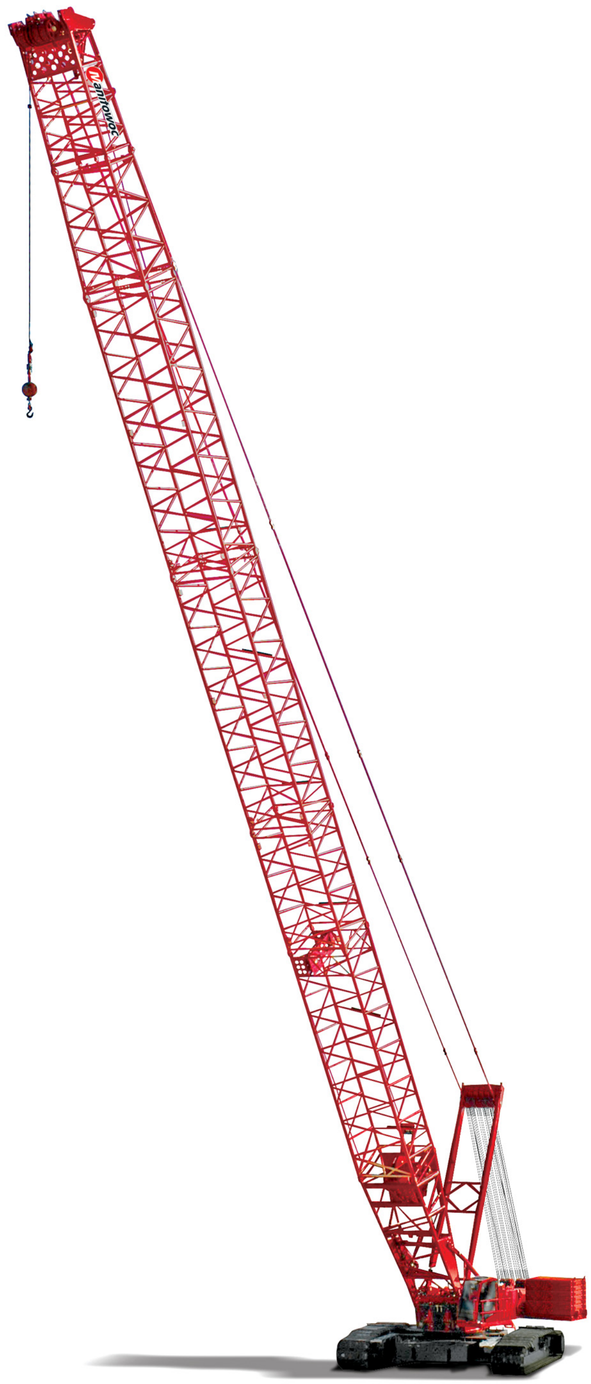
Manitowoc 16000

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 the Manitowoc Crane Care Lattice Team has of providing you with correct parts and service information.

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

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

⚠ WARNING

To prevent death or serious injury:

- Avoid unsafe operation and maintenance.

  Crane and attachments must be operated and maintained by trained and experienced personnel. Manitowoc is not responsible for qualifying these personnel.
- Do not operate or work on crane or attachments without first reading and understanding instructions contained in Operator Information Manual and Service Manual supplied with crane and applicable attachments.
- Store Operator Information Manual and Service Manual in operator's cab.

  If Operator Information Manual or Service Manual is missing from cab, contact your Manitowoc dealer for a new one.

Published 05-09-17, Control # 014-28

THE ORIGINAL LANGUAGE OF THIS PUBLICATION IS ENGLISH

See end of this manual for Alphabetical Index

SECTION 1 . . . . Introduction

Published 05-09-17, Control # 014-28

SECTION 1
INTRODUCTION

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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

General

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 their death or injury and costly damage to the crane and property.

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

Safety Alert Symbol

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

Signal Words

DANGER

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

WARNING

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

CAUTION

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

CAUTION

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

NOTE: Highlights operation or maintenance procedures.

SAFE MAINTENANCE PRACTICES

WARNING

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

Safety information in this publication is intended only as a guide to assist qualified maintenance personnel in safe maintenance. Manitowoc cannot foresee all hazards that will arise in field; therefore, ***safety remains responsibility of maintenance personnel and 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 and the Operator Manual provided with the crane.

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

Safe Maintenance Practices

1. Perform the following steps (as applicable) before starting a maintenance procedure:
   a. Park crane where it will not interfere with other equipment or operations.
   b. Lower all loads to ground or otherwise secure them against movement.
   c. Lower boom onto blocking at ground level, if possible, or otherwise secure boom from movement by wind or other outside forces (see Wind Conditions in 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 engine and render starting means inoperative.
   f. Place a warning sign at start controls alerting other personnel that crane is being serviced and engine must not be started. *Do not remove sign until it is safe to return crane to service.*
2. Do not attempt to maintain or repair any part of crane while engine is running, unless absolutely necessary.

   If engine must be run, keep your clothing and all parts of your body away from moving parts. ***Maintain constant verbal communication between person at controls and person performing 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 a moving crane. ***Climb onto and off crane only when it is parked and only with operator's permission***.

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

NOTE: Safety harness and tither line must be worn when working on top of enclosure.

   Lift tools and other equipment which cannot be carried in pockets or tool belts onto and off crane with hand lines or hoists.
6. Boom and gantry are not intended as ladders. Do not attempt to climb lattice work of boom or gantry to get to maintenance points. If boom or gantry is not equipped with an approved ladder, lower them before performing maintenance or repair procedures.
7. Do not remove cylinders until working unit has been securely restrained against movement.
8. Pinch points are impossible to eliminate; watch for them closely.
9. Pressurized air, coolant, and hydraulic oil can cause serious injury. Make sure all air, coolant, and hydraulic lines, fittings, and components are tight and serviceable.

   Do not use your hands to check for air and hydraulic oil leaks:
   - Use a soap and water solution to check for air leaks (apply to fittings and lines and watch for bubbles).
   - Use a piece of cardboard or wood to check for coolant and hydraulic oil leaks.
10. Relieve pressure before disconnecting air, coolant, and hydraulic lines and fittings.
11. Do not remove radiator cap while coolant is hot or under pressure. Stop engine, wait until pressure drops and coolant cools, then slowly remove cap.
12. Avoid battery explosion: do not smoke while performing battery maintenance, do not short across battery terminals to check its charge.
13. Read safety information in battery manufacturer's instructions before attempting to charge a battery.

14. Avoid battery acid contact with skin and eyes. If contact occurs, flush area with water and immediately consult a doctor.
15. Stop engine before refueling crane.
16. Do not smoke or allow open flames in 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 flame arrestor for refueling.
18. Mobile fueling 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 also be flammable. Do not smoke or allow open flames in area when filling hydraulic tanks.
20. Never handle wire rope with bare hands. Always wear heavy-duty gloves to prevent being cut by 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 tires, use a tire cage, a clip-on inflater, and an extension hose which permits standing well away from tire.
23. Only use cleaning solvents which are non-volatile and non-flammable.
24. Do not attempt to lift heavy components by hand. Use a hoist, jacks, or blocking to lift components.
25. Use care while welding or burning on 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 crane***:
    - Disconnect all cables from batteries
    - Disconnect output cables at engine junction box
    - Attach ground cable from welder directly to part being welded and as close to weld as possible

    Do not weld on engine or engine mounted parts (per engine manufacturer).
27. Disconnect and lock power supply switch before attempting to service high voltage electrical components and before entering tight areas (such as carbody openings) containing high voltage components.
28. When assembling and disassembling booms, jibs, or masts on ground (with or without support of boom rigging pendants or straps), securely block each section to provide adequate support and alignment.

    Do not go under boom, jib, or mast sections while connecting bolts or pins are being removed.
29. Unless authorized in writing by Manitowoc, do not alter crane in any way that affects crane's performance (to include welding, cutting, or burning of structural members or changing pressures and flows of air/ hydraulic components). Doing so will invalidate all warranties and capacity charts and make crane owner/ user liable for any resultant accidents.
30. ***Keep 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 around loose in operator's cab or on walkways and stairs.
32. Do not store flammable materials on crane.
33. Do not return crane to service at completion of maintenance or repair procedures until all guards and covers have been reinstalled, trapped air has been bled from hydraulic systems, safety devices have been reactivated, and all maintenance equipment has been removed.
34. Perform a function check to ensure proper operation at 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.

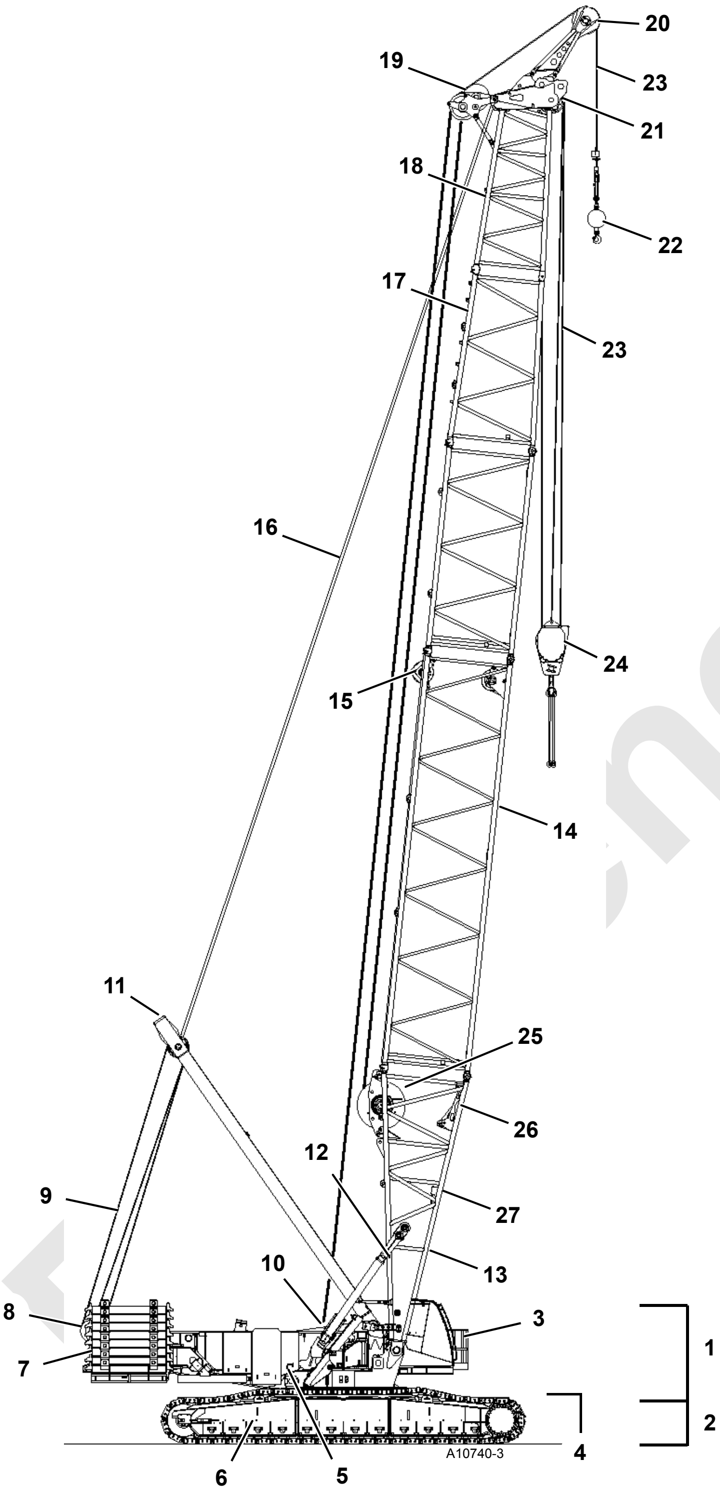
Handle and dispose of waste according to local, state, and federal environmental regulations.

When filling and draining crane components: do not pour 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 1-7 for graphic identification of crane components.



Item	Description
1	Upperworks
2	Undercarriage
3	Operator’s 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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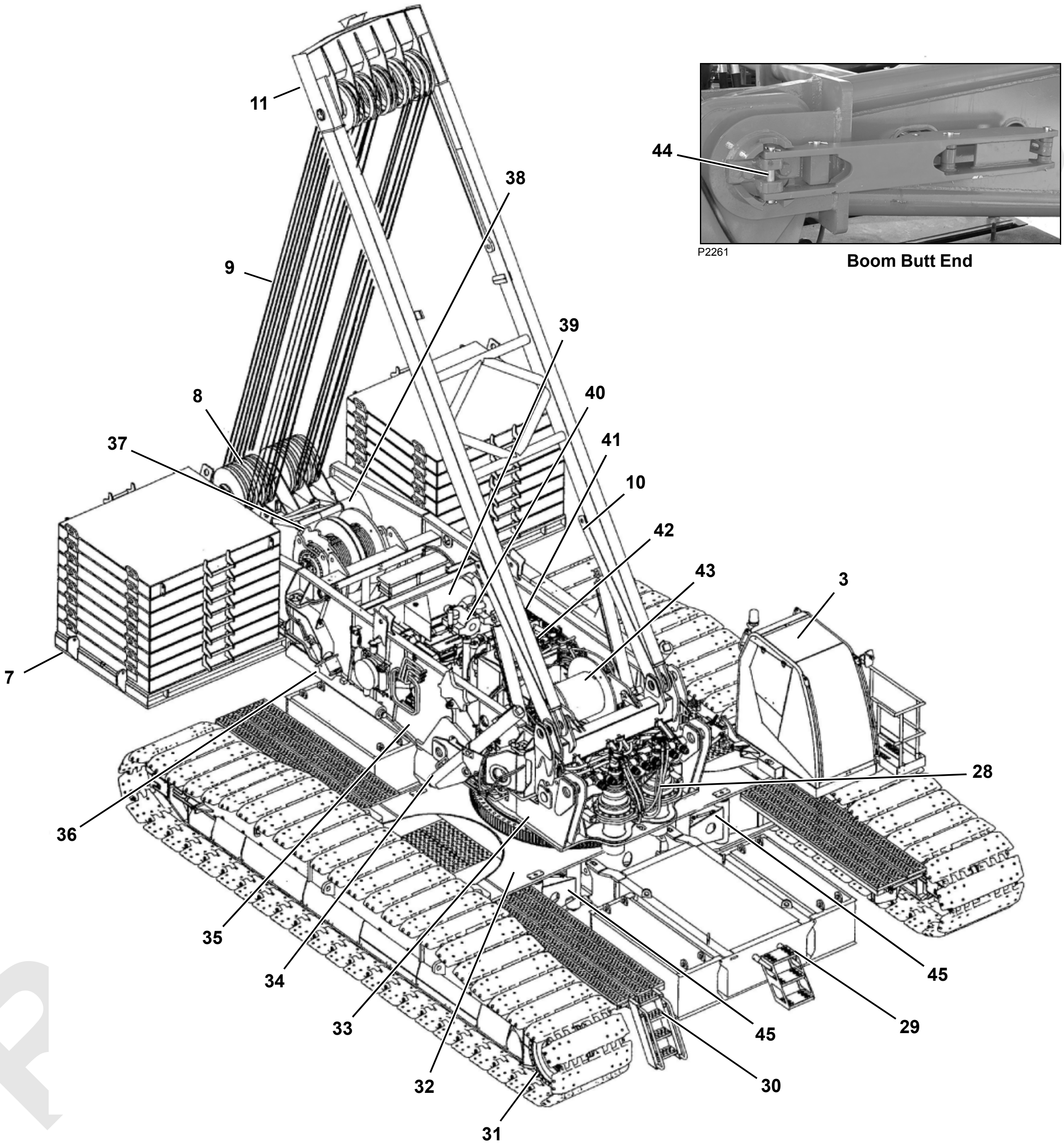

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Boom Butt End

FIGURE 1-1 continued

General Views

Item	Description	Item	Description
1	Boom/Mast Drum	10	Crawler Automatic Lubricator
2	Sequence Valve (all drum motors)	11	Left and Right Swing Gearboxes
3	Boom/Mast Motor	12	Turntable Automatic Lubricator
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		

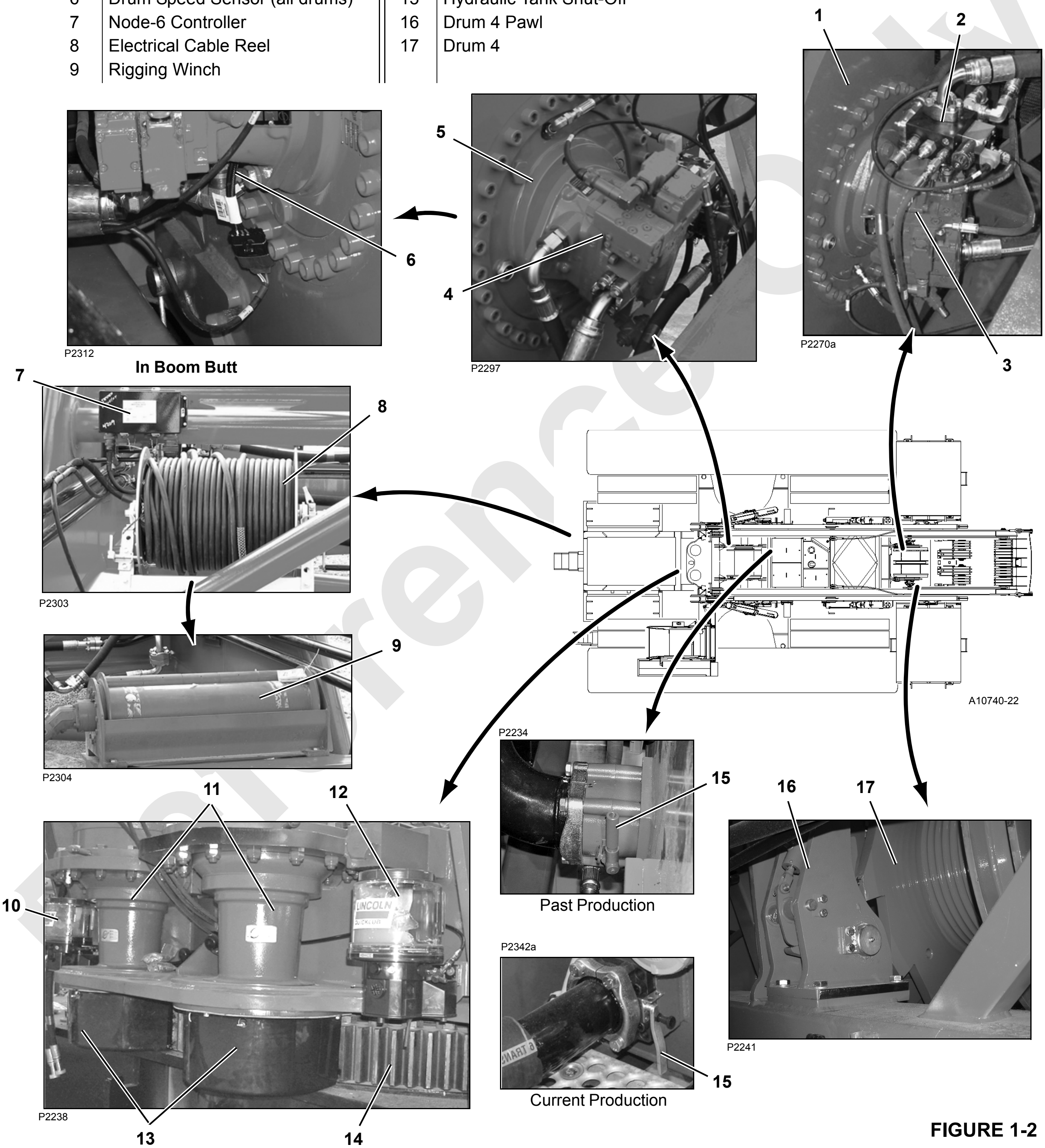
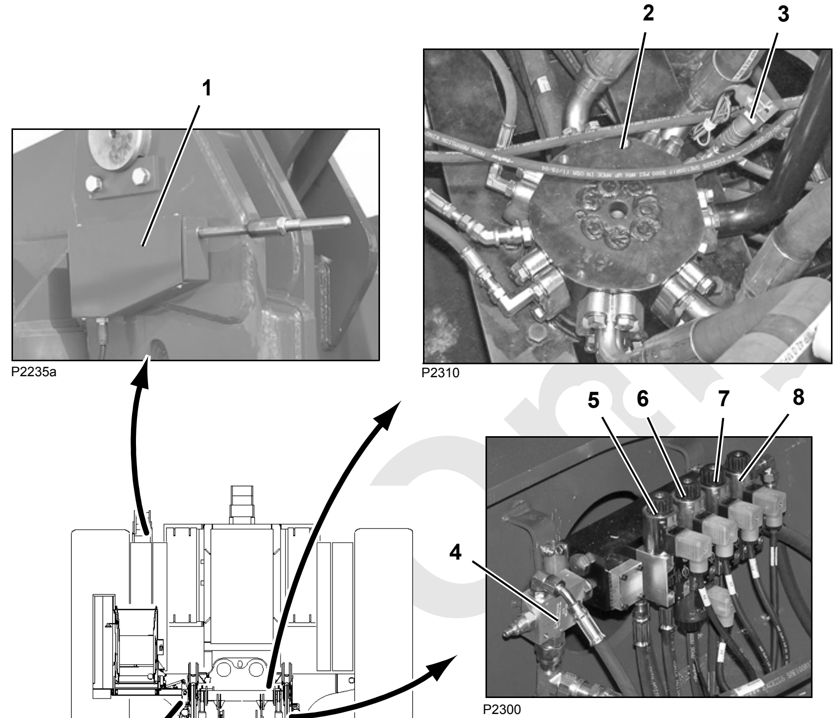


FIGURE 1-2

Top

Item	Description
1	Boom Stop Limit Switch
2	Swivel
3	Accessory System Enable Pressure Sender
4	Low-Pressure Reducing Valve
5	Swing Brake Solenoid
6	Swing Lock Solenoid (Past Production)
7	Travel Brake Solenoid
8	Travel Two-Speed Solenoid
9	Mast Angle Sensor
10	Mast Arm Raising Cylinder
11	Mast Arm Raising Cylinder Counterbalance Valve (1 each side)
12	Batteries
13	Swing/Travel Alarm (3 places)
14	Counterweight Cylinder
15	Counterweight Cylinder Pin



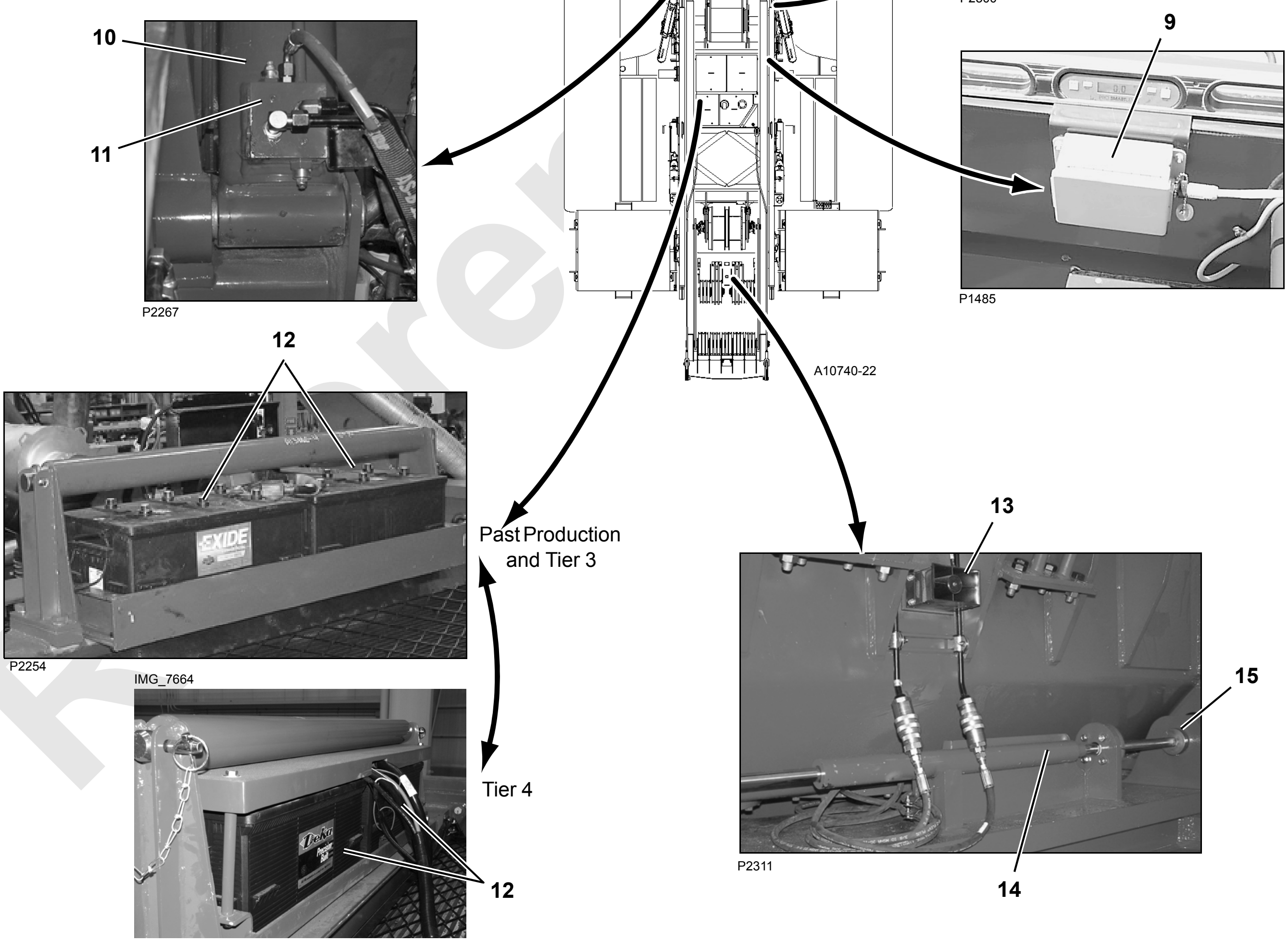
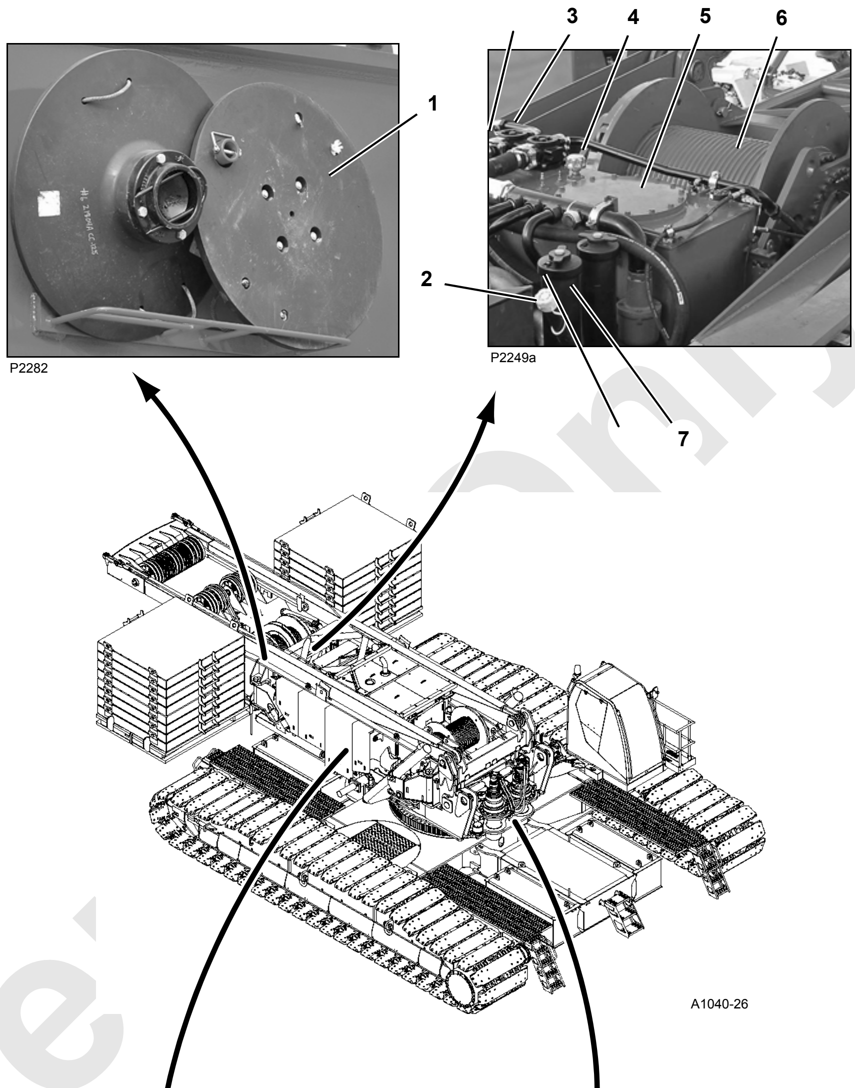


FIGURE 1-3

Right Side

Item	Description
1	Jacking Cylinder Pads
2	Engine Oil Fill
3	Hydraulic Oil Return Filters
4	Hydraulic Tank Breather (past production)
5	Tank Access Cover (16001141 and prior)
6	Drum 2
7	Charge Filters (16001141 and prior)
8	Fuel Filter
9	Coolant Filter
10	Ether Starting Aid Canister
11	Node-5 Controller
12	Engine Air Cleaner
13	Air Cleaner Service Indicator
14	Wireless Radio Receiver
15	Engine Node-0
16	Oil Filter
17	Swing Motor (two)
18	Swing Gearbox (two)



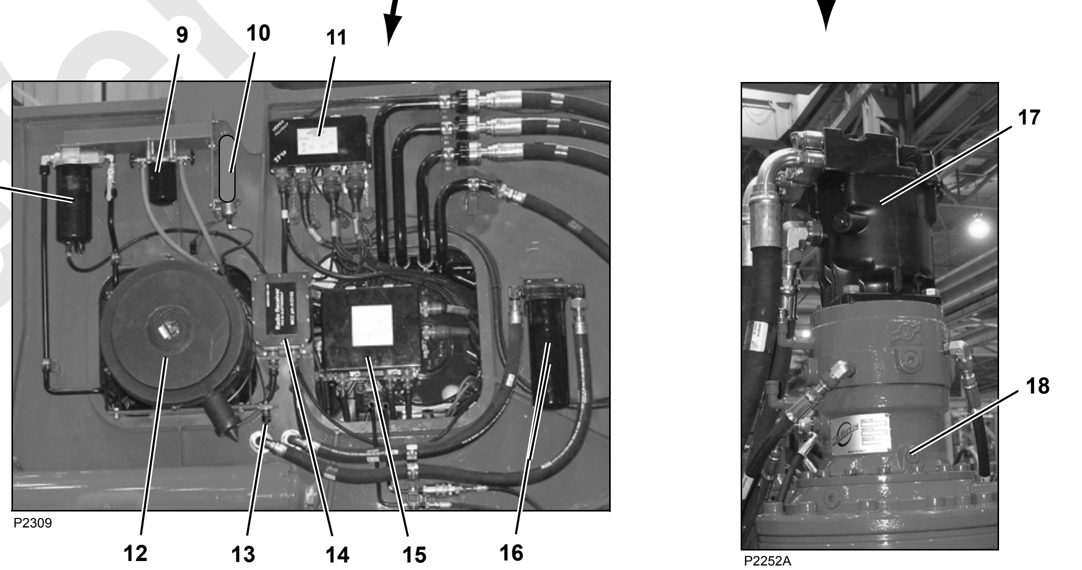
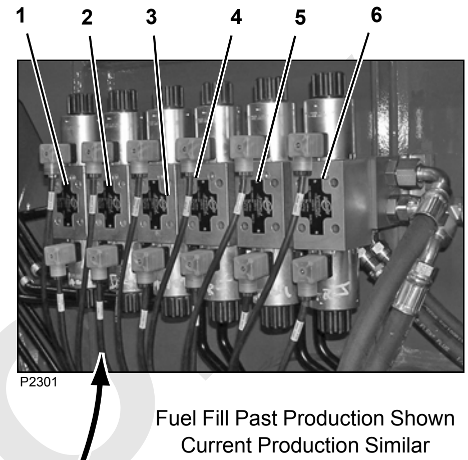


FIGURE 1-4

Left Side

Item	Description	Item	Description
1	Left Front Jacking Solenoid	19	Drum 2 to Drum 1 Diverting Solenoid
2	Right Front Jacking Solenoid	20	Drum 1 to Drum 2 Diverting Solenoid
3	Mast Raising Cylinders Solenoid	21	Drum 4 Pawl Solenoid
4	Rigging Winch Solenoid	22	R Travel to Drum 4 Diverting Solenoid
5	Right Rear Jacking Solenoid	23	L Travel to Drum 3 Diverting Solenoid
6	Left Rear Jacking Solenoid	24	Drum 4 to Drum 5 Diverting Solenoid
7	Node-4 Controller	25	Pressure Reducing Valve
8	Fuel Level Gauge	26	Drum 1 Pressure Sender
9	Fuel Fill	27	Boom/Mast A Pressure Sender
10	Node-3 Controller	28	Boom/Mast B Pressure Sender
11	Engine Oil Dipstick	29	Left Travel A Pressure Sender
12	Left Rear Jack	30	Left Travel B Pressure Sender
13	Hydraulic Fill Port	31	Right Travel A Pressure Sender
14	Rear Rotating Bed Pin Solenoid	32	Right Travel B Pressure Sender
15	Boom Hinge Pin Solenoid	33	Swing Right Pressure Sender
16	Cab Tilt Cylinder Solenoid	34	Swing Left Pressure Sender
17	Front Rotating Bed Pin Solenoid	35	Drum 2 Pressure Sender
18	Counterweight Pin Solenoid	36	Accessory Pressure Sender



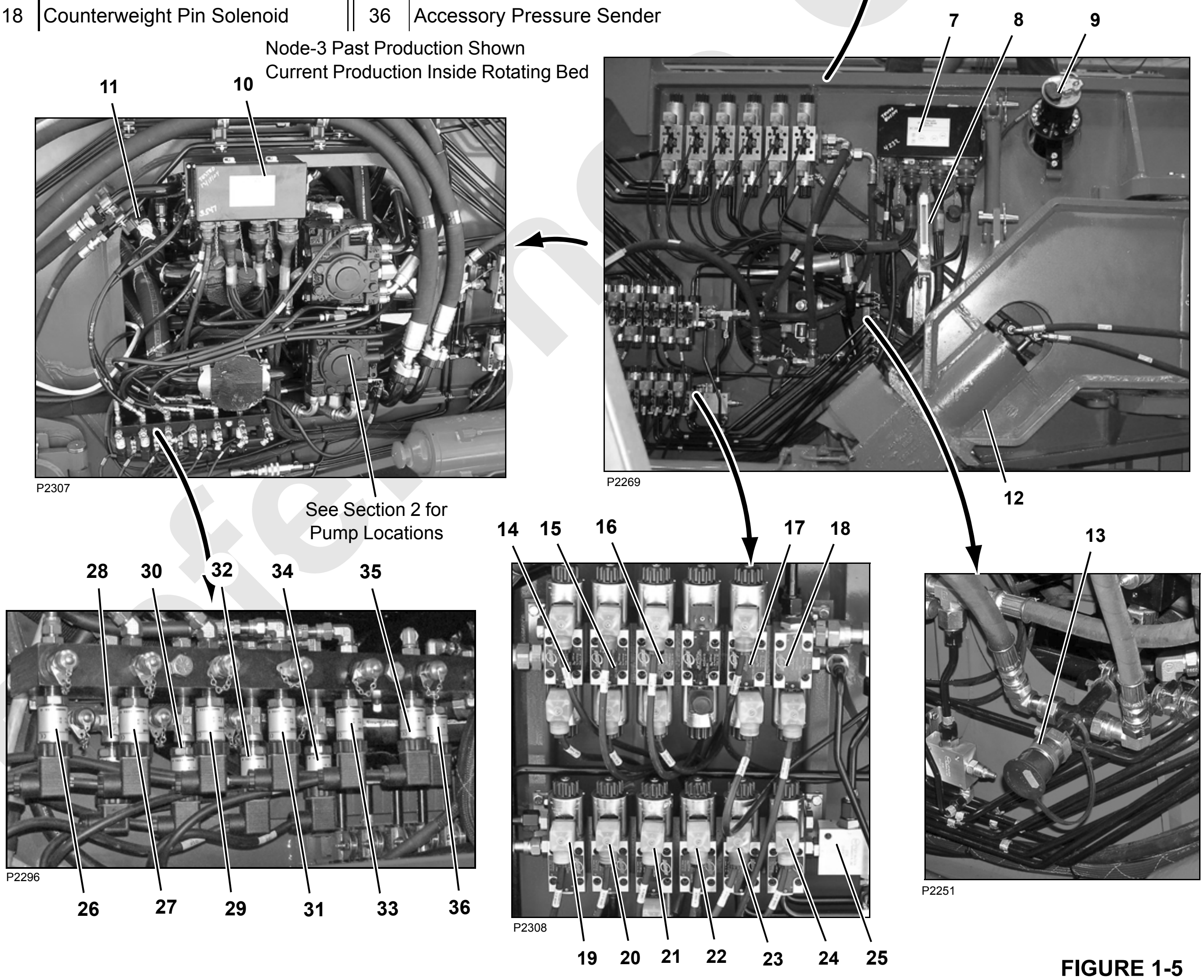
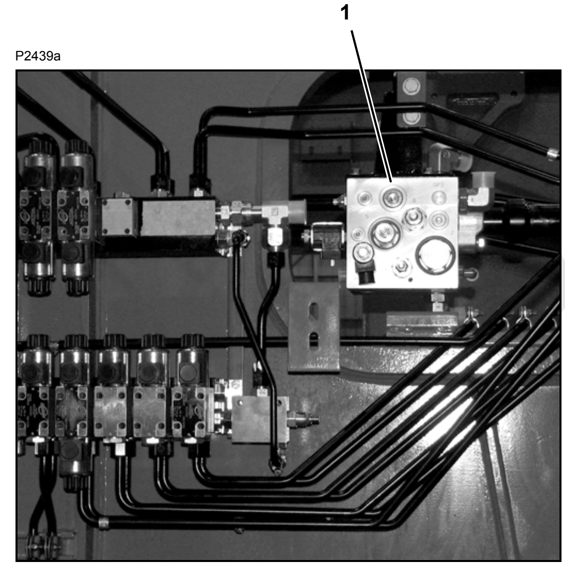
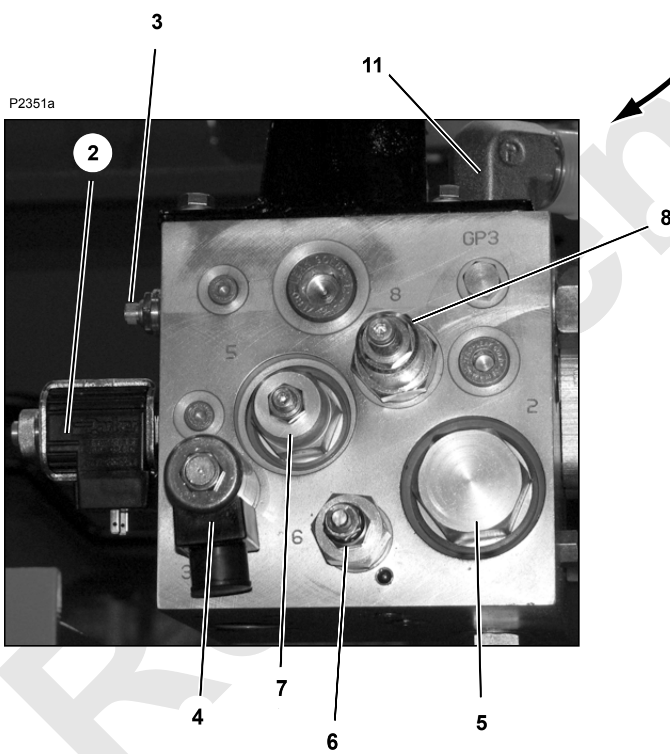


FIGURE 1-5

Left Side

Item	Description
1	Accessory System Manifold (S/N 16001142 and newer) for MAX-ER, Engine Cooling Fan, Accessory High Pressure, and Accessory Low Pressure
2	500 - 5,000 psi (35 to 345 bar) Accessory System Proportional Relief Valve HS-68
3	3,100 psi (214 bar) Relief Valve Fixed
4	24 volt, 3-way, 2 Position Hydro Fan Solenoid Valve
5	Logic Relief Element Set at 12 psi (.8 bar)
6	Pressure Reducing Valve Cartridge Set at 580 psi (40 bar)
7	Pressure Relieve Valve Cartridge Set at 5,000 psi (345 bar)
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





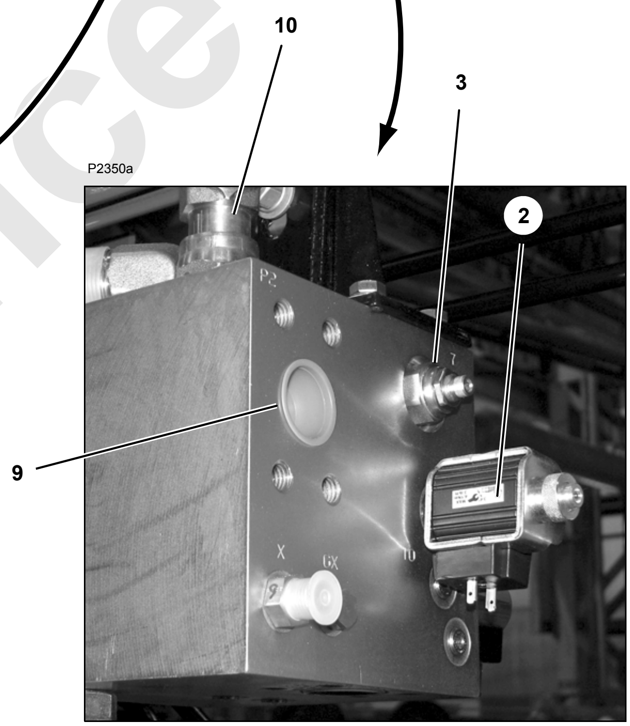
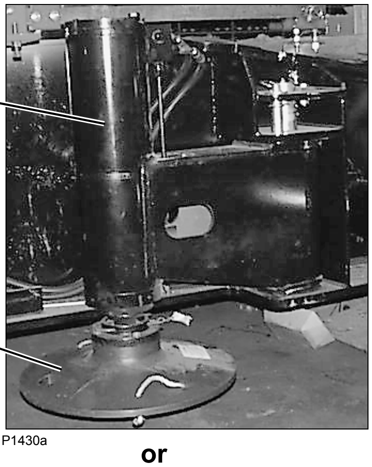


FIGURE 1-6



Undercarriage/Crawler

Item	Description
1	Carbody Pedestal
2	Intermediate Crawler Roller (14 each crawler)
3	Crawler Roller (1 each 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)

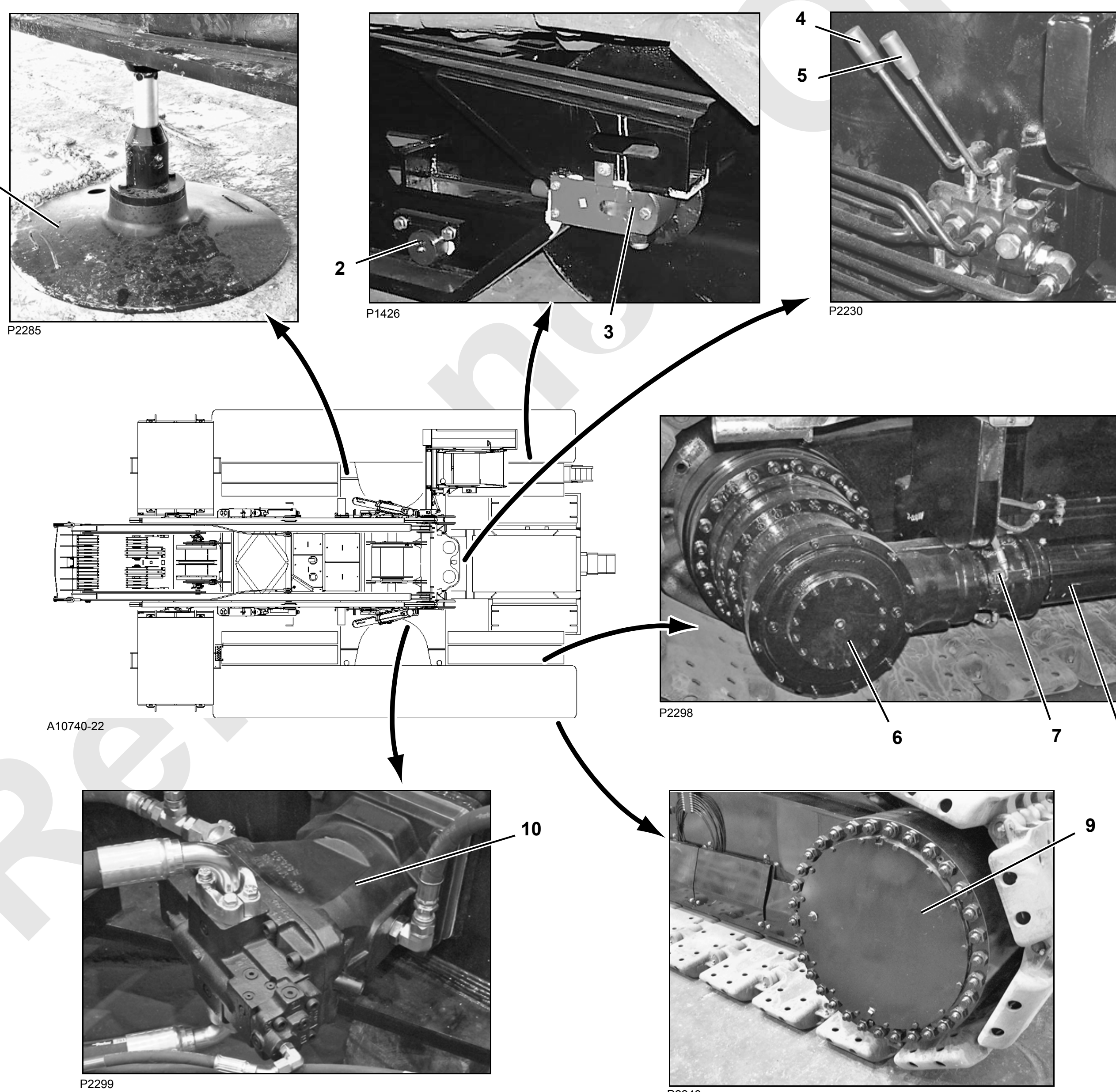


FIGURE 1-7

CRANE DESCRIPTION OF OPERATION

General Abbreviations

A	Amber Light
ACR	Air Conditioning Relay
AL	Auto Lube Pump
ALT	Alternator
AUX	Auxiliary
BH	Boom Hoist
CAN-bus	Controller Area Network
DISP	Displacement
EDC	Electrical Displacement Control (Pump)
EFC	Electronic Fuel Control
EPIC	Electrical Processed Independent Control
ER	Ether Relay
ES	Ether Start
FS	Fuel Solenoid
FSR	Fuel Solenoid Relay
G	Green Light
GND	Ground (Electrical)
HDC	Hydraulic Displacement Control
HS	Hydraulic Solenoid
LD	Load Drum
LJ	Luffing Jib
LT	Left Travel
MAX	Maximum
M/C	Motor Control
MINI	Minimum
P/C	Pump Control
PCOR	Pressure Compensated Over-Ride
PCP	Pressure Control Pilot (Motor)
PCR	Pressure Compensated Regulator
PCV	Pressure Control Valve
PWR	Power (Electrical)
R	Red Light
RT	Right Travel
S	Swing
SOL	Solenoid
SS	Starter Solenoid
VDC	Volts Direct Current
W	White Light

Solenoid Valve Identification

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

HS-1	Swing Brake Release
HS-2	Swing Lock Engage (Past Production)
HS-3	Swing Lock Disengage (Past Production)
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

GENERAL OPERATION

See Figure 1-8 for the following procedure.

This section describes the standard and optional equipment available for 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 line. 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 main display in operator's cab (see Main Display in Section 3).

A diesel engine provides power to operate 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 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 pump input. The crane closed loop systems are swing, right travel, left travel, boom/mast hoist, and load drums.

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

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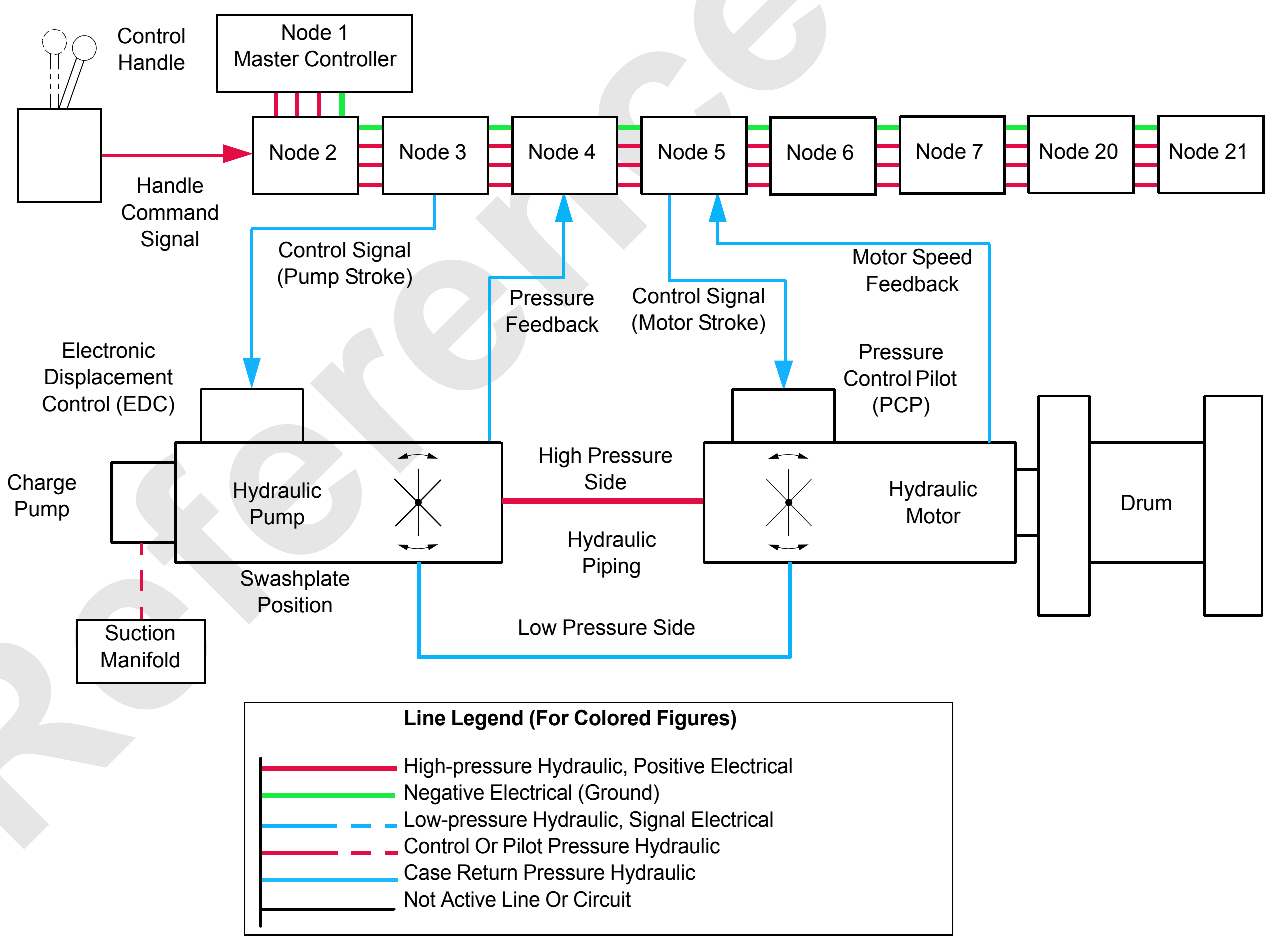

FIGURE 1-8

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. Hydraulic tank components include a separate breather, suction strainer, return filters, diffuser, temperature sensor, level sensor, and pressure ports.

The suction section has a 100 micron, 200 mesh strainer that allows fluid bypass around the strainer at 3 psi (0,21 bar) if it becomes plugged. The breather protects the tank from excessive pressures or vacuum opening at 1.5 in of mercury (38 mm HG).

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

Tank hydraulic strainers and filters remove contaminants from fluid. System 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 hydraulic shut-off valve is located between tank and suction manifold. Close this shut-off valve when performing maintenance on hydraulic systems. ***Open shut-off valve before starting engine.***

Supercharge Manifold

Supercharge manifold supplies fluid to all system pumps. When shut-off valve is open, fluid flows from tank to supercharge pump through suction manifold. Supercharge pump supplies hydraulic fluid to supercharge filter manifold. Charge filters must be changed when system fault alarm is enabled and fault display indicates that filters need to be serviced. Starting with 16001142, charge filters not present.

Return Manifolds

Return fluid from motor and pump case drains is routed through main return manifold and cooler before entering hydraulic tank. Main return manifold has a 25 psi (1,7 bar) bypass that allows fluid to bypass cooler if it becomes plugged. Return fluid from relief valves, brake valves, drum pawls, and counterbalance pin cylinders returns to other return manifold, bypassing cooler before entering tank.

Hydraulic Fluid Cooler

If hydraulic fluid temperature is above 140°F (60°C), fluid flows through cooler before returning to tank. Hydraulic fluid bypasses cooler if below above temperature.

Supercharge Pump(s/n 16001141 and prior)

The supercharge pump is a fixed displacement gear pump that draws hydraulic fluid from suction manifold and supplies make-up hydraulic fluid to supercharge manifold.

Accessory/MAX-ER Pump

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

Hydraulic Pumps

See hydraulic pump manufacturer's Service Manual for a complete description of a hydraulic piston pump.

Drum, swing, and travel pumps are variable displacement, axial piston pumps that operate in a bi-directional closed-loop system.

Each pump contains:

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

Each system pump has a gerotor type gear charge pump that is internally mounted on the end of each pump system drive shaft. System charge pump draws fluid directly from supercharge manifold and delivers it to closed-loop system at a charge pressure of approximately at 350 psi (24 bar). Charge pressure depends on 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 pump EDC as required for handle command direction. Pump EDC tilts swashplate to stroke pump in the command direction. Pump pistons move within cylinder block as the block rotates. The longer stroke of each piston draws in return fluid from system motor. As the stroke shortens, hydraulic fluid is pushed out of pump piston cylinders into hydraulic piping to the motor. Pressurized hydraulic fluid from the pump turns the motor in the command direction. Hydraulic fluid displaced by motor returns through hydraulic piping to inlet side of system pump.

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

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

Charge Pressure

Charge pressure in each closed-loop system is preset at approximately 350 psi (24 bar) with a relief valve in charge pump. Charge pressure must be at 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 neutral the main display indicates system charge pressure.

If any charge pressure system drops, the system brake begins to apply at approximately 200 psi (14 bar). Main system pumps de-stroke as charge pressure drops to minimum pressure. The accessory pump de-strokes if the suction side pressure drops below 160 psi (11 bar).

Hydraulic Motors

See 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. Boom/mast hoist and load drums motors have a PCP (Pressure Control Pilot) valve that controls output speed/torque of the motor.

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

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

Pressure Monitoring

The main display indicates the selected system pressures. The system pressure displayed is charge pressure or greater. System pressure can also be checked at each pressure sender diagnostic coupler with a 10,000 psi (690 bar) high pressure gauge, when that system pump is stroked.

Basic Operation

See Figure 1-9 or Figure 1-10 for the following procedure.

When a control handle is moved from neutral, an input voltage in the handle command direction is sent to 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 pump external EDC (Electrical Displacement Control). The output current magnetizes an armature (Figure 1-9) and starts to block one of the orifice ports, depending on command direction.

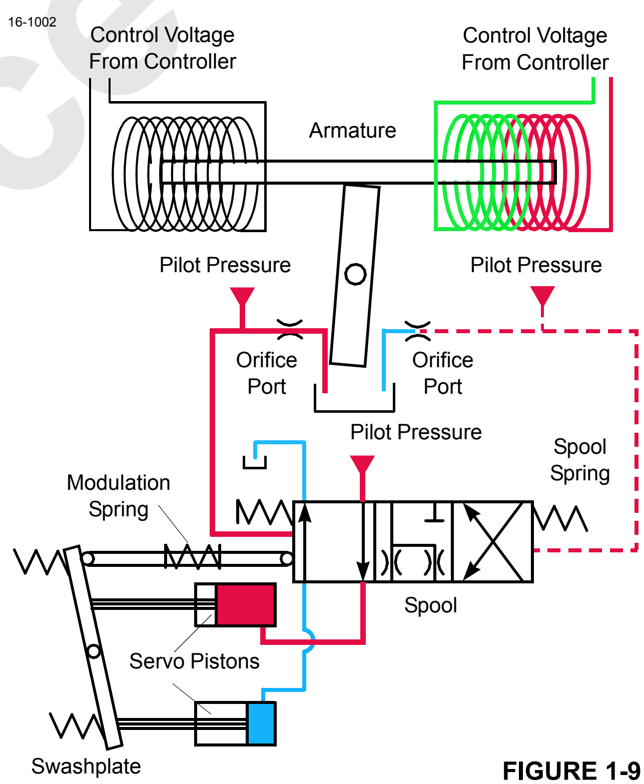

FIGURE 1-9

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

In travel pumps, the pressure relief and pressure-limiting sections of multifunction valves respond when relief pressure is reached. The pressure limiting function of travel pumps is set not to exceed 6090 psi (420 bar). If travel pump pressure exceeds preset pressure limit, pumps de-stroke to prevent overheating of system fluid.

Hydraulic fluid pressure overcomes spring resistance in pressure limiting relief valve (1, Figure 1-10), shifting spool to open a line for fluid pressure. Servo check valve (2) is spring loaded with an opening pressure of 750 psi (52 bar). Hydraulic fluid from pressure limiting relief valve flows through exhaust port of displacement control valve (3).

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

In other system pumps, pressure limiting is controlled through relief valve section of multifunction valves only. Flow control orifice (8) is removed from pump EDC. Servo check valves are removed from pump and lines to 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 pilot valve to open system relief valve (5) when desired relief pressure setting is reached. For example, if a pressure imbalance occurs on both sides of flow restrictor (9), pressure limiting valve opens and system relief valve relieves system pressure. Hydraulic fluid is directed to tank through relief valve (7) or the flow is transferred to low-pressure side of system through the make-up check valve (8).

Pump displacement depends on engine driven pump speed through pump drive and swashplate tilt angle. The engine provides power for work, while the swashplate tilt angle provides speed control. Engine speed is set and controlled with hand or foot engine throttle.

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

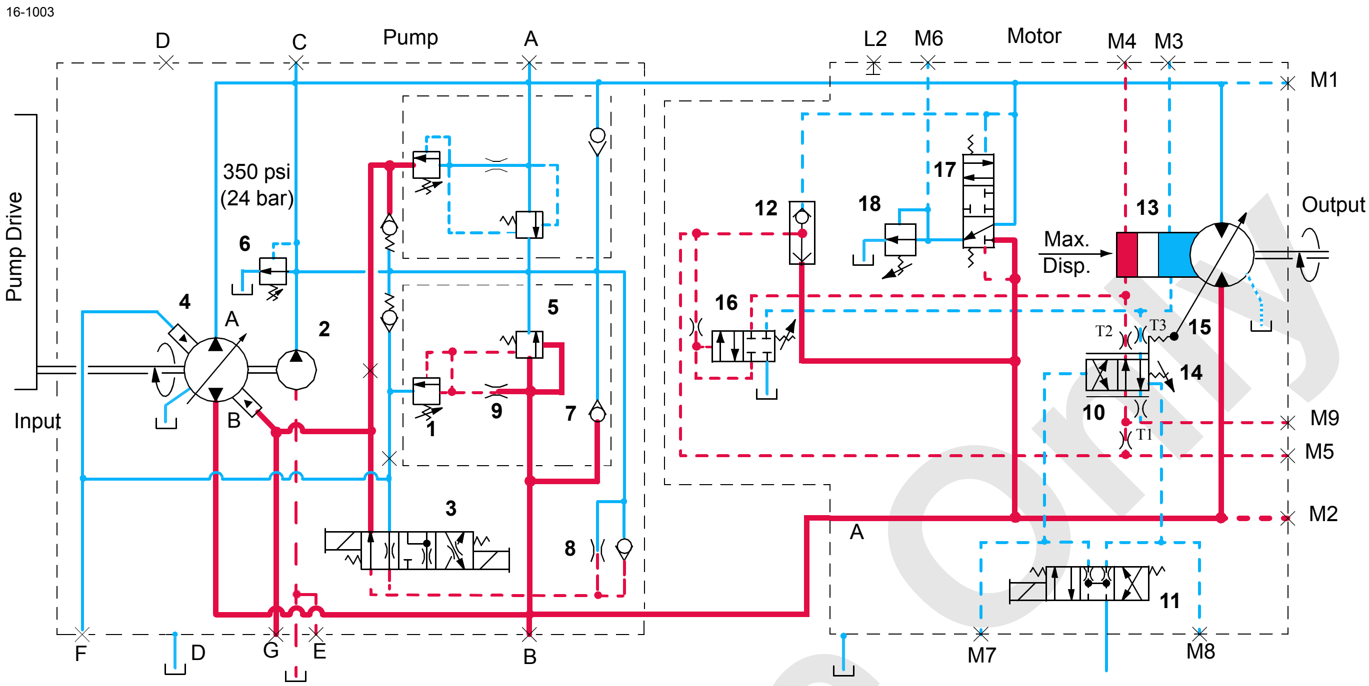

FIGURE 1-10

The load drums and boom/mast hoist motors also have a PCOR (Pressure Compensating Over-Ride) valve (16) that is enabled when system pressure of 4,930 (340 bar) is reached. When system pressure exceeds the PCOR setting, the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve overrides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

The travel motor servo is opposite of 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 starting torque is required and back to minimum displacement when in motion if load is below a preset pressure of 3,915 psi (270 bar). Depending on motor system, servo uses low pressure accessory system pressure to perform the shifting operation. Servo control fluid shifts shuttle valve and servo control valve before entering 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 closed-loop system. Motors also have an internal or external loop flushing (purge) system that consists of control valve (17) and relief valve (18). If system pressure is above 200 psi (14 bar), loop flushing removes 4 g/m (15 L/m) of hot fluid from system for added cooling and purification. If system pressure is under 200 psi (14 bar) loop flush is disabled.

Accessory/MAX-ER Pump

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

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 3,000 to 500 psi, 400 psi at standby (207 to 34.5 bar, 27.6 bar at standby) by the reducing valve for travel brake, travel two-speed, swing brake, and swing lock (past production).

NOTE: An external pump on the engine operates the engine cooling fan. On 16001142 and newer the accessory pump will also control the cooling fan. Tier 4 equipped machines will have a variable speed cooling fan.

Engine Controls

See engine manufacturer's manual for instructions.

The engine is started and stopped with engine key switch. Engine clutch lever for pump drive must be manually engaged for normal operation.

Crane systems speed depends on engine speed and system control handle movement. Engine speed is controlled with the hand throttle or foot throttle and is monitored with a speed sensor. Node-1 controller and engine Node-0 controller controls and processes engine information and displays the information on the main display.

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

ELECTRICAL CONTROL SYSTEM

See Figure 1-11 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 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. Node-1 controller compares these input data packet signals with programming directives and data information. Node-1 controller then provides 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 Node-1 controller.

Remote nodes on the boom monitor the boom, luffing jib, or fixed jib components and input the information to 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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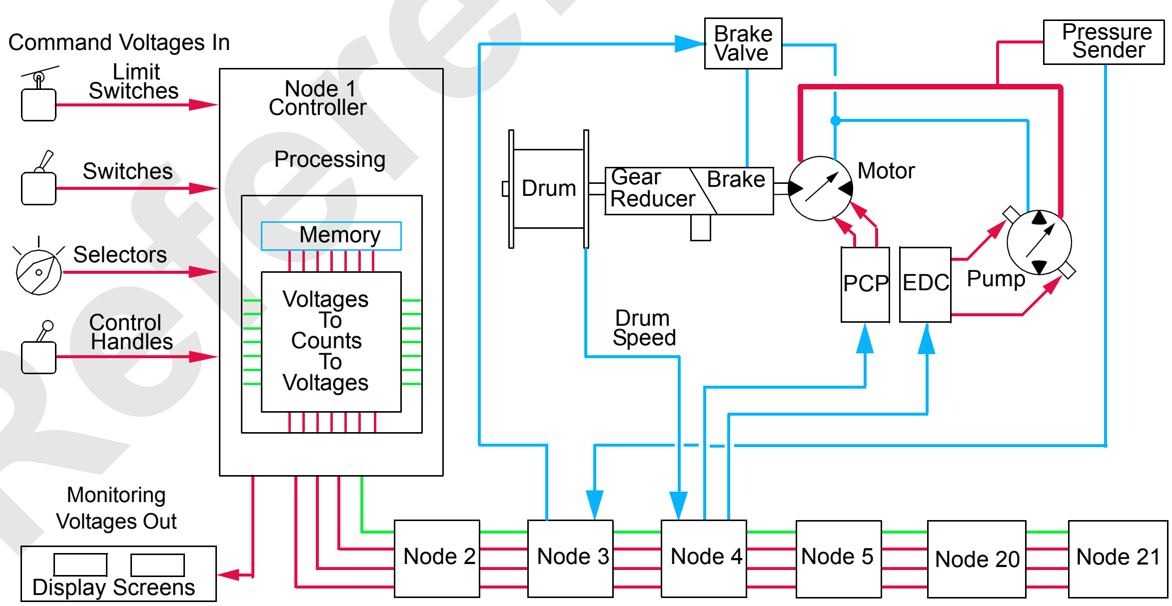


FIGURE 1-11

Display Screens

See Figure 1-11 for the following procedure.

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

Electrical Power to Operator's Cab

See Figure 1-12 for the following procedure.

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

- Engine control module (ADM2)
- CAN-bus system power relay (CAN PWR)
- CAN-bus system ground relay (CAN GND)
- Cab power relay (CAB PWR). When cab power relay is enabled, power is available to operate crane controls.
- Air conditioning system relay (A/C CLUTCH)

Cab Power Electrical Schematic

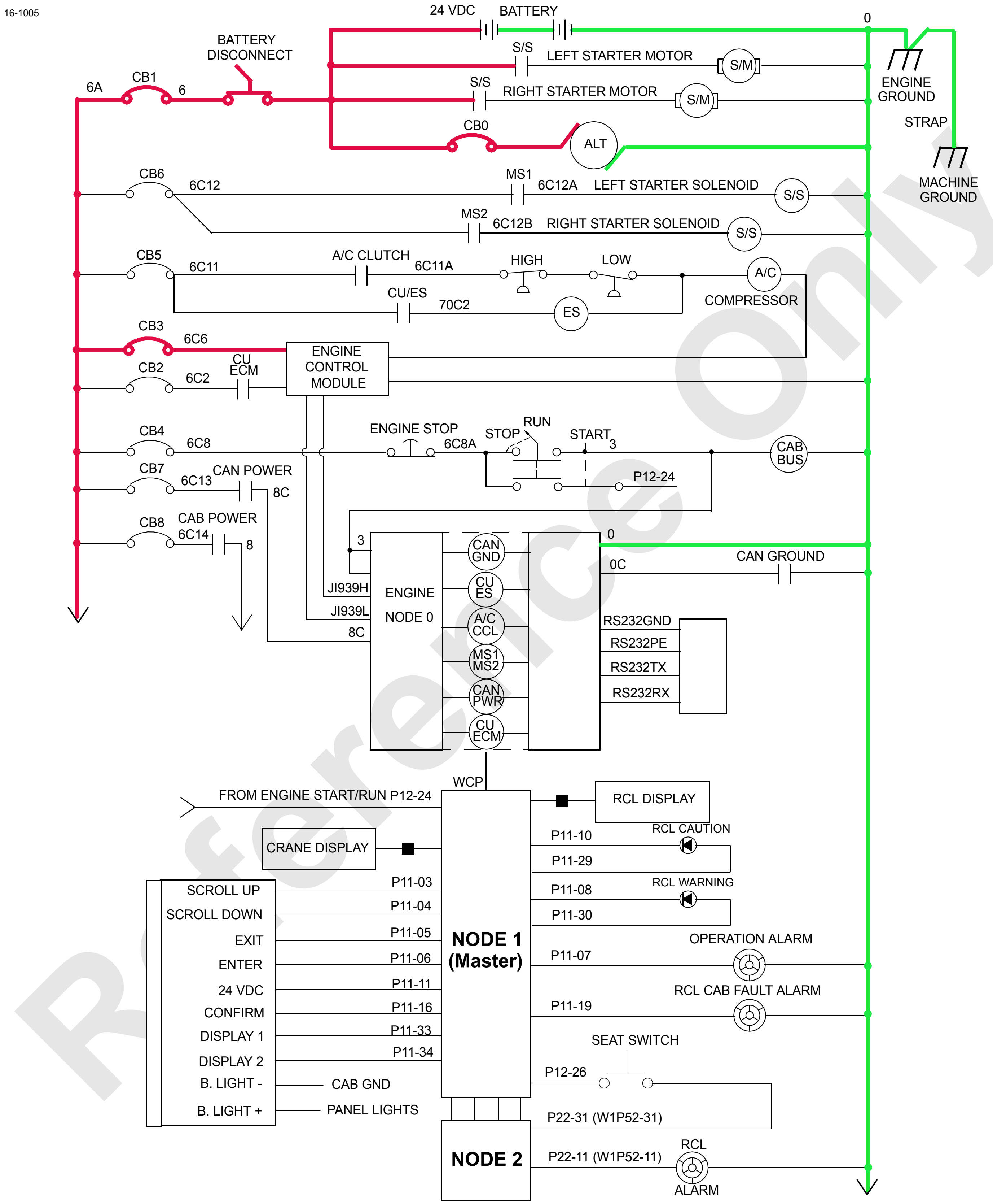


FIGURE 1-12

Pressure Senders and Speed Sensors

NOTE: The swing brake pressure sensor is only available on cranes with the swing lock removed.

Pressure senders monitor drum system pressures, right/left travel system pressure, swing right/left system pressure, swing brake pressure (cranes that do not have a swing lock), 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 Node-1 controller.

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

System Faults

See Figure 1-12 for the following procedure.

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).

When operating, all limit switches are closed, sending an input voltage to Node-1 controller. If a limit switch is tripped, the system node controller sends a zero output voltage to that system pump EDC and brake solenoid. System pump de-strokes and system brake valve shifts to apply brake.

Move control in the opposite direction away from limit to correct the problem.

The limit bypass switch allows crane to be operated beyond the limits for crane setup or maintenance only. For example, to add wire rope on load drum or to remove wire rope from load drum after an operating limit is enabled. The jib up limit bypass switch allows the jib maximum up limit to be bypassed when boom or luffing jib is lowered to 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 off - park position, the selected drum pawl is disengaged from drum. Place selected brake switch in on - park position to apply pawl to drum.

Node-1 controller releases the swing brake and swing lock (past production) immediately when swing brake switch is placed in off - park position.

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

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

Switches and Sensors Electrical Schematic

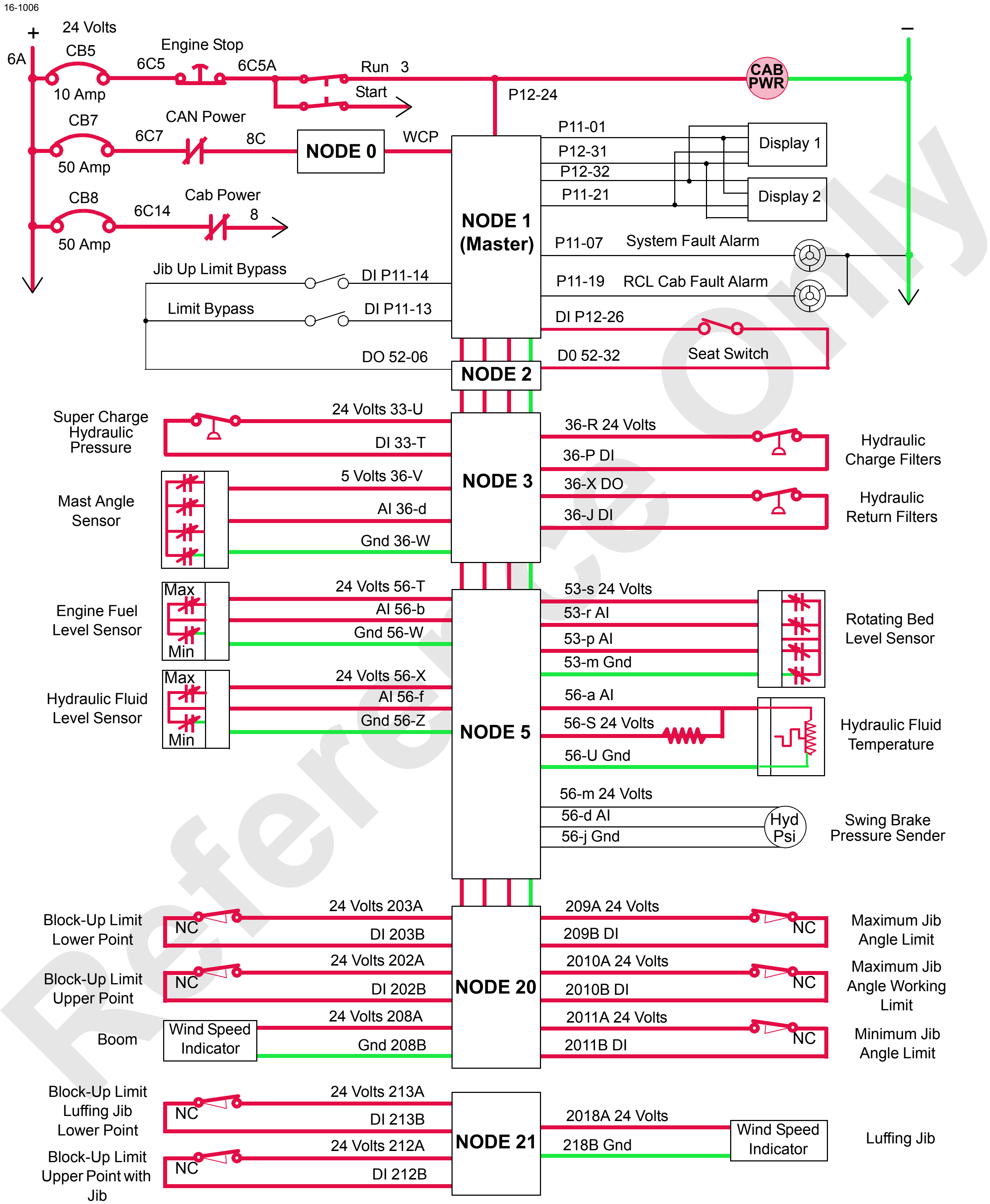


FIGURE 1-13

SWING SYSTEM OPERATION

See Figure 1-14, Figure 1-15, and Figure 1-17 for the following procedure.

One hydraulic swing pump drives two separate swing motors. The hydraulic motors drive gearboxes that mesh with tooth gears and turn rotating bed to swing. The swing system is controlled with swing control handle movement and node controllers. Swing control handle is inoperable when swing brake is applied or the swing lock is engaged. Rotating bed is free to coast if swing control handle is in neutral position, swing brake is released, and swing lock (past production) is disengaged.

The swing motors are controlled directly by the output fluid volume of the swing pump. 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 swing motor ports A and B allow smoother fluid flow when shifting swing directions. Continuous changing of closed-loop fluid occurs through leakage in pumps and motors.

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

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

Swing Brake and Swing Lock

NOTE: The swing lock is installed on past production cranes only. Cranes not equipped with a swing lock will only have the swing brake on the swing diagnostic screen of the crane display; see Figure 1-16.

The swing system has a spring-applied hydraulically released brake on drive shafts and a mechanical brake (swing lock) that places locking pins into slots in shaft locking flange of gearbox.

The source hydraulic pressure for releasing the swing brake and swing lock is from accessory/MAX-ER pump at 400 to 500 psi (28 to 35 bar). For swing brake and swing lock operation the system pressure must be above 200 psi (14 bar) for full release brake and lock. If system pressure is below 200 psi (14 bar), swing brake or swing lock could be partially applied and damage the swing system. If brake pressure or electrical power is lost when operating, the swing brake is applied.

After startup, place swing brake switch in off - park position. An input voltage is sent to Node-1 controller. Node-5 controller sends a 24 volt output to enable the swing brake solenoid HS-1 and swing lock out solenoid HS-3.

Swing brake valve shifts to hydraulically release swing brake from shaft. Swing lock out valve shifts to block tank port and supplies hydraulic system pressure to rod end of cylinder to hydraulically release mechanical locking pin from shaft-locking flange. Fluid from piston end of cylinder flows to tank.

Before shutdown, place swing brake switch in on - park position. An input voltage is sent to Node-1 controller. Node-5 controller sends a zero output voltage to disable swing brake solenoid HS-1 and a 24 volt output voltage to enable swing lock in solenoid HS-2.

Swing brake valve shifts to block fluid to brake and swing brake is applied. Fluid from brake flows to tank. Swing lock in valve shifts to block tank port and supplies hydraulic system pressure to piston end of cylinder to hydraulically engage mechanical locking pin into shaft locking flange. Fluid from rod end of cylinder flows to tank.

Swing Lock past production:

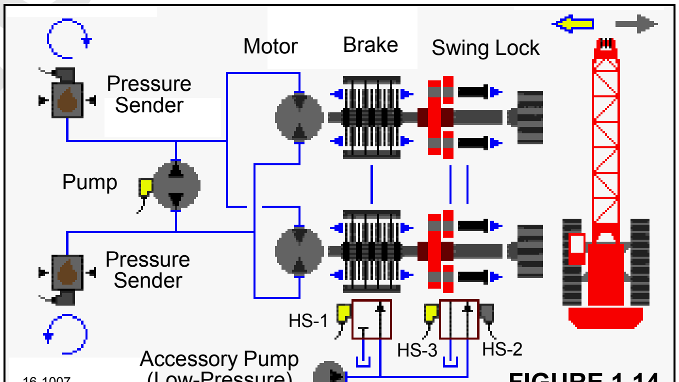


FIGURE 1-14

Swing Right or Left

See Figure 1-14 and Figure 1-15 for the following procedure.

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

Swing Lock past production.

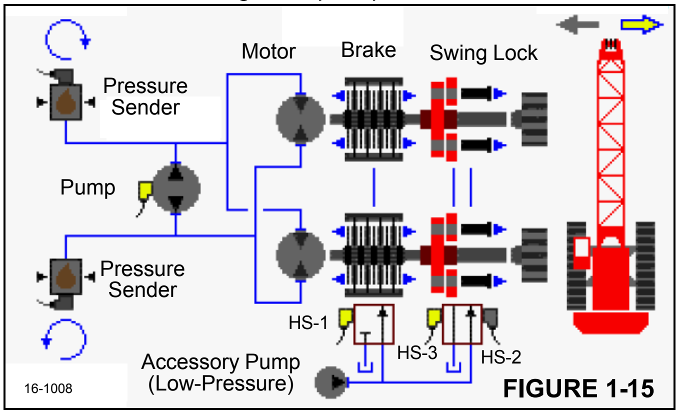


FIGURE 1-15

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

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

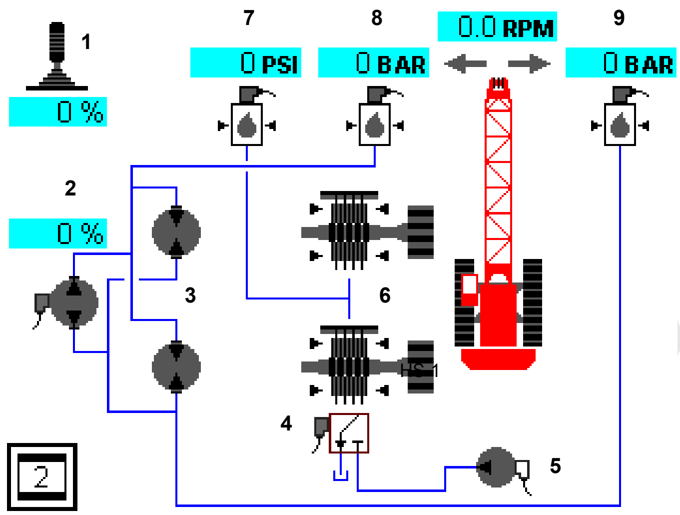
When in a swinging motion, the preferred way to stop or slow crane is to move swing control handle beyond center in the opposite direction. This allows rotating bed to gradually stop.

Swing Brake Pressure Sensor

See Figure 1-16 for the following procedure.

The swing lock is removed on current production cranes. An additional pressure sensor will report to Node-5 and monitor the swing brake pressure. The pressure sensor in the diagnostic screen will only be available and appear on cranes with the swing lock removed.

Swing Lock removed current production.



Legend for Figure 1-16

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 1-16

Swing Holding Brake Switch

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

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

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

Swing Electrical Schematic

Swing lock removed on current production cranes.

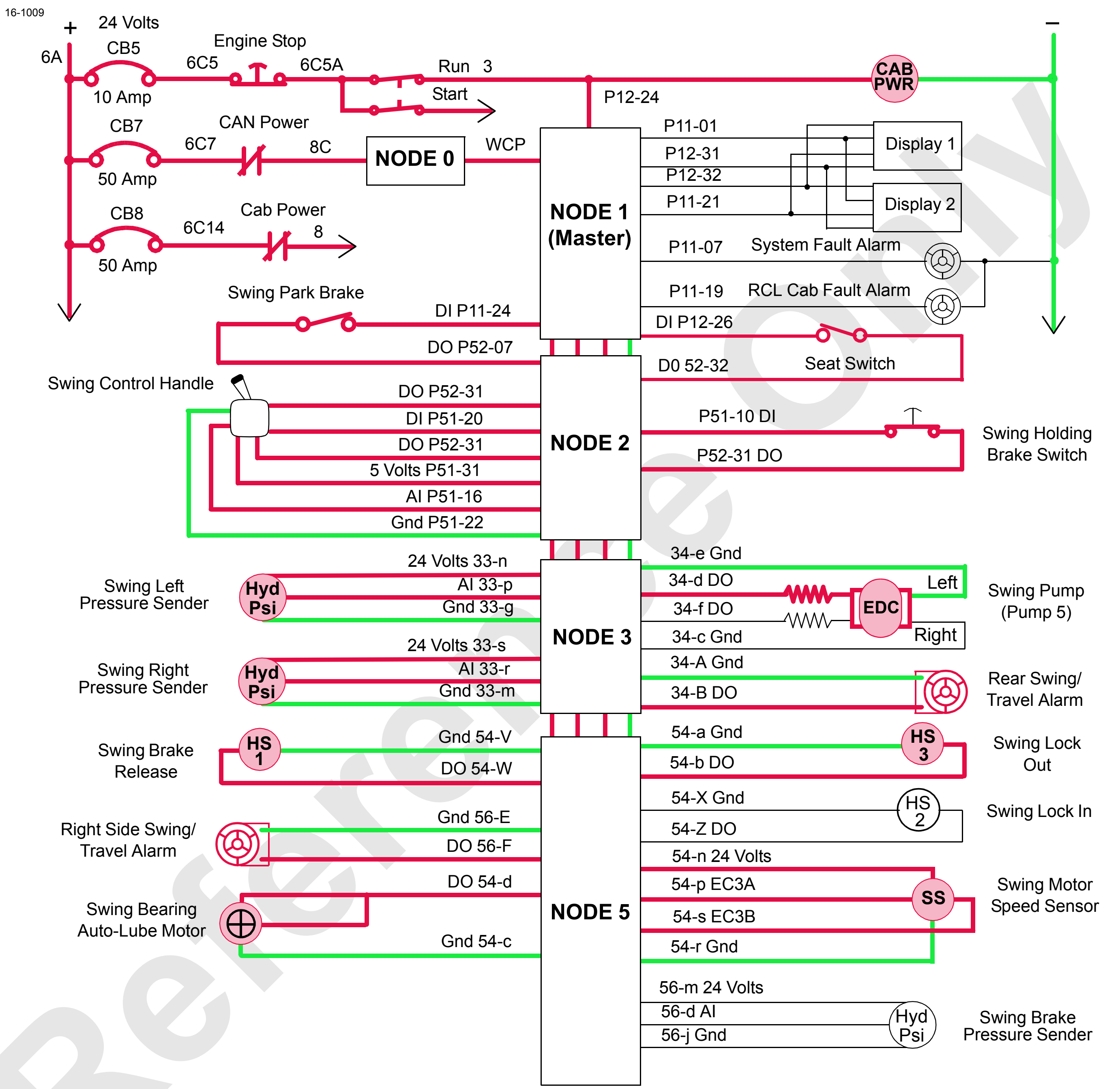


FIGURE 1-17

TRAVEL SYSTEM OPERATION

See Figure 1-18 and Figure 1-19 for the following procedure.

Each travel hydraulic pump drives a crawler system motor and gearbox. Each hydraulic pump and motor is controlled with travel control handle movement and node controllers. Travel control handles are inoperable when 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 crane travels in a straight line forward or reverse direction, each travel drive system has shuttle valves and pressure senders in each leg that monitor hydraulic pressure. When traveling, Node-4 controller monitors pressure information from pressure senders and adjusts 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 accessory/MAX-ER pump at 500 psi (35 bar). Continuous changing of closed-loop fluid occurs through leakage in pump, motor, and loop flushing valves that removes 5 g/m (19 L/m) of fluid to when system pressure is above 200 psi (14 bar).

