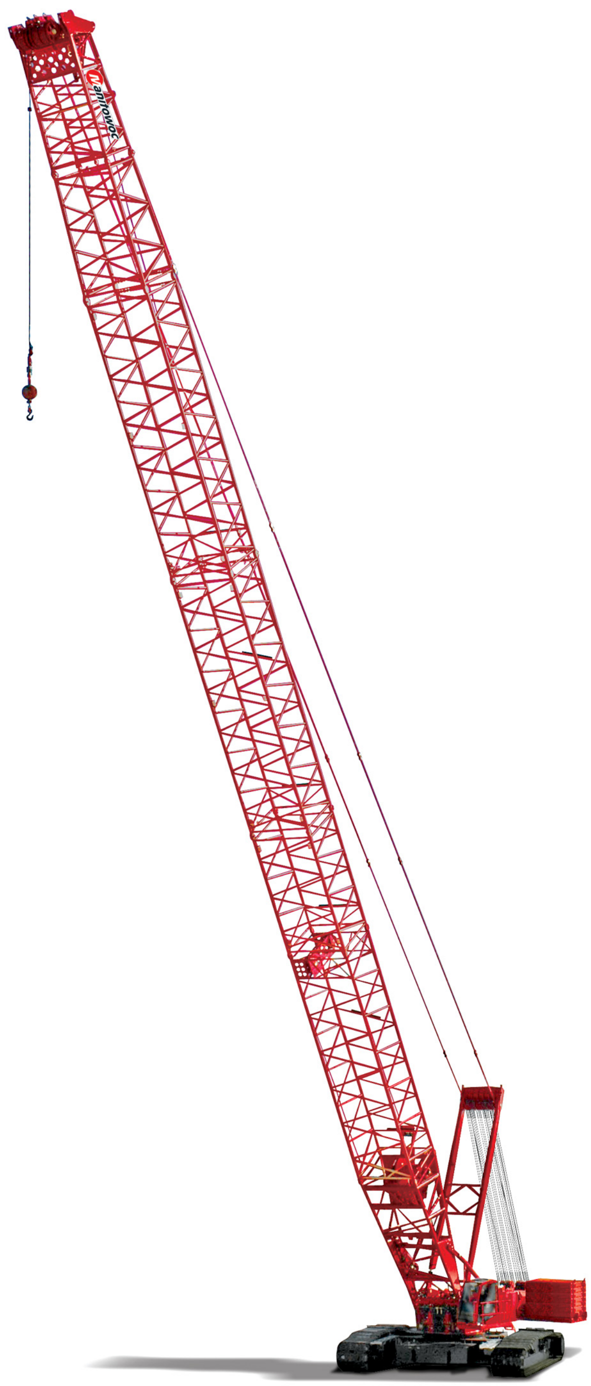
Manitowoc 16000

Service/Maintenance Manual



Grove   Manitowoc   National Crane   Potain

Manitowoc

SERVICE/MAINTENANCE MANUAL

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

16000

Crane Model Number

16001Ref

Crane Serial Number

This manual is divided into the following sections:

NOTICE

The serial number of the crane and applicable attachments (i.e. luffing jib, MAX-ER®) is the only method your Manitowoc dealer or Manitowoc Crane Care has of providing you with correct parts and service information.

The serial number is located on a crane identification plate attached to the operator's cab and each attachment. Refer to the Nameplate and Decal Assembly Drawing in Section 2 of this manual for the exact location of the crane identification plate.

Always furnish serial number of crane and its attachments when ordering parts or discussing service problems with your Manitowoc dealer or Manitowoc Crane Care.

⚠ 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 05-03-17, Control # 228-03

THE ORIGINAL LANGUAGE OF THIS PUBLICATION IS ENGLISH

See end of this manual for Alphabetical Index

SECTION 1 . . . . Introduction

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SECTION 1
INTRODUCTION

TABLE OF CONTENTS

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SECTION 1
INTRODUCTION

WARNING

California Proposition 65

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

- Always start and operate the engine in a well-ventilated area.
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

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

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

California Spark Arrestor

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

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 dealer or the Manitowoc Crane Care Lattice Team.

SAFETY MESSAGES

The importance of safe operation and maintenance cannot be over emphasized. Carelessness or neglect on the part of operators, job supervisors and planners, rigging personnel, and job site workers can result in 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

Without the safety alert symbol, identifies potential hazards that could result in property damage.

NOTE: A "NOTE" highlights operation or maintenance procedures.

SAFE MAINTENANCE PRACTICES

WARNING

The importance of safe maintenance cannot be over emphasized. Carelessness and neglect on the part of maintenance personnel can result in 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 cannot foresee all hazards that will arise in the field. Therefore, ***safety remains the responsibility of maintenance personnel and the crane owner***.

Maintenance Instructions

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

Crane maintenance and repair shall 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 Service Manual before attempting any maintenance procedure***. If there is any question regarding maintenance procedures or specifications, contact your Manitowoc dealer for assistance.

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

Safe Maintenance Practices

Use the following safe maintenance practices:

1. Perform the following steps (as applicable) before starting a maintenance procedure:
   a. Park the crane where it will not interfere with other equipment or operations.
   b. Lower all loads to the ground or otherwise secure them against movement.
   c. Lower the boom onto blocking at ground level if possible, or otherwise secure the boom from movement due to wind or other outside forces (see Wind Conditions topic in the capacity chart manual).
   d. Move all controls to OFF and secure all functions against movement by applying or engaging all brakes, pawls, or other locking devices.
   e. Stop the engine and render the starting means inoperative.
   f. Place a warning sign at the start controls alerting 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.
2. 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 run, keep your clothing and all parts of your body away from moving parts. ***Maintain constant verbal communication between the person at the controls and the person performing the maintenance or repair procedure***.
3. Wear clothing that is relatively tight and belted.
4. Wear appropriate eye protection and approved hard hat.
5. Never climb onto or off of a moving crane. ***Climb onto and off of the crane only when it is parked and only with operator permission***.

   Use both hands and the handrails, steps and ladders provided to climb onto and off of the crane.

NOTE: A safety harness and tether line must be worn when working on top of the enclosure.

   Tools and other equipment which cannot be carried securely onto and off of the crane in pockets or tool belts must be lifted with hand lines or hoists.
6. The boom and gantry are not intended as ladders. Do not attempt to climb lattice work on the boom or gantry to get to maintenance points. If the boom or gantry is not equipped with an approved ladder, lower them before performing maintenance or repair procedures.
7. Do not remove the cylinders until the working unit has been securely restrained against movement.
8. Pinch points are impossible to eliminate, so be aware of where they are and avoid them.
9. Pressurized air, coolant, and hydraulic oil can cause serious injury. Make sure all the air, coolant, and hydraulic lines, fittings, and components are installed correctly and are serviceable.

   Do not use your hands to check for air and hydraulic oil leaks:
   - Use a soap and water solution to check for air leaks (apply the solution to fittings and lines and watch for bubbles).
   - Use cardboard or wood to check for coolant and hydraulic oil leaks.
10. Relieve pressure before disconnecting any air, coolant, and hydraulic lines and fittings.
11. Do not remove the radiator cap while the coolant is hot or under pressure. Stop the engine, wait until the pressure drops and the coolant cools, and then slowly remove the cap.

12. Avoid battery explosion. Do not smoke while performing any battery maintenance, and do not short across the battery terminals to check its charge.

13. Read the safety information in the battery manufacturer instructions before attempting to charge a battery.

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

15. Stop the engine before refueling the crane.

16. Do not smoke or allow open flames in the refueling area.

17. If a safety-type can is used to add fuel to the fuel tank, it must have an automatic closing cap and a flame arrestor for refueling.

18. Mobile refueling of the crane from tank trucks and tank wagons must be in compliance with federal, state and local regulations and licensing. Best management practices must be used when fueling the crane.

19. Hydraulic oil can be flammable. Do not smoke or allow open flames in the area when filling the hydraulic tanks.

20. Never handle wire rope with your bare hands. Always wear heavy-duty gloves to avoid cuts from broken wires.

21. Use extreme care when handling coiled pendants. Stored energy can cause coiled pendants to uncoil quickly with considerable force.

22. When inflating the tires, use a tire cage, a clip-on inflater, and an extension hose that permits standing well away from the tire.

23. Only use cleaning solvents that are non-volatile and non-flammable.

24. Do not attempt to lift heavy components by hand. Use a hoist, jacks, or blocking to lift the components.

25. Use care while welding or burning on the crane. Cover all hoses and components with non-flammable shields or blankets to prevent a fire or other damage.

26. To prevent damage to crane parts (bearings, cylinders, swivels, slewing ring, computers, etc.), perform the following steps before welding on the crane:

- Disconnect all cables from the batteries
- Disconnect the output cables at the engine junction box
- Attach the 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 engine-mounted parts (per the engine manufacturer).

27. Disconnect and lock the power supply switch before attempting to service any high voltage electrical components and before entering any tight areas, such as the carbody openings, containing high voltage components.

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

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

29. Unless authorized in writing by Manitowoc, do not alter the crane in any way that affects the crane's performance (including 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/operator liable for any resultant accidents.

30. ***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.

31. Store tools, oil cans, spare parts, and other necessary equipment in tool boxes. Do not allow these items to lie loose in the operator cab or on walkways and stairs.

32. Do not store flammable materials on the crane.

33. Do not return the crane to service at the completion of maintenance or repair procedures until all guards and covers have been reinstalled, trapped air has been bled from the hydraulic systems, safety devices have been reactivated, and all maintenance equipment has been removed.

34. Perform a function check to ensure proper operation at the completion of maintenance or repair.

ENVIRONMENTAL PROTECTION

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

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

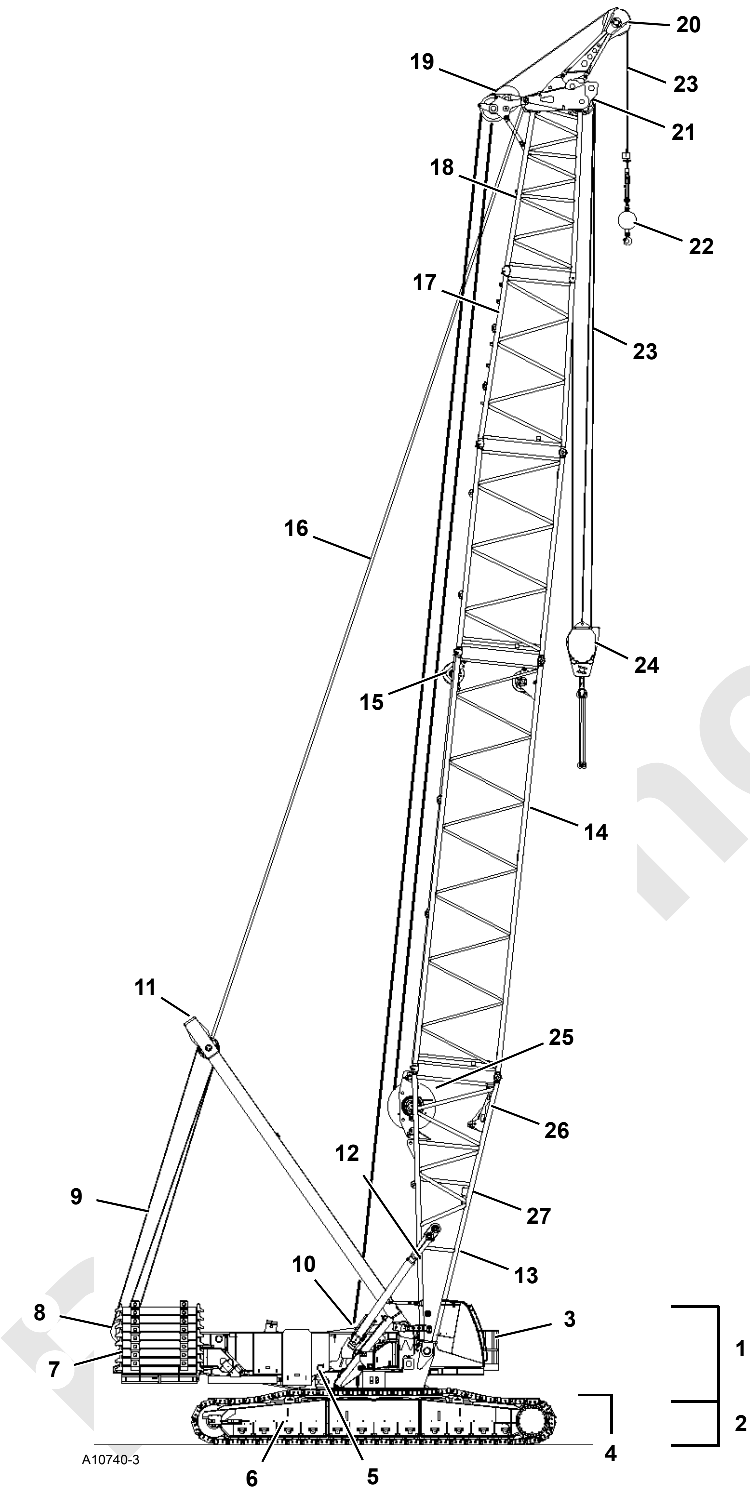
Handle and dispose of waste according to local, state, and federal environmental regulations.

When filling and draining crane components, do not pour any 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 COMPONENTS

See Figure 1-1 through Figure 1-6 for component identification.



Item	Description
1	Upperworks
2	Undercarriage
3	Operator Cab
4	Carbody Counterweight (both ends)
5	Enclosures (both sides)
6	Crawler
7	Crane Counterweight
8	Boom Hoist Sheaves
9	Boom Hoist Wire Rope
10	Mast Arms with Cylinders
11	Mast (live)
12	Telescopic Boom Stop
13	Boom Butt
14	Boom Insert
15	Wire Rope Guides (in insert)
16	Boom Straps
17	Transition Insert
18	Boom Top
19	Wire Rope Guide
20	Upper Boom Point
21	Lower Boom Point
22	Weight Ball
23	Load Lines
24	Load Block
25	Load Drum 1
26	Auxiliary or Luffing Hoist
27	Rigging Winch
28	Swing Drive
29	Carbody Counterweights (both ends)
30	Platform with Step
31	Crawler Drive
32	Carbody
33	Adapter Frame (rotating bed)
34	Rotating Bed Jack (both sides front) (not furnished with European option)
35	Rotating Bed
36	Rotating Bed Jack (both sides rear) (not furnished with European option)
37	Boom/Mast Hoist (standard) OR Boom Hoist (MAX-ER)
38	Fuel Tank
39	Radiator
40	Power Plant (with pump drive)
41	Pumps
42	Hydraulic Tank
43	Load Drum 2
44	Boom Hinge Pin (right side)
45	Carbody Jacks (European option)

FIGURE 1-1

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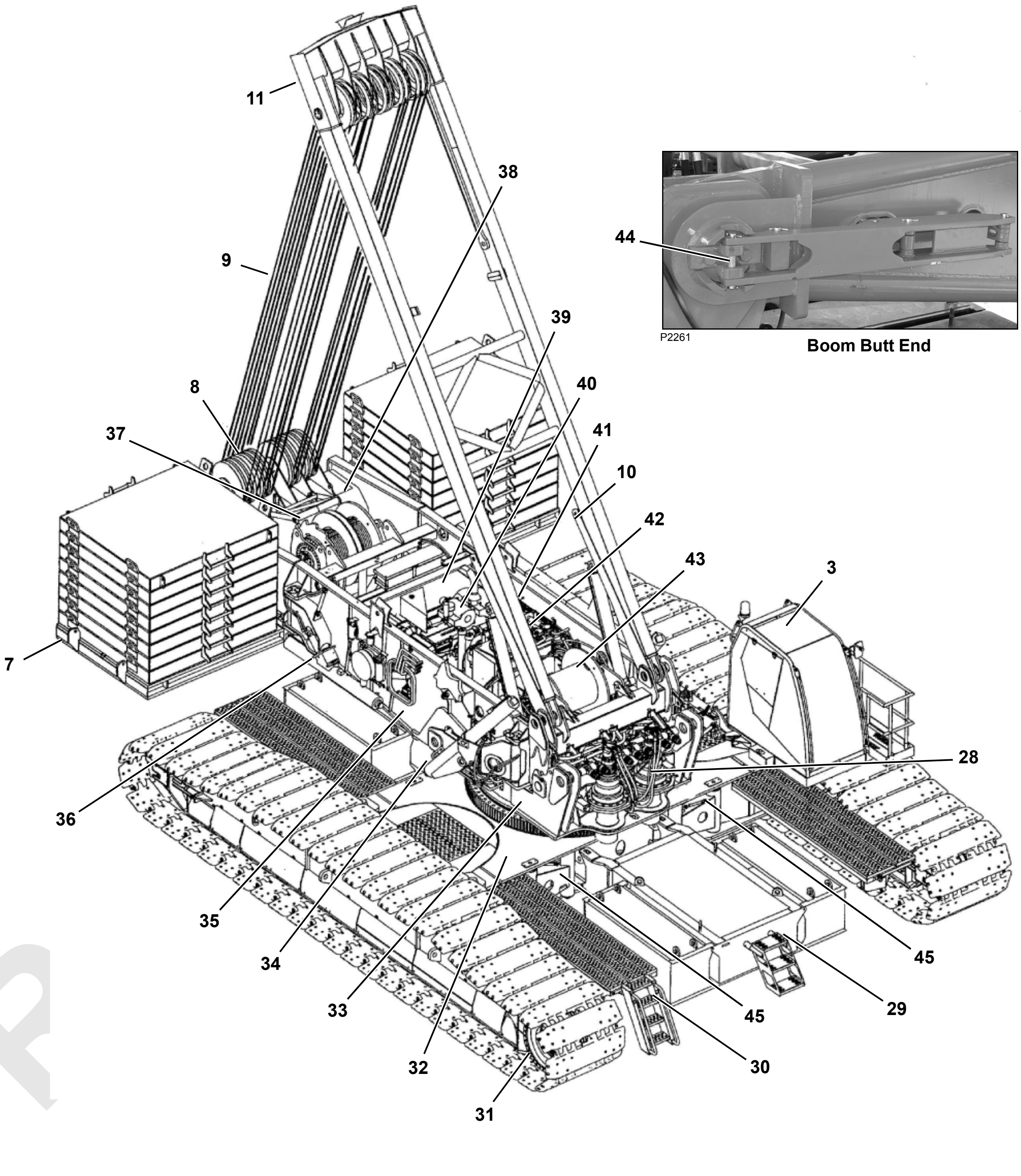

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Boom Butt End

FIGURE 1-1 continued

Assorted Views

Item	Description	Item	Description
1	Boom/Mast Drum	10	Crawler Auto Lube Pump
2	Sequence Valve (all drum motors)	11	Left and Right Swing Gearboxes
3	Boom/Mast Motor	12	Turntable Auto Lube Pump
4	Load Drum Motor	13	Swing Gears
5	Load Drum	14	Turntable Bearing
6	Drum Speed Sensor (all drums)	15	Hydraulic Tank Shut-off
7	Node-6 Controller	16	Drum 4 Pawl
8	Electrical Cable Reel	17	Drum 4
9	Rigging Winch		

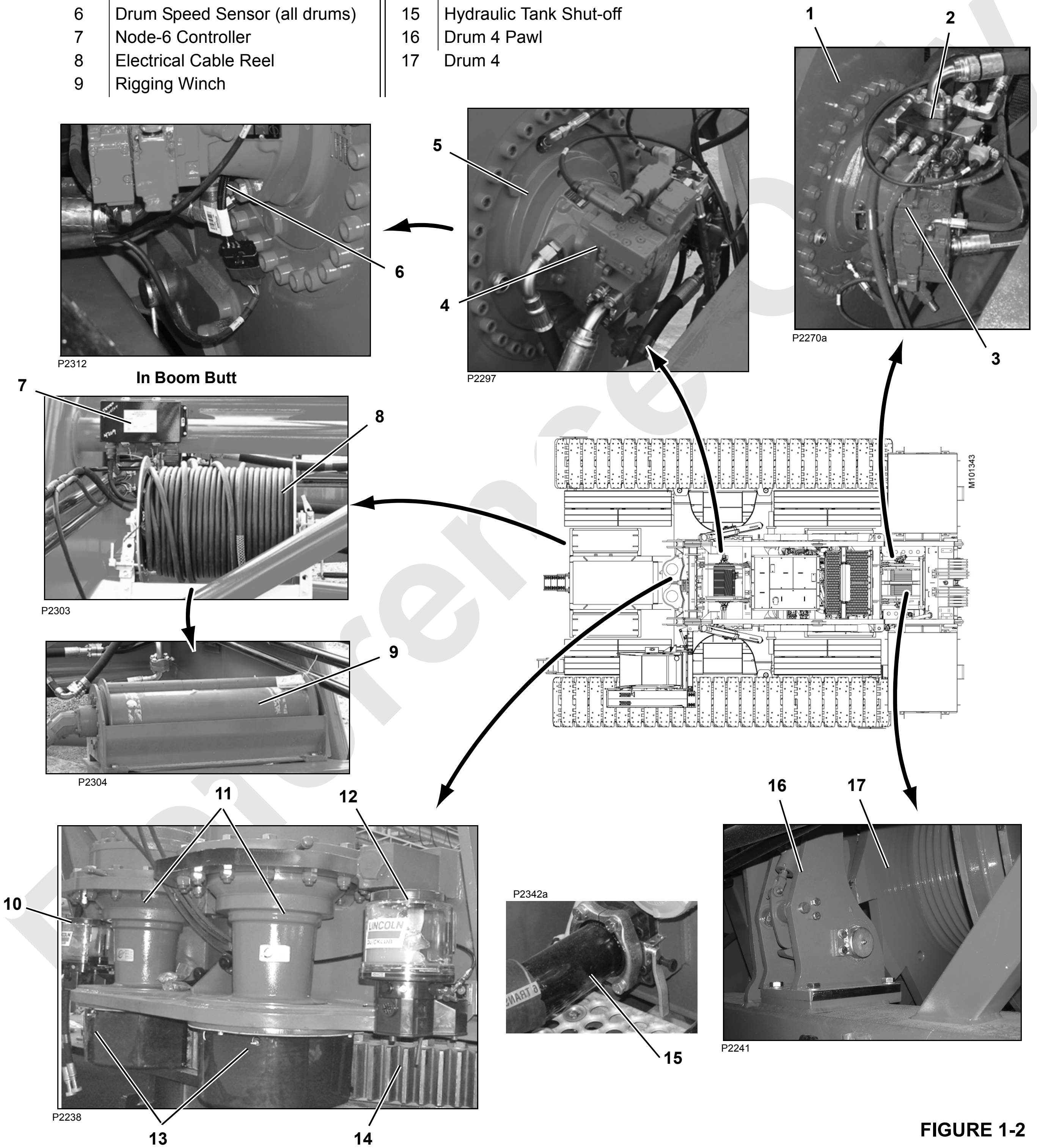
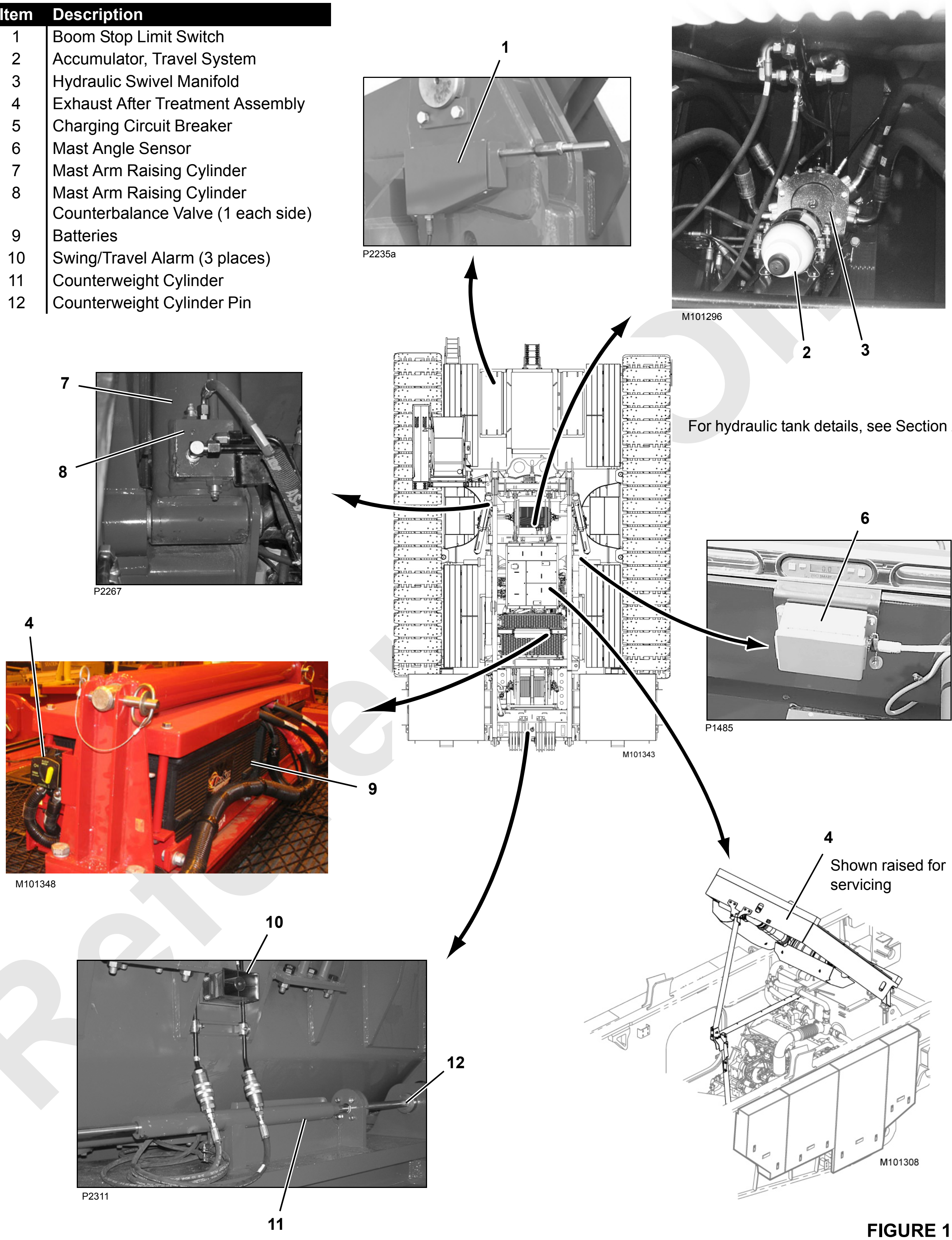


FIGURE 1-2

Top

Item	Description
1	Boom Stop Limit Switch
2	Accumulator, Travel System
3	Hydraulic Swivel Manifold
4	Exhaust After Treatment Assembly
5	Charging Circuit Breaker
6	Mast Angle Sensor
7	Mast Arm Raising Cylinder
8	Mast Arm Raising Cylinder Counterbalance Valve (1 each side)
9	Batteries
10	Swing/Travel Alarm (3 places)
11	Counterweight Cylinder
12	Counterweight Cylinder Pin



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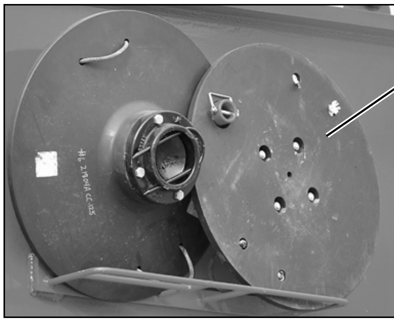

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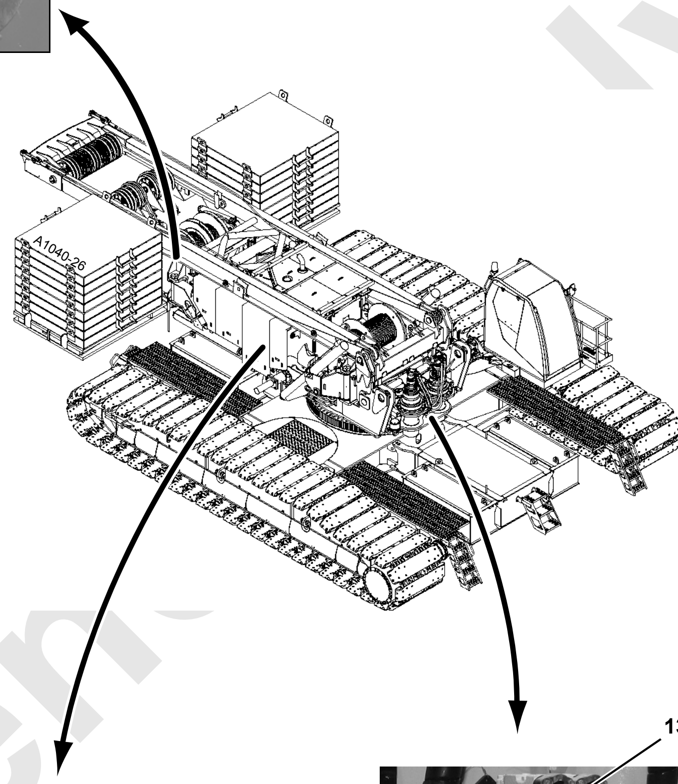
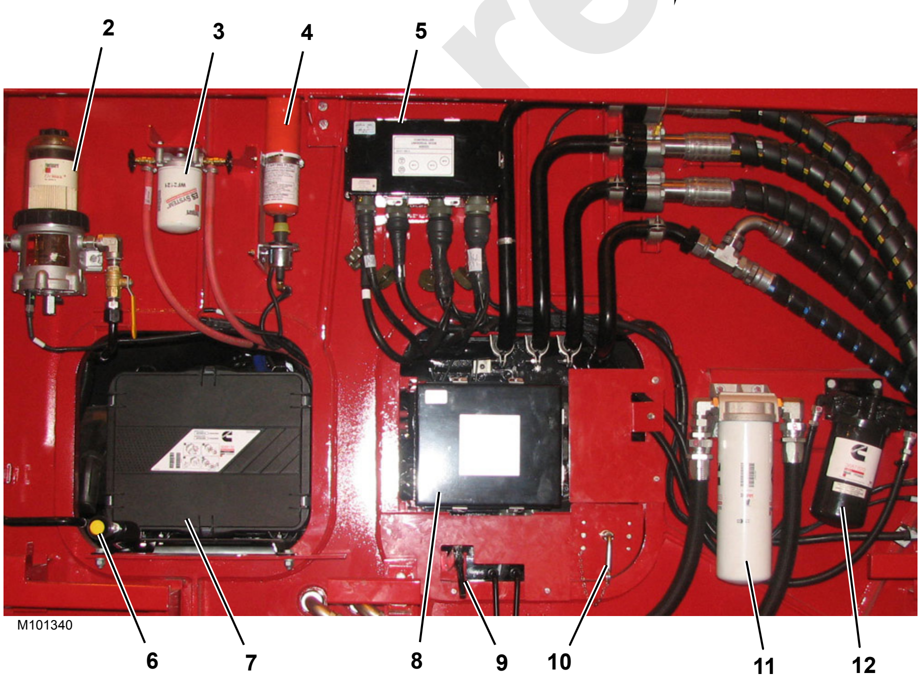


Right Side and Front

Item	Description
1	Jacking Cylinder Pads
2	Primary Fuel Filter/Water Separator
3	Coolant Filter
4	Ether Starting Aid Canister
5	Node 5 Controller
6	Air Cleaner Service Indicator
7	Engine Air Cleaner
8	Engine Node 0
9	Clutch Handle
10	Battery Disconnect Switch
11	Engine Oil Filter
12	Fuel Filter, Secondary
13	Swing Motor (2)
14	Swing Gearbox (2)



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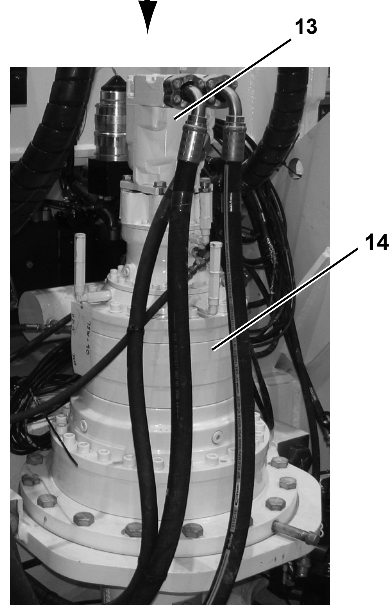

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FIGURE 1-4

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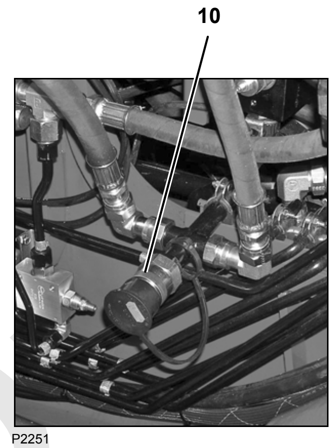
Left Side

Item	Description	Item	Description
1	Left Front Jacking Solenoid	18	Drum 4 Pawl Solenoid
2	Right Front Jacking Solenoid	19	R Travel to Drum 4 Diverting Solenoid
3	Mast Raising Cylinders Solenoid	20	L Travel to Drum 3 Diverting Solenoid
4	Rigging Winch Solenoid	21	Drum 4 to Drum 5 Diverting Solenoid
5	Right Rear Jacking Solenoid	22	Pressure Reducing Valve
6	Left Rear Jacking Solenoid	23	Drum 1 Pressure Sender
7	Pump Drive Dipstick	24	Boom/Mast A Pressure Sender
8	Engine Oil Dipstick	25	Boom/Mast B Pressure Sender
9	Left Rear Jack	26	Right Travel A Pressure Sender
10	Hydraulic Fill Port	27	Right Travel B Pressure Sender
11	Rear Rotating Bed Pin Solenoid	28	Left Travel A Pressure Sender
12	Boom Hinge Pin Solenoid	29	Left Travel B Pressure Sender
13	Cab Tilt Cylinder Solenoid	30	Swing Right Pressure Sender
14	Front Rotating Bed Pin Solenoid	31	Swing Left Pressure Sender
15	Counterweight Pin Solenoid	32	Drum 2 Pressure Sender
16	Drum 1 to Drum 2 Diverting Solenoid	33	Accessory Pressure Sender
17	Drum 2 to Drum 1 Diverting Solenoid		



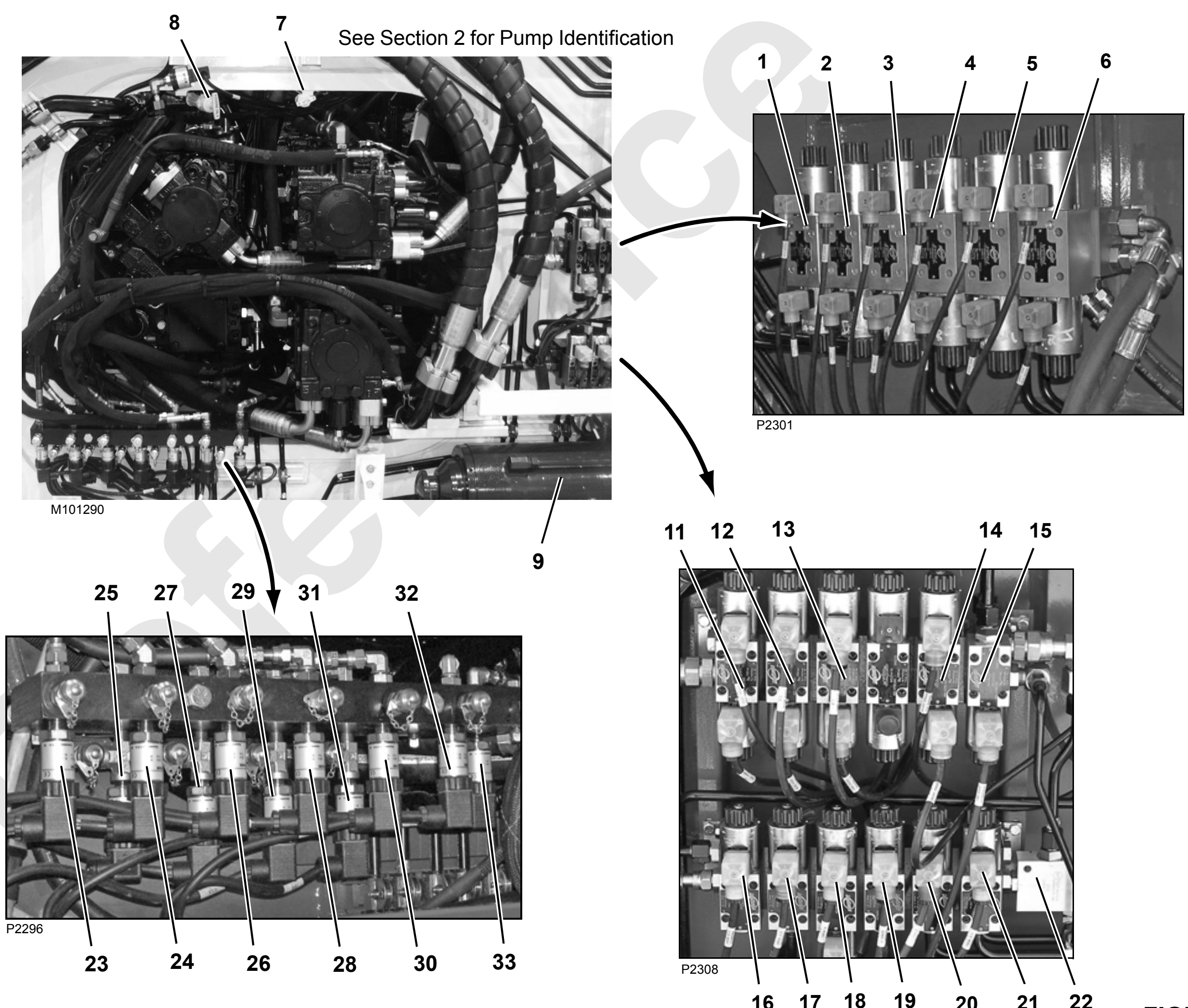
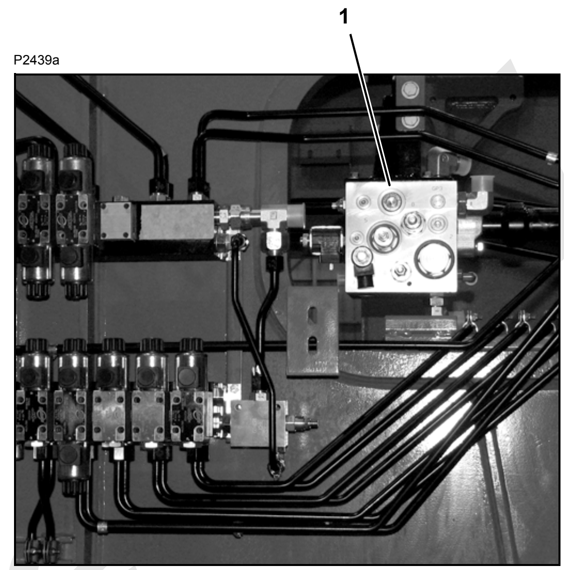


FIGURE 1-5

Left Side

Item	Description
1	Accessory System Manifold for MAX-ER, Engine Cooling Fan, Accessory High Pressure, and Accessory Low Pressure
2	35 to 345 bar (500 to 5,000 psi) Accessory System Proportional Relief Valve HS-68
3	214 bar (3,100 psi) Relief Valve Fixed
4	24 volt, 3-way, 2 Position Hydro Fan Solenoid Valve
5	Logic Relief Element Set at 0.8 bar (12 psi)
6	Pressure Reducing Valve Cartridge Set at 40 bar (580 psi)
7	Pressure Relieve Valve Cartridge Set at 345 bar (5,000 psi)
8	Sequence Valve with Internal Pilot
9	P2 Port for Pressure Supply from Variable Accessory Pump
10	P3 Port for Pressure Supply from Fixed Gear Accessory Pump
11	OUT Port to Fan Motor
12	P1 Port (not shown) Pressure Supply to Accessory and MAX-ER
13	P4 Port (not shown) Pressure Supply to Lower Accessory System
14	T Port (not shown) Return to Tank
15	P5 (not shown) Supply to Accessory System Pressure Sender



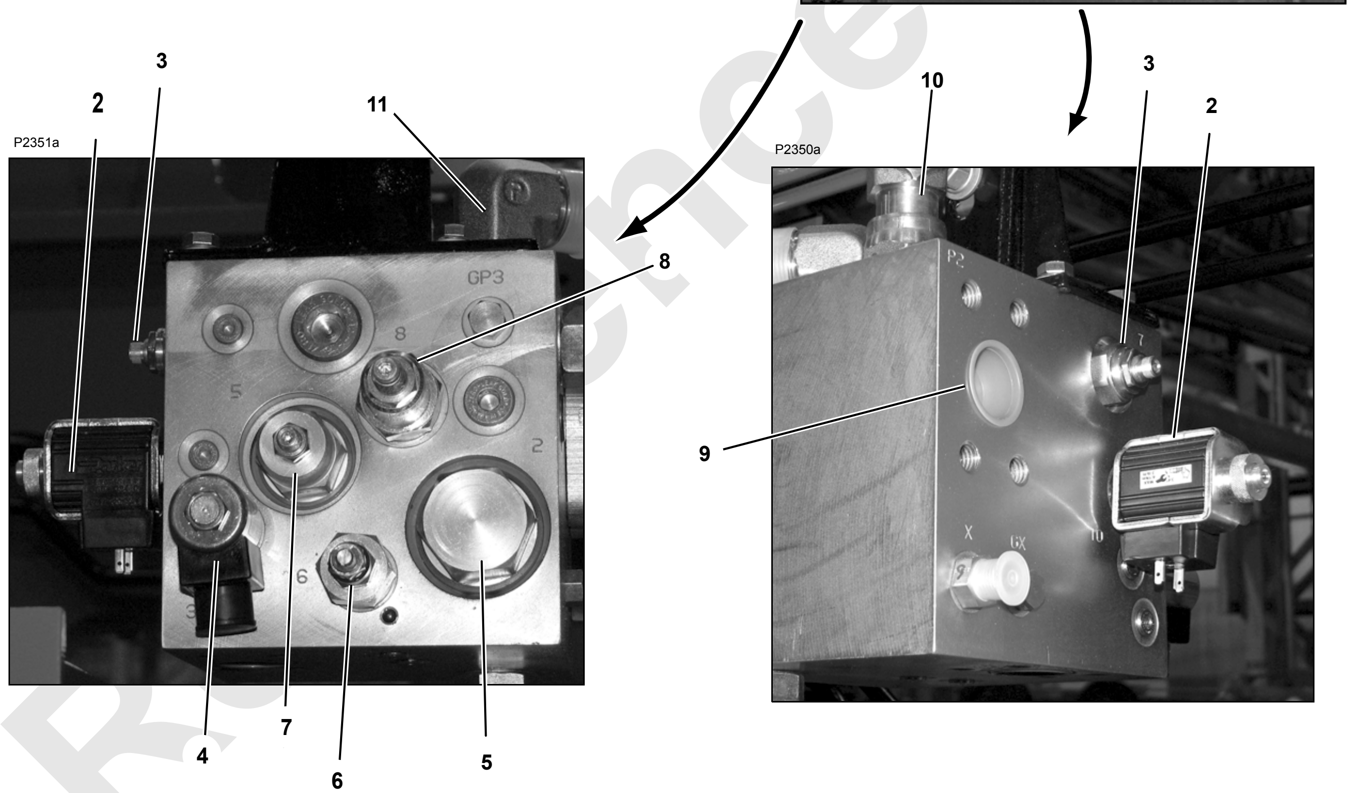
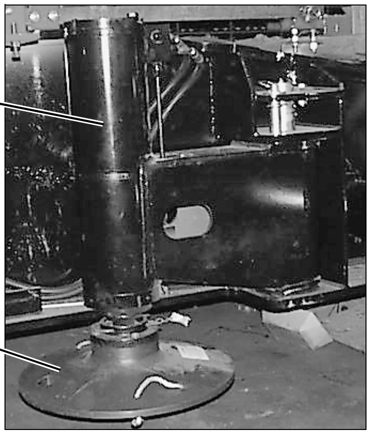


FIGURE 1-5 continued

Undercarriage/Crawler

Item	Description
1	Carbody Pedestal
2	Intermediate Crawler Roller (14 per crawler)
3	Crawler Roller (1 per crawler)
4	Right Crawler Pin Handle
5	Left Crawler Pin Handle
6	Crawler Input Planetary (both crawlers)
7	Crawler Brake (both crawlers)
8	Drive Shaft (both crawlers)
9	Crawler Output Gearbox (both crawlers)
10	Crawler Motor (both crawlers)
11	Carbody Jacks (European option)



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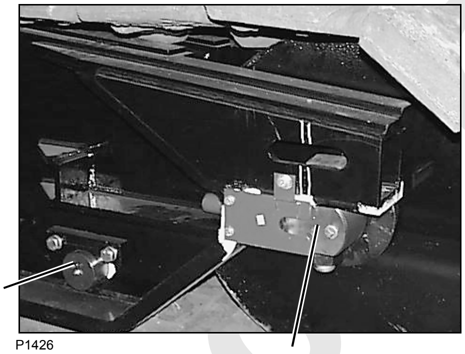

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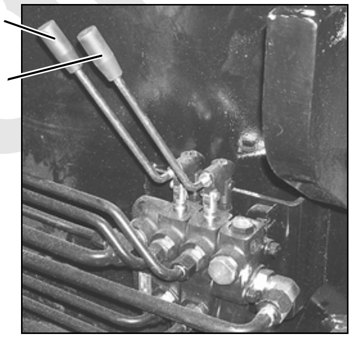

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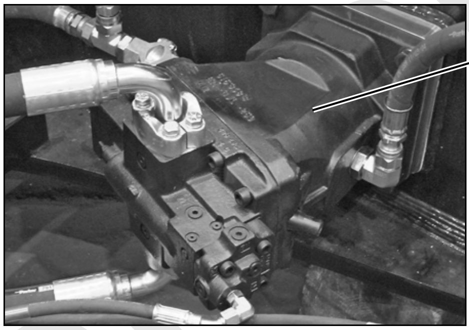

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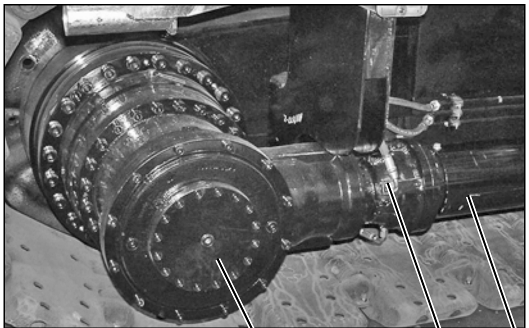

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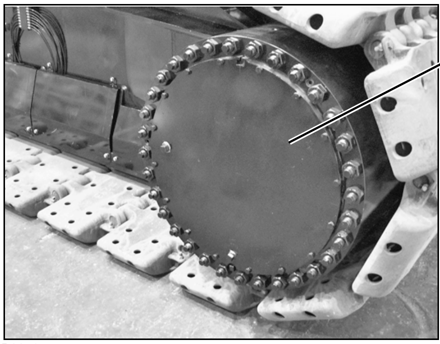

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FIGURE 1-6

Abbreviations Used in Section 1

A/C	Air Conditioning
AI	Analog Input
ALT	Alternator
AO	Analog Output
CAN	Controller Area Network
CB	Circuit Breaker
DISP	Displacement
EDC	Electrical Displacement Control
EPIC	Electrical Processed Independent Control
ES	Ether Start
GND	Ground (Electrical)
Hg	Mercury
HS	Hydraulic Solenoid
L	Left
LS	Left Side
M/C	Motor Control
P/C	Pump Control
PCOR	Pressure Compensated Over-Ride
PCP	Pressure Control Pilot
R	Right
RCL	Rated Capacity Limiter
RS	Right Side
SOL	Solenoid
SS	Starter Solenoid
S/S	Starter Solenoid
V	Volts
WCP	Cab Power

Solenoid Valve Identification

Each hydraulic solenoid valve is assigned an HS number for training identification only.

HS-1	Swing Brake Release
HS-5	Travel Brake Release
HS-6	Travel Two-Speed
HS-10	Drum 4 Boom/Mast Hoist Brake Release
HS-11	Drum 4 Boom/Mast Hoist Pawl In
HS-12	Drum 4 Boom/Mast Hoist Pawl Out
HS-13	Drum 4 to Drum 5 Diverting
HS-14	Right Travel Diverting to Drum 4
HS-15	Drum 1 Brake Release
HS-16	Drum 1 to Drum 2 Diverting
HS-20	Drum 2 Brake Release
HS-21	Drum 2 to Drum 1 Diverting
HS-25	Drum 3 Brake Release
HS-26	Drum 3 Pawl In
HS-27	Drum 3 Pawl Out
HS-28	Left Travel Diverting to Drum 3
HS-30	Drum 5 Boom Hoist Brake Release
HS-31	Drum 5 Boom Hoist Pawl In
HS-32	Drum 5 Boom Hoist Pawl Out
HS-40	Front Rotating Bed Pins Extend
HS-41	Front Rotating Bed Pins Retract
HS-42	Rear Rotating Bed Pins Extend
HS-43	Rear Rotating Bed Pins Retract
HS-50	Mast Cylinders Raise
HS-51	Mast Cylinders Lower
HS-52	Boom Hinge Pins Engage
HS-53	Boom Hinge Pins Disengage
HS-54	Rigging Winch Spool In
HS-55	Rigging Winch Spool Out
HS-56	Cab Tilt Up (Raise Cab Front)
HS-57	Cab Tilt Down (Lower Cab Front)
HS-58	Counterweight Pins Disengage
HS-59	Engine Hydro-Fan
HS-60	Left Front Jack Extend
HS-61	Left Front Jack Retract
HS-62	Right Front Jack Extend
HS-63	Right Front Jack Retract
HS-64	Left Rear Jack Extend
HS-65	Left Rear Jack Retract
HS-66	Right Rear Jack Extend
HS-67	Right Rear Jack Retract
HS-68	Accessory System Proportional Relief

DESCRIPTION OF CRANE OPERATION

See Figure 1-7.

This section describes the standard and optional equipment available for the Model 16000 crane. Disregard any equipment your crane does not have.

The operating system is an EPIC® (Electrical Processed Independent Control) with CAN-bus (Controller Area Network) technology. The CAN-bus system uses multiple nodes that contain remote controllers. The remote node controllers communicate with Node-1 master controller by sending information data packets over a two-wire bus. The data packets are tagged with addresses that identify each system component.

With the CAN-bus system, the independently powered pumps, motors, and cylinders provide controller-driven control logic, pump control, motor control, on-board diagnostics, and service information. Crane information is shown on the main display in the operator cab (see Main Display topic in Section 3).

A diesel engine provides power to operate the system pumps through a pump drive transmission.

In a closed-loop hydraulic system, high-pressure hydraulic fluid from the system pump drives a hydraulic motor or cylinder. Pressure develops within the closed-loop system while resistance to movement of the load on the motor or cylinder is overcome. When movement begins, pump volume displacement maintains motor speed or cylinder movement. The spent hydraulic fluid from the motor outlet returns to the pump input. The crane closed-loop systems are swing, right travel, left travel, the boom/mast hoist, and the load drums.

Enabled means hydraulic fluid ***can flow*** in a system or an electrical component ***is on***. ***Disabled*** means hydraulic fluid ***is blocked*** in a system or an electrical component ***is off***. Each hydraulic solenoid valve is assigned an HS number for identification in this section.

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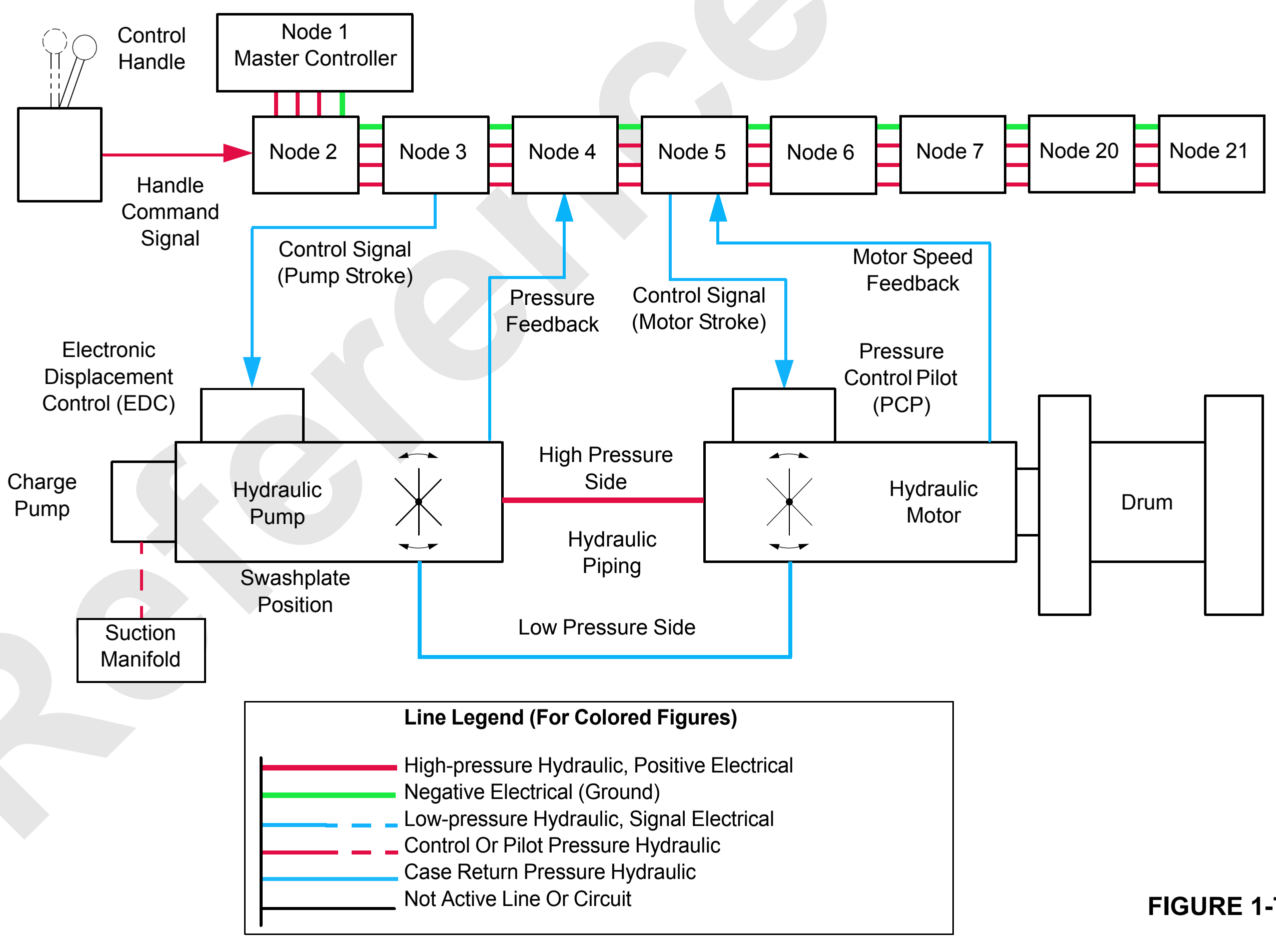

FIGURE 1-7

Hydraulic Components

High-pressure piston pumps driven by a multi-pump drive transmission provide independent closed-loop hydraulic power for crane functions. Each system has relief valves to protect for overload or shock.

Hydraulic Tank

The hydraulic tank has two sections separated by a baffle: a suction section and a return section. Components include a separate breather, suction strainer, return filters, diffuser, temperature sensor, level sensor, and pressure ports.

The suction section has a 150-micron (100-mesh) strainer that allows fluid bypass around the strainer at 0.2 bar (3 psi) if it becomes plugged. The breather protects the tank from excessive pressures or vacuum opening at 38 mm (1.5 in) of mercury (Hg).

A system fault alarm indicates when the hydraulic tank fluid level is low, hydraulic fluid temperature is too high, or filter is blocked.

Strainers and filters remove contaminants, but this filtration does not transform deteriorated fluid into purified-quality fluid. A program to test or replace hydraulic fluid at scheduled times must be established for efficient operation of all hydraulic systems.

Shut-off Valve

A shut-off valve is located between the hydraulic tank and the suction manifold. Close this valve when performing maintenance on hydraulic systems. ***Before starting the engine, always check that the hydraulic tank shut-off valve is open.***

Return Manifolds

Return fluid from the motor and pump case drains is routed through the main return manifold and cooler before entering the hydraulic tank. The main return manifold has a relief check valve set at 1.7 bar (25 psi); allowing fluid to bypass the cooler if it becomes plugged. Return fluid from relief valves, brake valves, drum pawls, and counterbalance pin cylinders returns to the other return manifold, bypassing the cooler before entering the tank.

Oil Temperature Valve

At the hydraulic tank, a thermostatically controlled valve is located on the return-to-cooler manifold. At 60°C (140°F), the valve begins to open, allowing return oil to flow to the cooler.

Accessory/MAX-ER Pump

The accessory/MAX-ER pump is a variable displacement piston pump that draws hydraulic fluid from the suction manifold and supplies hydraulic fluid to high and low pressure accessories and the optional MAX-ER attachment.

Hydraulic Pumps

See the hydraulic pump manufacturer's service manual for a description of a hydraulic piston pump.

The drum, swing, and travel pumps are variable displacement, axial piston pumps that operate in a bi-directional closed-loop system. Each pump contains the following components:

- A charge pump
- EDC (Electrical Displacement Control)
- A cylinder block where pistons are positioned axially around a drive shaft
- A charge pressure relief valve
- Two multifunction (relief) valves

A system charge pump draws fluid directly from the tank suction manifold and delivers it to the closed-loop system at a charge pressure of approximately at 24 bar (350 psi). The charge pressure depends on the engine load/speed, pressure relief valve settings, and hydraulic system efficiency.

When a system control handle is moved, a node controller sends a variable 0 to 24 volt output to the pump EDC as required for handle command direction. The pump EDC tilts the swashplate to the stroke pump in the command direction. Pump pistons move within the cylinder block as the block rotates. The longer stroke of each piston draws in return fluid from the system motor. As the stroke shortens, hydraulic fluid is pushed out of the pump piston cylinders into the hydraulic piping to the motor. Pressurized hydraulic fluid from the pump turns the motor in the command direction. Hydraulic fluid displaced by the motor returns through the hydraulic piping to the inlet side of the system pump.

The swashplate tilt angle determines the volume of fluid that can be pumped to the motor. Increasing the swashplate tilt angle increases the piston stroke length, allowing more fluid to be pumped to the motor. Motor servos in the drum and travel systems allow low and high-speed operation.

Each pump has two multifunction valves that consist of a system relief valve and charge flow make-up check valve. Pump system multifunction valves control the maximum system pressure and protect each pump system from damage by limiting pressure spikes in each operating direction. When the preset loop system pressure is reached, multifunction valves limit system pressure by de-stroking the pump or transferring fluid from the high-pressure side to the low-pressure side.

Charge Pressure

The charge pressure in each closed-loop system is preset at approximately 24 bar (350 psi) with a relief valve in the charge pump. The charge pressure must be at the preset value as lower pressures can cause a slowing or stopping of operation. If the charge pressure is set too high, the hydraulic system could be damaged. When a system control handle is in the neutral position the main display indicates the system charge pressure.

If any charge pressure system drops, the system brake begins to apply at approximately 14 bar (203 psi). The main system pumps de-stroke as charge pressure drops to the minimum pressure. The accessory pump de-strokes if the suction side pressure drops below 11 bar (160 psi).

Hydraulic Motors

See the hydraulic motor manufacturer's service manual for a complete description of a hydraulic piston motor.

Variable-displacement low torque/high speed, bent axis piston hydraulic motors are used in the travel, boom/mast hoist, and load drum systems. The swing system motor is a fixed displacement, low torque/high speed, bent-axis piston hydraulic motor. Each motor contains a cylinder block, pistons, output shaft, and internal flushing valve. The boom/mast hoist and load drums motor have a Pressure Control Pilot (PCP) valve that controls the output speed/torque of the motor.

The motor cylinder block axis is tilted at an angle to the output shaft with pistons fitted axially around its axis. The internal end of the output shaft has a large flange face similar to a pump swashplate. The motor piston ends are connected to output flange face and do not ride around the axis of the rotating flange face like the pump pistons.

Hydraulic fluid from the pump enters the selected inlet side of the motor and places a force against the pistons. The retained piston ends place a thrust against the output flange with a rotational torque that turns the output shaft. This also rotates the cylinder block on the bent axis, while the tilt angle to the flange face moves the pistons as they rotate. Hydraulic fluid displaced by the motor pistons exits the motor and returns to the inlet side of the system pump through the hydraulic piping.

Pressure Monitoring

The main display indicates the selected system pressures. The system pressure displayed is the charge pressure or greater. System pressure can also be checked when the system is stroked at each pressure sender diagnostic coupler with a 690 bar (10,008 psi) high pressure gauge.

Basic Operation

See Figure 1-8 or Figure 1-9 for the following procedure.

When a control handle is moved from the neutral position, an input voltage in the handle command direction is sent to the Node-1 controller. The selected component node controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the pump external EDC. The output current magnetizes an armature (Figure 1-8) and starts to block one of the orifice ports, depending on the command direction.

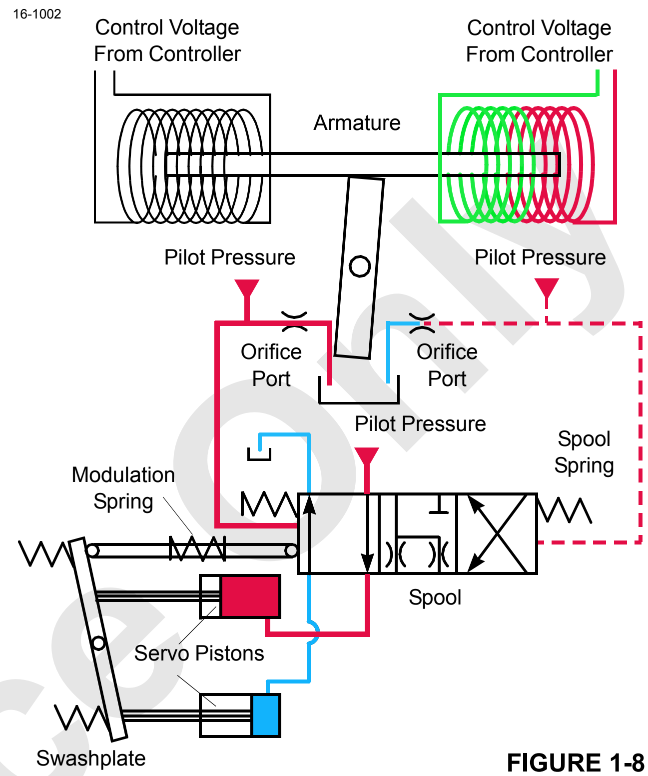

FIGURE 1-8

Blockage of flow at the exhaust side of the right orifice port causes a pressure difference across the spool. This pressure difference overcomes the resistance of the spool spring and moves the spool proportionally to pressurize the top servo pistons. The fluid from the bottom servo pistons is routed to the tank. This tilts the swashplate, stroking the pump in the selected command direction. As the swashplate tilts, the chamber spring is pulled in the opposite direction of the spool with the a linkage. This centers and maintains the spool in a neutral position until the 1 bar (15 psi) chamber spring pressure is reached.

In travel pumps, the pressure relief and pressure-limiting sections of multifunction valves respond when the relief pressure is reached. The pressure-limiting function of travel pumps is set not to exceed 420 bar (6,092 psi). If the travel pump pressure exceeds the preset pressure limit, the pumps de-stroke to prevent overheating of the system fluid.

Hydraulic fluid pressure overcomes the spring resistance in the pressure-limiting relief valve (1, Figure 1-9), shifting the spool to open a line for fluid pressure. The servo check valve (2) is spring loaded with an opening pressure of 52 bar (754 psi). Hydraulic fluid from the pressure-limiting relief valve flows through the exhaust port of the displacement control valve (3).

The exhaust port has a restricted orifice that develops pressure for the servo control cylinder (4) to pressurize and de-stroke the pump to limit system pressure. When rapid loading produces pressure spikes, the system relief valve (5) shifts. This allows high-pressure fluid to return to the tank through the charge pump relief valve (6). Alternatively, fluid transfers to the low-pressure side of the closed-loop system through the charge flow make-up check valve (7).

In other system pumps, the pressure limiting is controlled through the relief valve section of the multifunction valves only. The flow control orifice (8) is removed from the pump EDC. Servo check valves are removed from the pump and the lines to the servo control cylinders are plugged. These changes permit the pump to react quicker to control handle commands.

The pressure-limiting relief valve (1) serves as the pilot valve to open the system relief valve (5) when the desired relief pressure setting is reached. For example, if a pressure imbalance occurs on both sides of the flow restrictor (9), the pressure-limiting valve opens and the system relief valve relieves system pressure. Hydraulic fluid is directed to the tank through the relief valve (7) or the flow is transferred to the low-pressure side of the system through the make-up check valve (8).

Pump displacement depends on the swashplate tilt angle. The swashplate angle also affects pump speed.

Each variable-displacement motor, except travel, begins operation at maximum displacement (high torque, low speed) and shifts to minimum displacement (low torque, high speed) if the torque requirement is low. The motor remains in maximum displacement until the servo PC valve (10) receives a command from the PCP valve (11) to direct the system pressure and flow from the shuttle valve (12) to the minimum displacement side of the servo cylinder (13) that shifts the motor. As the PCP valve opens in proportion to the output voltage received from the node controller, the pilot line pressure is directed to shift the servo PC valve. After overcoming the adjustable valve spring (14) and valve spring (15), the servo PC valve shifts and directs fluid to stroke the motor at minimum displacement output. If the load at the motor shaft increases, the force on the adjustable valve spring increases. This shifts the servo PC valve to de-stroke the motor to maximum displacement for safe load handling.

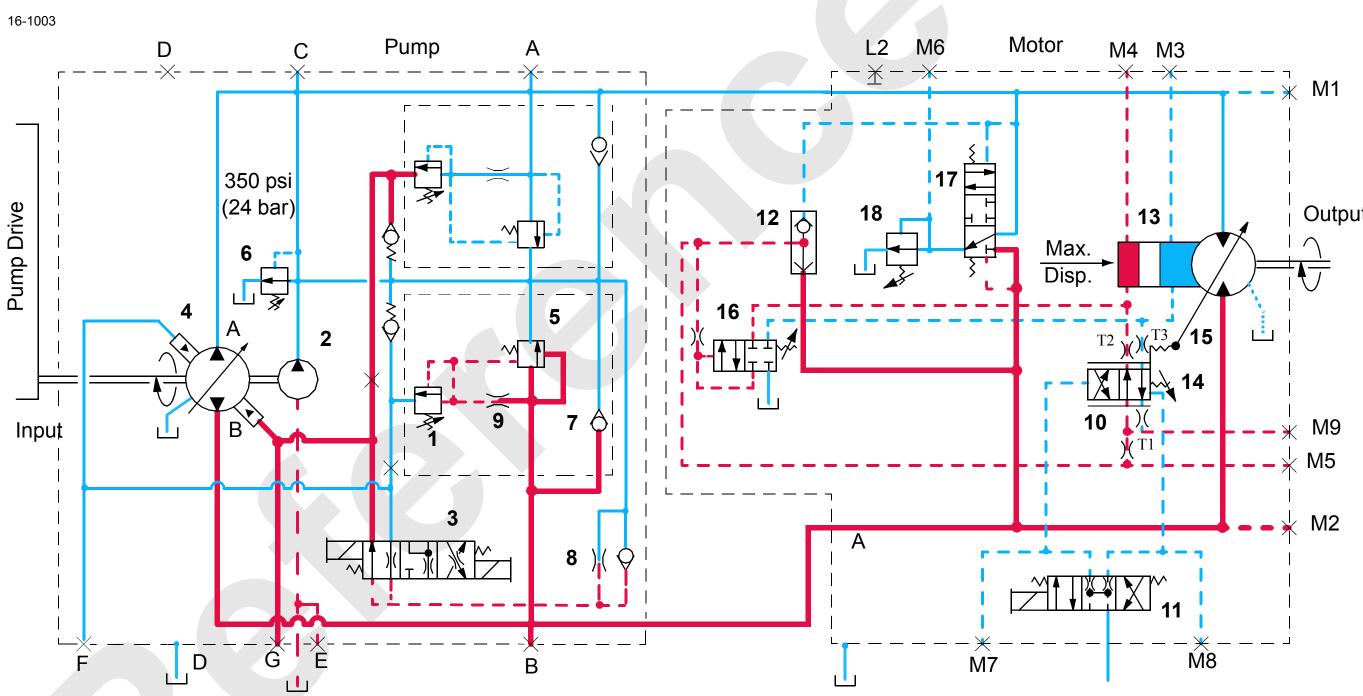

FIGURE 1-9

The load drums and boom/mast hoist motors also have a Pressure Compensating Over-Ride (PCOR) valve (16) that is enabled when system pressure of 340 bar (4,931 psi) is reached. When the system pressure exceeds the PCOR setting, the valve shifts to direct flow from the shuttle valve into the maximum displacement side of the servo cylinder. The PCOR valve over-rides the command from the servo PC valve, increasing motor displacement and output torque, while reducing output speed. When the PCOR valve closes, control of the motor returns to the servo PC valve.

The travel motor servo is the opposite of the other system motors. The travel variable displacement motors begin operation at minimum displacement (low torque, high speed). The motor shifts to maximum displacement (high torque, low speed) when the starting torque is required and back to minimum displacement when in motion if the load is below a preset pressure of 270 bar (3,916 psi). Depending on the motor system, the servo uses the low pressure accessory system pressure to perform the shifting operation. Servo control fluid shifts the shuttle valve and servo control valve before entering the servo cylinder.

Continuous changing of closed-loop fluid occurs through leakage in pumps, motors, and loop flushing valves. Motor case fluid drainage lubricates the motor and provides a re-circulation of hydraulic fluid to control heat in the closed-loop system. Motors also have an internal or external loop flushing (purge) system that consists of a control valve (17) and relief valve (18). If the system pressure is above 14 bar (203 psi), loop flushing removes 15 Lpm (4 gpm) of hot fluid from the system for added cooling and purification. If the system pressure is under 14 bar (203 psi) loop flush is disabled.

Accessory/MAX-ER Pump

The accessory/MAX-ER pump is the source of pressure for the accessory system components. The programmable controller controls the pump output pressure when an accessory valve is enabled.

The accessory/MAX-ER pump supplies hydraulic fluid to operate the jacking cylinders, pin cylinders, mast raising cylinders, rigging winch, and cab tilt cylinder. Accessory pump pressure is reduced from 207 bar to 35 bar (3,000 to 508 psi). Pressure at standby is 28 bar (406 psi) by the reducing valve for the travel brake, travel two-speed, and swing brake.

NOTE: An external pump on the engine operates the engine cooling fan. The accessory pump also controls the cooling fan. Tier 4 equipped machines will have a variable speed cooling fan.

Engine Controls

See the engine manufacturer's manual for instructions.

The engine key switch starts and stops the engine. The engine clutch lever for the pump drive must be manually engaged for normal operation.

Crane systems speed depends on engine speed and system control handle movement. The engine speed is controlled with the hand throttle or foot throttle and is monitored with a speed sensor. Node-1 and engine Node-0 controllers control and process engine information and display the information on the main display.

In an emergency, the emergency stop button stops the engine, applies all brakes, and stops all functions abruptly.

ELECTRICAL CONTROL SYSTEM

See Figure 1-10 for the following procedure.

The crane's boom, load lines, swing, crawler tracks, and accessory components are controlled electronically with the EPIC (Electrical Processed Independent Control) with CAN-bus (Controller Area Network) technology. The 24 volt CAN-bus programmable controller system uses remote nodes that contain controllers. The node controllers communicate with the Node-1 (master) controller by sending data packets over a two-wire bus line. The data packets are tagged with addresses that identify system components. The Node-1 controller compares these input data packet signals with programming directives and data information.The Node-1 controller then provides the appropriate output voltage commands to the remote node controllers.

Each node controller receives and sends both analog and digital input/output voltages. Analog input/output voltages are either AC or DC variable voltages or currents. Digital input/output voltages are zero volts (no voltage) or 24 volts.

Node controllers use the binary system. The binary system is based on binary multiples of two and only recognizes ***0 = OFF*** or ***1 = ON***. Basic counts of this system are exponents of the number two. These exponents are formed in words, called bytes, of eight numbers each. The eight numbers are 1, 2, 4, 8, 16, 32, 64, and 128 for an 8-bit controller or a combination of up to 255 bytes. These bytes represent electrical inputs/outputs to the Node-1 controller.

Remote nodes on the boom monitor the boom, luffing jib, or fixed jib components and input the information to the Node-1 controller. Boom components include angle sensors, block-up limits, and load pin sensors. The mast angle position is also monitored.

The system nodes controllers are listed below:

Node-1—Master (Front Console) Cab Controls
Node-2—Handles and Cab Controls
Node-3—Pumps, Accessories, Alarms, and Drum 4
Node-4—Accessories, Diverting, and Pressure Senders
Node-5—Sensors, Limits, Swing and Travel Components
Node-6—Drum 1, 3, and 5 Components
Node 7—MAX-ER
Node-20—Boom
Node-21—Luffing or Fixed Jib
Node-0—Engine

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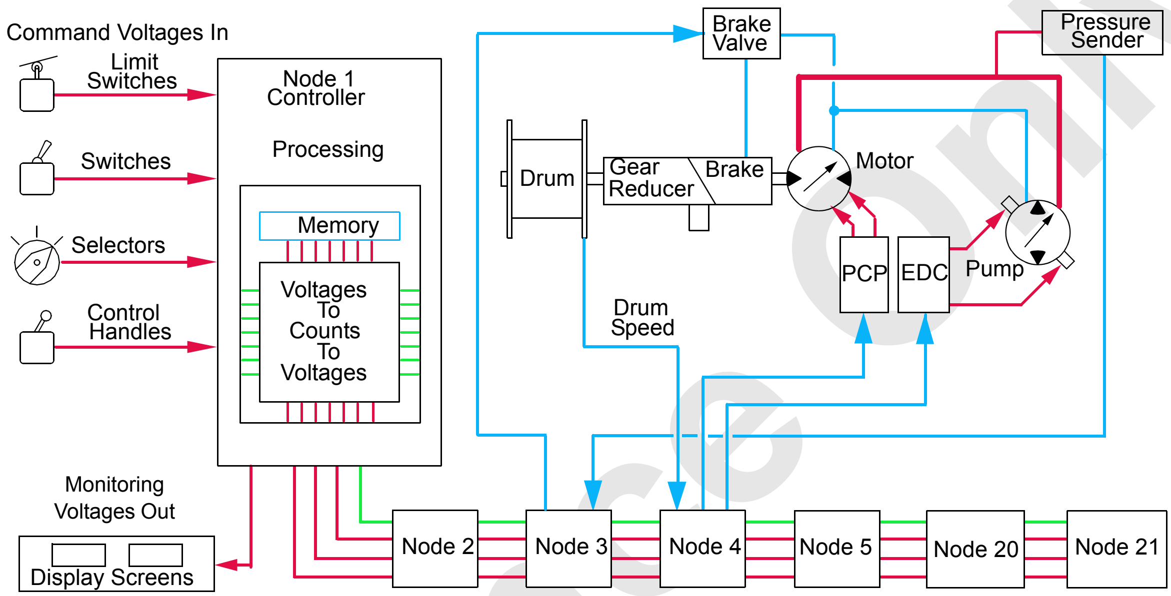

FIGURE 1-10

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Display Screens

See Figure 1-10.

The display screens contain the RCL display and main display. Use the menu screens to selected RCL and crane functions.

Electrical Power to Operator Cab

See Figure 1-11.

When the key-operated engine switch is in the STOP position, voltage is available to operate the dome light switch, and radio/clock. When the key-operated engine switch is placed in the RUN position, power is available to the following cab-related relays:

- Cab power relay (CAB PWR). When the cab power relay is enabled, power is available to operate crane controls.
- Air conditioning system relay (A/C CLUTCH)
- Engine control module
- CAN-bus system power relay (CAN PWR)
- CAN-bus system ground relay (CAN GND)
- Cab power relay (CAB PWR). When the cab power relay is enabled, power is available to operate crane controls.
- Air conditioning system relay (A/C CLUTCH)

Cab Power Electrical Schematic

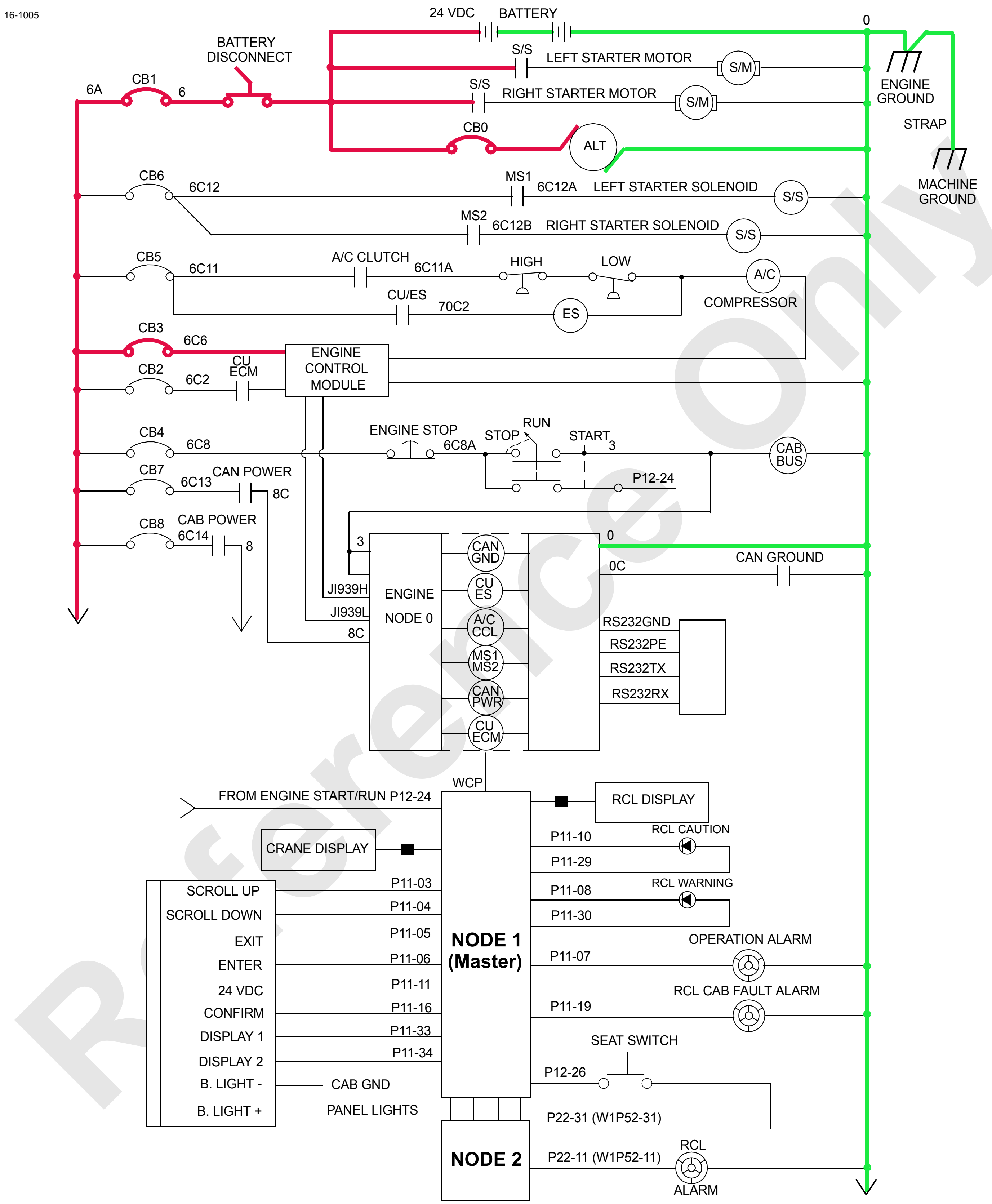


FIGURE 1-11

Pressure Senders and Speed Sensors

Pressure senders monitor drum system pressures, right/left travel system pressure, swing right/left system pressure, swing brake pressure, and accessory system pressure. Remote node controllers receive 0 to 5 volt input signals for each system pressure sender. Pressure senders transmit drum holding pressure information to the Node-1 controller.

Drum speed sensors detect the speed in rpm and direction of drum movement. The Node-1 controller receives this information as two out-of-phase square wave voltages that are converted to counts. The controller compares the control handle voltage with the pump output to determine when to vary the pump stroke.

System Faults

See Figure 1-12 for the following procedure.

The Node-1 controller monitors and enables an alarm if any system fault is detected and displays the fault on the crane information screen (see Section 3 in this manual).

When operating, all limit switches are closed, sending an input voltage to the Node-1 controller. If a limit switch is opened, the system node controller sends a zero-output voltage to that system pump EDC and brake solenoid. The system pump de-strokes and the system brake valve shifts to apply the brake. Move the control in the opposite direction from the limit to correct the problem.

The limit bypass switch allows the crane to be operated beyond the limits for crane setup or maintenance only. (For example, to add wire rope on the load drum or to remove wire rope from a load drum after an operating limit is enabled.) The jib up limit bypass switch allows the jib maximum up limit to be bypassed when the boom or luffing jib is lowered to the ground.

Brake and Drum Pawl Operation

All load drums, boom/mast hoist, travel, and swing park brakes are spring-applied and hydraulically released. Drums 3 (when configured with luffing jib), 4, and 5 have drum pawls that are released with the selected park switch. When the operator places the selected brake switch in the off-park position, the selected drum pawl is disengaged from the drum. Place the selected brake switch in the on-park position to apply the pawl to drum.

The Node-1 controller releases the swing brake immediately when swing brake switch is placed in the off-park position.

The travel Node-controller releases the brake with control handle movement.

With a drum control handle command, the Node-1 controller does not release the drum brake until the pressure memory holding pressure is reached to hold the load.

Switches and Sensors Electrical Schematic

16-1006

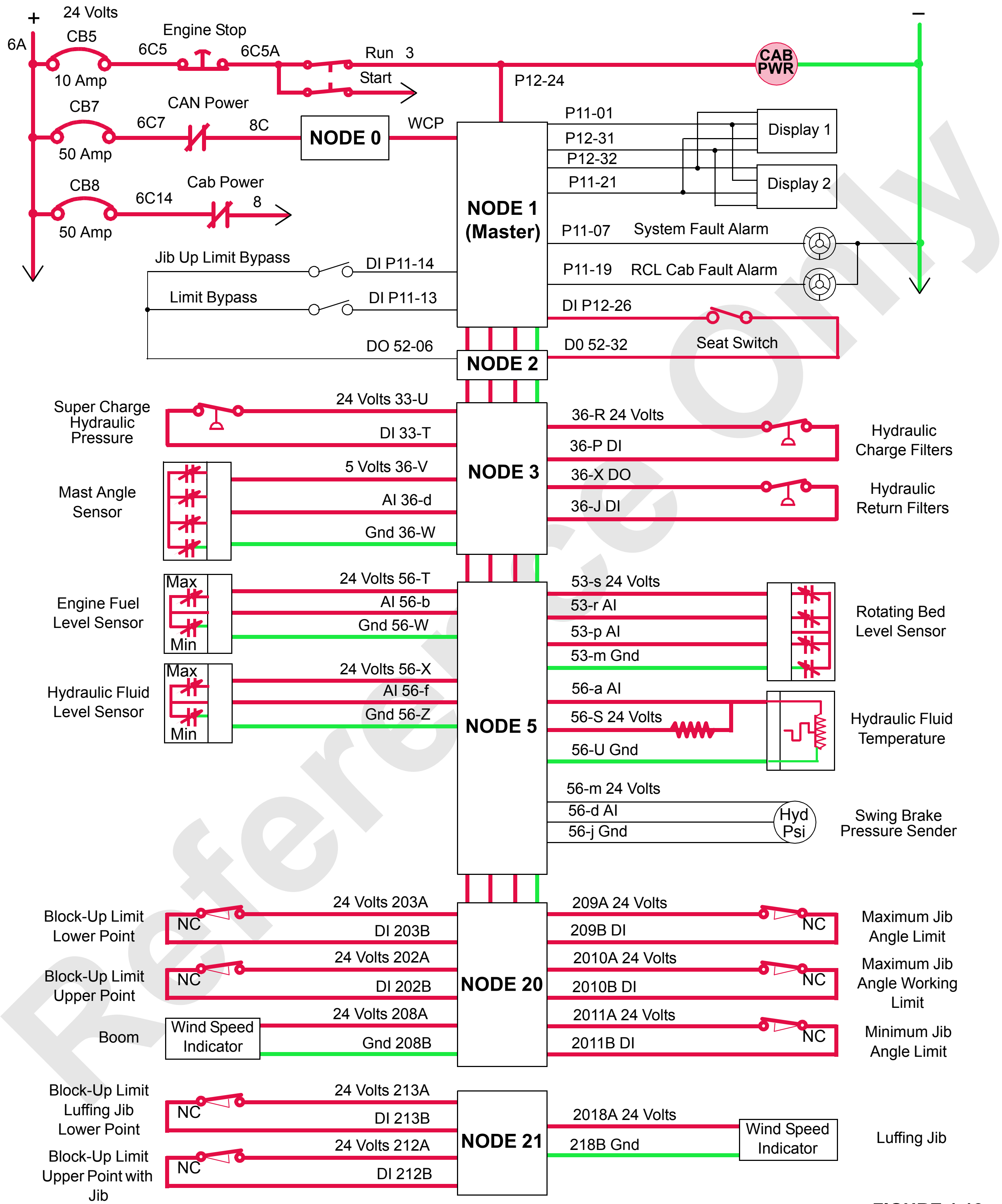


FIGURE 1-12

SWING SYSTEM OPERATION

See Figure 1-13 and Figure 1-14.

One hydraulic swing pump drives two separate swing motors. The hydraulic motors drive gearboxes that mesh with the ring gear and turn the rotating bed to swing. The swing system is controlled with the swing control handle movement and node controllers. The swing control handle is inoperable when the swing brake is applied. The rotating bed is free to coast if the swing control handle is in the neutral position.

The swing motors are controlled directly by the output fluid volume of the swing pump. The node controllers do not control the fixed displacement swing motors. Swing pressure senders monitor the pressure on swing left and swing right sides of closed loop system. An orifice across the swing motor ports A and B allows smoother fluid flow when shifting swing directions. Continuous changing of closed-loop fluid occurs through leakage in the pumps and motors.

Swing speed is monitored by a sensor at one hydraulic motor. Swing speed and swing torque can be selected for the type of work being performed on the Function Mode screen in Section 3.

When the swing control handle is moved from off, an input signal is sent to the Node-1 controller. The Node-3 and 5 controllers send a 24 volt signal to enable the rear and right side swing/travel alarms. When the swing control handle is moved to off, an input signal is sent to the Node-1 controller. The Node-3 and 5 controllers send a zero volt output signal to disable the rear and right side swing/travel alarms.

Swing Brake

The swing system has a spring-applied hydraulically released brake on the drive shafts.

The source hydraulic pressure for releasing the swing brake is from the accessory/MAX-ER pump at 28 to 35 bar (406 to 508 psi). For swing brake operation, the system pressure must be above 14 bar (203 psi) for full release of the brake. If the system pressure is below 14 bar (203 psi), the swing brake could be partially applied and damage the swing system. If the brake pressure or electrical power is lost when operating, the swing brake is applied.

After startup, place the swing brake switch in the off-park position. An input voltage is sent to the Node-1 controller. The Node-5 controller sends a 24 volt output to enable the swing brake solenoid HS-1.

The swing brake valve shifts to hydraulically release the swing brake from the shaft. Fluid from the piston end of the cylinder flows to the tank.

Before shutdown, place the swing brake switch in the on-park position. An input voltage is sent to the Node-1 controller. The Node-5 controller sends a zero-output voltage to disable the swing brake solenoid HS-1.

The swing brake valve shifts to block fluid to the brake and the swing brake is applied. Fluid from the brake flows to the tank. Fluid the from rod end of cylinder flows to the tank.

Swing Right or Left

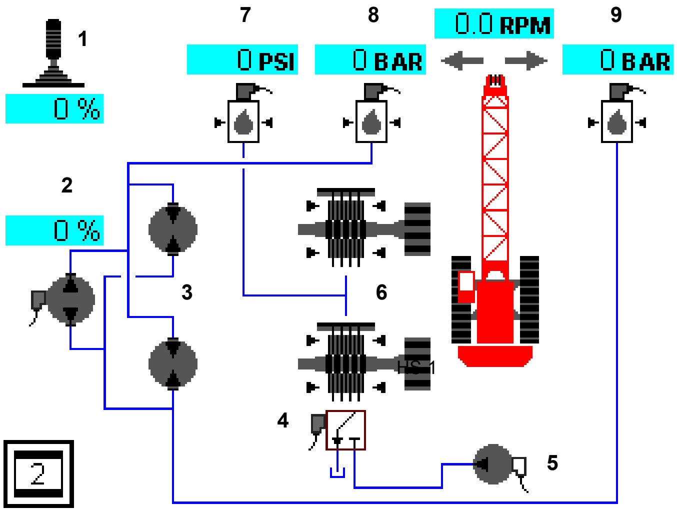
See Figure 1-13 and Figure 1-14.

When the swing control handle is moved to the ***left***, an input voltage of 2.4 volts or less is sent to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the swing pump EDC. The pump EDC tilts the swashplate relative to the handle movement. Fluid flows from the pump ports to the motor ports, moving the rotating bed to the left.

When the swing control handle is moved to the ***right***, an input voltage of 2.6 volts or more is sent to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the swing pump EDC. The pump EDC tilts the swashplate relative to the control handle movement. Fluid flows from the pump ports to the motor ports, moving the rotating bed to the right.

As the swing control handle is moved to the neutral position, The Node-1 controller compensates for the hydraulic system leakage or changing engine speed. The Node-3 controller sends a zero output voltage to adjust the pump swashplate to the centered position.

When in a swinging motion, the preferred way to stop or slow the crane is to move the swing control handle beyond center in the opposite direction. This allows the rotating bed to gradually stop.



Item	Description
1	Swing Handle Command in Percent
2	Swing Pump Command in Percent
3	Swing Motors
4	Swing Brake Solenoid HS-1
5	Accessory Pump (Low Pressure)
6	Swing Brake
7	Swing Brake Pressure Sensor
8	Swing Right Pressure Sensor
9	Swing Left Pressure Sensor

FIGURE 1-13

Swing Holding Brake Switch

The swing holding brake switch on the side of the swing control handle, holds the rotating bed in position (applies swing park brake) for short periods when operating. To prevent damage to the swing system, the swing holding brake switch must only be applied when crane is at a standstill.

When the holding brake switch is pressed in and held, an input voltage is sent to the Node-1 controller. The Node-5 controller sends a zero output voltage to the shift swing brake solenoid HS-1. The swing brake valve shifts to block fluid to the brake and the swing brake is applied.

When the swing holding brake switch is released, an input voltage is sent to the Node-1 controller. The Node-5 controller sends a 24 volt output to shift the swing brake solenoid HS-1. The swing brake valve shifts, allowing system pressure to hydraulically release the park brake.

Swing Electrical Schematic

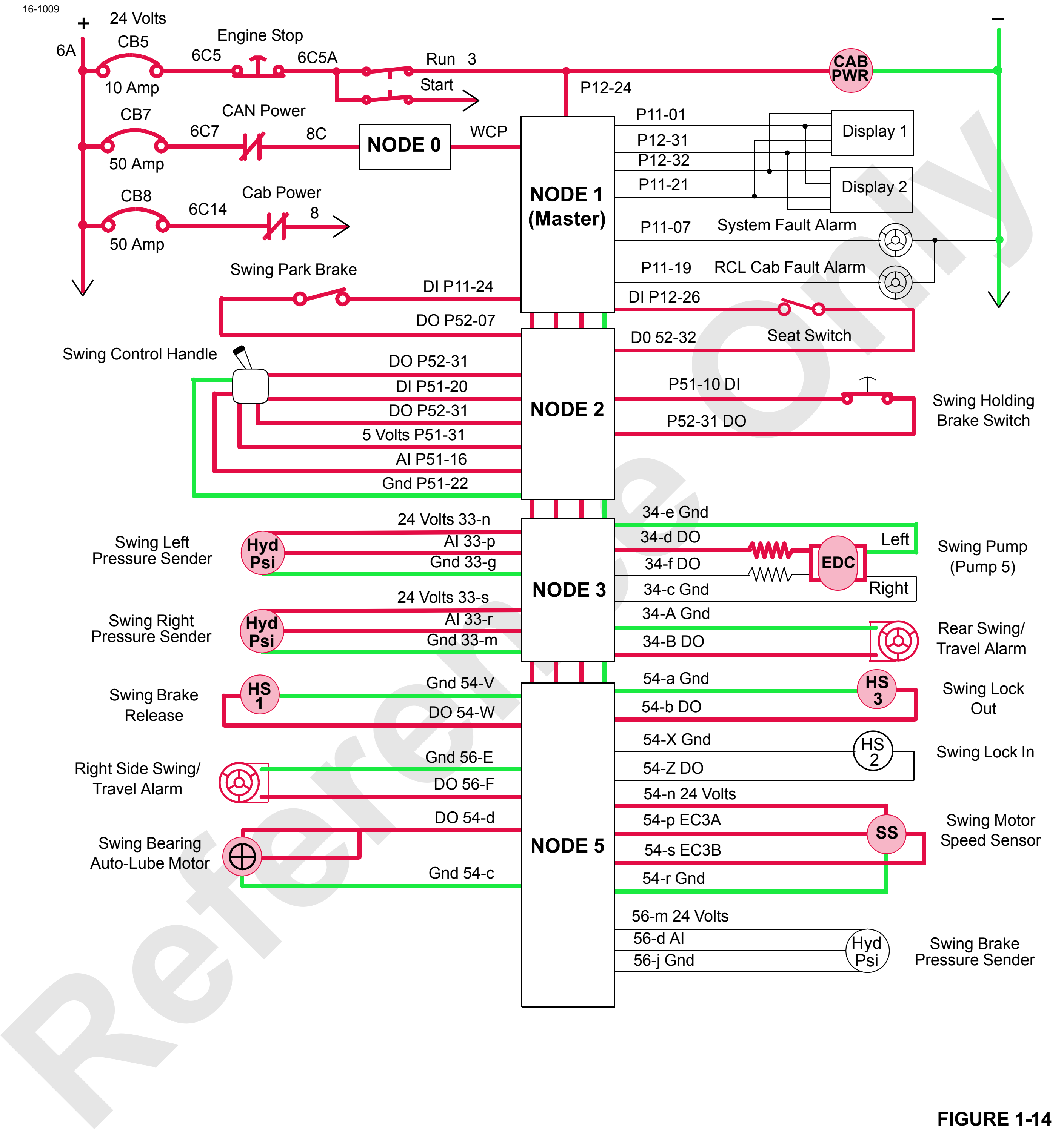


FIGURE 1-14

TRAVEL SYSTEM OPERATION

See Figure 1-15 and Figure 1-16. Each travel hydraulic pump drives a crawler system motor and gearbox. Each hydraulic pump and motor is controlled with the travel control handle movement and node controllers. The travel control handles are inoperable when the travel park brake is applied. The gearbox for each crawler is driven with a flexible shaft connected between the motor output and drive gearbox input.

The left travel pump is dedicated to operate drum 3 through a diverting valve if drum 3 is selected. The right travel pump is dedicated to operate drum 4 through a diverting valve if drum 4 is selected under certain conditions when drum 5 is also configured.

To ensure that the crane travels in a straight line in forward and reverse direction, each travel drive system has shuttle valves and pressure senders in each leg that monitor hydraulic pressure. When traveling, the Node-4 controller monitors pressure information from the pressure senders and adjusts the displacement of travel pumps to maintain equal pressure in each travel drive system.

The source of hydraulic pressure for releasing the travel brakes and enabling motor servo systems is from the accessory/MAX-ER pump at 35 bar (508 psi). Continuous changing of closed-loop fluid occurs through leakage in the pump, motor, and loop flushing valves that removes 19 Lpm (5 gpm) of fluid when the system pressure is above 14 bar (203 psi).

The travel pumps output can be programmed for 25% to 100% of rated volume on the Function Mode screen—see Section 3.

When either the travel control handle is moved from off, an input signal is sent to the Node-1 controller. The Node-3 and 5 controllers send a 24 volt signal to enable the rear and right side swing/travel alarms. When both the travel control handles are moved to off, an input signal is sent to the Node-1 controller. The Node-3 and 5 controllers send a zero volt output signal to disable the rear and right side swing/travel alarms.

Travel Brakes

Hydraulic pressure for releasing the travel brakes is output pressure from the accessory/MAX-ER pump at 28 to 35 bar (406 to 508 psi). For travel brake operation the system pressure must be above 14 bar (203 psi) for the brakes to release from each travel motor shaft. If the system pressure is below 14 bar (203 psi), the travel brake could be partially applied and damage the brake. If brake pressure or electrical power is lost when operating, the travel brakes apply.

When travel brake switch is in the ON-park position, the right and left travel brakes are applied to hold crane in position. The travel brake valve is open to allow hydraulic flow from the brake to the tank.

When the travel brake switch is in the OFF-park position, an input signal is sent to the Node-1 controller. The travel system circuit is enabled, waiting for a travel control handle command. When the travel control handle is moved an input signal is sent to the Node-1 controller. The Node-5 controller sends a 24 volt output to enable the travel brake release solenoid HS-5. The brake valve shifts to block the tank port and supplies the low pressure hydraulic fluid from the accessory/MAX-ER pump to release the crawler brakes. If brake pressure or electrical power is lost when operating, the brakes apply.

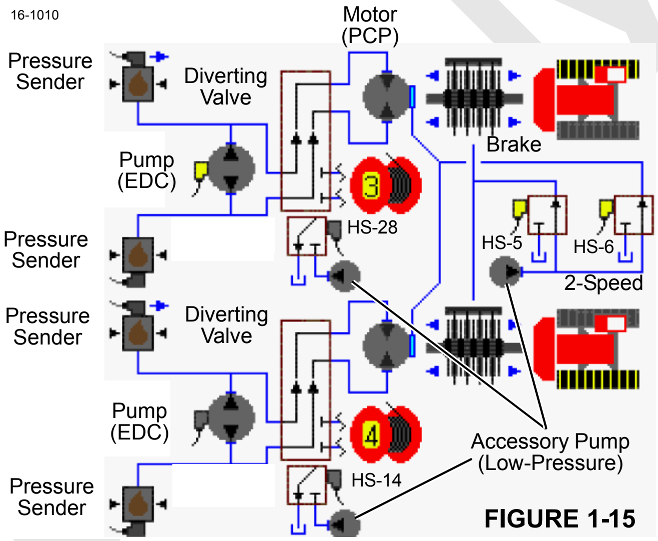


FIGURE 1-15

Travel Forward and Reverse

When a travel control handle is moved in the ***forward*** direction, an input voltage of 2.6 volts or more is sent to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the selected travel pump EDC. The Node-5 controller sends a 24 volt output to enable the travel brake release solenoid HS-5 and release both the left and right crawler brakes, before the travel pump(s) strokes.

The travel pump EDC tilts the pump swashplate in the ***forward*** direction. Hydraulic fluid flow is from the selected pump ports through the swivel to the motor ports. The Node-3 controller input voltage to the travel pump EDC is relative to the control handle movement.

When a travel control handle is moved in the ***reverse*** direction, an input voltage of 2.4 volts or less is sent to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the selected travel pump EDC. The Node-5 controller sends a 24 volt output to enable the travel brake solenoid HS-5 and release both crawler brakes, before the pump(s) strokes.

The travel pump EDC tilts the pump swashplate in the ***reverse*** direction. Hydraulic fluid flow is from the selected pump ports through the swivel to the motor ports. The Node-3 controller input voltage to the selected travel pump EDC is relative to the selected control handle movement.

