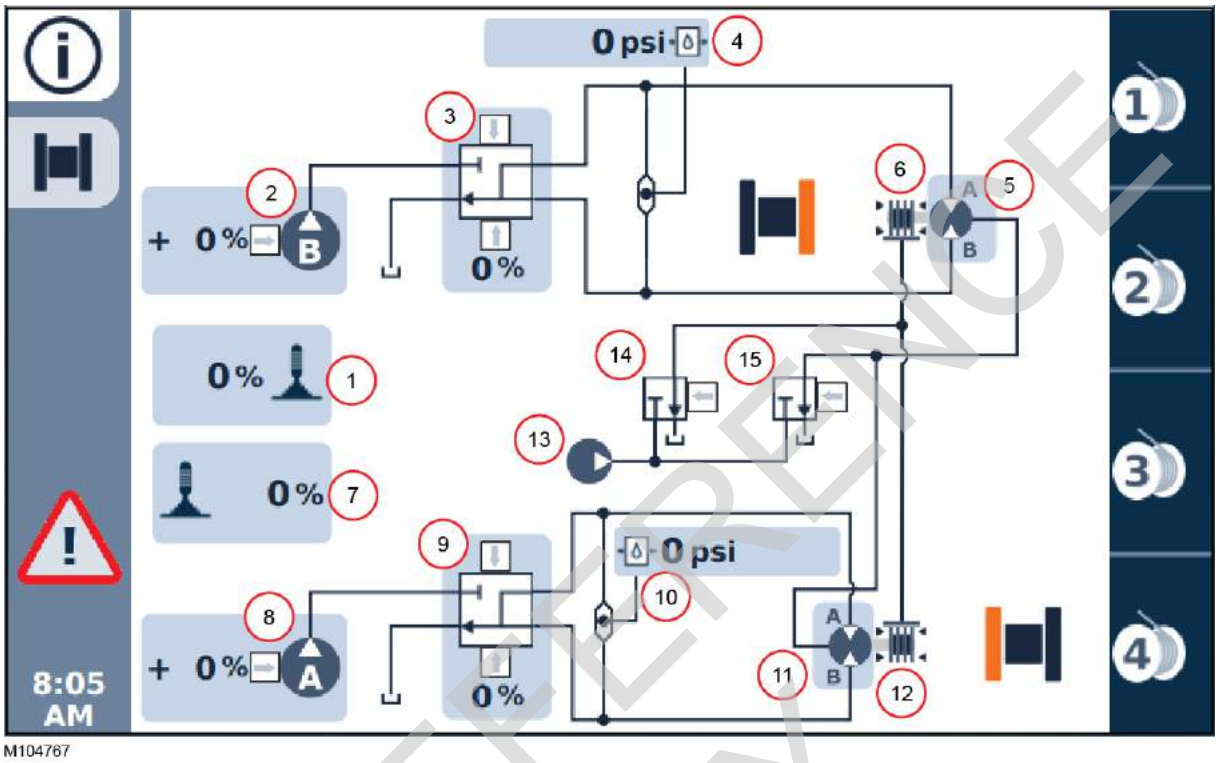
Item	Description
1	Travel Motor
2	Flushing Valve
3	Orifice: 8 L/min (2.1 gpm)

FIGURE 8-1

8

Travel Hydraulic Diagram

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



Item	RIGHT Crawler Components	Item	LEFT Crawler Components
1	Control Handle (Command -100 to 100%) + number = forward, – number = reverse	7	Control Handle (Command -100 to 100%) + number = forward, – number = reverse
2	Main Pump B (Command -100 to 100%) + number = forward, – number = reverse	8	Pump A (Command -100 to 100%) + number = forward, – number = reverse
3	Proportional Control Valve (Command -100 to100%) + number = forward, – number = reverse	9	Proportional Control Valve (Command -100 to100%) + number = forward, – number = reverse
4	Pressure Transducer	10	Pressure Transducer
5	Motor	11	Motor
6	Brake	12	Brake
13	Accessory Pump		
14	Brake Valve (right and left)		
15	2-Speed Valve (right and left)		