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

When either travel control handle is moved from off, an input signal is sent to Node-1 controller. Node-3 and 5 controllers send a 24 volt signal to enable the rear and right side swing/travel alarms. When both travel control handles are moved to off, an input signal is sent to Node-1 controller. 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 accessory/MAX-ER pump at 400 to 500 psi (28 to 35 bar). For travel brake operation the system pressure must be above 200 psi (14 bar) for travel brakes to fully release from each travel motor shaft. If system pressure is below 200 psi (14 bar), 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 on - park position, right and left travel brakes are applied to hold crane in position. Travel brake valve is open to allow hydraulic flow from the brake to tank.

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

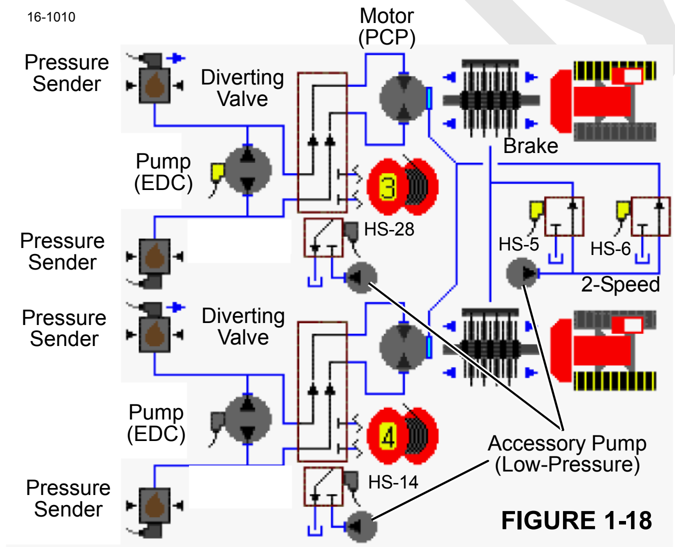


FIGURE 1-18

Travel Forward and Reverse

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

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

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

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

Travel Electrical Schematic

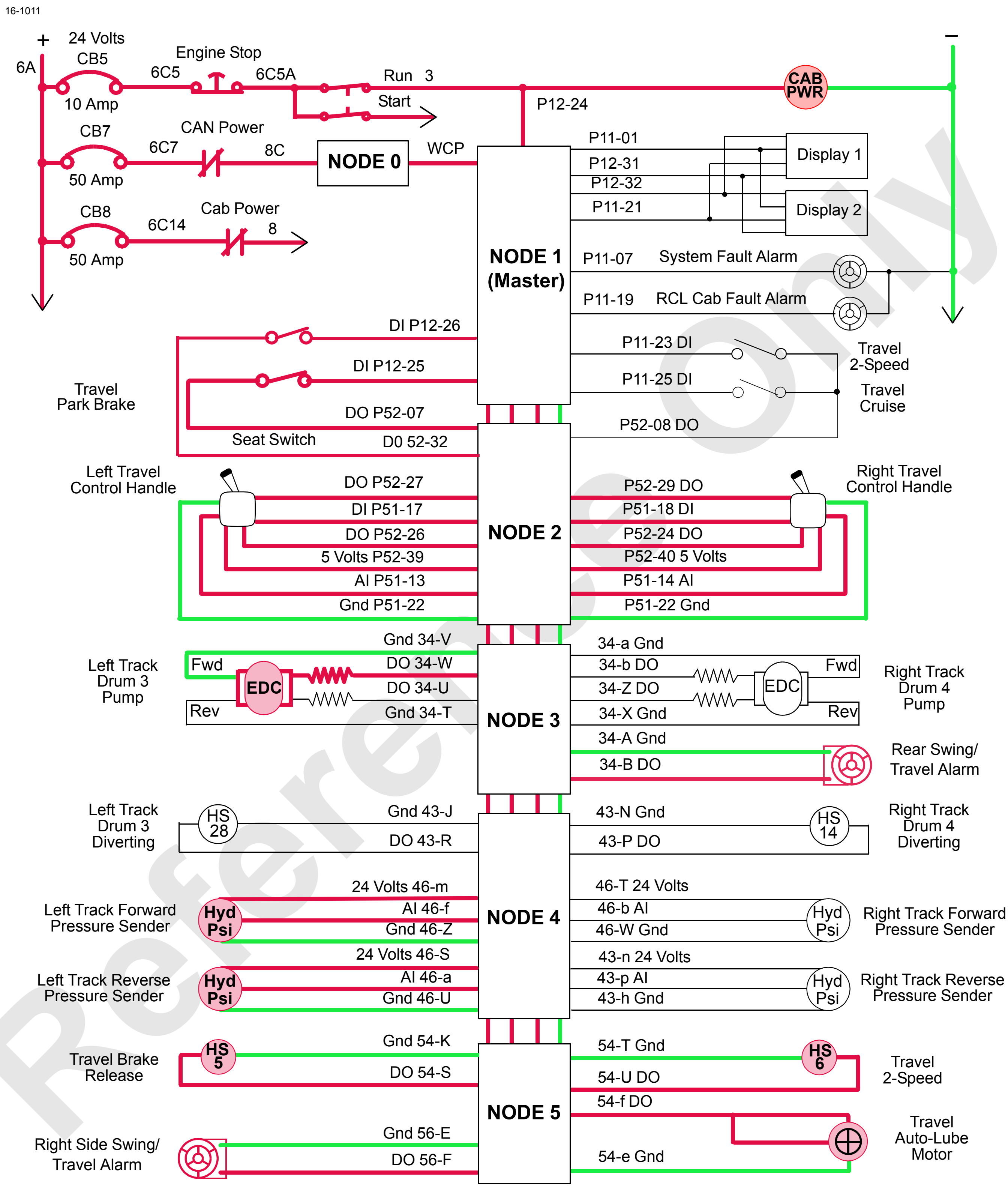


FIGURE 1-19

Travel motors are variable displacement and shift internally with an adjustable spring in each motor P/C (Pressure/Compensator) valve, preset at approximately 3,915 psi (270 bar). Travel motors are in minimum displacement (low torque, high-speed) position when starting. When crawler begins to move, a high system pressure shifts the PCOR (Pressure Compensated Over-Ride) spool placing travel motor in maximum displacement (high torque, low speed) position for breakaway torque.

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

Two-Speed Travel Operation

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

Place 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 accessory/MAX-ER pump at 400 to 500 psi (28 to 35 bar). When travel two-speed switch is in ***high*** speed position, travel motors shift to minimum displacement (low torque, high speed) automatically if engine speed is above 1500 rpm and system pressure is below 3,915 psi (270 bar). If engine is below 1500 RPM, two-speed travel solenoid HS-6 is enabled although travel two-speed switch in the ***high*** position. Travel two-speed solenoid HS-6 is disabled, shifting valve and removing hydraulic pilot pressure to P/C valve, allowing motor to operate in PCOR mode.

Travel Cruise

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

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

BOOM/MAST HOIST SYSTEM OPERATION

See Figure 1-20, Figure 1-21, and Figure 1-22 for the following procedure.

Boom/mast hoist (drum 4) is mounted at rear of rotating bed and controls the boom when crane is configured as a liftcrane. Boom hoist (drum 5) is mounted in mast butt and controls the boom when 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 setup configuration. The hoist drum is controlled with control handle movement and node controllers. The control handle is inoperable when park brake is applied.

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

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

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

Continuous changing of closed-loop fluid occurs through leakage in pump, motor, and external sequence/flow valve. Sequence/flow valve opens at 200 psi (14 bar) and removes 4 gallons per minute (15 l/m) of hot fluid from system by dumping fluid into the motor case where fluid returns to tank.

Boom/Mast Hoist Brake and Pawl

Hydraulic pressure to operate hoist brake is from low-pressure side of system. Hydraulic pressure to operate drum pawl is output pressure from accessory/MAX-ER pump at 400 to 500 psi (28 to 35 bar).

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

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

Raising Boom

See Figure 1-20 and Figure 1-22 for the following procedure.

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

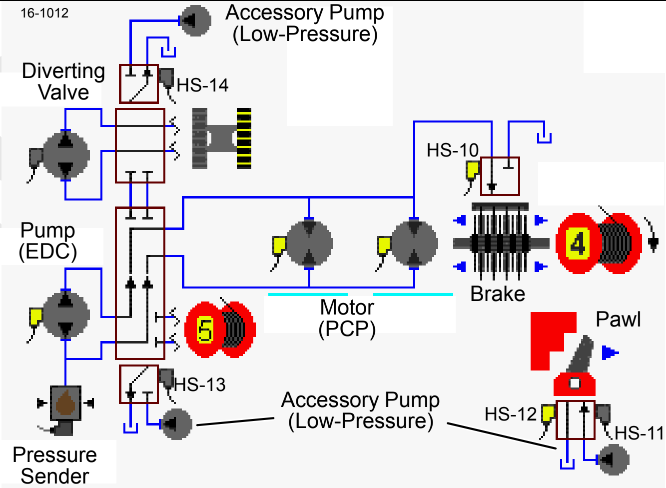


FIGURE 1-20

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

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

Node-3 controller output voltage to pump EDC and Node-4 and 5 controllers output voltage to each motor PCP is relative to control handle movement. As control handle is moved back, pump swashplate angle is increased. When system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

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

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

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

Lowering Boom

See Figure 1-21 and Figure 1-22 for the following procedure.

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

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. Node-1 controller checks that boom up limit switch is closed and no hydraulic system fault is present.

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

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

Node-3 controller output voltage to the pump EDC and Node-4 and 5 controllers output voltage to each motor PCP is relative to control handle movement. As control handle is pushed forward, pump swashplate angle is increased. When system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

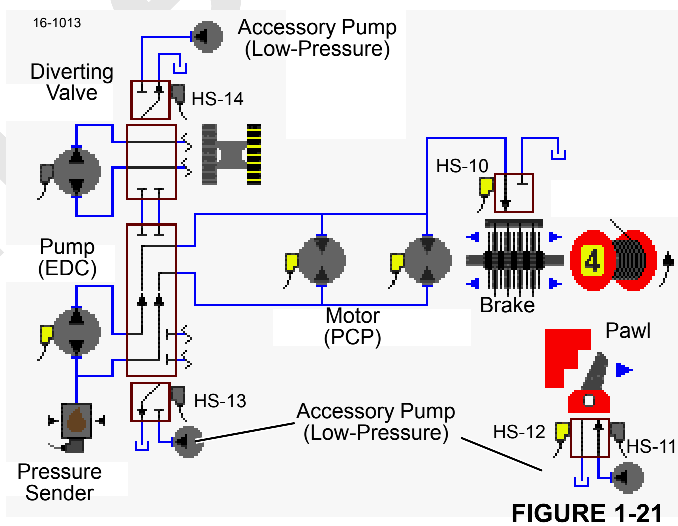


FIGURE 1-21

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

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

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

When control handle is moved to neutral position, Node-1 controller stores the load holding pressure in pressure memory. After control handle center switch opens, Node-4 controller sends a zero output to disable brake release solenoid HS-10. Drum brake valve shifts to block pilot pressure to brake and opens a line to tank. When brake applies, an input signal is sent to Node-1 controller. Node-4 controller sends a 0 volt output to boom pump EDC to de-stroke pump. Node-4 and 5 controllers send a 0 volt output to each motor PCP.

Drum 4 Electrical Schematic

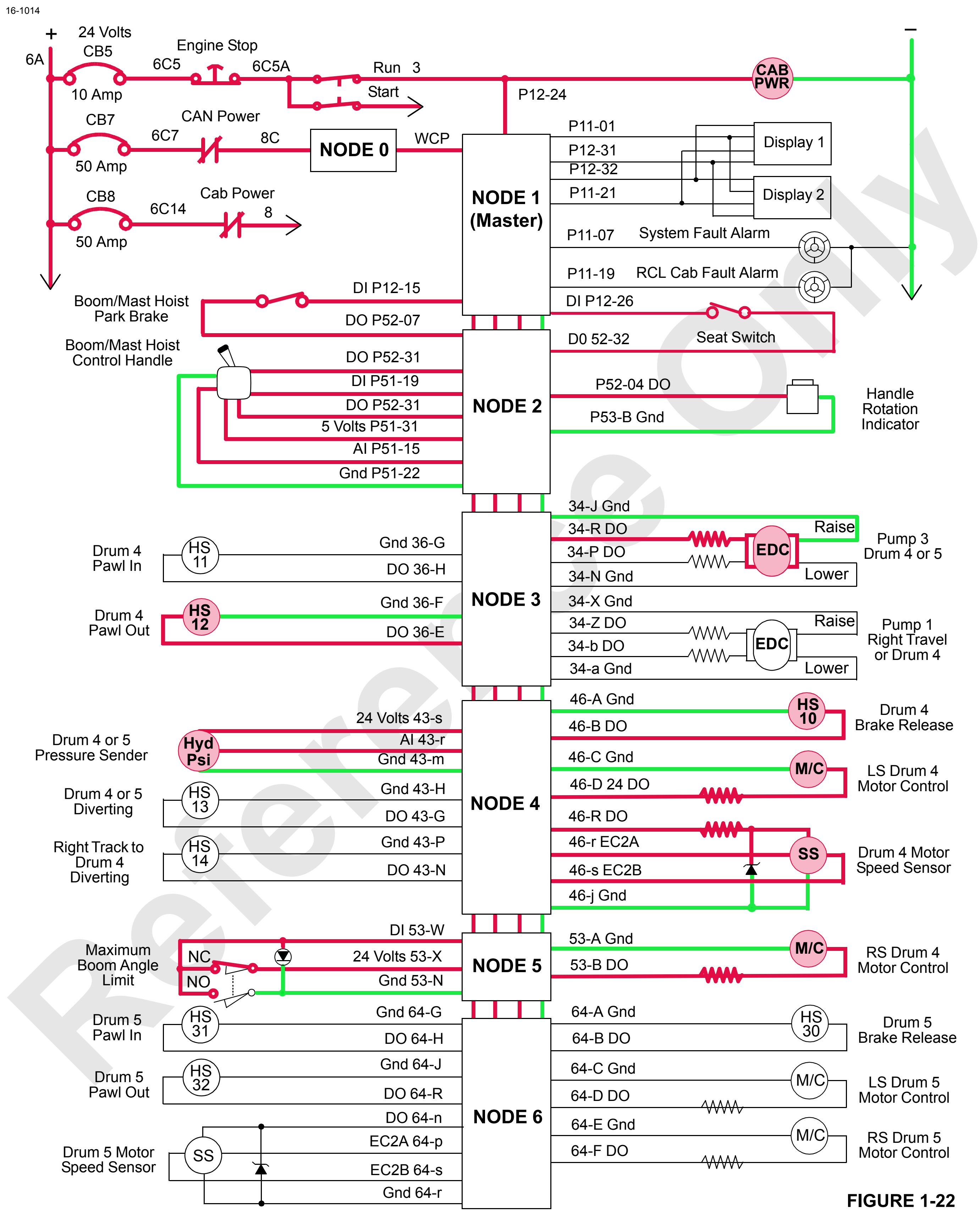


FIGURE 1-22

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LOAD DRUM 1

System Components

See Figure 1-23, Figure 1-24, and Figure 1-25 for the following procedure.

Load drum 1 is located in the boom butt. One hydraulic pump drives two separate motor gearboxes on each end of drum. Load drum 2 pump is dedicated to operate with load drum 1 though a diverging valve. Hydraulic connections between and pump and motors form a closed-loop system that is controlled with 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 system charge pump supplies hydraulic make-up fluid to low-pressure side of each drum 1 motor. A pressure sender in high-pressure side of pump leg provides system pressure information to Node-1 controller. Low-side pressure supplies hydraulic pilot pressure to operate motor servos. A fixed orifice between 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 Node-1 controller. Node-2 controller sends an output voltage to rotation indicator in control handle. As drum rotates faster, the rotation indicator on top of control handle pulsates with a varying frequency that indicates drum rotational speed. The handle command in percent from neutral is shown on Diagnostic Screen.

Continuous changing of closed-loop fluid occurs with leakage in pump, motor, and external sequence/flow valve. Sequence/flow valve opens at 200 psi (14 bar) and removes 4 gallons per minute (15 l/m) of hot fluid from system by discharging exhausted fluid into motor case where the fluid returns to tank.

Load Drum 1 Brake

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

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

When drum 1 brake switch is placed in off - park position, brake release solenoid HS-15 remains applied. Brakes remain applied until 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 1-23 and Figure 1-25 for the following procedure.

When drum 1 control handle is moved back for ***raising***, an input voltage of 2.4 volts or less is sent to Node-1 controller. Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to pump 4 EDC in the ***raising*** direction. Node-4 controller sends a 24 volt output to enable drum 2 to drum 1 diverting solenoid HS-21. 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 drum 1 motors. 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. Node-1 controller checks that drum block-up limit switches are closed and no system faults are present.

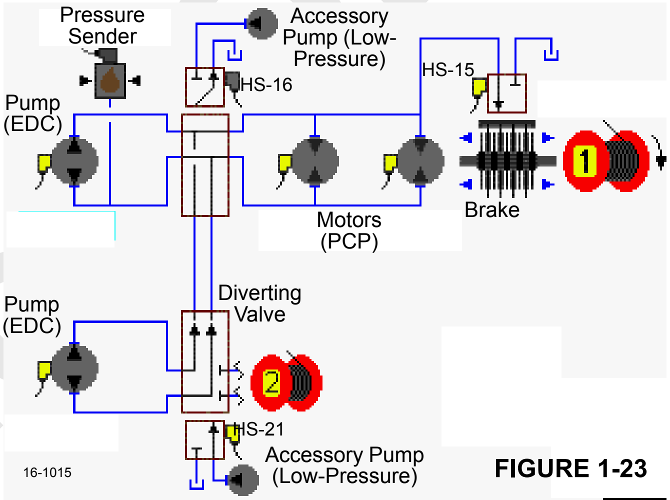


FIGURE 1-23

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

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

Node-3 controller output voltages to each pump EDC and Node-6 controller output voltage to each motor PCP is relative to control handle movement. As 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 drum 2 to drum 1 diverting solenoid HS-21. Drum 1 speed is reduced up to one half.

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

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

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

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

When brake applies, an input signal is sent to Node-1 controller. Node-3 controller sends a 0 volt output to each pump EDC to de-stroke pumps. Node-6 controller sends a 0 volt output to each motor PCP.

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

Lowering Load

See Figure 1-24 and Figure 1-25 for the following procedure.

When drum 1 control handle is moved forward for ***lowering***, an input voltage of 2.6 volts or more is sent to Node-1 controller. Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to pump 4 EDC in the ***raising*** direction. Node-4 controller sends a 24 volt output to enable drum 2 to drum 1 diverting solenoid HS-21. 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 drum 1 motors. Node-6 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to both motor PCP's. Node-1 controller checks that drum block-up limit switches are closed and no system faults are present.

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

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

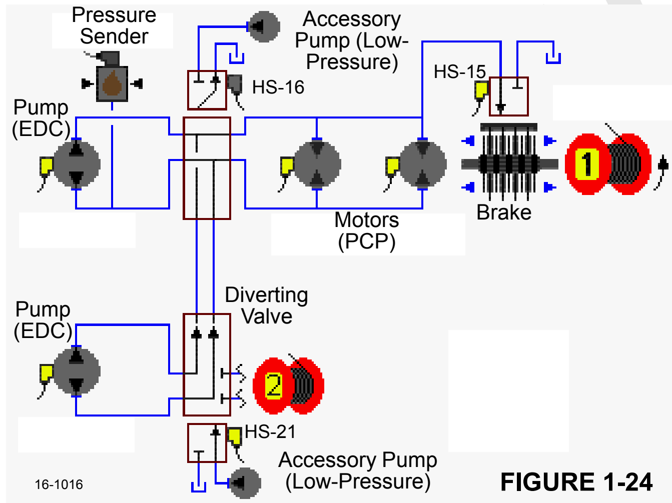


FIGURE 1-24

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

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

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

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

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

When control handle is moved to neutral position, Node-1 controller stores the load holding pressure in pressure memory. After control handle center switch opens, Node-4 controller sends a zero output to disable brake release solenoid HS-15. Drum brake valve shifts to block pilot pressure to brake and opens a line to tank. When brake applies, an input signal is sent to Node-1 controller. Node-3 controller sends a 0 volt output to each drum pump EDC to de-stroke pumps. Node-6 controller sends a 0 volt output to each motor PCP.

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

Drum 1 Electrical Schematic

16-1017

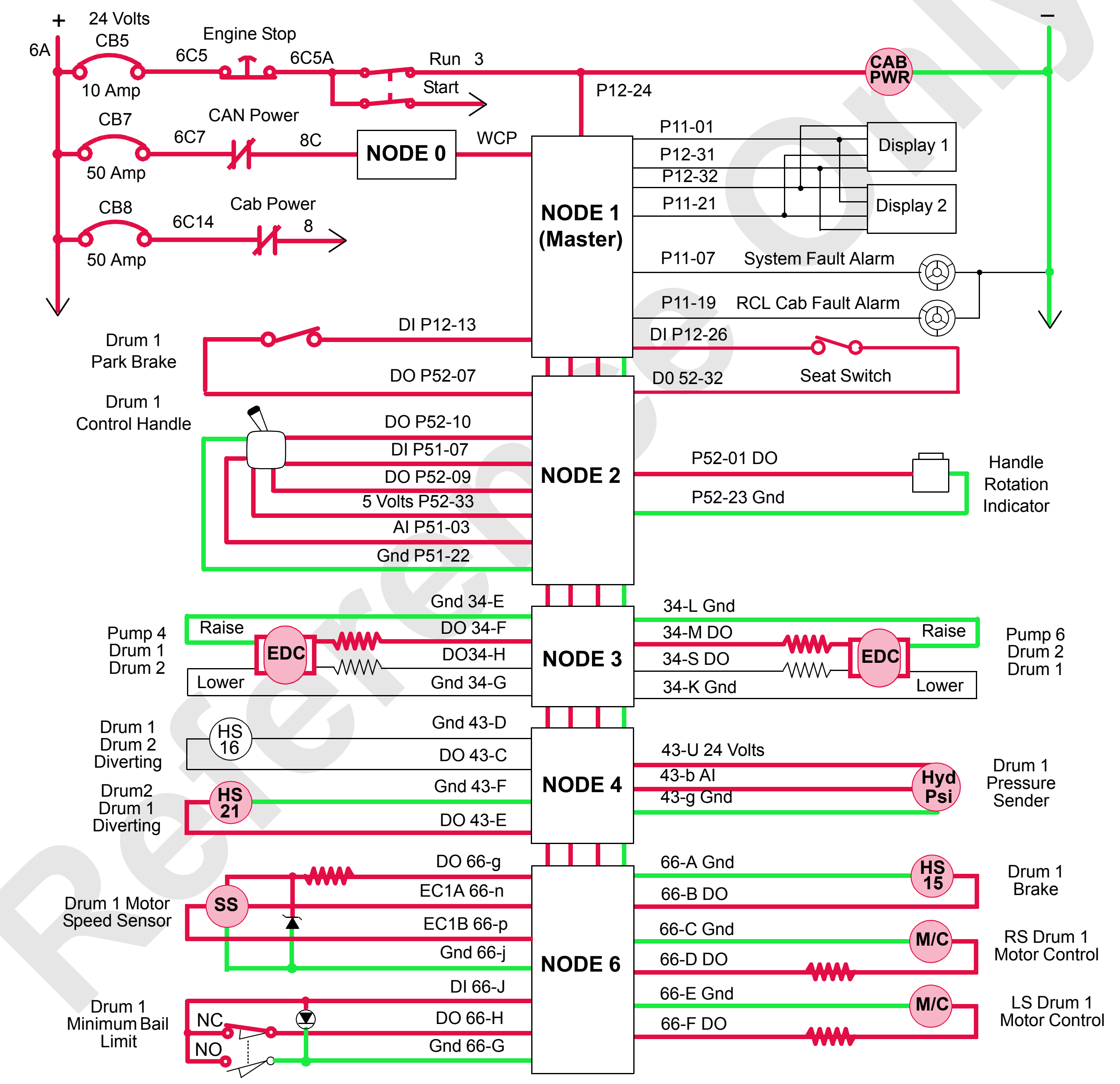


FIGURE 1-25

LOAD DRUM 2

System Components

See Figure 1-26, Figure 1-27, and Figure 1-28 for the following procedure.

Load drum 2 is located at the front top of 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). Load drum 1 pump is dedicated to operate with load drum 2 though a diverting valve. Hydraulic connections between the pump and motors form a closed-loop system that is controlled with 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 drum 2 park brake is applied.

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

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

Continuous changing of closed-loop fluid occurs with leakage in pump, motor, and external sequence/flow valve. Sequence/flow valve opens at 200 psi (14 bar) and removes 4 gallons per minute (15 l/m) of hot fluid from system by discharging exhausted fluid into motor case where the fluid returns to tank.

Load Drum 2 Brake

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

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

When drum 2 brake switch is placed in off - park position, brake release solenoid HS-20 remains applied. Brakes remain applied until 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 1-26 and Figure 1-28 for the following procedure.

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

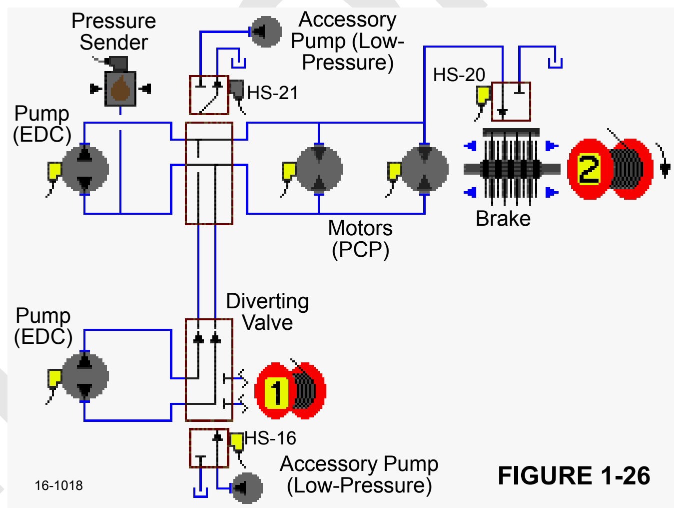


FIGURE 1-26

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

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

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

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

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

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

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

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

When brake applies, an input signal is sent to Node-1 controller. Node-3 controller sends a 0 volt output to each pump EDC to de-stroke pumps. Node-3 and 5 controllers send a 0 volt output to each motor PCP.

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

Lowering Load

See Figure 1-27 and Figure 1-28 for the following procedure.

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

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

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

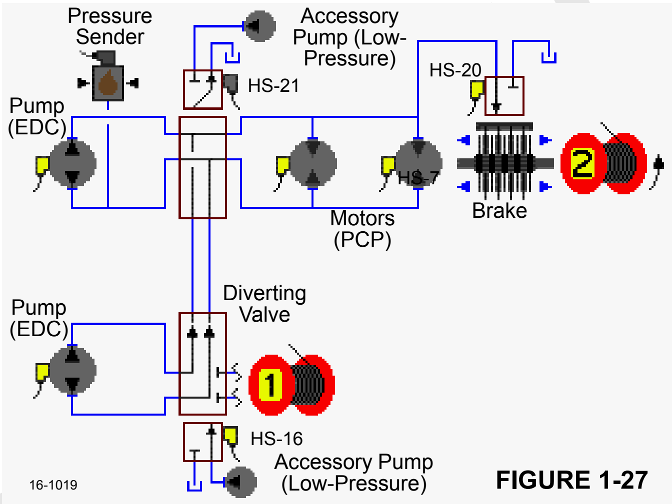


FIGURE 1-27

Node-3 controller output voltages to each pump EDC and Node-3 and 5 controllers output voltage to each motor PCP is relative to control handle movement. As 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, Node-4 controller sends a 24 volt output to disable drum 1 to drum 2 diverting solenoid HS-16. Drum 2 speed is reduced up to one half.

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

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

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

When control handle is moved to neutral position, Node-1 controller stores the load holding pressure in pressure memory. After control handle center switch opens, Node-5 controller sends a zero output to disable brake release solenoid HS-20. Drum brake valve shifts to block pilot pressure to brake and opens a line to tank. When brake applies, an input signal is sent to Node-1 controller. Node-3 controller sends a 0 volt output to each drum pump EDC to de-stroke pumps. Node-3 and 5 controllers sends a 0 volt output to each motor PCP.

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

Drum 2 Electrical Schematic

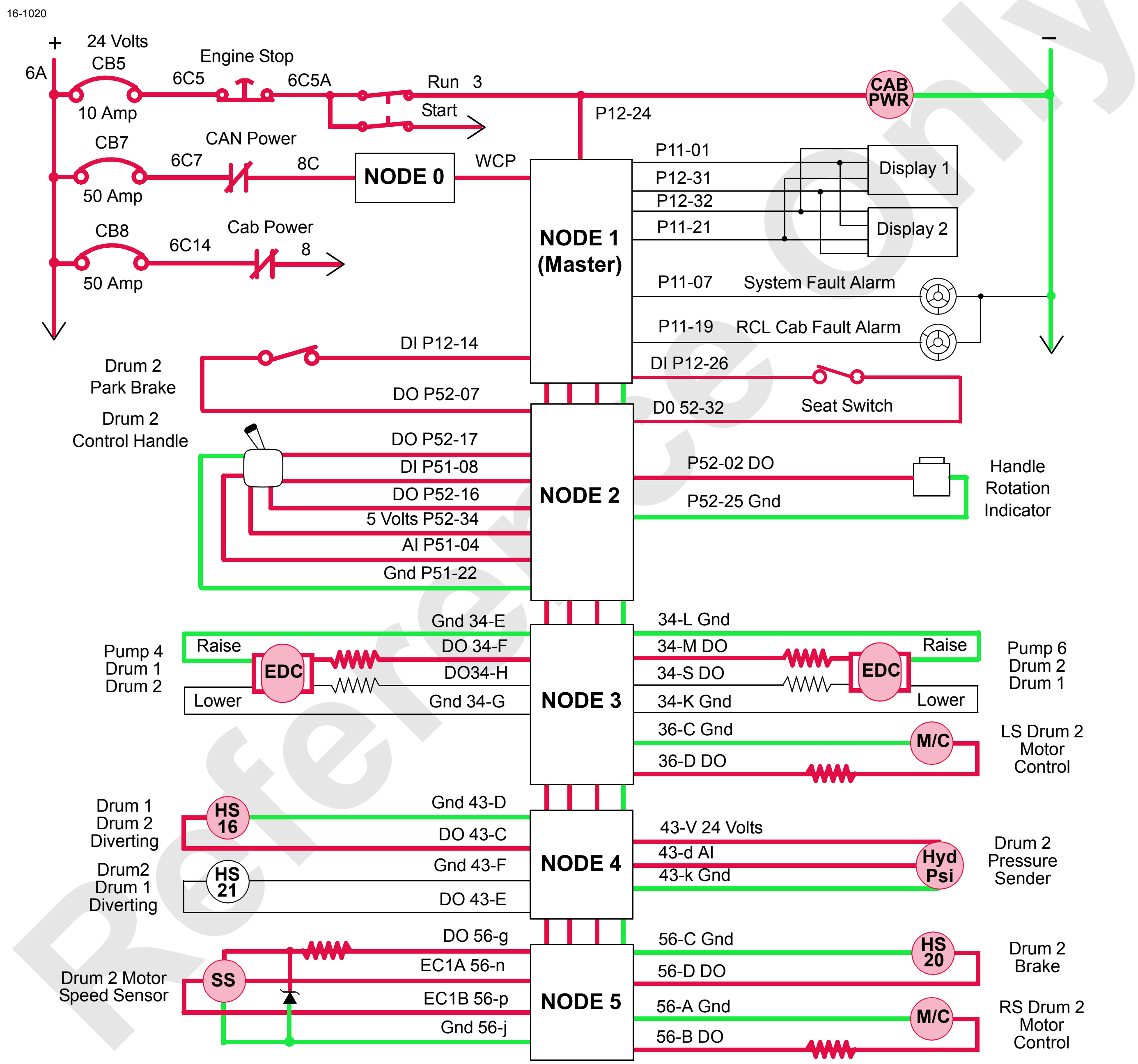


FIGURE 1-28

LOAD/LUFFING DRUM 3

System Components

See Figure 1-29, Figure 1-30, and Figure 1-31 for the following procedure.

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

One hydraulic pump drives one motor gearbox on 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 can not be operated at the same time. Hydraulic connections between the pump and motor form a closed-loop system that is controlled with control handle movement and node controllers. The far load drum control handle on the right side console operates drum 3 when configured a load drum. When configured as a luffing jib the control handle on left side console operates drum 3. The control handle is inoperable when drum 3 park brake is applied.

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

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

Continuous changing of closed-loop fluid occurs with leakage in pump, motor, and external sequence/flow valve. Sequence/flow valve opens at 200 psi (14 bar) and removes 4 gallons per minute (15 l/m) of hot fluid from system by discharging exhausted fluid into motor case where the fluid returns to tank.

Load Drum 3 Brake and Pawl

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

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

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

Raising

See Figure 1-29 and Figure 1-31 for the following procedure.

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

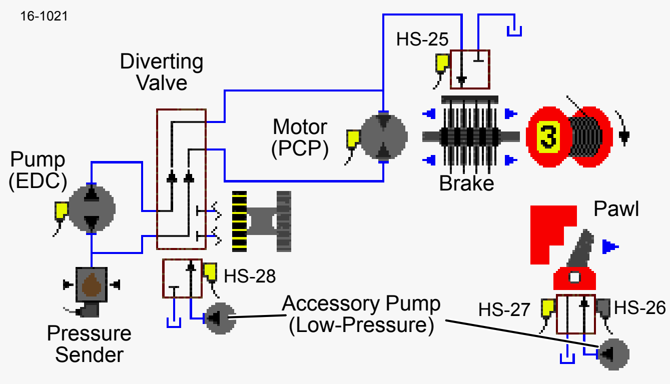


FIGURE 1-29

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

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

Node-3 controller output voltage to pump EDC and Node-6 controller output voltage to motor PCP is relative to control handle movement. As 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 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

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

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

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

When brake applies, an input signal is sent to Node-1 controller. Node-3 controller sends a 0 volt output to pump EDC to de-stroke pump. Node-6 controller sends a 0 volt output to motor PCP.

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

Lowering

See Figure 1-30 and Figure 1-31 for the following procedure.

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

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

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

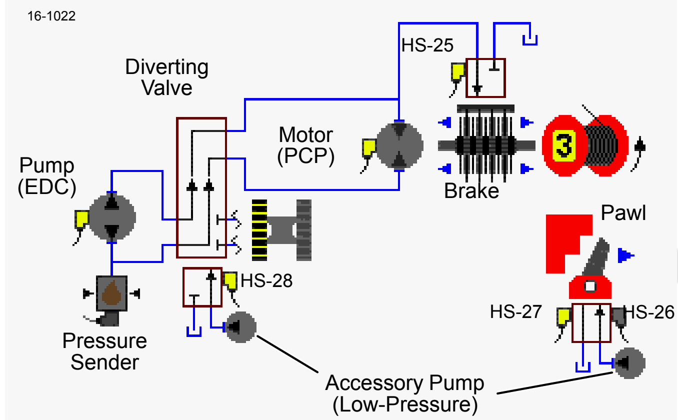


FIGURE 1-30

Node-3 controller output voltages to pump EDC and Node-6 controller output voltage to motor PCP is relative to control handle movement. As 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 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

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

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

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

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

Drum 3 Electrical Schematic

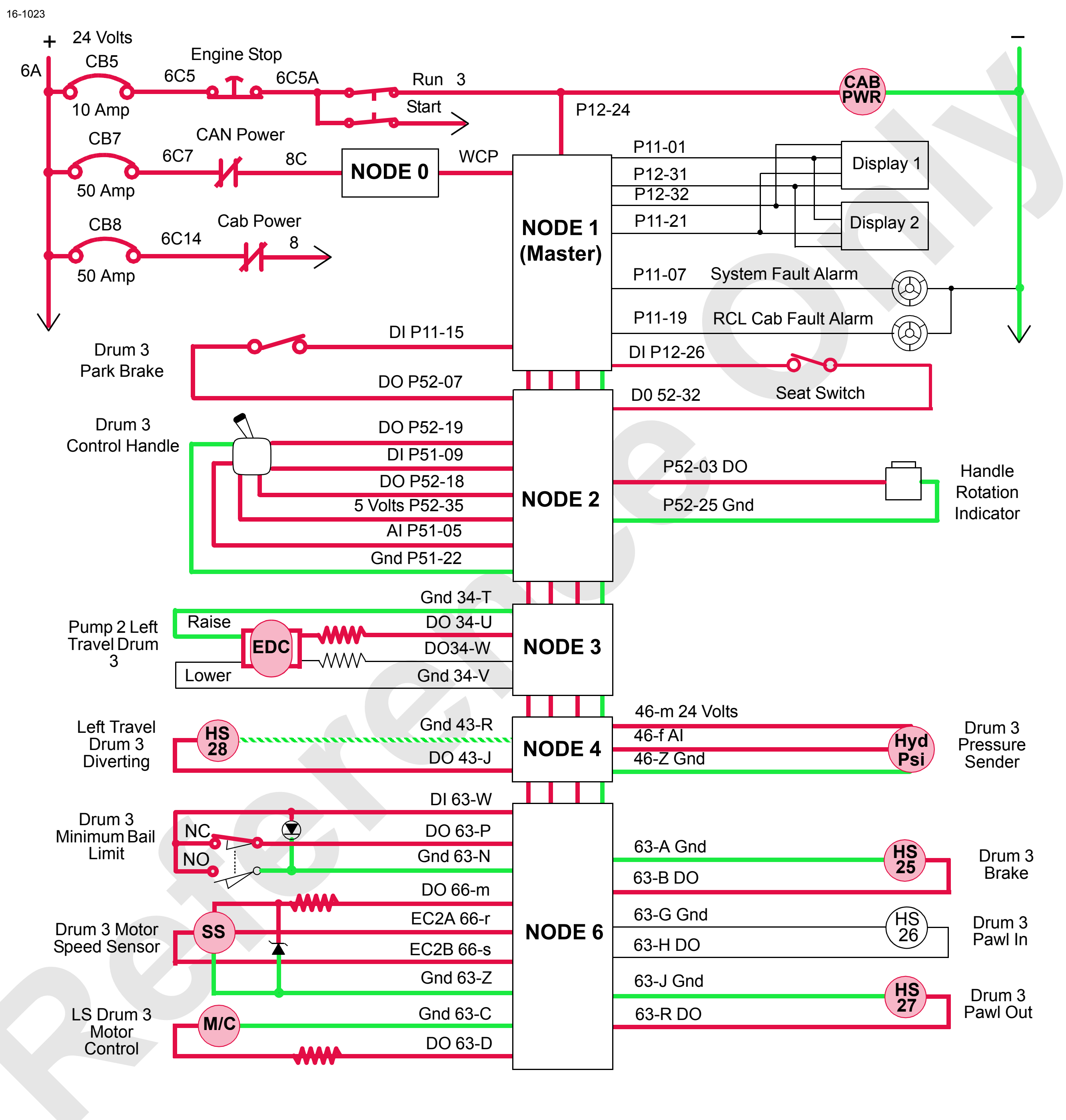


FIGURE 1-31

ACCESSORY SYSTEM COMPONENTS

Accessory Systems

Accessory system components includes rotating bed jacking cylinders, mast raising cylinders (high pressure), and 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 accessory system components. The accessory system proportional relief valve is controlled by 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 400 psi (28 bar). Excess supply flow from accessory/MAX-ER pump is dumped through valve to tank. When an accessory system component is enabled, an input signal is sent to Node-1 controller. 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 up to 3,000 psi (207 bar). The accessory systems pressure increases to operate selected component.

Jacking Cylinders

See Figure 1-32, Figure 1-33, and Figure 1-35 for the following procedure.

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

WARNING

Collapsing Hazard!

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

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

Each jacking cylinder has a counterbalance valve at the cylinder ports. Counterbalance valves ensure smooth control when raising or lowering the crane on jacks. Counterbalance valves lock the jacking cylinders in place if there is a hydraulic line breakage or accidental operation of control valve when the crane's power is shut down. Also, 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 neutral position where both valve section cylinder ports are connected to tank. This prevents in-line pressure from opening counterbalance valve, holding rotating bed load in position by the counterbalance valve.

Rotating Bed Jacking - Raise

Move jacking switch to ***extend*** position and hold (front right jack is shown in Figure 1-32). An input voltage is sent to Node-1 controller. Node-4 controller sends a 24 volt output to enable selected jacking cylinder proportional control solenoid HS-62 and shifts valve to the ***extend*** position. Node-3 controller sends a variable zero to 24 volt output to enable accessory system proportional relief solenoid HS-68.

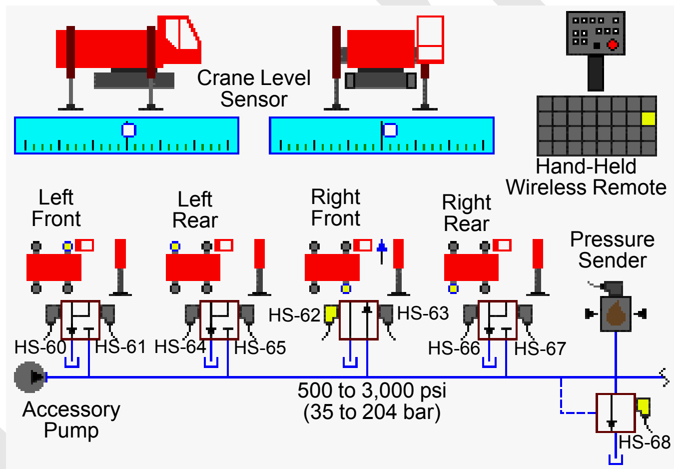


FIGURE 1-32

Hydraulic fluid pressure at approximately 3,000 psi (207 bar) flows to selected jacking cylinder(s) proportional control valve. Hydraulic fluid exits valve and enters free-flow check valve section of jacking cylinder counterbalance valve. Hydraulic fluid then enters piston end of jacking cylinder, extending cylinder to raise the rotating bed. Node-4 controller monitors accessory system pressure sender to control jacking cylinder raising speed rate.

Hydraulic fluid returning to tank from rod end of the jacking cylinder is blocked by the free-flow check valve section of counterbalance valve and flows through flow restraining section that has a relief setting of 2,500 psi (172 bar). 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 833 psi (57 bar). Restraining section of counterbalance valve opens, controlling the fluid out of the jacking cylinder. Hydraulic fluid then flows through free-flow check valve section of flow control valve before entering lower accessory valve. Hydraulic fluid leaving the accessory valve is returned to tank.

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

Rotating Bed Jacking - Lower

Move desired jacking switch to ***retract*** position and hold (front right jack is shown in Figure 1-33). An input voltage is sent to Node-1 controller. Node-4 controller sends a 24 volt output to enable selected jacking cylinder proportional control solenoid HS-63 and shifts valve to the ***retract*** position. Node-3 controller sends a variable zero to 24 volt output to enable accessory system proportional relief solenoid HS-68.

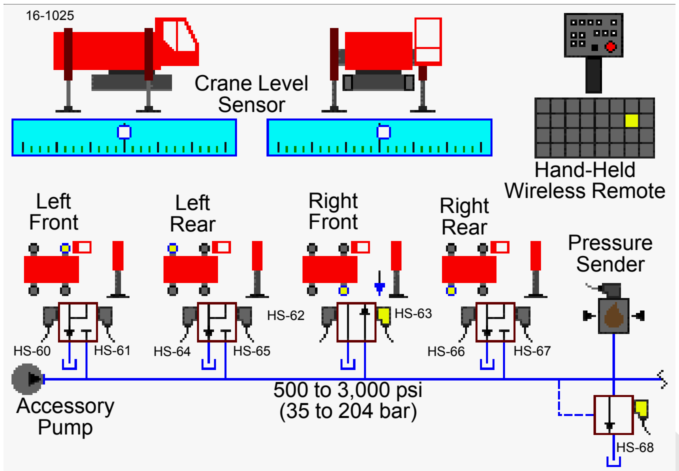


FIGURE 1-33

Hydraulic fluid pressure at approximately 3,000 psi (207 bar) flows to selected jacking cylinder(s) proportional control valve. Hydraulic fluid exits valve and enters the restraining section of 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 counterbalance valve. Hydraulic fluid then flows to rod end of jacking cylinder.

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

Hydraulic fluid returning to tank from piston end of jacking cylinder is blocked by free-flow check valve section of counterbalance valve. From counterbalance valve flow is through flow restraining section that has a relief setting of 2,500 psi (172 bar). 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 pressure in piston end of the cylinder is approximately 833 psi (57 bar).

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

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

Counterweight Pins

See Figure 1-34 and Figure 1-35 for the following procedure.

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

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

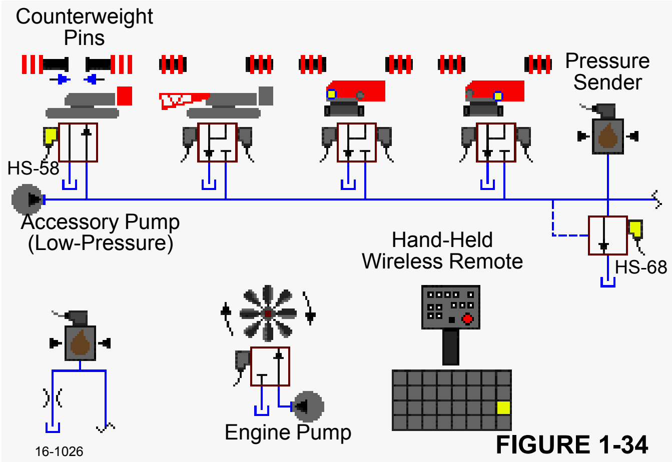


FIGURE 1-34

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

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

Accessory System Electrical Schematic

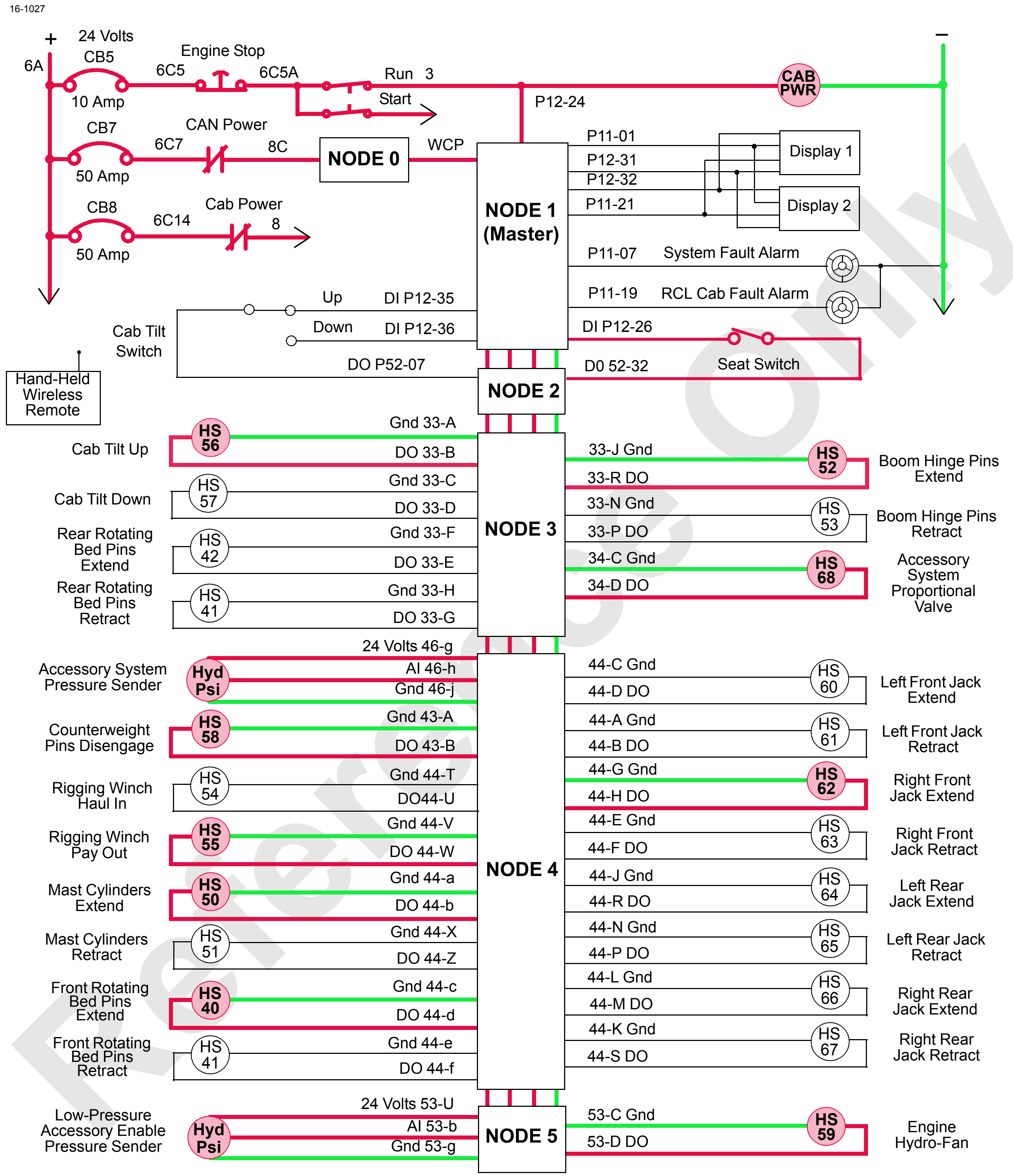


FIGURE 1-35

Boom Hinge Pins

See Figure 1-35, Figure 1-36, and Figure 1-37 for the following procedure.

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

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

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

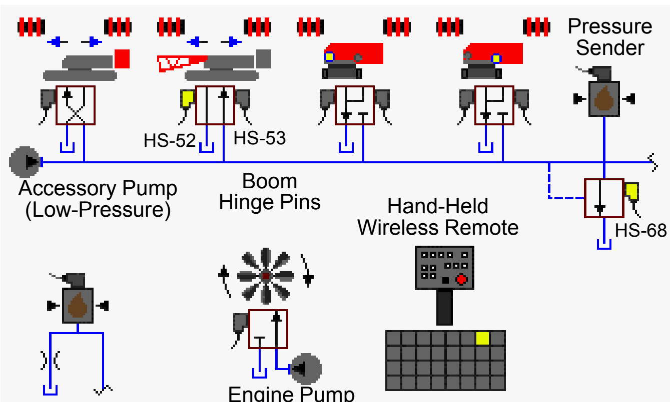


FIGURE 1-36

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to boom hinge pins accessory valve. Hydraulic fluid leaves the accessory valve and enters rod end of boom pin cylinder, retracting cylinder rod to engage the boom hinge pins. Hydraulic fluid from piston end of boom pin cylinder leaves accessory system valve and returns to tank. When boom hinge pins switch is released, valve returns to center position. Node-3 controller sends a variable zero to 24 volt output to disable accessory system proportional relief solenoid HS-68.

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

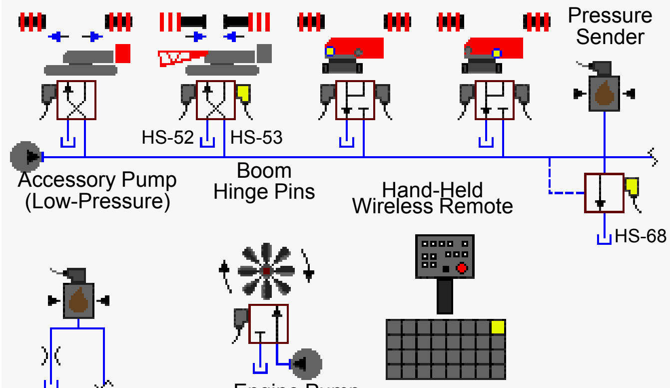


FIGURE 1-37

Hydraulic fluid pressure at approximately 3,000 psi (207 bar) flows to boom hinge pins accessory valve. Hydraulic fluid leaves the accessory valve and enters piston end of boom pin cylinder, extending cylinder rod to disengage the boom hinge pins. Hydraulic fluid from rod end of boom pin cylinder leaves accessory system valve and returns to tank. When boom hinge pins switch is released, valve returns to center position.

Front or Rear Rotating Bed Pins

See Figure 1-35, Figure 1-38, and Figure 1-39 for the following procedure.

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

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

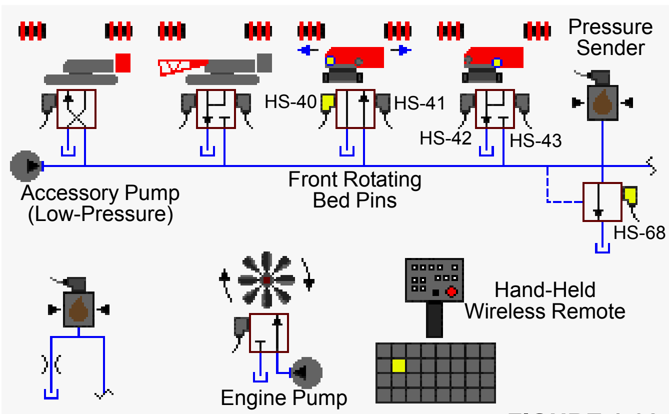


FIGURE 1-38

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

Hydraulic fluid pressure at approximately 3,000 psi (207 bar) flows to rotating bed pins accessory valve. Hydraulic fluid leaves the accessory valve and enters piston end of selected pin cylinders, extending cylinder rod to engage the rotating bed pins. Hydraulic fluid from rod end of pin cylinders leaves accessory system valve and returns to tank. When rotating bed pins switch is released, valve returns to center position.

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

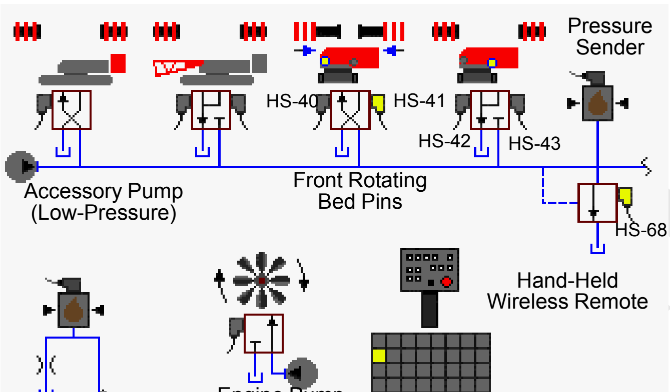


FIGURE 1-39

Hydraulic fluid pressure at approximately 3,000 psi (207 bar) flows to rotating bed pins accessory valve. Hydraulic fluid leaves the accessory valve and enters rod end of pin cylinders, retracting cylinder rods to disengage the rotating bed pins. Hydraulic fluid from piston end of pin cylinders leaves accessory system valve and returns to tank. When rotating bed pins switch is released, solenoid HS-41 (front) or HS-43 (rear) returns to center position. Node-3 controller sends a variable zero to 24 volt output to disable accessory system proportional relief solenoid HS-68.

Rigging Winch (Drum 0)

See Figure 1-35, Figure 1-40, and Figure 1-41 for following procedure.

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 tank port of valve spool section are connected in center position. When an accessory valve spool shifts, supply flow to the other accessory valves is limited. The accessory system pressure sender monitors accessory system pressure.

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

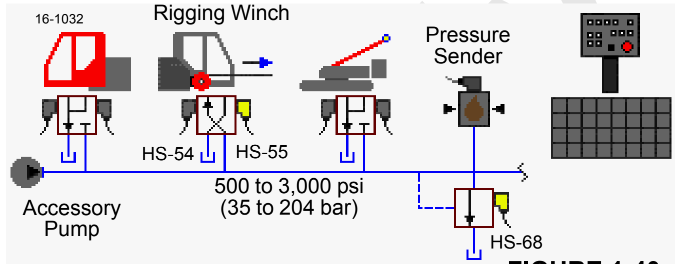


FIGURE 1-40

When selected rigging winch control handle is moved forward in ***pay out*** position, Node-4 controller sends a 24 volt output to enable rigging winch pay out solenoid HS-55 and shifts valve to the ***pay out*** position. Node-3 controller sends a variable zero to 24 volt output to enable 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 accessory system pressure.

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

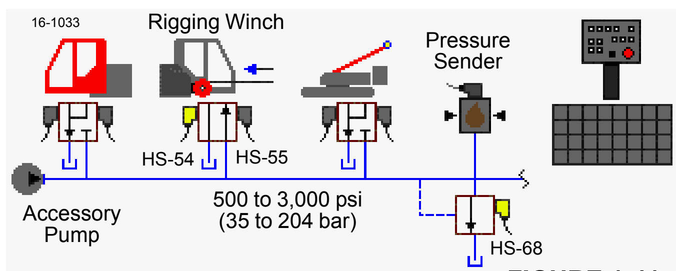


FIGURE 1-41

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

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

Cab Tilt

See Figure 1-35, Figure 1-42, and Figure 1-43 for the following procedure.

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

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

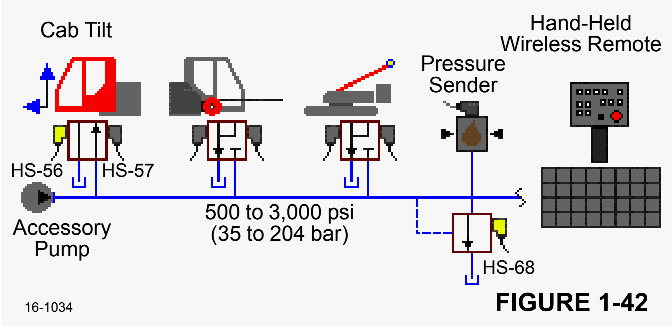


FIGURE 1-42

Hydraulic fluid pressure at approximately 3,000 psi (207 bar) flows to cab tilt accessory valve. Hydraulic fluid exits valve and enters free-flow check valve before entering piston end of cylinder, extending cylinder rod to raise the cab front.

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

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

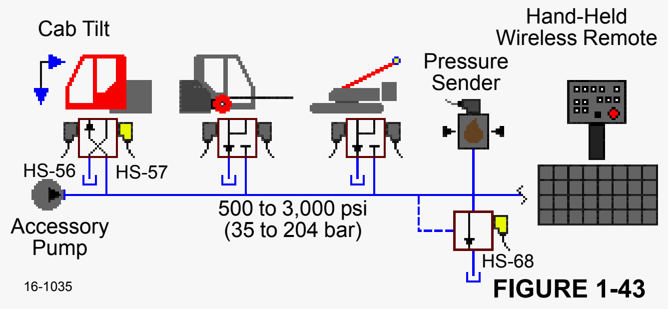


FIGURE 1-43

Hydraulic fluid pressure at approximately 3,000 psi (207 bar) flows to cab tilt accessory valve. Hydraulic fluid exits valve and enters free-flow check valve before entering rod end of cylinder, retracting cylinder rod to lower the cab front.

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

Crawler Pin Cylinders

See Figure 1-44 for the following procedure.

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

When a crawler pin handle is moved down to ***engage*** crawler pins into crawler track frame, the valve shifts to allow system pressure to pin cylinders. The lower accessory enable pressure transducer senses a pressure drop and sends an input signal to Node-1 controller. 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 3,000 psi (207 bar). The system pressure increases to operate selected crawler pin handle. Node-1 controller monitors system pressure.

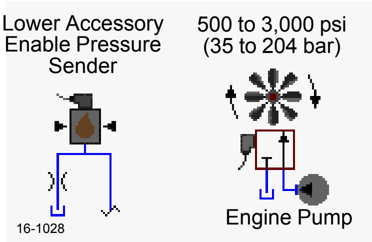


FIGURE 1-44

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

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

When a crawler pin handle is moved up to ***disengage*** crawler pins from crawler track frame, the valve shifts to allow system pressure to pin cylinders. The lower accessory enable pressure sender senses a pressure drop and sends an input signal to Node-1 controller. 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 3,000 psi (207 bar). The system pressure increases to operate selected crawler pin handle. Node-1 controller monitors system pressure.

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

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

Carbody Jacking Cylinders (optional)

See Figure 1-45 for the following procedure.

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

WARNING

Collapsing Hazard!

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

Each carbody jack cylinder has a counterbalance valve at the cylinder ports. Counterbalance valves ensure smooth control when raising or lowering the crane. Counterbalance valves lock the carbody jacking cylinders in place if there is a hydraulic line breakage or accidental operation of control valve when the crane's power is shut down. Also, 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 carbody jacking cylinder is blocked. In neutral, both valve section cylinder ports are connected to tank. This prevents in-line pressure from opening counterbalance valve, holding 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 jack cylinder. The lower accessory enable pressure transducer senses a pressure drop and sends an input signal to Node-1 controller. 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 3,000 psi (207 bar). The system pressure increases to operate selected jack handle. Node-1 controller monitors system pressure.

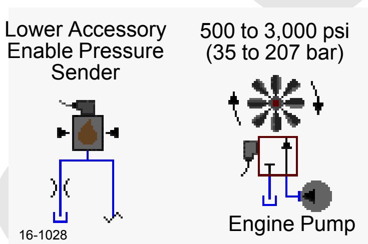


FIGURE 1-45

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

When handle is moved back to center position, the selected valve shifts to center position and closes system pressure to cylinders. Node-3 controller sends a zero volt output to disable 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 jack cylinder. The lower accessory enable pressure sender senses a pressure drop and sends an input signal to Node-1 controller. 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 3,000 psi (207 bar). The system pressure increases to operate selected jack handle. Node-1 controller monitors system pressure.

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

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

Live Mast

See Figure 1-46 through Figure 1-49 for the following procedure.

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. Mast raising and lowering rate is controlled by engine speed, as it regulates pay out and haul in of the cable reeving between boom/mast hoist sheaves and mast sheaves.

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

Mast Raising/Lowering with Mast Switch

See Figure 1-46 and Figure 1-49 for the following procedure.

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

When not enabled, mast raising cylinders are ***motor spooled*** where both cylinder ports and tank port of valve spool section are connected in center position. This type of spool prevents premature opening of equalizing valves. Load equalizing valves ensures mast-raising cylinders operate in unison, protecting mast from structural damage caused by twisting. Load equalizing valves also provides support resistance against mast to ensure 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 accessory system pressure.

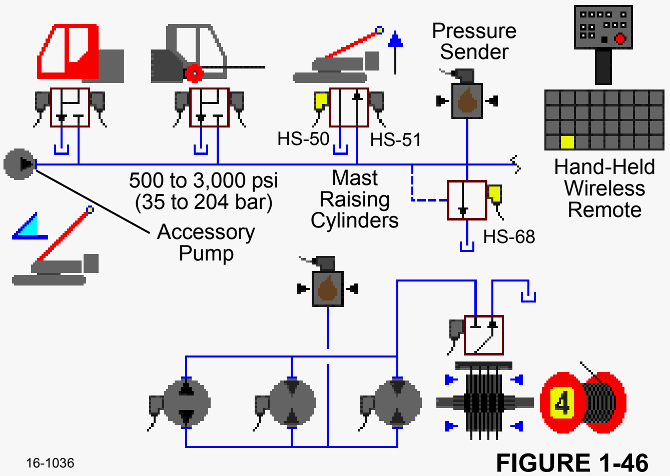


FIGURE 1-46

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

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

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

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

Mast Raising from Transport Position

See Figure 1-47 and Figure 1-49 for the following procedure.

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

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

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

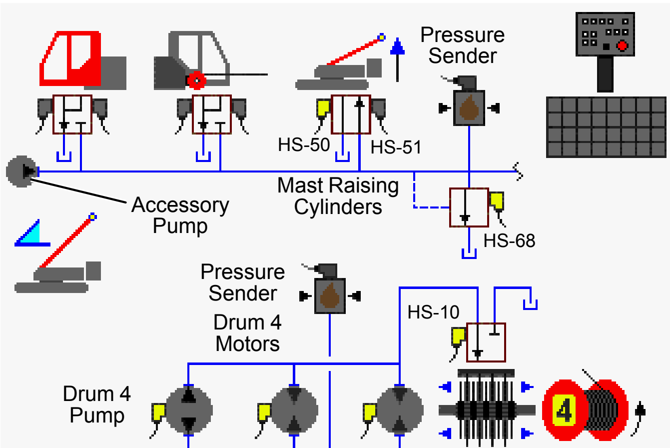


FIGURE 1-47

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

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

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

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

Fluid flow from rod end of mast raising cylinders is blocked by free-flow check valve sections on side ***B*** of counterbalance valves and flows through valve flow restrain sections preset for a relief pressure of 3,480 psi (240 bar). Counterbalance valves operate with a 5:1 pilot ratio of the relief valve pressure, permitting valve to open when pressure in rod end of the cylinders is approximately 700 psi (48 bar). Hydraulic fluid from side ***B*** sections of both 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 4,000 psi (276 bar). Load equalizing valve operates with a 1.5:1 pilot ratio of the relief valve pressure, permitting valve to open when the hydraulic pressure on side ***A*** of the load-equalizing valve is approximately 2,680 psi (185 bar). Restraining section on side ***B*** of load equalizing valve opens, controlling flow of fluid out of the cylinders to ensure cylinder operation is balanced.

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

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

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

Mast Lowering to Transport Position

See Figure 1-48 and Figure 1-49 for the following procedure.

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

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

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

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

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

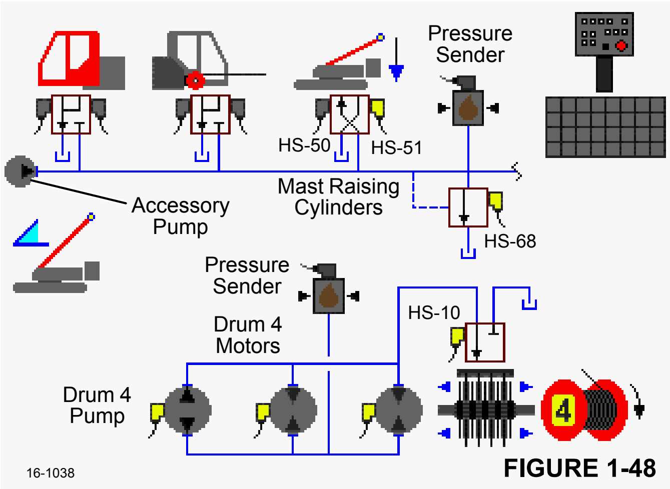


FIGURE 1-48

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

Fluid flow from piston end of mast raising cylinders is blocked by free-flow check valve sections on side ***A*** of counterbalance valves and flows through valve flow restrain sections preset for a relief pressure of 3,480 psi (240 bar). Counterbalance valves operate with a 5:1 pilot ratio of the relief valve pressure, permitting valve to open when pressure in piston end of cylinders is approximately 700 psi (48 bar).

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 4,000 psi (276 bar). Load equalizing valve operates with a 1.5:1 pilot ratio of the relief valve pressure, permitting valve to open when the hydraulic pressure on side ***A*** of the load-equalizing valve is approximately 2,680 (185 bar). Restraining section on side ***B*** of load equalizing valve opens, controlling flow of fluid out of the cylinders to ensure cylinder operation is balanced.

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

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

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

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

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

Live Mast Electrical Schematic

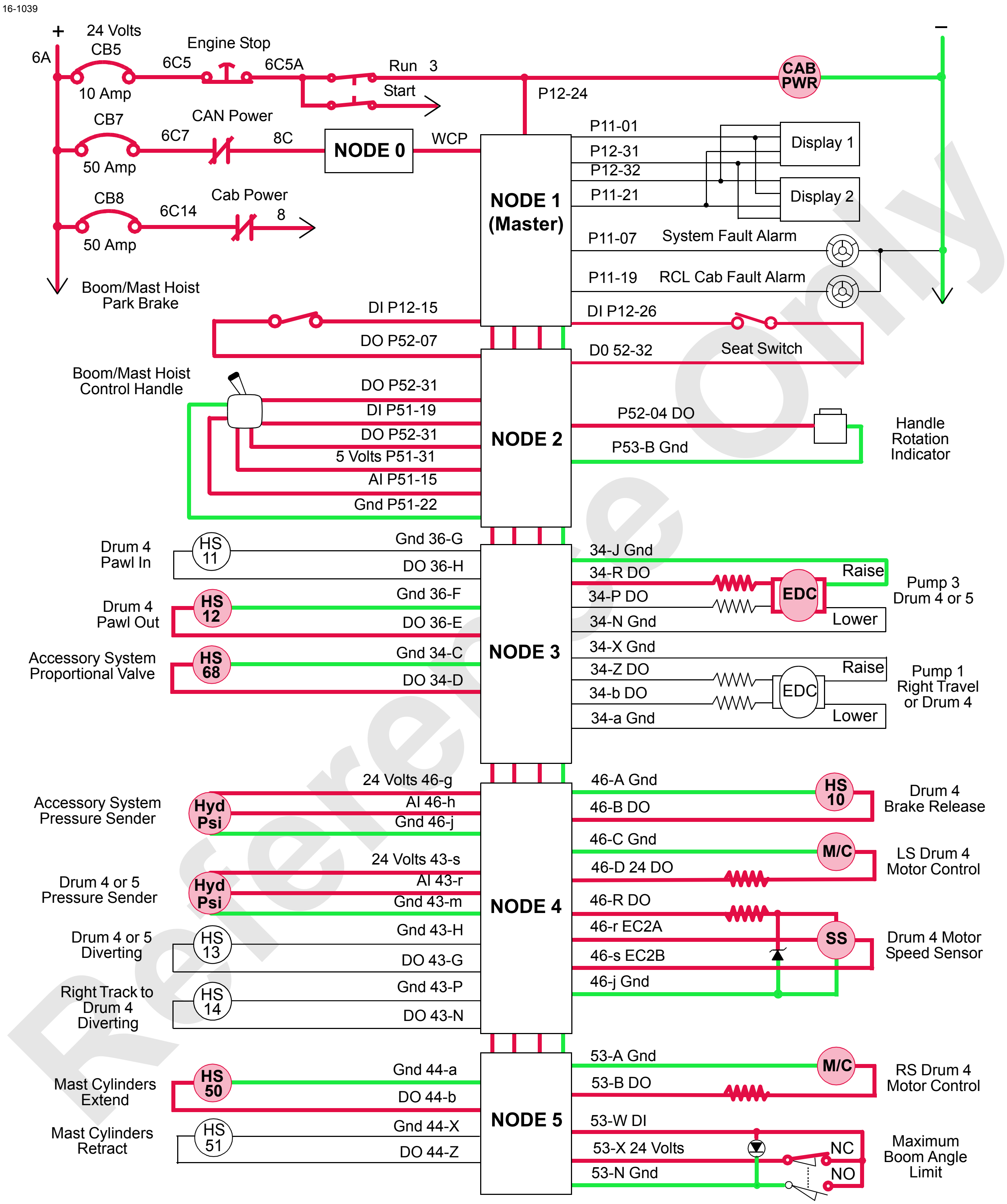


FIGURE 1-49

Hydraulic Cooling Fan

Past Production s/n 16001141 and older

See Figure 1-50 for the following procedure.

The hydraulic cooling fan is fluid driven from the fixed displacement gear pump mounted on the front of the engine. The crane controller turns the fan on or off by the normally closed solenoid operated relief valve set at 3,000 psi (207 bar). When the engine coolant temperature falls to 65°F (18°C) or if the engine RPM falls below 800, Node-1 disables the cooling fan by sending a 24 volt signal through Node-5 to solenoid HS-59. The electric signal causes the relief valve to vent to tank. The 24 volt signal is removed when the engine coolant temperature rises to 70°F (21°C) and if the engine RPM is above 800.

Past Production Cooling Fan Diagnostic Screen:

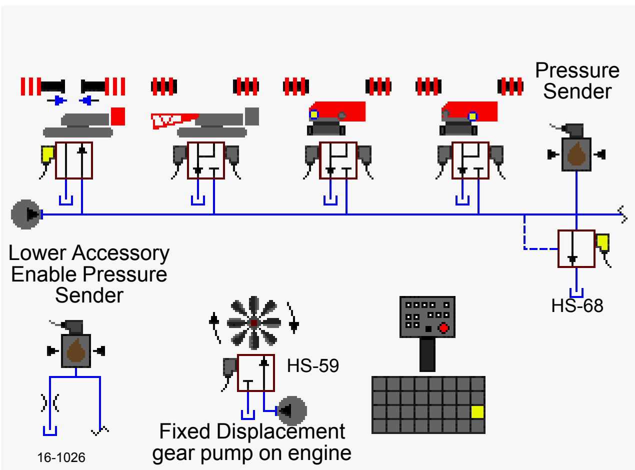


FIGURE 1-50

Current Production s/n 16001142 and newer.

See Figure 1-51 for the following procedure.

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. Node-1 will send a 24-volt signal through 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 3,000 psi (207 bar) pressure relief valve regulates the lower accessory system circuit pressure.

Tier 4 Equipped Machines

Machines equipped with a Tier 4 engine will have a variable speed cooling fan. The uni-directional, variable displacement accessory system pump will control 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 3,000 psi (207 bar) relief valve.

As 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 crane operator or a service technician.

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 only.

A variable-speed fan provides several benefits including quieter operation, higher efficiency and longer fan life. This type 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.

Current Production Cooling Fan Diagnostic Screen:

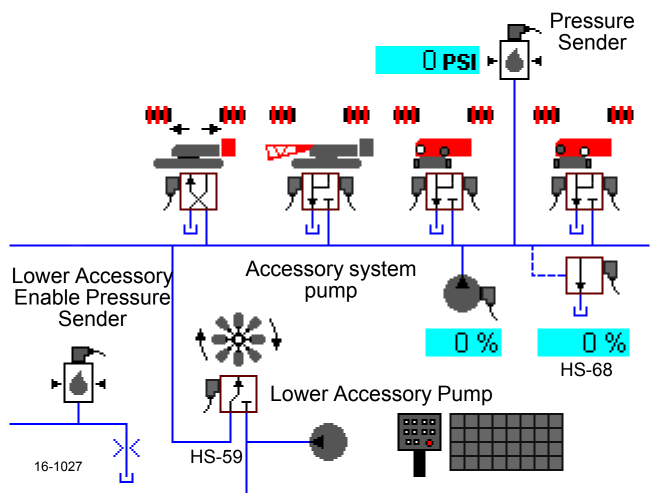


FIGURE 1-51

MAX-ER 16000 DESCRIPTION OF OPERATION

See MAX-ER Operator Manual for complete instructions.

MAX-ER Components

See Hydraulic Schematic in Section 2 of Service Manual.

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 (see Figure 1-52):

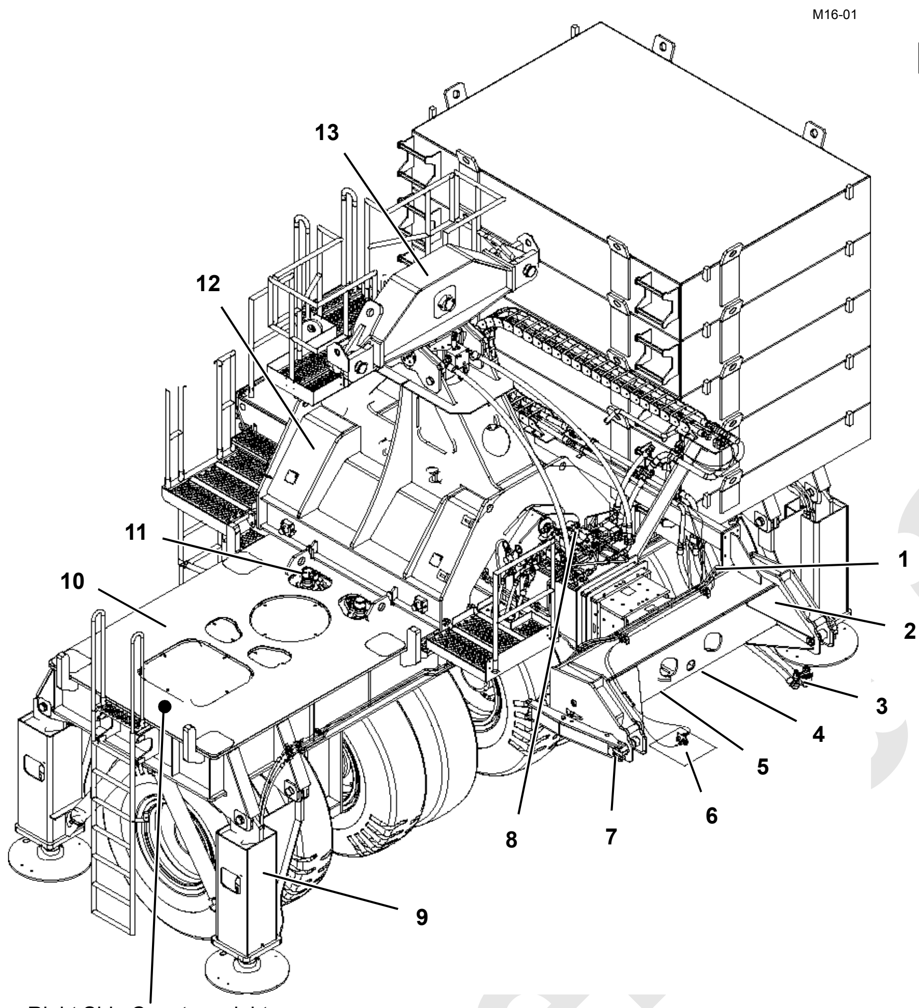
- **Wheeled Counterweight Assembly -** suspended from a fixed mast by straps and a hydraulic lift cylinder fastened to counterweight base. The wheeled counterweight assembly is connected to the rear of the crane by a telescopic beam which has three operating positions.
- **Counterweight Lifting Cylinder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

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 1-1 Hydraulic 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

FIGURE 1-52

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 proportional relief solenoid HS-68 to provide up to 5,000 psi (345 bar) system pressure when required.

A pressure control pilot relief valve keeps the MAX-ER system pressure at 400 psi (28 bar) when inactive.

Wheeled Counterweight Valves

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

1. Telescopic beam hinge pin in/out is a three position spool valve with open center mounted on a manifold (1, Figure 1-52) at rear of telescopic beam.
2. The jack cylinders (four valves) and wheel assembly (two valve) are three position spool valve with open center mounted (4) on a six bank manifold at front and center of counterweight base.
3. The right and left wheel assembly brake valves are two position spool valves with open center mounted on a manifold (5) at front and center of counterweight base.
4. The counterweight lift cylinder (two valves) and telescopic beam (one valve) are three position spool valve with open center mounted on a manifold (8) at platform, near 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 Node-1 (master) controller by sending information data packets over a two-wire buss 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. MAX-ER data is shown on information screen in operator's cab (see Main Display in Section 3 of MAX-ER Operator Manual).

MAX-ER Wireless Remote Controls

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

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

Electrical System

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

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Jacking Cylinders

See Figure 1-53 and Figure 1-54 in the flowing procedure.

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

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

DANGER

Tipping Hazard!

Wheeled counterweight assembly can tip:

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

Each jacking cylinder has an end of travel sensor that stops jacking cylinder travel at a preset position and sends an input voltage signal to 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.

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

Power is available to hand-held wireless remote control when, engine is running, MAX-ER function mode is selected, and power button is pressed. Jacking cylinders can not be extended/retracted until electrical cables and hydraulic lines are connected between rear of crane and telescopic beam of 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 jacking cylinders ***down***. Moving the left travel handle ***back*** enables all jacking cylinders ***up***. The left travel jacking cylinder extend/retract is similar to the hand-held wireless remote control operation described next.

Jack Cylinder(s) Extend

When selected jack or jack all switch is moved and held in ***extend*** position, an input signal from wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to 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.

Node-3 controller also sends a variable zero to 24 voltage to enable proportional relief solenoid HS-68 to provide approximately 4,500 psi (310 bar) pressure to jack system.

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

Hydraulic fluid from rod end of jack cylinder is blocked by free-flow check valve section of counterbalance valve and flow restraining section of relief valve preset for a relief setting of approximately 2,000 psi (138 bar). Rod end cylinder pressure opens restraining section of counterbalance valve, allowing fluid to exit valve. Return hydraulic fluid passes through six bank manifold valve before returning to crane hydraulic tank through a return line.

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

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

Node-3 sends a variable voltage output to accessory system proportional relief solenoid HS-68 to provide approximately 400 psi (28 bar) system pressure.

Jack Cylinder(s) Retract

When selected jack or all switch is moved and held in ***retract*** position, an input signal from wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to 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.

Node-3 controller also sends a variable zero to 24 voltage to enable proportional relief solenoid HS-68 to provide approximately 4,500 psi (310 bar) pressure to jack system.

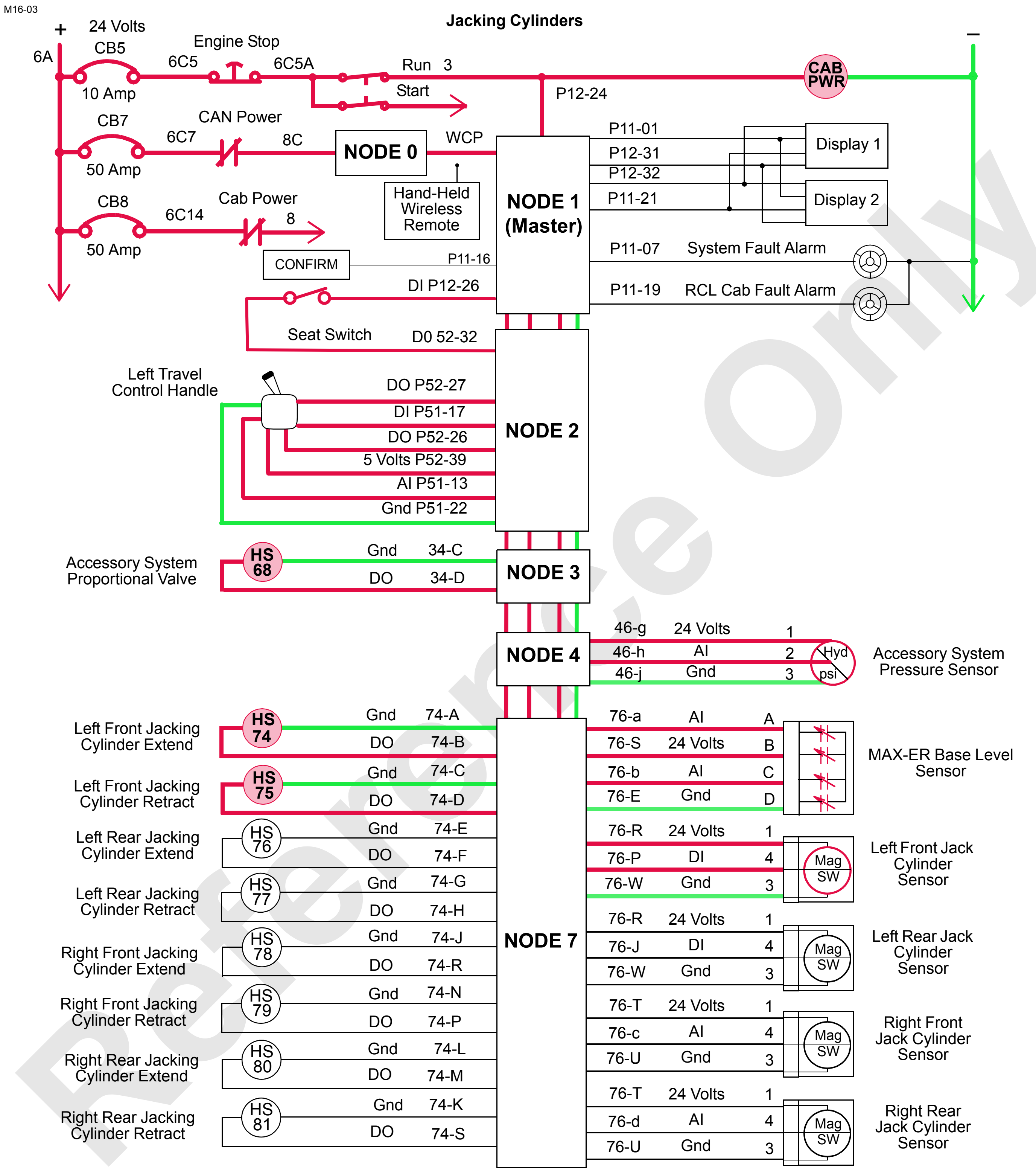


FIGURE 1-53

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

Hydraulic fluid from piston end of jack cylinder is blocked by free-flow check valve section of counterbalance valve and flow restraining section of relief valve preset for a relief setting of approximately 2,000 psi (138 bar). Piston end cylinder pressure opens restraining section of counterbalance valve, allowing fluid to exit valve. Return hydraulic fluid passes through six bank manifold valve before returning to crane hydraulic tank through return line.

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

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

Node-3 sends a variable voltage output to accessory system proportional relief solenoid HS-68 to provide approximately 400 psi (28 bar) system pressure.