Travel Electrical Schematic

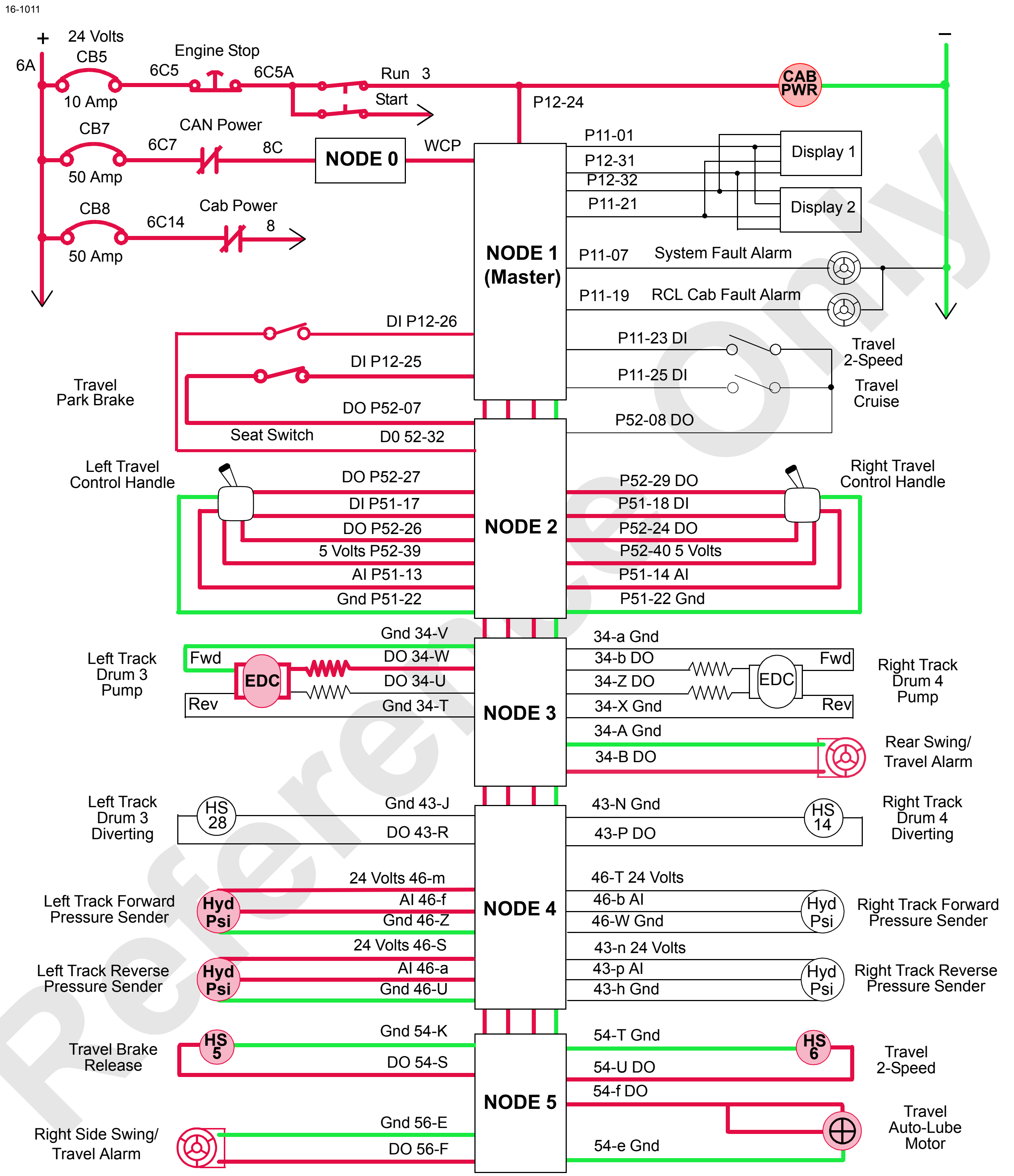


FIGURE 1-16

The travel motors are variable displacement and shift internally with an adjustable spring in each motor P/C (Pressure/Compensator) valve, preset at approximately 270 bar (3,916 psi).The travel motors are in the minimum displacement (low torque, high-speed) position when starting. When the crawler begins to move, a high system pressure shifts the PCOR (Pressure Compensated Over-Ride) spool placing the travel motor in the maximum displacement (high torque, low speed) position for breakaway torque.

As the travel control handle is moved to the neutral position, the Node-1 controller compensates for hydraulic system leakage or changing engine speed. The Node-3 controller sends a zero output voltage to the pump EDC to move the swashplate to the center position. After the travel control handle command is off for a preset time, the Node-5 controller sends a zero output voltage to disable the travel brake solenoid HS-5. The travel brake valve shifts to block pilot pressure to brakes and opens a line to tank. The brakes apply.

Two-Speed Travel Operation

The travel two-speed switch allows the operator to select ***low*** speed when smoother starts and precise control over the load is required. The low speed switch places the travel motor in maximum displacement (high torque, low speed) position and prevents the motor from shifting to high speed. When the travel two-speed switch is in the ***low*** speed position, the Node-5 controller sends a 24 volt output to enable the two-speed travel solenoid HS-6, shifting the valve and directing hydraulic pilot pressure to the P/C (Pressure/ Compensated) valve. The P/C valve shifts the PCOR (Pressure Compensated Over-Ride) spool placing the travel motor into maximum displacement (high torque, low speed) position. The travel motors remain in this position until the travel speed switch is placed in the ***high*** speed position and the engine speed is more than 1500 RPM.

Place the travel two-speed switch in ***high*** speed when maximum available travel speed is required (normal operation). Hydraulic pressure required for releasing travel two-speed solenoid valve is from the accessory/MAX-ER pump at 28 to 35 bar (406 to 508 psi). When the travel two-speed switch is in the ***high*** speed position, the travel motors shift to minimum displacement (low torque, high speed) automatically if the engine speed is above 1500 RPM and system pressure is below 270 bar (3,916 psi). If the engine is below 1500 RPM, the two-speed travel solenoid HS-6 is enabled although the travel two-speed switch is in the ***high*** position.The travel two-speed solenoid HS-6 is disabled, shifting the valve and removing the hydraulic pilot pressure to the P/C valve, allowing the motor to operate in the PCOR mode.

Travel Cruise

When the travel cruise switch is moved to the ***cruise*** position, an input signal is sent to the Node-1 one controller. The Node-3 controller sends an output signal to the travel pumps to lock-in the selected flow requirements and direction.

Moving the travel cruise switch to the OFF position or moving either travel handle in opposite direction from neutral sends an input signal to the Node-1 one controller. The Node-3 controller sends an output signal to the travel pumps to open the travel cruise circuit and return the control of travel system to the operator.

BOOM/MAST HOIST SYSTEM OPERATION

See Figure 1-17, Figure 1-18, and Figure 1-19.

The boom/mast hoist (drum 4) is mounted at the rear of the rotating bed and controls the boom when the crane is configured as a liftcrane. The boom hoist (drum 5) is mounted in the mast butt and controls the boom when the crane is configured with a with an optional MAX-ER attachment. Only one of these drums can be operated at a time, as the same pump operates both drums. The boom/mast hoist (drum 4) operation is described in this section; boom hoist (drum 5) is similar.

One hydraulic pump drives two separate motor gearboxes on each end of hoist drum. The right track pump can also power drum 4 through a diverting valve in the setup configuration. The hoist drum is controlled with the control handle movement and node controllers. The control handle is inoperable when the park brake is applied.

In the liftcrane configuration the boom/mast hoist (drum 4) is controlled with the control handle on left side console. In the luffing jib configuration the boom/mast hoist is controlled with the control handle on far right of the right side console, while the luffing jib hoist is controlled by the control handle on the left side console.

Hydraulic charge pressure from the system charge pump supplies hydraulic make-up fluid to the low-pressure side of each boom/mast hoist motor. A pressure sender in the high-pressure side of the boom/mast hoist system provides pressure information to the Node-1 controller. The low-side pressure supplies the hydraulic pilot pressure to operate the motor servos. A fixed orifice between pump ports A and B allows for smoother drum operation.

When the boom/mast hoist motors rotate, a speed sensor mounted at one motor monitors the rotor movement and sends an input voltage to the Node-1 controller. The Node-2 controller sends a 24 volt output to the rotation indicator in the control handle. As the boom/mast hoist drum rotates faster, the rotation indicator on top of the control handle pulsates with a varying frequency to indicate the drum rotational speed. The handle command in percent from neutral is shown on the Diagnostic Screen.

Continuous changing of closed-loop fluid occurs through leakage in the pump, motor, and external sequence/flow valve. The sequence/flow valve opens at 14 bar (203 psi) and removes 15 Lpm (4 gpm) of hot fluid from the system by dumping the fluid into the motor case where the fluid returns to the tank.

Boom/Mast Hoist Brake and Pawl

Hydraulic pressure to operate the hoist brake is from the low-pressure side of the system. Hydraulic pressure to operate the drum pawl is output pressure from the accessory/MAX-ER pump at 28 to 35 bar (406 to 508 psi).

When the boom/mast hoist brake switch is in the ON-park position, the hoist brake release solenoid HS-10 (drum 4) or HS-30 (drum 5) is disabled to apply the brake to drum. The hoist pawl in solenoid HS-11 (drum 4) or (drum 5) HS-31 is enabled to keep pawl applied to the drum flange. The hoist pump does not stroke in response to control handle movement.

When the hoist brake switch is in the OFF-park position, the Node-5 controller sends a zero volt output signal to the pawl in solenoid HS-11 and a 24 volt output to enable the pawl out solenoid HS-12 in the pawl out direction. The brake remains applied to drum until the Node-3 controller sends a 24 volt output to brake solenoid HS-10 to release the brake. The boom system circuit is active, waiting for a control handle command.

Raising Boom

See Figure 1-17 and Figure 1-19.

When the boom/mast hoist control handle is moved back for booming ***up***, an input voltage of 2.4 volts or less is sent to the Node-1 controller. The Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to the pump EDC. The Node-4 and 5 controllers send a variable zero to 24 volt output that is divided by a resistor and applied to each hoist motor PCP. The Node-1 controller checks that the boom up limit switch is closed and no hydraulic system fault is present.

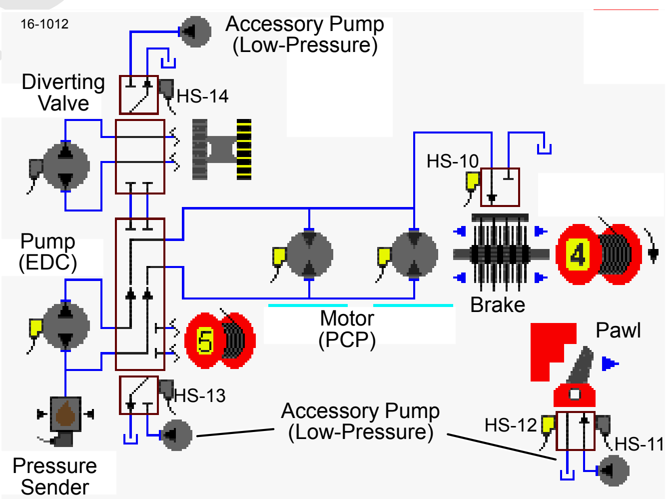


FIGURE 1-17

The pump EDC tilts the swashplate in the ***up*** direction to satisfy the pressure memory. The Node-1 controller compares boom holding pressure to the value in the pressure memory. When the system pressure is high enough, the Node-4 controller sends a 24 volt output to the brake release solenoid HS-10. The brake solenoid shifts to block the drain port and opens the port to the low-pressure side of system to release the drum 4 brake.

The pump EDC continues to tilt the swashplate in the ***up*** direction as the hydraulic fluid flows from the pump ports to the motor ports. Return fluid is from the motor outlet ports to the pump inlet port.

The Node-3 controller output voltage to the pump EDC and the Node-4 and 5 controllers output voltage to each motor PCP is relative to the control handle movement. As the control handle is moved back, the pump swashplate angle is increased. When the system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 340 bar (4,931 psi) the valve shifts to direct the flow from the shuttle valve into the maximum displacement side of the servo cylinder. The PCOR valve over-rides the command from the servo PC valve, increasing the motor displacement and the output torque and reducing the output speed. When the PCOR valve closes, the control of the motor returns to the servo PC valve.

The Node controllers are continuously balancing the system pressure and the motor displacement angle so the motor displacement goes to the minimum when the control handle is fully back, if the motor torque requirement is not too high. Node-4 and 5 controllers monitor the motor displacement and controls the motor speed by regulating the hydraulic fluid flow through the pumps.

When the control handle is moved to the neutral position, the Node-1 controller compensates for hydraulic system leakage or changing engine speed. The Node-3 controller sends a zero output voltage to the hoist pump EDC that moves the swashplate to the center position. This shifts the motor back to the maximum displacement for slower output speed to slow the drum rotation.

When the control handle is moved to the neutral position, the Node-1 controller stores the load holding pressure in the pressure memory. After the control handle center switch opens, the Node-4 controller sends a zero output voltage to disable the brake release solenoid HS-10. The drum brake solenoid valve shifts to block pilot pressure to the brakes and opens a line to the tank. Brakes apply before the drum pump de-strokes.

Lowering Boom

See Figure 1-18 and Figure 1-19.

When the boom/mast hoist control handle is moved forward for booming ***down***, an input voltage of 2.6 volts or more is sent to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the pump EDC.

The Node-4 and 5 controllers send a variable 0 to 24 volt output that is divided by a resistor and applied to each hoist motor PCP. The Node-1 controller checks that the boom up limit switch is closed and no hydraulic system fault is present.

The pump EDC tilts the swashplate in the ***up*** direction to satisfy the pressure memory. The Node-1 controller compares the drum holding pressure to the value in the pressure memory. When system pressure is high enough, the Node-4 controller sends a 24 volt output to the brake release solenoid HS-10. The brake solenoid shifts to block the drain port and opens the port to the low-pressure side of system to release the boom/mast hoist drum brake.

When the brake is released, the pump EDC tilts the swashplate to stroke the pump in the ***down*** direction. In the down direction, the hydraulic fluid flow is from the pump port to the motor port. Return fluid is from the motor outlet ports to the pump inlet port.

The Node-3 controller output voltage to the pump EDC and the Node-4 and 5 controllers output voltage to each motor PCP is relative to the control handle movement. As the control handle is pushed forward, the pump swashplate angle is increased. When the system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 340 bar (4,931 psi), the valve shifts to direct the flow from the shuttle valve into the maximum displacement side of the servo cylinder. The PCOR valve over-rides the command from the servo PC valve, increasing the motor displacement and the output torque while reducing the output speed. When the PCOR valve closes, control of the motor returns to the servo PC valve.

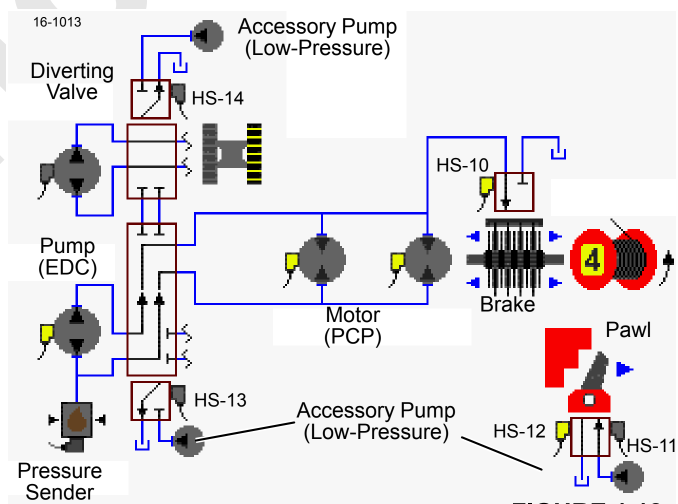


FIGURE 1-18

The node controllers continuously balance the system pressure and the motor displacement angle so the motor displacement goes to the minimum when the control handle is fully forward, if the motor torque requirement is not too high. The Node-1 controller monitors the motor displacement and controls the motor speed by regulating the hydraulic fluid flow through the pump.

The weight of the boom attempts to drive the motor faster than the return fluid can return to the low-pressure side of the pump. The system charge pump maintains the fluid supply at a positive pressure to the motor. The pump swashplate position restricts the returning fluid flow. The pressure builds on the fluid return side of the closed-loop, acting as a hydraulic brake to control the lowering speed.

When the control handle is moved toward the neutral position, the Node-3 controller sends an output voltage to the pump EDC that moves the swashplate toward the center position. This shifts the motors back to the maximum displacement for slower output speed to slow the drum rotation.

When the control handle is moved to the neutral position, The Node-1 controller stores the load holding pressure in the pressure memory. After the control handle center switch opens, the Node-4 controller sends a zero output to disable the brake release solenoid HS-10. The drum brake valve shifts to block the pilot pressure to the brake and opens a line to the tank. When the brake applies, an input signal is sent to the Node-1 controller. The Node-4 controller sends a zero volt output to the boom pump EDC to de-stroke the pump. The Node-4 and 5 controllers send a zero volt output to each motor PCP.

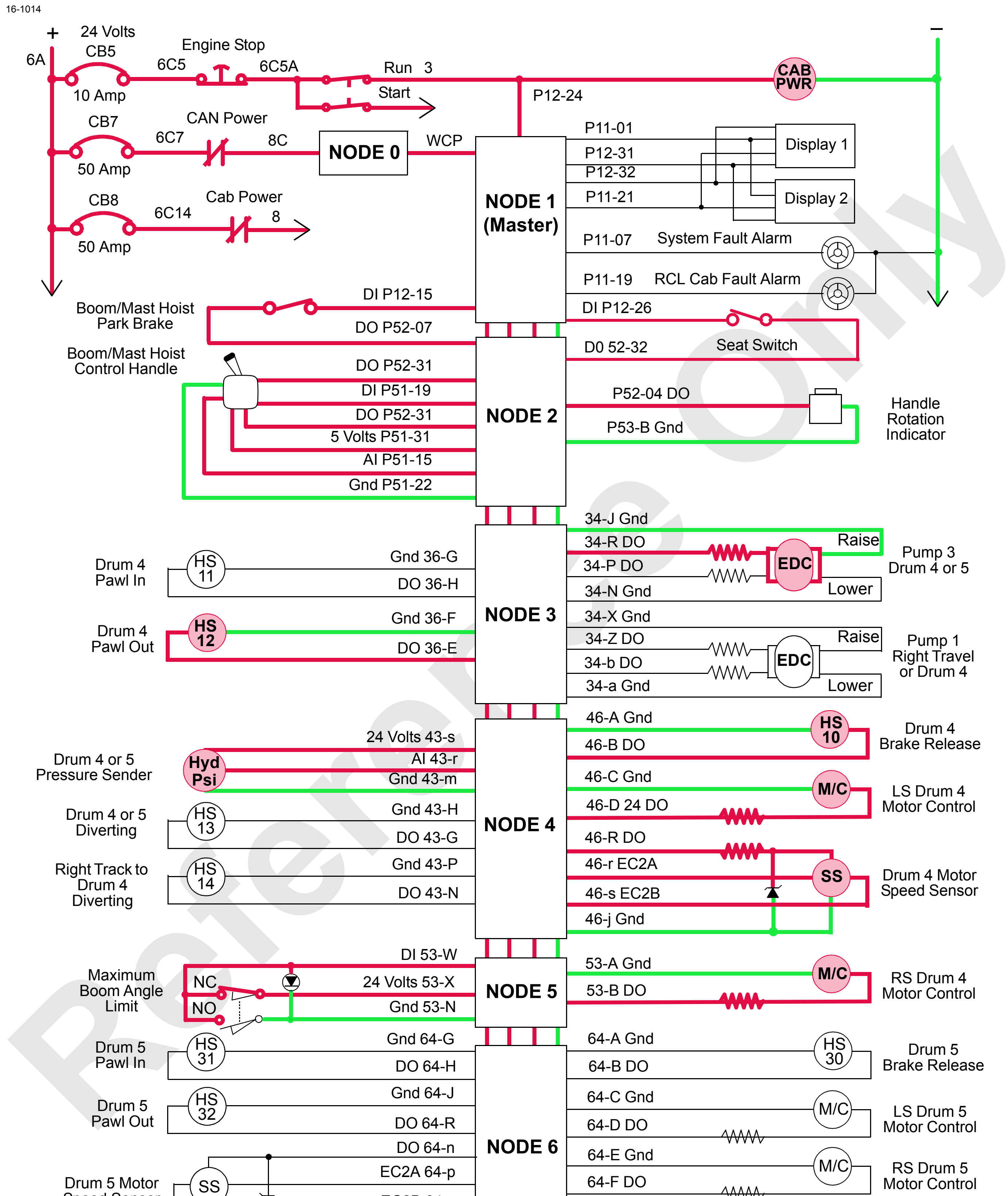

16-1014
+
24 Volts
6A
CB5
10 Amp
6C5
Engine Stop
6C5A
Run 3
Start
CAB PWR
−
P12-24
CB7
50 Amp
6C7
CAN Power
8C
NODE 0
WCP
CB8
50 Amp
6C14
Cab Power
8
NODE 1 (Master)
P11-01
P12-31
P12-32
P11-21
Display 1
Display 2
P11-07
System Fault Alarm
P11-19
RCL Cab Fault Alarm
DI P12-26
Seat Switch
D0 52-32
Boom/Mast Hoist Park Brake
DI P12-15
DO P52-07
Boom/Mast Hoist Control Handle
DO P52-31
DI P51-19
DO P52-31
5 Volts P51-31
AI P51-15
Gnd P51-22
NODE 2
P52-04 DO
P53-B Gnd
Handle Rotation Indicator
NODE 3
Drum 4 Pawl In
HS 11
Gnd 36-G
DO 36-H
Drum 4 Pawl Out
HS 12
Gnd 36-F
DO 36-E
34-J Gnd
34-R DO
34-P DO
34-N Gnd
EDC
Raise
Lower
Pump 3 Drum 4 or 5
34-X Gnd
34-Z DO
34-b DO
34-a Gnd
EDC
Raise
Lower
Pump 1 Right Travel or Drum 4
NODE 4
Drum 4 or 5 Pressure Sender
Hyd Psi
24 Volts 43-s
AI 43-r
Gnd 43-m
Drum 4 or 5 Diverting
HS 13
Gnd 43-H
DO 43-G
Right Track to Drum 4 Diverting
HS 14
Gnd 43-P
DO 43-N
46-A Gnd
46-B DO
HS 10
Drum 4 Brake Release
46-C Gnd
46-D 24 DO
M/C
LS Drum 4 Motor Control
46-R DO
46-r EC2A
46-s EC2B
46-j Gnd
SS
Drum 4 Motor Speed Sensor
NODE 5
Maximum Boom Angle Limit
NC
NO
DI 53-W
24 Volts 53-X
Gnd 53-N
53-A Gnd
53-B DO
M/C
RS Drum 4 Motor Control
NODE 6
Drum 5 Pawl In
HS 31
Gnd 64-G
DO 64-H
Drum 5 Pawl Out
HS 32
Gnd 64-J
DO 64-R
Drum 5 Motor Speed Sensor
SS
DO 64-n
EC2A 64-p
EC2B 64-s
Gnd 64-r
64-A Gnd
64-B DO
HS 30
Drum 5 Brake Release
64-C Gnd
64-D DO
M/C
LS Drum 5 Motor Control
64-E Gnd
64-F DO
M/C
RS Drum 5 Motor Control

FIGURE 1-19

LOAD DRUM 1

System Components

See Figure 1-20, Figure 1-21 and Figure 1-22.

Load drum 1 is located in the boom butt. One hydraulic pump drives two separate motor gearboxes on each end of the drum. The load drum 2 pump is dedicated to operate with load drum 1 though a diverging valve. The hydraulic connections between the pump and the motors form a closed-loop system that is controlled with the control handle movement and node controllers. The left load drum control handle on the right side console operates drum 1. The control handle is inoperable when drum 1 park brake is applied.

Hydraulic charge pressure from the system charge pump supplies hydraulic make-up fluid to the low-pressure side of each drum 1 motor. A pressure sender in the high-pressure side of the pump leg provides system pressure information to the Node-1 controller. The low-side pressure supplies the hydraulic pilot pressure to operate motor servos. A fixed orifice between the pump ports A and B allows for smoother drum operation.

When load drum 1 motors rotate, a speed sensor at one motor rotor monitors and sends an input voltage to the Node-1 controller. The Node-2 controller sends an output voltage to the rotation indicator in the control handle. As the drum rotates faster, the rotation indicator on top of the control handle pulsates with a varying frequency that indicates the drum rotational speed. The handle command in percent from neutral is shown on the Diagnostic Screen.

Continuous changing of closed-loop fluid occurs with leakage in the pump, the motor, and the external sequence/flow valve. The sequence/flow valve opens at 14 bar (203 psi) and removes 15 Lpm (4 gpm) of hot fluid from the system by discharging the exhausted fluid into the motor case where the fluid returns to the tank.

Load Drum 1 Brake

Hydraulic pressure to operate the drum 1 brake is from the low-pressure side of the system.

When the drum 1 brake switch is in the ON-park position, the drum brake release solenoid HS-15 is disabled so the brakes are applied to each side of the drum shaft. The drum pump does not stroke in response to the control handle movement.

When the drum 1 brake switch is placed in the OFF-park position, the brake release solenoid HS-15 remains applied. Brakes remain applied until the Node-6 controller sends a 24 volt output to release the brake. The drum circuit is active, waiting for a control handle command.

Raising Load

See Figure 1-20 and Figure 1-22. When the drum 1 control handle is moved back for raising, an input voltage of 2.4 volts or less is sent to the Node-1 controller. The Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to the pump 4 EDC in the raising direction. The Node-4 controller sends a 24 volt output to enable the drum 2 to drum 1 diverting solenoid HS-21. The Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to the pump 6 EDC in the raising direction. Both pumps supply hydraulic fluid to the drum 1 motors. The Node-6 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to both drum 1 motor PCP's. The Node-1 controller checks that the drum block-up limit switches are closed and no system faults are present.

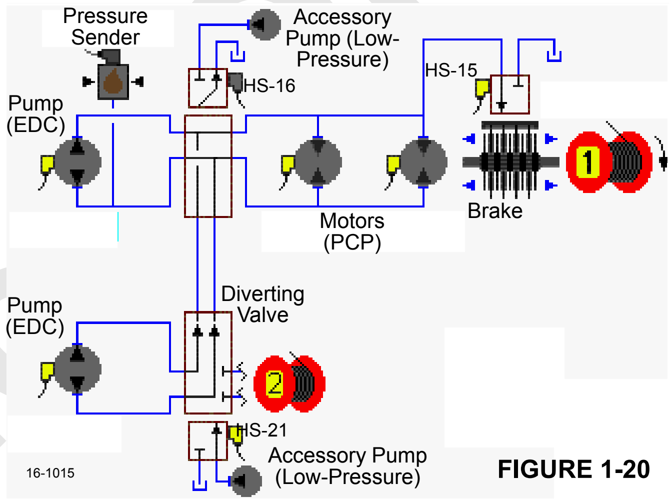


FIGURE 1-20

The pump EDC tilts the swashplate in the ***raising*** direction to satisfy the pressure memory. The Node-1 controller compares drum holding pressure to the value in the pressure memory. When system pressure is high enough, the Node-6 controller sends a 24 volt output to enable the drum 1 brake to release solenoid HS-15. The drum brake solenoid shifts to block the drain port and opens the port to the low-pressure side of the drum system to release the brake from the drum shaft.

Each pump EDC tilts the swashplate in the ***raising*** direction as hydraulic fluid flow is from the pump ports to the motor ports. Return fluid is from the motor outlet ports to the pump inlet ports.

The Node-3 controller output voltages to each pump EDC and the Node-6 controller output voltage to each motor PCP is relative to the control handle movement. As the control handle is moved back, an output voltage increases the pumps swashplate angles.

NOTE: If drum 2 is selected to be operated at the same time, The Node-4 controller sends a 24 volt output to disable the drum 2 to drum 1 diverting solenoid HS-21. Drum 1 speed is reduced up to one half.

When the system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 340 bar (4,930 psi), the valve shifts to direct the flow from the shuttle valve into the maximum displacement side of the servo cylinder. The PCOR valve over-rides the command from the servo PC valve, increasing the motor displacement and the output torque while reducing the output speed. When the PCOR valve closes, the control of the motor returns to the servo PC valve.

The node controllers continuously balance the drum system pressures and monitor the motor displacement angle so the motor displacement goes to the minimum when the control handle is all the way back, if the motor torque requirements are not too high. The Node-1 controller monitors the motor displacement and controls the motor speed by regulating the hydraulic fluid flow through the pumps.

When the drum control handle is moved to the neutral position, the Node-1 controller compensates for the hydraulic system leakage or changing engine speed. The Node-3 controller sends a zero output voltage to each pump EDC that moves the swashplate to the center position. This shifts the motors back to the maximum displacement for slower output speed to slow the drum rotation.

When the control handle is moved to the neutral position, The Node-1 controller stores the load holding pressure in the pressure memory. After the control handle center switch opens, the Node-6 controller sends a zero output voltage to disable the drum brake release solenoid HS-15. The drum brake solenoid valve shifts to block the pilot pressure to brakes and opens a line to the tank. The brakes apply before the drum pumps de-stroke.

When the brake applies, an input signal is sent to the Node-1 controller. The Node-3 controller sends a zero volt output to each pump EDC to de-stroke the pumps. The Node-6 controller sends a zero volt output to each motor PCP.

The drum 2 to drum 1 diverting solenoid HS-21 remains enabled until the drum 2 handle is moved.

Lowering Load

See Figure 1-21 and Figure 1-22.

When the drum 1 control handle is moved forward for ***lowering***, an input voltage of 2.6 volts or more is sent to the Node-1 controller. The Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to the pump 4 EDC in the ***raising*** direction. The Node-4 controller sends a 24 volt output to enable the drum 2 to drum 1 diverting solenoid HS-21. The Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to pump 6 EDC in the ***raising*** direction. Both pumps supply hydraulic fluid to the drum 1 motors. The Node-6 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to both the motor PCP's.

The Node-1 controller checks that the drum block-up limit switches are closed and no system faults are present.

The pump EDC tilts the swashplate in the ***raising*** direction to satisfy the pressure memory. The Node-1 controller compares the drum holding pressure to the value in the pressure memory. When the system pressure is high enough, The Node-6 controller sends a 24 volt output to enable drum 1 brake release solenoid HS-15. The drum brake solenoid shifts to block the drain port and opens the port to low-pressure side of drum system to release the brake from the drum shaft.

Each pump EDC tilts the swashplate in the ***lowering*** direction as the hydraulic fluid flow is from the pump ports to the motor ports. Return fluid is from the motor outlet ports to the pump inlet ports.

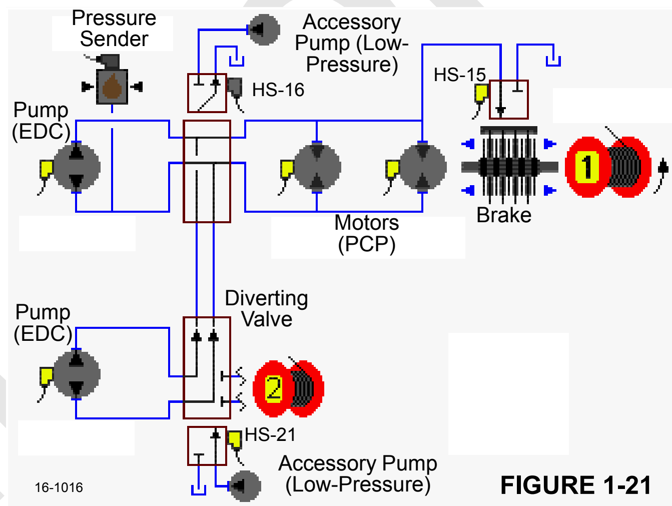


FIGURE 1-21

The Node-3 controller output voltages to each pump EDC and the Node-6 controller output voltage to each motor PCP is relative to the control handle movement. As the control handle is moved back, an output voltage increases the pumps swashplate angles.

NOTE: If drum 2 is selected to be operated at the same time, Node-4 controller sends a 24 volt output to disable the drum 2 to drum 1 diverting solenoid HS-21. Drum 1 speed is reduced up to one half.

When the system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 340 bar (4,931 psi), the valve shifts to direct the flow from the shuttle valve into the maximum displacement side of the servo cylinder. The PCOR valve over-rides the command from the servo PC valve, increasing the motor displacement and the output torque while reducing the output speed. When PCOR valve closes, control of the motor returns to the servo PC valve.

The node controllers continuously balance the drum system pressures and monitor the motor displacement angle so motor displacement goes to minimum when the control handle is fully forward, if the motor torque requirement is not too high. The Node-1 controller monitors the motor displacement and controls the motor speed by regulating the hydraulic fluid flow through the pumps.

When the drum control handle is moved to the neutral position, The Node-1 controller compensates for the hydraulic system leakage or changing engine speed. The Node-3 controller sends a zero output voltage to each pump EDC that moves the swashplate to the center position. This shifts the motors back to the maximum displacement for slower output speed to slow the drum rotation.

When the control handle is moved to the neutral position, the Node-1 controller stores the load holding pressure in the pressure memory. After the control handle center switch opens, the Node-4 controller sends a zero output to disable brake release solenoid HS-15. The drum brake valve shifts to block the pilot pressure to the brake and opens a line to the tank. When the brake applies, an input signal is sent to the Node-1 controller. The Node-3 controller sends a zero volt output to each drum pump EDC to de-stroke the pumps. The Node-6 controller sends a zero volt output to each motor PCP.

The drum 2 to drum 1 diverting solenoid HS-21 remains enabled until drum 2 handle is moved.

Drum 1 Electrical Schematic

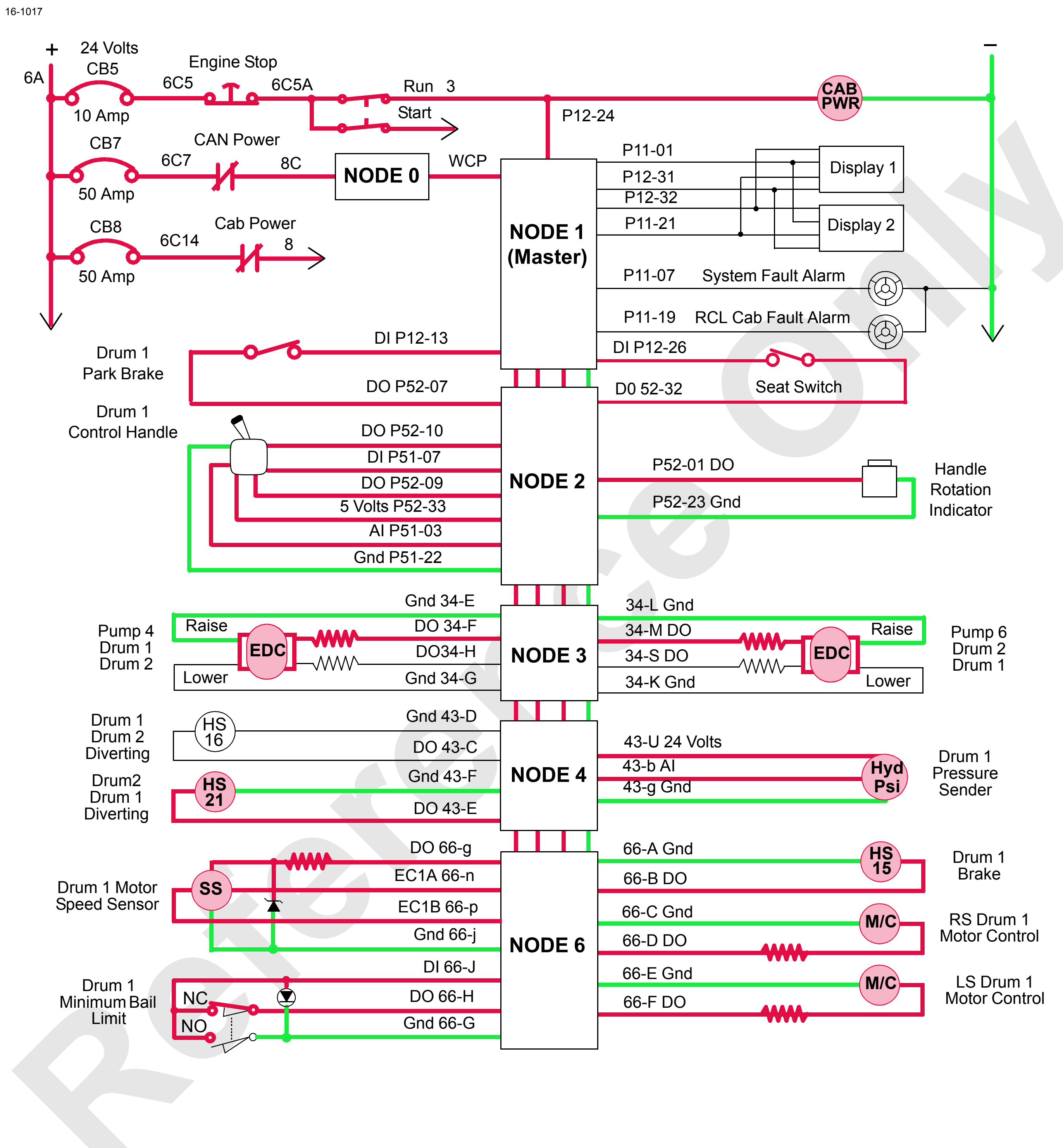


FIGURE 1-22

Manitowoc

LOAD DRUM 2

System Components

See Figure 1-23, Figure 1-24 and Figure 1-25.

Load drum 2 is located at the front top of the rotating bed. One hydraulic pump drives one motor gearbox on right side end of drum (standard) or drives two separate motor gearboxes on each end of drum 2 (optional). The load drum 1 pump is dedicated to operate with load drum 2 though a diverting valve. Hydraulic connections between the pump and the motors form a closed-loop system that is controlled with the control handle movement and node controllers. The center load drum control handle on the right side console operates drum 2. The control handle is inoperable when the drum 2 park brake is applied.

Hydraulic charge pressure from the system charge pump supplies hydraulic make-up fluid to the low-pressure side of each drum 2 motor. A pressure sender in the high-pressure side of the pump leg provides system pressure information to the Node-1 controller. The low-side pressure supplies hydraulic pilot pressure to operate the motor servos. A fixed orifice between the pump ports A and B allows for smoother drum operation.

When the load drum 2 motors rotate, a speed sensor at one motor rotor monitors and sends an input voltage to the Node-1 controller. The Node-2 controller sends an output voltage to the rotation indicator in the control handle. As the drum rotates faster, the rotation indicator on top of the control handle pulsates with a varying frequency that indicates the drum rotational speed. The handle command in percent from neutral is shown on the Diagnostic Screen.

Continuous changing of the closed-loop fluid occurs with the leakage in the pump, the motor, and the external sequence/flow valve. The sequence/flow valve opens at 14 bar (203 psi) and removes 15 Lpm (4 gpm) of hot fluid from system by discharging the exhausted fluid into the motor case where the fluid returns to the tank.

Load Drum 2 Brake

Hydraulic pressure to operate drum 2 brake is from the low-pressure side of the system.

When the drum 2 brake switch is in the ON-park position, the drum brake release solenoid HS-20 is disabled so the brakes are applied to each side of the drum shaft. The drum pump does not stroke in response to the control handle movement.

When the drum 2 brake switch is placed in the OFF-park position, the brake release solenoid HS-20 remains applied. The brakes remain applied until the Node-5 controller sends a 24 volt output to release the brake. The drum circuit is active, waiting for a control handle command.

Raising Load

See Figure 1-23 and Figure 1-24.

When the drum 2 control handle is moved back for ***raising***, an input voltage of 2.4 volts or less is sent to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the pump 6 EDC in the ***raising*** direction. The Node-4 controller sends a 24 volt output to enable drum 1 to drum 2 diverting solenoid HS-16. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the pump 4 EDC in the ***raising*** direction. Both pumps supply the hydraulic fluid to the drum 2 motors. The Node-3 and 5 controllers send a variable 0 to 24 volt output that is divided by a resistor and applied to both motor PCP's. The Node-1 controller checks that the drum block-up limit switches are closed and no system faults are present.

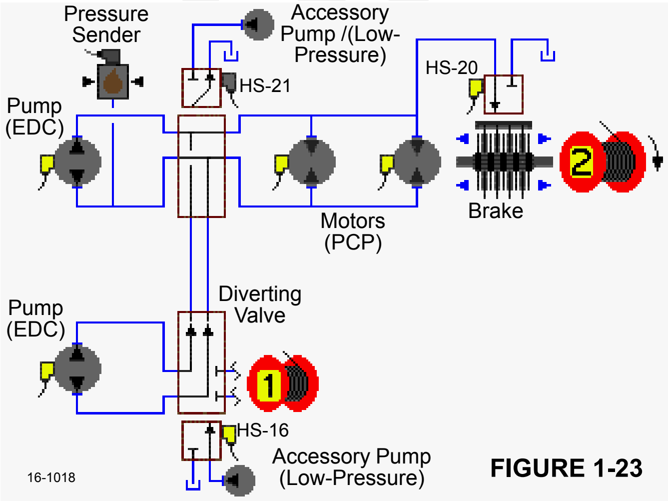


FIGURE 1-23

The pump EDC tilts the swashplate in the ***raising*** direction to satisfy the pressure memory. The Node-1 controller compares the drum holding pressure to the value in the pressure memory. When the system pressure is high enough, the Node-5 controller sends a 24 volt output to enable the drum 2 brake release solenoid HS-20. The drum brake solenoid shifts to block the drain port and opens the port to the low-pressure side of the drum system to release the brake from the drum shaft.

Each pump EDC tilts the swashplate in the ***raising*** direction as the hydraulic fluid flows from the pump ports to the motor ports. Return fluid flows from the motor to the pump.

The Node-3 controller output voltages to each pump EDC and the Node-3 and 5 controllers output voltage to each motor PCP is relative to the control handle movement. As control handle is moved back, an output voltage increases the pumps swashplate angles.

NOTE: If drum 1 is selected to operate at the same time, the Node-4 controller sends a 24 volt output to disable the drum 1 to drum 2 diverting solenoid HS-16. Drum 2 speed is reduced up to one half.

When the system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 340 bar (4,930 psi), the valve shifts to direct the flow from the shuttle valve into the maximum displacement side of the servo cylinder. The PCOR valve over-rides the command from the servo PC valve, increasing the motor displacement and the output torque while reducing the output speed. When the PCOR valve closes, control of the motor returns to the servo PC valve.

The node controllers continuously balance the drum system pressures and monitor the motor displacement angle so motor displacement goes to the minimum when the control handle is all the way back, if motor torque requirements are not too high. The Node-1 controller monitors the motor displacement and controls the motor speed by regulating the hydraulic fluid flow through the pumps.

When the drum control handle is moved to the neutral position, The Node-1 controller compensates for the hydraulic system leakage or changing engine speed. The Node-3 controller sends a zero output voltage to each pump EDC that moves the swashplate to the center position. This shifts the motors back to the maximum displacement for slower output speed to slow the drum rotation.

When the control handle is moved to the neutral position, the Node-1 controller stores the load holding pressure in the pressure memory. After the control handle center switch opens, the Node-5 controller sends a zero output voltage to disable the drum brake release solenoid HS-20. The drum brake solenoid valve shifts to block the pilot pressure to the brakes and opens a line to the tank. The brakes apply before the drum pumps de-stroke.

When the brake applies, an input signal is sent to the Node-1 controller. The Node-3 controller sends a zero volt output to each pump EDC to de-stroke pumps. The Node-3 and 5 controllers send a zero volt output to each motor PCP.

The drum 1 to drum 2 diverting solenoid HS-16 remains enabled until drum 1 handle is moved.

Lowering Load

See Figure 1-24 and Figure 1-25.

When the drum 2 control handle is moved forward for ***lowering***, an input voltage of 2.6 volts or more is sent to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the pump 6 EDC in the ***raising*** direction. The Node-4 controller sends a 24 volt output to enable the drum 1 to drum 2 diverting solenoid HS-16. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the pump 4 EDC in the ***raising*** direction. Both pumps supply the hydraulic fluid to the drum 2 motors. The Node-3 and 6 controllers send a variable 0 to 24 volt output that is divided by a resistor and applied to both the motor PCP's. The Node-1 controller checks that the drum block-up limit switches are closed and no system faults are present.

The pump EDC tilts the swashplate in the ***raising*** direction to satisfy the pressure memory. The Node-1 controller compares the drum holding pressure to the value in the pressure memory. When the system pressure is high enough, the Node-6 controller sends a 24 volt output to enable the drum 2 brake release solenoid HS-20. The drum brake solenoid shifts to block the drain port and opens the port to low-pressure side of drum system to release the brake from the drum shaft.

Each pump EDC tilts the swashplate in the ***lowering*** direction as the hydraulic fluid flow is from the pump ports to the motor ports. Return fluid is from the motor outlet ports to the pump inlet ports.

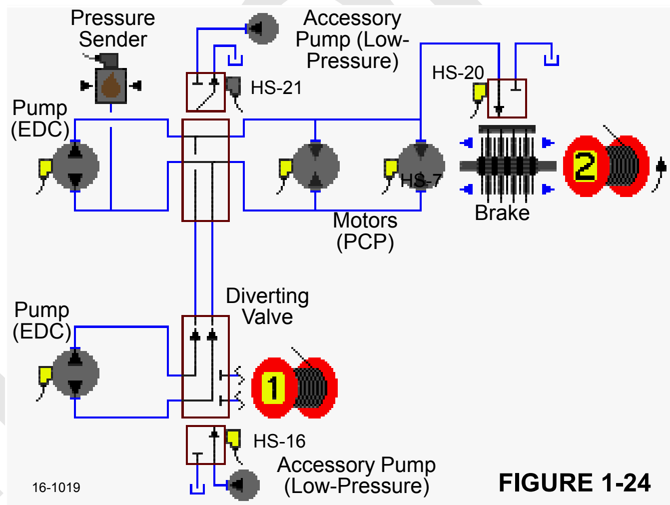


FIGURE 1-24

The Node-3 controller output voltages to each pump EDC and the Node-3 and 5 controllers output voltage to each motor PCP is relative to the control handle movement. As the control handle is moved back, an output voltage increases the pumps swashplate angles.

NOTE: If drum 1 is selected to be operated at the same time, the Node-4 controller sends a 24 volt output to the disable drum 1 to drum 2 diverting solenoid HS-16. Drum 2 speed is reduced up to one half.

When the system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 340 bar (4,931 psi), the valve shifts to direct flow from the shuttle valve into the maximum displacement side of the servo cylinder. The PCOR valve over-rides the command from the servo PC valve, increasing the motor displacement and the output torque while reducing the output speed. When the PCOR valve closes, the control of the motor returns to the servo PC valve.

The node controllers continuously balance the drum system pressures and monitor the motor displacement angle so the motor displacement goes to the minimum when the control handle is fully forward, if the motor torque requirements is not too high. The Node-1 controller monitors the motor displacement and controls the motor speed by regulating the hydraulic fluid flow through the pumps.

When the drum control handle is moved to the neutral position, the Node-1 controller compensates for the hydraulic system leakage or changing engine speed. The Node-3 controller sends a zero output voltage to each pump EDC that moves the swashplate to the center position. This shifts the motors back to the maximum displacement for slower output speed to slow the drum rotation.

When the control handle is moved to the neutral position, the Node-1 controller stores the load holding pressure in the pressure memory. After the control handle center switch opens, The Node-5 controller sends a zero output to disable the brake release solenoid HS-20. The drum brake valve shifts to block the pilot pressure to the brake and opens a line to the tank. When the brake applies, an input signal is sent to the Node-1 controller. The Node-3 controller sends a zero volt output to each drum pump EDC to de-stroke the pumps. The Node-3 and 5 controllers send a zero volt output to each motor PCP.

The drum 1 to drum 2 diverting solenoid HS-16 remains enabled until the drum 1 handle is moved.

Drum 2 Electrical Schematic

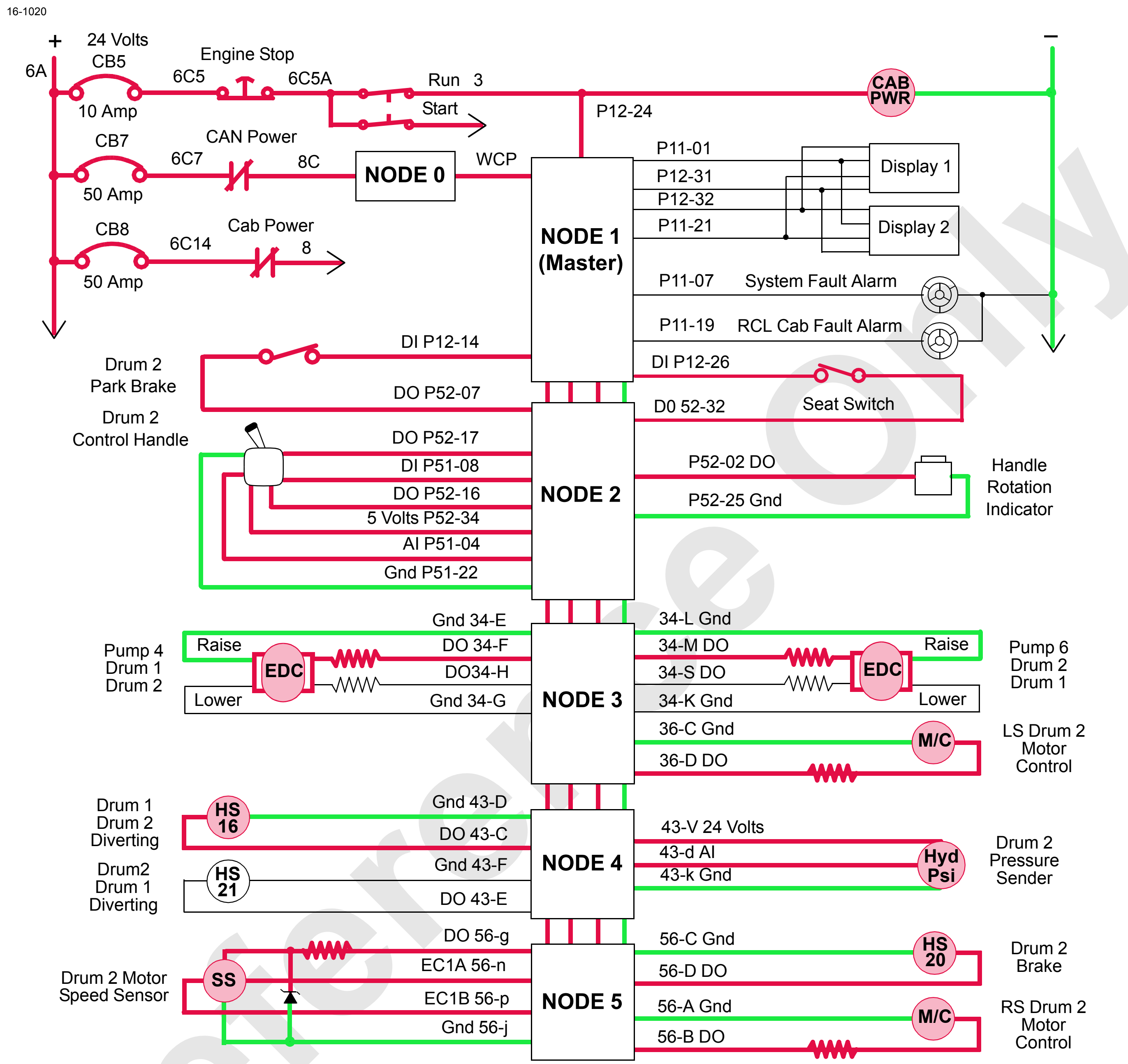


FIGURE 1-25

LOAD/LUFFING DRUM 3

System Components

See Figure 1-26, Figure 1-27 and Figure 1-28.

The load/luffing drum 3 is located in the boom butt. The drum can be configured either for luffing jib operation or as an auxiliary drum. If drum 3 is rigged for luffing jib operation it cannot be used as a load drum.

One hydraulic pump drives one motor gearbox on the left side end of drum 3. The left travel pump is dedicated to operate drum 3 though a diverging valve. The left track and drum 3 cannot be operated at the same time. Hydraulic connections between the pump and the motor form a closed-loop system that is controlled with the control handle movement and node controllers. The far load drum control handle on the right side console operates drum 3 when configured as a load drum. When configured as a luffing jib, the control handle on the left side console operates drum 3.

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The control handle is inoperable when the drum 3 park brake is applied.

The hydraulic charge pressure from the system charge pump supplies the hydraulic make-up fluid to the low-pressure side of the motor. A pressure sender in the high-pressure side of the pump leg provides system pressure information to the Node-1 controller. The low-side pressure supplies hydraulic pilot pressure to operate the motor servos. A fixed orifice between pump ports A and B allows for smoother drum operation.

When the load drum 3 motors rotate, a speed sensor at motor rotor monitors and sends an input voltage to the Node-1 controller. The Node-2 controller sends an output voltage to the rotation indicator in the control handle. As the drum rotates faster, the rotation indicator on top of the control handle pulsates with a varying frequency that indicates the drum rotational speed. The handle command in percent from neutral is shown on the Diagnostic Screen.

The continuous changing of the closed-loop fluid occurs with the leakage in the pump, the motor, and the external sequence/flow valve. The sequence/flow valve opens at 14 bar (203 psi) and removes 15 Lpm (4 gpm) of hot fluid from the system by discharging the exhausted fluid into the motor case where the fluid returns to the tank.

Load Drum 3 Brake and Pawl

The hydraulic pressure to operate the drum 3 brake is from the low-pressure side of the system. The hydraulic pressure to operate the drum pawl is from the low pressure accessory system.

When the drum 3 brake switch is in the ON-park position, the drum brake release solenoid HS-25 is disabled so the brake is applied to the drum shaft. The drum 3 pawl in the solenoid HS-26 is enabled to keep the pawl applied to the drum flange. The drum pump does not stroke in response to control handle movement.

When the drum 3 brake switch is placed in the OFF-park position, the brake release solenoid HS-25 remains applied. The brakes remain applied until the Node-6 controller sends a 24 volt output to release the brake. The Node-6 controller sends a zero volt output signal to the drum pawl in the solenoid HS-26 and a 24 volt output to enable the pawl out solenoid HS-27 to release the pawl. The drum circuit is active, waiting for a control handle command.

Raising

See Figure 1-26 and Figure 1-28.

When the drum 3 control handle is moved back for ***raising***, an input voltage of 2.6 volts or more is sent to the Node-1 controller. The Node-4 controller sends a 24 volt output to enable the left travel to the drum 3 diverting solenoid HS-28. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the pump 2 EDC in the ***raising*** direction. The Node-6 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the motor PCP. The Node-1 controller checks that the drum block-up limit switches are closed and no system faults are present.

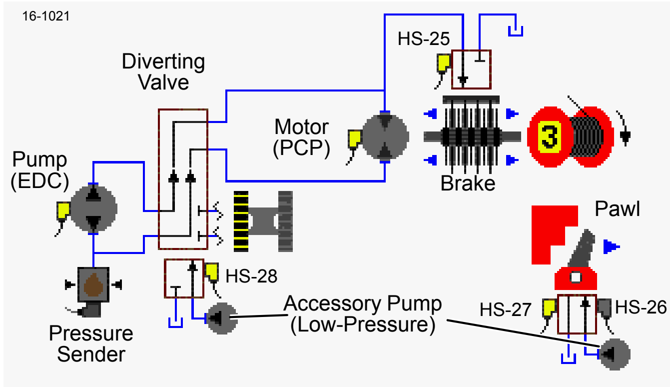

FIGURE 1-26

The Pump EDC tilts the swashplate in the ***raising*** direction to satisfy the pressure memory. The Node-1 controller compares the drum holding pressure to the value in the pressure memory. When the system pressure is high enough, the Node-6 controller sends a 24 volt output to enable the drum 3 brake release solenoid HS-25. The drum brake solenoid shifts to block the drain port and opens the port to the low-pressure side of drum system to release the brake from the drum shaft.

The pump EDC tilts the swashplate in the ***raising*** direction as the hydraulic fluid flow is from the pump port to the motor port. Return fluid is from the motor outlet port to the pump inlet port.

The Node-3 controller output voltage to the pump EDC and the Node-6 controller output voltage to the motor PCP is relative to the control handle movement. As the control handle is moved back, an output voltage increases the pump swashplate angle.

When the system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 340 bar (4,931 psi), the valve shifts to direct flow from the shuttle valve into the maximum displacement side of the servo cylinder. The PCOR valve over-rides the command from the servo PC valve, increasing the motor displacement and the output torque while reducing the output speed. When the PCOR valve closes, the control of the motor returns to the servo PC valve.

The Node controllers continuously balance the drum system pressures and monitor the motor displacement angle so the motor displacement goes to the minimum when the control handle is all the way back, if the motor torque requirement is not too high. The Node-1 controller monitors the motor displacement and controls the motor speed by regulating the hydraulic fluid flow through the pump.

When the drum control handle is moved to the neutral position, the Node-1 controller compensates for the hydraulic system leakage or changing engine speed. The Node-3 controller sends a zero output voltage to the pump EDC that moves the swashplate to the center position. This shifts the motor back to the maximum displacement for slower output speed to slow the drum rotation.

When the control handle is moved to the neutral position, the Node-1 controller stores the load holding pressure in the pressure memory. After the drum 3 control handle center switch opens, the Node-6 controller sends a zero output voltage to disable the drum brake release solenoid HS-25. The drum brake solenoid valve shifts to block the pilot pressure to the brake and opens a line to the tank. The brake applies before the drum pump de-stroke.

When the brake applies, an input signal is sent to the Node-1 controller. The Node-3 controller sends a zero volt output to the pump EDC to de-stroke the pump. The Node-6 controller sends a zero volt output to the motor PCP.

The left travel handle to the drum 3 diverting solenoid HS-28 remains enabled until the left travel handle is moved.

Lowering

See Figure 1-27 and Figure 1-28.

When the drum 3 control handle is moved forward for ***lowering***, an input voltage of 2.4 volts or less is sent to the Node-1 controller. The Node-4 controller sends a 24 volt output to enable the left travel to drum 3 diverting solenoid HS-28. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the pump 2 EDC in the ***raising*** direction. The Node-6 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the motor PCP. The Node-1 controller checks that the drum block-up limit switches are closed and no system faults are present.

The pump EDC tilts the swashplate in the ***raising*** direction to satisfy the pressure memory. The Node-1 controller compares the drum holding pressure to the value in the pressure memory. When the system pressure is high enough, the Node-6 controller sends a 24 volt output to enable the drum 3 brake release solenoid HS-25. The drum brake solenoid shifts to the block the drain port and opens the port to low-pressure side of drum system to release the brake from the drum shaft.

The pump EDC tilts the swashplate in the ***lowering*** direction as the hydraulic fluid flow is from the pump port to the motor port. Return fluid is from the motor outlet port to the pump inlet port.

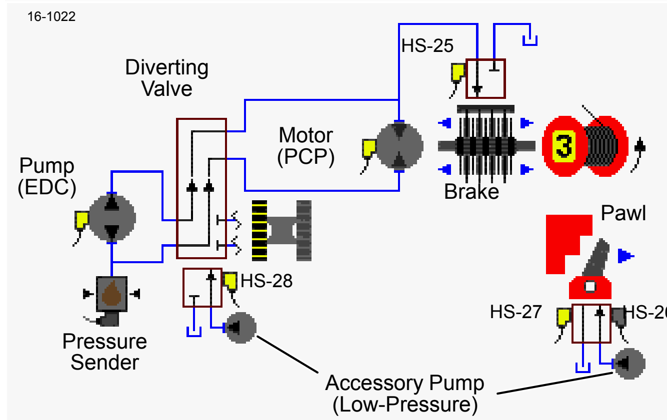

FIGURE 1-27

The Node-3 controller output voltages to the pump EDC and the Node-6 controller output voltage to the motor PCP is relative to the control handle movement. As the control handle is moved back, an output voltage increases the pump swashplate angle.

When system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 340 bar (4,931 psi), the valve shifts to direct flow from the shuttle valve into the maximum displacement side of the servo cylinder. The PCOR valve over-rides the command from the servo PC valve, increasing the motor displacement and the output torque while reducing the output speed. When the PCOR valve closes, motor control returns to the servo PC valve.

Node controllers continuously balance the drum system pressures and monitor the motor displacement angle so the motor displacement goes to the minimum when the control handle is fully forward, if the motor torque requirements are not too high. The Node-1 controller monitors the motor displacement and controls the motor speed by regulating the hydraulic fluid flow through the pump.

When the drum control handle is moved to the neutral position, the Node-1 controller compensates for hydraulic system leakage or changing engine speed. The Node-3 controller sends a zero output voltage to the pump EDC that moves the swashplate to the center position. This shifts the motor back to the maximum displacement for slower output speed to slow the drum rotation.

When the control handle is moved to the neutral position, the Node-1 controller stores the load holding pressure in the pressure memory. After the control handle center switch opens, the Node-4 controller sends a zero output to disable the brake release solenoid HS-25. The drum brake solenoid valve shifts to block the pilot pressure to the brake and opens a line to the tank. When the brake applies, an input signal is sent to the Node-1 controller. The Node-3 controller sends a 0 volt output to the drum pump EDC to de-stroke. The Node-6 controller sends a zero volt output to the motor PCP. The left travel to drum 3 diverting solenoid HS-28 remains enabled until the left travel handle is moved.

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Drum 3 Electrical Schematic

16-1023

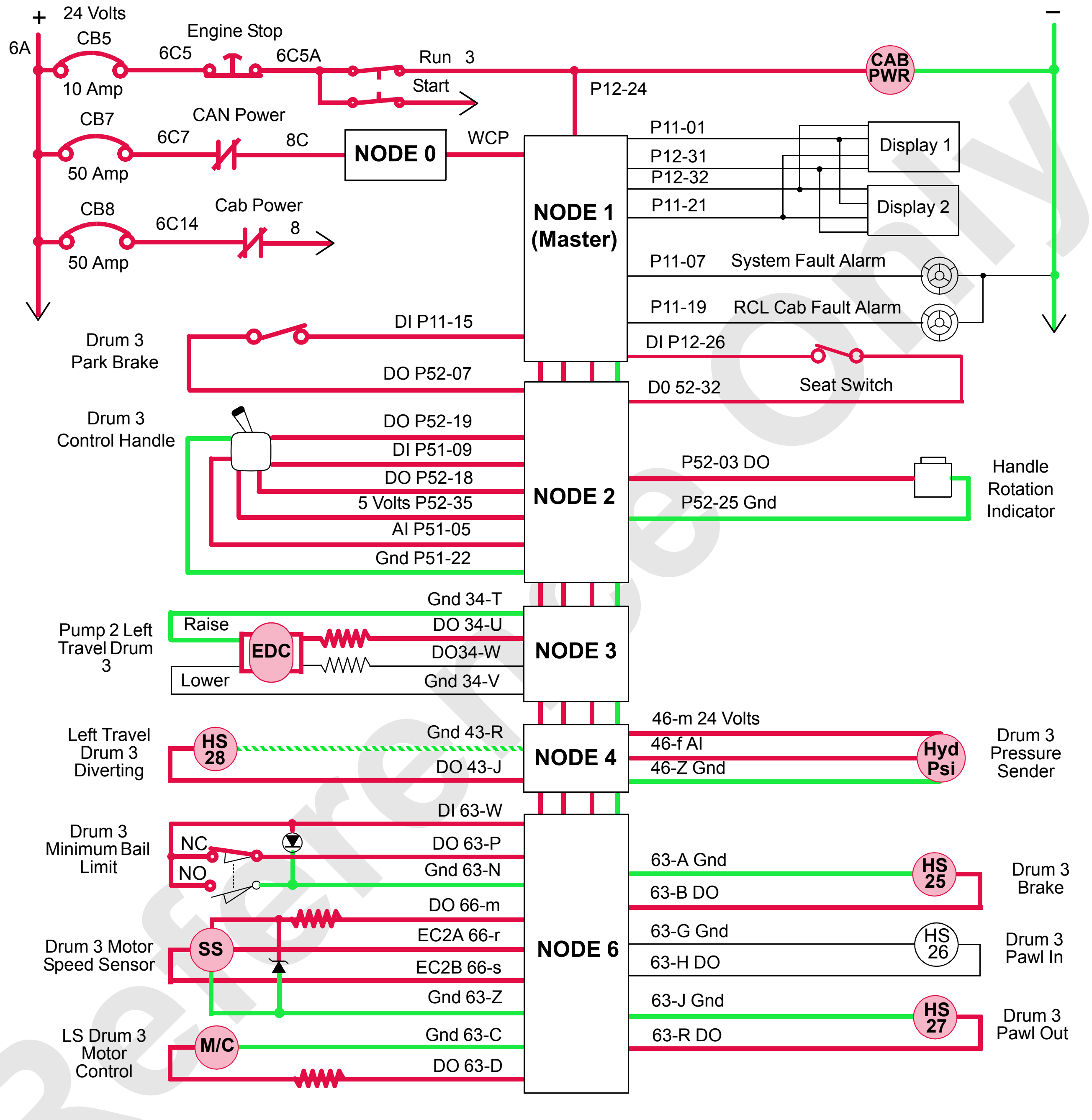


FIGURE 1-28

ACCESSORY SYSTEM COMPONENTS

Accessory Systems

Accessory system components include the rotating bed jacking cylinders, mast raising cylinders (high pressure), rigging winch, rotating bed pins, boom hinge pins, cab tilt, counterweight pins, crawler pin cylinders (low pressure), and the engine cooling fan.

The accessory/MAX-ER pump is the hydraulic pressure source to operate the accessory system components. The accessory system proportional relief valve is controlled by the Node-3 controller. The accessory system and the lower accessory system is monitored by separate pressure senders. During stand-by, the relief valve is set at approximately 28 bar (406 psi). Excess supply flow from the accessory/MAX-ER pump is dumped through the valve to the tank. When an accessory system component is enabled, an input signal is sent to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt signal to the accessory system proportional relief solenoid HS-68 to increase the relief valve setting up to 207 bar (3,003 psi). The accessory systems pressure increases to operate the selected component.

Jacking Cylinders

See Figure 1-29 and Figure 1-30.

Telescopic type jacking cylinders are mounted on each corner of the rotating bed. The jacking cylinder operation is controlled with switches on the hand-held wireless remote and programming. Operation of all four jacking cylinders is the same. The following description of operation is for the right front jacking cylinder.

WARNING

Collapsing Hazard!

Keep the rotating bed as level as possible while jacking. Operating the jacking cylinder with the rotating bed more than three degrees out of level can cause structural damage to jacking cylinders and possible collapse of the rotating bed.

The rotating bed level sensor keeps the rotating bed level when the ALL switch is used. The sensor controls the fluid to each cylinder by opening/closing the proportional control valves.

Each jacking cylinder has counterbalance valves at the cylinder ports. The counterbalance valves ensure smooth control when raising or lowering the crane on the jacks. The counterbalance valves lock the jacking cylinders in place if there is a hydraulic line breakage or accidental operation of the control valve when the crane's power is shut down. Also, the counterbalance valves provide relief protection for the cylinders and shields them from mechanical overloading.

When a jacking cylinder proportional control valve is not enabled, it shifts to the neutral position where both the valve section cylinder ports are connected to the tank. This prevents in-line pressure from opening the counterbalance valve, holding the rotating bed load in position by the counterbalance valve.

Rotating Bed Jacking - Raise

Move the jacking switch to the ***extend*** position and hold (front right jack is shown in Figure 1-29). An input voltage is sent to the Node-1 controller. The Node-4 controller sends a 24 volt output to enable the selected jacking cylinder proportional control solenoid HS-62 and shifts the valve to the ***extend*** position. The Node-3 controller sends a variable zero to 24 volt output to enable the accessory system proportional relief solenoid HS-68.

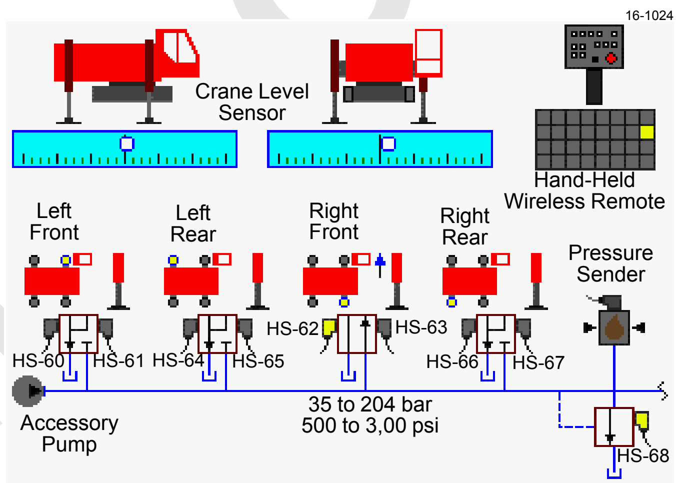


FIGURE 1-29

Hydraulic fluid pressure at approximately 204 bar (2,959 psi) flows to the selected jacking cylinder(s) proportional control valve. Hydraulic fluid exits the valve and enters the free-flow check valve section of the jacking cylinder counterbalance valve. Hydraulic fluid then enters the piston end of the jacking cylinder, extending the cylinder to raise the rotating bed. The Node-4 controller monitors the accessory system pressure sender to control the jacking cylinder raising speed rate.

Hydraulic fluid returning to the tank from the rod end of the jacking cylinder is blocked by the free-flow check valve section of the counterbalance valve and flows through the flow restraining section that has a relief setting of 172 bar (2,495 psi). The counterbalance valve acts as a deceleration control and functions with a 3:1 pilot ratio of the relief pressure. This permits the valve to open when the pressure in rod end of the cylinder is approximately 57 bar (827 psi). The restraining section of the counterbalance valve opens, controlling the fluid out of the jacking cylinder. Hydraulic fluid then flows through the free-flow check valve section of the flow control valve before entering the lower accessory valve. Hydraulic fluid leaving the accessory valve is returned to the tank.

When the jacking switch is moved back to the center position, an input voltage is sent to the Node-1 controller. The Node-4 controller sends a zero volt output to disable the selected jacking cylinder proportional control solenoid HS-62 and shifts valve spool to center position. The Node-3 controller sends a variable 0 to 24 volt output to disable accessory system proportional relief solenoid HS-68.

Rotating Bed Jacking - Lower

Move the desired jacking switch to the ***retract*** position and hold (front right jack is shown in Figure 1-30). An input voltage is sent to the Node-1 controller. The Node-4 controller sends a 24 volt output to enable the selected jacking cylinder proportional control solenoid HS-63 and shifts the valve to the ***retract*** position. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68.

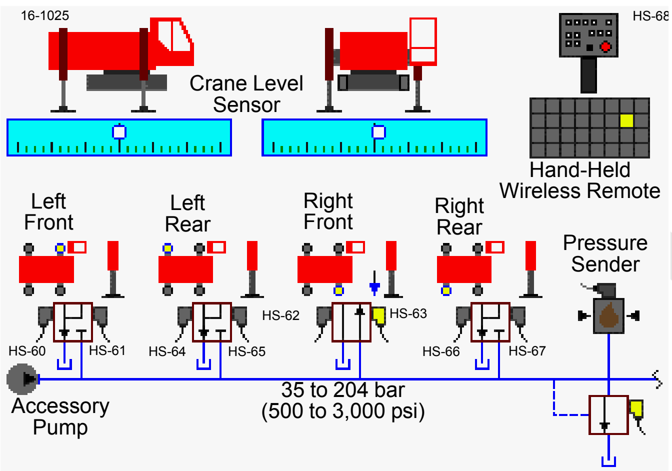


FIGURE 1-30

Hydraulic fluid pressure at approximately 204 bar (2,959 psi) flows to the selected jacking cylinder(s) proportional control valve. Hydraulic fluid exits the valve and enters the restraining section of the flow control valve. The restraining section controls the rate of speed for the cylinder to retract by limiting the fluid velocity before passing through the free-flow check valve section of the counterbalance valve. Hydraulic fluid then flows to the rod end of the jacking cylinder.

Hydraulic pressure trapped by the cylinder counterbalance valve at the piston end of the jacking cylinder supports the weight and gravitational force of the rotating bed. The Node-4 controller monitors the accessory system pressure sender to control the jacking cylinder lowering the speed rate.

Hydraulic fluid returning to the tank from the piston end of the jacking cylinder is blocked by the free-flow check valve. From the counterbalance valve flow is through flow restraining section that has a relief setting of 172 bar (2,495 psi). The counterbalance valve acts as a deceleration control and functions with a 3:1 pilot ratio of relief pressure. This permits the valve to open when the pressure in the piston end of the cylinder is approximately 57 bar (827 psi).

The restraining section of the counterbalance valve opens, controlling the fluid out of the jacking cylinder. Hydraulic fluid then flows through the free-flow check valve section of the flow control valve before entering the lower accessory valve. Hydraulic fluid leaving the lower accessory valve is returned to the tank.

When the jacking switch is moved back to the center position, an input voltage is sent to the Node-1 controller. The Node-4 controller sends a zero volt output to disable the selected jacking cylinder proportional control solenoid HS-63 and shifts the valve spool to the center position. The Node-3 controller sends a variable 0 to 24 volt output to disable the accessory system proportional relief solenoid HS-68.

Counterweight Pins

See Figure 1-31 and Figure 1-32.

During normal operation the counterweight pin solenoid is ***motor spooled*** where both cylinder ports and the tank port of the valve spool section are connected in the center position. When an accessory valve spool shifts, supply flow to the other accessory valves is limited. The accessory system pressure sender monitors the accessory system pressure.

The counterweight pin switch is spring-returned to the ***engage*** position. When the counterweight pin switch is moved to the ***disengage*** position and held, an input voltage is sent to the Node-1 controller. The Node-4 controller sends a 24 volt output to enable the counterweight proportional control solenoid HS-58 and shifts the valve to the ***disengage*** position. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68.

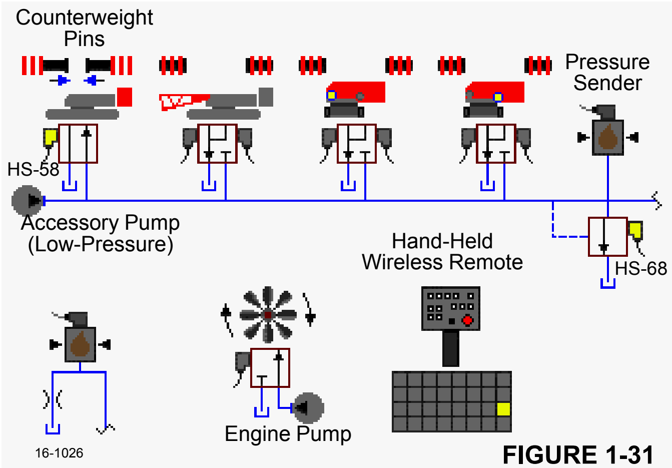


FIGURE 1-31

When the counterweight pins are extended, fluid flows through the counterweight pins solenoid HS-58 to the rod end of the pin cylinders. The cylinder pins extend while fluid from the piston end of the cylinder flows to the tank.

When the counterweight pins switch is released, the pins return to the ***extend*** position. The Node-3 controller sends a variable 0 to 24 volt output to disable the accessory system proportional relief solenoid HS-68.

Accessory System Electrical Schematic

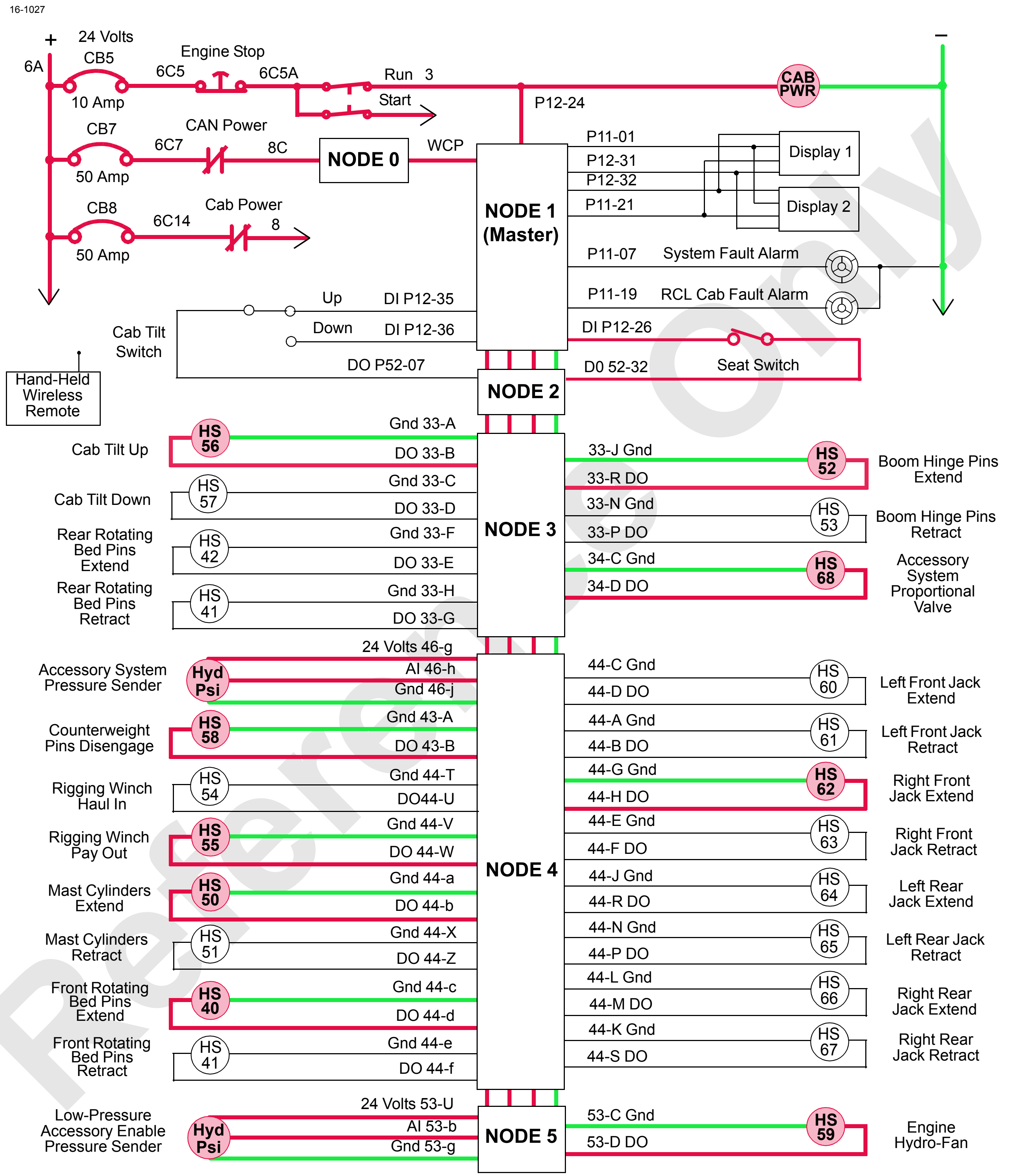


FIGURE 1-32

Boom Hinge Pins

See Figure 1-33 and Figure 1-34.

During normal operation the boom hinge pins solenoid valve is ***motor spooled*** where both cylinder ports and the tank port of the valve spool section are connected in the center position. When an accessory valve spool shifts, the supply flow to the other accessory valve is limited. The accessory system pressure sender monitors the accessory system pressure.

Power is available to the hand-held wireless remote control when the engine is running, and the power button is pressed. The boom hinge pins cannot be engaged/disengaged until the hydraulic line is connected between the crane and the boom butt and the keeper plates from the pins are removed.

When the boom hinge pins switch is placed in the ***engage*** position and held, an input voltage is sent to the Node-1 controller. The Node-4 controller sends a 24 volt output to enable the boom hinge pins solenoid HS-52 and shifts the valve to the ***engage*** position. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68.

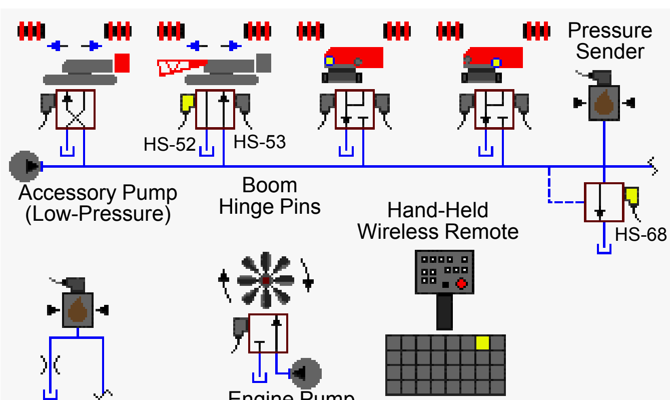


FIGURE 1-33

Hydraulic fluid pressure at approximately 204 bar (2,959 psi) flows to the boom hinge pins accessory valve. Hydraulic fluid leaves the accessory valve and enters the rod end of the boom pin cylinder, retracting the cylinder rod to engage the boom hinge pins. Hydraulic fluid from the piston end of the boom pin cylinder leaves the accessory system valve and returns to the tank. When the boom hinge pins switch is released, the valve returns to the center position. The Node-3 controller sends a variable 0 to 24 volt output to disable the accessory system proportional relief solenoid HS-68.

When the boom hinge pins switch is placed in the ***disengage*** position and held, an input voltage is sent to the Node-1 controller. The Node-4 controller sends a 24 volt output to enable the boom hinge pins solenoid HS-53 and shifts the valve to the ***disengage*** position. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68.

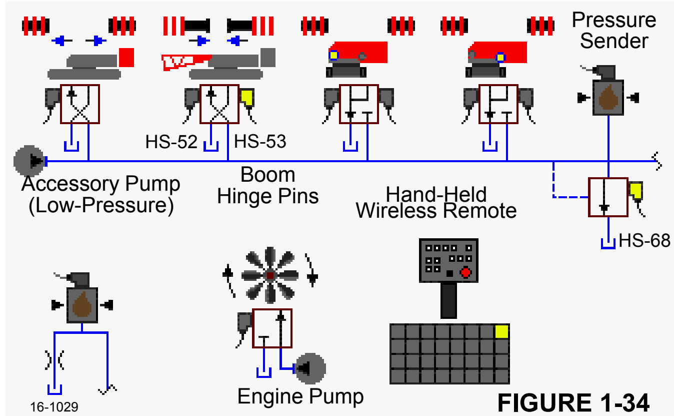


FIGURE 1-34

Hydraulic fluid pressure at approximately 204 bar (2,959 psi) flows to the boom hinge pins accessory valve. Hydraulic fluid leaves the accessory valve and enters piston end of the boom pin cylinder, extending the cylinder rod to disengage the boom hinge pins. Hydraulic fluid from the rod end of the boom pin cylinder leaves the accessory system valve and returns to the tank. When the boom hinge pins switch is released, the valve returns to the center position.

Front or Rear Rotating Bed Pins

See Figure 1-35, and Figure 1-36.

During normal operation the rotating bed pins solenoid valve is ***motor spooled*** where both cylinder ports and the tank port of the valve spool section are connected in the center position. When an accessory valve spool shifts, the supply flow to the other accessory valve is limited. The accessory system pressure sender monitors the accessory system pressure.

Power is available to the hand-held wireless remote control when the setup remote mode is selected, the engine is running, and the power button is pressed. The rotating bed pins cannot be engaged/disengaged until the keeper plates are removed from pins.

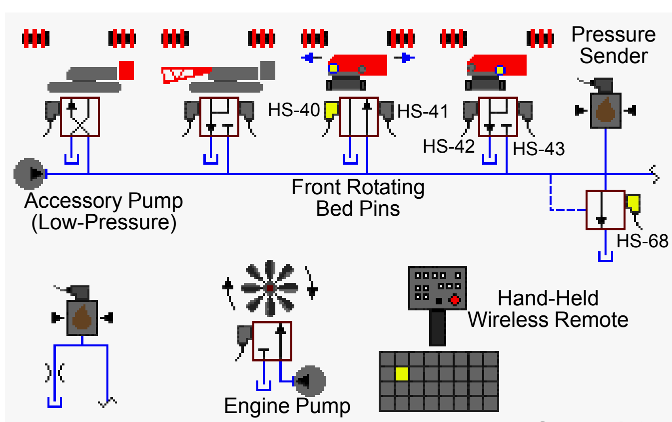


FIGURE 1-35

When the front or rear rotating bed pins switch is placed in the ***engage*** position and held, an input voltage is sent to the Node-1 controller. The Node-4 controller sends a 24 volt output to enable the rotating bed pins solenoid HS-40 (front selected) or HS-42 (rear) and shifts the valve to the ***engage*** position. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68.

Hydraulic fluid pressure at approximately 204 bar (2,959 psi) flows to the rotating bed pins accessory valve. Hydraulic fluid leaves the accessory valve and enters the piston end of the selected pin cylinders, extending the cylinder rod to engage the rotating bed pins. Hydraulic fluid from the rod end of the pin cylinders leaves the accessory system valve and returns to the tank. When the rotating bed pins switch is released, the valve returns to the center position.

When the rotating bed pins switch is placed in the ***disengage*** position and held, an input voltage is sent to the Node-1 controller. The Node-6 controller sends a 24 volt output to enable the selected front or rear pins solenoid HS-41 (front) or HS-43 (rear) and shifts the valve to the ***disengage*** position. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68.

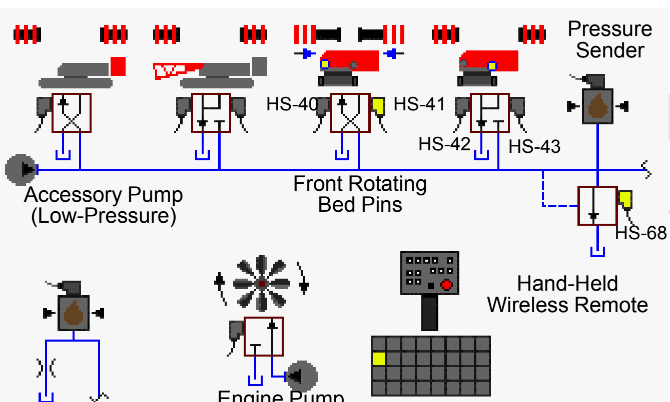


FIGURE 1-36

Hydraulic fluid pressure at approximately 204 bar (2,959 psi) flows to the rotating bed pins accessory valve. Hydraulic fluid leaves the accessory valve and enters the rod end of the pin cylinders, retracting the cylinder rods to disengage the rotating bed pins. Hydraulic fluid from the piston end of the pin cylinders leaves the accessory system valve and returns to the tank. When the rotating bed pins switch is released, the solenoid HS-41 (front) or HS-43 (rear) returns to the center position. The Node-3 controller sends a variable 0 to 24 volt output to disable the accessory system proportional relief solenoid HS-68.

Rigging Winch (Drum 0)

See Figure 1-37 and Figure 1-38.

The rigging winch (Drum 0) is located in the boom butt. During normal operation the rigging winch solenoid is ***motor spooled*** where both cylinder ports and the tank port of the valve spool section are connected in the center position. When an accessory valve spool shifts, supply flow to the other accessory valves is limited. The accessory system pressure sender monitors the accessory system pressure.

Access the rigging winch enable screen from the desired system drum Function Mode screen. When the rigging winch screen is enabled, the computer selects the handle to operate the rigging winch. The computer selected handle display light is 0.

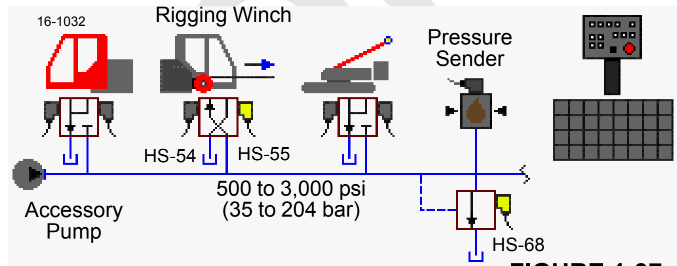


FIGURE 1-37

When the selected rigging winch control handle is moved forward in the ***pay out*** position, the Node-4 controller sends a 24 volt output to enable rigging winch pay out solenoid HS-55 and shifts the valve to the ***pay out*** position. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68. When an accessory valve spool shifts, the supply flow to the other accessory valve is limited. The accessory system pressure sender monitors the accessory system pressure.

Control handle movement controls the proportional relief valve hydraulic flow to the rigging winch accessory valve. Hydraulic fluid leaves the accessory valve and enters the pay out side of the winch motor to pay out wire rope. Return hydraulic fluid from the motor leaves the accessory system valve and returns to the tank. When the rigging control handle is moved to neutral, the accessory valve returns to the center position. The Node-3 controller sends a zero volt output to disable the accessory system proportional relief solenoid HS-68.

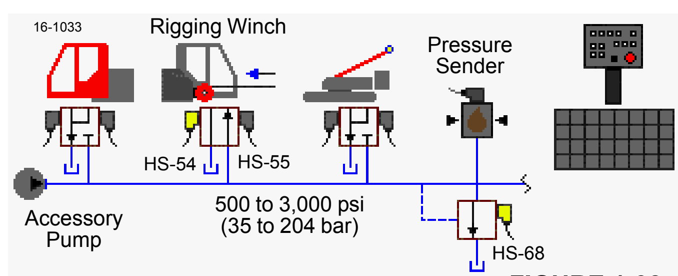


FIGURE 1-38

When the selected rigging winch control handle is moved back to the ***haul in*** position, the Node-4 controller sends a 24 volt output to enable the rigging winch pay out solenoid HS-54 and shifts the valve to the ***haul in*** position. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68.

When an accessory valve spool shifts, supply flow to the other accessory valves is limited. The accessory system pressure sender monitors the accessory system pressure.

Control handle movement controls the proportional relief valve hydraulic flow to the rigging winch accessory valve. Hydraulic fluid leaves the accessory valve and enters the haul in side of the winch motor to haul in the wire rope. Return hydraulic fluid from the motor leaves the accessory system valve and returns to the tank. When the rigging control handle is moved to neutral, the accessory valve returns to the center position. The Node-3 controller sends a zero volt output to disable the accessory system proportional relief solenoid HS-68.

Cab Tilt

See Figure 1-39, and Figure 1-40.

The cab tilt cylinder is attached to the cab frame. During normal operation the cab tilt solenoid is ***motor spooled*** where both cylinder ports and the tank port of the valve spool section are connected in the center position. When an accessory valve spool shifts, supply flow to the other accessory valves is limited. The accessory system pressure sender monitors the accessory system pressure. The cab tilt switch is on the right side console in operator cab.

When the top of cab tilt switch (raise front of cab) is pushed and held, an input voltage is sent to the Node-1 controller. The Node-3 controller sends a 24 volt output to enable the cab tilt up solenoid HS-56 and shifts the valve to the ***up*** position. The Node-3 controller sends a variable 0 to 24 volt output voltage to enable the accessory system proportional relief solenoid HS-68.

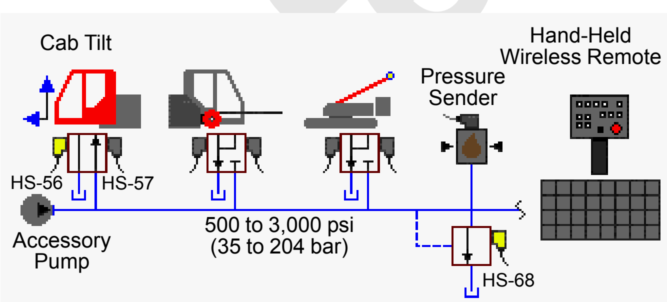


FIGURE 1-39

Hydraulic fluid pressure at approximately 204 bar (2,959 psi) flows to the cab tilt accessory valve. Hydraulic fluid exits the valve and enters the free-flow check valve before entering the piston end of the cylinder, extending the cylinder rod to raise the cab front.

Hydraulic fluid from the rod end of cylinder enters the free-flow check valve before entering the accessory valve and returns to the tank. When the cab tilt switch is released, the valve returns to the center position. The Node-3 controller sends a variable 0 to 24 volt output to disable the accessory system proportional relief solenoid HS-68.

When the bottom of cab tilt switch (lower front of cab) is pushed and held, an input voltage is sent to the Node-1 controller. The Node-3 controller sends a 24 volt output to enable solenoid HS-57 and shifts the valve to the ***lower*** position. The Node-3 controller sends a variable 0 to 24 volt output to enable accessory system proportional relief solenoid HS-68.

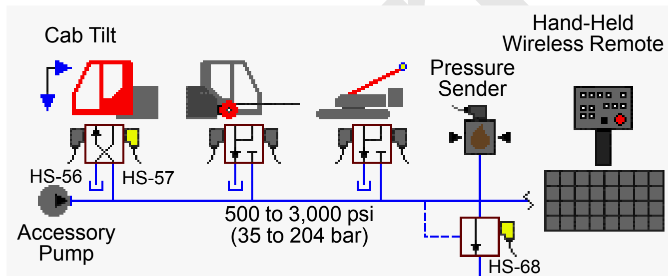


FIGURE 1-40

Hydraulic fluid pressure at approximately 204 bar (2,959 psi) flows to the cab tilt accessory valve. Hydraulic fluid exits the valve and enters the free-flow check valve before entering the rod end of the cylinder, retracting the cylinder rod to lower the cab front.

Hydraulic fluid from the piston end of cylinder enters the free-flow check valve before entering the accessory system valve and returns to the tank. When the cab tilt switch is released, the valve returns to the center position. The Node-3 controller sends a variable 0 to 24 volt output to disable the accessory system proportional relief solenoid HS-68.

Crawler Pin Cylinders

See Figure 1-41.

The crawler pin cylinder operation is controlled with the hydraulic valve handles on the front of the carbody and programming. Operation of both sets of pin cylinders is similar. The following description of operation is for the left side set of crawler pin cylinders.

When a crawler pin handle is moved down to engage the crawler pins into the crawler track frame, the valve shifts to allow system pressure to the pin cylinders. The lower accessory enable pressure transducer senses a pressure drop and sends an input signal to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt signal to the accessory system proportional relief solenoid HS-68 to increase the relief valve setting to approximately 207 bar (3,002 psi). The system pressure increases to operate the selected crawler pin handle. The Node-1 controller monitors the system pressure.

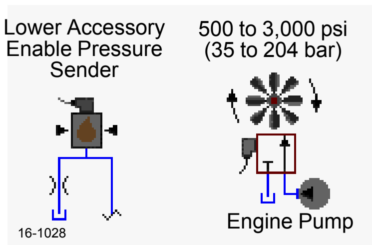


FIGURE 1-41

Hydraulic fluid enters the piston end of cylinder, extending the cylinder rod, pushing the pins to secure the crawler frame to the carbody. Hydraulic fluid from the rod end of the crawler pin cylinder flows through the lower accessory valve and returns to the tank.

When the crawler pin handle is moved back to the center position, the selected crawler pin valve shifts to the center position and closes system pressure to the cylinders. The Node-3 controller sends a zero-volt output to disable the accessory system proportional relief solenoid HS-68.

When a crawler pin handle is moved up to ***disengage*** the crawler pins from the crawler track frame, the valve shifts to allow system pressure to the pin cylinders. The lower accessory enable pressure sender senses a pressure drop and sends an input signal to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt signal to the accessory system proportional relief solenoid HS-68 to increase the relief valve setting to approximately 207 bar (3,002 psi). The system pressure increases to operate the selected crawler pin handle. The Node-1 controller monitors the system pressure.

Hydraulic fluid enters the rod end of the cylinders, retracting the cylinder rods, pulling the pins to disengage the crawler frame from the lowerworks. Hydraulic fluid from the piston end of the crawler pin cylinders flows through the lower accessory valve and is returned to the tank.

When the crawler pin handle is moved back to the center position, the selected crawler pin valve shifts to the center position and opens the line to the cylinders. The Node-3 controller sends a zero-volt output to disable the accessory system proportional relief solenoid HS-68.

Carbody Jacking Cylinders (optional)

See Figure 1-42.

The two-stage telescopic type jacking cylinders are mounted on each corner of the carbody. The jacking cylinder operation is controlled with the hydraulic valve handles on the front of the carbody and PC programming. Operation of all four jacking cylinders is the same. The following description of the operation is for a single jacking cylinder.

WARNING

Collapsing Hazard!

Keep the rotating bed as level as possible while jacking. Operating the jacking cylinder with the rotating bed more than 4° out of level can cause structural damage to the jacking cylinders and possible collapse of the rotating bed.

Each carbody jack cylinder has a counterbalance valve at the cylinder ports. The counterbalance valves ensure smooth control when raising or lowering the crane. The counterbalance valves lock the carbody jacking cylinders in place if there is a hydraulic line breakage or accidental operation of the control valve when the crane's power is shut down. Also, the counterbalance valves provide relief protection for the cylinders and shields them from mechanical overloading.

When a carbody jacking cylinder control valve handle is not enabled, it assumes a neutral position and hydraulic fluid passage to the carbody jacking cylinder is blocked. In neutral, both valve section cylinder ports are connected to the tank. This prevents in-line pressure from opening the counterbalance valve, holding the carbody load in position by the counterbalance valve.

When a carbody jack handle is moved back to ***raise***, the valve shifts to allow system pressure to the jack cylinder. The lower accessory enable pressure transducer senses a pressure drop and sends an input signal to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt signal to accessory system proportional relief solenoid HS-68 to increase the relief valve setting to approximately 207 bar (3,002 psi). The system pressure increases to operate the selected jack handle. The Node-1 controller monitors the system pressure.

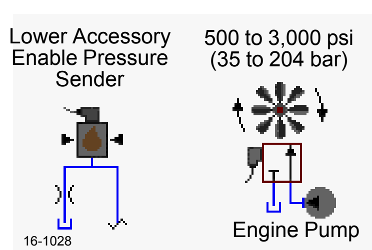


FIGURE 1-42

Hydraulic fluid enters the piston end of the cylinder, extending the cylinder rod, raising the carbody and the upperworks. Hydraulic fluid from the rod end of the cylinder flows through the lower accessory valve and returns to the tank.

When the handle is moved back to the center position, the selected valve shifts to the center position and closes the system pressure to the cylinders. The Node-3 controller sends a zero volt output to disable the accessory system proportional relief solenoid HS-68.

When a carbody jack handle is moved forward to ***lower***, the valve shifts to allow system pressure to the jack cylinder. The lower accessory enable pressure sender senses a pressure drop and sends an input signal to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt signal to accessory system proportional relief solenoid HS-68 to increase the relief valve setting to approximately 207 bar (3,002 psi). The system pressure increases to operate the selected jack handle. The Node-1 controller monitors the system pressure.

Hydraulic fluid enters the rod end of the cylinder, retracting the cylinder rods, lowering the carbody and the upperworks. Hydraulic fluid from the piston end of the cylinder flows through the lower accessory valve and is returned to the tank.

When the handle is moved back to the center position, the selected valve shifts to the center position and opens the line to the cylinders. The Node-3 controller sends a zero-volt output to disable the accessory system proportional relief solenoid HS-68.

Live Mast

See Figure 1-43, Figure 1-44, Figure 1-45, and Figure 1-46.

The live mast is the rectangular shaped structure that supports the boom. The mast is also used for crane assembly and disassembly.

The mast-raising sequence is controlled automatically by the computer program and the boom/mast hoist control handle. The mast raising and lowering rate is controlled by the engine speed, as it regulates the pay out and the haul in of the cable reeving between the boom/mast hoist sheaves and the mast sheaves.

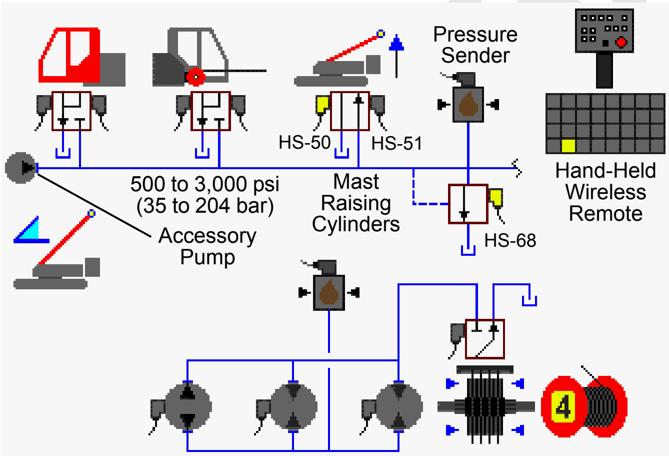
The mast system faults appear on the information screen when the mast is inoperable in either direction or the mast is at the maximum lower position. Stop operating when a fault appears.

Mast Raising/Lowering with Mast Switch

See Figure 1-43.

The mast switch on the hand-held wireless remote should only be used for raising/lowering the mast cylinders without wire rope rigging. Power is available to the hand-held wireless remote control when the engine is running, and the power button is pressed.

When not enabled, the mast raising cylinders are ***motor spooled*** where both cylinder ports and the tank port of the valve spool section are connected in the center position. This type of spool prevents the premature opening of the equalizing valves. The load equalizing valves ensure the mast-raising cylinders operate in unison, protecting the mast from structural damage caused by twisting. The load equalizing valves also provides the support resistance against the mast to ensure the control of the unit while rotating it at assembly. When an accessory valve spool shifts, supply flow to the other accessory valves is limited. The accessory system pressure sender monitors the accessory system pressure.



16-1036

FIGURE 1-43

When the mast cylinders switch is placed in the ***raise*** position and held, an input voltage is sent to the Node-1 controller. The Node-4 controller sends a 24 volt output to enable the mast cylinders raise solenoid HS-50 and shifts the valve to the ***raise*** position. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68. See the automatic raising/lowering procedure below for the complete cylinder operation.

When the mast cylinder switch is released, solenoid HS-50 returns to the center position. The Node-3 controller sends a zero volt output to disable the accessory system proportional relief solenoid HS-68.

When the mast cylinders switch is placed in the ***lower*** position and held, an input voltage is sent to the Node-1 controller. The Node-4 controller sends a 24 volt output to enable the mast cylinders lower solenoid HS-51 and shifts the valve to the ***lower*** position. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68. See the automatic raising/lowering procedure below for the complete cylinder operation.

When the mast cylinder switch is released, the solenoid HS-50 returns to the center position. The Node-3 controller sends a zero volt output to disable the accessory system proportional relief solenoid HS-68.

Mast Raising from Transport Position

See Figure 1-44 and Figure 1-45.

Use the RCL Screen to select the Liftcrane Mast Handling Capacity Chart. The mast controls will not operate and the mast operating limits remain off until the Liftcrane Mast Handling Capacities Chart is selected.

Use the mast switch on the hand-held wireless remote to raise the mast assist arms until the cylinders stall and stop.

When the boom/mast hoist control handle is moved forward for ***lowering***, an input voltage of 2.4 volts or less is sent to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the boom/mast hoist pump EDC in the down direction.

The Node-4 controller sends a 24 volt output to enable the mast cylinders extend solenoid HS-50 and shifts the valve to the ***extend*** position. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68.

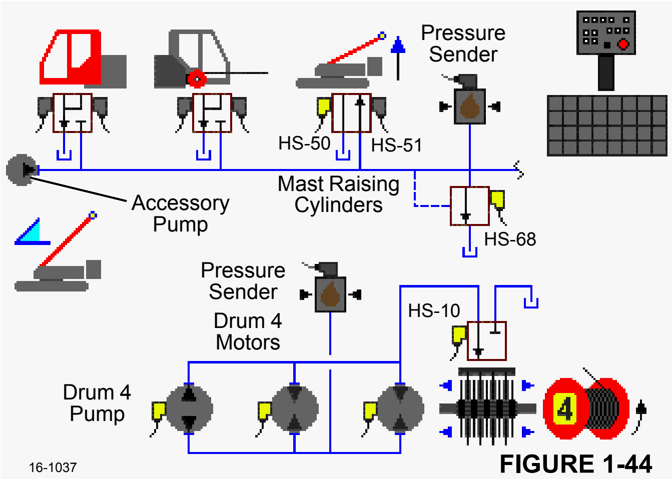


FIGURE 1-44

The Node-1 controller compares the drum holding pressure to the value in the pressure memory. When the system pressure is high enough, the Node-4 controller sends a 24 volt output to drum brake solenoid HS-10. The drum brake valve shifts to block the drain port and opens the port to the low-pressure side of the pump to release the brake.