FIGURE 8-2

Travel Electrical Diagram

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

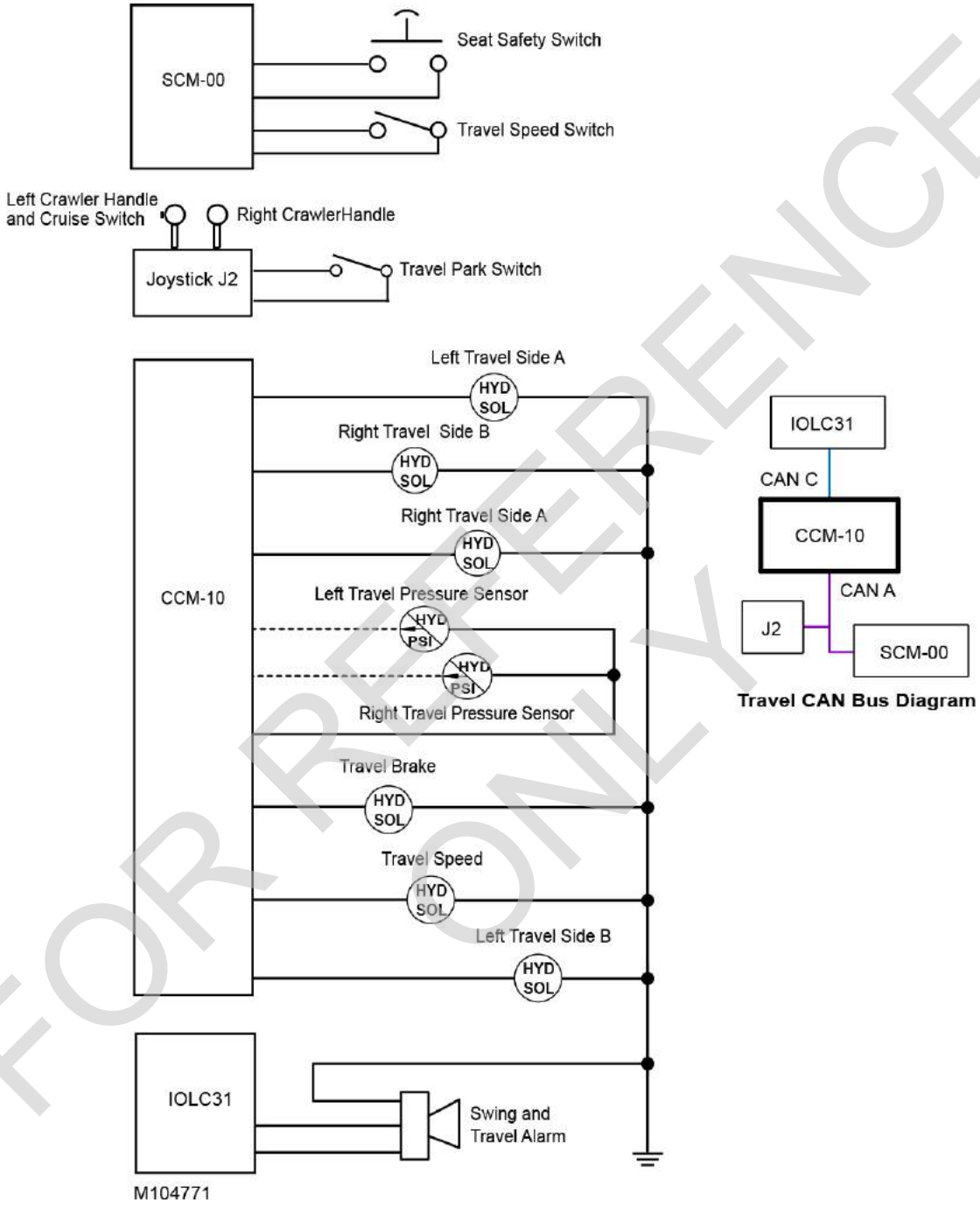


FIGURE 8-3

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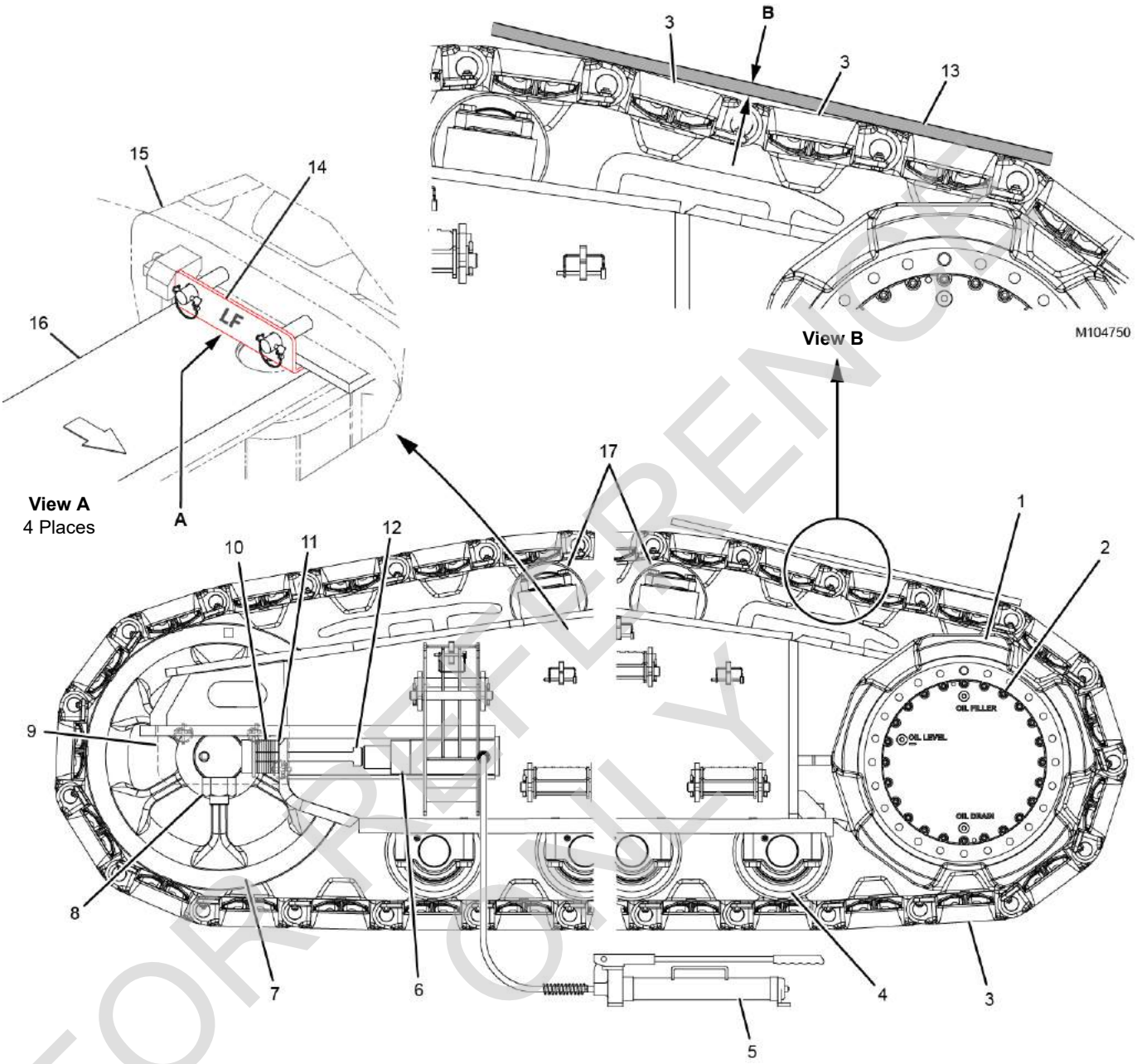


