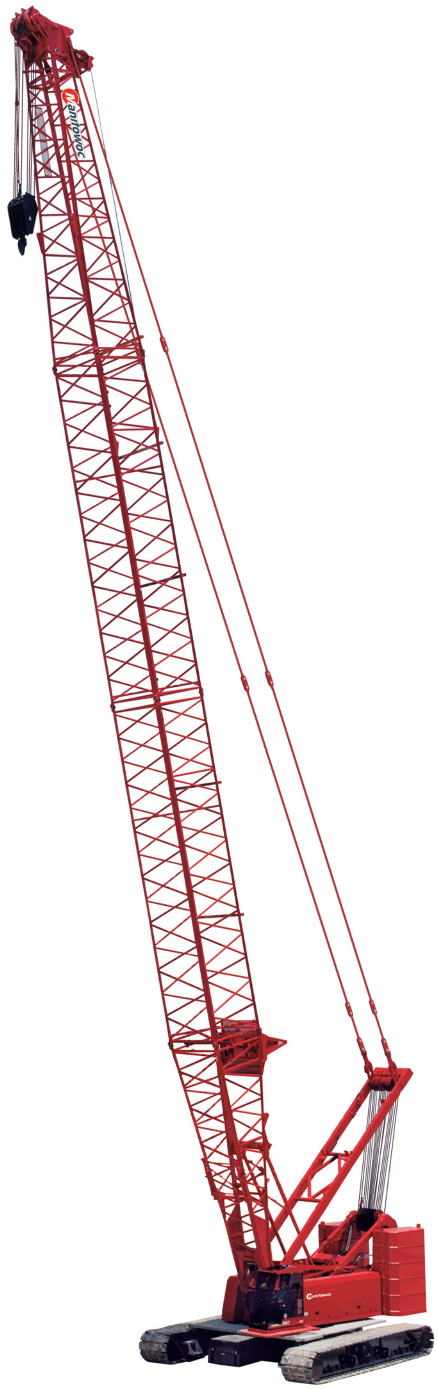
Manitowoc 14000

Service/Maintenance Manual



Grove Manitowoc National Crane Potain

Manitowoc

SERVICE/MAINTENANCE MANUAL

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

14000

Crane Model Number

14001Ref

Crane Serial Number

This manual is divided into the following sections:

NOTICE

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

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

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

⚠ WARNING

To prevent death or serious injury:

- Avoid unsafe operation and maintenance.

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

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

Published 09-05-14, Control # 226-02

1 2 3 4 5 6 7 8 9 10

THE ORIGINAL LANGUAGE OF THIS PUBLICATION IS ENGLISH

See end of this manual for Alphabetical Index

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SECTION 1
INTRODUCTION

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SECTION 1
INTRODUCTION

WARNING

California Proposition 65

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

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

California Spark Arrestor

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

CONTINUOUS INNOVATION

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

SAFETY MESSAGES

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

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 Service 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 must ***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 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 against dropping.
   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.

   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. Use a safety-type can with an automatic closing cap and flame arrestor for refueling.
18. Hydraulic oil can also be flammable. Do not smoke or allow open flames in area when filling hydraulic tanks.
19. Never handle wire rope with bare hands. Always wear heavy-duty gloves to prevent being cut by broken wires.
20. Use extreme care when handling coiled pendants. Stored energy can cause coiled pendants to uncoil quickly with considerable force.
21. When inflating tires, use a tire cage, a clip-on inflator, and an extension hose which permits standing well away from tire.
22. Only use cleaning solvents which are non-volatile and non-flammable.
23. Do not attempt to lift heavy components by hand. Use a hoist, jacks, or blocking to lift components.

24. 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.

25. To prevent damage to crane parts (bearings, cylinders, swivels, slewing ring, computers, etc.), perform 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).

26. 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.

27. 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.

28. 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.

29. ***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.

30. 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.

31. Do not store flammable materials on crane.

32. 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.

33. 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.

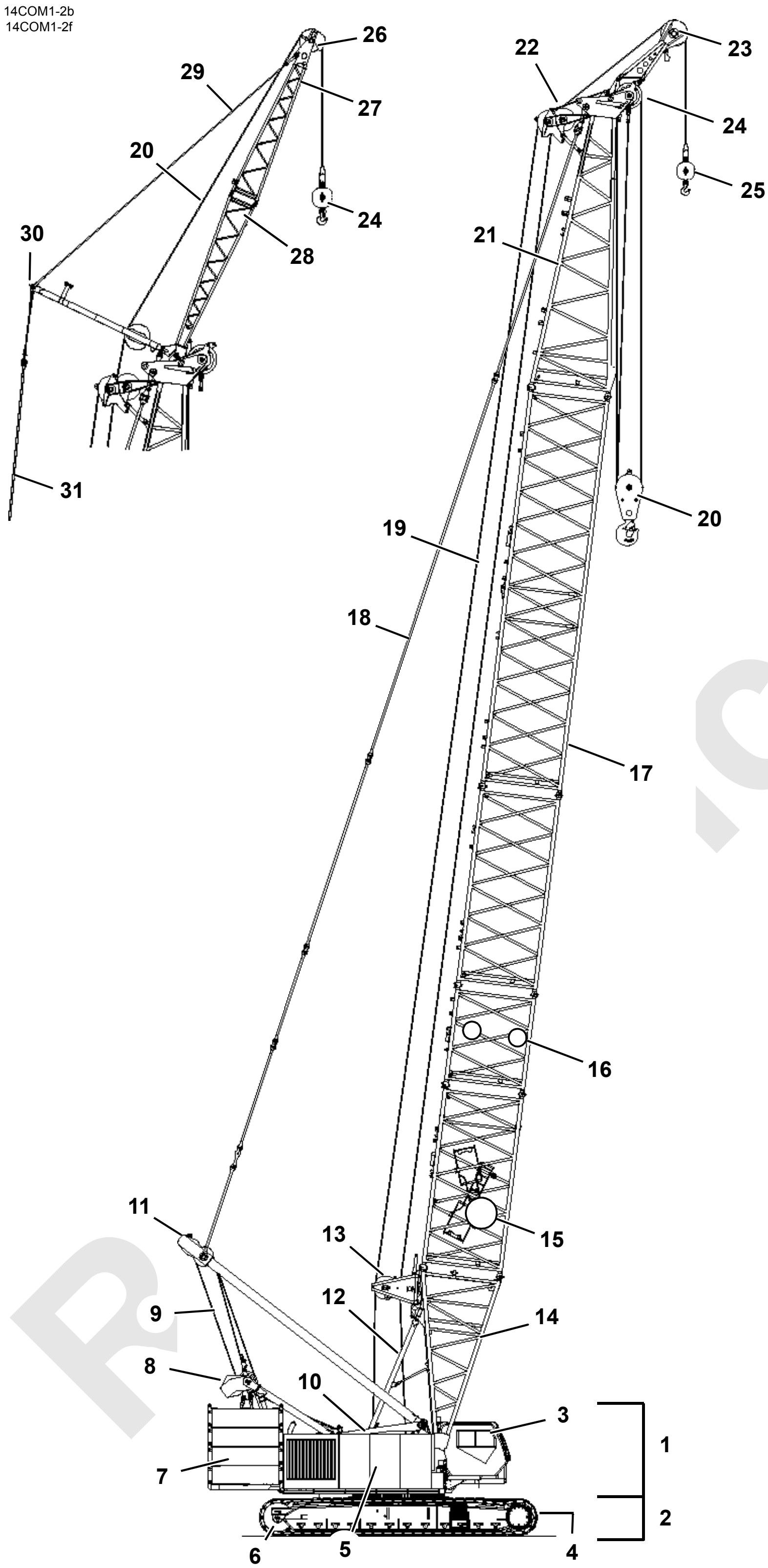
Handle and dispose of waste according to local, state, and federal environmental regulations.

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 Figures 1-1 through 1-6 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	Gantry
9	Boom Hoist Wire Rope
10	Mast Arms with Cylinders
11	Mast (Live)
12	Telescopic Boom Stop
13	Wire Rope Guide (Boom Butt)
14	Boom Butt
15	Drum 3 (Luffing Hoist or Auxiliary Load Drum)
16	Guide Sheaves (in Insert)
17	Inserts
18	Boom Straps
19	Load Lines
20	Load Block
21	Boom Top
22	Wire Rope Guide (Boom Top)
23	Upper Boom Point
24	Lower Boom Point
25	Weight Ball
26	Jib Point
27	Jib Top
28	Jib Butt
29	Jib Pendants
30	Jib Strut
31	Jib Backstay Pendants
32	Swing Drive
33	Drum 4 (Boom Hoist) Motor
34	Pump Drive with Pumps
35	Hydraulic Tank
36	Gantry Cylinder (2 places)
37	Drum 2 (Rear Load Drum)
38	Drum 1 (Front Load Drum)
39	Boom Hinge Pins (with Cylinder)
40	Rotating Bed
41	Carbody Jack (4 places)
42	Carbody
43	Fuel Tank
44	Power Plant
45	Air Cleaner
46	Selective Catalytic Reducer (SCR Module)
47	Decomposition Reactor Tube (DRT Module)