The boom/mast hoist pump EDC strokes the pump in the down direction. The Node-4 controller sends a 24 volt output to enable the mast raising cylinders solenoid HS-50 in the extend (mast raising) direction. The valve shifts to block the tank port and open the port to the accessory system pressure. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68.

The mast assist arm cylinders extend automatically as the mast raises from the transport position. The boom/mast hoist drum pays out the wire rope between the drum and the mast sheaves. A speed sensor at motor rotor monitors the drum rotational speed.

Fluid pressure from the accessory valve enters the free-flow check valve sections on side A of the load equalizing valve. From the equalizing valve, fluid enters the counterbalance valves and piston end of the mast cylinders, extending the cylinder rods to raise the mast. The Node-4 controller monitors the accessory system pressure to control the mast cylinder raising the speed rate.

Fluid flow from the rod end of the mast raising cylinders is blocked by the free-flow check valve sections on side B of the counterbalance valves and flows through the valve flow restrain sections preset for a relief pressure of 240 bar (3,481 psi). The counterbalance valves operate with a 5:1 pilot ratio of the relief valve pressure, permitting the valve to open when the pressure in rod end of the cylinders is approximately 48 bar (696 psi). Hydraulic fluid from side B sections of both the counterbalance valves combines, and the free-flow check valve section on side B of load equalizing valve blocks the flow.

The fluid then passes through the valve flow restrain section that is preset at 276 bar (4,003 psi). The load equalizing valve operates with a 1.5:1 pilot ratio of the relief valve pressure, permitting the valve to open when the hydraulic pressure on side A of the load-equalizing valve is approximately 185 bar (2,683 psi). The restraining section on side B of the load equalizing valve opens, controlling the flow of fluid out of the cylinders to ensure the cylinder operation is balanced.

When the mast cylinders are extending, the Node-4 controller monitors the drum speed sensor. The Node-1 controller maintains a speed that is proportional to the accessory system hydraulic pressure applied to the mast raising cylinders. The mast assist arms will stop rising automatically when the mast assist cylinders are fully extended (approximately 115°).

The Node-3 controller monitors the mast angle sensor when the mast is moving. The diagnostic screen monitors the mast operating angle. When the mast is raised to the operating range of 115° to 145°, the Node-3 controller sends a zero output voltage to the pump EDC. When the control handle center switch opens, the Node-4 controller sends a zero volt output to disable the brake solenoid HS-10 to apply the brake before pump de-strokes.

The Node-3 controller sends a variable 24 volt output signal to the pump EDC to de-stroke the pump. The Node-4 controller sends a zero output voltage to shift the spool of mast raising cylinder solenoid HS-50 to the center position. The Node-3 controller sends a zero volt output to disable the accessory system proportional relief solenoid HS-68.

Mast Lowering to Transport Position

See Figure 1-45.

Use the RCL Screen to select the Liftcrane Mast Handling Capacity Chart. The mast controls will not operate and the mast operating limits remain off until the Liftcrane Mast Handling Capacities Chart is selected.

Use the mast switch on the hand-held wireless remote to raise the mast assist arms until the cylinders stall and stop.

When the boom/mast hoist control handle is moved back for ***raising***, an input voltage of 2.6 volts or more is sent to the Node-1 controller. The Node-3 controller sends a variable 0 to 24 volt output that is divided by a resistor and applied to the boom/mast hoist pump EDC in the raise direction.

The Node-1 controller compares the drum holding pressure to value in the pressure memory. When the system pressure is high enough, the Node-4 controller sends a 24 volt output to the drum brake solenoid HS-10. The drum brake valve shifts to block the drain port and opens the port to the low-pressure side of the pump to release the brake.

The boom/mast hoist pump EDC strokes the pump in the ***raise*** direction. The Node-4 controller sends a 24 volt output to enable mast raising cylinders solenoid HS-51 in the retract (mast lowering) direction. The valve shifts to block the tank port and open the port to the low-pressure side of pump.

As the mast lowers to the transport position, the boom/mast drum hauls in wire rope between the boom and the mast sheaves.

From the accessory valve, the fluid pressure enters the free-flow check valve sections on side B of the load equalizing valve. From the equalizing valve, fluid enters the counterbalance valves and the rod end of the mast cylinders, retracting the cylinder rods.

Fluid flow from the piston end of the mast raising cylinders is blocked by the free-flow check valve sections on side A of the counterbalance valves and flows through the valve flow restrain sections preset for a relief pressure of 240 bar (3,481 psi). The counterbalance valves operate with a 5:1 pilot ratio of the relief valve pressure, permitting the valve to open when the pressure in the piston end of the cylinders is approximately 48 bar (696 psi).

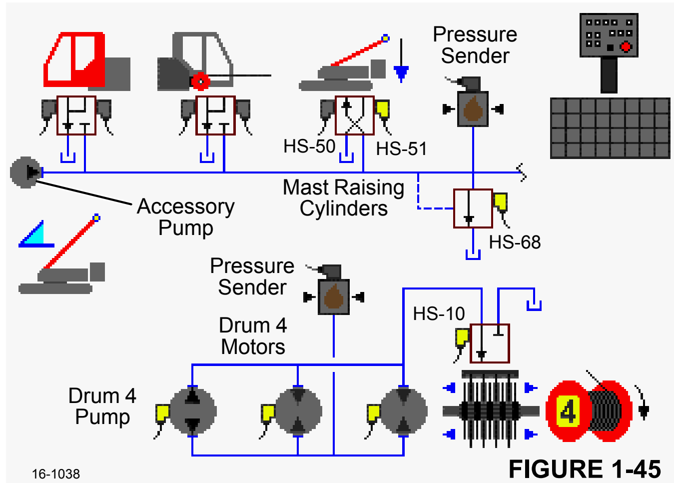


FIGURE 1-45

Hydraulic fluid from side A sections of both counterbalance valves combines, and the free-flow check valve section on side A of load equalizing valve blocks the flow. The fluid then passes through the valve flow restrain section that is preset at 276 bar (4,003 psi). The load equalizing valve operates with a 1.5:1 pilot ratio of the relief valve pressure, permitting the valve to open when the hydraulic pressure on side A of the load-equalizing valve is approximately 185 bar (2,683 psi). The restraining section on side B of the load equalizing valve opens, controlling the flow of the fluid out of the cylinders to ensure the cylinder operation is balanced.

When the mast cylinders are retracting, the Node-3 controller monitors the boom/mast hoist drum speed sensor. The Node-1 controller maintains a speed that is proportional to the accessory system the hydraulic pressure applied to the mast raising cylinders.

The Node-3 controller output voltage to the pump EDC is relative to the control handle movement. The system pump varies the flow to keep the drum at the handle command setting. As the control handle is moved back, an output voltage increases the pump swashplate angle.

The Node-3 controller monitors the mast angle sensor when the mast is moving. When the mast is near 0°, the Node-3 controller sends a zero output voltage to the pump EDC that moves the swashplate to the center position. After the control handle center switch opens, the Node-4 controller also sends a zero output voltage to disable the drum brake solenoid HS-10 to apply the brake before the pump de-strokes.

The Node-4 controller sends a zero output voltage to shift the spool of the mast raising cylinder HS-51 to the center position. The Node-3 controller sends a zero volt output to disable the accessory system proportional relief solenoid HS-68.

NOTE: It may be necessary to use the mast cylinders switch to lower the mast fully.

Live Mast Electrical Schematic

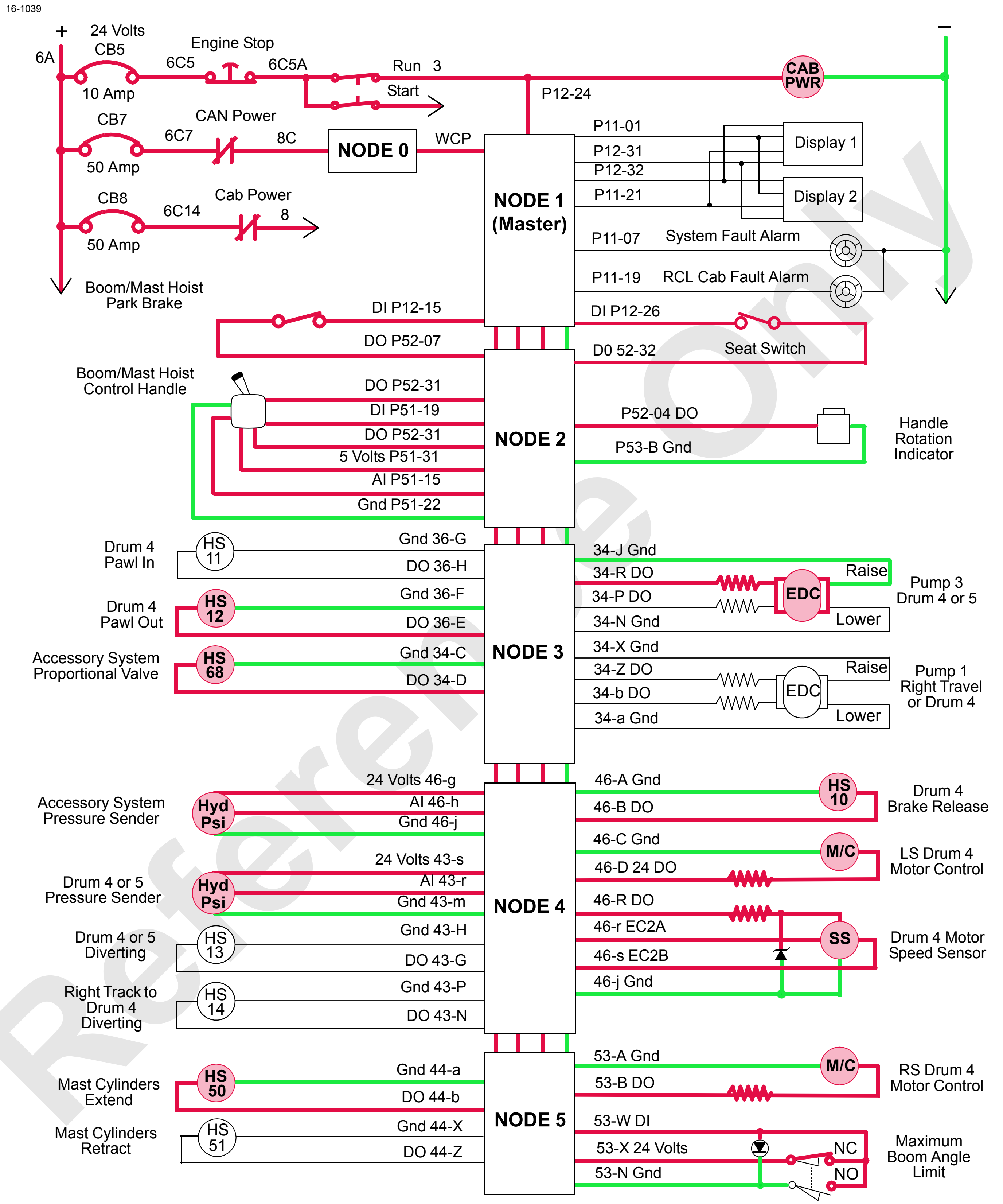


FIGURE 1-46

Hydraulic Cooling Fan

See Figure 1-47.

The hydraulic cooling fan is supplied fluid from either the uni-directional variable displacement accessory pump or the engine-mounted, fixed displacement, lower accessory gear pump. The accessory system pump will be the main oil supply to the fan motor until the accessory system is enabled. The Node-1 will send a 24-volt signal through the Node-5 to Solenoid HS-59 shifting the oil supply from the accessory pump to the lower accessory pump which will supply oil to the cooling fan. A preset 207 bar (3,002 psi) pressure relief valve regulates the lower accessory system circuit pressure.

Tier 4 Equipped Machines

Machines equipped with a Tier 4 engine have a variable-speed cooling fan. The uni-directional, variable displacement accessory system pump controls the fan RPM in relation to the feedback of various engine temperature sensors while the accessory system is disabled. When the accessory system is enabled, solenoid HS-59 shifts, allowing the lower accessory system pump to supply oil flow to the fan motor at a fixed displacement regulated by a 207 bar (3,000 psi) relief valve.

As the engine load increases, the fan speed will also increase to meet the engine's cooling needs. Fan speed is determined by the greatest demand of four inputs: coolant temperature, air intake temperature (IMT), hydraulic oil temperature and the state of the air conditioning clutch. The system monitors these inputs every ten seconds and adjusts the fan speed depending on the input readings.

A minimum fan speed indicator is included on the Main display in the cab. The minimum fan speed can be adjusted but this adjustment should be made only by the manufacturer. It should not be changed by either the operator or a service person.

NOTE: Fan speed should never be 100%. If the actual fan speed approaches 100%, the operator and/or service person should investigate to determine the cause of the problem.

NOTE: If there is an electrical failure, the fan will default to high-speed operation.

A variable-speed fan provides several benefits including quieter operation, higher efficiency and longer fan life. This type of fan also provides a more uniform engine temperature and results in more engine horsepower.

See the engine manufacturer's operating instructions manual for diagnostic information.

Cooling Fan Diagnostic Screen

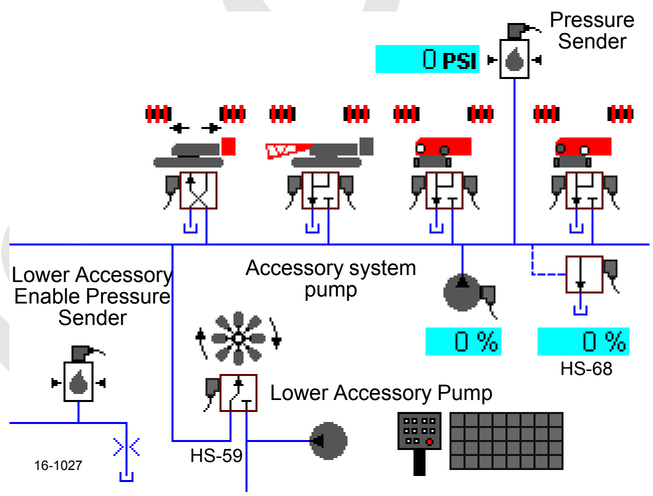


FIGURE 1-47

Manitowoc

MAX-ER 16000 DESCRIPTION OF OPERATION

See the MAX-ER Operator Manual for complete instructions.

MAX-ER Components

See the Hydraulic Schematic topic in Section 2.

The MAX-ER attachment has a wheeled counterweight assembly which supplements the crane's counterweights. Added counterweight increases the crane's capacity and the amount of boom it can operate while maintaining its ability to travel and swing with and without a load.

The MAX-ER 16000 wheeled counterweight assembly consists of the following components:

- **Wheeled Counterweight Assembly**—suspended from a fixed mast by straps and a hydraulic lift cylinder fastened to the counterweight base. The wheeled counterweight assembly is connected to the rear of the crane by a telescopic beam which has three operating positions.
- **Counterweight Lifting Cylinder**—suspends the wheeled counterweight assembly from the fixed mast. The lift cylinder automatically raises and lowers the wheeled counterweight assembly in response to changes in the load (weight of lifted load and boom angle).
- **Load Sensing Pin**—mounted in one mast strap and monitors the mast loading. The pin sends a variable input voltage to the crane's Node-1 controller for controlling the counterweight lift cylinder position.
- **Jacking Cylinders**—allow the wheeled counterweight assembly to stand alone and assist with positioning the wheels for traveling or swinging.
- **Wheel Assembly**—allows the wheeled counterweight assembly to travel or swing behind the crane.
- **Telescopic Beam Cylinder**—adjustable beam that connects the wheeled counterweight assembly to the crane.
- **CAN-Bus Programmable Controller**—monitors and operates the attachment's electrical and hydraulic systems. Automatically raises and lowers the wheeled counterweight assembly in response to signals from the load sensing pin and boom hoist control handle. See Electrical Schematics in Section 3.

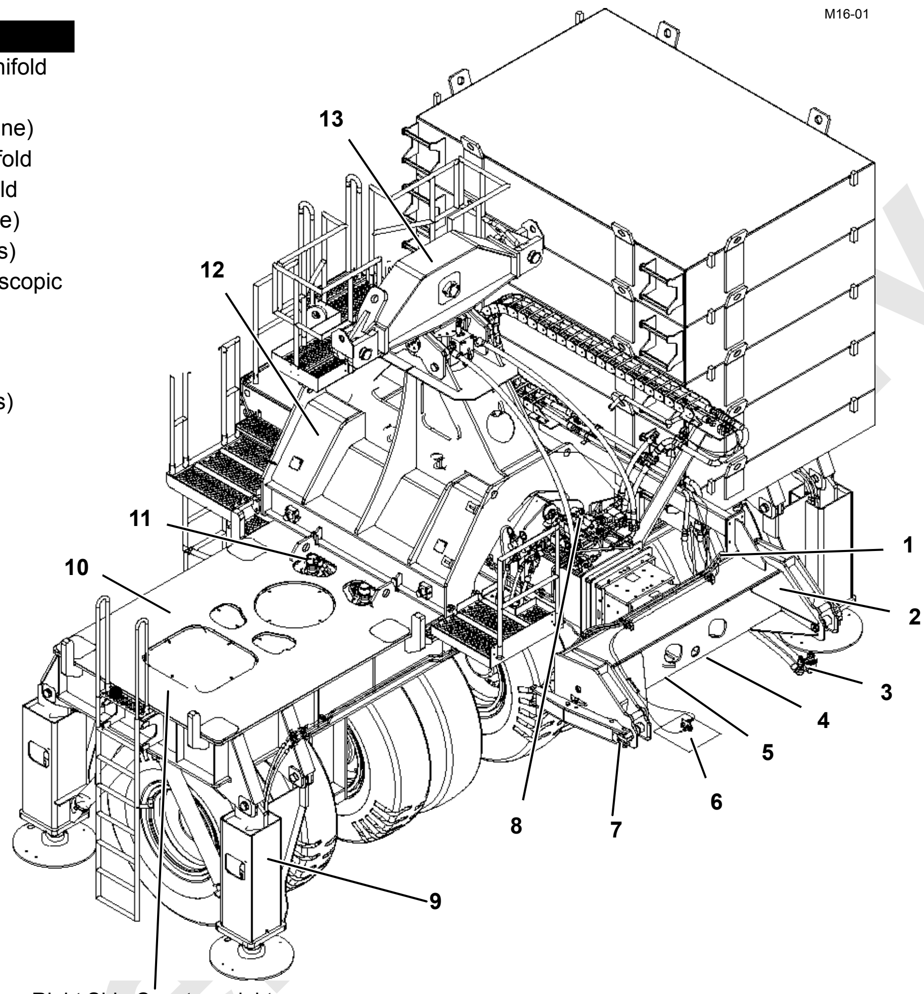
Hydraulic Solenoid Valve Identification

In this section a hydraulic system that is open means fluid can flow in the circuit. Each hydraulic solenoid valve in this section is assigned an HS number. Table 1-1 identifies each hydraulic solenoid valve.

Table 1-1Hydraulic Solenoid Valve Identification

HS-68	Accessory System Proportional Relief
HS-70	Counterweight Lift Cylinder Extend
HS-71	Counterweight Lift Cylinder Extend
HS-72	Counterweight Lift Cylinder Retract
HS-73	Counterweight Lift Cylinder Retract
HS-74	Left Front Jacking Cylinder Extend
HS-75	Left Front Jacking Cylinder Retract
HS-76	Left Rear Jacking Cylinder Extend
HS-77	Left Rear Jacking Cylinder Retract
HS-78	Right Front Jacking Cylinder Extend
HS-79	Right Front Jacking Cylinder Retract
HS-80	Right Rear Jacking Cylinder Extend
HS-81	Right Rear Jacking Cylinder Retract
HS-82	Left Wheel Steering Clockwise
HS-83	Left Wheel Steering Counter-Clockwise
HS-84	Right Wheel Steering Clockwise
HS-85	Right Wheel Steering Counter-Clockwise
HS-86	Left Wheel Brakes
HS-87	Right Wheel Brakes
HS-88	Telescopic Beam Cylinder Extend
HS-89	Telescopic Beam Cylinder Retract
HS-90	Telescopic Beam Hinge Pin In
HS-91	Telescopic Beam Hinge Pin Out

Item	Description
1	Telescopic Beam Hinge Pin Manifold
2	Telescopic Beam (Front)
3	Hydraulic Hoses (connect to crane)
4	Jacking Cylinders/Wheels Manifold
5	Wheel Assembly Brakes Manifold
6	Electric Cables (connect to crane)
7	Connecting Hinge Pins (2 places)
8	Counterweight Lift Cylinder/Telescopic Beam Cylinder Manifold
9	Jacking Cylinders (4 places)
10	Counterweight Base
11	Wheel Assembly Drive (4 places)
12	Lifting Frame
13	Lifting Cylinder with Spreader



Accessory Pumps

The main crane hydraulic tank supplies hydraulic fluid for the MAX-ER attachment. The auxiliary pumps supply pressurized hydraulic fluid between 400 psi (28 bar) and 5,000 psi (345 bar) to wheeled counterweight system.

MAX-ER System Pressure

The MAX-ER system pressure is monitored by a pressure sender and controlled by the Node-1 controller and the proportional relief solenoid HS-68 to provide up to 345 bar (5,004 psi) system pressure when required.

A pressure control pilot relief valve keeps the MAX-ER system pressure at 28 bar (406 psi) when inactive.

Wheeled Counterweight Valves

Each hydraulic valve spool section is electrically enabled with switches and/or the Node-1 controller program:

1. The telescopic beam hinge pin in/out is a three position spool valve with the open center mounted on a manifold (1, Figure 1-48) at the rear of the telescopic beam.
2. The jack cylinders (four valves) and the wheel assembly (two valve) are three position spool valve with the open center mounted (4) on a six bank manifold at the front and center of the counterweight base.
3. The right and left wheel assembly brake valves are two position spool valves with the open center mounted on a manifold (5) at the front and center of the counterweight base.
4. The counterweight lift cylinder (two valves) and telescopic beam (one valve) are three position spool valves with the open center mounted on a manifold (8) at platform, near the lift cylinder.

EPIC® Programmable Controller

The operating system is an EPIC® (Electrical Processed Independent Control) with CAN-bus (Controller Area Network) technology. The CAN-bus system uses multiple nodes that contain remote controllers. The remote node controllers communicate with the Node-1 (master) controller by sending information data packets over a two-wire bus line. The data packets are tagged with addresses that identify each system component.

With the CAN-bus system, independently powered pumps, motors, and cylinders provide controller driven control logic, pump control, motor control, on-board diagnostics, and service information. The MAX-ER data is shown on the information screen in the operator cab (see Main Display topic in Section 3 of the MAX-ER Operator Manual).

MAX-ER Wireless Remote Controls

To operate the MAX-ER wireless remote control see the Operating Controls and Procedure in Section 3 of the MAX-ER Operator Manual. Also, the MAX-ER Function mode screen must be selected on the main display.

Power is available to the hand-held wireless remote control when the engine is running, the MAX-ER function mode is selected, and the power button is pressed. When a MAX-ER wireless remote control is enabled, an input signal from the wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to the Node-1 controller. The Node-1 controller sends an output signal to enable the MAX-ER component in the direction or position selected.

Electrical System

Electrical cables WNE56 from the Node-4 controller and WN56 from Node-0 on the crane provide input/out connections to Node-7 on the wheeled counterweight assembly.

Jacking Cylinders

See Figure 1-49 and Figure 1-50.

There is one jacking cylinder on each corner of the counterweight base. The jacking cylinders are for raising the counterweight wheels off the ground to allow the wheeled counterweight assembly to stand by itself when not attached to the crane, wheel positioning, or to aid in tire maintenance. Struts must be pinned to each jack cylinder to stabilize the counterweight assembly when it is not attached to the crane.

Each jacking cylinder has a counterbalance valve at each cylinder port to provide smooth operation when operating. The counterbalance valves lock the cylinder in position and provide the cylinder with relief protection. The jacking three position spool valves are motor spooled where both cylinder ports and the tank port of the valve spool section are connected in the center position.

DANGER

Tipping Hazard!

Wheeled counterweight assembly can tip:

- Extend and retract jacking cylinders slowly to keep counterweight base as level as possible.
- Do not extend jacking cylinders if wheeled counterweight assembly is not attached to the crane and wheels are not at stand alone position.
- Make sure struts are pinned to the jacking cylinders when raising the base with the jacking cylinders.
- Read and understand the counterweight jack procedure before operating the MAX-ER wireless remote control.

Each jacking cylinder has an end of travel sensor that stops the jacking cylinder travel at a preset position and sends an input voltage signal to the Node-1 controller. Each jacking cylinder end of travel sensor is normally open. All jack end of travel switches must be closed before the wheeled counterweight assembly can travel or swing.

The MAX-ER base level sensor indicates the counterweight base roll and pitch to ± 4.5° from zero and sends an input voltage to the Node-1 controller.

Power is available to the hand-held wireless remote control when, the engine is running, the MAX-ER function mode is selected, and the power button is pressed. The jacking cylinders cannot be extended/retracted until the electrical cables and hydraulic lines are connected between the rear of the crane and the telescopic beam of the wheeled counterweight assembly.

When operating, the left travel handle can control the operation of the jacking cylinders when travel is parked and a MAX-ER chart is selected. Moving the left travel handle ***forward*** enables all the jacking cylinders ***down***. Moving the left travel handle ***back*** enables all the jacking cylinders ***up***. The left travel jacking cylinder extend/retract is similar to the hand-held wireless remote control operation described next.

Extend Jacking Cylinders

When selected the jack or jack all switch is moved and held in the extend position, an input signal from the wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to the Node-1 controller. Node-7 sends a 24 volt output to enable the selected jack cylinder solenoid (HS-74 in this example) and shifts the valve to the extend position.

The Node-3 controller also sends a variable 0 to 24 voltage to enable the proportional relief solenoid HS-68 to provide approximately 310 bar (4,496 psi) pressure to the jack system.

Hydraulic pressure from the accessory pump flows through the pressure control pilot valve, the six bank manifold valve, and enters the free-flow check valve section of the counterbalance valve. Fluid pressure on the piston end of selected jack cylinder extends the jack cylinder to raise the wheeled counterweight base.

Hydraulic fluid from the rod end of jack cylinder is blocked by the free-flow check valve section of the counterbalance valve and the flow restraining section of the relief valve preset for a relief setting of approximately 138 bar (2,002 psi). The rod end cylinder pressure opens the restraining section of the counterbalance valve, allowing fluid to exit the valve. Return hydraulic fluid passes through the six bank manifold valve before returning to the crane hydraulic tank through a return line.

When the desired jack cylinder extension is reached, release the selected jack switch to lock the jack cylinder(s) in position. Hydraulic fluid at the piston end of the jack cylinder counterbalance valve supports the weight and the gravity force of the wheeled counterweight assembly.

When the selected jack switch is released, an input signal is sent to the Node-1 controller. The Node-7 controller sends a zero volt output to the hydraulic solenoid HS-74 to the return valve to the center position.

Node-3 sends a variable voltage output to the accessory system proportional relief solenoid HS-68 to provide approximately 28 bar (406 psi) system pressure.

Retract Jacking Cylinders

When the selected jack or jack all switch is moved and held in the retract position, an input signal from the wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to the Node-1 controller. Node-7 sends a 24 volt output to enable the selected jack cylinder solenoid (HS-75 in this example) and shifts the valve to the retract position.

The Node-3 controller also sends a variable 0 to 24 voltage to enable the proportional relief solenoid HS-68 to provide approximately 310 bar (4,496 psi) pressure to the jack system.

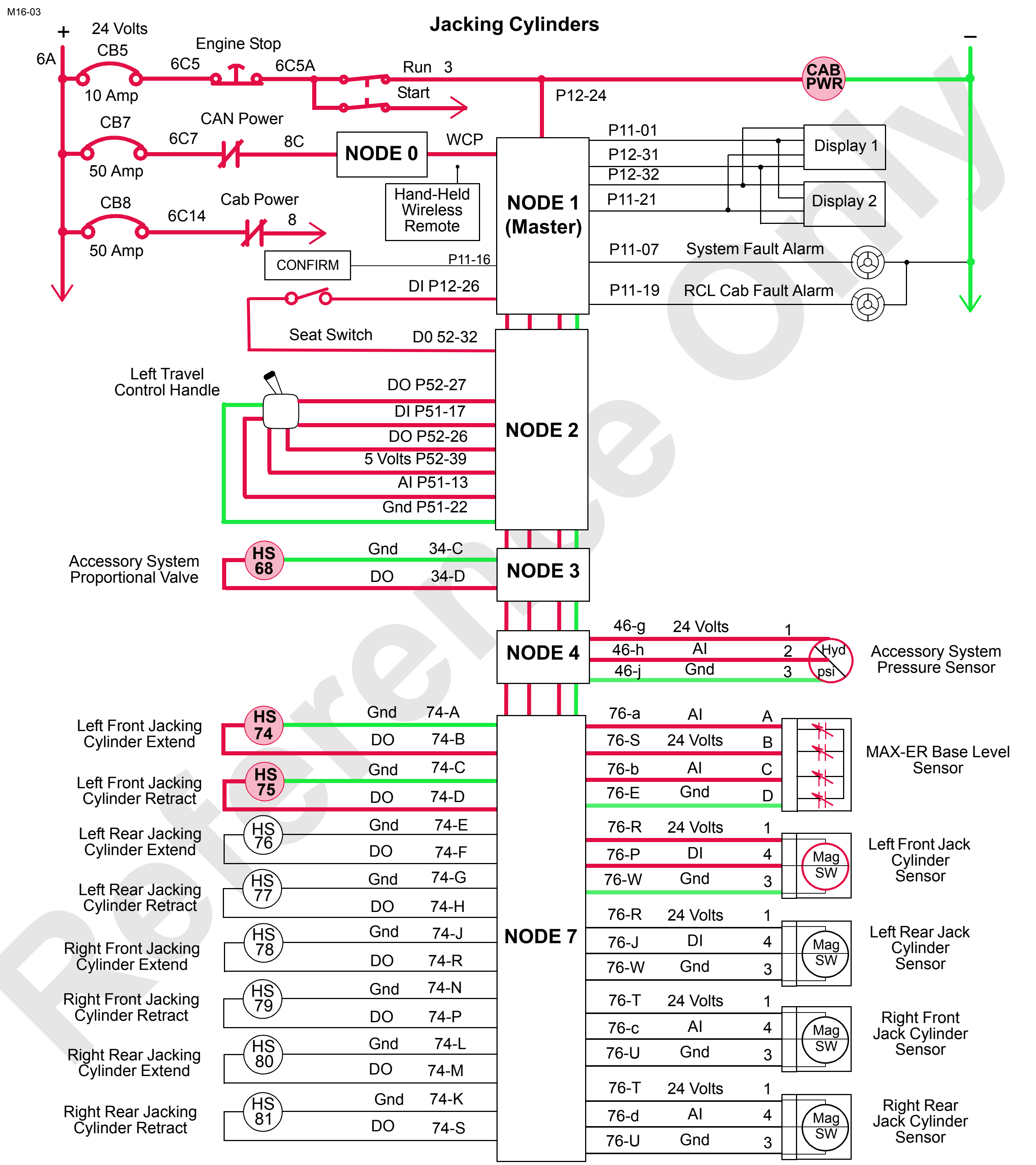


FIGURE 1-49

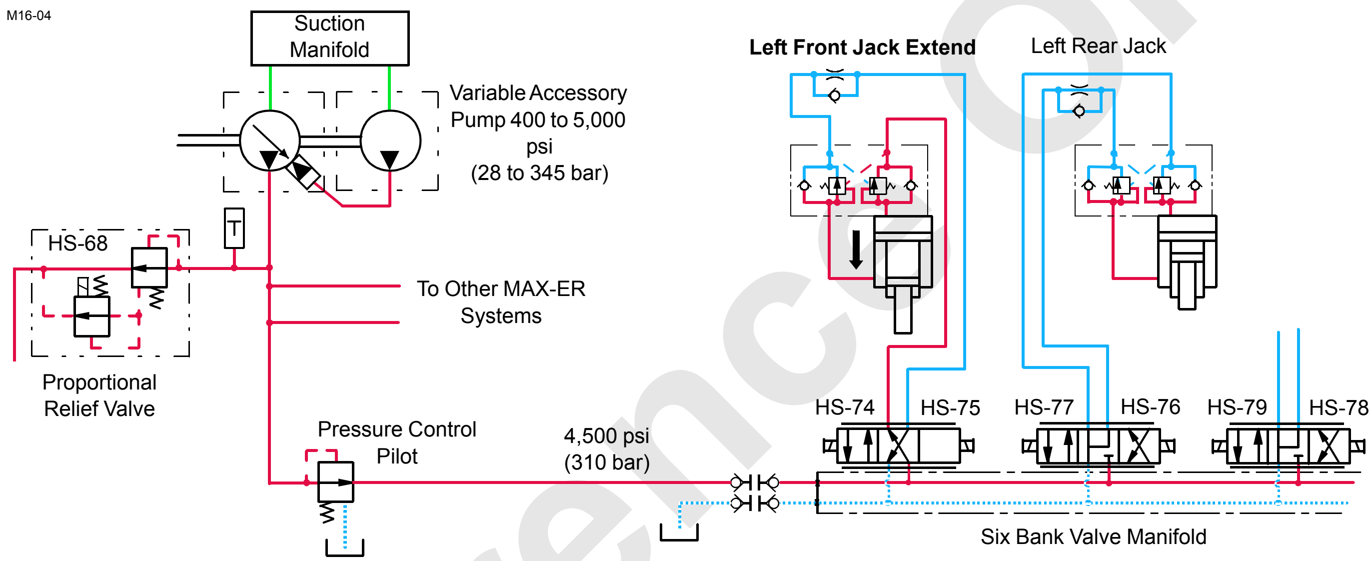
Hydraulic pressure from the accessory pump flows through the pressure control pilot valve, the six bank manifold valve, and enters the free-flow check valve section of the counterbalance valve. Fluid pressure on the rod end of selected jack cylinder retracts the jack cylinder to lower the counterweight base.

Hydraulic fluid from the piston end of the jack cylinder is blocked by the free-flow check valve section of the counterbalance valve and the flow restraining section of the relief valve preset for a relief setting of approximately 138 bar (2,002 psi). The piston end cylinder pressure opens the restraining section of the counterbalance valve, allowing fluid to exit the valve. Return hydraulic fluid passes through the six bank manifold valve before returning to the crane hydraulic tank through the return line.

When the desired jack cylinder retraction is reached, release the selected jack switch to lock the jack cylinder(s) in position. Hydraulic fluid at the piston end of the jack cylinder counterbalance valve supports the weight and the gravity force of the wheeled counterweight assembly.

When the selected jack switch is released, an input signal is sent to the Node-1 controller. The Node-7 controller sends a zero volt output to the hydraulic solenoid HS-75 to the return valve to the center position.

Node-3 sends a variable voltage output to the accessory system proportional relief solenoid HS-68 to provide approximately 28 bar (406 psi) system pressure.



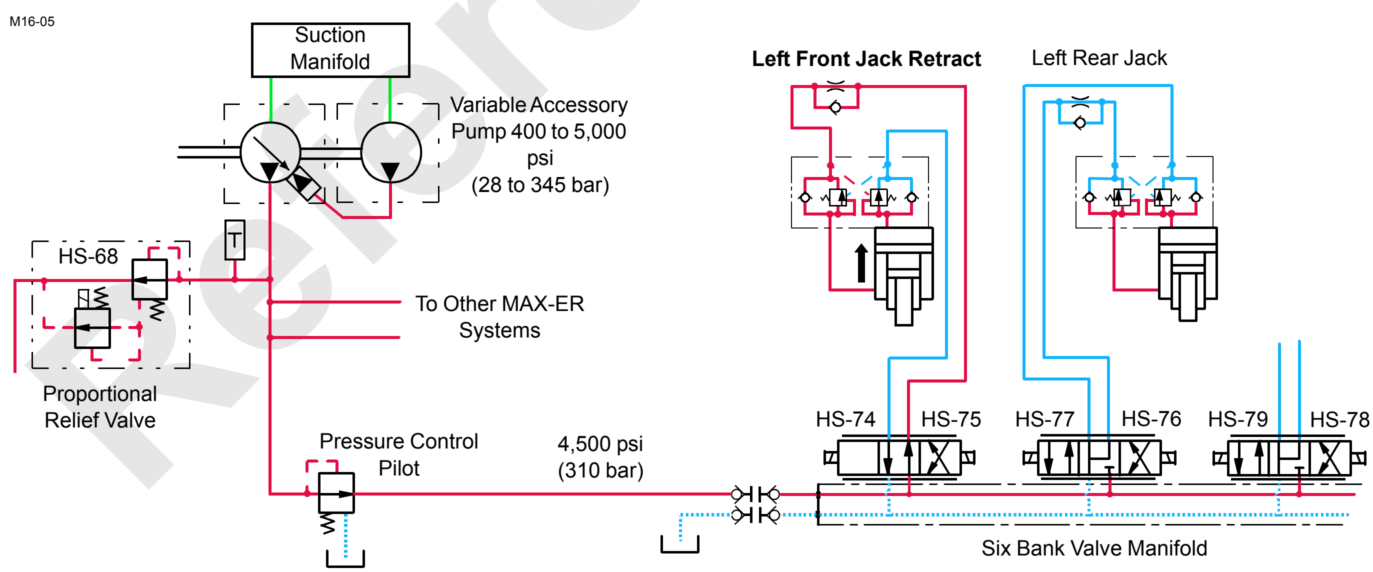


FIGURE 1-50

Telescopic Beam Cylinder

See Figure 1-51 and Figure 1-52.

The telescopic beam cylinder connects the wheeled counterweight assembly to the crane. The beam can be positioned to three different positions depending on the crane configuration.

The telescopic beam has a counterbalance valve at each cylinder port to provide smooth operation when operating. The counterbalance valves lock the cylinder in position and also provide relief protection for the cylinder. The telescopic beam three position spool valves are motor spooled where both cylinder ports and the tank port of the valve spool section are connected in the center position.

The top and bottom telescopic beam position encoders detect telescopic beam position and direction of the beam movement. The Node-1 controller receives this input information as two out-of-phase square wave voltages that are converted to counts. The information screen in the operator cab indicates the telescopic beam extend position in inch or metric.

Power is available to hand-held wireless remote control when, the engine is running, The MAX-ER function mode is selected, and the power button is pressed. The telescopic beam cannot be extended/retracted until the electrical cables and hydraulic lines are connected between the rear of crane and the telescopic beam of the MAX-ER.

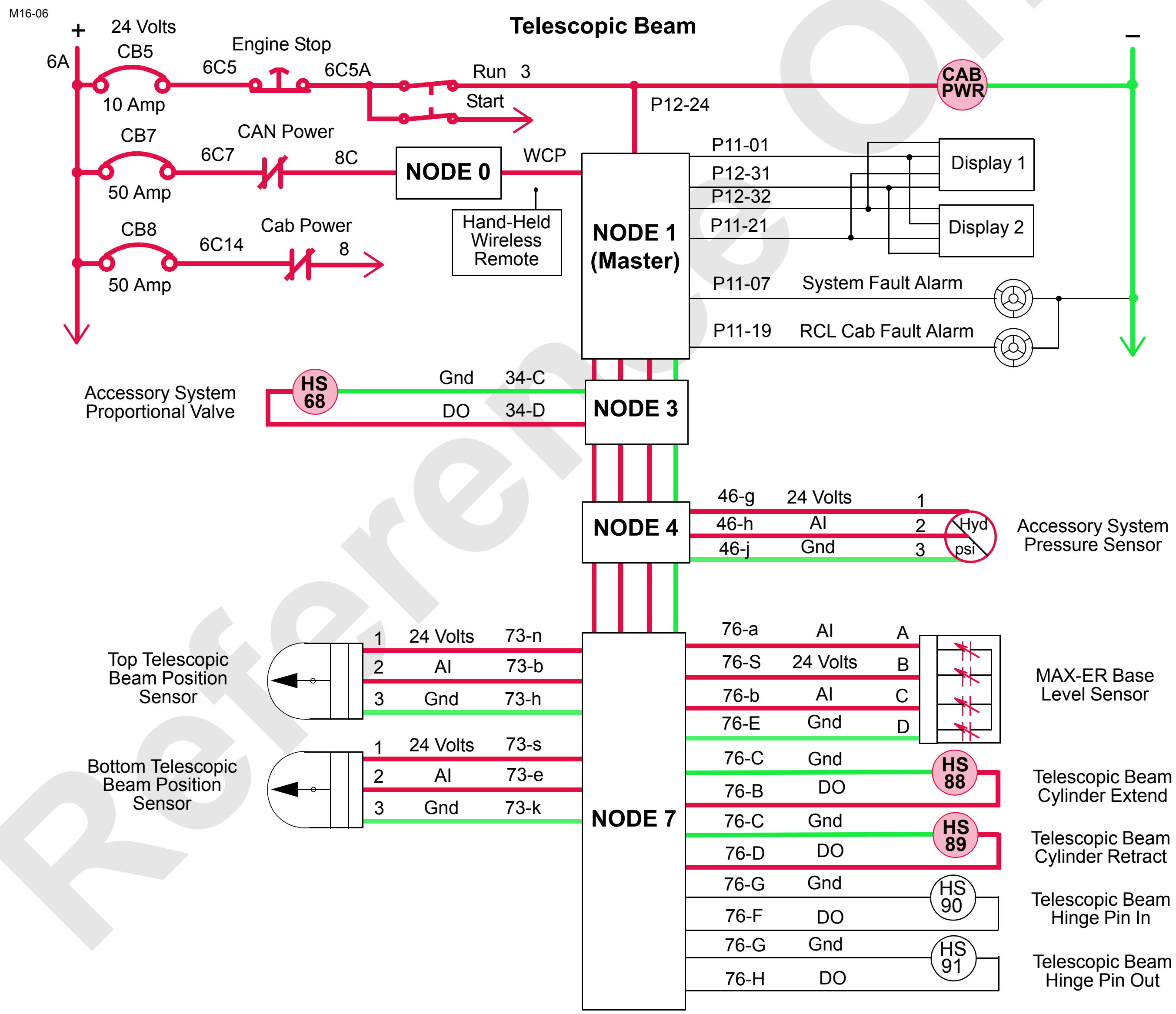


FIGURE 1-51

Extend Telescopic Beam Cylinder

When the telescopic beam switch is moved and held in the extend position, an input signal from the wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to the Node-1 controller. Node-7 sends a 24 volt output to enable the telescopic beam solenoid HS-88 and shifts the valve to the extend position.

The Node-3 controller also sends a variable 0 to 24 voltage to enable the proportional relief solenoid HS-68 to provide approximately 310 bar (4,496 psi) pressure to the telescopic beam system.

Hydraulic pressure from the accessory pump flows through the pressure control pilot valve, the three bank manifold valve, and enters the free-flow check valve section of the counterbalance valve. Fluid pressure on the piston end of the beam cylinder extends the beam to the desired length.

Hydraulic fluid from the rod end of the beam cylinder is blocked by the free-flow check valve section of the counterbalance valve and the flow restraining section of the relief valve preset for a relief setting of 152 bar (2,205 psi). The rod end cylinder pressure opens the restraining section of the counterbalance valve, allowing the fluid to exit the valve. Return hydraulic fluid passes through the three bank manifold valve before returning to the crane hydraulic tank through the return line.

When the desired beam extension is reached, release the switch to lock the cylinder in position. An input signal is sent to the Node-1 controller. The Node-7 controller sends a zero volt output to the hydraulic solenoid HS-88 to return the valve to the center position.

The Node-3 sends a variable voltage output to the accessory system proportional relief solenoid HS-68 to provide approximately 207 bar (3,002 psi) system pressure.

Retract Telescopic Beam Cylinder

When the telescopic beam switch is moved and held in the retract position, an input signal from the wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to the Node-1 controller. Node-7 sends a 24 volt output to enable the telescopic beam solenoid HS-89 and shifts the valve to the retract position.

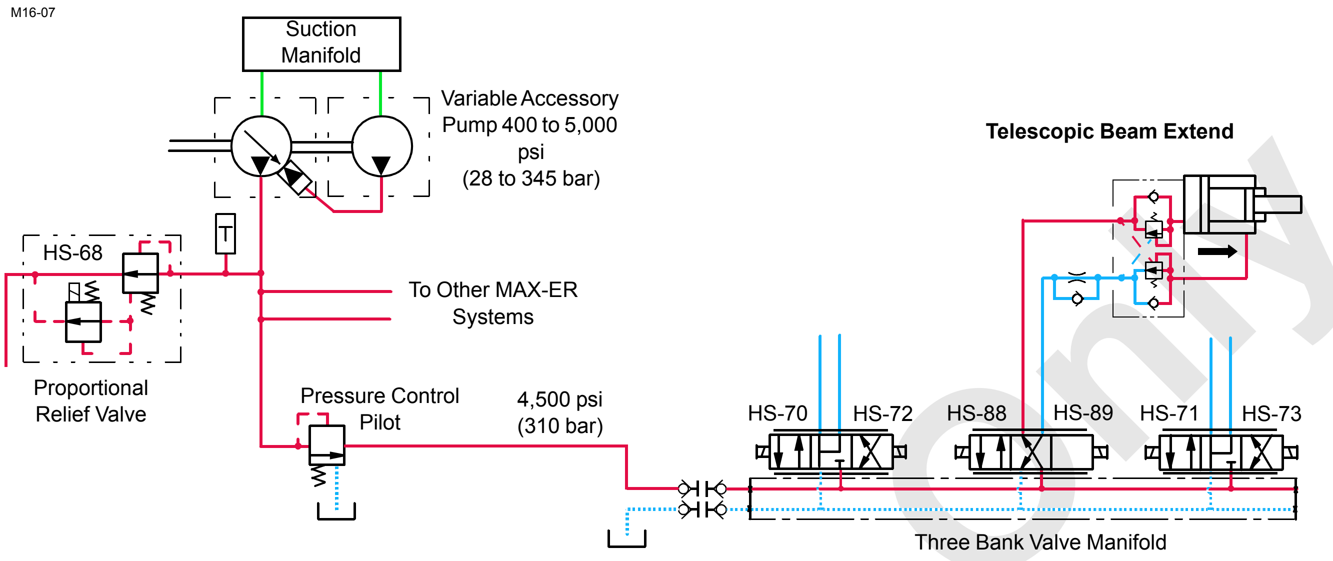
The Node-3 controller also sends a variable 0 to 24 voltage to enable the proportional relief solenoid HS-68 to provide approximately 310 bar (4,496 psi) pressure to the telescopic beam system.

Hydraulic pressure from the accessory pump flows through the pressure control pilot valve, the three bank manifold valve, and enters the free-flow check valve section of the counterbalance valve. Fluid pressure on the rod end of the beam cylinder retracts the beam to the desired length.

Hydraulic fluid from the piston end of the beam cylinder is blocked by the free-flow check valve section of the counterbalance valve and the flow restraining section of the relief valve preset for a relief setting of 152 bar (2,205 psi) The piston end cylinder pressure opens the restraining section of the counterbalance valve, allowing fluid to exit the valve. Return hydraulic fluid passes through the three bank manifold valve before returning to the crane hydraulic tank through the return line.

When the desired beam extension is reached, release the switch to lock the cylinder in position. An input signal is sent to the Node-1 controller. The Node-7 controller sends a zero volt output to the hydraulic solenoid HS-89 to the return valve to the center position.

The Node-3 controller sends a variable voltage output to the accessory system proportional relief solenoid HS-68 to provide approximately 207 bar (3,002 psi) system pressure.


M16-07
Suction Manifold
Variable Accessory Pump 400 to 5,000 psi (28 to 345 bar)
Telescopic Beam Extend
T
HS-68
To Other MAX-ER Systems
Proportional Relief Valve
Pressure Control Pilot
4,500 psi (310 bar)
HS-70
HS-72
HS-88
HS-89
HS-71
HS-73
Three Bank Valve Manifold

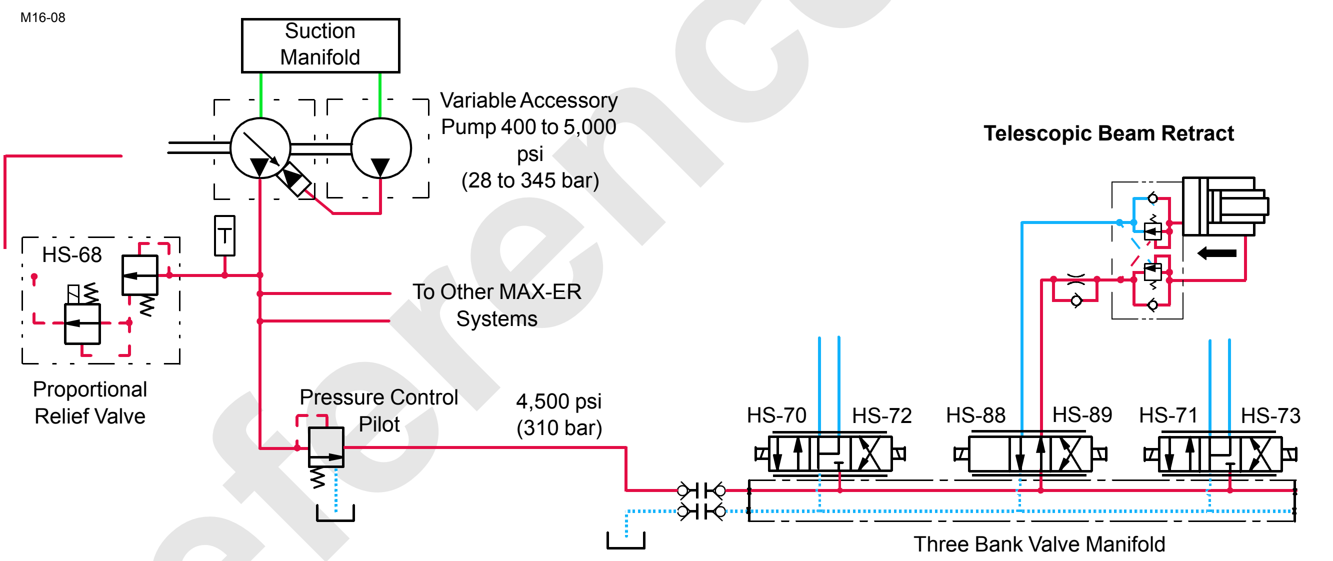

M16-08
Suction Manifold
Variable Accessory Pump 400 to 5,000 psi (28 to 345 bar)
Telescopic Beam Retract
T
HS-68
To Other MAX-ER Systems
Proportional Relief Valve
Pressure Control Pilot
4,500 psi (310 bar)
HS-70
HS-72
HS-88
HS-89
HS-71
HS-73
Three Bank Valve Manifold

FIGURE 1-52

Counterweight Lift Cylinder

See Figure 1-53 and Figure 1-54.

When a MAX-ER chart is selected, a load sensing pin in one mast strap monitors mast loading. The pin sends a variable 0.8 to 8.0 input voltage to the Node-1 controller for controlling counterweight lift cylinder position. Node-1 controller converts the load-sensing pin voltage signal to U.S tons that is displayed on MAX-ER information screen.

Counterweight lift cylinder automatically lifts the wheeled counterweight assembly off the ground and sets it back down when required depending on load (governed by boom angle, boom length, lifted load). When the wheeled counterweight assembly is off the ground, the crane can swing and travel in the normal manner to position the crane and load. When the wheeled counterweight assembly is on the ground, the wheels must be properly positioned before swinging or traveling the crane.

WARNING

Collapsing Mast!

After the mast straps are pinned to the lift cylinder spreader, do not manually retract the counterweight lift cylinder. The mast can be pulled over backwards. The lift cylinder automatically adjusts when the MAX-ER is operating.

Tipping Hazard!

The counterweight lift switch can be used to extend the mast lifting cylinder manually if load-sensing pin fails. Any other use of this control is neither intended nor approved.

The Node-1 controller monitors the MAX-ER's electronic and hydraulic systems to automatically extend and retract the counterweight lift cylinder to raise and lower the wheeled counterweight assembly in response to changes in the mast load sensing pin tension (see MAX-ER Operator Manual).

Pressure senders are located at the counterweight lift cylinder to measure system inlet and outlet pressures and send the pressure information as input voltage to the Node-1 controller. The information screen in the operator cab indicates the lift cylinder pressures in metric or inch.

The counterweight lift cylinder position sensor monitors the lift cylinder shaft position and sends the information as input voltage to the Node-1 controller. The information screen in the operator cab indicates the lift cylinder extend position in percent.

Counterweight Lift Cylinder Switch

The counterweight lift cylinder switch allows the lift cylinder to be disconnected from the mast straps during assembly/ disassembly. Power is available to the hand-held wireless remote control when the engine is running, the MAX-ER function mode is selected, and the power button is pressed.

The counterweight lift cylinder has a counterbalance valve at each cylinder port to provide smooth operation. The counterbalance valves lock the cylinder in position and also provide relief protection for the cylinder. The counterweight lift cylinder three position spool valves are motor spooled where both cylinder ports and the tank port of valve spool section are connected in the center position.

The crane accessory system pressure sender monitors the system pressure to the counterweight lift cylinder system. The Node-1 controller also monitors the lift cylinder pressure senders in both the extend and retract directions. The Node-1 controller sends a pressure output to the information screen in the operator cab.

A position sensor at the bottom of the lift cylinder monitors and sends a 0.8 to 8.0 voltage signal to the Node-1 controller. The Node-1 controller sends a percent output to the information screen in operator cab.

Extend Counterweight Lift Cylinder

When the counterweight lift cylinder switch is moved and held in the extend position, an input signal from the wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to the Node-1 controller. Node-7 sends a 24 volt output to enable the counterweight lift cylinder solenoids HS-70 and 71 and shifts the valve to the extend position.

The Node-3 controller also sends a variable 0 to 24 voltage to enable the proportional relief solenoid HS-68 to provide approximately 310 bar (4,496 psi) pressure to the counterweight lift cylinder system.

Hydraulic pressure from the accessory pump flows through the pressure control pilot valve, the three bank manifold valve, and enters the free-flow check valve section of the counterbalance valve. Fluid pressure on the piston end of the cylinder extends the cylinder to the desired length.

Hydraulic fluid from the rod end of the cylinder is blocked by the free-flow check valve section of the counterbalance valve and the flow restraining section of the relief valve preset for a relief setting of 152 bar (2,205 psi). The rod end cylinder pressure opens the restraining section of the counterbalance valve, allowing fluid to exit the valve. Return hydraulic fluid passes through the three bank manifold valve before returning to the crane hydraulic tank through the return line.

When the desired extension is reached, release the switch to lock the cylinder in position. Hydraulic fluid at the piston end of the cylinder counterbalance valve holds lift cylinder in the selected position.

When the switch is released, an input signal is sent to the Node-1 controller. The Node-7 controller sends a zero volt output to the hydraulic solenoids HS-70 and 71 to the return valve to the center position.

Node-3 sends a variable voltage output to the accessory system proportional relief solenoid HS-68 to provide approximately 207 bar (3,002 psi) system pressure.

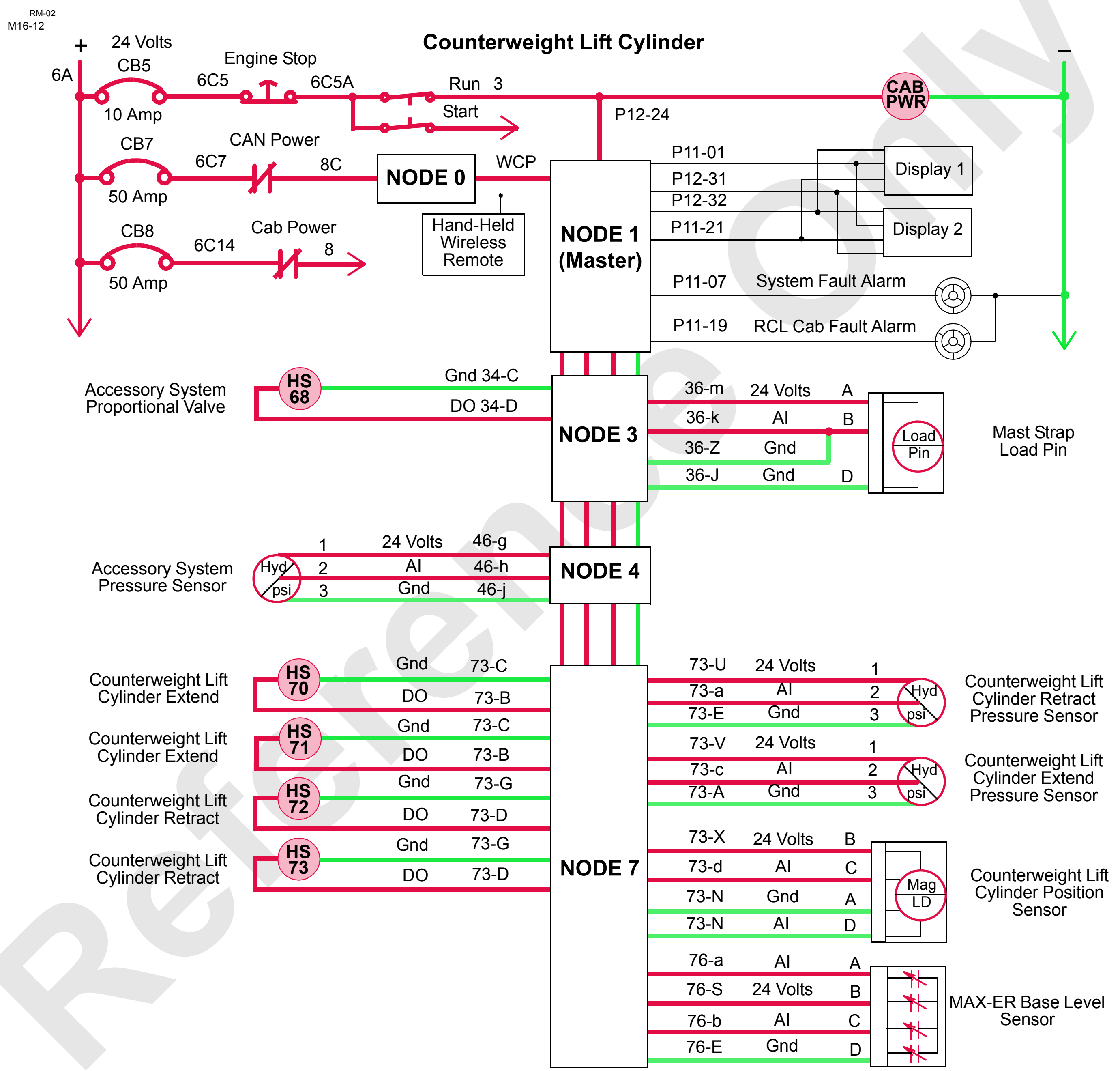


FIGURE 1-53

Retract Counterweight Lift Cylinder

When the counterweight lift cylinder switch is moved and held in the retract position, an input signal from the wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to the Node-1 controller. Node-7 sends a 24 volt output to enable the counterweight lift cylinder solenoids (HS-73 and 74) and shifts the valve to the retract position.

The Node-3 controller also sends a variable 0 to 24 voltage to enable the proportional relief solenoid HS-68 to provide approximately 310 bar (4,496 psi) pressure to the counterweight lift cylinder system.

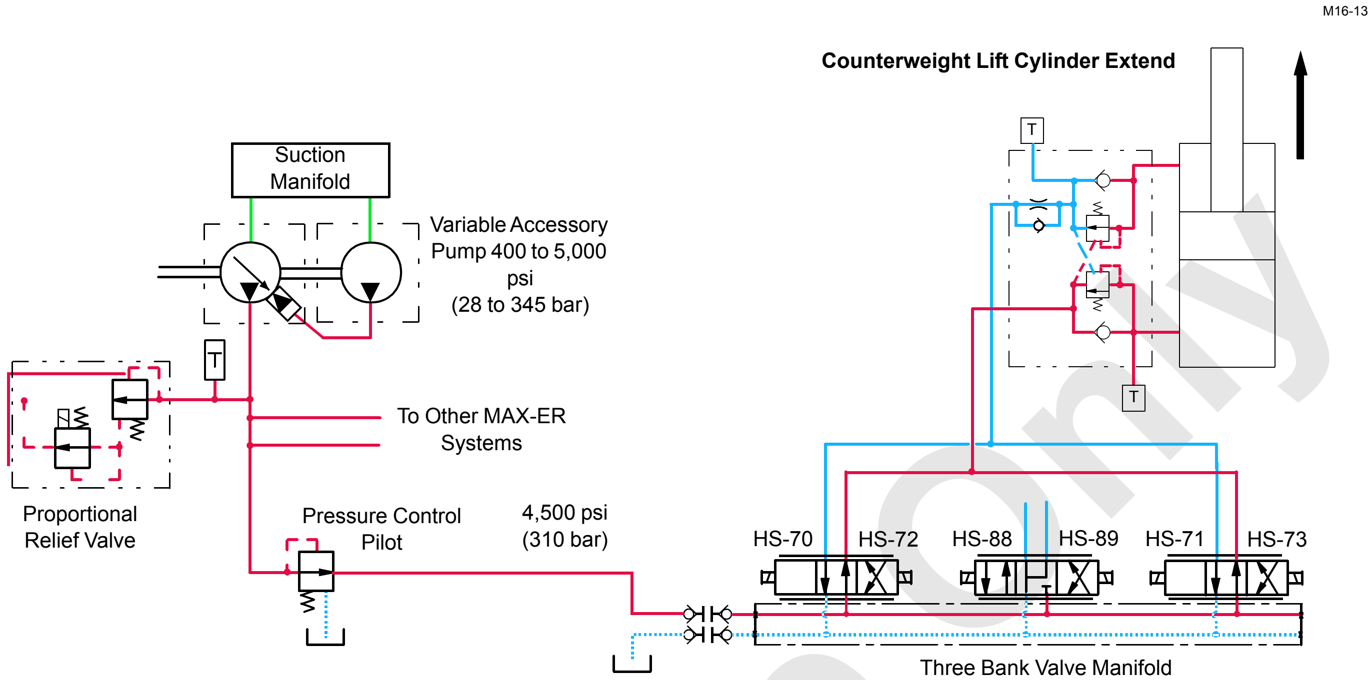
Hydraulic pressure from the accessory pump flows through the pressure control pilot valve, the three bank manifold valve, and enters the free-flow check valve section of the counterbalance valve. Fluid pressure on the rod end of the lift cylinder retracts the cylinder to the desired length.

Hydraulic fluid from piston end of the lift cylinder is blocked by the free-flow check valve section of the counterbalance valve and the flow restraining section of the relief valve preset for a relief setting of 152 bar (2,205 psi). The piston end cylinder pressure opens the restraining section of the counterbalance valve, allowing fluid to exit the valve. The return hydraulic fluid passes through the three bank manifold valve before returning to the crane hydraulic tank through the return line.

When the retraction is reached, release the switch to lock the cylinder in position. Hydraulic fluid at the piston end of the lift cylinder counterbalance valve holds the lift cylinder in the selected position.

When the switch is released, an input signal is sent to the Node-1 controller. The Node-7 controller sends a zero volt output to the hydraulic solenoids HS-72 and 73 to return the valve to the center position.

The Node-3 controller sends a variable voltage output to the accessory system proportional relief solenoid HS-68 to provide approximately 207 bar (3,002 psi) system pressure.


M16-13
Counterweight Lift Cylinder Extend
Suction Manifold
Variable Accessory Pump 400 to 5,000 psi (28 to 345 bar)
T
To Other MAX-ER Systems
Proportional Relief Valve
Pressure Control Pilot
4,500 psi (310 bar)
HS-70
HS-72
HS-88
HS-89
HS-71
HS-73
Three Bank Valve Manifold

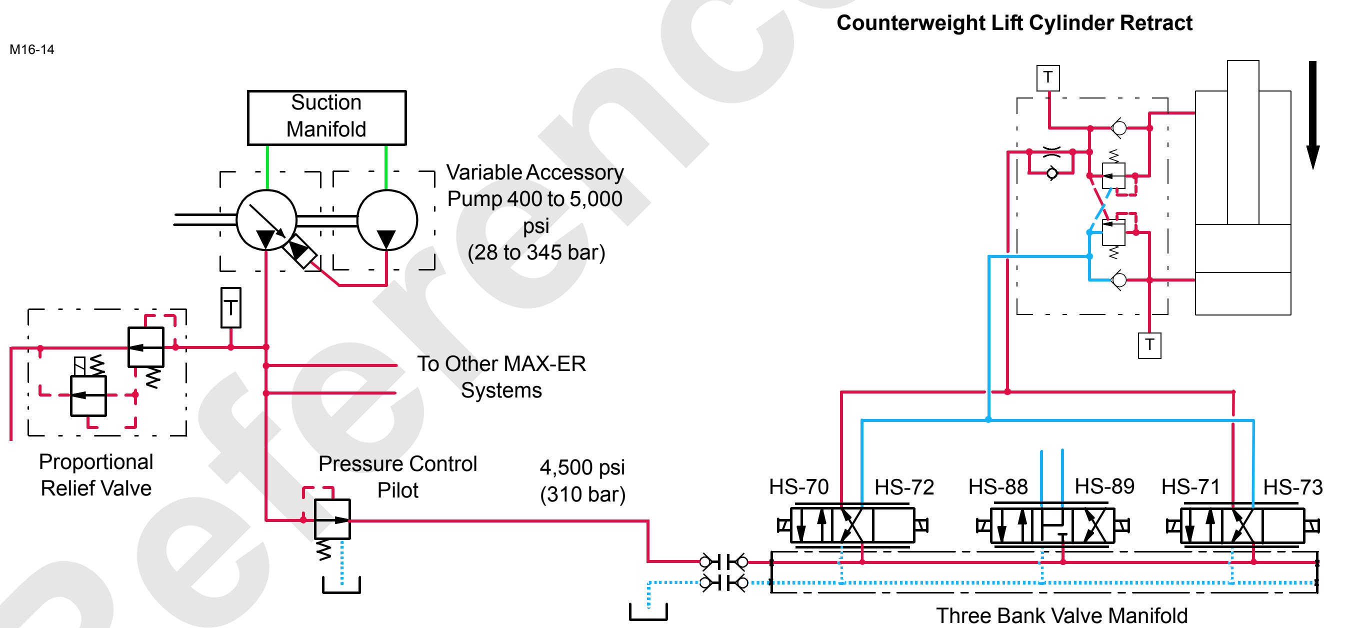

M16-14
Counterweight Lift Cylinder Retract
Suction Manifold
Variable Accessory Pump 400 to 5,000 psi (28 to 345 bar)
T
To Other MAX-ER Systems
Proportional Relief Valve
Pressure Control Pilot
4,500 psi (310 bar)
HS-70
HS-72
HS-88
HS-89
HS-71
HS-73
Three Bank Valve Manifold

FIGURE 1-54

Wheel Assemblies

See Figure 1-55 and Figure 1-56.

The wheel assembly swing motors allow the positioning of the MAX-ER wheels. Before operating any steering switch, make sure the jacking cylinders are in the correct position for rotating the wheels. The left side wheel assembly items are explained in this section, the right side wheel assembly items operate the same.

The wheel assembly valves have a counterbalance valve at each motor port. These valves provide smooth operation. Counterbalance valves also provide relief protection. The wheel assembly three position spool valves are motor spooled where both motor ports and the tank port of the valve spool section are connected in the center position.

The crane accessory system pressure sender monitors the system pressure to the wheel assembly motors.

Left and right wheel assembly encoders detect the wheel position and direction of the movement. Node-1 receives this information as two out-of-phase square wave input voltages that are converted to counts. The information screen in operator cab indicates the wheel positions in degrees.

Power is available to the hand-held wireless remote control when, the engine is running, the MAX-ER function mode is selected, and the power button is pressed. Wheels cannot be moved until the electrical cables and hydraulic lines are connected between the rear of the crane and the telescopic beam of the MAX-ER.

When operating, the right travel handle can operate the wheel assembly position when travel is parked and a MAX-ER chart is selected. Moving the handle forward moves the wheel assemblies to the straight position. Moving the handle back moves the wheel assemblies to the swing position. The right travel wheel assembly operation is similar to the hand-held wireless remote control operation described next.

Wheel Steering Clockwise

When the left wheel steering switch is moved and held in the clockwise position, an input signal from the wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to the Node-1 controller. The Node-7 controller sends a 24 volt output to enable the left wheel assembly solenoid (HS-82) and shifts the valve to rotate the left side wheels in a clockwise direction.

Node-7 also sends a 24 volt output to enable the left wheel assembly brake solenoid HS-86 to release the internal brakes on both left wheel swing shafts. The Node-3 controller also sends a variable 0 to 24 voltage to enable the proportional relief solenoid HS-68 to provide approximately 310 bar (4,496 psi) pressure to the wheel assembly

Hydraulic pressure from the accessory pump flows through the pressure control pilot valve, the six bank manifold valve, and enters the free-flow check valve section of the counterbalance valve. Fluid pressure turns the motor output shaft so the wheels rotate in a clockwise direction.

Return hydraulic fluid from the output side of the hydraulic swing motor flows through the flow control relief valve, the six bank manifold valve before returning to the crane hydraulic tank through the return line.

When the wheel position is reached, release the wheel steering switch. When the switch is released the Node-7 controller sends an input signal to the Node-1 controller. The Node-1 controller sends a zero volt output to disable the left wheel brake solenoid HS-87 and apply the internal brakes on both left wheel swing shafts.

After the brakes are applied, the Node-1 controller also sends a zero volt output to disable the left wheel assembly solenoid HS-83, to shift the valve to the center position.

The Node-3 controller sends a zero volt output to the accessory system proportional relief solenoid HS-68 to provide approximately 207 bar (3,002 psi) system pressure.

Wheel Steering Counter-Clockwise

When the left wheel steering switch is moved and held in the counter-clockwise position, an input signal from the wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to the Node-1 controller. The Node-7 controller sends a 24 volt output to enable the left wheel assembly solenoid HS-83 and shifts the valve to rotate left side wheels in the counter-clockwise direction.

The Node-3 controller also sends a variable 0 to 24 voltage to enable the proportional relief solenoid HS-68 to provide approximately 310 bar (4,496 psi) pressure to the wheel assembly.

Hydraulic pressure from the accessory pump flows through the pressure control pilot valve, the six bank manifold valve, and enters the free-flow check valve section of the counterbalance valve. Fluid pressure turns the motor output shaft so the wheels rotate in a clockwise direction.

When the wheel position is reached, release the wheel steering switch. When the switch is released the Node-7 controller sends an input signal to the Node-1 controller. The Node-1 controller sends a zero volt output to disable the left wheel brake solenoid HS-87 and apply the internal brakes on both left wheel swing shafts.

After the brakes are applied, the Node-1 controller sends a zero volt output to disable the left wheel assembly solenoid HS-83, to shift the valve to the center position.

The Node-3 controller sends a variable voltage output to the accessory system proportional relief solenoid HS-68 to provide approximately 207 bar (3,002 psi) system pressure.

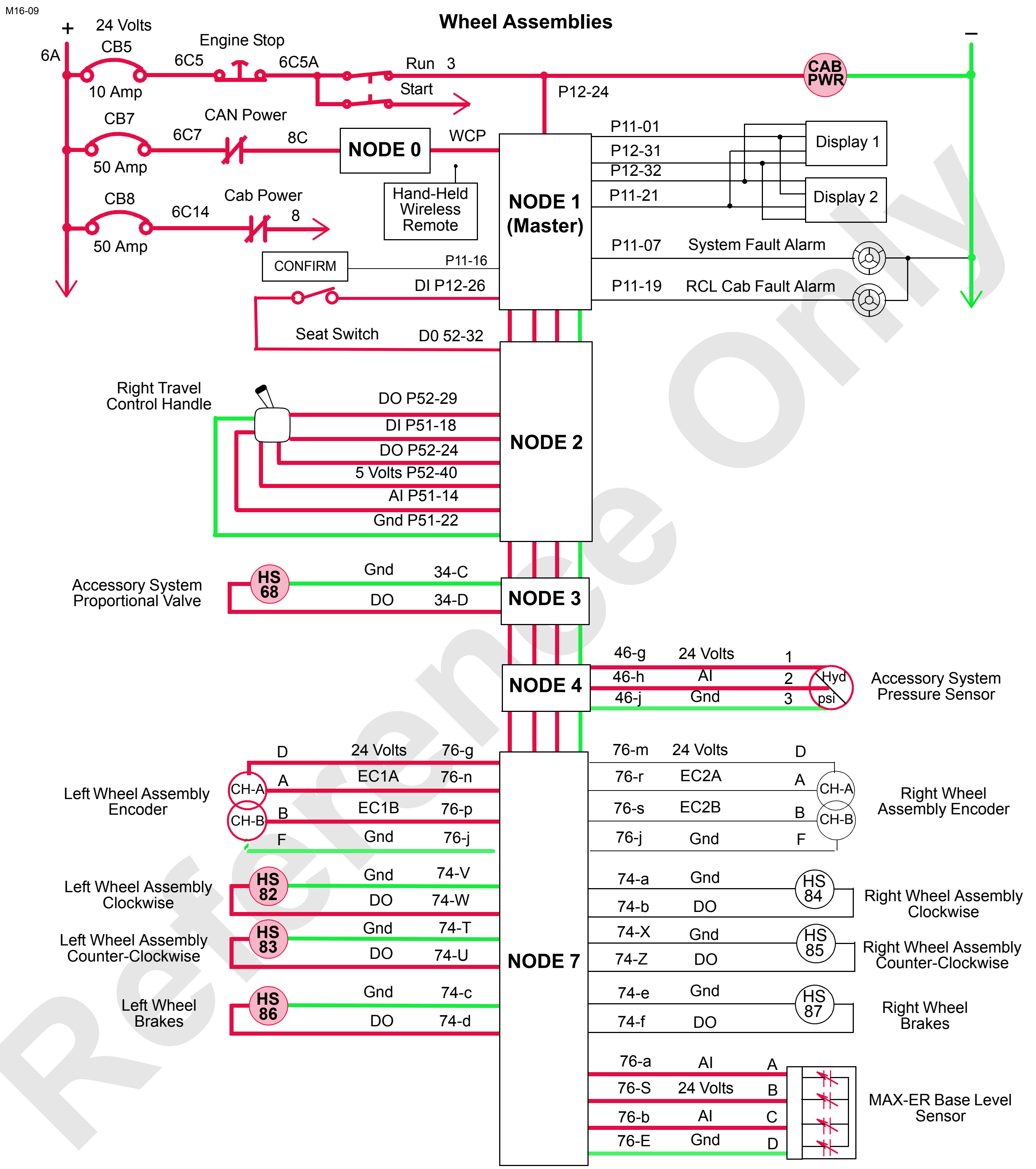
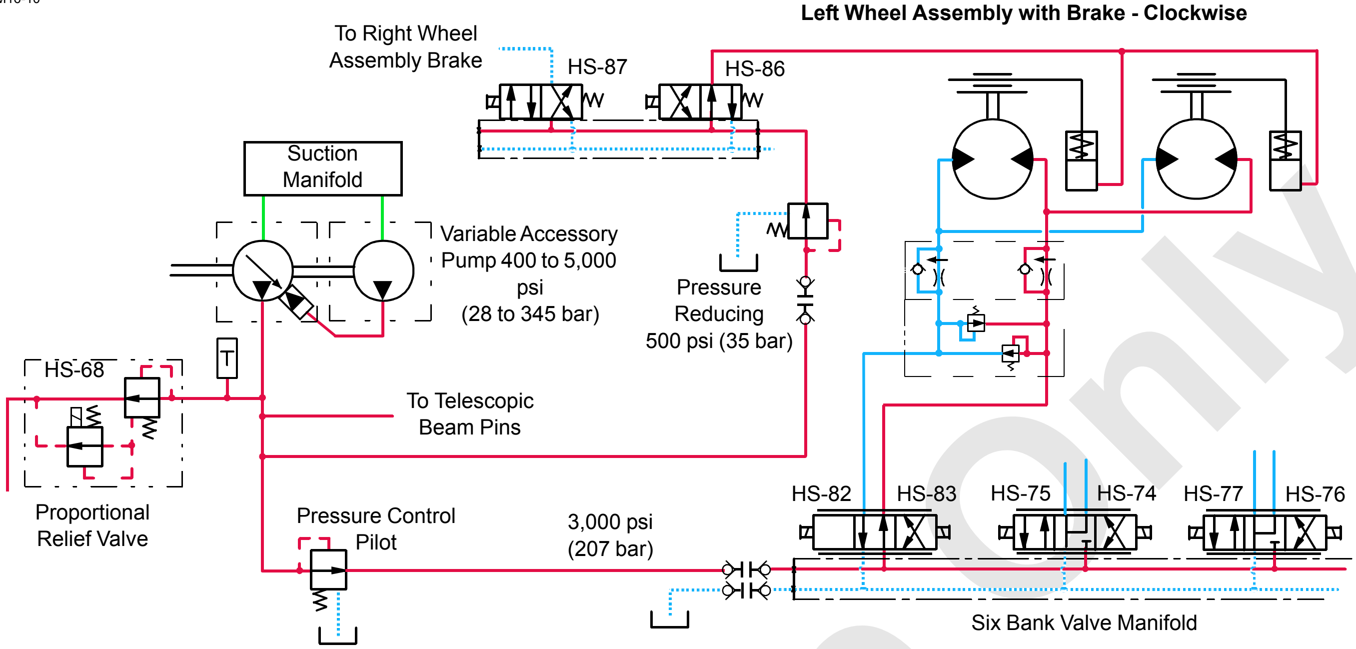

M16-09
Wheel Assemblies
+
24 Volts
6A
CB5
10 Amp
Engine Stop
6C5
6C5A
Run 3
Start
CAB PWR
–
P12-24
CB7
50 Amp
CAN Power
6C7
8C
NODE 0
WCP
CB8
50 Amp
Cab Power
6C14
8
Hand-Held Wireless Remote
NODE 1 (Master)
P11-01
P12-31
P12-32
P11-21
Display 1
Display 2
P11-07
System Fault Alarm
P11-19
RCL Cab Fault Alarm
CONFIRM
P11-16
DI P12-26
Seat Switch
D0 52-32
Right Travel Control Handle
DO P52-29
DI P51-18
DO P52-24
5 Volts P52-40
AI P51-14
Gnd P51-22
NODE 2
Accessory System Proportional Valve
HS 68
Gnd
34-C
DO
34-D
NODE 3
46-g
24 Volts
1
46-h
AI
2
46-j
Gnd
3
Hyd psi
NODE 4
Accessory System Pressure Sensor
Left Wheel Assembly Encoder
D
24 Volts
76-g
CH-A
A
EC1A
76-n
CH-B
B
EC1B
76-p
F
Gnd
76-j
76-m
24 Volts
D
76-r
EC2A
A
76-s
EC2B
B
76-j
Gnd
F
Right Wheel Assembly Encoder
Left Wheel Assembly Clockwise
HS 82
Gnd
74-V
DO
74-W
Left Wheel Assembly Counter-Clockwise
HS 83
Gnd
74-T
DO
74-U
Left Wheel Brakes
HS 86
Gnd
74-c
DO
74-d
NODE 7
74-a
Gnd
74-b
DO
HS 84
Right Wheel Assembly Clockwise
74-X
Gnd
74-Z
DO
HS 85
Right Wheel Assembly Counter-Clockwise
74-e
Gnd
74-f
DO
HS 87
Right Wheel Brakes
76-a
AI
A
76-S
24 Volts
B
76-b
AI
C
76-E
Gnd
D
MAX-ER Base Level Sensor
Reference Only

FIGURE 1-55

M16-10



M16-11

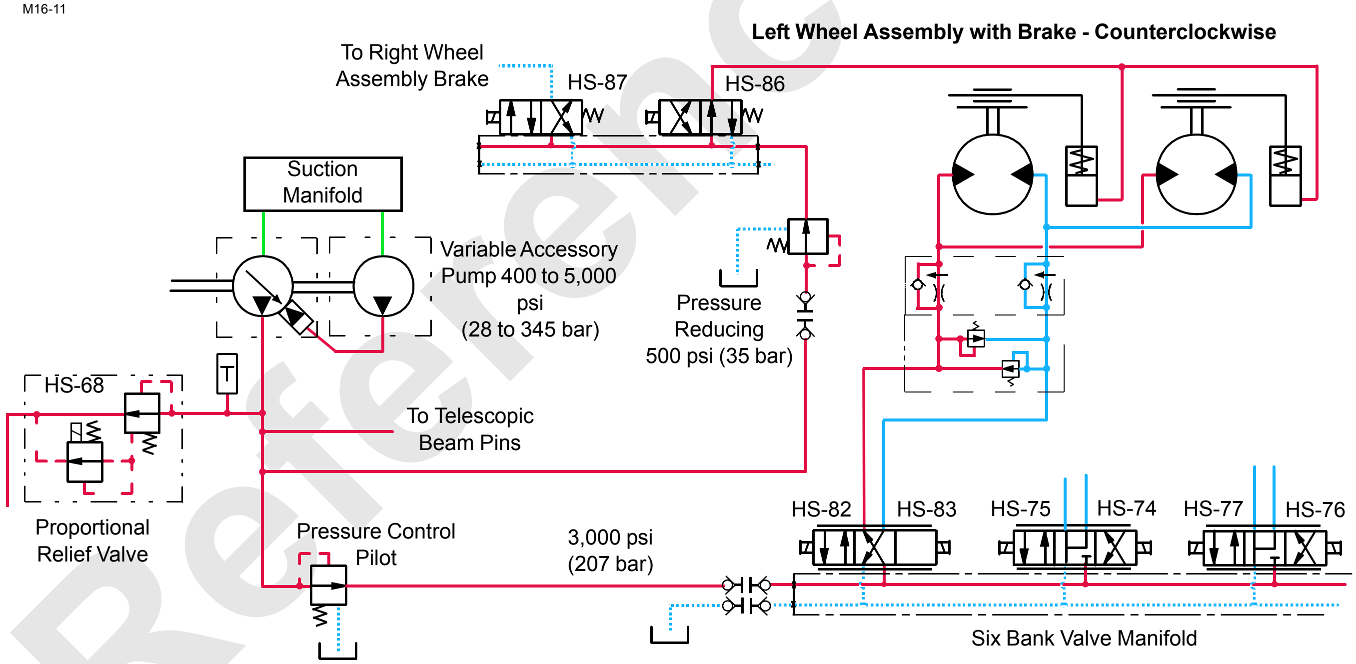


FIGURE 1-56

Telescopic Beam Hinge Pins

See Figure 1-57 and Figure 1-58.

The telescopic beam hinge pin cylinders have a three position spool valve that is motor spooled where both cylinder ports and the tank port of the valve spool section are connected in the center position.

The accessory system pressure sender monitors the accessory system pressure.

Power is available to the hand-held wireless remote control when the engine is running, the MAX-ER function mode is selected, and the power button is pressed. The telescopic beam hinge pins cannot be engaged/disengaged until the electrical cables and hydraulic lines are connected between the rear of the crane and the telescopic beam of the MAX-ER. Remove the beam locking pins from the engaged position.

When the beam hinge pins switch is moved and held in the disengage (out) position, an input signal from the wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to the Node-1 controller. The Node-7 controller sends a 24 volt output to enable the telescopic beam hinge pin solenoid HS-91 and shifts the valve to the disengage position.

The Node-3 controller sends a variable 0 to 24 volt output to enable accessory system proportional relief solenoid HS-68 for a system pressure of 28 bar (406 psi) to the hinge pin cylinders.

Hydraulic fluid pressure at approximately 28 bar (406 psi) flows to the telescopic hinge pin accessory valve. Hydraulic fluid leaves the accessory valve and enters the rod end of the beam pin cylinders, retracting the cylinder rod to disengage the beam hinge pins. Hydraulic fluid from the piston end of beam hinge pin cylinders leaves the accessory system valve and returns to the tank.

When the beam hinge pins switch is released, an input signal is sent to the Node-1 controller. The Node-7 controller sends a zero volt output to hydraulic solenoid HS-91 to return valve to the center position.

The Node-3 controller sends a variable voltage output to the accessory system proportional relief solenoid HS-68 to provide approximately 207 bar (3,002 psi) system pressure.

M16-15

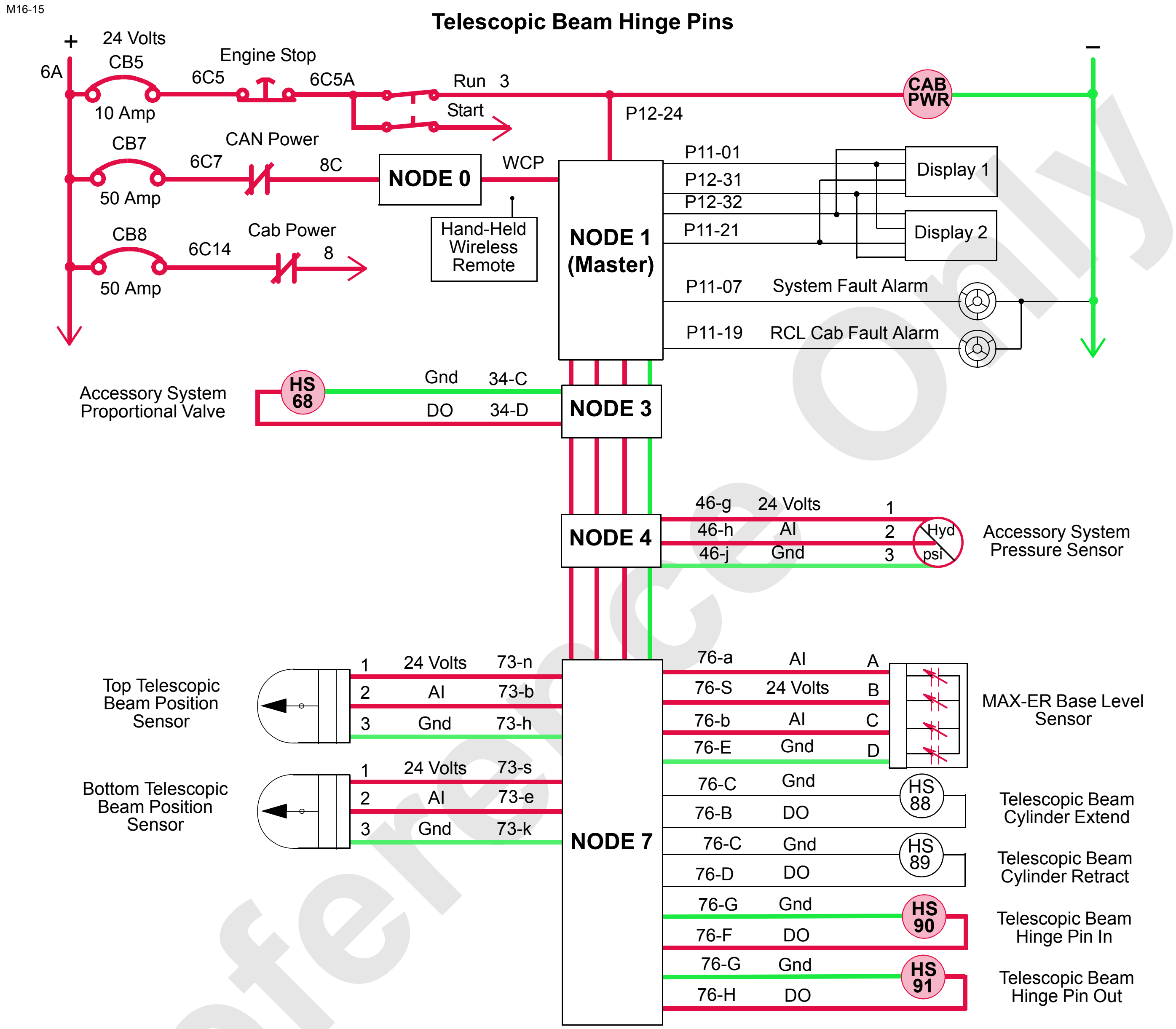


FIGURE 1-57

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When the telescopic beam hinge pin switch is moved and held in the engage (in) position, an input signal from the wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to the Node-1 controller. The Node-7 controller sends a 24 volt output to enable telescopic beam hinge pins solenoid HS-90 and shifts the valve to the engage position. The Node-3 controller sends a variable 0 to 24 volt output to enable the accessory system proportional relief solenoid HS-68 for a system pressure of 28 bar (406 psi) to the hinge pin cylinders.

Hydraulic fluid pressure at approximately 28 bar (406 psi) flows to the beam hinge pin accessory valve. Hydraulic fluid leaves the accessory valve and enters the piston end of the beam pin cylinder, extending the cylinder rod to engage the beam hinge pins. Hydraulic fluid from the rod end of the beam pin cylinder leaves the accessory system valve and returns to the tank.

When the beam hinge pins switch is released, an input signal is sent to the Node-1 controller. The Node-7 controller sends a zero-volt output to the hydraulic solenoid HS-90 to return the valve to the center position.

Node-3 sends a variable voltage output to the accessory system proportional relief solenoid HS-68 to provide approximately 207 bar (3,002 psi) system pressure.

Install the locking pins in the engaged position.

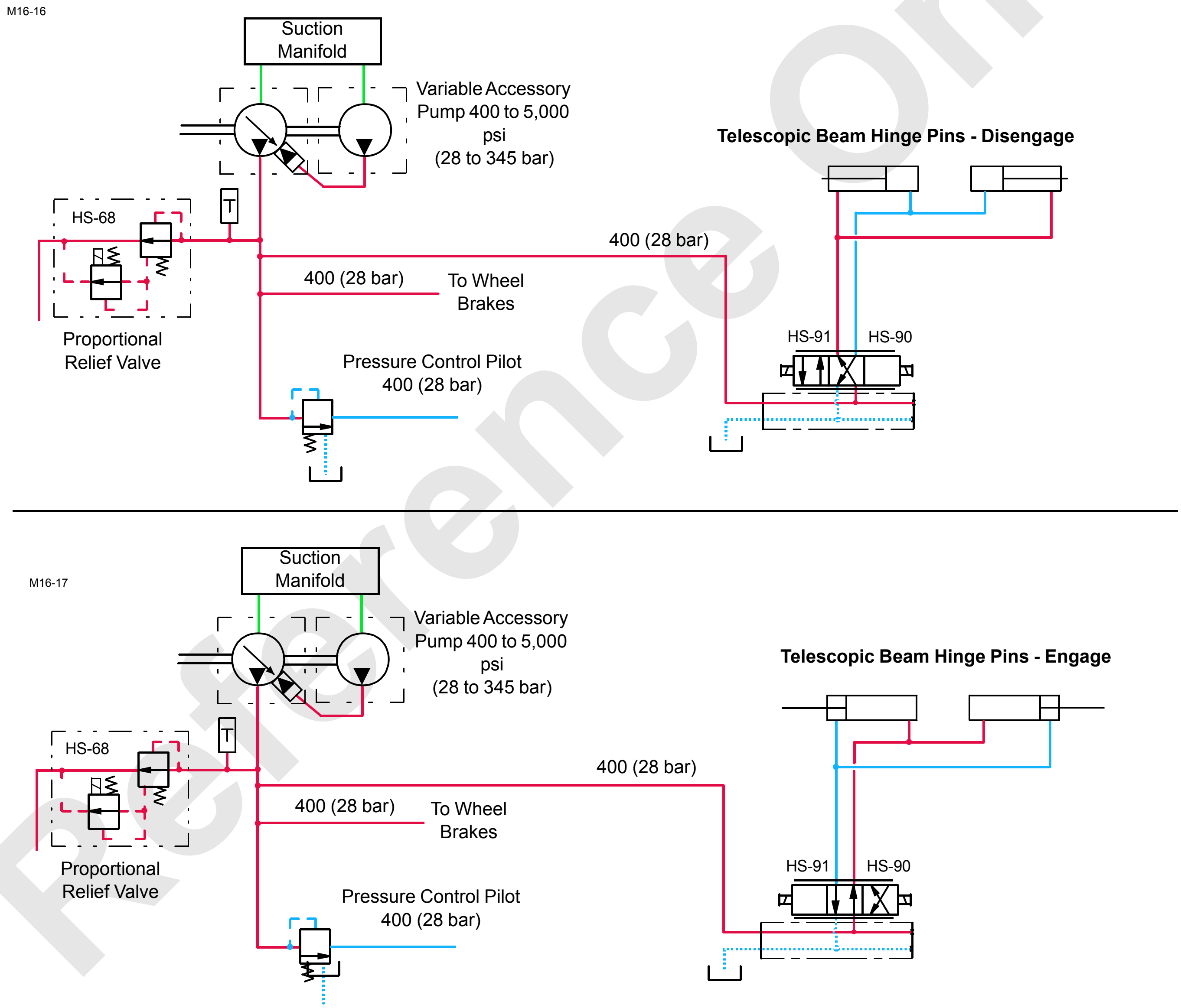

FIGURE 1-58

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SECTION 2
HYDRAULIC SYSTEM

TABLE OF CONTENTS

SECTION 2
HYDRAULIC SYSTEM

This section contains maintenance, adjustment, and test procedures for the hydraulic system and related components on the Model 16000 crane. See the end of this section for applicable hydraulic schematics.

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 display screen instructions in Section 3 of the 16000 Operator Manual.

For further information, contact the Manitowoc Crane Care Lattice Team for an explanation of any procedure not fully understood.

Adjustments described in this section were made to the crane before it was shipped from the factory. Adjustments by field personnel should only be necessary when parts are replaced or when instructed by the Crane Care Lattice Team.

CAUTION

Do not alter the hydraulic system specifications given in this section without approval from Manitowoc Crane Care.

Altering specifications can cause damage to hydraulic components and improper crane operation.

INSPECTING HYDRAULIC HOSES

CAUTION

Burn Hazard!

Oil in the hydraulic tank may be under pressure and extremely hot. Make sure that the hydraulic hose is depressurized and cool to the touch before loosening any connections.

Every Month or 200 Hours

Complete the following every month or 200 hours:

1. Visually inspect all hydraulic hose assemblies for the following:
   - Leaks in the hose or hose fittings
   - 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.

2. 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, evaluate the component for correction or replacement.

Degradation Due to Extreme Environment

Table 2-1 Climate Zone Classification

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

Salt Environment

Hydraulic hose assemblies operating in salt water climates could see a significant reduction in service life. Regularly inspect hydraulic hose assemblies per step 1.

Zone A and B

After 4,000 to 5,000 hours of service life, replace hydraulic hose assemblies operating in climate zones A and B with high ambient temperatures and high duty circuits. These hoses could experience a 40% to 50% reduction in service life.

Zone C

After 8,000 hours of service life, replace hydraulic hose assemblies operating in climate zone C.

Zone D and E

Cold temperatures will reduce the service life of hose assemblies operating in climate zones D and E.

High Duty Circuits

High duty circuits can include, but are not limited to hoists, boom lift, swing, travel, pump suction and discharge to directional valves, and directional valve return-to-reservoir circuits. Replace hoses on these circuits after 4,000 to 5,000 hours of service life.

HYDRAULIC SYSTEM MAINTENANCE

Safety

Use the following safety precautions when maintaining the hydraulic system:

- Lower or securely block hydraulically operated attachments and loads before service. Do not rely on controls to support attachments or loads.
- Stop the engine and relieve hydraulic pressure to zero before servicing or disconnecting any part of the hydraulic system. After stopping the engine, operate 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 any hydraulic system maintenance, adjustment or repair procedures unless authorized to do so. Read and understand all applicable instructions.
- Do not alter specified pressure settings. Pressures greater than specified can cause structural or hydraulic failure. Pressures lower than specified can cause loss of control.
- Check for leaks using a piece of cardboard or wood. Never check for hydraulic leaks using your hands. Oil under pressure can penetrate skin, causing serious injury. Oil escaping from a small hole can be very difficult to see.

Storing and Handling Oil

Use the following guidelines when storing or 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, which can cause leaks and allow dirt or water into the oil.
- Before opening a drum, carefully clean the top of the drum. Clean faucets or pumps used to remove oil from the drum.
- Only use clean transfer containers.
- Do not take oil from storage until the oil is needed. If oil cannot be used immediately, keep the transfer container tightly covered.

Storing and Handling Parts

Use the following guidelines when storing or handling parts:

- Store new parts (valves, pumps, motors, hoses, tubes) in a clean, dry indoor location.
- Do not unpack parts or remove port plugs until the parts are needed.
- Once unpacked, carefully inspect each part for damage that may have occurred during shipping. Remove all shipping material from any ports on the parts before installing.
- Clean fittings, hoses, and tubes before use that are not equipped with shipping caps or plugs. Flush fittings, hoses, and tubes with clean hydraulic oil. Seal all openings until the part is installed.
- Do not use rags to plug openings. Use clean plastic shipping plugs and caps.

Item	Description	Item	Description
1	Filters, Return	7a	Shut-Off Valve Handle
2a	Fill Plug (manual fill port)	7b	Locking Pin
2b	Power-Fill Coupling	8	Hydraulic Tank Drain Valve
3	Breather	9	Vacuum Switch
4a	Shrader Air Valve	10	Suction Manifold
4b	Coupler	11	Tube Nut Fitting
5	DEF System Hoses (Ref.)	12	Vent Cap for System Fill
6	Thermostatic Valve		

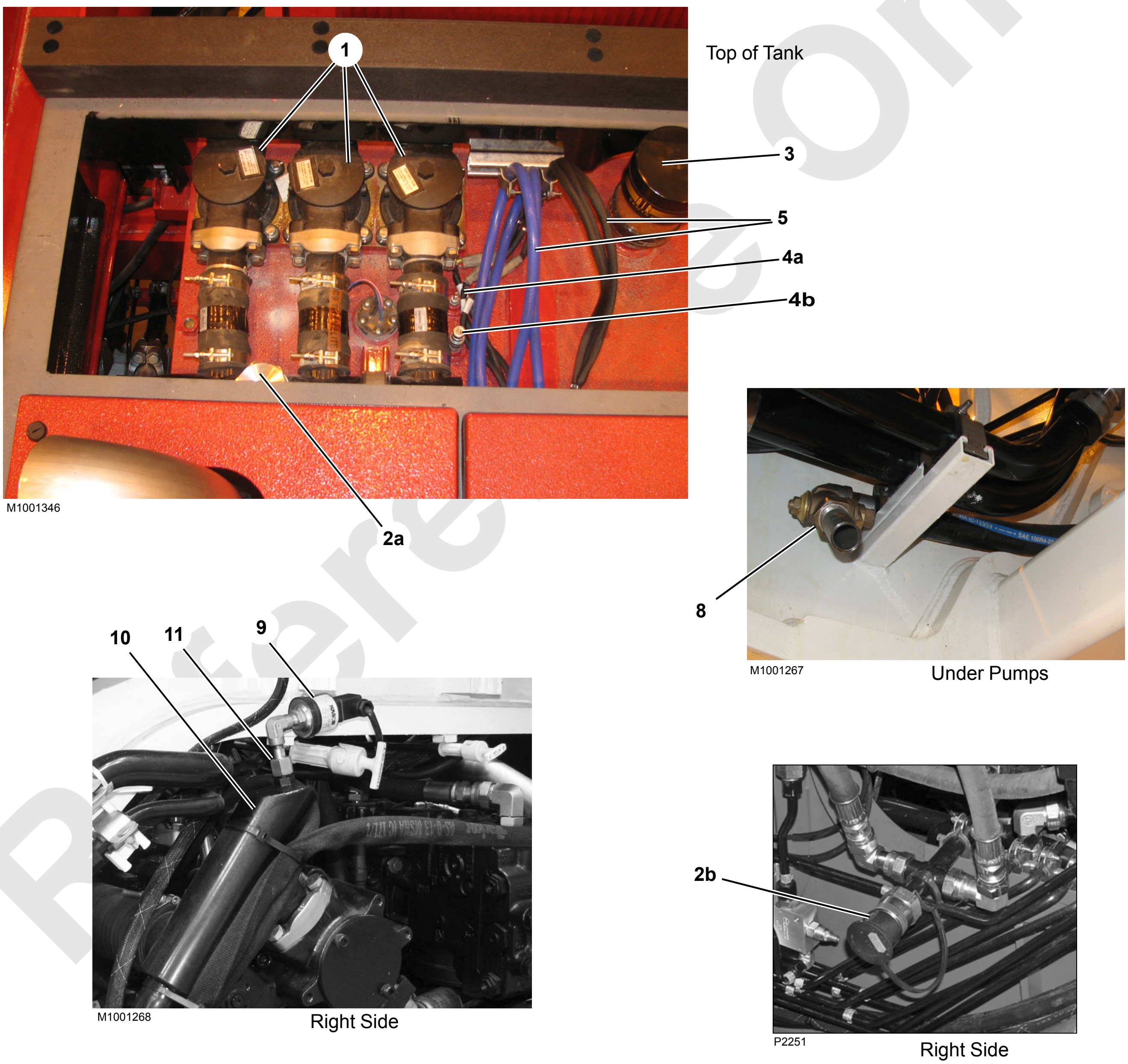
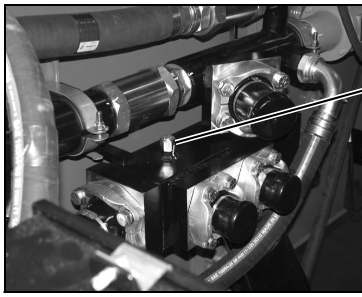
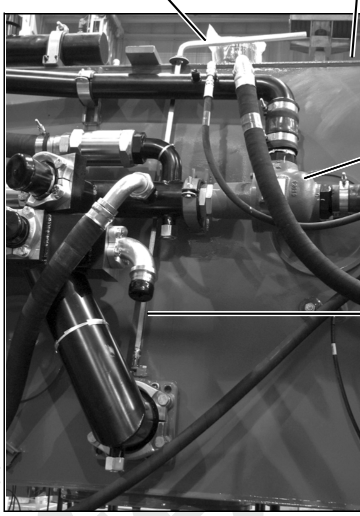


FIGURE 2-1



Rear Side of Hydraulic Tank



Rear Side of Hydraulic Tank

FIGURE 2-1 continued

Inspecting the System

The damaging effects of dirt, heat, air, and water in the hydraulic system can only be prevented by regular, and thorough inspection of the system. The frequency of inspection depends on the operating conditions and experience with the system. Inspecting the system and correcting deficiencies more frequently will make the system less likely to malfunction.