Quantities are for Both Crawler

Item	Description	Item	Description
1	Drive Tumbler	10	Shim: Qty 18, 6.4 mm (0.25 in) thick
2	Gearbox	11	Shim: Qty 2, 3.4 mm (0.134 in) thick
3	Tread	12	Adjusting Rod
4	Idler Rollers	13	Straightedge
5	Hand Pump	14	Shim Pack: 1 each 2 mm - 10 mm (0.08 in - 0.39 in) thick
6	Cylinder	15	Crawler
7	Front Roller	16	Carbody Leg (4 places)
8	Nut and Bolt	17	Top Rollers
9	Cover (shown removed)	**A**	Crawler to Carbody Gap: 1 mm to 3 mm (0.04 in to 0.112 in)
		B	Tread Slack Dimension • 13 mm (0.5 in) — Tight Limit • 51 mm (2.0 in) — Loose Limit

FIGURE 8-4

CRAWLER PREVENTIVE MAINTENANCE

Weekly or Every 40 Hours of Engine Operation

See Figure 8-4.

- 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.
- Inspect the shims (14, View A)(4 places). If the shims are damaged or difficult to take out or put back in, replace them with new ones.
- Measure the gap between the shims (14, View A) (4 places) and the carbody leg (16). If the gap exceeds dimension (**A**) install shims (14) so the gap is between 1.0 - 3.0 mm (0.04 - 0.12 in).

CRAWLER TREAD SLACK MEASUREMENT

Weekly or Every 40 Hours of Engine Operation

Check tread slack (**B**) at the drive tumbler (1, View B) end of each crawler. Maintain equal tread slack at both crawlers.

1. Travel forward or reverse on a firm level surface until all tread slack is in the top treads at the drive tumbler end of the crawlers.
2. Place a straightedge (13, View B) on top of the treads (3). ***The straightedge must span from the top of the rear top roller (17) to the top of the drive tumbler (1)***.
3. Measure the tread slack between the straightedge and the top of the tread at the lowest point.
   - Tight limit gap—13 mm (.5 in)
   - Loose limit gap—51 mm (2.0 in)
4. If the slack exceeds the tight or loose limit, adjust crawler tread slack.:

CAUTION

Avoid Tread Pin Damage!

Do not adjust the treads too tightly or the tread pins will wear rapidly and may break. Dirt buildup will tighten the treads further, increasing the possibility of damage.

Tight treads require more drive torque, resulting in faster wear and increased fuel consumption.

CRAWLER TREAD SLACK ADJUSTMENT

See Figure 8-4.

- Tighten the treads when operating on firm ground.
- Loosen the treads when operating on soft ground (mud or sand).

1. Thoroughly clean the crawler to be adjusted.
2. Remove the covers (9) from both sides of the crawler frame.
3. Loosen the nut and bolt (8) on both sides of the front roller (7).
4. Remove the hand pump (5), the cylinder (6), and the extra shims (10 and 11) from the parts box.
5. Place the cylinder (6) in position to jack against the adjusting rod (12). Using the hand pump, jack an equal amount on each side until the track is at the desired tension.
6. Install an equal number of shims (10 and 11) on both sides of the crawler frame as needed.

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. Fully retract and remove the cylinder (6).

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 (8) at the front roller (7) with Never-Seez or an equivalent anti-seizing lubricant.
11. Tighten the nuts (8) to 2700-4000 Nm (1991-2950 ft-lb).
12. Install the cover (9) 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.

14. Store the hand pump, the cylinder, and any remaining shims in the parts box.

Item	Description
1	Intermediate Roller (qty 11 each crawler)
2	Bolt with Flat Washer (qty 4 each roller

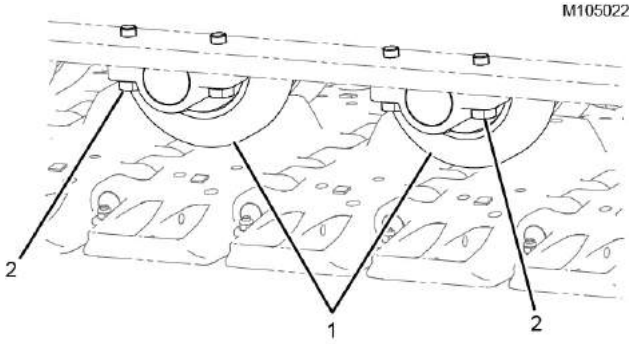


FIGURE 8-5

INTERMEDIATE ROLLER BOLT TORQUE

See Figure 8-5.

Annually, Every 2000 Hours of Engine Operation, or Every 250 Hours of Travel Operation, Whichever Occurs First

1. Check the torque of the bolts (2) at each intermediate roller (1). The bolts must be at 610 Nm (450 ft-lb) torque. ***The bolts must not turn***.
2. Replace ALL loose bolts with new bolts and torque as follows:
   - Clean threads with solvent/degreaser as needed
   - Apply LOCTITE™ 263 to threads
   - Torque bolts to 895 Nm (660 ft-lb)

CRAWLER HAND PUMP AND CYLINDER

WARNING

Hand Pump Explosion

The hand pump and cylinder is provided for crawler adjustment only, any other use is neither intended nor approved.

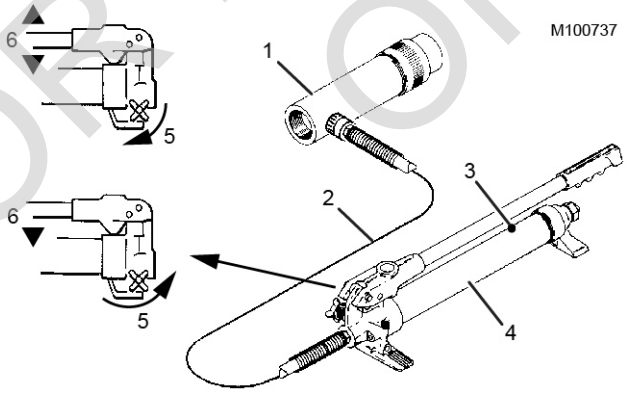
Wear safety glasses and other personal protective gear when operating the hand pump.