FIGURE 1-1

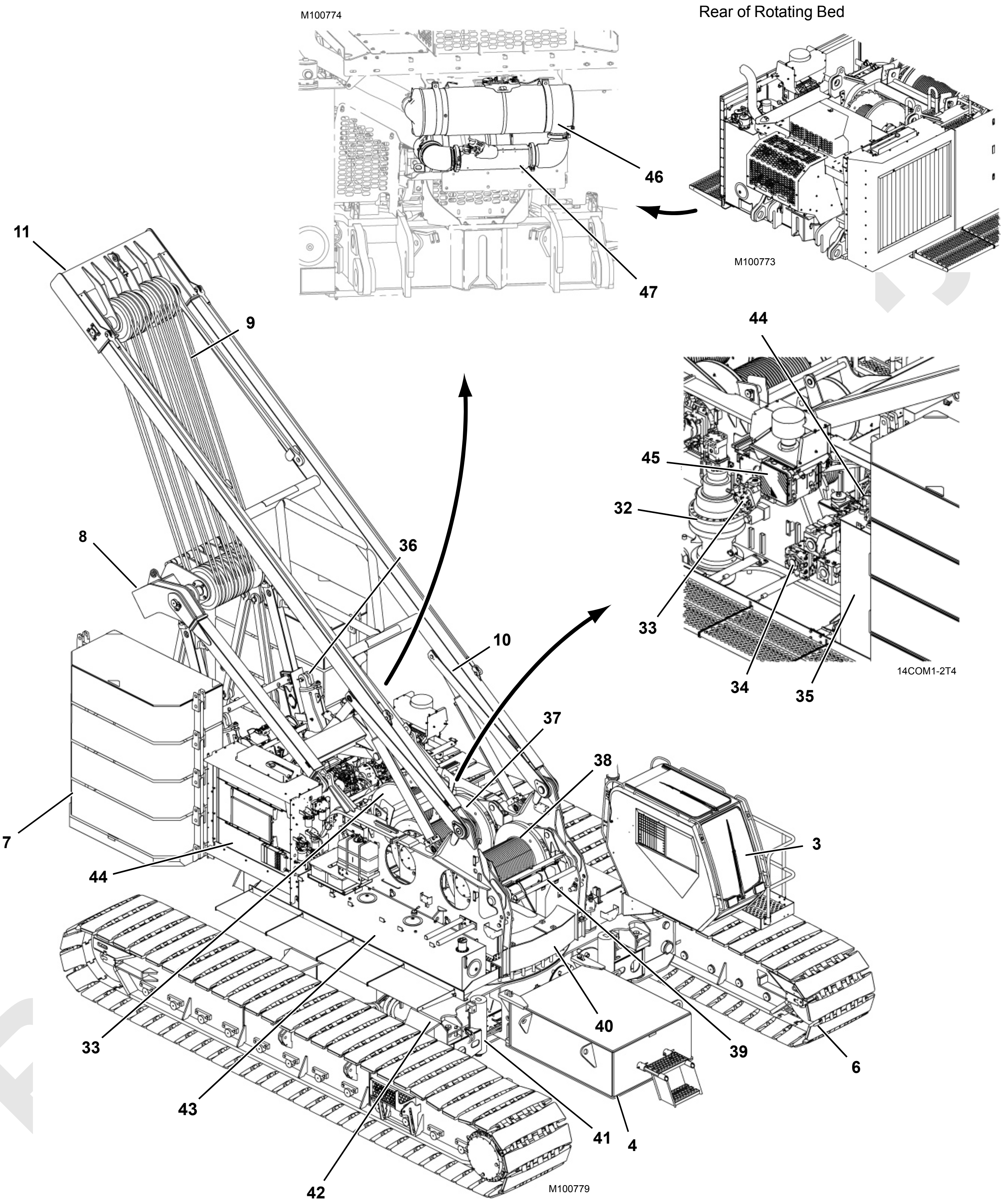


FIGURE 1-1 continued

Front of Crane/Cab Components

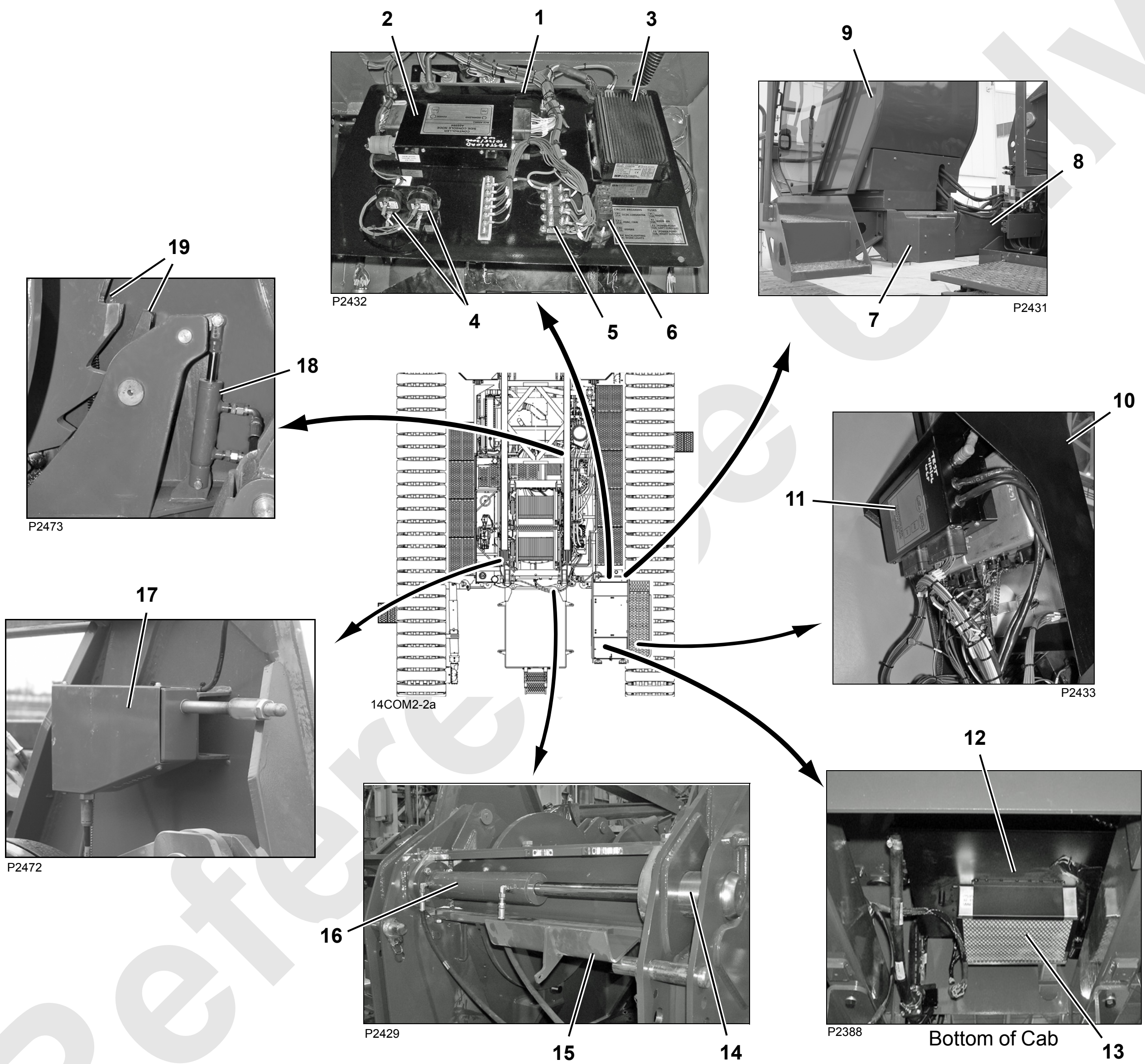
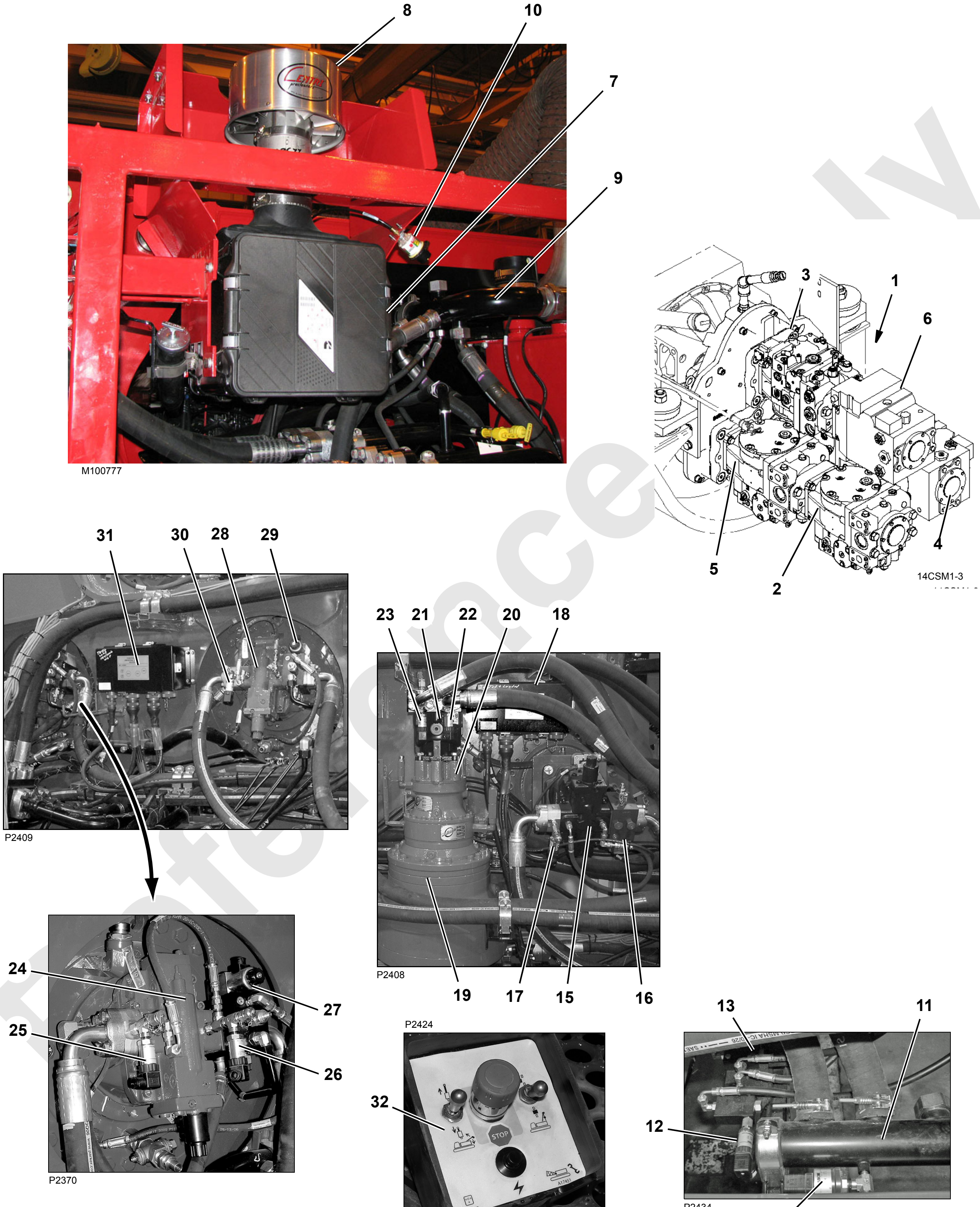


FIGURE 1-2

Front of Crane/Cab Components

Item	Description	Item	Description
1	Rear Console (electrical)	11	Node 1 Controller (master node)
2	Node 2 Controller	12	Air Conditioning Filter
3	Voltage Converter	13	Air Conditioner Unit
4	Operating Limit/System Fault Buzzers	14	Boom Hinge Pin
5	Circuit Breakers (four)	15	Boom Hinge Pin Cylinder Cover
6	Fuses (four)	16	Boom Hinge Pin Cylinder
7	Windshield Washer Fluid Tank	17	Automatic Boom Stop
8	Cab Support	18	Boom Hoist Drum Pawl Cylinder
9	Rear of Cab	19	Boom Hoist Drum Ratchet and Pawl
10	Front Console		

Left Side Components



Stored in Left Side Enclosure

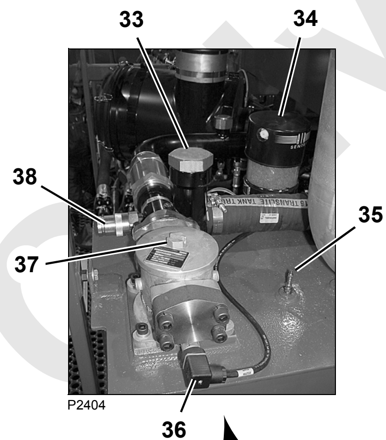
FIGURE 1-3

Left Side Components

Item	Description	Item	Description
1	Right Travel Pump #1 (not shown)	17	Boom Hoist Pressure Sender
2	Drum 1 (Front Drum) Pump #2	18	Node 4 Controller
3	Drum 3/Left Travel Pump #3	19	Swing Gearbox
4	Drum 4 (Boom Hoist) Pump #4	20	Swing Brake
5	Drum 2 (Rear Drum) Pump #5	21	Swing Motor
6	Swing Pump #6	22	Swing Left Pressure Sender
7	Engine Air Cleaner	23	Swing Right Pressure Sender
8	Air Inlet Cap	24	Drum 1(Rear Drum) Motor
9	Return Manifold (hydraulic fluid)	25	Drum 1 Pressure Sender - High
10	Air Cleaner Service Indicator	26	Drum 1 Pressure Sender - Low
11	Suction Manifold (hydraulic fluid)	27	Drum 1 (Rear Drum) Brake Solenoid
12	Travel Right Pressure Sender	28	Drum 2 (Rear Drum) Motor
13	Travel Left Pressure Sender	29	Drum 2 (Rear Drum) Brake Solenoid
14	Suction Vacuum Switch	30	Drum 2 Pressure Sender
15	Boom Hoist Motor	31	Node 3 Controller
16	Boom Hoist Brake Solenoid	32	Remote Controls