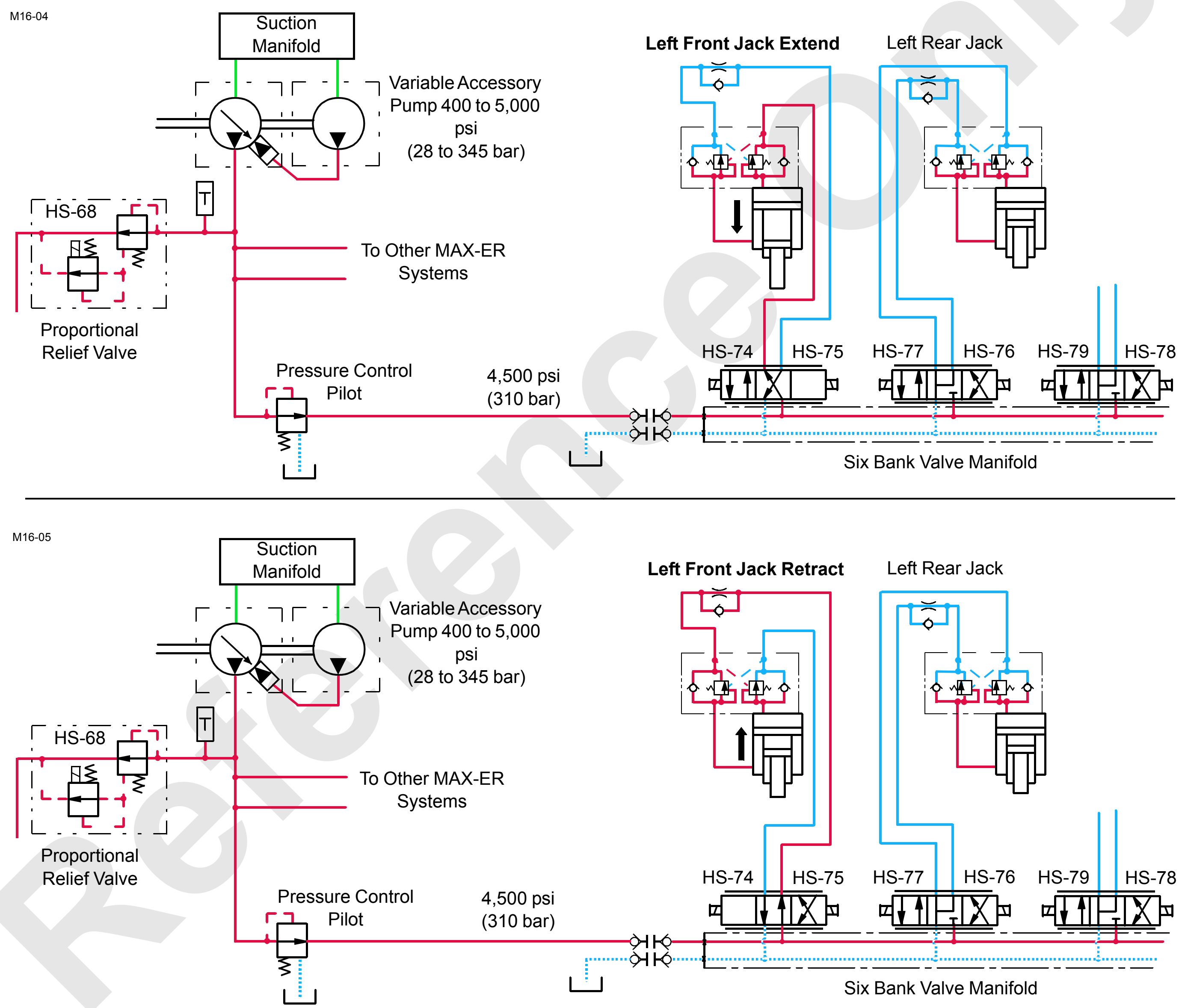


FIGURE 1-54

Telescopic Beam Cylinder

See Figure 1-55 and Figure 1-56 in the following procedure.

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

The telescopic beam has a counterbalance valve at each cylinder port to provide smooth operation when operating. Counterbalance valves lock 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 tank port of valve spool section are connected in center position.

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

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

Telescopic Beam Cylinder Extend

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

Node-3 controller also sends a variable zero to 24 voltage to enable proportional relief solenoid HS-68 to provide approximately 4,500 psi (310 bar) pressure to telescopic beam system.

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

Hydraulic fluid from rod end of beam cylinder is blocked by free-flow check valve section of counterbalance valve and flow restraining section of relief valve preset for a relief setting of 2,200 psi (152 bar). Rod end cylinder pressure opens restraining section of counterbalance valve, allowing fluid to exit valve. Return hydraulic fluid passes through three bank manifold valve before returning to crane hydraulic tank through return line.

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

Node-3 sends a variable voltage output to accessory system proportional relief solenoid HS-68 to provide approximately 3,000 psi (207 bar) system pressure.

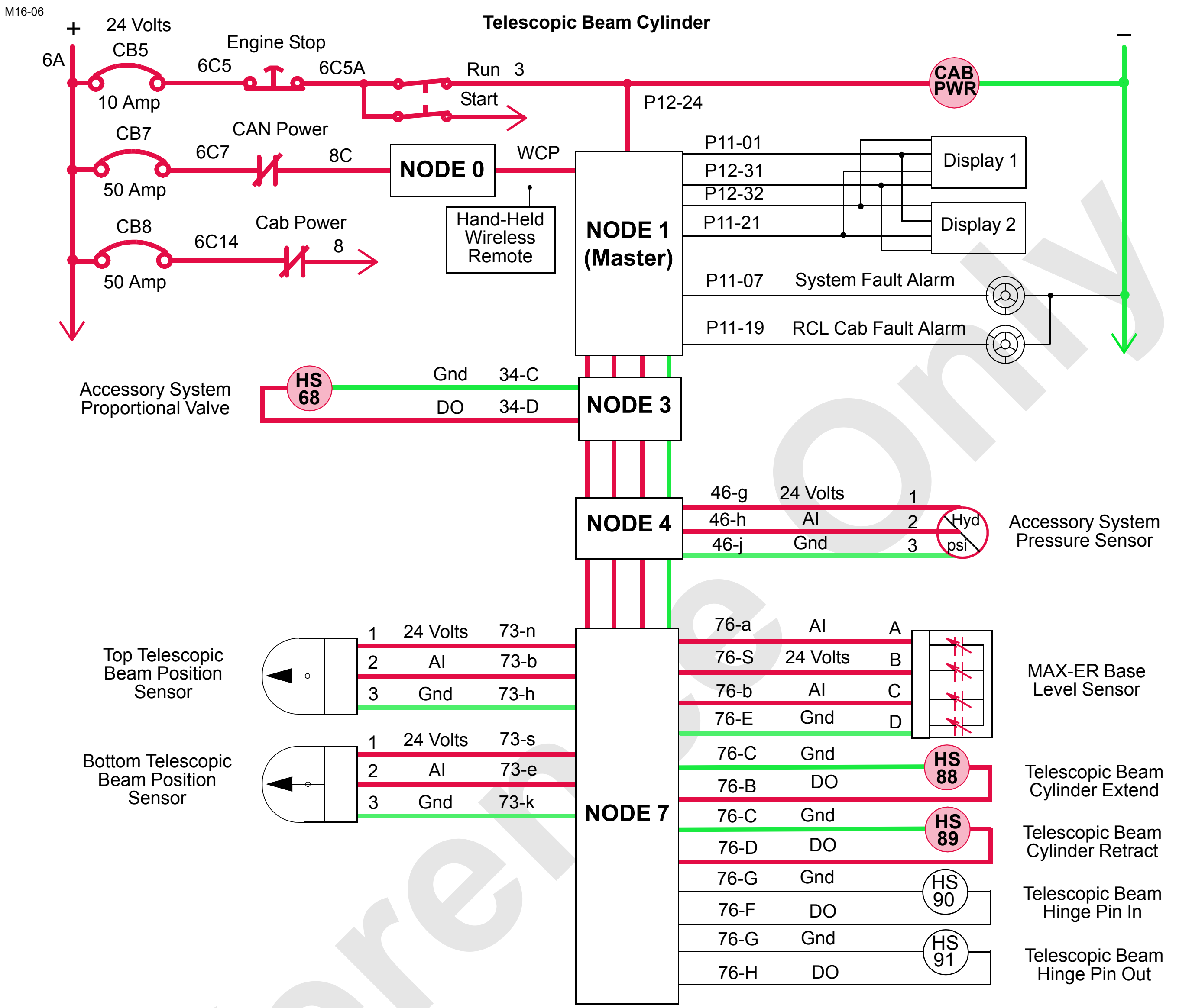


FIGURE 1-55

Telescopic Beam Cylinder Retract

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

Node-3 controller also sends a variable zero to 24 voltage to enable proportional relief solenoid HS-68 to provide approximately 4,500 psi (310 bar) pressure to telescopic beam system.

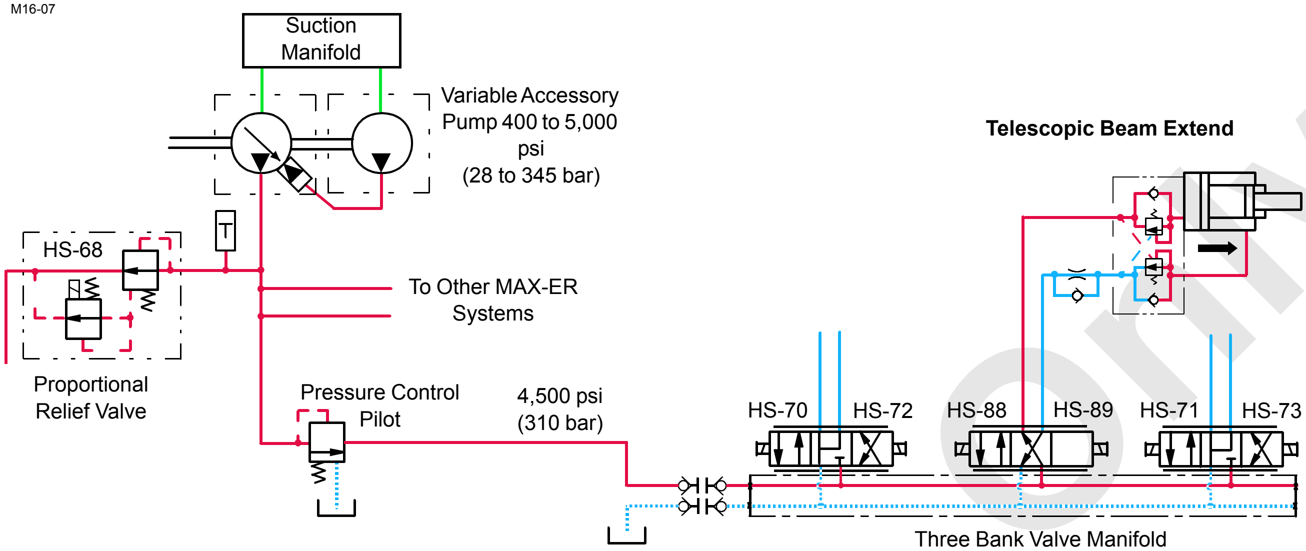
Hydraulic pressure from accessory pump flows through pressure control pilot valve, three bank manifold valve, and enters free-flow check valve section of counterbalance valve. Fluid pressure on rod end of beam cylinder retracts the beam to the desired length.

Hydraulic fluid from piston end of beam cylinder is blocked by free-flow check valve section of counterbalance valve and flow restraining section of relief valve preset for a relief setting of 2,200 psi (152 bar). Piston end cylinder pressure opens restraining section of counterbalance valve, allowing fluid to exit valve. Return hydraulic fluid passes through three bank manifold valve before returning to crane hydraulic tank through return line.

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

Node-3 sends a variable voltage output to accessory system proportional relief solenoid HS-68 to provide approximately 3,000 psi (207 bar) system pressure.

M16-07



M16-08

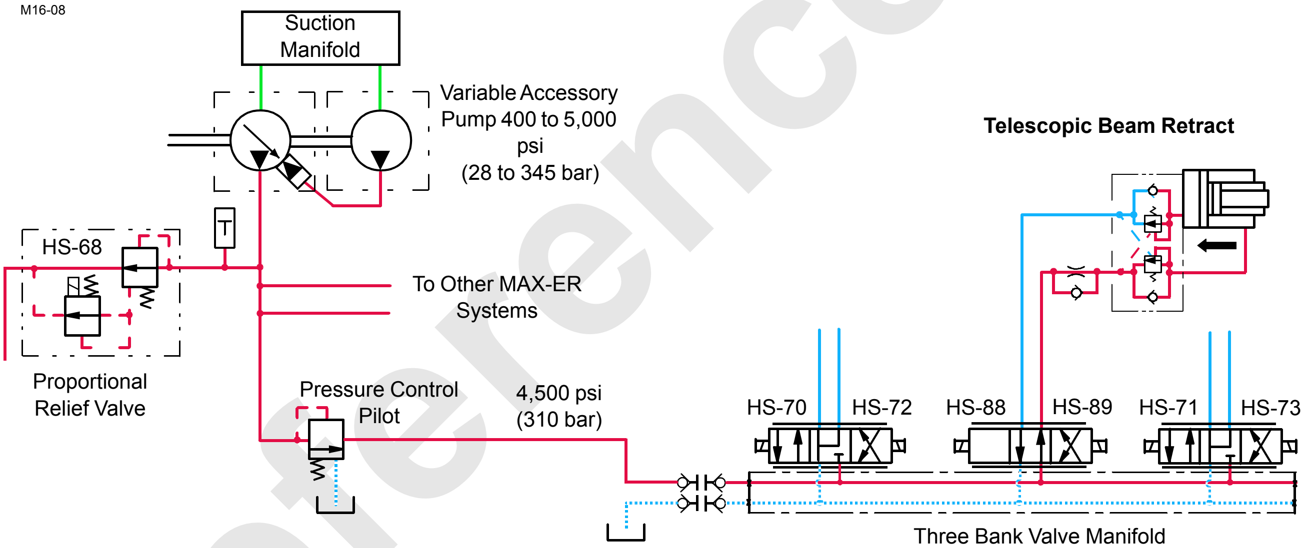


FIGURE 1-56

Counterweight Lift Cylinder

See Figure 1-57 and Figure 1-58 in the following procedure.

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 mast straps are pinned to lift cylinder spreader, do not manually retract counterweight lift cylinder. Mast can be pulled over backwards. Lift cylinder automatically adjust when MAX-ER is operating.

Tipping Hazard!

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

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 wheeled counterweight assembly in response to changes in mast load sensing pin tension (see MAX-ER Operator Manual).

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

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

Counterweight Lift Cylinder Switch

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

The counterweight lift cylinder has a counterbalance valve at each cylinder port to provide smooth operation when operating. Counterbalance valves lock 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 tank port of valve spool section are connected in center position.

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

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

Counterweight Lift Cylinder Extend

When counterweight lift cylinder switch is moved and held in ***extend*** position, an input signal from wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to 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 ***extend*** position.

Node-3 controller also sends a variable zero to 24 voltage to enable proportional relief solenoid HS-68 to provide approximately 4,500 psi (310 bar) pressure to counterweight lift cylinder system.

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

Hydraulic fluid from rod end of cylinder is blocked by free-flow check valve section of counterbalance valve and flow restraining section of relief valve preset for a relief setting of 2,200 psi (152 bar). Rod end cylinder pressure opens restraining section of counterbalance valve, allowing fluid to exit valve. Return hydraulic fluid passes through three bank manifold valve before returning to crane hydraulic tank through return line.

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

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

Node-3 sends a variable voltage output to accessory system proportional relief solenoid HS-68 to provide approximately 3,000 psi (207 bar) system pressure.

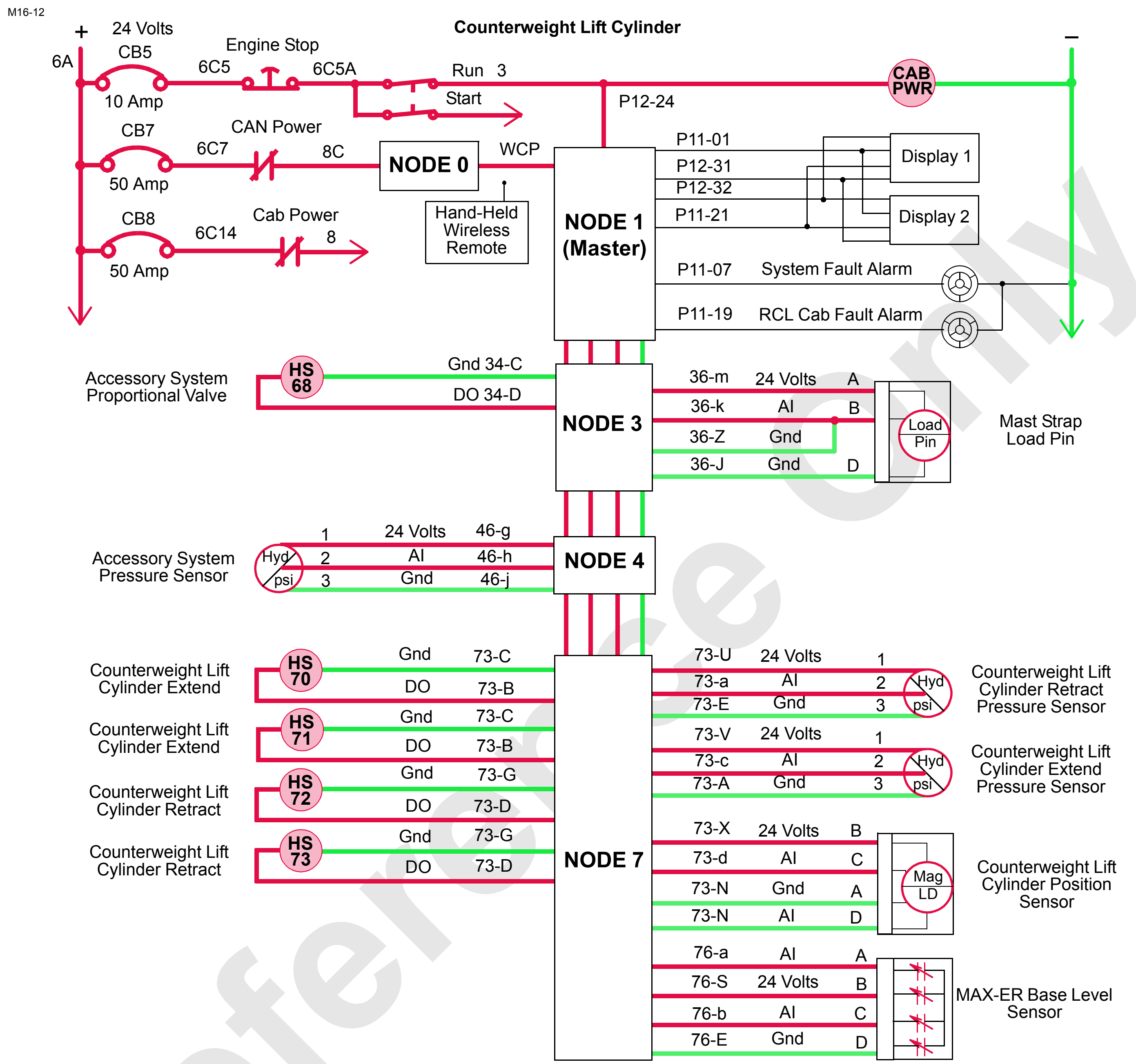


FIGURE 1-57

Counterweight Lift Cylinder Retract

When counterweight lift cylinder switch is moved and held in ***retract*** position, an input signal from wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to 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 ***retract*** position.

Node-3 controller also sends a variable zero to 24 voltage to enable proportional relief solenoid HS-68 to provide approximately 4,500 psi (310 bar) pressure to counterweight lift cylinder system.

Hydraulic pressure from accessory pump flows through pressure control pilot valve, three bank manifold valve, and enters free-flow check valve section of counterbalance

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valve. Fluid pressure on rod end of lift cylinder retracts the cylinder to the desired length.

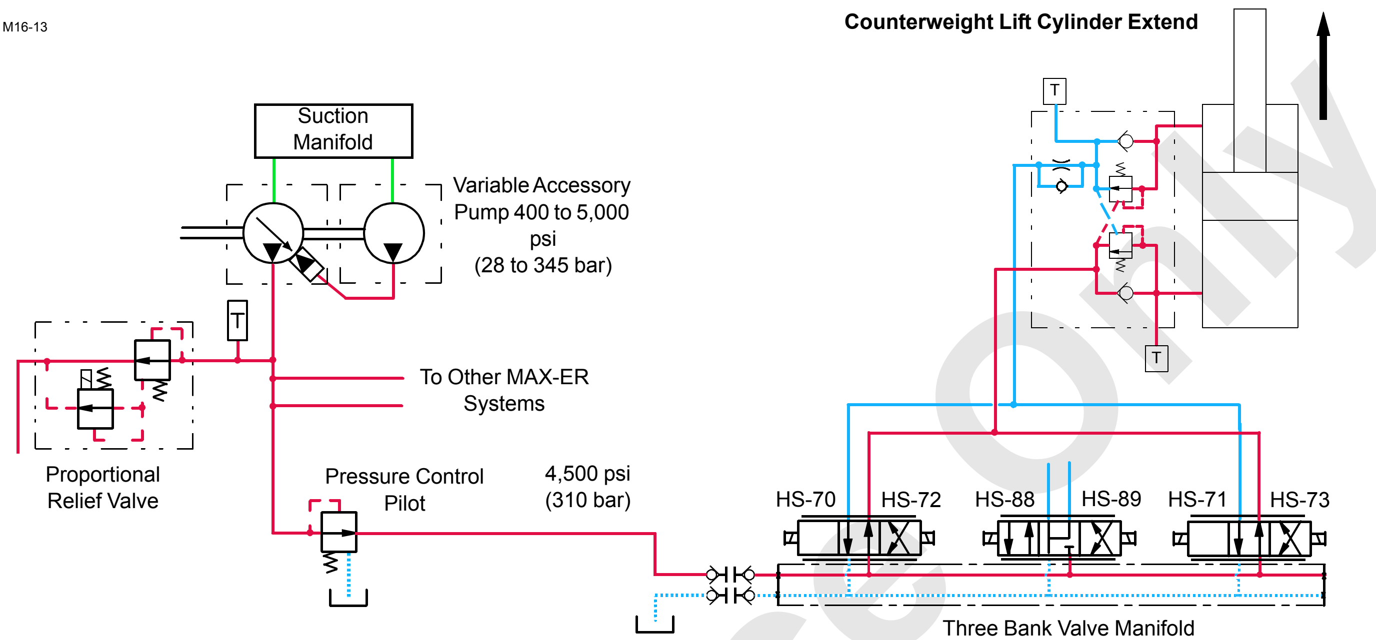
Hydraulic fluid from piston end of lift cylinder is blocked by free-flow check valve section of counterbalance valve and flow restraining section of relief valve preset for a relief setting of 2,200 psi (152 bar). Piston end cylinder pressure opens restraining section of counterbalance valve, allowing fluid to exit valve. Return hydraulic fluid passes through three bank manifold valve before returning to crane hydraulic tank through return line.

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

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

Node-3 sends a variable voltage output to accessory system proportional relief solenoid HS-68 to provide approximately 3,000 psi (207 bar) system pressure.

M16-13



M16-14

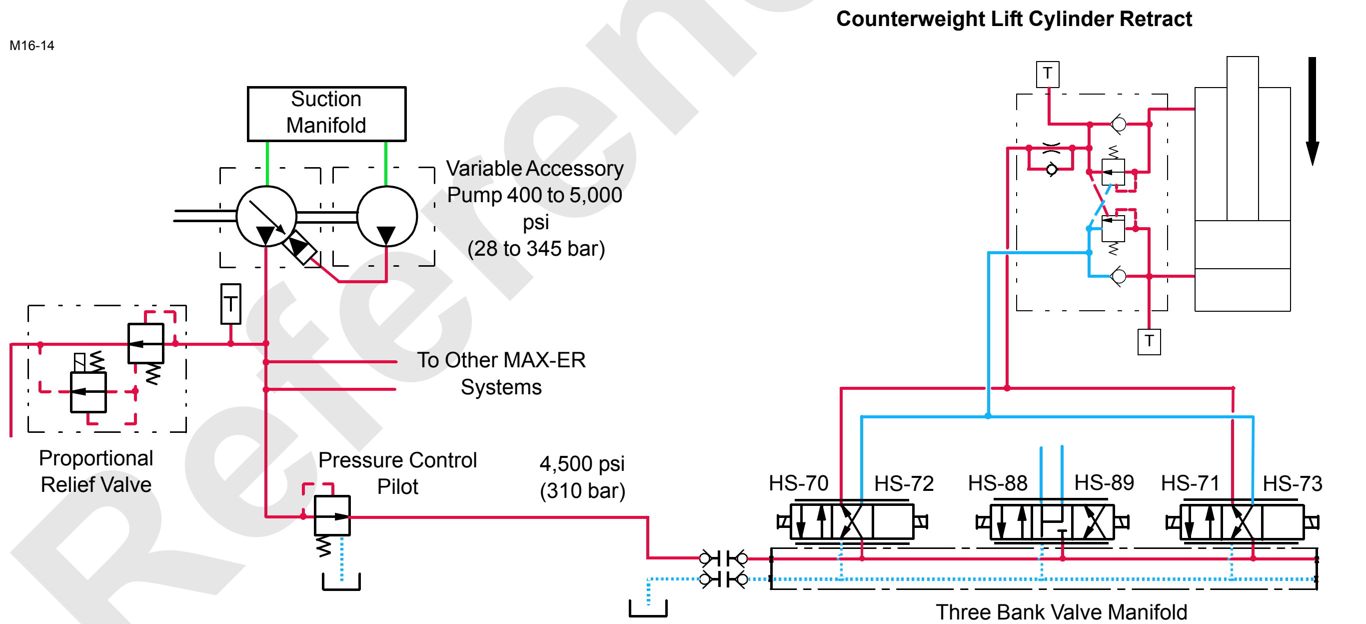


FIGURE 1-58

Wheel Assemblies

See Figure 1-59 and Figure 1-60 in the following procedure.

Wheel assembly swing motors allow positioning of MAX-ER wheels. Before operating any steering switch, make sure the jacking cylinders are in the correct position for rotating wheels. The left side wheel assembly items are used for an example in this section; 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 when operating. Counterbalance valves also provide relief protection. The wheel assembly three position spool valves are motor spooled where both motor ports and tank port of valve spool section are connected in center position.

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

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

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

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

Wheel Steering Clockwise

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

Node-3 controller also sends a variable zero to 24 voltage to enable proportional relief solenoid HS-68 to provide approximately 4,500 psi (310 bar) pressure to wheel assembly.

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

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

When wheel position is reached, release wheel steering switch. When switch is released Node-7 sends an input signal to Node-1 controller. 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 brakes are applied, Node-1 controller also sends a zero volt output to disable the left wheel Assembly solenoid HS-83, to shift the valve to center position.

Node-3 controller sends a zero volt output to accessory system proportional relief solenoid HS-68 to provide approximately 3,000 psi (207 bar) system pressure.

Wheel Steering Counter-Clockwise

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

Node-3 controller also sends a variable zero to 24 voltage to enable proportional relief solenoid HS-68 to provide approximately 4,500 psi (310 bar) pressure to wheel assembly.

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

When wheel position is reached, release wheel steering switch. When switch is released Node-7 sends an input signal to Node-1 controller. 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 brakes are applied, Node-1 controller also sends a zero volt output to disable the left wheel Assembly solenoid HS-83, to shift the valve to center position.

Node-3 sends a variable voltage output to accessory system proportional relief solenoid HS-68 to provide approximately 3,000 psi (207 bar) system pressure.

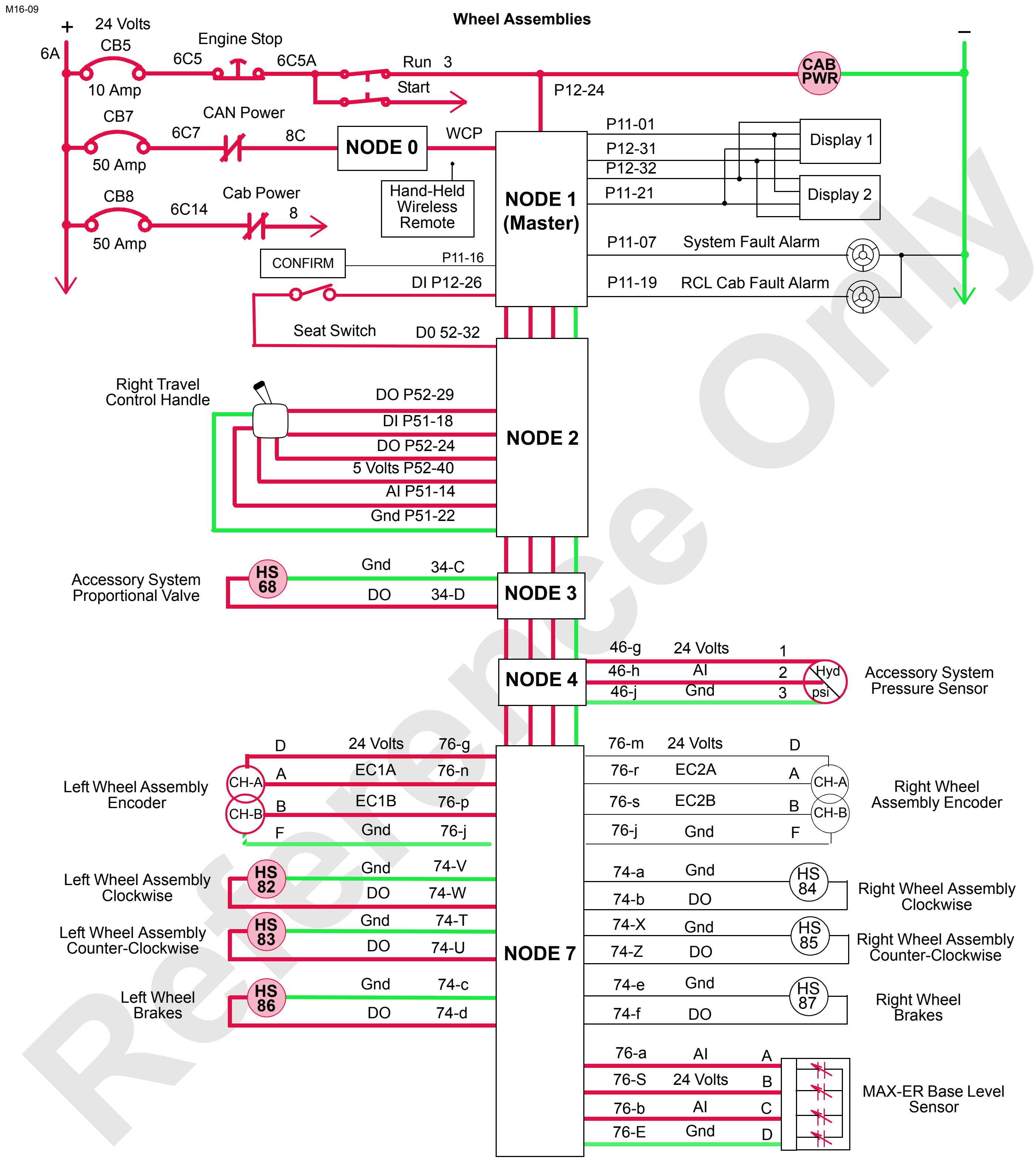
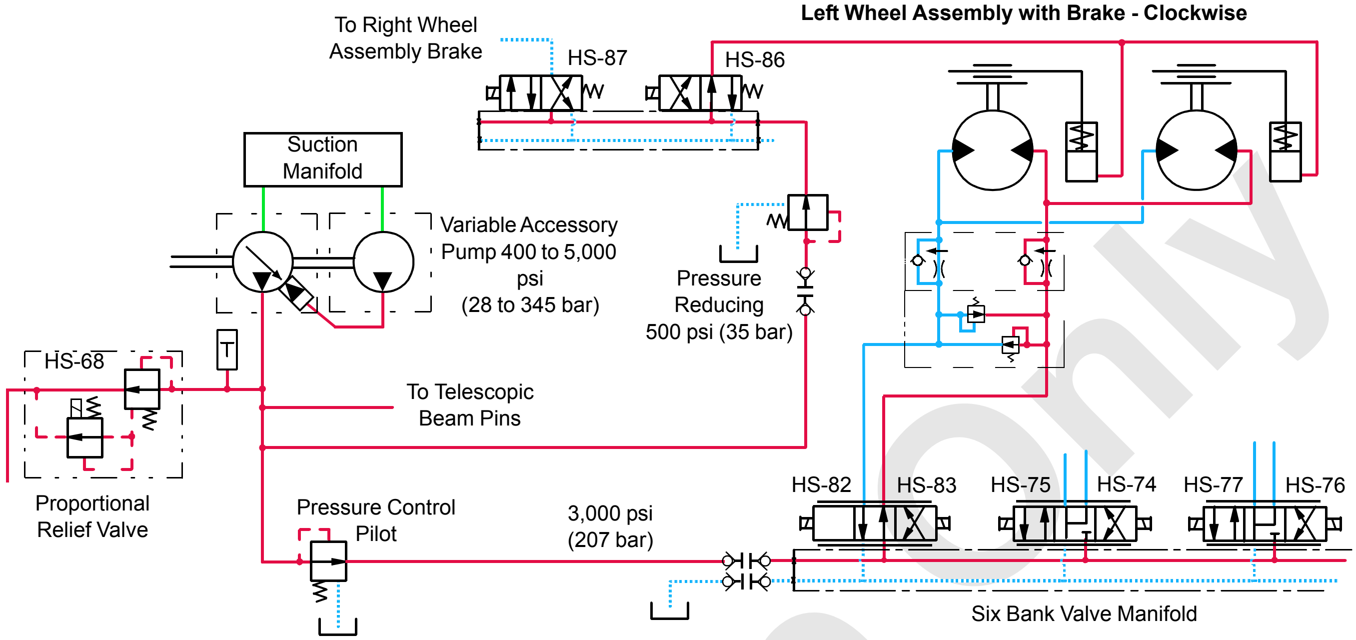

M16-09
Wheel Assemblies
24 Volts
6A
CB5
10 Amp
Engine Stop
6C5
6C5A
Run 3
Start
CAB PWR
P12-24
CB7
CAN Power
6C7
8C
50 Amp
NODE 0
WCP
P11-01
P12-31
P12-32
P11-21
Display 1
Display 2
CB8
Cab Power
6C14
8
50 Amp
Hand-Held Wireless Remote
NODE 1 (Master)
CONFIRM
P11-16
DI P12-26
P11-07 System Fault Alarm
P11-19 RCL Cab Fault Alarm
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
NODE 4
46-g 24 Volts 1
46-h AI 2
46-j Gnd 3
Hyd psi
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 1-59

M16-10



M16-11

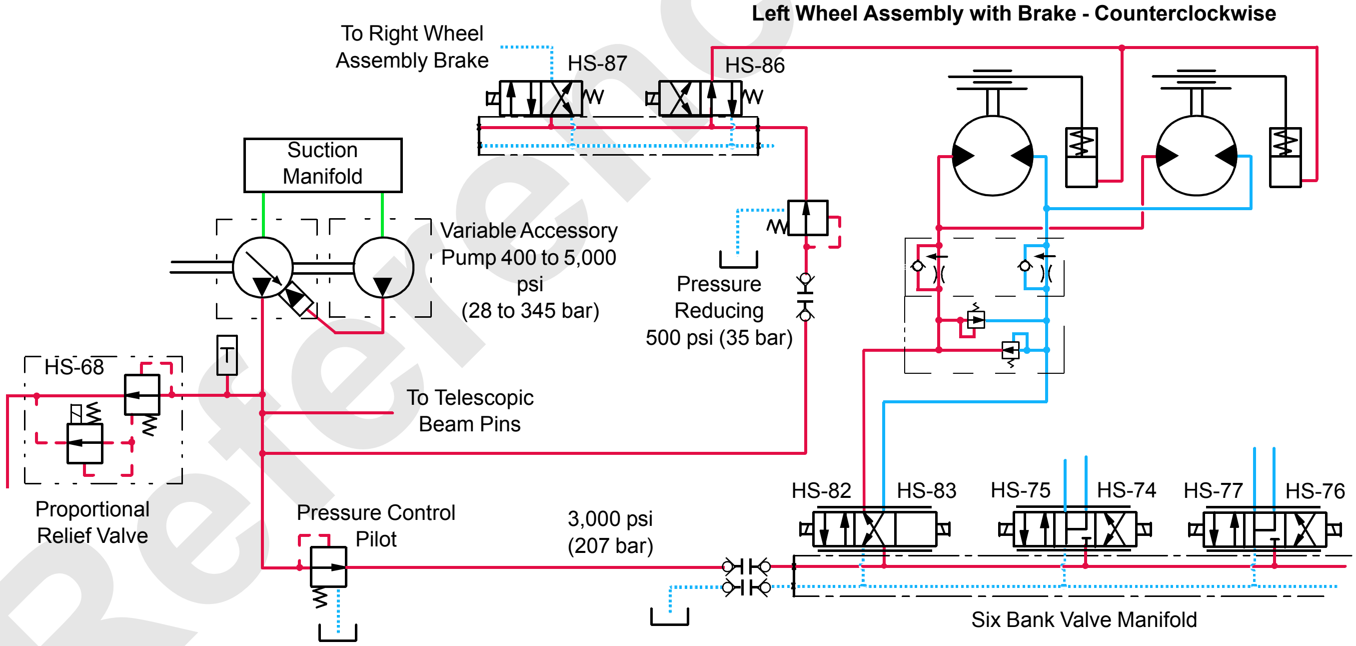


FIGURE 1-60

Telescopic Beam Hinge Pins

See Figure 1-61 and Figure 1-62 in the following procedure.

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

The accessory system pressure sender monitors accessory system pressure.

Power is available to hand-held wireless remote control when, engine is running, MAX-ER function mode is selected, and power button is pressed. Telescopic beam hinge pins can not be engaged/disengaged until electrical cables and hydraulic lines are connected between rear of crane and telescopic beam of MAX-ER (3 and 6, Figure 1-52). Remove beam locking pins from engaged position.

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

Node-3 controller sends a variable zero to 24 volt output to enable accessory system proportional relief solenoid HS-68 for a system pressure of 400 psi (28 bar) to hinge pin cylinders.

Hydraulic fluid pressure at approximately 400 psi (28 bar) flows to telescopic hinge pin accessory valve. Hydraulic fluid leaves the accessory valve and enters rod end of beam pin cylinders, retracting cylinder rod to disengage beam hinge pins. Hydraulic fluid from piston end of beam hinge pin cylinders leaves accessory system valve and returns to tank.

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

Node-3 sends a variable voltage output to accessory system proportional relief solenoid HS-68 to provide approximately 3,000 psi (207 bar) system pressure.

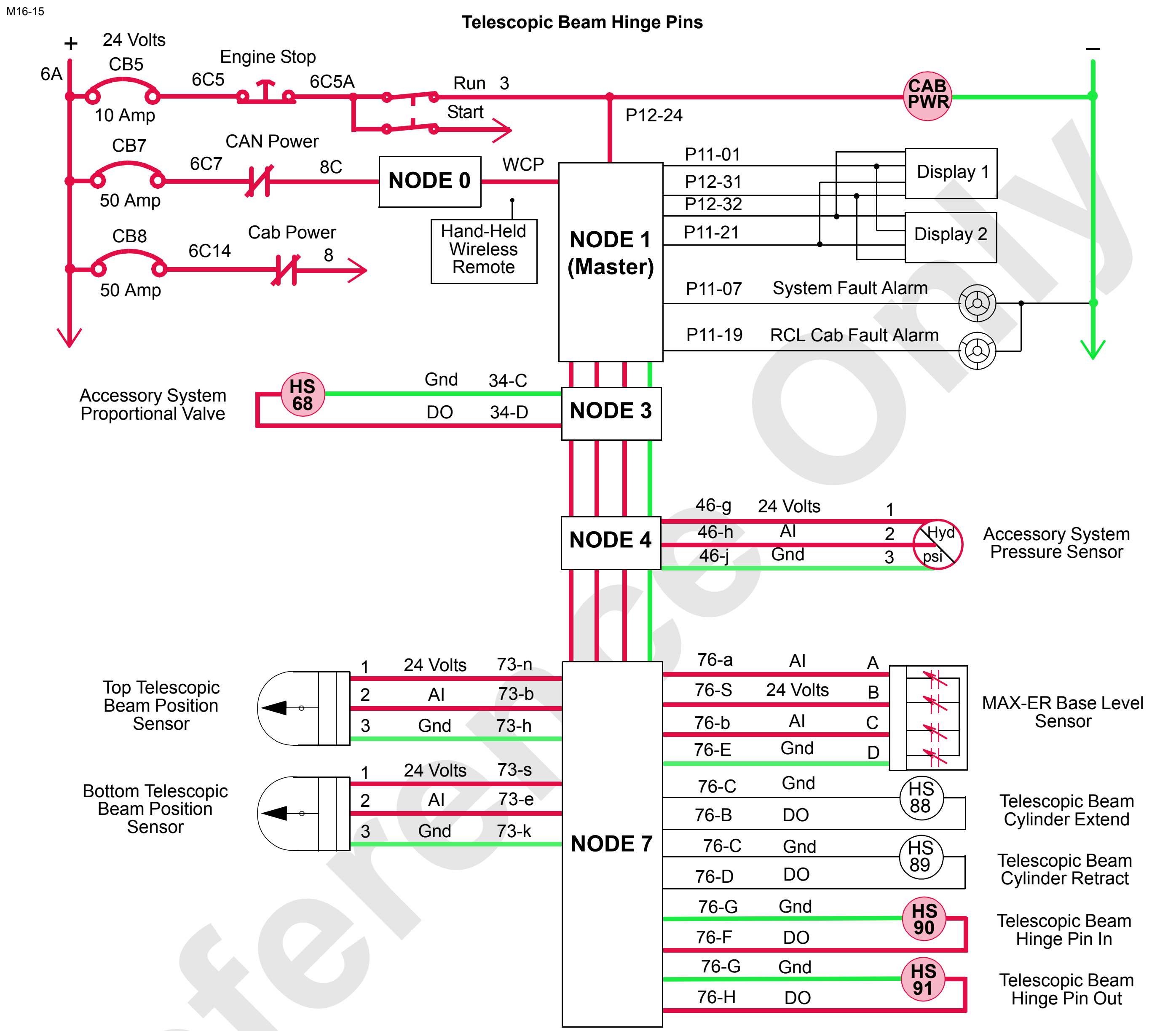

M16-15
Telescopic Beam Hinge Pins
+
24 Volts
CB5
6A
10 Amp
Engine Stop
6C5
6C5A
Run 3
Start
P12-24
CAB PWR
−
CB7
CAN Power
6C7
8C
50 Amp
NODE 0
WCP
Hand-Held Wireless Remote
CB8
Cab Power
6C14
8
50 Amp
NODE 1 (Master)
P11-01
P12-31
P12-32
P11-21
Display 1
Display 2
P11-07
System Fault Alarm
P11-19
RCL Cab Fault Alarm
Accessory System Proportional Valve
HS 68
Gnd 34-C
DO 34-D
NODE 3
NODE 4
46-g 24 Volts 1
46-h AI 2
46-j Gnd 3
Hyd psi
Accessory System Pressure Sensor
Top Telescopic Beam Position Sensor
1 24 Volts 73-n
2 AI 73-b
3 Gnd 73-h
Bottom Telescopic Beam Position Sensor
1 24 Volts 73-s
2 AI 73-e
3 Gnd 73-k
NODE 7
76-a AI A
76-S 24 Volts B
76-b AI C
76-E Gnd D
MAX-ER Base Level Sensor
76-C Gnd
76-B DO
HS 88
Telescopic Beam Cylinder Extend
76-C Gnd
76-D DO
HS 89
Telescopic Beam Cylinder Retract
76-G Gnd
76-F DO
HS 90
Telescopic Beam Hinge Pin In
76-G Gnd
76-H DO
HS 91
Telescopic Beam Hinge Pin Out

FIGURE 1-61

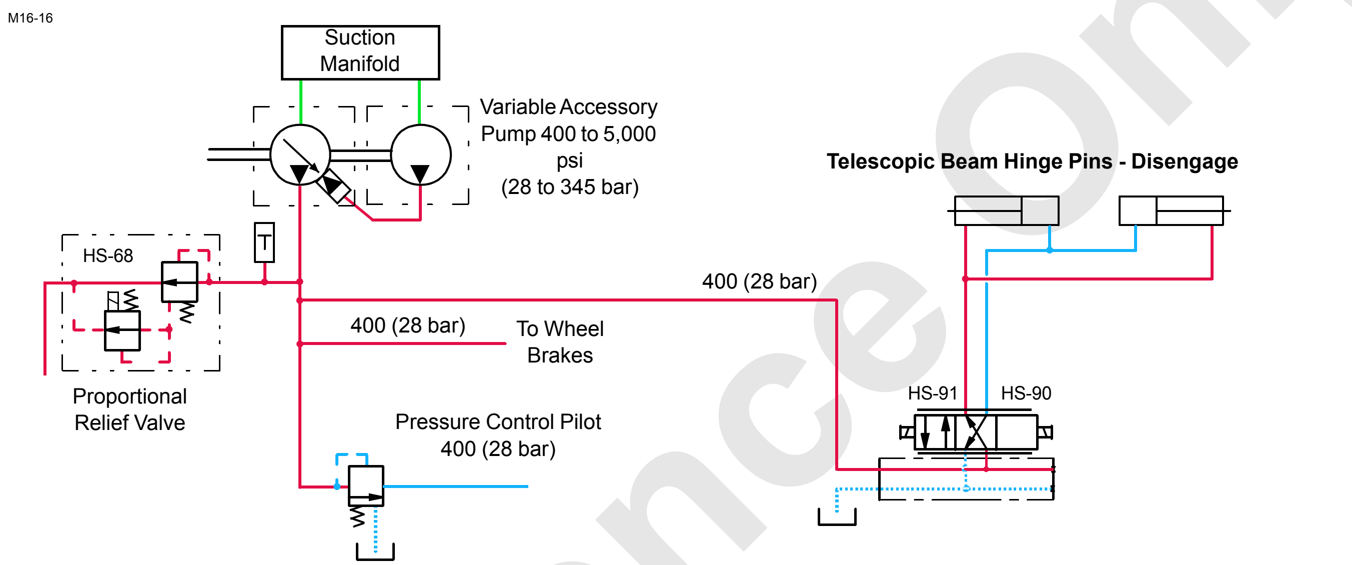
When telescopic beam hinge pin switch is moved and held in ***engage (in)*** position, an input signal from wireless transmitter is sent to a receiver on the crane. The receiver sends the input signal to Node-1 controller. Node-7 sends a 24 volt output to enable telescopic beam hinge pins solenoid HS-90 and shifts valve to the ***engage*** position. Node-3 controller sends a variable zero to 24 volt output to enable accessory system proportional relief solenoid HS-68 for a system pressure of 400 psi (28 bar) to hinge pin cylinders.

Hydraulic fluid pressure at approximately 400 psi (28 bar) flows to beam hinge pin accessory valve. Hydraulic fluid leaves the accessory valve and enters piston end of beam pin cylinder, extending cylinder rod to engage beam hinge pins. Hydraulic fluid from rod end of beam pin cylinder leaves accessory system valve and returns to tank.

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

Node-3 sends a variable voltage output to accessory system proportional relief solenoid HS-68 to provide approximately 3,000 psi (207 bar) system pressure.

Install locking pins in engaged position.



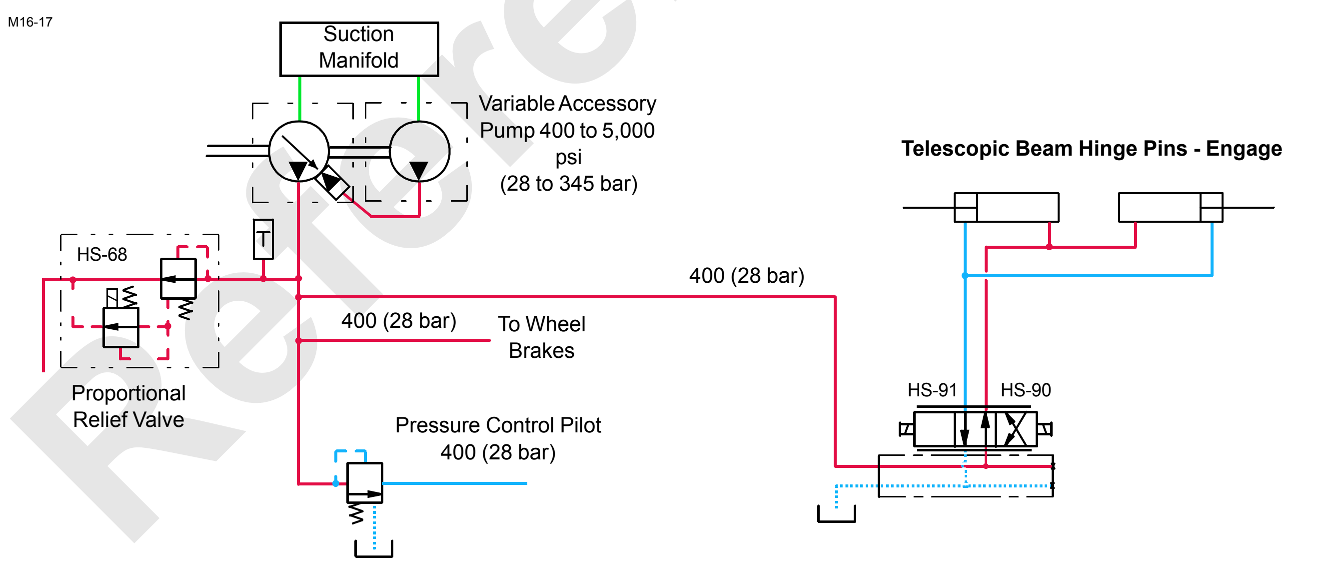


FIGURE 1-62

SECTION 2
HYDRAULIC SYSTEM

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SECTION 2
HYDRAULIC SYSTEM

HYDRAULIC SCHEMATICS

Applicable hydraulic schematics are attached at the end of this section.

HYDRAULIC SYSTEM – GENERAL

This section contains hydraulic system maintenance, adjustment, and test procedures for the hydraulic system and related components on the Model 16000.

Experienced technicians trained in the operation of this crane and its hydraulic system, shall perform the procedures described this section. The technicians shall read, understand, and comply with the instructions in this section and to the display screen instructions in Section 3 of the Crane Operator Manual.

Contact the Manitowoc Crane Care Lattice Team for an explanation of any procedure not fully understood.

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

CAUTION

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

Damage to hydraulic components and improper operation of crane can occur if specifications are altered.

CHECKING AND REPLACING HYDRAULIC HOSES

CAUTION

Burn Hazard!

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

Ensure that the hydraulic hose is depressurized before loosening any connections.

1. Visually inspect all hydraulic hose assemblies every month or at 200 hours of service life for the following:
   - **a.** Leaks at hose fittings or in hose
   - **b.** Damaged, cut or abraded cover
   - **c.** Exposed reinforcement
   - **d.** Kinked, crushed, flattened or twisted hose
   - **e.** Hard, stiff, heat cracked or charred hose
   - **f.** Blistered, soft, degraded, or loose cover
   - **g.** Cracked, damaged or badly corroded fittings
   - **h.** Fitting slippage on hose
   - **i.** Other signs of significant deterioration

   If any of these conditions exist, evaluate the hose assemblies for correction or replacement.
2. At the same service interval, visually inspect all other hydraulic components and valves for the following:
   - **a.** Leaking ports
   - **b.** Leaking valve sections or manifolds and valves installed into cylinders or onto motors
   - **c.** Damaged or missing hose clamps, guard or shields
   - **d.** Excessive dirt and debris around hose assemblies

   If any of these conditions exist, address them appropriately.

   See Table 2-1 below for the following items.
3. Hydraulic hose assemblies operating in climate ***zone C*** are recommended to be replaced after 8,000 hours of service life.
4. Hydraulic hose assemblies operating in climate ***zone A*** and ***zone B*** with high ambient temperatures and high duty circuits could see hose service life reduced by 40% to 50%. High duty circuits can include, but are not limited to hoist(s), boom lift, swing, travel, pump suction and discharge to directional valves and directional valve return to reservoir. It is recommended to replace these hoses after 4,000 to 5,000 hours of service life.

Table 2-1 Climate Zone Classification:

Item	Description
A	Tropical Moist: All months average above 65° F (18° C). 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

Hydraulic hose assemblies operating in climate ***zone D*** and ***zone E***, cold climates, should expect a degrade of mechanical properties and long term exposure to these cold temperatures will negatively impact service life. It is recommended for these hoses to be inspected to step 1 above as service life may be more than 8,000 hours.

HYDRAULIC SYSTEM – MAINTENANCE

Safety

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

Storing And Handling Oil

- Store oil drums in 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 entry of dirt or water into oil.
- Before opening a drum, carefully clean top of it. Also clean faucet or pump to remove oil from drum.
- Only use clean transfer containers.
- Do not take oil from storage until oil is needed. If oil cannot be used immediately, keep transfer container tightly covered.

Storing And Handling Parts

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

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Item	Description	Item	Description
1	Filter 2 (in tank return)(2 or 3 each)	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	Vent Cap (2 in charge pressure manifold) past production only
4a	Air Valve (for venting air)	10	Vent Cap (1 in suction manifold)
4b	Coupler	11	Vent Cap (1 in suction line at accessory pump)
5	Access Cover (past production shown)	12	Bleed Port for Initial Fill (16001142 and newer)
6	Filter 1 (charge filter assembly 2 each)	13	Heater (240V here if equipped)

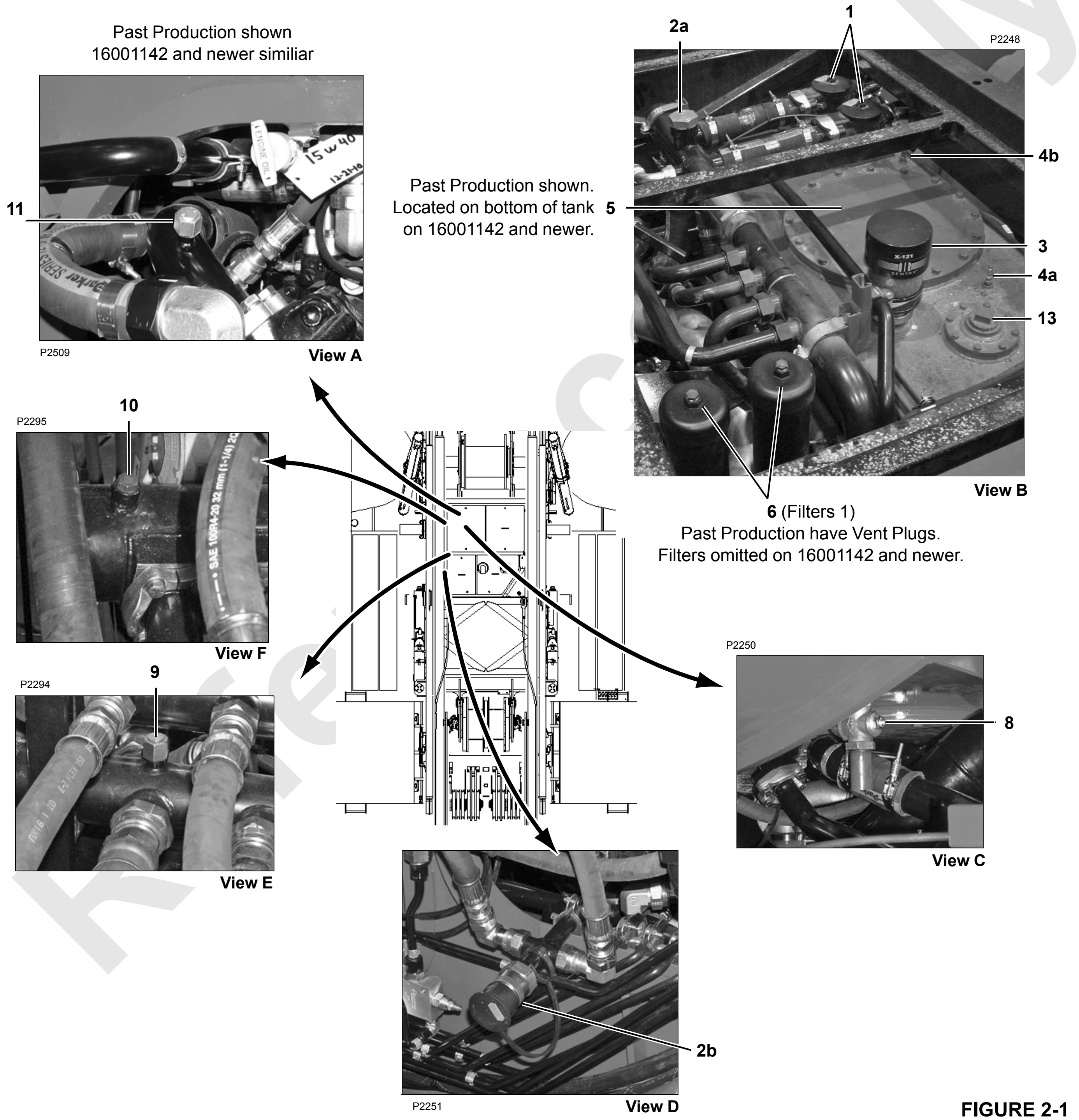


FIGURE 2-1

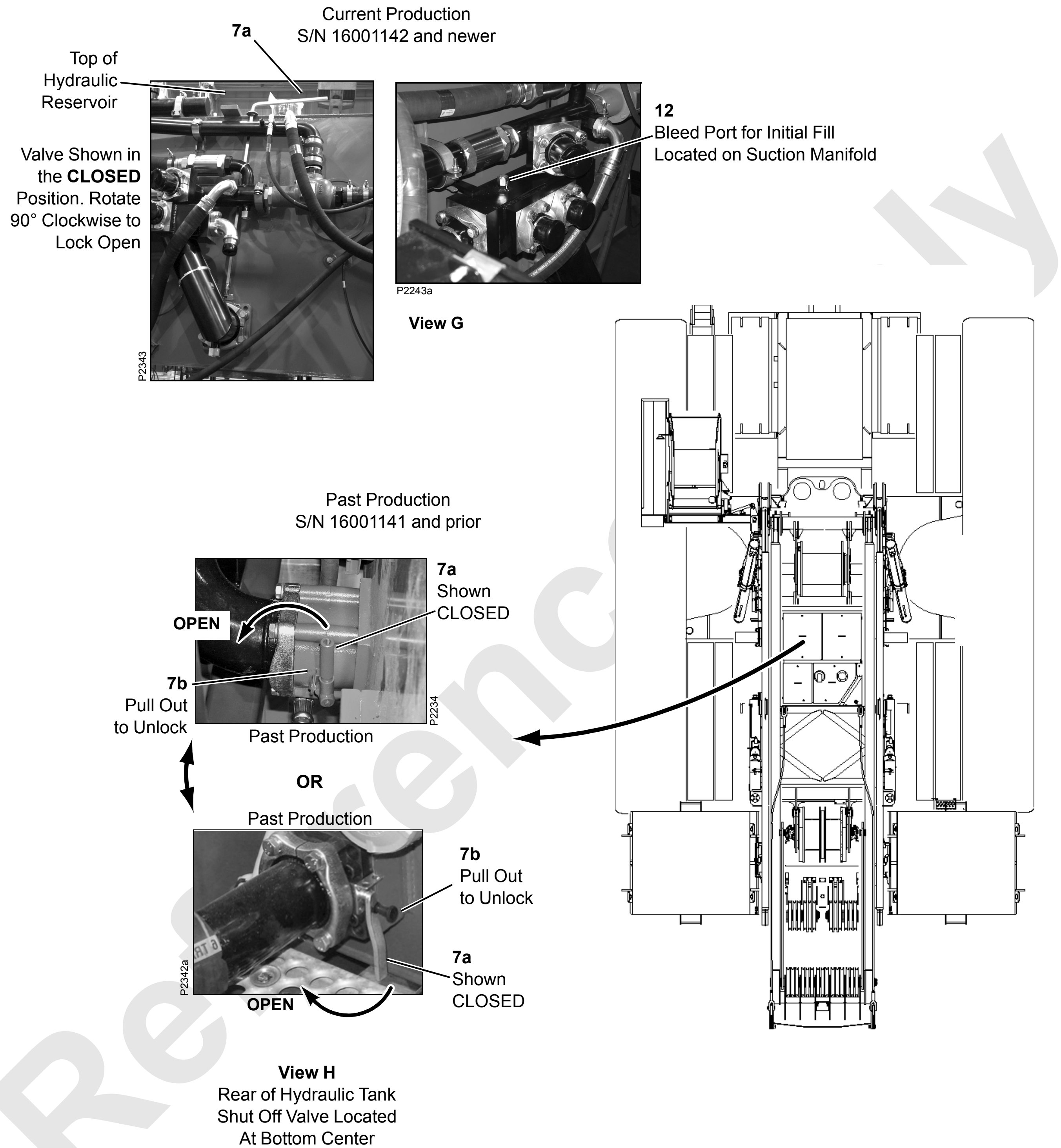


FIGURE 2-1 continued

Inspecting System

The damaging effects of dirt, heat, air, and water in the hydraulic system can only be prevented by regular, thorough inspection of the system. The frequency of inspection depends on operating conditions and experience with the system; however, the more often the system is inspected and deficiencies corrected, the less likely the system will malfunction.

A good inspection program will include the following checks:

1. Keep accurate records so future maintenance needs can be projected.

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

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

FULL COLD LEVEL
(approximately 60°F – 16°C)
Screen should read 87 to 90%.

FULL HOT LEVEL
(approximately 180°F – 82°C)
Screen should read 95%.

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

Hydraulic Tank Level and Temperature Display

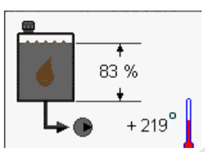


FIGURE 2-2

If oil level drops to 50%, a fault alarm will come on and a fault symbol will appear on the active display. HYDRAULIC FLUID LOW icon will appear on fault display (Figure 2-3). ***Fill tank immediately.***

HYDRAULIC FLUID LOW Fault Icon

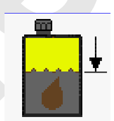


FIGURE 2-3

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

Do not fill tank through breather port or top of either filter. Hydraulic system could be contaminated from unfiltered oil.

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

4. If equipped with a desiccant breather (Figure 2-5), replace cartridge with a new one when all of the desiccant beads turn dark green (they are gold when new).

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

6. Check for external leaks. Leaks are not only unsafe, they also attract dirt and in some cases allow air and water to enter system. Do not return leakage oil back to hydraulic tank.

Do not to use your hands to check for leaks.

- Look for oil leaking from fittings and from between parts that are bolted together. Tighten loose fittings and attaching bolts to proper torque; do not over tighten.
- If leakage persists at these points, replace seals or gaskets.
- Look for oil leaking from pump and motor shaft ends, from valve spool ends, and from cylinder shaft ends. Replace 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 pumps and motors for unusual noises; a high pitched whine or scream can indicate that air is being drawn in.

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

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 (viscosity too high)

7. Look for signs of overheating: heat peeled parts, burned and scorched oil odor, and darkening and thickening of oil. Maximum temperature of oil in tank must not exceed 180°F (82°C).

If oil temperature in tank goes above 180°F (82°C), a fault alarm will come on and a fault symbol will appear on the active display. HYDRULIC RESERVOIR TEMPERATURE icon will appear on fault display (Figure 2-4).

FIGURE 2-4

8. Have hydraulic oil analyzed at regular intervals to determine condition of oil and extent of system contamination.

   By having the oil analyzed on a regular basis, an oil change interval meeting your operating conditions can be established.

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

Replacing Desiccant Breather

The following instructions apply only to current production cranes.

See Figure 2-5 for the following procedure.

1. Unscrew breather from tank.
2. Unscrew cap from cartridge and discard cartridge.
3. Remove protective caps from top and bottom of new cartridge.
4. Securely attach cap to cartridge — HAND TIGHTEN only.
5. Securely attach breather to hydraulic tank — HAND TIGHTEN only.

Current Production Desiccant Breather

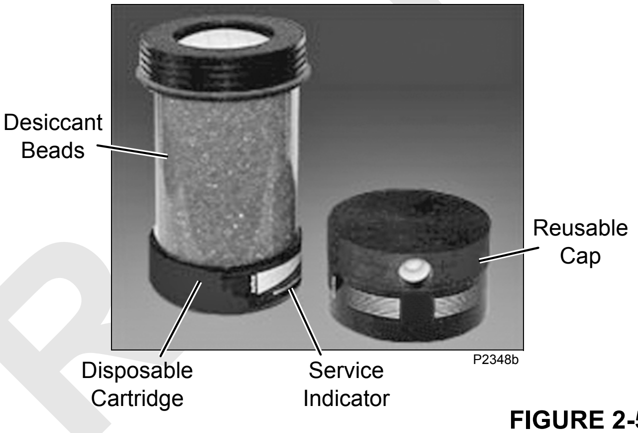


FIGURE 2-5

Replacing Filters

Reference Figure 2-1:

- Filter 1 (two installed on past production only): 12-micron absolute which filter oil to all charge pumps.
- Filter 2 (2 or 3 elements each return to tank): 12-micron absolute which filter all oil returning to tank.

If a filter is too dirty, a fault alarm will come on and a fault symbol will appear on the active display. HYDRULIC FILTER icon and corresponding filter number will appear on fault display (Figure 2-6).

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.

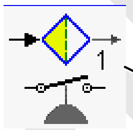


FIGURE 2-6

CAUTION

Avoid Hydraulic System Damage!

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

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

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

Filter 1 (Charge, past production)

See Figure 2-1 and Figure 2-7 for the following procedure.

Replace charge filter elements when FILTER 1 fault comes on and at each oil change interval.

1. Stop engine.
2. Clean outside of filter body in area around cover.
3. ***Past production style 1*** filter assemblies:
   a. Remove fill cap. ***Use care not to damage O-rings.*** Fill cap has a hexagon stud for easy removal.
   b. Twist element handle counter-clockwise and pull filter element out of body and discard element.

   Do not attempt to clean or reuse element.

   Do not operate crane without charge filter elements installed.
4. ***Past production style 2*** filter assemblies:
   a. Remove cover. ***Use care not to damage O-rings.***

b. Using handle provided, lift filter element out of body and discard element.

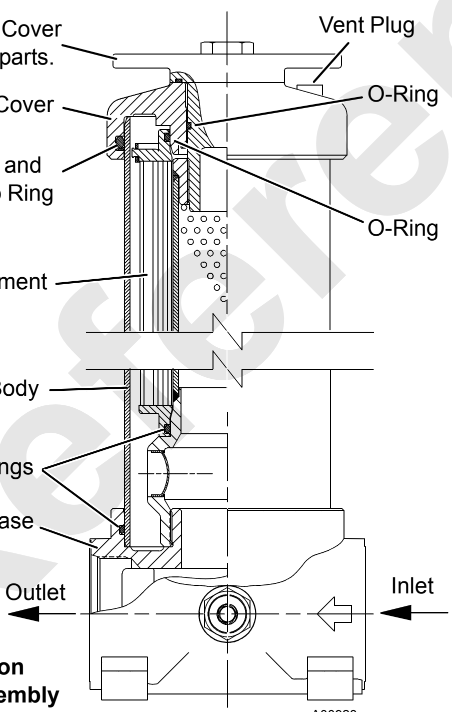
Do not attempt to clean or reuse element.

Do not operate crane without charge filter elements installed.

5. Lubricate O-ring at both ends of new element with clean hydraulic oil and securely install element over stem in base.
6. If necessary, replace O-ring and back-up ring in cover.
7. Reinstall cover and securely tighten handle.

Disregard steps 8 and 9 if you are also changing oil.

8. Remove vent plug from filter cover.
9. Apply 3-5 psi (.21-.35 bar) owner supplied air pressure to air valve (4a) or coupler (4b) in side of hydraulic tank. Some air will leak from breather cap.
10. Reinstall and securely tighten vent plug when oil starts flowing from vent port.
11. Disconnect air supply.
12. Start engine and allow hydraulic system to return to normal operating pressure and temperature. Check filter cover and plug for leaks. Securely tighten as required.
13. Stop engine, check tank level, and refill as required.



Past Production Charge Filter Assembly is Shown (Current Production is Omitted)

FIGURE 2-7

Filter 2 (Return)

See Figure 2-1 and Figure 2-8 for the following procedure.

Replace return filter elements when FILTER 2 fault comes on and at each oil change interval.

1. Stop engine.

WARNING

Burn Hazard!

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

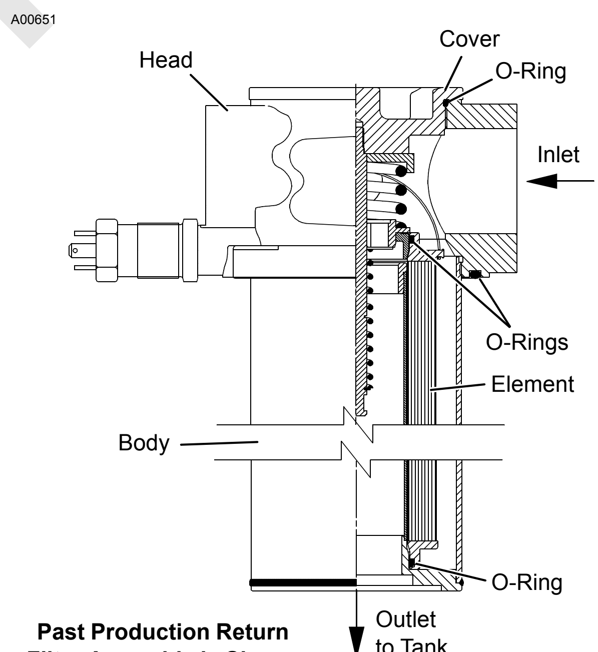
Hot oil can escape when you remove either filter cover.

RELIEVE PRESSURE through air valve (4a, Figure 2-1) on tank before servicing.

2. Clean outside of filter head in area around cover.
3. ***Current production*** filter assemblies:
   a. Remove fill cap. ***Use care not to damage O-rings.*** Fill cap has a hexagon stud for easy removal.
   b. Twist element handle counter-clockwise and pull filter element out of body and discard element.

   Do not attempt to clean or reuse element.

   Do not operate crane without return filter elements installed.



Past Production Return Filter Assembly is Shown (Current Production is Similar)

FIGURE 2-8

4. ***Past production*** filter assemblies:
   a. Remove cover. ***Use care not to damage O-rings.***
   b. Cover has a hexagon stud for easy removal with a wrench.
   c. Using handle provided, lift filter element out of body and discard element.

   Do not attempt to clean or reuse element.

   Do not operate crane without return filter elements installed.
5. Lubricate O-ring at both ends of new element with clean hydraulic oil and securely install element over stem in housing.
6. If necessary, replace O-ring in cover.
7. Reinstall cover and securely tighten.
8. Start engine and allow hydraulic system to return to normal operating pressure and temperature. Check filter cover and vent plug for leaks. Securely tighten as required.
9. Stop engine, check tank level, and refill as required.

Changing Oil

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 crane until hydraulic oil is at normal operating temperature. This will help prevent impurities from settling in system.
2. Stop engine.
3. Attach a rubber hose to pipe on drain valve (8) and insert end of hose into a suitable container to catch hydraulic oil. See Section 9 for hydraulic system capacity.
4. Open drain valve (8) and drain tank completely.
5. Clean all dirt from access cover (5) in top of tank and remove cover. ***Take care to prevent dust and wind-blown dirt from entering tank while covers are off.***
6. Flush out any sediment inside tank.
7. Carefully inspect suction filters (two inside tank) for damaged or clogged holes and for sludge, gum or lacquer formation. If necessary, clean as follows:
   a. Remove cover from bottom of tank.
   b. Using a wrench, remove suction filter from inside tank.
   c. Soak in clean, nonflammable solvent. Brush off outer surface, and flush from inside out. Discard if damaged.
   d. Securely reinstall suction filter.
8. Use new seals and securely fasten access covers to tank.
9. On past production cranes only, either replace breather (Figure 2-9) with a new one or replace breather element as follows, depending on which is more economical for you:
   a. Remove breather from tank.

   Use care not to lose parts inside breather when cover is removed.

   b. Remove three screws securing cover to base.
   c. Separate cover from base.
   d. Remove and discard old breather element and install a new element.
   e. Reassemble breather as shown in Figure 2-9.
   f. Fasten breather to tank.

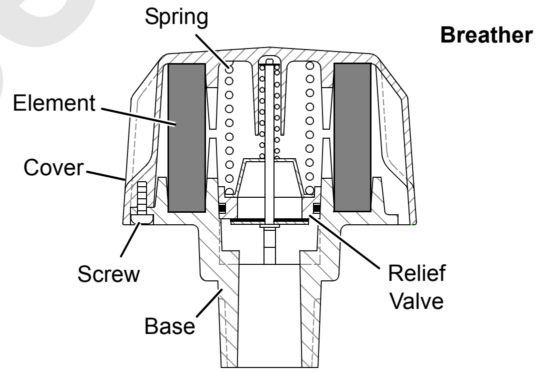


FIGURE 2-9

10. On current production cranes, replace desiccant breather when indicated (see instructions earlier in this section).
11. Replace all four filter elements (1a and 6a) as instructed earlier in this section.
12. Fully close drain valve (8) and remove rubber hose.
13. If equipped, remove vent plug from top of both charge filters (6).
14. Remove vent cap (9) from both ends of charge pressure manifold.
15. Remove vent plug (10 or 12) from suction manifold.
16. If equipped, remove vent cap (11) at accessory pump.

17. Fill hydraulic tank to ***FULL COLD LEVEL –*** 87-90% – while watching hydraulic tank display on information screen (see Figure 2-2). Use proper hydraulic oil (see Section 9).

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

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

Do not fill tank through breather port or top of either filter. Hydraulic system could be contaminated from unfiltered oil.

19. Securely install vent plug (10 or 12) and vent cap (11) and as soon as clear oil appears at each vent opening.

20. Apply 3-5 psi (.21-.35 bar) owner supplied air pressure to air valve (4a) or to coupler (4b) on hydraulic tank. Some air will leak from breather cap.

Observe bleed ports:

a. If equipped, securely install vent plugs when clear oil starts flowing from bleed ports in charge filters (6).

b. Securely install vent caps (9) when clear oil starts flowing from bleed ports in charge pressure manifold.

21. Disconnect air supply.

22. Check tank level and refill as required.

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

24. Stop engine, check tank level, and refill as required.

NOTE: If the hydraulic system was extremely dirty (gum or lacquer formation on parts indicated by erratic, jerky, or sluggish operation) repeat 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 shut-off valve (7a, Figure 2-1) in the pump suction manifold.

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

CAUTION

Avoid Damage to Pumps!

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

Tightening Hydraulic Connections

- Make sure fittings and O-rings being used are proper size and style.
- Flush sealing surfaces with clean hydraulic oil to remove any dirt.
- Carefully inspect threads and sealing surfaces for nicks, gouges, and other damage. Do not use damaged parts; they will leak.
- Carefully inspect O-rings for cuts and other damage. Do not use damaged O-rings: they will leak.
- Always lubricate O-rings when assembling on fittings.
- Be careful not to cut O-rings when assembling them to fittings. Use thimble as shown in Figure 2-10 when assembling O-ring over threads.

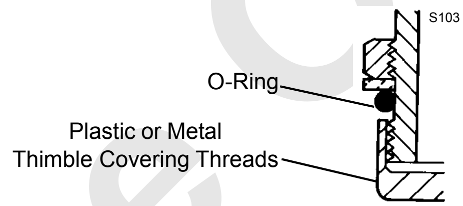


FIGURE 2-10

Pipe Thread Connection

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

CAUTION

Hydraulic System Damage!

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

---

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

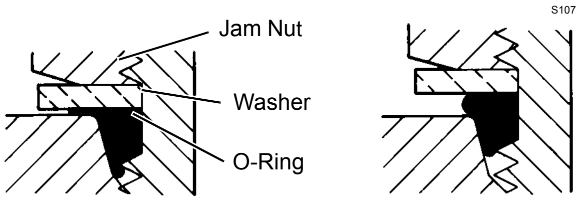
Table 2-2 Pipe Thread Leakages

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 2-11, View A. The compressed rubber between the washer and the spot face will cold flow out of compression, causing the fitting to loosen and leak as shown in Figure 2-11, View B.



View A

When jam nut and washer are not backed up, there is not enough room for O-ring when squeeze takes place.

View B

Washer cannot seat properly on spot face. Compressed rubber between washer and spot face will cold flow out of compression, causing fitting to loosen and leak.

FIGURE 2-11

Tighten SAE straight thread connections, as follows:

1. Back up jam nut and washer to end of smooth portion on fitting as shown in Figure 2-12, View A.

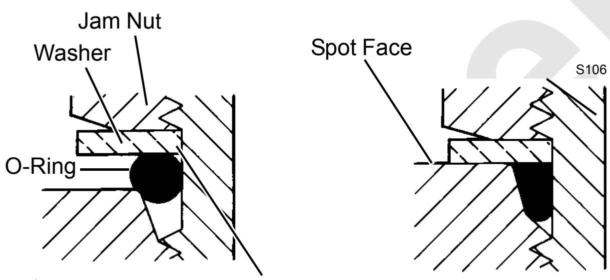


FIGURE 2-12

2. Lubricate O-ring with clean oil; this is very important.
3. Thread fitting into port until washer bottoms against spot face as shown in Figure 2-12, View B.

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

4. Tighten jam nut. When fitting is properly installed, O-ring will completely fill seal cavity and washer will be tight against spot face as shown in Figure 2-12, View B.

Table 2-3 Straight Thread Leakage

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.

1. Lubricate and install O-ring in adapter groove (Figure 2-13).

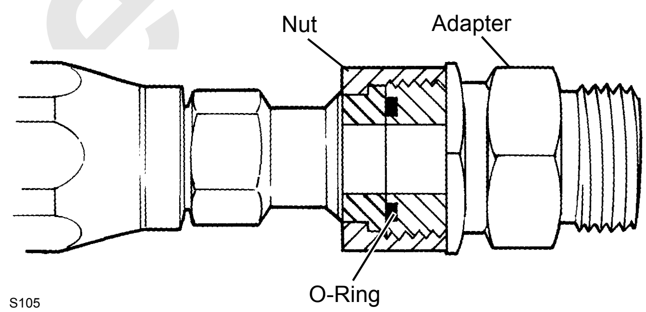


FIGURE 2-13

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

Table 2-4 ORS Assembly Torque

Nut Size in (mm) across flats	Fitting Size	Torque	
		In-Lb	Nm
5/8 (15,9)	-04	120 – 145	14 – 16
13/16 (20,6)	-06	203 – 245	23 – 28
15/16 (23,8)	-08	380 – 470	43 – 53
1-1/8 (28,6)	-10	550 – 680	62 – 77
1-3/8 (34,9)	-12	763 – 945	86 – 107
1-5/8 (41,3)	-16	1110 – 1260	125 – 142
1-7/8 (47,6)	-20	1500 – 1680	170 – 190

Table 2-5 ORS Leakage

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

1. Lubricate and install O-ring in shoulder groove (see Figure 2-14). Align shoulder with port and assemble flanges over shoulder.

NOTE: Bolts used must be grade-5 or better. Grade-5 bolt has three dashes in head.

2. Snug bolts in a diagonal manner (Figure 2-14) to 1/3 of torque given in Table 2-6.
3. Repeat step 2 to 2/3 of final torque. Repeat step 2 to final torque.

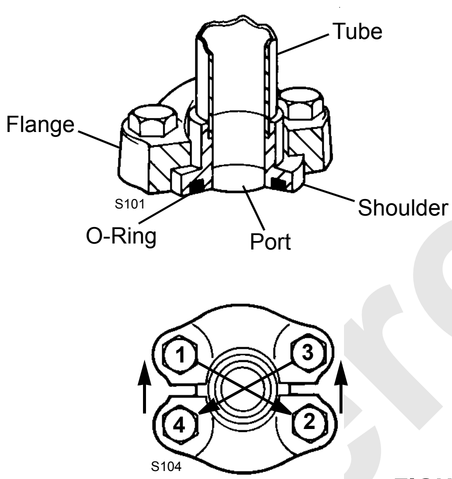


FIGURE 2-14

Table 2-6 Split Flange Assembly Torque

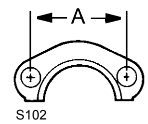
"A" Dimension inch (mm) 	Flange Size	Torque in-lb	Torque Nm
Standard Pressure Series			
1-1/2 (38,1)	-08	175 – 225	20 – 25
1-7/8 (47,6)	-12	225 – 350	25 – 40
2-1/16 (52,4)	-16	325 – 425	37 – 48
2-5/16 (58,7)	-20	425 – 550	48 – 62
2-3/4 (69,9)	-24	550 – 700	62 – 79
3-1/16 (77,8)	-32	650 – 800	73 – 90
3-1/8 (79,4)	-24	1400 – 1600	158 – 181
3-13/16 (96,8)	-32	2400 – 2600	271 – 294
High Pressure Series			
1-9/16 (39,7)	-08	175 – 225	20 – 25
2 (50,8)	-12	300 – 400	34 – 45
2-1/4 (57,2)	-16	500 – 600	57 – 68
2-5/8 (66,7)	-20	750 – 900	85 – 102
3-1/8 (79,4)	-24	1400 – 1600	158 – 181
3-13/16 (96,8)	-32	2400 – 2600	271 – 294

Table 2-7 Split Flange Leakage

Causes	Cures
Flanges not tight.	Tighten bolts evenly to proper torque.
Flanges tightened unevenly causing extrusion of O-ring.	Replace O-rings. Tighten bolts evenly to proper torque.
O-ring cut.	Replace.
O-ring wrong size.	Replace with 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. Retighten bolts after system is hot.

SAE Flare Connection

1. Tighten nut finger tight until sealing surfaces touch.
2. Mark a line (use felt pen or marker) on adapter and extend it onto connector nut (Figure 2-15, View A).
3. Using wrenches, tighten connector nut the number of flats shown in Table 7 (Figure 2-15, View B).

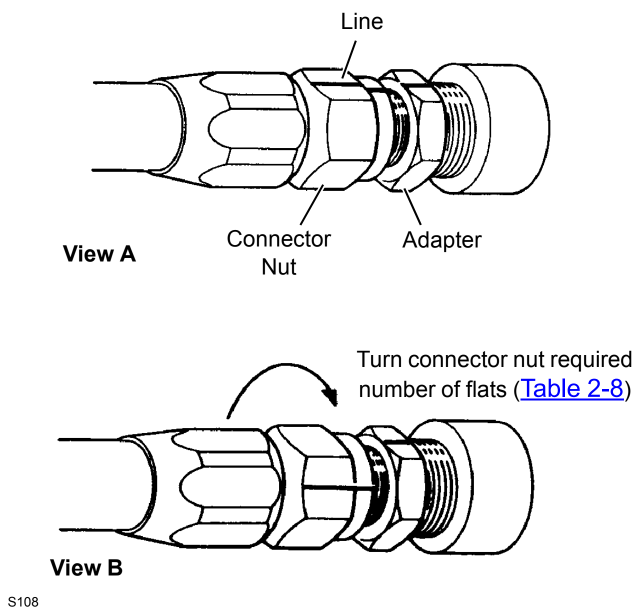


FIGURE 2-15

4. Misalignment of marks will show how much nut has been tightened, and best of all that it has been tightened.

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 (17,5)	-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 Leakage

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.

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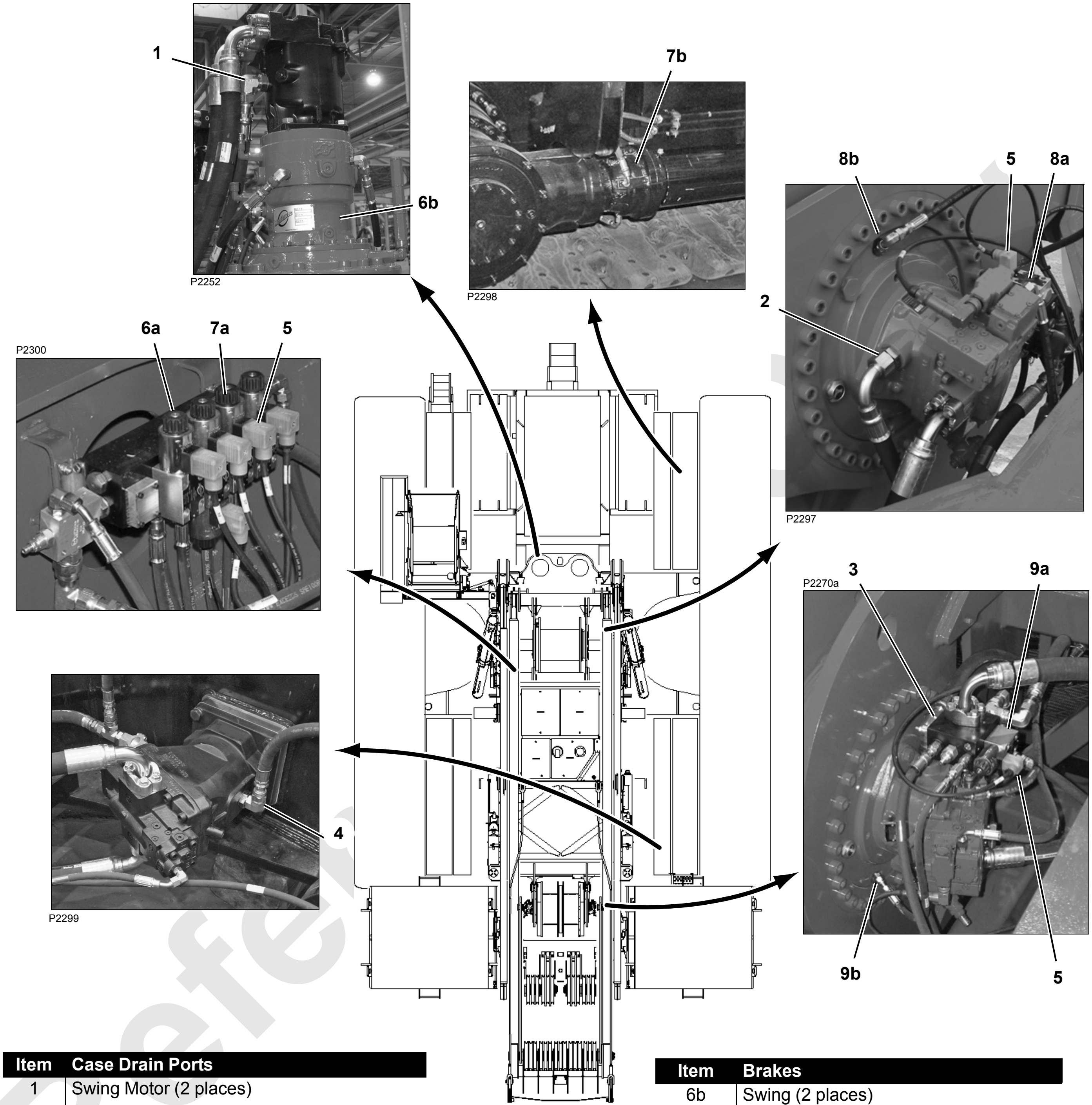


Item	Case Drain Ports
1	Swing Motor (2 places)
2	Load Drum Motor (1 or 2 places each drum)
3	Boom Hoist Motor (2 places)
4	Travel Motor (2 places)
Item	**Brake Solenoid Valves**
5	Electric Connector (typical)
6a	Swing
7a	Travel
8a	Load Drum (typical 1 motor each)
9a	Boom hoist (1 motor)

Item	Brakes
6b	Swing (2 places)
7b	Travel (2 places)
8b	Load Drum (1 or 2 places each drum) [1]
9b	Boom Hoist (2 places) [1]
1	Brakes are Inside Gear Boxes

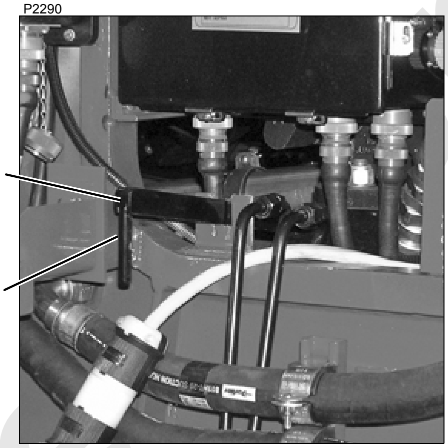
FIGURE 2-16

SHOP PROCEDURES

Initial Oil Fill

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

1. Fill all motor cases with oil (Figure 2-16).
   a. Disconnect fittings at case drain ports.
   b. Fill each motor case to level of case drain port. ***Use new hydraulic oil filtered through a 10-micron filter.***
   c. Reconnect fittings.
2. Open vent ports (Figure 2-1 or FIGURE 2-1 continued).
   a. If equipped, remove vent plug from top of both charge filters (6).
   b. Remove vent cap (9) from both ends of charge pressure manifold.
   c. Remove vent plug (10 or 12) from suction manifold.
   d. If equipped, remove vent cap (11) at accessory pump.
3. Make sure drain valve (8, Figure 2-1) is closed.
4. At engine, disengage engine clutch (Figure 2-17).