Do not set the pump relief valve higher than 10,000 psi (700 bar). Higher pressure can cause components to explode.

The pump is not vented. It can explode if subjected to high pressure. Do not attempt to return more oil to the pump than it is capable of holding. Do not overfill the pump.

In some cases, the pump handle can “kickback.” Always keep your body to side of pump, away from line of handle force.

Do not add extensions to handle. Extensions can cause unstable operation.



Item	Description
1	Jacking Cylinder
2	Hose
3	Vent Fill Cap
4	Pump
5	Valve
6	Jacking Handle

FIGURE 8-6

Assembly

1. Connect the hose from the pump outlet port to the cylinder inlet (Figure 8-6).

CAUTION

Hand Pump Damage

Do not apply sealant to the first complete thread to ensure the sealant does not shed into the hydraulic system and cause malfunctioning or damage.

2. Apply 1-1/2 wraps of a high-grade thread sealant (Teflon tape) to the fittings.

CAUTION

Leaks and Fitting Damage

Do not over tighten the connections, connections only need to be snug and leak free. Over tightening can cause premature thread failure and may cause fittings or castings to split at lower than their rated pressures.

Maintenance

See Figure 8-6.

1. Keep the unit clean and stored in a safe place where it cannot be damaged.
2. Assure correct pump oil level. To check the level:
   a. Turn the pump valve (5) counter-clockwise, push the jacking handle (6) all the way down, and fully retract the jacking cylinder (1) rod to return all oil to the pump. ***The cylinder must be fully retracted or the system will contain too much oil after filling.***
   b. Place the pump (4) horizontally on a flat surface.
   c. Using a screw driver, remove the vent fill cap (3).
   d. Add hydraulic oil to the pump until the reservoir is two-thirds full. ***Do not overfill.***
   e. Reinstall the vent fill cap.
   f. Test pump operation and remove air from system, if required. Recheck oil level after removing the air.

Air Removal

See Figure 8-6.

1. Rotate the valve (5) clockwise until finger tight.
2. Position the pump (4) so it is higher than the cylinder (1) and position the cylinder so the rod is down.
3. Operate the jacking handle (6) up and down to fully extend the jacking cylinder (1) rod.
4. Rotate the valve (5) counterclockwise, push the jacking handle (6) all the way down, and fully retract the jacking cylinder (1) rod to force oil and trapped air back into the pump.
5. Repeat this procedure until the cylinder operates smoothly. ***Erratic operation indicates air in the system.***

Operation

See Figure 8-6.

1. Before using the pump:
   - Check that all fittings are tight and leak free.
   - Check the oil level.
2. To pressurize the jacking cylinder (1) and extend the rod, close the valve (5) by turning it clockwise until finger tight. Pump the jacking handle (6) up and down. Pressure is maintained until the valve is opened.

   To reduce the handle effort at high pressure, use short strokes, maximum leverage is obtained in last five degrees of stroke.
3. To de-pressurize the jacking cylinder (1), push the jacking handle down fully and the open the valve (5) by turning it counterclockwise.
4. The pump can be operated in any position from horizontal to vertical as long as the ***hose end of the pump is down***.

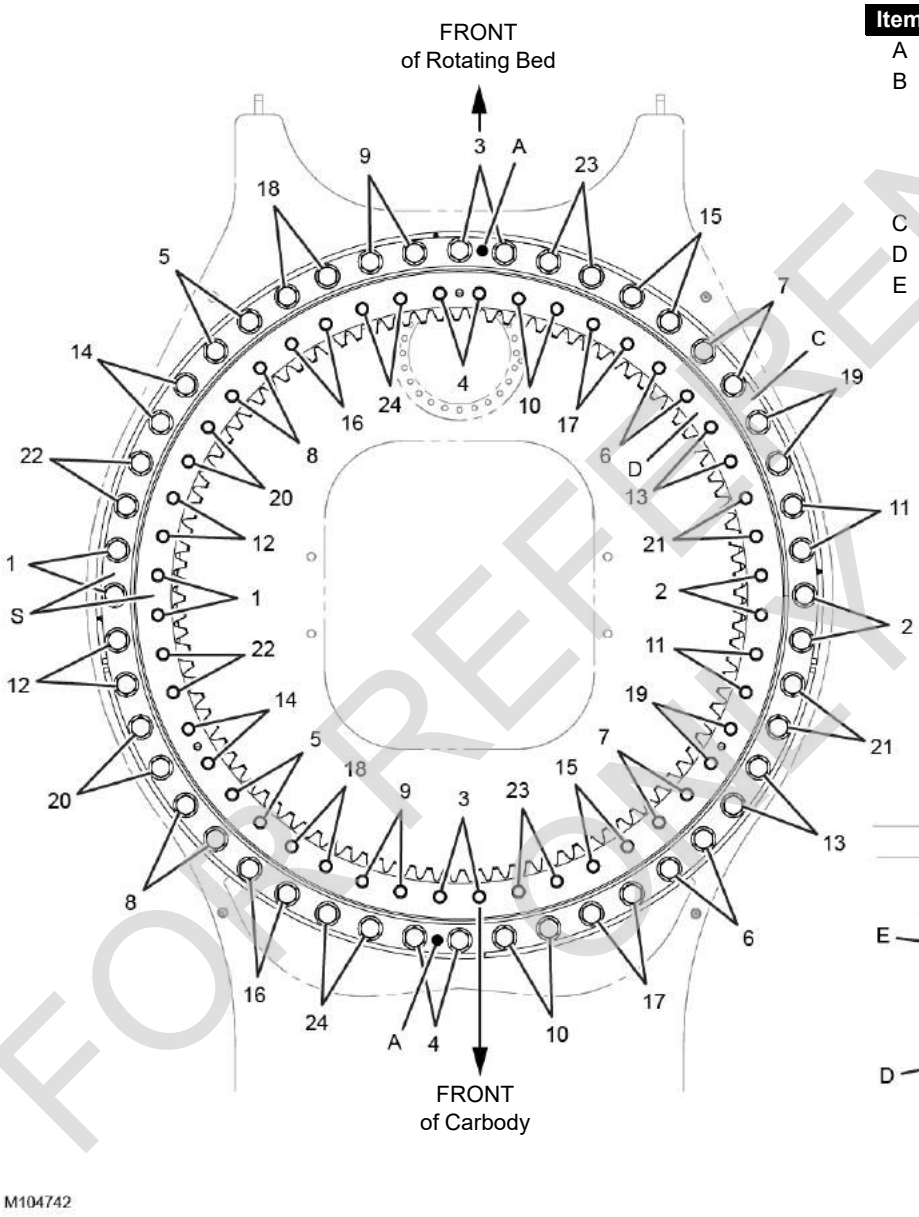
TURNTABLE BEARING ALIGNMENT

See Figure 8-7 for the following.