Left Side Components Continued

Item	Description	Item	Description
33	Hydraulic Tank Primary Fill Pipe	48	Cab Tilt Up Solenoid
34	Hydraulic Tank Breather	49	Cab Tilt Down Solenoid
35	Hydraulic Tank Air Valve	50	Boom Hinge Pin Solenoid
36	Return Filter Sensor	51	Mast Cylinder Extend Solenoid
37	Return Filter	52	Mast Cylinder Retract Solenoid
38	Hydraulic Tank Pressure Fill	53	Gantry Cylinder Extend Solenoid
39	Hydraulic Tank	54	Gantry Cylinder Retract Solenoid
40	Hydraulic Tank Level Gauge	55	Drum 3 Diverter Solenoid
41	Hydraulic Tank Shutoff Valve Handle	56	Travel Brake Release Solenoid
42	Hydraulic Tank Shutoff Valve	57	Travel Two-Speed Solenoid
43	Hydraulic Tank Drain	58	Swing Brake Release Solenoid
44	Engine Clutch Handle	59	Back Hitch Pins Release Solenoid
45	Turntable Bearing	60	Boom Hoist Pawl In Solenoid
46	Swing Gear	61	Boom Hoist Pawl Out Solenoid
47	Swing Gearbox	62	Rated Capacity Limiter Alarm



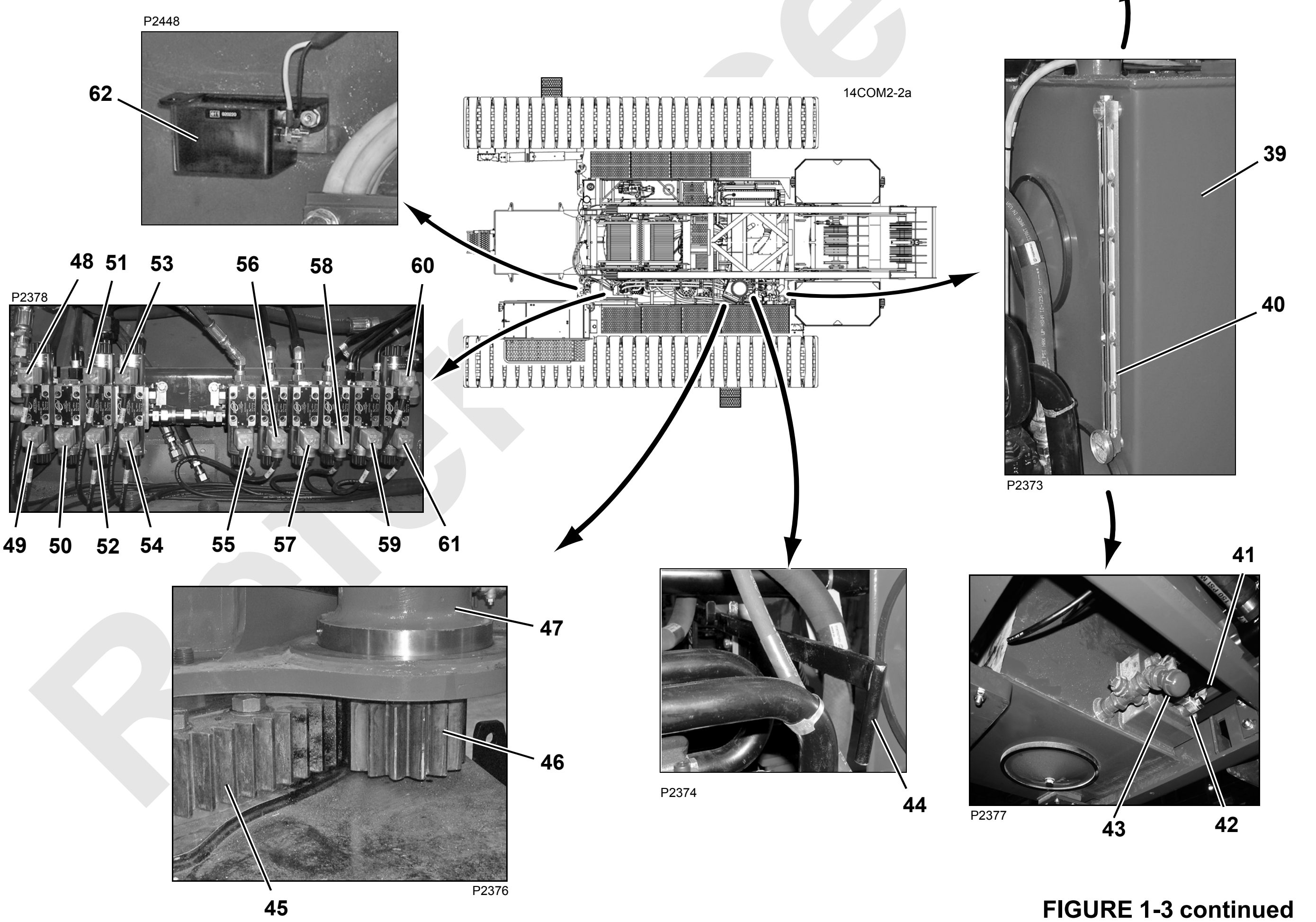


FIGURE 1-3 continued

Right Side Components

Item	Description	Item	Description
1	Fuel Fill Cap	11	DEF Tank
2	Fuel Level Sight Gauge	12	Circuit Breaker Box, Heaters (Optional)
3	Free Fall Proportional Valve (optional)	13	Batteries
4	Free Fall Enable Valves (optional)	14	Secondary Fuel Filter
5	Free Fall Drum Clutch/Brake (optional)	15	Primary Fuel Filter
6	Air Conditioning Drier	16	Fuel Cooler
7	Engine Coolant Filter	17	Hydraulic Oil Cooler
8	DEF Supply Module	18	Air Conditioning Condenser
9	Battery Disconnect Switch	19	Engine Radiator
10	Engine Controller (Node 0)	20	Engine Charge Air Cooler

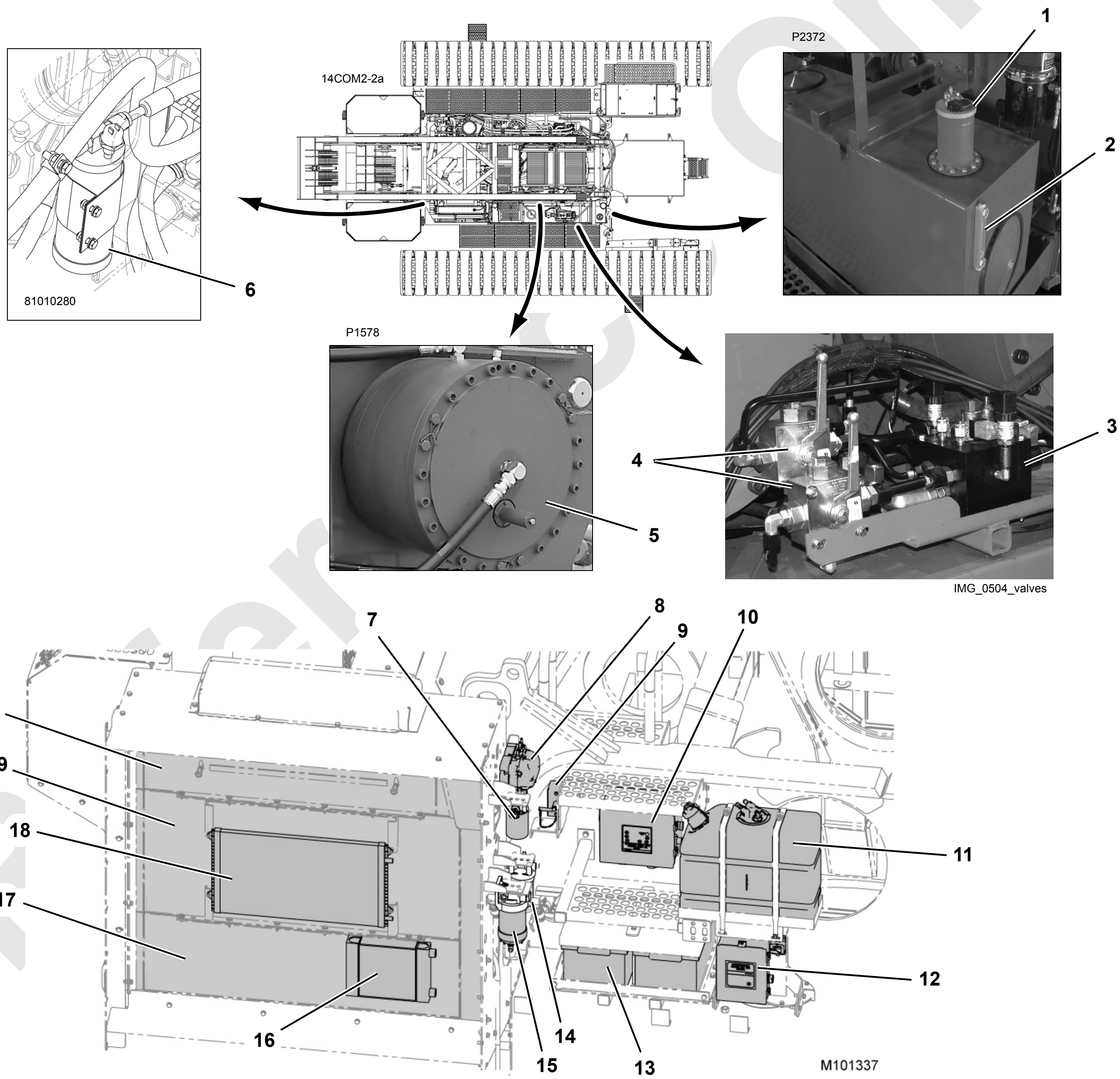


FIGURE 1-4

Rear/Top of Crane Components

Item	Description	Item	Description
1	Swivel	9	Mast Cylinders Counter Balance Valve
2	Carbody Enable Pressure Sender	10	Back Hitch Pin Cylinders
3	Gantry Cylinders Counter Balance Valve	11	Gantry Sheaves
4	Right Side Mast Cylinder	12	Gantry Cylinder
5	Mast Assist Arms	13	Back Hitch
6	Swing/Travel Alarm	14	Gantry
7	Heater Return Ball Valve (nearer to front of engine)	15	Live Mast
8	Heater Supply Ball Valve	16	Mast Angle Sensor