Left Side of Rotating Bed

FIGURE 2-17

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

   Do not fill tank through breather port or top of either filter. Hydraulic system could be contaminated from unfiltered oil.

6. Securely install vent plug (10 or 12, Figure 2-1) and vent cap (11) as soon as clear oil appears at each vent opening.
7. If required, apply 3 to 5 psi (0.20 to 0.34 bar) owner supplied air pressure to air valve (4a, Figure 2-1) or coupler (4b) on hydraulic tank.

   The tank breather allows 3 psi (.21 bar) pressure to remain in the tank to force oil into the charge system.
8. Observe bleed ports as charge system fills.
   a. If equipped, securely install vent plugs when clear oil starts flowing from bleed ports in charge filters (6).
   b. Securely install vent caps (9) when clear oil starts flowing from bleed ports in charge pressure manifold.

NOTE: It is extremely important to perform the bleed procedure described above in the field any time the system is drained completely – for any reason.

9. Check for hydraulic leaks and correct if found.

WARNING

Burn Hazard!

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

Hot oil can escape when you remove either filter cover.

RELIEVE PRESSURE through air valve (4a, Figure 2-1) in top of tank before servicing.

Initial Start-Up

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

The procedure requires two people: one to start the engine and monitor pressures on the diagnostic screens and one to monitor and close the bleed valves.

CAUTION

Avoid Damage to Hydraulic System!

If hydraulic fluid low alarm comes on at any time during start-up procedure, add oil to tank.

1. BEFORE starting engine, calibrate pressure senders as described in this section.

2. Make sure hydraulic tank shutoff valve (7a, Figure 2-1) is fully open. ***Pumps can be damaged from cavitation if this step is not performed.***
3. Connect bleed lines equipped with shut-off valves to gauge coupler at each pressure sender (Figure 2-35).
4. Open shut-off valve in each bleed line. Use a suitable container to catch oil.
5. ***With all controls off***, start and run engine at lowest possible speed.
6. Bleed pressure senders:
   a. Observe oil flowing from bleed line at each pressure sender.
   b. Close each bleed valve when a clear, steady stream of oil appears (no air bubbles in oil).
   c. If oil does not flow from any bleed line, determine cause and correct.

CAUTION

Equipment Damage!

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

7. On diagnostic screens (Figure 2-18), check pump pressures for load drums, boom hoist, swing, and travel pumps:
   a. Make sure pressure reading for each pump is 250 to 370 psi (17 to 26 bar).
   b. If pump pressures are not within specified range, ***stop engine immediately***. Determine cause of faulty pressure and correct.
8. Stop engine.
9. Remove bleed lines from gauge couplers at each pressure sender.
10. Start and run engine at low idle.
11. With engine at low idle, extend and retract all cylinders three times: rotating bed jacks, mast cylinders, rotating bed pins (before mounting upperworks) and carbody jacks (if equipped).

    If oil level drops to 50%, a fault alarm will come on and a fault symbol will appear on the active display. HYDRAULIC FLUID LOW icon will appear on fault display (Figure 2-3). ***Fill tank immediately.***
12. With engine running at low idle, slowly cycle each crane function in both directions for at least five minutes to vent any remaining air from hydraulic system.
13. Be sure all crane functions operate in proper direction with relation to control handle movement.
14. Check for hydraulic leaks and correct cause if found.
15. Stop engine and fill hydraulic tank to proper level.

System Calibration and Tests

Control Calibration

Perform the Control Calibration procedure in this section.

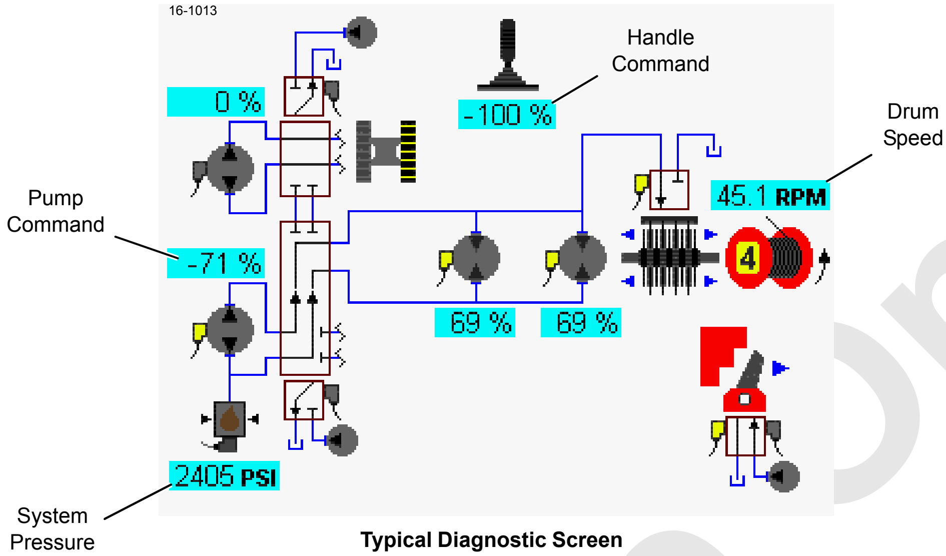
High Pressure Test

Perform the High Pressure Test procedure in this section.

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

Charge Pressure Test

Perform the Charge Pressure Test procedure in this section.



Typical Diagnostic Screen
(Screen for Drum 4 Shown)

FIGURE 2-18

Accessory System Checks

High Pressure Accessory System

High pressure accessories include:

- Rotating bed jacks
- Front and rear rotating bed pins
- Live mast cylinders
- Carbody jacks (if equipped)
- Crawler pins
- Counterweight pins
- Boom Hinge pins
- Cooling Fan
- Cab tilt
- Rigging winch

To operate these 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 is supported on the jacks.

1. Fully extend and retract jacks three to four times to remove air from cylinders.
2. Scroll to jacking diagnostic screen to verify that 3,000 psi (206 bar) is present when cylinders are fully extended and retracted (stalled).
3. When controls are off, cylinders must not retract. If they do, contact the Manitowoc Crane Care Lattice Team.
4. When retracting jacks, 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 rotating bed to adapter frame.

1. Unlock keeper plates to allow cylinders to operate.
2. Fully engage and disengage pins three to four times to remove air from cylinders.
3. Scroll to pins diagnostic screen to verify that 3,000 psi (206 bar) is present when pins are fully engaged and disengaged (stalled).

Live Mast Cylinders

Perform the following procedure when the mast is removed.

1. Fully raise and lower mast cylinders three to four times to remove air from mast cylinders.
2. Scroll to cab tilt, rigging winch, and mast diagnostic screen to verify that 3,000 psi (206 bar) is present when mast cylinders are fully extended (stalled) and 1,200 psi (88 bar) is present when mast cylinders are retracted.

CAUTION

Damage to Mast!

When raising mast for the first time or after maintenance of mast cylinder, raise mast slowly and check that both cylinders are raising mast evenly. 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 jacks three to four times to remove air from cylinders.
2. Scroll to jacking diagnostic screen to verify that 3,000 psi (206 bar) is present when cylinders are fully extended and retracted (stalled).
3. When controls are off, cylinders must not retract. If they do, contact the Manitowoc Crane Care Lattice Team.
4. When retracting jacks, carbody must lower slowly and smoothly.

Crawler Pins

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

1. Remove collars from ends of pins.
2. Fully engage and disengage pins three to four times to remove air from cylinders.
3. Scroll to pins diagnostic screen to verify that 3,000 psi (206 bar) is present when pins are fully engaged and

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 rear of 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 3,000 psi (206 bar) is present when pins are fully engaged and disengaged (stalled).

Boom Hinge Pins

Perform the following procedure after the hydraulic lines from 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 3,000 psi (206 bar) is present when pins are fully engaged and disengaged (stalled).

Cab Tilt

1. Fully raise and lower cab three to four times to remove air from cylinders (use switch in operator's cab).
2. Scroll to cab tilt diagnostic screen to verify that 3,000 psi (206 bar) is present when cylinders are fully engaged and disengaged (stalled).
3. When control is off, cylinders must not retract. If they do, contact the Manitowoc Crane Care Lattice Team.
4. When lowering cab, it must lower slowly and smoothly. If necessary adjust cab tilt flow meters as described in this section.

Rigging Winch (Optional):

1. Enable rigging winch (see instructions in Section 3 of Crane Operator Manual).
2. Operate winch several times in both directions to make sure it is operating properly and to remove air from system.
3. Scroll to cab tilt, rigging winch, and mast diagnostic screen to verify that 3,000 psi (206 bar) is present when operating 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, swing lock (past production), travel brake, travel 2-speed, diverting valves, and boom hoist pawl.

Swing Brake And Swing Lock

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.

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

1. Scroll to swing diagnostic screen to monitor swing component icons.
2. Turn off swing park, disengage swing lock, and attempt to swing crane by moving control handle in both directions.
3. Crane must swing freely.
4. Swing screen (past production) should indicate that swing park brake is released and swing lock is disengaged.
5. Swing screen (current production) should indicate that the swing park brake is released and the swing brake pressure senor will report to Node-5 the hydraulic pressure at the swing brake.
6. Bring upperworks to a complete stop, move control handle to off, turn on swing park and engage swing lock.
7. Swing handle should be inoperable.
8. Swing screen should indicate no handle or pump commands and that swing park brake is applied and swing lock is engaged.

Travel Brakes

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

1. Scroll to travel diagnostic screen to monitor travel component icons.
2. Turn off travel park and attempt to travel crane by moving control handles in both directions.
3. Crane must travel freely.
4. Travel screen should indicate that travel park brakes are released.
5. Turn on travel 2-speed. Travel speed should increase and travel screen should indicate that 2-speed is on.
6. Bring upperworks to a complete stop, move control handles to off, and turn on travel park.
7. Travel handles should be inoperable.
8. Travel screen should indicate no handle or pump commands and that 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 2-19).
2. Start and run engine at high idle.
3. Push both crawler control handles fully FORWARD to travel crane at full speed.
4. Have an assistant count number of revolutions timing marks make — must be within range given in Table 2-10.
5. If speed is not within specified range, contact the Manitowoc Crane Care Lattice Team.

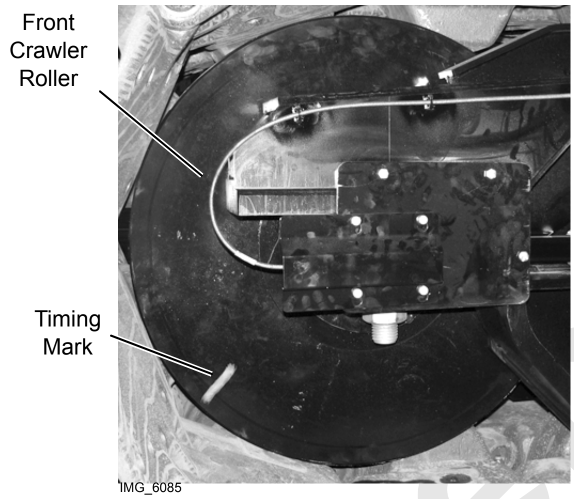


FIGURE 2-19

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 2-29) for swing and each drum with:

- 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.

2

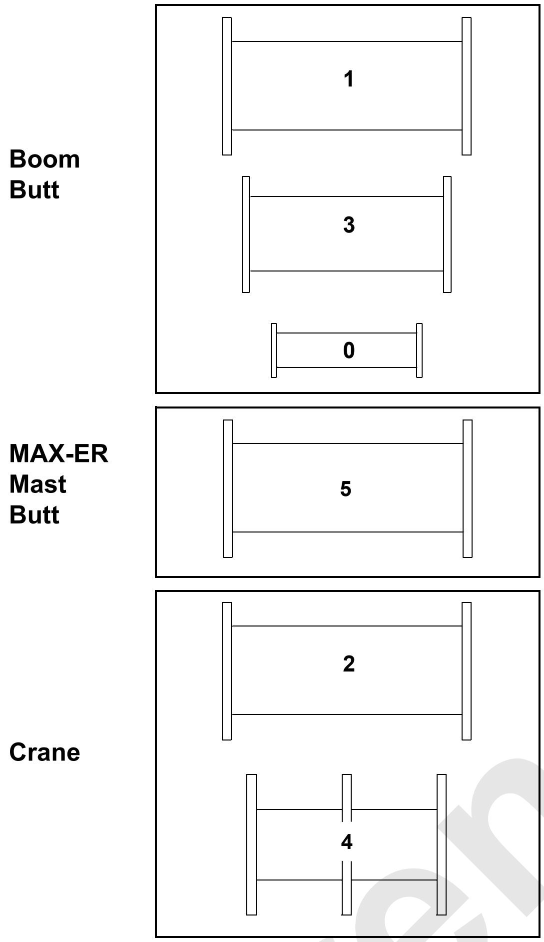
HYDRAULIC SYSTEM SPECIFICATIONS

Table 2-10 Hydraulic System Specifications

<table>
<tr><th>Function</th><th>Direction</th><th>Pump-Port</th><th>System Pressure 1 [1] psi (bar)</th><th>System Pressure 2 [2] psi (bar)</th><th>Charge Pressure psi (bar)</th><th>Speed [3] RPM</th></tr>
<tr><td rowspan="2">Drum 1</td><td>Hoist</td><td>Pump 4 - B</td><td rowspan="20">6,090 (420)</td><td>NA</td><td rowspan="20">350 (24)</td><td>50 - 55</td></tr>
<tr><td>Lower</td><td>Pump 4 - A</td><td>NA</td><td>44 - 52</td></tr>
<tr><td rowspan="2">Drum 2 (single drive)</td><td>Hoist</td><td>Pump 6 - B</td><td>NA</td><td>36 - 40</td></tr>
<tr><td>Lower</td><td>Pump 6 - A</td><td>NA</td><td>32 - 38</td></tr>
<tr><td rowspan="2">Drum 2 (dual drive)</td><td>Hoist</td><td>Pump 6 - B</td><td>NA</td><td>50 - 55</td></tr>
<tr><td>Lower</td><td>Pump 6 - A</td><td>NA</td><td>44 - 52</td></tr>
<tr><td rowspan="2">Drum 3 Past Production [8]</td><td>Up</td><td>Pump 2- B</td><td>NA</td><td>39 - 43</td></tr>
<tr><td>Down</td><td>Pump 2- A</td><td>NA</td><td>34 - 41</td></tr>
<tr><td rowspan="2">Drum 3 Current Production [8]</td><td>Up</td><td>Pump 2- B</td><td>NA</td><td>30 - 33</td></tr>
<tr><td>Down</td><td>Pump 2- A</td><td>NA</td><td>25 - 30</td></tr>
<tr><td rowspan="2">Drum 4</td><td>Up</td><td>Pump 3 - A</td><td>NA</td><td>36 - 40</td></tr>
<tr><td>Down</td><td>Pump 3 - B</td><td>NA</td><td>32 - 38</td></tr>
<tr><td rowspan="2">Drum 5</td><td>Up</td><td>Pump 3 - A</td><td>NA</td><td>50 - 55</td></tr>
<tr><td>Down</td><td>Pump 3 - B</td><td>NA</td><td>44 - 52</td></tr>
<tr><td rowspan="2">Swing</td><td>Left</td><td>Pump 5 - B</td><td>NA</td><td rowspan="2">1.2</td></tr>
<tr><td>Right</td><td>Pump 5 - A</td><td>NA</td></tr>
<tr><td rowspan="2">Right Crawler</td><td>Forward</td><td>Pump 1 - A</td><td>5,900 (407)</td><td rowspan="2">6.6 - 7 at Tumbler</td></tr>
<tr><td>Reverse</td><td>Pump 1 - B</td><td>5,900 (407)</td></tr>
<tr><td rowspan="2">Left Crawler</td><td>Forward</td><td>Pump 2 - B</td><td>5,900 (407)</td><td rowspan="2">6.6 - 7 at Tumbler</td></tr>
<tr><td>Reverse</td><td>Pump 2 - A</td><td>5,900 (407)</td></tr>
<tr><td>Low Pressure Accessory System [4]</td><td>NA</td><td>NA</td><td>400 (28) Standby
500 (34) Operation</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td>High Pressure Accessory System [5]</td><td>NA</td><td>NA</td><td>3,000 (207)</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td>Carbody Control System [6, 7]</td><td>NA</td><td>NA</td><td>3,000 (207)</td><td>NA</td><td>NA</td><td>NA</td></tr>
</table>

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 very plus or minus 5%.
4	Swing brakes, swing locks (past production), 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
8	Past Production 16001041 and prior. Current Production 16001042 and later.

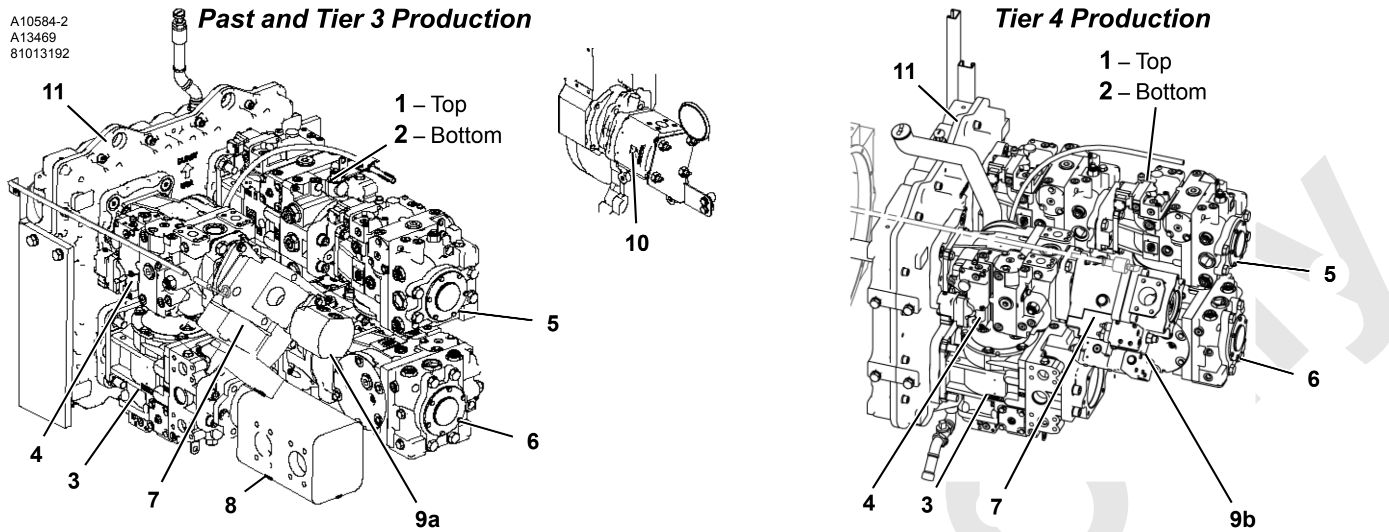
DRUM IDENTIFICATION



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 2-20

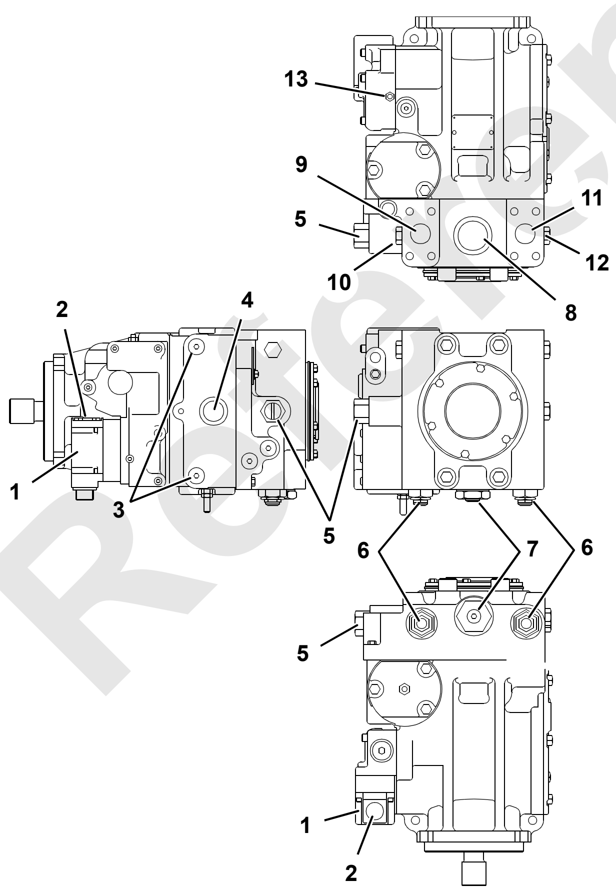
PUMP IDENTIFICATION



Item	Description	Item	Description	Item	Description
1	Right Crawler and Drum 4 Pump	5	Swing Pump	9a	Acc. Sys. Fixed Gear Pump (Past, T3 Prod.)
2	Left Crawler and Drum 3 Pump	6	Drum 2 and Drum 1 Pump	9b	Acc. Sys. Fixed Gear Pump (Tier 4 Prod.)
3	Drum 4 and Drum 5 Pump	7	Accessory System Variable Uni-directional Pump	10	Fan Pump (Front of Engine)
4	Drum 1 and Drum 2 Pump	8	Super Charge Pump (Past,T3 Prod.)	11	Pump Drive

FIGURE 2-21

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

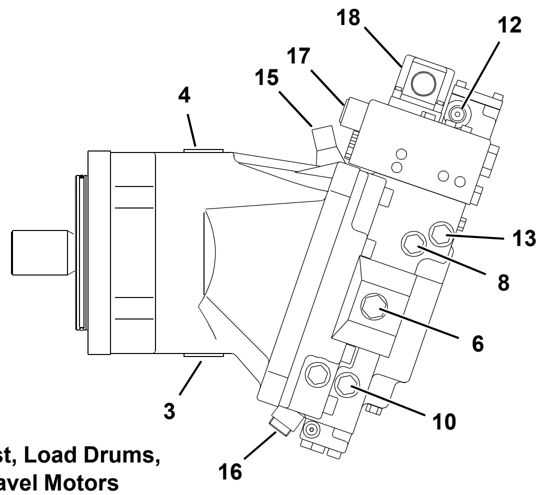
NOTE 1: Both Sides of Pump

NOTE 2: Valve is Directly Opposite Port it Protects.

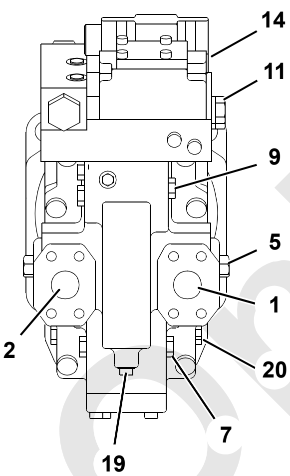
FIGURE 2-22

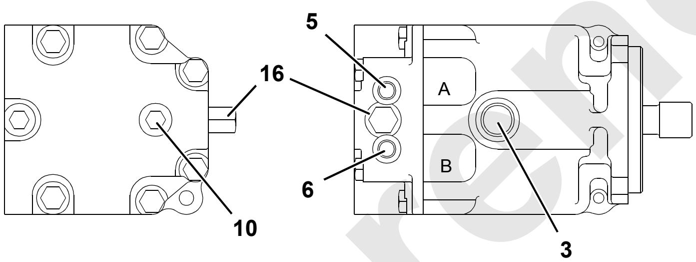
MOTOR COMPONENTS

A1188



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 2-23

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 operation of the main display and touch pad controls, READ instructions in Section 3 or the Crane Operator Manual.

The Pressure Test and Calibration Screen (see Figure 2-24 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.

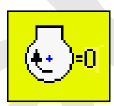
Pressure Test and Calibration screen operates on two ***levels***.

Level 1 — Test data box highlighted blue.

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

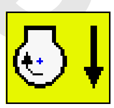
All test and calibration procedures must be run at a particular engine speed. If a test is started at the wrong speed, the appropriate prompt shown below appears in the data box and the procedure is aborted.

Engine Off



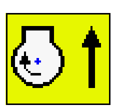
The yellow engine pressure **0** icon indicates that the test must be run with engine off.

Engine Low Idle

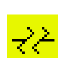


The yellow engine pressure **down arrow** icon indicates that the test must be run with engine at low idle.

Engine High Idle



The yellow engine pressure **up arrow** icon indicates that the test must be run with 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 2-24 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.

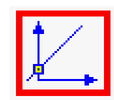
Perform this test when:

- 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 2-27.

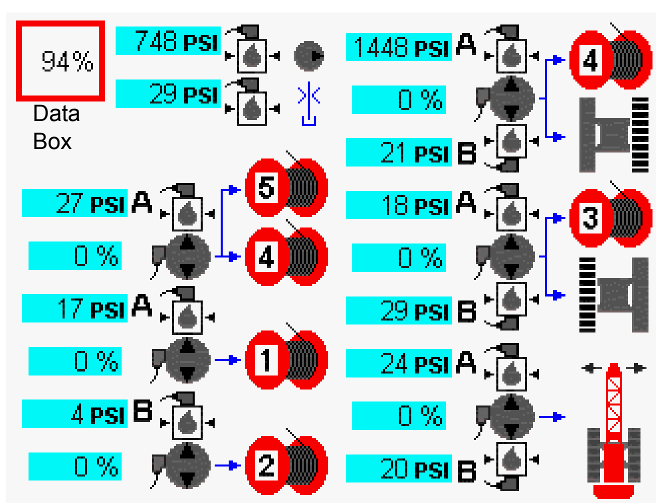
Test pressure senders as follows:

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



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

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



D16-26AA

FIGURE 2-24

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 pressure sender test.
- Attach an accurate hydraulic pressure gauge to the quick-coupler at the suspect pressure transducer (see topic in this section).
- If pressure appears on the gauge, bleed the corresponding system so the gauge reads zero pressure.
- Repeat pressure sender test and check 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 2-25 for the following procedure.

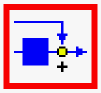
Control calibration calculates the pump threshold command level for all drum and swing functions. The allowable range is 5 to 25% pump command signal for the hoist pumps and 2.5 to 20% in each direction for the swing pump(s).

Perform this calibration when:

- 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 threshold is in error.
    - Excessive handle motion or time required to initiate motion
    - Inability to start motion smoothly

Calibrate controls as follows:

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



5. Press Confirm button to start test.
6. Calibration starts and percent of completion is displayed in data box.
7. When calibration is complete, control calibration icon reappears in 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 yellow. Troubleshoot failed circuit to determine cause of fault.

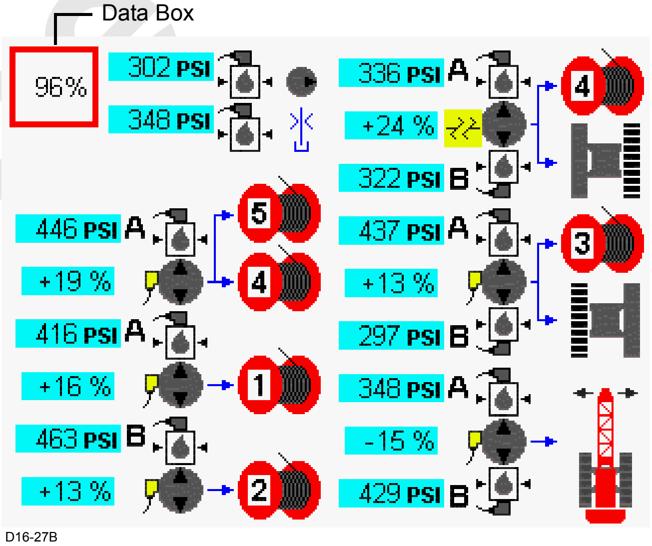


FIGURE 2-25

2

High Pressure Test

See Figure 2-26 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!

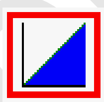
This test generates maximum pressure in the main hydraulic circuits. Defective brakes may allow unintended motion during test. Move the crane to an area where such motion is not a hazard.

Use a signal person to monitor functions operator cannot see.

Be prepared to stop engine if unintended motion occurs.

Test high pressure as follows:

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



5. Press Confirm button to start test.
6. Test starts and percent of completion is displayed in data box.
7. When test is complete, high pressure icon reappears in 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 failed circuit to determine cause of fault.

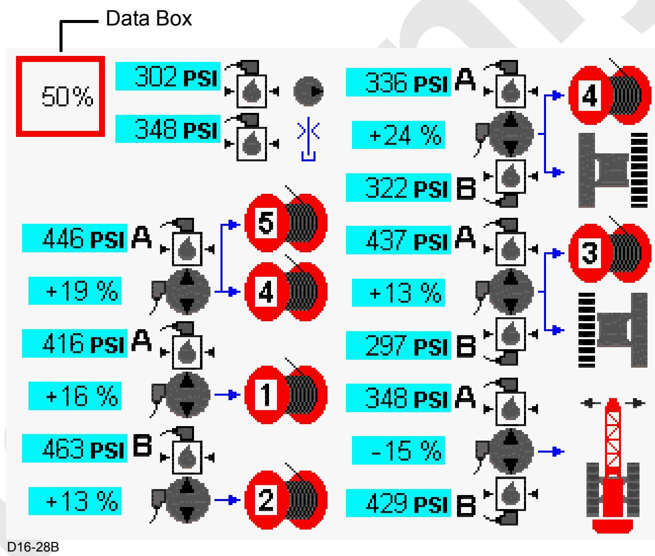


FIGURE 2-26

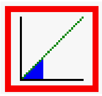
Charge Pressure Test

See Figure 2-27 for the following procedure.

The charge pressure test checks the ability of all primary cane 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 275 to 400 psi (19 to 27 bar).

Test charge pressure as follows:

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



5. Press Confirm button to start test.
6. Test starts and percent of completion is displayed in data box.
7. When test is complete, charge pressure icon reappears in 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 yellow. Troubleshoot failed circuit to determine cause of fault.

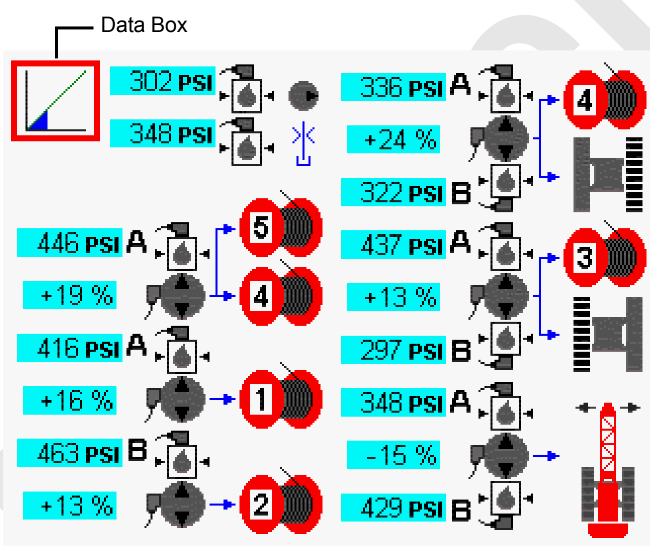


FIGURE 2-27

High Pressure Adjustment

The following adjustment is only required when a system fails the High Pressure Test described in this section.

Unless otherwise specified, see Figure 2-28 for the following procedure.

1. Scroll to diagnostic screen for corresponding function (see Figure 2-29).
2. Disconnect electric connector from corresponding brake solenoid valve (see Figure 2-16).
3. With engine running at low idle, slowly move 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 screen should indicate pressure specified in Table 2-10.
6. If proper pressure is not indicated, adjust corresponding multi-function valve:
   - **a.** Remove protective cap (3) from multi-function valve (1 or 2). See Table 2-10 and Figure 2-22 for pump port identification.
   - **b.** Loosen lock nut (4).

     DO NOT tamper with bypass hex (6). See pump manufacturer's instructions.
   - **c.** Using an internal hex wrench, adjust multi-function valve adjusting screw (5).
     - Turn IN to INCREASE pressure
     - Turn OUT to DECREASE pressure
7. Repeat step 6 until specified pressure is indicated.
8. Hold adjusting screw (5) in position and securely tighten lock nut (4).
9. Install protective cap (3).
10. Reconnect electric connector to corresponding brake solenoid valve (see Figure 2-16).

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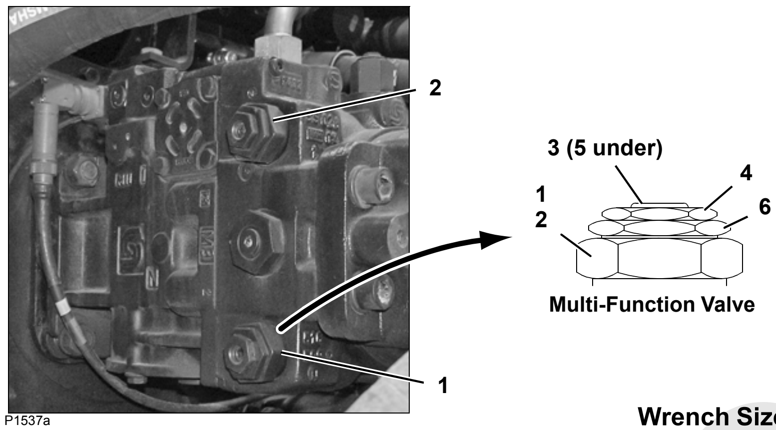
Typical Pump Installation



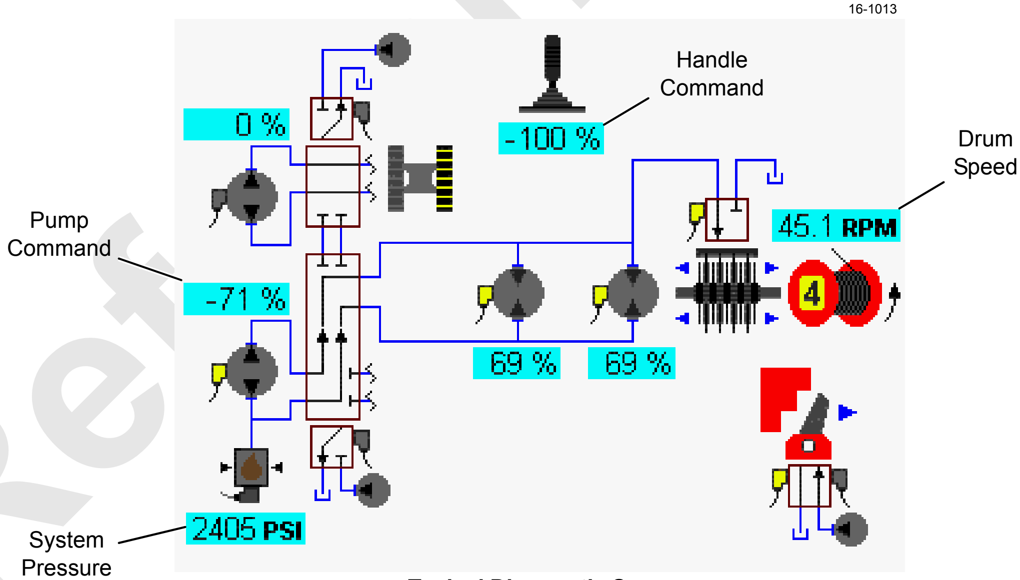
Item	Description
1	Port A Multi-Function Valve
2	Port B Multi-Function Valve
3	Protective Cap
4	Lock Nut
5	Adjusting Screw
6	Bypass Hex

Wrench Size

Pump Size	Lock Nut Hex Size	Internal Hex Size
Series 042 -100 Units	19 mm	5 mm
Series 130 Units	13 mm or 24 mm	4 mm or 8 mm

FIGURE 2-28

16-1013



Typical Diagnostic Screen
(Screen for Drum 4 Shown)

FIGURE 2-29

Charge Pressure Adjustment

The following adjustment is only required when a system fails the Charge Pressure Test described in this section.

1. Scroll to diagnostic screen for corresponding function (see Figure 2-29).
2. Start and run engine at high idle. With function in neutral, system pressure on diagnostic screen should read 320 to 370 psi (22 to 26 bar).
3. If specified pressure is not indicated, stop engine and connect an accurate 0 to 1,000 psi (0 to 69 bar) hydraulic pressure gauge to coupler at corresponding pressure sender (see Figure 2-35).
4. Repeat step 2. If specified pressure is still not indicated:
   - Do a Pressure Sender Test as instructed in this section. Replace faulty pressure sender if needed.
   - Do a Control Calibration as instructed in this section.

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

   See Figure 2-30 for the following procedure.

   a. Loosen lock nut (1).

   b. Adjust adjusting plug (2).
      - Turn IN to INCREASE pressure
      - Turn OUT to DECREASE pressure

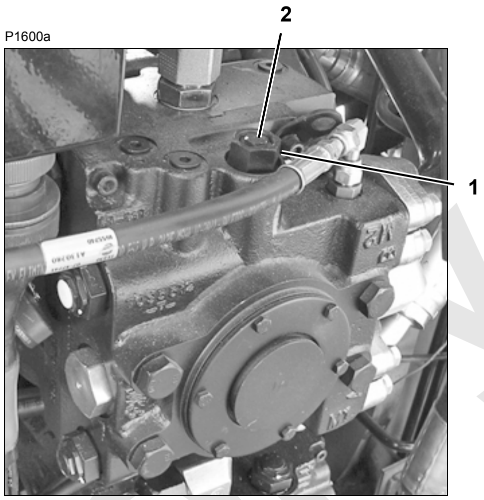
   c. Once specified pressure is indicated, hold adjusting plug (2) in position and securely tighten lock nut (1).
6. Stop engine and remove gauge from transducer gauge port.

Pump Neutral Adjustment

See Figure 2-31 for the following procedure.

To adjust pump neutral:

1. Park all crane functions and stop engine.
2. Disconnect electric connector from pump EDC (see Figure 2-34).
3. Install an accurate 0 to 1,000 psi (0 to 69 bar) hydraulic pressure gauge in each servo gauge port (1).
4. Start and run engine at high idle.



Typical Pump Installation

Item	Description	Hex Wrench Size
1	Lock Nut	1/2 inch
2	Adjusting Plug Series 030-100	1-1/16 inch
	Adjusting Plug Series 030-100	1-5/8 inch

FIGURE 2-30

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

Low Pressure Accessory Adjustment

See Figure 2-32 for the following procedure.

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

If you think that a low pressure accessory system is not operating properly, proceed as follows:

1. Install an accurate 0 to 1,000 psi (0 to 69 bar) hydraulic pressure gauge between end of supply line and corresponding port of actuator (brake port, for example).

   Fittings are 06 ORS.

2. Release brake by slowly moving control handle in either direction to operate corresponding function — pressure should be 400 to 500 psi (28 to 35 bar).

3. Apply brake by moving control handle to off — pressure should be zero.

4. If pressure is above 500 psi (35 bar), proceed as follows:

   a. Loosen lock nut (2).

   b. Adjust adjusting screw (3).

      - Turn IN to INCREASE pressure
      - Turn OUT to DECREASE pressure

   c. Start and run engine at high idle.

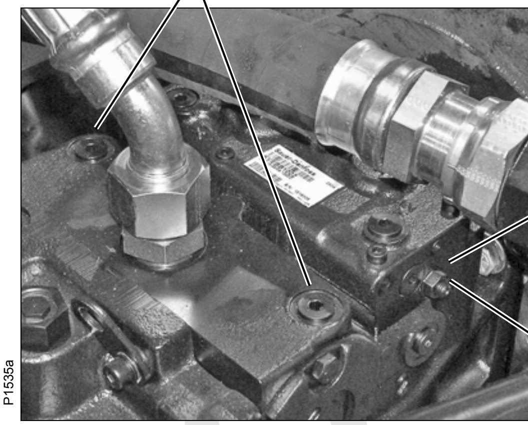
   d. Fully RETRACT (stall) a rotating bed jack with switch on setup remote control only long enough to get a gauge reading.

   e. Repeat steps until gauge reads no higher than 500 psi (35 bar).

   f. Hold adjusting screw in position and securely tighten locknut.

5. Stop engine, remove gauge, and reconnect hydraulic lines.

Typical Pump Installation

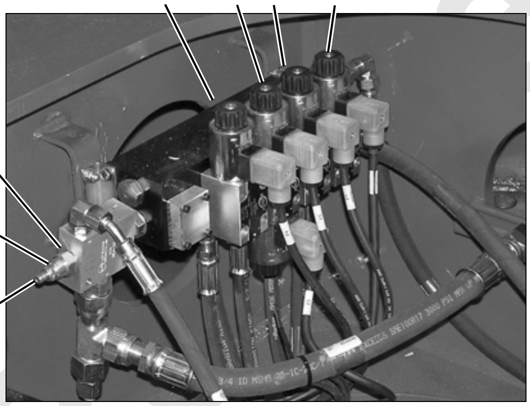


Item	Description
1	Servo Gauge Ports (SAE 06)
2	Lock Nut
3	Adjusting Screw

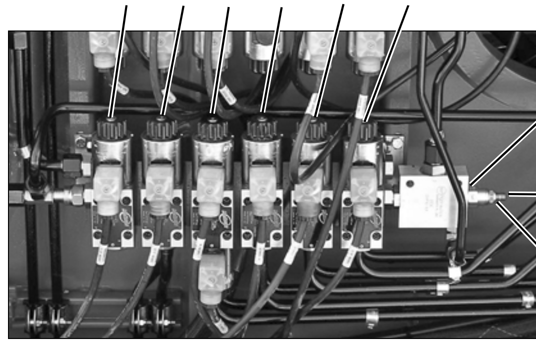
Wrench Size

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

FIGURE 2-31



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 2-32

Motor Leakage Test

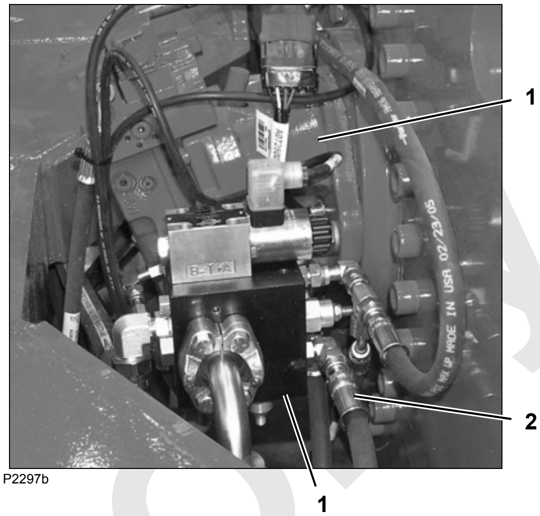
Perform the following test if troubleshooting indicates the need:

- Low Charge Pressure
- Sluggish Operation
- Excessive Heat

See Figure 2-33 for the following procedure.

1. Stop engine.
2. Install an accurate flow meter in highest case drain port (see Figure 2-16) at desired motor.
   - A 3,000 psi (207 bar) in-line meter with a flow rate of 30 gpm (114 L/m) is required.
   - All motors except swing require 16 ORS fittings. Swing requires 12 ORS fittings.
3. For hoist motors only, disable loop flushing as follows:
   a. Disconnect loop flushing hose (2) from elbow in loop flushing valve (1).
   b. Install an 08 ORS cap on end of elbow and an 08 ORS plug in end of hose.
4. Start and run engine at high idle.
5. Monitor flow meter. Under all operating conditions, leakage should not be more than 1-1/2 to 2-1/2 gpm (5,7 to 9,5 L/m.
6. Stop engine and enable loop flushing by reconnecting hose to elbow in loop flushing valve.
7. Start and run engine at high idle.
8. Monitor flow meter. Under all operating conditions, leakage should not be more than 5-1/2 to 6-1/2 gpm (20,8 to 24,6 L/m).
9. If motor leakage without loop flushing is not within specified range, REPLACE motor and pump.
10. If motor leakage with loop flushing is not within specified range, REPLACE loop flushing valve and/or motor and pump depending on which is the cause for high leakage.

Typical Motor Installation



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

FIGURE 2-33

Loop Flushing Valve Adjustment

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

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

Manual Override Tests

The pumps, motors, and solenoid valves are equipped with manual overrides that allow electric 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 crane when operating any manual override:

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

Pump or Motor Override

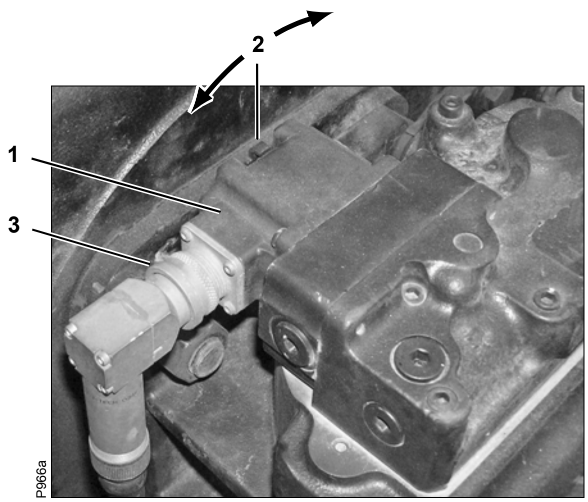
See Figure 2-34 for the following procedure.

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

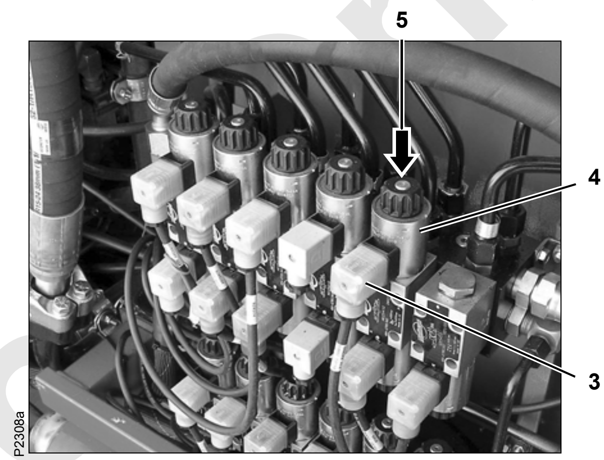
Solenoid Valve Override

See Figure 2-34 for the following procedure.

1. Start and run engine at low idle.
2. Insert a rigid steel rod through hole in end of valve cap.
3. Depress valve spool with rod.
4. If valve is operating properly, corresponding side of 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 2-34

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 exhaust from pressure sender ports.

See Figure 2-35 for identification of pressure senders.

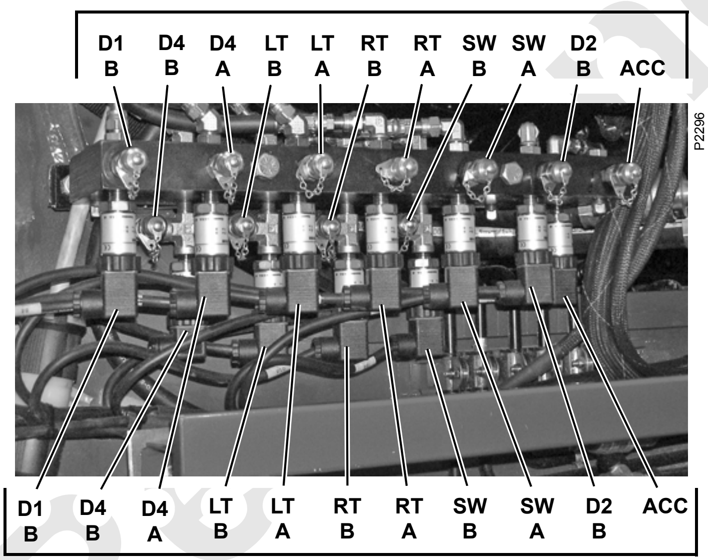
1. Lower all loads to ground.
2. Move all control handles to off and park all crane functions.
3. ***Stop engine.***
4. Place a suitable container under pressure senders to catch oil leakage.

Perform steps 5 – 9 only at faulty pressure senders.

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

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

Gauge Ports



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 2-35

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 2-16 shows the brake and brake solenoid valve locations.

NOTE: See Table 2-10 system pressure specifications.

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

1. Disconnect electric connector for brake being checked.
2. Start and run engine at low idle (850 to 950 RPM).
3. Select corresponding Liftcrane Boom Capacity Chart on the RCL screen.
4. Turn off park switch on control console for function being checked.
5. Access diagnostic screen (Figure 2-29) for function being checked – Drum, Boom Hoist, Swing, or Travel.

   Monitor system pressure and pump command while moving control handle.
6. Slowly move control handle for function being checked. Specified system pressure must be reached before 50% pump command is reached and ***brake must not slip***.
7. Repeat steps or 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 operational test is performed, repair or replace it before placing crane back into service. Loads could fall or crane could move if brakes are not operating properly.

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

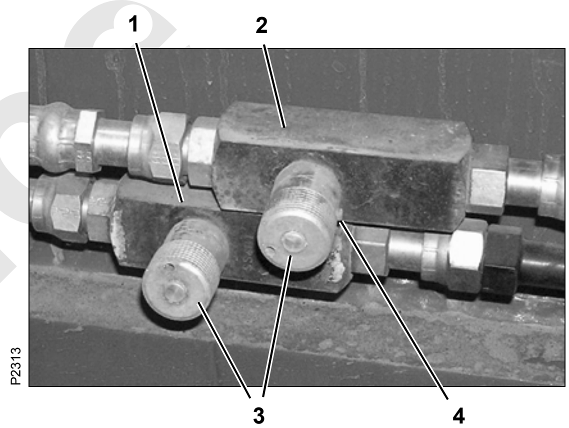
8. Reconnect electric connector to all brake solenoid valves at completion of operational test.
9. If disc brakes were repaired or replaced, retest brakes before operating with a load.

Cab Tilt Adjustment

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

See Figure 2-36 for the following procedure.

1. Loosen set screws.
2. Turn knobs fully CLOCKWISE to CLOSE valves.
3. Open both valves slightly.
4. Test cab tilt operation with switch on control console in cab.
5. Repeat steps until cab tilt starts and stops smoothly in both directions.
6. Securely tighten 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 2-36

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.

CHECKING AND REPLACING ELECTRICAL COMPONENTS

DANGER

Electrical Shock Hazard!

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

1. Visually inspect all electrical harnesses and cables every month or at 200 hours of service life for the following:
   a. Damaged, cut or deteriorated harness loom covering
   b. Damaged, cut or abraded individual wires or cable insulation
   c. Exposed bare copper conductors
   d. Kinked, crushed, flattened harnesses or cables
   e. Blistered, soft, degraded wires and cables
   f. Cracked, damaged, or badly corroded battery terminal connections
   g. Inspect all machine ground connections for damaged terminals or excessive corrosion.
   h. Other signs of significant deterioration

   If any of these conditions exist, evaluate the harness for repair or replacement.
2. At the same service interval, visually inspect all Controller Area Network (CAN) nodes and electrical junction boxes for the following:
   a. Damaged or loose connectors
   b. Damaged or missing electrical clamps or tie straps
   c. Excessive corrosion or dirt on the junction boxes
   d. Loose junction box mounting hardware

   If any of these conditions exist, address them appropriately.

   See Table 3-1 below for the following items.
3. Harness and battery cables operating in climate ***zone C*** are recommended to be replaced after 10,000 hours of service life.
4. Harness and cables operating in climate ***zone A*** and ***zone B*** with high ambient temperatures and high duty circuits could see electrical service life reduced by 25% to 40%. It is recommended to replace these assemblies after 8,000 hours of service life.
5. Harness and cable assemblies operating in climate ***zone D*** and ***zone E***, cold climates, should expect a degrade of mechanical properties and long term exposure to these cold temperatures will negatively impact service life. It is recommended for these electrical harnesses and cable assemblies to be inspected to step 1 above as service life may be more than 10,000 hours.
6. Harness and cable assemblies operating in salt water climates could see a significant reduction in service life. Therefore it is recommended for these electrical harnesses and cable assemblies to be inspected to step 1 above as service life may be more than 8,000 hours.

Table 3-1 Climate Zone Classification:

Item	Description
A	Tropical Moist: All months average above 65°DF (18°C) 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

This section identifies the fuses and circuit breakers.

Fuses are mounted in the fuse junction box located in the Operator's Cab, under the right-hand console (Figure 3-1) or the CRANESTAR TCU Harness connection at the batteries.

Circuit breakers are mounted in the following locations:

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

NOTE: CB-3 is 10 Amps for Tier 3 engines and 30 Amps for Tier 4 engines.

Circuit breakers ABCB1 through ABCB4 and fuses F1, F2, and F3 are mounted in load center under operator's seat.

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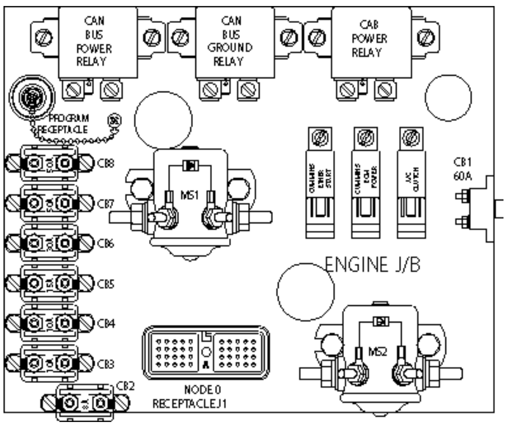

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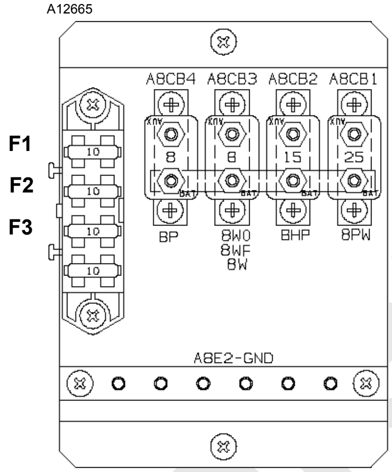

Circuit Breaker	Amps	Wire No.	Description of Items Protected
			Cummins QSX 15 Engine Only
CB-1	60	6	Main System 24 Volt Power
CB-2	8	6C2	Electronic Control Module (Cummins)
CB-3[1]	10	6C6	Electronic Control Module (Cummins)
CB-3[2]	30	6C6	Electronic Control Module (Cummins)
CB-4	10	6C8	Engine Stop, 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
A8CB1	8	8PW	24/12 Volt DC Converter
A8CB2	8	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

1 Tier 3 Engine

2 Tier 4 Engine

FIGURE 3-1

Circuit Breaker	Amps	Description of Items Protected
Cold Weather Package Circuit Breakers (Past Production)		
1	50	Cold Weather Package Main Load Center Circuit Breaker
2	20	Engine Coolant Heater, Engine Oil Heater
3	15	Hydraulic Reservoir Heaters – Left or Right
4	15	Hydraulic Reservoir – Left or Right, Cab Console and Battery Pad Heaters

3

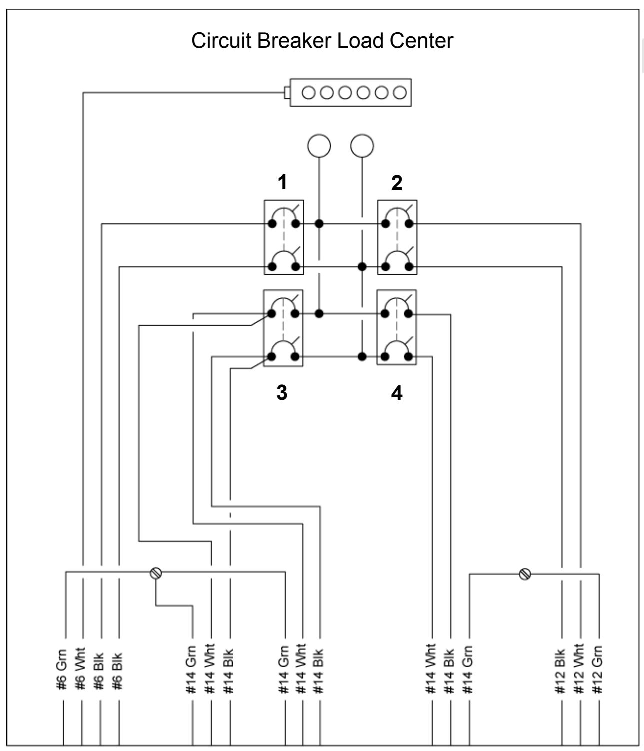

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FIGURE 3-2

Circuit Breaker	Amps	Description of Items Protected
Cold Weather Package Circuit Breakers (Current Production)		
1	50	Cold Weather Package Main Load Center Circuit Breaker
2	20	Engine Coolant Heater, Engine Oil Heater
3	15	Hydraulic Reservoir, Cab Console and Battery Pad Heaters
4		Spare

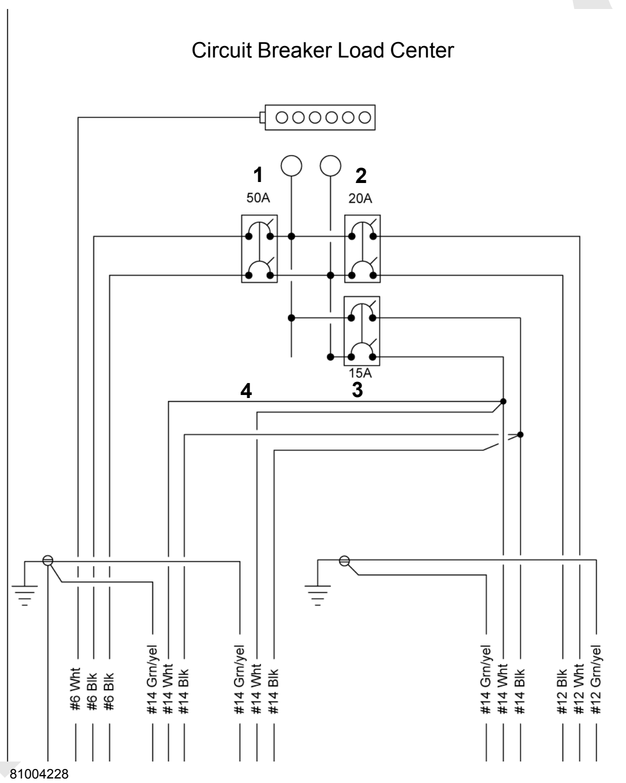
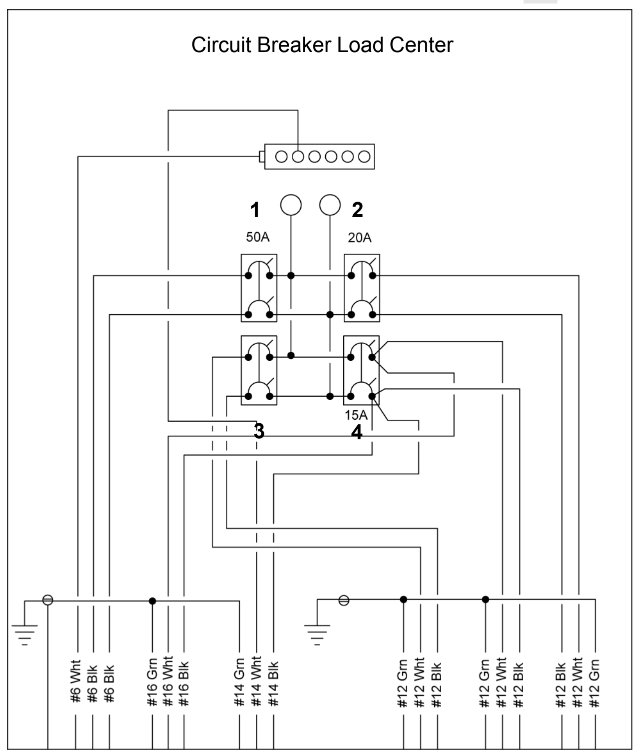


FIGURE 3-3

Circuit Breaker	Amps	Wire No.	Description of Items Protected
Air Conditioner & Heater Assembly Fuses			
A0A8CB2	15	8 HP	ECM/Power Interface Module, Cab Temp Sensor, Blower Motor, Evaporator Thermostat, Electric Water Valve
A0A8CB3	15	8W	Front Wiper, Overhead Wiper



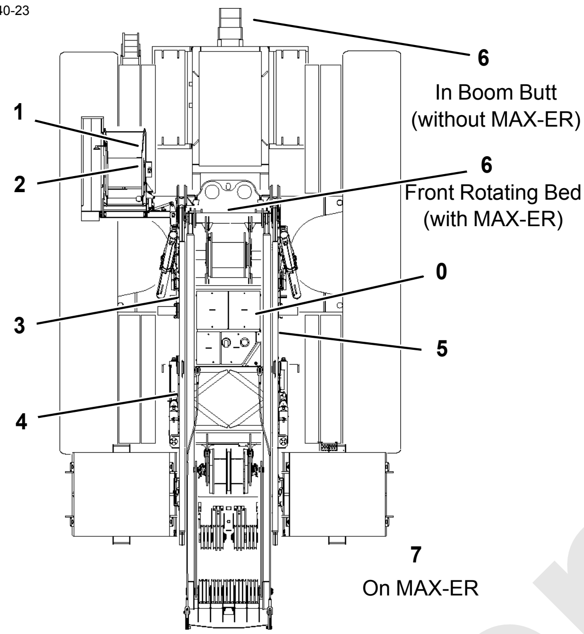
A17735_3

FIGURE 3-4

TEST VOLTAGES

The Model 16000 operating system is an EPIC® with CAN Bus® technology. The CAN Bus system uses multiple nodes that contain controllers. The controllers communicate with 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 of each node.

This section contains test voltages sorted by nodes. The nodes are listed and identified in Figure 3-5.



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
20 (Boom)	Mounted on Boom – Block-Up, Angle Indicator, Wind Speed, and Load Sensor.
21 (Jib)	Mounted on Jib – Block-Up, Angle Indicator, Wind Speed, and Load Sensor.

FIGURE 3-5

Node Heading Descriptions

The CAN ID. NO. indicates the CAN BUS system node number, cable, receptacle number, and pin number code (**34-R**) is as follows:

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 number ***R*** is the ***pin number*** of the receptacle.

FUNCTION TYPE — indicates the type of connection - such as power, ground, signal, analog input (AI), digital input (DI), or digital output (DO).

RECPT/PIN NO. — (Engine Node-0 only) indicates input to receptacle number and pin number code (J2-1).

WIRE NO. — (Engine Node-0 only) indicates wire to computer receptacle (0107) or wire number code (6C12A).

DESCRIPTION — indicates the component item.

PACKET CODE NO — indicates location of items for master node 1, node 2, universal nodes (3, 4 & 5), boom node 20, and luffing jib node 21. Engine node-0 does not have packet code numbers.

Master node-1:

CAN129-3-4 (Drum 1 Park Switch) indicates where the inputs/output are located on the node:

CAN129 is the ***packet*** location number.

Number ***3*** is the ***bank*** where information is stored.

Number ***4*** is the ***identifier*** for that item.

Alphabetical Index of Components

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

Component	Location
Accessory System Components	Node 3 & 4
Alarms	Nodes1, 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	Nodes 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	Nodes 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

The following abbreviations are used in test voltage tables:

AC	=	Alternating Current
A/C	=	Air Conditioning
AI	=	Analog Input
AO	=	Analog Output
AUX.	=	Auxiliary
CAN	=	Controller Area Network
CANH	=	Controller Area Network - High
CANL	=	Controller Area Network - Low
CHA or CHB	=	Channel A or B
DC	=	Direct Current
DI	=	Digital Input
DO	=	Digital Output
EC	=	Encoder Control
ENC	=	Encoder Number Count
GND	=	Ground
ID	=	Identification
I/O	=	Input/Output
L.E.D.	=	Light Emitting Diode
Max.	=	Maximum
Min.	=	Minimum
N/A	=	Not Applicable
N/C	=	No Connection
NO	=	Number
NS	=	Node Select
Opt.	=	Optional
RCL	=	Rated Capacity Indicator/Limiter
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 70°F (21°C) coil.

Node 1 — Master (Front Console)

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

CAN ID # Connector #	Function Type	Description	Test Voltages	Packet Code No.
P11	**Receptacle – Front Console (Unused Terminals are Omitted)**			
P11-1	24 Volts	Power from Node-3 to Node-1	24 Volts Nominal	
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	
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	
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	
P11-30	Ground	RCL Warning L.E.D.	Ground	
P11-31	CANH	CAN High Data Line to Node-2	N/A	
P11-32	CANL	CAN Low Data Line to Node-2	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	
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	
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	
P12-32	CANL	CAN Low Data Line to Bar Graph Display	N/A	
P12-33	DI-19	DPF Regen Disable (Inhibit)	0 Volts Off; 24 Volts On	CAN129-5-4
P12-34	DI-21	DPF 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.

Wire No.	Function Type	Description	Test Voltage	Packet Code No.
P51	**Receptacle – Controls (Unused Terminals are Omitted)**			
P51-1	CAN-H	CAN High Data Line to Set-Up Receiver	N/A	
P51-2	CAN-L	CAN Low Data Line to Set-Up Receiver	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	
P51-12	CAN-L	CAN Low Data Line to Node 1	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	
P51-22	AI Ground	Handles and Node Select Ground	Ground	
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	
P51-32	Node 1	Node Select 1 Jumper to Ground	0 Volts (With Jumper)	
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	
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	
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	
P52-24	Ground	Handle (H2) Rotation Indicator	Ground	
P52-25	Ground	Handle (H3) Rotation Indicator	Ground	
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	
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	
P52-34	5 Volts DC	Handle (H2) Power	5 Volts DC Nominal	
P52-35	5 Volts DC	Handle (H3) Power	5 Volts DC Nominal	
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	
P52-40	5 Volts DC	Right Travel Handle Power	5 Volts DC Nominal	
P53	**Receptacle – Controls (Unused Terminals are Omitted)**			
P53-A	Ground	To Setup Receiver	Ground	
P53-B	Ground	Boom Handle Rotation Indicator	Ground	
P53-E	24 Volts	To Setup Receiver	24 Volts Nominal	
P53-F	24 Volts	Bar Graph Display	24 Volts Nominal	

*1 – Lower four bits can be multiplied by 5 or 10 depending on sender, then divided by 16 for an estimation of sender voltage.
*2 – Number in 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.

CAN ID. No.	Function Type	Description	Test Voltage	Packet Code No.
Input/output cable routing to remote nodes vary - see Electrical Schematic specific to your crane.				
W33	**Receptacle — Pressure Senders and Accessories**			
33-A	Ground	Cab Tilt/Rotate Solenoid - Up	Ground	
33-B	DO-1	Cab Tilt/Rotate Solenoid - Up	0 Volts Off; 24 Volts On	CAN25-1-1
33-C	Ground	Cab Tilt/Rotate Solenoid - Down	Ground	
33-D	DO-2	Cab Tilt/Rotate Solenoid - Down	0 Volts Off; 24 Volts On	CAN25-1-2
33-E	Ground	Rear Rotating Bed Pin Solenoid - Extend	Ground	
33-F	DO-3	Rear Rotating Bed Pin Solenoid - Extend	0 Volts Off; 24 Volts On	CAN25-1-4
33-G	Ground	Rear Rotating Bed Pin Solenoid - Retract	Ground	
33-H	DO-4	Rear Rotating Bed Pin Solenoid - Retract	0 Volts Off; 24 Volts On	CAN25-1-8
33-J	Ground	Boom Hinge Pin Solenoid - Extend	Ground	
33-L	NS-2	Node Select Jumper to Ground	0 Volts (With Jumper)	
33-N	Ground	Boom Hinge Pin Solenoid - Retract	Ground	
33-P	DO-6	Boom Hinge Pin Solenoid - Retract	0 Volts Off; 24 Volts On	CAN25-1-32
33-R	DO-5	Boom Hinge Pin Solenoid - Extend	0 Volts Off; 24 Volts On	CAN25-1-16
33-T	DI-3	Super Charge Pressure Switch	0 Volts Off; 24 Volts On	CAN45-1-4
33-U	24 Volts	Super Charge Pressure Switch	24 Volts Nominal	
33-g	Ground	Swing Left Pressure Sender	Ground	
33-h	Ground	Jumper to Node Select	Ground	
33-m	Ground	Swing Right Pressure Sender	Ground	
33-n	24 Volts	Swing Left Pressure Sender	24 Volts Nominal	
33-p	AI-7	Swing Left Pressure Sender	1 V at 0 psi; 5 V at 7,000 psi	CAN5-6 *1
33-r	AI-8	Swing Right Pressure Sender	1 V at 0 psi; 5 V at 7,000 psi	CAN5-8 *1
33-s	24 Volts	Swing Right Pressure Sender	24 Volts Nominal	
W34	**Receptacle - Drum Pumps and Alarm**			
34-A	Ground	Left Side Swing/Travel Alarm	Ground	
34-B	DO-11	Left Side Swing/Travel Alarm	0 Volts Off; 24 Volts On	CAN25-2-4
34-C	Ground	Accessory Proportional Relief Solenoid	Ground	
34-D	DO-12	Accessory Proportional Relief Solenoid	0 Volts Off; Variable Volts On	CAN25-2-8
34-E	Ground	Pump 4 Control (Drum 1/Drum 2)	Ground	
34-F	DO-13	Pump 4 Control (Drum 1/Drum 2)	See Table 3-2, page 3-8	CAN25-2-16
34-G	Ground	Pump 4 Control (Drum 1/Drum 2)	Ground	
34-H	DO-14	Pump 4 Control (Drum 1/Drum 2)	See Table 3-2, page 3-8	CAN25-2-32
34-J	Ground	Pump 3 Control (Drum 4/Drum 5)	Ground	
34-K	Ground	Pump 6 Control (Drum 2/Drum 1)	Ground	
34-L	Ground	Pump 6 Control (Drum 2/Drum 1)	Ground	
34-M	DO-17	Pump 6 Control (Drum 2/Drum 1)	See Table 3-2, page 3-8	CAN25-3-1
34-N	Ground	Pump 3 Control (Drum 4/Drum 5)	Ground	
34-P	DO-16	Pump 3 Control (Drum 4/Drum 5)	See Table 3-2, page 3-8	CAN25-2-128

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34-R	DO-15	Pump 3 Control (Drum 4/Drum 5)	See Table 3-2, page 3-8	CAN25-2-64
34-S	DO-18	Pump 6 Control (Drum 2/Drum 1)	See Table 3-2, page 3-8	CAN25-3-2
34-T	Ground	Pump 2 Control (Left Travel/Drum 3)	Ground	
34-U	DO-19	Pump 2 Control (Left Travel/Drum 3)	See Table 3-2, page 3-8	CAN25-3-4
34-V	Ground	Pump 2 Control (Left Travel/Drum 3)	Ground	
34-W	DO-20	Pump 2 Control (Left Travel/Drum 3)	See Table 3-2, page 3-8	CAN25-3-8
34-X	Ground	Pump 1 Control (Right Travel/Drum 4)	Ground	
34-Z	DO-21	Pump 1 Control (Right Travel/Drum 4)	See Table 3-2, page 3-8	CAN25-3-16
34-a	Ground	Pump 1 Control (Right Travel/Drum 4)	Ground	
34-b	DO-22	Pump 1 Control (Right Travel/Drum 4)	See Table 3-2, page 3-8	CAN25-3-32
34-c	Ground	Pump 5 Control (Swing)	Ground	
34-d	DO-23	Pump 5 Control (Swing)	See Table 3-2, page 3-8	CAN25-3-64
34-e	Ground	Pump 5 Control (Swing)	Ground	
34-f	DO-24	Pump 5 Control (Swing)	See Table 3-2, page 3-8	CAN25-3-128
34-g	Ground	Jumper to Node Select 2	Ground	
34-j	NS-2	Node Select Jumper to Ground	0 Volts (With Jumper)	
W36	**Receptacle — Angle Sensors, Alarm and Drum Pawl**			
36-A	Ground	Left Side RCL Capacity Alarm	Ground	
36-B	DO-7	Left Side RCL Capacity Alarm	0 Volts Off; 24 Volts On	CAN25-1-64
36-C	Ground	Drum 2 Left Side Motor Control (Optional)	Ground	
36-D	DO-8	Drum 2 Left Side Motor Control (Optional)	See Table 3-2, page 3-8	CAN25-1-128
36-E	Ground	Boom/Mast Hoist (Drum 4) Pawl Sol. - Out	Ground	
36-F	DO-9	Boom/Mast Hoist (Drum 4) Pawl Sol. - Out	0 Volts Off; 24 Volts On	CAN25-2-1
36-G	Ground	Boom/Mast Hoist (Drum 4) Pawl Solenoid - In	Ground	
36-H	DO-10	Boom/Mast Hoist (Drum 4) Pawl Solenoid - In	0 Volts Off; 24 Volts On	CAN25-2-2
36-J	DI-8	Hydraulic Return Filter Alarm Switch (Bottom)	0 Volts Off; 24 Volts On	CAN45-1-128
36-L	NS-2	Node Select 2 Jumper to Ground	0 Volts (With Jumper)	
36-P	DI-7	Hydraulic Charge Filter Alarm Switch	0 Volts Off; 24 Volts On	CAN45 -1-64
36-R	24 Volts	Hydraulic Charge Filter Alarm Switch	24 Volts Nominal	
36-U	Ground	Jumper to Node Select 2	Ground	
36-V	5 Volts	Mast Angle Sensor	5 Volts	
36-W	Ground	Mast Angle Sensor	Ground	
36-X	24 Volts	Hydraulic Return Filter Alarm Switch (Bottom)	24 Volts Nominal	
36-Z	Ground	MAX-ER Mast Strap Load Pin	Ground	
36-d	AI-12	Mast Angle Sensor	5 volts DC Mast at Vertical	CAN6-8 *1
36-j	Ground	MAX-ER Mast Strap Load Pin	Ground	
36-k	AI-16	MAX-ER Mast Strap Load Pin	24 Volts Nominal	CAN7-8 *1
36-m	24 Volts	MAX-ER Mast Strap Load Pin	24 Volts Nominal	

*1 – Lower four bits can be multiplied by 5 or 10 depending on sender, then divided by 16 for an estimation of sender voltage.
*2 – Number in 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.

CAN ID. No.	Function Type	Description	Test Voltage	Packet Code No.
Input/output cable routing to remote nodes vary - see Electrical Schematic specific to your crane.				
W43	**Receptacle - Pressure Senders**			
43-A	Ground	Counterweight Pins Disengage Solenoid	Ground	
43-B	DO-1	Counterweight Pins Disengage Solenoid	0 Volts Off; 24 Volts On	CAN27-1-1
43-C	Ground	Drum 1 to Drum 2 Diversion Solenoid	Ground	
43-D	DO-2	Drum 1 to Drum 2 Diversion Solenoid	0 Volts Off; 24 Volts On	CAN27-1-2
43-E	Ground	Drum 2 to Drum 1 Diversion Solenoid	Ground	
43-F	DO-3	Drum 2 to Drum 1 Diversion Solenoid	0 Volts Off; 24 Volts On	CAN27-1-4
43-G	Ground	Drum 4 to Drum 5 Diversion Solenoid	Ground	
43-H	DO-4	Drum 4 to Drum 5 Diversion Solenoid	0 Volts Off; 24 Volts On	CAN27-1-8
43-J	Ground	Left Travel to Drum 3 Diversion Solenoid	Ground	
43-M	NS-3	Node Select Jumper to Ground Solenoid	0 Volts (With Jumper)	
43-N	Ground	Right Travel to Drum 4 Diversion Solenoid	Ground	
43-P	DO-6	Right Travel to Drum 4 Diversion Solenoid	0 Volts Off; 24 Volts On	CAN27-1-32
43-R	DO-5	Left Travel to Drum 3 Diversion Solenoid	0 Volts Off; 24 Volts On	CAN27-1-16
43-U	24 Volts	Load Hoist (Drum 1) Pressure Sender	24 Volts Nominal	
43-V	24 Volts	Load Hoist (Drum 2) Pressure Sender	24 Volts Nominal	
43-b	AI-2	Load Hoist (Drum 1) Pressure Sender	1 V at 0 psi; 5 V at 7,000 psi	CAN12-4 *1
43-d	AI-4	Load Hoist (Drum 2) Pressure Sender	1 V at 0 psi,; 5 V at 7,000 psi	CAN12-8 *1
43-g	Ground	Load Hoist (Drum 1) Pressure Sender	Ground	
43-h	Ground	Right Travel Reverse Pressure Sender/ Jumper to Node Select 3	Ground	
43-k	Ground	Load Hoist (Drum 2) Pressure Sender	Ground	
43-m	Ground	Drum 4 or Drum 5 Pressure Sender	Ground	
43-n	24 Volts	Right Travel Reverse Pressure Sender	24 Volts Nominal	
43-p	AI-7	Right Travel Reverse Pressure Sender	1 V at 0 psi,; 5 V at 7,000 psi	CAN13-6 *1
43-r	AI-8	Drum 4 or Drum 5 Pressure Sender	1 V at 0 psi; 5 V at 7,000 psi	CAN13-8 *1
43-s	24 Volts	Drum 4 or Drum 5 Pressure Sender	24 Volts Nominal	
W44	**Receptacle – Accessories**			
44-A	Ground	Left Front Jack Solenoid - Extend	Ground	
44-B	DO-11	Left Front Jack Solenoid - Extend	0 Volts Off; 24 Volts On	CAN27-2-4
44-C	Ground	Left Front Jack Solenoid - Retract	Ground	
44-D	DO-12	Left Front Jack Solenoid - Retract	0 Volts Off; 24 Volts On	CAN27-2-8
44-E	Ground	Right Front Jack Solenoid - Extend	Ground	
44-F	DO-13	Right Front Jack Solenoid - Extend	0 Volts Off; 24 Volts On	CAN27-2-16
44-G	Ground	Right Front Jack Solenoid - Retract	Ground	
44-H	DO-14	Right Front Jack Solenoid - Retract	0 Volts Off; 24 Volts On	CAN27-2-32
44-J	Ground	Left Rear Jack Solenoid - Extend	Ground	
44-K	Ground	Right Rear Jack Solenoid - Retract	Ground	
44-L	Ground	Right Rear Jack Solenoid - Extend	Ground	
44-M	DO-17	Right Rear Jack Solenoid - Extend	0 Volts Off; 24 Volts On	CAN27-3-1
44-N	Ground	Left Rear Jack Solenoid - Retract	Ground	

44-P	DO-16	Left Rear Jack Solenoid - Retract	0 Volts Off; 24 Volts On	CAN27-2-128
44-R	DO-15	Left Rear Jack Solenoid - Extend	0 Volts Off; 24 Volts On	CAN27-2-64
44-S	DO-18	Right Rear Jack Solenoid - Retract	0 Volts Off; 24 Volts On	CAN27-3-2
44-T	Ground	Rigging Winch Solenoid - Spool In	Ground	
44-U	DO-19	Rigging Winch Solenoid - Spool In	0 Volts Off; 24 Volts On	CAN27-3-4
44-V	Ground	Rigging Winch Solenoid - Spool Out	Ground	
44-W	DO-20	Rigging Winch Solenoid - Spool Out	0 Volts Off; 24 Volts On	CAN27-3-8
44-X	Ground	Mast Rasing Cylinders Solenoid - Extend	Ground	
44-Z	DO-21	Mast Rasing Cylinders Solenoid - Extend	0 Volts Off; 24 Volts On	CAN27-3-16
44-a	Ground	Mast Rasing Cylinders Solenoid - Retract	Ground	
44-b	DO-22	Mast Rasing Cylinders Solenoid - Retract	0 Volts Off; 24 Volts On	CAN27-3-32
44-c	Ground	Front Rotating Bed Pin Solenoid - Retract	Ground	
44-d	DO-23	Front Rotating Bed Pin Solenoid - Retract	0 Volts Off; 24 Volts On	CAN27-3-64
44-e	Ground	Front Rotating Bed Pin Solenoid - Extend	Ground	
44-f	DO-24	Front Rotating Bed Pin Solenoid - Extend	0 Volts Off; 24 Volts On	CAN27-3-128
44-g	Ground	Jumper to Node Select 4	Ground	
44-k	NS-3	Node Select 3 Jumper to Ground	0 Volts (With Jumper)	
W46	**Receptacle – Drum 4 and Pressure Sensors**			
46-A	Ground	Boom/Mast Hoist (Drum 4) Brake Solenoid	Ground	
46-B	DO-7	Boom/Mast Hoist (Drum 4) Brake Solenoid	0 Volts Off; 24 Volts On	CAN27-1-64
46-C	Ground	Boom/Mast Hoist (Drum 4) Left Side Motor	Ground	
46-D	DO-8	Boom/Mast Hoist (Drum 4) Left Side Motor	See Table 3-2, page 3-8	CAN27-1-128
46-E	Ground	Pump 7 Control (Accessory Pump)	Ground	
46-F	DO-9	Pump 7 Control (Accessory Pump)	See Table 3-2, page 3-8	CAN27-2-1
46-M	NS-3	Node Select 3 Jumper to Ground	0 Volts (With Jumper)	
46-R	24 Volts	Boom/Mast Hoist (Drum 4) Speed Sensor	24 Volts Nominal	
46-S	24 Volts	Left Travel Reverse Pressure Sender	24 Volts Nominal	
46-T	24 Volts	Right Travel Forward Pressure Sender	24 Volts Nominal	
46-U	Ground	Left Travel Reverse Pressure Sender/ Jumper to Node Select 3	Ground	
46-W	Ground	Right Travel Forward Pressure Sender	Ground	
46-Z	Ground	Left Travel Forward Pressure Sender	Ground	
46-a	AI-9	Left Travel Reverse Pressure Sender	1 V at 0 psi; 5 V at 7,000 psi	CAN14-2 *1
46-b	AI-10	Right Travel Forward Pressure Sender	1 V at 0 psi; 5 V at 7,000 psi	CAN14-4 *1
46-f	AI-14	Left Travel Forward Pressure Sender	1 V at 0 psi; 5 V at 7,000 psi	CAN15-4 *1
46-g	24 Volts	Accessory Pressure Sender	24 Volts Nominal	
46-h	AI-15	Accessory Pressure Sender	1 V at 0 psi; 5 V at 7,000 psi	CAN15-6 *1
46-j	Ground	Boom/Mast Hoist (Drum 4) Speed Sensor/ Accessory System Pressure Sender	Ground	
46-m	24 Volts	Left Travel Forward Pressure Sender/	24 Volts Nominal	
46-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
46-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 sender, then divided by 16 for an estimation of sender voltage.
*2 – Number in 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.