Install the inner ring (D) so the S stamp is towards the side of the carbody.

Two shear pins (A) are installed in the rotating bed to locate the outer ring (C) with the rotating bed.

Verify the S stamp in the outer ring (C) is toward the side of the rotating bed.



Item	Description
A	Shear Pin (2 places)
B	1-1/4 in—7 x 6 in Long Heavy Head Special Grade Bolt with Special Flat Washer • 48 Places Outer Ring • 48 Places Inner Ring
C	Outer Ring
D	Inner Ring
E	Washer Shim

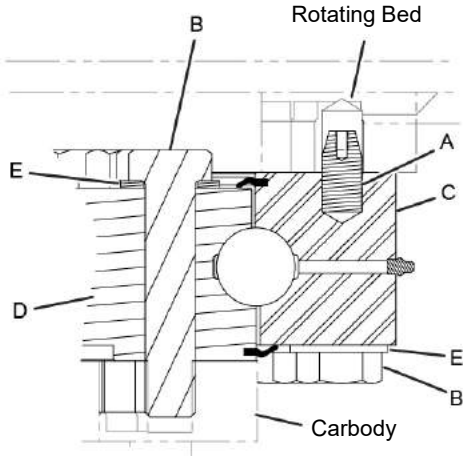


FIGURE 8-7

TIGHTENING TURNTABLE BEARING BOLT

See Figure 8-7 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, two at a time, in the numbered sequence given to 1 763 Nm (1300 ft-lb).

Annually or Every 2,000 Hours of Operation (whichever comes first)

Tighten all bolts, two at a time, in the numbered sequence given using two steps:

- First to 610 Nm (450 ft-lb)
- Final to 1 763 Nm (1,300 ft-lb)

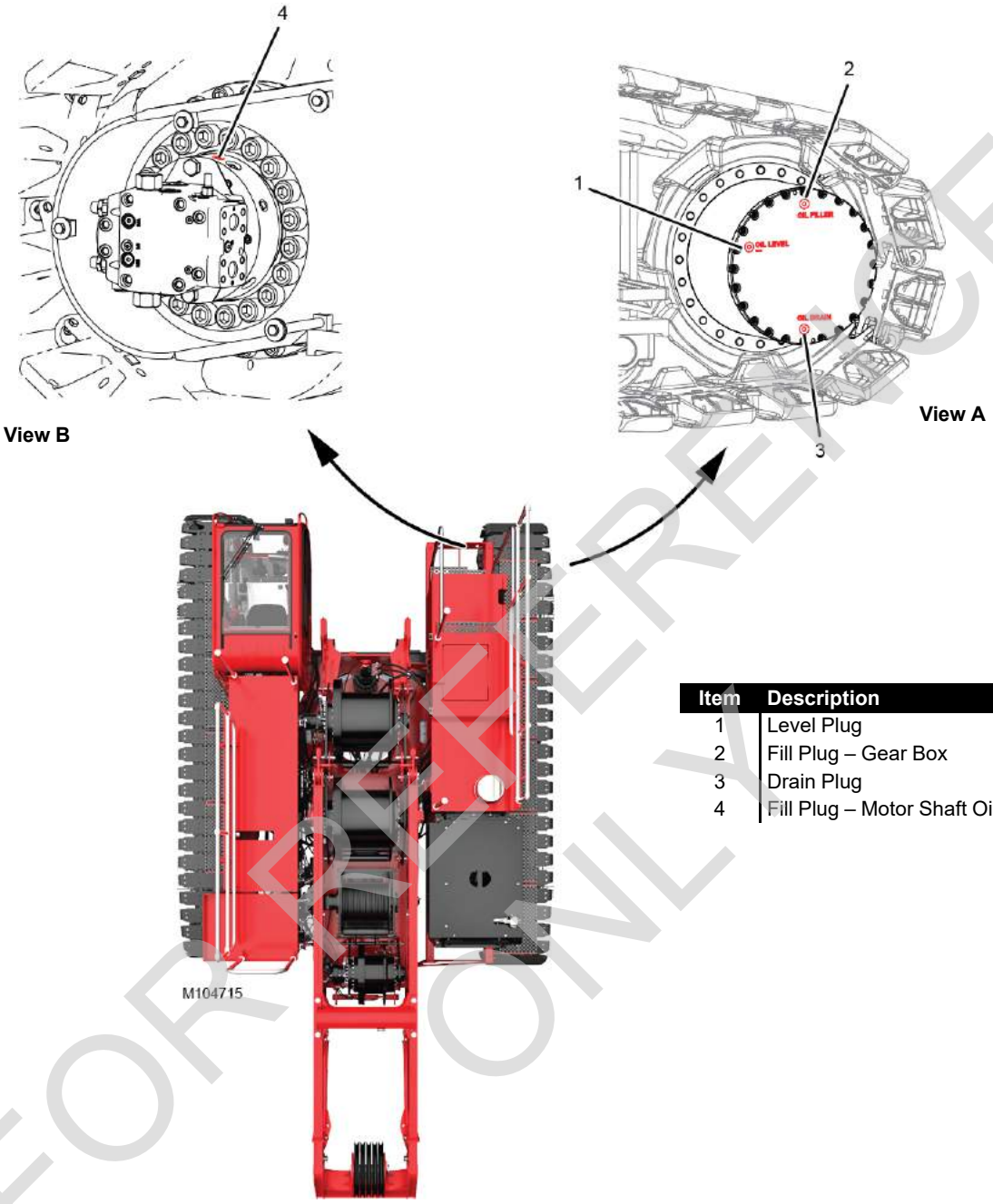
If during the annual interval:

- One or more bolts are found to be tightened to less than 1 410 Nm (1,040 ft-lb), replace each loose bolt and washer as well as one bolt and washer on each side of each loose bolt.
- 10 or more bolts in either ring are found to be tightened to less than 1 410 Nm (1,040 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. Install and tighten the bolts (A) and washers shims (E), two at a time, in the numbered sequence to an initial torque of 610 Nm (450 ft-lb).
3. Tighten the bolts, two at a time, in the numbered sequence to a final torque of 1 763 Nm (1,300 ft-lb).



Item	Description
1	Level Plug
2	Fill Plug – Gear Box
3	Drain Plug
4	Fill Plug – Motor Shaft Oil Cavity

FIGURE 8-8

CRAWLER GEARBOX OIL CHANGE

See Figure 8-8.

Gear Oil Specifications

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

Oil Analysis

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

Periodic Maintenance

Initial Operation

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

Weekly

Check the oil level in both crawler gearboxes weekly **or** every 10 hours of function operation **or** 20 hours of engine operation, whichever occurs first.

1. Travel the crawlers until the plugs are positioned as shown in View A
2. 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.

Semi-Annually

Drain and refill both crawler gearboxes semi-annually **or** every 200 hours of function operation **or** every 1000 hours of engine operation, whichever occurs first, unless an alternate interval has been established through an oil analysis program.

Oil Change Procedure

Change the oil when the crawler gearboxes are warm.

1. Travel the crawlers until the plugs are positioned as shown in View A
2. 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 (approximately 15 L – 4 gal).
6. Remove the drain plug.
7. Once the 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.

Motor Shaft Oil Cavity

If either crawler motor is removed for servicing, the motor shaft oil cavity (View B) must be filled with gear oil after the motor is reinstalled.

1. Remove the fill plug (4).
2. Add gear oil through the fill plug opening until the cavity is full.
3. Securely reinstall the fill plug (4).

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SECTION 9
LUBRICATION

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SECTION 9
LUBRICATION

LUBRICATION

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SECTION 10
ACCESSORIES

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SECTION 10
ACCESSORIES

This section provides operational information for the crane's accessory hydraulic systems.

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

- Section 2: Hydraulics
- Section 3: Electrical

NOTE: In the following instructions, **CCS** stands for **C**rane **C**ontrol **S**ystem.

COUNTERWEIGHT PINS

See Figure 10-1 and Figure 10-2

Counterweight Pins Overview

The counterweight pins are controlled by a switch on the remote control. The system consists of the accessory pump, a 2-position, solenoid operated control valve, and a double-acting hydraulic cylinder.

The setup remote control communicates with the counterweight pins solenoid valve via the CCS.

To activate the setup remote, it must be turned in crane's main display. See the Main Display Operation Manual provided with the crane.

The counterweight pins switch on the remote control is a 2-position momentary switch. The switch must be unlocked and held in the disengage position. The switch spring returns to the engage position when released.

Engage (extend)

When the counterweight pins switch is released to the engage position, the following occurs:

- The solenoid on the counterweight pins control valve is deenergized.
- A spring shifts the control valve to the engage position.
- Hydraulic oil from the accessory pump is routed to the barrel end of the counterweight pin cylinders.
- The counterweight pin cylinder rods extend to engage the counterweight pins.
- The oil from the rod end of the cylinders flows back to tank via the low pressure accessory valve.

Disengage (retract)

When the counterweight pins switch is held in the disengage, the following occurs:

- The solenoid on the counterweight pins control valve is energized by 24 V_{DC} from the CCS.
- The solenoid shifts the control valve to the disengage position.
- Hydraulic oil from the accessory pump is routed to the rod end of the counterweight pin cylinders.
- The counterweight pin cylinder rods retract to disengage the counterweight pins.

The oil from the barrel end of the cylinders flows back to tank via the low pressure accessory valve.

Counterweight Limit Switch

The counterweight limit switch stops the boom hoist and the gantry from raising the crane counterweights too high during counterweight installation.

GANTRY CYLINDER OPERATION

See Figure 10-1 and Figure 10-2

Gantry Cylinders Overview

The gantry cylinders are controlled by a switch either on the remote control or on the right side cab console.

The system consists of the main pump A, a 2-position, proportional solenoid-operated accessory enable control valve, a 3-position, solenoid-operated control valve, and two double-acting hydraulic cylinders with holding valves.

The setup remote control communicates with the gantry cylinder solenoid valves via the CCS.

The switch on the cab console communicates with the gantry cylinder solenoid valves via the CCS.

To activate the setup remote control, it must be turned in crane's main display. See the Main Display Operation Manual provided with the crane.

To activate the gantry cylinders switch on the cab console, the Boom Butt Configuration must be selected in the RCL/RCI Display. See the RCL/RCI Operation Manual supplied with the crane.

Both gantry cylinder switches are 3-position momentary switches that are spring returned to the off position when released.

Neutral

When there is no command from either gantry cylinders switch, the following occurs:

- The solenoid on the accessory enable valve is deenergized and a spring shifts the valve to block pump A flow to the high pressure accessory valve bank.
- The solenoids on the gantry cylinders control valve are deenergized and springs shift the valve to the neutral position.
- The gantry cylinders are help in their last position by the holding valve on each cylinder.