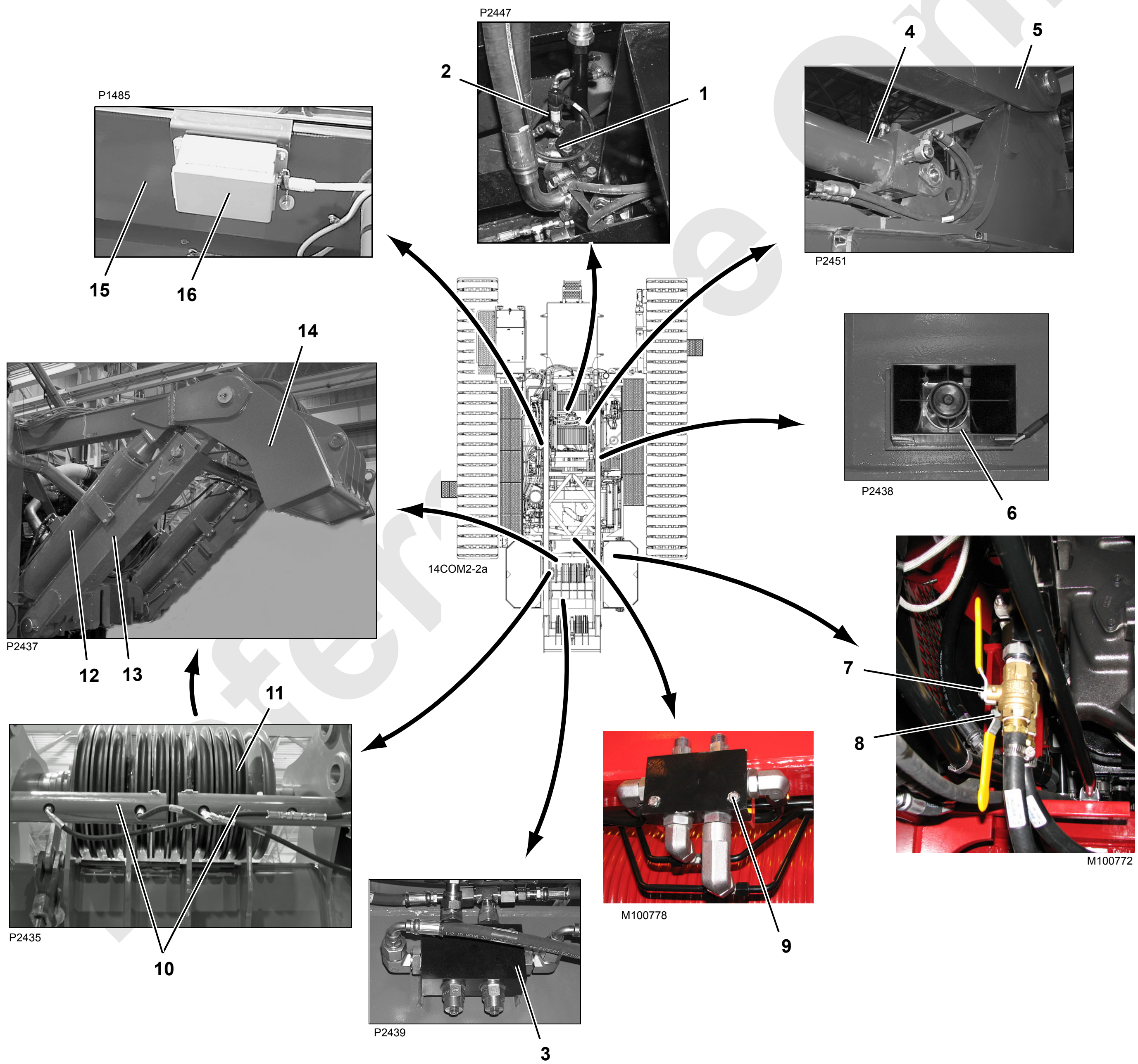


FIGURE 1-5

Carbody/Crawler Components

Item	Description	Item	Description
1	Crawler Pin Handles	8	Crawler Brake (both crawlers)
2	Jacking Cylinder Handles	9	Drive Shaft (both crawlers)
3	Level (on front of carbody)	10	Crawler Input Planetary (both crawlers)
4	Crawler Pin Cylinder (1 each crawler)	11	Crawler Output Gearbox (both crawlers)
5	Crawler Hydraulic Motor (1 each crawler)	12	Carbody Jack Cylinder (four)
6	Intermediate Crawler Rollers (each crawler)	13	Carbody Jacks (store on front/back carbody)
7	Crawler Roller (1 each crawler)		

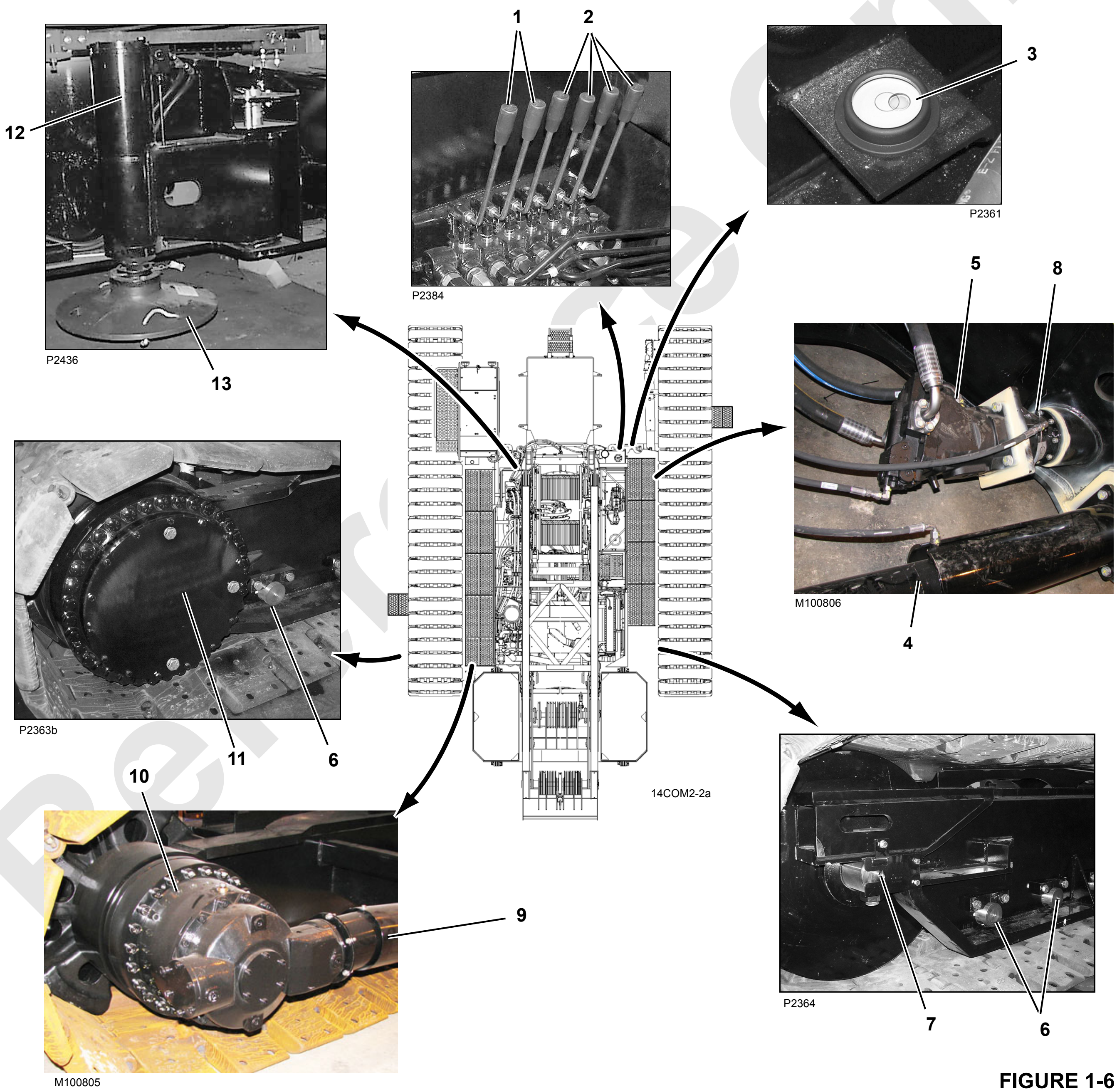


FIGURE 1-6

Abbreviations

A	Amber Light
ACR	Air Conditioning Relay
AL	Auto Lube Pump
ALT	Alternator
AUX	Auxiliary
BH	Boom Hoist
CAN	Controller Area Network
DISP	Displacement
ECOR	Electric Compensated Over-Ride
EDC	Electrical Displacement Control (Pump)
EFC	Electronic Fuel Control
EPIC	Electrical Processed Independent Control
FS	Fuel Solenoid
FF	Free Fall
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
MIN	Minimum
P/C	Pump Control
PCOR	Pressure Compensated Over-Ride
PCP	Pressure Control Pilot (Motor)
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	Drum 1 (Front Drum) Brake Release
HS-2	Drum 1 Free Fall Proportional Valve A
HS-4	Drum 2 (Rear Drum) Brake Release
HS-5	Drum 2 Free Fall Proportional Valve B
HS-6	Drum 1 & 2 Free Fall/Rigging Winch Enable
HS-7	Drum 3/Luffing Jib Drum Brake Release
HS-8	Drum 3/Luffing Pawl Out
HS-9	Drum 3/Luffing Pawl In
HS-10	Drum 3/Left Travel Diverter
HS-11	Drum 4 (Boom Hoist) Brake Release
HS-12	Drum 4 (Boom Hoist) Pawl In
HS-13	Drum 4 (Boom Hoist) Pawl Out
HS-14	Swing Brake Release
HS-15	Travel Brake Release
HS-16	Travel 2-Speed
HS-17	Travel Cruse
HS-20	Cab Tilt Down (Lower Cab Front)
HS-21	Cab Tilt Up (Raise Cab Front)
HS-22	Mast Cylinders Raise
HS-23	Mast Cylinders Lower
HS-24	Gantry Cylinders Raise
HS-25	Gantry Cylinders Lower
HS-26	Back Hitch Pins Disengage
HS-27	Boom Hinge Pin Disengage
HS-28	Rigging Winch Brake
HS-29	Rigging Winch Haul In
HS-30	Rigging Winch Pay Out

DESCRIPTION OF CRANE OPERATION

See Figure 1-7.

This section describes the standard and optional equipment available for Model 14000 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 of this manual).

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. Pressure develops within the closed-loop system while resistance to movement of the load on motor is overcome.

When movement begins, pump volume displacement maintains motor speed or cylinder movement. Spent hydraulic fluid from motor outlet returns to pump input. The crane closed loop systems are front drum, rear drum, auxiliary/luffing jib drum, boom hoist, swing, right travel, and left travel.

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.