Can ID. No.	Function Type	Description	Test Voltages	Packet Code No.
Input/output cable routing to remote nodes vary - see Electrical Schematic specific to your crane.				
W53	**Receptacle – Sensors**			
53-A	Ground	Boom/Mast Hoist (Drum 4) RS Motor Control	Ground	
53-B	DO-1	Boom/Mast Hoist (Drum 4) RS Motor Control	See Table 3-2, page 3-8	CAN29-1-1
53-C	Ground	Engine Cooler Fan/Acc Enable Solenoid	Ground	
53-D	DO-2	Engine Cooler Fan/Acc Enable Solenoid	0 Volts Off; 24 Volts On	CAN29-1-2
53-E	Ground	Hanging CTWT Lift Cylinder - Extend	Ground	
53-F	DO-3	Hanging CTWT Lift Cylinder - Extend	0 Volts Off; 24 Volts On	CAN29-1-4
53-G	Ground	Right Side RCL Capacity Alarm	Ground	
53-H	DO-4	Right Side RCL Capacity Alarm	0 Volts Off; 24 Volts On	CAN29-1-8
53-J	Ground	Hanging CTWT Lift Cylinder - Retract	Ground	
53-N	Ground	Maximum Boom Angle Limit Switch	Ground	
53-P	DO-6	Hanging CTWT Lift Cylinder - Remote Power	0 Volts Off; 24 Volts On	CAN29-1-32
53-R	DO-5	Hanging CTWT Lift Cylinder - Retract	0 Volts Off; 24 Volts On	CAN29-1-16
53-S	NS-4	Node Select 4 Jumper to Ground	0 Volts (With Jumper)	
53-T	DI-3	Hanging CTWT Lift Cylinder - Remote Stop	0 Volts Off; 24 Volts On	CAN53 -1-4
53-U	24 Volts	Lower Accessory Pressure Enable	24 Volts Nominal	
53-V	24 Volts	Hanging CTWT Lift Cylinder - Retract PSI	24 Volts Nominal	
53-W	DI-4	Maximum Boom Angle Limit Switch	0 Volts Off; 24 Volts On	CAN53 -1-8
53-X	24 Volts	Maximum Boom Angle Limit Switch	24 Volts Nominal	
53-a	AI-1	Hanging CTWT Lift Cylinder - Remote Extend	Variable 0 to 5 Volts	CAN20-2 *1
53-b	AI-2	Lower Accessory Pressure Enable	Variable 0 to 5 Volts	CAN20-4 *1
53-c	AI-3	Hanging CTWT Lift Cylinder Position Sensor	Variable 0 to 5 Volts	CAN20-6 *1
53-d	AI-4	Hanging CTWT Lift Cylinder - Retract PSI	Variable 0 to 5 Volts	CAN20-8 *1
53-e	AI-5	Hanging CTWT Lift Cylinder - Extend PSI	Variable 0 to 5 Volts	CAN21-2*1
53-f	AI-6	Hanging CTWT Lift Cylinder - Remote Retract	Variable 0 to 5 Volts	CAN21-4*1
53-g	Ground	Lower Accessory Pressure Enable Jumper to Node Select 4	Ground	
53-h	Ground	H-Counterweight Lift Cylinder Position Sensor	Ground	
53-k	Ground	H-Counterweight Lift Cylinder - Extend PSI	Ground	
53-m	Ground	Rotating Bed Level Sensor	Ground	
53-n	24 Volts	H-Counterweight Lift Cylinder Position Sensor	24 Volts Nominal	
53-p	AI-7	Rotating Bed Level Sensor (Pitch)	Variable 0 to 10 Volts	CAN21-6 *1
53-r	AI-8	Rotating Bed Level Sensor (Roll)	Variable 0 to 10 Volts	CAN21-8 *1
53-s	24 Volts	Rotating Bed Level Sensor	24 Volts Nominal	
W54	**Receptacle – Travel/Swing Brakes and Auto Lubrication**			
54-K=	Ground	Travel Brake Release Solenoid	Ground	
54-S=	DO-18	Travel Brake Release Solenoid	0 Volts Off; 24 Volts On	CAN29-3-2
54-T=	Ground	Travel 2-Speed Solenoid	Ground	

54-U	DO-19	Travel 2-Speed Solenoid	0 Volts Off; 24 Volts On	CAN29-3-4
54-V	Ground	Travel Brake Release Solenoid	Ground	
54-W	DO-20	Swing Brake Release Solenoid	0 Volts Off; 24 Volts On	CAN29-3-8
54-X	Ground	Swing Lock Solenoid - In *3	Ground	
54-Z	DO-21	Swing Lock Solenoid - In *3	0 Volts Off; 24 Volts On	CAN29-3-16
54-a	Ground	Swing Lock Solenoid - Out *3	Ground	
54-b	DO-22	Swing Lock Solenoid - Out *3	0 Volts Off; 24 Volts On	CAN29-3-32
54-c	Ground	Swing Bearing Auto Lubrication	Ground	
54-d	DO-23	Swing Bearing Auto Lubrication	0 Volts Off; 24 Volts On	CAN29-3-64
54-e	Ground	Crawler Track Rollers Auto Lubrication	Ground	
54-f	DO-24	Crawler Track Rollers Auto Lubrication	0 Volts Off; 24 Volts On	CAN29-3-128
54-g	Ground	Jumper to Node Select 4	Ground	
54-m	NS-4	Node Select 4 Jumper to Ground	0 Volts (With Jumper)	
54-n	24 Volts	Swing Motor Speed Sensor	24 Volts Nominal	
54-p	EC1A	Swing Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN53-6 *2
54-r	Ground	Swing Motor Speed Sensor	ground	
54-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**			
56-A	Ground	Load Hoist (Drum 2) Right Side Motor Control	Ground	
56-B	DO-7	Load Hoist (Drum 2) Right Side Motor Control	See Table 3-2, page 3-8	CAN29-1-64
56-C	Ground	Load Hoist (Drum 2) Brake Solenoid	Ground	
56-D	DO-8	Load Hoist (Drum 2) Brake Solenoid	0 Volts Off; 24 Volts On	CAN29-1-128
56-E	Ground	Right Side Swing/Travel Alarm	Ground	
56-F	DO-9	Right Side Swing/Travel Alarm	0 Volts Off; 24 Volts On	CAN29-2-1
56-G	Ground	Drum 2 Minimum Bail	Ground	
56-H	DO-10	Drum 2 Minimum Bail	0 Volts Off; 24 Volts On	CAN29-2-2
56-J	DI-8	Drum 2 Minimum Bail	0 Volts Off; 24 Volts On	CAN55-1-128
56-N	NS-4	Node Select 4 Jumper to Ground	0 Volts (With Jumper)	
56-S	24 Volts	Hydraulic Fluid Temperature Sensor	24 Volts Nominal	
56-T	24 Volts	Engine Fuel Level Sensor	24 Volts Nominal	
56-U	Ground	Hydraulic Fluid Temperature Sensor/ Jumper to Node Select 4	0 Volts (With Jumper)	
56-W	Ground	Engine Fuel Level Sensor	Ground	
56-X	24 Volts	Hydraulic Fluid Level Sensor	24 Volts Nominal	
56-Z	Ground	Hydraulic Fluid Level Sensor	Ground	
56-a	AI-9	Hydraulic Fluid Temperature Sensor	0 Volts Off; 24 Volts On	CAN22-2 *1
56-b	AI-10	Engine Fuel Level Sensor	1.8 Volts Full; 4.1 Volts Empty	CAN22-4 *1
56-d	AI-11	Swing Brake Pressure Sensor	1 V at 0 psi; 5 V at 750 psi	
56-f	AI-14	Hydraulic Fluid Level Sensor	1.8 Volts Full; 4.1 Volts Empty	CAN23-4 *1
56-g	24 Volts	Load Hoist (Drum 2) Motor Speed Sensor	24 Volts Nominal	
56-j	Ground	Load Hoist (Drum 2) Motor Speed Sensor	Ground	
56-m	24 Volts	Swing Brake Pressure Sensor	24 Volts Nominal	

56-n	EC1A	Load Hoist (Drum 2) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN52-2 *2
56-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 sender, then divided by 16 for an estimation of sender voltage.
*2 – Number in indicated bank should increment in positive direction and decrement in negative direction with item rotation.
*3 – Swing Lock removed on current production cranes.

Node 6 — Drum Brakes, Pawls, and Motor Sensors

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

Can ID. No.	Function Type	Description	Test Voltages	Packet No.
Input/output cable routing to remote nodes vary - see Electrical Schematic specific to your crane.				
W63	**Receptacle – Drum 3**			
63-A	Ground	Load/Luffing (Drum 3) Brake Solenoid	Ground	
63-B	DO-1	Load/Luffing (Drum 3) Brake Solenoid	0 Volts Off, 24 Volts On	CAN26-1-1
63-C	Ground	Load/Luffing (Drum 3) Right Motor Control	Ground	
63-D	DO-2	Load/Luffing (Drum 3) Right Motor Control	See Table 3-2, page 3-8	CAN26-1-2
63-E	Ground	Boom Raise and Lower Works Supply Divert		
63-F	DO-3	Boom Raise and Lower Works Supply Divert	0 Volts Off, 24 Volts On	CAN26-1-4
63-G	Ground	Load/Luffing (Drum 3) Pawl Solenoid - In	Ground	
63-H	DO-4	Load/Luffing (Drum 3) Pawl Solenoid - In	0 Volts Off, 24 Volts On	CAN26-1-8
63-J	Ground	Load/Luffing (Drum 3) Pawl Solenoid - Out	Ground	
63-K	NS-1	Node Select 1 Jumper to Ground	0 Volts (With Jumper)	
63-L	NS-2	Node Select 2 Jumper to Ground	0 Volts (With Jumper)	
63-N	Ground	Load/Luffing (Drum 3) Minimum Bail Limit	Ground	
63-P	DO-6	Load/Luffing (Drum 3) Minimum Bail Limit	0 Volts Off, 24 Volts On	CAN26-1-32
63-R	DO-5	Load/Luffing (Drum 3) Pawl Solenoid - Out	0 Volts Off; 24 Volts On	CAN26-1-16
63-W	DI-4	Load/Luffing (Drum 3) Minimum Bail Limit	0 Volts Off; 24 Volts On	CAN47-1-8
63-e	AI-5	Right Mast Strap Load Pin (BRS)	24 Volts Nominal	CAN9-2*1
63-g	Ground	Jumper to Node Select 2	Ground	
63-k	Ground	Right Mast Strap Load Pin (BRS)	Ground	
63-m	Ground	Right Mast Strap Load Pin (BRS)	Ground	
63-s	24 Volts	Right Mast Strap Load Pin (BRS)	24 Volts Nominal	
W64	**Receptacle – Drum 5**			
64-A	Ground	Boom Hoist (Drum 5) Brake Solenoid	Ground	
64-B	DO-11	Boom Hoist (Drum 5) Brake Solenoid	0 Volts Off; 24 Volts On	CAN26-2-4
64-C	Ground	Boom Hoist (Drum 5) Left Motor Control	Ground	
64-D	DO-12	Boom Hoist (Drum 5) Left Motor Control	See Table 3-2, page 3-8	CAN26-2-8
64-E	Ground	Boom Hoist (Drum 5) Right Motor Control	Ground	
64-F	DO-13	Boom Hoist (Drum 5) Right Motor Control	See Table 3-2, page 3-8	CAN26-2-16
64-G	Ground	Boom Hoist (Drum 5) Pawl Solenoid - In	Ground	
64-H	DO-14	Boom Hoist (Drum 5) Pawl Solenoid - In	0 Volts Off; 24 Volts On	CAN26-2-32
64-J	Ground	Boom Hoist (Drum 5) Pawl Solenoid - Out	Ground	
64-R	DO-15	Boom Hoist (Drum 5) Pawl Solenoid - Out	0 Volts Off; 24 Volts On	CAN26-2-64
64-g	Ground	Jumper to Node Select 1	Ground	
64-h	NS-1	Node Select 1 Jumper to Ground	0 Volts (With Jumper)	
64-j	NS-2	Node Select 2 Jumper to Ground	0 Volts (With Jumper)	
64-n	24 Volts	Load/Luffing (Drum 5) Motor Speed Sensor	24 Volts Nominal	
64-p	EC3A	Load/Luffing (Drum 5) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN47-6 *2

Can ID. No.	Function Type	Description	Test Voltages	Packet No.
64-r	Ground	Load/Luffing (Drum 3) Motor Speed Sensor/ Jumper to Node Select 2	Ground	
64-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**			
66-A	Ground	Load Hoist (Drum 1) Brake Solenoid	Ground	
66-B	DO-7	Load Hoist (Drum 1) Brake Solenoid	0 Volts Off, 24 Volts On	CAN26-1-64
66-C	Ground	Load Hoist (Drum 1) Left Side Motor Control	Ground	
66-D	DO-8	Load Hoist (Drum 1) Left Side Motor Control	See Table 3-2, page 3-8	CAN26-1-128
66-E	Ground	Load Hoist (Drum 1) Right Side Motor Control	Ground	
66-F	DO-9	Load Hoist (Drum 1) Right Side Motor Control	See Table 3-2, page 3-8	CAN26-2-1
66-G	Ground	Load Hoist (Drum 1) Min. Bail Limit Switch	Ground	
66-H	DO-10	Load Hoist (Drum 1) Min. Bail Limit Switch	0 Volts Off, 24 Volts On	CAN26-2-2
66-J	DI-8	Load Hoist (Drum 1) Min. Bail Limit Switch	0 Volts Off, 24 Volts On	CAN47-1-128
66-K	NS-1	Node Select 1 Jumper to Ground	0 Volts (With Jumper)	
66-L	NS-2	Node Select 2 Jumper to Ground	0 Volts (With Jumper)	
66-U	Ground	Jumper to Node Select	Ground	
66-W	Ground	MAX-ER Strut Position Sensor	Ground	
66-X	24 Volts	MAX-ER Strut Position Sensor	24 Volts Nominal	
66-Z	Ground	Load/Luffing (Drum 3) Motor Speed Sensor	Ground	
66-e	AI-13	MAX-ER Strut Position Sensor	0 Volts Off; 24 Volts On	CAN11-2 *1
66-g	24 Volts	Load Hoist (Drum 1) Motor Speed Sensor	24 Volts Nominal	
66-j	Ground	Load Hoist (Drum 1) Motor Speed Sensor	Ground	
66-m	24 Volts	Load/Luffing (Drum 3) Motor Speed Sensor	24 Volts Nominal	
66-n	EC1A	Load Hoist (Drum 1) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN46-2 *2
66-p	EC1B	Load Hoist (Drum 1) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN46-2 *2
66-r	EC2A	Load/Luffing (Drum 3) Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; .2 Volts Moving	CAN46-2 *2
66-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 sender, then divided by 16 for an estimation of sender voltage.
*2 – Number in 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.

CAN ID. No.	Function Type	Description	Test Voltage	Packet Code No.
Input/output cable routing to remote nodes vary - see Electrical Schematic specific to your crane.				
W73	**Receptacle - Counterweight Lift Cylinder and Sensors**			
73-A	Ground	Counterweight Lift Cylinder Extend Sensor	Ground	
73-B	DO-1	Counterweight Lift Cylinder Extend	0 Volts Off; 24 Volts On	CAN28-1-1
73-C	Ground	Counterweight Lift Cylinder Extend	Ground	
73-D	DO-2	Counterweight Lift Cylinder Retract	0 Volts Off; 24 Volts On	CAN28-1-2
73-E	Ground	Counterweight Lift Cylinder Retract Sensor	Ground	
73-G	Ground	Counterweight Lift Cylinder Retract	Ground	
73-K	NS-1	Node Select 1 Jumper to Ground	Ground	
73-M	NS-3	Node Select 3 Jumper to Ground	0 Volts (With Jumper)	
73-N	Ground	Counterweight Lift Cylinder Position Sensor	Ground	
73-U	24 Volts	Counterweight Lift Cylinder Retract Sensor	24 Volts Nominal	
73-V	24 Volts	Counterweight Lift Cylinder Extend Sensor	24 Volts Nominal	
73-X	24 Volts	Counterweight Lift Cylinder Position Sensor	24 Volts Nominal	
73-a	AI-1	Counterweight Lift Cylinder Retract Sensor	1 V at 0 psi; 5 V at 7,000 psi	CAN16-2 *1
73-b	AI-2	Top Telescopic Beam Position Sensor		CAN16-4 *1
73-c	AI-3	Counterweight Lift Cylinder Extend Sensor	1 V at 0 psi; 5 V at 7,000 psi	CAN16-6 *1
73-d	AI-4	Counterweight Lift Cylinder Position Sensor		CAN16-8 *1
72-e	AI-5	Bottom Telescopic Beam Position Sensor		CAN17-2 *1
73-g	Ground	Top Telescopic Beam Position Sensor	Ground	
73-h	Ground	Top Telescopic Beam Position Sensor	Ground	
73-k	Ground	Bottom Telescopic Beam Position Sensor	Ground	
73-m	Ground	Bottom Telescopic Beam Position Sensor	Ground	
73-n	24 Volts	Top Telescopic Beam Position Sensor	24 Volts Nominal	
73-s	24 Volts	Bottom Telescopic Beam Position Sensor	24 Volts Nominal	
W74	**Receptacle – Jacking Cylinders, Steering**			
74-A	Ground	Left Front Jacking Cylinder Extend	Ground	
74-B	DO-11	Left Front Jacking Cylinder Extend	0 Volts Off; 24 Volts On	CAN28-2-4
74-C	Ground	Left Front Jacking Cylinder Retract	Ground	
74-D	DO-12	Left Front Jacking Cylinder Retract	0 Volts Off; 24 Volts On	CAN28-2-8
74-E	Ground	Left Rear Jacking Cylinder Extend	Ground	
74-F	DO-13	Left Rear Jacking Cylinder Extend	0 Volts Off; 24 Volts On	CAN28-2-16
74-G	Ground	Left Rear Jacking Cylinder Retract	Ground	
74-H	DO-14	Left Rear Jacking Cylinder Retract	0 Volts Off; 24 Volts On	CAN28-2-32
74-J	Ground	Right Front Jacking Cylinder Extend	Ground	
74-K	Ground	Right Rear Jacking Cylinder Retract	Ground	
74-L	Ground	Right Rear Jacking Cylinder Extend	Ground	
74-M	DO-17	Right Rear Jacking Cylinder Extend	0 Volts Off; 24 Volts On	CAN28-3-1
74-N	Ground	Right Front Jacking Cylinder Retract	Ground	

74-P	DO-16	Right Front Jacking Cylinder Retract	0 Volts Off; 24 Volts On	CAN28-2-128
74-R	DO-15	Right Front Jacking Cylinder Extend	0 Volts Off; 24 Volts On	CAN28-2-64
74-S	DO-18	Right Rear Jacking Cylinder Retract	0 Volts Off; 24 Volts On	CAN28-3-2
74-T	Ground	Left Wheel Steering Clockwise	Ground	
74-U	DO-19	Left Wheel Steering Clockwise	0 Volts Off; 24 Volts On	CAN28-3-4
74-V	Ground	Left Wheel Steering Counter-Clockwise	Ground	
74-W	DO-20	Left Wheel Steering Counter-Clockwise	0 Volts Off; 24 Volts On	CAN28-3-8
74-X	Ground	Right Wheel Steering Clockwise	Ground	
74-Z	DO-21	Right Wheel Steering Clockwise	0 Volts Off; 24 Volts On	CAN28-3-16
74-a	Ground	Right Wheel Steering Counter-Clockwise	Ground	
74-b	DO-22	Right Wheel Steering Counter-Clockwise	0 Volts Off; 24 Volts On	CAN28-3-32
74-c	Ground	Left Wheel Brakes	Ground	
74-d	DO-23	Left Wheel Brakes	0 Volts Off; 24 Volts On	CAN28-3-64
74-e	Ground	Right Wheel Brakes	Ground	
74-f	DO-24	Right Wheel Brakes	0 Volts Off; 24 Volts On	CAN28-3-128
74-g	Ground	Jumper to Node Select 1 and 3	Ground	
74-h	NS1	Node Select 1 Jumper to Ground		
74-k	NS-3	Node Select 3 Jumper to Ground	0 Volts (With Jumper)	
W76	**Receptacle – Telescopic Beam, Steering Encoder, and Jacking Limits**			
76-A	Ground	Jumper to Node Select 1 and 3	Ground	
76-B	DO-7	Telescopic Beam Cylinder Extend	0 Volts Off; 24 Volts On	CAN28-1-64
76-C	Ground	Telescopic Beam Cylinder Extend and Retract	Ground	
76-D	DO-8	Telescopic Beam Cylinder Retract	0 Volts Off; 24 Volts On	CAN28-1-128
76-E	Ground	MAX-ER Tray Level Sensor	Ground	
76-F	DO-9	Telescopic Beam Hinge Pin In	0 Volts Off; 24 Volts On	CAN28-2-1
76-G	Ground	Telescopic Beam Hinge Pin In and Out	Ground	
76-H	DO-10	Telescopic Beam Hinge Pin Out	0 Volts Off; 24 Volts On	CAN28-2-2
76-J	DI-8	Left Rear Jacking Cylinder Limit	0 Volts Off; 24 Volts On	CAN51-1-128
76-K	NS-1	Node Select 1 Jumper to Ground	0 Volts (With Jumper)	
76-M	NS-3	Node Select 3 Jumper to Ground	0 Volts (With Jumper)	
76-P	DI-7	Left Front Jacking Cylinder Limit	0 Volts Off; 24 Volts On	CAN51-1-64
76-R	24 Volts	Left Front and Rear Jacking Cylinder Limit	24 Volts Nominal	
76-S	24 Volts	MAX-ER Tray Level Sensor	24 Volts Nominal	
76-T	24 Volts	Right Front and Rear Jacking Cylinder Limit	24 Volts Nominal	
76-U	Ground	Right Front and Rear Jacking Cylinder Limit	Ground	
76-W	Ground	Left Front and Rear Jacking Cylinder Limit	Ground	
76-a	AI-9	MAX-ER Tray Level Sensor	0 to 10 VDC Roll	CAN18-2 *1
76-b	AI-10	MAX-ER Tray Level Sensor	0 to 10 VDC Pitch	CAN18-4 *1
76-c	AI-11	Right Front Jacking Cylinder Limit	0 Volts Off; 24 Volts On	CAN18-6 *1
76-d	AI-12	Right Front and Rear Jacking Cylinder Limit	0 Volts Off; 24 Volts On	CAN18-8 *1
76-g	24 Volts	Left Wheel Steering Encoder	24 Volts Nominal	
76-j	Ground	Left and Right Wheel Steering Encoder	Ground	
76-m	24 Volts	Right Wheel Steering Encoder	24 Volts Nominal	

76-n	EC-1A	Left Wheel Steering Encoder	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN50-2 *2
76-p	EC-1B	Left Wheel Steering Encoder	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN50-2 *2
76-r	EC-2A	Right Wheel Steering Encoder	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN50-2 *4
76-s	EC-2B	Right Wheel Steering Encoder	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN50-2 *4

*1 – Lower four bits can be multiplied by 5 or 10 depending on sender, then divided by 16 for an estimation of sender voltage.
*2 – Number in 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.

CAN ID. No.	Function Type	Description	Test Voltage	Packet Code No.
J1	**Receptacle – CAN In (From RCL Receiver)**			
201-A	24 Volts	CAN BUS System	24 Volts Nominal	
201-B	BNSO	Node Select	Node Select Jumper to GND	
201-C	CANH	CAN High Wire Transmission	N/A	
201-D	Ground	CAN BUS System	Ground	
201-E	Ground	Node Select Ground to AI-NS	Ground	
201-F	CANL	CAN Low Wire Transmission	N/A	
J2	**Receptacle – Upper Block Up**			
202-A	24 Volts	Block Up Limit Boom Upper Point	24 Volts Nominal	
202-B	DI-2	Block Up Limit Boom Upper Point	0 Volts Off; 24 Volts On	CAN112-6-128*
J3	**Receptacle – Lower Block Up**			
203-A	24 Volts	Block Up Limit Boom Lower Point	24 Volts Nominal	
203-B	DI-1	Block Up Limit Boom Lower Point	0 Volts Off; 24 Volts On	CAN112-6-64*
J4	**Receptacle – CAN Out**			
204-A	24 Volts	CAN BUS System	24 Volts Nominal	
204-C	CANH	CAN High Wire Transmission	N/A	
204-D	Ground	CAN BUS System	Ground	
204-E	DI-ID	To Jib Butt Cable Reel	0 Volts Off; 24 Volts On	
204-F	CANL	CAN Low Wire Transmission	N/A	
J8	**Receptacle – Wind Speed**			
208-A	AI-3	Wind Speed Sensor	.05 to 16 Volts DC	
208-B	Ground	Wind Speed Sensor	Ground	
J9	**Receptacle – Maximum Jib Angle Limit**			
209-A	24 Volts	Maximum Jib Angle Limit	24 Volts Nominal	
209-B	DI-6	Maximum Jib Angle Limit	0 Volts Off; 24 Volts On	CAN112-6-32
J11	**Receptacle – Minimum Jib Angle Limit**			
2011-A	24 Volts	Minimum Jib Angle Limit	24 Volts Nominal	
2011-B	DI-4	Minimum Jib Angle Limit	0 Volts Off; 24 Volts On	CAN112-6-8
	Boom Angle Indicator			
Wire 1	Ground	Boom Angle Indicator	Ground	
Wire 2	Signal	Boom Angle Indicator	Variable 0 to 5 Volts	
Wire 3	5 Volts	Boom Angle Indicator	5 Volts Nominal	

*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.

CAN ID. No.	Function Type	Description	Test Voltage	Packet Code No.
J1	**Receptacle – CAN In (From Jib Butt)**			
211-A	24 Volts	CAN BUS System	24 Volts Nominal	
211-B	AI-NS	Node Select AI-NS	Node Select Jumper to GND	
211-C	CANH	CAN High Wire Transmission	N/A	
211-D	Ground	CAN BUS System	Ground	
211-E	Ground	Node Select Ground to AI-NS	Ground	
211-F	CANL	CAN Low Wire Transmission	N/A	
J2	**Receptacle – Upper Block Up**			
212-A	24 Volts	Block Up Limit Luffing/Fixed Jib Upper Pt.	24 Volts Nominal	
212-B	DI-2	Block Up Limit Luffing/Fixed Jib Upper Pt.	0 Volts Off; 24 Volts On	CAN113-6-128*
J3	**Receptacle – Lower Block Up**			
213-A	24 Volts	Block Up Limit Luffing Jib Lower Point	24 Volts Nominal	
213-B	DI-1	Block Up Limit Luffing Jib Lower Point	0 Volts Off; 24 Volts On	CAN113-6-64*
J4	**Receptacle – CAN Out**			
214-A	24 Volts	CAN BUS System	24 Volts Nominal	
214-C	CANH	CAN High Wire Transmission	N/A	
214-D	Ground	CAN BUS System	Ground	
214-E	DI-ID	Last Node Terminating Plug	24 Volts Nominal	
214-F	CANL	CAN Low Wire Transmission	N/A	
J8	**Wind Speed Indicator**			
218-A	AI-3	Wind Speed Sensor	.05 to 16 Volts DC	
218-B	Ground	Wind Speed Sensor	Ground	
	Jib Angle Indicator			
Wire 1	Ground	Jib Angle Indicator	Ground	
Wire 2	Signal	Jib Angle Indicator	Variable 0 to 5 Volts	
Wire 3	5 Volts	Jib Angle Indicator	5 Volts Nominal	

*Packet number depends on specific attachment used.

Node 0 — Engine

Reference Electrical Schematic A10871, Sheet 1 and 12.

Receptacle/ Pin No.	Wire No.	Function Type	Description	Test Voltage
P1	**Connector – 40 Pin**			
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)
CAN41-3-16	Swing Lock – In (N5) (past production)
CAN41-3-32	Swing Lock – Out (N5) (past production)
CAN41-3-64	Swing Bearing Grease Motor (N5)
CAN41-3-128	Crawler Track Grease Motor (N5)

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 Rasing Cylinders – Extend (N4)
CAN27-3-32	Mast Rasing 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)
CAN29-3-16	Swing Lock – In (N5) (past production)
CAN29-3-32	Swing Lock – Out (N5) (past production)
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)		

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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	DPF 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	DPF 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)
CAN113-6-128	Block Up Limit Luffing/Fixed Jib Upper Pt. (N21)	CAN129-6-8	Travel 2-Speed Switch (N1)
CAN113-6-64	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 (Software, m002047.0 & up)

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 3-6 for the following procedure.

Troubleshoot components on main display first. Any further testing should be completed with in-line test boards at 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 is contained in node Test Volt tables.

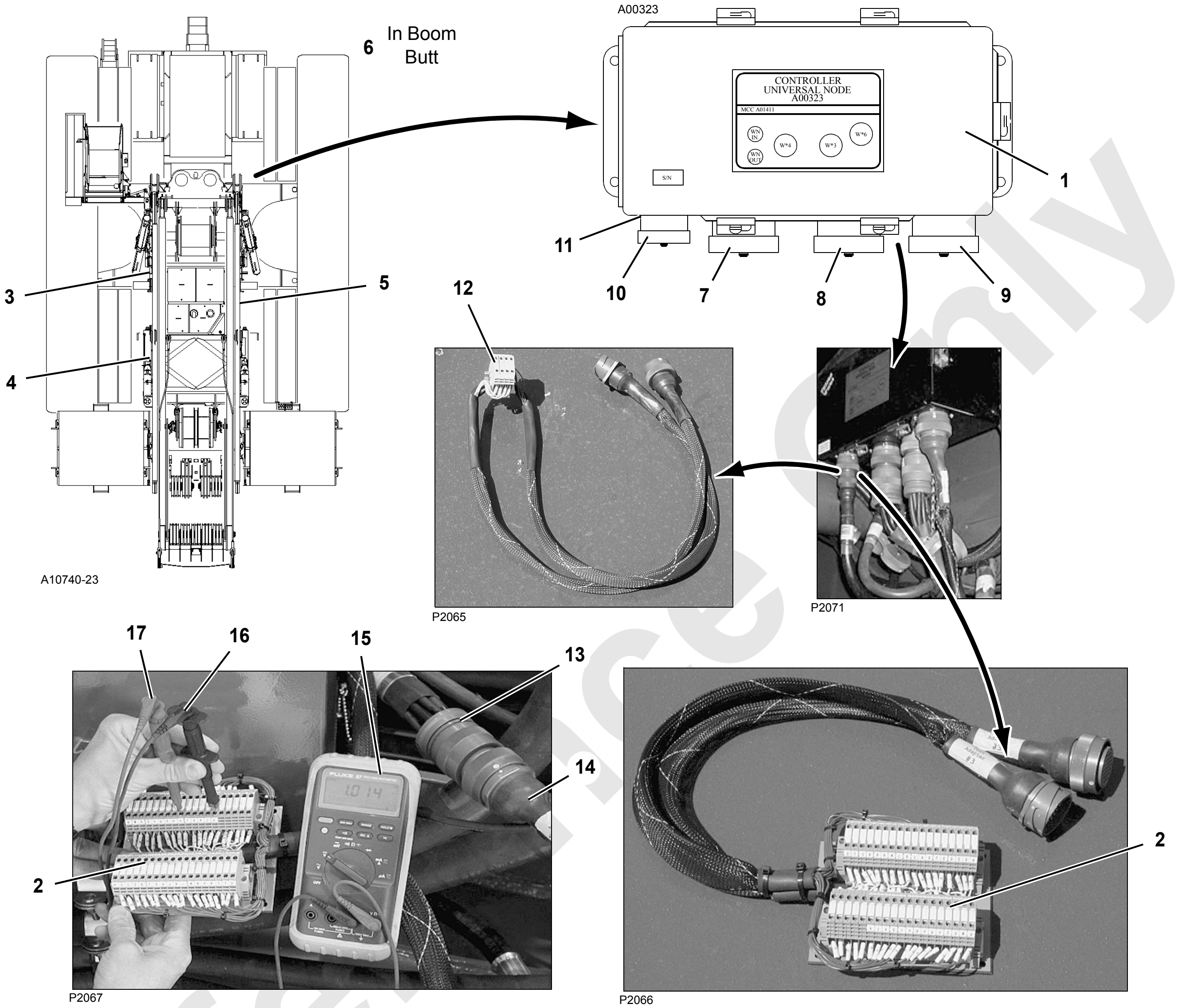
To test a problem component at a universal node with in-line test board:

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

7. To test for amperes:
    a. Open knife switch across test terminal.
    b. Select amperes on meter.
    c. Connect meter leads across test board problem component terminal.
    d. Enable test component and check ampere reading on meter.
8. To test for a communication problem:
    a. Engine must be off and engine key switch in ***run*** position, with all brakes and locks engaged.
    b. Access desired node to install communication in-line test board.
    c. Remove cable from node at W1 or W7 connector.
    d. Connect communication in-line test board between cable and universal node connector.
    e. Check between terminals C (CAN high) to D (ground) ***or*** F (CAN low) to D (ground).
    f. 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 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 3-6

DISPLAYS

Display Controls

See Figure 3-7 for the following procedure.

The Menu screens for the RCL and crane is displayed with select buttons. Use the following controls to operate the display screens.

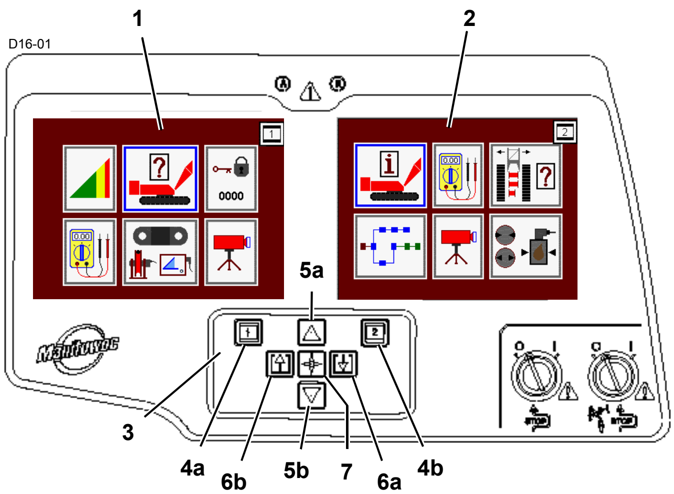


FIGURE 3-7

1 – Rated Capacity Indicator (RCI) Display

Rated Capacity Indicator/Limiter (RCI) display is on the left side of front console. (See RCI document for operation.)

2 – Main Display

The main display is on the right side of the front console (these screens are described in this section).

3 – Display Touchpad Controls

Contains all the screen controls required to operate the RCI display and Main display screens.

4 – RCI Select Buttons

4a. Select Screen 1 (RCI)

4b. Select Screen 2 (Main Display)

5 – 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

6 – Enter/Exit Buttons

Use the red touch pad buttons to enter (6a) or exit (6b) a screen or to change the screen's operating ***level***.

6a. Enter Button

6b. Exit Button

Use Enter button (6a) to enter a screen or go to the next level. Use Exit button (6b) to exit a screen or level.

7 – Confirm Button

Use the purple Confirm touch pad 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, proceed as follows:

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

This procedure only applies to cranes with program number 16000 FCN 2.039 and newer.

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)
5. The selected Display (1 or 2) is reset to factory default settings.

Blank Display

If a display goes blank on cranes with program number 16000 FCN 2.039 and newer, try the following procedure to restore the display. ***Do not return a display to Manitowoc until this procedure has been tried.***

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 Select buttons (5a and 5b) at the same time to return to the factory default display settings.

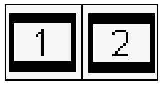
4. Press the Confirm button (7).

Main GUI Display Format

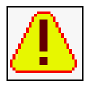
The basic components for the Main GUI display format are the Information screen, Diagnostic screens, Function Screens, CAN Bus screen, Camera screens and Pressure Test and Calibration screens. The appearance and function of each screen depends on the screen ***level***. Some screen levels show icons and/or data boxes that can be selected to change parameters and/or to enter different screen levels.

Screen Prompts

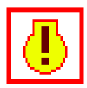
- The RCL Display is item 1 and the Main Display is item 2.



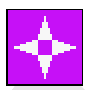
- The yellow alert symbol is displayed if a system fault occurs. See Information screen topic in this section to access faults.



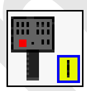
- Engine alert symbol is displayed when the engine needs to be serviced at the first available opportunity (water-in-fuel detected or coolant level low). Also appears when DPF alert is on indicating DPF is nearly full and a stationary regeneration is required immediately.



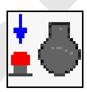
- The purple confirm prompt appears when the operator must start certain test routines from the screen and to confirm data when required.



- The wireless remote symbol is displayed when the hand-held wireless remote is enabled.



- The engine stopped symbol is displayed when engine is stopped.



- On cranes with software version FCN 2.654 and newer, 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).

A graphic picture of Manitowoc is displayed at crane startup See Figure 3-8. The Manitowoc screen displays the following program items:

- Model/ Program Number (16000 FCN 1.012 shown)
- Con Number (009 000 000 008 shown)
- Screen Program Number (GUI 2.007 shown)

D16-02

FIGURE 3-8

Menu Screen

See Figure 3-9 for the following procedure.

The Menu screen is the ***base*** screen for the crane system. All other screens must be entered from this screen. Exiting from any screen will return to the Menu screen.

D16-03

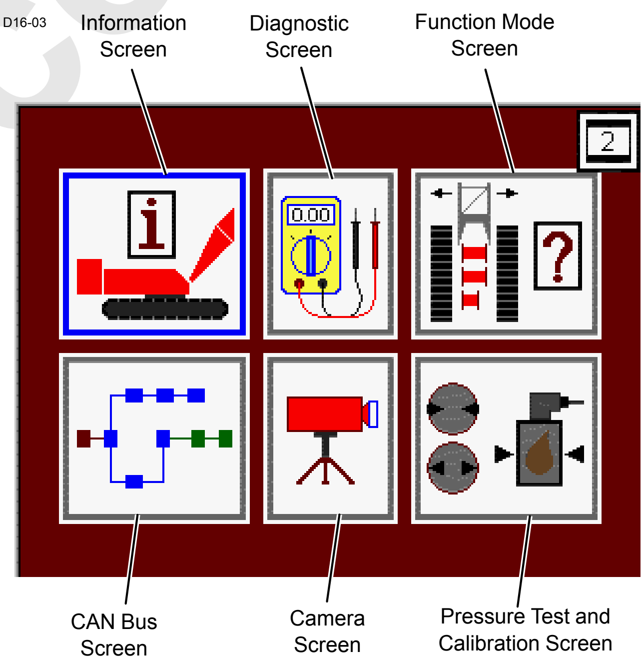


FIGURE 3-9

The Menu screen shows six screen icons:

1. Information Screen icon
2. Diagnostic Screen icon
3. Function Mode Screen icon
4. CAN Bus Screen icon
5. Camera Screen icon
6. Pressure Test and Calibration Screen icon

The Menu screen operates on one ***level*** only.

- Use Select buttons to highlight icon that represents the screen to be entered. Press the Enter button to go to selected screen.
- To return to Menu screen, press Exit button until Menu screen appears.

Information Screen

See Figure 3-10 for the following procedure.

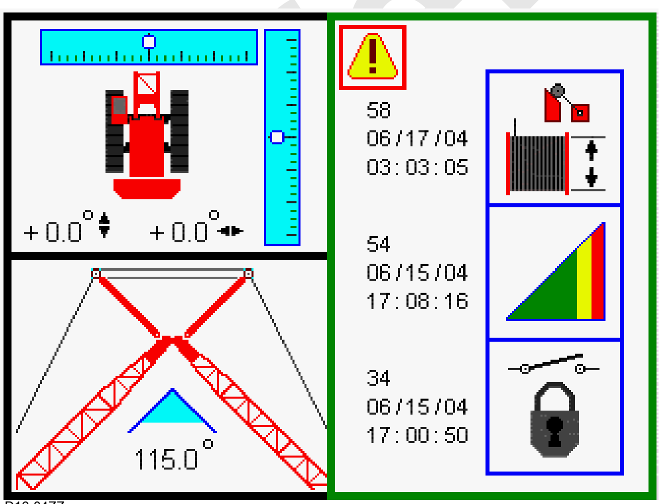
Information screen shows all the general crane information required for viewing during normal operation. The screens contain three data boxes which may be individually tailored to show the information items appropriate for the current crane application.

The Information screen operates on three ***levels***:

Level 1— Selected data box highlighted blue. Use Select buttons to highlight the data box to change.

Level 2 — Selected data box highlighted red. Use Select buttons to choose the information item to be shown in the highlighted data box.

Level 3 — Selected data box highlighted green (if applicable). Use Select buttons to alter the information displayed in the highlighted data box.

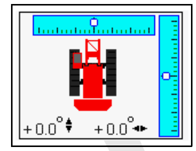


D16-04ZZ

FIGURE 3-10

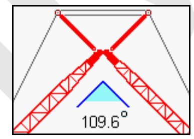
The crane information items currently available (if equipped) for the two smaller data boxes on the left side of the screen are as follows:

Crane Level



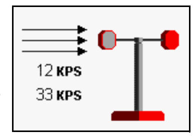
Crane level icon displays the crane level condition forward to rear and side to side. Unless otherwise specified in capacity charts, all crane operations must be performed with crane level to within one 1% of grade in all directions — 1 ft in 100 ft (0,3 m in 30 m); or crane could tip.

Boom to Luffing Jib Working Angle



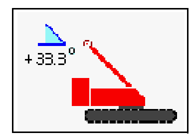
Boom to luffing jib icon displays the boom to jib working angle between center line of boom and center line of luffing jib.

Wind Speed Indicator



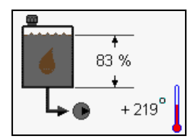
Wind speed icon displays the steady wind speed and maximum gust wind speed. The indicator is reset with Confirm button in ***level 3***.

Mast Angle



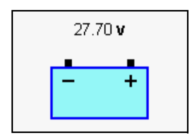
Mast angle icon displays the mast angle in degrees mast is positioned above transport position.

Hydraulic Tank



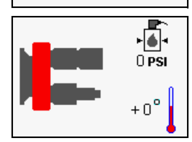
Hydraulic tank icon displays the tank fluid level in percent and temperature in degrees.

Battery



Battery icon displays the active battery voltage.

Pump Drive



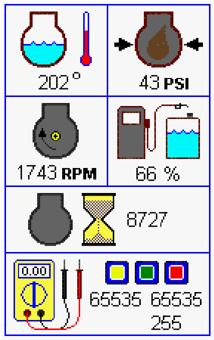
Pump drive icon displays the oil pressure and temperature of pump drive cooling system.

MAX-ER Icons

MAX-ER counterweight lift position and telescopic beam extend icons are not shown. See MAX-ER Operator Manual for complete MAX-ER attachment information.

The crane information items currently available (if equipped) for the large data box on the right side of the screen are as follows:

Engine



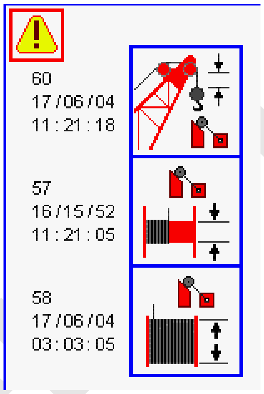
Engine data box displays the following engine items:

- Engine coolant temperature should be below 204°F (96°C)
- Engine oil pressure should be above 15 psi (1,03 bar)
- Engine speed in RPM: 1050 RPM low idle 1,800 RPM high idle
- Fuel level in percent of fuel in main tank
- Engine hours displays the total number of hours engine has been run.
- Diagnostic box with engine manufacturer's fault code/ flash code. See engine Owners Manual for description of fault codes.

MAX-ER (Optional)

MAX-ER data box displays the MAX-ER wheel position icons (not shown). See MAX-ER Operator Manual for complete MAX-ER attachment information.

Faults



The fault data box displays the fault icon with the fault number, date, and time of day listed in the order they occurred.

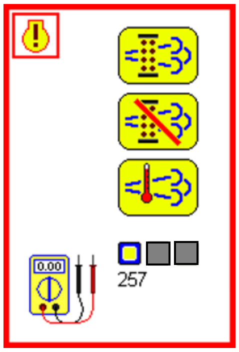
When one or more faults are enabled, an alarm turns on to warn the operator. The yellow alert symbol is displayed on active screen if a fault occurs. You shall go to Information screen to identify the fault. When the fault data box is selected, the screen scrolls through the current faults one icon at a time. The fault history goes back in time to review past faults.

Press the Enter button to access ***level 2*** and use Select buttons to view past fault history. Press the Exit button to exit the fault screen. The alarm turns off when the cause of fault is corrected. Depending on the configuration, not all listed faults are active (see faults in Table 3-8).

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 a 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 as possible.***

Engine Prompt — Diesel Particulate Filter

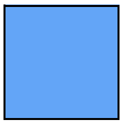
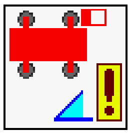
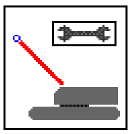
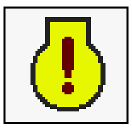
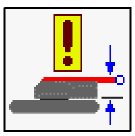
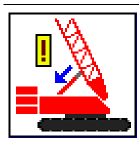
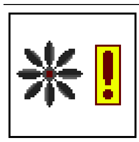
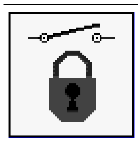
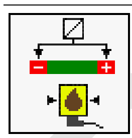
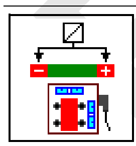
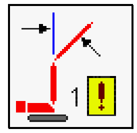
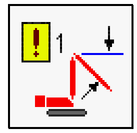
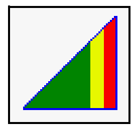
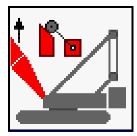
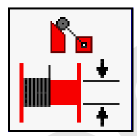
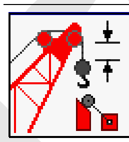
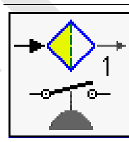
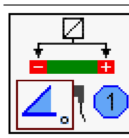
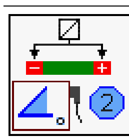
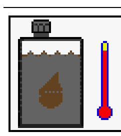
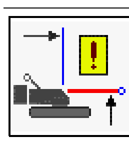


The Engine Prompt detail screen displays the three Diesel Particulate Filter (DPF) conditions (see Engine Operation and Maintenance Manual):

- DPF Regeneration In Progress
- DPF Regeneration Inhibited
- High Exhaust System Temperature

(See page 3-41 for details on engine prompts).

Table 3-8. Faults

Item	Description
	0-No Fault.
	4-Out of Level (cranes with software version FCN 2.654 and newer) — Indicates that crane is approximately 3° to 4-1/2° out of level while jacking upperworks with setup remote control.
	6-Setup Mode — Indicates setup mode is on (Liftcrane Mast Capacities Chart selected in configuration screen of RCL or luffing jib setup mode, if applicable, is on.
	10-Engine Fault* — See engine data box on Information screen. See engine Owners Manual for diagnostics fault codes.
	13-Mast 2 Degree Fault* — Stops down movement of live mast when lowering to transport position. Complete mast lowering manually with hand-held wireless remote.
	27-Mast Stop Retracted* — applies to software version M002066 and newer. 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 MAX-ER Operator Manual.
	30-Hydraulic Fan — Indicates 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 indicated park switch off or sit down in operator's seat.
	41-Transducer Out of Range — One or more hydraulic pressure sensors is out of range.
	43-Out of Level Sensor (cranes with software version FCN 2.654 and newer) — Indicates that crane is approximately 4-1/2° out of level while jacking upperworks with ALL switch on setup remote control. Relevel crane with individual jacking switches on remote control.
	49-Jib Maximum Up 1* — Program limit stops luffing jib when jib is raised to maximum working angle. Lower luffing jib. Can bypass this limit to raise jib to Maximum Up 2 limit.
	50-Jib Maximum Down 1* — Program limit activates fault alarm. Operation does not stop. You can lower luffing jib an additional 3° to Luffing jib maximum down 2 limit (67).
	54-Rated Capacity Indicator/Limiter* — Stops all drums. Land load or raise boom/jib.
	55-Boom Up* — Limit switch stops boom in up direction. Move boom in lowering direction.
	57-Minimum Bail* — Limit switch stops drum (x) from lowering or down direction. Move drum in hoisting or up direction.
	60-Block Up Limit* — Limit switch stops load drum and boom. Lower load or raise boom.
	61-Filter 1 — Filter is dirty or plugged. 62-Filter 2 Replace element or clean filter.
	63-Boom Angle Sensor — Boom angle sensor is out of normal range (0.15 to 4.85 Volts).
	64-Jib Angle Sensor — Luffing jib angle sensor is out of normal range (0.15 to 4.85 Volts).
	65-Hydraulic Fluid Temperature — Fluid temperature in hydraulic tank is below 65°F (18°C) or above 180°F (82°C).
	66-Mast Too Far Forward* — Live mast is below 156°. Raise live mast. Further lowering is not intended - ***mast will fall***.

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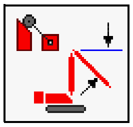
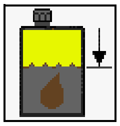
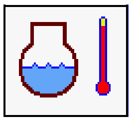
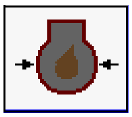
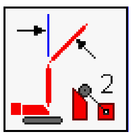
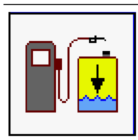
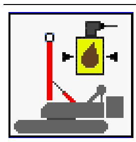
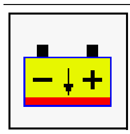
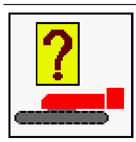
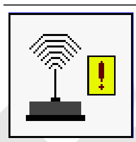
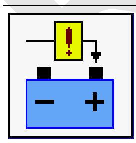
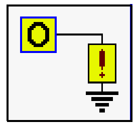
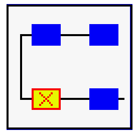
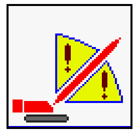
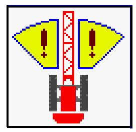
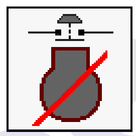
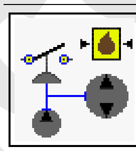
Item	Description
	67-Jib Maximum Down 2* — Limit switch stops luffing jib when jib is lowered to minimum angle. Raise luffing jib.
	69-Hydraulic Reservoir Level— Hydraulic oil at ***caution low level*** indicated on tank gauge. Fill tank.
	70-Engine Coolant Temperature — Engine coolant temperature above 205°F (96°C).
	71-Engine Oil Pressure — Oil pressure below 7.25 psi (0.5 bar).
	73-Jib Maximum Up 2* — Limit switch stops luffing jib when jib is raised to maximum angle. Lower luffing jib. Cannot bypass this limit.
	75-Low Fuel Level — Five percent fuel remaining in tank. Fill tank as soon as possible to prevent engine stoppage.
	77-Mast System — Boom/mast hoist inoperable in both directions. Determine cause of fault and correct.
	78-Battery Low — Battery voltage below 18 volts. Determine cause of fault and correct.
	80-Invalid Configuration*— Make sure selected RCL configuration for load drums is correct.
	81-Wireless System — Wireless load link sensing fault. See wireless link information in separate Rated Capacity Indicator/Limiter manual.
	83-Alternator — Engine alternator is not generating a charge to the battery.

Item	Description
	84-Digital Output Disabled — Digital output signal has a short circuit between computer node and output device. See CAN Bus screen or Diagnostic screen information to identify problem component.
	85-CAN Communication — One or more computer nodes are not communicating correctly. See CAN Bus screen to identify node(s).
	86-Boom Range Limiter* — Up or down range limiter is tripped. Move boom in direction away from limit.
	87-Swing Range Limiter* — Right or left range limiter is tripped. Swing rotating bed in direction away from limit.
	88-Engine Shutdown* — Remote emergency stop shut down switch is pushed. Pull switch up to reset and allow engine to start.
	89-Super Charge Pressure— Pressure switch that monitors hydraulic fluid to main pumps is open.

3

Diagnostic Screen

Diagnostic screen shows a graphic of hydraulic circuit and status of all pumps, motors, valves, and switches that apply to crane function selected.

This view-only screen operates on two ***levels***:

Level 1— Image of overall crane shown. Use Select buttons to highlight individual crane functions.

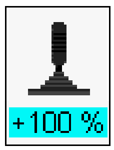
Level 2 — Shows Diagnostic screen for highlighted crane functions.

The yellow alert symbol is displayed if a system fault occurs. You must go back to Information screen to identify the fault.

Diagnostic Screen Component Icons

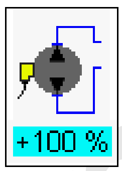
Each Diagnostic screen component icon is identified and described in the following paragraphs.

Control Handle



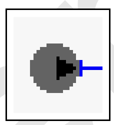
Displays system control handle command in percent from neutral with +raise and –lower for drums, +right and –left for swing, and +forward and –reverse for travel.

Variable Closed-Loop Pump



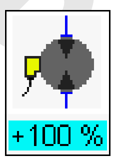
Pump command from neutral (0%) to +/-% of full displacement for drums, swing, and travel.

Gear Pump



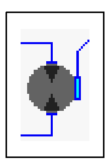
Accessory pump or system charge pump.

Variable Closed-Loop Motor



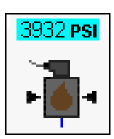
Displays motor command with 0% maximum displacement and 100% minimum displacement.

Closed Loop Variable Motor with Remote Pilot



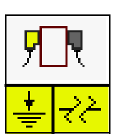
Displays two-speed motor with remote pilot. This motor type is used for shifting motor speeds automatically when selected.

System Pressure Sender



Displays hydraulic pressure (psi/bar).

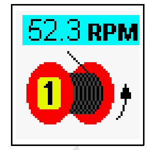
DIN Electrical Connector



DIN electrical connector changes to yellow when selected item is enabled. The yellow short to ground icon or open circuit icon indicates a circuit fault that must be serviced immediately.

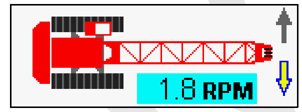
NOTE: Variable outputs may show a yellow icon all the time.

Drum Speed



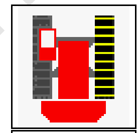
Displays drum speed in revolutions per minute (RPM). Drum direction is also shown.

Swing Status



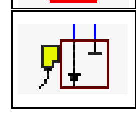
Displays status of swing. Swing right (shown) or swing left arrow is yellow when swing is enabled. Swing speed is shown in revolutions per minute (RPM).

Track Symbol



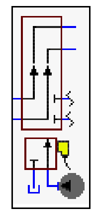
Shows travel function. Travel (right shown) is yellow when function is operating.

Valve Status



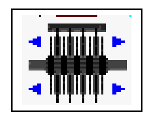
Displays status of a valve.

Pilot Valve



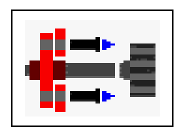
Displays status of an external piloted valve.

Disc Brake



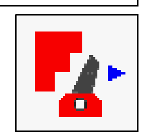
Displays disc brake status— applied or released (shown).

Swing Lock (past production)



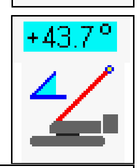
Displays swing lock status — disengaged (shown) or engaged.

Drum Pawl



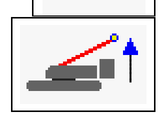
Displays pawl status — engaged or disengaged (shown).

Mast Angle



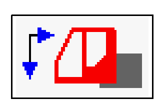
Displays mast angle in degrees mast is positioned above transport position.

Mast Raise Status



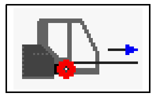
Displays command state of mast raise cylinders.

Cab Tilt Status



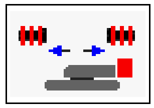
Displays command state of cab tilt cylinder — cab up/out or down/in (shown).

Rigging Winch Status



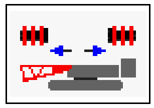
Displays command state of rigging winch — haul in or pay out (shown) line.

Counterweight Pin Status



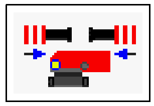
Displays command state of counterweight pin cylinders — extended (shown) or retracted.

Boom Hinge Pin Status



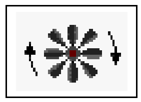
Displays command state of boom hinge pin cylinders — extended (shown) or retracted.

Rotating Bed Pin Status



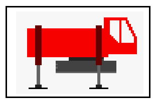
Displays command state of rotating bed pins — extended or retracted (shown).

Engine Cooling Fan Status



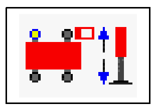
Displays command state of engine cooling fan (shown on).

Crane on Jacks Symbol



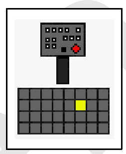
Displays image of crane on jacks. Front view icon also shown on Diagnostic screen.

Jack Status



Displays command state of a jack cylinder. Left rear jack shown extended.

Remote Control: Wireless and Wired



Displays remote control status by indicating which switches are closed. Each control switch corresponds with a number (see Table 3-9). Switch numbers start from 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 enabled in example shown.

Table 3-9 Wireless Remote Switch Identification

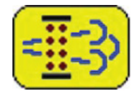
No.	Description	No.	Description
1	Engine Low Speed	16	Right Front Jack - Extend
2	Engine High Speed	17	Left Rear Jack - Retract
7	Boom Pins - In	18	Left Rear Jack - Extend
8	Boom Pins - Out	19	Right Rear Jack - Retract
9	Front Adapter Pins - In	20	Right Rear Jack - Extend
10	Front Adapter Pins - Out	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

Engine Diagnostics Screen

Engine Prompt

Displays when continued engine operation could result in damage to Diesel Particulate Filter (DPF). Stop the engine when safe and call for service.

Diesel Particulate Filter (DPF) ON



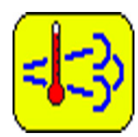
Displays one of three conditions (see Engine Manufacturer's manual for additional information):

- DPF is starting to fill. Ensure Regeneration Inhibit Switch is OFF. No immediate action is required. Perform a Stationary Regeneration at earliest convenience.
- Diesel Particulate Filter (DPF) FLASHING — DPF is nearly full. The operator may sense a reduction in power. Ensure Regeneration Inhibit Switch is OFF. No immediate action is required, but a Stationary Regeneration should be initiated as soon as possible.
- Diesel Particulate Filter (DPF) FLASHING and Check Engine light ON. The DPF is full. The operator will notice that engine power is significantly reduced. Stop operation and perform a Stationary Regeneration immediately.

DPF Regeneration Inhibited

Displays when active regeneration has been disallowed by pressing the Regeneration Inhibit switch. Excessive use of Regeneration Inhibit will result in the need to service or replace the DPF.

High Exhaust System Temperature (HEST)



Displays when higher than normal exhaust temperatures may exist due to DPF regeneration. See Engine Manufacturer's manuals for additional information.

Drum Diagnostic Screens

Select drum icon in screen ***level 1*** as shown Figure 3-11. Press Enter button to go to ***level 2***.

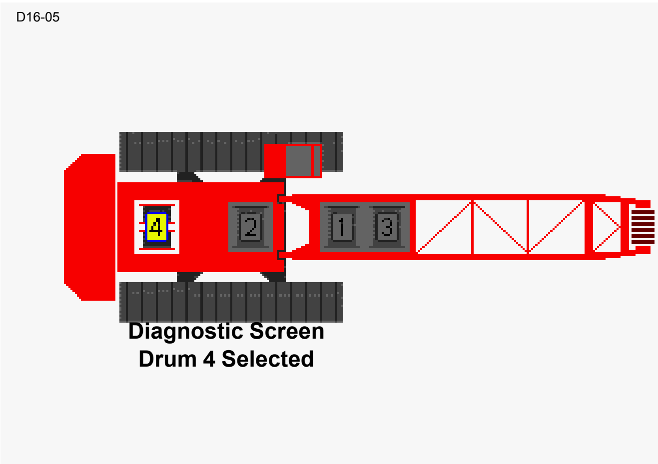


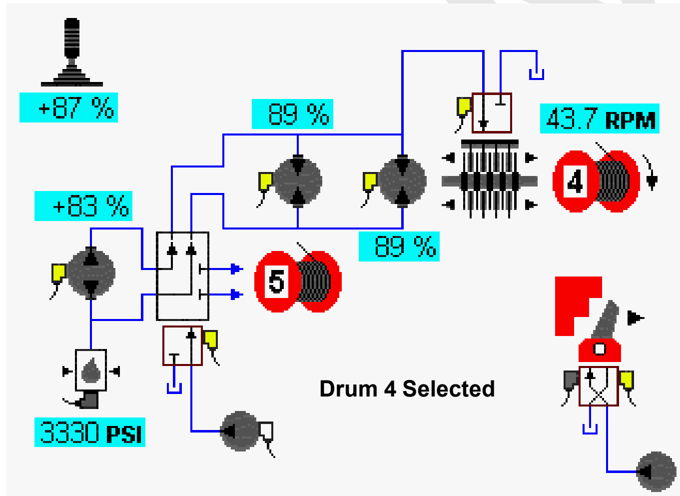
FIGURE 3-11

In the drum example shown in Figure 3-12, 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 upper diverting valve.

NOTE: Mast hoist drum 5 is only selected when crane is configured with a MAX-ER.

For load drums 1 or 2, drum 2 pump is dedicated to the drum 1 motor through 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 one half speed.

For load drum 3, the left travel pump is dedicated to operate drum 3 motor through diverting valve when drum 3 is selected. Drum 3 is inoperable when traveling. Drum 3 can be configured as load drum or luffing jib.



D16-06B

FIGURE 3-12

Swing Diagnostic Screen

Select swing icon in screen ***level 1*** as shown in Figure 3-13. Press Enter button to go to ***level 2.***

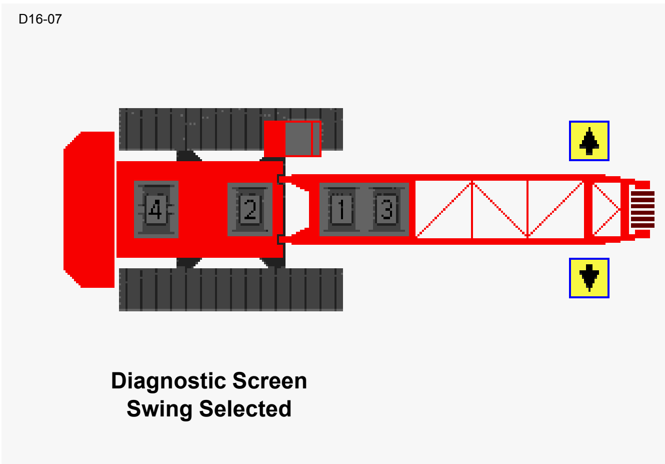


FIGURE 3-13

Swing system icons are displayed in Figure 3-14. The example shows how the swing function might appear when swinging right. Circular arrow symbols near each pressure sender indicate which sender monitors swing right and left pressures.

NOTE: Current production swing diagnostic screen for cranes with swing lock removed, see chapter one, swing section.

Swing Lock Past Production Cranes

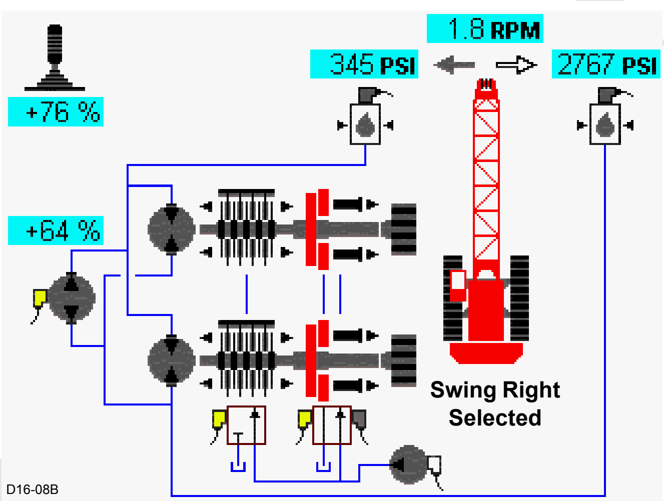


FIGURE 3-14

Travel Diagnostic Screen

Select travel icon in screen ***level 1*** as shown in Figure 3-15. Press Enter button to go to ***level 2.***

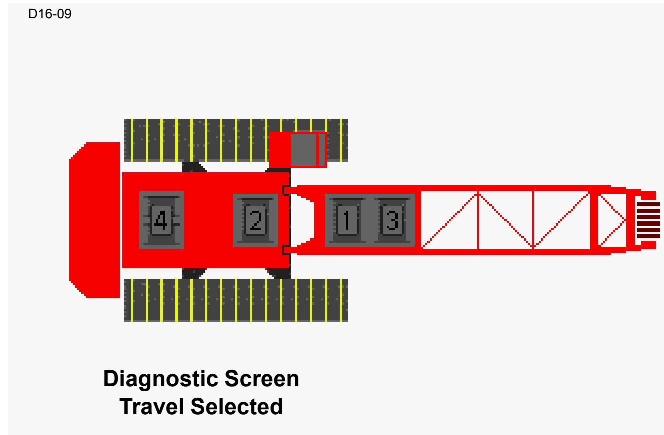


FIGURE 3-15

In travel system example shown in Figure 3-16, the left travel pump is dedicated to operate drum 3 through diverting valve if drum 3 is selected. The right travel pump is dedicated to operate drum 4 a through diverting valve if drum 4 is selected under certain conditions when drum 5 is also configured.

NOTE: When crane travel is enabled, drum 3 is disabled.

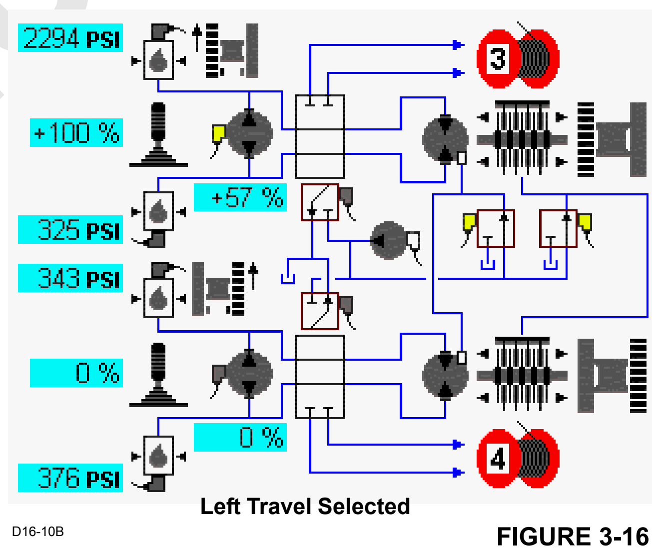
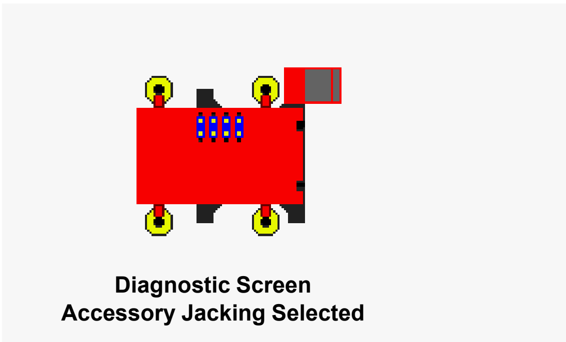


FIGURE 3-16

Jacking Accessory Diagnostic Screen

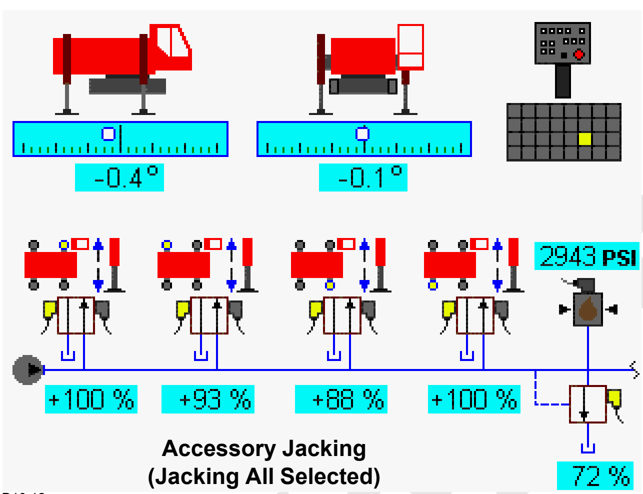
Select crane carbody with jacking icon in screen ***level 1*** as shown in Figure 3-27. Press Enter button to go to ***level 2.***



D16-11

FIGURE 3-17

At jacking accessory diagnostic screen component icons are displayed as shown in Figure 3-18. In the following example, all jack switch on wireless remote is selected. The crane on jacks icons indicate crane level status.

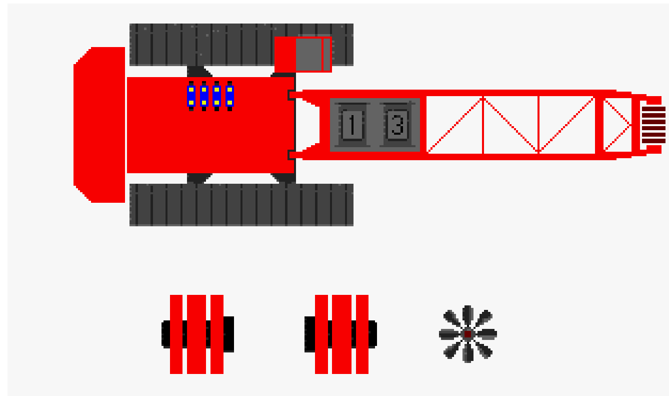


D16-12

FIGURE 3-18

Pins and Fan Accessory Diagnostic Screen

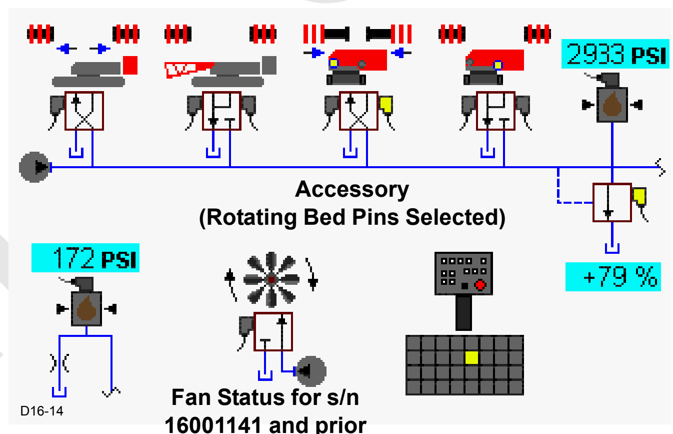
Select crane, pins, and engine fan icon in screen ***level 1*** as shown in Figure 3-19. Press Enter button to go to ***level 2***.



D16-13

FIGURE 3-19

For counterweight pins, boom hinge pins, front/rear rotating bed pins, and engine fan screen see Figure 3-20. In the following example, the left front rotating bed pin on wireless remote is selected. Fan status views are shown in Figure 3-20 and Figure 3-21 for current and past production.



D16-14

FIGURE 3-20

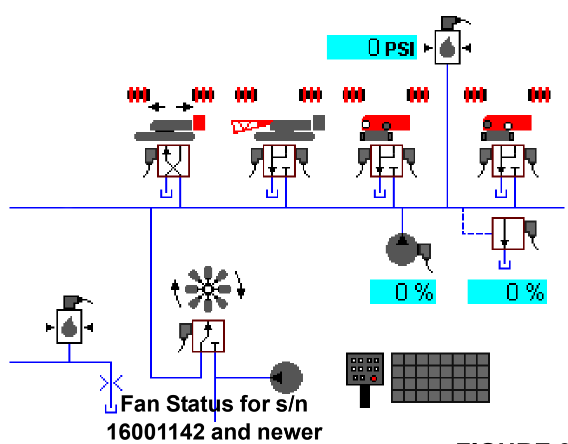


FIGURE 3-21

Cab Tilt, Rigging Winch, and Mast Accessory Diagnostic Screen

Select cab tilt, rigging winch, and mast icon in screen ***level 1*** as shown in Figure 3-22. Press Enter button to go to ***level 2***.

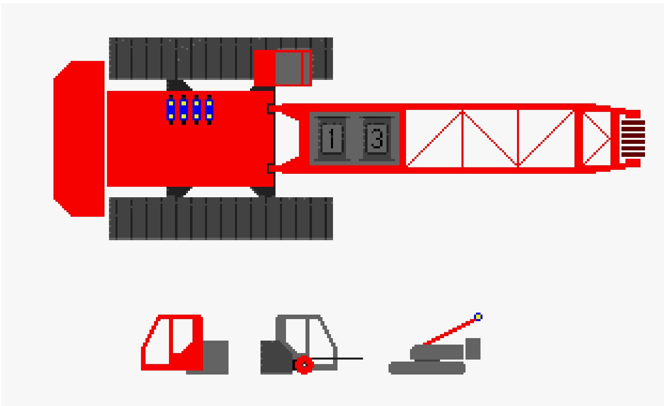


FIGURE 3-22

For cab tilt, rigging winch, and mast raising cylinders screen see Figure 3-23. In the following example, the mast rasing cylinders in up direction on wireless remote is selected.

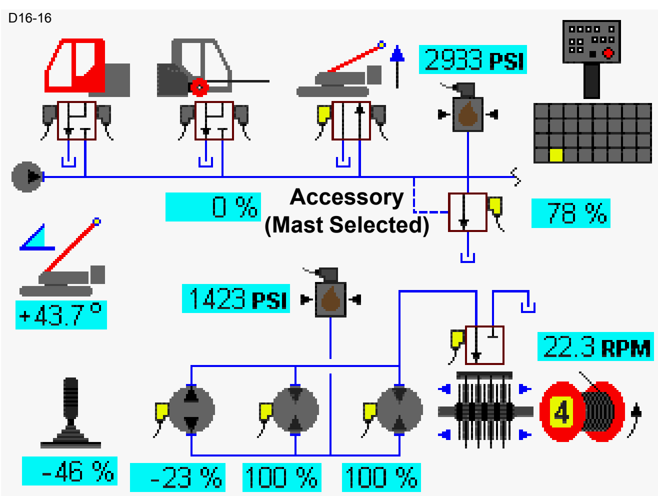


FIGURE 3-23

MAX-ER Diagnostic Screen

Select MAX-ER (optional) icon in screen ***level 1*** and press enter button to go to ***level 2***. See MAX-ER Operator's Manual for complete MAX-ER attachment information.

Function Mode Screens

See Figure 3-24 for the following procedure.

The Function Mode screen is to enable/disable modes and to set operating parameter for the individual crane functions. This screen operates on four ***levels***.

Level 1— Image of overall crane shown. Use Select buttons to highlight individual crane functions.

Level 2 — Shows the function mode screen for highlighted crane function. The selected mode or limit data box is highlighted blue. Use Select buttons to choose a mode or limit data box.

Level 3 — The selected mode or limit data box highlighted red. Use Select buttons to enable/disable a mode or to set a limit.

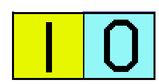
Level 4 — The selected mode or limit data box highlighted green. Use Select buttons to adjust the value shown in data box.

To enable/disable modes or to set operating parameters for the individual crane functions:

1. Press Enter or Exit buttons as required to go to ***level 1***. Use Select buttons to highlight desired crane function.
2. Press Enter button to go to ***level 2***. Use Select buttons to choose the mode or limit data box to access. Press Enter button to go to ***level 3***.
3. Use Select buttons to enable/disable mode or to adjust operational parameter.
4. Press Enter button to go to ***level 4*** if required. Use Select buttons to adjust 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 Information screen to access faults.

On (I) and ***off*** (0) icons in some data boxes indicate and enable the electrical status of item.



Drum Functions

Select drum functions 1 through 5 from screen shown below.

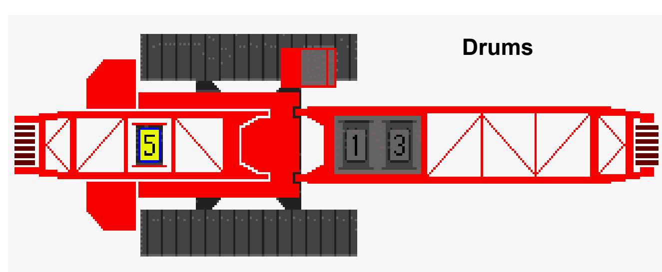


FIGURE 3-24

Swing Functions

Select swing functions from screen shown below.

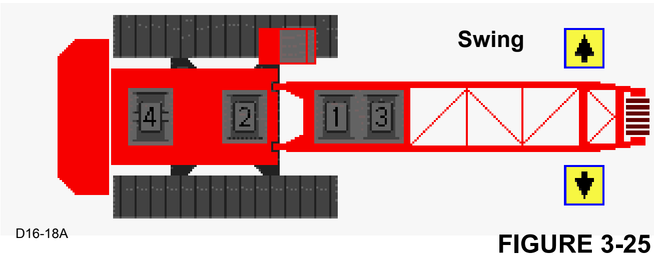


FIGURE 3-25

Travel Functions

Select travel functions from screen shown below.

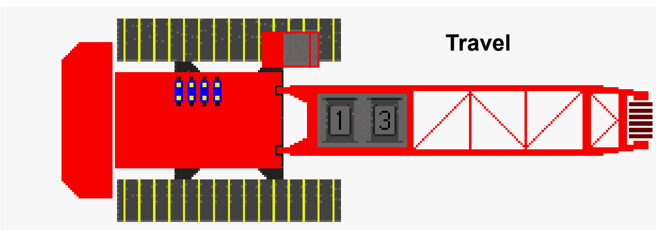


FIGURE 3-26

Crane Setup Remote Functions

Select crane setup remote functions from screen shown below.

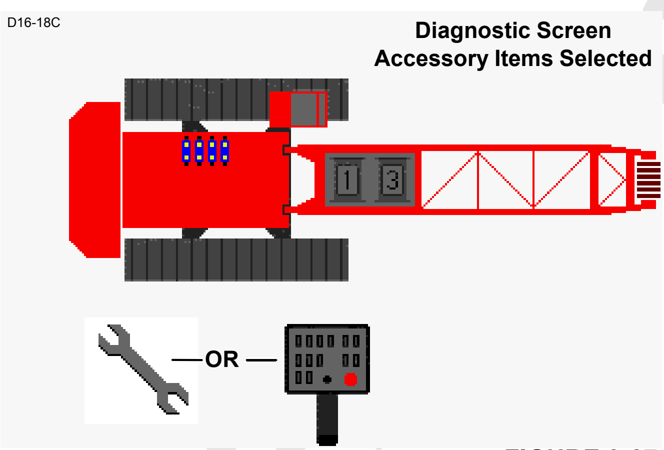


FIGURE 3-27

MAX-ER Functions

Select MAX-ER functions from MAX-ER attachment screen. See MAX-ER Operator Manual for complete MAX-ER attachment information.

Drum, Swing or Track Speed Limits

See Figure 3-28 in the following procedure.

Drum, swing, and crawler speeds can be selected. In ***level 3***, the value shown in these data boxes can be adjusted with the Select buttons to limit the function speed between 25% and 100% of maximum capability.

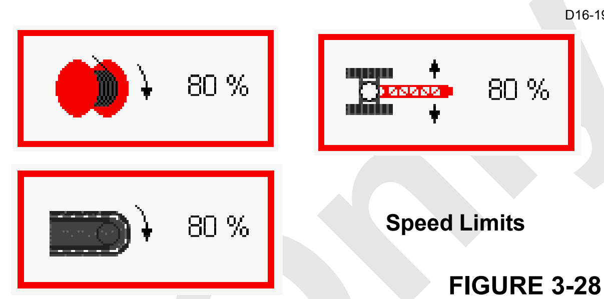


FIGURE 3-28

Swing Pressure Limit

See Figure 3-29 in the following procedure.

In ***level 3***, the value shown in this data box can be adjusted with the Select buttons to limit swing pressure between 25% and 100% of maximum capability.

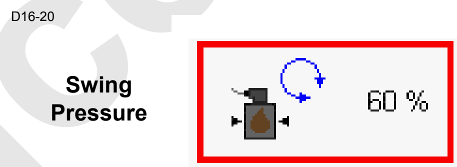


FIGURE 3-29

Rigging Winch Mode

See Figure 3-30 in the following procedure.

In **level 3**, use the Select buttons to enable or disable 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 rigging winch is enabled, the computer selects control handle (selected handle display light is 0). If rigging winch is enabled for drum 4, the computer selects a load drum handle to control winch.

FIGURE 3-30

Boom or Swing Motion Limiter Mode

See Figure 3-30 in the following procedure.

NOTE: Motion limiter mode data boxes do not appear unless crane has this option.

In ***level 3***, use the Select buttons to enable or disable the motion limiter mode. When in ***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 boom or swing motion.

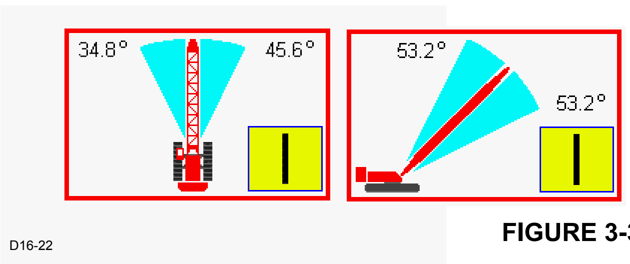


FIGURE 3-31

Crane Setup Remote Mode

To turn on the crane setup remote control, see the procedure in Section 3 of the Crane Operator Manual.

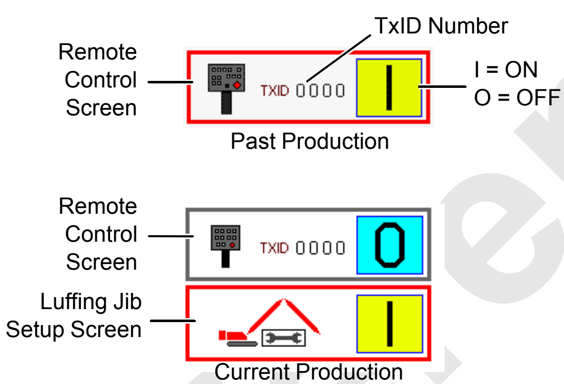


FIGURE 3-32

Fan Function

See Figure 3-33 for the following procedure.

The fan speed can be set above a minimum 25% of rated speed in increments of 5% (to 30%, 35%, 40%, etc.). **The minimum fan speed is set by the factory and does not require further adjustment.**

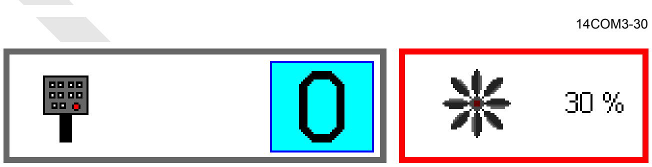


FIGURE 3-33

CAN Bus Screen

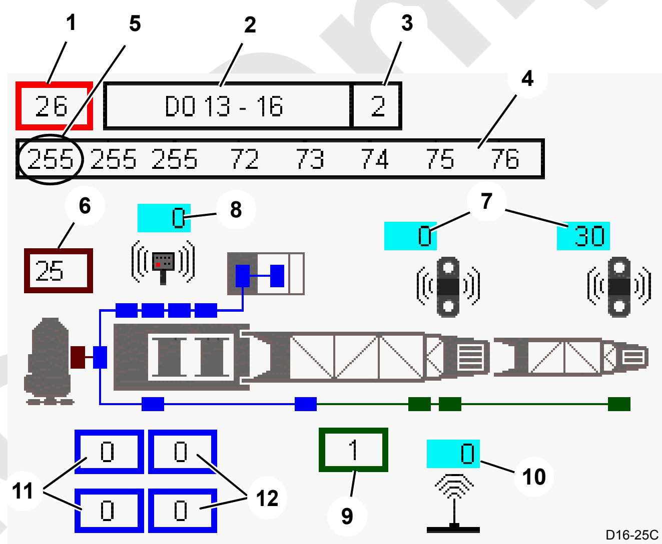
See Figure 3-34 for the following procedure.

The CAN (Controller Area Network) bus diagnostic screen is for technicians. The screen displays CAN bus packet and node information, engine status, history status, and boom status. Any node that is yellow indicates that communication is lost to that node.

The CAN Bus screen operates on two ***levels***:

Level 1 — Packet number data box highlighted blue

Level 2 — Packet number data box highlighted red



Item	Description	Item	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 3-34

Packet Information

See Figure 3-34, items 1 to 5.

The top row of the screen contains CAN Bus packet number (26). Enter the desired packet number in the first data box by using Select buttons.

Packet type (DO) is displayed on top middle data box.

Related node (2) is displayed in top last data box.

Packet contents are displayed in the eight banks under the row. Packet content and format depends on packet type. Many packets are not easily interpreted by other than factory technical personnel and their content is 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 – 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, you need to know the CAN packet number (see Table 3-3 through Table 3-6). For example: ***Drum 1 Brake*** has a packet number of ***CAN26-1-64***.

The first part of the Code Number (***26***) indicates that the individual input or output is located in ***packet 26*** of the CAN communications.

Second part of Code Number (***1***) indicates the ***bank*** where the individual information is shown on the CAN screen.

The third part of the Code Number (***64***) is the item ***identifier***.

Determine status of the individual input/output by check the total in bank 1 (255). Find 255 in the numbered column of Table 3-10 - Bank Identifier Numbers. In the corresponding row the identifier numbers that are ON in the bank are shaded. In the above example if ***64*** is shaded the ***Drum 1 Brake*** is ON.

Digital Output Disable Fault

See Figure 3-34, items 4 and 5.

The control system is capable of detecting an open or short circuit in most of the system's digital outputs. When ***Fault 84-Digital Output Disable*** is shown in fault section of Information screen, check for DOD fault in packets 36 through 41:

1. Scroll through packet numbers 36 through 41.
2. Banks 1, 2, and 3 of CAN bus screen should display number 255.
3. If a number less than 255 is displayed in banks 1, 2, and 3, use the Bank Identifier Numbers in Table 3-10 to determine which bit(s) are ***off***.
4. Use Table 3-3 to show what outputs are not working.
5. Investigate indicated outputs for short to ground, short to shield or other problem.

Engine Node Status

See Figure 3-34, item 6.

Engine displays node bus status that is for factory use only. Communication number should be under 64. See engine manufacturers manual for engine fault code information.

Load Link Status (900 MHz System)

CON0 depicted in Figure 3-8, page 3-35.

See Figure 3-34, item 7.

The load link sensor icons indicate the selected load sensor operating status. The selected link sensor is operating normal if blue antenna icon is displayed. The following numbers indicate the type of communication error:

4 = is a calibration fault.

8 = is RF (radio frequency) state. The selected link sensor is not communicating.

64 = is a sign on error

128 = indicates a RF (radio frequency) communication error.

The following numbers indicate drum load link and wireless remote battery status:

16 and 32 On = 75% and up battery charge.

32 On, 16 Off = 50% to 75% battery charge.

32 Off, 16 On = 25% to 50% battery charge.

Both Off = 0% to 25% battery charge.

Load Link Status (2.4 GHz System)

CON1 or CON2 depicted in Figure 3-8, page 3-35.

See Figure 3-34, item 7.

The load link sensor icons indicate the selected load sensor operating status. The selected link sensor is operating normal if blue antenna icon is displayed. The following numbers indicate the type of communication error:

8 = is RF (radio frequency) state. The selected link sensor is not communicating.

32 = is a calibration fault.

64 = is a sign on error.

128 = indicates a RF (radio frequency) communication error.

The battery status is shown in bank 4 CAN Bus screen for the corresponding packet number (Drum 1-packet 141, Drum 2-packet 142, Drum 3-packet 143, Drum 6-packet 144):

15 = full battery charge.

0 = critically low battery charge.

Remote Control Status

See Figure 3-34, item 8.

Identifies which remote control is active.