A good inspection program will include the following:

1. Keep accurate records for future maintenance needs.

NOTE: For detailed instructions on accessing the display screens in the cab, see Section 3 of the Service Manual.

2. Check the hydraulic oil level daily when the oil is cold by looking at the hydraulic tank display on the information screen in the cab (Figure 2-2).

   Full (Cold) Level
   (approximately 16°C [60°F])
   Screen should read 87 to 90%.

   Full (Hot) Level
   (approximately 82°C [180°F])
   Screen should read 95%.

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

Hydraulic Tank Level and Temperature Display

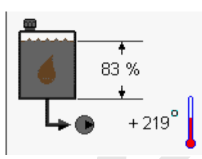


FIGURE 2-2

If the oil level drops to 50%, a fault alarm will come on and a fault symbol will appear on the active display. The HYDRAULIC FLUID LOW icon will appear on the fault display (). ***Fill the tank immediately.***

HYDRAULIC FLUID LOW Fault Icon

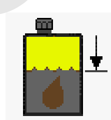


FIGURE 2-3

Fill the tank manually through the plug opening (2a, Figure 2-1) or by pumping oil through the power-fill coupling (2b) with a portable pump.

Do not fill the tank through the breather port. The hydraulic system could be contaminated with unfiltered oil.

3. Only use approved hydraulic oil in the system (see Section 9 in this manual).

4. Replace the disposable cartridge in the desiccant breather when all the desiccant beads have turned from gold (when new) to dark green. See Replacing Desiccant Breather topic for more information.

5. Clean the exterior of the system often. Do not let dirt accumulate on or around any part of the system.

6. Check for external leaks. Leaks are unsafe, attract dirt, and may allow air and water into the system. Do not return leakage oil back to the hydraulic tank.

   Do not use your hands to check for leaks.

   Use the following to check for leaks:

   - Look for oil leaking from fittings or between parts that are bolted together. Tighten any loose fittings and attaching bolts to the proper torque. Do not over-tighten any loose fittings or attaching bolts.
   - If leakage persists at these points, replace the seals or gaskets.
   - Look for oil leaking from the pump, motor shaft, valve spool, and 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 any unusual noises. A high-pitched whine or scream can indicate that air is being drawn into the system.

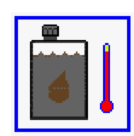
   To pinpoint an air leak, flood the inlet fitting, hose, or tube with oil. If there is an air leak, the oil will reduce the noise noticeably. Correct the cause of any air leak, to avoid permanent damage to the pump/motor.

NOTE: A high-pitched whine or scream from the pump can also indicate cavitation (pump being starved of oil). This condition is caused by the following problems:

- Collapsed or plugged suction line
- Wrong oil (the viscosity is too high)

7. Look for signs of overheating, including heat-peeled parts, burned or scorched oil odor, or darkened thick oil. The temperature of the oil in the tank must not exceed 82°C (180°F).

   If the oil temperature in the tank goes above 82°C (180°F), a fault alarm will come on and a fault symbol will appear on the active display. The hydraulic reservoir temperature icon will appear on the fault display.



8. Analyze the hydraulic oil 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, the established oil change interval can meet the operating conditions.

NOTE: Contact the oil supplier for the availability and process of oil analysis services.

Replacing Desiccant Breather

See Figure 2-4 for the following procedure:

1. Remove the keyed cover above the hydraulic tank.
2. Unscrew the breather from the tank.
3. Unscrew the cap from the cartridge and discard the cartridge.
4. Remove the protective caps from the top and bottom of the new cartridge.
5. Attach the cap to the cartridge only to hand tightness.
6. Attach the breather to the hydraulic tank by hand tightening.

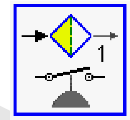
FIGURE 2-4

Replacing Filters

See Figure 2-1 for the following procedure.

There are three 12-micron absolute filter elements that filter all oil returning to the tank.

If a filter is too dirty, a fault alarm will come on and a fault symbol will appear on the active display. The hydraulic filter icon will appear on the fault display.



NOTE: It is normal for the alert to come on at start-up when the oil is cold. If the filters are not plugged, the alert will turn off after the hydraulic oil warms up.

CAUTION

Avoid Hydraulic System Damage!

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

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

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

See Figure 2-1 for the following procedure.

Replace the return filter elements when the filter fault comes on and at each oil change interval:

1. Stop the engine.
2. Remove the keyed cover above the hydraulic tank.

WARNING

Burn Hazard!

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

Hot oil can escape when either filter cover is removed.

Relieve pressure through the air valve (4a, Figure 2-1) on the tank before servicing.

3. Clean the outside of the filter head around the cover.
4. Remove the fill cap. ***Do not damage the o-rings.*** The fill cap has a hexagon stud for easy removal.

5. Twist the element handle counter-clockwise and pull the filter element out of the body. Discard the element.

   Do not attempt to clean or reuse the element.

   Do not operate the crane without the return filter elements installed.

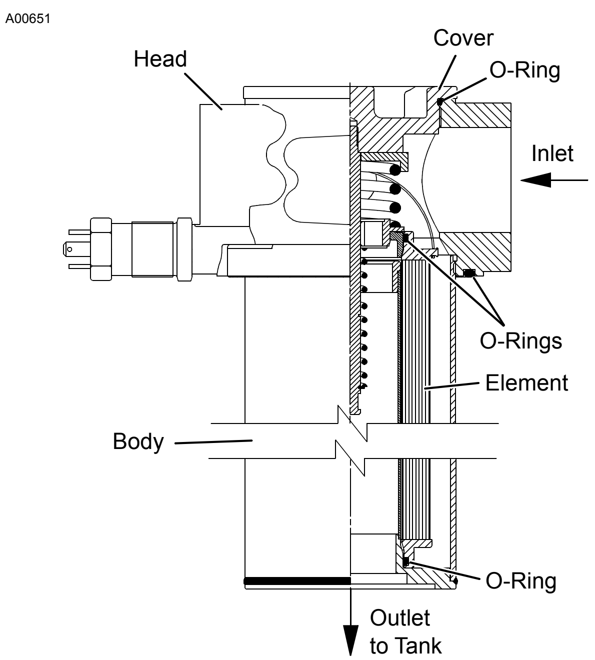


FIGURE 2-5

6. Lubricate the o-ring at both ends of the new element with clean hydraulic oil and securely install the element over the stem in the housing.
7. If necessary, replace the o-ring in the filter cover.
8. Reinstall and securely tighten the filter cover.
9. Start the engine and allow the hydraulic system to return to normal operating pressure and temperature. Check the filter cover and vent plug for leaks. Securely tighten the filter cover and vent plug as required.
10. Stop the engine, check the tank level, and refill the tank as required.
11. Reinstall the two covers over the hydraulic tank.

Changing Oil

CAUTION

In the Event of a Catastrophic Failure of a Hydraulic Component

Contact your Manitowoc dealer or the Crane Care Lattice Team if the crane's hydraulic system has experienced a catastrophic failure. To avoid additional damage, the process of removing debris and contaminants must be guided or performed by experienced crane technicians.

For general instructions following a catastrophic failure, see Manitowoc Service Bulletin W007-009.

See Figure 2-1 for the following procedure.

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

1. Operate the crane until the hydraulic oil is at the normal operating temperature. This will help prevent impurities from settling in the system.
2. Make sure the crane is level.
3. Stop the engine.
4. Remove the cover above the hydraulic tank.
5. Remove the manual fill plug (2a).
6. Open the drain valve (8) and drain the tank completely into a suitable container.
7. Clean all dirt from the access cover in the underside of the tank and remove the cover. ***Keep dust and dirt from entering the tank while covers are off.***
8. Flush out any sediment inside the tank.
9. Carefully inspect the suction filters (strainers, inside the tank) for damaged or clogged holes and for sludge, gum or lacquer formation. If necessary, clean the filters:
   a. Remove the access cover from the side of the tank.
   b. Inspect the cover gasket and replace it if it is damaged.
   c. Remove the filter (strainers) from inside the tank.
   d. Soak the filter in clean, nonflammable solvent. Brush off the outer surface, and flush the filter from the inside out. Discard the filter if it is damaged.
   e. Securely reinstall the filter.
   f. Re-install the access cover on the side of the tank.
10. Using a new o-ring, secure the access cover to the underside of the tank.

11. Replace the desiccant breather when necessary (see the Replacing Desiccant Breather topic).

12. Replace the filter elements.

13. Fully close the drain valve (8).

14. Loosen the tube nut fitting (11) located on the suction manifold.

15. Remove the vent cap (12) from the suction manifold.

16. Fill the tank manually through the plug opening (2a) or by pumping oil through the power-fill coupling (2b) with a portable pump. Use new hydraulic oil filtered through a 10-micron filter.

Do not fill the tank through the breather port. The hydraulic system could be contaminated from unfiltered oil.

Fill the hydraulic tank to the full cold level (87 to 90%) while watching the hydraulic tank display on the information screen (see Figure 2-2). Use the proper hydraulic oil (see Section 9).

Do not fill the tank to 100%. Oil will contaminate the desiccant breather.

17. Watch the vent cap (11) and fitting (12). When oil appears at either location, tighten the fitting.

18. Apply 0.2 to 0.3 bar (3 to 4.4 psi) air pressure to the air valve (4a) or to the coupler (4b) on the hydraulic tank.

Observe the vent ports and tighten the vent caps when clear oil starts flowing from the vent ports.

19. Disconnect the air supply.

20. Check the tank level and refill as required.

21. Start the engine and allow the hydraulic system to return to the normal operating pressure and temperature. Check for leaks and tighten parts as required.

22. Stop the engine, check the tank level, and refill the tank 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 Changing Oil 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 shut-off valve (7a, Figure 2-1).

Open the valve prior to starting the engine after servicing the pumps.

CAUTION

Avoid Damage to Pumps!

Open the hydraulic tank shut-off valve before starting the engine. Failing to open the valve will result in damage to the pumps.

Hydraulic Connections

Precautions to Observe During Maintenance and Repair

Use the following precautions during maintenance and repair:

- Make sure the fittings and o-rings being used are the proper size and style.
- Flush the sealing surfaces with clean hydraulic oil to remove any dirt.
- Carefully inspect the threads and sealing surfaces for nicks, gouges, and other damage. Do not use damaged parts. They will leak.
- Carefully inspect the o-rings for cuts and other damage. Do not use damaged o-rings: they will leak.
- Always lubricate the o-rings when assembling onto fittings.
- Be careful not to cut the o-rings when assembling them to fittings. Use a thimble as shown in Figure 2-6 when assembling o-ring over threads.

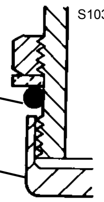


FIGURE 2-6

Pipe Thread Connection

1. Apply sealant (Loctite 92 or equivalent) to the male threads, never to the female threads. Do not apply sealant to the first two male threads.

CAUTION

Hydraulic System Damage!

Do not use PTFE (teflon) tape to seal threads. Pieces of tape will enter the hydraulic system and cause damage.

2. Tighten fittings about 4-1/2 turns by hand and then 3 additional turns with a wrench.

Table 2-2
Pipe Thread Fitting Troubleshooting

Causes	Cures
Fitting loose.	Tighten.
Fitting too tight causing thread distortion.	Replace damaged parts.
Threads on fitting/port wrong size.	Use proper size threads.
Threads dirty, galled or nicked.	Clean or replace parts.
Straight thread used instead of tapered thread.	Use proper type and size thread.
Threads expanded from heat.	Tighten when hot.
Fitting loosened by vibration.	Retighten.

SAE Straight Thread Connection

This type of connection leaks most often because the jam nut and washer are not backed up before assembly.

When the jam nut and washer are not backed up, there is not enough room for the o-ring when the squeeze takes place and the washer cannot seat properly as shown in Figure 2-7, View A. The compressed o-ring between the washer and the spot face will cold flow out of compression, causing the fitting to loosen and leak as shown in Figure 2-7, View B.

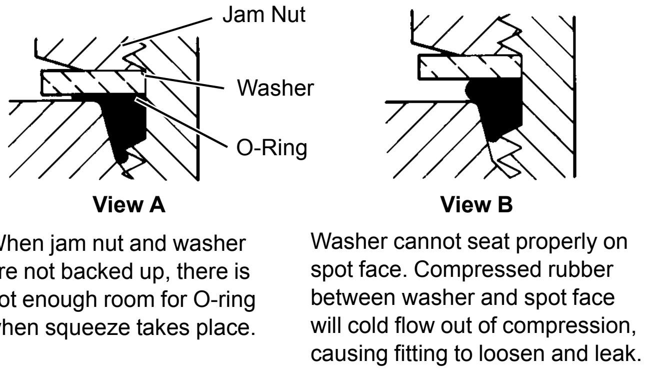


FIGURE 2-7

Tighten SAE straight thread connections using the following procedure:

1. Back off jam nut and washer to the end of the smooth portion on the fitting as shown in Figure 2-8, View A.

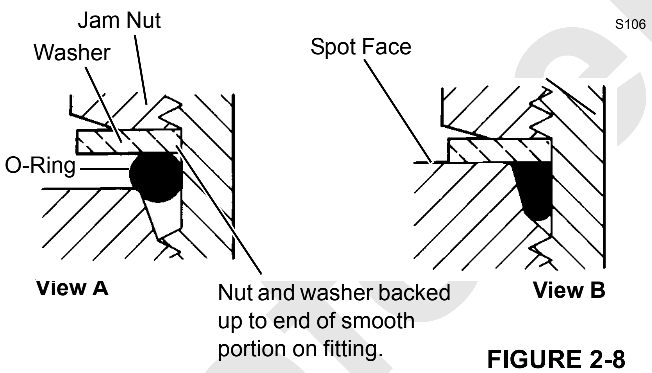


FIGURE 2-8

2. Be sure to lubricate the o-ring with clean oil.
3. Thread fitting into the port until the washer bottoms against the spot face as shown in Figure 2-8, View B.

NOTE: If an elbow is being used, back it out as necessary to align it with hose.

4. Tighten the jam nut. When the fitting is properly installed, the o-ring will completely fill the seal cavity and the washer will be tight against the spot face as shown in Figure 2-8, View B.

Table 2-3
Straight Thread Fitting Troubleshooting

Causes	Cures
Jam nut and washer not backed up at assembly, causing O-ring to be pinched.	Replace O-ring and tighten fitting properly.
O-ring cut.	Replace.
O-ring wrong size.	Replace with proper size.
Sealing surfaces gouged or scratched.	Repair if possible or replace damaged parts.
Sealing surfaces dirty.	Clean and lubricate.

ORS Connection

NOTE: ORS is the registered trade mark for a face-type seal manufactured by Aeroquip Corporation.

To maintain an ORS fitting, use the following procedure:

1. Lubricate and install the o-ring in the adapter groove (Figure 2-9).

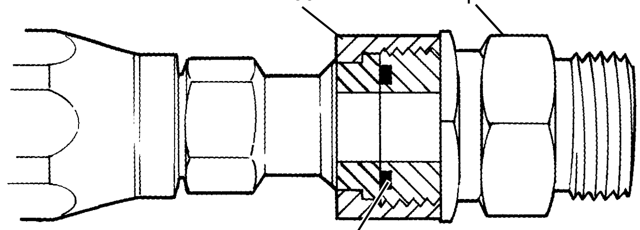


FIGURE 2-9

2. Lubricate the threads.
3. Tighten the nut to the torque value given in Table 2-4.

Table 2-4
ORS Assembly Torque

Nut Size inch across flats	**Fitting Size**	**Torque**	
		Nm	In-Lb
5/8	-04	120 to 145	14 to 16
13/16	-06	203 to 245	23 to 28
15/16	-08	380 to 470	43 to 53
1-1/8	-10	550 to 680	62 to 77
1-3/8	-12	763 to 945	86 to 107
1-5/8	-16	1110 to 1260	125 to 142
1-7/8	-20	1500 to 1680	170 to 190

Table 2-5
ORS Fitting Troubleshooting

Causes	**Cures**
Nut loose.	Tighten to proper torque.
O-ring cut.	Replace.
O-ring wrong size.	Replace with proper size.
Sealing surfaces gouged or scratched.	Repair if possible or replace damaged parts.
Sealing surfaces dirty.	Clean and lubricate.

Split Flange Connection

To maintain a split flange fitting, use the following procedure:

1. Lubricate and install the o-ring in the shoulder groove (see Figure 2-10). Align the shoulder with the port and assemble the flanges over the shoulder.

NOTE: Bolts used must be grade-5 or better. Grade-5 bolts have three dashes on the head.

2. Snug bolts in a diagonal manner (Figure 2-10) to 1/3 of torque given in Table 2-7.
3. Repeat step 2 to 2/3 of final torque. Repeat step 2 to final torque.

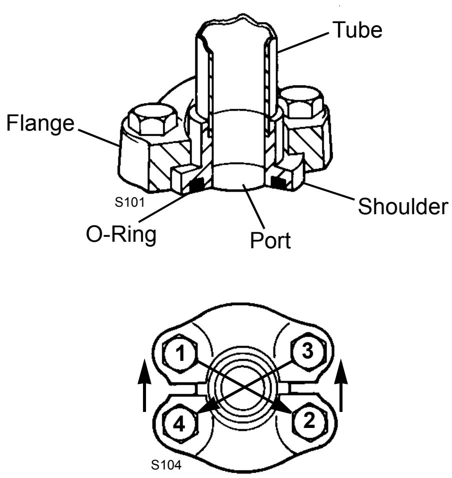
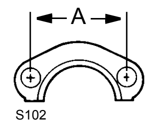


FIGURE 2-10

Table 2-6
Split Flange Fitting Troubleshooting

Causes	Cures
Flanges not tight.	Tighten the bolts evenly to proper torque.
Flanges tightened unevenly causing extrusion of O-ring.	Replace o-rings. Tighten the bolts evenly to the proper torque.
O-ring cut.	Replace.
O-ring wrong size.	Replace with the proper size.
Sealing surfaces not smooth, scratched or gouged.	Repair if possible or replace parts.
Sealing surfaces dirty.	Clean.
Flanges keep getting loose in service.	Use SAE grade 5 bolts or better. Re-tighten the bolts after the system is hot.

Table 2-7
Split Flange Assembly Torque

"A" Dimension inch (mm) 		**Torque**	
	Flange Size	**Nm**	**in-lb**
Standard Pressure Series			
1-1/2 (38)	-08	175 to 225	20 to 25
1-7/8 (48)	-12	225 to 350	25 to 40
2-1/16 (52)	-16	325 to 425	37 to 48
2-5/16 (59)	-20	425 to 550	48 to 62
2-3/4 (70)	-24	550 to 700	62 to 79
3-1/16 (78)	-32	650 to 800	73 to 90
3-1/8 (79)	-24	1400 to 1600	158 to 181
3-13/16 (97)	-32	2400 to 2600	271 to 294
High Pressure Series			
1-9/16 (40)	-08	175 to 225	20 to 25
2 (51)	-12	300 to 400	34 to 45
2-1/4 (57)	-16	500 to 600	57 to 68
2-5/8 (67)	-20	750 to 900	85 to 102
3-1/8 (79)	-24	1400 to 1600	158 to 181
3-13/16 (97)	-32	2400 to 2600	271 to 294

SAE Flare Connection

To maintain an SAE flare connection, use the following procedure:

1. Tighten the nut finger tight until the sealing surfaces touch.
2. Mark a line (use felt pen or marker) on the adapter and extend it onto the connector nut (Figure 2-11, View A).
3. Using wrenches, tighten connector nut the number of flats shown in Table 7 (Figure 2-11, View B).

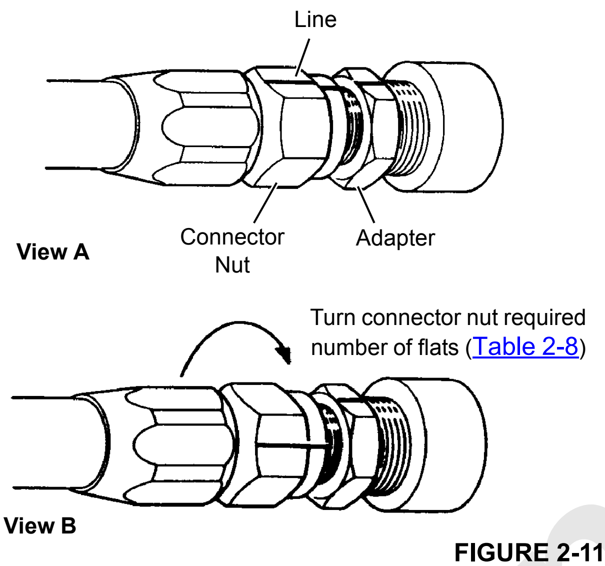


FIGURE 2-11

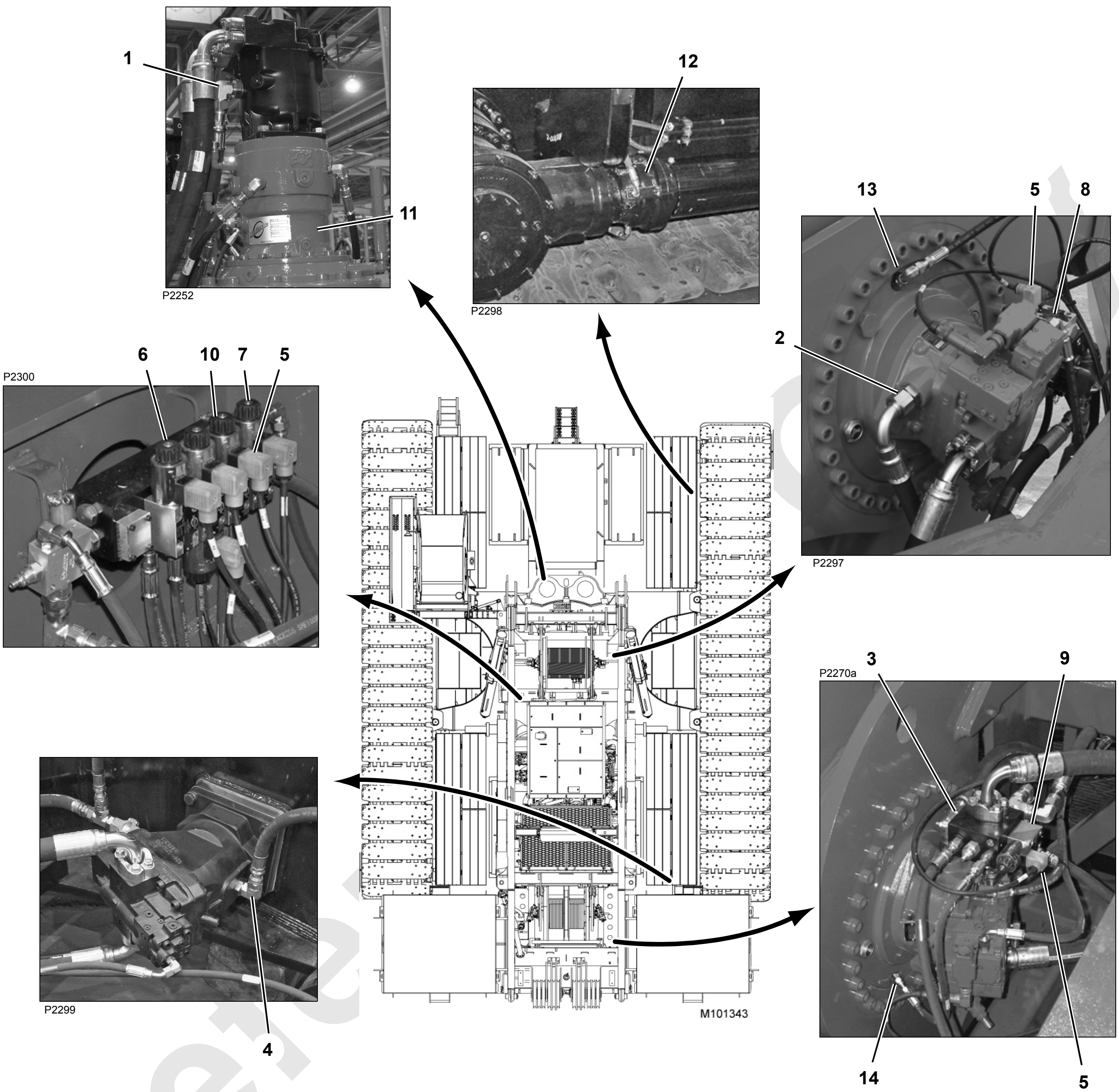
4. Misalignment of marks will show that the fitting has been tightened and the number of flats past the marks.

Table 2-8
SAE 37°Flare Tightening

Connector Nut Size in (mm) across flats	Fitting Size	Adapter Flats to Rotate
9/16 (14,3)	-04	2-1/2
5/8 (15,9)	-05	2-1/2
11/16 (17,4)	-06	2
7/8 (22,2)	-08	2
1 (25,4)	-10	1-1/2 – 2
1-1/4 (31,8)	-12	1
1-1/2 (38,1)	-16	3/4 – 1
2 (50,8)	-20	3/4 – 1
2-1/4 (57,2)	-24	1/2 – 3/4

Table 2-9
SAE 37° Flare Connection Troubleshooting

Causes	Cures
Joint loose.	Tighten properly.
Sealing surfaces dirty.	Clean.
Sealing surfaces not smooth, scratched or gouged.	Replace faulty parts.
Sealing surfaces cracked.	Replace faulty parts.
SAE 45° parts used with SAE 37° parts.	Use only SAE 37° parts.

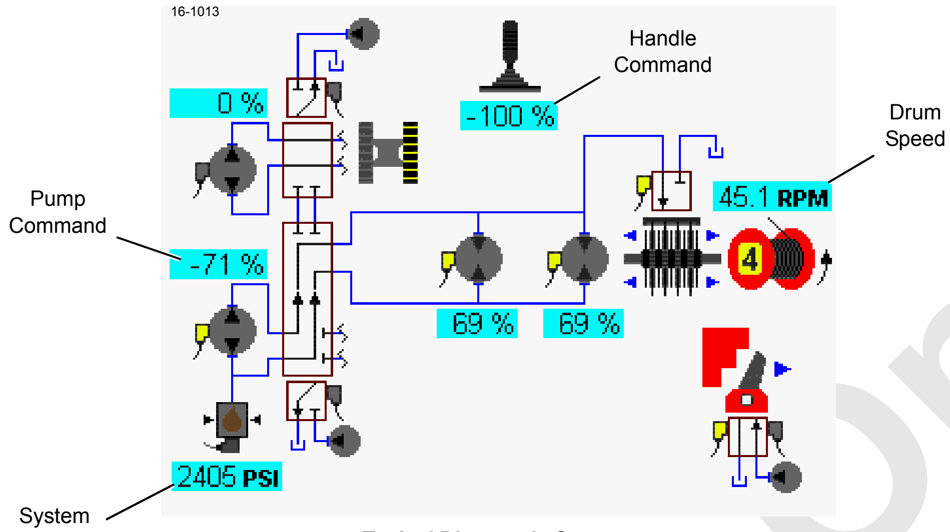


Item	Description	Item	Description
1	Swing Motor Drain Case Port	8	Load Drum Brake Solenoid (typical
2	Load Drum Motor Case Drain (1 or 2 places per drum)	9	Boom Hoist Brake Solenoid
3	Boom Hoist Motor Case Drain	10	Travel Speed Solenoid
4	Travel Motor Case Drain	11	Swing Brake
5	Electric Connector (typical)	12	Travel Brake
6	Swing Brake Solenoid	13	Load Drum Brake
7	Travel Brake Solenoid	14	Boom Hoist Brake (2, inside gear boxes)

FIGURE 2-12

Published 05-03-17, Control # 228-03

SYSTEM CALIBRATION AND TESTS



Typical Diagnostic Screen
(Screen for Drum 4 Shown)

FIGURE 2-13

Accessory System Checks

To operate the following items, use the controls on the hand-held remote control and select the Liftcrane Mast Handling Capacities Chart on the RCL screen.

Rotating Bed Jacking Cylinders

Perform the following procedure when the upperworks are supported on the jacks:

1. Fully extend and retract the jacks three to four times to remove air from the cylinders.
2. Scroll to the jacking diagnostic screen to verify that 206 bar (2,989 psi) is present when cylinders are fully extended and retracted (stalled).
3. When the controls are off, the cylinders must not retract. If they do, contact Manitowoc Crane Care Lattice Team.
4. When retracting the jacks, the rotating bed must lower slowly and smoothly.

Front and Rear Rotating Bed Pins

Perform the following procedure after the hydraulic lines are connected to the cylinders just prior to connecting the rotating bed to the adapter frame:

1. Unlock the keeper plates to allow the cylinders to operate.
2. Fully engage and disengage the pins three to four times to remove air from the cylinders.
3. Scroll to the pins diagnostic screen to verify that 206 bar (2,989 psi) is present when the pins are fully engaged and disengaged (stalled).

Live Mast Cylinders

Perform the following procedure when the mast is removed:

1. Fully raise and lower the mast cylinders three to four times to remove air from the mast cylinders.
2. Scroll to the cab tilt, rigging winch, and mast diagnostic screen to verify that 206 bar (2,989 psi) is present when the mast cylinders are fully extended (stalled) and 88 bar (1,276 psi) is present when the mast cylinders are retracted.

CAUTION

Damage to Mast!

When raising the mast for the first time, or after maintenance of mast cylinder, raise the mast slowly and check that both cylinders are raising the mast evenly. The mast could twist if one cylinder is not working correctly.

Carbody Jacking Cylinders (Optional)

Perform the following procedure when the upperworks and carbody are supported on the jacks:

1. Fully extend and retract the jacks three to four times to remove air from the cylinders.
2. Scroll to the jacking diagnostic screen to verify that 206 bar (2,989 psi) is present when the cylinders are fully extended and retracted (stalled).

3. When the controls are off, the cylinders must not retract. If they do, contact the Manitowoc Crane Care Lattice Team.
4. When retracting the jacks, the carbody must lower slowly and smoothly.

Crawler Pins

Perform the following procedure prior to connecting the crawlers to the carbody:

1. Remove the collars from the ends of the pins.
2. Fully engage and disengage the pins three to four times to remove air from the cylinders.
3. Scroll to the pins diagnostic screen to verify that 206 bar (2,989 psi) is present when the pins are fully engaged and disengaged (stalled).

Counterweight Pins

Perform the following procedure after the hydraulic lines are connected to the cylinders just prior to lifting the counterweight tray into position at the rear of rotating bed:

1. Fully engage and disengage the pins three to four times to remove air from the cylinders.
2. Scroll to the pins diagnostic screen to verify that 206 bar (2,989 psi) is present when the pins are fully engaged and disengaged (stalled).

Boom Hinge Pins

Perform the following procedure after hydraulic lines from the butt are connected to the crane just prior to aligning the boom butt with the rotating bed:

1. Fully engage and disengage pins three to four times to remove air from cylinders.
2. Scroll to pins diagnostic screen to verify that 206 bar (2,989 psi) is present when pins are fully engaged and disengaged (stalled).

Cab Tilt

To verify cab tilt operation, use the following procedure:

1. Fully raise and lower the cab three to four times to remove air from the cylinders (use the switch in the cab).
2. Scroll to the cab tilt diagnostic screen to verify that 206 bar (2,989 psi) is present when the cylinders are fully engaged and disengaged (stalled).
3. With control off, the cylinders must not retract. If they do, contact the Manitowoc Crane Care Lattice Team.
4. When lowering the cab, it must lower slowly and smoothly. If necessary adjust the cab tilt flow meters as described in this section.

Rigging Winch (Optional)

To verify wench operation, use the following procedure:

1. Enable the rigging winch (see instructions in Section 3 of 16000 Operator Manual).
2. Operate the winch several times in both directions to make sure it is operating properly and to remove air from the system.
3. Scroll to the cab tilt, rigging winch, and mast diagnostic screen to verify that 206 bar (2,989 psi) is present when operating the winch.

Low Pressure Accessory System

A pressure reducing valve limits pressure in the low pressure accessory system to the value specified in Table 2-10.

The low pressure accessory system controls the swing brake, travel brake, travel 2-speed, diverting valves, and boom hoist pawl.

Swing Brake

Perform the following check in an area where the crane can be swung without interference:

1. Scroll to the swing diagnostic screen to monitor the swing component icons.
2. Turn off the swing park and attempt to swing the crane by moving the control handle in both directions.
3. The crane must swing freely.
4. The swing screen should indicate that the swing park brake is released and the swing brake pressure sensor will report to Node-5 the hydraulic pressure at the swing brake.
5. Bring the upperworks to a complete stop, move the control handle to off, and turn on the swing park.
6. The swing handle should be inoperable.
7. The swing screen should indicate no handle or pump commands and that the swing park brake is applied.

Travel Brakes

Perform the following check in an area where the crane can be traveled without interference:

1. Scroll to the travel diagnostic screen to monitor the travel component icons.
2. Turn off the travel park and attempt to travel the crane by moving the control handles in both directions.
3. The crane must travel freely.
4. The travel screen should indicate that the travel park brakes are released.

5. Turn on the travel 2-speed. The travel speed should increase and the travel screen should indicate that the 2-speed is on.
6. Bring the upperworks to a complete stop, move the control handles to off, and turn on the travel park.
7. The travel handles should be inoperable.
8. The travel screen should indicate no handle or pump commands and that the travel park brakes are applied.

Speed Checks

Travel Speed

Perform the following check in an area where the crane can be traveled without interference:

1. Put a timing mark on the front crawler roller (Figure 2-14).
2. Start and run the engine at high idle.
3. Push both crawler control handles fully forward to travel the crane at full speed.
4. Have an assistant count the number of revolutions the timing marks make—the number must be within ranges given in Table 2-10.
5. If speed is not within the specified range, contact the Manitowoc Crane Care Lattice Team.

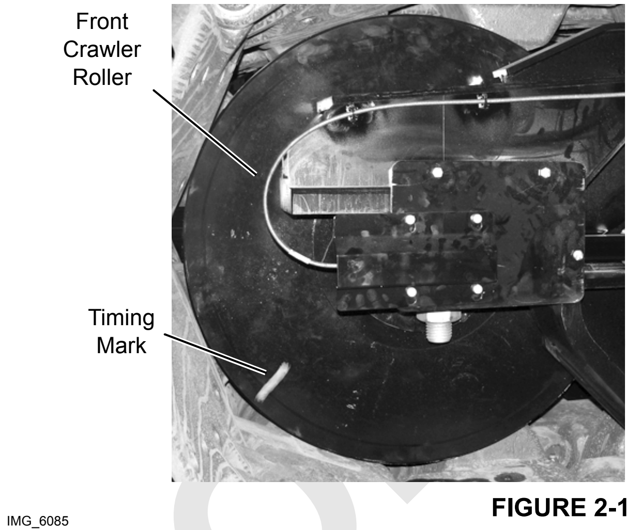


FIGURE 2-14

Swing and Drum Speeds

Perform the following check in an area where the crane can be swung without interference.

Check operating speed on the diagnostic screens (Figure 2-24) for swing and each drum in the following conditions:

- Engine running at high idle
- Control handles moved fully forward and back
- No load
- No rope on drums

Speeds must be within the ranges specified in Table 2-10. If proper speeds are not indicated, contact the Manitowoc Crane Care Lattice Team.

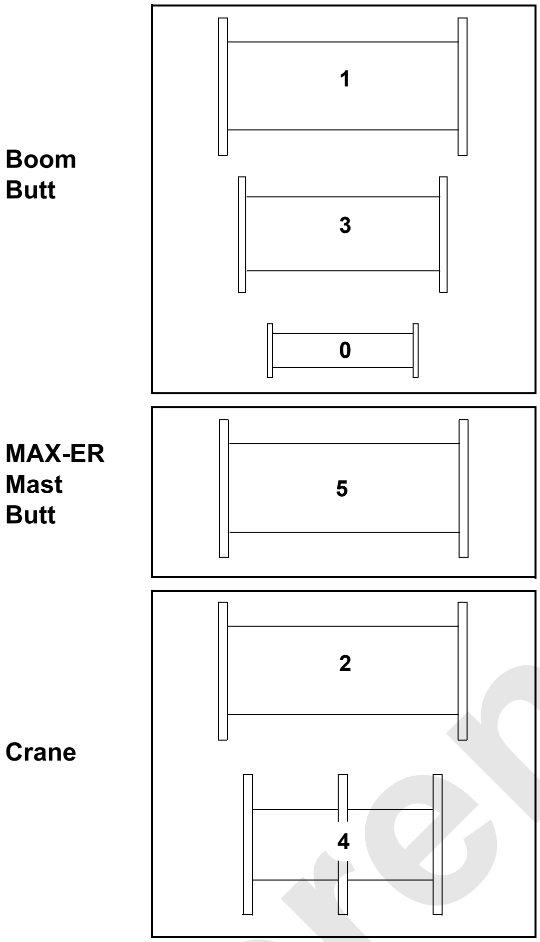
HYDRAULIC SYSTEM SPECIFICATIONS

Table 2-10

Function	Direction	Pump-Port	System Pressure 1 [1] bar (psi)	System Pressure 2 [2] bar (psi)	Charge Pressure	Speed [3] rpm
Drum 1	Hoist	Pump 4 - B		NA		50 to 55
	Lower	Pump 4 - A		NA		44 to 52
Drum 2 (single drive)	Hoist	Pump 6 - B		NA		36 to 40
	Lower	Pump 6 - A		NA		32 to 38
Drum 2 (dual drive)	Hoist	Pump 6 - B		NA		50 to 55
	Lower	Pump 6 - A		NA		44 to 52
Drum 3	Up			NA		39 to 43
	Down			NA		34 to 41
Drum 4	Up	Pump 3 - A	420 (6,092)	NA	24 (350)	36 to 40
	Down	Pump 3 - B		NA		32 to 38
Drum 5	Up	Pump 3 - A		NA		50 to 55
	Down	Pump 3 - B		NA		44 to 52
Swing	Left	Pump 5 - B		NA		1.2
	Right	Pump 5 - A		NA		
Right Crawler	Forward	Pump 1 - A		407 (5,900)		6.6 to 7 at Tumbler
	Reverse	Pump 1 - B		407 (5,900)		
Left Crawler	Forward	Pump 2 - B		407 (5,900)		6.6 to 7 at Tumbler
	Reverse	Pump 2 - A		407 (5,900)		
Low Pressure Accessory System [4]	NA	NA	28 (406) Standby 34 (493) Operation	NA	NA	NA
High Pressure Accessory System [5]	NA	NA	207 (3,002)	NA	NA	NA
Carbody Control System [6, 7]	NA	NA	207 (3002)	NA	NA	NA

Notes	
NA	Not Applicable.
1	Controlled by multi-function valves in each pump.
2	Controlled by crane's programmable controller.
3	Speeds based on engine at high idle, no load (no rope on drums), and handles moved fully forward or back. Speeds can vary plus or minus 5%.
4	Swing brakes, travel brakes, travel two speed, diverting valves, and boom hoist pawl. Controlled by a pressure reducing valve next to each valve bank.
5	Rotating bed jacks, rotating bed pins, live mast cylinders, carbody jacks (optional), crawler pins, counterweight pins, boom hinge pins, cab tilt, rigging winch.
6	Crawler pins and optional carbody jacks.
7	Controlled by crane's programmable controller.

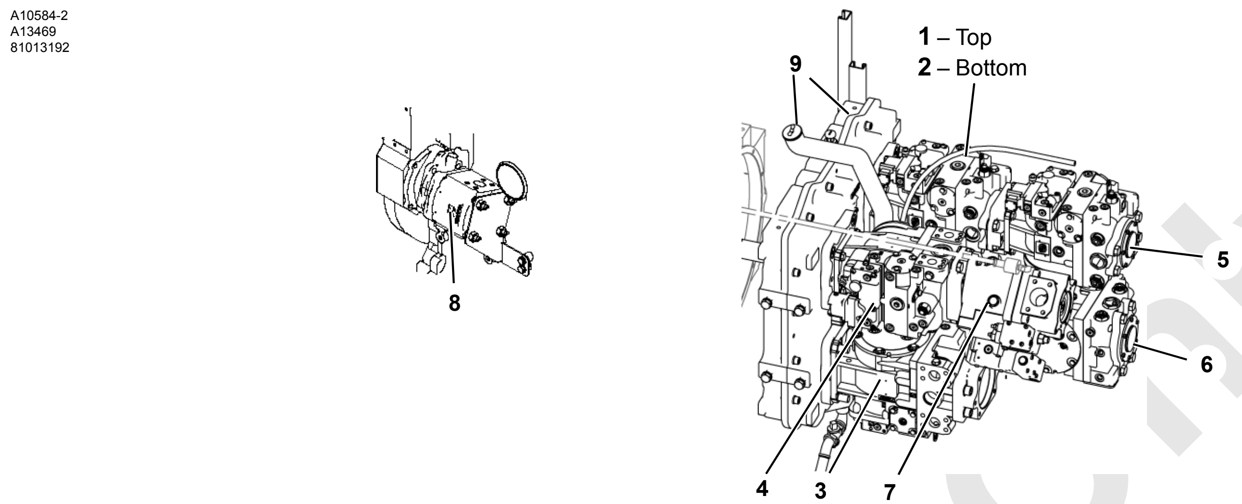
DRUM IDENTIFICATION



Drum No.	Description
1	Main Load Drum
2	Whip Load Drum
3	Luffing/Auxiliary Load Drum
4	Boom Hoist - Standard
5	Mast Hoist - with MAX-ER (in mast butt)
0	Rigging Winch

FIGURE 2-15

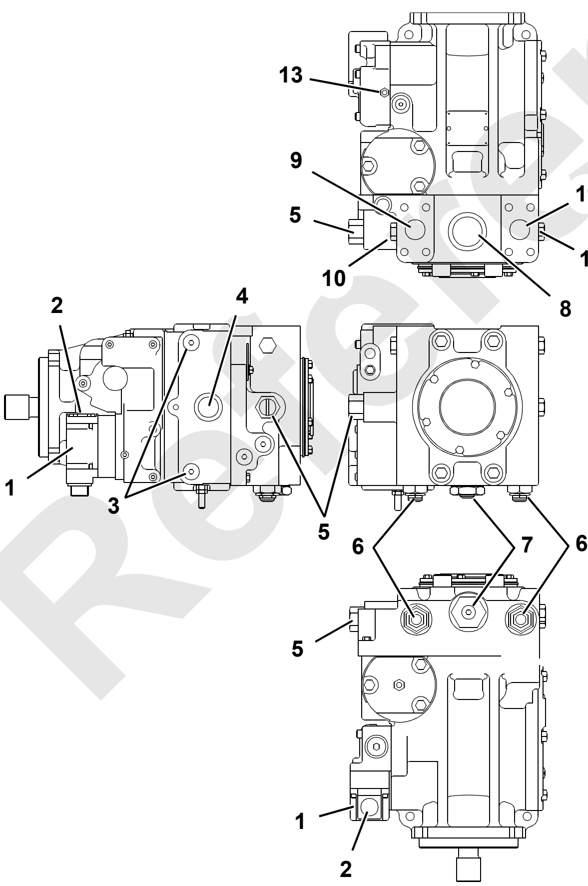
PUMP IDENTIFICATION



Item	Description	Item	Description	Item	Description
1	Right Travel or Boom Drum	4	Drum 1 or Drum 2	7	Accessory System
2	Left Travel or Luff Drum	5	Swing	8	Gear Pump for Fan (Front of Engine)
3	Boom or Mast Boom Drum	6	Drum 2 or Drum 1	9	Pump Drive and Pump Drive Oil Fill

FIGURE 2-16

PUMP COMPONENTS



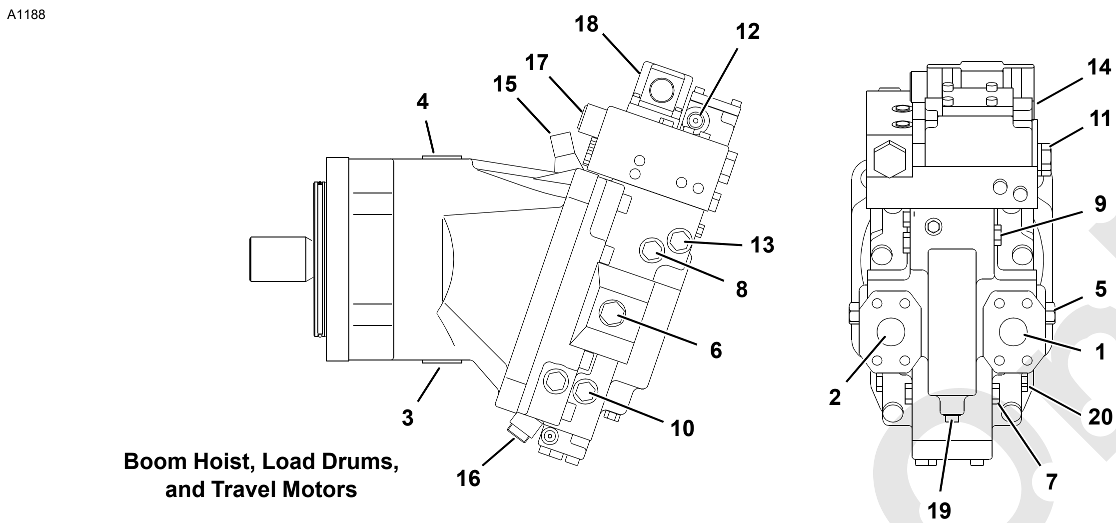
Item	Description
1	EDC (Electronic Displacement Control)
2	Manual Override Control
3	Servo Ports
4	Case Drain Port (NOTE 1:)
5	Charge Pressure Relief Valve
6	Multi-Function Valve (NOTE 2:)
7	Charge Pressure Gauge Port
8	Charge Pump Inlet Port
9	Pump Port B
10	Pump Port B Gauge Port
11	Pump Port A
12	Pump Port A Gauge Port
13	Neutral Adjusting Screw

NOTE 1: Both sides of pump

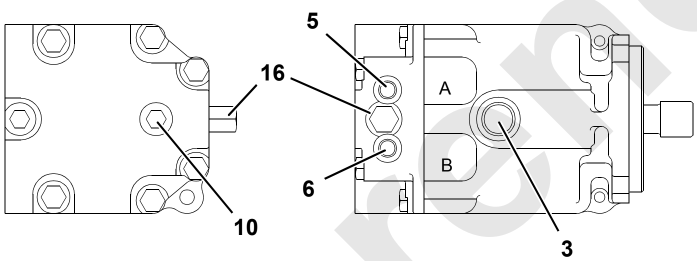
NOTE 2: Valve is directly opposite port it protects

FIGURE 2-17

MOTOR COMPONENTS



Boom Hoist, Load Drums,
and Travel Motors



Swing Motor

Item	Port	Description
1	A	Main System Pressure
2	B	Main System Pressure
3	L1	Case Pressure
4	L2	Case Pressure
5	M1	Gauge Port A
6	M2	Gauge Port B
7	M3	Servo Pressure Gauge Port or Servo Pressure Supply
8	M4	Servo Pressure Gauge Port or Servo Pressure Supply
9	M5	Servo Pressure Supply
10	M6	Charge Pressure Gauge Port
11	M7	Control Pressure
12	M8	Control Pressure
13	M9	Servo Pressure Supply
14	X1	External PCP Supply Pressure
15		Minimum Displacement Limiter
16		Charge Pressure Relief valve
17		Pressure Compensator Adjuster
18		Manual Override
19		Control Start Setting
20		Loop Flushing Shuttle Valve

FIGURE 2-18

HYDRAULIC SYSTEM TEST, CALIBRATION, AND ADJUSTMENT PROCEDURES

It is only necessary to perform the following procedures at the specified intervals or when instructed to do so during troubleshooting (see Section 10).

Pressure Test and Calibration Screen

NOTE: To understand the operation of the main display and touch pad controls, read the instructions in Section 3 or the 16000 Operator Manual.

The Pressure Test and Calibration Screen (see Figure 2-19) is used to initiate and monitor the four hydraulic test and calibration procedures described in this section.

The screen shows the pump commands and pressure levels for all primary crane functions. Use the data box in the upper left corner of the screen to select and start a specific test or calibration procedure.

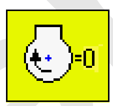
The pressure Test and Calibration screen operates on two ***levels***.

Level 1—Test data box highlighted blue

Level 2—Test data box highlighted red. Use Select buttons to choose the test or calibration procedure

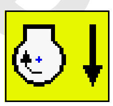
All test and calibration procedures must be run at a particular engine speed. If a test is started at the wrong speed, the appropriate prompt shown below appears in the data box and the procedure is aborted.

Engine Off



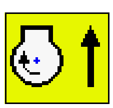
The yellow engine pressure **0** icon indicates that the test must be run with the engine off.

Engine Low Idle

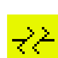


The yellow engine pressure **down arrow** icon indicates that the test must be run with the engine at low idle.

Engine High Idle



The yellow engine pressure **up arrow** icon indicates that the test must be run with the engine at high idle.



The yellow open-circuit icon indicates a circuit fault that must be serviced immediately.

The yellow short-to-ground icon indicates a circuit fault that must be serviced immediately.

Pressure Sender Test

See Figure 2-19 for the following procedure.

The pressure sender test calculates the zero-pressure output level for each pressure sender. Pressure sender null (0) must be with in 0.65 to 1.35 volts.

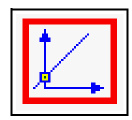
Perform this test when the following situations occur:

- A new pressure sender is installed
- A new controller node that monitors pressure senders is installed
- A new master node or master node software is installed
- Pressure readings are noticeably in error

Be aware that if there is any residual pressure in the system during the calibration process, the display pressure reading in the cab may not reflect actual system pressure. See Note on page 2-23.

Test pressure senders using the following procedure:

1. Stop the engine and turn the ignition switch to the run position. Push the Enter button to go to the Pressure Test and Calibration screen from the Menu screen.
2. Press the Enter button to go to level 2. Use the Select buttons to show the PRESSURE SENDER icon in the data box.



3. Press the Confirm button to start the test.
4. The test starts and the percent of completion is displayed in the data box.
5. When the test is complete, the pressure sender icon reappears in the data box.

The pressure senders must show a signal within a specified range during this test. Any sender signal out of this range is highlighted in yellow. Troubleshoot the failed senders to determine the cause of the fault.

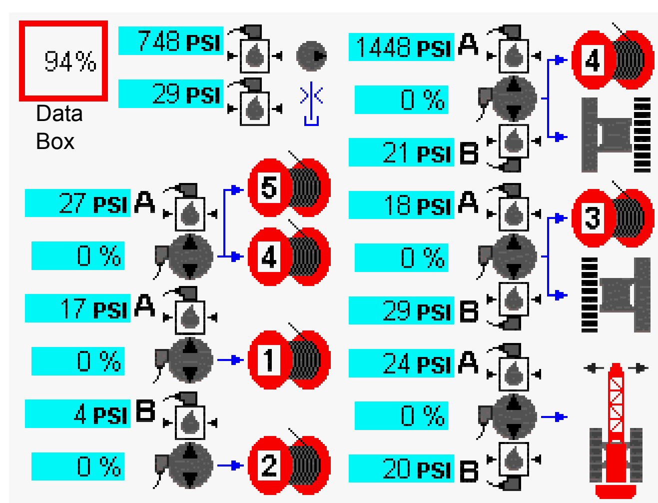


FIGURE 2-19

NOTE: The cause of a failed pressure sender test or faulty display pressure reading may not be the pressure sender. The cause of the fault could be trapped air or hydraulic pressure in the system during the pressure sender test.

Before replacing a pressure sender, do the following:

- Perform the pressure sender test.
- Attach an accurate hydraulic pressure gauge to the quick-coupler at the suspect pressure transducer (see topic in this section).
- If the pressure appears on the gauge, bleed the corresponding system so the gauge reads zero pressure.
- Repeat the pressure sender test and check the pressure on the display with the engine running at idle — the display reading and the gauge reading should be the same.
- Before replacing a pressure sender, check the signal voltage at the sender. It should be 1.00 volt against ground at 0 psi.

Control Calibration

See Figure 2-20 for the following procedure.

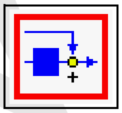
Control calibration calculates the pump threshold command level for all drum and swing functions. The allowable range is 5 to 25% pump command signal for the hoist pumps and 2.5 to 20% in each direction for the swing pump(s).

Perform this calibration when the following situations occur:

- A new pump or motor is installed in a drum or swing function
- A new master node or master node software is installed
- Operation indicates the threshold is in error, including excessive handle motion or time required to initiate motion or inability to start motion smoothly.

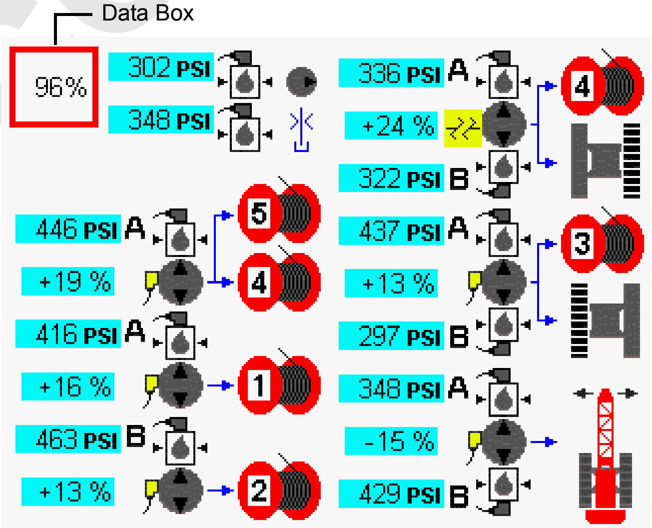
Calibrate controls using the following procedure:

1. Apply all park brakes with the switches on the control console.
2. Start and run the engine at high idle.
3. Press the Enter button to go to the Pressure Test and Calibration screen from the Menu screen.
4. Press the Enter button to go to ***level 2***. Use the Select buttons to show the CONTROL CALIBRATION icon in the data box.



5. Press the Confirm button to start the test.
6. The Calibration starts and the percent of completion is displayed in the data box.
7. When the calibration is complete, the control calibration icon reappears in the data box.

   Pump threshold command levels must be within a specified range during this test. Any pump requiring a threshold command level outside this range is highlighted in yellow. Troubleshoot the failed circuit to determine the cause of the fault.



D16-27B

FIGURE 2-20

High Pressure Test

See Figure 2-21 for the following procedure.

The high pressure test checks the ability of all primary crane functions to reach and hold high pressure. This test generally is used only as a shop procedure on new cranes. It can also be used as a quick way to test hydraulic components in the primary hydraulic circuits.

CAUTION: Only perform this high pressure test when absolutely necessary and by a qualified service technician.

⚠ WARNING

High Pressure Hazard!

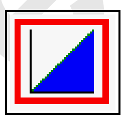
This test generates maximum pressure in the main hydraulic circuits. Defective brakes may allow unintended motion during test. Move the crane to an area where such motion is not a hazard.

Use a signal person to monitor functions operator cannot see.

Be prepared to stop the engine if unintended motion occurs.

Test high pressure using the following procedure:

1. Apply all park brakes with the switches on the control console.
2. Start and run the engine at high idle.
3. Press the Enter button to go to the Pressure Test and Calibration screen from the Menu screen.
4. Press the Enter button to go to ***level 2***. Use the Select buttons to show the HIGH PRESSURE icon in the data box.



5. Press the Confirm button to start the test.
6. The test starts and the percent of completion is displayed in the data box.
7. When the test is complete, the high pressure icon reappears in the data box.

Maximum pressure levels must be reached within a specific pump command range during this test. Any pump requiring a command in excess of this range or failing to generate maximum pressure is highlighted yellow. Troubleshoot the failed circuit to determine the cause of the fault.

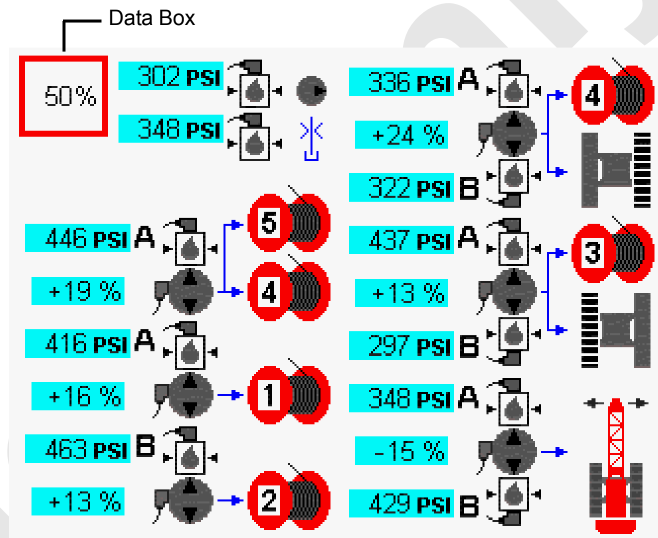


FIGURE 2-21

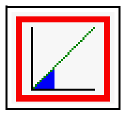
Charge Pressure Test

See Figure 2-22 for the following procedure.

The charge pressure test checks the ability of all primary crane functions to build proper charge pressure. This test generally is used only as a shop procedure on new cranes. It can also be used as a quick way to test hydraulic components in the primary hydraulic circuits. Charge pump pressure must be within 19 to 27 bar (276 to 392 psi).

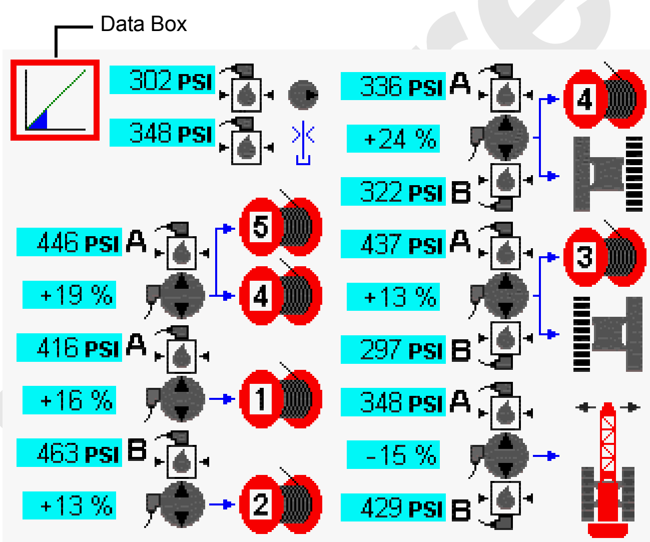
Test charge pressure using the following procedure:

1. Apply all the park brakes with the switches on the control console.
2. Start and run the engine at low idle.
3. Press the Enter button to go to the Pressure Test and Calibration screen from the Menu screen.
4. Press the Enter button to go to ***level 2***. Use the Select buttons to show the LOW PRESSURE icon in the data box.



5. Press the Confirm button to start the test.
6. The test starts and the percent of completion is displayed in the data box.
7. When the test is complete, the charge pressure icon reappears in the data box.

   Charge pressure levels must be within a specified range during this test. Any pump that failed to maintain charge pressure within a specified range is highlighted in yellow. Troubleshoot the failed circuit to determine the cause of fault.



D16-29B

FIGURE 2-22

High Pressure Adjustment

The following adjustment is only required when a system fails the High Pressure Test.

Unless otherwise specified, see Figure 2-23 for the following procedure:

1. Scroll to the diagnostic screen for the corresponding function (see Figure 2-24).
2. Disconnect the electrical connector from the corresponding brake solenoid valve (see Figure 2-12).
3. With the engine running at low idle, slowly move the desired control handle:
   - In either direction from off for swing or travel
   - Back from off (hoist direction) for all drums
4. Do not demand any more than 20% handle command.
5. Pressure on the screen should indicate the pressure specified in Table 2-10.
6. If the proper pressure is not indicated, adjust the corresponding multi-function valve:
   a. Remove the protective cap (3) from the multi-function valve (1 or 2). See Table 2-10 and Figure 2-17 for pump port identification.
   b. Loosen the lock nut (4)

   DO NOT tamper with the bypass hex (6). See the pump manufacturer's instructions.

   c. Using an internal hex wrench, adjust the multi-function valve adjusting screw (5):
      - Turn IN to increase the pressure
      - Turn OUT to decrease the pressure
7. Repeat step 6 until the specified pressure is indicated.
8. Hold the adjusting screw (5) in position and securely tighten the lock nut (4).
9. Install the protective cap (3).
10. Reconnect the electrical connector to the corresponding brake solenoid valve (see Figure 2-12).

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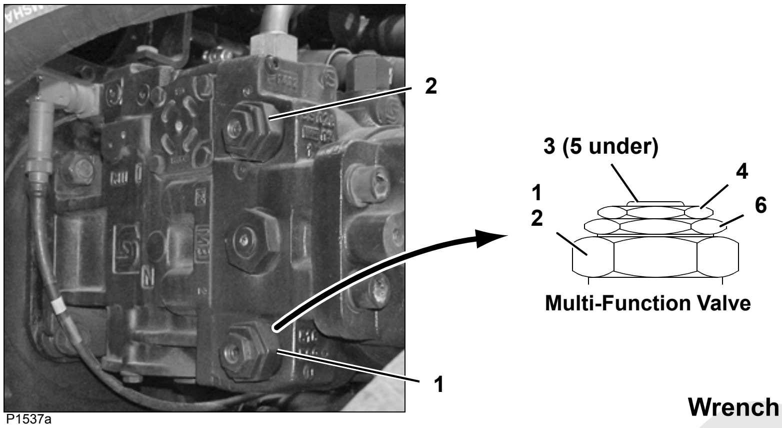
Typical Pump Installation



P1537a

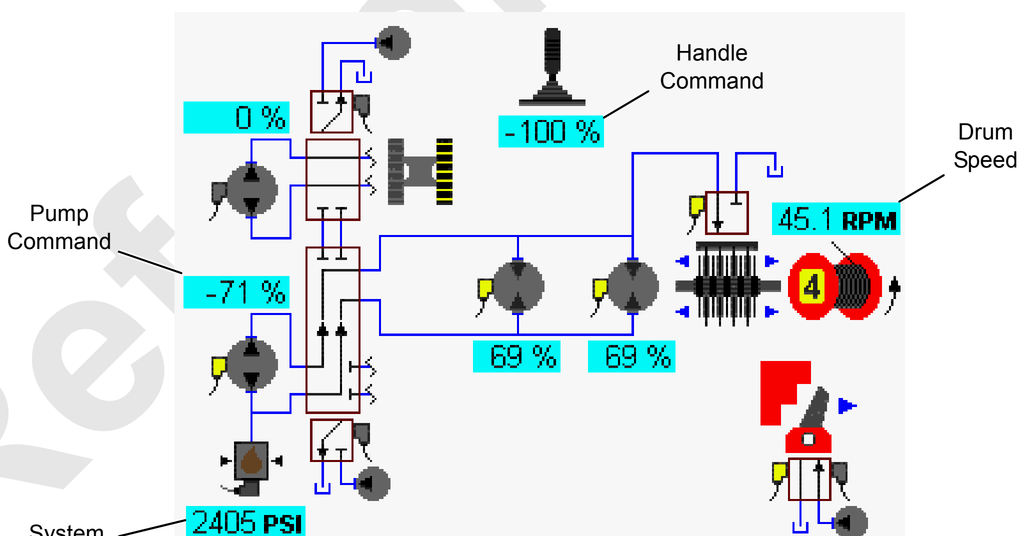
Item	Description
1	Port A Multi-Function Valve
2	Port B Multi-Function Valve
3	Protective Cap
4	Lock Nut
5	Adjusting Screw
6	Bypass Hex

Wrench Size

Pump Size	Lock Nut Hex Size	Internal Hex Size
Series 130 Units	13 mm (1/2 in) or 24 mm (15/16 in)	4 mm (5/32 in) or 8 mm (5/16 in)

FIGURE 2-23

16-1013



Typical Diagnostic Screen
(Screen for Drum 4 Shown)

FIGURE 2-24

Charge Pressure Adjustment

The following adjustment is only required when a system fails the Charge Pressure Test.

1. Scroll to the diagnostic screen for the corresponding function (see Figure 2-24).
2. Start and the run engine at high idle. With the function in neutral, the system pressure on the diagnostic screen should read 22 to 26 bar (319 to 377 psi).
3. If the specified pressure is not indicated, stop the engine and connect an accurate 0 to 69 bar (0 to 1,001 psi) hydraulic pressure gauge to the coupler at the corresponding pressure sender (see Figure 2-30).
4. Repeat step 2. If the specified pressure is still not indicated:
    - Perform a Pressure Sender Test. Replace the faulty pressure sender if needed
    - Perform a Control Calibration

    If the specified pressure is still not indicated, take the following actions:

    - If pressure is too high, check that the pump neutral is adjusted properly. If the pressure is still high, adjust the charge pressure relief valve.
    - If pressure is too high, adjust the charge pressure relief valve. If you cannot raise the charge pressure, excessive system leakage is indicated.
5. To adjust the charge pressure:

    See Figure 2-25 for the following procedure:

    a. Loosen the lock nut (1).

    b. Adjust the adjusting plug (2):

    - Turn IN to increase the pressure
    - Turn OUT to decrease the pressure

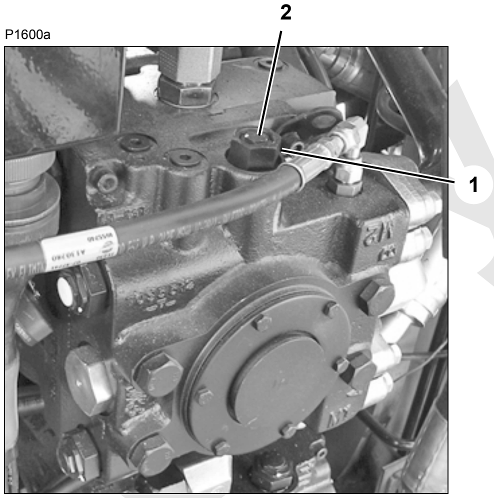
    c. Once the specified pressure is indicated, hold the adjusting plug (2) in position and securely tighten the lock nut (1).
6. Stop the engine and remove the gauge from the transducer gauge port.

Pump Neutral Adjustment

See Figure 2-26 for the following procedure.

To adjust pump neutral:

1. Park all the crane functions and stop the engine.
2. Disconnect the electrical connector from the pump EDC (see Figure 2-29).
3. Install an accurate 0 to 69 bar (0 to 1,001 psi) hydraulic pressure gauge in each servo gauge port (1).
4. Start and run the engine at high idle.



Typical Pump Installation

Item	Description	Hex Wrench Size
1	Lock Nut	12,7 mm (1/2 in)
2	Adjusting Plug Series 030-100	27 mm (1-1/16 in)
	Adjusting Plug Series 030-100	41,3 mm (1-5/8 in)

FIGURE 2-25

5. Loosen the lock nut (2).
6. Using an internal hex wrench, turn the adjusting screw (3) IN until the pressure increase in either gauge.
7. Note the angular position of internal hex wrench.
8. Then, turn the adjusting screw OUT until pressure increases an equal amount in the other gauge.
9. Again, note the angular position of the internal hex wrench.
10. Turn the adjusting screw in half the distance between the positions noted above.
11. The pump control should now be in neutral with both gauges reading the same pressure.
12. Hold the adjusting screw (3) in position and securely tighten the lock nut (2).
13. Stop the engine, remove the gauges, and securely install the servo gauge port plugs (1).

Low Pressure Accessory Adjustment

See Figure 2-26 for the following procedure.

The pressure reducing valve (1) controls pressure in the low pressure accessory systems—swing brake, swing lock (past production), travel brakes, and the travel 2-speed

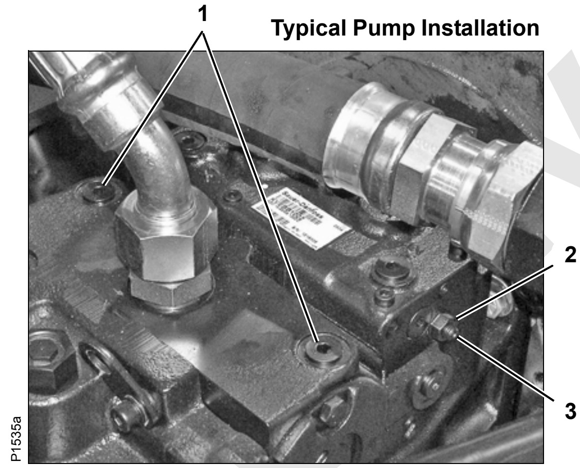
If you think that a low pressure accessory system is not operating properly, use the following procedure:

1. Install an accurate 0 to 69 bar (0 to 1,001 psi) hydraulic pressure gauge between end of the supply line and the corresponding port of actuator (brake port, for example).

   Fittings are 06 ORS.

2. Release the brake by slowly moving the control handle in either direction to operate the corresponding function—the pressure should be 28 to 35 bar (406 to 508 psi).
3. Apply the brake by moving the control handle to off— the pressure should be zero.
4. If the pressure is above 35 bar (508 psi), use the following procedure:
   a. Loosen the lock nut (2).
   b. Adjust the adjusting screw (3):
      - Turn IN to increase the pressure
      - Turn OUT to decrease the pressure
   c. Start and run the engine at high idle.
   d. Fully retract (stall) a rotating bed jack with the switch on the setup remote control only long enough to get a gauge reading.
   e. Repeat steps a through d until gauge reads no higher than 35 bar (508 psi).
   f. Hold the adjusting screw in position and securely tighten the locknut.
5. Stop the engine, remove the gauge, and reconnect the hydraulic lines.

Typical Pump Installation

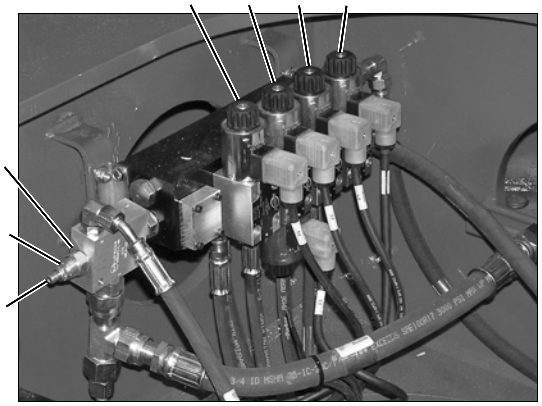


Item	Description
1	Servo Gauge Ports (SAE 06)
2	Lock Nut
3	Adjusting Screw

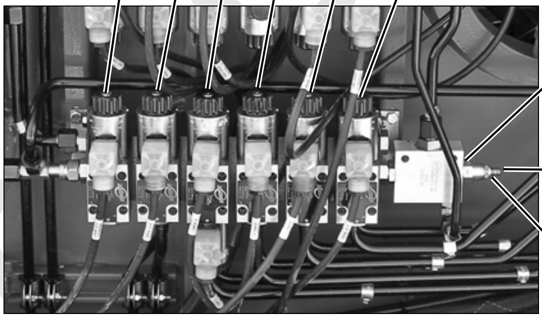
Wrench Size

Pump Series	Lock Nut Hex Size	Internal Hex Size
Early Series Units	17 mm	5 mm
Current Series Units	10 mm	3 mm

FIGURE 2-26



Inside Adapter Frame



Left Side of Rotating Bed

Item	Description	Item	Description
1	Pressure Reducing Valve	8	Drum 2 to Drum 1 Diverting Solenoid
2	Lock Nut – 0.562 inch Hex	9	Drum 1 to Drum 2 Diverting Solenoid
3	Adjusting Screw – 0.188 inch Internal Hex	10	Drum 4 Pawl Solenoid
4	Swing Brake Solenoid Valve	11	R Travel to Drum 4 Diverting Solenoid
5	Swing Lock Solenoid Valve (past production)	12	L Travel to Drum 3 Diverting Solenoid
6	Travel Brake Solenoid Valve	13	Drum 4 to Drum 5 Diverting Solenoid
7	Travel 2-Speed Solenoid Valve		

FIGURE 2-27

Motor Leakage Test

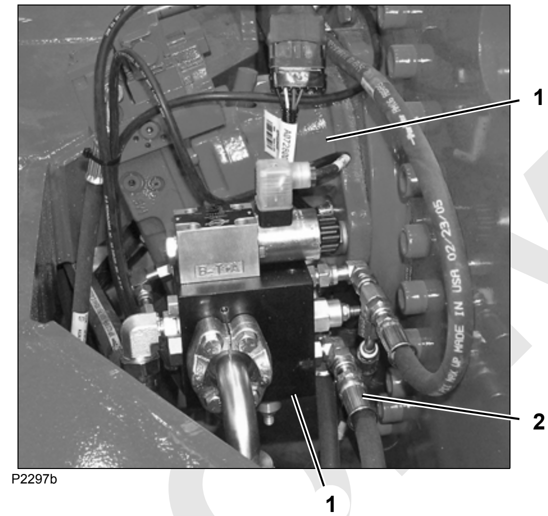
Perform the following test if troubleshooting indicates the need:

- Low Charge Pressure
- Sluggish Operation
- Excessive Heat

See Figure 2-28 for the following procedure:

1. Stop the engine.
2. Install an accurate flow meter in the highest case drain port (see Figure 2-12) at the desired motor:
   - A 207 bar (3,002 psi) in-line meter with a flow rate of 114 L/m (30 gpm) is required
   - All motors except the swing require 16 ORS fittings Swing requires 12 ORS fittings
3. For hoist motors only, disable the loop flushing:
   a. Disconnect the loop flushing hose (2) from the elbow in the loop flushing valve (1).
   b. Install an 08 ORS cap on the end of the elbow and an 08 ORS plug in the end of the hose.
4. Start the engine and run at high idle.
5. Monitor the flow meter. Under all operating conditions, leakage should not be more than 5.7 to 9.5 L/m (1-1/2 to 2-1/2 gpm).
6. Stop the engine and enable the loop flushing by reconnecting the hose to the elbow in the loop flushing valve.
7. Start the engine and run at high idle.
8. Monitor the flow meter. Under all operating conditions, the leakage should not be more than 20.8 to 24.6 L/m (1-1/2 to 2-1/2 gpm).
9. If the motor leakage without loop flushing is not within the specified range, replace the motor and pump.
10. If the motor leakage with the loop flushing is not within the specified range, replace the loop flushing valve and/or the motor and pump depending on which is the cause for the high leakage.

Typical Motor Installation



Item	Description
1	Loop Flushing Valve
2	Loop Flushing Hose
3	Motor

FIGURE 2-28

Loop Flushing Valve Adjustment

The loop flushing valves for the hoists – load and boom – ***are not adjustable***. Do not tamper with the settings of the valve cartridges in the loop flushing valve manifold.

If you are experiencing excessive leakage do to a faulty loop flushing valve, replace the valve.

Manual Override Tests

The pumps, motors, and solenoid valves are equipped with manual overrides that allow electrical problems to be isolated from mechanical problems when troubleshooting hydraulic system problems.

DANGER

Falling or Moving Load Hazard!

To prevent unexpected movement of loads or the crane when operating any manual override:

- Park the crane in an area where it will not interfere with other job site equipment or structures.
- Land all loads and lower the boom onto blocking at ground level.
- Park all crane functions.

Pump or Motor Override

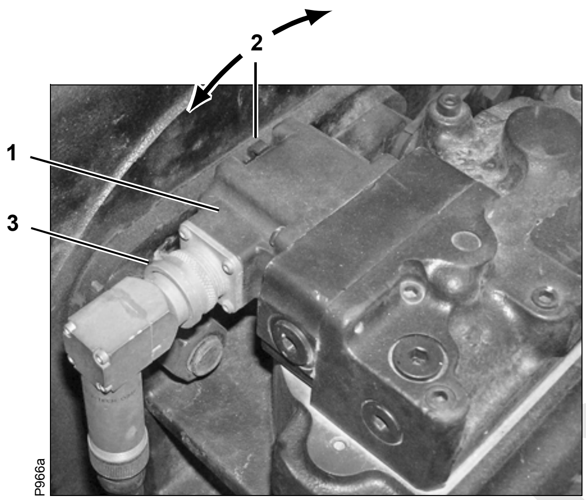
See Figure 2-29 for the following procedure:

1. Start the engine and run at low idle.
2. Rotate the manual override (2) in either direction to stroke the pump or motor in the corresponding direction.
3. If the pump or motor is operating properly, the corresponding side of the circuit will stall.

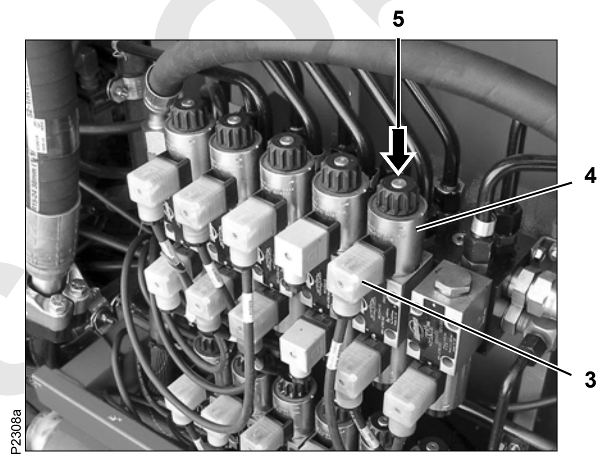
Solenoid Valve Override

See Figure 2-29 for the following procedure:

1. Start the engine and run at low idle.
2. Insert a rigid steel rod through the hole in end of the valve cap.
3. Depress the valve spool with the rod.
4. If the valve is operating properly, the corresponding side of the circuit should operate.



Typical Pump or Motor Installation



Typical Solenoid Valve Installation

Item	Description
1	Pump or Motor EDC
2	Manual Override
3	Electric Connector
4	Solenoid Valve
5	Manual Override (though end cap)

FIGURE 2-29

Pressure Sender Replacement

WARNING

High Pressure Oil Hazard!

Do not attempt to remove a pressure sender unless the following steps are performed. High pressure oil will bleed from the pressure sender ports.

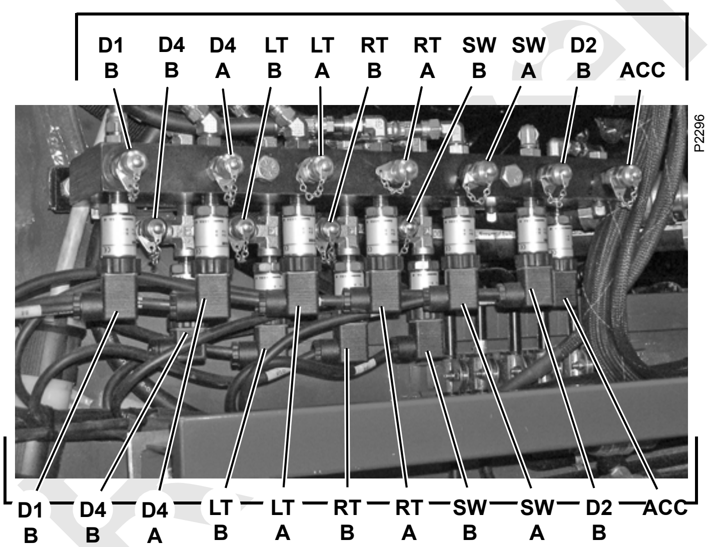
See Figure 2-30 for identification of pressure senders:

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 pressure senders to catch oil leakage.

Perform steps 5 to 9 only at faulty pressure senders.

5. Disconnect the electrical plug from the pressure senders.
6. Slowly loosen the pressure senders only enough to allow any remaining pressure to exhaust.
7. Remove the pressure senders.
8. Install the new pressure senders and connect electrical cords.

   Pressure senders have pipe threads. ***Be sure to install thread sealant.***
9. Bleed the pressure senders:
   a. Connect the bleed lines equipped with shut-off valves to the couplers on the pressure sender manifold. Open the shut-off valves. Use a suitable container to catch the oil flow.
   b. With all the control handles off, start and run the engine at low idle (850 to 950 RPM).
   c. Observe oil flowing from the bleed lines.
   d. Close the shut-off valves when clear oil flows from the bleed lines (no air bubbles in oil).
   e. Stop the engine.
   f. Remove the bleed lines from the couplers at the pressure senders.
10. Test the pressure senders (see the procedure in this section).



Pressure Senders
On Left Side of Rotating Bed

Item	Function	Direction	Pump - Port
D1 B	Drum 1	Hoist	Pump 4 - B
D2 B	Drum 2	Hoist	Pump 6 - B
D4 A	Drum 4 or Drum 5	Up	Pump 3 - A
D4 B		Down	Pump 3 - B
LT A	Left Crawler	Reverse	Pump 2 - A
LT B		Forward	Pump 2 - B
RT A	Right Crawler	Forward	Pump 1 - A
RT B		Reverse	Pump 1 - B
SW A	Swing	Right	Pump 5 - A
SW B		Left	Pump 5 - B
ACC	Accessory System	NA	NA

FIGURE 2-30

Disc Brake Operational Test

There is no physical way to check the disc brakes for travel, boom hoist, load drums, and swing. Therefore, an operational test of each brake must be performed weekly. Figure 2-12 shows the brake and brake solenoid valve locations.

NOTE: See Table 2-10 for system pressure specifications.

The electrical connectors must be disconnected at the brake solenoid valves to stall the crane functions during the test.

To test the disc brakes, use the following procedure:

1. Disconnect the electrical connector for the brake being checked.
2. Start the engine and run at low idle (850 to 950 RPM).
3. Select the corresponding Liftcrane Boom Capacity Chart on the RCL screen.
4. Turn off the park switch on the control console for the function being checked.
5. Access the diagnostic screen (Figure 2-24) for the function being checked – Drum, Boom Hoist, Swing, or Travel.

   Monitor the system pressure and the pump command while moving the control handle.
6. Slowly move the control handle for the function being checked. The specified system pressure must be reached before 50% pump command is reached and the ***brake must not slip***.
7. Repeat steps 3 through 6 for each function.

CAUTION

Overheating Hazard!

Do not hold any function on stall for more than 5 seconds. Damage from overheating can occur to system components.

WARNING

Falling Load/Moving Crane Hazard!

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

See the gear box manufacturer's manual for the disc brake repair instructions.

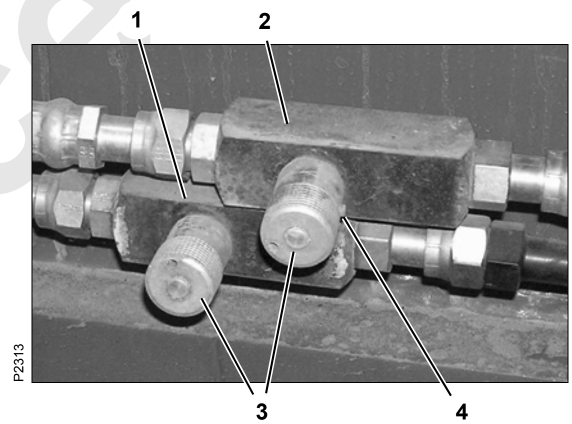
8. Reconnect the electrical connector to all the brake solenoid valves at the completion of the operational test.
9. If disc brakes were repaired or replaced, retest the brakes before operating with a load.

Cab Tilt Adjustment

To adjust the speed at which the cab tilts up and down, proceed as follows:

See Figure 2-31 for the following procedure:

1. Loosen the set screws.
2. Turn the knobs fully clockwise to close the valves.
3. Open both valves slightly.
4. Test the cab tilt operation with the switch on the control console in the cab.
5. Repeat steps until the cab tilt starts and stops smoothly in both directions.
6. Securely tighten the set screws.



Near Cab On Left Side of Rotating Bed

Item	Description
1	Tilt DOWN Flow Control Valve
2	Tilt UP Flow Control Valve
3	Adjusting Knob
4	Set Screw

FIGURE 2-31

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SECTION 3
ELECTRIC SYSTEM

TABLE OF CONTENTS

SECTION 3
ELECTRIC SYSTEM

ELECTRICAL DRAWINGS AND SCHEMATICS

Applicable electrical system drawings and schematics are attached at the end of this section.

INSPECT ELECTRICAL COMPONENTS

DANGER

Electrical Shock Hazard!

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

Every Month or 200 Hours

Complete the following inspections every month or 200 hours of use:

1. Visually inspect all the electrical harnesses and cables for the following conditions:
   - 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 or cables
   - Cracked, damaged, or badly corroded battery terminal connections
   - Damaged or excessively corroded terminals
   - 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 conditions:
   - Damaged or loose connectors
   - Damaged or missing electrical clamps or tie straps
   - Excessively corroded or dirty junction boxes
   - Loose junction box mounting hardware

   If any of these conditions exist, address them appropriately.

Degradation Due to Extreme Environment

See Table 3-1 for climate zone definition.

Zones A and B:

Replace harnesses and battery cables when operating in climate zone A and B after 8,000 hours of service life. In zones A and B, electrical service life is reduced by 25% to 40%.

Zone C:

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

Zones D and E:

Inspect electrical harnesses and cable assemblies when operating in climate zone E per step 1 of the monthly inspection. Cold temperatures reduce service life.

Salt Environment:

For harnesses and cable assemblies, operating in a salt water environment could reduce service life. Regularly inspect electrical harnesses and cable assemblies per step 1 of the monthly inspection.

Table 3-1 Climate Zone Classification

Zone	Description
A	Tropical Moist: All months average above 18° C (64° F). Latitude: 15° - 25° N & S
B	Dry or Arid: Deficient precipitation most of the year. Latitude: 20° - 35° N & S
C	Moist Mid-Latitude: Temperate with mild winters. Latitude: 30° - 50° N & S
D	Moist Mid-Latitude: Cold winters. Latitude 50° - 70° N & S
E	Polar: Extremely cold winters and summers. Latitude: 60° - 75° N & S

CIRCUIT BREAKER AND FUSE ID

Fuses are mounted in the fuse junction box located in the operator cab, under the right-hand console (Figure 3-1) or the Cranestar TCU Harness connection at the batteries.

Circuit breakers CB-1 to CB-8 are mounted in the engine node-0 controller box in the left side enclosure. There are no in-line fuses used on this crane model.

Circuit breakers A8CB1 to A8CB4 and fuses F1, F2, and F3 are mounted in the load center under the operator seat.

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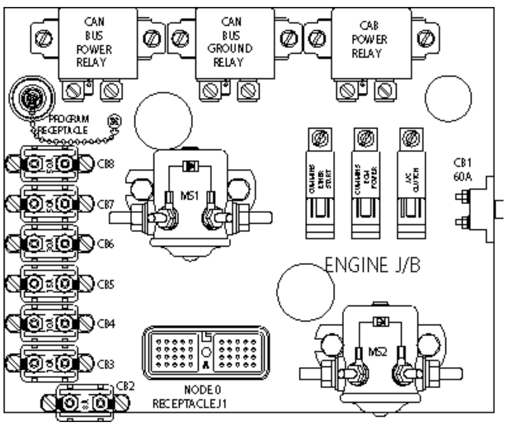
Engine Node (Node 0)



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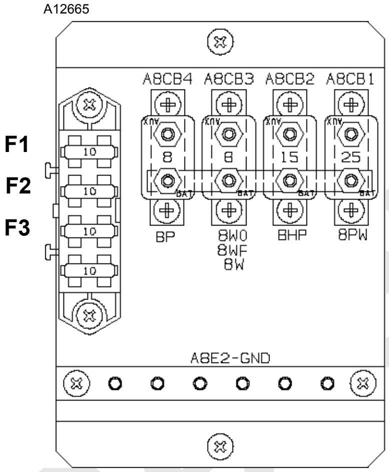


Circuit Breaker	Amps	Wire No.	Items Protected
Located on right side of battery assembly			
CB-0	150	6-3	Alternator Circuit
Located in node 0			
CB-1	120	6	Main System 24 Volt Power
CB-2	8	6C2	Electronic Control Module (Cummins)
CB-3	30	6C6	Electronic Control Module (Cummins)
CB-4	10	6C8	Engine Stop, Engine Stop-Run-Start
CB-5	15	6C11	Ether Start, Air Conditioner Clutch
CB-6	30	6C12	Starter Solenoids
CB-7	50	6C13	CAN Bus Power
CB-8	50	6C14	Cab Bus Power
Located in aftertreatment junction box			
CB10	15	6-8	DEF Supply Module Heater
CB11	10	6-7	DEF System Switch
CB12	15	6-6	DEF Hose Heaters
Located under operator seat			
A8CB1	8	8PW	24/12 Volt DC Converter
A8CB2	15	8HP	Air Conditioning/Heater Power
A8CB3	15	8W	Front and Overhead Wiper
A8CB4	25	8P	Radio and Panel Lights
F1	10	12VF1	Right Side Power Point
F2	10	12VF2	Left Side Power Point
F3	10	12VF3	Radio

FIGURE 3-1

Circuit Breaker	Amps	Items Protected
Cold Weather Package Circuit Breakers		
1	50	Cold Weather Package Main Circuit Breaker
2	20	Engine Coolant Heater, Engine Oil Heater
3	15	Hydraulic Reservoir, Cab Console and Battery Pad Heaters

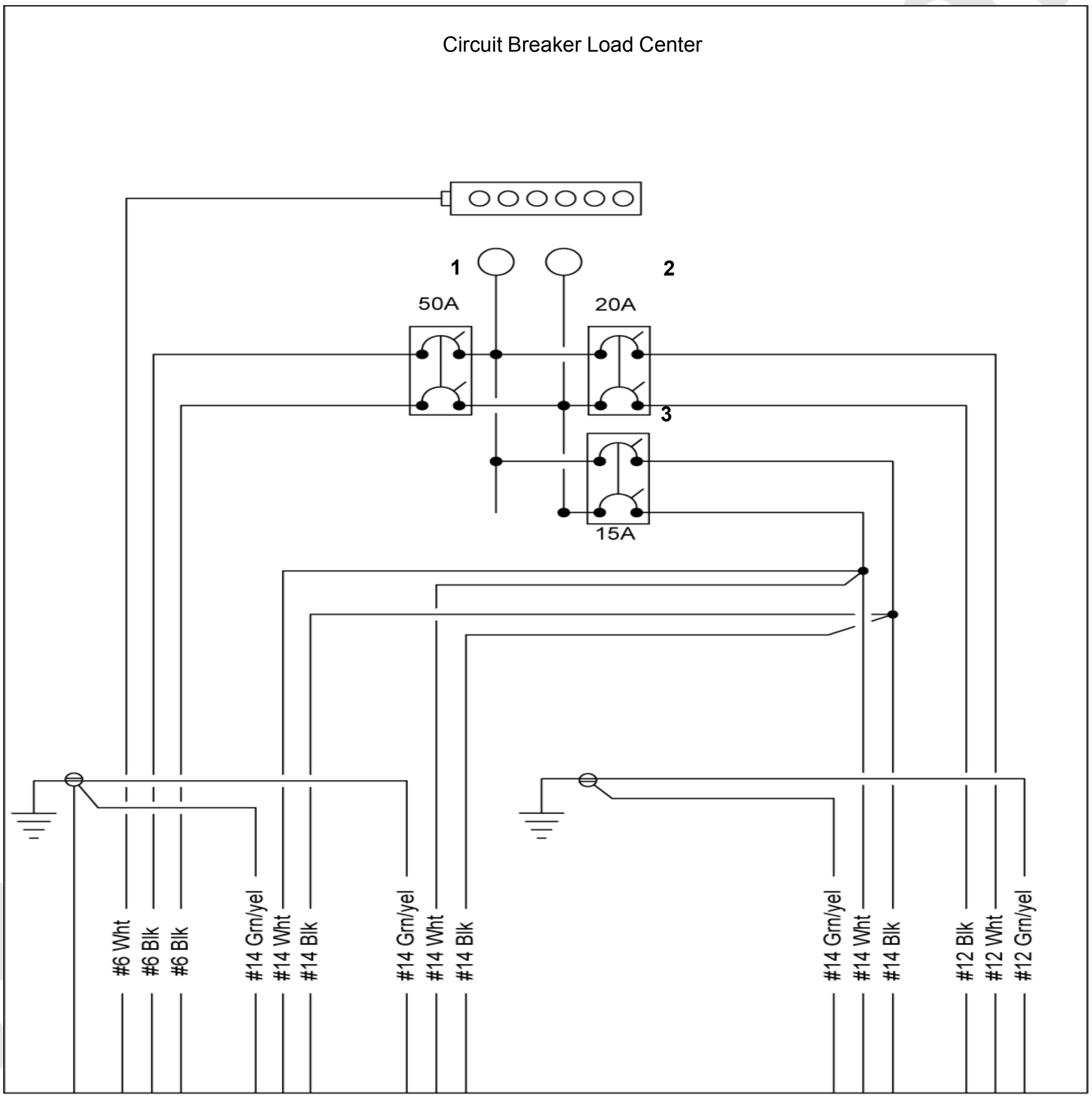
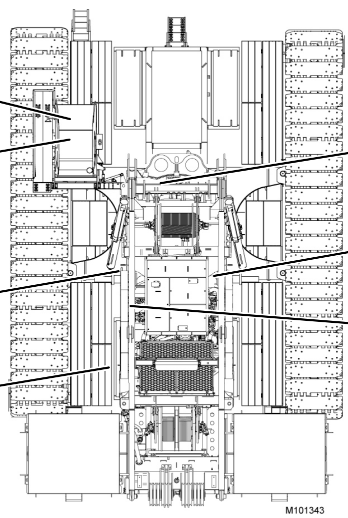


FIGURE 3-2

TEST VOLTAGES

The Model 16000 operating system uses the EPIC® system with CAN Bus® technology. The CAN Bus system uses multiple nodes containing controllers that communicate with the node 1 (master) controller by sending data packets over a two-wire bus line. The data packets are tagged with addresses that identify the system components of each node.

This section contains test voltages sorted by the nodes. The nodes are listed and identified in Figure 3-3.



Node	Description
1	Master (Front Console)
2	Handles and Cab Controls
3	Drum Pump, Alarms, Sensors, and Accessories
4	Pressure Senders, Drum 4, and Accessories
5	Drum 2, Sensors, and Auto Lubrication
6	Drum Brakes, Pawls, and Sensors
7	MAX-ER
0	Engine

FIGURE 3-3

Node Table Heading Descriptions

The CAN tables on the following pages provide information found on the crane's electrical schematics at the end of this section.

Interpret the connector codes using the following example for code 34-R:

- The number ***34*** is the **cable *number***:
  - The number ***3*** is the ***node number***.
  - The number ***4*** is the ***receptacle number*** where the item is located on the node.
- The last character ***R*** is the receptacle ***pin number***.

The Function Type indicates the type of connection, such as power, ground, signal, analog input (AI), digital input (DI), or digital output (DO).

The Receptacle/Pin No. (Engine Node-0 only) indicates the input-to-receptacle number and pin number code.

The Wire No. (Engine Node-0 only) indicates the wire-to-computer receptacle or wire number code.

The CAN Packet Number indicates the location of items for all nodes except node 0, which does not have CAN packet numbers. For example, interpret CAN Packet Number CAN129-3-4 (Drum 1 Park Switch) using the following:

- ***CAN129*** is the ***packet*** location number.
- Number ***3*** is the ***bank*** where information is stored.
- Number ***4*** is the ***identifier*** for that item.

Component–Node Cross-Reverence

Find the desired component item in this index. Check the component item node location, then refer to the indicated node to find the test voltage for that item.

Component	Location
Accessory System Components	Node 3 & 4
Alarms	Nodes 1, 3 & 5
Air Conditioning Clutch	Node 1
Auto Lube Pumps	Node 5
Block Up Limit (Boom)	Node 20
Block Up Limit (Luffing Jib)	Node 21
Boom Suspension Load Pin	Node 5
Cab Switches and Controls	Nodes 1 & 2
Cab Power	Node 0
Cab Tilt	Node 3
Control Handles	Nodes 1 & 2
Counterweight Pins	Node 4
Boom/Mast Hoist (Drum 4) Components	Nodes 3, 4, 5 & 6
Engine Control Module	Node 0
Engine Fuel Level Sensor	Node 5
Engine Cooler Fan/Acc Enable Solenoid	Node 5
Filters	Node 3
Hydraulic Fluid Level and Temperature	Node 5
Hydraulic Vacuum Switch	Node 3
Limits	Nodes 5 & 6
Load Hoist (Drum 1) Components	Nodes 3, 4 & 6
Load Hoist (Drum 2) Components	Nodes 3, 4 & 5
Load/Luffing (Drum 3) Components	Node 6
Mast	Node 4
MAX-ER	Node 7
Pressure Senders	Nodes 3, 4 & 5
Rigging Winch	Node 4
Rotating Bed Level Sensor	Node 5
Swing Components	Nodes 3 & 5
Throttle (Hand and Foot)	Node 2
Travel Components	Nodes 4 & 5
Wind Speed Indicator (Boom)	Node 20
Wind Speed Indicator (Jib)	Node 21

Abbreviations Used in Test Voltage Tables

The test voltage tables use the following abbreviations:

Acc	Accessory
AI	Analog Input
AO	Analog Output
CAN	Controller Area Network
CANH	Controller Area Network - High
CANL	Controller Area Network - Low
CTWT	Counterweight
DC	Direct Current
DI	Digital Input
DO	Digital Output
EC	Encoder Control
GND	Ground
ID	Identification
L.E.D.	Light Emitting Diode
LS	Left Side
Min.	Minimum
N/A	Not Applicable
NS	Node Select
PSI or psi	Pounds per Square Inch
RCL	Rated Capacity Indicator/Limiter
RS	Right Side
Sol	Solenoid
SW	Switch
V	Volt or Volts
VDC	Volts Direct Current
W	Wire

Table 3-2. Pump and Motor Control Test Voltages

All Hoist Pumps	Boom and Mast Hoist Motors	Load and Luffing Hoist Motors
0 to 25.4 Volts (at Node)	0 to 18.8 Volts (at Node)	0 to 16 Volts (at Node)
0 to 2.0 Volts (at Pump)	0 to 1.9 Volts (at Motor)	0 to 1.6 Volts (at Motor)
0 to 100 mA [1]	0 to 75 mA [1]	0 to 65 mA [1]

[1] Resistance increases as temperature rises on the pump or motor control coil resulting in decreased current values when measured with a meter. The listing in the table is the current range for a 21°C (70°F) coil.

Node 1 — Master (Front Console)

Reference Electrical Schematic A10871, Sheet 1, 4, 5, and 14.

Connector	Function Type	Description	Test Voltages	CAN Packet Number
P11	**Receptacle – Front Console (Unused Terminals are Omitted)**			
P11-1	24 Volts	Power from Node-3 to Node-1	24 Volts Nominal	N/A
P11-3	DI-12	Display Scroll Up Switch	0 Volts Off, 24 Volts On	CAN129-4-8
P11-4	DI-14	Display Scroll Down Switch	0 Volts Off, 24 Volts On	CAN129-4-32
P11-5	DI-31	Display Exit Switch	0 Volts Off, 24 Volts On	CAN129-6-64
P11-6	DI-9	Display Enter Switch	0 Volts Off, 24 Volts On	CAN129-4-1
P11-7	DO-1	System Operation Alarm	0 Volts Off, 24 Volts On	CAN129-1-1
P11-8	DO-3	RCL Warning L.E.D.	0 Volts Off, 24 Volts On	CAN129-1-4
P11-10	DO-6	RCL Caution L.E.D.	0 Volts Off, 24 Volts On	CAN129-1-32
P11-11	24 Volts	Power to Membrane (Display) Switches	24 Volts Nominal	N/A
P11-13	DI-11	Limit Bypass Switch	0 Volts Off, 24 Volts On	CAN129-4-4
P11-14	DI-13	Jib Up Limit Bypass Switch	0 Volts Off, 24 Volts On	CAN129-4-16
P11-15	DI-32	Load/Luffing (Drum 3) Park Switch	0 Volts Off, 24 Volts On	CAN129-6-128
P11-16	DI-10	Confirm Switch	0 Volts Off, 24 Volts On	CAN129-4-2
P11-19	DO-7	RCL Fault Alarm in Cab	0 Volts Off, 24 Volts On	CAN129-1-64
P11-21	Ground	Ground to Node-3 and Displays 1 & 2	Ground	N/A
P11-23	DI-28	Travel 2-Speed Switch	0 Volts Off, 24 Volts On	CAN129-6-8
P11-24	DI-30	Swing Park Switch – On	0 Volts Off, 24 Volts On	CAN129-6-32
P11-25	DI-15	Travel Cruise Switch - On	0 Volts Off, 24 Volts On	CAN129-4-64
P11-29	Ground	RCL Caution L.E.D.	Ground	N/A
P11-30	Ground	RCL Warning L.E.D.	Ground	N/A
P11-31	CANH	CAN High Data Line to Node-2	N/A	N/A
P11-32	CANL	CAN Low Data Line to Node-2	N/A	N/A
P11-33	DI-27	Display 1	0 Volts Off, 24 Volts On	CAN129-6-4
P11-34	DI-29	Display 2	0 Volts Off, 24 Volts On	CAN129-6-16

P12	Receptacle – Front Console (Unused Terminals are Omitted)			
P12-1	24 Volts	Power from Node-3 to Node-1	24 Volts Nominal	N/A
P12-13	DI-3	Load Hoist (Drum 1) Park Switch	0 Volts Off, 24 Volts On	CAN129-3-4
P12-14	DI-5	Load Hoist (Drum 2) Park Switch	0 Volts Off, 24 Volts On	CAN129-3-16
P12-15	DI-24	Boom/Mast Hoist (Drum 4) Park Switch	0 Volts Off, 24 Volts On	CAN129-5-128
P12-16	DI-1	Boom Hoist (Drum 5) Park Switch	0 Volts Off, 24 Volts On	CAN129-3-1
P12-17	DO-10	Drum Handle Display (H1)	24 Volts Nominal	CAN129-2-2
P12-18	DO-12	Drum Handle Display (H3)	24 Volts Nominal	CAN129-2-8
P12-19	DO-15	Drum Handle Display (H2)	24 Volts Nominal	CAN129-2-64
P12-20	DO-13	Drum Handle Display (H4)	24 Volts Nominal	CAN129-2-16
P12-21	Ground	Ground to Node-3 and Displays 1 & 2	Ground	N/A
P12-23	DI-20	Air Conditioning Compressor Clutch - On	0 Volts Off, 24 Volts On	CAN129-5-8
P12-24	DI-22	Engine Run/Start	0 Volts Off, 24 Volts On	CAN129-5-32
P12-25	DI-7	Travel Park Switch	0 Volts Off, 24 Volts On	CAN129-3-64
P12-26	DI-17	Seat Switch	0 Volts Off, 24 Volts On	CAN129-5-1
P12-31	CANH	CAN High Data Line to Bar Graph Display	N/A	N/A
P12-32	CANL	CAN Low Data Line to Bar Graph Display	N/A	N/A
P12-33	DI-19	Regen Disable (Inhibit)	0 Volts Off, 24 Volts On	CAN129-5-4
P12-34	DI-21	Regen Initiate (Manual)	0 Volts Off, 24 Volts On	CAN129-5-16
P12-35	DI-8	Cab Tilt Up Switch	0 Volts Off, 24 Volts On	CAN129-3-128
P12-36	DI-18	Cab Tilt Down Switch	0 Volts Off, 24 Volts On	CAN129-5-2

Node 2 — Handles and Cab Controls

Reference Electrical Schematic A10871, Sheet 1, 4, 5, 6, and 15.