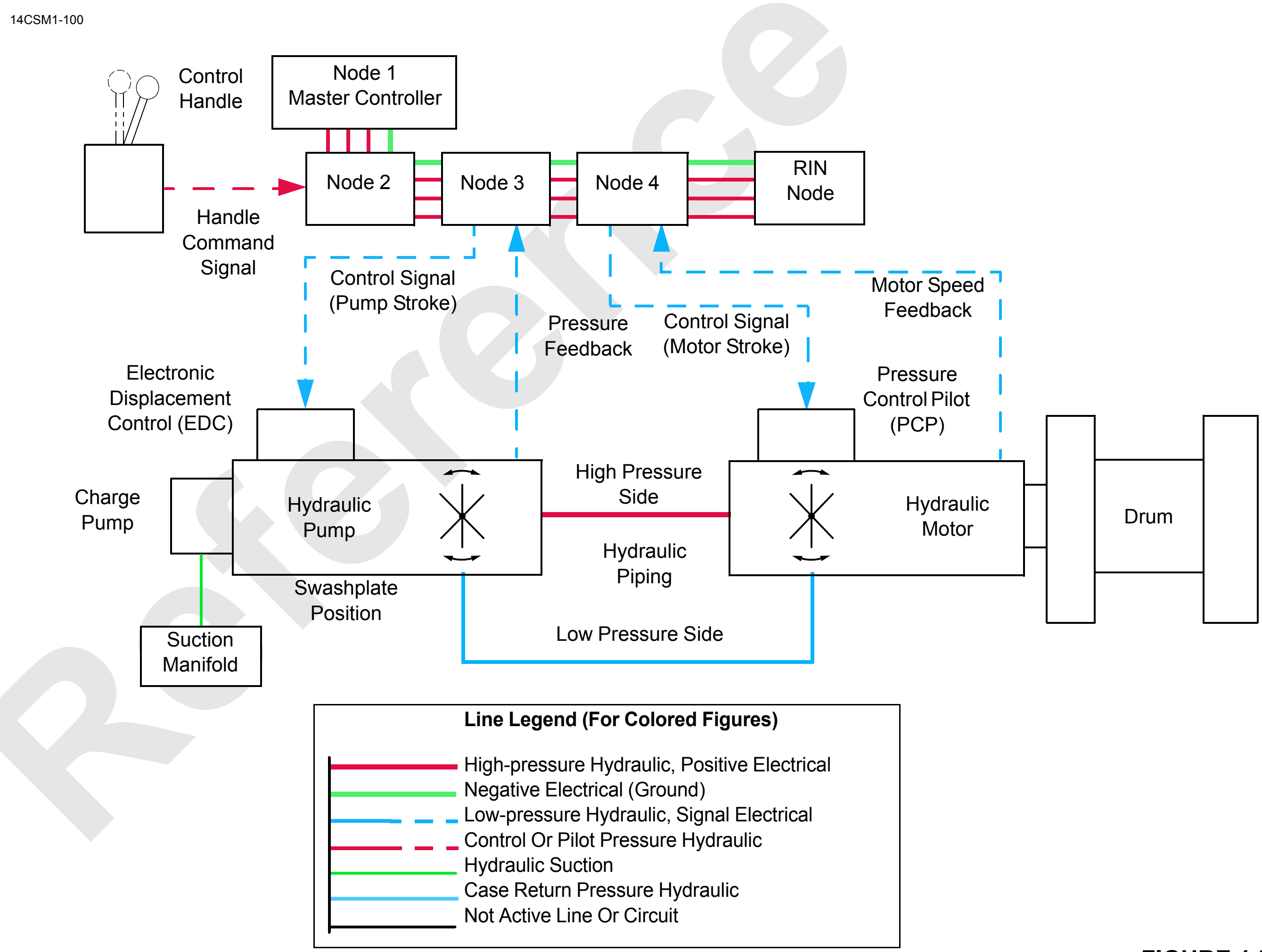


FIGURE 1-7

Hydraulic Components

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

Hydraulic Tank

The hydraulic tank has two sections; a suction section and a return section. Hydraulic tank components include a separate breather, suction strainer, return filter, temperature sensor, level sensor, and pressure port.

The suction section has a 200 mesh (74 micron) mesh strainer that allow fluid bypass around strainer at 5 psi (0.34 bar) if it becomes plugged. The breather protects the tank from excessive pressures and opens at 2.1 psi (0.14 bar).

Return filter has a 25 psi (1.7 bar) bypass that enables system fault alarm if filter becomes plugged. A system fault alarm also indicates when hydraulic tank fluid level is low, hydraulic fluid temperature is too high.

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

Suction Manifold

Tank suction manifold supplies fluid to all system pumps. When shut-off valve is open, fluid flows from tank through suction manifold to charge pump inlets. Suction line vacuum opens at 0.3 psi (15 mm Hg).

Return Manifold

Return fluid from motor and pump case drains, valves and cylinders is routed through return manifold and cooler before entering hydraulic tank. Return manifold has a at 25 psi (1.7 bar) bypass that allows fluid to bypass cooler if it becomes plugged.

Oil Temperature Valve

Behind the lower right side of the radiator is the thermostatically controlled valve. At 140°F (60°C), the valve begins to open, allowing return oil to flow to the cooler.

Hydraulic Pumps

See hydraulic pump manufacturer's manual for a description of a hydraulic piston pump. See Hydraulic System Specifications in Section 2 of this manual.

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 suction 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, node 1 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.

Accessory System Pressure Sources

The low pressure side of drum 1 pump is the pressure source for high pressure accessory system components. The programmable controller controls drum 1 pump output pressure when an accessory valve is enabled.

Drum 3/left travel charge pump is the pressure source for low pressure system components.

Hydraulic Motors

See hydraulic pump manufacturer's manual for a description of a hydraulic motor.

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

Variable displacement motors 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. 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.

Hydraulic System Operation

See Figures 1-8 *or* 1-9.

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 resistors and applied to pump external EDC (Electrical Displacement Control). The output current magnetizes an armature (Figure 1-8) and starts to block one of the orifice ports, depending on command direction.

Item	Description	Item	Description
1	Control Voltage	6	Spool Spring
2	Armature	7	Modulation Spring
3	Orifice Port	8	Swashplate
4	Pilot Pressure	9	Servo Pistons
5	Spool		

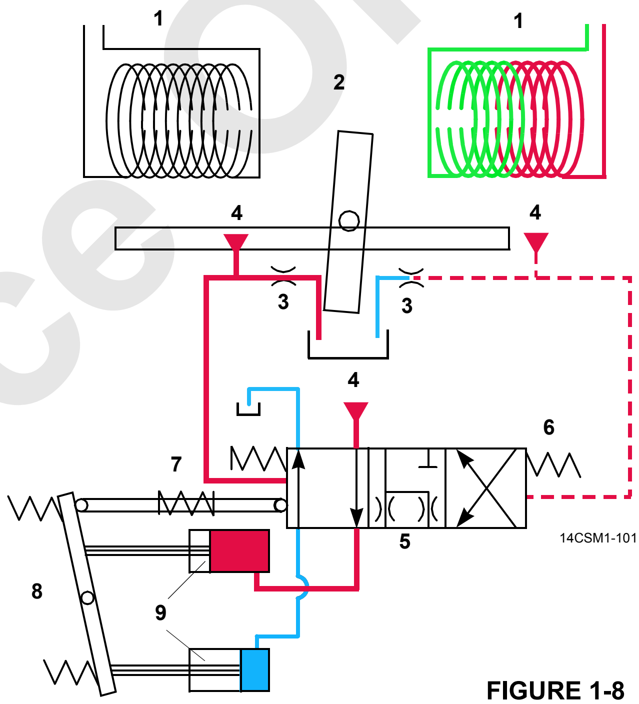


FIGURE 1-8

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 1-9), 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 (5) or the flow is transferred to low-pressure side of system through the make-up check valve (7).

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.

Item	Description	Item	Description	Item	Description
1	Pressure Limiting Relief Valve	7	Make-Up Check Valve	13	Servo Cylinder
2	Servo Check Valve	8	Flow Control Orifice	14	Adjustable Valve Spring
3	Displacement Control Valve	9	Flow Restrictor	15	Valve Spring
4	Servo Control Cylinder	10	Servo PC Valve	16	ECOR Valve
5	System Relief Valve	11	Pressure Control Pilot Valve	17	Control Valve
6	Charge Pump Relief Valve	12	Shuttle Valve	18	Relief Valve

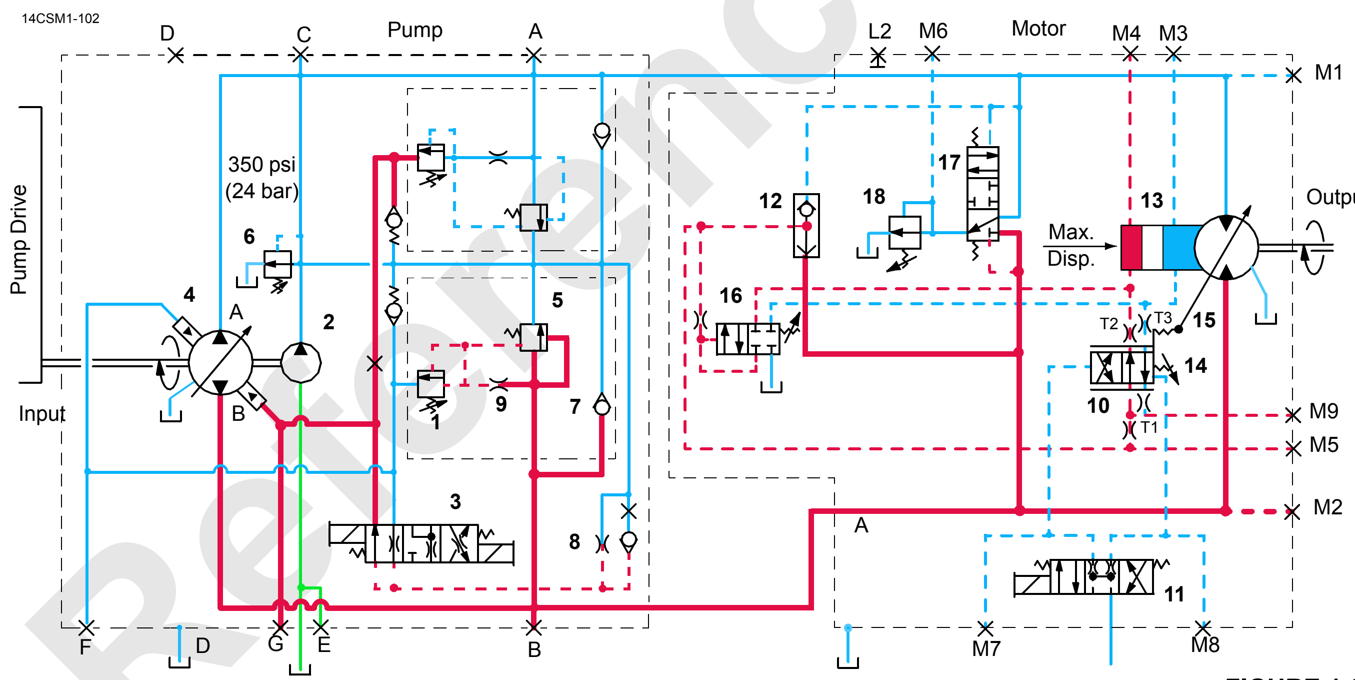


FIGURE 1-9

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.

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

Gear Pumps (optional)

One engine gear pump supplies hydraulic fluid to front and/ or rear free fall drums and rigging winch. One engine gear pump recirculates hydraulic fluid from self contained spotter circuit.