1 = Crane remote

2 = MAX-ER remote

Boom Node Status

See Figure 3-34, item 9.

The boom node status displays boom top node and jib node communication. Zero is displayed if there is a communication error. Boom data box indicates what boom nodes may be available on the bus:

0 = No communication.

1 = is boom top node.

2 = is luffing jib node.

4 = is fixed jib node.

128 = indicates a node is present that is not currently identified.

Wireless Receiver Status

See Figure 3-34, item 10.

Wireless receiver status displays boom top and wireless receiver communication. The following numbers indicate the type of communication:

0 = Communication error.

1 = Boom top transmitter working.

2 = Rotating bed receiver working.

8 = MAX-ER Remote control is communicating.

Crane Status

See Figure 3-34, item 11.

Two crane status banks display crane errors, and should normally read zero.

The number displayed in the crane status top bank corresponds to the numbered communication errors listed below:

0 = Crane status 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 = Bin node is not communicating.

64 = Node 7 is not communicating.

128 = Engine node is not communicating.

On current production cranes, the number displayed in the crane status bottom bank corresponds to the following:

0 = BRS (boom raising system) status normal.

1 = BRS Node-9 is not communicating.

Crane History

See Figure 3-34, item 12.

Top crane history bank displays errors since power was last cycled.

Bottom crane history bank is not used at this time.

3

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	■	■		■		■		
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		■	■		■		■	
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.

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			■	■		■		■
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	■	■	■		■		■	■
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 (not shown) displays camera options and items for selecting and operating. The camera option includes up to three different cameras to monitor drum spooling and the area behind the crane.

Use Select buttons to select the camera screen on the Menu screen. Press Enter button to access the screen.

Use Select buttons to select desired camera view.

Press Exit button until Menu screen appears.

DIELECTRIC GREASE

The following figures show the proper application of dielectric grease on J - tech type connectors.

Dielectric grease is need when assembling J - tech type connectors. A bead of grease needs to be applied on O-ring and face of the socket connector ***and only on the O-ring for a pin connector.***

FIGURE 3-35

The size of the grease bead on the O-ring is as follows:

- On a 3 pin connector a 1/16 inch (1,59 mm) bead is required.
- On a 24 pin connector a 1/8 inch (3,18 mm) bead is required.
- On a 37 pin connector a 3/16 inch (4,76 mm) bead is required.

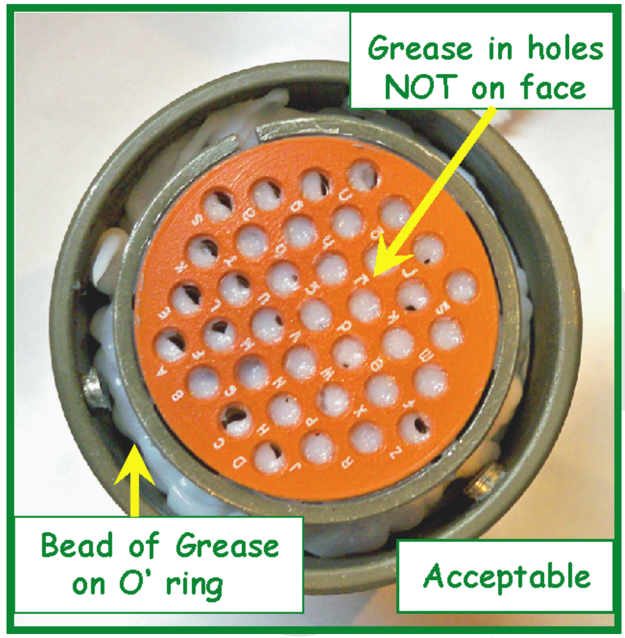


FIGURE 3-36

Place a small amount of grease on your finger for the application on the connector's face. Wipe your finger across the face leaving grease inside the socket holes and less than 0.001 inch (0,025 mm) on the connector's face. This helps assure that water will be kept out of the connectors and keep the pins from fretting.

FIGURE 3-37

SECTION 4
BOOM

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4

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SECTION 4
BOOM

AUTOMATIC BOOM STOP ADJUSTMENT

Maximum Boom Angle

Boom stop limit switch (5, Figure 4-2) automatically 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 description.

When the boom is below the maximum angle, limit switch (5) is closed and its LED (light-emitting diode) is ON (View B). The boom hoist can be operated.

When the boom is raised to the maximum angle, boom butt (1) pushes adjusting rod (2a or 2b) in and actuator rod (11, View A) opens limit switch (5). The LED then goes OFF. Boom hoist operation stops automatically because the open limit switch turns off power to the boom hoist electric circuit. The boom hoist pump shifts to neutral and the brake applies to stop boom movement.

WARNING

Falling Attachment Hazard!

If boom fails to stop for any reason, stop engine immediately. Troubleshoot system to determine problem.

Do not resume operation until problem has been corrected.

Maintenance

At least once weekly, check that the automatic 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 automatic boom stop is properly adjusted, it should not require periodic adjustment. Adjustment is required, however, when:

- The luffing jib is installed or removed.
- Parts are replaced.

WARNING

Falling Attachment Hazard!

Do not operate crane unless automatic boom stop is properly adjusted and operational. Do not adjust maximum operating angle higher than specified. Boom could be pulled over backwards or collapse, causing death or serious injury.

Table 4-1 — Boom Stop Limits

Angle A (see Figure 4-1)	
83° — #58 Boom without Luffing Jib 87° — #58 Boom with #59 Luffing Jib	For Cranes with a Boom Up Limit that ***Can be Bypassed****
84° — #58 Boom without Luffing Jib 88° — #58 Boom with #59 Luffing Jib	For Cranes with a Boom Up Limit that ***Cannot be Bypassed****
* To determine if the boom up limit on your crane can be bypassed or not, perform Bypass Limit Test given below.	

Bypass Limit Test

Perform the following test to determine if the boom up limit on your crane can be bypassed or not.

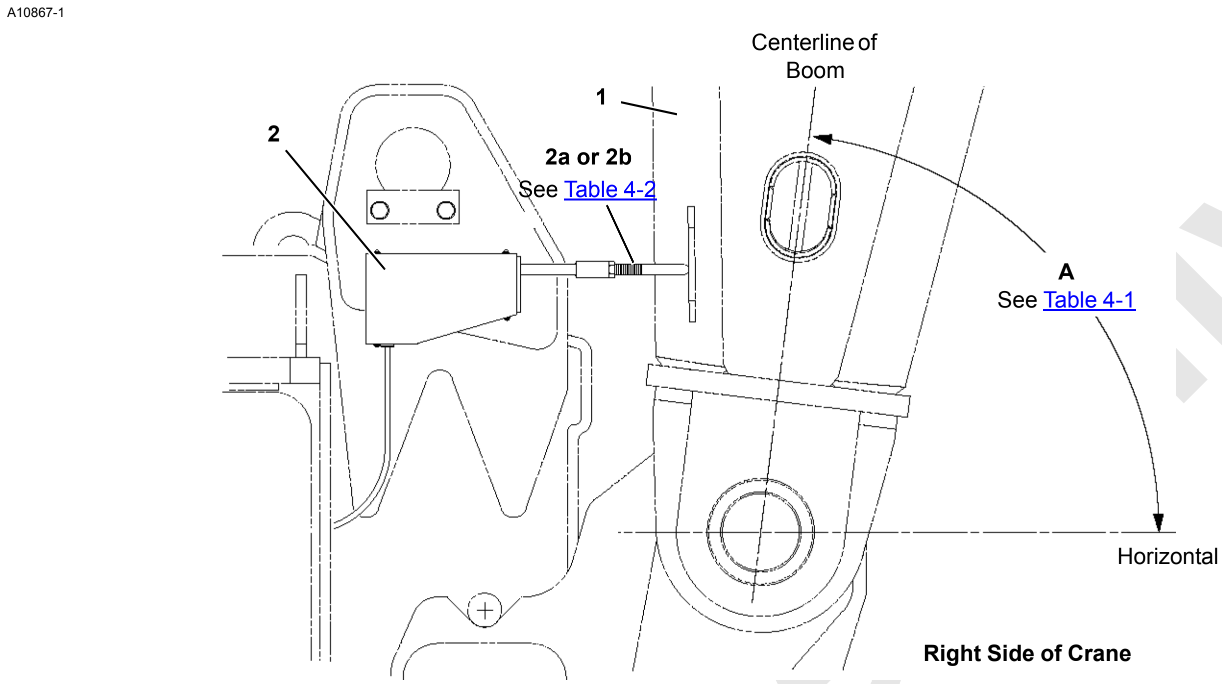
WARNING

Crush Hazard!

Maintain constant communication between operator and assistant during following steps.

Stay clear of moving parts.

1. Lower the boom onto blocking at ground level.
2. Have an assistant push the adjusting rod (Figure 4-2) in to trip the boom stop limit switch open.
3. Rotate the limit bypass key (in crane cab) to the bypass position and hold.
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.

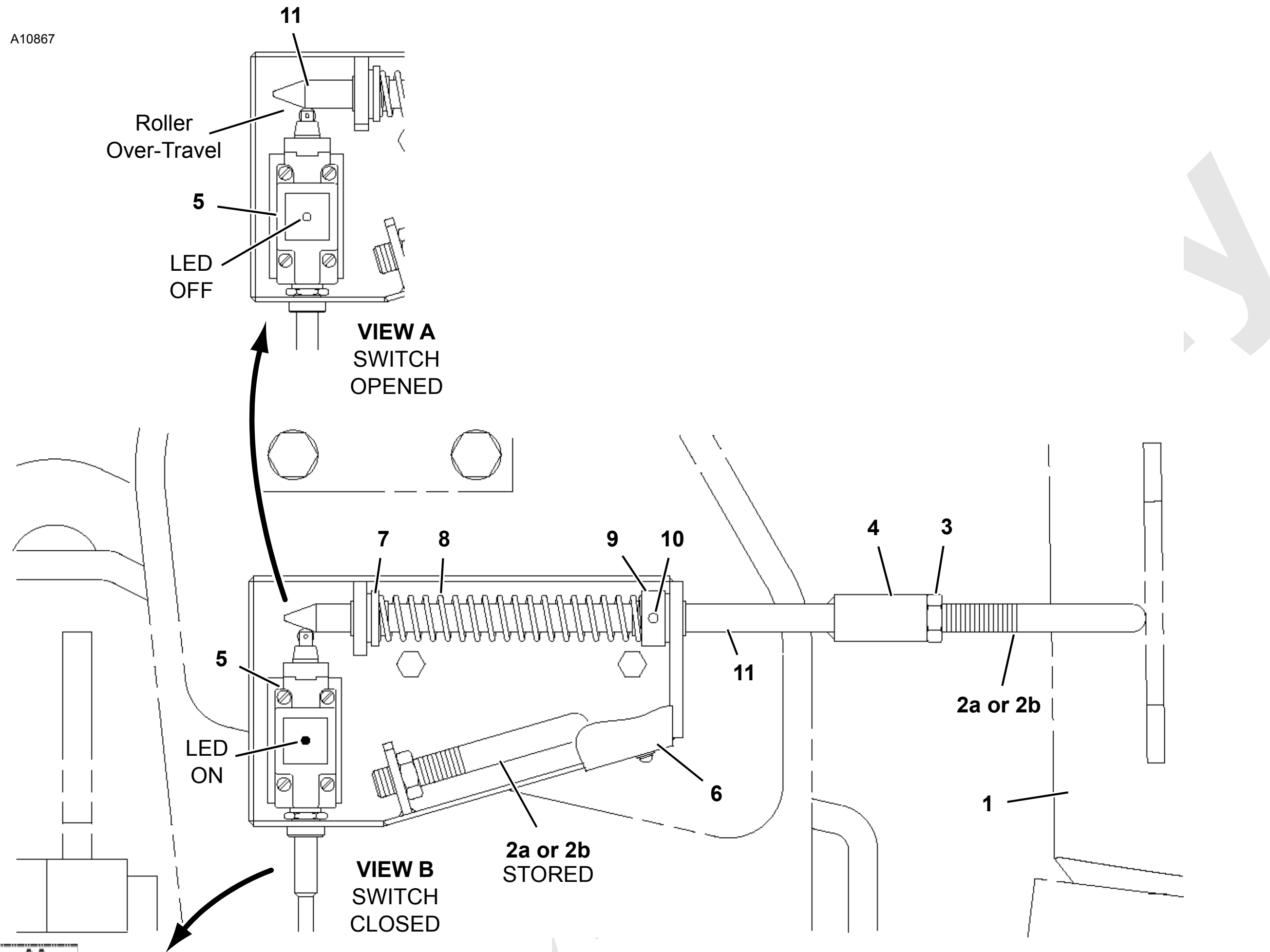


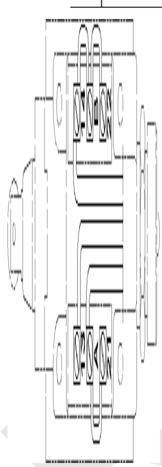
Item	Description
1	Boom Butt
2	Switch Assembly

FIGURE 4-1

Table 4-2 — Adjusting Rod

Adjusting Rod and Length (see Figure 4-1)	
2a Boom Only	**2b** With Luffing Jib
145471 7 in (178 mm)	A18794 6-1/8 in (156 mm)





Limit Switch Wiring

Receptacle	Switch Terminals			Function
1 (green)	22	B	14	Max Angle
2 (black)	A	13		LED
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 1/4 in (6,35 mm) Diameter
11	Actuator Rod
12	Digital Level (see Figure 4-3)

FIGURE 4-2

Angle A	Digital Level Angle
83°	75.3°
84°	76.3°
87°	79.3°
88°	80.3°

A10415

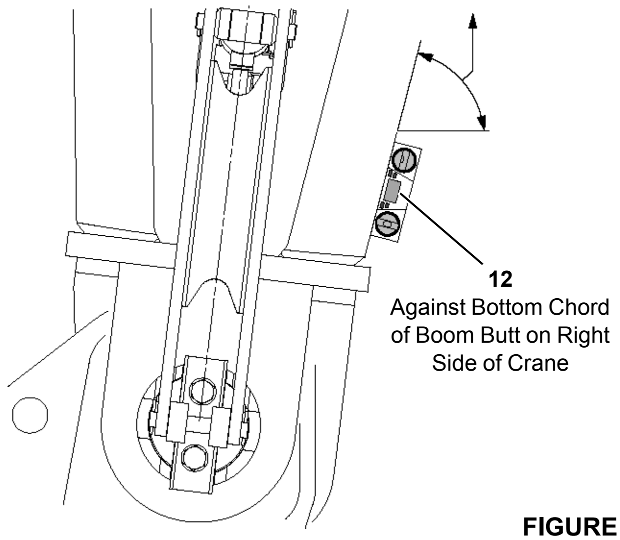


FIGURE 4-3

ADJUSTMENT

1. Park the crane on a firm level surface or level the crane by 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 reaches the specified angle before it stops, go to step 7.

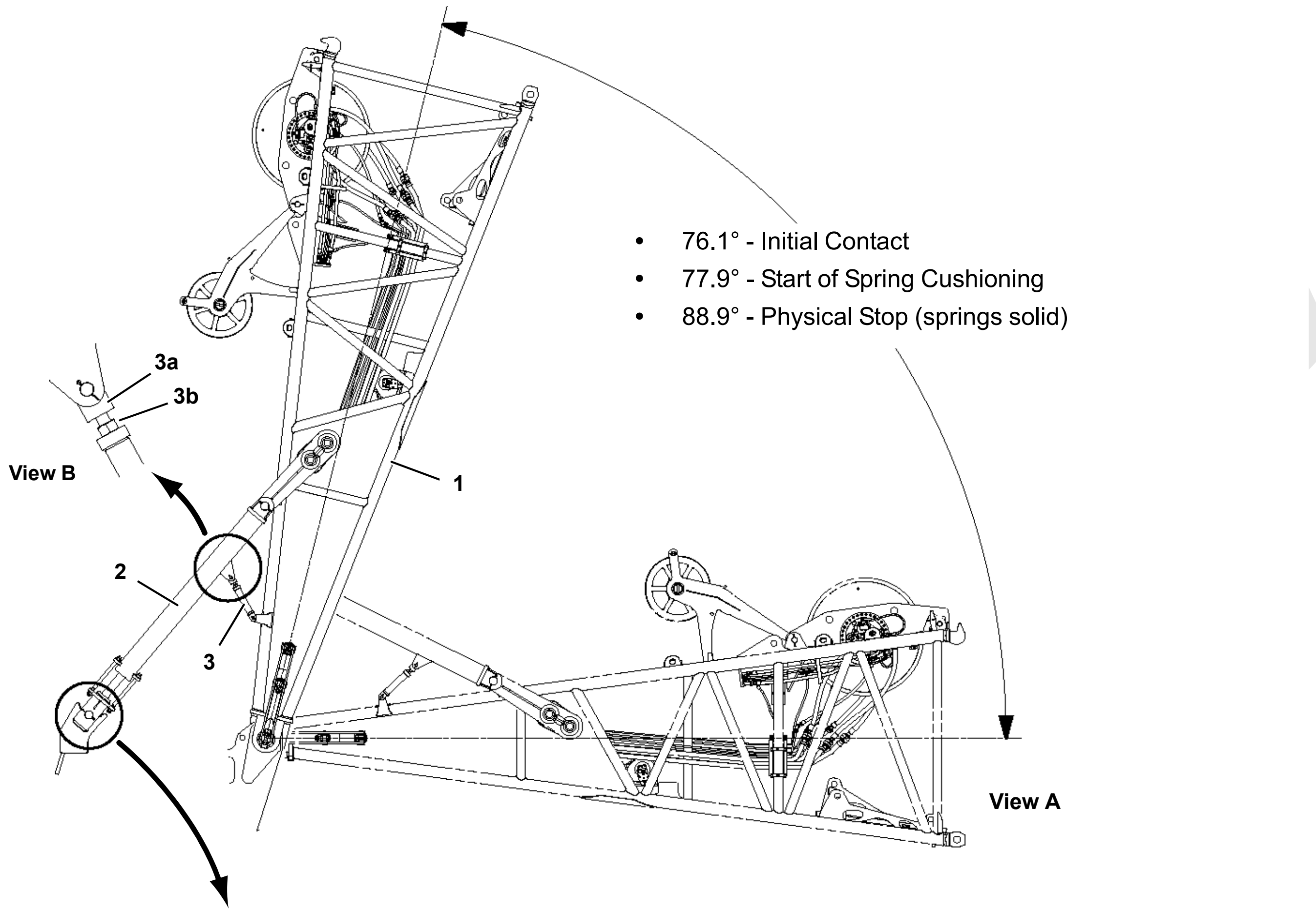
See Figure 4-2 for the remaining steps.

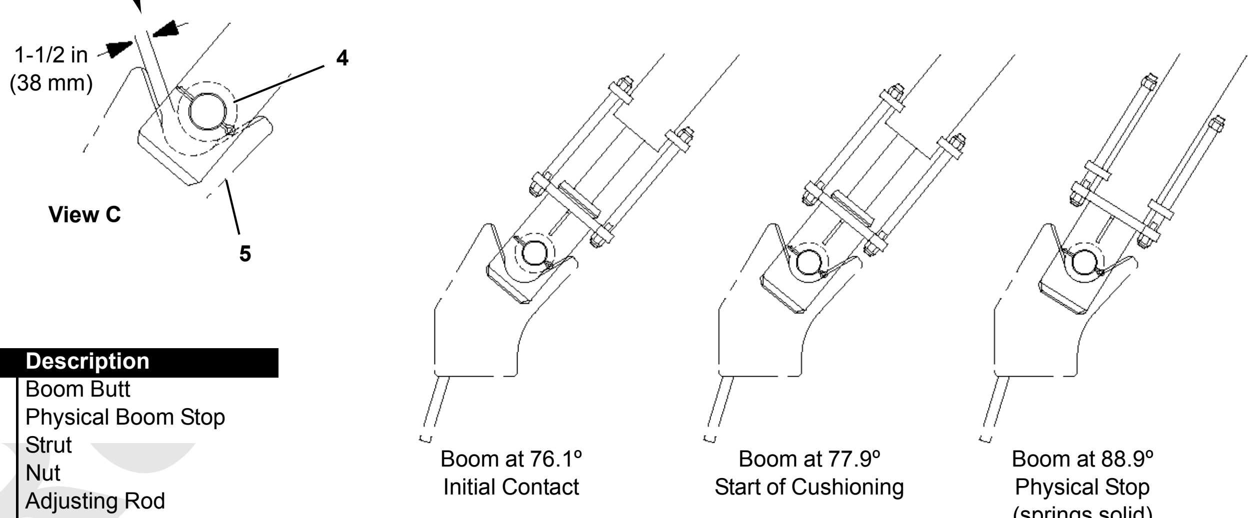
6. If the boom stops before reaching the specified angle:
   - **a.** Loosen jam nut (3, View B).
   - **b.** Turn adjusting rod (2a or 2b) all the way into coupling (4).
   - **c.** Boom up slowly until the boom reaches the specified angle.
   - **d.** Turn adjusting rod (2a or 2b) out against boom butt (1) until limit switch (5) “clicks” open and the LED is OFF (View A).
   - **e.** Tighten jam nut (3).
7. If the boom reaches the specified angle before it stops:
   - **a.** Loosen jam nut (3, View B).
   - **b.** Turn adjusting rod (2a or 2b) out against boom butt (1) until limit switch (5) “clicks” open and the LED is OFF (View A).
   - **c.** Tighten jam nut (3).
8. Check that actuator rod (11) over-travels the limit switch as shown in View A.
9. Test the adjustment as follows:
   - **a.** Lower the boom several degrees below specified Angle A.
   - **b.** Slowly raise the boom.
   - **c.** ***Boom must stop at specified Angle A.*** If the boom does not stop at the specified angle:
     - Stop raising the boom (move 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 damaged actuator rod (11).
2. Slide spring washers (7 and 9) and spring (8) over new actuator rod (11) while sliding the actuator rod into the bracket assembly.
3. Position actuator rod (11) so the tapered end just touches the roller of limit switch (5, View B). The actuator rod must not depress the limit switch roller.
4. Drill a 1/4 in (6,35 mm) hole through spring washer (9) and actuator rod (11).
5. Install dowel pin (10).
6. Install 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

FIGURE 4-4

PHYSICAL BOOM STOP

See Figure 4-4 for the following procedure.

Physical Boom Stop Angles

The physical boom stops serve the following purposes:

- 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 boom at maximum operating angle. Automatic boom stop must be installed and properly adjusted.

Operation

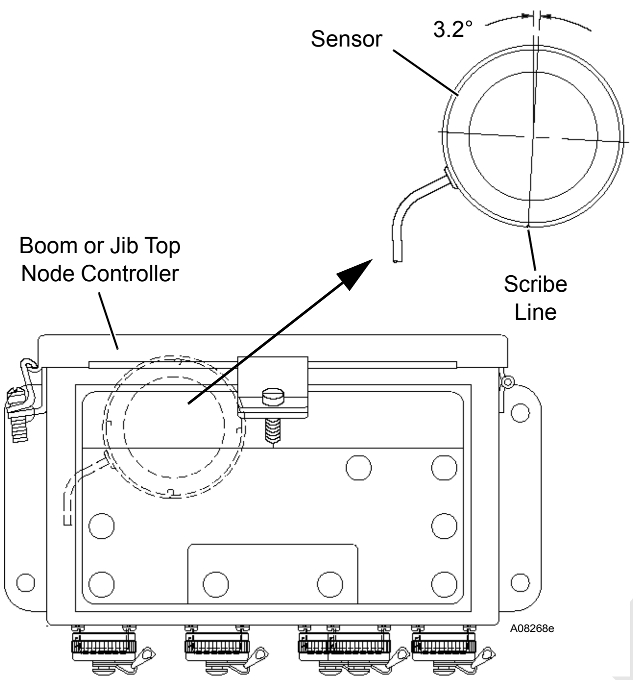
1. When the boom is raised to 77.9°, springs in the boom stop tubes begin to compress.
2. As the boom is raised higher, spring compression increases to exert greater force against the boom.
3. If for any reason the boom is raised to 88.9°, the boom stop springs fully compress to provide a physical stop.

Adjustment

1. Raise boom butt (1, View A) until boom stop rollers (4) just contact saddles (5, View C) on rotating bed.
2. Adjust rod ends (3a, View B) so gap between rollers (4) and bottom of saddles is at dimension shown in View C.
3. Securely tighten jam nuts (3b).

BOOM AND LUFFING JIB ANGLE INDICATOR CALIBRATION

Angle indicator sensors are located inside the node controllers mounted on the boom top and on the luffing jib top (see Figure 4-6). The boom and luffing jib angles are calibrated automatically by the crane's programmable controller as part of the load indicator calibration procedure (see RCL Operation Manual for instructions).



Wires	Receptacle ID	Function
Red	J17-1	Ground
Green	J17-2	Signal
Black	J17-3	5 VDC Supply
White	Not Used	

FIGURE 4-5

MAST ANGLE ADJUSTMENT

See Figure 4-6 for the following procedure.

Mast Angle Sensor

The mast angle sending unit (Figure 4-6) houses a solid-state sensor (Figure 4-8) which provides an electric signal to the crane's programmable controller. The programmable controller uses the signal for the following purposes:

- Automatically control the position of the mast raising cylinder and levers during crane setup.
- Allow the operator to monitor the mast angle on the display during crane setup.

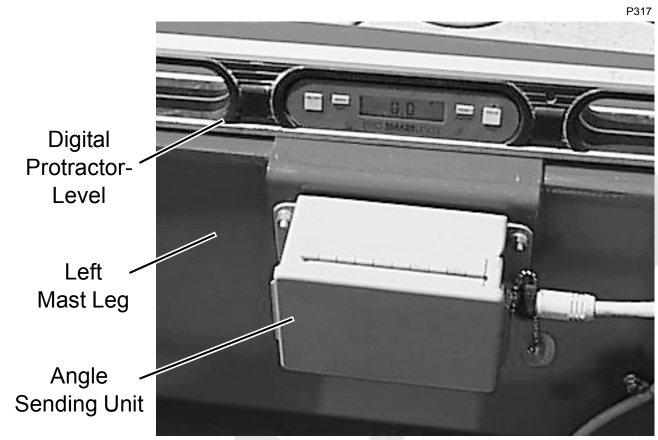


FIGURE 4-6

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.

1. Park crane on a solid, level surface.
2. Lower mast to transport position.
3. Place a digital protractor-level on mast (Figure 4-6) and note mast angle.
4. Go to MAST ANGLE on information screen of main display. Note mast angle.

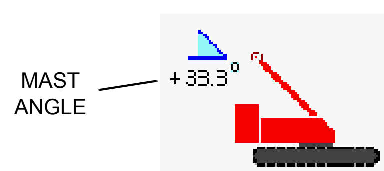


FIGURE 4-7

5. Angle noted in steps 3 and 4 must match within 1°.
6. If necessary, loosen mounting screws and rotate sending unit in mounting slots until reading on display matches angle on level.
7. Securely tighten mounting screws to lock adjustment.

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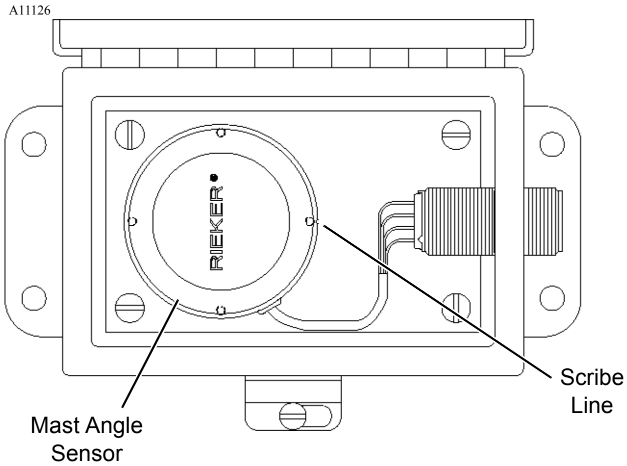


Wires	Receptacle ID	Function
Red	J1-A	Supply Voltage 5 VDC or 10 VDC
Green	J1-B	Analog Output 1 0 to 5 VDC
Black	J1-C	System Ground Power and Signal
White	J1-D	Analog Output 2 0 to 10 VDC

FIGURE 4-8

DRUM PRESSURE-ROLLER ADJUSTMENT

General

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 drum and turn off engine before adjusting.

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 the following steps:

1. Hold spring guide (7) wrench flats.
2. Tighten 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

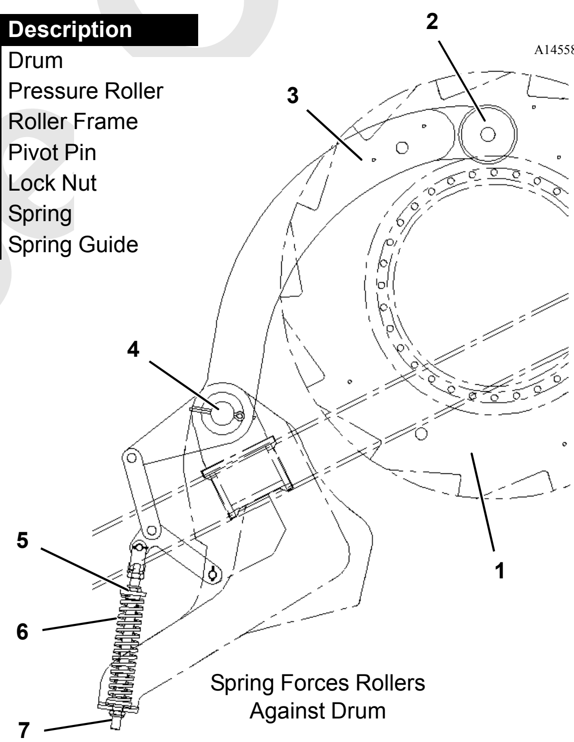


FIGURE 4-9

STRAP INSPECTION AND MAINTENANCE

This section is a guide to crane owners for properly inspecting and maintaining straps in the field. It is impossible to predict whether or when a strap may fail. Frequent and periodic inspections can help reveal potential for failure. Straps are to be inspected regularly by a ***qualified person*** as part of 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, **strap** means straps and connecting links.

Inspection

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

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

Frequent Inspection

Visually inspect all straps once each work shift for obvious damage which 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, strap must be checked to make sure it is within specifications given in this section.

Periodic Inspection

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

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

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

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

Cranes Not In Regular Use

A qualified inspector should determine 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, part number is stamped into both ends of each strap as shown in Figure 4-10.

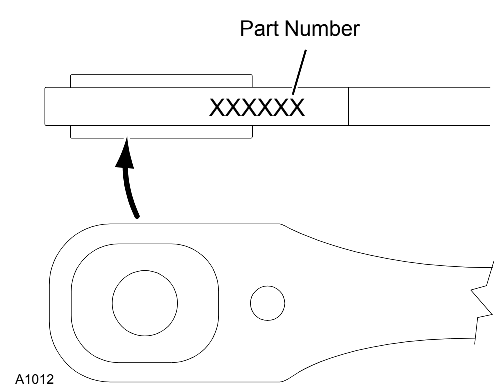


FIGURE 4-10

Replacement Specifications

Any strap not within specifications listed in Table 4-3 must be replaced.

WARNING

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

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

Table 4-3
Strap Specifications

Condition	Reference	Allowable Tolerance or Deviation	Corrective Action
Dent	Figure 4-11	< 0.12 in (3,048 mm)	Monitor condition.
		≥ 0.12 in (3,048 mm)	Remove strap from service.
Kink	Figure 4-12	None	Remove strap from service.
Crack or Break	Figure 4-13	None	Remove 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 strap from service.
Straightness (gradual or sweeping bend)	Figure 4-15	Varies depending on strap length	Remove 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 strap from service.
Length	Figure 4-18	None	Remove strap from service.

< = less than
≥ = equal to or greater than

Dent

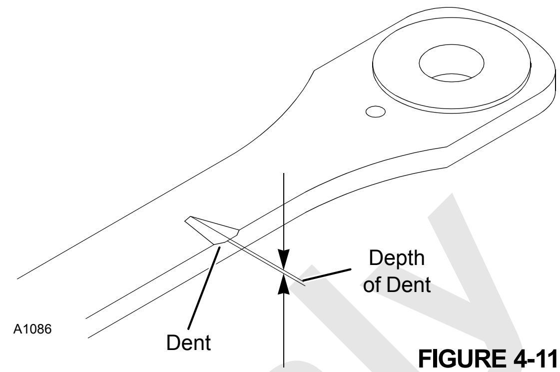


FIGURE 4-11

Kink

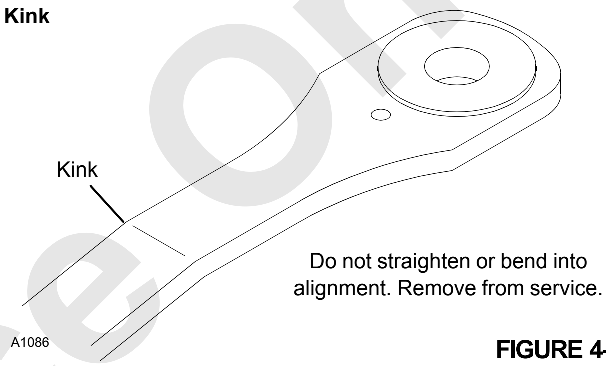


FIGURE 4-12

Crack Or Break

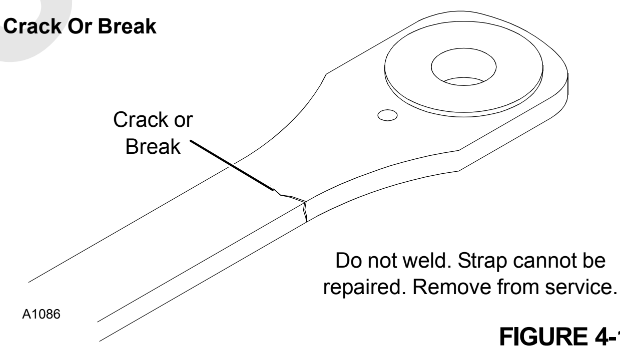


FIGURE 4-13

Corrosion or Abrasion

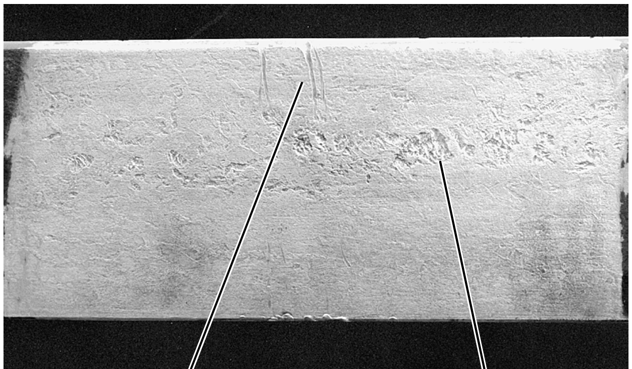
See Figure 4-14 for the following procedure.

For quick identification by repair workers, clearly mark damaged areas with brightly colored tape.

1. Sandblast to remove corrosion. **Do not grind!**
2. Determine reduction in thickness.
3. If reduction is less than 6% of strap thickness, paint strap to maintain continuous protective coating.
4. If reduction is 6% or more, remove strap from service.

Corrosion or Abrasion

P325



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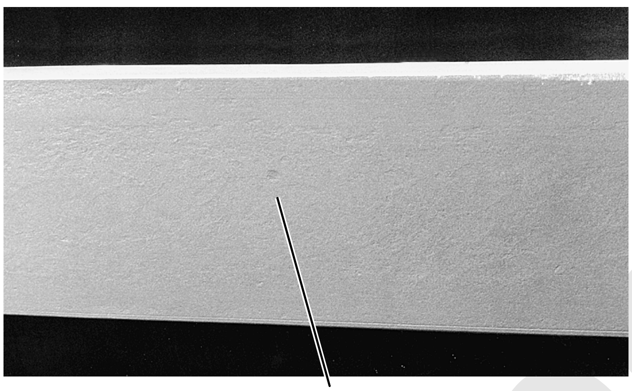


FIGURE 4-14

Straightness

See Figure 4-15 for the following procedure.

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

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

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

Straightness (gradual or sweeping bend)

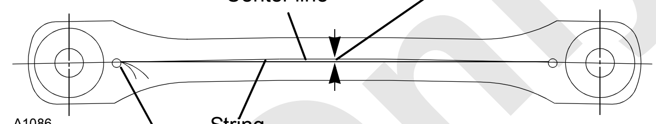


FIGURE 4-15

Flatness

See Figure 4-16 for the following procedure.

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

   If deviation from straight is greater than maximum allowed, remove strap from service.
6. Remove line. Turn strap over.
7. Repeat steps 1-5 above.

Flatness (includes twisted straps)

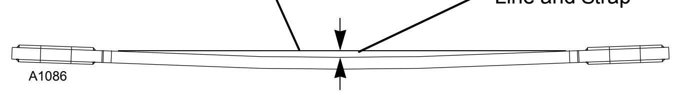


FIGURE 4-16

Elongated Hole

See Figure 4-17 for the following procedure.

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

3. Push pin tight against edge of hole along vertical center line. Measure dimension between pin and hole (View B).

   If dimensions A and B are not identical, hole is elongated. Remove strap from service.

   If two dimensions are identical, but greater than 0.030 in (0,8 mm), contact factory Service Department.

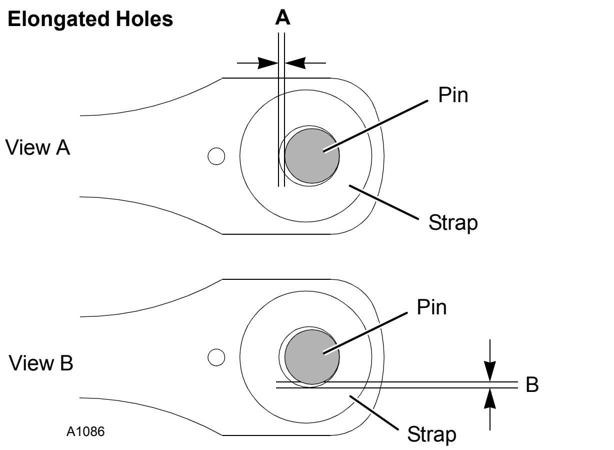
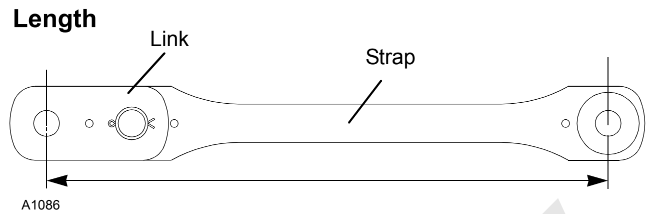


FIGURE 4-17

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

< = less than

≥ = equal to or greater than



Measure to check length. See appropriate Rigging Drawing in Operator Manual for original length. Strap length includes connecting link. If change in length is detected, remove 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, strap will have to 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 specification, check the box (☑)next to the item to indicate that its specific condition was evaluated and found acceptable. If damage is not within specification, indicate so in the box next to the item (for example: **D** to indicate damage).

4

Table 4-4 Lacing and Chord Wall Thickness

This table applies only to past production cranes. Lacing and chord wall thicknesses for current production cranes are located in the Lacing Drawings in the Attachment Section of the Parts Manual supplied with the crane.

Boom, Jib, Tower, or Mast Number	**Lacing Wall Thickness** in (mm)	**Chord Wall Thickness** in (mm)
8	0.095 (2,4)	Angle (NOTE 1)
9A	0.095 (2,4)	Angle (NOTE 1)
17	0.109 (2,8)	0.340 (8,6)
18	0.095 (2,4)	0.25 (6,4) Butt 0.156 (4,0) Top & Inserts
22A, B, C	0.095 (2,4)	Angle (NOTE 1)
23	0.095 (2,4)	0.188 (4,8)
27	0.095 (2,4)	Angle (NOTE 1)
27A-27	0.095 (2,4)	Angle (NOTE 1)
27B	Butt: 3-3/4 (95,3) OD = 0.188 (4,8) 3-1/2 (88,9) OD = 0.156 (4,0) 3-1/4 (82,6) OD = 0.095 (2,4) 2-3/4 (69,9) OD = 0.095 (2,4) Top & Inserts = 0.095 (2,4)	Angle (NOTE 1)
39	0.095 (2,4)	Angle (NOTE 1)
39A	0.095 (2,4)	Angle (NOTE 1)
40	0.095 (2,4)	Angle (NOTE 1)
42	0.095 (2,4)	0.25 (6,4) (NOTE 2)
45	0.120 (3,0)	0.156 (4,0)
46	0.120 (3,0)	0.188 (4,8)
47	0.120 (3,0)	0.25 (6,4)
62	4-1/2 (114,3) OD = 0.156 (4,0) 3-1/2 (88,9) OD = 0.156 (4,0) 3 (76,2) OD = 0.095 (2,4)	Angle (NOTE 1)
65	4-1/2 (114,3) OD = 0.156 (4,0) 3-1/2 (88,9) OD = 0.156 (4,0) 3-3/4 (95,3) OD = 0.188 (4,8)	Angle (NOTE 1)
122A	0.095 (2,4)	0.188 (4,8)
123	0.095 (2,4)	0.156 (4,0)
124	0.109 (2,8)	0.109 (2,8)
125	0.095 (2,4)	0.188 (4,8)
128	0.109 (2,8)	0.109 (2,8)
130	0.120 (3,0)	0.120 (3,0)

NOTE 1 Measure a good section of chord to determine the thickness.

NOTE 2 The two top chords on the boom top have 0.188 in (4,8 mm) wall thickness.

LATTICE SECTION INSPECTION AND LACING REPLACEMENT

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

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SECTION 5
HOISTS

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SECTION 5
HOISTS

BOOM/MAST HOIST PAWL ADJUSTMENT

General

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 is controlled by Drum 4 park switch in the operator’s cab:

- When park is turned ON, the pawl engages. The hydraulic cylinder extends and spring force rotates the pawl into engagement with the ratchet.
- When park is turned OFF, the pawl disengages. The hydraulic cylinder retracts, and the cam rotates to disengage the pawl from the ratchet.

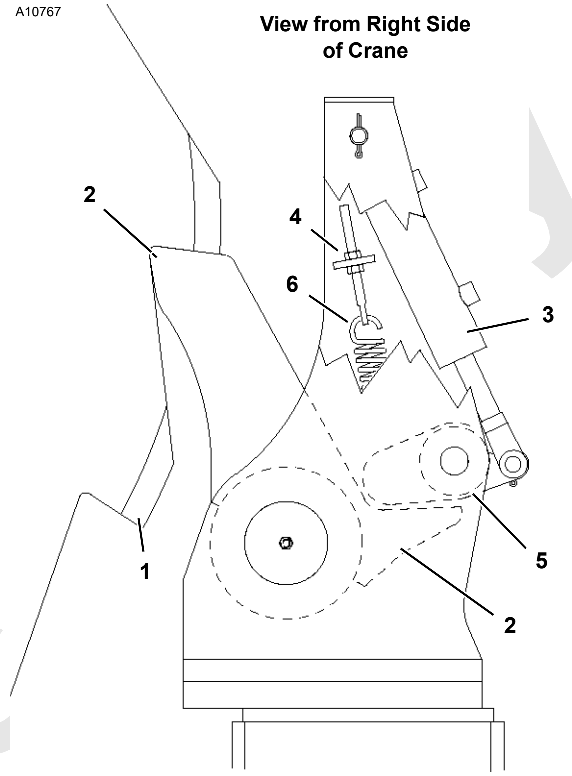
  It may be necessary to hoist slightly to fully disengage the pawl from the ratchet.

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

SPEED SENSOR ADJUSTMENT

General

The hydraulic motors for the hoists (boom, mast, load) and swing have a speed sensor. For those functions having more than one motor, only one of the motors has a speed sensor.

Each speed sensor monitors rotational speed and direction of the corresponding function's 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.

Speed Sensor Replacement

WARNING

Burn Hazard!

Hot oil will drain from motor port when sensor is removed. Wait for hydraulic oil to cool before removing 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's top case drain port ***before starting engine***.

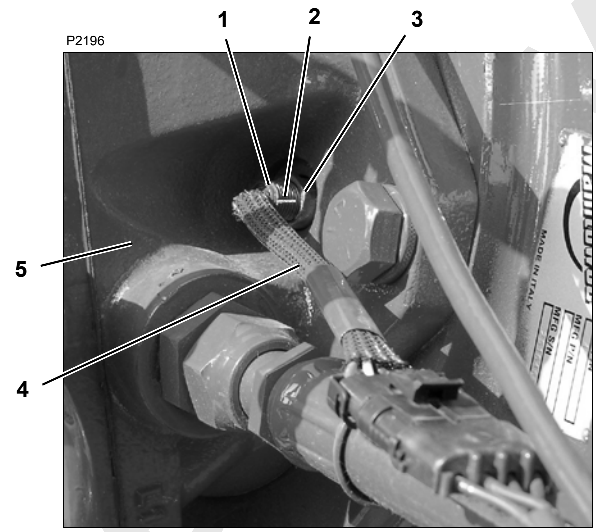
Speed Sensor Adjustment

The speed sensors are set at the factory and should not need adjustment, unless replaced.

1. Bring corresponding function to a complete stop, land suspended load if load drum is being serviced, and PARK function.
2. Remove faulty sensor. Do not connect sensor cable to crane wire harness until initial adjustment is made.
3. Loosen lock nut and carefully turn sensor in (clockwise) by hand until it gently contacts speed ring inside motor.
4. Back sensor out 1 turn or more until notch is positioned 180° from motor shaft (facing outboard side of motor).
5. Connect sensor cable to crane wire harness.
6. Operate drum motor and check for a steady drum speed (RPM) signal on corresponding drum's diagnostic screen in cab.

   If necessary, turn sensor out slightly until drum speed (RPM) is steady at low and high RPM.
7. Hold sensor in position and securely tighten 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 ADJUSTMENT

See Figure 5-3 for the following instructions.

The optional minimum bail limit assembly on Drum 1 (main hoist) and Drum 2 (auxiliary hoist) — is a protective device which 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 drum with less than 3 or 4 full wraps of wire rope remaining on drum. Doing so can cause wire rope to be pulled out of drum and load to fall.

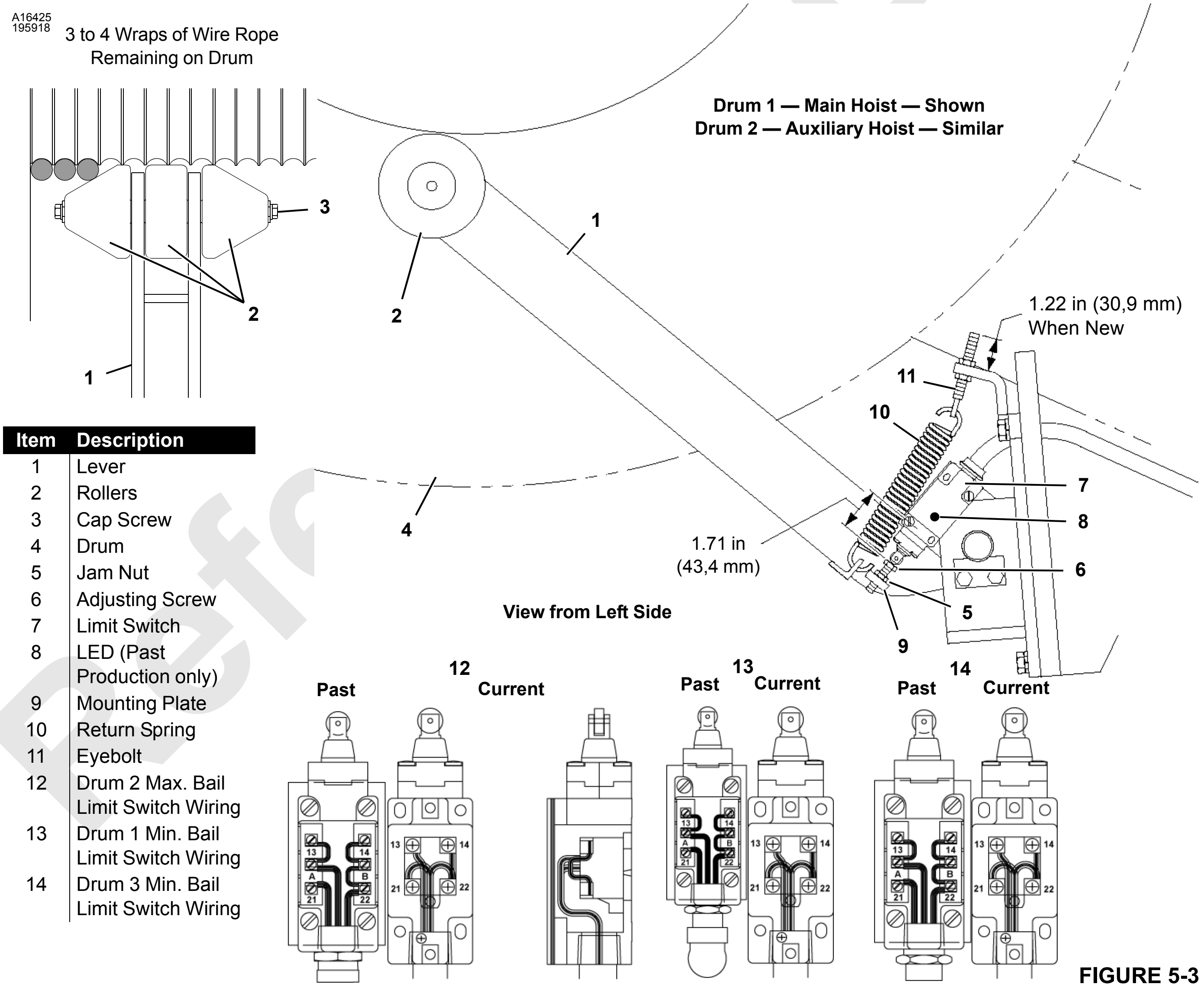
Weekly Maintenance

1. Check minimum bail limit switch for proper operation.
   a. LED (light emitting diode, Past Production only) should be on for normal operation. For both Past and Current Production, limit switch should be depressed to dimension given in Figure 5-3 for normal operation.
   b. Pay out wire rope from drum. Drum should stop with approximately 3 to 4 wraps of wire rope remaining on first layer (LED off on Past Production only). Adjust limit switch if necessary.
2. Check that cap screws holding rollers on lever shaft are tight.
3. Check tension of return springs. If necessary, adjust eyebolts so springs hold rollers snug against bare drum.

Adjustment

1. Pay out wire rope until rollers are against bare drum with 3 to 4 wraps of wire rope remaining on first layer.
2. Ensure rollers (2) contact drum (4).
3. Turn adjusting screw (6) until limit switch is depressed to the 43,4 mm (1.7 in) dimension given in Figure 5-3.
4. Spool several wraps of wire rope onto drum. Then pay out wire rope. Drum must stop with 3 to 4 wraps of wire rope remaining first layer.

   Repeat adjustment steps if necessary.
5. Tighten jam nut against mounting plate to lock adjustment.
6. Check that return springs have sufficient tension to hold rollers snugly against bare drum. Adjust eyebolts if necessary.



Item	Description
1	Lever
2	Rollers
3	Cap Screw
4	Drum
5	Jam Nut
6	Adjusting Screw
7	Limit Switch
8	LED (Past Production only)
9	Mounting Plate
10	Return Spring
11	Eyebolt
12	Drum 2 Max. Bail Limit Switch Wiring
13	Drum 1 Min. Bail Limit Switch Wiring
14	Drum 3 Min. Bail Limit Switch Wiring

FIGURE 5-3

BLOCK-UP LIMIT CONTROL

General

A block-up limit (also called anti two-block device) is a ***two-blocking prevention device*** which automatically stops the load drum from hoisting and the boom from lowering when a load is hoisted a predetermined distance.

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

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

WARNING

Two-Blocking Hazard!

Block-up limit is a protective device designed only to assist operator in preventing a two-blocking condition; any other use is neither intended nor approved.

Block-up limit may not prevent two-blocking when load is hoisted at maximum single line speed. Operator shall determine fastest line speed that allows 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):

1. Normally closed limit switch assembly fastened at the following locations:
   a. Lower boom point
   b. Upper boom point
2. Weight freely suspended by chain from each limit switch actuating lever (weight encircles load line as shown).
3. Lift block fastened to load line or lift plates fastened to load block.

Operation

See Figure 5-4 and Figure 5-5 for component identification.

For a complete wiring diagram of the system, see 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 the 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, load drum and boom parking brakes apply to stop load drum from hoisting and boom from lowering.

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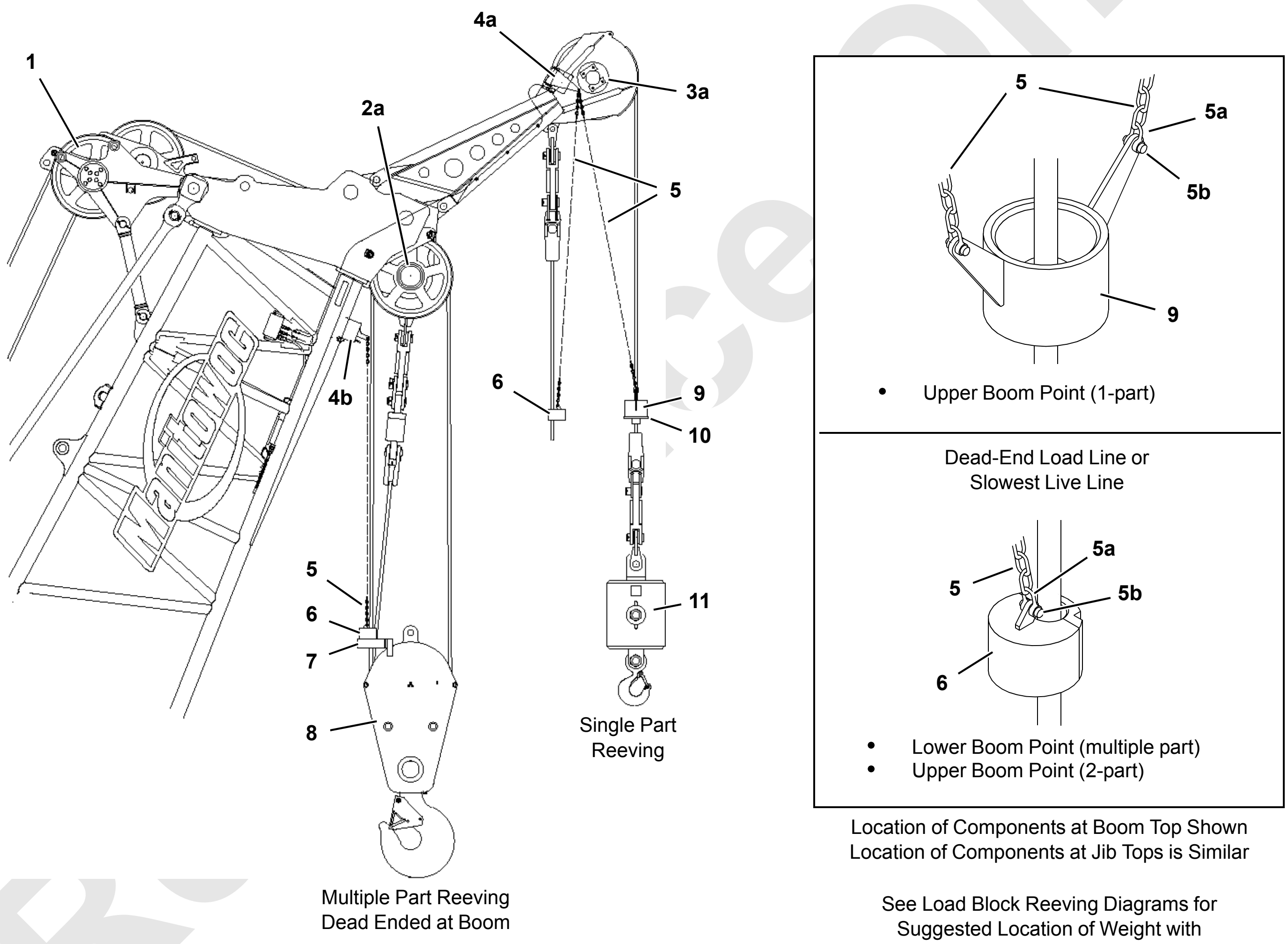
Item	Description	Item	Description
1	Wire Rope Guide	5a	Shackle
2a	Lower Boom Point	5b	Pin
2b	Extended Upper Boom Point (lower sheaves)	6	Weight
3a	Standard Upper Boom Point	7	Lift Plate
3b	Extended Upper Boom Point (upper sheave)	8	Load Block
4a	Block-Up Limit Switch (left hand)	9	Weight
4b	Block-Up 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

5

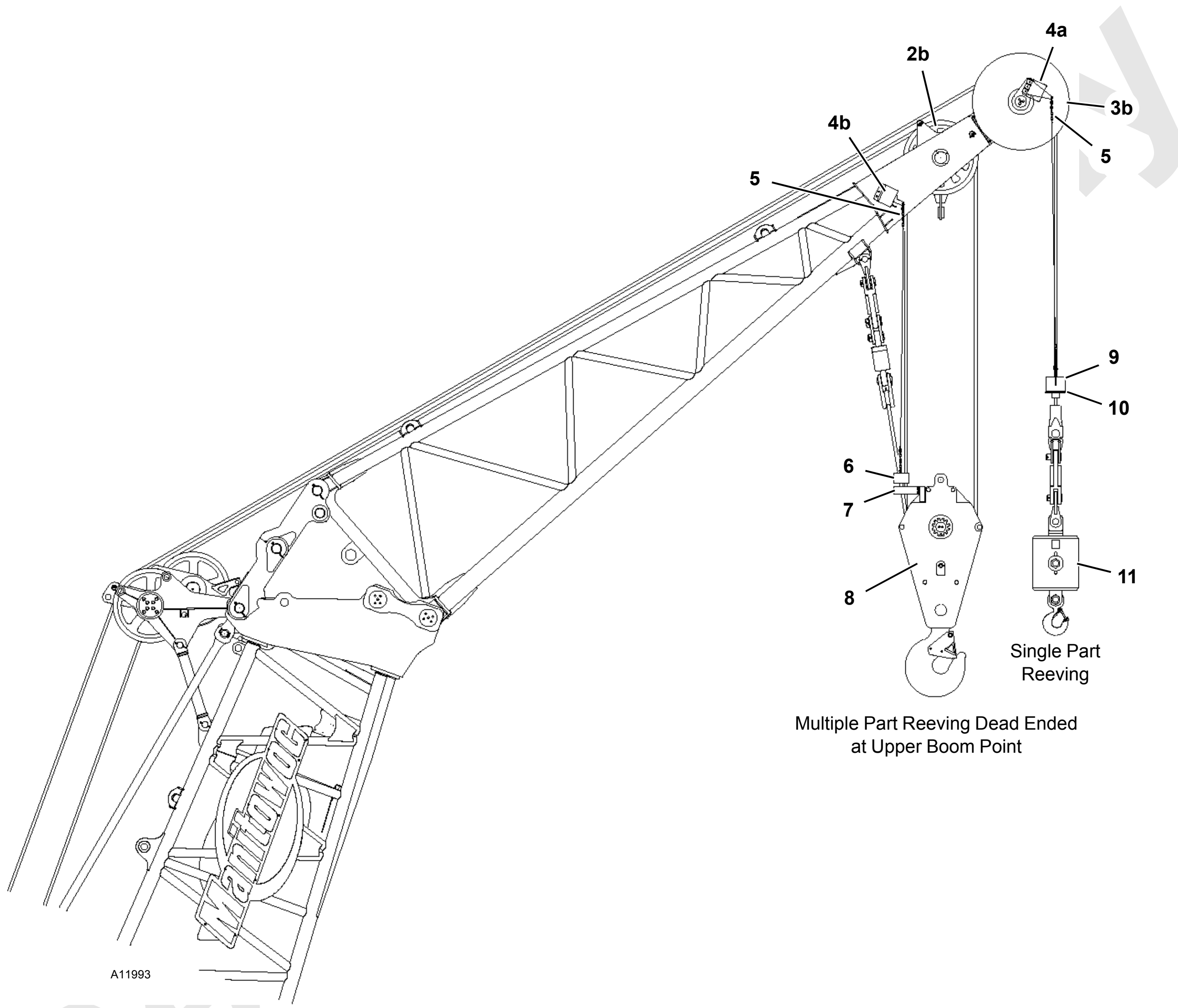


FIGURE 5-4 continued

Maintenance

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

CAUTION

Avoid Machinery Damage!

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

1. Lower the boom and jib onto blocking at ground level and carefully inspect the following items:

   a. Inspect each limit switch lever and actuating lever for freedom of movement. Apply one-half shot of grease to 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, each chain, each shackle and each connecting pin for excessive or abnormal wear. Make sure cotter pins for shackles are installed and spread.

   d. Inspect entire length of each electric cable for damage.

   e. Check that electric cables are clear of all moving parts on boom and jib and that cables are securely fastened to boom and jib with nylon straps.

   f. Check that all plugs are securely fastened.

2. Test block-up limits for proper operation using either of the following methods:

   a. BOOM LOWERED: Manually lift each weight — ***one at a time*** — while engine is running. Load drum should not operate in HOIST direction and boom/mast hoist should not operate in LOWER direction.

   b. BOOM RAISED: ***Slowly*** hoist each load block and weight ball — ***one at a time*** — against weight. When chain goes slack, corresponding load drum should stop HOISTING and boom/mast hoist should not operate in LOWER direction.

CAUTION

Avoid Sheave Damage!

Use extreme care when testing block-up limits when boom is raised. If a block-up limit fails to stop load, immediately stop load by moving drum control handle to off; otherwise, two-blocking may occur.

Adjustment

See Figure 5-5 for the following procedure.

Lower boom onto blocking at ground level and adjust each limit switch as follows:

1. Adjust spring tension so there is enough force to lift weight of chain and rotate actuating lever when weight is lifted.

2. Loosen setscrew in limit switch lever so lever is free to rotate.

3. Manually lift weight to allow actuating lever to rotate upward.

4. Hold lever at Dimension A.

5. Hold roller on limit switch lever against actuating lever while performing step 6.

6. Turn limit switch shaft COUNTERCLOCKWISE (for right hand) or CLOCKWISE (for left hand) ***only enough to "click" limit switch open and hold.*** Then securely tighten setscrew in limit switch lever.

7. Test limit switch for proper operation (see Maintenance topic); repeat adjustment steps until limit switch operates properly.

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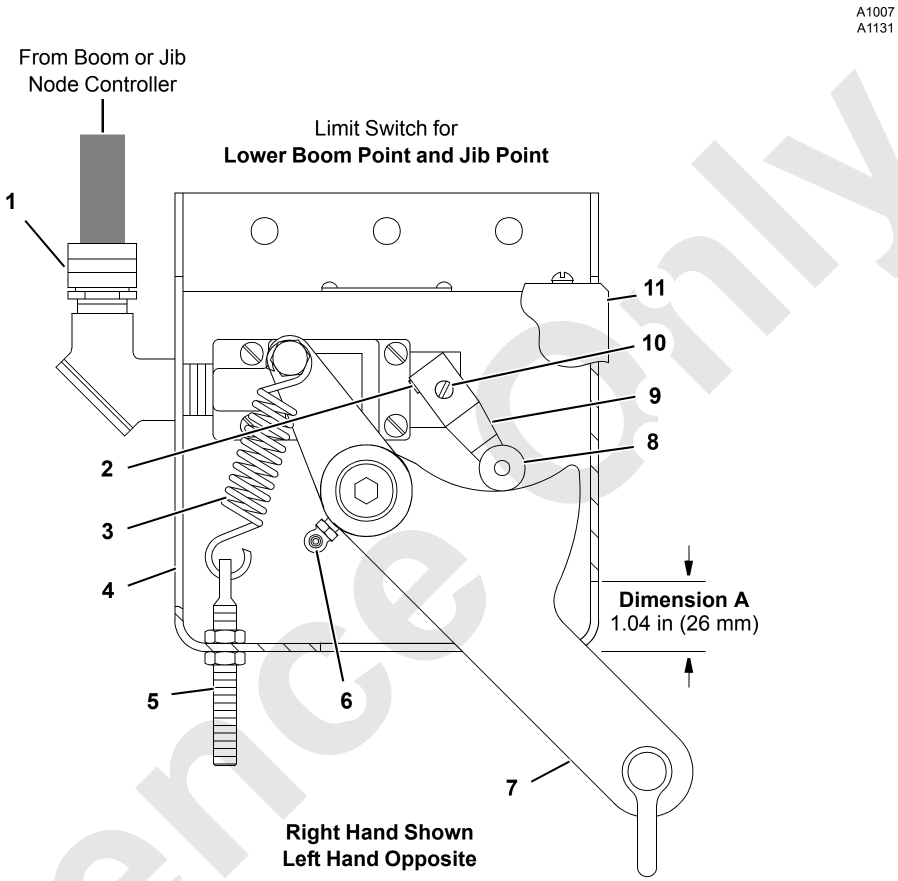


Item	Description
1	Elbow with Cord Gripper
2	Setscrew
3	Spring
4	Enclosure
5	Adjusting Screw (Spring Tension)
6	Grease Fitting
7	Actuating Lever
8	Roller
9	Limit Switch Lever
10	Shaft
11	Cover

FIGURE 5-5

WIRE ROPE LUBRICATION

Refer to the Lubrication Guide in Section 9 for recommendations.

WIRE ROPE INSPECTION AND REPLACEMENT

The inspection and replacement guidelines which follow comply with United States regulations.

It is impossible to predict when a wire rope will fail; however, frequent and periodic careful inspection by a qualified inspector will indicate when the potential for failure exists.

Keeping Records

A signed and dated report of the wire rope's condition at each periodic inspection must be kept on file at all times. The report must cover all inspection points listed in this section. The information in the records can then be used to establish data which can be used to determine when a wire rope should be replaced.

It is recommended that the wire rope inspection program include reports on the examination of wire rope removed from service. 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.

Inspecting Wire Rope In Use

Frequent Inspection

Visually inspect all running ropes in service once each work shift and observe the rope during operation. Pay particular attention to areas of the rope where wear and other damage is likely to occur:

- Pick-Up Points — sections of 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 rope or the point where the rope is attached to the drum.
- Abuse points — the point where the rope is subjected to abnormal scuffing and scraping.

Inspect all rope which can be reasonably expected to be in use during operation for obvious damage which poses an immediate hazard, such as the following:

- Rope distortion such as kinking, crushing, unstranding, bird caging, main strand displacement, and core protrusion
- Loss of rope diameter and unevenness of the outer strands indicate that the rope should be replaced.
- Corrosion (clean and lubricate)
- Broken or cut strands
- Broken wires (see Periodic Inspection for additional information)
- Core failure in rotation resistant rope (indicated by lay lengthening and reduction in diameter)

Periodic Inspection

The periodic inspection interval must be determined by a qualified inspector and be based on the following factors:

- Expected rope life as indicated by the rope manufacturer or past experience as determined by the qualified inspector
- Severity of the environment the rope is operated in
- Size, nature, and frequency of lifts
- The rope's exposure to shock loading and other abuse
- Rope maintenance practices

Periodic inspection must be performed at least annually.

During the periodic inspection, the entire length of rope must be inspected for the following types of damage. Any damage found must be recorded and a determination made as to whether continued use of the rope is safe.

- All points listed under frequent inspection
- Reduction in rope diameter below the nominal diameter caused by loss of core support, internal or external corrosion, or wear of the outside wires
- Severely corroded or broken wires at end attachments
- Severely corroded, cracked, bent, worn, or improperly applied end attachments

Inspecting Rope Not In Regular Use

Wire rope must be given a complete inspection if it has been idle for a month or more due to shutdown or storage of the crane on which the rope is installed. The inspection must be performed by a qualified inspector looking for the damage identified under both Frequent and Periodic Inspection.

Replacing Wire Rope

The final decision as to when a wire rope should be replaced is the responsibility of the qualified inspector. Discovery of the following conditions is sufficient reason for questioning a wire rope's safety and for replacing it.

Wire Rope Diameter

Measure and record the diameter of a new wire rope after initial loading for comparison with future inspections. A reduction in rope diameter is often the first outward sign that the rope core is damaged.

Measure the rope's diameter across the crowns of the strands so the true diameter is measured as shown in Figure 5-6

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

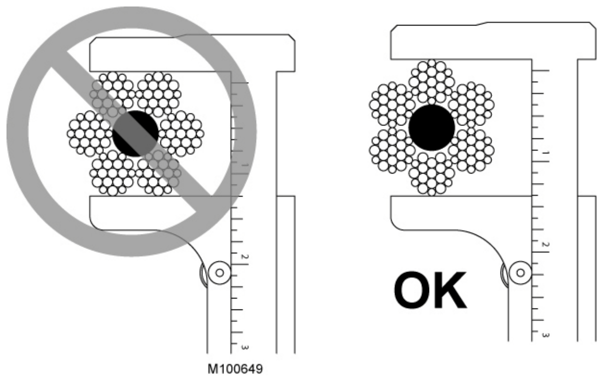
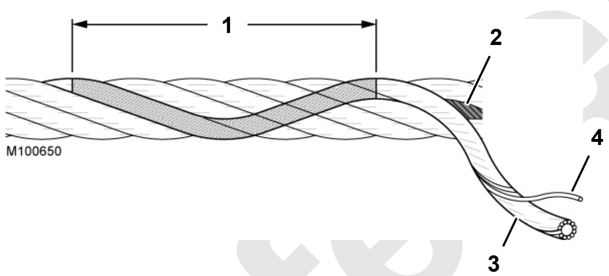


FIGURE 5-6

Broken Wires

Thoroughly clean the wire rope so breaks can be seen. Relax the rope, move it off "pick-up points," and flex it as much as possible. Use a sharp awl to pick and probe between wires and strands, lifting any wire which appears loose or moves excessively.

See Figure 5-7 for an explanation of lay length.



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

FIGURE 5-7

The wire rope must be taken out of service when it has the following number of broken wires.

- RUNNING ROPES (working lines) — six randomly distributed broken wires in one lay length, or three broken wires in one strand of one lay length
- ROTATION RESISTANT ROPS — two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in thirty rope diameters
- 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)
- ALL ROPES — one outer wire broken at the point of contact with the core. The broken wire protrudes or loops out of the rope structure.

NOTE: 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

Replace wire rope when more than one broken wire appears at point marked by arrow.

Item	Description
1	Swaged Socket
2	Wedge Socket
3	Poured Zink Socket
4	Hand Spliced Socket
5	Button Socket

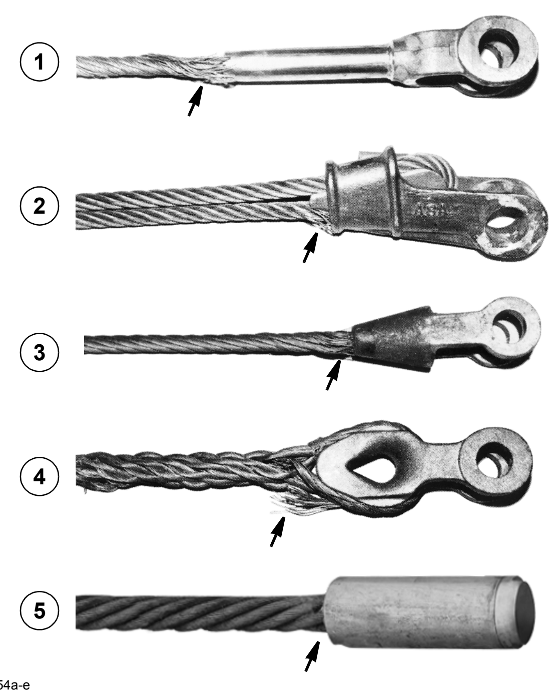


FIGURE 5-8

Wear and Other Damage

See Figure 5-9 for examples of wire rope damage.

It is normal for the outer wires of the rope to wear first because of friction.

The wire rope must be taken out of service if:

- Rope core protrudes from between outer strands
- Severe corrosion – indicated by pitting – exists
- Obvious damage exists from any heat source to include – but not limited to – welding, power line strike, or lighting
- Kinking, crushing, bird caging, or any other damage resulting in distortion of the rope structure exists

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⚠ WARNING

Falling Load Hazard!

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

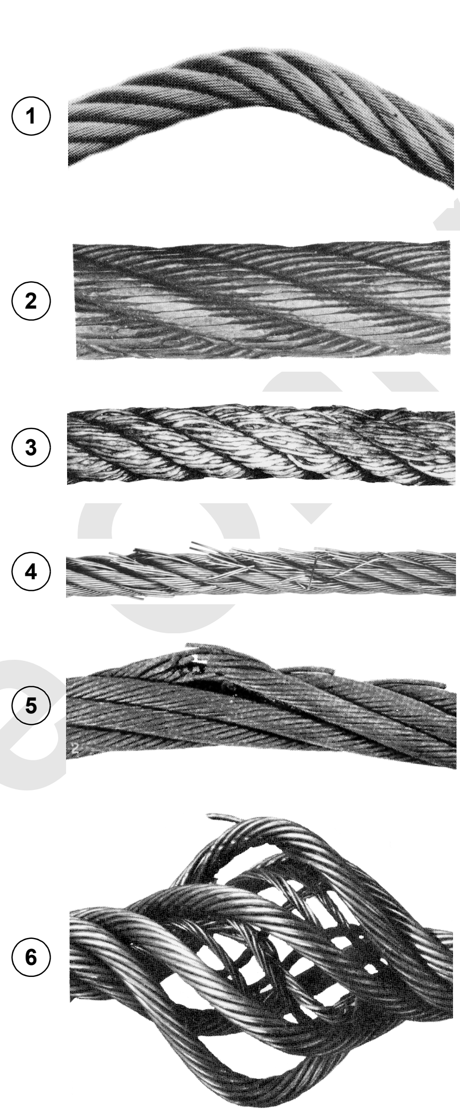
- Wire Rope Specifications Chart located in Capacity Chart Manual (for load lines)
- Boom or Jib Assembly Drawings located in Crane Operator Manual (for boom or luffing hoist)
- Mast Assembly Drawing located in Parts Manual

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 drum 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.



Item	Description
1	Dog-Leg or Kink
2	Drum Abrasion
3	Drum Crushing
4	Sheaves Too Small
5	Button Socket
6	Bird Cage

FIGURE 5-9

DRUM KICKER ADJUSTMENT

General

A drum kicker is provided on both flanges of the main load drum (in 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.

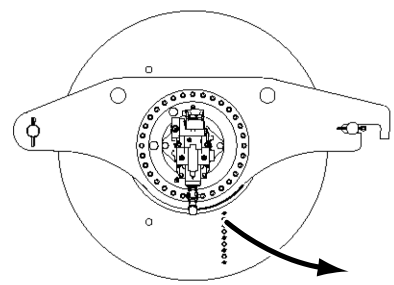
Observe the wire rope during initial break-in and periodically during operation. If the rope stacks up at either end of the drum, adjust the drum kickers.

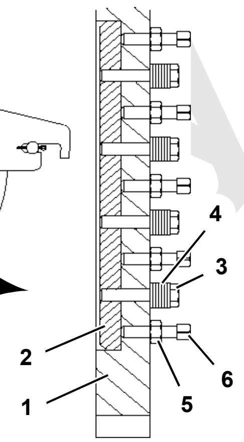
Adjustment

See Figure 5-10 for the following procedure.

To move drum kickers (1) into the drum (take up space), proceed as follows:

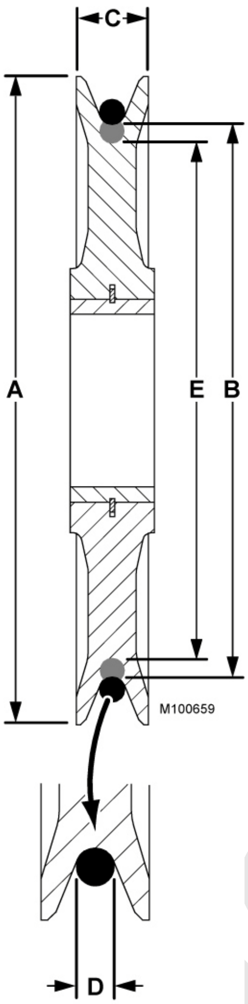
1. Remove drum guard from both ends of drum.
2. Remove an equal number of washers (3) from both sides of kicker (1), one side at a time. Each washer allows kicker to move 0.098 in (2,5 mm).
3. Loosely reinstall cap screws (2) and remaining washers (3).
4. Loosen lock nuts (4) and adjust set screws (5) to move kickers (1) into drum.
5. Repeat steps 1-3 only enough to improve spooling. ***Moving drum kickers in too far can cause premature wire rope wear.***
6. Securely tighten set screws (5) and lock nuts (4).
7. Reinstall drum guards.





Item	Description
1	Drum Flange
2	Kicker
3	Cap Screw
4	Washers
5	Lock Nut
6	Set Screw

FIGURE 5-10



PLASTIC SHEAVE DATA

Sheave Part No.	A Outside Diameter		B Tread Diameter [1]		C Width		D Rope Diameter	
	inch	mm	inch	mm	inch	mm	inch	mm
912738	13.19	335,0	11.42	290,1	1.77	45,0	5/8	16
631054								
631056								
631065	16.00	406,4	13.37	339,6	2.17	55,1	9/16	14
631071	16.00	406,4	13.88	352,6	2.17	55,1	5/8	16
631526	19.25	489,0	16.63	422,4	2.00	50,8	7/8	22
631527	19.25	489,0	16.63	422,4	2.00	50,8	5/8	16
631055	19.69	500,1	17.60	447,0	1.85	47,0	7/8	22
631067	19.69	500,1	17.75	450,9	1.97	50,0	3/4	19
631529	20.00	508,0	17.00	431,8	3.00	76,2	1	25
631519	23.00	584,2	20.13	511,0	2.25	57,2	7/8	22
631084	23.00	584,2	20.13	511,0	2.50	63,5	7/8	22
631102								
631520								
A00049								
A00083								
631082	27.00	685,8	23.00	584,2	3	76,2	1	28
631096								
631103								
A00050								
A00051								
631100	30.00	762,0	27.00	685,8	3.00	76,2	1-1/8	29

[1] If tread print exists in root of sheave groove, measure to maximum tread diameter.

PLASTIC SHEAVE REPLACEMENT DATA

E = B - 3/16 in (4,8 mm) Maximum from Original Tread Diameter

FIGURE 5-11

5

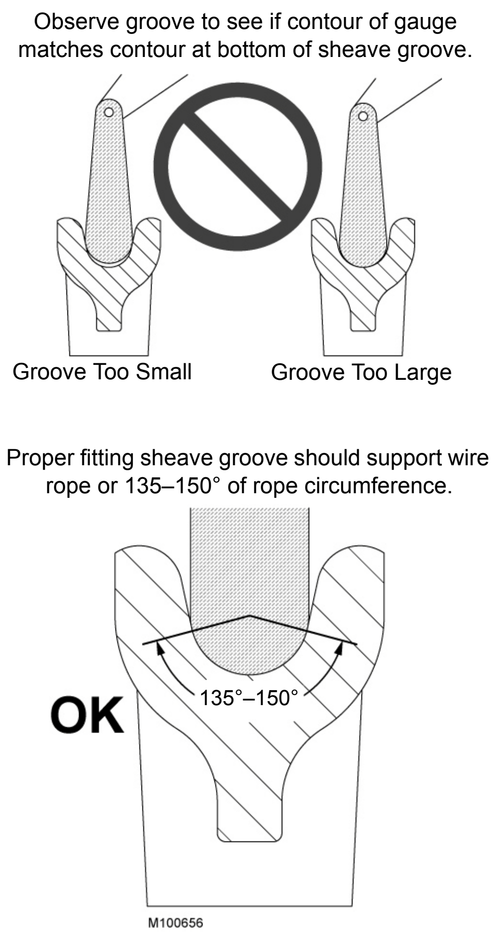
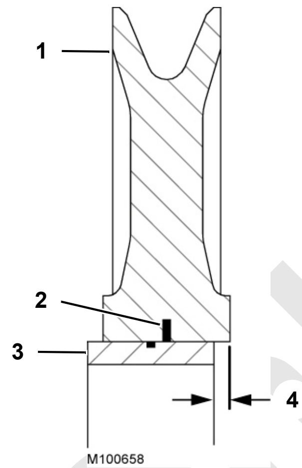


FIGURE 5-12

FIGURE 5-13



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 5-14

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:
   a. Unusual noises
   b. Freedom of movement — must turn freely by hand. Wire rope may have to be loosened to perform this inspection.
   c. Wobble — must turn true with very little side-to-side or up-and-down play.
   d. Signs of rust (indicating that water may have entered bearing)
   e. Grease leaks (indicating a faulty seal or water in grease)

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

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

3. For steel sheaves, check depth, width, and contour of each sheave using a groove gauge as shown in Figure 5-12. Replace sheaves that have over or under size grooves.
4. Replace grooved drums that allow one wrap of wire rope to contact next wrap as rope spools onto 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 5-13.

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***.

7. Inspect nylon sheaves for excessive tread diameter wear at locations E in Figure 5-11. Measure at three positions to check for uneven wear.

   Wear must not exceed the limits given in the table. **Replace worn or damaged 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 140° F (60° C).

8. Inspect nylon sheaves to verify they have not separated and "walked off" steel inserts or bearings as shown in Figure 5-14. Maximum sideways displacement is 1/8 in (3 mm). **Replace worn or damaged sheaves**.
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).

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

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

LOAD BLOCK AND HOOK-AND-WEIGHT BALL INSPECTION

WARNING

Falling Load Hazard!

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

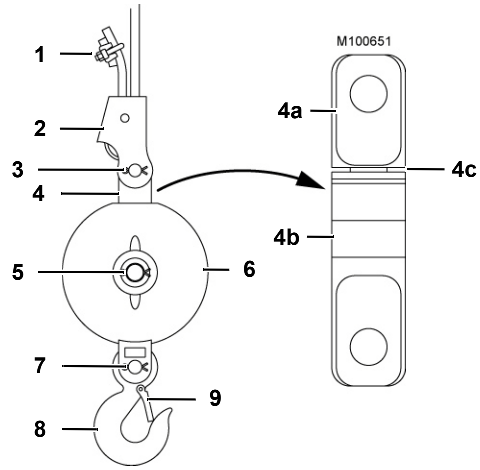
- Only use a load block or a hook-and-weight ball which has a capacity equal to or greater than load to be handled.
- Do not remove or deface nameplate (Figure 5-15) attached to load blocks and hook-and-weight balls.
- See Duplex Hook topic in Section 4 of Operator Manual for recommended sling angles and capacity restrictions when load block has duplex or quadruplex hook.

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

FIGURE 5-15

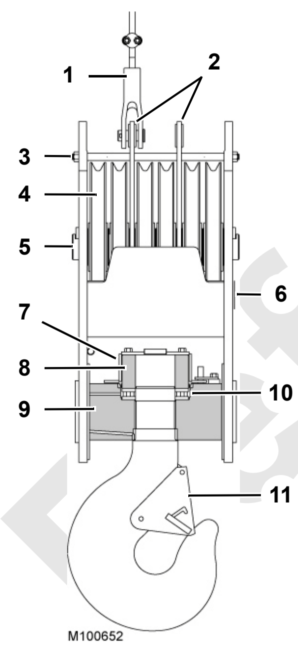
The operating condition of the load block and the hook-and-weight ball can change daily with use; therefore, they must be inspected daily (at start of each shift) and observed during operation for any defects which could affect their safe operation. Correct all defects before using the load block or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

Daily inspection and maintenance will include the following points (see Figure 5-16 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 the hook-and-weight ball.
2. Lubricate the sheaves (if fittings provided), the hook trunnion, the hook swivel, and any other part equipped with a grease fitting at the intervals specified in the "Lubrication Guide."
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 0.020 in (0,508 mm) to 0.050 in (1,27 mm). If the gap increases, swivel-bearing failure is indicated.

8. Check the load block for signs of overloading: 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 load from dropping, hook latch must retain slings or other rigging in hook under slack conditions.

Hook latch is not intended as anti-fouling device, and caution must be taken to prevent hook latch from supporting any part of load.

Slings or other rigging must be seated in hook when handling load; they must never be in position to foul 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*

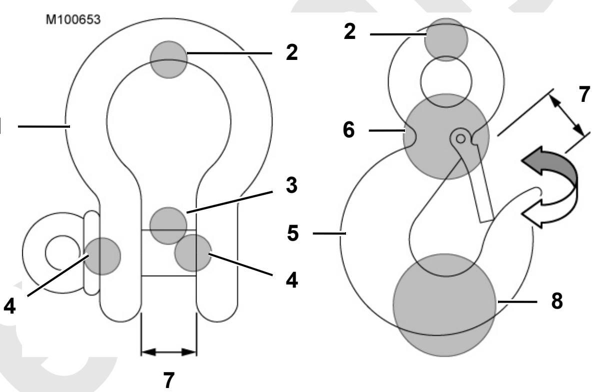
14. Contact the supplier of your hooks, shackles, blocks, and other rigging for repair instructions.

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 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

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SECTION 6
SWING

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SECTION 6
SWING

MANUAL RELEASE OF SWING BRAKE AND LOCK

NOTE: Current production cranes do not have a swing lock; therefore, they will not have the swing lock piping shown in Figure 6-1.

See Figure 6-1 for the following procedure.

The hydraulic swing brake and hydraulic swing lock (if equipped) 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!

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

The procedure given in this section is for servicing purposes only. Swing brake and swing lock must be fully operational when operating crane.

Hydraulic hand pumps with pressure gauges are needed to manually release the swing brake and swing lock.

1. Disconnect hoses from fitting at brake release port and, if equipped, at swing lock OUT port.
2. Attach hand pump to each port — brake release and swing lock OUT.
3. Pressurize brake and swing lock to 350 psi (24 bar).
4. Proceed to remove or install swing planetary.
5. Relieve pressure and remove hand pumps.

CAUTION

Avoid damage to parts!