Connector #	Function Type	Description	Test Voltage	CAN Packet Number
P51		**Receptacle – Controls (Unused Terminals are Omitted)**		
P51-1	CAN-H	CAN High Data Line to Set-Up Receiver	N/A	N/A
P51-2	CAN-L	CAN Low Data Line to Set-Up Receiver	N/A	N/A
P51-3	AI-2	Handle (H1) Output Signal	Raise 2.4 – 0.5 Volts, Lower 2.6 – 4.5 Volts	CAN0-4 [1]
P51-4	AI-5	Handle (H2) Output Signal	Raise 2.4 – 0.5 Volts, Lower 2.6 – 4.5 Volts	CAN1-2 [1]
P51-5	AI-10	Handle (H3) Output Signal	Lower 2.4 – 0.5 Volts, Raise 2.6 – 4.5 Volts	CAN2-4 [1]
P51-6	AI-14	Hand Throttle Input Signal	Low Idle 0.5 Volts, High Idle 4.5 Volts	CAN3-4 [1]
P51-7	DI-10	Handle (H1) Direction Signal	0 Volts Off, 24 Volts On	CAN43-2-2
P51-8	DI-11	Handle (H2) Direction Signal	0 Volts Off, 24 Volts On	CAN43-2-4
P51-9	DI-2	Handle (H3) Direction Signal	0 Volts Off, 24 Volts On	CAN43-1-2
P51-10	DI-3	Swing Holding Brake Switch	0 Volts Off, 24 Volts On	CAN43-1-4
P51-11	CAN-H	CAN High Data Line to Node 1	N/A	N/A
P51-12	CAN-L	CAN Low Data Line to Node 1	N/A	N/A
P51-13	AI-4	Left Travel Handle Output Signal	Forward 2.6 – 4.5 Volts, Reverse 2.4 – 0.5 Volts	CAN0-8 [1]
P51-14	AI-6	Right Travel Handle Output Signal	Forward 2.6 – 4.5 Volts, Reverse 2.4 – 0.5 Volts	CAN1-4 [1]
P51-15	AI-9	Handle (H4) Output Signal	Raise 2.4 – 0.5 Volts, Lower 2.6 – 4.5 Volts	CAN2-2 [1]
P51-16	AI-13	Swing Handle Output Signal	Left 2.4 – 0.5 Volts, Right 2.6 – 4.5 Volts	CAN3-2 [1]
P51-17	DI-9	Left Track Direction Signal	0 Volts Off, 24 Volts On	CAN43-2-1
P51-18	DI-12	Right Track Direction Signal	0 Volts Off, 24 Volts On	CAN43-2-8
P51-19	DI-1	Handle (H4) Direction Signal	0 Volts Off, 24 Volts On	CAN43-1-1
P51-20	DI-4	Swing Handle Direction Signal	0 Volts Off, 24 Volts On	CAN43-1-8
P51-21	Ground	Foot Throttle and Handles	Ground	N/A
P51-22	AI Ground	Handles and Node Select Ground	Ground	N/A
P51-23	AI-1	Foot Throttle Input Signal	Low Idle 2.9 – 3.0 Volts, High Idle 0.9 – 1.0 Volts	CAN0-2 [1]
P51-31	5 Volts DC	Handles, Throttle, and Pedal Power	5 Volts	N/A
P51-32	Node 1	Node Select 1 Jumper to Ground	0 Volts (With Jumper)	N/A
P51-37	DI-8	Boom Raise Cylinder Extend	0 Volts Off, 24 Volts On	CAN43-1-128
P51-38	DI-6	Boom Raise Cylinder Retract	0 Volts Off, 24 Volts On	CAN43-1-32
P52		**Receptacle – Controls (Unused Terminals are Omitted)**		
P52-1	DO-7	Handle (H1) Rotation Indicator	24 Volts Nominal	CAN24-1-64
P52-2	DO-3	Handle (H2) Rotation Indicator	24 Volts Nominal	CAN24-1-4
P52-3	DO-6	Handle (H3) Rotation Indicator	24 Volts Nominal	CAN24-1-32
P52-4	DO-2	Handle (H4) Rotation Indicator	24 Volts Nominal	CAN24-1-2

P52-5	DO-5	Overhead Wiper Switch	0 Volts Off, 24 Volts On	CAN24-1-16
P52-6	DO-13	Limit Bypass and Jib Up Limit Switches	24 Volts Nominal	CAN24-2-16
P52-7	DO-16	Park Switches	24 Volts Nominal	CAN24-2-128
P52-8	DO-9	Cab Switches	24 Volts Nominal	CAN24-2-1
P52-9	DO-19	Handle (H1) Raise Direction	0 Volts Off, 24 Volts On	CAN24-3-4
P52-10	DO-12	Handle (H1) Lower Direction	0 Volts Off, 24 Volts On	CAN24-2-8
P52-11	DO-4	Front Wiper Switch	0 Volts Off, 24 Volts On	CAN24-1-8
P52-13	DO-8	Handle (H1) Display	24 Volts Nominal	CAN24-1-128
P52-14	Ground	Handle (H1) Display	Ground	N/A
P52-15	DO-1	Cab Base RCL Beacon	0 Volts Off, 24 Volts On	CAN24-1-1
P52-16	DO-22	Handle (H2) Raise Direction	0 Volts Off, 24 Volts On	CAN24-3-32
P52-17	DO-24	Handle (H2) Lower Direction	0 Volts Off, 24 Volts On	CAN24-3-128
P52-18	DO-10	Handle (H3) Lower Direction	0 Volts Off, 24 Volts On	CAN24-2-2
P52-19	DO-18	Handle (H3) Raise Direction	0 Volts Off, 24 Volts On	CAN24-3-2
P52-20	Ground	Handle (H3) Display	Ground	N/A
P52-21	DO-8	Handle (H3) Display	24 Volts Nominal	CAN24-1-128
P52-22	DO-8	Handle (H2) Display	24 Volts Nominal	CAN24-1-128
P52-23	Ground	Handle (H1) Rotation Indicator	Ground	N/A
P52-24	Ground	Handle (H2) Rotation Indicator	Ground	N/A
P52-25	Ground	Handle (H3) Rotation Indicator	Ground	N/A
P52-26	DO-15	Left Travel Handle Reverse Direction	0 Volts Off, 24 Volts On	CAN24-2-64
P52-27	DO-14	Left Travel Handle Forward Direction	0 Volts Off, 24 Volts On	CAN24-2-32
P52-28	DO-11	Right Travel Handle Reverse Direction	0 Volts Off, 24 Volts On	CAN24-2-4
P52-29	DO-17	Right Travel Handle Forward Direction	0 Volts Off, 24 Volts On	CAN24-3-1
P52-30	Ground	Handle (H2) Display	Ground	N/A
P52-31	DO-8	Handle (H4) Display/Direction/Seat Switch	0 Volts Off, 24 Volts On	CAN24-1-128
P52-33	5 Volts DC	Handle (H1) Power	5 Volts DC Nominal	N/A
P52-34	5 Volts DC	Handle (H2) Power	5 Volts DC Nominal	N/A
P52-35	5 Volts DC	Handle (H3) Power	5 Volts DC Nominal	N/A
P52-37	DO-23	Foot Throttle Output	24 Volts Nominal	CAN24-3-64
P52-39	5 Volts DC	Left Travel Handle Power	5 Volts DC Nominal	N/A
P52-40	5 Volts DC	Right Travel Handle Power	5 Volts DC Nominal	N/A
P53	**Receptacle – Controls (Unused Terminals are Omitted)**			
P53-A	Ground	To Setup Receiver	Ground	N/A
P53-B	Ground	Boom Handle Rotation Indicator	Ground	N/A
P53-E	24 Volts	To Setup Receiver	24 Volts Nominal	N/A
P53-F	24 Volts	Bar Graph Display	24 Volts Nominal	N/A

[1] Lower four bits can be multiplied by 5 or 10 depending on the sender, then divided by 16 for an estimation of the sender voltage.
Number in the indicated bank should increment in positive direction and decrement in negative direction with item rotation.

Node 3 — Drum Pumps, Alarms, Sensors, and Accessories

Reference Electrical Schematic A10871, Sheet 1, 7, and 16.

Connector #	Function Type	Description	Test Voltage	CAN Packet Number
W33	**Receptacle — Pressure Senders and Accessories**			
W33-A	Ground	Cab Tilt/Rotate Solenoid - Up	Ground	N/A
W33-B	DO-1	Cab Tilt/Rotate Solenoid - Up	0 Volts Off, 24 Volts On	CAN25-1-1
W33-C	Ground	Cab Tilt/Rotate Solenoid - Down	Ground	N/A
W33-D	DO-2	Cab Tilt/Rotate Solenoid - Down	0 Volts Off, 24 Volts On	CAN25-1-2
W33-E	Ground	Rear Rotating Bed Pin Solenoid - Extend	Ground	N/A
W33-F	DO-3	Rear Rotating Bed Pin Solenoid - Extend	0 Volts Off, 24 Volts On	CAN25-1-4
W33-G	Ground	Rear Rotating Bed Pin Solenoid - Retract	Ground	N/A
W33-H	DO-4	Rear Rotating Bed Pin Solenoid - Retract	0 Volts Off, 24 Volts On	CAN25-1-8
W33-J	Ground	Boom Hinge Pin Solenoid - Extend	Ground	N/A
W33-L	NS-2	Node Select Jumper to Ground	0 Volts (with Jumper)	N/A
W33-N	Ground	Boom Hinge Pin Solenoid - Retract	Ground	N/A
W33-P	DO-6	Boom Hinge Pin Solenoid - Retract	0 Volts Off, 24 Volts On	CAN25-1-32
W33-R	DO-5	Boom Hinge Pin Solenoid - Extend	0 Volts Off, 24 Volts On	CAN25-1-16
W33-T	DI-3	Super Charge Pressure Switch	0 Volts Off, 24 Volts On	CAN45-1-4
W33-U	24 Volts	Super Charge Pressure Switch	24 Volts Nominal	N/A
W33-g	Ground	Swing Left Pressure Sender	Ground	N/A
W33-h	Ground	Jumper to Node Select	Ground	N/A
W33-m	Ground	Swing Right Pressure Sender	Ground	N/A
W33-n	24 Volts	Swing Left Pressure Sender	24 Volts Nominal	N/A
W33-p	AI-7	Swing Left Pressure Sender	1 V at 0 psi, 5 V at 7,000 psi	CAN5-6 [1]
W33-r	AI-8	Swing Right Pressure Sender	1 V at 0 psi, 5 V at 7,000 psi	CAN5-8 [1]
W33-s	24 Volts	Swing Right Pressure Sender	24 Volts Nominal	N/A
W34	**Receptacle - Drum Pumps and Alarm**			
W34-A	Ground	Left Side Swing/Travel Alarm	Ground	N/A
W34-B	DO-11	Left Side Swing/Travel Alarm	0 Volts Off, 24 Volts On	CAN25-2-4
W34-C	Ground	Accessory Proportional Relief Solenoid	Ground	N/A
W34-D	DO-12	Accessory Proportional Relief Solenoid	0 Volts Off, Variable Volts On	CAN25-2-8
W34-E	Ground	Pump 4 Control (Drum 1/Drum 2)	Ground	N/A
W34-F	DO-13	Pump 4 Control (Drum 1/Drum 2)	See Table 3-2, page 3-6	CAN25-2-16
W34-G	Ground	Pump 4 Control (Drum 1/Drum 2)	Ground	N/A
W34-H	DO-14	Pump 4 Control (Drum 1/Drum 2)	See Table 3-2, page 3-6	CAN25-2-32
W34-J	Ground	Pump 3 Control (Drum 4/Drum 5)	Ground	N/A
W34-K	Ground	Pump 6 Control (Drum 2/Drum 1)	Ground	N/A
W34-L	Ground	Pump 6 Control (Drum 2/Drum 1)	Ground	N/A
W34-M	DO-17	Pump 6 Control (Drum 2/Drum 1)	See Table 3-2, page 3-6	CAN25-3-1
W34-N	Ground	Pump 3 Control (Drum 4/Drum 5)	Ground	N/A
W34-P	DO-16	Pump 3 Control (Drum 4/Drum 5)	See Table 3-2, page 3-6	CAN25-2-128
W34-R	DO-15	Pump 3 Control (Drum 4/Drum 5)	See Table 3-2, page 3-6	CAN25-2-64

W34-S	DO-18	Pump 6 Control (Drum 2/Drum 1)	See Table 3-2, page 3-6	CAN25-3-2
W34-T	Ground	Pump 2 Control (Left Travel/Drum 3)	Ground	N/A
W34-U	DO-19	Pump 2 Control (Left Travel/Drum 3)	See Table 3-2, page 3-6	CAN25-3-4
W34-V	Ground	Pump 2 Control (Left Travel/Drum 3)	Ground	N/A
W34-W	DO-20	Pump 2 Control (Left Travel/Drum 3)	See Table 3-2, page 3-6	CAN25-3-8
W34-X	Ground	Pump 1 Control (Right Travel/Drum 4)	Ground	N/A
W34-Z	DO-21	Pump 1 Control (Right Travel/Drum 4)	See Table 3-2, page 3-6	CAN25-3-16
W34-a	Ground	Pump 1 Control (Right Travel/Drum 4)	Ground	N/A
W34-b	DO-22	Pump 1 Control (Right Travel/Drum 4)	See Table 3-2, page 3-6	CAN25-3-32
W34-c	Ground	Pump 5 Control (Swing)	Ground	N/A
W34-d	DO-23	Pump 5 Control (Swing)	See Table 3-2, page 3-6	CAN25-3-64
W34-e	Ground	Pump 5 Control (Swing)	Ground	N/A
W34-f	DO-24	Pump 5 Control (Swing)	See Table 3-2, page 3-6	CAN25-3-128
W34-g	Ground	Jumper to Node Select 2	Ground	N/A
W34-j	NS-2	Node Select Jumper to Ground	0 Volts (with Jumper)	N/A
W36	**Receptacle — Angle Sensors, Alarm and Drum Pawl**			
W36-A	Ground	Left Side RCL Capacity Alarm	Ground	N/A
W36-B	DO-7	Left Side RCL Capacity Alarm	0 Volts Off, 24 Volts On	CAN25-1-64
W36-C	Ground	Drum 2 Left Side Motor Control (Optional)	Ground	N/A
W36-D	DO-8	Drum 2 Left Side Motor Control (Optional)	See Table 3-2, page 3-6	CAN25-1-128
W36-E	Ground	Boom/Mast Hoist (Drum 4) Pawl Sol. - Out	Ground	N/A
W36-F	DO-9	Boom/Mast Hoist (Drum 4) Pawl Sol. - Out	0 Volts Off, 24 Volts On	CAN25-2-1
W36-G	Ground	Boom/Mast Hoist (Drum 4) Pawl Solenoid - In	Ground	N/A
W36-H	DO-10	Boom/Mast Hoist (Drum 4) Pawl Solenoid - In	0 Volts Off, 24 Volts On	CAN25-2-2
W36-J	DI-8	Hydraulic Return Filter Alarm Switch (Bottom)	0 Volts Off, 24 Volts On	CAN45-1-128
W36-L	NS-2	Node Select 2 Jumper to Ground	0 Volts (With Jumper)	N/A
W36-P	DI-7	Hydraulic Charge Filter Alarm Switch	0 Volts Off, 24 Volts On	CAN45 -1-64
W36-R	24 Volts	Hydraulic Charge Filter Alarm Switch	24 Volts Nominal	N/A
W36-U	Ground	Jumper to Node Select 2	Ground	N/A
W36-V	5 Volts	Mast Angle Sensor	5 Volts	N/A
W36-W	Ground	Mast Angle Sensor	Ground	N/A
W36-X	24 Volts	Hydraulic Return Filter Alarm Switch (Bottom)	24 Volts Nominal	N/A
W36-Z	Ground	MAX-ER Mast Strap Load Pin	Ground	N/A
W36-d	AI-12	Mast Angle Sensor	5 volts DC Mast at Vertical	CAN6-8 [1]
W36-j	Ground	MAX-ER Mast Strap Load Pin	Ground	N/A
W36-k	AI-16	MAX-ER Mast Strap Load Pin	24 Volts Nominal	CAN7-8 [1]
W36-m	24 Volts	MAX-ER Mast Strap Load Pin	24 Volts Nominal	N/A

[1] Lower four bits can be multiplied by 5 or 10 depending on the sender, then divided by 16 for an estimation of the sender voltage.
Number in the indicated bank should increment in positive direction and decrement in negative direction with item rotation.

Node 4 — Pressure Senders, Drum 4, and Accessories

Reference Electrical Schematic A10871, Sheet 1, 8, and 16.

Connector #	Function Type	Description	Test Voltage	CAN Packet Number
Input/output cable routing to remote nodes vary - see Electrical Schematic specific to your crane.				
W43	**Receptacle - Pressure Senders**			
W43-A	Ground	Counterweight Pins Disengage Solenoid	Ground	N/A
W43-B	DO-1	Counterweight Pins Disengage Solenoid	0 Volts Off, 24 Volts On	CAN27-1-1
W43-C	Ground	Drum 1 to Drum 2 Diversion Solenoid	Ground	N/A
W43-D	DO-2	Drum 1 to Drum 2 Diversion Solenoid	0 Volts Off, 24 Volts On	CAN27-1-2
W43-E	Ground	Drum 2 to Drum 1 Diversion Solenoid	Ground	N/A
W43-F	DO-3	Drum 2 to Drum 1 Diversion Solenoid	0 Volts Off, 24 Volts On	CAN27-1-4
W43-G	Ground	Drum 4 to Drum 5 Diversion Solenoid	Ground	N/A
W43-H	DO-4	Drum 4 to Drum 5 Diversion Solenoid	0 Volts Off, 24 Volts On	CAN27-1-8
W43-J	Ground	Left Travel to Drum 3 Diversion Solenoid	Ground	N/A
W43-M	NS-3	Node Select Jumper to Ground Solenoid	0 Volts (with Jumper)	N/A
W43-N	Ground	Right Travel to Drum 4 Diversion Solenoid	Ground	N/A
W43-P	DO-6	Right Travel to Drum 4 Diversion Solenoid	0 Volts Off, 24 Volts On	CAN27-1-32
W43-R	DO-5	Left Travel to Drum 3 Diversion Solenoid	0 Volts Off, 24 Volts On	CAN27-1-16
W43-U	24 Volts	Load Hoist (Drum 1) Pressure Sender	24 Volts Nominal	N/A
W43-V	24 Volts	Load Hoist (Drum 2) Pressure Sender	24 Volts Nominal	N/A
W43-b	AI-2	Load Hoist (Drum 1) Pressure Sender	1 V at 0 psi, 5 V at 7,000 psi	CAN12-4 [1]
W43-d	AI-4	Load Hoist (Drum 2) Pressure Sender	1 V at 0 psi, 5 V at 7,000 psi	CAN12-8 [1]
W43-g	Ground	Load Hoist (Drum 1) Pressure Sender	Ground	N/A
W43-h	Ground	Right Travel Reverse Pressure Sender/ Jumper to Node Select 3	Ground	N/A
W43-k	Ground	Load Hoist (Drum 2) Pressure Sender	Ground	N/A
W43-m	Ground	Drum 4 or Drum 5 Pressure Sender	Ground	N/A
W43-n	24 Volts	Right Travel Reverse Pressure Sender	24 Volts Nominal	N/A
W43-p	AI-7	Right Travel Reverse Pressure Sender	1 V at 0 psi, 5 V at 7,000 psi	CAN13-6 [1]
W43-r	AI-8	Drum 4 or Drum 5 Pressure Sender	1 V at 0 psi, 5 V at 7,000 psi	CAN13-8 [1]
W43-s	24 Volts	Drum 4 or Drum 5 Pressure Sender	24 Volts Nominal	N/A
W44	**Receptacle – Accessories**			
W44-A	Ground	Left Front Jack Solenoid - Extend	Ground	N/A
W44-B	DO-11	Left Front Jack Solenoid - Extend	0 Volts Off, 24 Volts On	CAN27-2-4
W44-C	Ground	Left Front Jack Solenoid - Retract	Ground	N/A
W44-D	DO-12	Left Front Jack Solenoid - Retract	0 Volts Off, 24 Volts On	CAN27-2-8
W44-E	Ground	Right Front Jack Solenoid - Extend	Ground	N/A
W44-F	DO-13	Right Front Jack Solenoid - Extend	0 Volts Off, 24 Volts On	CAN27-2-16
W44-G	Ground	Right Front Jack Solenoid - Retract	Ground	N/A
W44-H	DO-14	Right Front Jack Solenoid - Retract	0 Volts Off, 24 Volts On	CAN27-2-32
W44-J	Ground	Left Rear Jack Solenoid - Extend	Ground	N/A
W44-K	Ground	Right Rear Jack Solenoid - Retract	Ground	N/A
W44-L	Ground	Right Rear Jack Solenoid - Extend	Ground	N/A
W44-M	DO-17	Right Rear Jack Solenoid - Extend	0 Volts Off, 24 Volts On	CAN27-3-1
W44-N	Ground	Left Rear Jack Solenoid - Retract	Ground	N/A

W44-P	DO-16	Left Rear Jack Solenoid - Retract	0 Volts Off, 24 Volts On	CAN27-2-128
W44-R	DO-15	Left Rear Jack Solenoid - Extend	0 Volts Off, 24 Volts On	CAN27-2-64
W44-S	DO-18	Right Rear Jack Solenoid - Retract	0 Volts Off, 24 Volts On	CAN27-3-2
W44-T	Ground	Rigging Winch Solenoid - Spool In	Ground	N/A
W44-U	DO-19	Rigging Winch Solenoid - Spool In	0 Volts Off, 24 Volts On	CAN27-3-4
W44-V	Ground	Rigging Winch Solenoid - Spool Out	Ground	N/A
W44-W	DO-20	Rigging Winch Solenoid - Spool Out	0 Volts Off, 24 Volts On	CAN27-3-8
W44-X	Ground	Mast Rasing Cylinders Solenoid - Extend	Ground	N/A
W44-Z	DO-21	Mast Rasing Cylinders Solenoid - Extend	0 Volts Off, 24 Volts On	CAN27-3-16
W44-a	Ground	Mast Rasing Cylinders Solenoid - Retract	Ground	N/A
W44-b	DO-22	Mast Rasing Cylinders Solenoid - Retract	0 Volts Off, 24 Volts On	CAN27-3-32
W44-c	Ground	Front Rotating Bed Pin Solenoid - Retract	Ground	N/A
W44-d	DO-23	Front Rotating Bed Pin Solenoid - Retract	0 Volts Off, 24 Volts On	CAN27-3-64
W44-e	Ground	Front Rotating Bed Pin Solenoid - Extend	Ground	N/A
W44-f	DO-24	Front Rotating Bed Pin Solenoid - Extend	0 Volts Off, 24 Volts On	CAN27-3-128
W44-g	Ground	Jumper to Node Select 4	Ground	N/A
W44-k	NS-3	Node Select 3 Jumper to Ground	0 Volts (With Jumper)	N/A
W46	**Receptacle – Drum 4 and Pressure Sensors**			
W46-A	Ground	Boom/Mast Hoist (Drum 4) Brake Solenoid	Ground	N/A
W46-B	DO-7	Boom/Mast Hoist (Drum 4) Brake Solenoid	0 Volts Off, 24 Volts On	CAN27-1-64
W46-C	Ground	Boom/Mast Hoist (Drum 4) Left Side Motor	Ground	N/A
W46-D	DO-8	Boom/Mast Hoist (Drum 4) Left Side Motor	See Table 3-2, page 3-6	CAN27-1-128
W46-E	Ground	Pump 7 Control (Accessory Pump)	Ground	N/A
W46-F	DO-9	Pump 7 Control (Accessory Pump)	See Table 3-2, page 3-6	CAN27-2-1
W46-M	NS-3	Node Select 3 Jumper to Ground	0 Volts (with Jumper)	N/A
W46-R	24 Volts	Boom/Mast Hoist (Drum 4) Speed Sensor	24 Volts Nominal	N/A
W46-S	24 Volts	Left Travel Reverse Pressure Sender	24 Volts Nominal	N/A
W46-T	24 Volts	Right Travel Forward Pressure Sender	24 Volts Nominal	N/A
W46-U	Ground	Left Travel Reverse Pressure Sender/ Jumper to Node Select 3	Ground	N/A
W46-W	Ground	Right Travel Forward Pressure Sender	Ground	N/A
W46-Z	Ground	Left Travel Forward Pressure Sender	Ground	N/A
W46-a	AI-9	Left Travel Reverse Pressure Sender	1 V at 0 psi, 5 V at 7,000 psi	CAN14-2 [1]
W46-b	AI-10	Right Travel Forward Pressure Sender	1 V at 0 psi, 5 V at 7,000 psi	CAN14-4 [1]
W46-f	AI-14	Left Travel Forward Pressure Sender	1 V at 0 psi, 5 V at 7,000 psi	CAN15-4 [1]
W46-g	24 Volts	Accessory Pressure Sender	24 Volts Nominal	N/A
W46-h	AI-15	Accessory Pressure Sender	1 V at 0 psi, 5 V at 7,000 psi	CAN15-6 [1]
W46-j	Ground	Boom/Mast Hoist (Drum 4) Speed Sensor/ Accessory System Pressure Sender	Ground	N/A
W46-m	24 Volts	Left Travel Forward Pressure Sender/	24 Volts Nominal	N/A
W46-r	EC-2A	Boom/Mast Hoist (Drum 4) Speed Sensor	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN48-4 [2]
W46-s	EC-2B	Boom/Mast Hoist (Drum 4) Speed Sensor	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN48-4 [2]

[1] Lower four bits can be multiplied by 5 or 10 depending on the sender, then divided by 16 for an estimation of the sender voltage.
Number in the indicated bank should increment in positive direction and decrement in negative direction with item rotation.

3

Node 5 — Drum 2, Sensors, and Auto Lubrication

Reference Electrical Schematic A10871, Sheet 1, 9, and 16.

Connector #	Function Type	Description	Test Voltages	CAN Packet Number
Input/output cable routing to remote nodes vary - see wiring diagram specific to your crane.				
W53	**Receptacle – Sensors**			
W53-A	Ground	Boom/Mast Hoist (Drum 4) RS Motor Control	Ground	N/A
W53-B	DO-1	Boom/Mast Hoist (Drum 4) RS Motor Control	See Table 3-2, page 3-6	CAN29-1-1
W53-C	Ground	Engine Cooler Fan/Acc Enable Solenoid	Ground	N/A
W53-D	DO-2	Engine Cooler Fan/Acc Enable Solenoid	0 Volts Off, 24 Volts On	CAN29-1-2
W53-E	Ground	Hanging CTWT Lift Cylinder - Extend	Ground	N/A
W53-F	DO-3	Hanging CTWT Lift Cylinder - Extend	0 Volts Off, 24 Volts On	CAN29-1-4
W53-G	Ground	Right Side RCL Capacity Alarm	Ground	N/A
W53-H	DO-4	Right Side RCL Capacity Alarm	0 Volts Off, 24 Volts On	CAN29-1-8
W53-J	Ground	Hanging CTWT Lift Cylinder - Retract	Ground	N/A
W53-N	Ground	Maximum Boom Angle Limit Switch	Ground	N/A
W53-P	DO-6	Hanging CTWT Lift Cylinder - Remote Power	0 Volts Off, 24 Volts On	CAN29-1-32
W53-R	DO-5	Hanging CTWT Lift Cylinder - Retract	0 Volts Off, 24 Volts On	CAN29-1-16
W53-S	NS-4	Node Select 4 Jumper to Ground	0 Volts (with Jumper)	N/A
W53-T	DI-3	Hanging CTWT Lift Cylinder - Remote Stop	0 Volts Off, 24 Volts On	CAN53 -1-4
W53-U	24 Volts	Lower Accessory Pressure Enable	24 Volts Nominal	N/A
W53-V	24 Volts	Hanging CTWT Lift Cylinder - Retract PSI	24 Volts Nominal	N/A
W53-W	DI-4	Maximum Boom Angle Limit Switch	0 Volts Off, 24 Volts On	CAN53 -1-8
W53-X	24 Volts	Maximum Boom Angle Limit Switch	24 Volts Nominal	N/A
W53-a	AI-1	Hanging CTWT Lift Cylinder - Remote Extend	Variable 0 to 5 Volts	CAN20-2 [1]
W53-b	AI-2	Lower Accessory Pressure Enable	Variable 0 to 5 Volts	CAN20-4 [1]
W53-c	AI-3	Hanging CTWT Lift Cylinder Position Sensor	Variable 0 to 5 Volts	CAN20-6 [1]
W53-d	AI-4	Hanging CTWT Lift Cylinder - Retract PSI	Variable 0 to 5 Volts	CAN20-8 [1]
W53-e	AI-5	Hanging CTWT Lift Cylinder - Extend PSI	Variable 0 to 5 Volts	CAN21-2 [1]
W53-f	AI-6	Hanging CTWT Lift Cylinder - Remote Retract	Variable 0 to 5 Volts	CAN21-4 [1]
W53-g	Ground	Lower Accessory Pressure Enable Jumper to Node Select 4	Ground	N/A
W53-h	Ground	H-Counterweight Lift Cylinder Position Sensor	Ground	N/A
W53-k	Ground	H-Counterweight Lift Cylinder - Extend PSI	Ground	N/A
W53-m	Ground	Rotating Bed Level Sensor	Ground	N/A
W53-n	24 Volts	H-Counterweight Lift Cylinder Position Sensor	24 Volts Nominal	N/A
W53-p	AI-7	Rotating Bed Level Sensor (Pitch)	Variable 0 to 10 Volts	CAN21-6 [1]
W53-r	AI-8	Rotating Bed Level Sensor (Roll)	Variable 0 to 10 Volts	CAN21-8 [1]
W53-s	24 Volts	Rotating Bed Level Sensor	24 Volts Nominal	N/A
W54	**Receptacle – Travel/Swing Brakes and Auto Lubrication**			
W54-K=	Ground	Travel Brake Release Solenoid	Ground	N/A
W54-S=	DO-18	Travel Brake Release Solenoid	0 Volts Off, 24 Volts On	CAN29-3-2
W54-T=	Ground	Travel 2-Speed Solenoid	Ground	N/A

W54-U	DO-19	Travel 2-Speed Solenoid	0 Volts Off, 24 Volts On	CAN29-3-4
W54-V	Ground	Travel Brake Release Solenoid	Ground	N/A
W54-W	DO-20	Swing Brake Release Solenoid	0 Volts Off, 24 Volts On	CAN29-3-8
W54-c	Ground	Swing Bearing Auto Lubrication	Ground	N/A
W54-d	DO-23	Swing Bearing Auto Lubrication	0 Volts Off, 24 Volts On	CAN29-3-64
W54-e	Ground	Crawler Track Rollers Auto Lubrication	Ground	N/A
W54-f	DO-24	Crawler Track Rollers Auto Lubrication	0 Volts Off, 24 Volts On	CAN29-3-128
W54-g	Ground	Jumper to Node Select 4	Ground	N/A
W54-m	NS-4	Node Select 4 Jumper to Ground	0 Volts (with Jumper)	N/A
W54-n	24 Volts	Swing Motor Speed Sensor	24 Volts Nominal	N/A
W54-p	EC1A	Swing Motor Speed Sensor	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN53-6 [2]
W54-r	Ground	Swing Motor Speed Sensor	Ground	N/A
W54-s	EC1B	Swing Motor Speed Sensor	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN53-6 [2]
W56	**Receptacle – Drum 2, Alarm and Sensors**			
W56-A	Ground	Load Hoist (Drum 2) Right Side Motor Control	Ground	N/A
W56-B	DO-7	Load Hoist (Drum 2) Right Side Motor Control	See Table 3-2, page 3-6	CAN29-1-64
W56-C	Ground	Load Hoist (Drum 2) Brake Solenoid	Ground	N/A
W56-D	DO-8	Load Hoist (Drum 2) Brake Solenoid	0 Volts Off, 24 Volts On	CAN29-1-128
W56-E	Ground	Right Side Swing/Travel Alarm	Ground	N/A
W56-F	DO-9	Right Side Swing/Travel Alarm	0 Volts Off, 24 Volts On	CAN29-2-1
W56-G	Ground	Drum 2 Minimum Bail	Ground	N/A
W56-H	DO-10	Drum 2 Minimum Bail	0 Volts Off, 24 Volts On	CAN29-2-2
W56-J	DI-8	Drum 2 Minimum Bail	0 Volts Off, 24 Volts On	CAN55-1-128
W56-N	NS-4	Node Select 4 Jumper to Ground	0 Volts (with Jumper)	N/A
W56-S	24 Volts	Hydraulic Fluid Temperature Sensor	24 Volts Nominal	N/A
W56-T	24 Volts	Engine Fuel Level Sensor	24 Volts Nominal	N/A
W56-U	Ground	Hydraulic Fluid Temperature Sensor/ Jumper to Node Select 4	0 Volts (with Jumper)	N/A
W56-W	Ground	Engine Fuel Level Sensor	Ground	N/A
W56-X	24 Volts	Hydraulic Fluid Level Sensor	24 Volts Nominal	N/A
W56-Z	Ground	Hydraulic Fluid Level Sensor	Ground	N/A
W56-a	AI-9	Hydraulic Fluid Temperature Sensor	0 Volts Off, 24 Volts On	CAN22-2 [1]
W56-b	AI-10	Engine Fuel Level Sensor	1.8 Volts Full, 4.1 Volts Empty	CAN22-4 [1]
W56-d	AI-11	Swing Brake Pressure Sensor	1 V at 0 psi, 5 V at 7,000 psi	N/A
W56-f	AI-14	Hydraulic Fluid Level Sensor	1.8 Volts Full, 4.1 Volts Empty	CAN23-4 [1]
W56-g	24 Volts	Load Hoist (Drum 2) Motor Speed Sensor	24 Volts Nominal	N/A
W56-j	Ground	Load Hoist (Drum 2) Motor Speed Sensor	Ground	N/A
W56-m	24 Volts	Swing Brake Pressure Sensor	24 Volts Nominal	N/A
W56-n	EC1A	Load Hoist (Drum 2) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN52-2 [2]

W56-p	EC1B	Load Hoist (Drum 2) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN52-2 [2]

[1] Lower four bits can be multiplied by 5 or 10 depending on the sender, then divided by 16 for an estimation of the sender voltage.
Number in the indicated bank should increment in positive direction and decrement in negative direction with item rotation.

Node 6 — Drum Brakes, Pawls, and Motor Sensors

Reference Electrical Schematic A10871, Sheet 1, 10, and 16.

Connector #	Function Type	Description	Test Voltages	CAN Packet Number
Input/output cable routing to remote nodes vary - see Electrical Schematic specific to your crane.				
W63	**Receptacle – Drum 3**			
W63-A	Ground	Load/Luffing (Drum 3) Brake Solenoid	Ground	N/A
W63-B	DO-1	Load/Luffing (Drum 3) Brake Solenoid	0 Volts Off, 24 Volts On	CAN26-1-1
W63-C	Ground	Load/Luffing (Drum 3) Right Motor Control	Ground	N/A
W63-D	DO-2	Load/Luffing (Drum 3) Right Motor Control	See Table 3-2, page 3-6	CAN26-1-2
W63-G	Ground	Load/Luffing (Drum 3) Pawl Solenoid - In	Ground	N/A
W63-H	DO-4	Load/Luffing (Drum 3) Pawl Solenoid - In	0 Volts Off, 24 Volts On	CAN26-1-8
W63-J	Ground	Load/Luffing (Drum 3) Pawl Solenoid - Out	Ground	N/A
W63-K	NS-1	Node Select 1 Jumper to Ground	0 Volts (with Jumper)	N/A
W63-L	NS-2	Node Select 2 Jumper to Ground	0 Volts (with Jumper)	N/A
W63-N	Ground	Load/Luffing (Drum 3) Minimum Bail Limit	Ground	N/A
W63-P	DO-6	Load/Luffing (Drum 3) Minimum Bail Limit	0 Volts Off, 24 Volts On	CAN26-1-32
W63-R	DO-5	Load/Luffing (Drum 3) Pawl Solenoid - Out	0 Volts Off, 24 Volts On	CAN26-1-16
W63-W	DI-4	Load/Luffing (Drum 3) Minimum Bail Limit	0 Volts Off, 24 Volts On	CAN47-1-8
W63-g	Ground	Jumper to Node Select 2	Ground	N/A
W64	**Receptacle – Drum 5**			
W64-A	Ground	Boom Hoist (Drum 5) Brake Solenoid	Ground	N/A
W64-B	DO-11	Boom Hoist (Drum 5) Brake Solenoid	0 Volts Off, 24 Volts On	CAN26-2-4
W64-C	Ground	Boom Hoist (Drum 5) Left Motor Control	Ground	N/A
W64-D	DO-12	Boom Hoist (Drum 5) Left Motor Control	See Table 3-2, page 3-6	CAN26-2-8
W64-E	Ground	Boom Hoist (Drum 5) Right Motor Control	Ground	N/A
W64-F	DO-13	Boom Hoist (Drum 5) Right Motor Control	See Table 3-2, page 3-6	CAN26-2-16
W64-G	Ground	Boom Hoist (Drum 5) Pawl Solenoid - In	Ground	N/A
W64-H	DO-14	Boom Hoist (Drum 5) Pawl Solenoid - In	0 Volts Off, 24 Volts On	CAN26-2-32
W64-J	Ground	Boom Hoist (Drum 5) Pawl Solenoid - Out	Ground	N/A
W64-R	DO-15	Boom Hoist (Drum 5) Pawl Solenoid - Out	0 Volts Off, 24 Volts On	CAN26-2-64
W64-g	Ground	Jumper to Node Select 1	Ground	N/A
W64-h	NS-1	Node Select 1 Jumper to Ground	0 Volts (with Jumper)	N/A
W64-j	NS-2	Node Select 2 Jumper to Ground	0 Volts (with Jumper)	N/A
W64-n	24 Volts	Load/Luffing (Drum 5) Motor Speed Sensor	24 Volts Nominal	N/A
W64-p	EC3A	Load/Luffing (Drum 5) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN47-6 [2]
W64-r	Ground	Load/Luffing (Drum 3) Motor Speed Sensor/ Jumper to Node Select 2	Ground	N/A
W64-s	EC3B	Load/Luffing (Drum 3) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN47-6 [2]
W66	**Receptacle – Drum 2 Controls**			
W66-A	Ground	Load Hoist (Drum 1) Brake Solenoid	Ground	N/A
W66-B	DO-7	Load Hoist (Drum 1) Brake Solenoid	0 Volts Off, 24 Volts On	CAN26-1-64

Connector #	Function Type	Description	Test Voltages	CAN Packet Number
W66-C	Ground	Load Hoist (Drum 1) Left Side Motor Control	Ground	N/A
W66-D	DO-8	Load Hoist (Drum 1) Left Side Motor Control	See Table 3-2, page 3-6	CAN26-1-128
W66-E	Ground	Load Hoist (Drum 1) Right Side Motor Control	Ground	N/A
W66-F	DO-9	Load Hoist (Drum 1) Right Side Motor Control	See Table 3-2, page 3-6	CAN26-2-1
W66-G	Ground	Load Hoist (Drum 1) Min. Bail Limit Switch	Ground	N/A
W66-H	DO-10	Load Hoist (Drum 1) Min. Bail Limit Switch	0 Volts Off, 24 Volts On	CAN26-2-2
W66-J	DI-8	Load Hoist (Drum 1) Min. Bail Limit Switch	0 Volts Off, 24 Volts On	CAN47-1-128
W66-K	NS-1	Node Select 1 Jumper to Ground	0 Volts (with Jumper)	N/A
W66-L	NS-2	Node Select 2 Jumper to Ground	0 Volts (with Jumper)	N/A
W66-U	Ground	Jumper to Node Select	Ground	N/A
W66-W	Ground	MAX-ER Strut Position Sensor	Ground	N/A
W66-X	24 Volts	MAX-ER Strut Position Sensor	24 Volts Nominal	N/A
W66-Z	Ground	Load/Luffing (Drum 3) Motor Speed Sensor	Ground	N/A
W66-e	AI-13	MAX-ER Strut Position Sensor	0 Volts Off, 24 Volts On	CAN11-2 [1]
W66-g	24 Volts	Load Hoist (Drum 1) Motor Speed Sensor	24 Volts Nominal	N/A
W66-j	Ground	Load Hoist (Drum 1) Motor Speed Sensor	Ground	N/A
W66-m	24 Volts	Load/Luffing (Drum 3) Motor Speed Sensor	24 Volts Nominal	N/A
W66-n	EC1A	Load Hoist (Drum 1) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN46-2 [2]
W66-p	EC1B	Load Hoist (Drum 1) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN46-2 [2]
W66-r	EC2A	Load/Luffing (Drum 3) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving, .2 Volts Moving	CAN46-2 [2]
W66-s	EC2B	Load/Luffing (Drum 3) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN46-2 [2]

[1] Lower four bits can be multiplied by 5 or 10 depending on the sender, then divided by 16 for an estimation of the sender voltage.
Number in the indicated bank should increment in positive direction and decrement in negative direction with item rotation.

Node 7 — MAX-ER

Reference Electrical Schematic A15592, Sheet 1, 2, 3 and 4.

Connector #	Function Type	Description	Test Voltage	CAN Packet Number
Input/output cable routing to remote nodes vary - see Electrical Schematic specific to your crane.				
W73	**Receptacle - Counterweight Lift Cylinder and Sensors**			
W73-A	Ground	Counterweight Lift Cylinder Extend Sensor	Ground	N/A
W73-B	DO-1	Counterweight Lift Cylinder Extend	0 Volts Off, 24 Volts On	CAN28-1-1
W73-C	Ground	Counterweight Lift Cylinder Extend	Ground	N/A
W73-D	DO-2	Counterweight Lift Cylinder Retract	0 Volts Off, 24 Volts On	CAN28-1-2
W73-E	Ground	Counterweight Lift Cylinder Retract Sensor	Ground	N/A
W73-G	Ground	Counterweight Lift Cylinder Retract	Ground	N/A
W73-K	NS-1	Node Select 1 Jumper to Ground	Ground	N/A
W73-M	NS-3	Node Select 3 Jumper to Ground	0 Volts (with Jumper)	N/A
W73-N	Ground	Counterweight Lift Cylinder Position Sensor	Ground	N/A
W73-U	24 Volts	Counterweight Lift Cylinder Retract Sensor	24 Volts Nominal	N/A
W73-V	24 Volts	Counterweight Lift Cylinder Extend Sensor	24 Volts Nominal	N/A
W73-X	24 Volts	Counterweight Lift Cylinder Position Sensor	24 Volts Nominal	N/A
W73-a	AI-1	Counterweight Lift Cylinder Retract Sensor	1 V at 0 psi, 5 V at 7,000 psi	CAN16-2 [1]
W73-b	AI-2	Top Telescopic Beam Position Sensor		CAN16-4 [1]
W73-c	AI-3	Counterweight Lift Cylinder Extend Sensor	1 V at 0 psi, 5 V at 7,000 psi	CAN16-6 [1]
W73-d	AI-4	Counterweight Lift Cylinder Position Sensor		CAN16-8 [1]
W73-e	AI-5	Bottom Telescopic Beam Position Sensor		CAN17-2 [1]
W73-g	Ground	Top Telescopic Beam Position Sensor	Ground	N/A
W73-h	Ground	Top Telescopic Beam Position Sensor	Ground	N/A
W73-k	Ground	Bottom Telescopic Beam Position Sensor	Ground	N/A
W73-m	Ground	Bottom Telescopic Beam Position Sensor	Ground	N/A
W73-n	24 Volts	Top Telescopic Beam Position Sensor	24 Volts Nominal	N/A
W73-s	24 Volts	Bottom Telescopic Beam Position Sensor	24 Volts Nominal	N/A
W74	**Receptacle – Jacking Cylinders, Steering**			
W74-A	Ground	Left Front Jacking Cylinder Extend	Ground	N/A
W74-B	DO-11	Left Front Jacking Cylinder Extend	0 Volts Off, 24 Volts On	CAN28-2-4
W74-C	Ground	Left Front Jacking Cylinder Retract	Ground	N/A
W74-D	DO-12	Left Front Jacking Cylinder Retract	0 Volts Off, 24 Volts On	CAN28-2-8
W74-E	Ground	Left Rear Jacking Cylinder Extend	Ground	N/A
W74-F	DO-13	Left Rear Jacking Cylinder Extend	0 Volts Off, 24 Volts On	CAN28-2-16
W74-G	Ground	Left Rear Jacking Cylinder Retract	Ground	N/A
W74-H	DO-14	Left Rear Jacking Cylinder Retract	0 Volts Off, 24 Volts On	CAN28-2-32
W74-J	Ground	Right Front Jacking Cylinder Extend	Ground	N/A
W74-K	Ground	Right Rear Jacking Cylinder Retract	Ground	N/A
W74-L	Ground	Right Rear Jacking Cylinder Extend	Ground	N/A
W74-M	DO-17	Right Rear Jacking Cylinder Extend	0 Volts Off, 24 Volts On	CAN28-3-1

W74-N	Ground	Right Front Jacking Cylinder Retract	Ground	N/A
W74-P	DO-16	Right Front Jacking Cylinder Retract	0 Volts Off, 24 Volts On	CAN28-2-128
W74-R	DO-15	Right Front Jacking Cylinder Extend	0 Volts Off, 24 Volts On	CAN28-2-64
W74-S	DO-18	Right Rear Jacking Cylinder Retract	0 Volts Off, 24 Volts On	CAN28-3-2
W74-T	Ground	Left Wheel Steering Clockwise	Ground	N/A
W74-U	DO-19	Left Wheel Steering Clockwise	0 Volts Off, 24 Volts On	CAN28-3-4
W74-V	Ground	Left Wheel Steering Counter-Clockwise	Ground	N/A
W74-W	DO-20	Left Wheel Steering Counter-Clockwise	0 Volts Off, 24 Volts On	CAN28-3-8
W74-X	Ground	Right Wheel Steering Clockwise	Ground	N/A
W74-Z	DO-21	Right Wheel Steering Clockwise	0 Volts Off, 24 Volts On	CAN28-3-16
W74-a	Ground	Right Wheel Steering Counter-Clockwise	Ground	N/A
W74-b	DO-22	Right Wheel Steering Counter-Clockwise	0 Volts Off, 24 Volts On	CAN28-3-32
W74-c	Ground	Left Wheel Brakes	Ground	N/A
W74-d	DO-23	Left Wheel Brakes	0 Volts Off, 24 Volts On	CAN28-3-64
W74-e	Ground	Right Wheel Brakes	Ground	N/A
W74-f	DO-24	Right Wheel Brakes	0 Volts Off, 24 Volts On	CAN28-3-128
W74-g	Ground	Jumper to Node Select 1 and 3	Ground	N/A
W74-h	NS-1	Node Select 1 Jumper to Ground	0 Volts (with Jumper)	N/A
W74-k	NS-3	Node Select 3 Jumper to Ground	0 Volts (with Jumper)	N/A
W76	**Receptacle – Telescopic Beam, Steering Encoder, and Jacking Limits**			
W76-A	Ground	Jumper to Node Select 1 and 3	Ground	N/A
W76-B	DO-7	Telescopic Beam Cylinder Extend	0 Volts Off, 24 Volts On	CAN28-1-64
W76-C	Ground	Telescopic Beam Cylinder Extend and Retract	Ground	N/A
W76-D	DO-8	Telescopic Beam Cylinder Retract	See Table 3-2, page 3-6	CAN28-1-128
W76-E	Ground	MAX-ER Tray Level Sensor	Ground	N/A
W76-F	DO-9	Telescopic Beam Hinge Pin In	0 Volts Off, 24 Volts On	CAN28-2-1
W76-G	Ground	Telescopic Beam Hinge Pin In and Out	Ground	N/A
W76-H	DO-10	Telescopic Beam Hinge Pin Out	0 Volts Off, 24 Volts On	CAN28-2-2
W76-J	DI-8	Left Rear Jacking Cylinder Limit	0 Volts Off, 24 Volts On	CAN51-1-128
W76-K	NS-1	Node Select 1 Jumper to Ground	0 Volts (with Jumper)	N/A
W76-M	NS-3	Node Select 3 Jumper to Ground	0 Volts (with Jumper)	N/A
W76-P	DI-7	Left Front Jacking Cylinder Limit	0 Volts Off, 24 Volts On	CAN51-1-64
W76-R	24 Volts	Left Front and Rear Jacking Cylinder Limit	24 Volts Nominal	N/A
W76-S	24 Volts	MAX-ER Tray Level Sensor	24 Volts Nominal	N/A
W76-T	24 Volts	Right Front and Rear Jacking Cylinder Limit	24 Volts Nominal	N/A
W76-U	Ground	Right Front and Rear Jacking Cylinder Limit	Ground	N/A
W76-W	Ground	Left Front and Rear Jacking Cylinder Limit	Ground	N/A
W76-a	AI-9	MAX-ER Tray Level Sensor	0 to 10 VDC Roll	CAN18-2 [1]
W76-b	AI-10	MAX-ER Tray Level Sensor	0 to 10 VDC Pitch	CAN18-4 [1]
W76-c	AI-11	Right Front Jacking Cylinder Limit	0 Volts Off, 24 Volts On	CAN18-6 [1]
W76-d	AI-12	Right Front and Rear Jacking Cylinder Limit	0 Volts Off, 24 Volts On	CAN18-8 [1]
W76-g	24 Volts	Left Wheel Steering Encoder	24 Volts Nominal	N/A
W76-j	Ground	Left and Right Wheel Steering Encoder	Ground	N/A

W76-m	24 Volts	Right Wheel Steering Encoder	24 Volts Nominal	N/A
W76-n	EC-1A	Left Wheel Steering Encoder	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN50-2 [2]
W76-p	EC-1B	Left Wheel Steering Encoder	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN50-2 [2]
W76-r	EC-2A	Right Wheel Steering Encoder	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN50-2 [3]
W76-s	EC-2B	Right Wheel Steering Encoder	1.2 or 3.2 Volts Not Moving, 2.2 Volts Moving	CAN50-2 [3]

[1] Lower four bits can be multiplied by 5 or 10 depending on the sender, then divided by 16 for an estimation of the sender voltage.
Number in the indicated bank should increment in positive direction and decrement in negative direction with item rotation.

Boom Node 20 — Block-Up, Load Sensor, Angle Indicator, and Wind Speed

Reference Electrical Schematic A10871, Sheet 1, 11, and 20.

Connector #	Function Type	Description	Test Voltage	CAN Packet Number
J1	**Receptacle – CAN In (From RCL Receiver)**			N/A
J201-A	24 Volts	CAN Bus System	24 Volts Nominal	N/A
J201-B	BNSO	Node Select	Node Select Jumper to GND	N/A
J201-C	CANH	CAN High Wire Transmission	N/A	N/A
J201-D	Ground	CAN Bus System	Ground	N/A
J201-E	Ground	Node Select Ground to AI-NS	Ground	N/A
J201-F	CANL	CAN Low Wire Transmission	N/A	N/A
J2	**Receptacle – Upper Block Up**			N/A
J202-A	24 Volts	Block Up Limit Boom Upper Point	24 Volts Nominal	N/A
J202-B	DI-2	Block Up Limit Boom Upper Point	0 Volts Off, 24 Volts On	CAN112-6-128 [1]
J3	**Receptacle – Lower Block Up**			N/A
J203-A	24 Volts	Block Up Limit Boom Lower Point	24 Volts Nominal	N/A
J203-B	DI-1	Block Up Limit Boom Lower Point	0 Volts Off, 24 Volts On	CAN112-6-64 [1]
J4	**Receptacle – CAN Out**			N/A
J204-A	24 Volts	CAN Bus System	24 Volts Nominal	N/A
J204-C	CANH	CAN High Wire Transmission	N/A	N/A
J204-D	Ground	CAN Bus System	Ground	N/A
J204-E	DI-ID	To Jib Butt Cable Reel	0 Volts Off, 24 Volts On	N/A
J204-F	CANL	CAN Low Wire Transmission	N/A	N/A
J8	**Receptacle – Wind Speed**			N/A
J208-A	AI-3	Wind Speed Sensor	0.05 to 16 Volts DC	N/A
J208-B	Ground	Wind Speed Sensor	Ground	N/A
J9	**Receptacle – Maximum Jib Angle Limit**			N/A
J209-A	24 Volts	Maximum Jib Angle Limit	24 Volts Nominal	N/A
J209-B	DI-6	Maximum Jib Angle Limit	0 Volts Off, 24 Volts On	CAN112-6-32
J11	**Receptacle – Minimum Jib Angle Limit**			N/A
J2011-A	24 Volts	Minimum Jib Angle Limit	24 Volts Nominal	N/A
J2011-B	DI-4	Minimum Jib Angle Limit	0 Volts Off, 24 Volts On	CAN112-6-8
	Boom Angle Indicator			N/A
Wire 1	Ground	Boom Angle Indicator	Ground	N/A
Wire 2	Signal	Boom Angle Indicator	Variable 0 to 5 Volts	N/A
Wire 3	5 Volts	Boom Angle Indicator	5 Volts Nominal	N/A

[1] Packet number depends on specific attachment used.

Jib Node 21 — Block-Up, Load Pin, And Wind Speed

Reference Electrical Schematic A10871, Sheet 1, 11 and 21.

Connector #	Function Type	Description	Test Voltage	CAN Packet Number
J1	**Receptacle – CAN In (From Jib Butt)**			N/A
J211-A	24 Volts	CAN Bus System	24 Volts Nominal	N/A
J211-B	AI-NS	Node Select AI-NS	Node Select Jumper to GND	N/A
J211-C	CANH	CAN High Wire Transmission	N/A	N/A
J211-D	Ground	CAN Bus System	Ground	N/A
J211-E	Ground	Node Select Ground to AI-NS	Ground	N/A
J211-F	CANL	CAN Low Wire Transmission	N/A	N/A
J2	**Receptacle – Upper Block Up**			N/A
J212-A	24 Volts	Block Up Limit Luffing/Fixed Jib Upper Pt.	24 Volts Nominal	N/A
J212-B	DI-2	Block Up Limit Luffing/Fixed Jib Upper Pt.	0 Volts Off, 24 Volts On	CAN86-6-64 [1]
J3	**Receptacle – Lower Block Up**			N/A
J213-A	24 Volts	Block Up Limit Luffing Jib Lower Point	24 Volts Nominal	N/A
J213-B	DI-1	Block Up Limit Luffing Jib Lower Point	0 Volts Off, 24 Volts On	CAN86-6-128 [1]
J4	**Receptacle – CAN Out**			N/A
J214-A	24 Volts	CAN Bus System	24 Volts Nominal	N/A
J214-C	CANH	CAN High Wire Transmission	N/A	N/A
J214-D	Ground	CAN Bus System	Ground	N/A
J214-E	DI-ID	Last Node Terminating Plug	24 Volts Nominal	N/A
J214-F	CANL	CAN Low Wire Transmission	N/A	N/A
J8	**Wind Speed Indicator**			N/A
J218-A	AI-3	Wind Speed Sensor	0 to 8 Volts DC	N/A
J218-B	Ground	Wind Speed Sensor	Ground	N/A
	Jib Angle Indicator			N/A
Wire 1	Ground	Jib Angle Indicator	Ground	N/A
Wire 2	Signal	Jib Angle Indicator	Variable 0 to 5 Volts	N/A
Wire 3	5 Volts	Jib Angle Indicator	5 Volts Nominal	N/A

[1] Packet number depends on specific attachment used.

Node 0 — Engine

Reference Electrical Schematic A10871, Sheet 1 and 12.

Connector #	Wire No.	Function Type	Description	Test Voltage
P1	**Connector – 40 Pin**			N/A
P1-1	3	24 Volts	Ignition Signal	24 Volts Nominal
P1-2	0102	Ground	CAN Bus System	Ground
P1-3	0103	24 Volts	Ether Relay Coil - High	24 Volts Nominal
P1-7	0107	24 Volts	Air Conditioning Clutch Relay Coil - High	24 Volts Nominal
P1-10	0110	24 Volts	MS1/MS2 Relay Coil - High	24 Volts Nominal
P1-11	0	Ground	Battery	Ground
P1-12	0112	Ground	CAN Bus Relay Coil - Low	Ground
P1-17	0117	Ground	Air Conditioning Clutch Relay Coil - Low	Ground
P1-19	0119	Ground	Ether Relay Coil - Low	Ground
P1-20	0120	Ground	MS1/MS2 Relay Coil - Low	Ground
P1-21	OC	Ground	CAN Bus Ground	Ground
P1-22	0122	Ground	CAN Bus Power Relay Coil - Low	Ground
P1-29	RS232GND	Ground	Program	Ground
P1-30	RS232PE	Signal	Program Enable	N/A
P1-31	8C	24 Volts	CAN Bus Power Relay	24 Volts Nominal
P1-32	0132	24 Volts	CAN Bus Power Relay Coil - High	24 Volts Nominal
P1-33	3	24 Volts	Ignition Signal	24 Volts Nominal
P1-36	J1939H	Signal	SAE J1939 Communication – High	N/A
P1-37	J1939L	Signal	SAE J1939 Communication – Low	N/A
P1-39	RS232TX	Signal	Program Transmit	N/A
P1-40	RS232RX	Signal	Program Receive	N/A

Digital Output Disable Chart

Table 3-3 Digital Output Disable

CAN Packet Number	Item Description (Node Number)
CAN36-1-1	Cab Base RCL Beacon (N2)
CAN36-1-2	Handle (H4) Rotation Indicator (N2)
CAN36-1-4	Handle (H2) Rotation Indicator (N2)
CAN36-1-8	Front Wiper Switch (N2)
CAN36-1-16	Overhead Wiper Switch (N2)
CAN36-1-32	Handle (H3) Rotation Indicator (N2)
CAN36-1-64	Handle (H1) Rotation Indicator (N2)
CAN36-1-128	Handle Displays, Seat Switch (N2)
CAN36-2-1	Travel 2-Speed, Travel Cruise Switch (N2)
CAN36-2-16	Limit Bypass and Jib Up Limit Switches (N2)
CAN36-2-128	Drum Park Switches (N2)
CAN36-3-64	Foot Throttle Output (N2)
CAN37-1-1	Cab Tilt Up Solenoid (N3)
CAN37-1-2	Cab Tilt Down Solenoid (N3)
CAN37-1-4	Rear Rotating Bed Pins - Extend (N3)
CAN37-1-8	Rear Rotating Bed Pins - Retract (N3)
CAN37-1-16	Boom Hinge Pin – Extend (N3)
CAN37-1-32	Boom Hinge Pin – Retract (N3)
CAN37-1-64	Left Side RCL Capacity Alarm (N3)
CAN37-1-128	Load Hoist (Drum 2) LS Motor Control (N3)
CAN37-2-1	Boom/Mast Hoist (Drum 4) Pawl – Out (N3)
CAN37-2-2	Boom/Mast Hoist (Drum 4) Pawl – In (N3)
CAN37-2-4	Left Side Swing/Travel Alarm Solenoid (N3)
CAN37-2-8	Accessory Proportional Relief Solenoid (N3)
CAN37-2-16	Pump 4 Control – Drum 1/Drum 2 (N3)
CAN37-2-32	Pump 4 Control – Drum 1/Drum 2 (N3)
CAN37-2-64	Pump 3 Control – Drum 4/Drum 5 (N3)
CAN37-2-128	Pump 3 Control – Drum 4/Drum 5 (N3)
CAN37-3-1	Pump 6 Control – Drum 2/Drum 1 (N3)
CAN37-3-2	Pump 6 Control – Drum 2/Drum 1 (N3)
CAN37-3-4	Pump 2 Control – Left Travel/Drum 3 (N3)
CAN37-3-8	Pump 2 Control – Left Travel/Drum 3 (N3)
CAN37-3-16	Pump 1 Control – Right Travel/Drum 4 (N3)
CAN37-3-32	Pump 1 Control – Right Travel/Drum 4 (N3)
CAN37-3-64	Pump 5 Control – Swing (N3)
CAN37-3-128	Pump 5 Control – Swing (N3)
CAN38-1-1	Load/Luffing (Drum 3) Brake Sol. (N6)
CAN38-1-2	Load/Luffing (Drum 3) RS Motor Cont. (N6)
CAN38-1-8	Load/Luffing (Drum 3) Pawl In (N6)
CAN38-1-16	Load/Luffing (Drum 3) Pawl Out (N6)
CAN38-1-64	Load Hoist (Drum 1) Brake Solenoid (N6)
CAN38-1-128	Load Hoist (Drum 1) LS Motor Control (N6)
CAN38-2-1	Load Hoist (Drum 1) RS Motor Control (N6)
CAN38-2-2	Load Hoist (Drum 1) Min. Bail Limit Sw. (N6)
CAN38-2-4	Boom Hoist (Drum 5) Brake Solenoid (N6)
CAN38-2-8	Boom Hoist (Drum 5) LS Motor Control (N6)
CAN38-2-16	Boom Hoist (Drum 5) RS Motor Control (N6)
CAN38-2-32	Boom Hoist (Drum 5) Pawl – In (N6)
CAN38-2-64	Boom Hoist (Drum 5) Pawl – Out (N6)
CAN39-1-1	Counterweight Pins Disengage (N4)
CAN39-1-2	Drum 1 to Drum 2 Diversion Solenoid (N4)
CAN39-1-4	Drum 2 to Drum 1 Diversion Solenoid (N4)
CAN39-1-8	Drum 4 to Drum 5 Diversion Solenoid (N4)
CAN39-1-16	Left Travel to Drum 3 Diversion Sol. (N4)
CAN39-1-32	Right Travel to Drum 4 Diversion Sol. (N4)
CAN39-1-64	Boom/Mast Hoist (Drum 4) Brake (N4)
CAN39-1-128	Boom/Mast Hoist (Drum 4) Motor Cont. (N4)
CAN39-2-4	Left Front Jack Solenoid - Extend (N4)
CAN39-2-8	Left Front Jack Solenoid - Retract (N4)
CAN39-2-16	Right Front Jack Solenoid - Extend (N4)
CAN39-2-32	Right Front Jack Solenoid - Retract (N4)
CAN39-2-64	Left Rear Jack Solenoid - Extend (N4)
CAN39-2-128	Left Rear Jack Solenoid - Retract (N4)
CAN39-3-1	Right Rear Jack Solenoid - Extend (N4)
CAN39-3-2	Right Rear Jack Solenoid - Retract (N4)
CAN39-3-4	Rigging Winch - Spool In (N4)
CAN39-3-8	Rigging Winch - Spool Out (N4)
CAN39-3-16	Mast Rasing Cylinders – Extend (N4)
CAN39-3-32	Mast Rasing Cylinders – Retract (N4)
CAN39-3-64	Front Rotating Bed Pins - Retract (N4)
CAN39-3-128	Front Rotating Bed Pins - Extend (N4)
CAN41-1-1	Boom/Mast Hoist (Drum 4) Motor Cont. (N5)
CAN41-1-2	Engine Cooler Fan/Acc Enable Solenoid (N5)
CAN41-1-8	Right Side RCL Capacity Alarm (N5)
CAN41-1-64	Load Hoist (Drum 2) RS Motor Control (N5)
CAN41-1-128	Load Hoist (Drum 2) Brake Solenoid (N5)
CAN41-2-1	Right Side Swing/Travel Alarm (N5)
CAN41-3-2	Travel Brake Release Solenoid (N5)
CAN41-3-4	Travel Two Speed Solenoid (N5)
CAN41-3-8	Swing Brake Release Solenoid (N5)
CAN41-3-64	Swing Bearing Grease Motor (N5)
CAN41-3-128	Crawler Track Grease Motor (N5)

3

Digital Output Reference Chart

Table 3-4 Digital Outputs

CAN Packet Number	Item Description (Node Number)
CAN24-1-1	Cab Base RCL Beacon (N2)
CAN24-1-2	Handle (H4) Rotation Indicator (N2)
CAN24-1-4	Handle (H2) Rotation Indicator (N2)
CAN24-1-8	Front Wiper Switch (N2)
CAN24-1-16	Overhead Wiper Switch (N2)
CAN24-1-32	Handle (H3) Rotation Indicator (N2)
CAN24-1-64	Handle (H1) Rotation Indicator (N2)
CAN24-1-128	Handle Displays, Seat Switch (N2)
CAN24-2-1	Travel 2-Speed, Travel Cruise Switch (N2)
CAN24-2-16	Limit Bypass and Jib Up Limit Switches (N2)
CAN24-2-128	Drum Park Switches (N2)
CAN24-3-64	Foot Throttle Output (N2)
CAN25-1-1	Cab Tilt Up Solenoid (N3)
CAN25-1-2	Cab Tilt Down Solenoid (N3)
CAN25-1-4	Rear Rotating Bed Pins - Extend (N3)
CAN25-1-8	Rear Rotating Bed Pins - Retract (N3)
CAN25-1-16	Boom Hinge Pin – Extend (N3)
CAN25-1-32	Boom Hinge Pin – Retract (N3)
CAN25-1-64	Left Side RCL Capacity Alarm (N3)
CAN25-1-128	Load Hoist (Drum 2) LS Motor Control (N3)
CAN25-2-1	Boom/Mast Hoist (Drum 4) Pawl – Out (N3)
CAN25-2-2	Boom/Mast Hoist (Drum 4) Pawl – In (N3)
CAN25-2-4	Left Side Swing/Travel Alarm Solenoid (N3)
CAN25-2-8	Accessory Proportional Relief Solenoid (N3)
CAN25-2-16	Pump 4 Control – Drum 1/Drum 2 (N3)
CAN25-2-32	Pump 4 Control – Drum 1/Drum 2 (N3)
CAN25-2-64	Pump 3 Control – Drum 4/Drum 5 (N3)
CAN25-2-128	Pump 3 Control – Drum 4/Drum 5 (N3)
CAN25-3-1	Pump 6 Control – Drum 2/Drum 1 (N3)
CAN25-3-2	Pump 6 Control – Drum 2/Drum 1 (N3)
CAN25-3-4	Pump 2 Control – Left Travel/Drum 3 (N3)
CAN25-3-8	Pump 2 Control – Left Travel/Drum 3 (N3)
CAN25-3-16	Pump 1 Control – Right Travel/Drum 4 (N3)
CAN25-3-32	Pump 1 Control – Right Travel/Drum 4 (N3)
CAN25-3-64	Pump 5 Control – Swing (N3)
CAN25-3-128	Pump 5 Control – Swing (N3)
CAN26-1-1	Load/Luffing (Drum 3) Brake Sol. (N6)
CAN26-1-2	Load/Luffing (Drum 3) RS Motor Cont. (N6)
CAN26-1-8	Load/Luffing (Drum 3) Pawl In (N6)
CAN26-1-16	Load/Luffing (Drum 3) Pawl Out (N6)
CAN26-1-32	Load/Luffing (Drum 3) Min. Bail Limit (N6)
CAN26-1-64	Load Hoist (Drum 1) Brake Solenoid (N6)
CAN26-1-128	Load Hoist (Drum 1) LS Motor Control (N6)
CAN26-2-1	Load Hoist (Drum 1) RS Motor Control (N6)
CAN26-2-2	Load Hoist (Drum 1) Min. Bail Limit Sw. (N6)
CAN26-2-4	Boom Hoist (Drum 5) Brake Solenoid (N6)
CAN26-2-8	Boom Hoist (Drum 5) LS Motor Control (N6)
CAN26-2-16	Boom Hoist (Drum 5) RS Motor Control (N6)
CAN26-2-32	Boom Hoist (Drum 5) Pawl – In (N6)
CAN26-2-64	Boom Hoist (Drum 5) Pawl – Out (N6)
CAN27-1-1	Counterweight Pins Disengage (N4)
CAN27-1-2	Drum 1 to Drum 2 Diversion Solenoid (N4)
CAN27-1-4	Drum 2 to Drum 1 Diversion Solenoid (N4)
CAN27-1-8	Drum 4 to Drum 5 Diversion Solenoid (N4)
CAN27-1-16	Left Travel to Drum 3 Diversion Sol. (N4)
CAN27-1-32	Right Travel to Drum 4 Diversion Sol. (N4)
CAN27-1-64	Boom/Mast Hoist (Drum 4) Brake (N4)
CAN27-1-128	Boom/Mast Hoist (Drum 4) Motor Cont. (N4)
CAN27-2-1	Pump 7 Control – Accessory Pump (N4)
CAN27-2-4	Left Front Jack Solenoid - Extend (N4)
CAN27-2-8	Left Front Jack Solenoid - Retract (N4)
CAN27-2-16	Right Front Jack Solenoid - Extend (N4)
CAN27-2-32	Right Front Jack Solenoid - Retract (N4)
CAN27-2-64	Left Rear Jack Solenoid - Extend (N4)
CAN27-2-128	Left Rear Jack Solenoid - Retract (N4)
CAN27-3-1	Right Rear Jack Solenoid - Extend (N4)
CAN27-3-2	Right Rear Jack Solenoid - Retract (N4)
CAN27-3-4	Rigging Winch - Spool In (N4)
CAN27-3-8	Rigging Winch - Spool Out (N4)
CAN27-3-16	Mast Raising Cylinders – Extend (N4)
CAN27-3-32	Mast Raising Cylinders – Retract (N4)
CAN27-3-64	Front Rotating Bed Pins - Retract (N4)
CAN27-3-128	Front Rotating Bed Pins - Extend (N4)
CAN29-1-1	Boom/Mast Hoist (Drum 4) Motor Cont. (N5)
CAN29-1-2	Engine Cooler Fan/Acc Enable Solenoid (N5)
CAN29-1-8	Right Side RCL Capacity Alarm (N5)
CAN29-1-64	Load Hoist (Drum 2) RS Motor Control (N5)
CAN29-1-128	Load Hoist (Drum 2) Brake Solenoid (N5)
CAN29-2-1	Right Side Swing/Travel Alarm (N5)
CAN29-2-2	Drum 2 Minimum Bail (N5)
CAN29-3-2	Travel Brake Release Solenoid (N5)
CAN29-3-4	Travel Two Speed Solenoid (N5)
CAN29-3-8	Swing Brake Release Solenoid (N5)
	Not Used
	Not Used
CAN29-3-64	Swing Bearing Grease Motor (N5)
CAN29-3-128	Crawler Track Grease Motor (N5)
CAN129-1-1	System Operation Alarm (N1)
CAN129-1-4	RCL Warning L.E.D. (N1)
CAN129-1-32	RCL Caution L.E.D. (N1)
CAN129-1-64	Displays 1 and 2 (N1)
CAN129-2-2	Drum Handle Display H1 (N1)
CAN129-2-8	Drum Handle Display H3 (N1)
CAN129-2-16	Drum Handle Display H4 (N1)
CAN129-2-64	Drum Handle Display H2 (N1)

CAN Packet Number	Item Description (Node Number)	CAN Packet Number	Item Description (Node Number)
MAX-ER		CAN-28-2-64	Right Front Jacking Cylinder Extend (N7)
CAN-28-1-1	Counterweight Lift Cylinder Extend (N7)	CAN-28-2-128	Right Front Jacking Cylinder Retract (N7)
CAN-28-1-2	Counterweight Lift Cylinder Retract (N7)	CAN-28-3-1	Right Rear Jacking Cylinder Extend (N7)
CAN-28-1-64	Telescopic Beam Cylinder Extend (N7)	CAN-28-3-2	Right Rear Jacking Cylinder Retract (N7)
CAN-28-1-128	Telescopic Beam Cylinder Retract (N7)	CAN-28-3-4	Right Wheel Steering Clockwise (N7)
CAN-28-2-1	Telescopic Beam Hinge Pin In (N7)	CAN-28-3-8	Left Wheel Steering Counter-Clock. (N7)
CAN-28-2-2	Telescopic Beam Hinge Pin Out (N7)	CAN-28-3-16	Right Wheel Steering Clockwise (N7)
CAN-28-2-4	Left Front Jacking Cylinder Extend (N7)	CAN-28-3-32	Right Wheel Steering Counter-Clock. (N7)
CAN-28-2-8	Left Front Jacking Cylinder Retract (N7)	CAN-28-3-64	Left Wheel Brakes (N7)
CAN-28-2-16	Left Rear Jacking Cylinder Extend (N7)	CAN-28-3-128	Right Wheel Brakes (N7)
CAN-28-2-32	Left Rear Jacking Cylinder Retract (N7)		

Digital Input Reference Chart

Table 3-5 Digital Inputs

CAN Packet Number	Item Description (Node Number)	CAN Packet Number	Item Description (Node Number)
CAN43-1-1	Handle (H4) Direction Signal (N2)	CAN129-3-4	Load Hoist (Drum 2) Park Switch (N1)
CAN43-1-2	Handle (H3) Direction Signal (N2)	CAN129-3-16	Load Hoist (Drum 2) Park Switch (N1)
CAN43-1-4	Swing Holding Brake Switch (N2)	CAN129-3-64	Travel Park Switch (N1)
CAN43-1-8	Swing Handle Direction Signal (N2)	CAN129-3-128	Cab Tilt Up Switch (N1)
CAN43-1-32	Boom Raise Cylinder Retract	CAN129-4-1	Display Enter Switch (N1)
CAN43-1-128	Boom Raise Cylinder Extend	CAN129-4-2	Confirm Switch (N1)
CAN43-2-1	Left Track Direction Signal (N2)	CAN129-4-4	Limit Bypass Switch (N1)
CAN43-2-2	Handle (H1) Direction Signal (N2)	CAN129-4-8	Display Scroll Up Switch (N1)
CAN43-2-4	Handle (H2) Direction Signal (N2)	CAN129-4-16	Jib Up Limit Bypass Switch (N1)
CAN43-2-8	Right Track Direction Signal (N2)	CAN129-4-32	Display Scroll Down Switch (N1)
CAN45-1-4	Super Charge Pressure Switch (N3)	CAN129-4-64	Travel Cruise Switch - On (N1)
CAN45-1-64	Hydraulic Charge Filter Alarm Switch (N3)	CAN129-5-1	Seat Switch (N1)
CAN45-1-128	Hydraulic Return Filter Alarm Switch (N3)	CAN129-5-2	Cab Tilt Up Switch (N1)
CAN47-1-8	Load/Luffing (Drum 3) Minimum Bail Limit (N6)	CAN129-5-4	Regen Inhibit
CAN47-1-128	Load Hoist (Drum 1) Minimum Bail Limit (N6)	CAN129-5-8	Air Conditioning Compressor Clutch On (N1)
CAN51-1-64	Left Front Jacking Cylinder Limit (N7)	CAN129-5-16	Regen Initiate
CAN51-1-128	Left Rear Jacking Cylinder Limit (N7)	CAN129-5-32	Engine Run/Start (N1)
CAN55-1-8	Maximum Boom Angle Limit Switch (N5)	CAN129-5-128	Boom/Mast Hoist (Drum 4) Park Switch (N1)
CAN55-1-128	Drum 2 Minimum Bail Limit (N5)	CAN129-6-4	Display 1 (N1)
CAN86-6-64	Block Up Limit Luffing/Fixed Jib Upper Pt. (N21)	CAN129-6-8	Travel 2-Speed Switch (N1)
CAN86-6-128	Block Up Limit Luffing Jib Lower Point (N21)	CAN129-6-16	Display 2 (N1)
CAN112-6-64	Block Up Limit Boom Upper Point (N20)	CAN129-6-32	Swing Park Switch - On (N1)
CAN112-6-128	Block Up Limit Boom Lower Point (N20)	CAN129-6-64	Display Exit Switch (N1)
CAN129-3-1	Boom Hoist (Drum 5) Park Switch (N1)	CAN129-6-128	Load/Luffing (Drum 3) Park Switch (N1)

MAX-ER Faults

Table 3-6 Digital Inputs

CAN Packet Number	Item Description (Node Number)
Wheeled MAX-ER	
CAN147-1-1	Lift Cylinder Length Sensor Out of Range
CAN147-1-2	Lift Cylinder Retract Pressure Sensor Out of Range
CAN147-1-4	Lift Cylinder Extend Pressure Sensor Out of Range
CAN147-1-8	Top Reel Length Sensor Out of Range
CAN147-1-16	Bottom Reel Length Sensor Out of Range
CAN147-1-32	Bottom Reel Length Longer than Top Reel Length
CAN147-1-64	Top Reel Length Longer than Bottom Reel Length
CAN147-1-128	Fore-Aft Level Sensor Out of Range
CAN147-2-1	Port-Starboard Level Sensor Out of Range
CAN147-2-2	Out of Level
CAN147-2-4	Left Wheel Fault
CAN147-2-8	Right Wheel Fault
CAN147-2-16	Mast Strap Load Sensor Out of Range
CAN147-2-32	Mast Stop Sensor Out of Range
CAN147-2-64	Mast Stop Fault
CAN147-3-128	Set-Up Out of Level
CAN147-4-1	Set-Up Mast Stop Limit
CAN147-4-2	Set-Up Mast Stop Sensor Out of Range
Hanging MAX-ER	
CAN147-2-128	Lift Cylinder Length Sensor Out of Range
CAN147-3-1	Lift Cylinder Retract Pressure Sensor Out of Range
CAN147-3-2	Lift Cylinder Extend Pressure Sensor Out of Range
CAN147-3-4	Mast Strap Load Sensor Out of Range
CAN147-3-8	Mast Stop Sensor Out of Range
CAN147-3-16	Mast Stop Fault
CAN147-3-32	Set-Up Mast Stop Limit
CAN147-3-64	Set-Up Mast Stop Sensor Out of Range

Wired Remote

Table 3-7 Digital Inputs

CAN Packet Number	Item Description
CAN168-1-1	Engine Low Speed Switch
CAN168-1-2	Engine High Speed Switch
CAN168-1-64	Boom Pins In Switch
CAN168-1-128	Boom Pins Out Switch
CAN168-2-1	Front Adapter Pins In Switch
CAN168-2-2	Front Adapter Pins Out Switch
CAN168-2-4	Rear Adapter Pins In Switch
CAN168-2-8	Rear Adapter Pins Out Switch
CAN168-2-16	Left Front Jack Retract Switch
CAN168-2-32	Left Front Jack Extend Switch
CAN168-2-64	Right Front Jack Retract Switch
CAN168-2-128	Right Front Jack Extend Switch
CAN168-3-1	Left Rear Jack Retract Switch
CAN168-3-2	Left Rear Jack Extend Switch
CAN168-3-4	Right Rear Jack Retract Switch
CAN168-3-8	Right Rear Jack Extend Switch
CAN168-3-16	All Jacks Retract Switch
CAN168-3-32	All Jacks Extend Switch
CAN168-3-128	Counterweight Pins Out Switch
CAN168-4-1	Mast Lower Switch
CAN168-4-2	Mast Raise Switch
CAN168-4-4	Remote Emergency Stop Switch
CAN168-4-8	Cab Lower Switch
CAN168-4-16	Cab Raise Switch

CHECKING ELECTRICAL INPUTS/OUTPUTS

See Figure 3-4 for the following procedure.

Troubleshoot components on the main display first. Any further testing should be completed with in-line test boards at the universal nodes. The in-line test boards can be ordered from the Manitowoc Crane Care Lattice Team.

The node number and pin numbers for each component to be checked are contained in the node Test Volt tables.

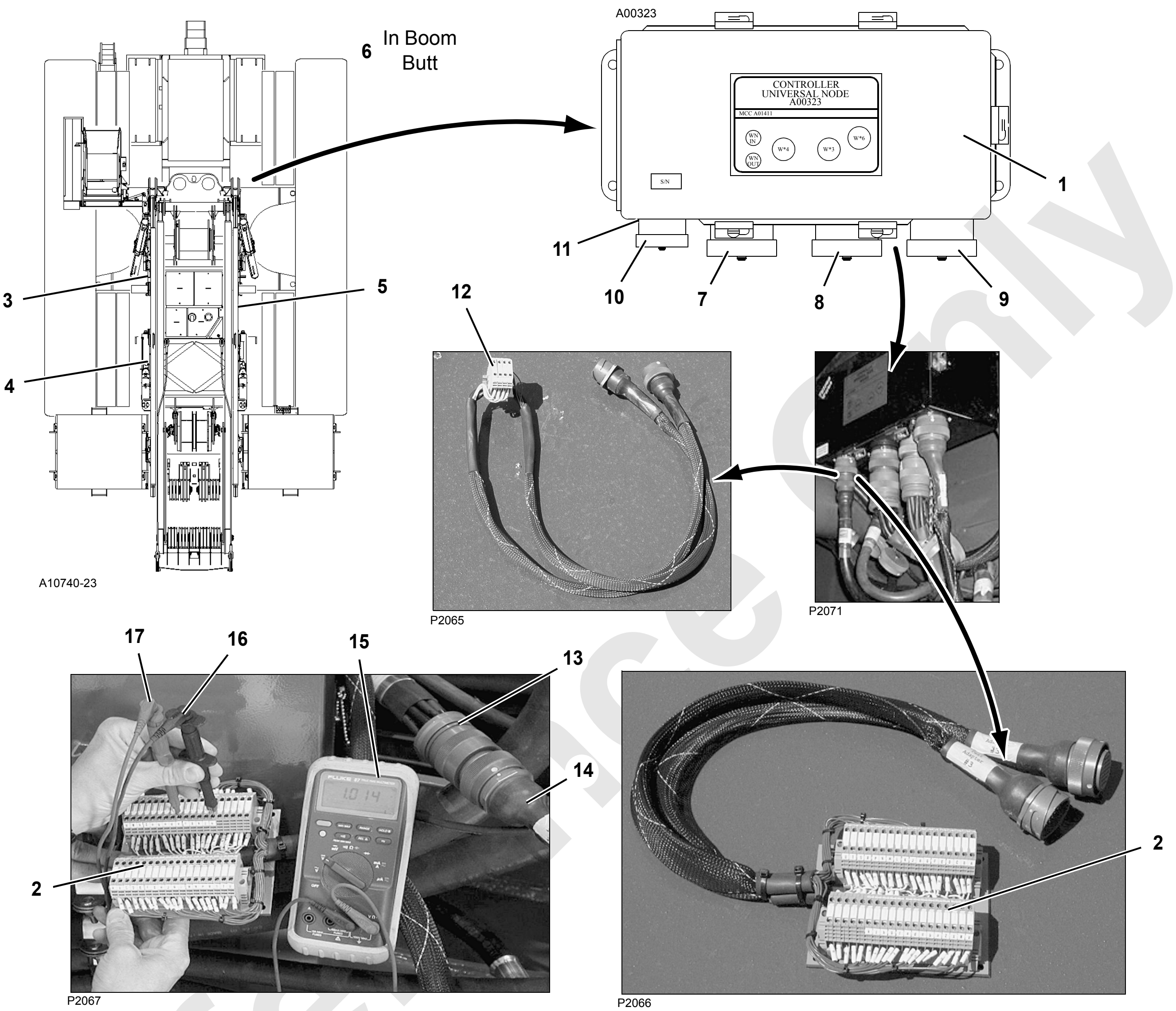
To test a problem component at a universal node with an in-line test board, use the following:

1. Shut down the engine and turn the engine key switch to the run position.
2. Determine the universal node (3 through 5) and keyed connector (W3, W4, or W6) where the problem component is located.
3. Remove the cable to the correct connector and insert the keyed in-line test board between the cable and universal node. At least one cable to the node computer must remain connected when testing.
4. Determine the wire number(s) of the item to be checked.
5. To test for the correct voltage, use the following:
    a. Close the knife switch across the test terminal on the board.
    b. Select voltage on the meter.
    c. Connect the meter negative lead to the problem component ground terminal on the test board.
    d. Connect the meter positive lead to the problem component signal terminal on the test board.
    e. Enable the test component and check the voltage reading on the meter.

NOTE: A meter reading of 9 volts can indicate an output is turned on and is an open circuit. A meter reading of 3 volts can indicate that a circuit is turned off and is an open circuit.

6. To test for the correct amperes, use the following:
    a. Open the knife switch across the test terminal.
    b. Select amperes on the meter.
    c. Connect the meter leads across the test board problem component terminal.
    d. Enable the test component and check the ampere reading on the meter.
7. To test for a communication problem, use the following:
    a. Make sure the engine is off and the engine key switch is in the run position, with all brakes and locks engaged.
    b. Access the desired node to install the communication in-line test board.
    c. Remove the cable from the node at the W1 or W7 connector.
    d. Connect the communication in-line test board between the cable and universal node connector.
    e. Check from terminal C (CAN high) to D (ground) or from terminal F (CAN low) to D (ground).

NOTE: A reading of 1 to 3 volts indicates normal communication between nodes. A steady reading of 0 or 2.5 volts can indicate no communication on the CAN Bus.



Item	Description	Item	Description
1	Universal Node Controller (3, 4, & 5)	10	J1 Connector - Communication In
2	Node In-line Test Board (3 separate boards)	11	J7 Connector - Communication Out
3	Node-3 Left Side of Crane	12	Communication In-line Test Board (1 board)
4	Node-4 Left Side of Crane	13	Node Input/output Cable
5	Node-5 Right Side of Crane	14	In-line Test Board Connector
6	Node-6 in Boom Butt	15	Test Meter
7	W4 Connector - 110 Degree Key	16	Positive Meter Lead
8	W3 Connector - Zero Degree Key	17	Negative Meter Lead
9	W6 Connector - 80 Degree Key		

FIGURE 3-4

DISPLAYS

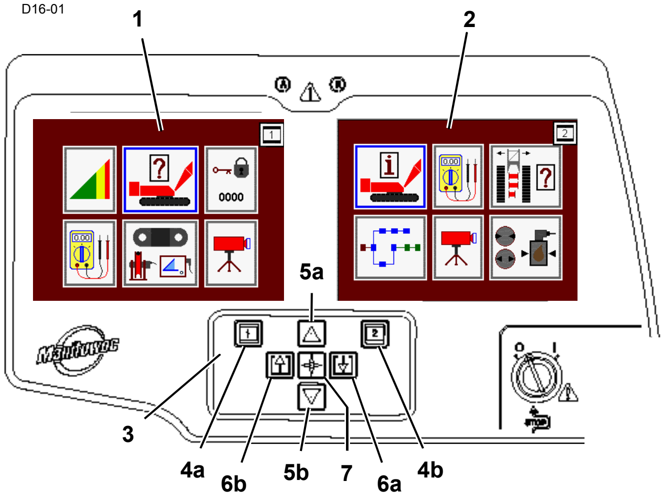
Navigation and Settings

Display Navigation

See Figure 3-5 for the following procedure.

The Menu screens for the RCL and the crane are displayed with select buttons. Use the following controls to operate the display screens.

D16-01



Item	Description
1	Rated Capacity Indicator/Limiter Display
2	Main Display
3	Display Touch Pad Controls
4a and 4b	Display Select Buttons
5a and 5b	Select Buttons
6a and 6b	Enter/Exit Buttons
7	Confirm Buttons

FIGURE 3-5

Rated Capacity Indicator (RCI) Display

The Rated Capacity Indicator/Limiter (RCI) display is on the left side of the front console (See the RCI document for more information).

Main Display

The main display is on the right side of the front console (these screens are described in this section).

Touchpad Controls

The touchpad control area contains all the screen controls required to operate the RCI display and Main display screens.

Display Select Buttons

Use the display select buttons to select or switch between the RCI and main display screens:

4a. Select Screen 1 (RCI)

4b. Select Screen 2 (Main Display)

Select Buttons

Use the green select touch pad buttons to select screen images, icons or data boxes, and values or icons within data boxes:

5a. Select Scroll Up

5b. Select Scroll Down

Enter/Exit Buttons

Use the red touch pad buttons to enter or exit a screen or to change the screen operating level:

6a. Enter Button

6b. Exit Button

Use the Enter button (6a) to enter a screen or go to the next level. Use the Exit button (6b) to exit a screen or level.

Confirm Button

Use the purple Confirm touchpad button to start certain test routines from the screen and to confirm data when required.

Display Brightness and Color Contrast

To adjust the display brightness and contrast, use the following:

1. Depress the desired Display button (4a or 4b) and the Confirm button (7) at the same time.
2. Release the Confirm button (7) first, and then release the Display Select button (4a or 4b).
3. Press the top Select button (5a) to lighten the display, or press the bottom Select button (5b) to darken the display.
4. Press the Enter button (6a) to increase color intensity, or press the Exit button (6b) to decrease the color intensity.
5. Press the Confirm button (7).

Restore Factory Default Display Settings

To restore the factory default display settings, use the following:

1. Select the screen to adjust by holding the Confirm button (7) and the desired Display Select button (4a or 4b).
2. Release the Confirm button first (7), and then release the Display Select button (4a or 4b).
3. Press both the Select Scroll Up (5a) and Select Scroll Down (5b) buttons at the same time.
4. Press the Confirm button (7).

The selected Display (1 or 2) should be reset to the factory default settings.

Blank Display

If a display goes blank, try the following procedure to restore the display. Do not return a display to Manitowoc Crane Care before attempting this procedure:

1. Press the desired Display button (4a or 4b) and the Confirm button (7) at the same time.
2. Release the Confirm button (7) first, and then the Display button (4a or 4b).
3. Press the Select buttons (5a and 5b) at the same time to return to the factory default display settings.
4. Press the Confirm button (7).

Main Display

The basic components for the Main display are the Information screen, Diagnostic screens, Function screens, CAN Bus screen, Camera screens, Pressure Test, and Calibration screens.

The appearance and function of each screen depends on the screen level. Some screen levels show icons and/or data boxes that can be selected to change parameters and/or to enter different screen levels.

"Manitowoc" Screen

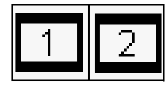
The initial view displayed at crane startup is the "Manitowoc" screen, shown in Figure 3-6. This screen displays the following:

- Model/ Program Number (16000 FCN 1.01.2 shown)
- Con Number (009 000 000 008 shown)
- Screen Program Number (GUI 2.007 shown)

D16-02

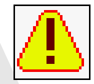
FIGURE 3-6

Screen Prompts

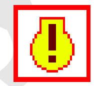


To select the RCL Display, press and hold the Confirm key, and then press key 1. Then release the Confirm key.

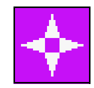
To select the Main Display, press and hold the Confirm key, and then press key 2. Then, release the Confirm key.



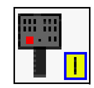
The yellow alert symbol is displayed if a system fault occurs. For more information, see Section 3 of the 16000 Operator Manual.



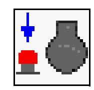
The engine alert symbol is displayed when the engine needs to be serviced at the first available opportunity. For more information, see Section 3 of the 16000 Operator Manual.



The purple confirm prompt appears when the operator shall start certain test routines from the screen and to confirm data when required.



The wireless remote symbol is displayed when the hand-held wireless remote is enabled.



The engine stopped symbol is displayed when engine is stopped.

The data logger icon is displayed for 60 seconds at startup if there is a problem with the data logger (most likely caused by the real time clock).

Menu Screen

See Figure 3-7 for the following procedure.

The Menu screen is the base screen for the crane system. Enter all other screens from this screen. Exiting from any screen will return to the Menu screen.

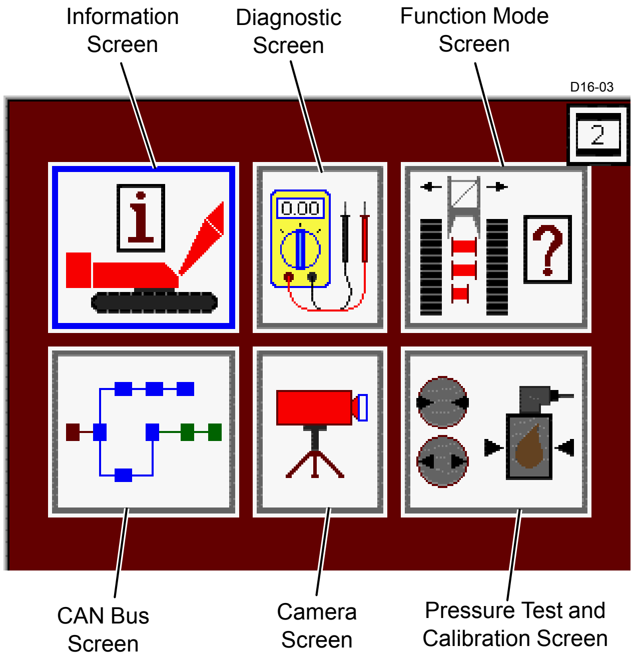


FIGURE 3-7

The Menu screen shows six screen icons and operates on one level only:

- Use the Select buttons to select an icon. Press the Enter button to go to the screen for the selected icon.
- To return to the Menu screen, press the Exit button until the Menu screen appears.

Information Screen

Engine and Crane Information

The Information screen shows the crane information required for viewing during normal operation, as well as engine diagnostic and fault information. Faults are also shown on the Information screen. Potential crane faults are shown below.

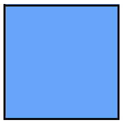
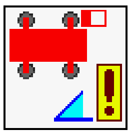
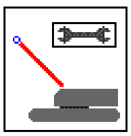
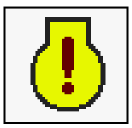
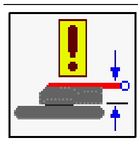
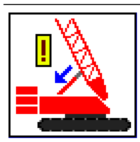
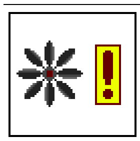
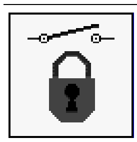
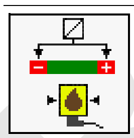
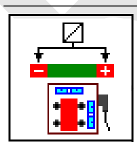
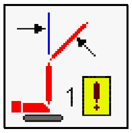
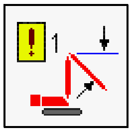
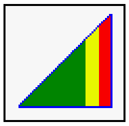
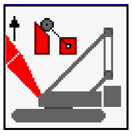
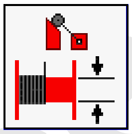
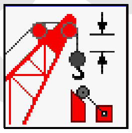
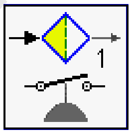
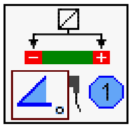
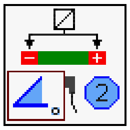
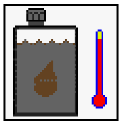
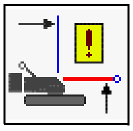
For details on the information screen, see Section 3 of the 16000 Operator Manual.

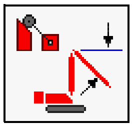
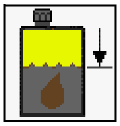
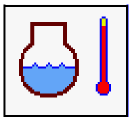
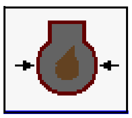
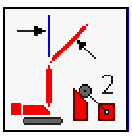
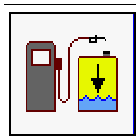
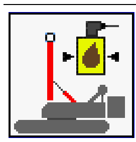
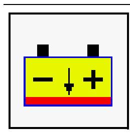
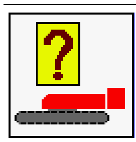
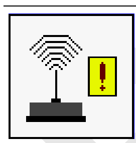
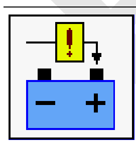
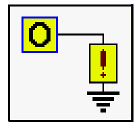
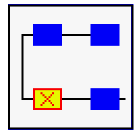
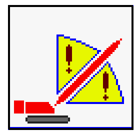
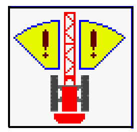
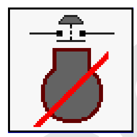
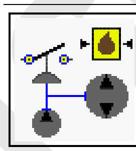
Crane Faults

The Fault Information box (on the Information screen) provides information on crane faults. Table 3-8 lists all the faults that can appear in the fault screen. Some of the fault items shown in Table 3-8 may not be on your crane.

Faults indicated with an asterisk (*) will stop crane operation in the direction of the fault. Corrective action must be taken before continuing crane operation. The other faults will not stop crane operation. Correct all faults as soon possible.

Table 3-8. Faults

Item	Description
	0-No Fault.
	4-Out of Level—Crane is approximately 3° to 4-1/2° out of level while jacking upperworks with the setup remote control.
	6-Setup Mode—Setup mode is on (Liftcrane Mast Capacities Chart selected in the configuration screen of RCL or luffing jib setup mode, if applicable, is on).
	10-Engine Fault*—See the engine data box on the Information screen. See the engine Owners Manual for diagnostics fault codes.
	13-Mast 2 Degree Fault*—Stops down movement of the live mast when lowering to transport position. Complete the mast lowering manually with the hand-held wireless remote.
	27-Mast Stop Retracted*—MAX-ER lift and boom hoist up will be disabled. This fault cannot be bypassed. This fault will also activate if Node-6 electric cables are not connected properly. See the MAX-ER Operator Manual.
	30-Hydraulic Fan—A short in the fan circuit or the pressure senders (transducers) are out of range. Fault 41 (Transducer Voltage) or Fault 84 (Digital Output Disable) should light at the same time, indicating the problem.
	34-Function Parked*—Function inoperable because it is parked. Turn the indicated park switch off or sit down the in operator seat.
	41-Transducer Out of Range- One or more hydraulic pressure sensors is out of range.
	43-Out of Level Sensor—Crane is approximately 4-1/2° out of level while jacking upperworks with ALL switch on the setup remote control. Relevel the crane with the individual jacking switches on the remote control.
	49-Jib Maximum Up 1*—Program limit stops the luffing jib when the jib is raised to the maximum working angle. Lower the luffing jib. Can bypass this limit to raise the jib to Maximum Up 2 limit.
	50-Jib Maximum Down 1*—Program limit activates fault alarm. Operation does not stop. You can lower the luffing jib an additional 3° to the luffing jib maximum down 2 limit (67).
	54-Rated Capacity Indicator/Limiter*—Stops all drums. Land the load or raise the boom/jib.
	55-Boom Up*—Limit switch stops the boom in the up direction. Moves the boom in lowering direction.
	57-Minimum Bail*—Limit switch stops the drum from lowering or down direction. Move the drum in hoisting or up direction.
	60-Block Up Limit*—Limit switch stops the load drum and boom. Lower the load or raise the boom.
	62-Filter—Replace elements.
	63-Boom Angle Sensor—Boom angle sensor is out of the normal range (0.15 to 4.85 Volts).
	64-Jib Angle Sensor—Luffing jib angle sensor is out of the normal range (0.15 to 4.85 Volts).
	65-Hydraulic Fluid Temperature—Fluid temperature in the hydraulic tank is below 18°C (65°F) or above 82°C (180°F).
	66-Mast Too Far Forward*—Live mast is below 156°. Raise the live mast. Further lowering is not intended or the mast will fall.

Item	Description
	67-Jib Maximum Down 2*—Limit switch stops the luffing jib when the jib is lowered to the minimum angle. Raise the luffing jib.
	69-Hydraulic Reservoir Level—Hydraulic oil at caution low level indicated on the tank gauge. Fill the tank.
	70-Engine Coolant Temperature—Engine coolant temperature is above 96°C (205°F).
	71-Engine Oil Pressure—Oil pressure is below 0.5 bar (7.25 psi).
	73-Jib Maximum Up 2*—Limit switch stops the luffing jib when the jib is raised to the maximum angle. Lower the luffing jib. Cannot bypass this limit.
	75-Low Fuel Level—Five percent fuel remaining in tank. Fill the tank as soon as possible to prevent engine stoppage.
	77-Mast System—Boom/mast hoist inoperable in both directions. Determine the cause of the fault and correct.
	78-Battery Low—Battery voltage below 18 volts. Determine the cause of the fault and correct.
	80-Invalid Configuration*—Make sure the selected RCL configuration for the load drums is correct.
	81-Wireless System—Wireless load link sensing fault. See wireless link information in the separate Rated Capacity Indicator/Limiter manual.
	83-Alternator—Engine alternator is not generating a charge to the battery.
	84-Digital Output Disabled—Digital output signal has a short circuit between the computer node and output device. See CAN Bus screen or Diagnostic screen information to identify the problem component.
	85-CAN Communication—One or more computer nodes are not communicating correctly. See CAN Bus screen to identify the node(s).
	86-Boom Range Limiter*—Up or down range limiter is tripped. Move the boom in a direction away from the limit.
	87-Swing Range Limiter*—Right or left range limiter is tripped. Swing the rotating bed in a direction away from the limit.
	88-Engine Shutdown*—Remote emergency stop shut down switch is pushed. Pull the switch up to reset and allow the engine to start.
	89-Super Charge Pressure—Pressure switch that monitors hydraulic fluid to the main pumps is open.

Diagnostic Screen

The diagnostic screen shows a graphic of the hydraulic circuit and the status of all pumps, motors, valves, and switches that apply to the crane function selected.

This view-only screen operates on two levels:

Level 1—An image of the overall crane is shown. Use the Select buttons to highlight individual crane functions.

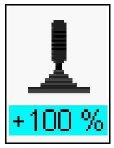
Level 2—The Diagnostic screen for the highlighted crane function is shown.

The yellow alert symbol is displayed if a system fault occurs. Go back to the Information screen to identify the fault.

Component Information Icons

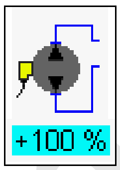
See the following topics for the identification and description of each Diagnostic screen component icon.

Control Handle



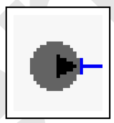
System control handle command in percent from neutral with + raise and – lower for drums, + right and – left for swing, and + forward and – reverse for travel.