Engine Controls

See Engine Controls topic in Section 3 of Operator Manual for engine operation. See engine manufacturer's manual for engine 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 hand throttle or foot throttle and is monitored with a speed sensor. Node 1 controller and engine node 0 controller controls and process engine information and display 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.

Brake and Drum Pawl Operation

All load drums, boom hoist, travel, and swing park brakes are spring-applied and hydraulically released.

- Swing brake is released immediately when swing brake switch is placed in ***off - park*** position.
- Travel brake is released with control handle movement.
- Selected drum brake is not released until pressure memory holding pressure is reached to hold the load.

Drum 4 (boom hoist) and drum 3 (when configured with luffing jib) have drum pawls that are released with the selected park switch. When operator places 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.

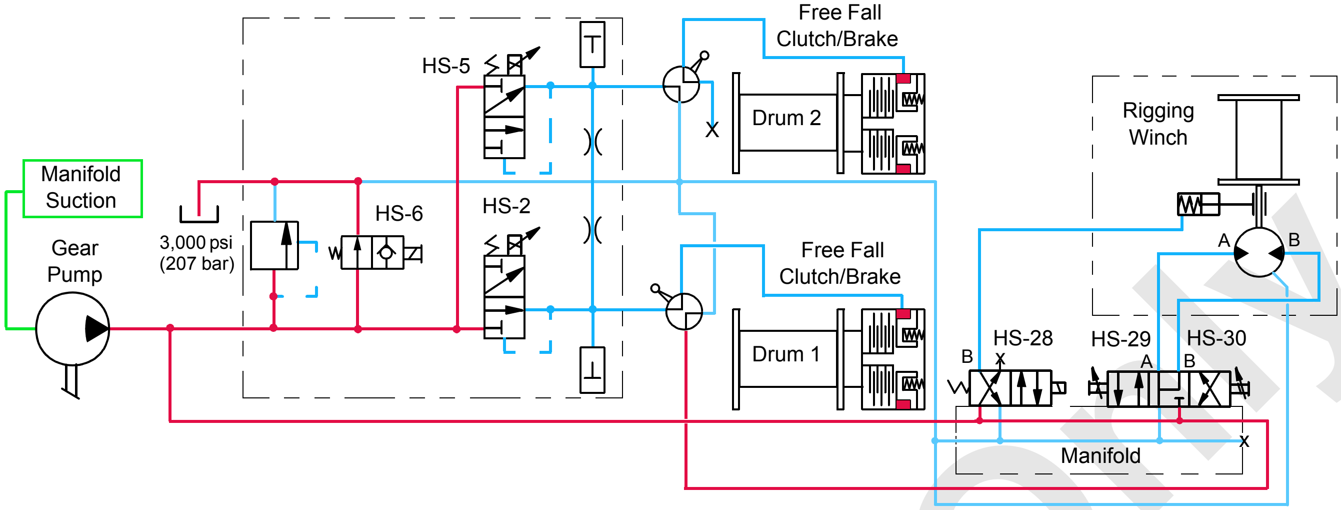

Manifold
Suction
Gear
Pump
3,000 psi
(207 bar)
HS-6
HS-5
HS-2
Free Fall
Clutch/Brake
Drum 2
Free Fall
Clutch/Brake
Drum 1
Rigging
Winch
A
B
HS-28
HS-29
HS-30
B
A
B
Manifold

FIGURE 1-10

ELECTRICAL CONTROL SYSTEM

See Figure 1-11.

The crane's boom, load lines, swing, crawler tracks, and high pressure 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. Node controllers communicate with node 1 (master) controller by sending data packets over a two-wire bus line. 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 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 nominal 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, wind speed, 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 — Drums 1, 2, 3, Limits, and Accessories
Node 4 — Pumps, Sensors, and Drum 4
Node 0 — Engine
RIN (Remote Input Node) Boom

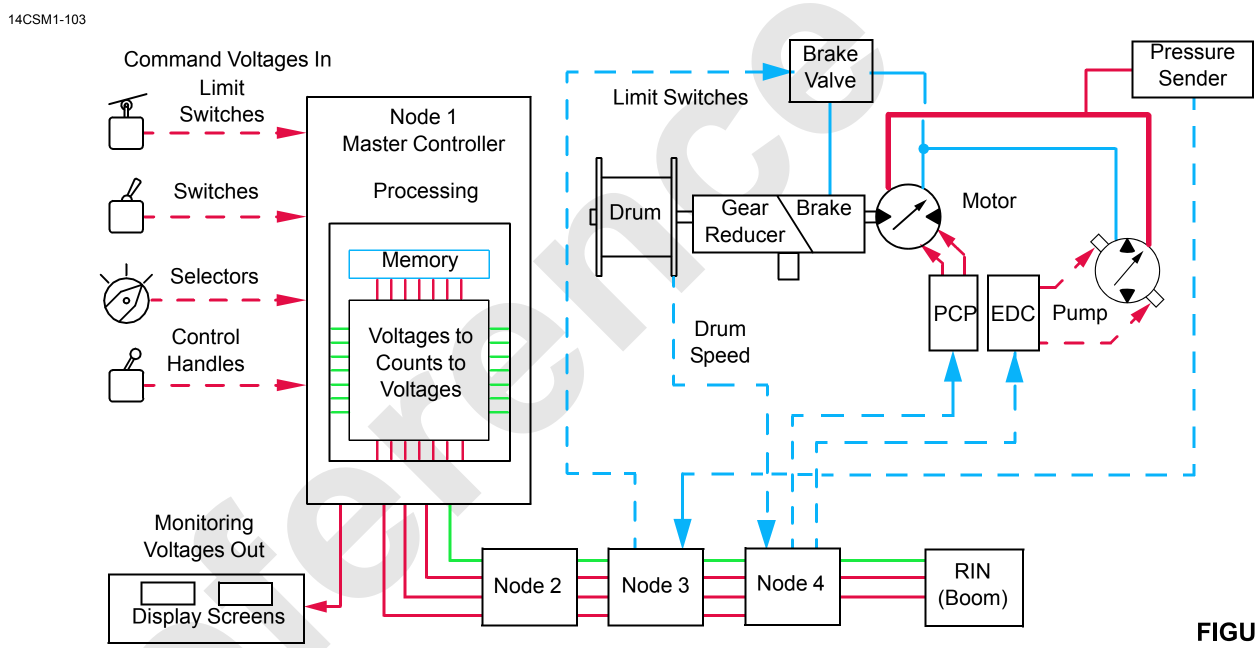


FIGURE 1-11

Display Screens

See Figure 1-11 for following procedure.

The display screens contains the Rated Capacity Indicator/Limiter display and main display. Use the menu screens to selected Rated Capacity Indicator/Limiter and crane functions.

Electrical Power to Operator's Cab

See Electrical Schematic drawing A17144 Sheet 26 and 27.

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 starter (SS) and grid heater (HR).
- 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 COMP).

Pressure Senders and Speed Sensors

Pressure senders monitor drum system pressures, right/left travel system pressure, swing right/left system pressure, accessory system pressure, and lower accessory valve pressure. Remote node controllers receive a 0 to 5 volt input signal 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***. Node 1 controller compares control handle voltage with pump output to determine when to vary pump stroke.

System Faults

See Section 3 of this manual for list of faults.

Node 1 controller monitors and enables an alarm if any system fault is detected and displays the fault on the crane information screen.

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

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.

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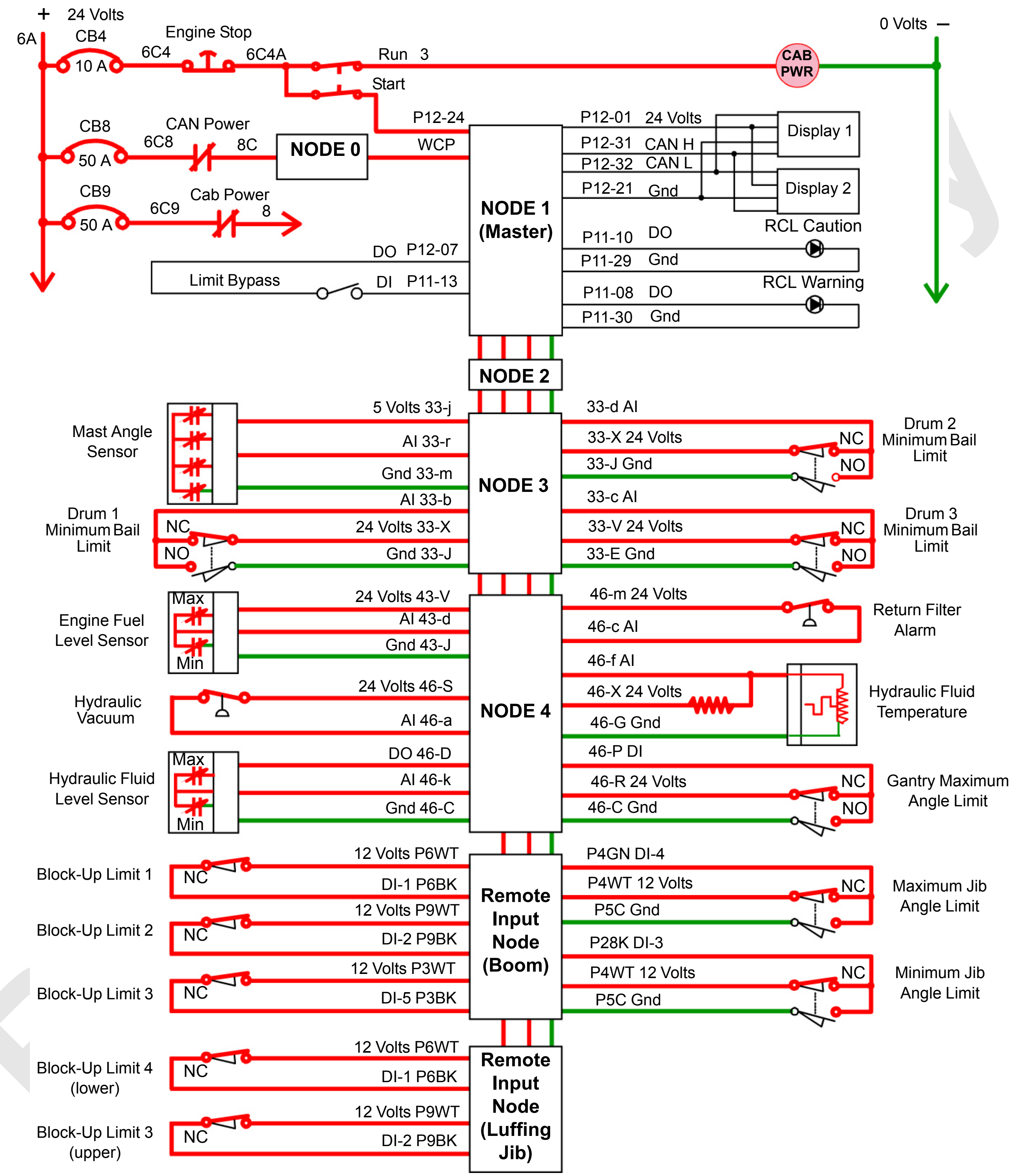

FIGURE 1-12

SWING SYSTEM

See Figures 1-13 and 1-14.