Do not exceed 350 psi (24 bar) pressure when releasing swing brake or swing lock.

6

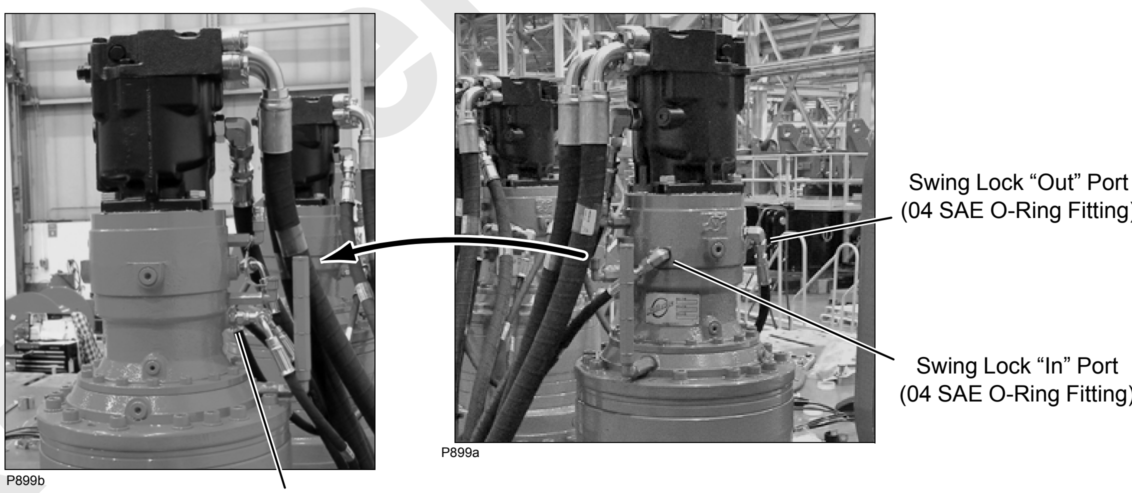

FIGURE 6-1

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SECTION 7
POWER TRAIN

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SECTION 7
POWER TRAIN

BATTERY MAINTENANCE

Safety Information

WARNING

Battery gases are explosive!

Batteries can explode with great violence and spraying of acid if a spark or flame is brought too near them. The room or compartment in which batteries are stored must be ventilated and away from flames or sparks.

Avoid sparks while charging batteries; do not disturb connection between batteries until charger is OFF.

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

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. First connect both jumper cables to the battery on the crane to be started. Do not allow ends of cables to touch.
2. Then connect the positive cable to the positive terminal of the booster battery.
3. Finally, connect the remaining cable to the frame or block of the starting vehicle. ***Never*** connect it 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. 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 (°F)
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 covered. 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 wiring diagram for correct connection**.

NOTE: Installing batteries with reversed electrical connections will not only damage batteries but also crane's electrical system, voltage regulator, and/or alternator.

Maintenance

Weekly – Check Electrolyte Level

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. Distilled water should be used. Drinking water is, however, satisfactory. Water with a high mineral content (well, creek, pond) must not be used.
3. Never overfill the cells. Overfilling will cause electrolyte to pump out, and corrosion damage will result.

   Any spills on painted or metal surfaces must be immediately cleaned and acid neutralized 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 (a indication of overcharging).

   An excessive amount of water consumption also indicates overcharging.
5. Sulfuric acid must never be added to a cell unless it is known that acid has been spilled out or otherwise lost — **consult your battery dealer for instructions**.

Every 2 Months – Test Batteries

Before testing a battery determine that the alternator is putting out current, that the current is flowing to the battery, and that the voltage delivered is within acceptable limits.

Hydrometer Test

1. The electrolyte level in each cell must be at its proper height to get reliable readings. Confirm that the plates in each cell are completely covered with electrolyte.
2. Readings should not be taken immediately after water is added. The solution must be thoroughly mixed by charging.
3. Likewise, readings should not be taken after a battery has been discharged at a high rate, such as 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 for each 6° below 27°C (81°F). Add 0.004 for each 6° above 27°C (81°F).

NOTE: It is the electrolyte temperature which is important, not air temperature.

8. Temperature corrected hydrometer readings may be explained as shown in Table 7-2.

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, the battery should be replaced	

NOTE: For more specific hydrometer test information, see the instructions provided with your hydrometer.

Open-Circuit Voltage Test

A sensitive voltmeter (Figure 7-1) can be used to determine a battery's state-of-charge as shown in Table 7-3.

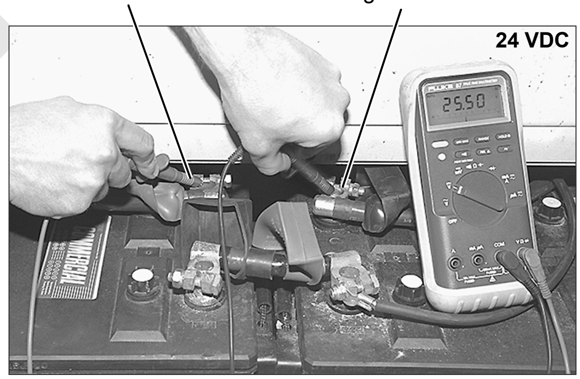


FIGURE 7-1

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.

This test must not be performed 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: Detailed test information is provided by the meter manufacturer.

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 regardless of a battery's condition. The voltage drop can be caused by a poor contact between the cable terminal and ground or between the clamp terminal and the battery post. Poor start-switch contacts and frayed, broken, or corroded cables can also be the cause.

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 tightly coated with grease to prevent corrosion.
4. Make sure the hold-downs are in good condition; replace faulty parts.
5. Replace frayed, broken, or corroded cables.
6. Replace the batteries if their containers are cracked or worn to the point they leak.
7. Ensure a good tight contact between the clamp terminals and battery posts.
8. Make sure the hold-downs are tight enough to prevent battery movement but not so tight to cause distortion.

Charging

The battery should be at room temperature when recharging. Before a battery is recharged, it must be thoroughly cleaned. Take care not to allow dirt to enter the cells.

A battery should be recharged in the way it was discharged. If it was discharged over a long period of time, it should be recharged slowly at 6 to 10 amperes for up to 10 hours. A rule-of-thumb value for a slow rate is a current equal to about one-half the number of plates per cell in the battery. A battery with 13 plates per cell, should, therefore be charged at 7 amperes.

If a battery was discharged rapidly (cranking until dead), it can be recharged on a fast charger with an output of up to 40 amperes for a maximum of 2 hours. If the electrolyte temperature reaches 52°C (126°F) or if it gases violently, the charging current must be reduced or halted to avoid battery damage.

For optimum charging results, adhere to the charger manufacturer's instructions.

Storage

When the crane is left idle for prolonged periods, it should be run periodically to charge the batteries.

When storing a battery, make sure it is at least 75% charged to prevent the possibility of freezing.

Follow your battery dealer's recommendations.

Battery Disconnect Switch

See Figure 7-2 in the following procedure.

A battery disconnect switch is provided on the right side of upperworks near the engine node. Use the switch to disconnect the batteries when servicing the electrical control system.

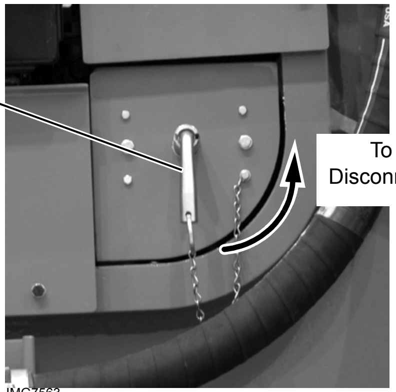
See Section 3 of Crane Operator Manual for operation of the battery disconnect switch.

CAUTION

Engine Damage!

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

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



Right Side of Rotating Bed

FIGURE 7-2

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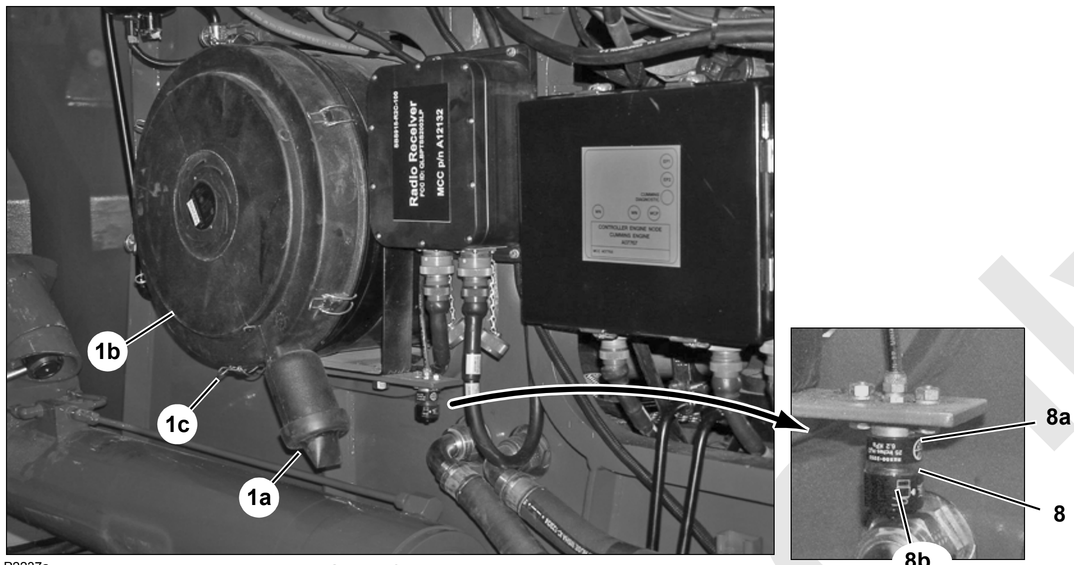
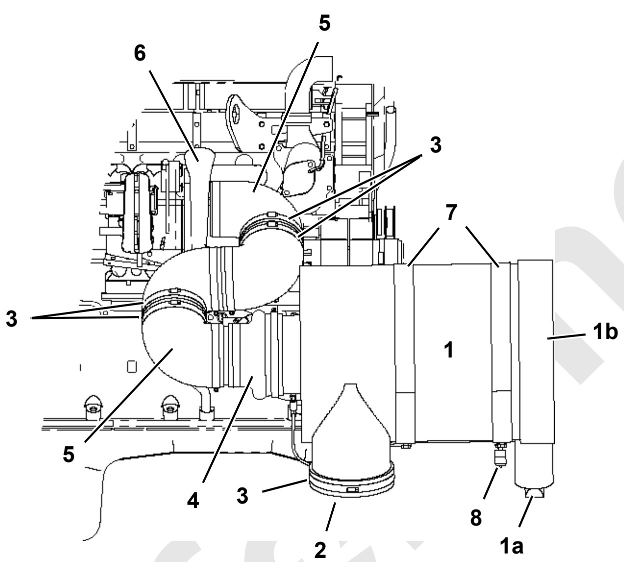
A10577



Right Side of Upperworks



Item	Description
1	Air Cleaner Assembly
1a	Evacuator™ Valve
1b	Service Cover
1c	Latch
1d	O-Ring
1e	Primary Filter
1f	Safety Filter
1g	Housing
2	Inlet Cap
3	Clamp (11 each)
4	Rubber Reducer
5	Rubber Elbow (4 each)
6	Engine Intake
7	Mounting Bands
8	Service Indicator
8a	Service Window
8b	Reset Button

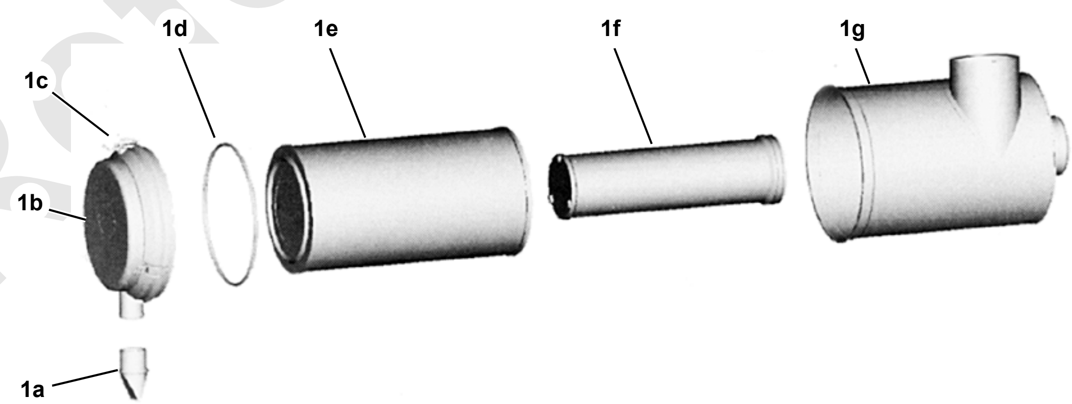


FIGURE 7-3

ENGINE AIR CLEANER MAINTENANCE – PAST PRODUCTION AND TIER 3

See Figure 7-3 for the following procedures.

The air cleaner is mounted horizontally and fastened to engine air intake (6) with rubber elbows (5) and reducer (4). Servicing the air cleaner is an important maintenance function:

- Clogged air cleaner filters will prevent adequate air flow to the engine, causing poor starting and increased exhaust emissions.
- An improperly installed or damaged air cleaner can allow dirty air to be drawn directly into the engine.

Either condition can cause engine damage.

Inspection

To maintain engine protection and filter service life, inspect the following areas at regular intervals:

Daily

Check service indicator (8) with engine running. The indicator gives a visual indication when it is time to replace the filters.

- A red flag in indicator window (8a) extends as the filters become plugged. ***Replace filters when red flag locks in place at end of indicator.***
- The red flag remains locked in place after the engine is stopped. When the filters are replaced, push button (8b) **IN** to reset the indicator.

Monthly

1. Inspect rubber fittings (4 and 5) between air cleaner and engine for cracks or other damage which might allow unfiltered air to enter engine. Replace worn or damaged parts.
2. Check housing (1g) for dents or other damage that may allow unfiltered air to enter engine. Replace housing if damaged.
3. Check for loose clamps (3) and bands (7). Tighten loose parts.
4. Inspect inlet cap (2) for obstructions. Clean as required.
5. Check that Evacuator valve (1a) is open.

CAUTION

Engine Damage!

STOP ENGINE before servicing air cleaner, or unfiltered air will be drawn directly into engine.

Do not attempt to clean and reuse old filters. Discard old filters and install a new ones.

Service

1. Release seal carefully:

   Unlatch and remove service cover (1b). The air cleaner has two filters: primary (1e) and safety (1f). The filters should be removed gently to reduce the amount of dust dislodged. There will be some initial resistance, similar to breaking the seal on a jar. Gently move the end of the primary filter back and forth to break the seal.

2. Avoid dislodging dust from filters:

   Gently pull primary filter (1e) off outlet tube and out of housing (1g). Avoid knocking filter against housing.

   Repeat steps for safety filter (1f).

3. Clean sealing surfaces in housing:

   Use a clean cloth to wipe sealing surfaces clean. Dust on sealing surfaces could hinder an effective seal and cause leakage. Make sure all contamination is removed before new filters are installed.

4. Clean inside of outlet tube:

   Carefully wipe inside of outlet tube with a clean cloth. Dirt accidentally transferred to inside of outlet tube will reach engine and cause wear (engine manufacturers say that it takes only a few grams of dirt to destroy an engine). Be careful not to damage sealing area of tube.

5. Check old filters for leak clues:

   Visually inspect old filters for any signs of leaks. A streak of dust on clean side of filter is a telltale sign. Remove any cause of leaks before installing new filter.

6. Inspect new filters for damage:

   Inspect new filters, paying attention to inside of open end, which is sealing area.***Never*** install damaged filters.

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7. Install filters by hand:

Insert new safety filter (1e) carefully and seal it by hand, making certain filter is completely seated in housing (1g).

Repeat this step for primary filter (1e). Make sure O-ring (1d) is installed.

8. Install service cover:

Once filter is in place, put service cover (1b) back on, making sure Evacuator valve (1a) points in direction shown. Fasten latches (1c). Cover should go on without extra force.

Never use latches on cover to force filters into air cleaner. It is tempting to assume cover will do the job of sealing the filter – but it will not! Using latches to push filters in could cause damage to housing and will void warranty.

ENGINE AIR CLEANER MAINTENANCE — TIER 4 ENGINE

See Figure 7-4 for the following procedure.

The air cleaner is mounted using lugs (7) that are fastened to the engine air intake (6) with two rubber elbow reducers (5), clamps (3), steel tubes (2) and straight adapter fitting (4). Servicing the air cleaner is an important function because:

- Clogged air cleaner filters will prevent adequate air flow to the engine, causing poor starting and increased exhaust emissions.
- An improperly installed or damaged air cleaner can allow dirty air to be drawn directly into the engine.

Either condition can cause engine damage.

Inspection

To maintain engine protection and filter service life, inspect the following areas at regular intervals:

Daily

Check service indicator (8) with engine running. The indicator gives a visual indication when it is time to replace the filters.

- A yellow flag in the indicator window (8a) extends as the filters become 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 is stopped. When the filters are replaced, push button (8b) ***in*** to reset the indicator.

Monthly

1. Inspect rubber reducers (5) between air cleaner and engine for cracks or other damage which might allow unfiltered air to enter the engine. Replace worn or damaged parts.

2. Check housing (1e) for dents or other damage that may allow unfiltered air to enter engine. Replace housing if damaged.

3. Check for loose clamps (3). Tighten if necessary.

4. Inspect engine intake (6) for obstructions. Clean as required.

CAUTION

Engine Damage!

STOP ENGINE before servicing air cleaner or unfiltered air will be drawn directly into engine.

Before servicing clean fittings, remove mounting hardware and area around component(s).

Never operate engine without air cleaner.

Replace 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 filter elements by impact or compressed air voids the warranty and can degrade or damage the filter media, leading to malfunction.

Service

Service the air cleaner and its primary and secondary filter elements per the intervals specified by the engine manufacturer and per the engine manufacturer's instructions. An illustration of these instructions is located on the air filter cover (see Figure 7-4).

Replacement of the primary filter is indicated only when the red flag locks in place at the top of the service indicator.

NOTE: The recommended service interval for replacing the secondary element is every **3rd** time the primary element is replaced

CAUTION

Engine Damage!

STOP ENGINE before servicing air cleaner, or unfiltered air will be drawn directly into engine.

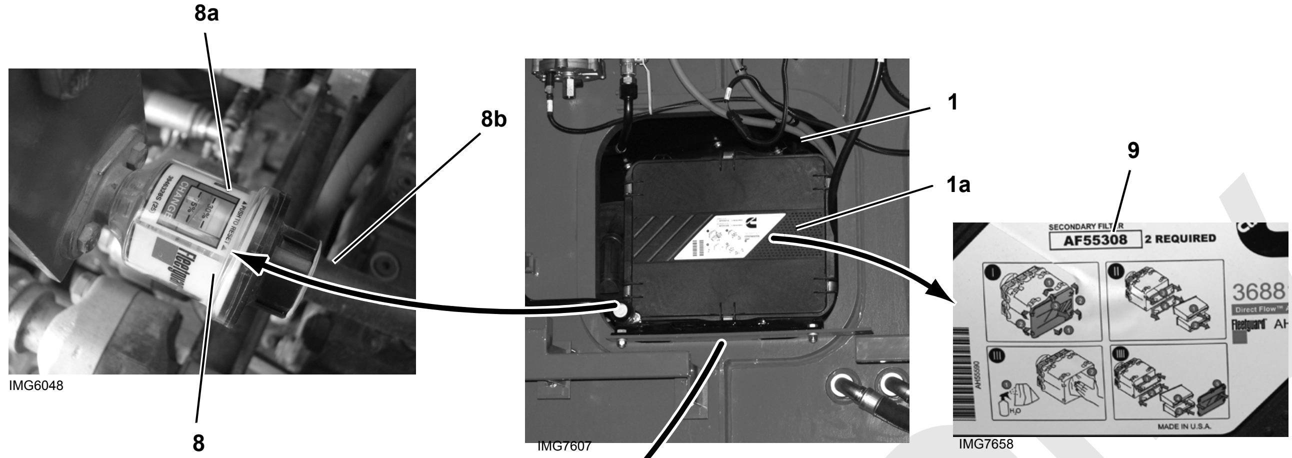
Do not attempt to clean and reuse old filter. Discard old filter and install a new one.

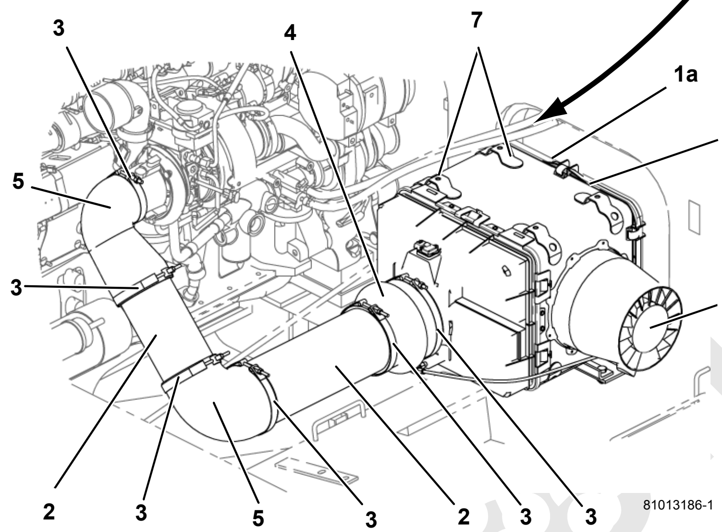
1. Wipe any accumulated dirt, grease, or other foreign material from the outside surface of the air cleaner assembly to prevent contamination when opening the air cleaner or integral pre-cleaner assemblies.

   Do not allow foreign matter to enter 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.

AIR CLEANER — TIER 4 ONLY





Item1	Description
1	Air Cleaner Assembly
1a	Service Cover
1b	Latch (6)
1c	Primary Filter (2)
1d	Secondary Filter (2)
1e	Housing
2	Steel Tube (2)
3	Clamp (6)
4	Straight Adapter Fitting
5	Rubber Elbow Reducer (2)
6	Engine Intake
7	Mounting Lugs (8)
8	Service Indicator
8a	Service Window
8b	Reset Button
9	Decal With Service Instructions

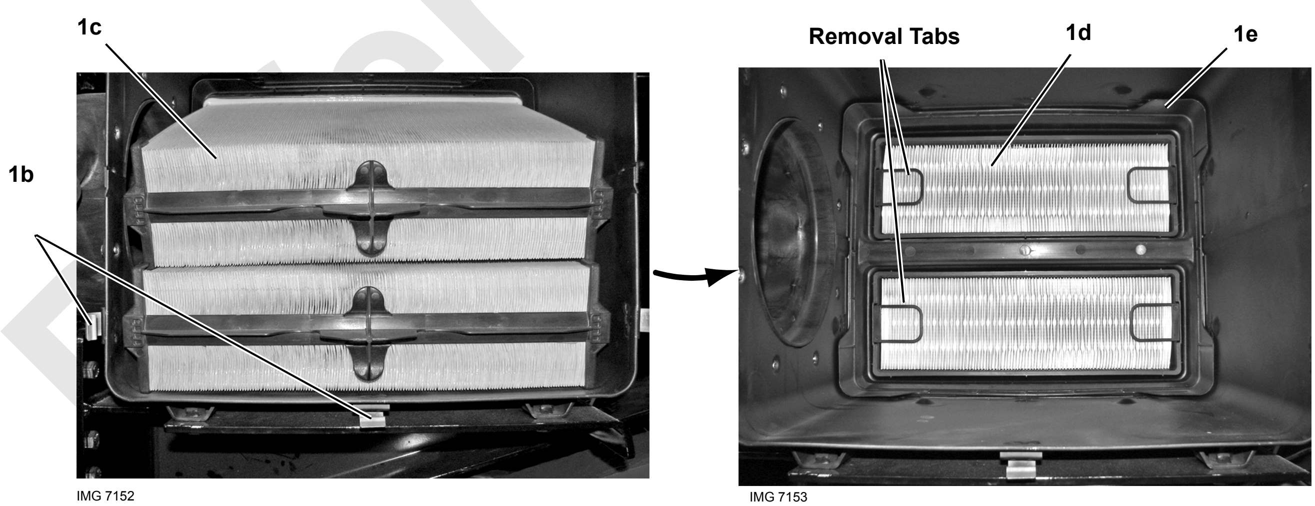


FIGURE 7-4

ENGINE CLUTCH ADJUSTMENT

See Figure 7-5 for the following procedure.

A disc-type manually operated clutch is mounted between the engine and the pump drive on this crane. The clutch allows the pump drive to be disconnected from the engine, thereby 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 engine longer than 20 minutes with clutch disengaged. Clutch release bearing can be damaged.

Operation

1. Grease clutch monthly. See Section 9.
2. At least once each month, disengage and engage the clutch several times with engine running. This practice will clean the disc surfaces and prevent the discs from seizing.
3. When disengaging clutch, check free travel. Readjust clutch when free travel decreases to less than 1-3/8 in (35 mm).

Adjustment

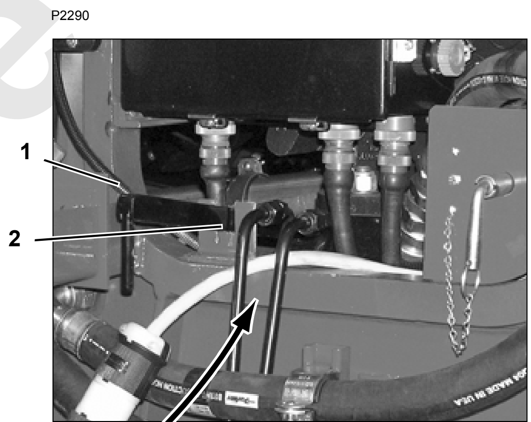
The clutch is adjusted internally through the cover plate on top of the clutch housing. See the clutch manufacturer's manual for adjustment instructions.

DANGER!

Moving Machinery Hazard!

Parts inside clutch rotate when engine is running. Stop engine before adjusting clutch.

Item	Description
1	Handle
2	Latch
3	Engine
4	Clutch
5	Cover Plate
6	Pump Drive



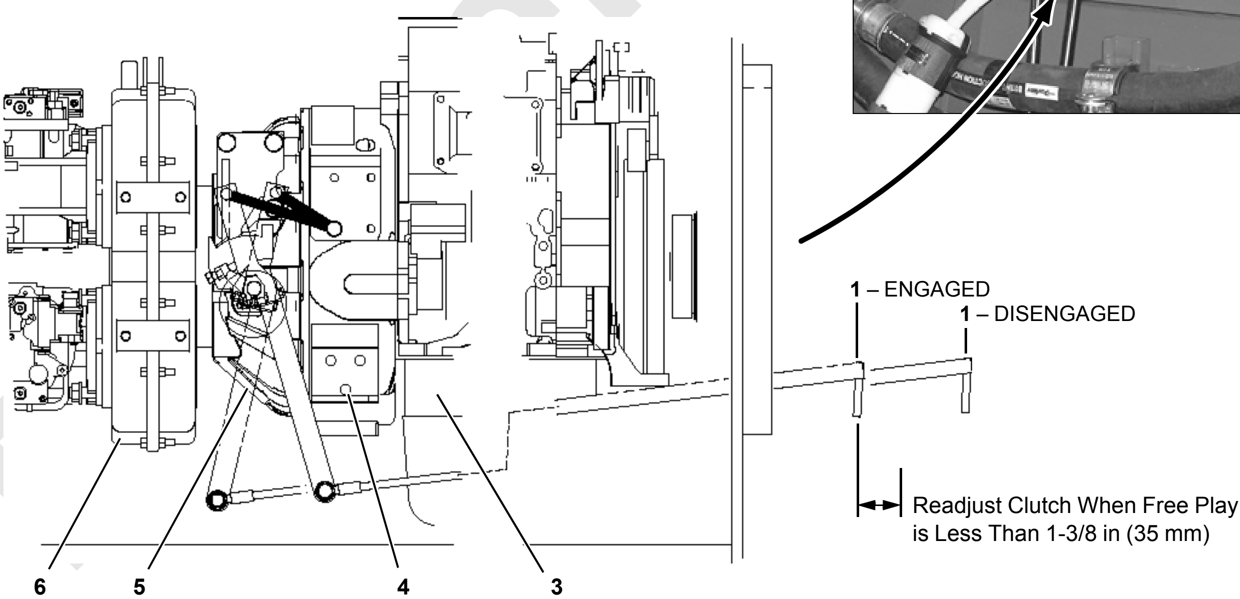


FIGURE 7-5

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ENGINE THROTTLE ADJUSTMENT

The engine throttle assembly consists of an electronic hand throttle controller in the left console and an electronic foot throttle controller on the cab floor. There is no mechanical linkage between the controllers.

Electronic signals from the throttle controllers are transmitted to the crane's programmable controller, and the programmable controller increases and decreases engine speed accordingly.

Hand Throttle Controller

The hand throttle controller does not require adjustment, and is not repairable.

Foot Throttle Controller

See Figure 7-6 for the following procedure.

The foot throttle controller was properly assembled and calibrated at initial installation and should not require further attention.

Assemble and calibrate the foot throttle controller as follows if it is repaired or replaced.

Foot Throttle Controller Assembly

1. To assemble shaft (3) and torsion spring (5) into housing (1), first assemble spring onto shaft by inserting lug on one end of spring into hole in head of shaft.

2. Insert shaft (3) into cavity in bottom of housing (1), through bearing (9), and into pedal (2).

Lug on outboard end of spring (5) must engage hole in housing (1) (Section A-A).

3. Insert shaft (4) into cavity in bottom of housing (1), through bearing (9), and into pedal (2).

4. Rotate pedal (2) as needed and install roll pins (14) through holes in pedal and shafts (Pedal Position ***A***).

5. Install setscrew (16). Do not insert deep enough to contact head on shaft (3).

6. Rotate pedal approximately 40° to position B (low idle). At this time flat on head of shaft (3) should be parallel with surface X on housing. Finish turning in setscrew (14) until it contacts flat on head of shaft (Section A-A).

Foot Throttle Controller Calibration

Supply voltage to be 25.0 to 26.0 VDC.

1. Turn potentiometer (7) shaft fully CCW as viewed from shaft end (zero volts out).

2. With pedal (3) in Position B, insert potentiometer (7) into cavity in bottom of housing (1) as shown in View B-B. Insert potentiometer shaft into end of shaft (4) and tighten setscrew (22).

3. Rotate pedal to high idle position, hold in place using setscrew (16), and rotate potentiometer housing to obtain an output of 0.90 to 1.00 VDC.

4. Apply silicone sealant RTV-162 (MCC #622201) between housing (1) and potentiometer (7). Do not get sealant on shaft (4). Allow sealant to cure one to two hours before proceeding to next step.

5. After sealant has cured, check output for 0.90 to 1.00 VDC in high idle position.

6. Remove setscrew (16), apply Loctite #243 (MCC #A18004) to threads, and adjust setscrew to obtain a low idle position output reading of 2.90 to 3.00 VDC.

Engine Speed Calibration

Engine speed is calibrated automatically by the crane's programmable controller:

- HIGH IDLE = 1,800 RPM
- LOW IDLE = 1,050 RPM

Component Identification for Figure 7-6

Item	Qty.	Description	Item	Qty.	Description
1	1	Foot Pedal Housing	10	1	Conduit Nut (1/2 inch)
2	1	Foot Pedal	11	2	Roll Pin (3/16 inch Diameter x 1-1/2 inch Long)
3	1	Foot Pedal Shaft (right)	12	1	3-Pole Male Receptacle
4	1	Foot Pedal Shaft (left)	13	1	Resistor (220 Ohm, 1Watt)
5	1	Torsion Spring	14	2	Hex Head Cap Screw (3/8 inch-16UNC x 3/4 inch Long)
6	1	Receptacle Mounting Bracket	15	2	Flat Head Brass Screw (#6-32UNC x 1/2 inch Long)
7	1	Potentiometer	16	1	Allen Head Cup Set Screw (5/6 inch-18UNC x 3/4 inch Long)
8	1	Zener Diode (22 VDC, 5 Watt)	17	1	Allen Head Cup Set Screw (#6-32UNC x 3/16 inch Long)
9	2	Roller Bearing	18	2	Lock Washer (3/8 inch)

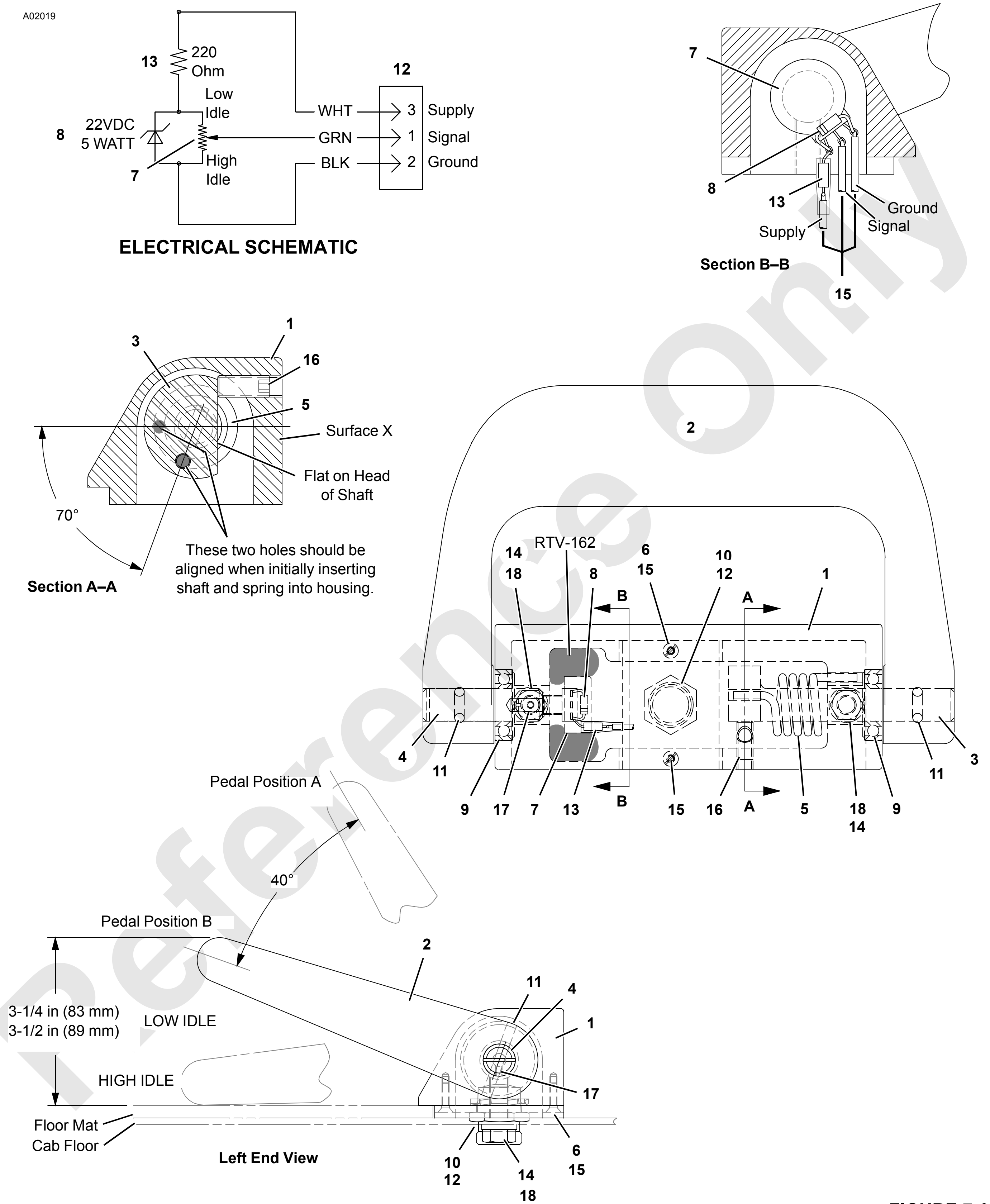
A02019
13
220
Ohm
12
Low
Idle
WHT
3 Supply
8
22VDC
5 WATT
GRN
1 Signal
7
High
Idle
BLK
2 Ground
ELECTRICAL SCHEMATIC
7
8
13
Ground
Signal
Supply
Section B–B
15
1
3
16
5
Surface X
Flat on Head
of Shaft
70°
These two holes should be
aligned when initially inserting
shaft and spring into housing.
Section 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
11
4
1
3-1/4 in (83 mm)
3-1/2 in (89 mm)
LOW IDLE
HIGH IDLE
17
Floor Mat
Cab Floor
Left End View
10
12
14
18
6
15

FIGURE 7-6

7

ENGINE ENCLOSURE

The enclosure has panels (see Figure 7-7) that can be removed to allow access for engine service.

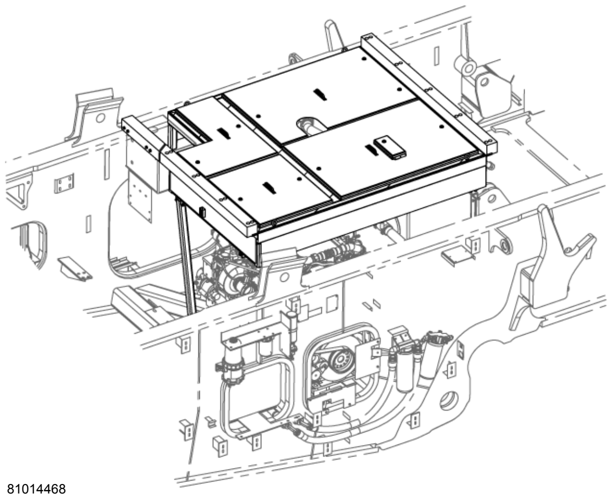

FIGURE 7-7

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

ENGINE BELT ROUTING — TIER 3 ENGINE ONLY

Engine belt routing for the Tier 3 engine is shown in Figure 7-8 to help service personnel when installing a new fan belt.

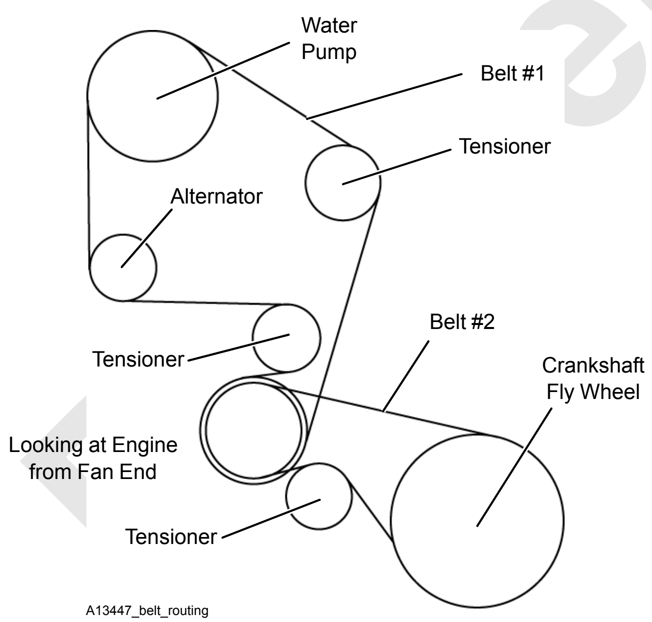

FIGURE 7-8

ENGINE BELT ROUTING — TIER 4 ENGINE ONLY

Engine belt routing for the Tier 4 engine is shown in Figure 7-9 to help service personnel when installing a new fan belt.

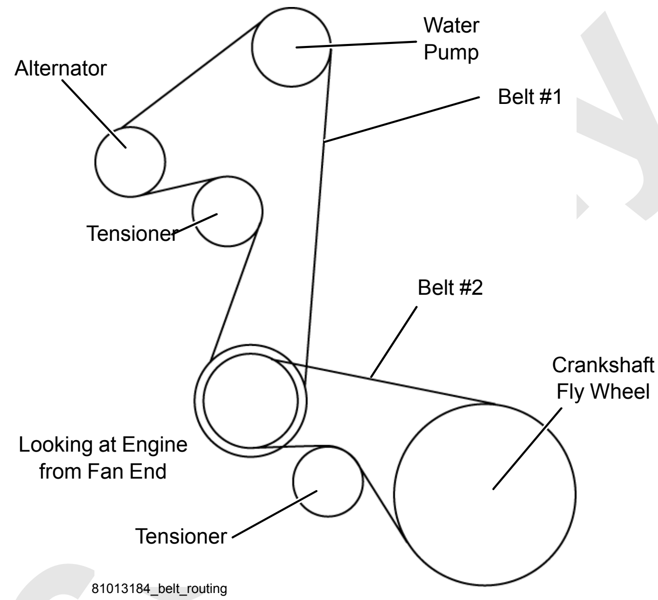

FIGURE 7-9

ENGINE COOLING SYSTEM FILL — CURRENT PRODUCTION TIER 4

General

The cooling system consists of a horizontal radiator (mounted above the engine) and a variable-speed, hydraulically driven blower-type fan.

Cooling System Operation

Cooling system flow is illustrated in Figure 7-10.

The cooling system is of the deaeration type, which continually removes air from the system, as follows:

- A small percentage of total coolant flow is circulated through a vent line to the radiator.
- Since coolant circulation is very slow in the radiator, air separates from the coolant.
- Air collects at the top of the radiator. When pressure rises to 15 psi (1,03 bar), the relief in the fill cap opens to exhaust air through overflow line.
- Deaerated coolant returns to the system through a make-up line.

A678a

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

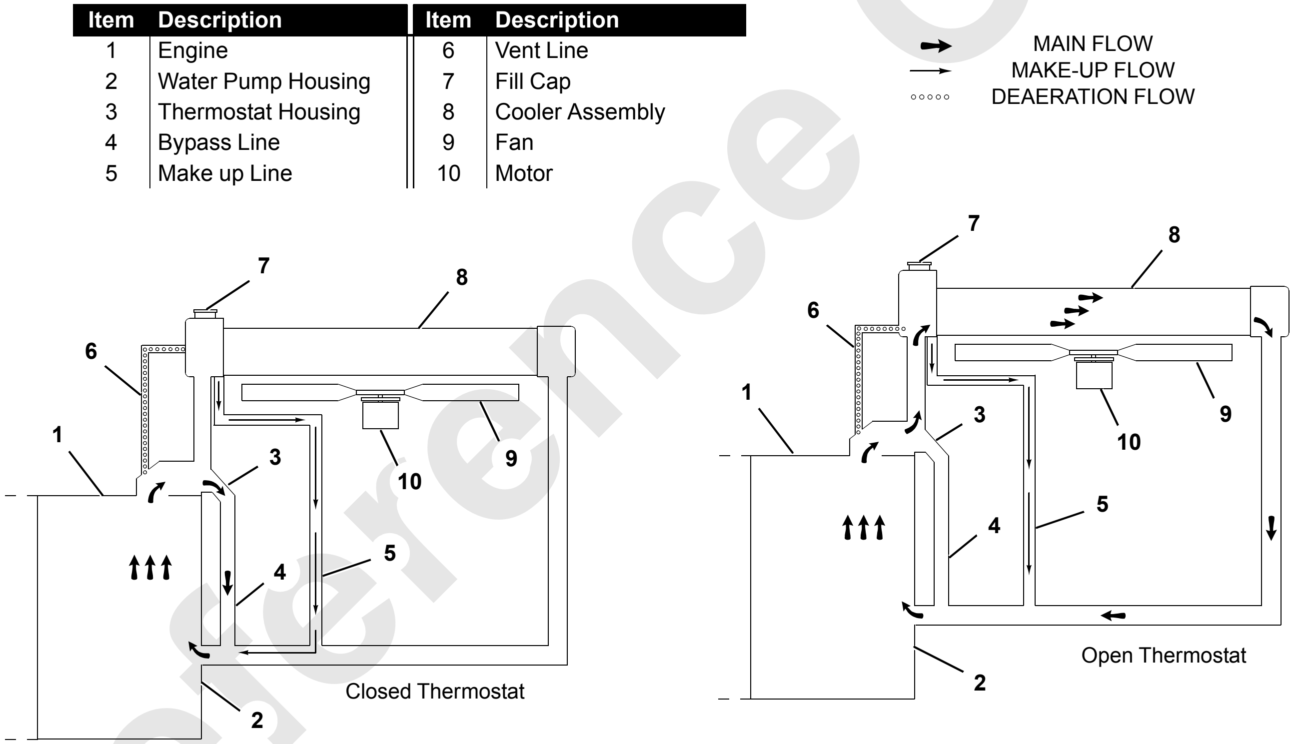

FIGURE 7-10

Maintenance

WARNING

Burn Hazard!

Avoid personal injury from heated coolant spray or steam — do not remove radiator cap from hot engine. Stop engine and wait until coolant temperature is below 120° F (50° C). Then:

- Place a protective covering over fill cap.
- Slowly turn fill cap counterclockwise until it stops at safety detent.
- Wait until pressure (indicated by hissing sound) is completely relieved.
- Depress fill cap and turn counterclockwise to remove.

CAUTION

Overheating Hazard!

Avoid engine damage from overheating — do not allow coolant level to go below low level on gauge.

Daily Maintenance (Start of Each Shift)

Check coolant level when cold (see Figure 7-11):

1. Coolant should be at full level of cold gauge.
2. Fill cooling system as required with coolant. To ensure adequate fill, do not add coolant at a rate greater than 3 gallons/minute (11.3 liters/minute).

   See engine manufacturer's manual for antifreeze and coolant additive recommendations.
3. Look for coolant leaks while engine is running; correct if found.

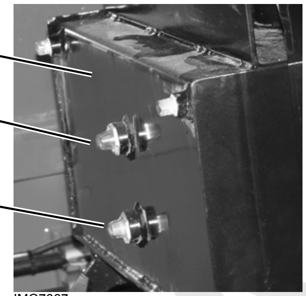

FIGURE 7-11

Semiannual Checks

1. Inspect fill cap and thermostat for proper operation and replace worn parts:
   - Fill cap relieves at 15 psi (1,03 bar).
   - Thermostat closes at 180° F (82° C) and opens fully at 200° F (93° C).
2. Inspect water pump belts for wear and proper adjustment (see engine manufacturer's manual).
3. Inspect cooling system hoses for deterioration and other defects. Replace as necessary.
4. Tighten hose clamps.
5. Clean all dirt and other debris from outside of radiator.
6. Check that overflow line on tank is open.

Draining Radiator

Drain radiator system, as follows:

1. Stop engine.
2. Open one bleed valve located on top coolant tube and four bleed screws, two located on the bracket between the two cooling fin, one on each side, and one on each outer corner of the large cooling fin (see Figure 7-12 and Figure 7-13).
3. Remove the deaeration tank fill cap (Figure 7-12).

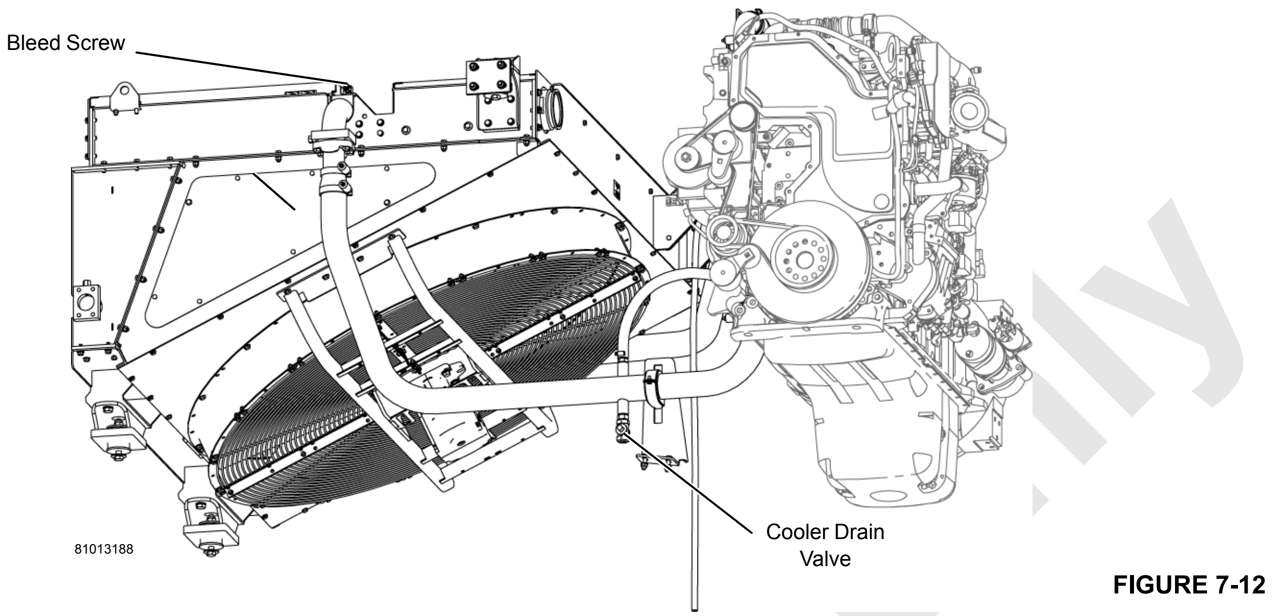

FIGURE 7-12

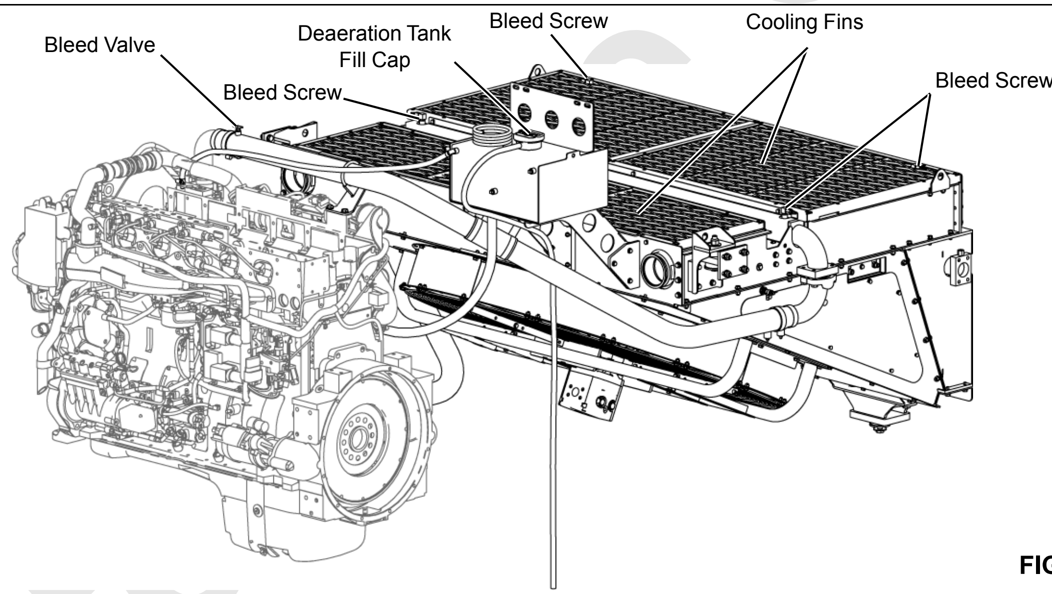

FIGURE 7-13

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4. Open drain valve (Figure 7-14) and drain coolant into a suitable container.

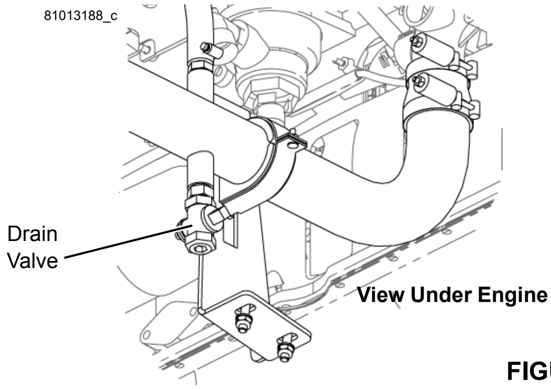

FIGURE 7-14

5. Close the drain valve once the system is completely drained.

Filling the Cooling System

See the engine manufacturer's manual for antifreeze and coolant additive recommendations. Refer to the operator manual for detailed cooling system fill instructions. Add coolant to FULL (COLD) LEVEL as determined on checks per the schedule in the engine owner's manual.

1. Fully open one bleed valve located on top coolant tube and four bleed screws: two located on the bracket between the two cooling fins, one on each side, and two on the outer corners of the largest fin.
2. Fill cooling system through deaeration tank fill cap to FULL (COLD) LEVEL mark on sight gauge. Coolant system capacity is approximately 25 gallons (94.6 liters).
3. Observe and close bleed valves once clear coolant appears at the bleed valves.
4. Continue adding coolant until the level is at the FULL (COLD) mark.

NOTE: Maximum fill rate is 3 GPM (11.3 liters/min).

5. Install fill cap and run engine until at normal operating temperature.

CAUTION!

Engine Damage!

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

Do not remove the deaeration tank fill cap from a hot engine. Allow the engine to cool below 50°C (120° F) before adding coolant.

Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool below 50°C (120°F) before adding coolant.

Coolant is toxic. Do not ingest. If not reused, dispose of in accordance with all local and other applicable environmental regulations.

6. Look for coolant leaks while engine is running; correct if found.
7. Stop engine, wait until engine is cool, and refill cooling system to FULL (COLD) level mark.

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 engine manufacturer's operator manual and per warnings, cautions and instructions in the engine manufacturer's service manual.

DIESEL PARTICULATE FILTER REGENERATION — TIER 4 ONLY

General

The Diesel Particulate Filter (DPF) — located at the rear of the upperworks — captures soot and ash from the engine exhaust.

- Soot is partially burned fuel particles that occur during normal operation (black smoke).
- Ash is partially burned engine oil particles that occur during normal operation.

Over time, both soot and ash are collected in the DPF and must be removed.

- Soot is removed by a process called **regeneration**.
- Ash is removed by manually cleaning the DPF at specified intervals (see Engine Manufacturer's Manual for detailed instructions).

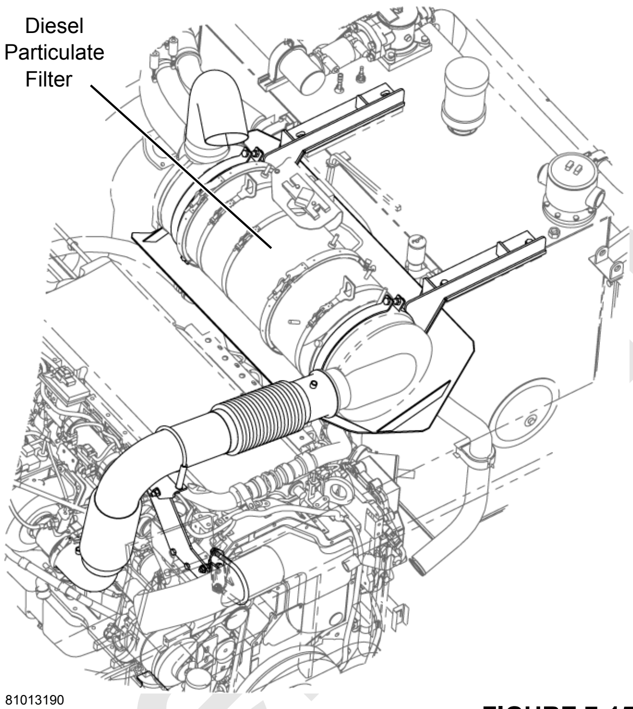

FIGURE 7-15

Regeneration

General

Regeneration is the process of converting the soot collected in the DPF into carbon dioxide. Regeneration requires heat to occur. Two types of regeneration are used: passive and active.

Passive Regeneration

Passive regeneration occurs when exhaust temperatures are naturally high enough to oxidize the soot faster than it is collected in the DPF.

The process typically occurs when the crane is operated at high speeds and/or under heavy loads.

The operator will not know when passive regeneration is occurring.

Active Regeneration

Active regeneration occurs when exhaust temperatures are NOT naturally high enough to oxidize the soot faster than it is collected in the DPF. If this happens, the engine's controller will initiate the process (see Engine Manufacturer's Manual for detailed instructions).

The process occurs more frequently in cranes operated at low speed, light or no load, or stop and go cycles.

Active regeneration will be transparent to the operator, except that he/she may notice an increase in turbocharge noise and an increase in exhaust temperature (high exhaust temperature icon comes on).

NOTE: Use the INHIBIT switch in the operator's cab only for special circumstances where it is desirable to disable active regeneration. Prolonged engine operation with INHIBIT 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.

Stationary Regeneration

Stationary regeneration is a form of active regeneration that is initiated by the operator when the crane is parked. The DPF ON light will flash to alert the operator if stationary regeneration is required (see Section 3 of Crane Operator Manual and the Engine Manufacturer's Manual for detailed instructions).

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DIESEL PARTICULATE FILTER (DPF) MAINTENANCE

Accumulated ash must be periodically cleaned from the DPF. A build-up of ash can result in cold spots and compact the ash within the DPF. This reduces the life of the filter, can damage it, and may increase the time required for regeneration.

In the United States, the Environmental Protection Agency requires that cleaning of the DPF be done at a minimum service interval of 4,500 operating hours, (roughly every two years of one-shift operation). This cleaning requires special tools using equipment specifically made for this purpose. The DPF cannot be cleaned using conventional methods. For this reason, it is recommended that the DPF be sent to the manufacturer for cleaning, or exchanged for a clean DPF if operation of the crane is critical. The DPF must be removed, sent for cleaning, then the cleaned DPF or a replacement installed.

Removing the DPF for Cleaning or Replacement

See Figure 7-16 for the following procedure.

For inspection and/or cleaning, the DPF must be removed. It may be re-useable.

NOTE: The DPF must be removed and replaced if engine Fault Code 1981 or 1922 has been noted and the DPF is contaminated with coolant.

DANGER

Electrical Shock Hazard!

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

WARNING!

Explosion Hazard!

Batteries can explode and emit explosive gas. To reduce the chance of injury, always ventilate the area before servicing the batteries. Always remove the negative battery cable first and attach the negative cable last.

WARNING

Burn and Inhalation Hazards!

Temperature of exhaust and exhaust components for Tier 4 engines can be higher than other engines.

To prevent death or serious injury:

- Allow engine and diesel particulate filter to cool before performing maintenance.

CAUTION

Engine Damage!

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

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

1. Disconnect the crane's batteries by disconnecting the negative battery cable first and the positive battery cable last or turn the battery disconnect to the "Disconnect" position (see Figure 7-2) and remove the key.
2. Disconnect the electrical wiring to the DPF (2) from the wiring harness (16).
3. Loosen (but do not remove) V-band clamp (5) and gasket (10), and clamp (6) and gasket (9) from the inlet side of the DPF. Move clamps onto inlet tube.
4. Loosen screws (22), locknuts (15) and washers (23) securing tube support bracket (13) or remove U-bolt guillotine clamp (17) to free inlet tube assembly.
5. Disconnect inlet tube assembly (7) from engine and DPF.
6. Loosen (but do not remove) V-band clamp (11) and clamp (12) from the outlet side and move onto outlet tube.
7. Disconnect outlet tube assembly (8) from DPF.
8. Mark the direction of exhaust flow, from inlet to outlet, on the outside of the DPF (2). This will help if the DPF will be cleaned and re-installed.

7

Diesel Particulate Filter Component Overview

Item	Description	Item	Description
1	Engine	13	Tube Support Brackets (2)
2	Diesel Particulate Filter	14	Hex-head Cap screws (4)
3	Exhaust Filter Mounts (2)	15	Locknuts (6)
4	Mounting Straps (2)	16	Wiring Harness
5	V-Band Clamp	17	U-bolt Guillotine Clamp
6	Clamp	18	P-Clamps (2)
7	Inlet Tube Assembly	19	V-Band Clamp (Inlet to DPF)
8	Outlet Tube Assembly	20	Band Clamp (Lifting Hook)
9	Gasket	21	Exhaust Gas Temperature Sender
10	Gasket	22	Hex-head Cap screws (2)
11	V-Band Clamp	23	Washers (2)
12	Clamp		

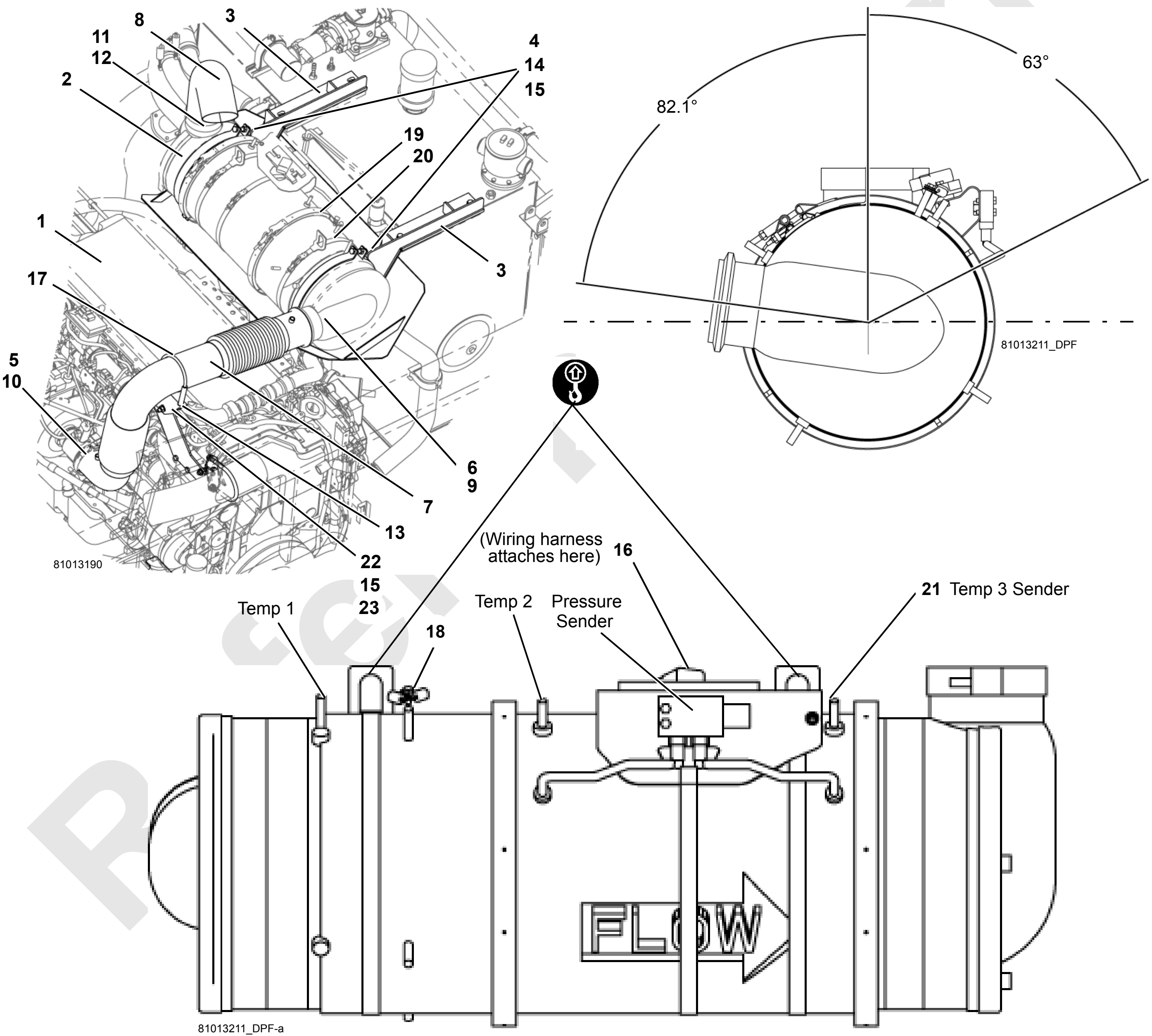

FIGURE 7-16

WARNING!

Personal Injury Hazard!

The Diesel Particulate Filter assembly weighs more than 50 lb (23 kg). To prevent serious personal injury, use assistance or appropriate lifting equipment when lifting or removing.

CAUTION!

Equipment Damage!

The oxidation catalyst elements of the diesel particulate filter are made of brittle material. Do not drop or strike the side of the DPF as damage to these elements can result.

9. Attach hoist chains to lifting hooks on the DPF (see Figure 7-16) and lift just enough to remove slack in the chain.
10. Remove two hex cap screws (14) and locknuts (15) on each DPF mounting strap (4) and remove the top half of the straps.
11. Using hoist, lift the DPF (2) out of the support.

Installing the DPF

See Figure 7-16 for the following procedure.

WARNING!

Personal Injury Hazard!

The Diesel Particulate Filter assembly weighs more than 50 lb (23 kg). To prevent serious personal injury, use assistance or appropriate lifting equipment when lifting or removing.

CAUTION!

Equipment Damage!

The oxidation catalyst elements of the diesel particulate filter are made of brittle material. Do not drop or strike the side of the DPF as damage to these elements can result.

1. Attach hoist chains to lifting hooks on DPF and lift DPF over exhaust filter mounts (3) and straps (4). Ensure the DPF is oriented correctly.
2. The DPF consists of inlet, center and outlet sections. Check the orientation of the sections as shown in Figure 7-16. If not correct, the DPF sections will need to be reoriented (see Side Inlet Re-orientation).
3. Position top half of mounting straps (4), then loosely tighten straps with hex-head cap screws (14) and locknuts (15).
4. Orient the DPF as shown in Figure 7-16.
5. Tighten hex-head cap screws (14) and locknuts (15) enough to clamp the filter, but not distort it.
6. Connect the DPF electrical wiring to the wiring harness (16).
7. Connect outlet tube assembly (8) to DPF (2).
8. Install and tighten V-band clamp (11) and clamp (12). Tighten V-band clamp (11) to a torque value of 14.8 ± 1.48 lbs-ft (20 ± 2.0 Nm).
9. Connect inlet tube assembly (7) to engine (1) and DPF (2).
10. Install U-bolt guillotine clamp (17) or secure tube support bracket using screws (22), locknuts (15) and washers (23).
11. Install V-band clamp (5) and gasket (10). Tighten V-band clamps (5) to a torque value of 14.8 ± 1.48 lbs-ft (20 ± 2.0 Nm).
12. Install and tighten clamp (6) and gasket (9).

WARNING!

Explosion Hazard!

Batteries can explode and emit explosive gas. To reduce the chance of injury, always ventilate the area before servicing the batteries. Always remove the negative battery cable first and attach the negative cable last.

13. Connect the crane's battery and/or insert the "Battery Disconnect" switch key and move the handle to the "Connect" or "1" position.
14. Start the crane's engine and run with a load for at least five minutes to ensure the DPF is performing properly. Check for exhaust leaks and engine Fault Codes.
15. If the DPF has been cleaned, perform a stationary regeneration (see Operator Manual). This will remove any remaining soot not removed during cleaning. It will also test the efficiency of the catalyst inside and ensure the DPF is functioning properly.

NOTE: Engine Fault Codes:

If DPF was replaced or cleaned as a result of engine Fault Code 1922, the stored soot load in the engine ECM must be reset (see Engine Manufacturer's Service Manual).

If engine Fault Code 1981 is active and Fault Codes 2639, 1921 and 1922 are NOT active, a stationary regeneration is not required after replacing the DPF.

If engine Fault Code 1981 and/or 1922 are active after cleaning the DPF, a stationary regeneration MUST be performed after installing the DPF.

Side Inlet Re-orientation

NOTE: The DPF cleaning vendor should return the DPF with the three sections of the DPF oriented properly. Follow steps below only if re-orientation of DPF is required.

1. Remove P-clamps (18) from standoff.
2. Loosen the V-band clamp (19) connecting the inlet section to the filter section until the inlet section can be freely rotated around the center section of the DPF. Do not fully remove the clamp or gasket.
3. Rotate the inlet section to the orientation shown in Figure 7-16.
4. Tighten V-band clamp (19) to a torque value of 14.8 ± 1.48 lbs-ft (20 ± 2.0 Nm).
5. Using a rubber mallet, gently tap the circumference of the clamp to ensure proper seating of V-band clamp (19). Re-torque V-clamp to a value of 14.8 ± 1.48 lbs-ft (20 ± 2.0 Nm).
6. Loosen the band clamp retaining the lifting hook (20) on the inlet section until the lifting hook can be freely rotated.
7. Return hook to vertical position. Ensure band clamp hardware is rotated 35° from the hook as shown in Figure 7-16. Adjust hook orientation to ensure sensor wires will not be damaged while lifting.
8. Tighten the band clamp to 64.6 ± 8.9 lbs-in (7.30 ± 1.0 Nm).
9. Re-install the P-clamps (18) and tighten to a torque of 64.6 ± 8.9 lbs-in (7.30 ± 1.0 Nm). Ensure wires installed in P-clamps are not within 1 in (25 mm) of DPF body. Avoid sharp bends and excessive tension in sensor wires.

SECTION 8
UNDER CARRIAGE

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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.

TURNTABLE BEARING BOLT TORQUE

Torque Requirements

DANGER

Crushing Injury Hazard!

Two people are required to torque turntable bearing bolts: an operator to operate swing control and a mechanic to torque bolts.

Mechanic must go inside carbody to torque inner turntable bearing bolts.

- Maintain constant communication between operator and mechanic while mechanic is inside carbody.
- Operator, do not swing upperworks until instructed to do so by mechanic.

Mechanic, stay well clear of moving parts while upper is being swung to position bolts.

WARNING

Bolt Failure!

Loose or improperly torqued bolts can cause bolts or turntable bearing to fail, possibly allowing upperworks to break away from carbody.

Lubrication

Before installing the turntable bearing bolts, lubricate the following with “Never-Seez” (MCC No. 361010) or an equivalent anti-seizing lubricant:

- Threads of each bolt
- Underside of head of each bolt
- Both sides of each washer

Torque Values

Torque each turntable bearing bolt to 2,600 ft-lb (3 525 Nm).

When new bolts are installed, torque the bolts in two steps:

- FIRST to 1,000 ft-lb (1 356 Nm)
- SECOND to 2,600 ft-lb (3 525 Nm)

Torque Sequence

Torque the bolts (three at a time) in the numbered sequence given in Figure 8-1 (one ring at a time).

Torque Intervals

INITIAL 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 or more bolts are found to be torqued to less than 2,080 ft-lb (2 820 Nm), 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 2,080 ft-lb (2 820 Nm), 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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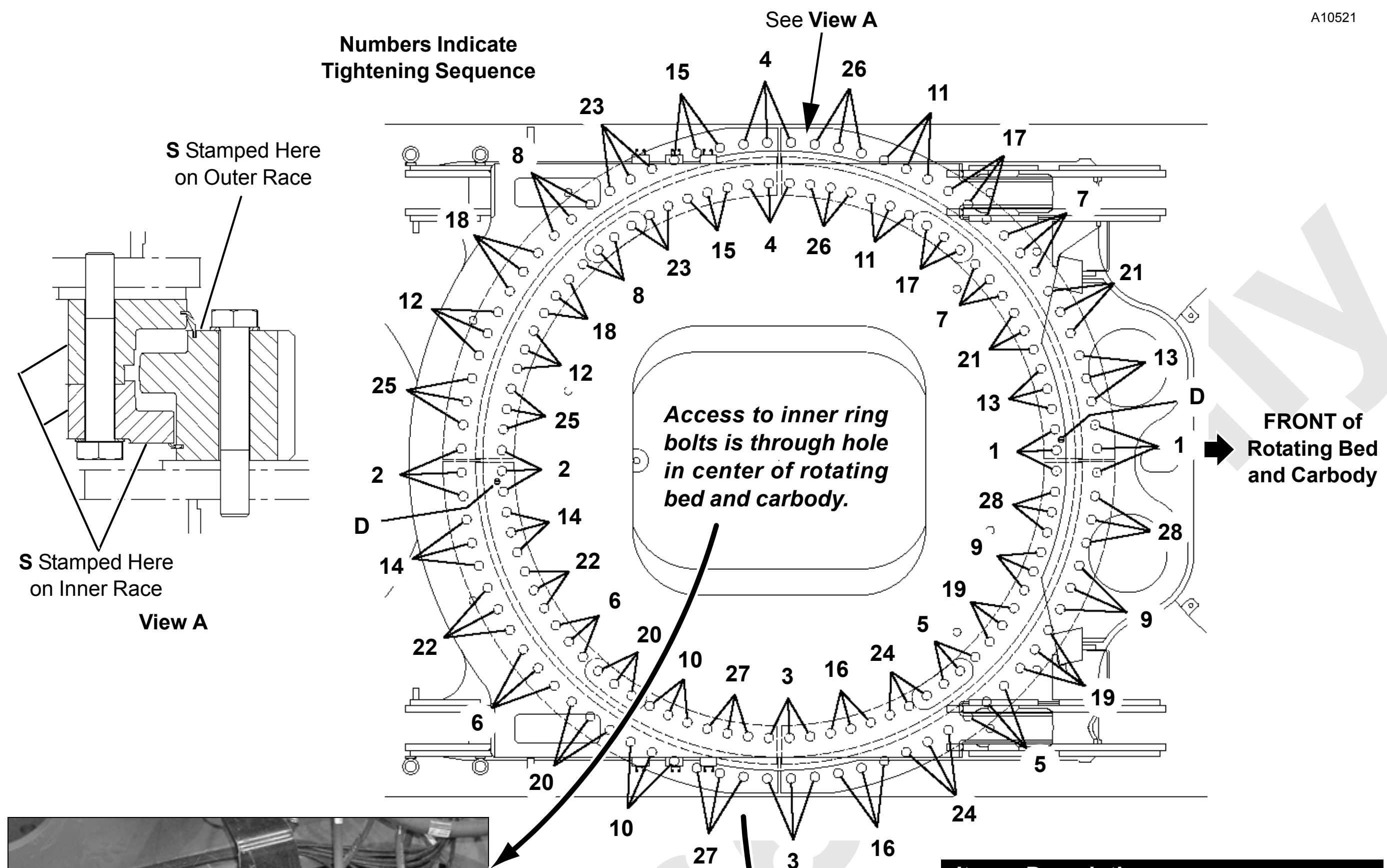
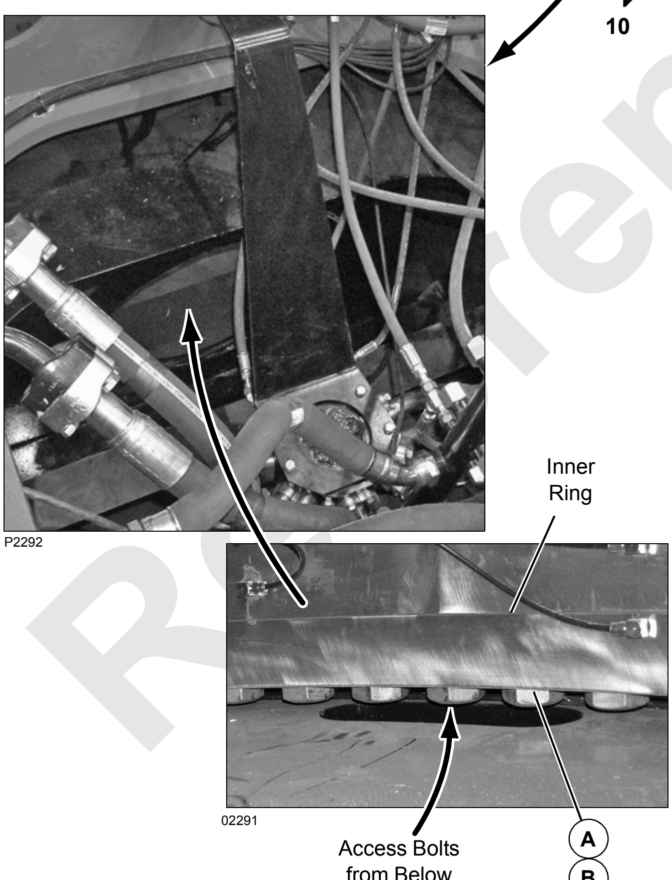
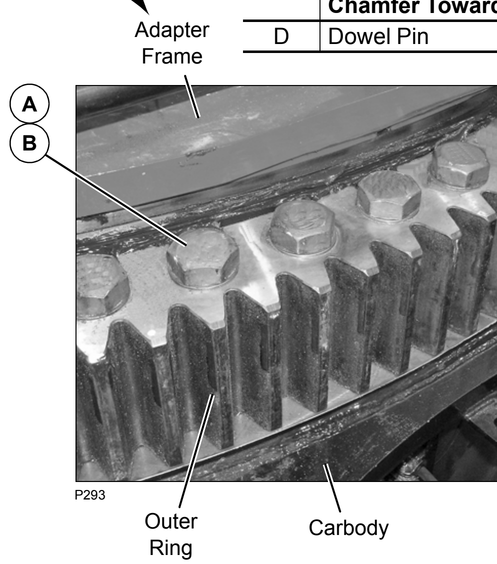






Item	Description
A	Heavy Hex Head Bolt – 1-1/2 inch- 6 UNRC x 10 inch Long SPECIAL Grade 84 Each Ring
B	Special Flat Steel Washer – 2-5/8 inch OD x 1-9/16 inch ID 84 Each Ring with **Chamfer Toward Bolt**
D	Dowel Pin

FIGURE 8-1

CRAWLER ADJUSTMENT

Maintenance

Crawler wear cannot be eliminated, but the rate of wear can be reduced through regular preventive maintenance, as follows:

- Lubricate crawlers as instructed in Lubrication Guide.
- Keep crawlers clean and avoid dirt build-up when cutting.
- Keep all mounting bolts tight (see 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 top rollers without touching rollers, as shown in Figure 8-2.

Tread Slack Adjustment

Adjustment Guideline

Check tread slack at the tumbler end of each crawler. Maintain equal tread slack at both crawlers.

1. Travel forward or reverse on a firm level surface so all tread slack is in top of treads at tumbler end of crawlers as shown in Figure 8-2.
2. Place straight edge on tread as shown in Figure 8-2. Gap between straight edge and top of tread at lowest point should be 1-1/2 in (38 mm) at tight limit to 3 in (76 mm) at loose limit.
3. Adjust tread slack if gap exceeds either limit.
4. Adjust treads tighter when operating on firm ground and looser when operating on soft ground (mud or sand).

CAUTION

Pin Damage!

Do not adjust treads too tight; tread pins will wear rapidly and may break. Dirt build-up will tighten treads even more, increasing possibility of damage.

More torque is required to drive tight treads, which results in faster wear and more fuel consumption.

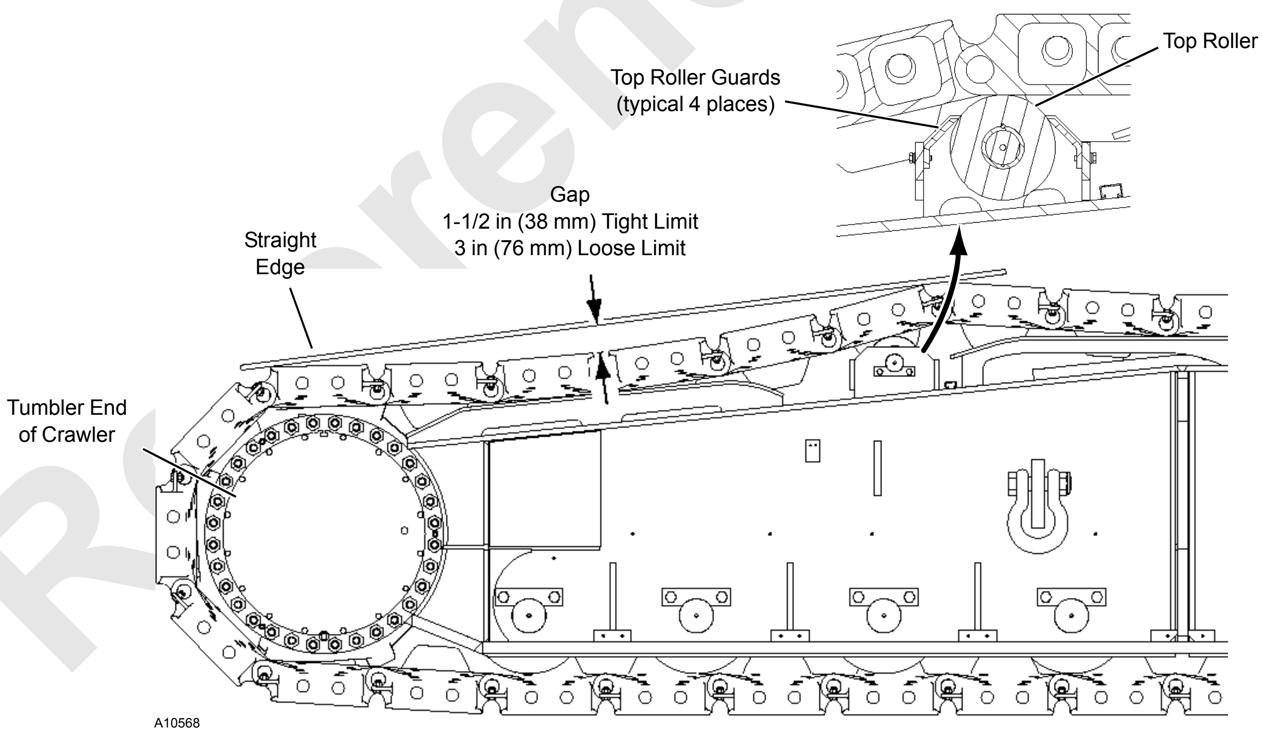


FIGURE 8-2

Adjustment Procedure

Adjust tread slack at roller end of each crawler (Figure 8-3).

1. Thoroughly clean crawler to be adjusted.
2. Loosen bolt (8) on each side of crawler roller.
3. Remove cover (5) from both sides of crawler frame.
4. Place jacking cylinder (3) on support.
5. Jack against rod (4) an equal amount on both sides of crawler frame.
6. Add or remove an equal thickness of shims (9) on both sides of crawler frame.
7. Remove jacking cylinder (3).
8. Travel crane forward or reverse to tighten shims (9).

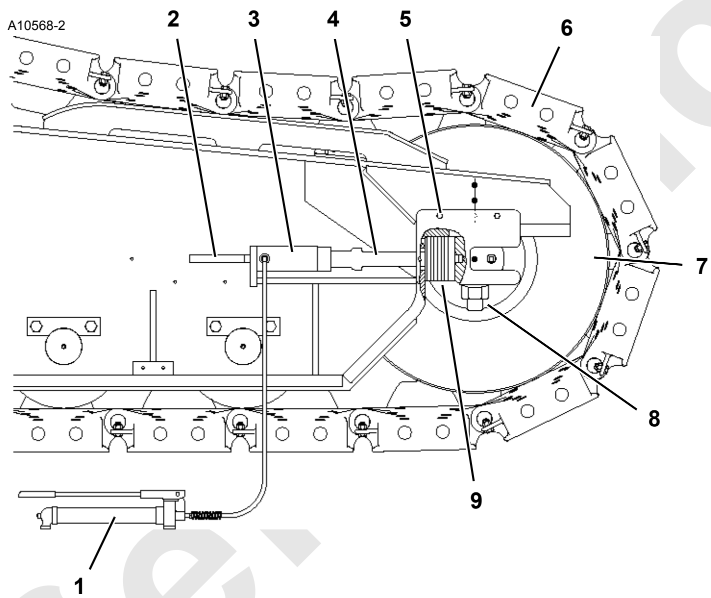
CAUTION

Part Wear!

Crawler roller and tumbler must be square with crawler frame within 1/8 in (3,0 mm); otherwise, parts will wear rapidly.

9. Check for proper adjustment (see Adjustment Guideline) and readjust as required (steps 4 through 8).
10. Tighten nuts on bolts (8) at crawler roller to 2,000 ft-lb (2 712 Nm) lubricated with Never-Seez or an equivalent oil and graphite mixture.
11. Install cover (5) on both sides of crawler frame.

NOTE: The extreme limit of tread adjustment occurs when the bolts (8) 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	Crawler Roller
8	Bolts
9	Shims 0.472 in (12 mm) and 0.236 in (6 mm) Thick

FIGURE 8-3

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HYDRAULIC HAND PUMP

See Figure 8-4 for the following procedures.

WARNING

Prevent Possible Death or Serious Injury to Maintenance Personnel

Manitowoc has provided hand pump and cylinder for crawler adjustment only. Any other use is neither intended nor approved.

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

Do not exceed maximum pressure rating of components (pump, cylinder, hose) – 10,000 psi (700 bar). Higher pressure can cause components to explode.

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

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

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

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

Assembly

1. Connect hose from pump outlet port to cylinder inlet.
2. Use 1-1/2 wraps of a high-grade thread sealant on fittings (for example, Teflon tape).

   Do not apply sealant to first complete thread to ensure tape does not shed into hydraulic system and cause malfunctioning or damage.
3. Do not overtighten connections. Connections only need to be snug and leak free. Overtightening can cause premature thread failure and may cause fittings or castings to split at lower than their rated pressures.

Maintenance

1. Keep unit clean and stored in a safe place where it cannot be damaged.
2. Keep oil in pump at proper level. Check level as follows:
   - **a.** Open valve and fully retract cylinder rod to return all oil to pump. ***Cylinder must be fully retracted or system will contain too much oil.***
   - **b.** For Simplex pump:
     - Place pump in horizontal position on a flat surface.
     - Using a screw driver, remove vent/fill cap.
     - Add hydraulic oil until reservoir is 2/3 full. ***Do not overfill.***
     - Securely reinstall vent/fill cap.
   - **c.** For Enerpac pump:
     - Place pump in vertical position with hose end down.
     - Using a screw driver, remove vent/fill cap.
     - Add hydraulic oil until it is at mark on dipstick. ***Do not overfill.***
     - Securely reinstall vent/fill cap.
   - **d.** Test operation and remove air from system, if required. Recheck level after removing air.

Air Removal

1. Close valve finger tight only.
2. Position pump higher than cylinder and position cylinder so rod is down.
3. Operate pump to fully extend cylinder rod.
4. Open valve and retract cylinder rod to force oil and trapped air back into pump.
5. Repeat steps until cylinder operates smoothly. Erratic operation indicates air in system.