Variable Closed-Loop Pump



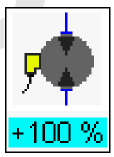
Pump command from neutral (0%) to +/-% full displacement for drums, swing, and travel.

Gear Pump



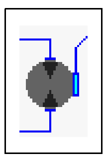
Accessory pump or system charge pump.

Variable Closed-Loop Motor



Motor command with 0% maximum displacement and 100% minimum displacement.

Closed-Loop Variable Motor with Remote Pilot

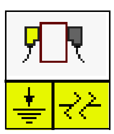


Two-speed motor with remote pilot. This motor type is used for shifting motor speeds automatically when selected.

System Pressure Sender

Hydraulic pressure (psi/bar).

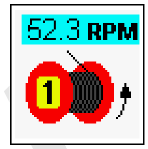
DIN Electrical Connector



DIN electrical connector changes to yellow when the selected item is enabled. The yellow short to ground icon or open circuit icon indicates a circuit fault that must be serviced immediately.

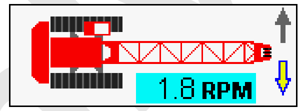
NOTE: Variable outputs may show a yellow icon all the time.

Drum Speed



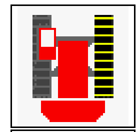
Drum speed in revolutions per minute (RPM). Drum direction is also shown.

Swing Status



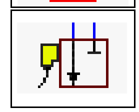
Swing status. Swing right (shown) or swing left arrow is yellow when swing is enabled. Swing speed is shown in revolutions per minute (RPM).

Track Symbol



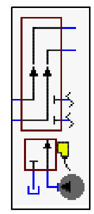
Travel function. Travel (right shown) is yellow when the function is operating.

Valve Status



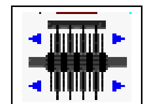
Status of a valve.

Pilot Valve



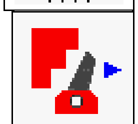
Status of an external piloted valve.

Disc Brake



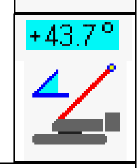
Disc brake status, applied or released (shown).

Drum Pawl



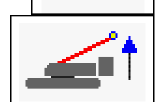
Pawl status, engaged or disengaged (shown).

Mast Angle



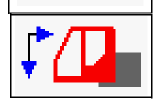
Mast angle in degrees the mast is positioned above the transport position.

Mast Raise Status



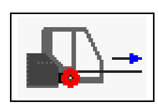
Command state of the mast raise cylinders.

Cab Tilt Status



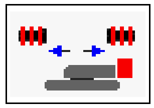
Command state of the cab tilt cylinder, cab up/out or down/in (shown).

Rigging Winch Status



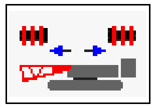
Command state of the rigging winch, haul in or pay out (shown) the line.

Counterweight Pin Status



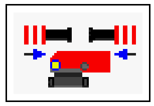
Command state of the counterweight pin cylinders, extended (shown) or retracted.

Boom Hinge Pin Status



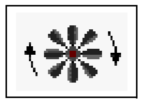
Command state of the boom hinge pin cylinders, extended (shown) or retracted.

Rotating Bed Pin Status



Command state of the rotating bed pins, extended or retracted (shown).

Engine Cooling Fan Status



Command state of the engine cooling fan (shown on).

Crane on Jacks Symbol

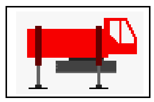
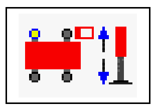


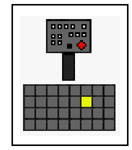
Image of the crane on jacks. The front view icon is also shown on the Diagnostic screen.

Jack Status



Command state of a jack cylinder. The left rear jack in the extended state is shown.

Remote Control: Wireless and Wired



Remote control status, indicating which switches are closed.

Each control switch corresponds with a number (see Table 3-9). Switch numbers are 1 through 8 in row one, 9 through 16 in row two, 17 through 24 in row three and 25 through 32 in row four. Not all switch numbers are used. Switch number 14 (Left Front Jack - Extend) is closed in the example shown.

Table 3-9 Wireless Remote Switch Identification

No.	Description	No.	Description
1	Engine Low Speed	16	Right Front Jack - Extend
2	Engine High Speed	17	Left Rear Jack - Retract
7	Boom Pins - In	18	Left Rear Jack - Extend
8	Boom Pins - Out	19	Right Rear Jack - Retract
9	Front Adapter Pins - In	20	Right Rear Jack - Extend
10	Front Adapter Pins - Out	21	All Jacks - Retract
11	Rear Adapter Pins - In	22	All Jacks - Extend
12	Rear Adapter Pins - Out	24	Counterweight Pins - Out
13	Left Front Jack - Retract	25	Mast Lower
14	Left Front Jack - Extend	26	Mast Raise
15	Right Front Jack - Retract	27	Remote Stop

Published 05-03-17, Control # 228-03

Drum Diagnostic Screens

Select the drum icon on screen level 1 as shown Figure 3-8. Press the Enter button to go to level 2.

D16-05

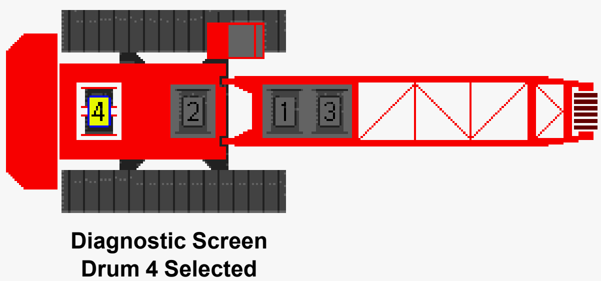


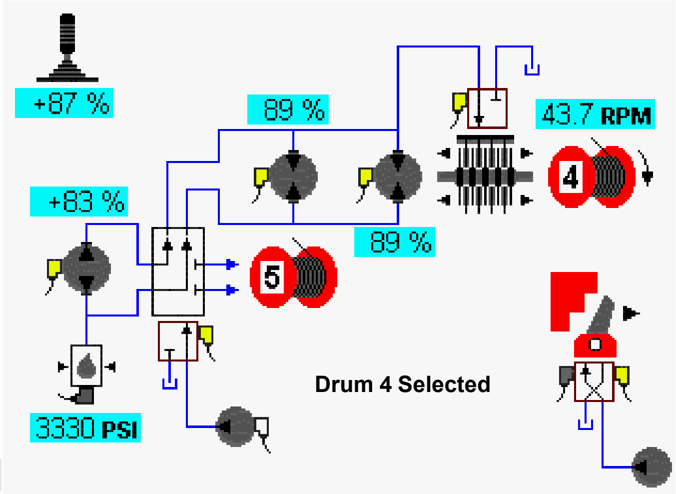
FIGURE 3-8

In the drum example shown in Figure 3-9, the drum 4 function is shown hoisting up. A single pump is shared with drum 5 and is connected to drum 4 through a diverting valve. A second pump could also power drum 4, shown connected to the left track through an upper diverting valve.

NOTE: Mast hoist drum 5 is only selected when the crane is configured with a MAX-ER.

For load drums 1 or 2, the drum 2 pump is dedicated to the drum 1 motor through a diverting valve when drum 1 is selected. The opposite is true when drum 2 is selected. Both drums can be operated at the same time but would operate at half speed.

For load drum 3, the left travel pump is dedicated to operate the drum 3 motor through a diverting valve when drum 3 is selected. Drum 3 is inoperable when traveling. Drum 3 can be configured as a load drum or luffing jib.



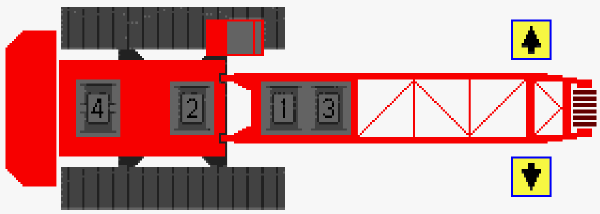
D16-06B

FIGURE 3-9

Swing Diagnostic Screen

Select the swing icon on screen level 1 as shown in Figure 3-10. Press the Enter button to go to level 2.

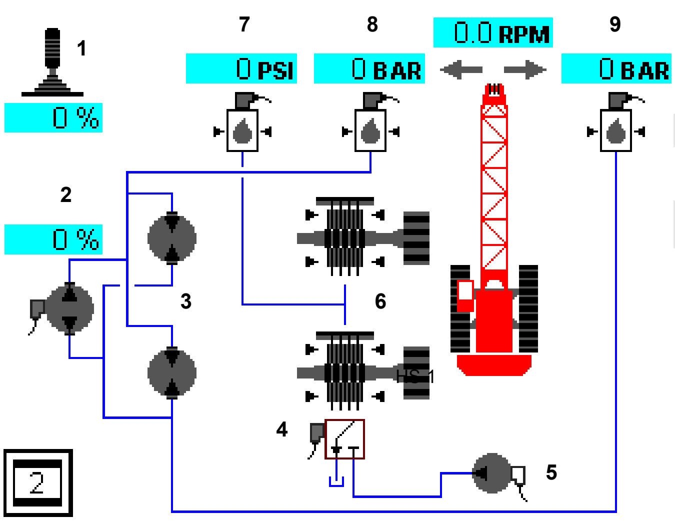
D16-07



Diagnostic Screen
Swing Selected

FIGURE 3-10

The swing system icons are displayed in Figure 3-11. The example shows the swing function swinging right. Circular arrow symbols near each pressure sender indicate which sender monitors swing right and left pressures.



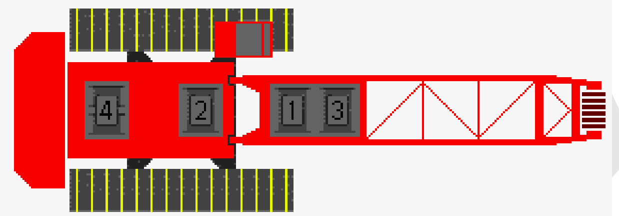
Item	Description
1	Swing Handle Command in Percent
2	Swing Pump Command in Percent
3	Swing Motors
4	Swing Brake Solenoid HS-1
5	Accessory Pump (low pressure)
6	Swing Brake
7	Swing Brake Pressure Sensor
8	Swing Right Pressure Sensor
9	Swing Left Pressure Sensor

FIGURE 3-11

Travel Diagnostic Screen

Select the travel icon on screen level 1 as shown in Figure 3-12. Press the Enter button to go to level 2.

D16-09

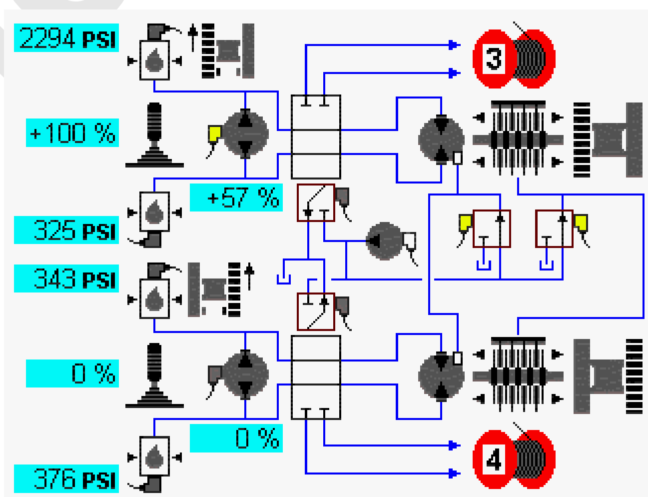


Diagnostic Screen
Travel Selected

FIGURE 3-12

In the travel system example shown in Figure 3-13, the left travel pump is dedicated to operate drum 3 through a diverting valve if drum 3 is selected. Under certain conditions when drum 5 is also configured, the right travel pump is dedicated to operate drum 4 a through a diverting valve if drum 4 is selected.

NOTE: When crane travel is enabled, drum 3 is disabled.



D16-10B

Left Travel Selected

FIGURE 3-13

Jacking Accessory Diagnostic Screen

Select the crane carbody with the jacking icon on screen level 1 as shown in Figure 3-14. Press the Enter button to go to level 2.

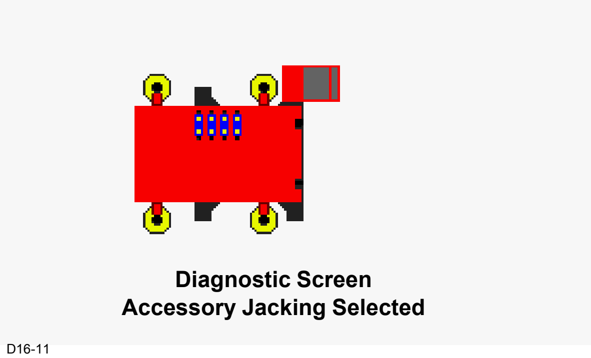


FIGURE 3-14

At the jacking accessory diagnostic screen, the component icons are displayed as shown in Figure 3-15. In the following example, the all jack switch on the wireless remote is selected. The crane on jacks icons indicate the crane level status.

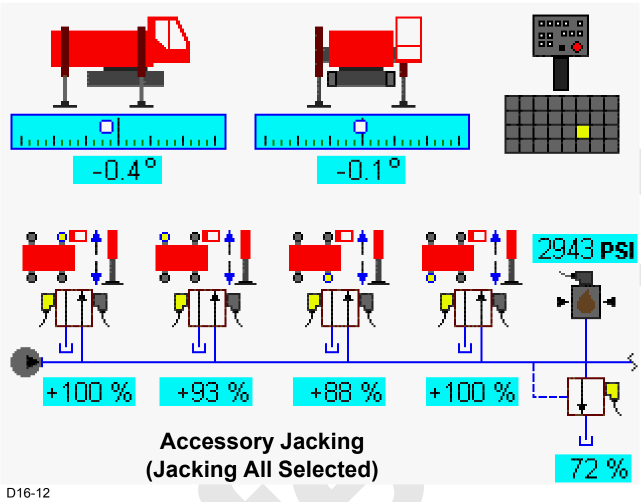


FIGURE 3-15

Pins and Fan Accessory Diagnostic Screen

Select the crane, pins, and engine fan icon on screen level 1 as shown in Figure 3-16. Press the Enter button to go to level 2.

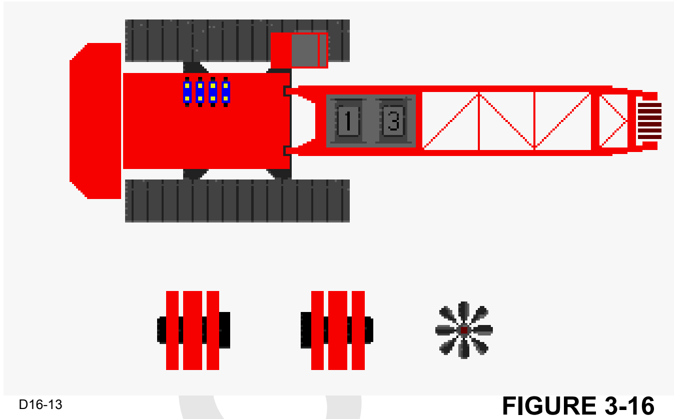


FIGURE 3-16

For the counterweight pins, boom hinge pins, front/rear rotating bed pins, and engine fan screen, see Figure 3-17. In the following example, the left front rotating bed pin on the wireless remote is selected.

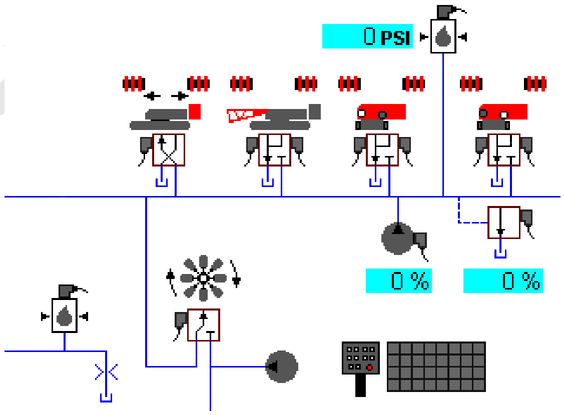


FIGURE 3-17

3

Cab Tilt, Rigging Winch, and Mast Accessory Diagnostic Screen

Select the cab tilt, rigging winch, and mast icon on screen level 1 as shown in Figure 3-18. Press the Enter button to go to level 2.

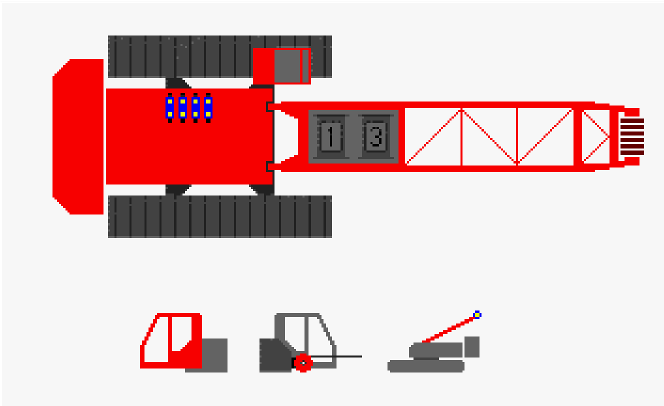


FIGURE 3-18

For the cab tilt, rigging winch, and mast raising cylinders screen see Figure 3-19. In the example, the mast raising cylinders up direction on the wireless remote is selected.

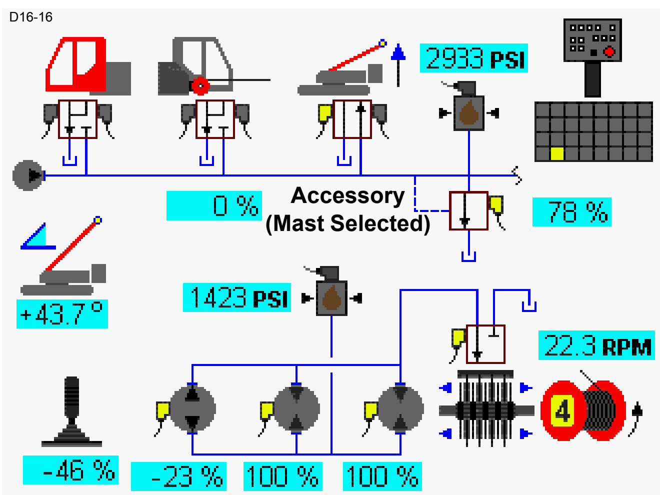


FIGURE 3-19

MAX-ER Diagnostic Screen

Select the MAX-ER (optional) icon on screen level 1 and press the enter button to go to level 2. See the MAX-ER Operator Manual for complete MAX-ER attachment information.

Function Mode Screens

See Figure 3-20 for the following:

Use the Function Mode screen to enable/disable modes and to set operating parameters for the individual crane functions. This screen operates on four levels.

Level 1—Image of the overall crane is shown. Use the Select buttons to highlight the individual crane functions.

Level 2—Function mode screen for the highlighted crane function is shown. The selected mode or limit data box is highlighted blue. Use the Select buttons to choose a mode or limit data box.

Level 3—The selected mode or limit data box highlighted red is shown. Use the Select buttons to enable/disable a mode or to set a limit.

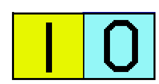
Level 4—The selected mode or limit data box highlighted green is shown. Use the Select buttons to adjust the value shown in the data box.

To enable/disable modes or to set operating parameters for the individual crane functions, use the following:

1. Press the Enter or Exit buttons as required to go to level 1. Use the Select buttons to highlight the desired crane function.
2. Press the Enter button to go to level 2. Use the Select buttons to choose the mode or limit data box to access. Press the Enter button to go to level 3.
3. Use the Select buttons to enable/disable the mode or to adjust the operational parameter.
4. If required, press the Enter button to go to level 4. Use Select buttons to adjust the operational parameter.
5. Press the Exit button as required to return to a previous level or to the Menu screen.

The yellow alert symbol is displayed if a system fault occurs. See the Information screen to access faults.

The On (I) and Off (0) icons in some data boxes indicate the electrical status of the item.



Drum Functions

Select drum functions 1 through 5 from the screen shown below.

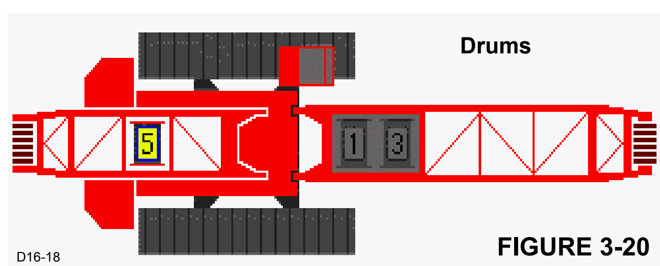


FIGURE 3-20

Swing Functions

Highlight and select the swing functions as shown here.

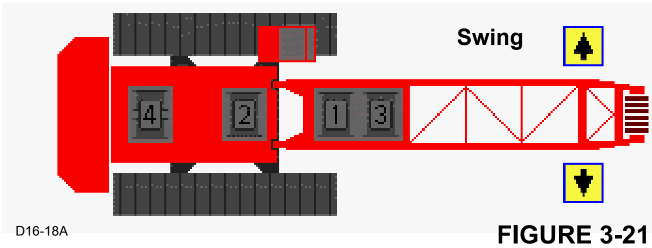


FIGURE 3-21

Travel Functions

Highlight and select the travel functions as shown here.

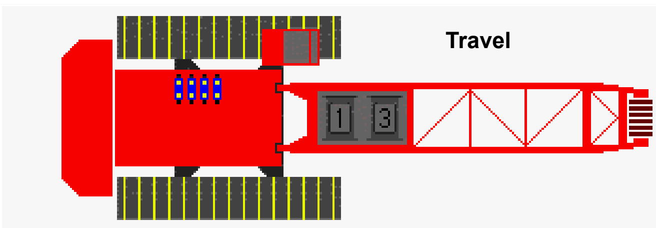


FIGURE 3-22

Crane Setup Remote Functions

Highlight and select the crane setup remote functions as shown here.

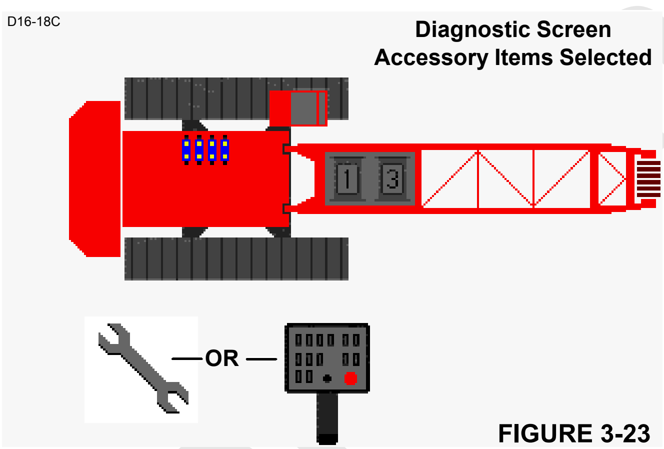


FIGURE 3-23

MAX-ER Functions

Select the MAX-ER functions from the MAX-ER attachment screen. See the MAX-ER Operator Manual for complete MAX-ER attachment information.

Drum, Swing, or Track Speed Limits

See Figure 3-24 for the following procedure.

The drum, swing, and crawler speeds can be selected and adjusted. On level 3, use the select buttons to highlight the value in a data box and limit the function speed between 25% and 100% of maximum capability.

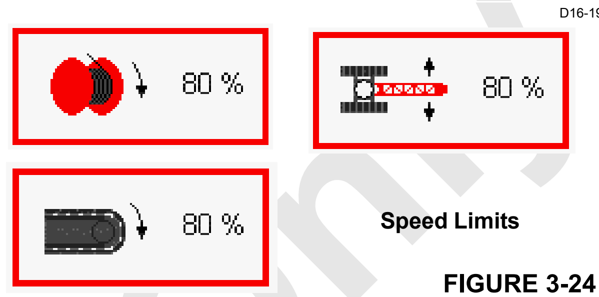


FIGURE 3-24

Swing Pressure Limit

See Figure 3-25 for the following procedure.

On level 3, use the select buttons to highlight the value shown in this data box and limit the swing pressure between 25% and 100% of maximum capability.

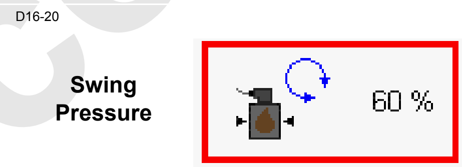


FIGURE 3-25

Rigging Winch Mode

See Figure 3-26 for the following procedure.

On level 3, use the select buttons to enable or disable the rigging winch for the selected drum function. The rigging winch mode data box, shown disabled, will not appear in the function mode screen unless this feature is available.

When the rigging winch is enabled, the computer selects the control handle. (The selected handle display light is 0 in the figure.) If the rigging winch is enabled for drum 4, the computer selects a load drum handle to control the winch.

FIGURE 3-26

Boom or Swing Motion Limiter Mode

See Figure 3-27 for the following procedure.

NOTE: The motion limiter mode data boxes do not appear unless the crane has this option.

On level 3, use the select buttons to enable or disable the motion limiter mode. On level 3 with the motion limiter mode enabled, the controller monitors and stores the maximum right/left or up/down angles during operation. After exiting level 3, these angles are used to limit the boom or swing motion.

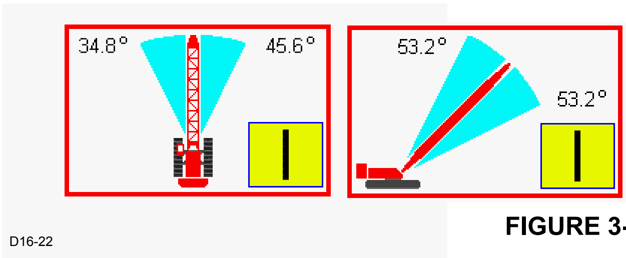


FIGURE 3-27

Crane Setup Remote Mode

To turn on the crane setup remote control, see the procedure in Section 3 of the Operator Manual.

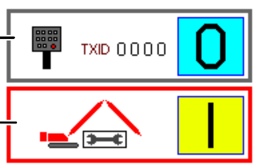


FIGURE 3-28

Fan Function

See Figure 3-29 for the following procedure.

The fan speed can be set above a minimum 25% of rated speed in increments of 5% (for example, 30%, 35%, 40%, etc...). The minimum fan speed is set at the factory and does not require further adjustment.

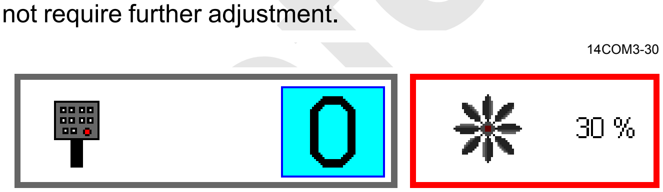


FIGURE 3-29

CAN Bus Screen

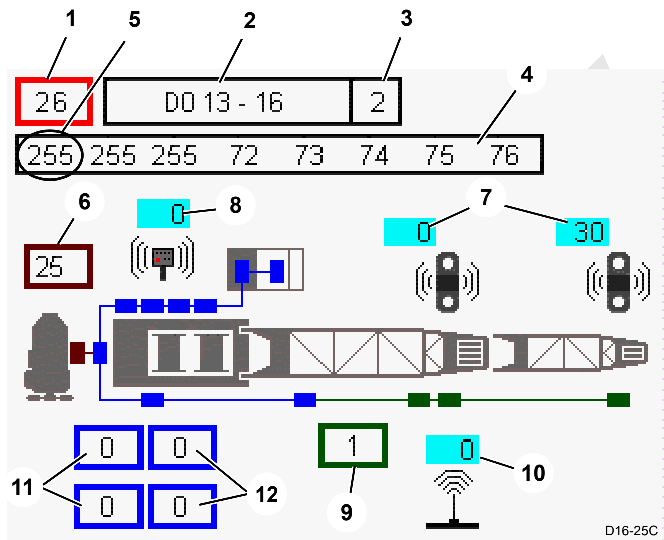
See Figure 3-30

The CAN (Controller Area Network) bus diagnostic screen is for technicians. The screen displays CAN bus packet and node information along with the engine, history, and boom status. Any node highlighted yellow has lost communication with the crane.

The CAN Bus screen operates on two levels:

Level 1—The packet number data box is highlighted blue.

Level 2—The packet number data box is highlighted red.



	Description		
1	Packet Number	7	Drum Load Links
2	Packet Type	8	Remote Status
3	Packet Node Number	9	Boom Node Status
4	Packet Banks (8)	10	Wireless Receiver Status
5	Bank 1 Total	11	Crane Status
6	Engine Node Status	12	Crane History

FIGURE 3-30

Packet Information

See Figure 3-30, Items 1 through 5 for the following procedure.

The top row of the screen contains the CAN Bus packet number (26). Enter the desired packet number in the first data box using the select buttons.

The packet type (DO in the figure) is displayed in the top middle data box.

The related node (2 in the figure) is displayed in the top right data box.

The packet contents are displayed in the eight banks in the second row. The packet contents and format depend on the packet type. Many packets are not easily interpreted by non-Manitowoc technical personnel and are not discussed in this publication.

Each individual input/output is assigned a number (identifier) in the binary system (powers of two). The identifiers of all inputs/outputs that are ON (active) for each bank are added for a total of 0 to 255. The number displayed for each bank is the sum of all identifiers that are ON in that bank. Each possible ON/OFF combination per bank has a unique total.

To determine the status of an individual digital input or output, determine the CAN packet number (see Table 3-3 through Table 3-6). For example, the Drum 1 Brake packet number is CAN26-1-64.

The first part of the Code Number (26 in the example) indicates which packet contains the CAN communications for that input or output.

The second part of the Code Number (1 in the example) indicates the bank where the individual information is shown on the CAN screen.

The third part of the Code Number (64 in the example) is the item identifier.

To determine the status of the individual input or output, find the total in bank 1 (255 in the example). Reference the total in the numbered column of Table 3-10. In the corresponding row, the identifier numbers that are on in the bank are shaded. In the above example, the column for 64 is shaded, indicating the Drum 1 Brake is on.

Digital Output Disable (DOD) Fault

See Figure 3-30, Items 4 and 5 for the following procedure.

The control system is capable of detecting an open or short circuit in most of the system's digital outputs. When the fault section of the display screen shows "Fault 84-Digital Output Disable", check for DOD faults in packets 36 through 41:

1. Scroll through packet numbers 36 through 41.
2. Check banks 1, 2, and 3 on the CAN bus screen for a value of 255. If the value is less than 255 in banks 1, 2, or 3, use the bank identifier numbers in Table 3-10 to determine which bits are off.
3. Use Table 3-3 to determine which outputs are not working.
4. Investigate the indicated outputs for a short to ground, a short to the shield, or another problem.

Engine Node Status

See Figure 3-30, Item 6 for the following procedure.

The engine displays node bus status is for factory use only. The communication number should be less than 64. See the engine manufacturer manual for engine fault code information.

Load Link Status (900 MHz System)

See Figure 3-30, Item 7 for the following procedure.

The load link sensor icons indicate the selected load sensor operating status. The selected link sensor is operating normally if the blue antenna icon is displayed. If the sensor is not operating normally, the following numbers indicate the type of communication error:

4—Calibration fault

8—Radio frequency (RF) state. The selected link sensor is not communicating.

64—Sign-on error

128—RF communication error

The following numbers indicate the drum load link and wireless remote battery status:

32 On, 16 On—75% to 100% battery charge

32 On, 16 Off—50% to 75% battery charge

32 Off, 16 On—25% to 50% battery charge

32 Off, 16 Off—0% to 25% battery charge

Load Link Status (2.4 GHz System)

See Figure 3-30, Item 7 for the following procedure:

The load link sensor icons indicate the selected load sensor operating status. The selected link sensor is operating normally if the blue antenna icon is displayed. If the sensor is not operating normally, the following numbers indicate the type of communication error:

8—Radio Frequency (RF) state. The selected link sensor is not communicating.

32—Calibration fault

64—Sign-on error

128—RF communication error

The battery status is shown in bank 4 on the CAN Bus screen for the corresponding packet number. The drum 1-packet number is 141. The drum 2-packet number is 142. The drum 3-packet number is 143. The drum 6-packet number is 144. The following numbers indicate the battery status:

15—Full battery charge

0—Critically low battery charge

Remote Control Status

See Figure 3-30, Item 8 for the following procedure:

The remote control status icon identifies which remote control is active according to the following numbers:

1—Crane remote

2—MAX-ER remote

3

Boom Node Status

See Figure 3-30, Item 9 for the following procedure.

The boom node status displays the boom top node and jib node communication. A zero is displayed if there is a communication error. The boom data box indicates what boom nodes may be available on the bus:

0—No communication

1—Boom top node

2—Luffing jib node

4—Fixed jib node

128—A node is present that is not currently identified.

Wireless Receiver Status

See Figure 3-30, Item 10 for the following procedure.

The wireless receiver status displays the boom top and wireless receiver communication. The following numbers indicate the type of communication:

0—Communication error

1—The boom top transmitter is working.

2—The rotating bed receiver is working.

8—The MAX-ER Remote control is working.

Crane Status

See Figure 3-30, Item 11 for the following procedure.

Two crane status banks display crane errors, and both banks should normally display a zero. The number displayed in the crane status top bank corresponds to the following numbered communication errors:

0—Crane status is normal.

1—Node 2 is not communicating.

2—Node 3 is not communicating.

4—Node 4 is not communicating.

8—Node 5 is not communicating.

16—Node 6 is not communicating.

32—The bin node is not communicating.

64—Node 7 is not communicating.

128—The engine node is not communicating.

The number displayed in the crane status bottom bank corresponds to the following numbered errors:

0—The boom raising system (BRS) status is normal.

1—The BRS node (Node 9) is not communicating.

Crane History

See Figure 3-30, Item 12 for the following procedure.

The top crane history bank displays the errors since power was last cycled.

The bottom crane history bank is not used at this time.

Table 3-10 Bank Identifier Numbers

	1	2	4	8	16	32	64	128
1	■							
2		■						
3	■	■						
4			■					
5	■		■					
6		■	■					
7	■	■	■					
8				■				
9	■			■				
10		■		■				
11	■	■		■				
12			■	■				
13	■		■	■				
14		■	■	■				
15	■	■	■	■				
16					■			
17	■				■			
18		■			■			
19	■	■			■			
20			■		■			
21	■		■		■			
22		■	■		■			
23	■	■	■		■			
24				■	■			
25	■			■	■			
26		■		■	■			
27	■	■		■	■			
28			■	■	■			
29	■		■	■	■			
30		■	■	■	■			
31	■	■	■	■	■			
32						■		
33	■					■		
34		■				■		
35	■	■				■		
36			■			■		
37	■		■			■		
38		■	■			■		
39	■	■	■			■		
40				■		■		
41	■			■		■		
42		■		■		■		
43	■	■		■		■		

	1	2	4	8	16	32	64	128
44			■	■		■		
45	■		■	■		■		
46		■	■	■		■		
47	■	■	■	■		■		
48					■	■		
49	■				■	■		
50		■			■	■		
51	■	■			■	■		
52			■		■	■		
53	■		■		■	■		
54		■	■		■	■		
55	■	■	■		■	■		
56				■	■	■		
57	■			■	■	■		
58		■		■	■	■		
59	■	■		■	■	■		
60			■	■	■	■		
61	■		■	■	■	■		
62		■	■	■	■	■		
63	■	■	■	■	■	■		
64							■	
65	■						■	
66		■					■	
67	■	■					■	
68			■				■	
69	■		■				■	
70		■	■				■	
71	■	■	■				■	
72				■			■	
73	■			■			■	
74		■		■			■	
75	■	■		■			■	
76			■	■			■	
77	■		■	■			■	
78		■	■	■			■	
79	■	■	■	■			■	
80					■		■	
81	■				■		■	
82		■			■		■	
83	■	■			■		■	
84			■		■		■	
85	■		■		■		■	
86		■	■		■		■	

	1	2	4	8	16	32	64	128
87	■	■	■		■		■	
88				■	■		■	
89	■			■	■		■	
90		■		■	■		■	
91	■	■		■	■		■	
92			■	■	■		■	
93	■		■	■	■		■	
94		■	■	■	■		■	
95	■	■	■	■	■		■	
96						■	■	
97	■					■	■	
98		■				■	■	
99	■	■				■	■	
100			■			■	■	
101	■		■			■	■	
102		■	■			■	■	
103	■	■	■			■	■	
104				■		■	■	
105	■			■		■	■	
106		■		■		■	■	
107	■	■		■		■	■	
108			■	■		■	■	
109	■		■	■		■	■	
110		■	■	■		■	■	
111	■	■	■	■		■	■	
112					■	■	■	
113	■				■	■	■	
114		■			■	■	■	
115	■	■			■	■	■	
116			■		■	■	■	
117	■		■		■	■	■	
118		■	■		■	■	■	
119	■	■	■		■	■	■	
120				■	■	■	■	
121	■			■	■	■	■	
122		■		■	■	■	■	
123	■	■		■	■	■	■	
124			■	■	■	■	■	
125	■		■	■	■	■	■	
126		■	■	■	■	■	■	
127	■	■	■	■	■	■	■	
128								■
129	■							■

Dark shaded boxes indicate ON, white boxes OFF.

3

Table 3-10 Bank Identifier Numbers (continued)

	1	2	4	8	16	32	64	128
130		■						■
131	■	■						■
132			■					■
133	■		■					■
134		■	■					■
135	■	■	■					■
136				■				■
137	■			■				■
138		■		■				■
139	■	■		■				■
140			■	■				■
141	■		■	■				■
142		■	■	■				■
143	■	■	■	■				■
144					■			■
145	■				■			■
146		■			■			■
147	■	■			■			■
148			■		■			■
149	■		■		■			■
150		■	■		■			■
151	■	■	■		■			■
152				■	■			■
153	■			■	■			■
154		■		■	■			■
155	■	■		■	■			■
156			■	■	■			■
157	■		■	■	■			■
158		■	■	■	■			■
159	■	■	■	■	■			■
160						■		■
161	■					■		■
162		■				■		■
163	■	■				■		■
164			■			■		■
165	■		■			■		■
166		■	■			■		■
167	■	■	■			■		■
168				■		■		■
169	■			■		■		■
170		■		■		■		■
171	■	■		■		■		■
172			■	■		■		■

	1	2	4	8	16	32	64	128
173	■		■	■		■		■
174		■	■	■		■		■
175	■	■	■	■		■		■
176					■	■		■
177	■				■	■		■
178		■			■	■		■
179	■	■			■	■		■
180			■		■	■		■
181	■		■		■	■		■
182		■	■		■	■		■
183	■	■	■		■	■		■
184				■	■	■		■
185	■			■	■	■		■
186		■		■	■	■		■
187	■	■		■	■	■		■
188			■	■	■	■		■
189	■		■	■	■	■		■
190		■	■	■	■	■		■
191	■	■	■	■	■	■		■
192							■	■
193	■						■	■
194		■					■	■
195	■	■					■	■
196			■				■	■
197	■		■				■	■
198		■	■				■	■
199	■	■	■				■	■
200				■			■	■
201	■			■			■	■
202		■		■			■	■
203	■	■		■			■	■
204			■	■			■	■
205	■		■	■			■	■
206		■	■	■			■	■
207	■	■	■	■			■	■
208					■		■	■
209	■				■		■	■
210		■			■		■	■
211	■	■			■		■	■
212			■		■		■	■
213	■		■		■		■	■
214		■	■		■		■	■
215	■	■	■		■		■	■

	1	2	4	8	16	32	64	128
216				■	■		■	■
217	■			■	■		■	■
218		■		■	■		■	■
219	■	■		■	■		■	■
220			■	■	■		■	■
221	■		■	■	■		■	■
222		■	■	■	■		■	■
223	■	■	■	■	■		■	■
224						■	■	■
225	■					■	■	■
226		■				■	■	■
227	■	■				■	■	■
228			■			■	■	■
229	■		■			■	■	■
230		■	■			■	■	■
231	■	■	■			■	■	■
232				■		■	■	■
233	■			■		■	■	■
234		■		■		■	■	■
235	■	■		■		■	■	■
236			■	■		■	■	■
237	■		■	■		■	■	■
238		■	■	■		■	■	■
239	■	■	■	■		■	■	■
240					■	■	■	■
241	■				■	■	■	■
242		■			■	■	■	■
243	■	■			■	■	■	■
244			■		■	■	■	■
245	■		■		■	■	■	■
246		■	■		■	■	■	■
247	■	■	■		■	■	■	■
248				■	■	■	■	■
249	■			■	■	■	■	■
250		■		■	■	■	■	■
251	■	■		■	■	■	■	■
252			■	■	■	■	■	■
253	■		■	■	■	■	■	■
254		■	■	■	■	■	■	■
255	■	■	■	■	■	■	■	■

Dark shaded boxes indicate ON, white boxes OFF.

Camera Screen (Optional)

The camera screen sets the desired camera operation. The camera option includes up to three different cameras to monitor drum spooling and the area behind the crane.

Use the select buttons to select the camera screen from the menu screen. Press the enter button to access the screen. Use the select buttons to select the desired camera view. When done, press the exit button until the menu screen appears.

Pressure Test and Calibration Screen

The pressure test and calibration screen initiates and monitors the hydraulic test and calibration procedures. For instructions to run these tests, refer to Section 2.

DIELECTRIC GREASE

The following figures show the proper application of dielectric grease on all J-tech type connectors.

Dielectric grease is needed when assembling the J-tech type connectors. Apply a bead of grease on the o-ring and face of the socket connector. Apply a bead of grease on the o-ring of the pin connector. Do not apply grease to the face of the pin connector.

FIGURE 3-31

Use the following sizes when applying the bead of grease:

- On a 3-pin connector, apply a 1,5 mm (1/16 in.) bead.
- On a 24-pin connector, apply a 3 mm (1/8 in.) bead.
- On a 37-pin connector, apply a 5 mm (3/16 in.) bead.

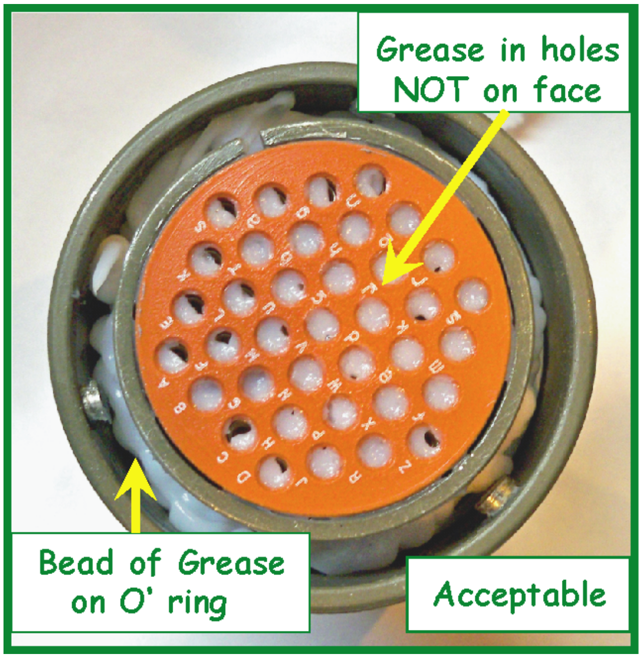


FIGURE 3-32

To apply the grease to the connector face, place a small amount of grease on your finger. Wipe your finger across the face, applying grease inside the socket holes with a layer less than 0,025 mm (0.001 in.) on the connector face. This keeps water out of the connectors and keeps the pins from fretting.

FIGURE 3-33

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SECTION 4
BOOM

TABLE OF CONTENTS

4

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Published 05-03-17, Control # 228-03

SECTION 4
BOOM

AUTOMATIC BOOM STOP

Maximum Boom Angle

The boom stop limit switch (5, Figure 4-2) stops the boom and applies the boom hoist brake when the boom is raised to angle A shown in Figure 4-1 and listed in Table 4-1.

Operation

See Figure 4-2 for the following procedure.

When the boom is below the maximum angle, the limit switch (5) is closed. The boom hoist can be operated.

When the boom is raised to the maximum angle, the boom butt (1) pushes the adjusting rod (2a or 2b) in and the actuator rod (11, View A) opens the limit switch (5). The boom hoist operation stops because the open limit switch turns off power to the boom hoist electrical circuit. The boom hoist pump shifts to neutral and the brake applies to stop boom movement.

WARNING

Falling Attachment Hazard!

If the boom fails to stop for any reason, stop the engine immediately. Troubleshoot the system to determine the problem.

Do not resume operation until the problem has been corrected.

Maintenance

At least once per week, make sure the boom stop stops the boom at the specified maximum angle. If not, replace any worn or damaged parts and/or adjust the boom stop.

Once the boom stop is properly adjusted, it should not require periodic adjustment. Adjustment is required, however, when the following occur:

- The luffing jib is installed or removed
- Parts are replaced

WARNING

Falling Attachment Hazard!

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

Table 4-1 — Boom Stop Angles

Angle A (see Figure 4-1)
84° — #58 Boom without Luffing Jib 88° — #58 Boom with #59 Luffing Jib

4

Bypass Limit Test

Perform the following test to determine if the boom up limit on your crane can be bypassed or not:

WARNING

Crush Hazard!

The weight of the boom will crush you and/or any surrounding equipment. Stay clear of any moving parts and maintain clear communications while working with the boom and boom accessories.

1. Lower the boom onto the blocking at ground level.
2. Have an assistant push in the adjusting rod (Figure 4-2) in to open the boom stop limit switch.
3. Rotate and hold the limit bypass key (in the crane cab) to the bypass position.
4. Try to boom up. Do not raise the boom any higher than necessary to perform the test:
    a. If the boom rises, your boom up limit can be bypassed.
    b. If the boom does not rise, your boom up limit cannot be bypassed.
5. The test is complete. Release the limit bypass key and the adjusting rod to the normal operating positions.

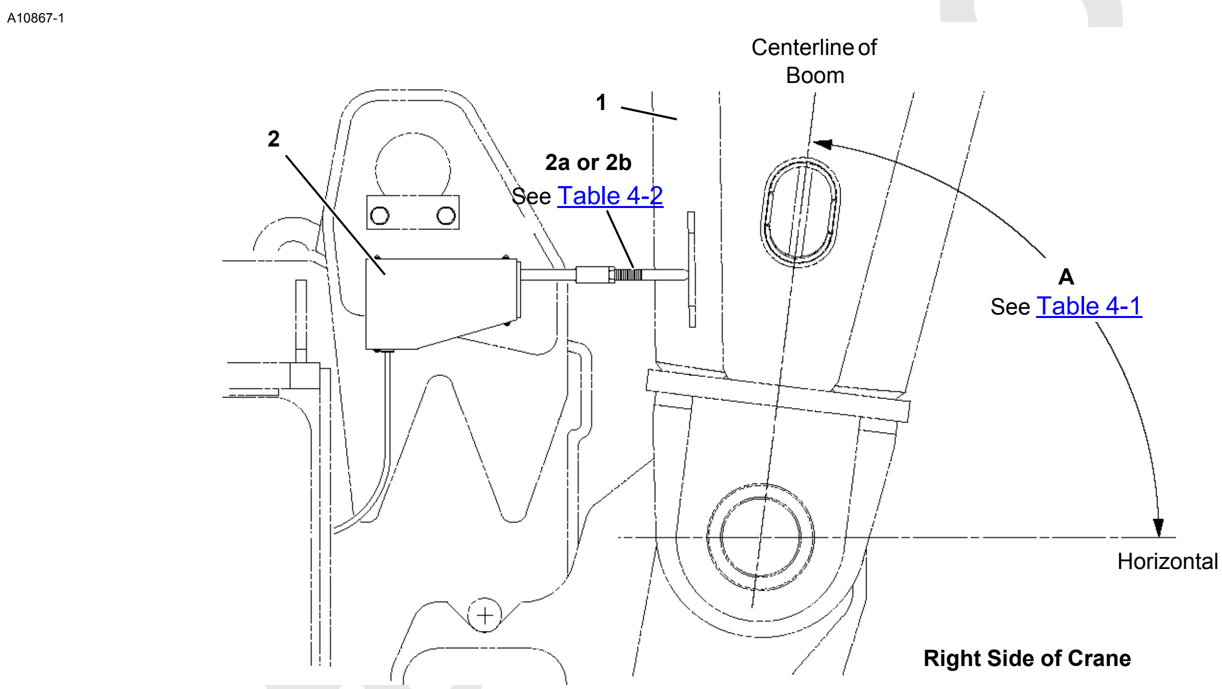


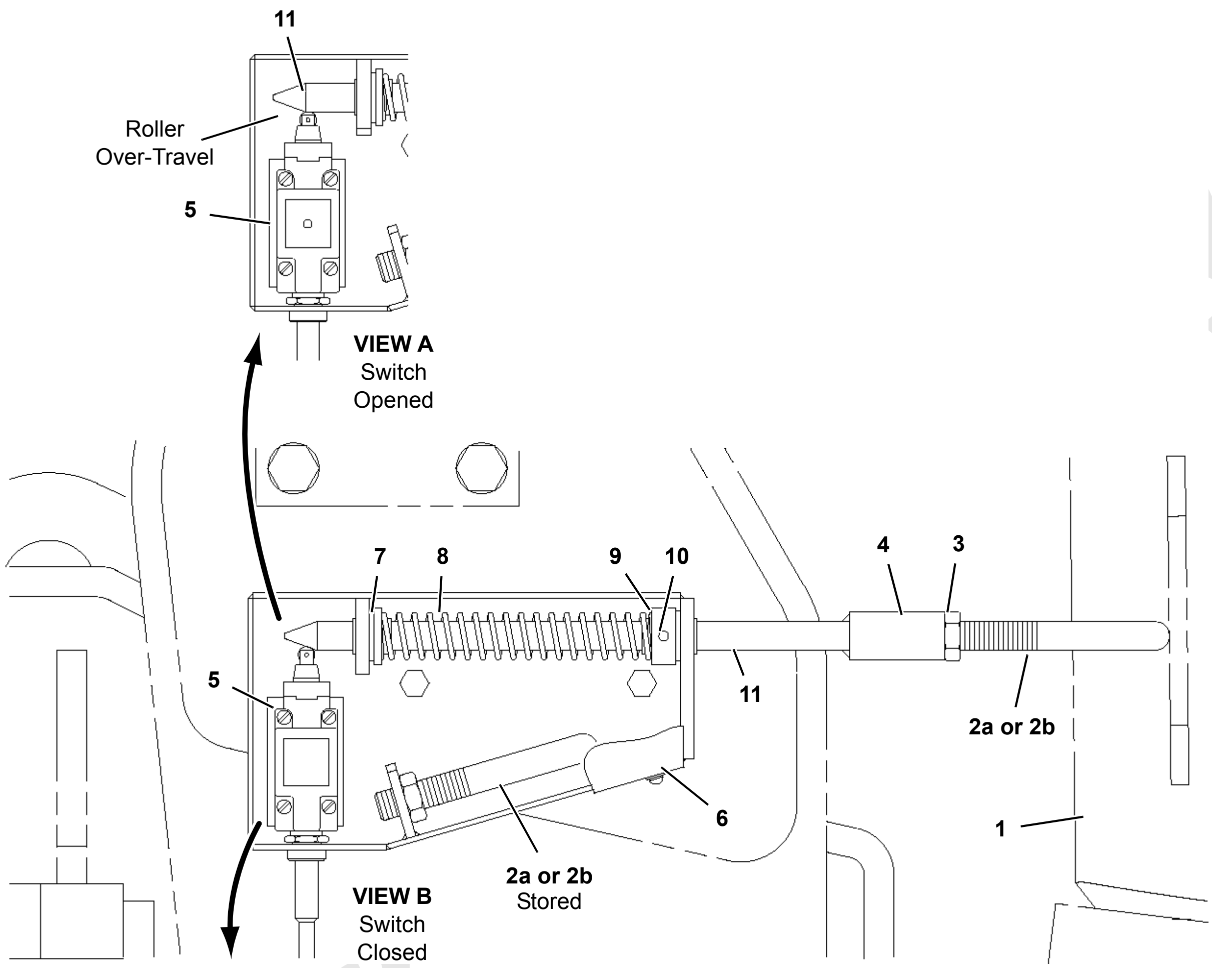
Table 4-2 — Adjusting Rods

Adjusting Rod and Length (see Figure 4-1)	
2a Boom Only	**2b** With Luffing Jib
145471 178 mm (7 in)	A18794 156 mm (6-1/8 in)

Item	Description
1	Boom Butt
2	Switch Assembly

FIGURE 4-1

A10867



Limit Switch Wiring

Receptacle	Switch Terminals			Function
1 (green)	22		14	Max Angle
2 (black)		13		GND
3 (white)	21			12 VDC Supply

Item	Description
1	Boom Butt
2a	Adjusting Rod – Boom only
2b	Adjusting Rod – Boom with Luffing Jib
3	Jam Nut
4	Coupling
5	Limit Switch
6	Cover
7	Spring Washer
8	Spring
9	Spring Washer
10	Dowel Pin 6 mm (1/4 in) Diameter
11	Actuator Rod
12	Digital Level (see Figure 4-3)

FIGURE 4-2

A10415

Angle A	Digital Level Angle
84°	76.3°
88°	80.3°

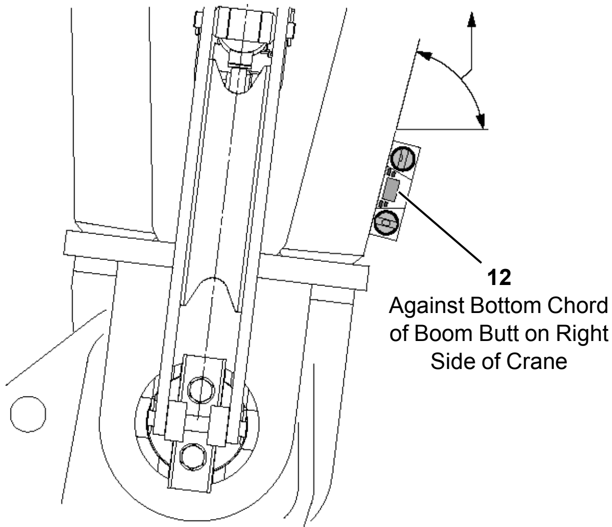


FIGURE 4-3

Adjustment

To adjust the boom limit, use the following procedure:

1. Park the crane on a firm level surface or level the crane by placing blocking under the crawlers.
2. Make sure the proper adjusting rod is installed (see Table 4-2).
3. Raise the boom to specified angle A (Figure 4-1) while monitoring the angle on the mechanical indicator or on the operating conditions screen of the front-console display.
4. Verify that the boom is at proper angle A:
   - **a.** Place an accurate digital level (12) on the boom butt as shown in Figure 4-3. The corresponding Digital Level Angle should appear on the digital level.
   - **b.** Raise or lower the boom as necessary.
5. If the boom stops at the specified angle, further adjustment is not needed.
   - **a.** If the boom stops before reaching the specified angle, go to step 6.
   - **b.** If the boom stops after reaching the specified angle, go to step 7.

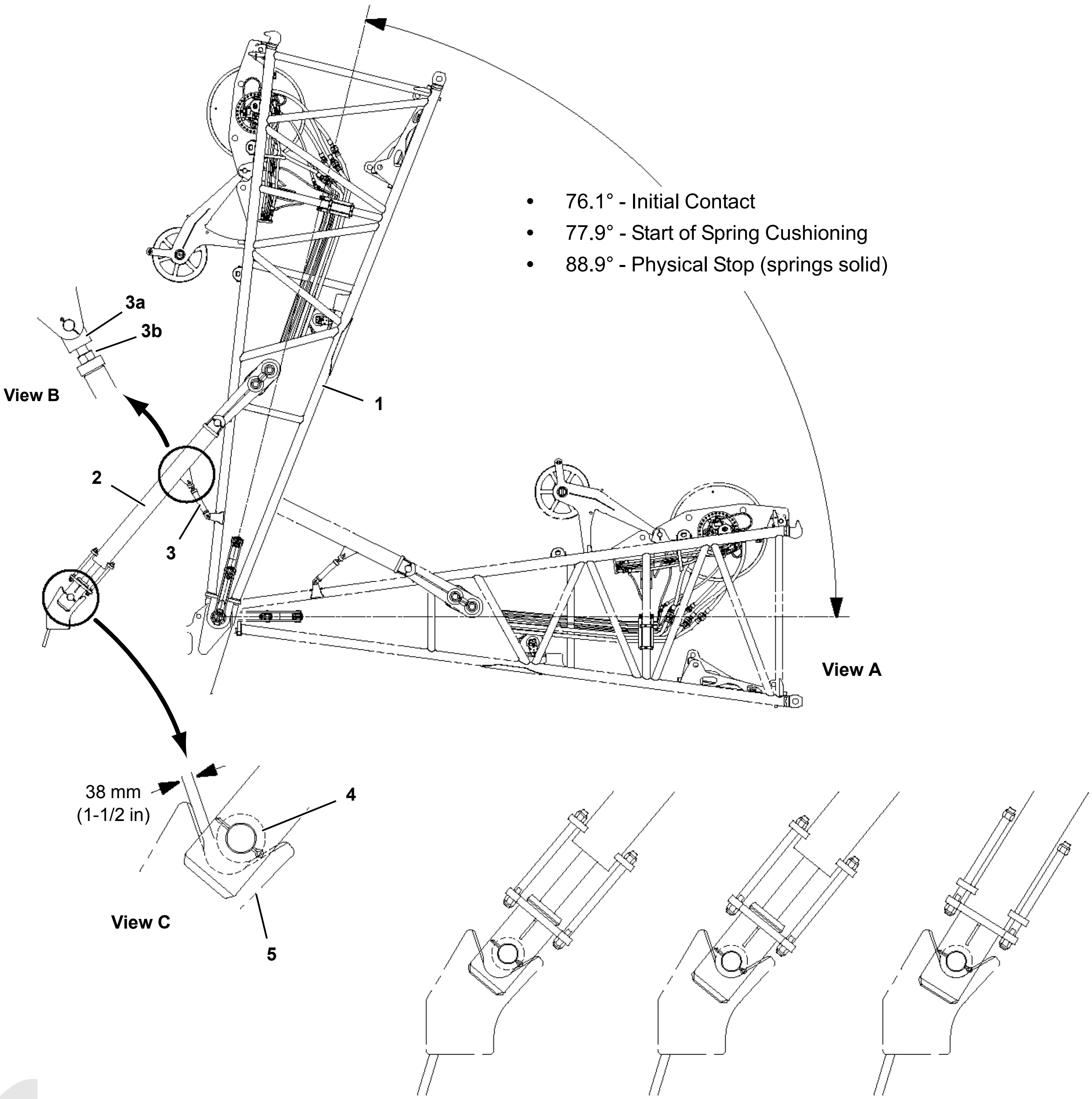
See Figure 4-2 for the remaining steps.

6. If the boom stops before reaching the specified angle, use the following procedure:
   - **a.** Loosen the jam nut (3, View B).
   - **b.** Turn the adjusting rod (2a or 2b) all the way into the coupling (4).
   - **c.** Boom up slowly until the boom reaches the specified angle.
   - **d.** Turn the adjusting rod (2a or 2b) out against the boom butt (1) until the limit switch (5) clicks in the open position (View A).
   - **e.** Tighten the jam nut (3).
7. If the boom stops after reaching the specified angle, use the following procedure:
   - **a.** Loosen the jam nut (3, View B).
   - **b.** Turn the adjusting rod (2a or 2b) out against the boom butt (1) until the limit switch (5) clicks in the open position (View A).
   - **c.** Tighten the jam nut (3).
8. Make sure the actuator rod (11) over-travels the limit switch as shown in View A.
9. To test the adjustment, using the following procedure:
   - **a.** Lower the boom several degrees below specified angle A.
   - **b.** Slowly raise the boom.
   - **c.** The boom must stop at specified angle A. If the boom does not stop at the specified angle, use the following procedure:
     - Stop raising the boom (move the control handle to OFF).
     - Lower the boom several degrees below the specified angle.
   - **d.** Repeat adjustment steps 2 through 9.

ACTUATOR ROD REPLACEMENT

See Figure 4-2, View B for the following procedure:

1. Remove the damaged actuator rod (11).
2. Slide the spring washers (7 and 9) and spring (8) over the new actuator rod (11) then slide the actuator rod into the bracket assembly.
3. Position the actuator rod (11) so the tapered end just touches the roller on the limit switch (5, View B). The actuator rod must not depress the limit switch roller.
4. Drill a 6 mm (1/4 in) hole through the spring washer (9) and actuator rod (11).
5. Install a dowel pin (10).
6. Install the proper adjusting rod (2a or 2b).
7. Adjust the boom stop.



Item	Description
1	Boom Butt
2	Physical Boom Stop
3	Strut
3a	Nut
3b	Adjusting Rod
4	Roller
5	Saddle

Boom at 76.1º
Initial Contact

Boom at 77.9º
Start of Cushioning

Boom at 88.9º
Physical Stop
(Springs Solid)

FIGURE 4-4

PHYSICAL BOOM STOP

See Figure 4-4

Stop Angles

The physical boom stops multiple purposes, including the following:

- Assist in stopping the boom smoothly at any angle above 77.9°
- Assist in preventing the boom rigging from pulling the boom back when traveling or setting loads with the boom at any angle above 77.9°
- Assist in moving the boom forward when lowering the boom from any angle above 77.9°
- Provide a physical stop at 88.9°

WARNING

Physical boom stops must be installed for all crane operations.

Physical boom stops do not automatically stop the boom at the maximum operating angle. The automatic boom stop must be installed and properly adjusted.

Operation

The physical boom stops operate in the following order:

1. When the boom is raised to 77.9°, springs in the boom stop tubes begin to compress.
2. As the boom is raised higher, spring compression increases to exert greater force against the boom.
3. If, for any reason, the boom is raised to 88.9°, the boom stop springs fully compress to provide a physical stop.

Adjustment

To adjust a physical boom stop, use the following procedure:

1. Raise the boom butt (1, View A) until the boom stop rollers (4) make contact with the saddles (5, View C) on the rotating bed.
2. Adjust the rod ends (3a, View B) so the gap between the rollers (4) and the bottom of the saddles is at the dimension shown in View C.
3. Securely tighten the jam nuts (3b).

BOOM AND LUFFING JIB ANGLE INDICATOR

Angle indicator sensors are located inside the node controllers mounted on the boom top and on the luffing jib top (see Figure 4-5). The boom and luffing jib angles are calibrated automatically by the crane's programmable controller as part of the load indicator calibration procedure (see the RCL Operation Manual for instructions).

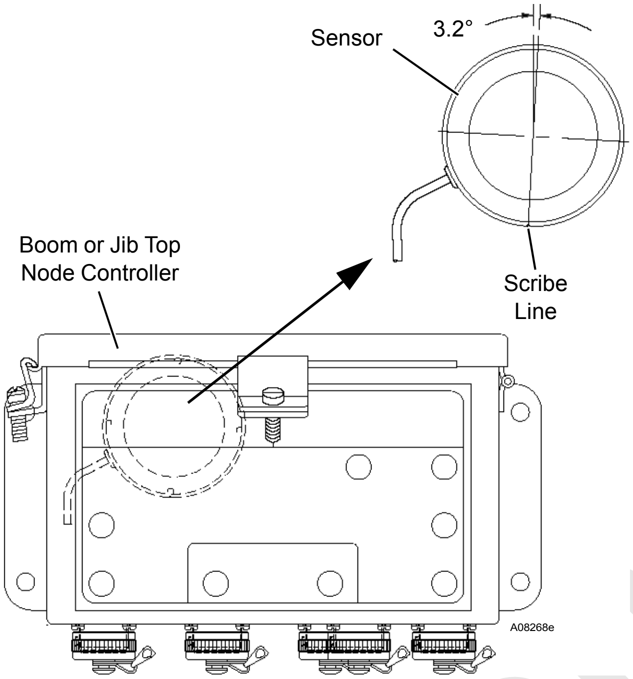


FIGURE 4-5

Table 4-3

Wires	Receptacle ID	Function
Red	J17-1	Ground
Green	J17-2	Signal
Black	J17-3	5 VDC Supply
White	Not Used	

MAST ANGLE

See Figure 4-6 for the following.

Mast Angle Sensor

The mast angle sending unit (Figure 4-6) houses a solid-state sensor (Figure 4-8) that provides an electrical signal to the crane's programmable controller. The programmable controller uses the signal to automatically control the position of the mast raising cylinder and levers during crane setup, as well as to allow the operator to monitor the mast angle on the display during crane setup.

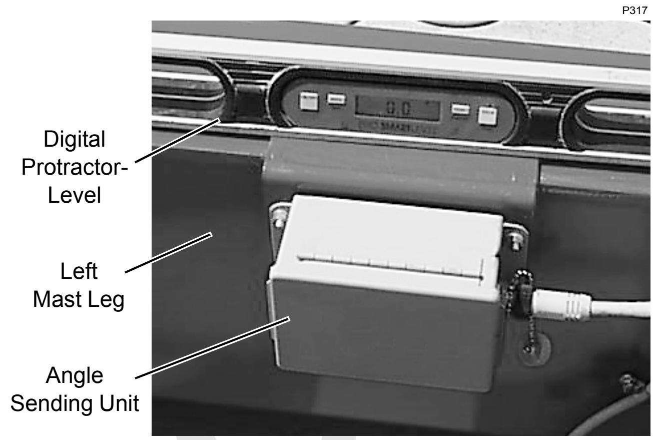


FIGURE 4-6

Adjusting Mast Angle

The mast angle sensor was set at the factory and should not require periodic adjustment. However, adjustment is necessary when parts are replaced. To adjust the mast angle sensor, use the following procedure:

1. Park the crane on a solid, level surface.
2. Lower the mast to the transport position.
3. Place a digital protractor-level on the mast (Figure 4-6) and note the mast angle.
4. Go to the mast angle on the information screen of the main display. Note the mast angle.

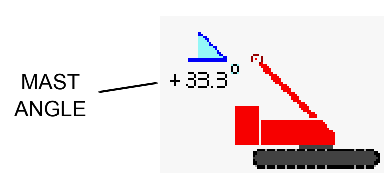


FIGURE 4-7

5. The angles noted in steps 3 and 4 must match within 1°.
6. If necessary, loosen the mounting screws and rotate the sending unit in the mounting slots until the reading on the display matches the angle on the level.
7. Securely tighten the mounting screws to lock the adjustment.

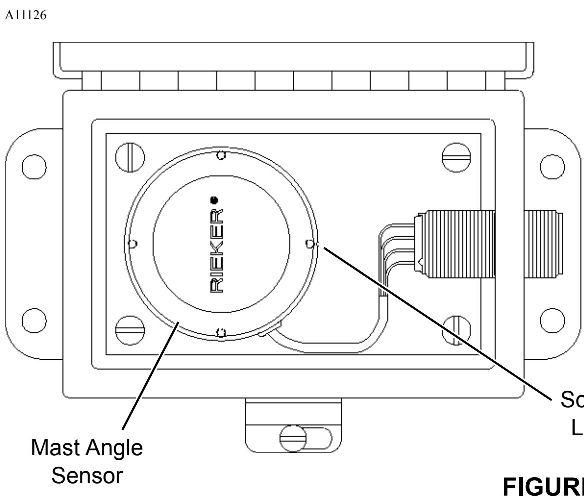


FIGURE 4-8

Table 4-4

Wires	Receptacle ID	Function
Red	J1-A	Supply Voltage 5 VDC or 10 VDC
Green	J1-B	Analog Output 1 0 to 5 VDC
Black	J1-C	System Ground Power and Signal
White	J1-D	Analog Output 2 0 to 10 VDC

DRUM PRESSURE ROLLER

An optional pressure roller assembly is available for the boom hoist drum.

The roller is spring-loaded to assist in maintaining proper wire rope spooling by firmly holding the wire rope against the drum and subsequent layers.

WARNING

Crush Hazard!

The roller is spring-loaded. Stop the drum and turn off the engine before adjusting the roller.

Adjustment

See Figure 4-9 for the following procedure.

The operator shall monitor drum spooling during operation.

If the wire rope jumps layers or does not wind smoothly onto the drum, perform following steps:

1. Hold the spring guide (7) wrench flat.
2. Tighten the lock nut (5) to increase spring tension.

Item	Description
1	Drum
2	Pressure Roller
3	Roller Frame
4	Pivot Pin
5	Lock Nut
6	Spring
7	Spring Guide

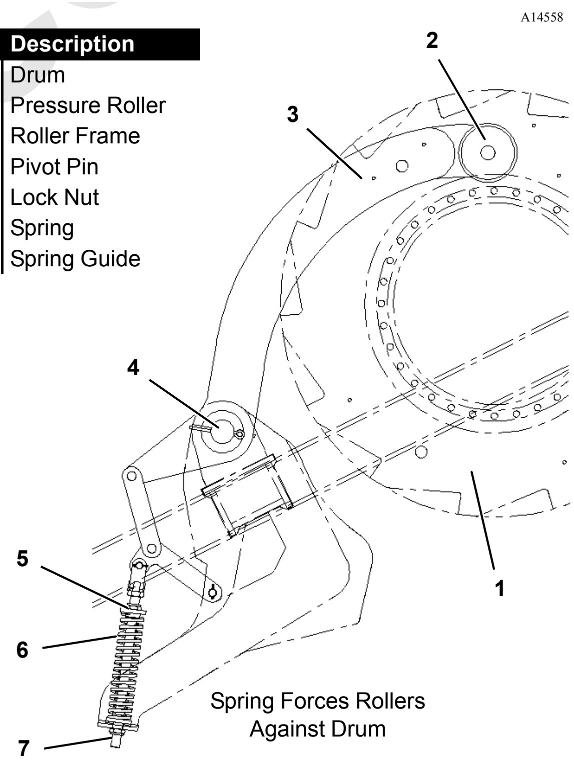


FIGURE 4-9

STRAP INSPECTION AND MAINTENANCE

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

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

WARNING

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

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

Inspection

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

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

Frequent Inspection

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

Periodic Inspection

Periodic inspection must be performed at least monthly. During this inspection, the entire length of the strap must be inspected to ensure it is within specifications. The strap must comply with all specifications identified in this section. Any damage found must be recorded and a determination made as to repair or replace.

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

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

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

Cranes Not in Regular Use

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

Identifying Straps

To aid in identification, the part number is stamped into both ends of each strap as shown in Figure 4-10.

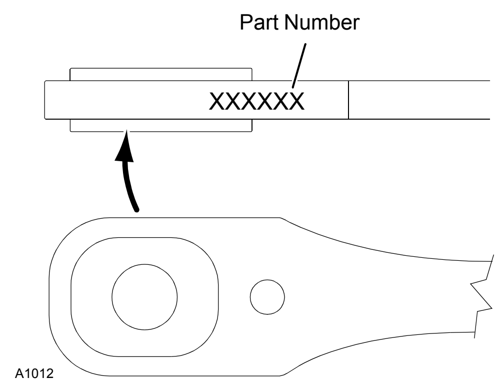


FIGURE 4-10

Replacement Specifications

Any strap not within the specifications listed in Table 4-5 must be replaced.

⚠ WARNING

If damage to the strap exceeds what is allowed within the specifications, do not operate the crane until the strap has been replaced.

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

Table 4-5 Strap Specifications

Condition	Reference	Allowable Tolerance or Deviation	Corrective Action
Dent	Figure 4-11	< 3,175 mm (0.13 in)	Monitor condition.
		≥ 3,175 mm (0.13 in)	Remove the strap from service.
Kink	Figure 4-12	None	Remove the strap from service.
Crack or Break	Figure 4-13	None	Remove the strap from service.
Corrosion or Abrasion	Figure 4-14	<6% of strap thickness	Sandblast and paint to maintain continuous protective coating.
		≥6% of strap thickness	Remove the strap from service.
Straightness (gradual or sweeping bend)	Figure 4-15	Varies depending on strap length	Remove the strap from service if deviation exceeds maximum allowed.
Flatness (includes twisted straps)	Figure 4-16	Varies depending on strap length.	Remove strap from service if deviation exceeds maximum allowed.
Elongated Holes	Figure 4-17	None	Remove the strap from service.
Length	Figure 4-18	None	Remove the strap from service.

< = less than
≥ = equal to or greater than

Dent

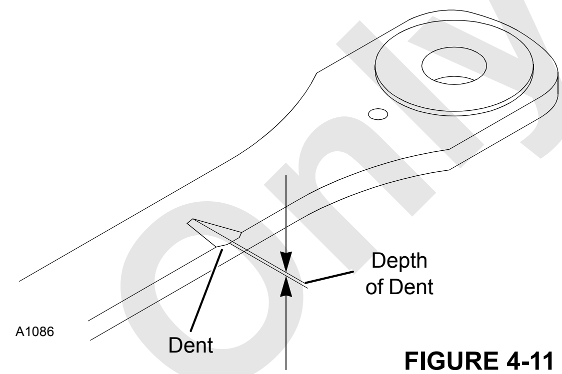


FIGURE 4-11

Kink

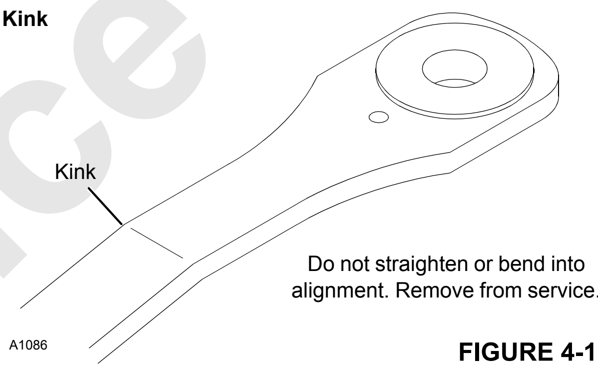


FIGURE 4-12

Crack or Break

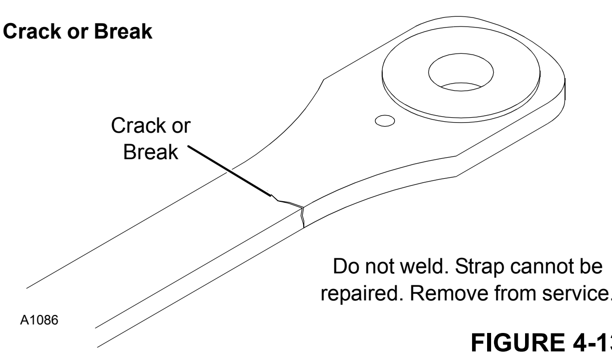


FIGURE 4-13

Corrosion or Abrasion

See Figure 4-14 for the following procedure.

For quick identification by repair workers, clearly mark the damaged areas with brightly colored tape.

To evaluate the strap for corrosion, use the following procedure:

1. Sandblast to remove corrosion. **Do not grind.**
2. Determine the reduction in thickness.
3. If reduction is less than 6% of strap thickness, paint the strap to maintain continuous protective coating.
4. If reduction is 6% or more, remove the strap from service.

Corrosion or Abrasion

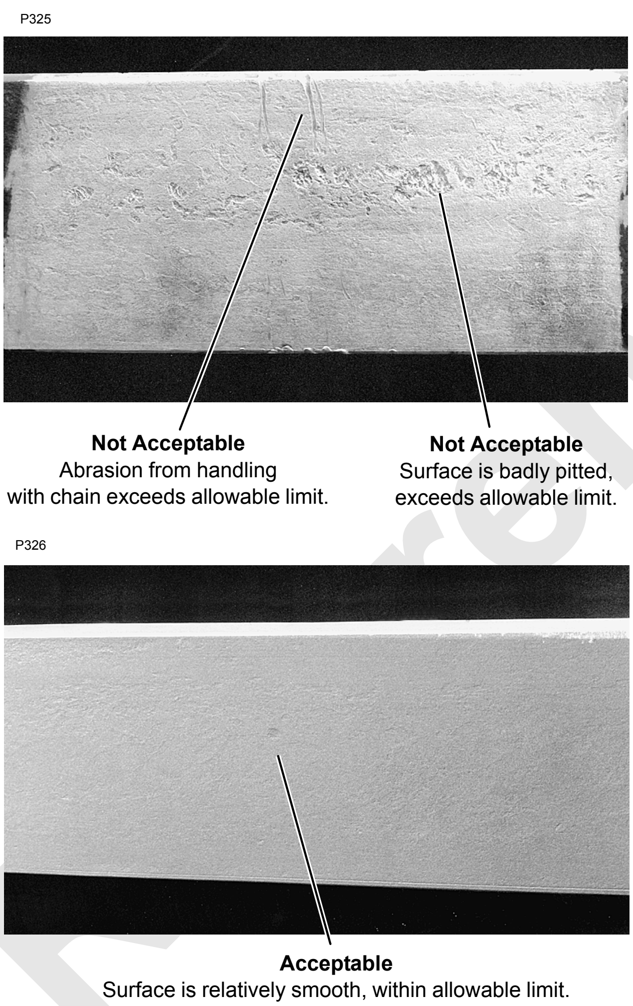


FIGURE 4-14

Straightness

See Figure 4-15 for the following procedure:

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

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

Strap Length (L)	Maximum Deviation Allowed
1,5 to <3,0m (5 to <10 ft)	1,5 mm (0.060 in)
3,0 to <6,1 m(10 to <20 ft)	3 mm (0.125 in)
6,1 to <9,1 m (20 to <30 ft)	6 mm (0.236)
9,1 to <12,2 m (30 to <40 ft)	9 mm (0.375)
12,2 to <15,2 m (40 to <50 ft)	12mm (0.50)

< = less than

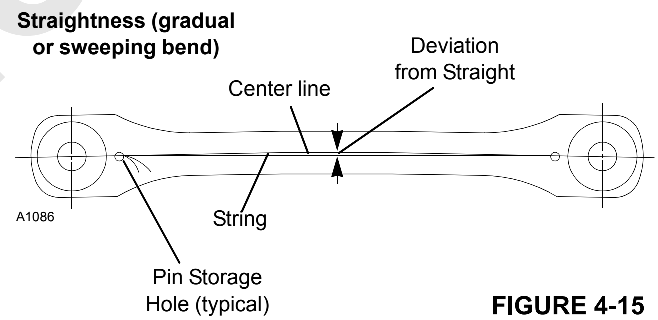


FIGURE 4-15

Flatness

See Figure 4-16 for the following procedure:

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

   If deviation from straight is greater than the maximum allowed, remove the strap from service.
6. Remove the line. Turn the strap over.
7. Repeat steps 1 through 5 above.

Flatness (includes twisted straps)

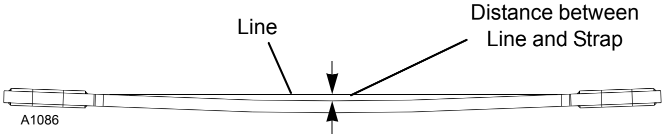


FIGURE 4-16

Elongated Hole

See Figure 4-17 for the following procedure:

1. Insert the pin into the hole.
2. Push the pin tight against the edge of the hole along the horizontal center line. Measure the dimension between the pin and the hole (View A).
3. Push the pin tight against the edge of the hole along the vertical center line. Measure the dimension between the pin and the hole (View B).

   If dimensions A and B are not identical, the hole is elongated. Remove the strap from service.

   If the two dimensions are identical, but greater than 0,8 mm (0.030 in), contact the Manitowoc Crane Care Lattice Team.

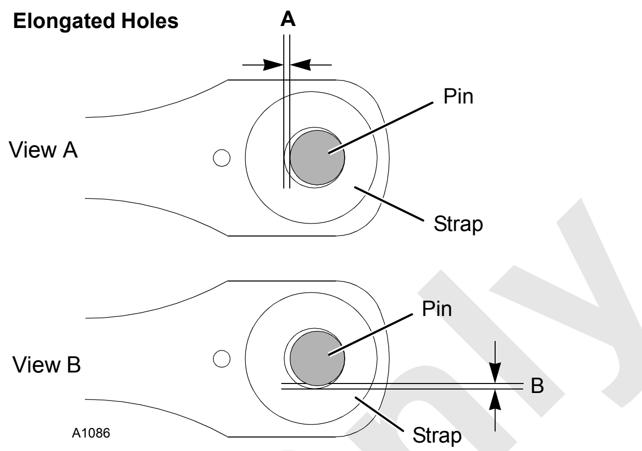


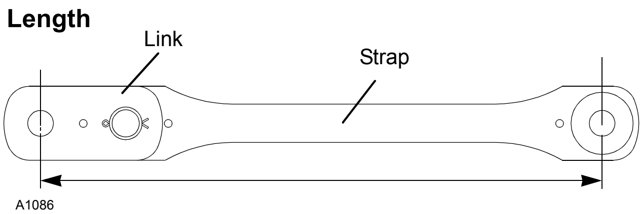
FIGURE 4-17

Table 4-6

Strap Length (L) m (f)	Maximum Deviation Allowed	
	25 to <51 mm (1 to <2 in) Thick	51 to <102 mm (2 to <4 in) Thick
<0,9 (<3)	4,3 (0.17)	12,7 (0.50)
0,9 to <1,2 (3 to <4)	15,9 (0.63)	14,3 (0.56)
1,2 to <1,5 (4 to <5)	19,1 (0.75)	17,5 (0.69)
1,5 to <1,8 (5 to <6)	20,6 (0.81)	19,1 (0.75)
1,8 to <2,1 (6 to <7)	22,2 (0.87)	19,1 (0.75)
2,1 to <2,4 (7 to <8)	23,8 (0.94)	19,1 (0.75)
2,4 to <2,7 (8 to <9)	25,4 (1.0)	19,1 (0.75)
2,7 to <3,0 (9 to <10)	25,4 (1.0)	22,2 (0.87)
3,0 to <3,7 (10 to <12)	25,4 (1.0)	25,4 (1.0)
≥3,7 (≥12)	Deviation not to exceed 25,4 mm (1 in) in any 3,7 m (12 ft) length of strap	

< = less than

≥ = equal to or greater than



Measure to check the length. See the appropriate Rigging drawing in the Operator Manual for the original length. Strap length includes the connecting link. If change in the length is detected, remove the strap from service.

FIGURE 4-18

Storing Straps

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

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

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

Removing Straps from Service

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

Inspection Checklist

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

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

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

LATTICE INSPECTION AND LACING REPLACEMENT

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

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SECTION 5
HOISTS

TABLE OF CONTENTS

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SECTION 5
HOISTS

BOOM/MAST HOIST PAWL

See Figure 5-1 for the following procedure.

The boom/mast hoist (Drum 4) has a drum pawl which is a positive locking device. When engaged, the pawl prevents the boom/mast hoist drum from turning in the down direction.

The pawl (2) is controlled by the Drum 4 park switch in the operator cab:

- When park is turned on, the pawl engages. The hydraulic cylinder (3) extends and spring force (6) rotates the pawl into engagement with the ratchet (1).
- When park is turned off, the pawl disengages. The hydraulic cylinder retracts, and the cam (5) rotates to disengage the pawl from the ratchet.

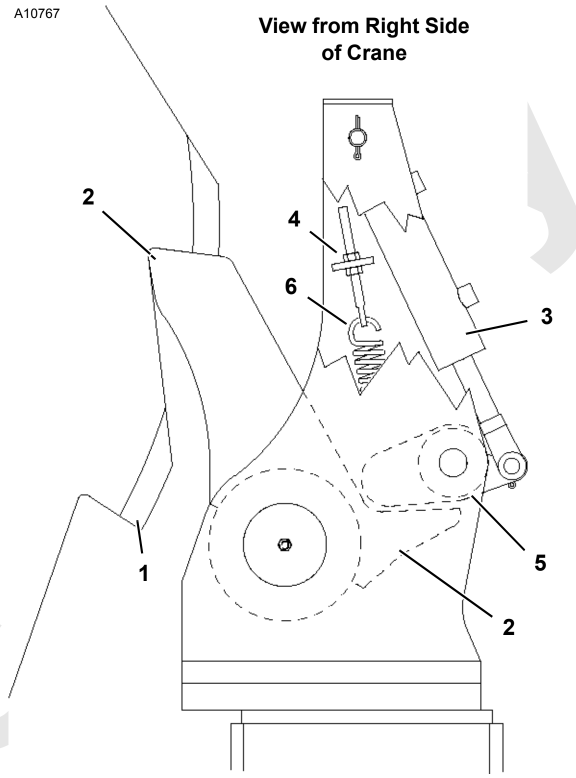
  It may be necessary to hoist slightly to fully disengage the pawl from the ratchet.

Maintenance

The only maintenance required is to visually check the pawl for proper operation. This should be done daily when the boom/mast hoist is in use.

If necessary, adjust the eye bolt so the spring has sufficient tension to fully engage the pawl with the ratchet.

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.



Item	Description
1	Ratchet
2	Pawl
3	Hydraulic Cylinder
4	Eye Bolt
5	Cam
6	Spring

FIGURE 5-1

5

SPEED SENSOR

See Figure 5-2 for the following procedure.

The hydraulic motors for the hoists (boom, mast, load) and swing have a speed sensor. For those functions with more than one motor, only one of the motors has a speed sensor.

Each speed sensor monitors the rotational speed and direction of the corresponding motor. The sensor sends a signal to a remote node controller that transmits the information to the crane's master controller. The master controller uses the information to control the crane function.

Replacement

WARNING

Burn Hazard!

Hydraulic oil that may be hot will drain from the motor port when the sensor is removed. Wait for the hydraulic oil to cool before removing the sensor.

When removing the speed sensor from a motor, be careful to contain the hydraulic fluid that will drain from the motor. After installing a new sensor, add clean hydraulic oil to the level of the motor top case drain port before starting the engine.

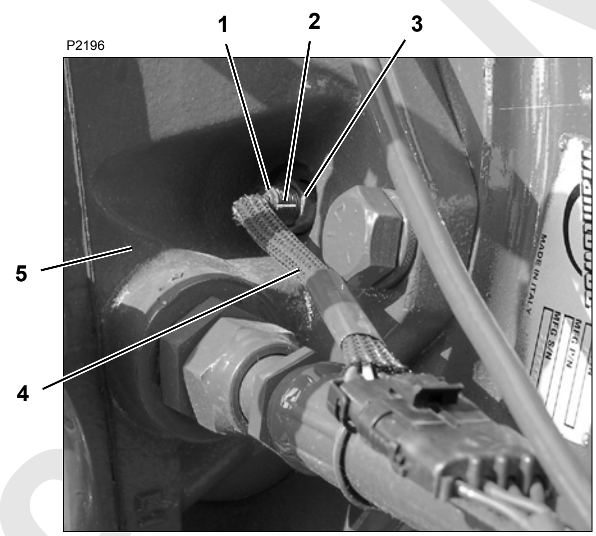
Adjustment

The speed sensors are set at the factory and should not need adjustment, unless replaced. In the event the sensors need adjustment, use the following procedure:

1. Bring the corresponding function to a complete stop, land any suspended load if a load drum is being serviced, and park the function.
2. Remove the faulty sensor. Do not connect the sensor cable (4) to the crane wire harness until the initial adjustment is made.
3. Loosen the lock nut (3) and carefully turn the sensor(1) clockwise by hand until it gently contacts the speed ring inside the motor.
4. Back the sensor out one full rotation or more until the notch is positioned 180° from the motor shaft (facing the outboard side of the motor).
5. Connect the sensor cable to the crane wire harness.
6. Operate the drum motor and check for a steady drum speed (RPM) signal on the corresponding drum diagnostic screen in the cab.

   If necessary, turn the sensor out slightly until the drum speed (RPM) is steady at a low and high RPM.
7. Hold the sensor in position and securely tighten the lock nut.

Item	Description
1	Speed Sensor
2	Notch
3	Lock Nut
4	Cable
5	Motor



Typical Speed Sensor Location

FIGURE 5-2

MINIMUM BAIL LIMIT

See Figure 5-3 for the following procedure.

The optional minimum bail limit assembly on Drum 1 (main hoist) and Drum 2 (auxiliary hoist) is a protective device that limits how much wire rope can be spooled off either drum.

The minimum bail limit automatically stops the corresponding drum when there are 3 to 4 wraps of wire rope remaining on the first layer. The drum can be operated in the hoist direction when the minimum bail limit switch is contacted.

Adjusting the minimum bail limit switch requires operating the drum to spool wire rope off the drum.

WARNING

Falling Load Hazard!

Do not operate a drum with less than 3 or 4 full wraps of wire rope remaining on the drum. Doing so can cause the wire rope to be pulled out of the drum and the load to fall.

Weekly Maintenance

Perform the following during weekly maintenance:

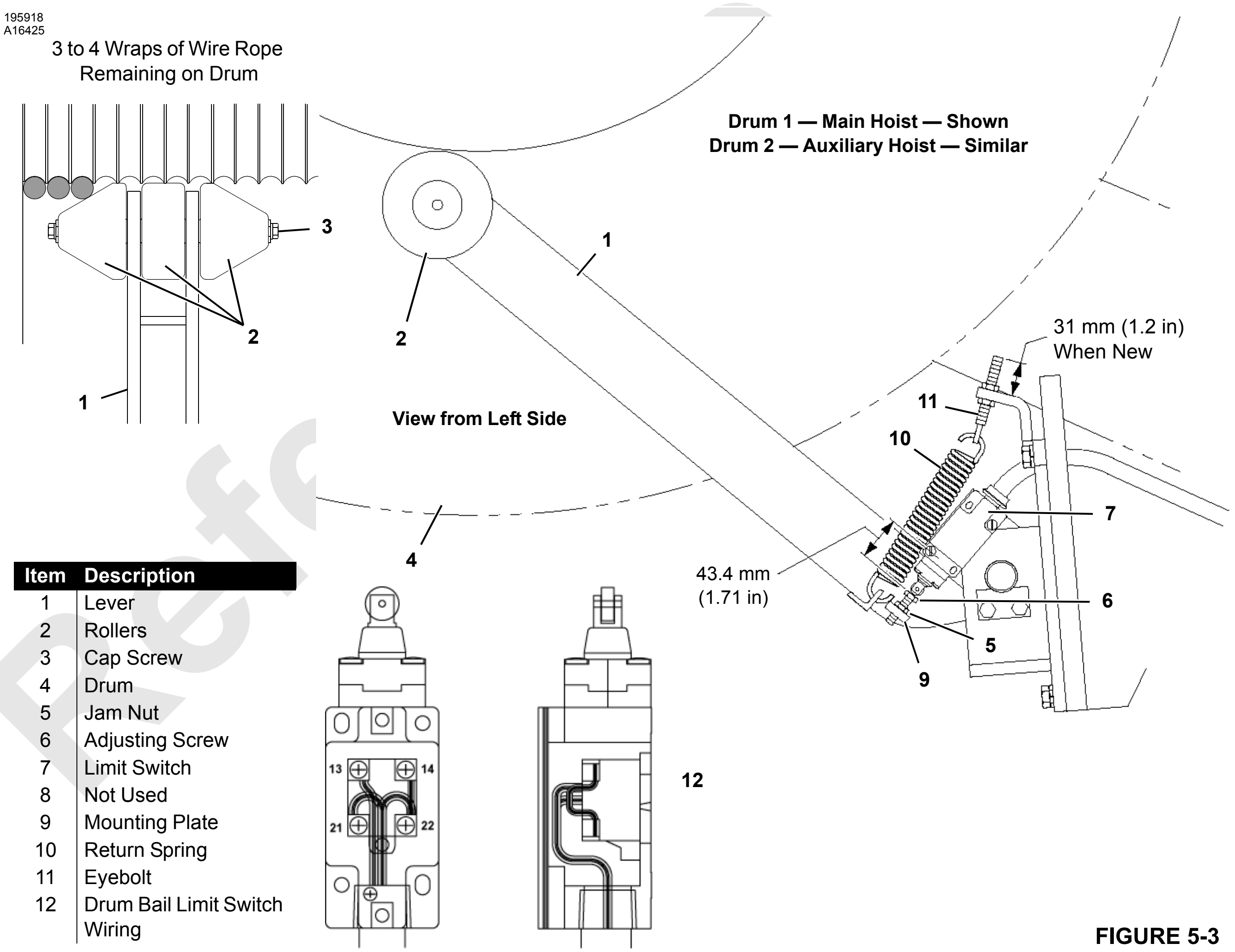
1. Check the minimum bail limit switch for proper operation:
   a. The limit switch should be depressed to the dimension given in Figure 5-3 for normal operation.
   b. Pay out wire rope from the drum. The drum should stop with approximately 3 to 4 wraps of wire rope remaining on the first layer. Adjust the limit switch if necessary.
2. Make sure the cap screws holding the rollers on the lever shaft are tight.
3. Check the tension on the return springs. If necessary, adjust the eyebolts so the springs hold the rollers snug against the bare drum.

Adjustment

Use the following steps during adjustment:

1. Pay out wire rope until the rollers are against the bare drum with 3 to 4 wraps of wire rope remaining on the first layer.
2. Make sure the rollers (2) contact the drum (4).
3. Turn the adjusting screw (6) until the limit switch is depressed to 43,4 mm (1.71 in) as shown in Figure 5-3.
4. Spool several wraps of wire rope onto the drum. Then, pay out wire rope. The drum must stop with 3 to 4 wraps of wire rope remaining on the first layer.

   Repeat the adjustment steps if necessary.
5. Tighten the jam nut against the mounting plate to lock the adjustment.
6. Make sure the return springs have sufficient tension to hold the rollers snugly against the bare drum. Adjust the eyebolts if necessary.



Item	Description
1	Lever
2	Rollers
3	Cap Screw
4	Drum
5	Jam Nut
6	Adjusting Screw
7	Limit Switch
8	Not Used
9	Mounting Plate
10	Return Spring
11	Eyebolt
12	Drum Bail Limit Switch Wiring

FIGURE 5-3

BLOCK-UP LIMIT

A block-up limit (also called an anti two-block device) is a two-blocking prevention device that automatically stops the load drum from hoisting and the boom from lowering when a load is hoisted a predetermined distance.

Two-blocking is an unsafe condition when the load block or weight ball contacts the sheave assembly it is suspended from.

Two-blocking can cause sheaves and wire rope to fail, possibly causing the load to fall.

WARNING

Two-Blocking Hazard!

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

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

The block-up limit system consists of the following components (see Figure 5-4):

- A normally closed limit switch assembly fastened at the following locations:
  - Lower boom point
  - Upper boom point
- A weight, freely suspended by chain from each limit switch actuating lever, that encircles the load line as shown.
- A lift block fastened to the load line, or lift plates fastened to the load block.

Operation

See Figure 5-4 and Figure 5-5 for component identification.

For a complete wiring diagram of the system, see the Boom Wiring and Limits Drawing in Section 3.

Block-Up Limit Control Deactivated

During normal operation, the weight overcomes spring force and rotates the actuating lever away from the limit switch lever. This action allows the limit switch to close the load drum up and boom down electric circuits. Therefore, the load can be hoisted and the boom can be lowered.

Block-Up Limit Control Activated

When the weight is lifted by the lift block or lift plates, spring force rotates the actuating lever against the limit switch lever. This action causes the corresponding limit switch to open the load drum up and boom down electric circuits.

The load drum and boom/mast hoist pumps stroke to off. At the same time, the load drum and boom parking brakes apply to stop the load drum from hoisting and the boom from lowering.

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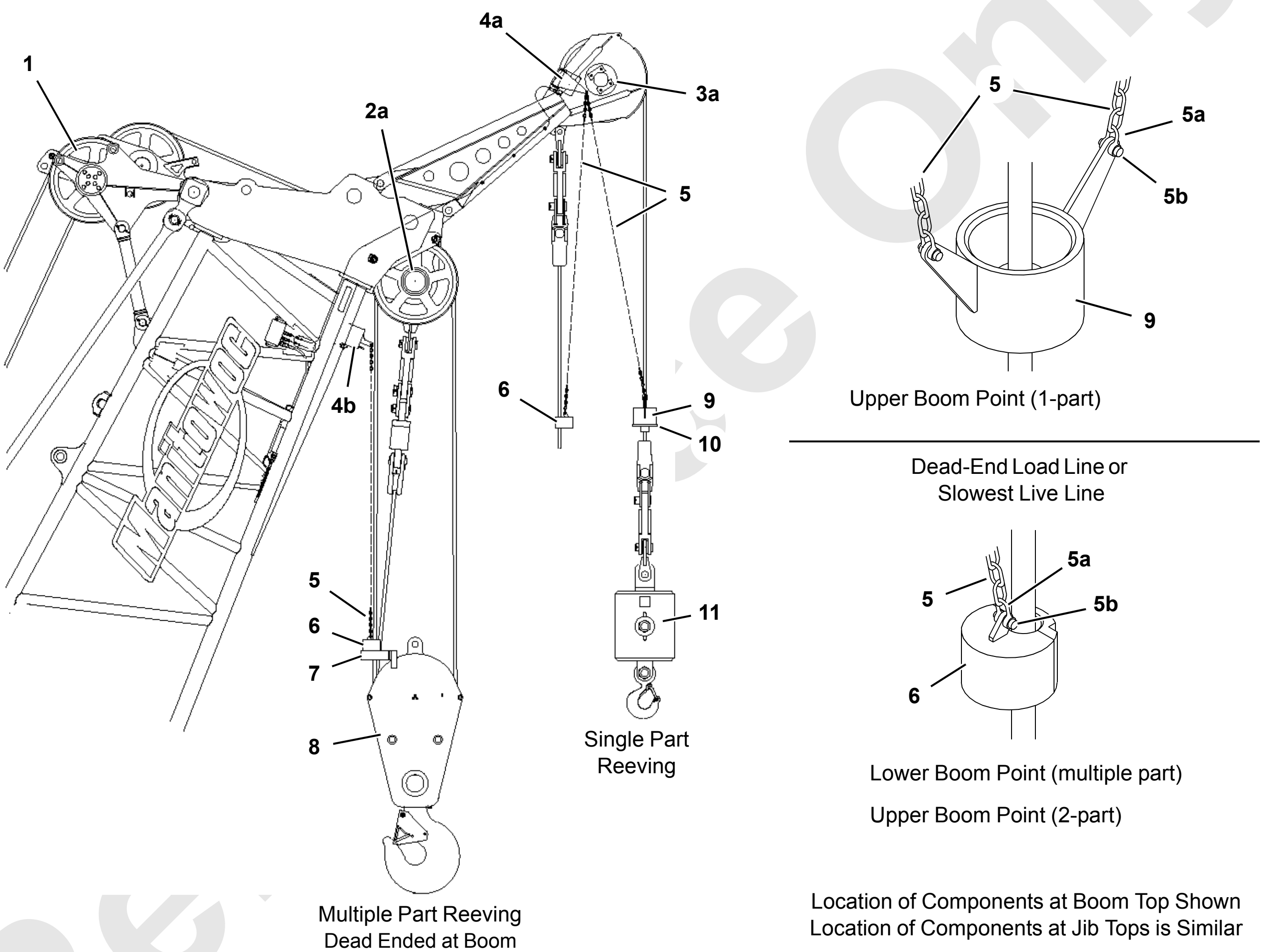
Item	Description	Item	Description
1	Wire Rope Guide	5a	Shackle
2a	Lower Boom Point	5b	Pin
2b	Extended Upper Boom Point (lower sheaves)	6	Weight
3a	Standard Upper Boom Point	7	Lift Plate
3b	Extended Upper Boom Point (upper sheave)	8	Load Block
4a	Block-Up Limit Switch (left hand)	9	Weight
4b	Block-Up Limit Switch (right hand)	10	Lift Block
5	Chain	11	Weight Ball



Location of Components at Boom Top Shown
Location of Components at Jib Tops is Similar

See Load Block Reeving Diagrams for
Suggested Location of Weight with
Multiple Part Reeving

FIGURE 5-4

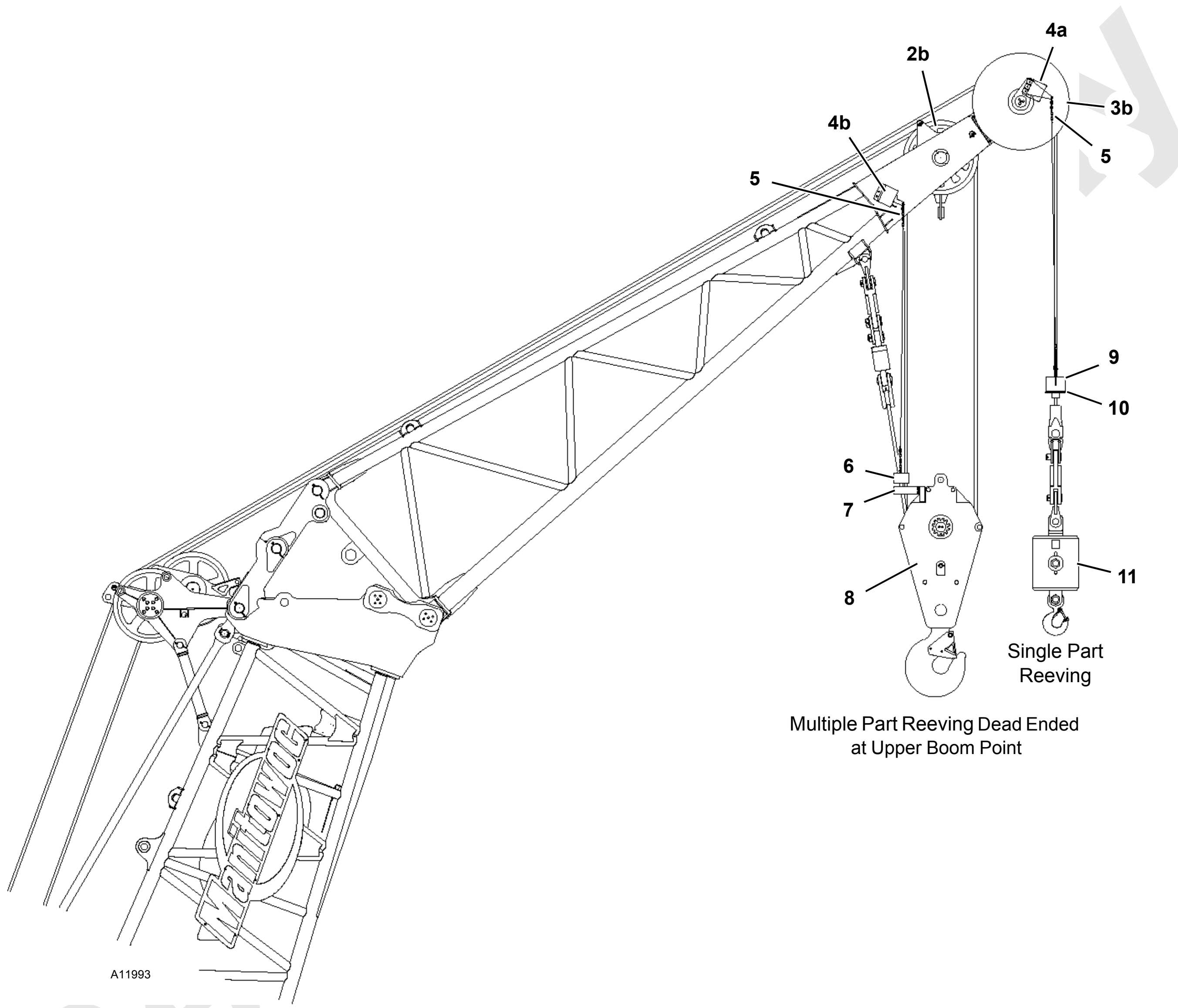


FIGURE 5-4 continued

Maintenance

Inspect and test the block-up limits weekly or every 40 hours of operation, whichever comes first, using the following procedure:

CAUTION

Avoid Machinery Damage!