One hydraulic swing pump drives one swing motor. The hydraulic motor drives a gearbox that meshes with tooth gears that turns rotating bed to swing. Swing system is controlled with swing control handle movement and node controllers. Swing control handle is inoperable when swing brake is applied. Rotating bed is free to coast if swing control handle is in neutral position and swing brake is released.

Swing motor is fixed displacement and controlled directly by output fluid volume of swing pump as controlled by handle command. Swing pressure senders monitor pressure for both swing left and swing right sides of closed loop system. An orifice across swing motor ports A and B allow smooth fluid flow when shifting swing directions. Continuous changing of closed-loop fluid occurs through leakage in pumps and motors.

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 speed and swing torque can be selected for type of work being performed on Function Mode screen (see Section 3 of this manual).

When swing control handle is moved from off, an input signal is sent to node 1 controller. Node 4 controller sends a 24 volt signal to enable right side and left side swing/travel alarm. When swing control handle is moved to off, an input signal is sent to node 1 controller. Node 3 controller sends a zero volt output signal to disable right side and left side swing/travel alarm.

Swing Brake

Swing system has a spring-applied hydraulically released brake on drive shaft.

The source hydraulic pressure for releasing swing brake is from drum 3/left travel charge pump at approximately 350 psi (24 bar). Swing brake system pressure must be above 200 psi (14 bar) to fully release brake. If system pressure is below 200 psi (14 bar), swing brake could be partially applied and damage swing system. If brake pressure or electrical power is lost when operating, swing brake applies.

After startup, place swing brake switch in ***off - park*** position. An input voltage is sent to node 1 controller. Node 3 controller sends a 24 volt output to enable swing brake solenoid HS-14. Swing brake valve shifts to hydraulically release swing brake from shaft.

Before shutdown or to prevent swing movement, place swing brake switch in ***on - park*** position. An input voltage is sent to node 1 controller. Node 3 controller sends a zero output voltage to disable swing brake solenoid HS-14. Swing brake valve shifts to block fluid to brake and swing brake applies. Fluid from brake flows to tank.

Swing Left

See Figures 1-13 and 1-14.

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 4 controller sends a variable 0 to 24 volt output that is divided by resistors and applied to swing pump EDC. Pump EDC tilts swashplate relative to handle movement and direction. Hydraulic fluid flows from pump outlet port B to motor inlet port, moving rotating bed to left. Hydraulic return fluid from motor outlet port flows to pump inlet port A.

As swing control handle is moved to neutral position, node 1 controller compensates for hydraulic system leakage or changing engine speed. Node 4 controller sends a zero output voltage to move pump swashplate to center position.

Swing Right

When swing control handle is moved to ***right***, an input voltage of 2.6 volts or more is sent to node 1 controller. Node 4 controller sends a variable 0 to 24 volt output that is divided by resistors and applied to swing pump EDC. Pump Hydraulic fluid flows from pump outlet port A to motor inlet port, moving rotating bed to right. Hydraulic return fluid from motor outlet port flows to pump inlet port B, completing closed-loop circuit.

As swing control handle is moved to neutral position, node 1 controller compensates for hydraulic system leakage or changing engine speed. Node 4 controller sends a zero output voltage to move pump swashplate to center position.

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 swing holding brake switch is pressed in and held, an input voltage is sent to node 1 controller. Node 3 controller sends a zero output voltage to shift swing brake solenoid HS-14 to ***on - park*** position. 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 3 controller sends a 24 volt output to shift swing brake solenoid HS-14 to ***off - park*** position. Swing brake valve shifts, allowing system pressure to hydraulically release park brake.

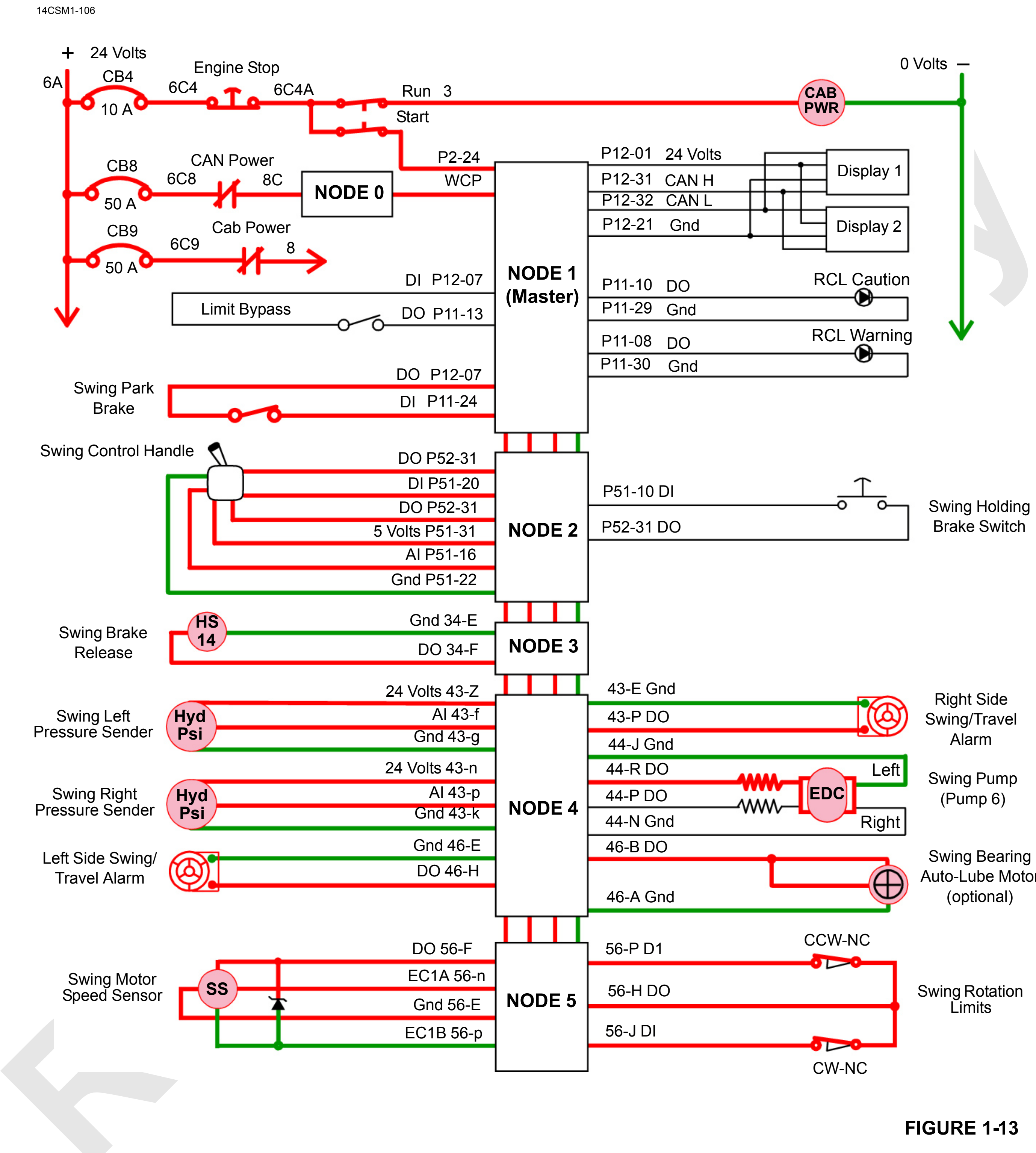
14CSM1-106
+ 24 Volts
6A
CB4
10 A
6C4
Engine Stop
6C4A
Run 3
Start
0 Volts –
CAB PWR
CB8
50 A
6C8
CAN Power
8C
NODE 0
P2-24
WCP
CB9
50 A
6C9
Cab Power
8
P12-01 24 Volts
P12-31 CAN H
P12-32 CAN L
P12-21 Gnd
Display 1
Display 2
NODE 1 (Master)
DI P12-07
Limit Bypass
DO P11-13
P11-10 DO
P11-29 Gnd
RCL Caution
P11-08 DO
P11-30 Gnd
RCL Warning
Swing Park Brake
DO P12-07
DI P11-24
Swing Control Handle
DO P52-31
DI P51-20
DO P52-31
5 Volts P51-31
AI P51-16
Gnd P51-22
NODE 2
P51-10 DI
P52-31 DO
Swing Holding Brake Switch
Swing Brake Release
HS 14
Gnd 34-E
DO 34-F
NODE 3
Swing Left Pressure Sender
Hyd Psi
24 Volts 43-Z
AI 43-f
Gnd 43-g
Swing Right Pressure Sender
24 Volts 43-n
AI 43-p
Gnd 43-k
Left Side Swing/ Travel Alarm
Gnd 46-E
DO 46-H
NODE 4
43-E Gnd
43-P DO
Right Side Swing/Travel Alarm
44-J Gnd
44-R DO
44-P DO
44-N Gnd
EDC
Left
Right
Swing Pump (Pump 6)
46-B DO
46-A Gnd
Swing Bearing Auto-Lube Motor (optional)
Swing Motor Speed Sensor
SS
DO 56-F
EC1A 56-n
Gnd 56-E
EC1B 56-p
NODE 5
56-P D1
56-H DO
56-J DI
CCW-NC
CW-NC
Swing Rotation Limits

FIGURE 1-13

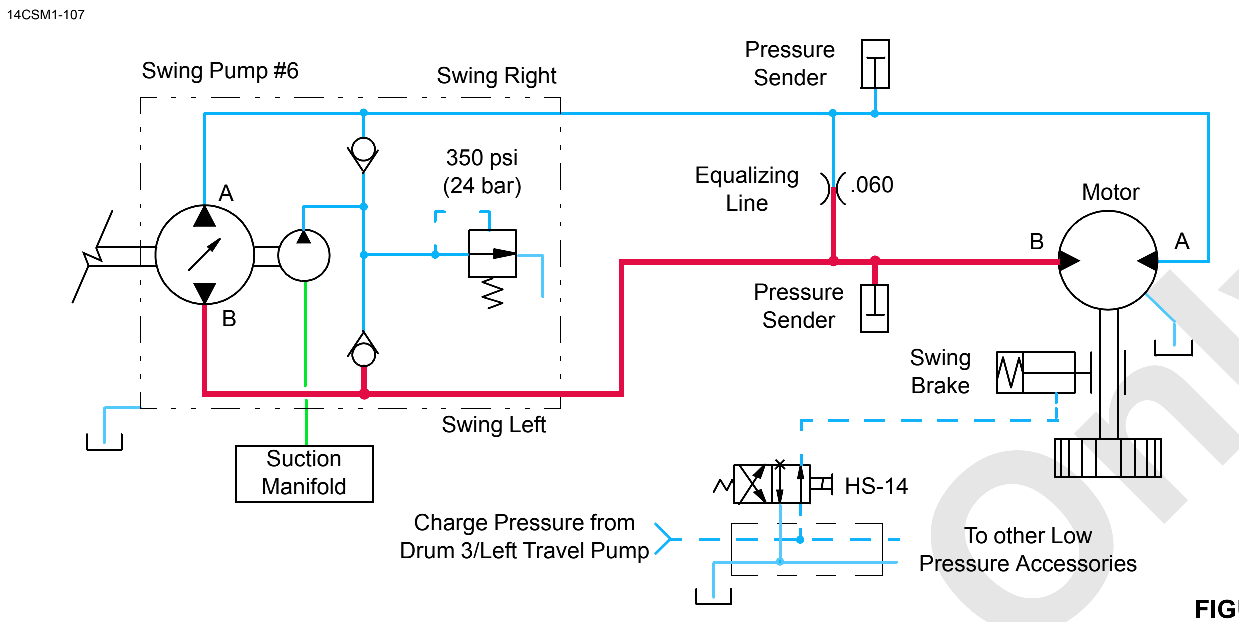
14CSM1-107
Swing Pump #6
Swing Right
Pressure Sender
350 psi
(24 bar)
A
Equalizing Line
.060
Motor
B
A
B
Pressure Sender
Swing Brake
Swing Left
Suction Manifold
HS-14
Charge Pressure from Drum 3/Left Travel Pump
To other Low Pressure Accessories

FIGURE 1-14

TRAVEL (CRAWLERS) SYSTEM

See Figures 1-15 and 1-16.