Retract

When a retract command is sent by either gantry cylinders switch, the following occurs:

- The proportional solenoid on the accessory enable valve is energized by a PWM (pulse width modulation) signal from the CCS to adjust the flow rate of oil to the high pressure accessory valve bank.
- At the same time, the retract solenoid on the gantry cylinders control valve is energized by 24 V_{DC} from the CCS.
- The energized solenoid shifts the valve spool to the position that routes hydraulic oil to the rod end of the gantry cylinders.
- Pressure from the rod ends of the cylinders pilots open the load holding valves allowing the oil from the barrel end of the cylinders to flow back to tank via the high pressure accessory valve.
- The cylinder rods retract to lower the gantry.

Load Holding

If hydraulic pressure is lost for any reason, the holding valves close and the check valve traps the oil in the barrel end of each cylinder, preventing the cylinders from retracting.

Extend

When an extend command is sent by either gantry cylinders switch, the following occurs:

- The proportional solenoid on the accessory enable valve is energized by a PWM signal from the control system to adjust the flow rate of oil to the high pressure accessory valve bank.
- At the same time, the extend solenoid on the gantry cylinders control valve is energized by 24 V_{DC} from the CCS.
- The energized solenoid shifts the valve spool to the position that routes hydraulic oil to the barrel end of the gantry cylinders.
- The oil flows over the load holding check valves to the barrel end of the cylinders and the cylinders extend to raise the gantry.
- The hydraulic oil in the rod end of the cylinders flows back to tank via the high pressure accessory valve.

BOOM HOIST OPERATION

See Figure 10-1 and Figure 10-2

The thumbwheel on the remote control operates the boom hoist in the same manner as the control handle in the cab.

The boom hoist park switch in the cab must be unparked to operate the boom hoist.

The sync switch allows the gantry cylinders to follow along with the gantry when the boom hoist thumbwheel is used to raise and lower the gantry during counterweight installation and removal.

CRAWLER POSITIONING CYLINDERS OPERATION

Crawler Positioning Cylinders Overview

The crawler positioning cylinders are controlled by a switch on the right side cab console.

The system consists of the main pump A, a 2-position, proportional solenoid-operated accessory enable valve, a 3-position, solenoid-operated control valve, and two double-acting hydraulic cylinders. The crawlers are locked in the extended or retracted position by manually inserted pins.

The crawler positioning switch on the cab console communicates with the gantry cylinder solenoid valves via the CCS.

The crawler positioning switch is a 3-position momentary switch that is spring returned to the off position when released. The switch is active whenever the engine is running.

Neutral

When there is no command from crawler positioning switch, the following occurs:

- The solenoid on the accessory enable valve is deenergized and a spring shifts the valve to block pump A flow to the high pressure accessory valve bank.
- The solenoids on the crawler positioning control valve are deenergized and springs shift the valve to the neutral position.
- The crawler positioning cylinders remain in their last position.

Retract

When a retract command is sent by the crawler positioning switch, the following occurs:

- The proportional solenoid on the accessory enable valve is energized by a PWM signal from the control system to adjust the flow rate of oil to the high pressure accessory valve bank.
- At the same time, the retract solenoid on the crawler positioning control valve is energized by 24 V_{DC} from the CCS.
- The energized solenoid shifts the valve spool to the position that routes hydraulic oil to the rod end of the crawler positioning cylinders and the cylinders retract.
- The hydraulic oil in the barrel end of the cylinders flows back to tank via the high pressure accessory valve.

Extend

When an extend command is sent by the crawler positioning switch, the following occurs:

- The proportional solenoid on the accessory enable valve is energized by a PWM signal from the control system to adjust the flow rate of oil to the high pressure accessory valve bank.
- At the same time, the extend solenoid on the crawler positioning control valve is energized by 24 V_{DC} from the CCS.
- The energized solenoid shifts the valve spool to the position that routes hydraulic oil to the barrel end of the crawler positioning cylinders and the cylinders extend.
- The hydraulic oil in the rod end of the cylinders flows back to tank via the high pressure accessory valve.

HYDRAULIC COOLING FAN OPERATION

See Figure 10-1 and Figure 10-2

The system consists of the fan pump, the hydraulic oil cooler and motor, and the hydraulic oil temperature switch.

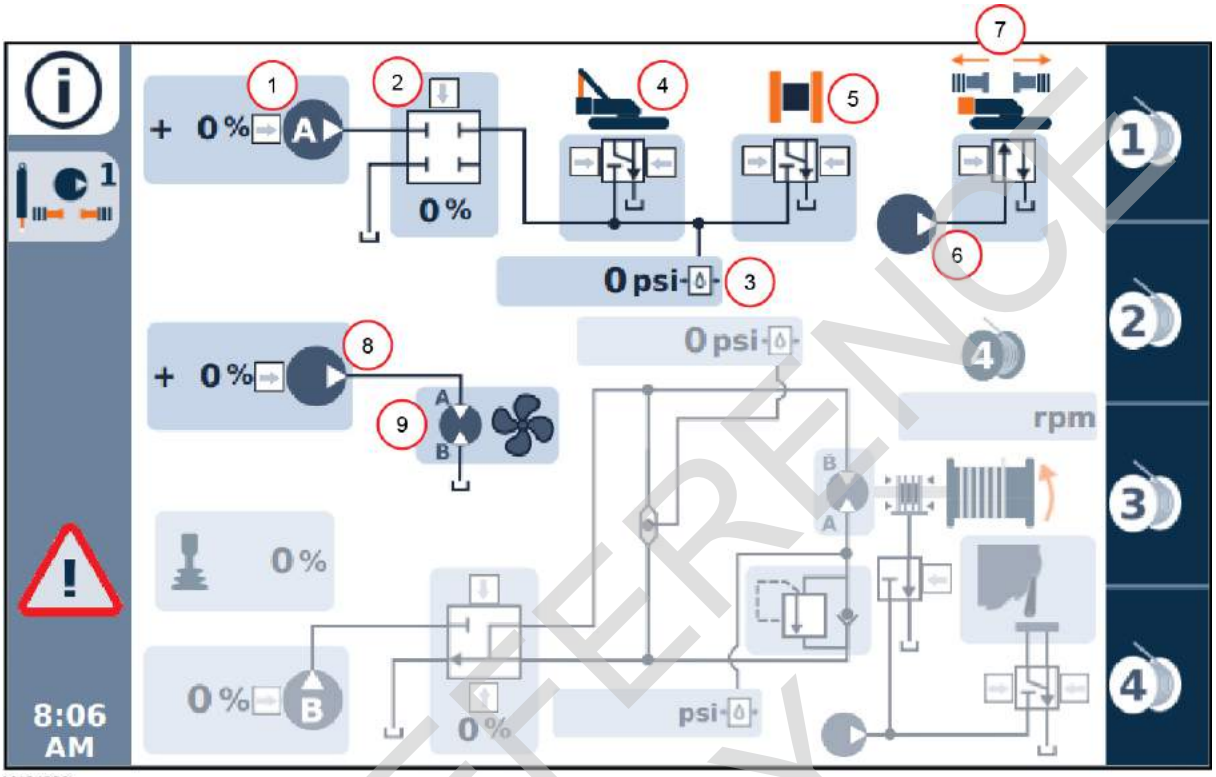
The hydraulic cooling fan is controlled by the temperature of the hydraulic oil:

- It turns on when the hydraulic oil temperature rises above 60°C (140°F)
- It turns off when the hydraulic oil temperature drops below 58°C (136.4°F).

The fan motor is equipped with a check valve that prevents cavitation when the motor is stopped by allowing return oil to flow from the motor outlet to motor inlet until the motor comes to a complete stop.

ACCESSORY SYSTEMS HYDRAULIC DIAGRAM

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



Item	Accessory Systems Components	Item	Accessory Systems Components
1	Pump A (Command (0 to 100%)	6	Accessory System Pump (low pressure)
2	Accessory System Enable Valve (Command 0 to 100%)	7	Counterweight Pins Control Valve
3	Accessory System Pressure Sensor	8	Hydraulic Cooler Fan Pump (Command (0 or 100%)
4	Gantry Cylinders Control Valve	9	Hydraulic Cooler Fan Motor
5	Crawler Cylinder Control Valve		

FIGURE 10-1

ACCESSORY SYSTEMS ELECTRICAL DIAGRAM

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

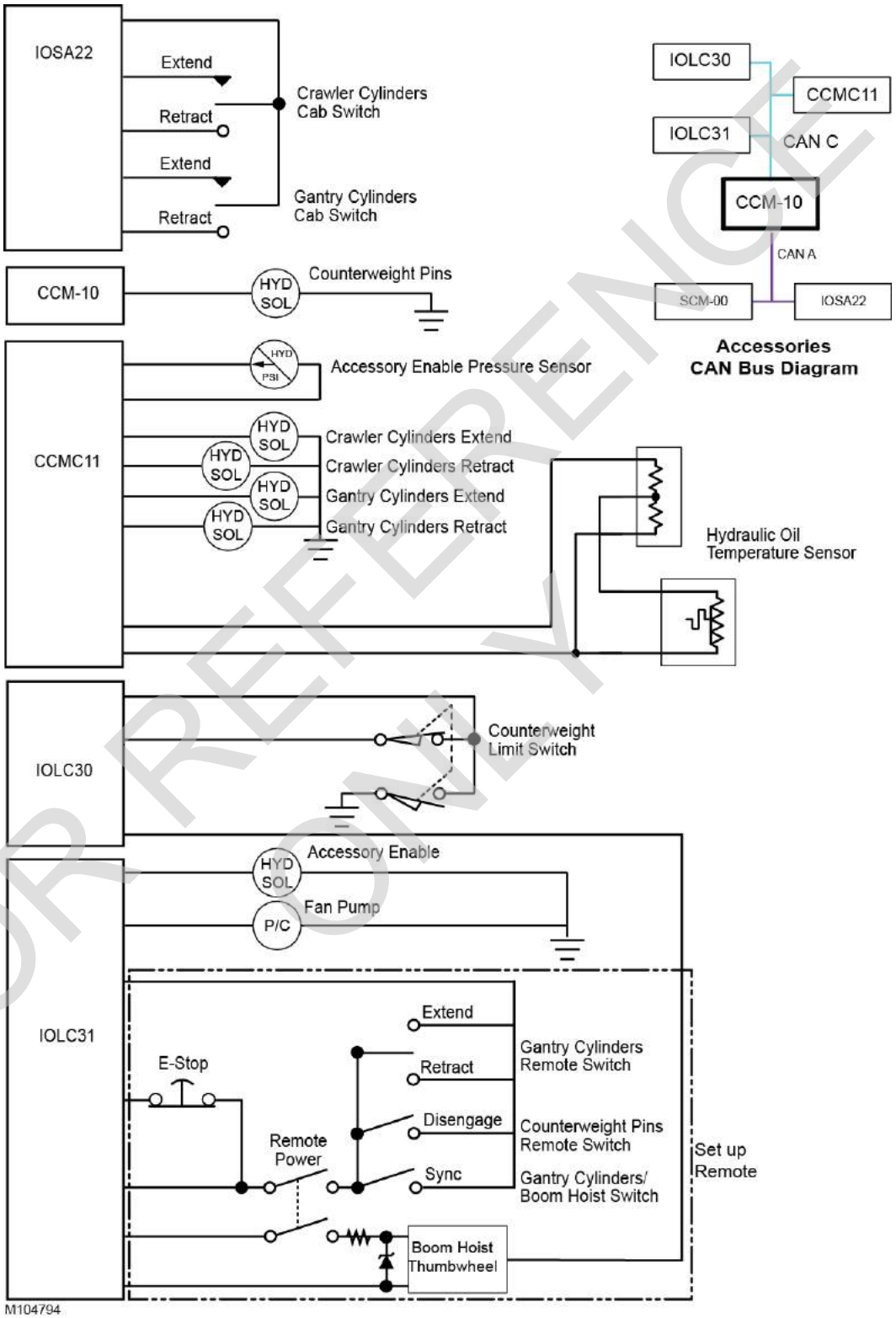


FIGURE 10-2

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ALPHABETICAL INDEX

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