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

---

1. Lower the boom and jib onto blocking at the ground level and carefully inspect the following items:
   a. Inspect each limit switch lever and actuating lever for freedom of movement. If movement is not free, apply a half shot of grease to the fitting on the actuating lever. Wipe away any excess grease.
   b. Inspect each weight for freedom of movement on the load line.
   c. Inspect each weight, chain, shackle and connecting pin for excessive or abnormal wear. Make sure all cotter pins or shackles are installed and spread.
   d. Inspect the entire length of each electric cable for damage.
   e. Make sure electrical cables are clear of all moving parts on the boom and jib and that cables are securely fastened to the boom and jib with nylon straps.
   f. Check that all plugs are securely fastened.
2. Test the block-up limits for proper operation using either of the following methods:
   a. To test with the boom lowered, manually lift each weight, one at a time, while the engine is running. The load drum should not operate in the hoist direction and the boom/mast hoist should not operate in the lower direction.
   b. To test with the boom raised, slowly hoist each load block and weight ball, one at a time, against weight. When the chain goes slack, the corresponding load drum should stop hoisting and the boom/mast hoist should not operate in the lower direction.

CAUTION

Avoid Sheave Damage!

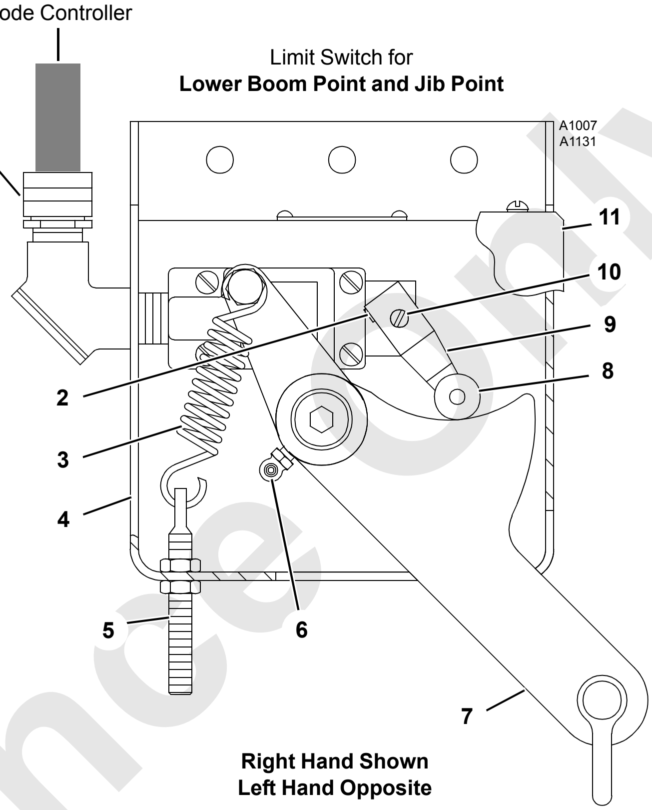
Use extreme care when testing block-up limits when the boom is raised. If a block-up limit fails to stop the load, immediately stop the load by moving the drum control handle to off. If the load is not stopped, two-blocking may occur.

Adjustment

See Figure 5-5 for the following procedure.

Lower the boom onto blocking at the ground level and adjust each limit switch using the following procedure:

1. Adjust the spring tension so there is enough force to lift the weight of the chain and rotate the actuating lever when the weight is lifted.
2. Loosen the setscrew in the limit switch lever so the lever is free to rotate.
3. Manually lift the weight to allow the actuating lever to rotate upward.
4. Hold the actuating lever at the position shown in Figure 5-5.
5. Hold the roller on the limit switch lever against the actuating lever while performing step 6.
6. Turn the limit switch shaft counterclockwise (for right hand) or clockwise (for left hand) only enough for the limit switch to click into the open position and hold there. Then securely tighten the setscrew in the limit switch lever.
7. Test the limit switch for proper operation (see the Maintenance topic for details). Repeat adjustment steps until the limit switch operates properly.



Item	Description
1	Elbow with Cord Gripper
2	Set screw
3	Spring
4	Enclosure
5	Adjusting Screw (spring tension)
6	Grease Fitting
7	Actuating Lever
8	Roller
9	Limit Switch Lever
10	Shaft
11	Cover

FIGURE 5-5

WIRE ROPE LUBRICATION

Refer to the Lubrication Guide in Section 9 for recommendations.

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 the Manitowoc Crane Care Lattice Team.

Wire Rope Lubrication

Refer to the Lubrication Guide for recommendations.

Maintain a Wire Rope Condition Report

Always keep on file a signed and dated periodic inspection report of the wire rope's condition. 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 as shown in Figure 5-7.

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 the Replacement Criteria topic on page 5-12 for inspection guidelines.

Required Inspection Intervals

The frequency of wire rope inspection must be the following:

- Daily, as described in the Daily Inspection topic
- Yearly, as described in the Periodic Comprehensive Inspection topic

Wire Rope Care and Replacement Guidelines

Use the following guidelines for wire rope care:

1. When replacing fixed-length wire rope assemblies (for example pendants) having permanently attached end fittings, use only pre-assembled lengths of wire rope as supplied by Manitowoc Crane Care Lattice Team. Do not build lengths from individual components.
2. Replace an entire wire rope assembly. Do not attempt to rework damaged wire rope or wire rope ends.
3. Never electroplate wire rope assemblies.
4. 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.
5. 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.
6. On systems equipped with two or more wire rope assemblies operating as a matched set, the live rope assembly shall be replaced as an entire set.
7. Do not paint or coat wire ropes with any substance other than 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 (see Maintain a Wire Rope Condition Report Topic).

WARNING

Personal Injury Hazard

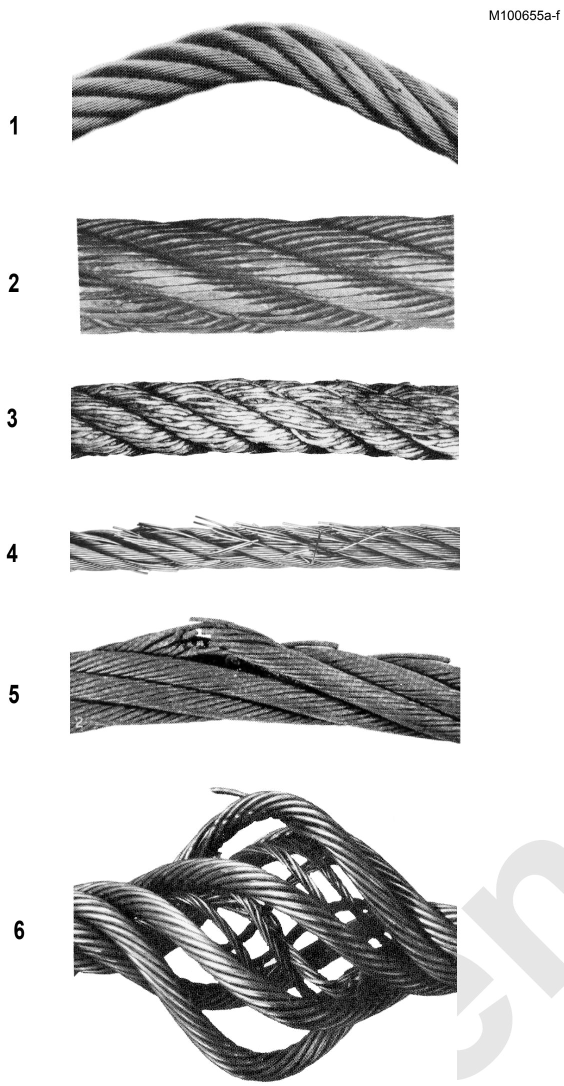
Prior to conducting an inspection of wire rope use the following precautions:

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

See Figure 5-9 for the following procedure:

1. Each work day, 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 such as shown in Figure 5-9
   - Loss of rope diameter (see the Reduction in Rope Diameter topic)
   - Broken wires—Record the number, distribution and type of broken wires (see the Broken Rope Wires Topic)
   - Internal wear or broken wires for ropes operating on synthetic sheaves. Common indicators of internal deterioration include localized reduction in rope diameter, corrosion between the strands, localized lengthening of lay, wire displacement, or wire distortion.
   - End fitting wear/abrasion
   - Minor or general corrosion
   - Areas that deteriorate more rapidly, such as flange points, crossover points, and repetitive pickup points on drums
   - Take special care to observe boom hoist ropes and rotation-resistant ropes for evidence of core failure or other deterioration (remove ropes showing signs of core failure or deterioration from service). Internal deterioration of rotation-resistant ropes may not be readily observable.

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



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 5-6

Periodic Comprehensive Inspection

The comprehensive inspection must be completed 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 areas:

- All points listed under the Daily Inspection topic
- Diameter (see the Reduction in Rope Diameter topic)
- Comprehensive examination for broken wires (see the Broken Rope Wires topic)
- End connections including broken wires or severely corroded, cracked, bent, worn, or improperly applied end connections
- Areas subjected to rapid deterioration such as the following areas:
  - Sections in contact with saddles, equalizer sheaves, or other sheaves where wire rope travel is limited
  - Sections of wire rope at or near terminal ends where corroded or broken wires may protrude
  - Boom sheaves, hook block sheaves, gantry/mast sheaves, boom extension/jib sheaves, jib strut sheaves, and hoist drums

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

Any wire rope damage found must be recorded and a determination made as to whether continued use of the rope is safe. Refer to the Replacement Criteria topic.

DANGER

Falling Load Hazard

- As a wire rope approaches the end of its useful life, inspections should be performed more frequently.
- All wire rope will eventually deteriorate to a point where it is no longer usable.
- A comprehensive inspection of each wire rope must be performed at least once a year.

Determining Frequency of Inspection

Intervals for comprehensive inspections may vary from machine to machine. The inspection interval must be determined by a qualified person and be based on factors such 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 conditions:
  - Variation in temperature
  - Continuous excessive moisture levels
  - Exposure to corrosive chemicals or vapors
  - Wire rope to subject to abrasive material
  - Power line contact

- Exposure to abuse and shock loads, such as the following conditions:
  - High-velocity movement, such as hoisting or swinging of a load followed by abrupt stops
  - Load suspension while traveling over irregular surfaces such as railroad tracks, potholes, and rough terrain
  - Load movement beyond the rated capacity of the lifting mechanism (overloading)

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

Replacement Criteria

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

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

- Reduction in the rope diameter and excessive broken wires. See the Reduction in Rope Diameter and Broken Rope Wires topics.
- 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 from any heat source including, but not limited to, welding, power line strike, or lightning

Reduction in Rope Diameter

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

After the initial loading of a new wire rope, measure and record the diameter for comparison to future inspections. See the Maintain a Wire Rope Condition Report topic.

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

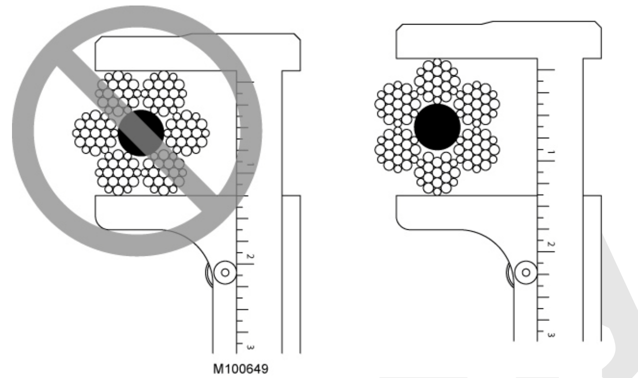


FIGURE 5-7

Broken Rope Wires

When conducting the Periodic Comprehensive Inspection, thoroughly clean the wire rope so any breaks can be seen. Relax the rope, move it off any pick-up points, and flex it as much as possible. Use a sharp awl to pick and probe between wires and strands, lifting any wire that appears loose or moves excessively. Do not open strands of rotation-resistant 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.

See Figure 5-9 for an explanation of lay length.

The wire rope must be taken out of service when it has the following number of broken wires:

- 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 5-8).
- 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 that protrudes or loops out of the rope structure. Additional inspection is required.
- End Attachments (Figure 5-8)—more than one broken wire appears at the attachment. (Replace the rope or cut off the affected area and reattach the fitting).

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

WARNING

Falling Load Hazard

Replace wire rope when more than one broken wire appears at the point marked by the arrow.

Item	Description
1	Swaged Socket
2	Wedge Socket
3	Poured Zink Socket
4	Hand-spliced Socket
5	Button Socket

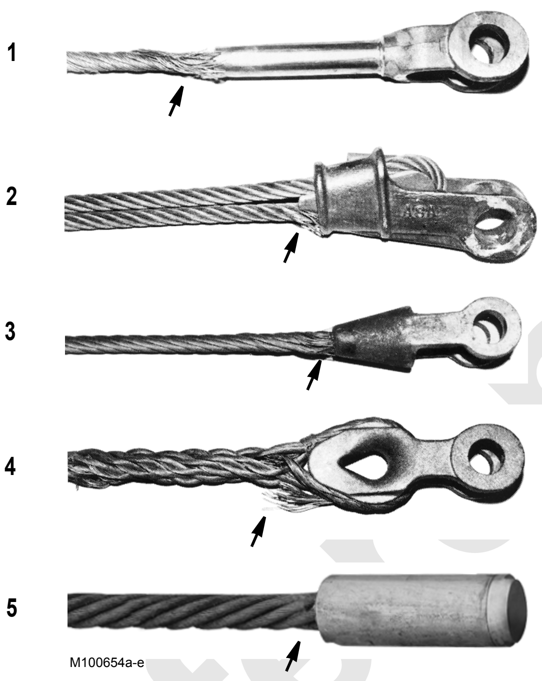
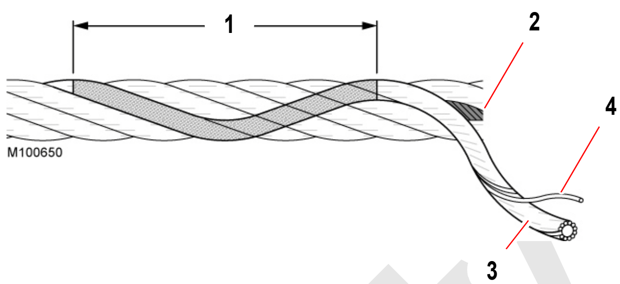


FIGURE 5-8



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

FIGURE 5-9

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 the Daily and Periodic Comprehensive Inspections.

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

DANGER

Falling Load Hazard

Replacement wire rope can break if it does not meet the Manitowoc 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 crane 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 different sections of 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 wire rope at the worn end and refasten it. The piece cut off should be long enough to move wire rope at least one full drum wrap.

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

5

SHEAVE, ROLLER, AND DRUM INSPECTION

Perform the following inspections weekly:

1. Check the drum clutches and brakes for proper adjustment.
2. Check all sheaves, rollers, and drums for the following conditions:
    - Unusual noises
    - Freedom of movement—must turn freely by hand. The rope may have to be loosened to perform this inspection.
    - Wobble (the sheave, roller, or drum must turn true with very little side-to-side or up-and-down play)
    - Signs of rust, which indicate that water may have entered the bearing
    - Grease leaks, which indicate 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 new bearings with grease at assembly.
3. For steel sheaves, check the depth, width, and contour of each sheave using a groove gauge as shown in Figure 5-10. Replace sheaves that have over or under sized grooves.
4. Replace grooved drums that allow one wrap of wire rope to contact the next wrap as rope spools onto the drum.
5. Inspect 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.
6. Remachine or replace steel sheaves, drums, or rollers that have been corrugated by the wire rope's print as shown in Figure 5-11.
7. Inspect nylon sheaves for excessive tread diameter wear at location E in Figure 5-14. Measure at three places to check for uneven wear.

    Wear must not exceed the limits given in the table. Replace worn or damaged sheaves.

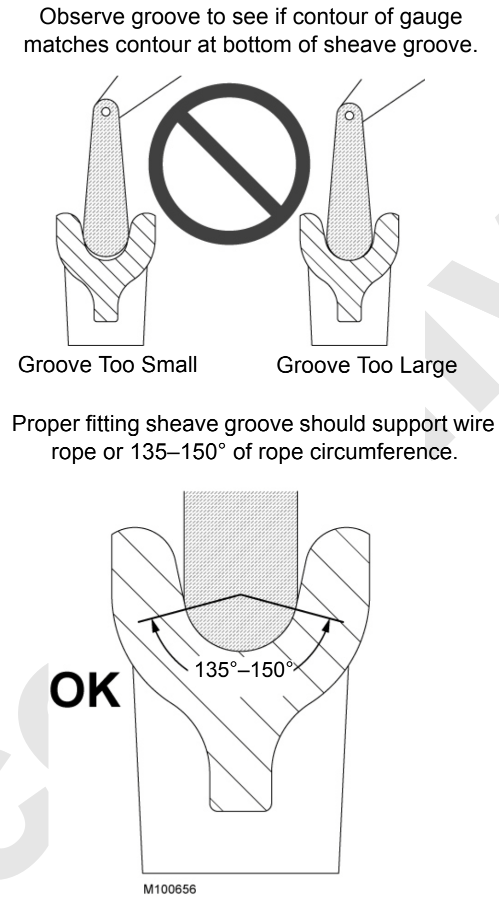


FIGURE 5-10

FIGURE 5-11

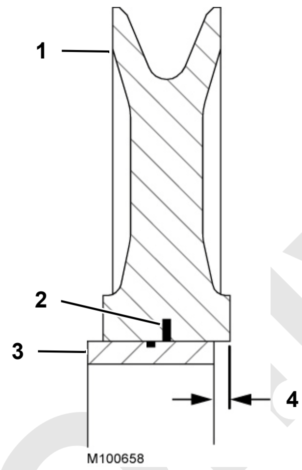
8. Inspect nylon sheaves to verify they have not separated and “walked off” steel inserts or bearings as shown in Figure 5-12. Maximum sideways displacement is 3 mm (1/8 in). Replace worn or damaged sheaves.

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

NOTE: 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).



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

FIGURE 5-12

9. Make sure sheaves, drums, and rollers are properly lubricated according to the instructions in the lubrication guide provided with the crane (see Section 9).

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 Crane LUBE 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 components.

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 have to be replaced.

5

DRUM KICKER

A drum kicker is provided on both flanges of the main load drum (in the boom butt) to improve wire rope spooling for long boom lengths with small fleet angles where the wire rope might stack up along either drum flange.

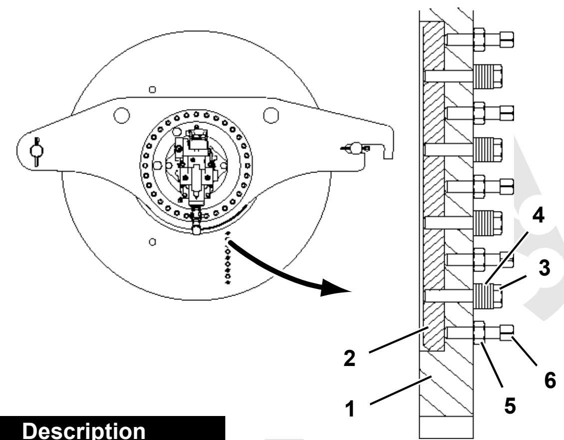
Observe the wire rope during initial break-in and periodically during operation. If the rope stacks up at either end of the drum, adjust the drum kickers.

Adjustment

See Figure 5-13 for the following procedure.

To move the drum kickers into the drum (take up space), use the following procedure:

1. Remove the drum guard from both ends of the drum.
2. Remove an equal number of washers (4) from both sides of the kicker (2), one side at a time. Each washer allows the kicker to move 2,5 mm (0.098 in).
3. Loosely reinstall the cap screws (3) and remaining washers (4).
4. Loosen the lock nuts (5) and adjust the set screws (6) to move the kickers (2) into the drum.
5. Repeat steps 1 through 3 only enough to improve spooling. ***Moving drum kickers in too far can cause premature wire rope wear.***
6. Securely tighten the set screws (6) and lock nuts (5).
7. Reinstall the drum guards.



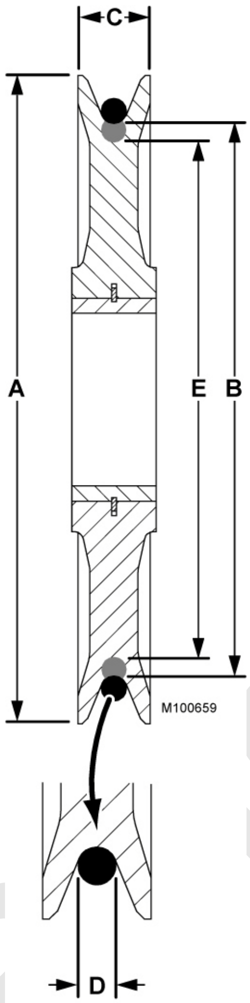
Item	Description
1	Drum Flange
2	Kicker
3	Cap Screw
4	Washers
5	Lock Nut
6	Set Screw

FIGURE 5-13

E = Replacement dimension

E = B – 5 mm (3/16 in) (maximum)

If 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	
	mm	inch	mm	inch	mm	inch	mm	inch
912738 631056	335,0	13.19	290,1	11.42	45,0	1.77	16	5/8
631054	335,0	13.19	290,1	11.42	45,0	1.77	22	7/8
631065	406,4	16.00	339,6	13.37	55,1	2.17	14	9/16
631071	406,4	16.00	352,6	13.88	55,1	2.17	16	5/8
631526	489,0	19.25	422,4	16.63	50,8	1.94	22	7/8
631527	489,0	19.25	422,4	16.63	50,8	1.94	16	5/8
631055	500,1	19.69	447,0	17.60	47,0	1.85	22	7/8
631067	500,1	19.69	450,9	17.75	50,0	1.97	19	3/4
631529	508,0	20.00	431,8	17.00	76,2	3.00	25	1
631519 631520	584,2	23.00	511,0	20.13	57,2	2.25	22	7/8
631084 A00083	584,2	23.00	511,0	20.13	63,5	2.50	22	7/8
631102	584,2	23.00	511,0	20.13	63,5	2.50	25	1
631082 631103 A00051	685,8	27.00	584,2	23.00	76,2	3.00	25	1
631096 A00050	685,8	27.00	584,2	23.00	76,2	3.00	28	1.18
631100	762,0	30.00	685,8	27	76,2	3.00	29	1-1/8

FIGURE 5-14

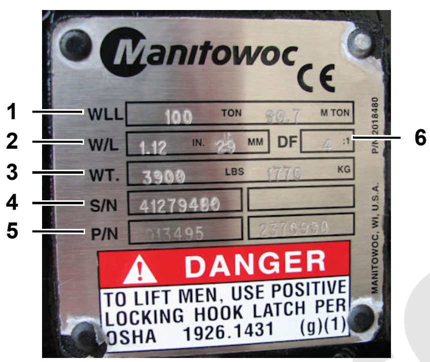
LOAD BLOCK AND HOOK-AND-WEIGHT BALL INSPECTION

WARNING

Falling Load Hazard!

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

- Only use a load block or a hook-and-weight ball which has a capacity greater than or equal to the load to be handled.
- Do not remove or deface the nameplate (Figure 5-15) attached to load blocks and hook-and-weight balls.
- See the Duplex Hook topic in Section 4 of Operator Manual for recommended sling angles and capacity restrictions when the load block has a duplex or quadruplex hook.

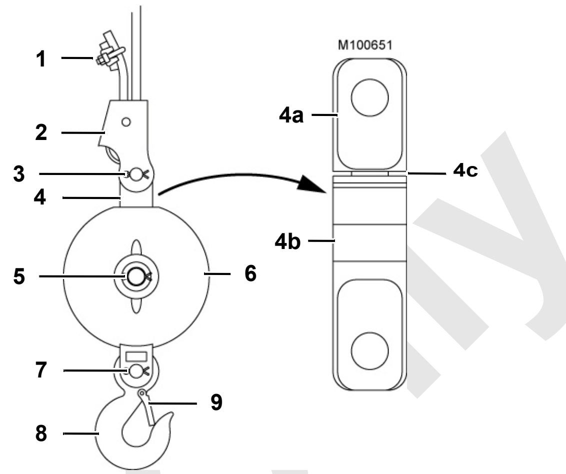


Item	Description
1	Working Load Limit (US and metric ton)
2	Wire Rope Diameter (in and mm)
3	Block Weight (lb and kg)
4	Block Serial Number
5	Block Part Number (OEM and Manitowoc)
6	Design Factor

FIGURE 5-15

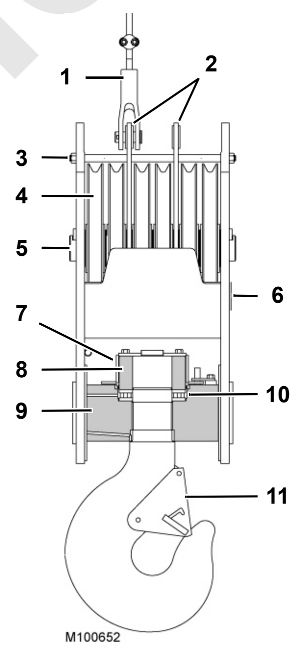
The operating condition of the load block and the hook-and-weight ball can change daily with use. Therefore, they must be inspected daily (at the start of each shift) and observed during operation for any defects that could affect their safe operation. Correct all defects before using the load block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

Daily inspection and maintenance will include the following points (see Figure 5-16 and Figure 5-17):



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 5-16



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 5-17

1. Clean the load block or hook-and-weight ball.
2. Lubricate the sheaves (if the fittings are provided), hook trunnion, hook swivel, and any other part equipped with a grease fitting at the intervals specified in the Lubrication Guide.

3. Tighten loose tie-bolts, cap screws, and set screws. Check that all cotter keys are installed and opened.
4. 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.
5. 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.
6. Check that the hook, the trunnion, and the swivel rotate freely without excessive play. Faulty operation indicates faulty bushings or bearings or inadequate lubrication.
7. 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: The swivel will turn freely in one spot and lock-up in another. This condition can also be checked by looking gap (4c, Figure 5-16) between the barrel and shank (swivel must be removed from weight ball to check). 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 0,508 mm (0.020 in) to 1,27 mm (0.050 in). If the gap increases, swivel-bearing failure is indicated.

8. Check the load block for signs of overloading including spread side plates, elongated holes, bent or elongated tie-bolts, and cracks.
9. Check all welds for defects and cracks.
10. Check the wire rope for wear and broken wires at the point the wire rope enters the dead-end socket. Check the socket for cracks. Tighten the wire-rope clips at the dead end of the wire rope.
11. Check that each hook has a latch and that the hook latch operates properly. The latch must not be wired open or removed.

WARNING

Falling Load Hazard!

To prevent a load from dropping, the hook latch must retain slings or other rigging in the hook under slack conditions.

The hook latch is not intended as an anti-fouling device, and caution must be taken to prevent the hook latch from supporting any part of the load.

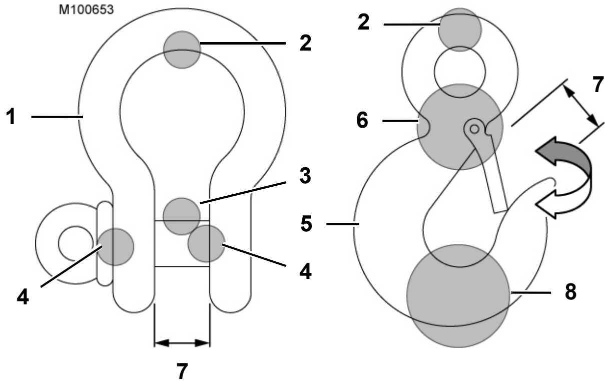
Slings or other rigging must be seated in the hook when handling the load. They must never be in position to foul the hook latch.

12. Inspect each hook and shackle for damage as shown in Figure 5-18.
13. 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)
14. Contact the supplier of your hooks, shackles, blocks, and other rigging for repair instructions.
15. Check each hook and shackle at least yearly for cracks using a dye penetrant test, MAG particle test, ultrasonic test, or by X-ray.

WARNING

Falling Load Hazard!

To prevent a load from dropping due to hook or shackle failure, do not attempt to repair cracks in hooks and shackles by welding. Furthermore, do not weld on any load bearing component unless proper welding methods are used. Contact the Manitowoc Crane Care Lattice Team for material and welding specifications.



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 5-18

SECTION 6
SWING

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Published 05-03-17, Control # 228-03

SECTION 6
SWING

MANUAL RELEASE OF SWING BRAKE AND LOCK

See Figure 6-1 for the following procedure.

The hydraulic swing brake must be released when the swing planetary is removed and reinstalled to allow alignment of the gear teeth in the swing shaft with the teeth in the ring gear.

WARNING

Unexpected Crane Movement!

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

The procedure given in this section is for servicing purposes only. The swing brake must be fully operational when operating the crane.

Hydraulic hand pumps with pressure gauges are needed to manually release the swing brake:

1. Disconnect the hoses from the fitting at the brake release port.
2. Attach the hand pump to the brake release port.
3. Pressurize the brake to 24 bar (348 psi).
4. Proceed to remove or install the swing planetary.
5. Release the pressure and remove the hand pump.

CAUTION

Avoid Damage to Parts!

Do not exceed 24 bar (348 psi) pressure when releasing the swing brake.

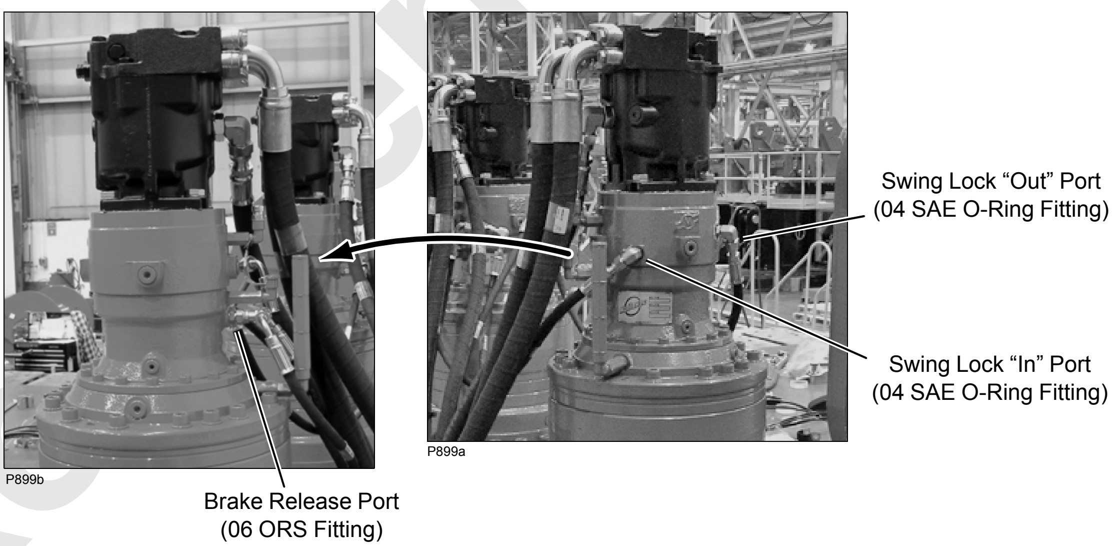

FIGURE 6-1

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SECTION 7
POWER TRAIN

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7

SECTION 7
POWER TRAIN

BATTERIES

Safety

WARNING

Batteries can Produce Explosive Gases!

Do not smoke, use open flame, or create an ark or sparks near the battery. Ventilate well when in an enclosed area and when charging. Do not disturb the connection between the battery and the charger cables until the charger has completed its cycle. Reversing the connection of the charging equipment or the batteries will damage the batteries, the crane's electrical system and may cause an explosion.

Improper use of a booster battery to start a crane when the normal battery is inadequate presents a definite explosion hazard. To minimize this hazard, the following procedure is suggested:

1. Connect both jumper cables to the battery on the crane to be started. Do not allow the opposite ends of the cables to touch.
2. Connect the positive cable to the positive terminal of the booster battery.
3. Connect the negative cable to the frame or block of the starting vehicle. Never connect the remaining cable to the grounded terminal of the starting vehicle.

If electrolyte comes in contact with eyes, skin, or clothing, the area must be immediately flushed with large amounts of water. Seek first aid if discomfort continues.

Causes of Battery Failure

Overcharging

Overcharging is the number 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 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 causes strains in the positive plates which causes plate buckling. Buckled plates can pinch the separators and cause a short circuit. Also, an undercharged battery is not only unable to deliver power, but may freeze (see Table 7-1).

Table 7-1 Battery Freeze Points

State of Charge	Specific Gravity	Freeze Point °C (ºF)
100%	1.26	-57 (-71)
75%	1.23	-38 (-36)
50%	1.20	-26 (-15)
25%	1.17	-19 (-2)
DISCHARGED	1.11	-8 (18)

The sulfate condition can eventually be converted to metallic lead, which can short the positive and negative plates. These small shorts can cause low cell voltage when the battery is charged.

Lack of Water

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

Hold-Downs

Loose hold-downs will allow the battery to vibrate in the holder. This can cause cracks or wear in the container and cause acid to leak. Leaking acid corrodes terminals and cables causing high resistance battery connections. This weakens the power of the battery. Overtightened hold-downs can also distort or crack the container.

Overloads

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

Multiple Battery System

Multiple battery systems are connected either in series or in parallel. Always refer to the Wiring Diagram for the correct connection.

NOTE: Installing batteries with reversed electrical connections will damage the batteries and the crane's electrical system, voltage regulator, and/or alternator.

Maintenance

Weekly – Check Electrolyte Level

Perform the following checks weekly:

1. Clean the top of the battery before removing the vent caps. Keep foreign material out. Confirm that the plates in each cell are completely covered with electrolyte.
2. Use distilled water. Drinking water is satisfactory. Do not use water with a high mineral content (well, creek, pond).
3. Never overfill the cells. Overfilling will cause electrolyte to pump out, and corrosion damage will result.

   Immediately clean any spills on painted or metal surfaces and neutralize the acid with baking soda or ammonia.
4. Look for heavy deposits of black lead-like mineral on the bottom of the vent caps. This indicates that active material is being shed (an indication of overcharging).

   An excessive amount of water consumption also indicates overcharging.
5. Never add sulfuric acid to a cell unless it is known that acid has spilled out or otherwise been lost—consult the battery dealer for instructions.

Every 2 Months – Test Batteries

Before testing a battery, determine that the alternator is putting out current, the current is flowing to the battery, and the voltage delivered is within acceptable limits.

Hydrometer Test

To perform the hydrometer test, use the following:

1. Make sure that the electrolyte level in each cell is at the proper height to get reliable readings. Confirm that the plates in each cell are completely covered with electrolyte.
2. Do not take readings immediately after water is added-the solution must be thoroughly mixed by charging.
3. Do not take readings after a battery has been discharged at a high rate, such as after cranking.
4. When reading a hydrometer, hold the barrel vertical with the float freely suspended.
5. Draw the electrolyte in and out several times to bring the float temperature to that of the electrolyte.
6. Take the reading across the bottom of the liquid level. Disregard curvature of the liquid.
7. Readings must be temperature corrected. Subtract 0.004 from the reading each 6° C (10º F) below 27°C (80º F). Add 0.004 each 6° C (10º F) above 27°C (80º F).

NOTE: The electrolyte temperature is important. The air temperature is not important.

8. See Table 7-2 for an explanation of temperature corrected hydrometer readings.

Table 7-2 Hydrometer Readings

Hydrometer Reading — Specific Gravity	% Charge
1.260 – 1.280	100%
1.230 – 1.250	75%
1.200 – 1.220	50%
1.170 – 1.190	25%
1.140 – 1.160	Very little useful capacity
1.110 – 1.130	Discharged

If any two cells show more than 0.050 specific gravity variation, try to recharge the battery. If the variation persists, replace the battery.

NOTE: For more specific hydrometer test information, see the instructions provided with the hydrometer.

Open-Circuit Voltage Test

A sensitive voltmeter (Figure 7-1) can determine a battery's state-of-charge as shown in Table 7-3.

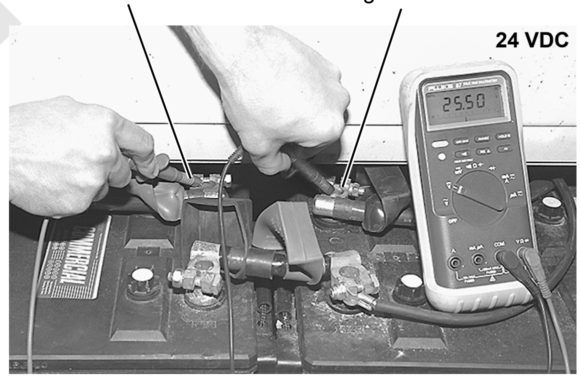

FIGURE 7-1

The open circuit test is not as reliable in determining a battery's condition as the hydrometer test. This test is acceptable for stored batteries, but not ones in use.

Do not perform this test on batteries being charged or delivering power. Charging causes an increase in voltage which may persist for an extended period.

Table 7-3 Open Circuit Cell Voltage

% Charge	Specific Gravity	Approximate Open Circuit Cell Voltage
100	1.260	2.10
75	1.230	2.07
50	1.200	2.04
25	1.170	2.01
Discharged	1.110	1.95

NOTE: The meter manufacturer will provide detailed test information.

High Resistance Test

When cranking, a voltage drop of more than 0.2 volts between the starting motor cable and ground can cause hard starting. 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, or by poor start-switch contacts and frayed, broken, or corroded cables.

Quarterly - Clean and Inspect Batteries

Perform the following checks quarterly:

1. Thoroughly clean the batteries and the holder with baking soda.
2. If provided, make sure the drain holes are open in the holder. If water collects in the holder, drill drain holes.
3. Clean the posts and terminals. The posts can be completely coated with grease to prevent corrosion.
4. Make sure the hold-downs are in good condition. Replace faulty parts. Make sure the hold-downs are tight enough to prevent battery movement without causing distortion.
5. Replace frayed, broken, or corroded cables.
6. Replace the batteries with containers that are cracked or worn enough to leak.
7. Ensure a tight contact between the clamp terminals and battery posts.

Charging

The battery should be at room temperature when recharging. Before recharging a battery, clean it thoroughly. Do not allow dirt to enter the cells.

Recharge a battery the way it was discharged. For batteries discharged over a long period of time, recharge slowly at 6 to 10 amperes for up to 10 hours. (For a slow rate, use a current equal to approximately one-half the number of plates per cell in the battery. For instance, charge a battery with 13 plates per cell at 7 amperes.

If a battery was discharged rapidly (for instance, cranking until dead), recharge it using a fast charger with an output of up to 40 amperes for a maximum of 2 hours. If the electrolyte temperature reaches 52°C (126ºF) or gases violently, reduce the charging current or stop charging to avoid battery damage.

For optimum charging results, follow the charger manufacturer's instructions.

Storage

Run the crane periodically to charge the batteries when the crane is left idle for prolonged periods.

When storing a battery, make sure it is at least 75% charged to prevent the possibility of freezing.

Follow the battery dealer recommendations.

Disconnect Switch

See Figure 7-2 for the following procedure.

A battery disconnect switch is provided on the right side of the upperworks near the engine node. Use the switch to disconnect the batteries when servicing the electrical control system.

See Section 3 of the Operator Manual for operation of the battery disconnect switch.

CAUTION

Engine Damage!

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

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

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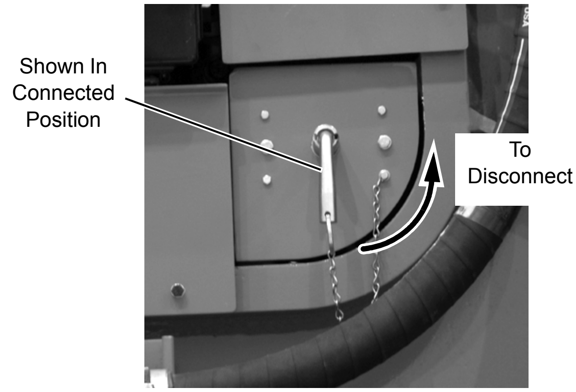


Right Side of Rotating Bed

FIGURE 7-2

AIR CLEANER

See Figure 7-3 for the following procedures.

The air cleaner is mounted using lugs (7) to the engine. Rubber elbow reducers (5), clamps (3), steel tube (2) and a straight adapter fitting (4) are part of the mounting assembly. Service the air cleaner to avoid engine damage:

- Clogged air cleaner filters prevent adequate air flow to the engine, causing poor starting and increased exhaust emissions.
- Improperly installed or damaged air cleaners can allow dirty air directly into the engine.

Inspection

To maintain engine protection and filter service life, inspect the following areas at regular intervals.

Daily

Check the service indicator (8) with the engine running. The indicator gives a visual indication when it is time to replace the filters:

- A yellow flag in the indicator window (8a) rotates as the filters are plugged. Replace filters when the yellow indicator reaches the red zone at the end of the indicator.
- The yellow flag remains locked in place after the engine stops. After replacing the filters, push the button (8b) in to reset the indicator.

Monthly

Perform the following inspections monthly:

1. Inspect the rubber reducers (5) between the air cleaner and engine for cracks or other damage that might allow unfiltered air to enter the engine. Replace worn or damaged parts.
2. Check the housing (1e) for dents or other damage that may allow unfiltered air to enter engine. Replace the housing if damaged.
3. Check for loose clamps (3). Tighten clamps if necessary.
4. Inspect the engine intake (6) for obstructions. Clean the intake as required.

CAUTION

Engine Damage!

Stop the engine before servicing the air cleaner or unfiltered air will be drawn directly into the engine.

Before servicing, clean all fittings, mounting hardware and the area around the component(s) to be removed.

Never operate the engine without the air cleaner.

Replace the secondary filter as quickly as possible to avoid engine ingestion of contaminants.

Do not attempt to clean and reuse old filters. Discard old filters and install new filters. Cleaning the filter elements by impact or compressed air voids the warranty and can degrade or damage the filter media, leading to malfunction.

Filter Replacement

Service the air cleaner and its primary and secondary filter elements at the intervals specified by the engine manufacturer per the engine manufacturer's instructions. An illustration of these instructions is located on the air filter cover (see Figure 7-3).

Replace the primary filter only when the red flag locks in place at the top of the service indicator.

NOTE: Replace the secondary element every 3rd time the primary element is replaced

To replace a filter, use the following procedure:

CAUTION

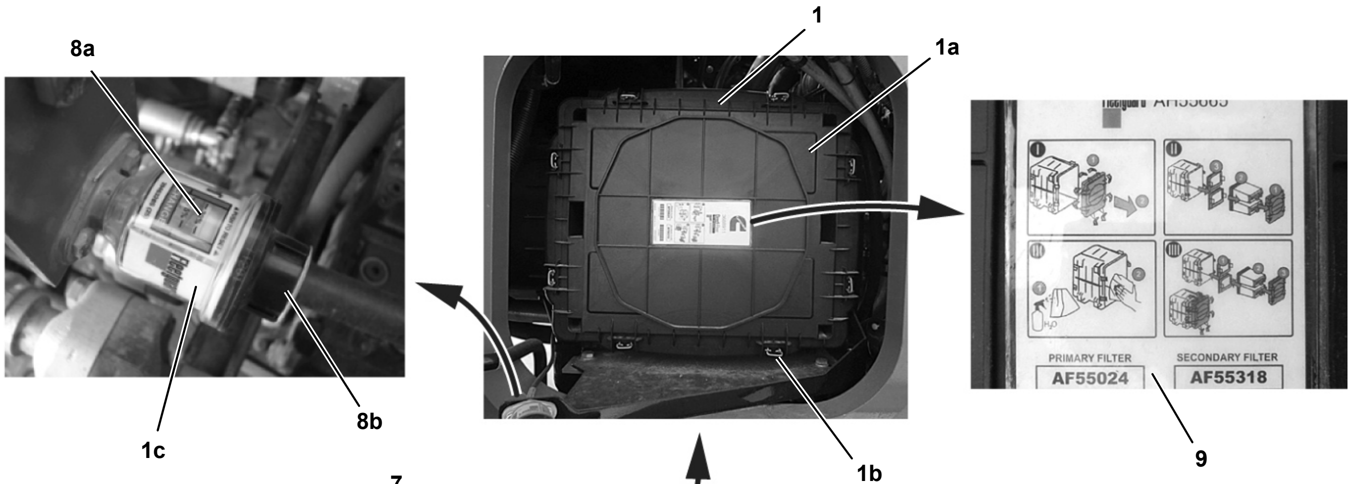
Engine Damage!

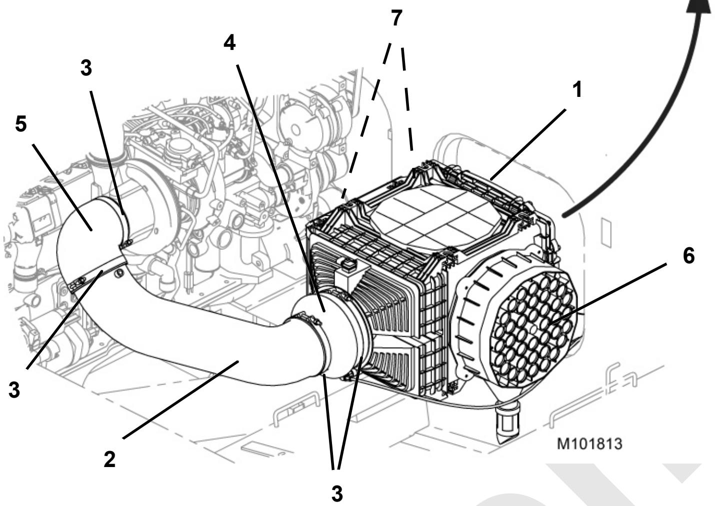
Stop the engine before servicing the air cleaner, or unfiltered air will be drawn directly into the engine.

Do not attempt to clean and reuse old filters. Discard old filters and install new ones.

1. Wipe any accumulated dirt, grease, or other foreign material from the outside surface of the air cleaner assembly to prevent contamination when opening the air cleaner or integral pre-cleaner assemblies.

   Do not allow foreign matter to enter the housing, tubing or air inlet hole to the engine.
2. Refer to the engine manufacturer's instructions to open, service, and close the air cleaner or integral pre-cleaner assemblies.





Item1	Description
1	Air Cleaner Assembly
1a	Service Cover
1b	Latch (8)
1c	Primary Filter (2)
1d	Secondary Filter (2)
1e	Housing
2	Steel Tube
3	Clamp (4)
4	Straight Adapter Fitting
5	Rubber Elbow Reducer
6	Engine Intake
7	Mounting Lugs (4)
8	Service Indicator
8a	Service Window
8b	Reset Button
9	Decal With Service Instructions

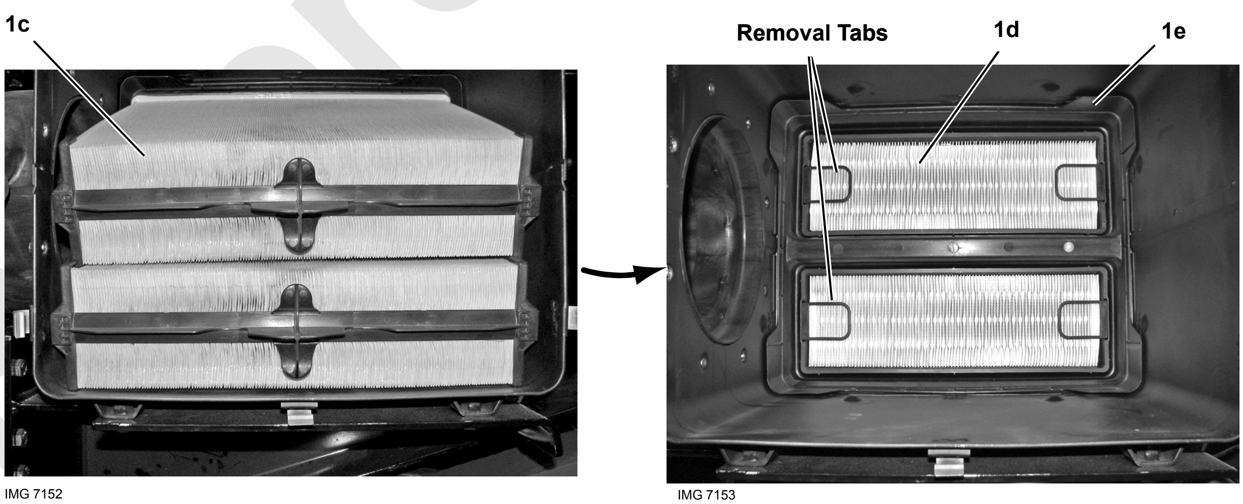


FIGURE 7-3

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's programmable controller, which increases and decreases the engine speed accordingly.

Hand Throttle Control

The hand throttle control does not require adjustment and is not repairable.

Foot Throttle Control

See Figure 7-4 for the following procedure.

If there is a problem with the foot throttle, replace it or send the unit to the Manitowoc Crane Care Lattice Team for repair.

If the foot throttle is disassembled, use the following procedure to re-assemble and calibrate the throttle control.

Foot Throttle Control Assembly and Calibration

Complete the following procedure on a clean work bench:

1. To assemble the right-side shaft (3) and torsion spring (5) into the housing (1), secure 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 (3) into the cavity in the bottom of the housing (1), through the bearing (9), and into the pedal (2). The lug on the outboard end of the spring (5) must engage the hole in the housing (1) (section view A-A).
3. Insert the left-side shaft (4) into the cavity in the bottom of the housing (1), through the bearing (9), and into the pedal (2).
4. Rotate the pedal (2) and install the roll pins (11) through the holes in the pedal and shafts (Pedal Position A).
5. Install the set screw (16). Do not insert the set screw deep enough to contact the head on the right-side shaft (3).
6. Rotate the pedal approximately 40° to position B (low idle). The flat on the head of the right-side shaft (3) should be parallel with surface X on housing. Tighten the set screw (16) until it contacts the flat on the head of the shaft (section view A-A).
7. Install the potentiometer (7) and calibrate the foot throttle:
   a. Re-solder the control wires to the potentiometer and resistor leads.
   b. With a supply voltage of 25.0 to 26.0 VDC, turn the potentiometer (7) shaft fully counter-clockwise as viewed from the shaft end (zero volts out).
   c. With the pedal (3) in Position B, insert the potentiometer (7) into the cavity in the bottom of the housing (1) as shown in View B-B. Insert the potentiometer shaft into the end of the shaft (4) and tighten the set screw (17).
   d. Rotate the pedal to the high idle position and secure it using the set screw (16).
   e. Rotate the potentiometer housing to obtain an output of 0.90 to 1.00 VDC.
   f. Apply silicone sealant RTV-162 between the housing (1) and potentiometer (7). Do not get sealant on the shaft (4). Allow the sealant to cure one to two hours before proceeding.
   g. After the sealant has cured, check the output for 0.90 to 1.00 VDC in the high idle position.
   h. Remove the set screw (16), apply Loctite 243 to the threads, and adjust the set screw to obtain a low idle position output reading of 2.90 to 3.00 VDC.
8. Install the assembly on the crane.

Component Identification for Figure 7-4

Item	Qty.	Description	Item	Qty.	Description
1	1	Foot Pedal Housing	10	1	Conduit Nut
2	1	Foot Pedal	11	2	Roll Pin
3	1	Foot Pedal Shaft (right)	12	1	Receptacle
4	1	Foot Pedal Shaft (left)	13	1	Resistor
5	1	Torsion Spring	14	2	Cap Screw
6	1	Receptacle Mounting Bracket	15	2	Flat Head Screw
7	1	Potentiometer	16	1	Set Screw
8	1	Zener Diode	17	1	Set Screw
9	2	Roller Bearing	18	2	Lock Washer

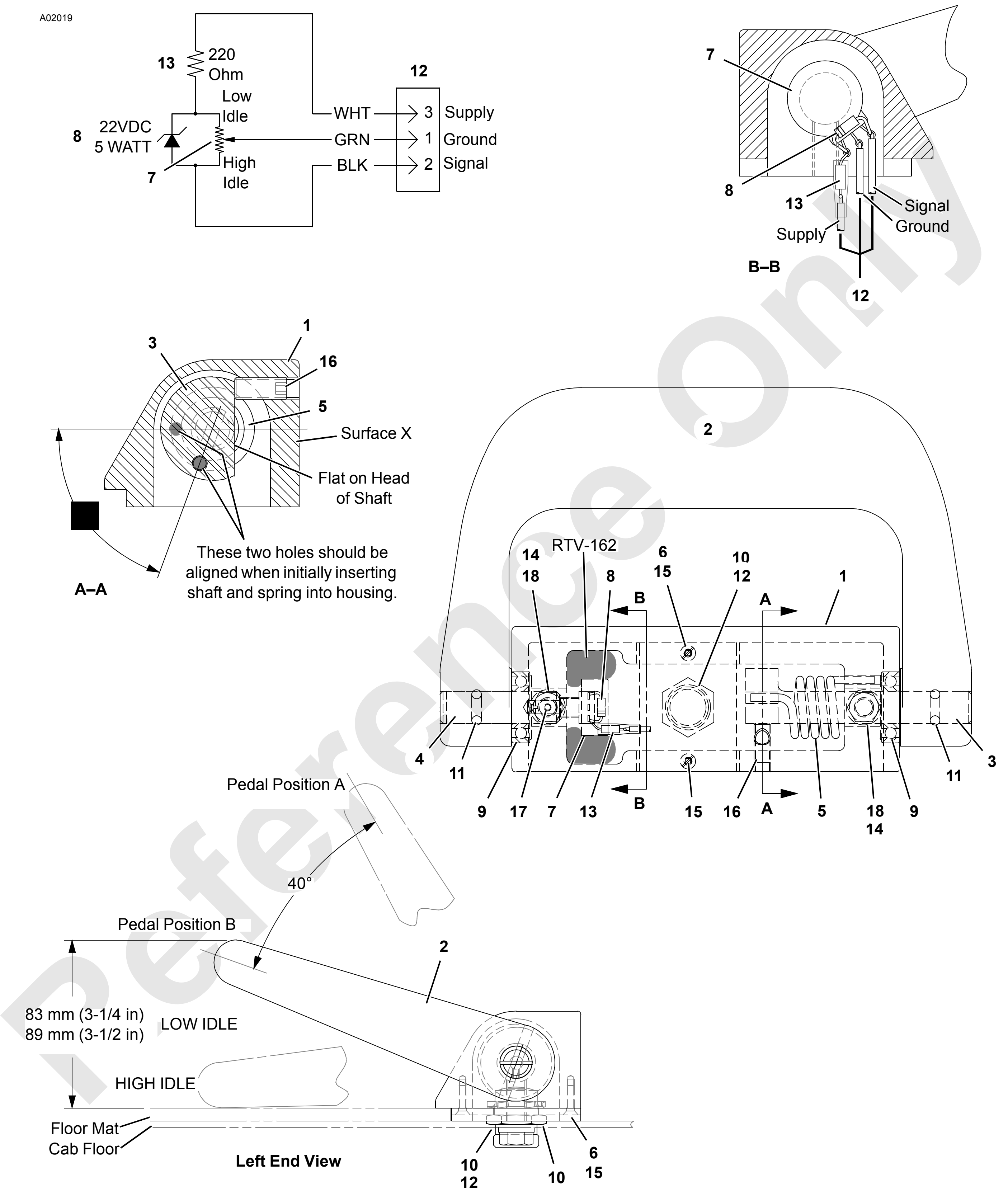

A02019
13
220
Ohm
Low
Idle
8
22VDC
5 WATT
7
High
Idle
WHT
GRN
BLK
12
3 Supply
1 Ground
2 Signal
7
8
13
Supply
Signal
Ground
B–B
12
1
3
16
5
Surface X
Flat on Head
of Shaft
These two holes should be
aligned when initially inserting
shaft and spring into housing.
A–A
2
RTV-162
14
18
8
6
15
10
12
1
B
A
4
11
9
17
7
13
B
15
16
A
5
18
14
9
11
3
Pedal Position A
40°
Pedal Position B
2
83 mm (3-1/4 in)
89 mm (3-1/2 in)
LOW IDLE
HIGH IDLE
Floor Mat
Cab Floor
Left End View
10
12
10
6
15

FIGURE 7-4

7

ENGINE CLUTCH

See Figure 7-5 for the following procedure.

A disc-type manually-operated clutch is mounted between the engine and the pump drive. The clutch allows the pump drive to disconnect from the engine, reducing engine load and making start-up easier in cold weather. The clutch can be engaged or disengaged while the engine is running or off.

CAUTION

Parts Damage

Do not run the engine longer than 20 minutes with the clutch disengaged. The clutch release bearing can be damaged.

Monthly Maintenance

Perform the following maintenance monthly:

1. Grease the clutch monthly. See Section 9.
2. At least once each month, disengage and engage the clutch several times with the engine running to clean disc surfaces and prevent discs from seizing.
3. To check free-travel, pull on the handle when the clutch is engaged until meeting resistance. This is the free-travel.

   Readjust the clutch when free-travel decreases to less than 35 mm (1-3/8 in).

Adjustment

Adjust the clutch internally through the cover plate on top of the clutch housing. See the clutch manufacturer's manual for adjustment instructions.

DANGER

Moving Machinery Hazard

Parts inside the clutch rotate when the engine is running. Stop the engine before adjusting the clutch.

Item	Description
1	Handle
2	Latch
3	Engine
4	Clutch
5	Cover Plate
6	Pump Drive

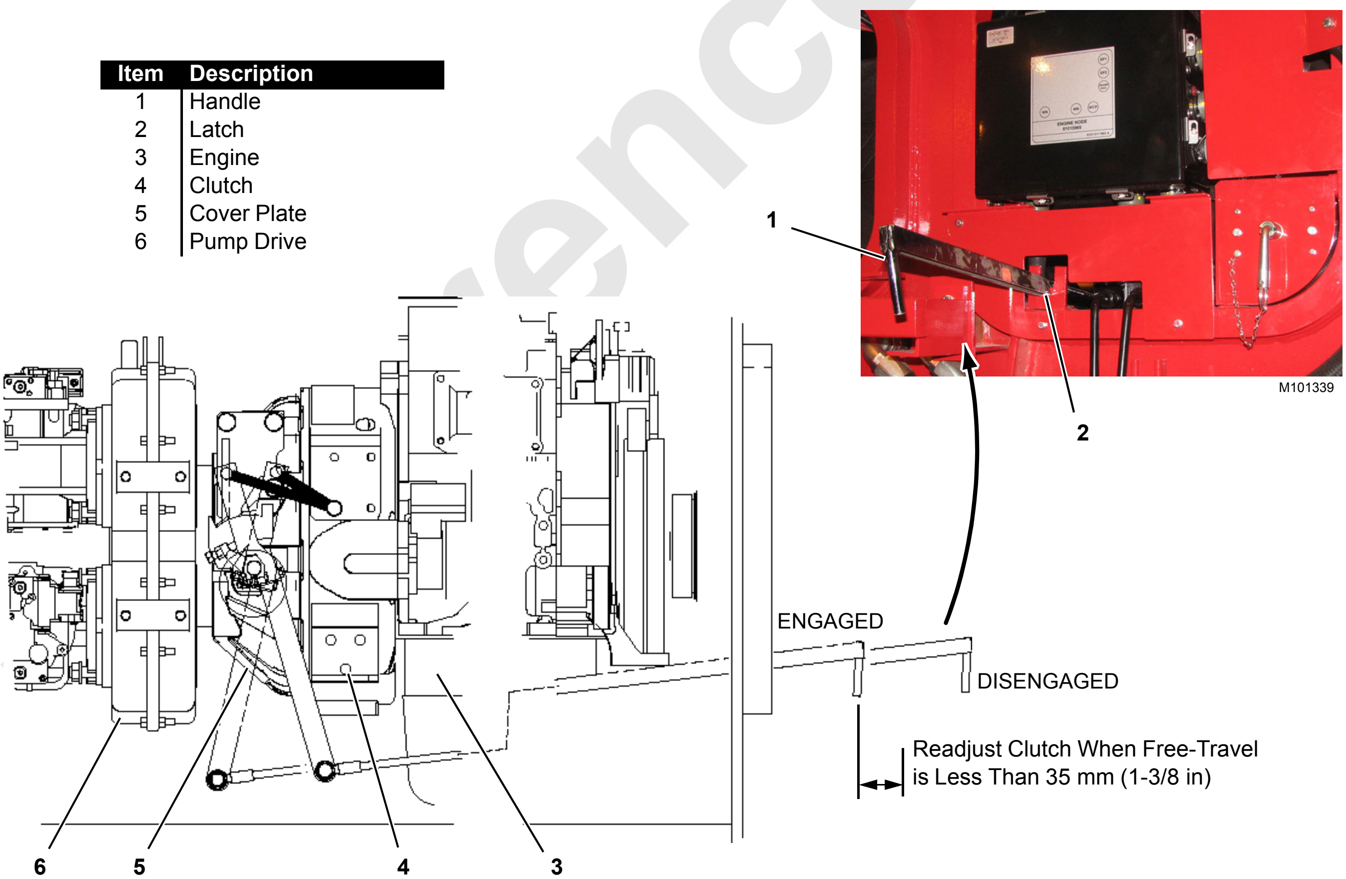


FIGURE 7-5

ENGINE BELT ROUTING

Service personnel may reference Figure 7-6 for engine belt routing when installing a drive belt on a QSX15 Tier 4F Cummins engine.

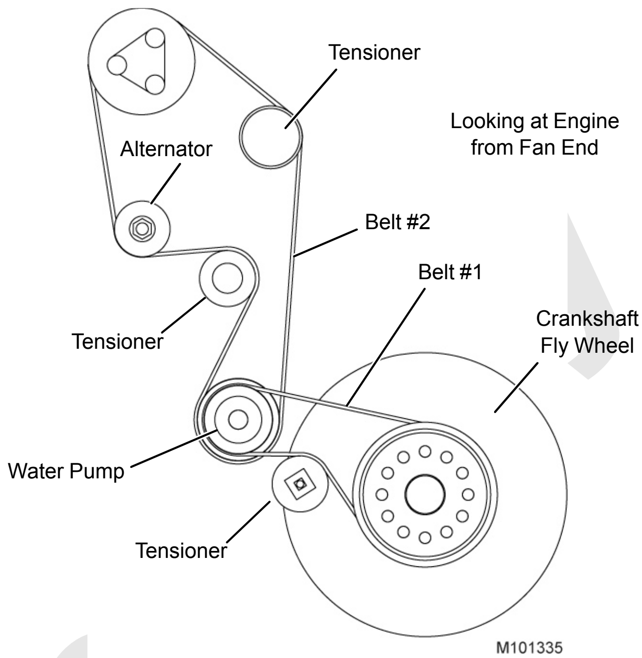


FIGURE 7-6

7

COOLING SYSTEM

The cooling system consists of a horizontal radiator mounted above the engine and a variable-speed, hydraulically-driven blower-type fan.

The cooling system flow is illustrated in Figure 7-9.

The deaeration cooling system continually removes air from the system:

1. A small percentage of total coolant flow is circulated through a vent line to the radiator.
2. Air separates from the coolant.
3. Air collects at the top of the radiator. When pressure rises to 1 bar (14.5 psi), a relief in the pressure cap opens to exhaust air through the overflow line.
4. Deaerated coolant returns to the system through a make-up line.

Maintenance

WARNING

Burn Hazard!

Avoid personal injury from heated coolant spray or steam. Do not remove the radiator pressure cap when the engine is hot. Stop the engine and wait until the coolant temperature is below 50°C (122°F). To remove the pressure cap, use the following procedure:

- Place a protective covering over the pressure cap.
- Slowly turn the pressure cap counterclockwise until it stops at the safety detent.
- Wait until the pressure (indicated by a hissing sound) is completely relieved.
- Depress the pressure cap and turn it counterclockwise to remove it.

CAUTION

Overheating Hazard!

Do not allow the coolant level drop below the level of the upper sight glass located on the deaeration tank.

At the start of each shift, check the coolant level when the coolant is cold:

1. Make sure that the coolant level is at the upper sight glass (Figure 7-7) on the deaeration tank.
2. If the coolant level is low, fill the system with coolant.

   See the engine manufacturer's manual for antifreeze and coolant additive recommendations.
3. Look for coolant leaks while the engine is running. Fix any leaks.

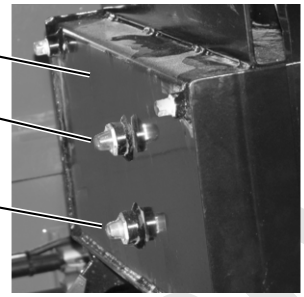


FIGURE 7-7

Semiannual Checks

Perform the following checks every six months:

1. Inspect the pressure cap and thermostat for proper operation and replace worn parts:
   - The Pressure cap relieves at 1 bar (14.5 psi).
   - The Thermostat begins to open at 82°C (180°F) and opens fully at 93°C (200°F).
2. Inspect engine belts for wear and proper adjustment (see the engine manufacturer's manual).
3. Inspect cooling system hoses for deterioration and other defects. Replace hoses as necessary.
4. Tighten hose clamps.
5. Clean all dirt and other debris from the outside of the radiator.
6. Make sure the overflow line on the tank is open.

Draining Cooling System

See Figure 7-8 for the following procedure.

To drain the cooling system, use the following:

1. Stop the engine.
2. Open the seven bleed valves:
   - One on top of the coolant tube
   - Four on the radiator
   - Two on the DEF coolant manifold block (see Figure 7-12)
3. Place a suitable container under the drain valve. System capacity is approximately 95 L (25 gal).
4. Remove the pressure cap.
5. Open the drain valve.
6. When the system is drained, close the drain valve.
7. Recycle used coolant at a facility that accepts coolant.

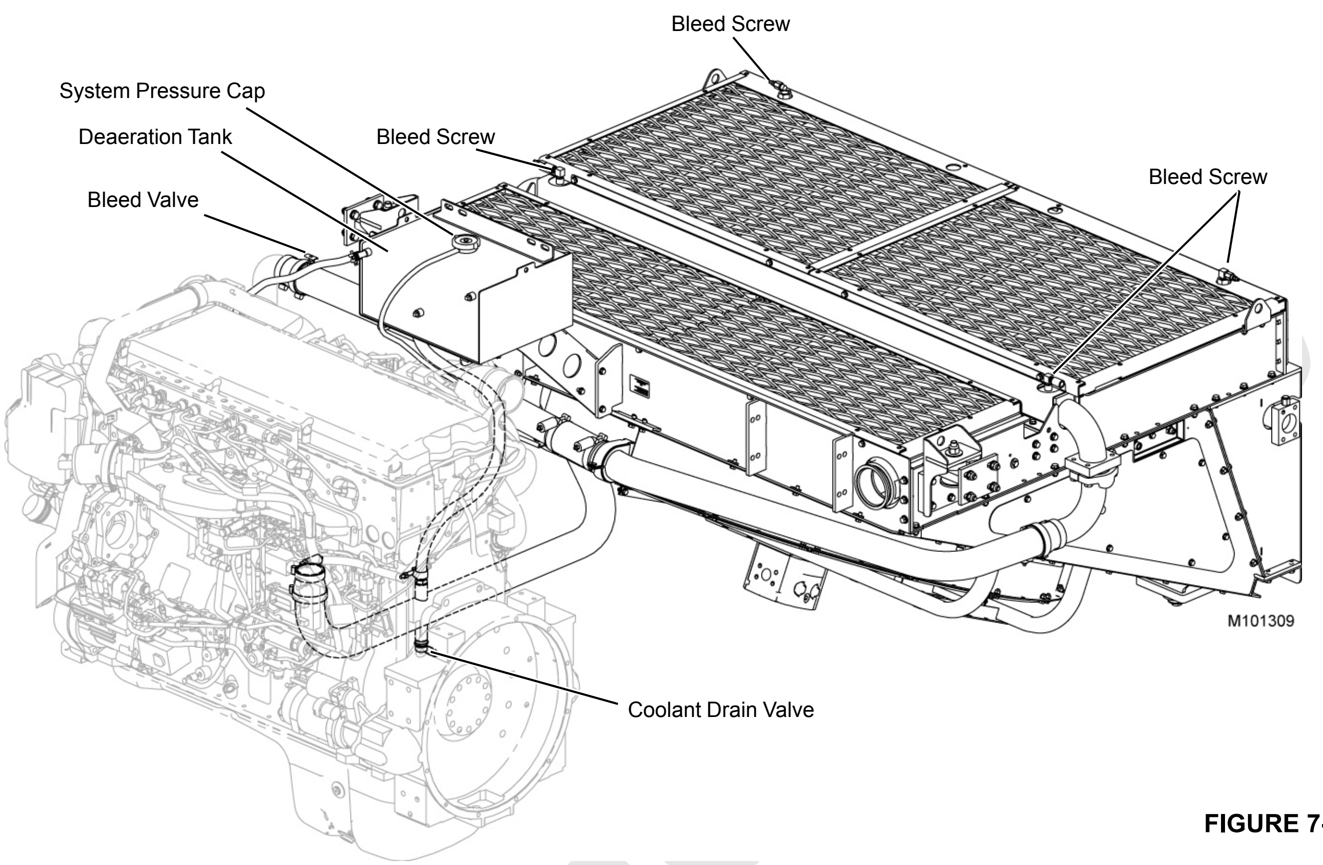


FIGURE 7-8

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MAIN FLOW
MAKE-UP FLOW
DEAERATION FLOW

Item	Description	Item	Description
1	Engine	6	Vent Line
2	Water Pump Housing	7	Fill Cap
3	Thermostat Housing	8	Cooler Assembly
4	Bypass Line	9	Fan
5	Make up Line	10	Motor

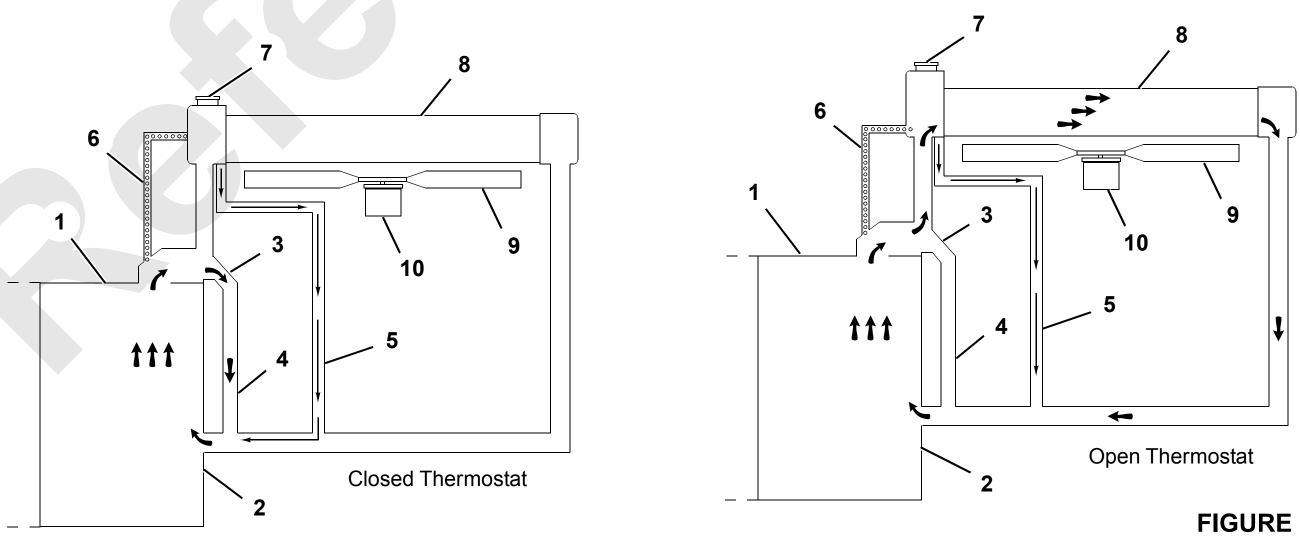

FIGURE 7-9

Filling Cooling System

See Figure 7-8 for the following procedure.

CAUTION

Material Hazard!

Coolant is toxic. Do not ingest coolant. If the coolant is not reused, dispose of the coolant in accordance with all local and other applicable environmental regulations.

CAUTION

Engine Damage!

The required Supplemental Coolant Additive (SCA) concentration must be maintained to prevent engine damage.

Supplemental Coolant Additive must be added to the cooling system to prevent liner pitting and for scaling protection.

Check SCA concentration according to the schedule in the Cummins manual and per the warnings, cautions, and instructions.

For antifreeze and coolant additive recommendations, see the Cummins Operation and Maintenance Manual.

Coolant system capacity is approximately 95 liters (25 gallons).

1. Open the seven bleed valves:
   - One on top of the coolant tube
   - Four on the radiator
   - Two on the DEF coolant manifold block (see Figure 7-12)
2. Remove the pressure cap from the deaeration tank and begin to fill the cooling system.

   While filling, observe the bleed valves. When coolant without bubbles appears at a bleed valve, close the valve.
3. Continue adding coolant until the level is at the upper sight glass. Make sure all bleed valves are closed.

NOTE: Maximum fill rate is 11 liters/min (3 gpm).

4. Install the pressure cap and run the engine until it reaches normal operating temperature.

   While the engine is running, look for coolant leaks.

WARNING

Burn Hazard!

Avoid personal injury from heated coolant spray or steam. Do not remove the pressure cap from a hot radiator/engine. Stop the engine and wait until the coolant temperature is below 50° C (122° F). To remove the pressure cap, use the following procedure:

- Place a protective covering over the pressure cap.
- Slowly turn the cap counterclockwise until it stops at the safety detent.
- Wait until the pressure (indicated by a hissing sound) is completely relieved.
- Depress the pressure cap and turn it counterclockwise to remove it.

5. Stop the engine, wait until the engine is cool, and refill the cooling system to the upper sight glass.

CAUTION

Engine Damage!

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

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EXHAUST ASSEMBLY

See Figure 7-11 for the following procedure. Covers can be unlatched with a screwdriver and removed to allow access to the exhaust system and hydraulic tank for service.

The entire exhaust assembly may be raised. The assembly can be held in the raised position by a rod that is stored on the exhaust assembly frame.

The exhaust assembly can also be entirely removed if required for the engine, hydraulic system, or other service.

Do not operate the crane without all covers securely fastened in place.

WARNING

Crush Hazard

The exhaust assembly weighs approximately 400 kg (880 lb) with the access covers removed. If the assembly falls, personnel may be crushed.

Use appropriate lifting equipment when raising the exhaust assembly.

CAUTION

Avoid Electronic Control Module Malfunction

Before disconnecting the batteries, make sure the engine ignition switch has been off for 70 seconds. This will avoid engine fault codes and undesirable operation.

Raising the Exhaust Assembly

To raise the exhaust assembly, use the following procedure:

1. Stop the engine and open the battery disconnect switch.
2. Remove the access covers that are on the exhaust assembly frame.
3. Loosen the clamp (Figure 7-10) that secures the DOC/ DPF module to the bellows exhaust pipe from the engine.
4. Remove the loosened clamp. Create separation between the pipe and the module.
5. Remove the rod with the hitch pin from the storage position inside the forward part of the frame.
6. Remove the hitch pin that is located in the center of the rear of the frame.
7. Using a crane and appropriate rigging, raise the exhaust assembly. A cutout in the rear of the frame is provided as a lifting point.
8. Using the two hitch pins, install the frame support rod as shown in Figure 7-11.
9. After service, use a crane to lower the assembly back into the crane. Place the support rod back into the storage location.

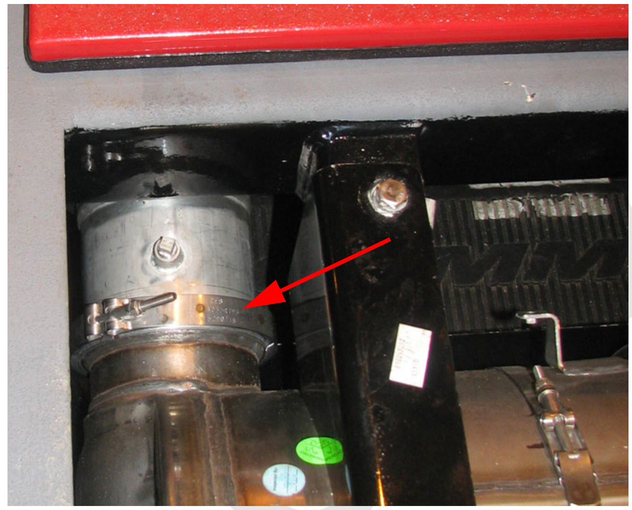

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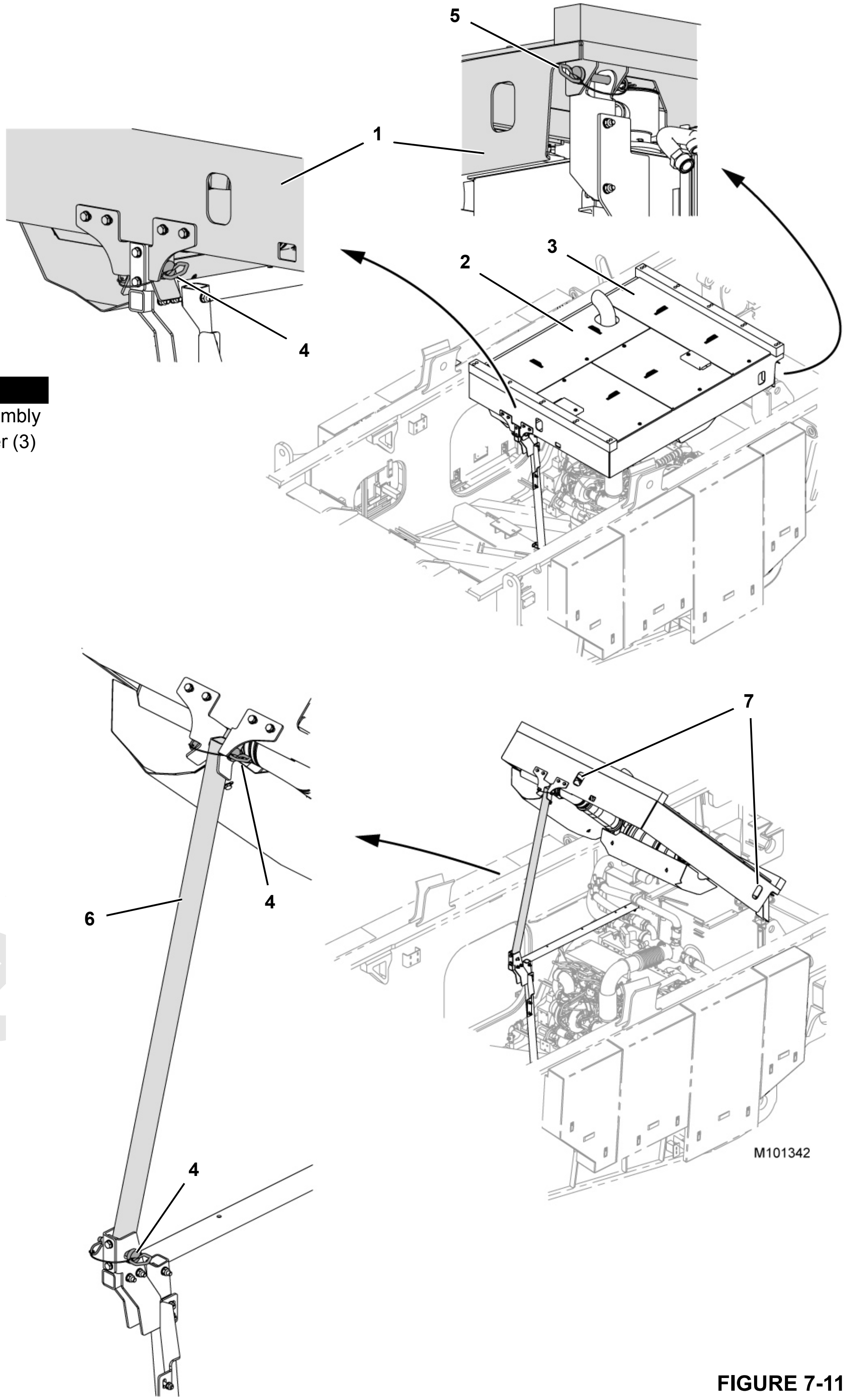
FIGURE 7-10

Removing the Exhaust Assembly

To remove the exhaust assembly, use the following:

1. Stop the engine and open the battery disconnect switch.
2. Remove the covers from the exhaust assembly frame.
3. Remove the DEF and coolant hoses from the DEF dosing module.
4. Disconnect the electrical connector located above the dosing module.
5. Disconnect all the electrical connectors for the SCR module and the DPF module.
6. Raise the exhaust assembly according to the Raising the Exhaust Assembly procedure.
7. Check that the DEF and coolant hoses are removed from any clamps that would prevent exhaust assembly removal.
8. Make sure that all electrical wires are disconnected as needed and removed from any clamps that would prevent the exhaust assembly removal.
9. Check for any other components that may interfere with the assembly as it is removed.
10. Using an assist crane to support the exhaust assembly, remove the support rod and lower the assembly back into the crane.
11. Remove both 2-hole pins that secure the front of the exhaust assembly frame to the crane.
12. Using a 3-point lift at the provided lifting holes, remove the exhaust assembly from the crane.



Item	Description
1	Exhaust After Treatment Assembly
2	Exhaust System Access Cover (3)
3	Hydraulic Tank Access Cover
4	Hitch Pin with Safety Clip
5	2-Hole Pin (2)
6	Frame Support Rod
7	Lifting Points

FIGURE 7-11

EXHAUST AFTER TREATMENT SYSTEM

See Figure 7-12 for the following procedures.

WARNING

Hot Exhaust Surfaces and Inhalation Hazards!

Extremely hot surfaces and exhaust gases can cause death or serious injury. Allow the engine and 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.

Starting at the engine, the primary components of the exhaust after treatment system include the following:

- Diesel Particulate Filter (DPF) / Diesel Oxidation Catalyst (DOC) module
- DRT Module with DEF dosing module
- Selective Catalytic Reduction (SCR) module

Also, a Diesel Exhaust Fluid (DEF) dosing system supplies DEF to the DRT module.

DPF/DOC Module

The Diesel Particulate Filter (DPF) (9) portion of this module captures soot and ash from the engine exhaust. Periodically the module will undergo an automatic cleaning process, or “regeneration.” For more information, see DPF/DOC Module Operation and Service on page 7-20 and Section 3 of the Operator Manual.

The DOC module oxidizes remaining hydrocarbons in the exhaust to carbon dioxide.

The DPF/DOC must be periodically removed and replaced. See DPF/DOC Module Replacement.

DRT Module

Between the DPF/DOC and the SCR is the Decomposition Reactor Tube (DRT) (7). The DEF dosing valve is mounted to the DRT.

The DEF dosing module (8) is also mounted on the DRT. The dosing module injects Diesel Exhaust Fluid (DEF), a liquid mixture of urea and water, into the exhaust stream toward the SCR inlet. Coolant lines run through the dosing module to keep it cool and operable. The tube contains a mixer to help DEF mists distribute evenly in the exhaust stream prior to entering the SCR.

The DRT module requires no maintenance.

SCR Module

The primary function of the Selective Catalytic Reduction (SCR) module (6) is to reduce NO_x content to nitrogen. The Diesel Exhaust Fluid injected at the DRT module enters the SCR, where the urea and de-ionized water participate in a chemical reaction that results in the desired exhaust emission composition.

The SCR incorporates a catalyst, two temperature sensors, an ammonia (NH_3) sensor, and a NO_x sensor.

There is no maintenance requirement for the SCR module.

Excessive NO_x Warning System

CAUTION

Loss of Power or Engine Shutdown Hazard

If NO_x emissions exceed legislated limits, warning lights and audible warnings will alert the operator. If the condition is not corrected in a timely manner, an engine derate and shutdown sequence will begin. For more information, refer to Section 3 of the 16000 Operator Manual.

If an excessive NO_x warning is issued, check anything that might cause an elevated NO_x level, including the following:

- Disconnected 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
- EGR valve malfunction

After Treatment Protection System

The Cummins After Treatment Protection System (APS) continually monitors exhaust gas temperatures. In the event of excessive exhaust temperatures, the APS will illuminate the High Exhaust System Temperature (HEST) lamp.

Item	Description
1	Coolant Manifold Block
2	Air Bleed Valves
3	Coolant Flow Control Solenoid Valve
4	DEF Tank
5	DEF Supply Module
6	Selective Catalytic Reduction (SCR) Module
7	Decomposition Reactor Tube (DRT) Module
8	DEF Dosing Module
9	Diesel Particulate Filter/Diesel Oxidation Catalyst Module (DPF/DOC)

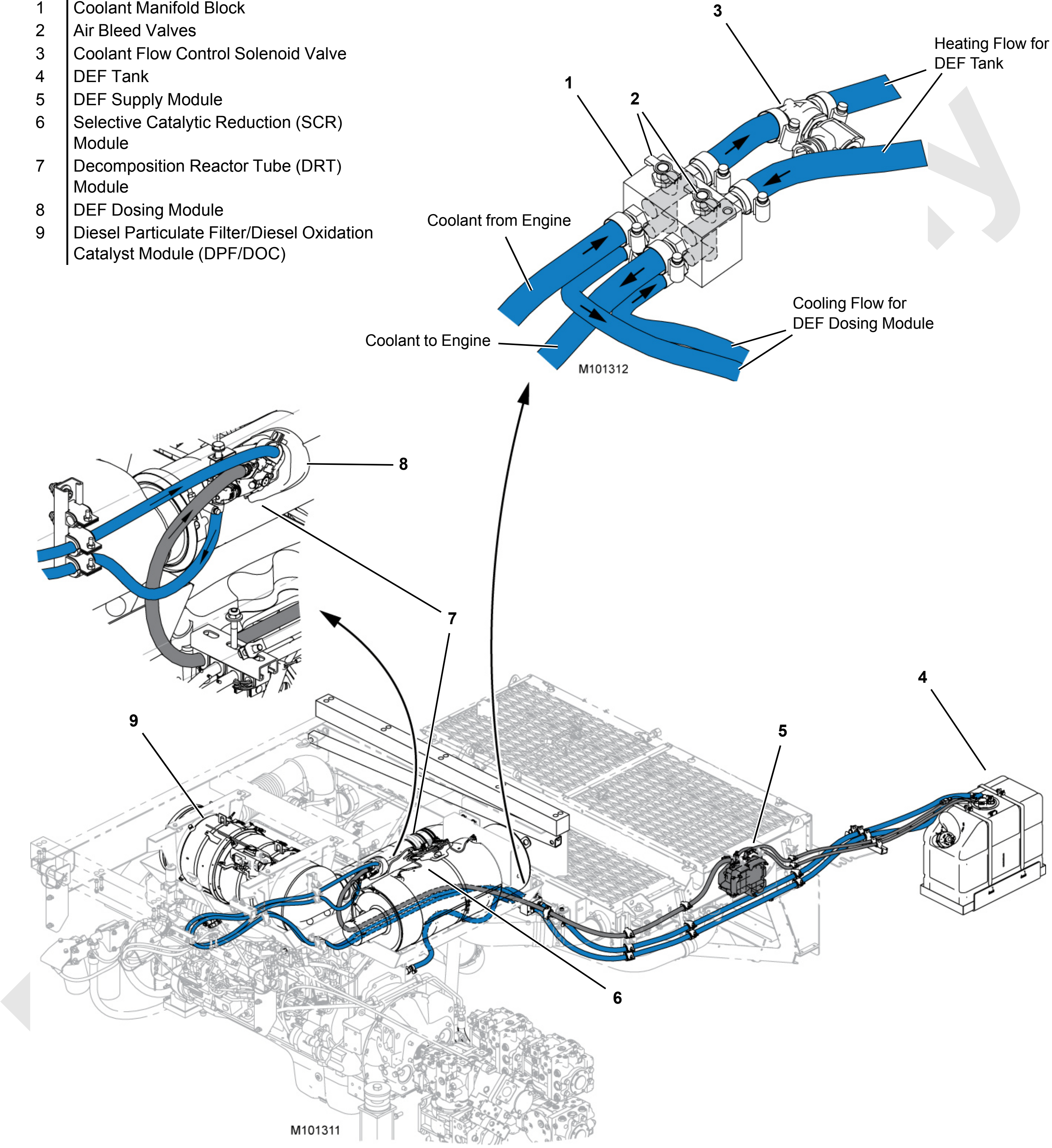


FIGURE 7-12

DEF Dosing System

A diesel exhaust fluid (DEF) supplies the required DEF to the DEF dosing module (8).

DEF Delivery Heating/Cooling System

Engine Coolant

Warm coolant from the engine is routed to a manifold (1) where it splits into two paths: one delivers coolant to the heat exchanger in the DEF tank (4) to keep the DEF warm or to thaw, and the other delivers coolant to the dosing module (8) to keep it from overheating. See Figure 7-12 for hose routing and coolant flow direction.

A solenoid valve (3) adjusts coolant flow to the DEF tank according to the temperature of the DEF in the tank. If the tank temperature drops below –4°C (25°F), this solenoid valve will be signaled to open by the ECM, and engine coolant will flow through the heat exchanger in the DEF tank.

24 VDC Heating Elements

To keep the DEF flowing during cold temperatures, one electric heating element is in the DEF supply module and one element is installed in each DEF line at the module. These elements come on if the ambient air temperature sensor reads a temperature below –4°C (25°F).

Maintenance Heating Cycle

The DEF dosing module will not prime the system until every component is completely defrosted. If ambient conditions continue to be cold after the system has primed, the ECM will command a maintenance heating cycle to prevent the DEF system from refreezing. This feature will cycle the heating on and off to the DEF lines, DEF tank, and dosing module.

NOTE: DEF will freeze at –11°C (12°F) and when frozen will expand by 7%. There are no approved additives to improve the freezing point.

DEF Supply Module

The DEF supply module (5, Figure 7-12) 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 DRT.

The supply module is heated electrically and has a 10-micron filter that requires periodic cleaning and inspection. For filter maintenance intervals, refer to the Cummins engine 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

DEF system components are designed to withstand freezing and to be compatible with DEF fluid and other unique characteristics of the system. Use of non-approved replacement parts may result in system damage.

Diesel Exhaust Fluid (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 DEF. In the event DEF is ingested, contact a physician immediately.

DEF (or AdBlue in Europe) consists of 32% urea and 68% de-ionized water. A constant mist of DEF, equal to 2 to 3% of fuel used, is injected into the DRT. This is about 10 gallons of DEF per 2 to 3 tanks of fuel.

The engine control module monitors DEF quality via a sensor in the tank. If poor quality DEF is sensed, an error code will be set.

NOTE: Do not store DEF for long periods of time. DEF will deteriorate faster in warmer temperatures. 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 will be set. These conditions can lead to engine power being reduced (de-rated) by the ECM. If the condition persists, engine shutdown may occur.

For more information, refer to the Fault Level Indicators topic in Section 3 of the 16000 Operator Manual.

DEF Tank

The DEF quality, level, and temperature are monitored by the engine control module via sensors in the tank.

The DEF can be heated by engine coolant that is circulated through a heat exchanger in the tank. If the tank temperature drops below –4°C (25°F), the DEF tank coolant solenoid valve will be commanded open by the ECM, and engine coolant will flow through the heat exchanger.

There is a 40-micron filter in the DEF supply (suction) pipe. For filter maintenance intervals, refer to the Cummins engine manual.

A drain valve is provided in case the tank needs to be emptied of poor-quality DEF.

The DEF tank capacity is 57 liters (15 gallons).

Item	Description
1	15 Gallon DEF Tank
2	Drain Valve
3	Hose and Electrical Fittings
4	Fill Cap

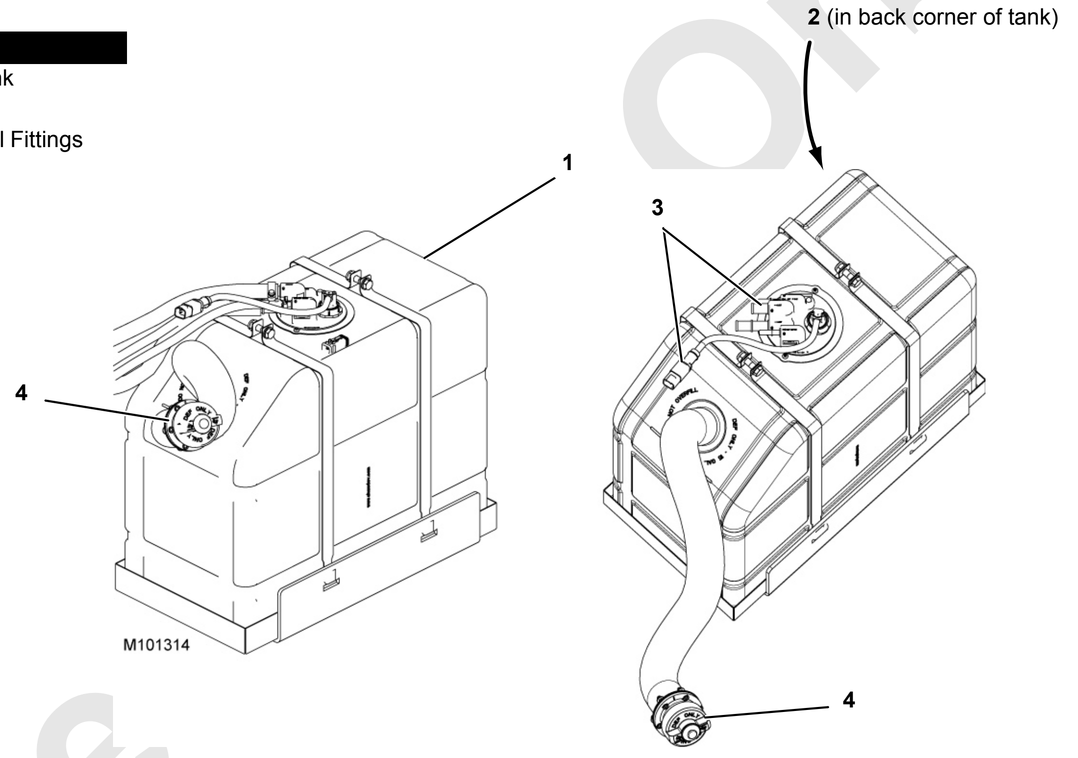


FIGURE 7-13

DPF/DOC MODULE OPERATION AND SERVICE

The Diesel Particulate Filter / Diesel Oxidation Catalyst (DPF/DOC) module (Figure 7-14) is the first stage of the diesel exhaust after treatment system. It incorporates a NO_x (nitrogen oxide) sensor, a dual pressure (dP) sensor, and two temperature sensors.

The Diesel Oxidation Catalyst (DOC) portion of the module is the inlet end of the module. The DOC oxidizes remaining hydrocarbons in the exhaust to carbon dioxide.

The DPF portion of the module is the outlet end of the module. The DPF captures soot and ash:

- 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. The remaining ash is captured and must be removed at periodic intervals. See the Maintenance topic later in this document for more information.

Regeneration

Regeneration is the process of converting the soot collected in the DPF into carbon dioxide. Regeneration requires heat.

Two types of regeneration are used: passive and active.

Passive Regeneration

Passive regeneration occurs when the exhaust temperatures are naturally high enough to oxidize the soot faster than it is collected in the DPF.

The process typically occurs during normal crane operation. The operator will not know when passive regeneration is occurring.

Active Regeneration

Active regeneration occurs when the exhaust temperatures are not naturally high enough to oxidize the soot faster than it is collected in the DPF. If this happens, the engine controller will initiate the process (see the engine manufacturer's manual for detailed instructions).

The process occurs more frequently in cranes operated at light or no load.

Active regeneration may not be apparent to the operator. Turbocharger noise and exhaust temperature may increase. The High Exhaust System Temperature icon should be on during regeneration and remain on until after completion of the regeneration cycle and the exhaust temperatures return to normal.

Manual Regeneration

Manual regeneration is active regeneration that is initiated by the operator. The DPF icon will come on if manual regeneration is required.

Regeneration Inhibit

Do not use the Inhibit switch unless specifically instructed to do so by the Manitowoc Crane Care Lattice Team.

NOTE The Inhibit switch is only for special circumstances where it is desirable to disable active regeneration.

Prolonged engine operation with the inhibit switch on will cause the DPF to fill with soot. Too much soot could cause the engine to stop. If that occurs, it will be necessary to clean the DPF before the engine can be restarted.

NOTE: The programmed engine idle speeds for the QSX15 Tier 4F Cummins engine are the following:

- High idle—1,800 RPM
- Low idle, normal operation—1,050 RPM
- Low idle, manual regeneration—850 RPM

For information on operation, switches, and faults related to regeneration, see Section 3 of the Operator Manual.

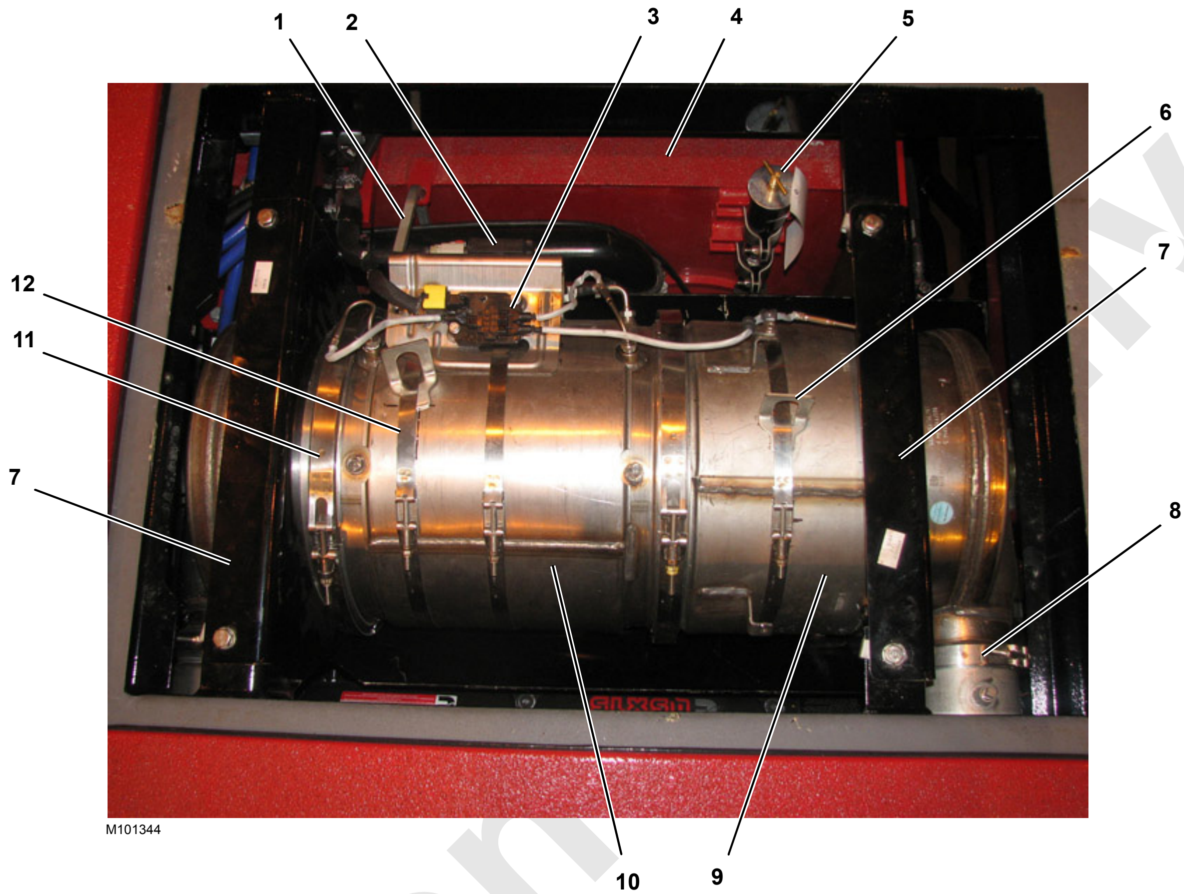
Maintenance

If ash build-up is not removed, the DPF can be damaged or its life reduced.

At a minimum service interval of 4,500 operating hours (roughly every two years of one-shift operation), the DPF/DOC module should be sent to the manufacturer for cleaning or exchanged for a clean one.

DPF cleaning requires special tools and equipment and should not be attempted by field service personnel.

For inspection and/or cleaning, the DPF/DOC module shall be removed. The module may be re-useable. For removal instructions, see DPF/DOC Module Replacement on page 7-16. If engine Fault Code 1981 or 1922 has been noted and the DPF is contaminated with coolant, the DPF/DOC module must be removed and replaced.



Item	Description
1	Handle, Hydraulic Tank Suction Valve
2	Thermistor Junction
3	Pressure Sensor Junction
4	Hydraulic Tank
5	Plug on Engine Oil Fill Tube
6	Lifting Tab (2)
7	Bracket Clamp
8	Clamp, Inlet Pipe
9	DOC half of Module
10	DPF half of Module
11	V-Band Clamp (2)
12	Band Clamp (3)

FIGURE 7-14

DPF/DOC Module Replacement

WARNING

Hot Exhaust Surfaces and Inhalation Hazards

Extremely hot surfaces and exhaust gases can cause death or serious injury.