Operation

1. Before using pump:
   - **a.** Check that all fittings are tight and leak free.
   - **b.** Check oil level.
2. To pressurize cylinder and extend rod, close valve by turning clockwise until finger tight only. Then pump handle up and down.

   Pressure will be maintained until valve is opened.

   To reduce handle effort at high pressure, use short strokes. Maximum leverage is obtained in last five degrees of stroke.
3. To depressurize cylinder, push handle down fully and open valve by turning counterclockwise.
4. Pump can be operated in any position from horizontal to vertical as long as ***hose end of pump is down***.

S135
S137
S138

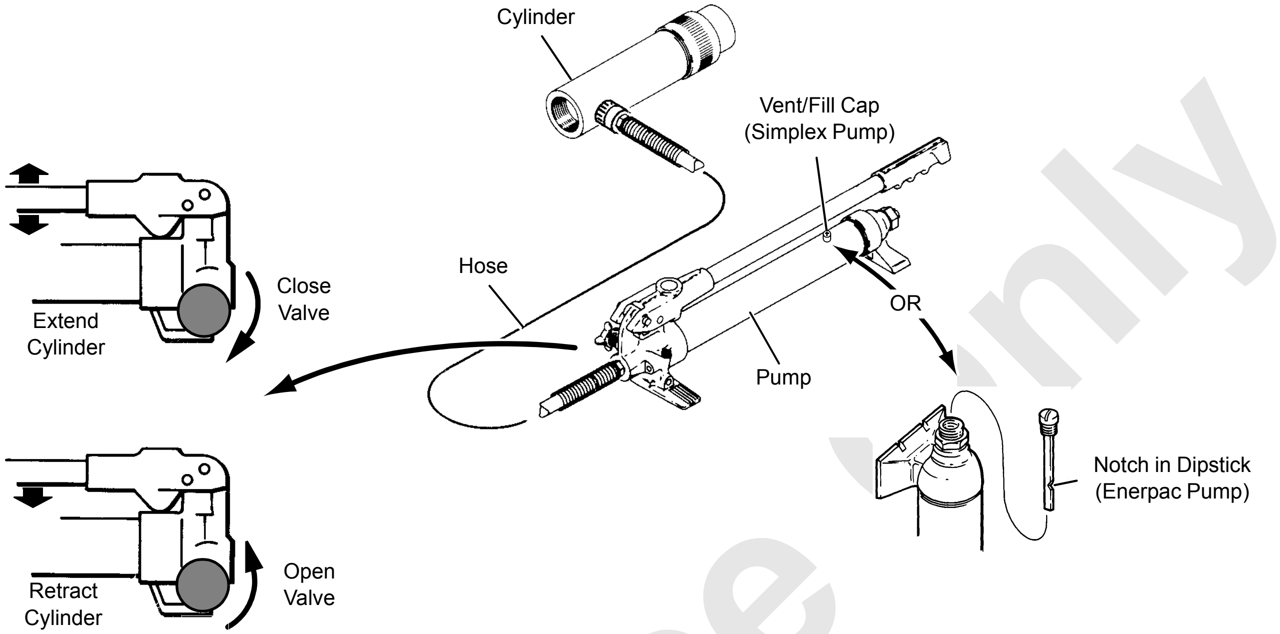

FIGURE 8-4

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LUBRICATION

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SECTION 9
LUBRICATION

LUBRICATION

See Folio 2109 at the end of this section.

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 also 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, you must comply with the following:

- Read the Operator Manual and Service Manual before beginning troubleshooting operations.
- You shall be a qualified service technician, competent in the repair and testing of electrical and hydraulic equipment. Manitowoc is not responsible for training personnel who might use this manual to perform the troubleshooting operations.
- Whenever possible, turn off crane engine for your protection and keep unauthorized personnel away from the crane when troubleshooting.
- Never troubleshoot the crane alone. Always perform troubleshooting procedures with a qualified operator in crane cab. Maintain constant communication with this operator when performing operations that require crane engine to be running.
- Do not return 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 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 shall be familiar with the equipment, trained in testing methods, 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 engine, remove key, and relieve pressure on system before disconnecting, adjusting, or repairing any component.

Ensure that connections are made correctly, O-rings or gaskets are in place, and connectors are tight before pressurizing system.

Use 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 crane while manually actuating a valve or pump to avoid unexpected equipment movement that can cause death or serious injury.

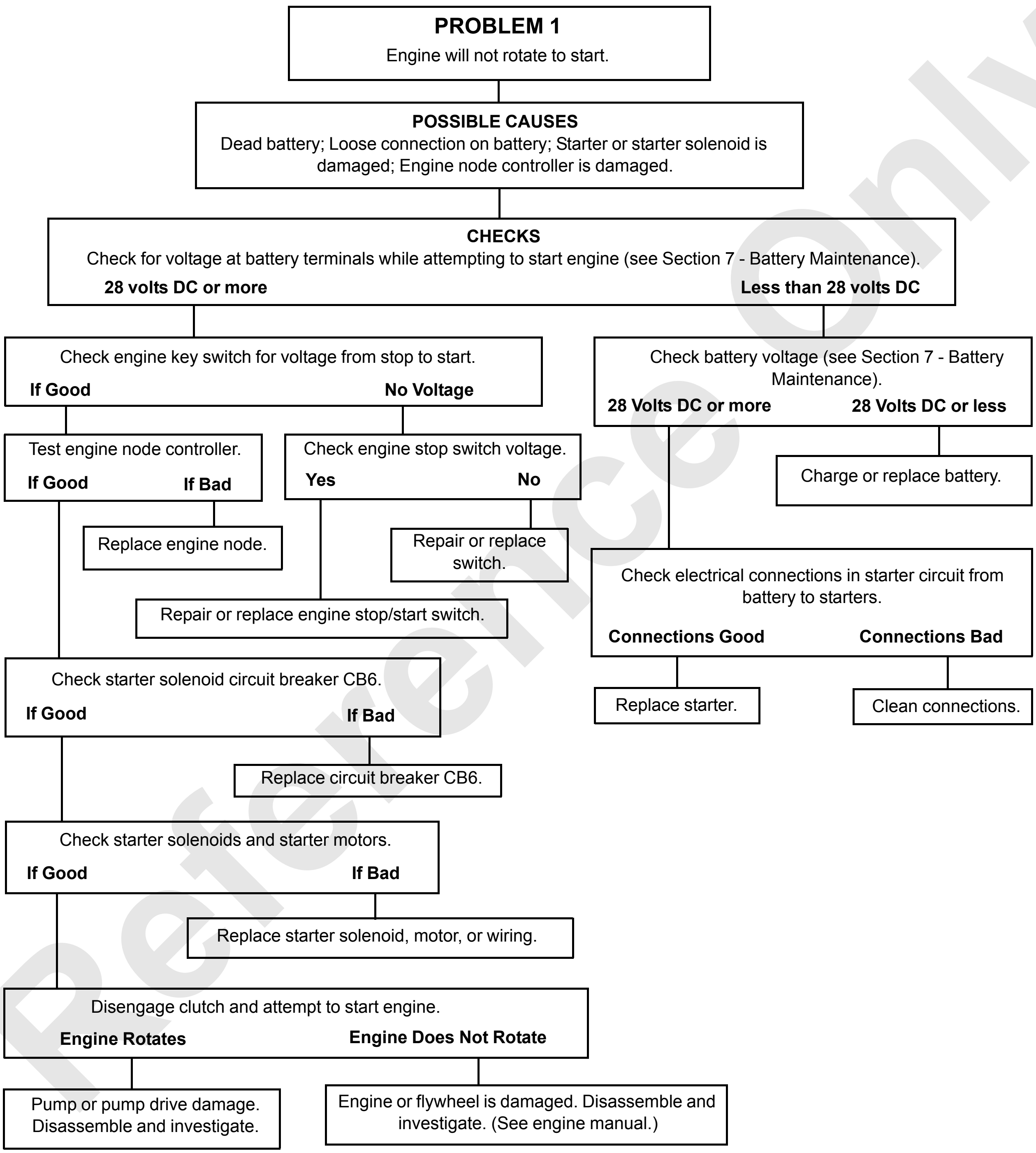
GENERAL TROUBLESHOOTING

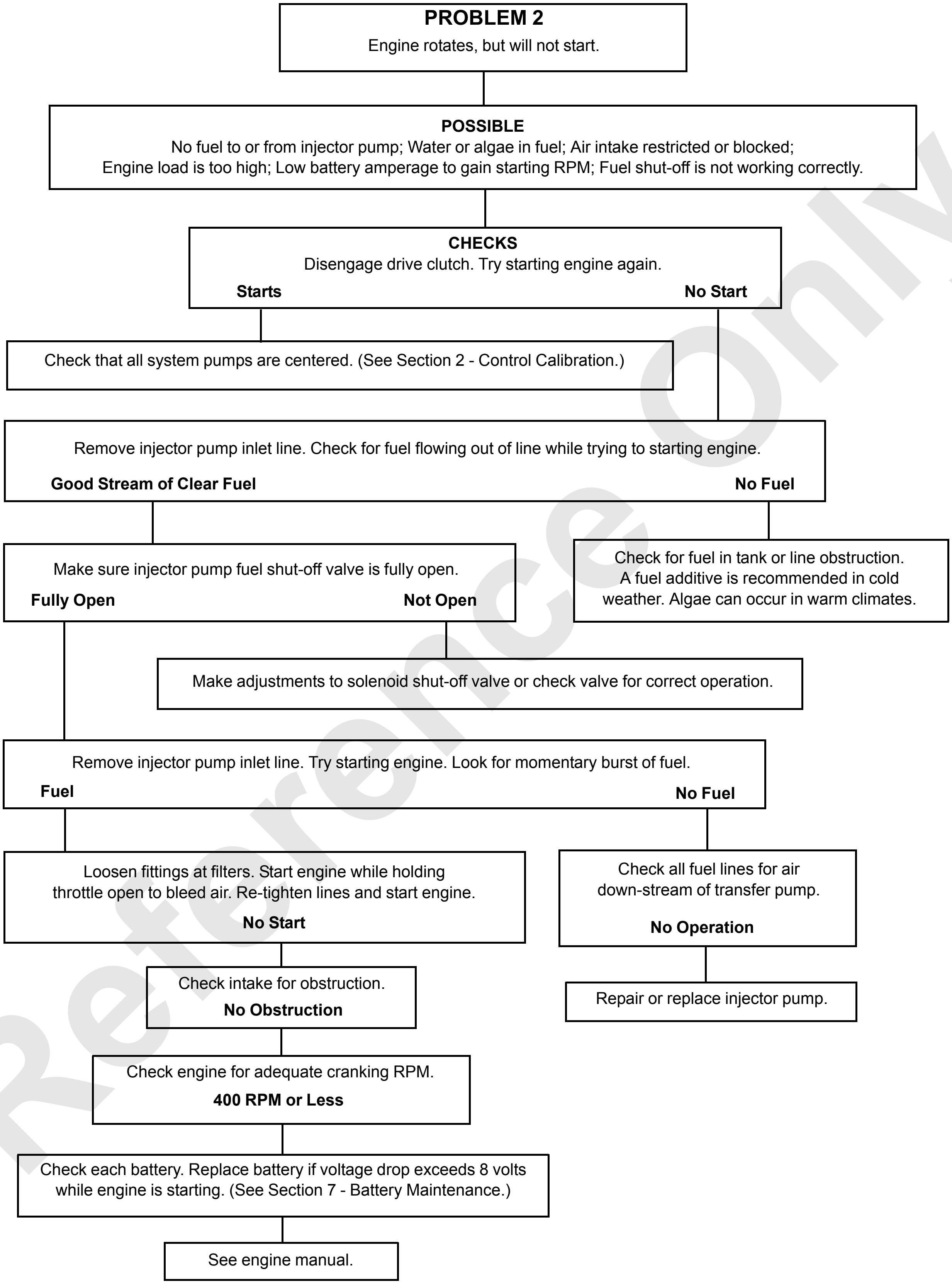
The following guidelines apply to all troubleshooting operations:

- Do not remove cylinders or counterbalance valve(s) from a cylinder until its 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 of 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 pump, motor, handle, brake, etc. components.
- Use the in-line test boards (available from the Manitowoc Crane Care Lattice Team) for further testing of computer nodes and electrical circuits.

TROUBLESHOOTING CHARTS

Troubleshooting Charts provide a series of flow charts that identify problems that could be encountered 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 that should be performed to move through the complete troubleshooting procedure. If directed, consult your Manitowoc dealer or the Manitowoc Crane Care Lattice Team before proceeding.




PROBLEM 2
Engine rotates, but will not start.
POSSIBLE
No fuel to or from injector pump; Water or algae in 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 drive clutch. Try starting engine again.
Starts
No Start
Check that all system pumps are centered. (See Section 2 - Control Calibration.)
Remove injector pump inlet line. Check for fuel flowing out of line while trying to starting engine.
Good Stream of Clear Fuel
No Fuel
Make sure injector pump fuel shut-off valve is fully open.
Fully Open
Not Open
Check for fuel in tank or line obstruction.
A fuel additive is recommended in cold
weather. Algae can occur in warm climates.
Make adjustments to solenoid shut-off valve or check valve for correct operation.
Remove injector pump inlet line. Try starting engine. Look for momentary burst of fuel.
Fuel
No Fuel
Loosen fittings at filters. Start engine while holding
throttle open to bleed air. Re-tighten lines and start engine.
No Start
Check all fuel lines for air
down-stream of transfer pump.
No Operation
Check intake for obstruction.
No Obstruction
Repair or replace injector pump.
Check engine for adequate cranking RPM.
400 RPM or Less
Check each battery. Replace battery if voltage drop exceeds 8 volts
while engine is starting. (See Section 7 - Battery Maintenance.)
See engine manual.

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PROBLEM 3

Engine runs, but no hydraulic operation.

POSSIBLE CAUSES

Clutch not engaged; No hydraulic fluid in tank; Blocked charge inlet to pumps; Clogged tank vent; Drive train damaged from flywheel to pump mount.

CHECKS

Check hydraulic filter service shut-off valve.

Ok **Not Ok**

Check clutch engagement.

Clutch Engaged **Clutch not Engaged**

Open filter service shut-off valve or replace filters if necessary.

Engage clutch.

Remove check vent, fluid level, and viscosity. In extreme cold conditions, oil may not flow freely to pump inlets causing pump cavitation.

Tank Vent, Oil Level, Viscosity Ok **Not Ok**

Make sure all brakes are applied and swing lock (past production) is in place. Check manual override on two or more pumps. (See Section 2 - Manual Override Tests.) Does engine load when manual override is applied?

Pump Loads **Pump does not Load**

Service hydraulic system.

Check electrical input from controller to pump. (See Section 3 - Checking Electrical Inputs/Outputs.)

Consult Manitowoc dealer or Crane Care Lattice Team.

PROBLEM 4

Engine runs, but 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 voltmeter between alternator 28-volt terminal and ground terminal.
Take reading with cab power ON and engine running.

Zero Volts DC

Repair wiring or connections.

28 Volts DC or less

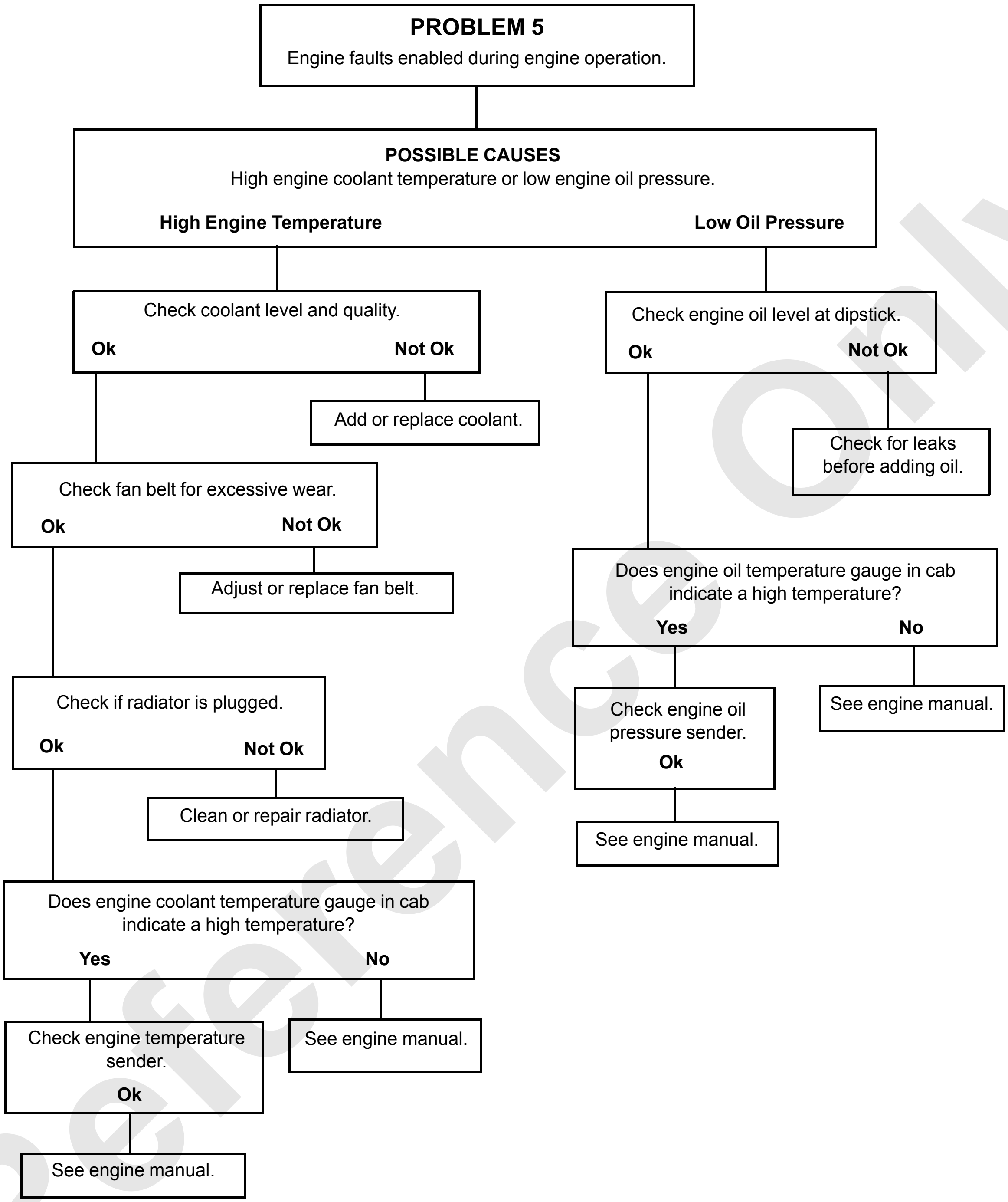
Replace alternator.

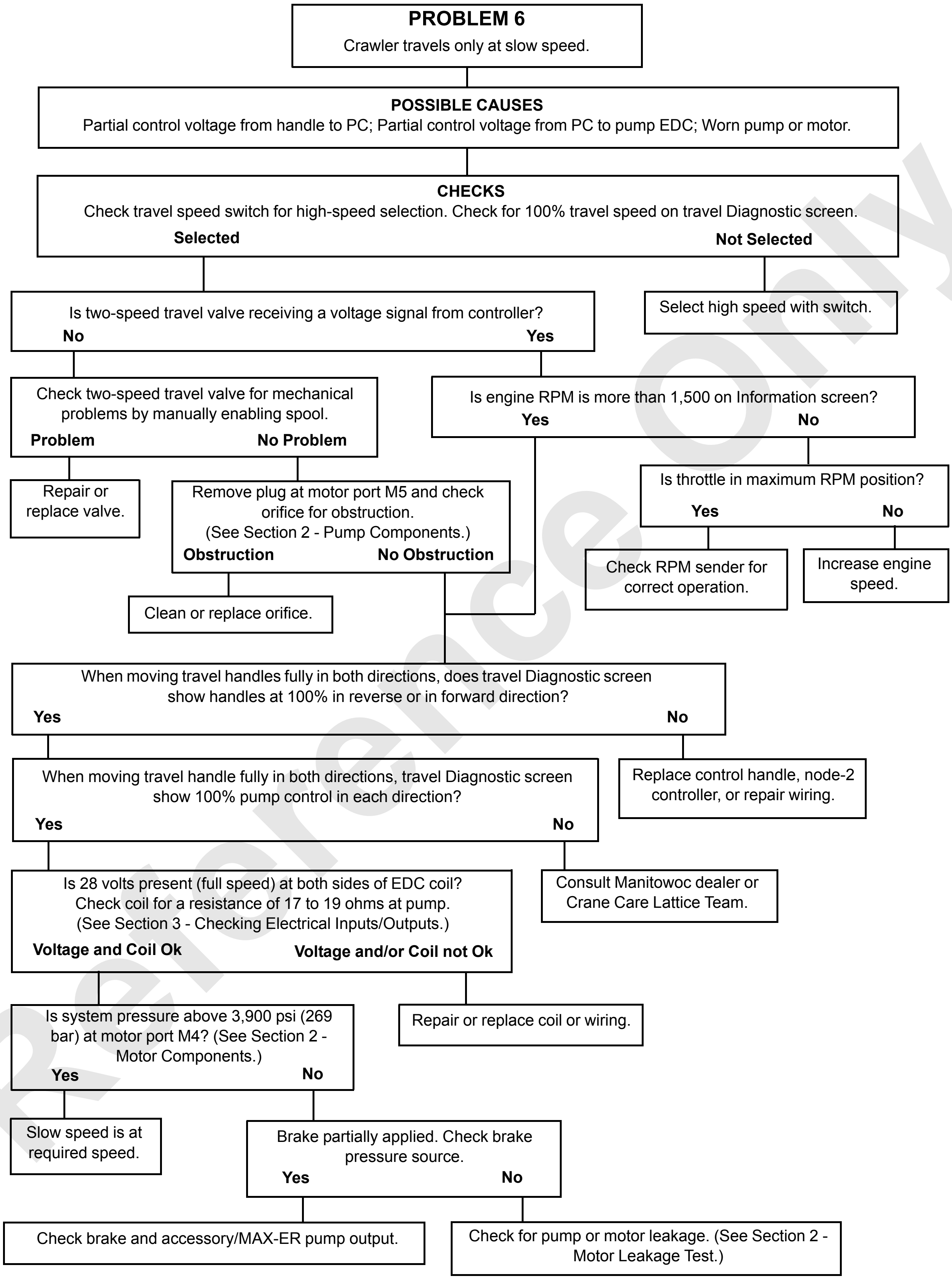
20.8 Volts DC or more

Test batteries for weak cells.
(See Section 7 - Battery Maintenance.)

Not Ok

Tighten drive belt or replace belt.


PROBLEM 5
Engine faults enabled during engine operation.
POSSIBLE CAUSES
High engine coolant temperature or low engine oil pressure.
High Engine Temperature
Low Oil Pressure
Check coolant level and quality.
Ok
Not Ok
Add or replace coolant.
Check fan belt for excessive wear.
Ok
Not Ok
Adjust or replace fan belt.
Check if radiator is plugged.
Ok
Not Ok
Clean or repair radiator.
Does engine coolant temperature gauge in cab indicate a high temperature?
Yes
No
Check engine temperature sender.
Ok
See engine manual.
See engine manual.
Check engine oil level at dipstick.
Ok
Not Ok
Check for leaks before adding oil.
Does engine oil temperature gauge in cab indicate a high temperature?
Yes
No
Check engine oil pressure sender.
Ok
See engine manual.
See engine manual.


PROBLEM 6
Crawler travels only at slow speed.
POSSIBLE CAUSES
Partial control voltage from handle to PC; Partial control voltage from PC to pump EDC; Worn pump or motor.
CHECKS
Check travel speed switch for high-speed selection. Check for 100% travel speed on travel Diagnostic screen.
Selected
Not Selected
Is two-speed travel valve receiving a voltage signal from controller?
No
Yes
Select high speed with switch.
Check two-speed travel valve for mechanical problems by manually enabling spool.
Problem
No Problem
Is engine RPM is more than 1,500 on Information screen?
Yes
No
Repair or replace valve.
Remove plug at motor port M5 and check orifice for obstruction. (See Section 2 - Pump Components.)
Obstruction
No Obstruction
Is throttle in maximum RPM position?
Yes
No
Check RPM sender for correct operation.
Increase engine speed.
Clean or replace orifice.
When moving travel handles fully in both directions, does travel Diagnostic screen show handles at 100% in reverse or in forward direction?
Yes
No
When moving travel handle fully in both directions, travel Diagnostic screen show 100% pump control in each direction?
Yes
No
Replace control handle, node-2 controller, or repair wiring.
Is 28 volts present (full speed) at both sides of EDC coil? Check 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 Manitowoc dealer or Crane Care Lattice Team.
Is system pressure above 3,900 psi (269 bar) at motor port M4? (See Section 2 - Motor Components.)
Yes
No
Repair or replace coil or wiring.
Slow speed is at required speed.
Brake partially applied. Check brake pressure source.
Yes
No
Check brake and accessory/MAX-ER pump output.
Check for pump or motor leakage. (See Section 2 - Motor Leakage Test.)

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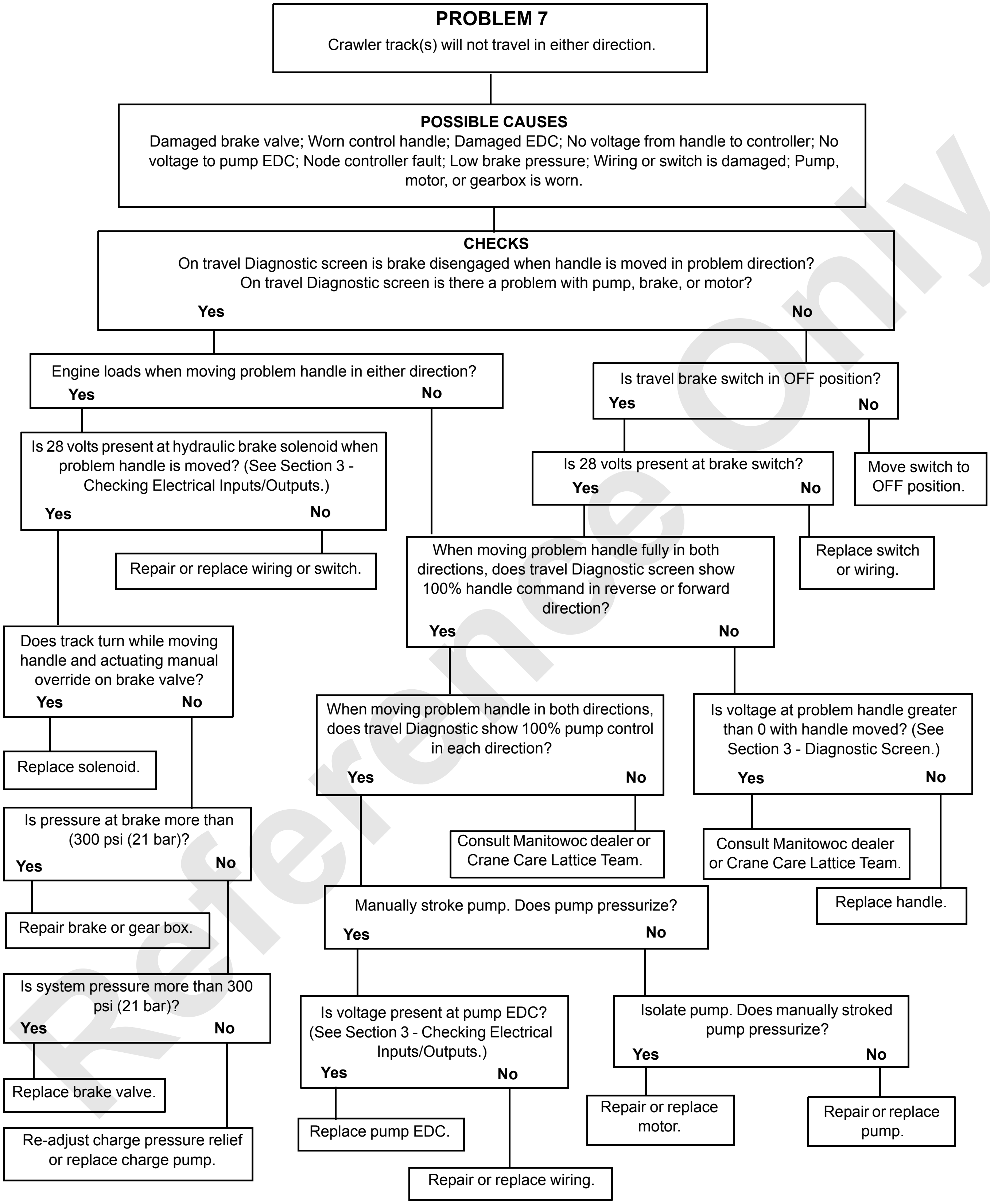
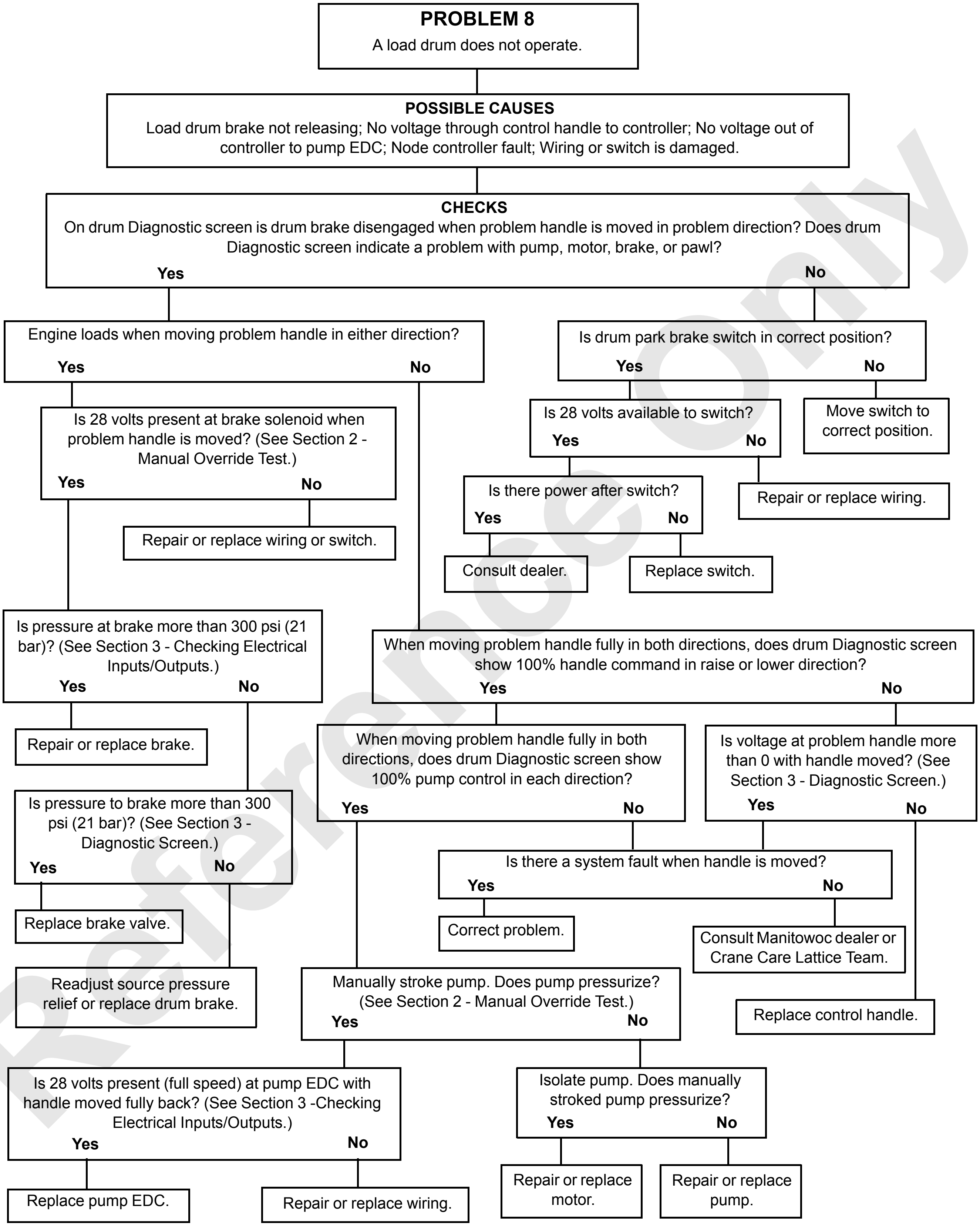

PROBLEM 7
Crawler track(s) will not travel in either direction.
POSSIBLE CAUSES
Damaged brake valve; Worn control handle; Damaged EDC; No voltage from handle to controller; No voltage to pump EDC; Node controller fault; Low brake pressure; Wiring or switch is damaged; Pump, motor, or gearbox is worn.
CHECKS
On travel Diagnostic screen is brake disengaged when handle is moved in problem direction?
On travel Diagnostic screen is there a problem with pump, brake, or motor?
Yes
No
Engine loads when moving problem handle in either direction?
Yes
No
Is 28 volts present at hydraulic brake solenoid when problem handle is moved? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Repair or replace wiring or switch.
Does track turn while moving handle and actuating manual override on brake valve?
Yes
No
Replace solenoid.
Is pressure at brake more than (300 psi (21 bar)?
Yes
No
Repair brake or gear box.
Is system pressure more than 300 psi (21 bar)?
Yes
No
Replace brake valve.
Re-adjust charge pressure relief or replace charge pump.
Is travel brake switch in OFF position?
Yes
No
Move switch to OFF position.
Is 28 volts present at brake switch?
Yes
No
Replace switch or wiring.
When moving problem handle fully in both directions, does travel Diagnostic screen show 100% handle command in reverse or forward direction?
Yes
No
When moving problem handle in both directions, does travel Diagnostic show 100% pump control in each direction?
Yes
No
Consult Manitowoc dealer or Crane Care Lattice Team.
Is voltage at problem handle greater than 0 with handle moved? (See Section 3 - Diagnostic Screen.)
Yes
No
Consult Manitowoc dealer or Crane Care Lattice Team.
Replace handle.
Manually stroke pump. Does pump pressurize?
Yes
No
Is voltage present at pump EDC? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Replace pump EDC.
Repair or replace wiring.
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Repair or replace motor.
Repair or replace pump.


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 drum Diagnostic screen is drum brake disengaged when problem handle is moved in problem direction? Does drum Diagnostic screen indicate a problem with pump, motor, brake, or pawl?
Yes
No
Engine loads when moving problem handle in either direction?
Yes
No
Is drum park brake switch in correct position?
Yes
No
Is 28 volts present at brake solenoid when problem handle is moved? (See Section 2 - Manual Override Test.)
Yes
No
Is 28 volts available to switch?
Yes
No
Move switch to correct position.
Is there power after switch?
Yes
No
Repair or replace wiring.
Repair or replace wiring or switch.
Consult dealer.
Replace switch.
Is pressure at brake more than 300 psi (21 bar)? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
When moving problem handle fully in both directions, does drum Diagnostic screen show 100% handle command in raise or lower direction?
Yes
No
Repair or replace brake.
When moving problem handle fully in both directions, does drum Diagnostic screen show 100% pump control in each direction?
Yes
No
Is voltage at problem handle more than 0 with handle moved? (See Section 3 - Diagnostic Screen.)
Yes
No
Is pressure to brake more than 300 psi (21 bar)? (See Section 3 - Diagnostic Screen.)
Yes
No
Is there a system fault when handle is moved?
Yes
No
Replace brake valve.
Correct problem.
Consult Manitowoc dealer or Crane Care Lattice Team.
Readjust source pressure relief or replace drum brake.
Manually stroke pump. Does pump pressurize? (See Section 2 - Manual Override Test.)
Yes
No
Replace control handle.
Is 28 volts present (full speed) at pump EDC with handle moved fully back? (See Section 3 -Checking Electrical Inputs/Outputs.)
Yes
No
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Replace pump EDC.
Repair or replace wiring.
Repair or replace motor.
Repair or replace pump.

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PROBLEM 9

Load drum will not raise load, but will lower 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 applicable switch or handle is enabled is 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**

Does drum Diagnostic screen show 100% handle command with handle moved back?

Yes **No**

Check for problem and repair limit switch operation, wiring, or circuit breaker.

Repair or replace control handle/wiring.

Does drum Diagnostic screen show 100% pump control with handle moved back?

Yes **No**

Consult Manitowoc dealer or Crane Care Lattice Team.

Is 28 volts present (full speed) at pump EDC with handle moved fully back? (See Section 3 - Checking Electrical Inputs/Outputs.)

Yes **No**

Replace pump EDC or replace pump.

Repair or replace wiring.

PROBLEM 10

Load drum will not lower load, but will raise load.

POSSIBLE CAUSES

Pawl in; Control handle is worn; Minimum bail limit opened; Pump is damaged; Speed sender is damaged.

CHECKS

When applicable switch or handle is enabled is 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**

Any of the above displayed: Check for problem. Repair limit switch, wiring, or circuit breaker.

None of the above displayed: Does drum Diagnostic screen show 100% handle command with handle moved forward?

Yes **No**

No: Replace control handle or repair wiring.

Yes: Does drum Diagnostic screen show 100% pump control with handle moved forward?

Yes **No**

No: Consult Manitowoc dealer or Crane Care Lattice Team.

Yes: Is 28 volts present (full speed) at pump EDC with handle moved back? (See Section 3 - Checking Electrical Inputs/Outputs.)

Yes **No**

Yes: Replace EDC or replace pump.

No: Repair or replace wiring.

PROBLEM 11

Load drum will not reach load drum maximum speed.

POSSIBLE CAUSES

Partial control from handle to controller; Partial control voltage from controller to pump EDC or motor PCP; Damaged pump or motor.

CHECKS

Check selected load drum speed screen for 100% speed selected.

Yes

No

Make proper adjustment.

When moving problem handle fully in both directions, does drum Diagnostic screen show 100% handle command in raise or lower direction?

Yes

No

Replace control handle or repair wiring.

When moving load drum handle fully in both directions, does drum Diagnostic screen show 100% pump or motor control in each direction?

Yes

No

Consult Manitowoc dealer or Crane Care Lattice Team.

is 28 volts present (full speed) and coil resistance of 17 to 19 ohms at 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 coil or wiring.

Remove plug at motor port M5 and check orifice for obstruction. (See Section 2 - Motor Components.)

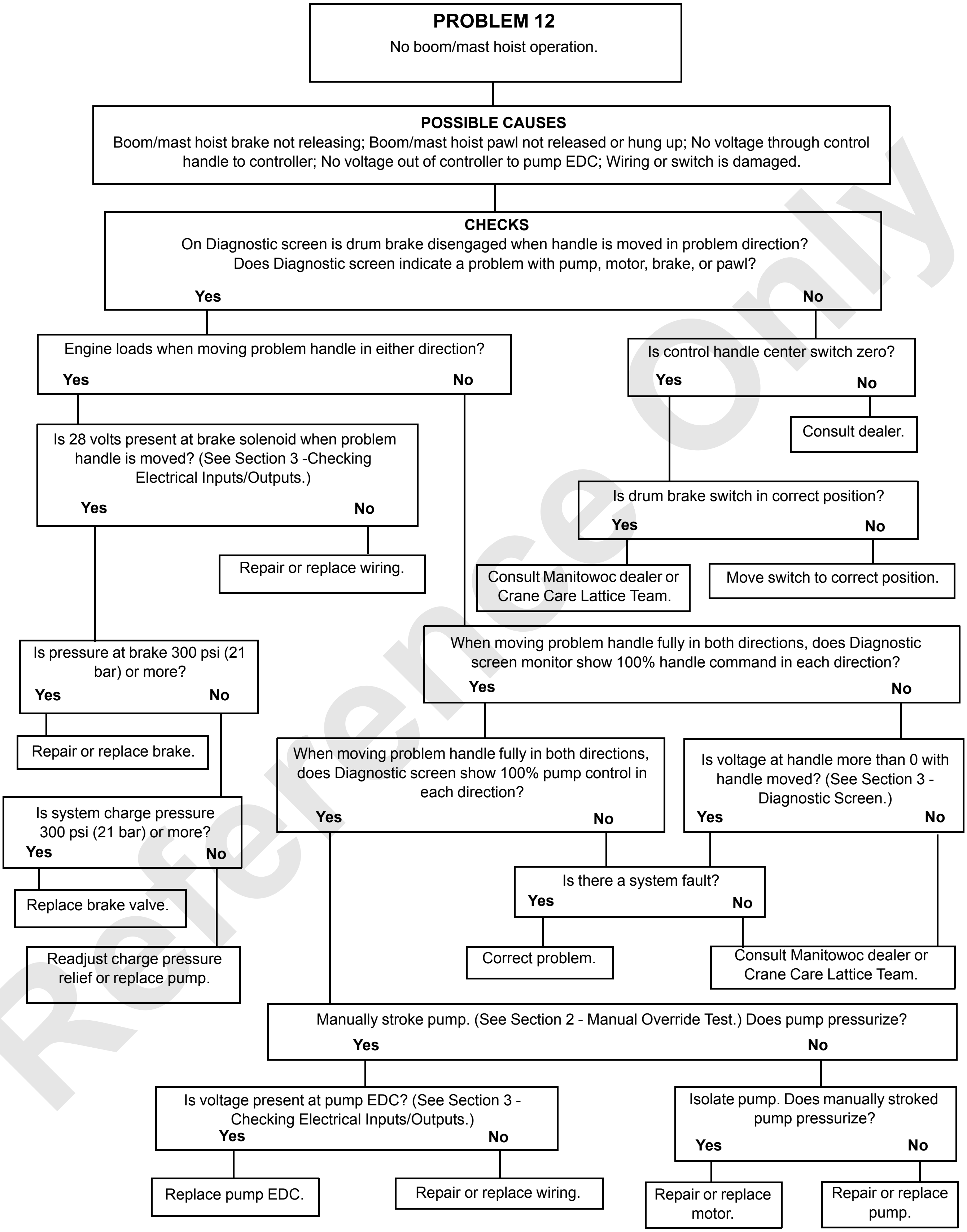
Obstruction

No Obstruction

Clean or replace orifice.

Check pump and motor for leakage. (See Section 2 - Motor Leakage Test.)

Repair or replace pump or motor.


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 control handle to controller; No voltage out of controller to pump EDC; Wiring or switch is damaged.
CHECKS
On Diagnostic screen is drum brake disengaged when handle is moved in problem direction?
Does Diagnostic screen indicate a problem with pump, motor, brake, or pawl?
Yes
No
Engine loads when moving problem handle in either direction?
Yes
No
Is control handle center switch zero?
Yes
No
Consult dealer.
Is 28 volts present at brake solenoid when problem handle is moved? (See Section 3 -Checking Electrical Inputs/Outputs.)
Yes
No
Repair or replace wiring.
Is drum brake switch in correct position?
Yes
No
Consult Manitowoc dealer or Crane Care Lattice Team.
Move switch to correct position.
Is pressure at brake 300 psi (21 bar) or more?
Yes
No
Repair or replace brake.
When moving problem handle fully in both directions, does Diagnostic screen monitor show 100% handle command in each direction?
Yes
No
Is system charge pressure 300 psi (21 bar) or more?
Yes
No
Replace brake valve.
Readjust charge pressure relief or replace pump.
When moving problem handle fully in both directions, does Diagnostic screen show 100% pump control in each direction?
Yes
No
Is voltage at handle more than 0 with handle moved? (See Section 3 - Diagnostic Screen.)
Yes
No
Is there a system fault?
Yes
No
Correct problem.
Consult Manitowoc dealer or Crane Care Lattice Team.
Manually stroke pump. (See Section 2 - Manual Override Test.) Does pump pressurize?
Yes
No
Is voltage present at pump EDC? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Replace pump EDC.
Repair or replace wiring.
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Repair or replace motor.
Repair or replace pump.

PROBLEM 13

Boom/mast hoist will not reach maximum speed.

POSSIBLE CAUSES

Partial control voltage from handle to controller; Partial control voltage from controller to pump EDC; Motor controller in low; Pump or motor damaged.

CHECKS

Check boom/mast hoist drum speed screen for 100% reading.

Yes **No**

- No: Make proper adjustment.
- Yes: When moving boom/mast hoist control handle fully in both directions, does Diagnostic screen show 100% handle command in raise or lower direction?

Yes **No**

- No: Repair wiring/consult dealer.
- Yes: When moving boom/mast hoist control handle fully in both directions, does Diagnostic screen show 100% pump control in each direction?

Yes **No**

- No: Consult Manitowoc dealer or Crane Care Lattice Team.
- Yes: Check for control voltage and coil resistance of 17 to 19 ohms at 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**

- Voltage and/or Coil not Ok: Repair or replace coil or wiring.
- Voltage and Coil Ok: Remove plug at motor port M5 and check orifice for obstructions. (See Section 2 - Motor Components.)

Obstruction **No Obstruction**

- Obstruction: Clean or replace orifice.
- No Obstruction: Check for pump and motor leakage. (See Section 2 - Motor Leakage Test.)

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PROBLEM 14

Boom will not boom up, but will boom down.

POSSIBLE CAUSES

Boom maximum up limit opened; Pump is damaged; Equalizer/boom stop limit opened; Control handle is worn.

CHECKS

When 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 problem. Repair limit switch, wiring, or circuit breaker.

None of the above displayed: When moving boom/mast hoist handle fully back, does Diagnostic screen show 100% handle command in raise direction?

- **No**: Replace control handle.
- **Yes**: Does Diagnostic screen read 100% pump control with handle moved back?
  - **No**: Consult Manitowoc dealer or Crane Care Lattice Team.
  - **Yes**: Is 28 volts present (full speed) at pump EDC when control handle is moved back? (See Section 3 - Checking Electrical Inputs/Outputs.)
    - **No**: Repair or replace wiring.
    - **Yes**: Does pump charge pressure at charge pressure port drop to 247 psi (17 bar) or less when booming up?
      - **Yes**: Repair or replace pump.
      - **No**: Replace pump EDC.

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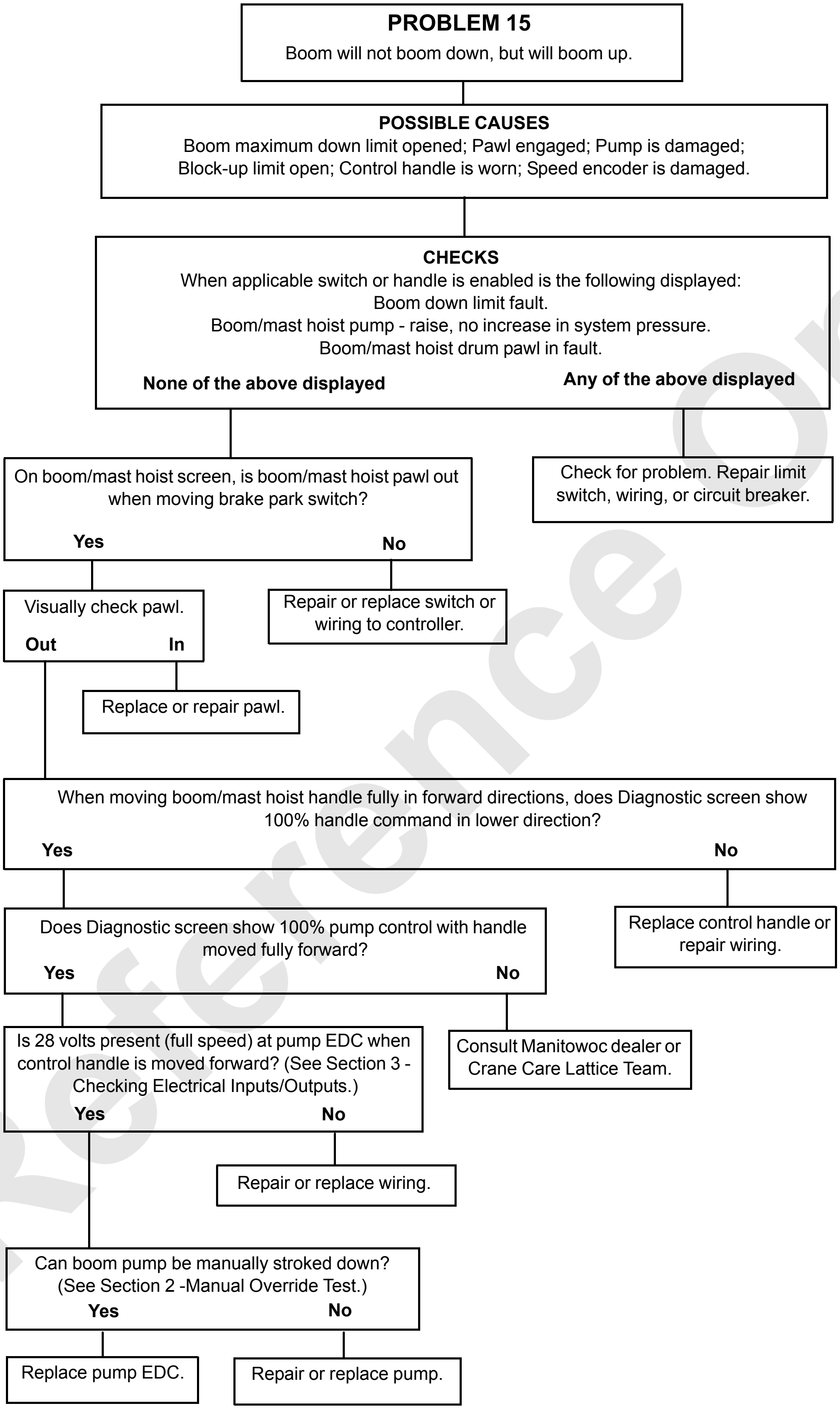
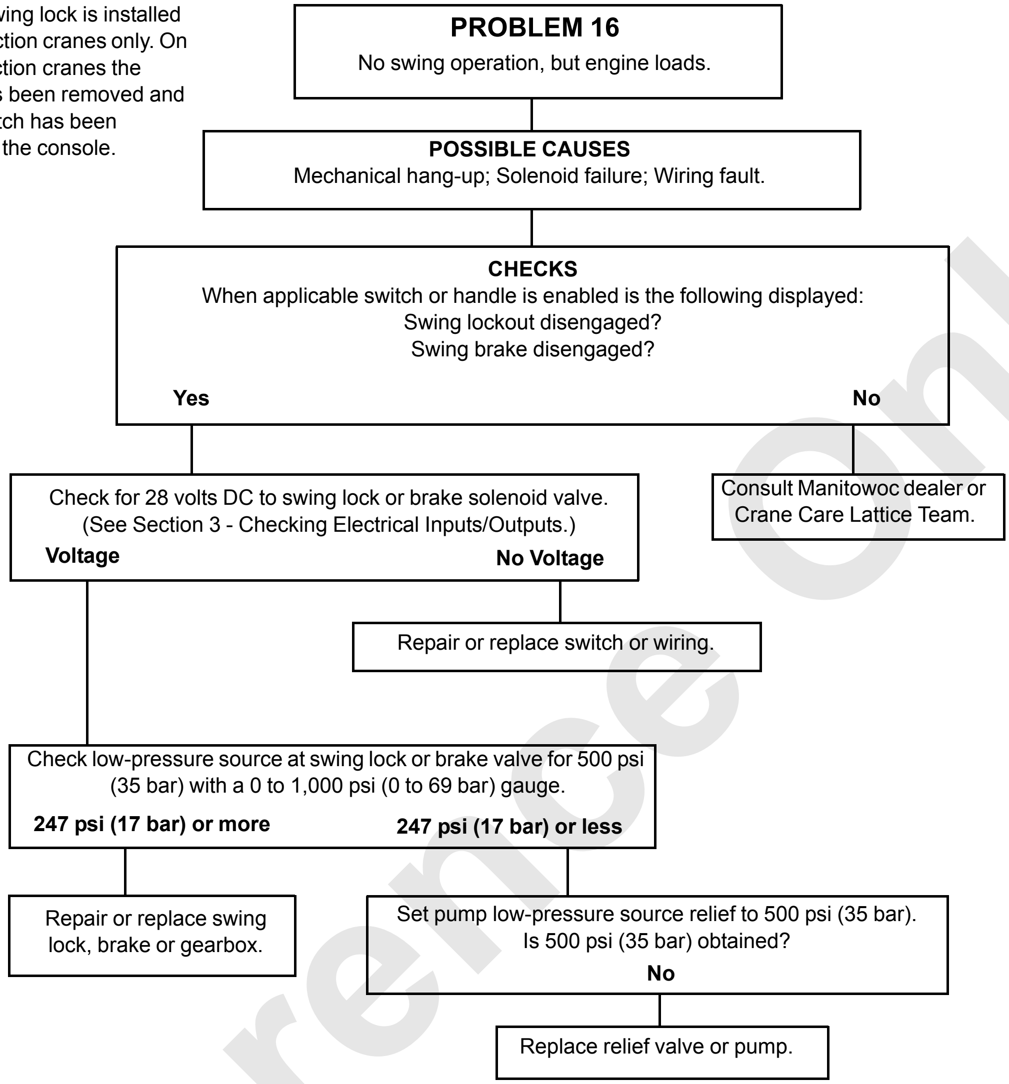

PROBLEM 15
Boom will not boom down, but will boom up.
POSSIBLE CAUSES
Boom maximum down limit opened; Pawl engaged; Pump is damaged; Block-up limit open; Control handle is worn; Speed encoder is damaged.
CHECKS
When applicable switch or handle is enabled is the following displayed:
Boom down limit fault.
Boom/mast hoist pump - raise, no increase in system pressure.
Boom/mast hoist drum pawl in fault.
None of the above displayed
Any of the above displayed
On boom/mast hoist screen, is boom/mast hoist pawl out when moving brake park switch?
Yes
No
Check for problem. Repair limit switch, wiring, or circuit breaker.
Visually check pawl.
Out
In
Repair or replace switch or wiring to controller.
Replace or repair pawl.
When moving boom/mast hoist handle fully in forward directions, does Diagnostic screen show 100% handle command in lower direction?
Yes
No
Does Diagnostic screen show 100% pump control with handle moved fully forward?
Yes
No
Replace control handle or repair wiring.
Is 28 volts present (full speed) at pump EDC when control handle is moved forward? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Consult Manitowoc dealer or Crane Care Lattice Team.
Repair or replace wiring.
Can boom pump be manually stroked down? (See Section 2 -Manual Override Test.)
Yes
No
Replace pump EDC.
Repair or replace pump.

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 17

No swing operation, engine does not load.

POSSIBLE CAUSES

No voltage through control handle to controller; No voltage out of controller to pump EDC; Wiring or switch is damaged; Node Damaged; Damaged pump or motor; Swing holding brake switch actuated.

CHECKS

On swing Diagnostic screen is brake disengaged when handle is moved in problem direction? Does Diagnostic screen indicate a problem with pump, brake, swing lock in, or swing lock out (see NOTE below)?

Yes **No**

Is swing handle center switch closed? Does handle voltage on Diagnostic screen go to 0 when handle is moved to neutral?

Yes **No**

Check for 28 volts from swing brake switch. (See Section 3 - Checking Electrical Inputs/Outputs.)

Yes **No**

When handle is enabled, does handle percent change?

Yes **No**

Is there voltage to swing handle?

Yes **No**

Repair or replace wiring, node, or contact service.

Consult Manitowoc dealer or Crane Care Lattice Team.

Replace switch.

When moving applicable handle fully in both directions, does Diagnostic screen show 100% handle command in left or right direction?

Yes **No**

Replace control handle or repair wiring.

Consult Manitowoc dealer or Crane Care Lattice Team.

Replace control handle or repair wiring.

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.

Check wiring connector at pump EDC.

Ok **Not Ok**

Tighten or repair connector.

Manually stroke swing pump. (See Section 2 - Manual Override Test.) Does bed rotate?

Yes **No**

Is voltage present at pump EDC? (See Section 3 - Checking Electrical Inputs/Outputs.)

Yes **No**

Is system pressurized?

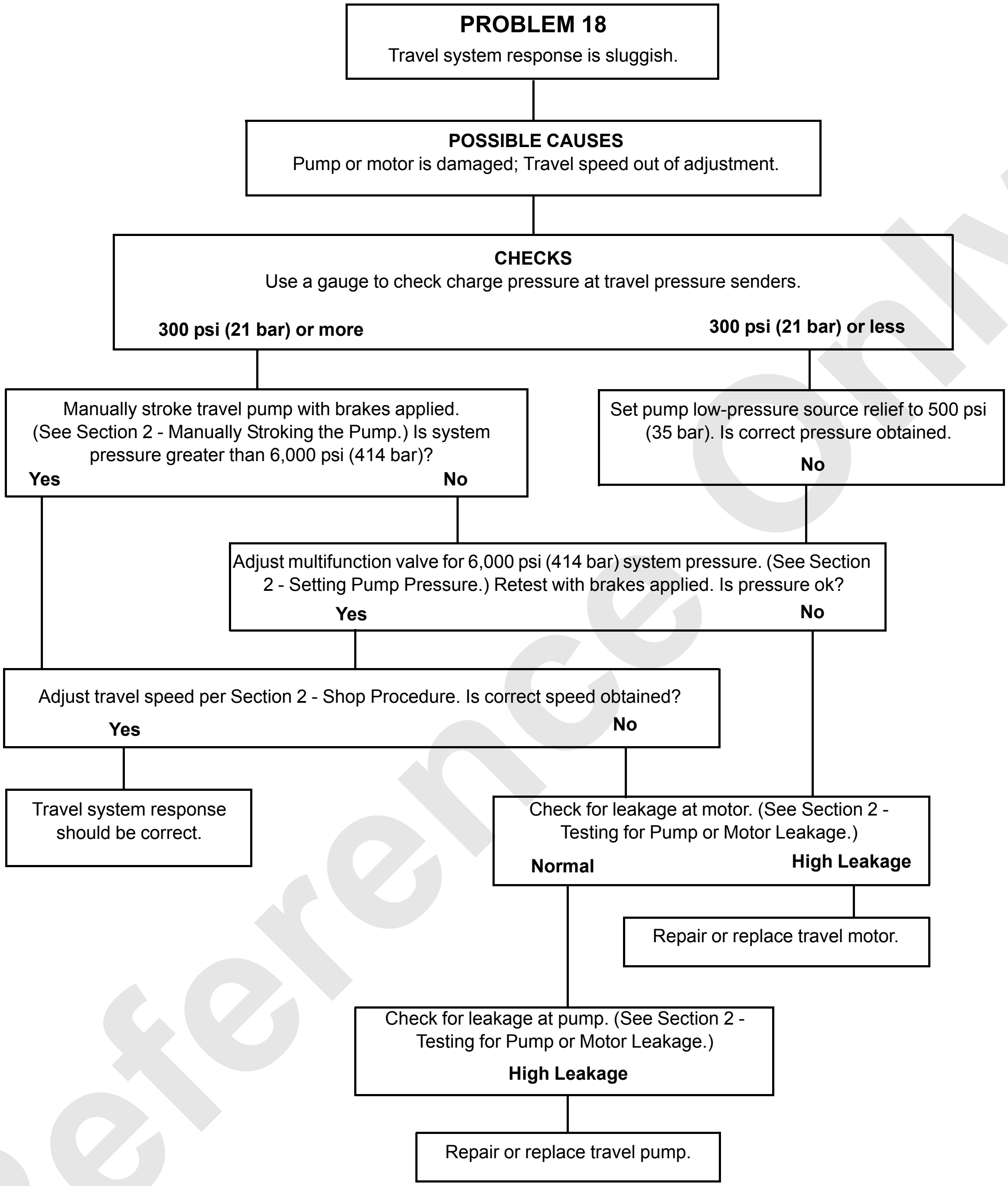
Yes **No**

Replace pump EDC.

Repair or replace wiring.

Repair or replace motor.

Repair or replace pump.


PROBLEM 18
Travel system response is sluggish.
POSSIBLE CAUSES
Pump or motor is damaged; Travel speed out of adjustment.
CHECKS
Use a gauge to check charge pressure at travel pressure senders.
300 psi (21 bar) or more
300 psi (21 bar) or less
Manually stroke travel pump with brakes applied. (See Section 2 - Manually Stroking the Pump.) Is system pressure greater than 6,000 psi (414 bar)?
Yes
No
Set pump low-pressure source relief to 500 psi (35 bar). Is correct pressure obtained.
No
Adjust multifunction valve for 6,000 psi (414 bar) system pressure. (See Section 2 - Setting Pump Pressure.) Retest with brakes applied. Is pressure ok?
Yes
No
Adjust travel speed per Section 2 - Shop Procedure. Is 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 travel motor.
Check for leakage at pump. (See Section 2 - Testing for Pump or Motor Leakage.)
High Leakage
Repair or replace travel pump.

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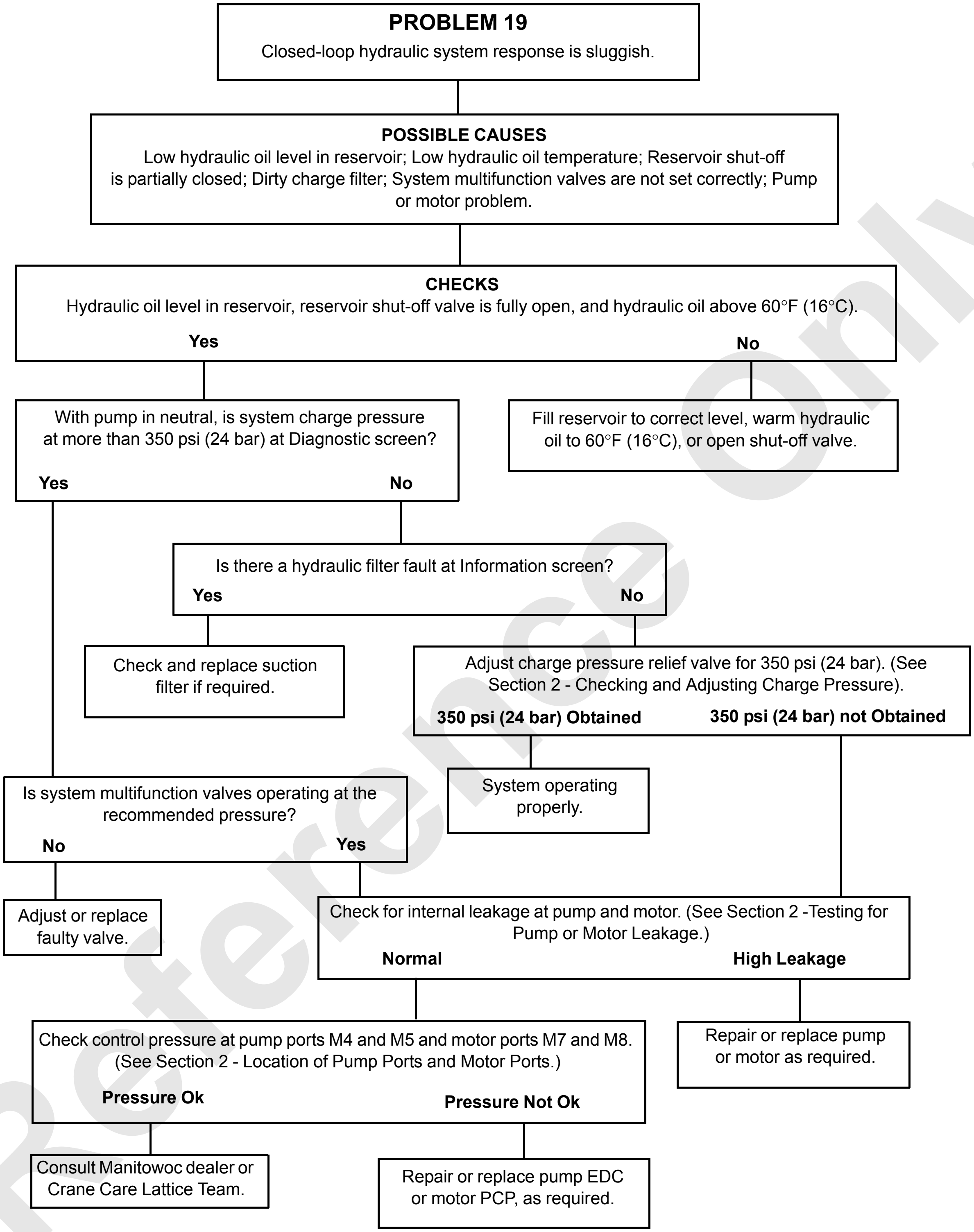
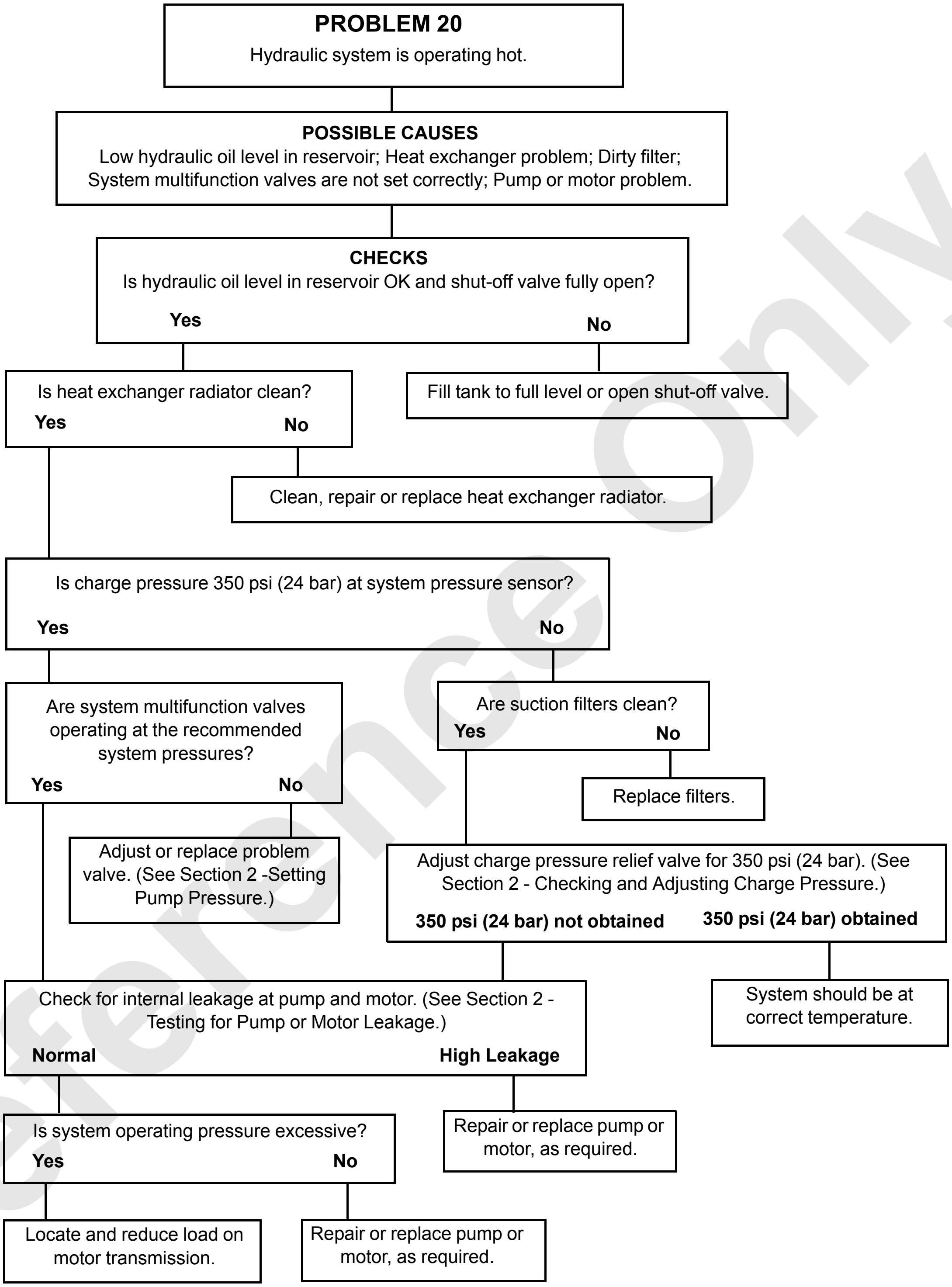

PROBLEM 19
Closed-loop hydraulic system response is sluggish.
POSSIBLE CAUSES
Low hydraulic oil level in reservoir; Low hydraulic oil temperature; Reservoir shut-off is partially closed; Dirty charge filter; System multifunction valves are not set correctly; Pump or motor problem.
CHECKS
Hydraulic oil level in reservoir, reservoir shut-off valve is fully open, and hydraulic oil above 60°F (16°C).
Yes
No
With pump in neutral, is system charge pressure at more than 350 psi (24 bar) at Diagnostic screen?
Yes
No
Fill reservoir to correct level, warm hydraulic oil to 60°F (16°C), or open shut-off valve.
Is there a hydraulic filter fault at Information screen?
Yes
No
Check and replace suction filter if required.
Adjust charge pressure relief valve for 350 psi (24 bar). (See Section 2 - Checking and Adjusting Charge Pressure).
350 psi (24 bar) Obtained
350 psi (24 bar) not Obtained
Is system multifunction valves operating at the recommended pressure?
No
Yes
System operating properly.
Adjust or replace faulty valve.
Check for internal leakage at pump and motor. (See Section 2 -Testing for Pump or Motor Leakage.)
Normal
High Leakage
Check control pressure at pump ports M4 and M5 and motor ports M7 and M8. (See Section 2 - Location of Pump Ports and Motor Ports.)
Pressure Ok
Pressure Not Ok
Repair or replace pump or motor as required.
Consult Manitowoc dealer or Crane Care Lattice Team.
Repair or replace pump EDC or motor PCP, as required.


PROBLEM 20
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 hydraulic oil level in reservoir OK and shut-off valve fully open?
Yes
No
Is heat exchanger radiator clean?
Yes
No
Fill tank to full level or open shut-off valve.
Clean, repair or replace heat exchanger radiator.
Is charge pressure 350 psi (24 bar) at system pressure sensor?
Yes
No
Are system multifunction valves operating at the recommended system pressures?
Yes
No
Are suction filters clean?
Yes
No
Replace filters.
Adjust or replace problem valve. (See Section 2 -Setting Pump Pressure.)
Adjust charge pressure relief valve for 350 psi (24 bar). (See Section 2 - Checking and Adjusting Charge Pressure.)
350 psi (24 bar) not obtained
350 psi (24 bar) obtained
Check for internal leakage at pump and motor. (See Section 2 - Testing for Pump or Motor Leakage.)
Normal
High Leakage
System should be at correct temperature.
Is system operating pressure excessive?
Yes
No
Repair or replace pump or motor, as required.
Locate and reduce load on motor transmission.
Repair or replace pump or motor, as required.

PROBLEM 21

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 Diagnostic screen show a percent for problem handle in neutral position?

Yes — Repair or replace system control handle or wiring.

No — With system handle in neutral does Diagnostic screen show command activity for pump?

- **Yes** — Consult Manitowoc dealer or Crane Care Lattice Team.
- **No** — Does system pump EDC manually return to neutral? (See Section 3 - Checking Electrical Inputs/Outputs.)
  - **Yes** — Adjust pump neutral. (See Section 2 - Pump Neutral Adjustment.)
    - Does system pump EDC manually return to neutral?
      - **No** — Replace system pump EDC.
  - **No** — Repair or replace system pump.

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PROBLEM 22

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 pawl linkage. Check for pawl or pawl actuator/cylinder for freedom of movement.

No Damage **Damage**

Repair damage. Test and adjust.

Move park brake switch to apply and release positions. Check drum Diagnostic screen for pawl in and pawl out positions when applicable function was enabled:

Drum 3 pawl in.
Drum 3 pawl out.
Boom/mast hoist pawl in.
Boom/mast hoist pawl out.

If pawl is not moving

Is there voltage applied to pawl valve? (See Section 3 - Checking Electrical Inputs/Outputs.)

Yes **No**

Check wiring.

When enabling problem pawl switch, check pawl cylinder for 350 psi (24 bar) or more at valve cylinder ports.

Pressure **No Pressure**

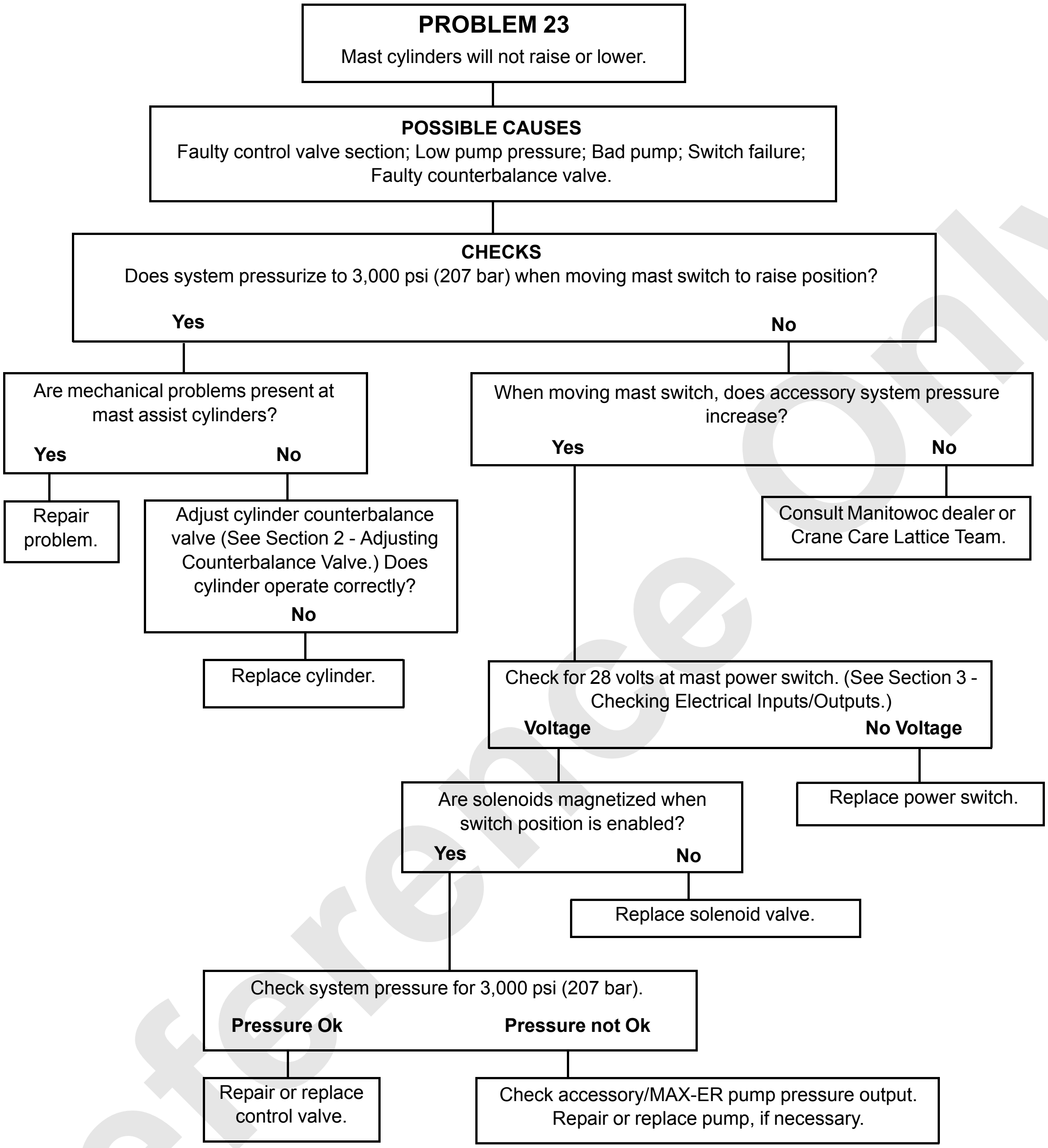
Check for binding or faulty cylinder.

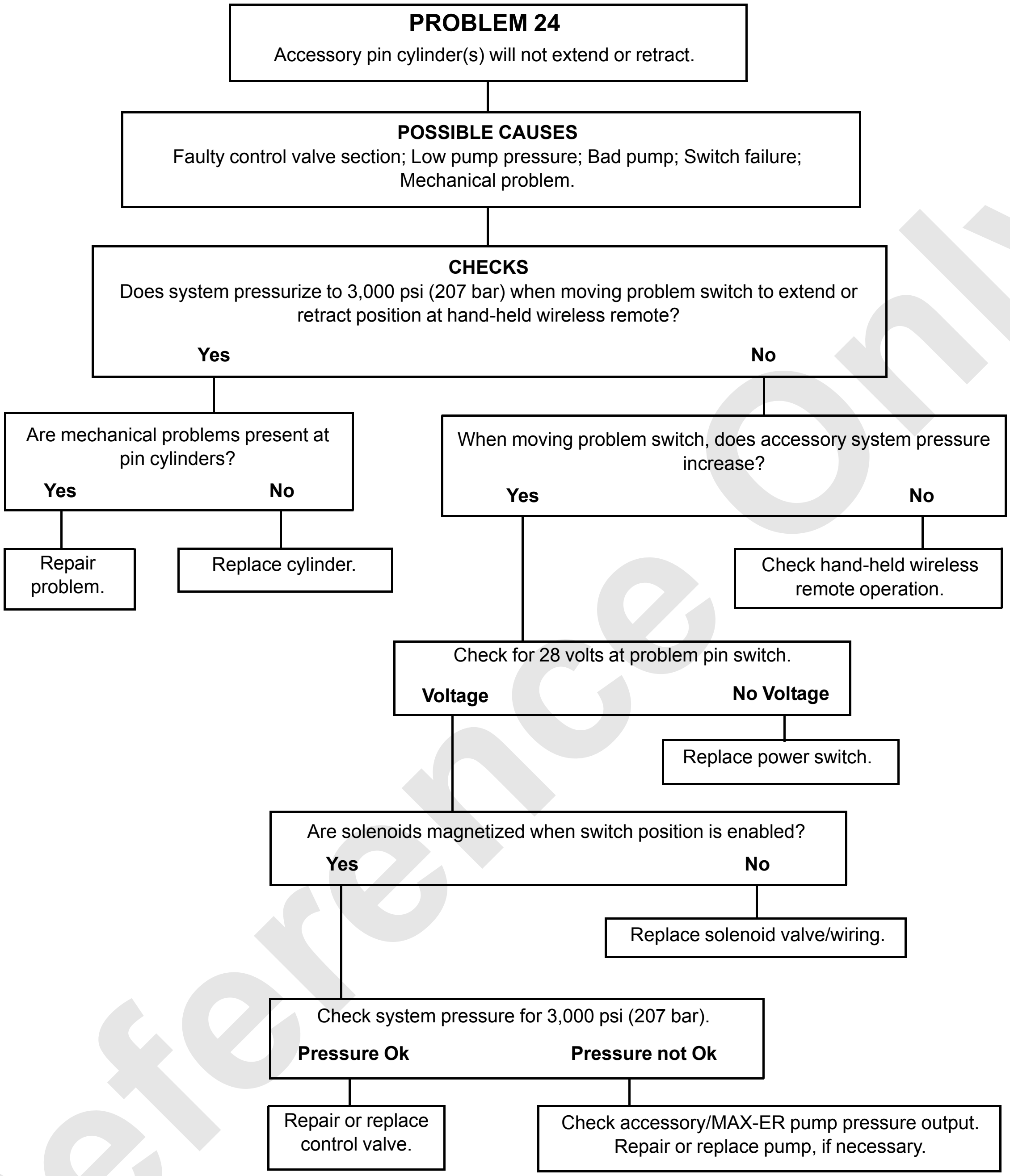
Repair or replace control valve.

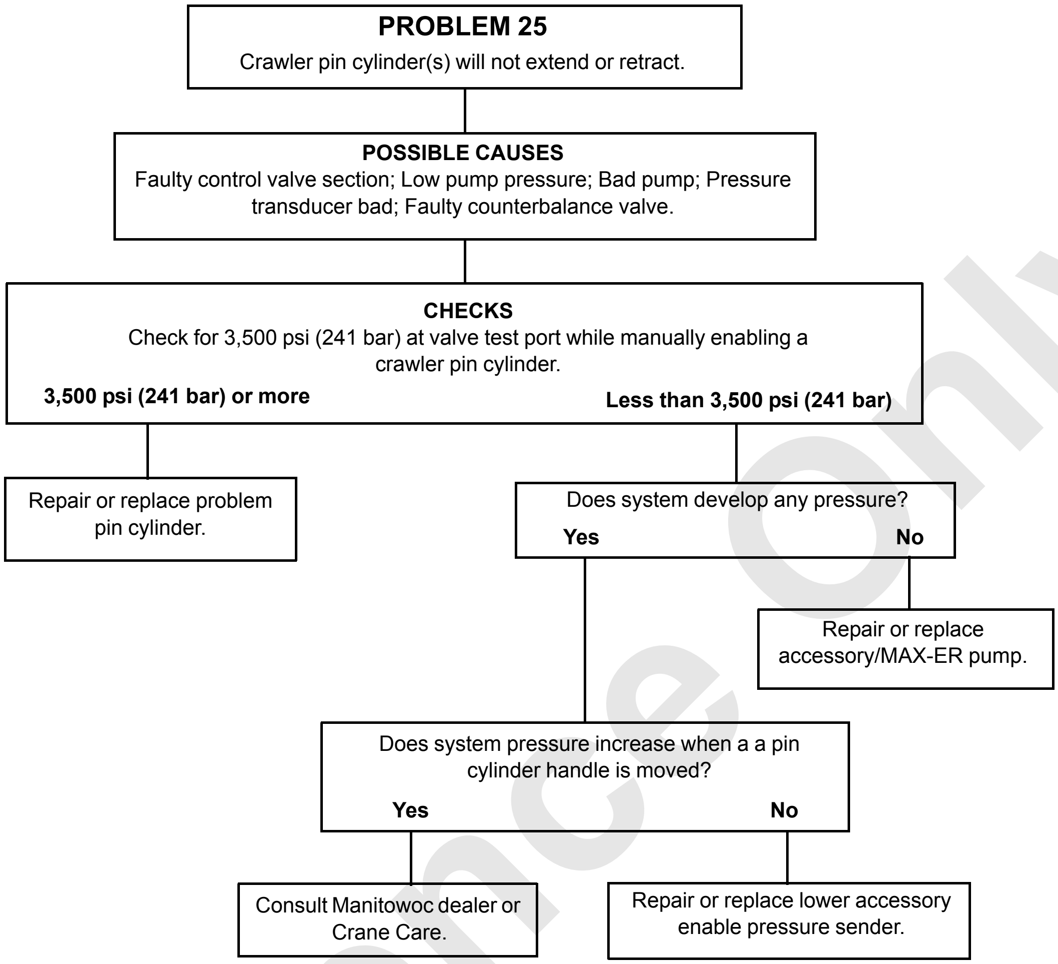
Readjust source charge pressure relief valve. Does this solve problem?

No

Repair or replace pump.


PROBLEM 23
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 system pressurize to 3,000 psi (207 bar) when moving mast switch to raise position?
Yes
No
Are mechanical problems present at mast assist cylinders?
Yes
No
Repair problem.
Adjust cylinder counterbalance valve (See Section 2 - Adjusting Counterbalance Valve.) Does cylinder operate correctly?
No
Replace cylinder.
When moving mast switch, does accessory system pressure increase?
Yes
No
Consult Manitowoc dealer or Crane Care Lattice Team.
Check for 28 volts at mast power switch. (See Section 3 - Checking Electrical Inputs/Outputs.)
Voltage
No Voltage
Replace power switch.
Are solenoids magnetized when switch position is enabled?
Yes
No
Replace solenoid valve.
Check system pressure for 3,000 psi (207 bar).
Pressure Ok
Pressure not Ok
Repair or replace control valve.
Check accessory/MAX-ER pump pressure output. Repair or replace pump, if necessary.


PROBLEM 24
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 system pressurize to 3,000 psi (207 bar) when moving problem switch to extend or retract position at hand-held wireless remote?
Yes
No
Are mechanical problems present at pin cylinders?
Yes
No
Repair problem.
Replace cylinder.
When moving problem switch, does accessory system pressure increase?
Yes
No
Check hand-held wireless remote operation.
Check for 28 volts at problem pin switch.
Voltage
No Voltage
Replace power switch.
Are solenoids magnetized when switch position is enabled?
Yes
No
Replace solenoid valve/wiring.
Check system pressure for 3,000 psi (207 bar).
Pressure Ok
Pressure not Ok
Repair or replace control valve.
Check accessory/MAX-ER pump pressure output. Repair or replace pump, if necessary.


PROBLEM 25
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 3,500 psi (241 bar) at valve test port while manually enabling a crawler pin cylinder.
3,500 psi (241 bar) or more
Less than 3,500 psi (241 bar)
Repair or replace problem pin cylinder.
Does system develop any pressure?
Yes
No
Repair or replace accessory/MAX-ER pump.
Does system pressure increase when a a pin cylinder handle is moved?
Yes
No
Consult Manitowoc dealer or Crane Care.
Repair or replace lower accessory enable pressure sender.

PROBLEM 26

Jacking 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 3,500 psi (241 bar) at valve test port while enabling jacking cylinder.

3,500 psi (241 bar) or more **Less than 3,500 psi (241 bar)**

Check for 3,500 psi (241 bar) at system test port while enabling another jacking cylinder.

3,500 psi (241 bar) or more

Exchange both counterbalance valve cartridges on problem jacking cylinder. Is cylinder enabled with handle movement?

Yes **No**

Replace counterbalance valve.

Repair or replace jacking cylinder.

Check for 28 volts at problem pin switch. (See Section 3 -Checking Electrical Inputs/Outputs.)

Voltage **No Voltage**

Replace power switch.

Are solenoids magnetized when switch position is enabled?

Yes **No**

Replace solenoid valve/wiring.

Check system pressure for 3,500 psi (241 bar).

Pressure Ok **Pressure not Ok**

Repair or replace control valve/wiring.

Check accessory/MAX-ER pump pressure output. Repair or replace pump, if necessary.

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ALPHABETICAL INDEX

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