When the HEST icon is illuminated, all personnel must stay at least 1,5 m (5 ft) from the exhaust pipe, and the pipe must not be directed toward anything that can melt, burn, or explode.

Allow the engine and the exhaust system to cool before servicing.

WARNING

Personal Injury Hazard—Heavy Objects

The DPF/DOC module weighs 53 kg (117 lbs) when empty.

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

WARNING

Electrical Shock Hazard

A dangerous shock is possible from a 12 VDC or 24 VDC source. Ensure that the battery cables are disconnected from the batteries before loosening any electrical connections.

CAUTION

Avoid Electronic Control Module Malfunction

Before disconnecting the batteries, make sure the engine ignition switch has been off for 70 seconds. This will avoid engine fault codes and undesirable operation.

Removal

See Figure 7-14 for the following procedure:

1. Raise the exhaust assembly according to Raising the Exhaust Assembly on page 7-14.
2. Loosen, but do not remove, the pipe clamp with the gasket from the DPF/DOC module outlet and slide the clamp onto the outlet tube.
3. Lower the exhaust assembly back down.
4. Disconnect the electrical connectors from the module.
5. Remove the bolts from the bracket clamps. Remove the clamp halves.
6. Attach the appropriate lifting equipment to the lifting tabs on the module.
7. Lift the module out of the engine compartment. Use the appropriate procedures when transporting the module.

CAUTION

Avoid Damage to the DPF/DOC Module

The oxidation catalyst elements of the diesel particulate filter are made of brittle material. Do not drop or strike the side of the module or damage to these elements can result.

Installation

To install the module, use the following procedure:

1. Install the DPF/DOC module by following the removal procedure in reverse.
2. Check the inlet orientation of any replacement module per Figure 7-15. If it is not oriented correctly, perform the re-orientation procedure. See DPF/DOC Module Inlet Re-orientation on page 7-16.

DPF/DOC Module Inlet Re-orientation

See Figure 7-15 for the following procedure.

Re-orient a replacement DPF/DIC if it is not oriented per Figure 7-15. If the inlet section (1) cannot be re-oriented, contact the supplier for a replacement module that has all components in the proper orientation.

To re-orient the module, use the following procedure:

1. If necessary, remove the thermistor (6) located on the inlet. Using an appropriate high-temperature sealant, install a plug into the threaded hole.
2. Orient the inlet section:
   - **a.** Loosen the V-band clamp (3) that connects the inlet section until it can be freely rotated. Do not remove the clamp or the gasket.
   - **b.** Loosen the band clamp (4) that holds the lifting tab (2) and the clamps for the thermistor wire onto the inlet section.
   - **c.** Rotate the inlet section to the orientation shown.
   - **d.** Tighten the V-band clamp to 20 Nm (15 ft-lb).

     Gently tap the circumference of the V-band clamp with a rubber mallet to make sure that the clamp is properly seated. Re-tighten to 20 Nm (15 ft-lb).
   - **e.** Position the lifting tab back to vertical. Position the band clamp hardware 35° from the tab.
   - **f.** Tighten the band clamp to 7.3 Nm (64 in-lb).
3. Reinstall the thermistor using an appropriate high-temperature sealant.

NOTE: The white-insulated wires must not be within 25 mm (1 in.) of the module body.

Avoid sharp bends and excessive tension in the wires.

Item	Description
1	Inlet Section (DOC)
2	Lifting Tab
3	V-Band Clamp
4	Band Clamp
5	Outlet Section (DPF)
6	Thermistor

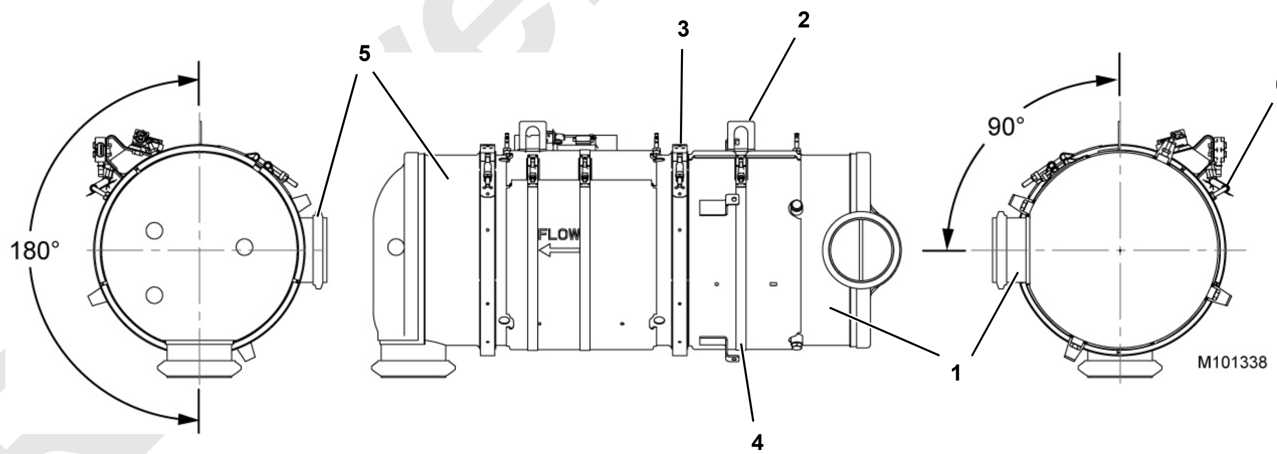


FIGURE 7-15

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SECTION 8
UNDER CARRIAGE

TABLE OF CONTENTS

8

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SECTION 8
UNDER CARRIAGE

TURNTABLE BEARING

Installation

When installing a turntable bearing, align the dowel pin holes in the inner ring with the dowel pins in the underside of the rotating bed.

Bearing Bolt Torque

DANGER
Crushing Injury Hazard!

Two people are required to torque the turntable bearing bolts: an operator to operate the swing control and a mechanic to torque the bolts.

To torque the inner turntable bearing bolts, use the following procedure:

- The mechanic shall enter the carbody
- Maintain constant communication between the operator and mechanic while the mechanic is inside the carbody.
- 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 are being swung to position the bolts.

WARNING
Bolt Failure!

Loose or improperly torqued bolts can cause the bolts or turntable bearing to fail, possibly allowing the upperworks to break away from the carbody.

Lubrication

Before installing the turntable bearing bolts, lubricate the following with "Never-Seez" or an equivalent anti-seize compound:

- Threads of each bolt
- The underside of the head of each bolt
- Both sides of each washer

Torque Values

Torque each turntable bearing bolt to 3,525 Nm (2,600 ft-lb).

When new bolts are installed, torque the bolts in two steps:

- First, torque them to 1,356 Nm (1,000 ft-lb).
- Then, torque them to 3,525 Nm (2,600 ft-lb).

Torque Sequence

Torque the bolts, three at a time, in the numbered sequence given in Figure 8-1. Torque one ring at a time.

Torque Intervals

At the beginning of crane operation, torque all bolts to the specified value after the first 50 hours of operation.

Yearly or every 2,000 hours of operation, whichever comes first, torque all bolts to the specified value.

Bolt Replacement

If, at the yearly inspection interval, one to 16 bolts are found to be torqued to less than 2,820 Nm (2,080 ft-lb), replace each loose bolt and washer. Also, replace the bolt and washer on each side of each loose bolt.

If, at the yearly inspection interval, 17 or more bolts in either ring are found to be torqued to less than 2,820 Nm (2,080 ft-lb), replace all of the bolts and washers for the corresponding ring.

Replace all bolts and washers each time a new turntable bearing is installed.

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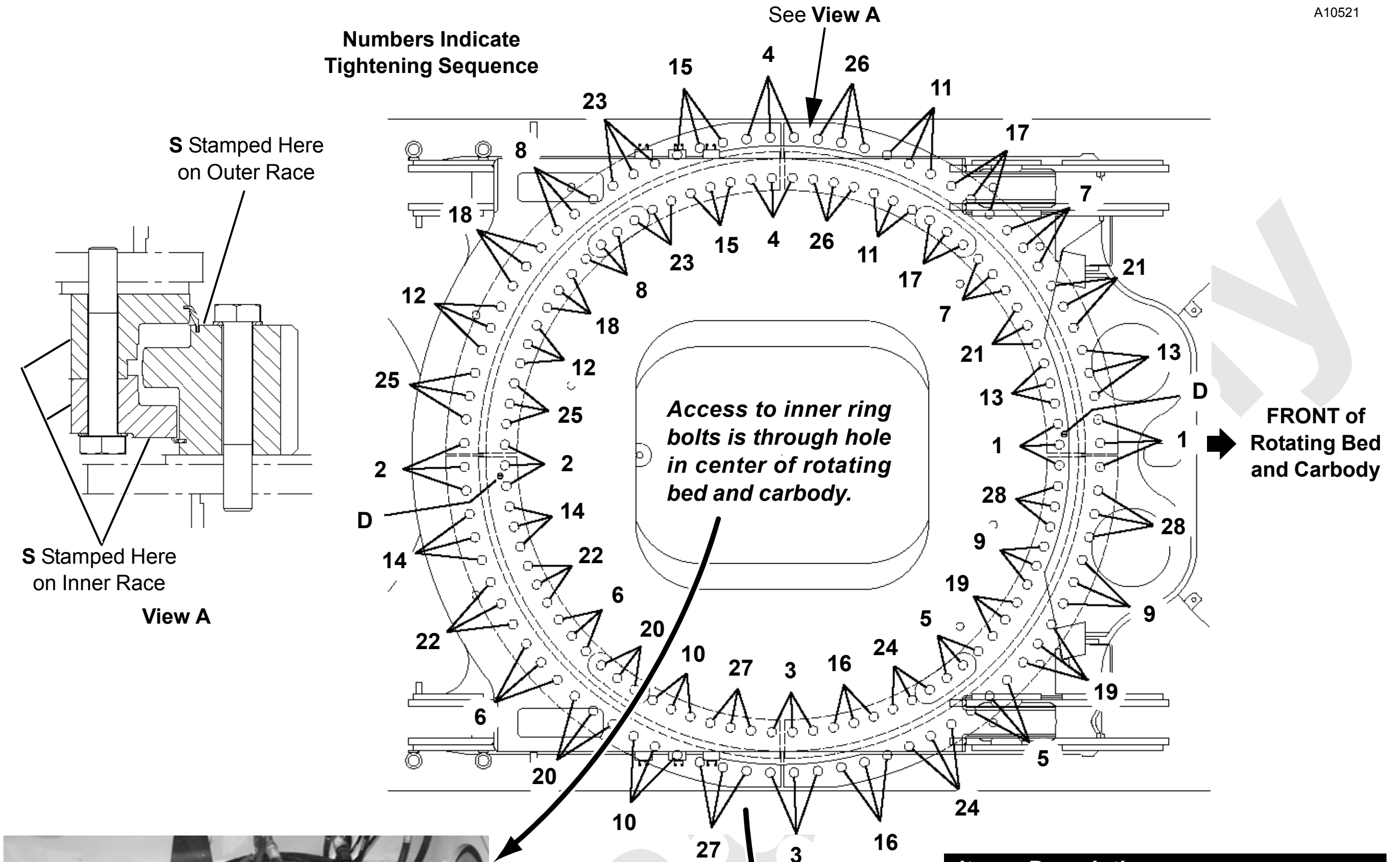
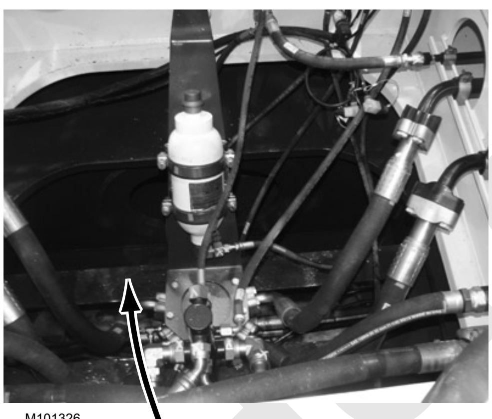
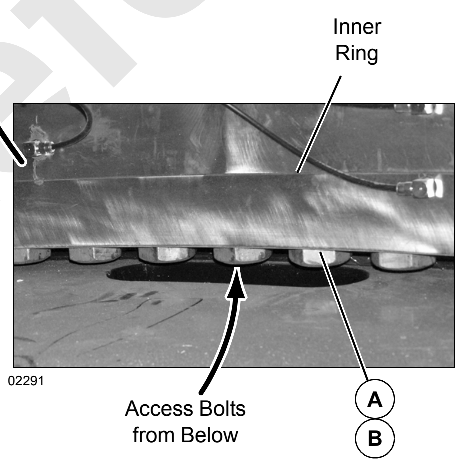


Item	Description
A	Heavy Hex Head Bolt – 1-1/2 in (38 mm)- 6 UNRC x 10 inch Long SPECIAL Grade 84 Each Ring
B	Special Flat Steel Washer – 2-5/8 inch OD x 1-9/16 inch ID 84 Each Ring with **Chamfer Toward Bolt**
D	Dowel Pin





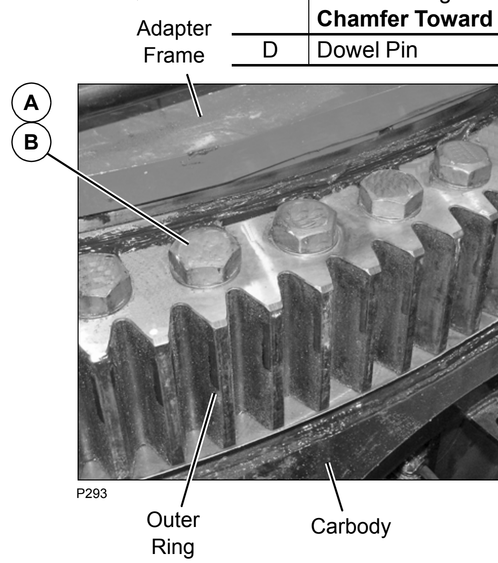


FIGURE 8-1

CRAWLER

Maintenance

Crawler wear cannot be eliminated, but the rate of wear can be reduced through regular preventive maintenance, as follows:

- Lubricate the crawlers as instructed in the Lubrication Guide.
- Keep the crawlers clean and avoid dirt build-up when cutting.
- Keep all the mounting bolts tight (see the Parts Manual for applicable torque values).
- Keep treads properly adjusted.
- Inspect crawler gear cases, crawler frames, rollers, and treads on a regular basis.

  Look for oil leaks, excessive wear, cracks, and other damage. Broken or cracked parts can indicate that the treads are adjusted too tight.

  Repair or replace damaged parts immediately to prevent further damage.
- Adjust top roller guards close to the top rollers without touching the rollers as shown in Figure 8-2.

Tread Slack

Measuring Tread Slack

Check tread slack at the tumbler end of each crawler. Maintain equal tread slack at both crawlers. Use the following procedure:

1. Travel forward or reverse on a firm level surface so all tread slack is in the top of the treads at the tumbler end of the crawlers as shown in Figure 8-2.
2. Place a straight edge on the tread as shown in Figure 8-2. The gap between the straight edge and the top of the tread at the lowest point should be between 38 mm (1-1/2 in) and 76 mm (3 in).
3. Adjust tread slack if the gap exceeds either limit.
4. Adjust the treads tighter when operating on firm ground and looser when operating on soft ground (mud or sand).

CAUTION

Pin Damage and Tread Wear!

Do not adjust the treads too tight. Tread pins will wear rapidly and may break. Dirt build-up will tighten the treads even more, increasing the possibility of damage.

More torque is required to drive tight treads, which results in faster wear and more fuel consumption.

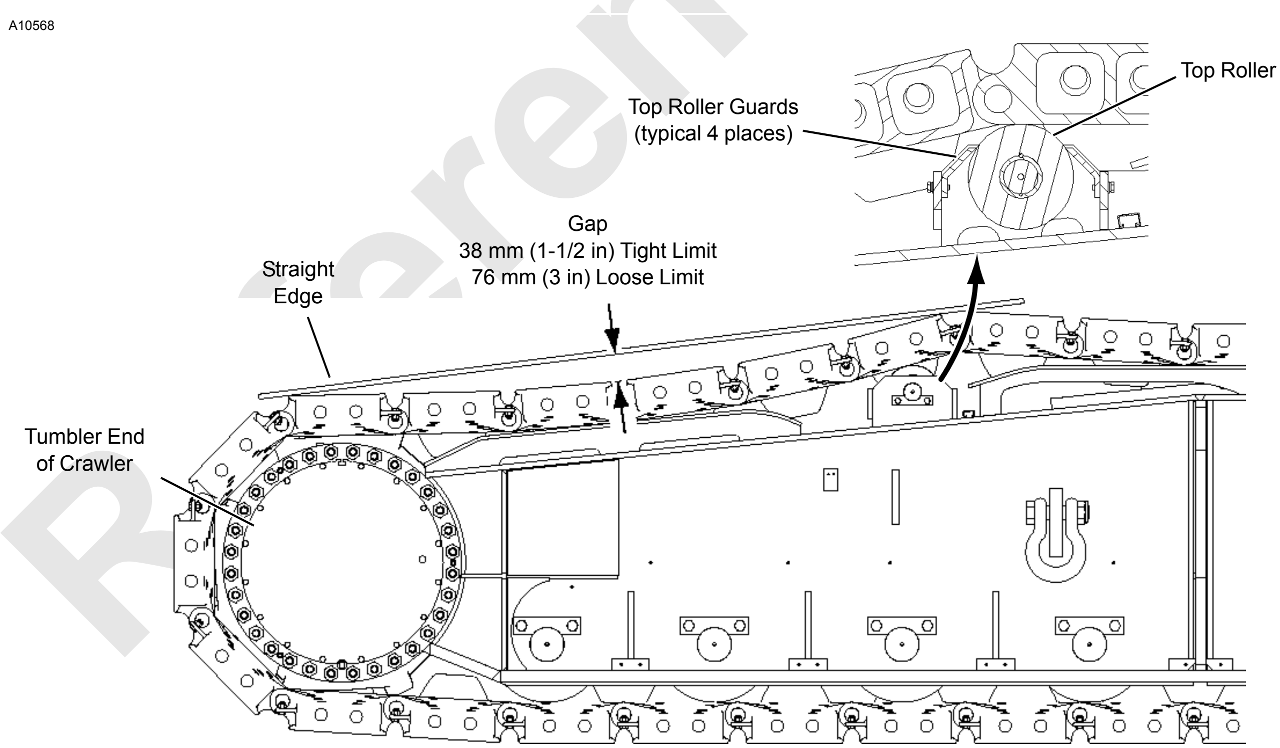


FIGURE 8-2

Adjusting Tread Slack

Adjust the tread slack at the roller end of each crawler (Figure 8-3):

1. Thoroughly clean the crawler to be adjusted.
2. Loosen the bolt on each side of the crawler roller.
3. Remove the cover from both sides of the crawler frame.
4. Place the jacking cylinder on the support.
5. Jack against the rod an equal amount on both sides of the crawler frame.
6. Add or remove an equal thickness of shims on both sides of the crawler frame.
7. Remove the jacking cylinder.
8. Travel forward or reverse to tighten the shims.
9. Make sure the dimension from the center punch in the shaft to the center punch line in the crawler frame is the same on both sides of the crawler within 3 mm (1/8 in).

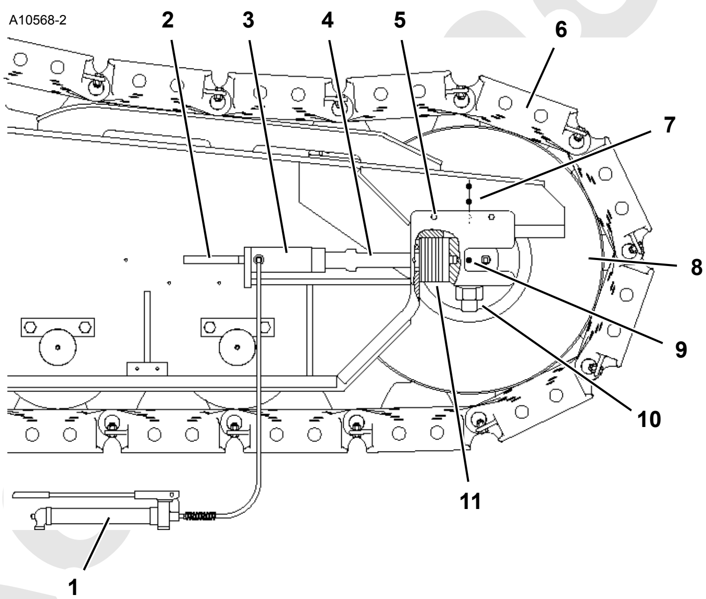
CAUTION

Part Wear!

The crawler roller and tumbler must be square with the crawler frame within 3 mm (1/8 in) or the parts will wear rapidly.

10. Check for proper adjustment (see the Adjustment Guideline) and readjust as required using steps 4 through 9.
11. Lubricate the nuts and bolts at the crawler roller with Never-Seez or an equivalent anti-seize compound.
12. Tighten the nuts to the bolts at the crawler roller to 2 712 Nm (2,000 ft-lb).
13. Install the cover on both sides of the crawler frame.

NOTE: The extreme limit of tread adjustment occurs when the bolts are tight against the front end of the slots in the crawler frame. One crawler tread can be removed when this limit is reached.



Item	Description
1	Hand Pump
2	Support
3	Jacking Cylinder
4	Rod
5	Cover
6	Tread
7	Center Punch Line
8	Crawler Roller
9	Center Punch
10	Bolts
11	Shims 12 mm (0.472 in) and 6 mm (0.236 in) Thick

FIGURE 8-3

HYDRAULIC HAND PUMP

See Figure 8-4 for the following procedures.

WARNING

Prevent Possible Death or Serious Injury to Maintenance Personnel!

Manitowoc has provided a hand pump and cylinder for crawler adjustment only. Any other use is neither intended nor approved.

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

Do not exceed the maximum pressure rating of 700 bar (10,153 psi) for the components (pump, cylinder, hose). Higher pressure can cause components to explode.

Do not set the pump relief valve above 700 bar (10,153 psi). Higher pressure can cause components to explode.

The pump can explode. The pump is not vented and may explode if subjected to high pressure. Do not overfill the pump.

The pump handle can kick back. Always keep your body to the side of the pump, away from the line of handle force. Do not add extensions to the handle. Extensions can cause unstable operation. Do not add extensions to the handle.

Assembly

To assemble the pump, use the following procedure:

1. Connect the hose from the pump outlet port to the cylinder inlet.
2. Apply 1-1/2 wraps of a high-grade thread sealant on the fittings (for example, Teflon tape).

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

   Do not over-tighten the connections. The 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.

Operation

To operate the pump, use the following procedure:

Before using the pump make sure all the fittings are tight and leak free, check the oil level.

1. To pressurize the cylinder and extend the rod, close the valve by turning it clockwise until finger-tight. Then, pump the handle up and down.

   Pressure will be maintained until the valve is opened.

   To reduce handle effort at high pressure, use short strokes. Maximum leverage is obtained in the last five degrees of stroke.

2. To depressurize the cylinder, push the handle down fully. Open the valve by turning it counterclockwise until you hear air being released.

The pump can be operated in any position to vertical as long as the hose end of the pump is down.

Maintenance

To maintain the pump, use the following procedure:

1. Keep the unit clean and stored in a safe place where it cannot be damaged.
2. Keep oil in the pump at the proper level. Check the level:
   a. Open the valve and fully retract the cylinder rod to return all oil to pump. The cylinder must be fully retracted or the system will contain too much oil.
   b. For a Simplex pump, use the following:
      - Place the pump in horizontal position on a flat surface.
      - Using a screw driver, remove the fill cap.
      - Add hydraulic oil until the reservoir is 2/3 full. Do not overfill the pump.
      - Securely reinstall the fill cap.
   c. For an Enerpac pump, use the following:
      - Place the pump in vertical position with the hose end down.
      - Using a screw driver, remove the vent/fill cap.
      - Add hydraulic oil until it is at the mark on the dipstick.Do not overfill the pump.
      - Securely reinstall the fill cap.
   d. Test the pump operation and remove air from the system, if required. Recheck the oil level after removing the air.

Air Removal

To remove air, use the following procedure:

1. Close the valve finger-tight-only.
2. Position the pump higher than the cylinder. Position the cylinder so the rod is down.
3. Operate the pump to fully extend the cylinder rod.
4. Open the valve and retract the cylinder rod to force oil and trapped air back into the pump.

Repeat these steps until the cylinder operates smoothly. Erratic operation indicates air in the system.

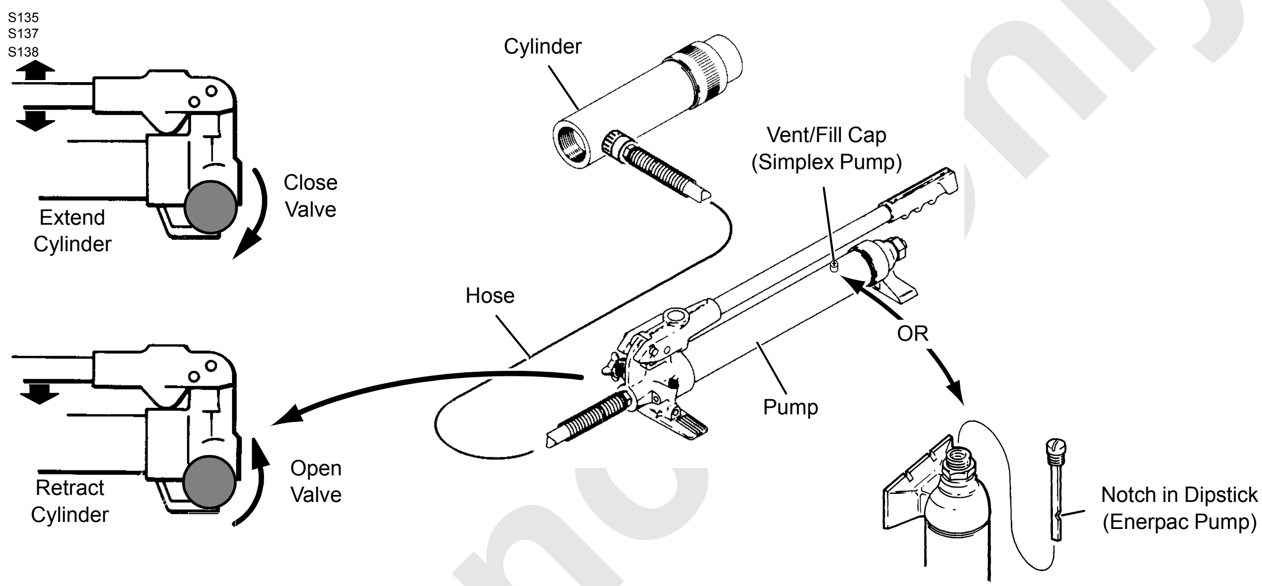


FIGURE 8-4

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SECTION 9
LUBRICATION

LUBRICATION

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LUBE AND COOLANT PRODUCT GUIDE

See the publication at the end of this section.

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SECTION 10
TROUBLESHOOTING

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SECTION 10
TROUBLESHOOTING

INTRODUCTION

This troubleshooting section is designed for qualified service technicians familiar with the operation and repair of electrical and hydraulic equipment. It is not possible to predict all problems that might occur or the correct procedure for troubleshooting each problem. ***If a problem is encountered that is not covered in this manual, first consult your Manitowoc dealer. The Manitowoc Crane Care Lattice Team can provide assistance, if necessary.***

SAFETY SUMMARY

Hazards are always a possibility when performing trouble-shooting operations on heavy equipment. To minimize the risk of potential hazards and to prevent serious injury or death, comply with the following:

- Read the Operator Manual and Service Manual before beginning troubleshooting operations.
- A qualified service technician-competent in the repair and testing of electrical and hydraulic equipment-must complete troubleshooting. Manitowoc is not responsible for training personnel who might use this manual to perform troubleshooting operations.
- When possible, turn off the crane engine for safety. Keep unauthorized personnel away from the crane when troubleshooting.
- Never troubleshoot the crane alone. Always perform troubleshooting procedures with a qualified operator in the crane cab. Maintain constant communication with this operator when performing operations that require the crane engine to be running.
- Do not return the crane to service after completion of maintenance or repair procedures until all guards and covers are re-installed, trapped air is bled from hydraulic systems, safety devices are enabled and all maintenance equipment is removed.
- Perform a function check to ensure correct operation at the completion of maintenance or repair operations.

The following warnings apply to all troubleshooting operations. Manitowoc cannot foresee all hazards that may occur.

You must be familiar with the equipment and trained in the testing method and use common sense while troubleshooting to avoid other hazards.

WARNING

Eye, Skin, and Respiratory Hazards!

Wear proper eye and skin protection and avoid direct contact with battery acid, oil, or ether spray when searching for leaks, opening connections, or installing pressure gauges.

Pressurized hydraulic oil can cause serious injury. Turn off the engine, remove the key, and relieve pressure in the system before disconnecting, adjusting, or repairing any component.

Ensure that connections are made correctly, o-rings or gaskets are in place, and connectors are properly installed before pressurizing the system.

Use the necessary precautions to prevent electrical burns when checking battery charging and starter circuits.

Death or serious injury can occur if these warnings are ignored.

Unexpected Moving Part Hazard!

Keep personnel away from the crane while manually actuating a valve or pump to avoid unexpected equipment movement that can cause death or serious injury.

GUIDELINES

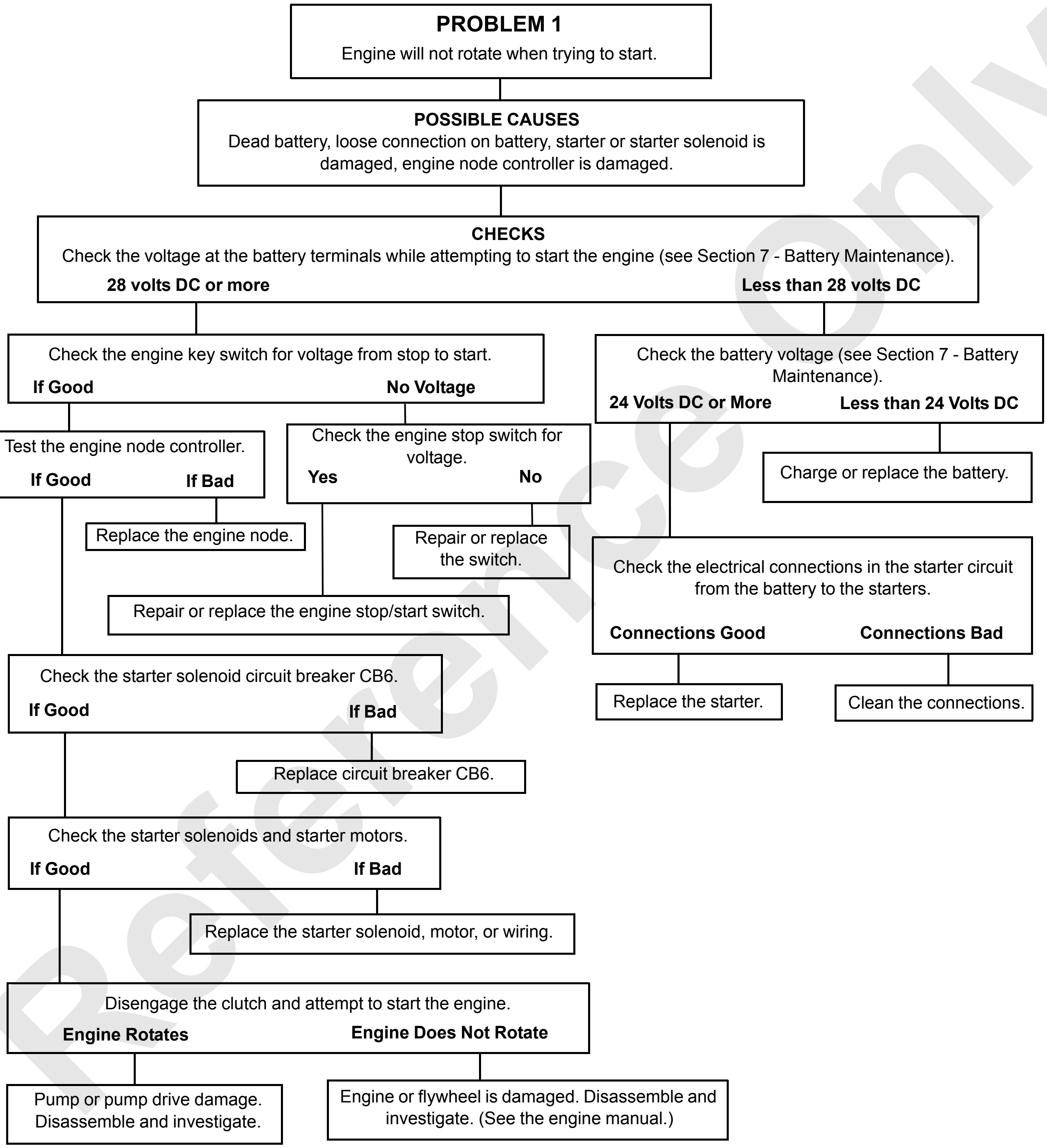
The following guidelines apply to all troubleshooting operations:

- Do not remove cylinders or counterbalance valve(s) from a cylinder until the cylinder's working unit is restrained against movement.
- Do not use your hands to check for hydraulic oil leaks. Use a piece of cardboard to check for hydraulic oil leaks.
- Use gauges with the correct pressure range when checking hydraulic circuits.
- Check pressures at the specified hydraulic component ports.
- Use the RCL display and main display for checking the pump, motor, handle, brake, and other components.
- Use the in-line test boards (available from Manitowoc Crane Care) for further testing of computer nodes and electrical circuits.

TROUBLESHOOTING CHARTS

This topic provides a series of flow charts that identify potential problems during normal operation. These charts contain instructions to assist in identifying and correcting problems. Follow the procedural steps in the order indicated.

Some steps direct you to other charts in this manual or reference a specific test to perform to move through the complete troubleshooting procedure. If directed, consult your Manitowoc dealer or Manitowoc Crane Care before proceeding.



PROBLEM 2

The engine rotates, but will not start.

POSSIBLE

No fuel to or from the injector pump, water or algae in the fuel, air intake restricted or blocked, engine load is too high, low battery amperage to gain starting RPM, fuel shut-off is not working correctly.

CHECKS

Disengage the drive clutch. Try starting the engine again.

Starts — Check that all system pumps are centered. (See Section 2 - Control Calibration.)

No Start — Remove the injector pump inlet line. Check for fuel flowing out of the line while trying to start the engine.

- **No Fuel** — Check for fuel in the tank or line obstruction. A fuel additive is recommended in cold weather. Algae can occur in warm climates.
- **Good Stream of Clear Fuel** — Make sure the injector pump fuel shut-off valve is fully open.
  - **Not Open** — Make adjustments to the solenoid shut-off valve or check valve for the correct operation.
  - **Fully Open** — Remove the injector pump inlet line. Try starting the engine. Look for any momentary burst of fuel.
    - **No Fuel** — Check all fuel lines for air down-stream of the transfer pump.
      - **No Operation** — Repair or replace the injector pump
    - **Fuel** — Loosen fittings at the filters. Start the engine while holding the throttle open to bleed air. Re-tighten the lines and start the engine.
      - **No Start** — Check the intake for obstruction.
      - **No Obstruction** — Check the engine for adequate cranking RPM.
      - **400 RPM or Less** — Check each battery. Replace the battery if the voltage drop exceeds 8 volts while engine is starting. (See Section 7 - Battery Maintenance.)
      - See the engine manual.

PROBLEM 3

Engine runs, but there is no hydraulic operation.

POSSIBLE CAUSES

Clutch not engaged, no hydraulic fluid in the tank, blocked charge inlet to pumps, clogged tank vent, drive train damaged from flywheel to pump mount.

CHECKS

Check the hydraulic filter service shut-off valve.

Ok / **Not Ok**

- **Not Ok:** Open the filter service shut-off valve or replace filters if necessary.
- **Ok:** Check clutch engagement.
  - **Clutch not Engaged:** Engage the clutch.
  - **Clutch Engaged:** Remove the vent. Check the fluid level, temperature, and viscosity. In extreme cold conditions, oil may not flow freely to the pump inlets causing pump
    - **Not Ok:** Service the hydraulic system.
    - **Tank Vent, Oil Level, Temperature, and Viscosity Ok:** Make sure all brakes are applied. Check the manual override on two or more pumps. (See Section 2 - Manual Override Tests.) Does the engine load when manual override is applied?
      - **Pump Loads:** Check the electrical input from controller to pump. (See Section 3 - Checking Electrical Inputs/Outputs.)
      - **Pump does not Load:** Consult your Manitowoc dealer or the Crane Care Lattice Team.

PROBLEM 4

The engine runs, but the battery is not charging.

POSSIBLE CAUSES

Belt loose or broken, no input to alternator terminals, damaged alternator, corroded or loose battery connection, battery damaged.

CHECKS

Check drive belt for correct tension.
(See engine manual for drive belt deflection specifications.)

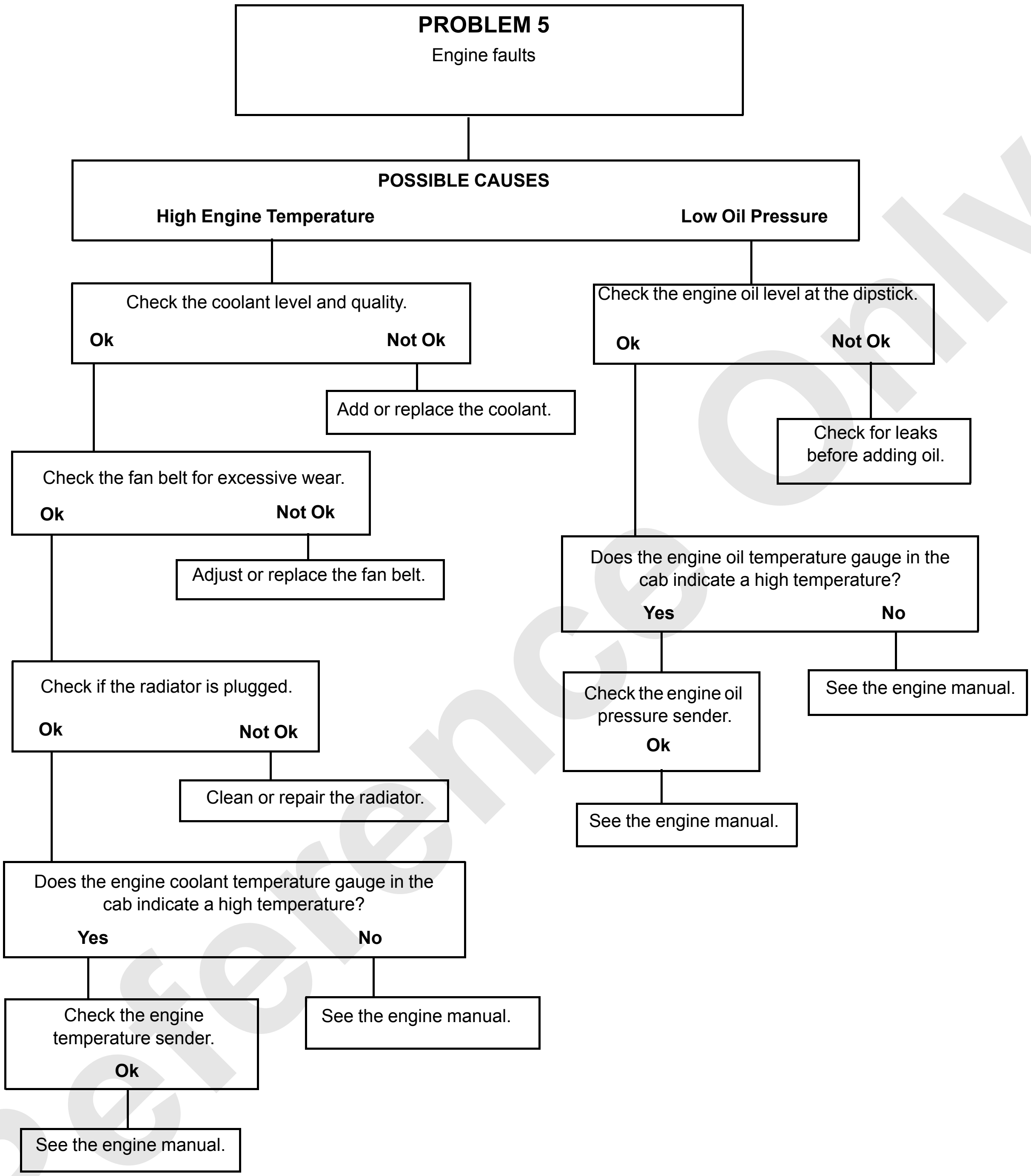
Ok

Connect the voltmeter between the alternator 28-volt terminal and the ground terminal. Take the reading with the cab power ON and the engine running.

- **Zero Volts DC** — Repair wiring or connections.
- **28 Volts DC or Less** — Replace the alternator.
- **20.8 Volts DC or More** — Test the batteries for any weak cells. (See Section 7 - Battery Maintenance.)

Not Ok

Tighten the drive belt or replace the belt.



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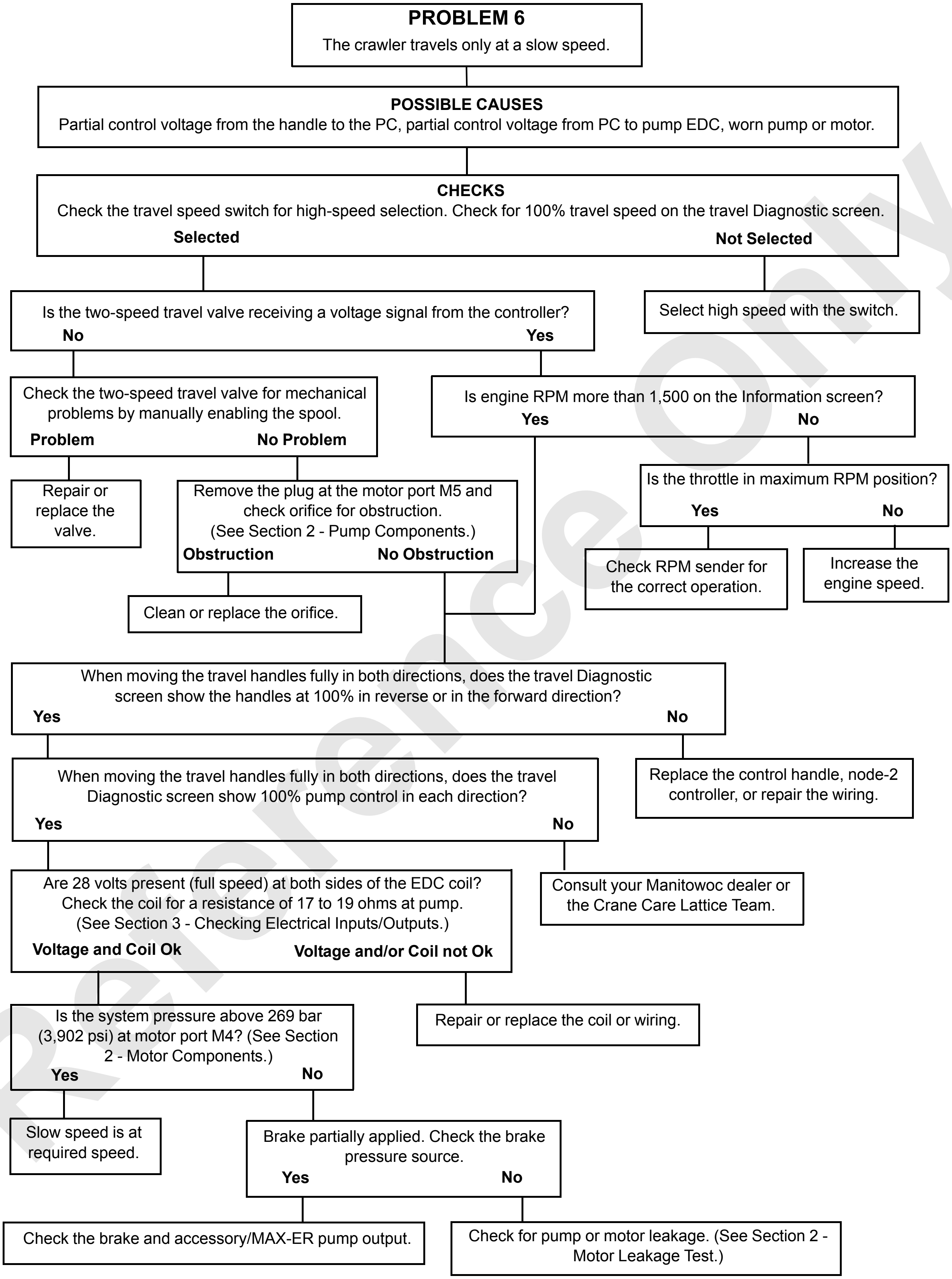
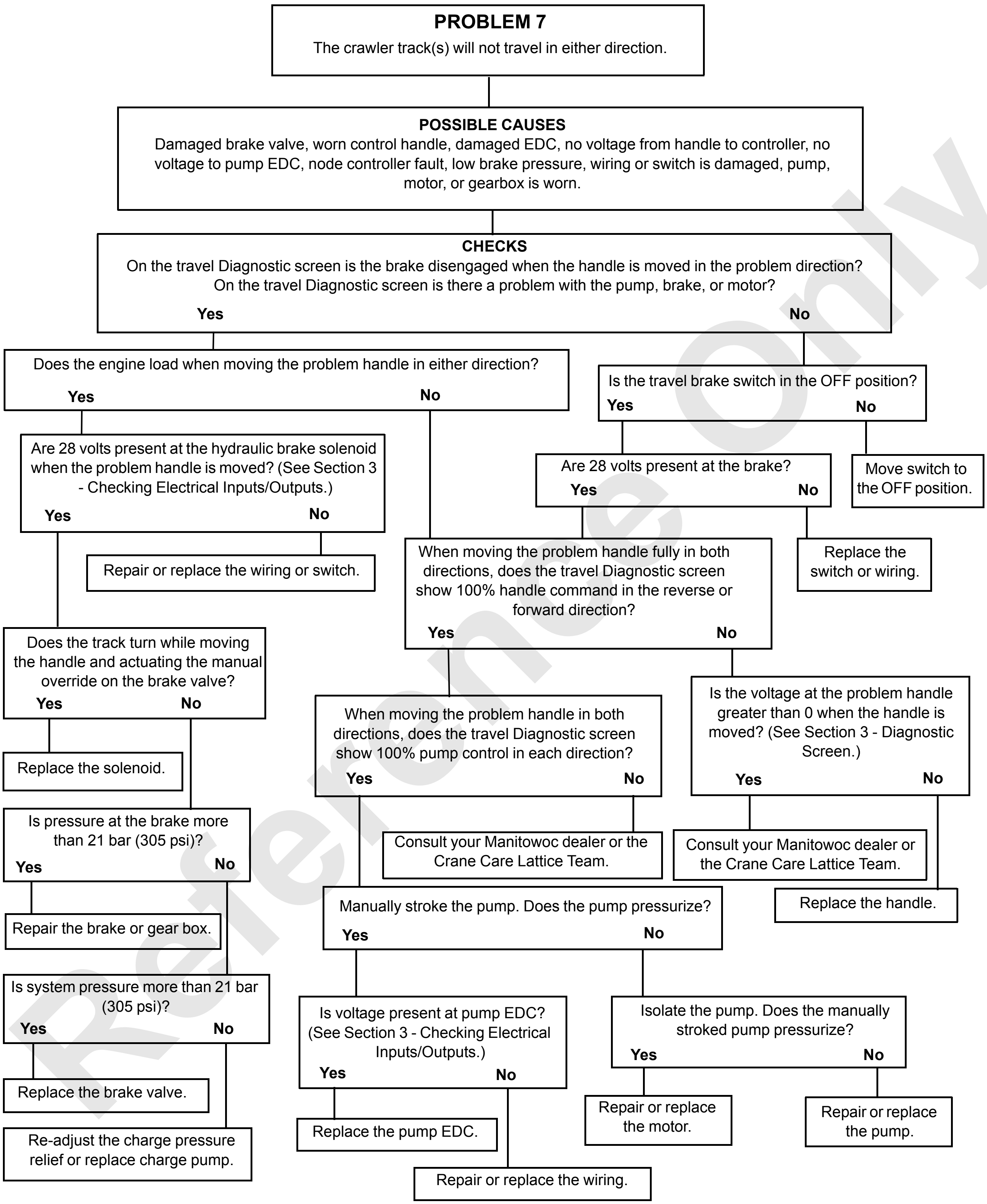
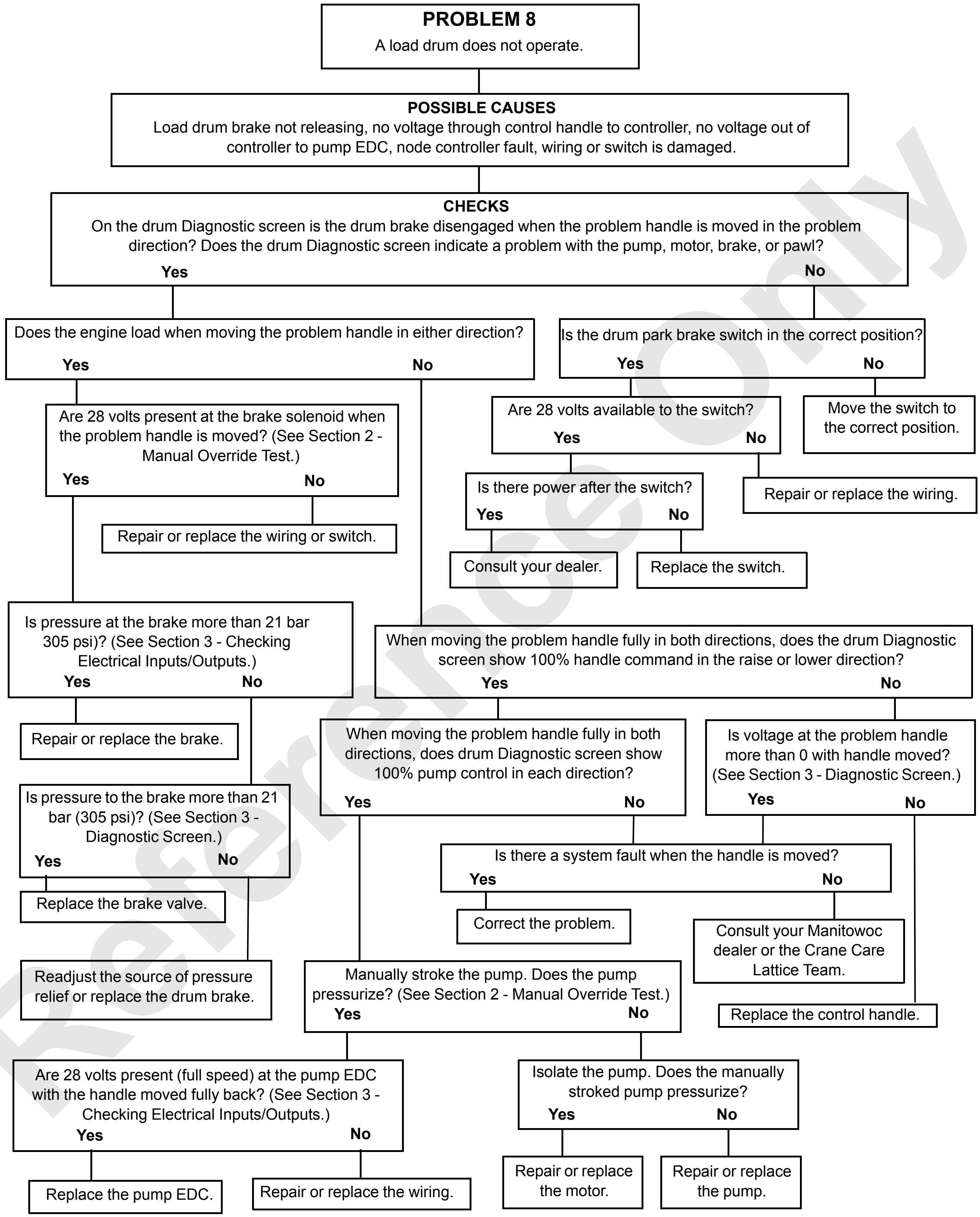

PROBLEM 6
The crawler travels only at a slow speed.
POSSIBLE CAUSES
Partial control voltage from the handle to the PC, partial control voltage from PC to pump EDC, worn pump or motor.
CHECKS
Check the travel speed switch for high-speed selection. Check for 100% travel speed on the travel Diagnostic screen.
Selected
Not Selected
Is the two-speed travel valve receiving a voltage signal from the controller?
No
Yes
Select high speed with the switch.
Check the two-speed travel valve for mechanical problems by manually enabling the spool.
Problem
No Problem
Is engine RPM more than 1,500 on the Information screen?
Yes
No
Repair or replace the valve.
Remove the plug at the motor port M5 and check orifice for obstruction. (See Section 2 - Pump Components.)
Obstruction
No Obstruction
Is the throttle in maximum RPM position?
Yes
No
Check RPM sender for the correct operation.
Increase the engine speed.
Clean or replace the orifice.
When moving the travel handles fully in both directions, does the travel Diagnostic screen show the handles at 100% in reverse or in the forward direction?
Yes
No
When moving the travel handles fully in both directions, does the travel Diagnostic screen show 100% pump control in each direction?
Yes
No
Replace the control handle, node-2 controller, or repair the wiring.
Are 28 volts present (full speed) at both sides of the EDC coil? Check the coil for a resistance of 17 to 19 ohms at pump. (See Section 3 - Checking Electrical Inputs/Outputs.)
Voltage and Coil Ok
Voltage and/or Coil not Ok
Consult your Manitowoc dealer or the Crane Care Lattice Team.
Is the system pressure above 269 bar (3,902 psi) at motor port M4? (See Section 2 - Motor Components.)
Yes
No
Repair or replace the coil or wiring.
Slow speed is at required speed.
Brake partially applied. Check the brake pressure source.
Yes
No
Check the brake and accessory/MAX-ER pump output.
Check for pump or motor leakage. (See Section 2 - Motor Leakage Test.)


PROBLEM 7
The crawler track(s) will not travel in either direction.
POSSIBLE CAUSES
Damaged brake valve, worn control handle, damaged EDC, no voltage from handle to controller, no voltage to pump EDC, node controller fault, low brake pressure, wiring or switch is damaged, pump, motor, or gearbox is worn.
CHECKS
On the travel Diagnostic screen is the brake disengaged when the handle is moved in the problem direction?
On the travel Diagnostic screen is there a problem with the pump, brake, or motor?
Yes
No
Does the engine load when moving the problem handle in either direction?
Yes
No
Is the travel brake switch in the OFF position?
Yes
No
Are 28 volts present at the hydraulic brake solenoid when the problem handle is moved? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Are 28 volts present at the brake?
Yes
No
Move switch to the OFF position.
Repair or replace the wiring or switch.
When moving the problem handle fully in both directions, does the travel Diagnostic screen show 100% handle command in the reverse or forward direction?
Yes
No
Replace the switch or wiring.
Does the track turn while moving the handle and actuating the manual override on the brake valve?
Yes
No
Replace the solenoid.
When moving the problem handle in both directions, does the travel Diagnostic screen show 100% pump control in each direction?
Yes
No
Is the voltage at the problem handle greater than 0 when the handle is moved? (See Section 3 - Diagnostic Screen.)
Yes
No
Is pressure at the brake more than 21 bar (305 psi)?
Yes
No
Consult your Manitowoc dealer or the Crane Care Lattice Team.
Consult your Manitowoc dealer or the Crane Care Lattice Team.
Repair the brake or gear box.
Manually stroke the pump. Does the pump pressurize?
Yes
No
Replace the handle.
Is system pressure more than 21 bar (305 psi)?
Yes
No
Is voltage present at pump EDC? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Isolate the pump. Does the manually stroked pump pressurize?
Yes
No
Replace the brake valve.
Replace the pump EDC.
Repair or replace the motor.
Repair or replace the pump.
Re-adjust the charge pressure relief or replace charge pump.
Repair or replace the wiring.


PROBLEM 8
A load drum does not operate.
POSSIBLE CAUSES
Load drum brake not releasing, no voltage through control handle to controller, no voltage out of controller to pump EDC, node controller fault, wiring or switch is damaged.
CHECKS
On the drum Diagnostic screen is the drum brake disengaged when the problem handle is moved in the problem direction? Does the drum Diagnostic screen indicate a problem with the pump, motor, brake, or pawl?
Yes
No
Does the engine load when moving the problem handle in either direction?
Yes
No
Is the drum park brake switch in the correct position?
Yes
No
Are 28 volts present at the brake solenoid when the problem handle is moved? (See Section 2 - Manual Override Test.)
Yes
No
Are 28 volts available to the switch?
Yes
No
Move the switch to the correct position.
Is there power after the switch?
Yes
No
Repair or replace the wiring.
Repair or replace the wiring or switch.
Consult your dealer.
Replace the switch.
Is pressure at the brake more than 21 bar 305 psi)? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
When moving the problem handle fully in both directions, does the drum Diagnostic screen show 100% handle command in the raise or lower direction?
Yes
No
Repair or replace the brake.
When moving the problem handle fully in both directions, does drum Diagnostic screen show 100% pump control in each direction?
Yes
No
Is voltage at the problem handle more than 0 with handle moved? (See Section 3 - Diagnostic Screen.)
Yes
No
Is pressure to the brake more than 21 bar (305 psi)? (See Section 3 - Diagnostic Screen.)
Yes
No
Is there a system fault when the handle is moved?
Yes
No
Replace the brake valve.
Correct the problem.
Consult your Manitowoc dealer or the Crane Care Lattice Team.
Readjust the source of pressure relief or replace the drum brake.
Manually stroke the pump. Does the pump pressurize? (See Section 2 - Manual Override Test.)
Yes
No
Replace the control handle.
Are 28 volts present (full speed) at the pump EDC with the handle moved fully back? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Isolate the pump. Does the manually stroked pump pressurize?
Yes
No
Replace the pump EDC.
Repair or replace the wiring.
Repair or replace the motor.
Repair or replace the pump.

PROBLEM 9

The load drum will not raise the load, but will lower the load.

POSSIBLE CAUSES

Block up limit is opened, pump is damaged, control handle is worn, maximum bail limit is opened, speed sender is damaged.

CHECKS

When the applicable switch or handle is enabled are any of the following displayed:

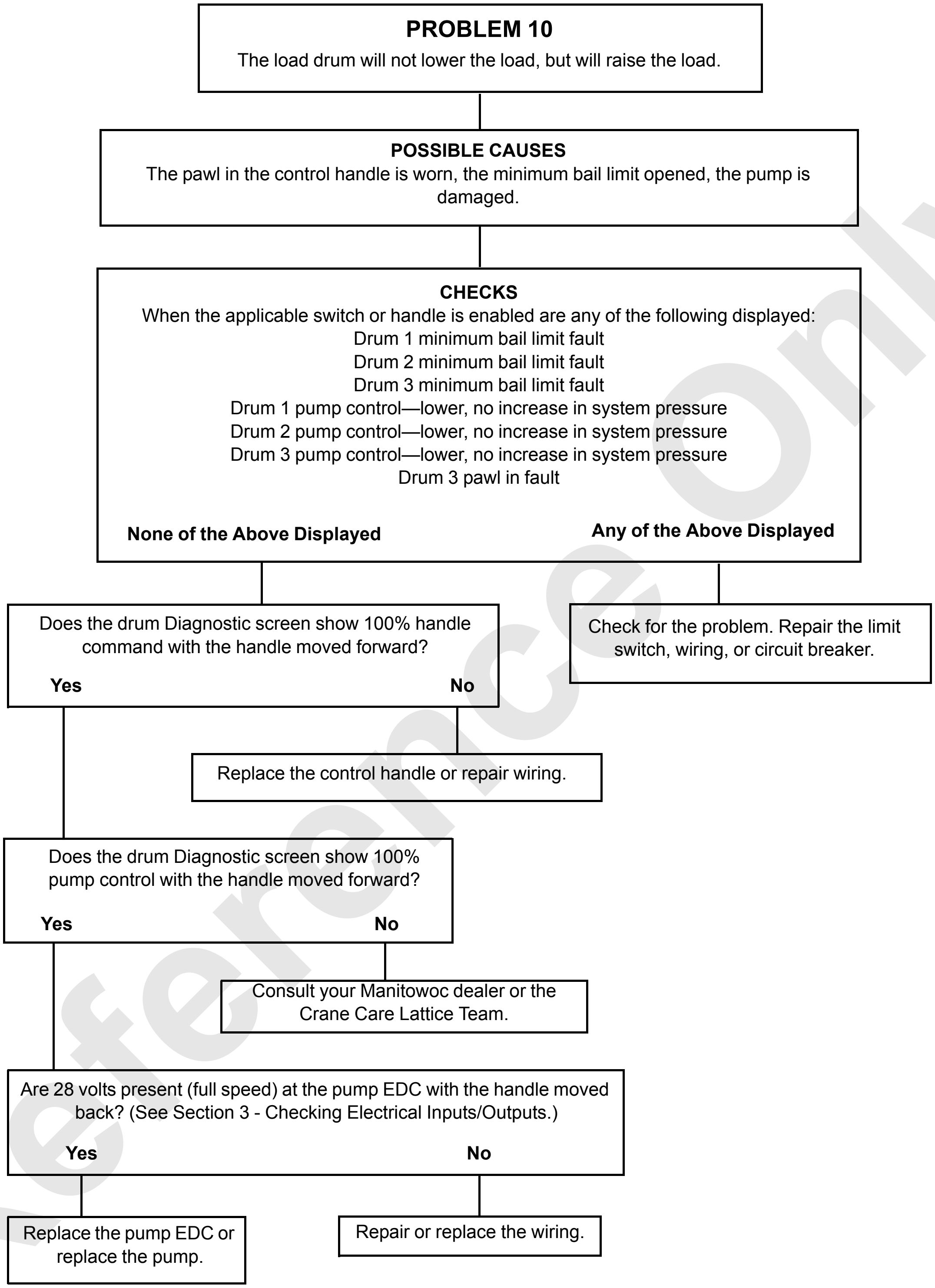
Boom block-up limit fault
Luffing jib block-up limit fault
Drum 1 pump control—raise, no increase in system pressure
Drum 2 pump control—raise, no increase in system pressure
Drum 3 pump control—raise, no increase in system pressure

None of the Above Displayed **Any of the Above Displayed**

Any of the Above Displayed: Check for the problem and repair the limit switch operation, wiring, or circuit breaker.

None of the Above Displayed: Does the drum Diagnostic screen show 100% handle command with the handle moved back?

- **No:** Repair or replace the control handle/wiring.
- **Yes:** Does the drum Diagnostic screen show 100% pump control with the handle moved back?
  - **No:** Consult your Manitowoc dealer or the Crane Care Lattice Team.
  - **Yes:** Are 28 volts present (full speed) at the pump EDC with the handle moved fully back? (See Section 3 - Checking Electrical Inputs/Outputs.)
    - **Yes:** Replace pump EDC or replace the pump.
    - **No:** Repair or replace the wiring.


PROBLEM 10
The load drum will not lower the load, but will raise the load.
POSSIBLE CAUSES
The pawl in the control handle is worn, the minimum bail limit opened, the pump is damaged.
CHECKS
When the applicable switch or handle is enabled are any of the following displayed:
Drum 1 minimum bail limit fault
Drum 2 minimum bail limit fault
Drum 3 minimum bail limit fault
Drum 1 pump control—lower, no increase in system pressure
Drum 2 pump control—lower, no increase in system pressure
Drum 3 pump control—lower, no increase in system pressure
Drum 3 pawl in fault
None of the Above Displayed
Any of the Above Displayed
Does the drum Diagnostic screen show 100% handle command with the handle moved forward?
Yes
No
Check for the problem. Repair the limit switch, wiring, or circuit breaker.
Replace the control handle or repair wiring.
Does the drum Diagnostic screen show 100% pump control with the handle moved forward?
Yes
No
Consult your Manitowoc dealer or the Crane Care Lattice Team.
Are 28 volts present (full speed) at the pump EDC with the handle moved back? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Replace the pump EDC or replace the pump.
Repair or replace the wiring.

PROBLEM 11

The load drum will not reach the maximum speed.

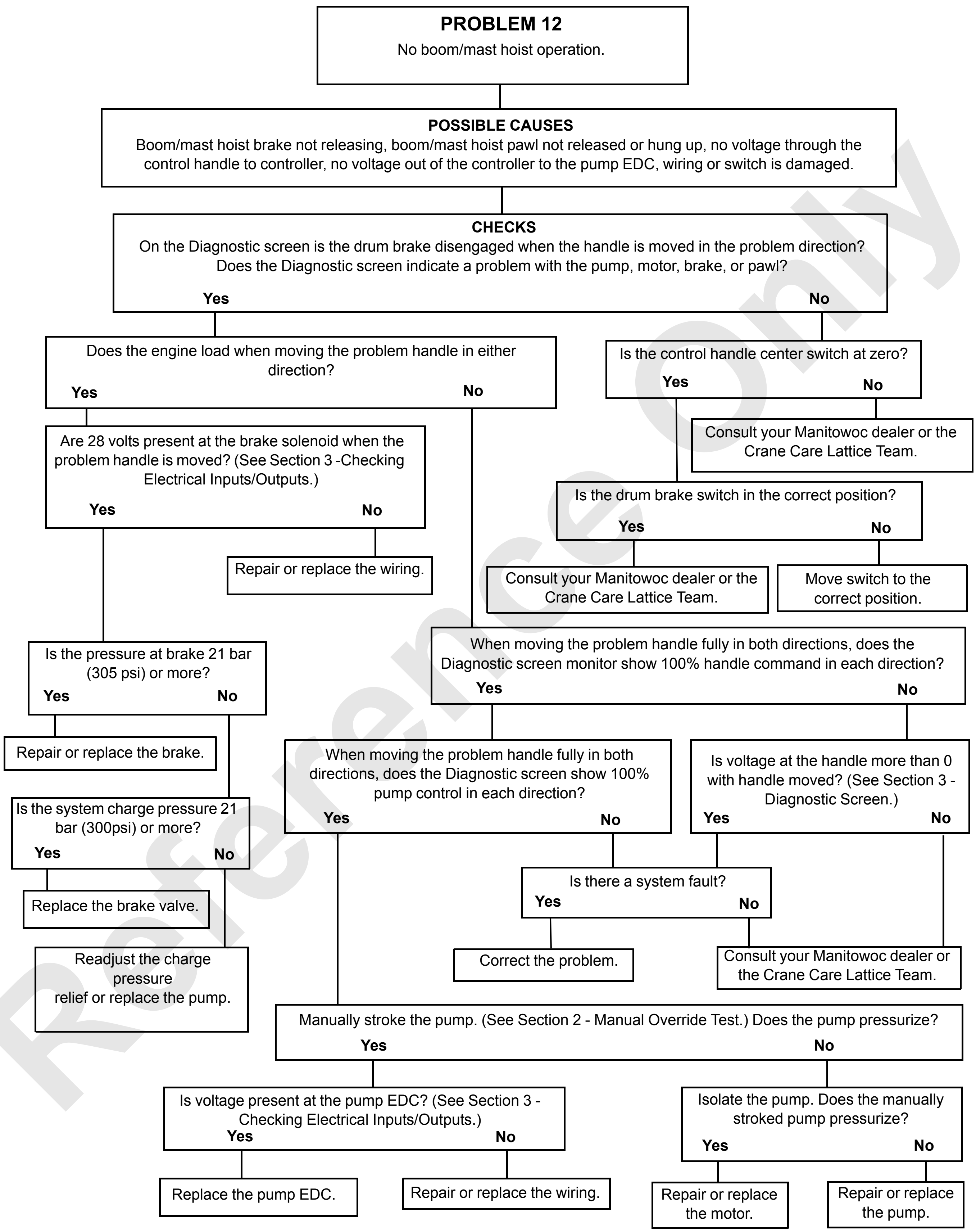
POSSIBLE CAUSES

Partial control from the handle to the controller, partial control voltage from the controller to the pump EDC or motor PCP, damaged pump or motor.

CHECKS

Check the selected load drum speed screen for 100% speed selected.

- **Yes** → When moving the problem handle fully in both directions, does the drum Diagnostic screen show 100% handle command in the raise or lower direction?
  - **Yes** → When moving the load drum handle fully in both directions, does the drum Diagnostic screen show 100% pump or motor control in each direction?
    - **Yes** → Are 28 volts present (full speed) and coil resistance of 17 to 19 ohms at the pump EDC or to 26 ohms at the Motor PCP? (See Section 3 - Checking Electrical Inputs/Outputs.)
      - **Voltage and Coil Ok** → Remove the plug at motor port M5 and check orifice for obstruction. (See Section 2 - Motor Components.)
        - **Obstruction** → Clean or replace the orifice.
        - **No Obstruction** → Check the pump and motor for leakage. (See Section 2 - Motor Leakage Test.) → Repair or replace the pump or motor.
      - **Voltage and/or Coil not Ok** → Repair or replace the coil or wiring.
    - **No** → Consult your Manitowoc dealer or the Crane Care Lattice Team.
  - **No** → Replace the control handle or repair the wiring.
- **No** → Make the proper adjustment.


PROBLEM 12
No boom/mast hoist operation.
POSSIBLE CAUSES
Boom/mast hoist brake not releasing, boom/mast hoist pawl not released or hung up, no voltage through the control handle to controller, no voltage out of the controller to the pump EDC, wiring or switch is damaged.
CHECKS
On the Diagnostic screen is the drum brake disengaged when the handle is moved in the problem direction? Does the Diagnostic screen indicate a problem with the pump, motor, brake, or pawl?
Yes
No
Does the engine load when moving the problem handle in either direction?
Yes
No
Is the control handle center switch at zero?
Yes
No
Consult your Manitowoc dealer or the Crane Care Lattice Team.
Are 28 volts present at the brake solenoid when the problem handle is moved? (See Section 3 -Checking Electrical Inputs/Outputs.)
Yes
No
Is the drum brake switch in the correct position?
Yes
No
Repair or replace the wiring.
Consult your Manitowoc dealer or the Crane Care Lattice Team.
Move switch to the correct position.
Is the pressure at brake 21 bar (305 psi) or more?
Yes
No
When moving the problem handle fully in both directions, does the Diagnostic screen monitor show 100% handle command in each direction?
Yes
No
Repair or replace the brake.
When moving the problem handle fully in both directions, does the Diagnostic screen show 100% pump control in each direction?
Yes
No
Is voltage at the handle more than 0 with handle moved? (See Section 3 - Diagnostic Screen.)
Yes
No
Is the system charge pressure 21 bar (300psi) or more?
Yes
No
Is there a system fault?
Yes
No
Replace the brake valve.
Correct the problem.
Consult your Manitowoc dealer or the Crane Care Lattice Team.
Readjust the charge pressure relief or replace the pump.
Manually stroke the pump. (See Section 2 - Manual Override Test.) Does the pump pressurize?
Yes
No
Is voltage present at the pump EDC? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Isolate the pump. Does the manually stroked pump pressurize?
Yes
No
Replace the pump EDC.
Repair or replace the wiring.
Repair or replace the motor.
Repair or replace the pump.
Reference Only

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PROBLEM 13

The boom/mast hoist will not reach the maximum speed.

POSSIBLE CAUSES

Partial control voltage from the handle to the controller, partial control voltage from the controller to the pump EDC, motor controller in low, pump or motor damaged.

CHECKS

Check the boom/mast hoist drum speed screen for 100% reading.

Yes **No**

Make the proper adjustment.

When moving the boom/mast hoist control handle fully in both directions, does the Diagnostic screen show 100% handle command in the raise or lower direction?

Yes **No**

Repair the wiring/consult your Manitowoc dealer or the Crane Care Lattice Team.

When moving the boom/mast hoist control handle fully in both directions, does the Diagnostic screen show 100% pump control in each direction?

Yes **No**

Consult your Manitowoc dealer or the Crane Care Lattice Team.

Check for control voltage and coil resistance of 17 to 19 ohms at the pump EDC or to 26 ohms at Motor PCP. (See Section 3 - Checking Electrical Inputs/Outputs.)

Voltage and Coil Ok **Voltage and/or Coil not Ok**

Repair or replace the coil or wiring.

Remove the plug at motor port M5 and check the orifice for obstructions. (See Section 2 - Motor Components.)

Obstruction **No Obstruction**

Clean or replace the orifice.

Check for pump and motor leakage. (See Section 2 - Motor Leakage Test.)

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PROBLEM 14

The boom will not boom up, but will boom down.

POSSIBLE CAUSES

The boom maximum up limit opened, the pump is damaged, equalizer/boom stop limit opened, the control handle is worn.

CHECKS

When the applicable switch or handle is enabled is the following displayed:
Maximum boom up limit fault.
Boom/mast hoist pump pressure - raise, no increase in system pressure.

None of the above displayed **Any of the above displayed**

- **Any of the above displayed:** Check for the problem. Repair the limit switch, wiring, or circuit breaker.
- **None of the above displayed:** When moving the boom/mast hoist handle fully back, does the Diagnostic screen show 100% handle command in the raise direction?
  - **No:** Replace the control handle.
  - **Yes:** Does the Diagnostic screen read 100% pump control with the handle moved back?
    - **No:** Consult your Manitowoc dealer or the Crane Care Lattice Team.
    - **Yes:** Are 28 volts present (full speed) at the pump EDC when the control handle is moved back? (See Section 3 - Checking Electrical Inputs/Outputs.)
      - **No:** Repair or replace the wiring.
      - **Yes:** Does the pump charge pressure at the charge pressure port drop to 17 bar (247 psi) or less when booming up?
        - **Yes:** Repair or replace the pump.
        - **No:** Replace the pump EDC.

PROBLEM 15

The boom will not boom down, but will boom up.

POSSIBLE CAUSES

The boom maximum down limit opened, the pawl engaged, the pump is damaged, block-up limit open, the control handle is worn, the speed encoder is damaged.

CHECKS

When the applicable switch or handle is enabled is the following displayed:
Boom down limit fault.
Boom/mast hoist pump - raise, no increase in system pressure.
Boom/mast hoist drum pawl in fault.

- **Any of the Above Displayed:** Check for the problem. Repair the limit switch, wiring, or circuit breaker.
- **None of the Above Displayed:** On the boom/mast hoist screen, is the boom/mast hoist pawl out when moving the brake park switch?
  - **No:** Repair or replace switch or wiring to the controller.
  - **Yes:** Visually check the pawl.
    - **In:** Replace or repair the pawl.
    - **Out:** When moving the boom/mast hoist handle fully in the forward direction, does the Diagnostic screen show 100% handle command in the lower direction?
      - **No:** Replace the control handle or repair the wiring.
      - **Yes:** Does the Diagnostic screen show 100% pump control with the handle moved fully forward?
        - **No:** Consult your Manitowoc dealer or the Crane Care Lattice Team.
        - **Yes:** Are 28 volts present (full speed) at the pump EDC when the control handle is moved forward? (See Section 3 - Checking Electrical Inputs/Outputs.)
          - **No:** Repair or replace the wiring.
          - **Yes:** Can the boom pump be manually stroked down? (See Section 2 -Manual Override Test.)
            - **Yes:** Replace the pump EDC.
            - **No:** Repair or replace the pump.

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NOTE: The swing lock is installed on past production cranes only. On current production cranes the swing lock has been removed and the rocker switch has been removed from the console.

PROBLEM 16

No swing operation, but the engine loads.

POSSIBLE CAUSES

Mechanical hang-up, solenoid failure, wiring fault.

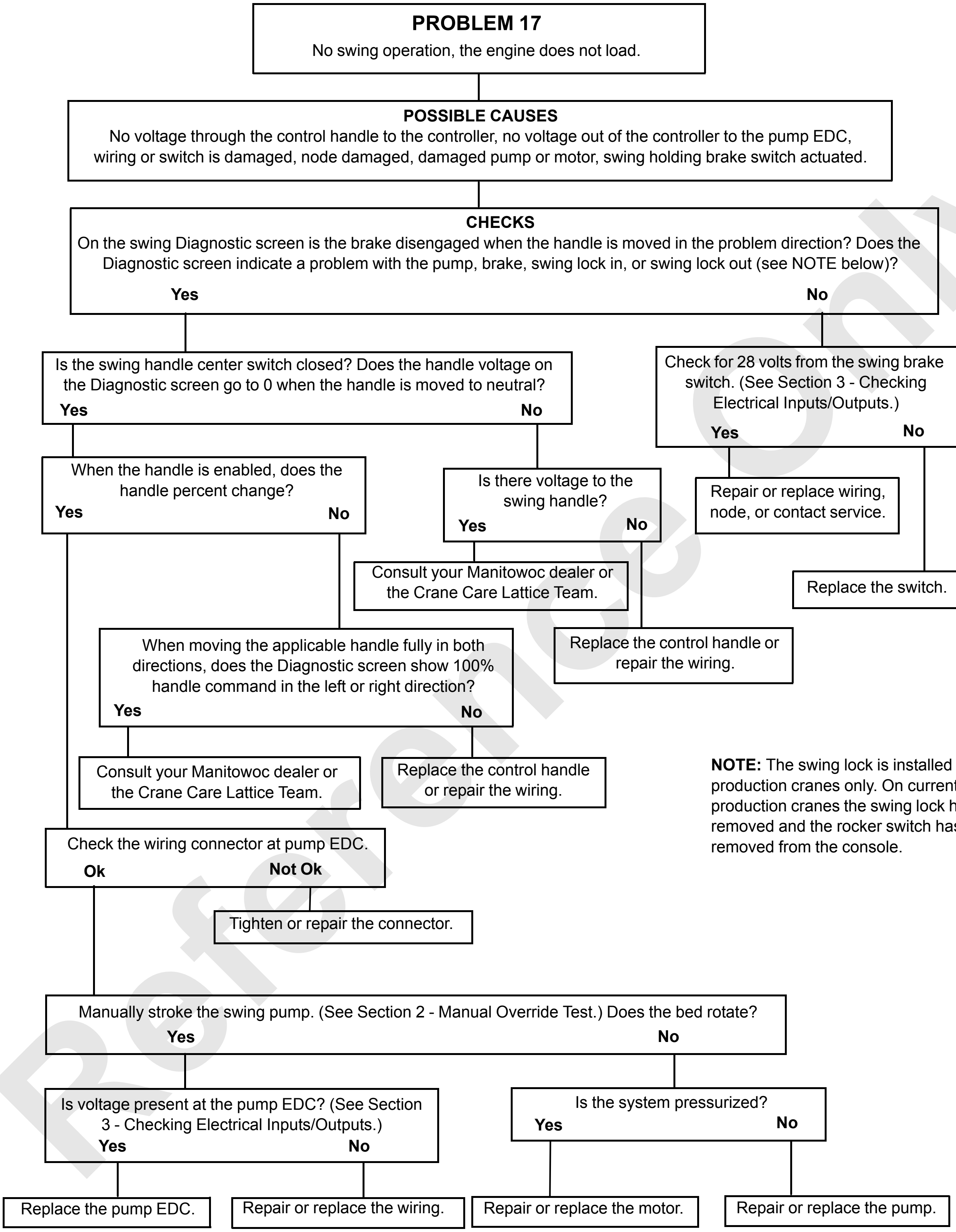
CHECKS

When the applicable switch or handle is enabled is the following displayed:
Swing lockout disengaged
Swing brake disengaged

Yes — Check for 28 volts DC to the swing lock or brake solenoid valve. (See Section 3 - Checking Electrical Inputs/Outputs.)

- **Voltage** — Check the low-pressure source at the swing lock or the brake valve for 35 bar (508 psi) with a 0 to 69 bar (0 to 1,001 psi) gauge.
  - **More than 17 bar (247 psi)** — Repair or replace the swing lock, brake or gearbox.
  - **17 bar (247 psi) or Less** — Set the pump low-pressure source relief to 35 bar (508 psi). Is 35 bar (508 psi) obtained?
    - **No** — Replace the relief valve or pump.
- **No Voltage** — Repair or replace the switch or wiring.

No — Consult your Manitowoc dealer or the Crane Care Lattice Team.



NOTE: The swing lock is installed on past production cranes only. On current production cranes the swing lock has been removed and the rocker switch has been removed from the console.

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PROBLEM 18
Travel system response is sluggish.

POSSIBLE CAUSES
The pump or motor is damaged, the travel speed out of adjustment.

CHECKS
Use a gauge to check charge pressure at travel pressure senders.

More than 21 bar (305 psi) **21 bar (305 psi) or Less**

Manually stroke the travel pump with brakes applied. (See Section 2 - Manually Stroking the Pump.) Is the system pressure greater than 413 bar (6,000 psi)?
Yes **No**

Set pump low-pressure source relief to 35 bar (500 psi). Is the correct pressure obtained.
No

Adjust the multifunction valve for 413 bar (6,000 psi) system pressure. (See Section 2 - Setting Pump Pressure.) Retest with brakes applied. Is the pressure ok?
Yes **No**

Adjust the travel speed per Section 2 - Shop Procedure. Is the correct speed obtained?
Yes **No**

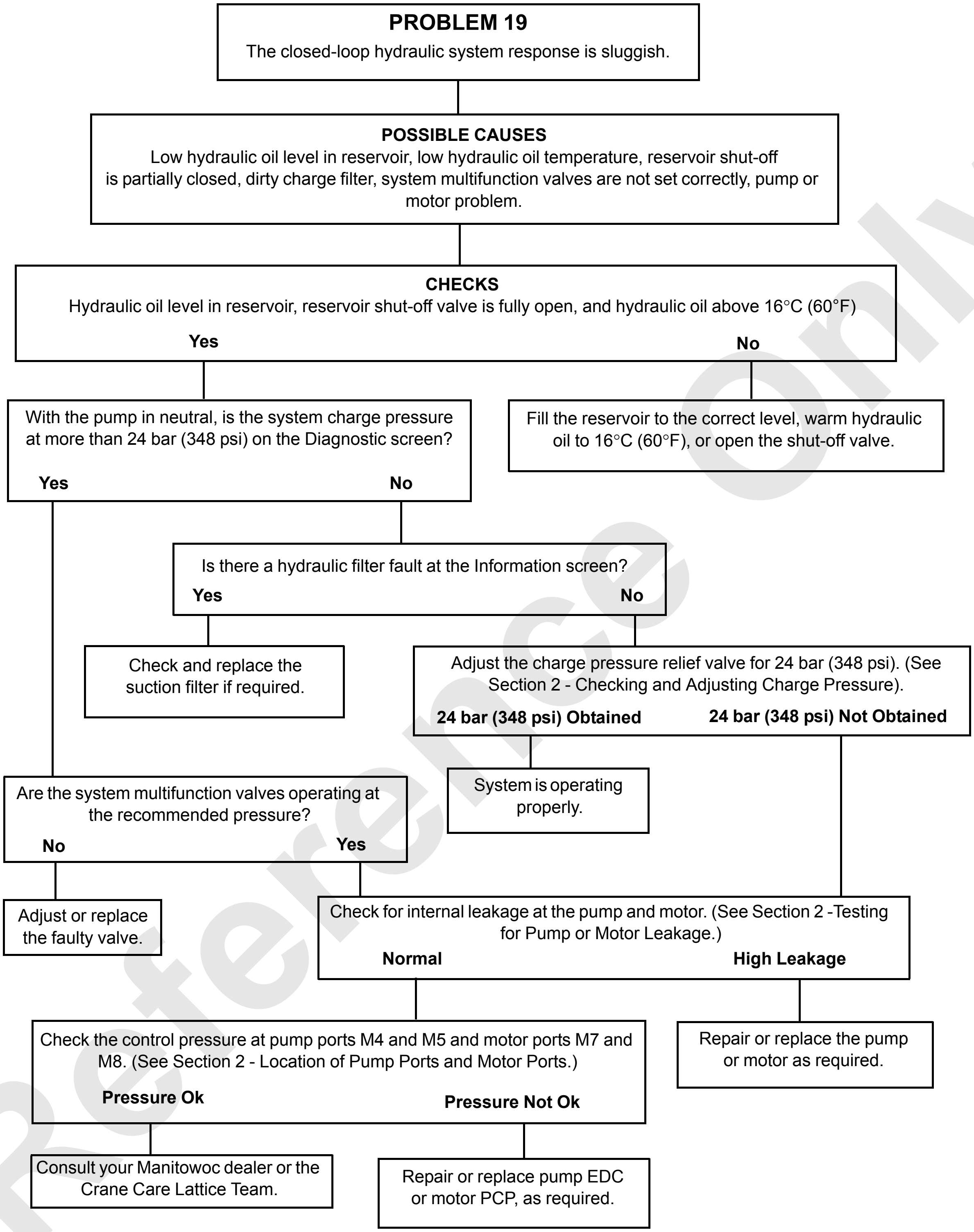
Travel system response should be correct.

Check for leakage at motor. (See Section 2 -Testing for Pump or Motor Leakage.)
Normal **High Leakage**

Repair or replace the travel motor.

Check for leakage at pump. (See Section 2 -Testing for Pump or Motor Leakage.)
High Leakage

Repair or replace the travel pump.



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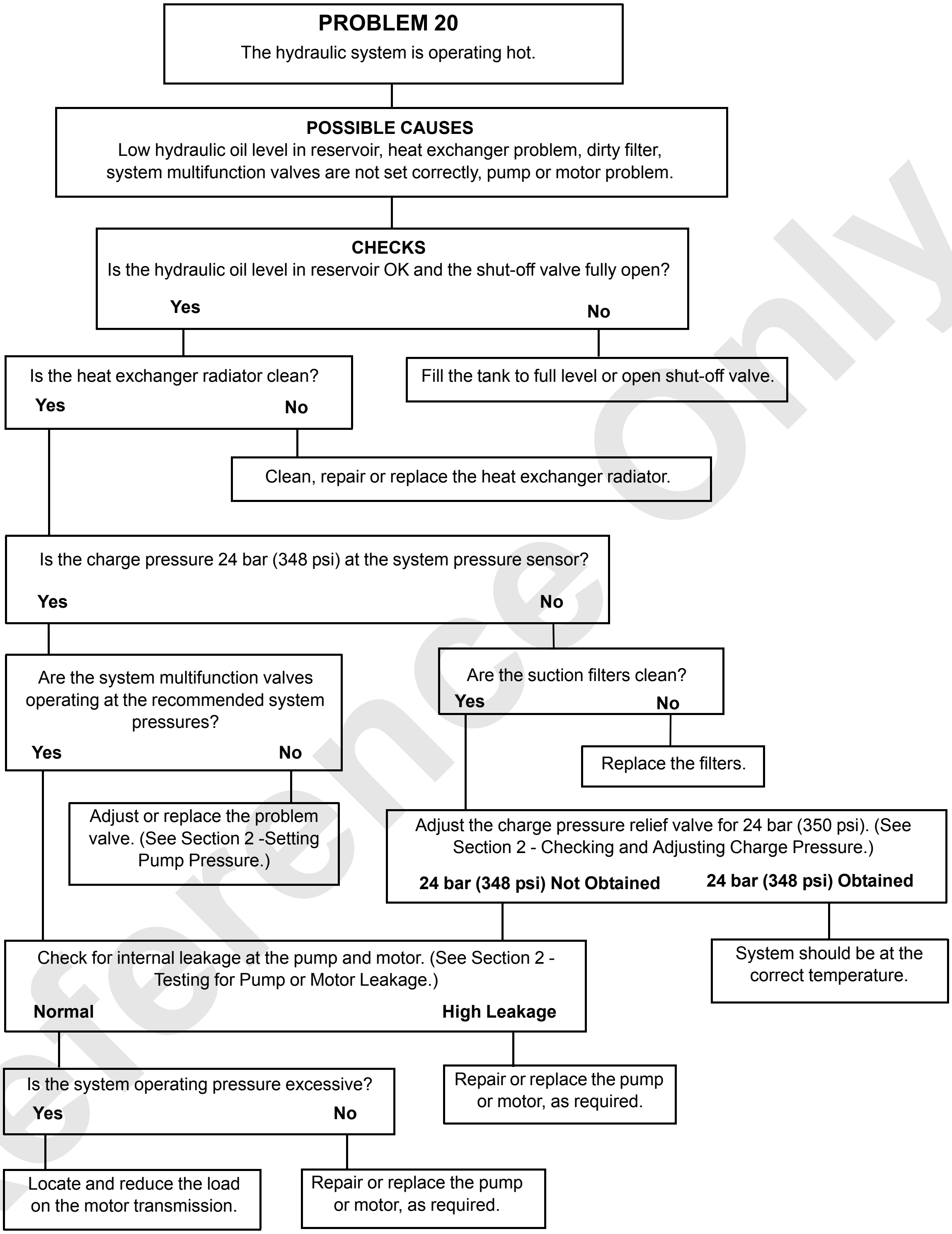
PROBLEM 20
The hydraulic system is operating hot.
POSSIBLE CAUSES
Low hydraulic oil level in reservoir, heat exchanger problem, dirty filter, system multifunction valves are not set correctly, pump or motor problem.
CHECKS
Is the hydraulic oil level in reservoir OK and the shut-off valve fully open?
Yes
No
Is the heat exchanger radiator clean?
Yes
No
Fill the tank to full level or open shut-off valve.
Clean, repair or replace the heat exchanger radiator.
Is the charge pressure 24 bar (348 psi) at the system pressure sensor?
Yes
No
Are the system multifunction valves operating at the recommended system pressures?
Yes
No
Are the suction filters clean?
Yes
No
Replace the filters.
Adjust or replace the problem valve. (See Section 2 -Setting Pump Pressure.)
Adjust the charge pressure relief valve for 24 bar (350 psi). (See Section 2 - Checking and Adjusting Charge Pressure.)
24 bar (348 psi) Not Obtained
24 bar (348 psi) Obtained
Check for internal leakage at the pump and motor. (See Section 2 - Testing for Pump or Motor Leakage.)
Normal
High Leakage
System should be at the correct temperature.
Is the system operating pressure excessive?
Yes
No
Repair or replace the pump or motor, as required.
Locate and reduce the load on the motor transmission.
Repair or replace the pump or motor, as required.

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PROBLEM 21

The system pump will not return to neutral.

POSSIBLE CAUSES

System pump control handle is worn, system pump EDC is damaged, system pump is damaged, pump is not centered.

CHECKS

Does the Diagnostic screen show a percent for the problem handle in the neutral position?

- **Yes** — Repair or replace the system control handle or wiring.
- **No** — With the system handle in neutral does the Diagnostic screen show command activity for the pump?
  - **Yes** — Consult your Manitowoc dealer or the Crane Care Lattice Team.
  - **No** — Does the system pump EDC manually return to neutral? (See Section 3 - Checking Electrical Inputs/Outputs.)
    - **Yes** — Adjust the pump to neutral. (See Section 2 - Pump Neutral Adjustment.)
      - Does the system pump EDC manually return to neutral?
        - **No** — Replace the system pump EDC.
    - **No** — Repair or replace the system pump.

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PROBLEM 22

The drum pawl is not operating correctly.

POSSIBLE CAUSES

Mechanical hang-up, no hydraulic pressure, no voltage to pawl solenoid, bad wiring, actuator/cylinder failure.

CHECKS

Check for damage to the pawl linkage, check for pawl or pawl actuator/cylinder for freedom of movement.

- **Damage**: Repair the damage. Test and adjust.
- **No Damage**: Move the park brake switch to the apply and release positions. Check the drum Diagnostic screen for pawl in and pawl out positions when the applicable function was enabled:

  Drum 3 pawl in
  Drum 3 pawl out
  Boom/mast hoist pawl in
  Boom/mast hoist pawl out

  If the pawl is not moving

Is there voltage applied to the pawl valve? (See Section 3 - Checking Electrical Inputs/Outputs.)

- **No**: Check the wiring.
- **Yes**: When enabling the problem pawl switch, check the pawl cylinder for 24 bar (348 psi) or more at valve cylinder ports.
  - **Pressure**: Check for binding or faulty cylinder. → Repair or replace the control valve.
  - **No Pressure**: Readjust the source charge pressure relief valve. Does this solve the problem?
    - **No**: Repair or replace the pump.

PROBLEM 23

The mast cylinders will not raise or lower.

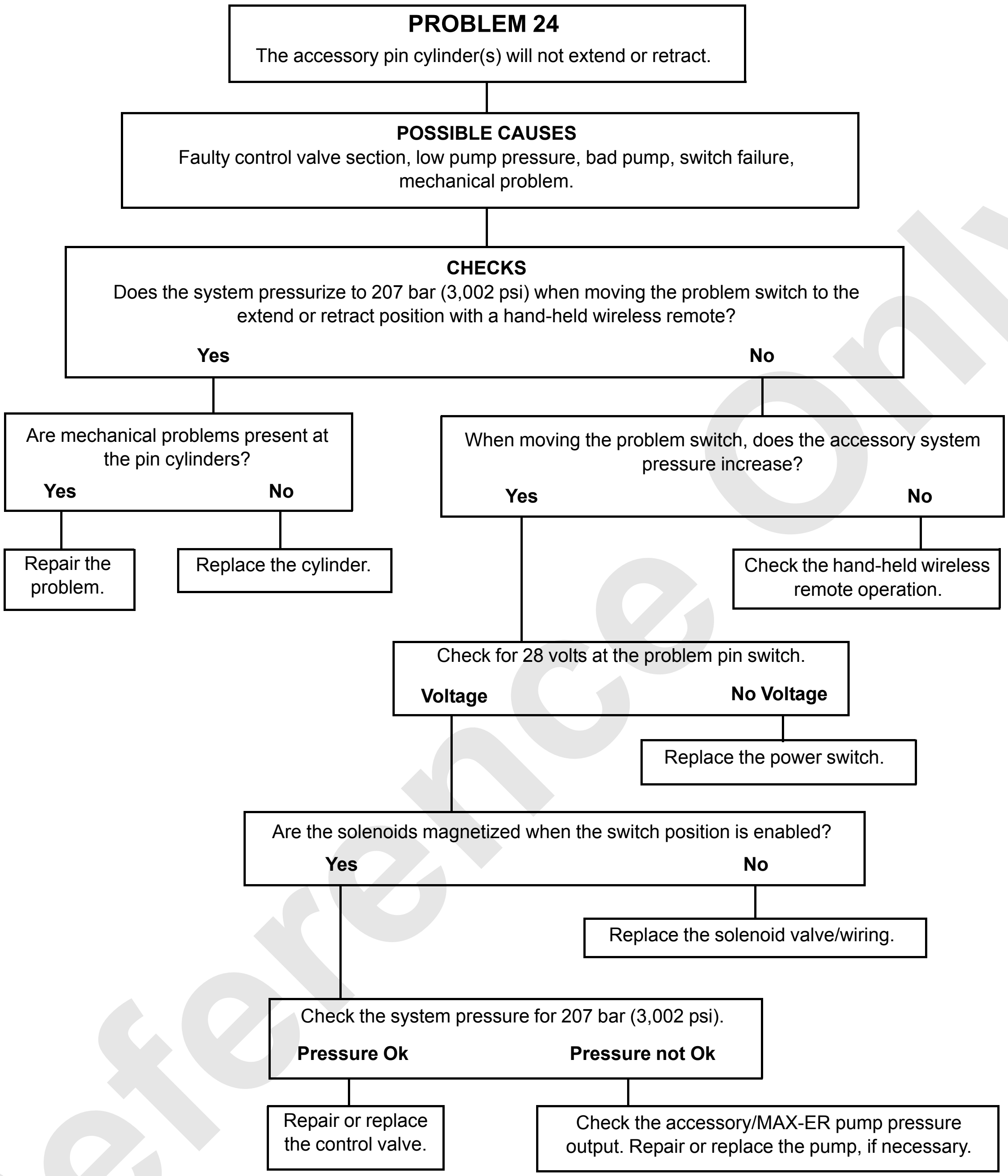
POSSIBLE CAUSES

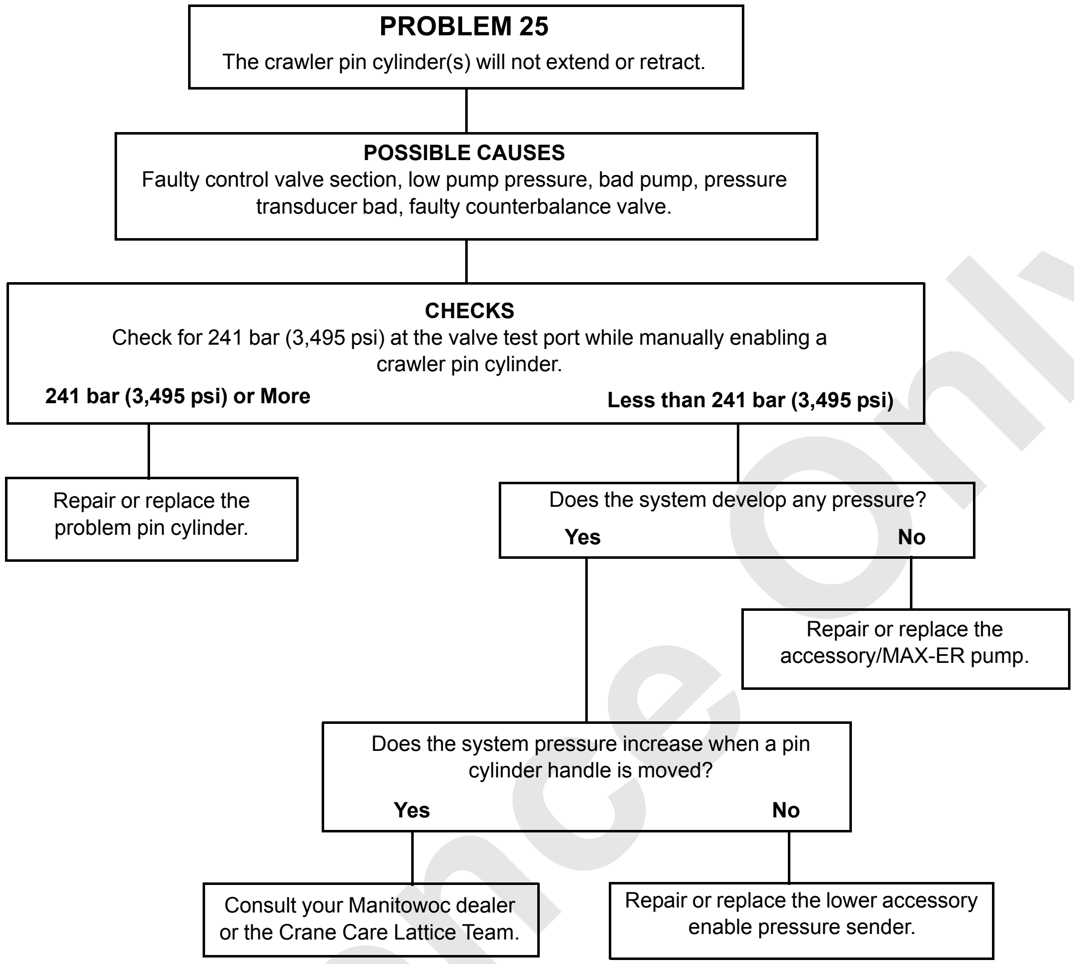
Faulty control valve section, low pump pressure, bad pump, switch failure, faulty counterbalance valve.

CHECKS

Does the system pressurize to 207 bar (3,002 psi) when moving the mast switch to the raise position?

- **Yes** — Are mechanical problems present at the mast assist cylinders?
  - **Yes** — Repair the problem.
  - **No** — Adjust the cylinder counterbalance valve (See Section 2 - Adjusting Counterbalance Valve.) Does the cylinder operate correctly?
    - **No** — Replace the cylinder.
- **No** — When moving the mast switch, does the accessory system pressure increase?
  - **Yes** — Check for 28 volts at the mast power switch. (See Section 3 -Checking Electrical Inputs/Outputs.)
    - **Voltage** — Are the solenoids magnetized when the switch position is enabled?
      - **Yes** — Check the system pressure for 207 bar (3,002 psi).
        - **Pressure Ok** — Repair or replace the control valve.
        - **Pressure not Ok** — Check the accessory/MAX-ER pump pressure output. Repair or replace the pump, if necessary.
      - **No** — Replace the solenoid valve.
    - **No Voltage** — Replace the power switch.
  - **No** — Consult your Manitowoc dealer or the Crane Care Lattice Team.


PROBLEM 24
The accessory pin cylinder(s) will not extend or retract.
POSSIBLE CAUSES
Faulty control valve section, low pump pressure, bad pump, switch failure, mechanical problem.
CHECKS
Does the system pressurize to 207 bar (3,002 psi) when moving the problem switch to the extend or retract position with a hand-held wireless remote?
Yes
No
Are mechanical problems present at the pin cylinders?
Yes
No
Repair the problem.
Replace the cylinder.
When moving the problem switch, does the accessory system pressure increase?
Yes
No
Check the hand-held wireless remote operation.
Check for 28 volts at the problem pin switch.
Voltage
No Voltage
Replace the power switch.
Are the solenoids magnetized when the switch position is enabled?
Yes
No
Replace the solenoid valve/wiring.
Check the system pressure for 207 bar (3,002 psi).
Pressure Ok
Pressure not Ok
Repair or replace the control valve.
Check the accessory/MAX-ER pump pressure output. Repair or replace the pump, if necessary.


PROBLEM 25
The crawler pin cylinder(s) will not extend or retract.
POSSIBLE CAUSES
Faulty control valve section, low pump pressure, bad pump, pressure transducer bad, faulty counterbalance valve.
CHECKS
Check for 241 bar (3,495 psi) at the valve test port while manually enabling a crawler pin cylinder.
241 bar (3,495 psi) or More
Less than 241 bar (3,495 psi)
Repair or replace the problem pin cylinder.
Does the system develop any pressure?
Yes
No
Repair or replace the accessory/MAX-ER pump.
Does the system pressure increase when a pin cylinder handle is moved?
Yes
No
Consult your Manitowoc dealer or the Crane Care Lattice Team.
Repair or replace the lower accessory enable pressure sender.

ALPHABETICAL INDEX

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