Each travel hydraulic pump drives a crawler system motor and gearbox. Each pump and motor is controlled with travel control handle movement and node controllers. Travel control handles are inoperable when travel brake is applied. The gearbox for each crawler is driven by a flexible shaft connected to the motor output.

Left travel pump is dedicated to operate drum 3 through a diverting valve if drum 3 operation is selected. Only one system can be operated at a time. See Drum 3 (Auxiliary/Luffing Jib) topic in this section.

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.

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 of this manual).

When either travel control handle is moved from off, an input signal is sent to node 1 controller. Node 4 controller sends a 24 volt signal to enable right side and left side swing/travel alarm. When both travel control handles are moved to off, an input signal is sent to node 1 controller. Node 3 controller sends a zero volt output signal to disable right side and left side swing/travel alarm.

Travel Brakes

Hydraulic pressure for releasing travel brakes is from drum 3/left travel charge pump at approximately 350 psi (24 bar). For travel brake operation 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 opens to allow hydraulic flow from 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 3 controller sends a 24 volt output to enable travel brake release solenoid HS-15. Brake valve shifts to block tank port and supplies low pressure hydraulic fluid from drum 3/left travel charge pump at approximately 350 psi (24 bar) to release crawler brakes. If brake pressure or electrical power is lost when operating, brakes apply.

Travel Motors

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 ECOR (Electric Compensated Over-Ride) spool placing travel motor in maximum displacement (high torque, low speed) position for breakaway torque.

Travel Forward

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 checks that drum 3/left travel diverting solenoid valve HS-10 is disabled (open to left travel motor) and closed to drum 3 motor (normal condition).

Node 4 controller sends a variable 0 to 24 volt output that is divided by resistors and applied to selected travel pump EDC. Node 3 controller sends a 24 volt output to enable travel brake release solenoid HS-15 and release selected crawler brake, before travel pump(s) strokes.

Travel pump EDC tilts selected pump swashplate in ***forward*** direction. Hydraulic fluid flow is from left travel pump outlet B and right travel pump outlet A, through diverter valve (left travel flow only), through swivel to left travel motor inlet port and right travel motor inlet port. Return fluid is from motor outlet ports to pump inlet ports.

Node 4 controller input voltage to travel pumps EDC is relative to control handle movement. As selected travel control handle is moved to neutral position, node 1 controller compensates for hydraulic system leakage or changing engine speed. Node 4 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, node 3 controller sends a zero output voltage to disable travel brake solenoid HS-15. Travel brake valve shifts to block pilot pressure to brakes and opens a line to tank. Brakes apply.

Travel in Reverse

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 checks that drum 3/left travel diverting solenoid valve HS-10 is disabled (open to left travel motor) and closed to drum 3 motor (normal condition).

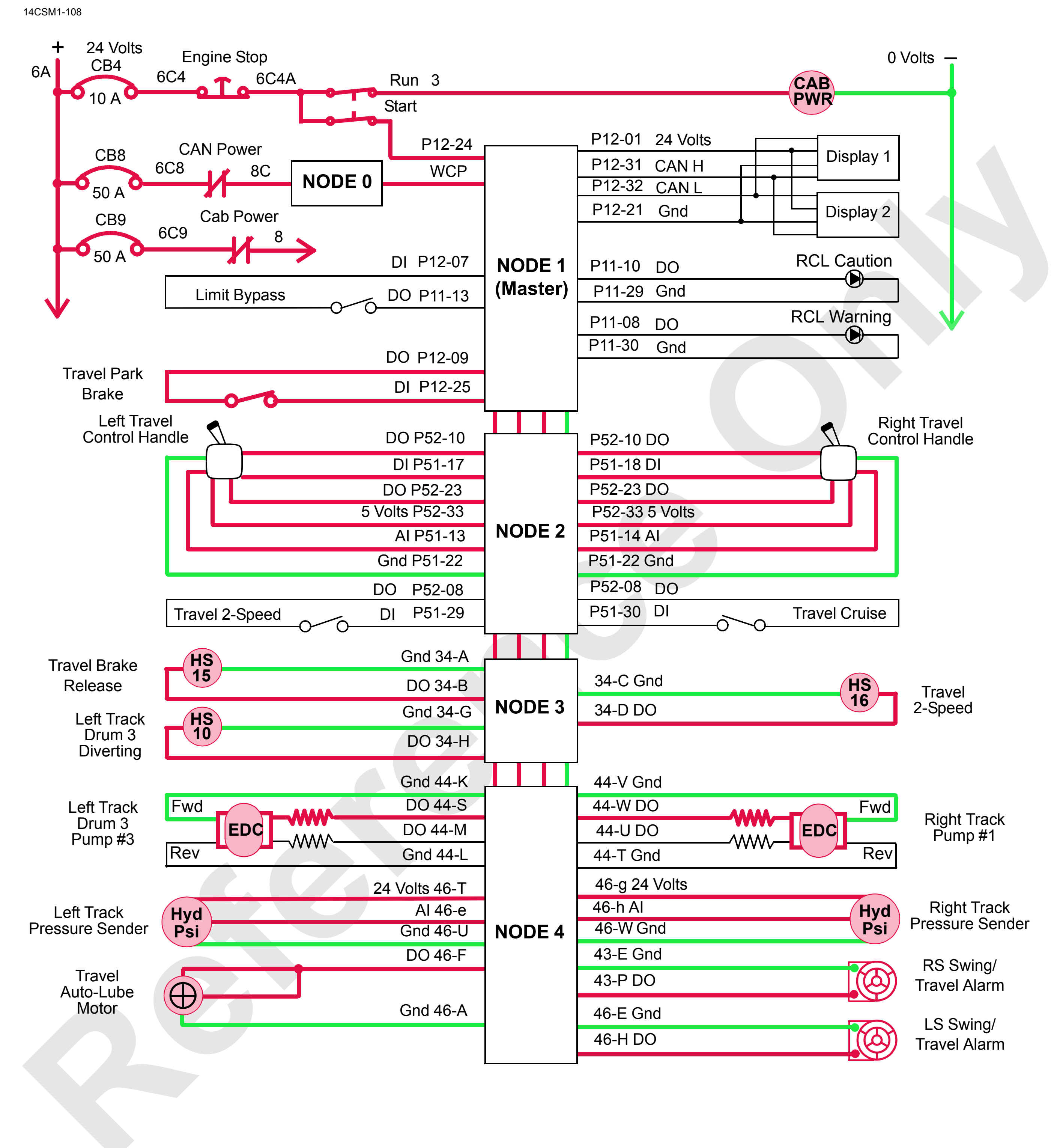
14CSM1-108
+
24 Volts
CB4
6A
10 A
Engine Stop
6C4
6C4A
Run 3
Start
0 Volts –
CAB PWR
CB8
CAN Power
6C8
8C
50 A
NODE 0
P12-24
WCP
CB9
Cab Power
6C9
8
50 A
P12-01 24 Volts
P12-31 CAN H
P12-32 CAN L
P12-21 Gnd
Display 1
Display 2
DI P12-07
Limit Bypass
DO P11-13
NODE 1 (Master)
P11-10 DO
P11-29 Gnd
RCL Caution
P11-08 DO
P11-30 Gnd
RCL Warning
DO P12-09
Travel Park Brake
DI P12-25
Left Travel Control Handle
DO P52-10
DI P51-17
DO P52-23
5 Volts P52-33
AI P51-13
Gnd P51-22
NODE 2
P52-10 DO
P51-18 DI
P52-23 DO
P52-33 5 Volts
P51-14 AI
P51-22 Gnd
Right Travel Control Handle
DO P52-08
Travel 2-Speed
DI P51-29
P52-08 DO
P51-30 DI
Travel Cruise
Travel Brake Release
HS 15
Gnd 34-A
DO 34-B
Left Track Drum 3 Diverting
HS 10
Gnd 34-G
DO 34-H
NODE 3
34-C Gnd
34-D DO
HS 16
Travel 2-Speed
Left Track Drum 3 Pump #3
Fwd
Rev
EDC
Gnd 44-K
DO 44-S
DO 44-M
Gnd 44-L
44-V Gnd
44-W DO
44-U DO
44-T Gnd
EDC
Fwd
Rev
Right Track Pump #1
Left Track Pressure Sender
Hyd Psi
24 Volts 46-T
AI 46-e
Gnd 46-U
NODE 4
46-g 24 Volts
46-h AI
46-W Gnd
Hyd Psi
Right Track Pressure Sender
Travel Auto-Lube Motor
DO 46-F
Gnd 46-A
43-E Gnd
43-P DO
RS Swing/ Travel Alarm
46-E Gnd
46-H DO
LS Swing/ Travel Alarm
Reference Only

FIGURE 1-15

Node 4 controller sends a variable 0 to 24 volt output that is divided by resistors and applied to selected travel pump EDC. Node 3 controller sends a 24 volt output to enable travel brake release solenoid HS-15 and release selected crawler brake, before travel pump(s) strokes.

Travel pump EDC tilts selected pump swashplate in ***reverse*** direction. Hydraulic fluid flow is from left travel pump outlet A and right travel pump outlet B, through diverter valve (left travel flow only), through swivel to left travel motor inlet port and right travel motor inlet port. Return fluid is from motor outlet ports to pump inlet ports.

Node 4 controller input voltage to travel pumps EDC is relative to control handle movement. As selected travel control handle is moved to neutral position, node 1 controller compensates for hydraulic system leakage or changing engine speed. Node 4 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, node 3 controller sends a zero output voltage to disable travel brake solenoid HS-15. 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 smooth 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 3 controller sends a 24 volt output to enable two-speed travel solenoid HS-16, shifting valve and directing hydraulic pilot pressure to P/C (Pressure/ Compensated) valve. The P/C valve shifts ECOR (Electric 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 1,500 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 drum 3/left travel diverting charge pump at approximately 350 psi (24 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 1,500 rpm and system pressure is below 3,915 psi (270 bar).

If engine is below 1,500 rpm, two-speed travel solenoid HS-16 is enabled although travel two-speed switch in the ***high*** position. Travel two-speed solenoid HS-16 is disabled, shifting valve and removing hydraulic pilot pressure to P/C valve, allowing motor to operate in ECOR mode.

Travel Cruise

When travel cruise switch is moved to ***cruise*** position, an input signal is sent to node 1 one controller. Node 4 controller sends a constant output signal to travel pumps to lock-in selected flow requirements and direction.

Moving 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 4 controller sends an output signal to travel pumps to open travel cruise circuit and return control of travel system to operator.

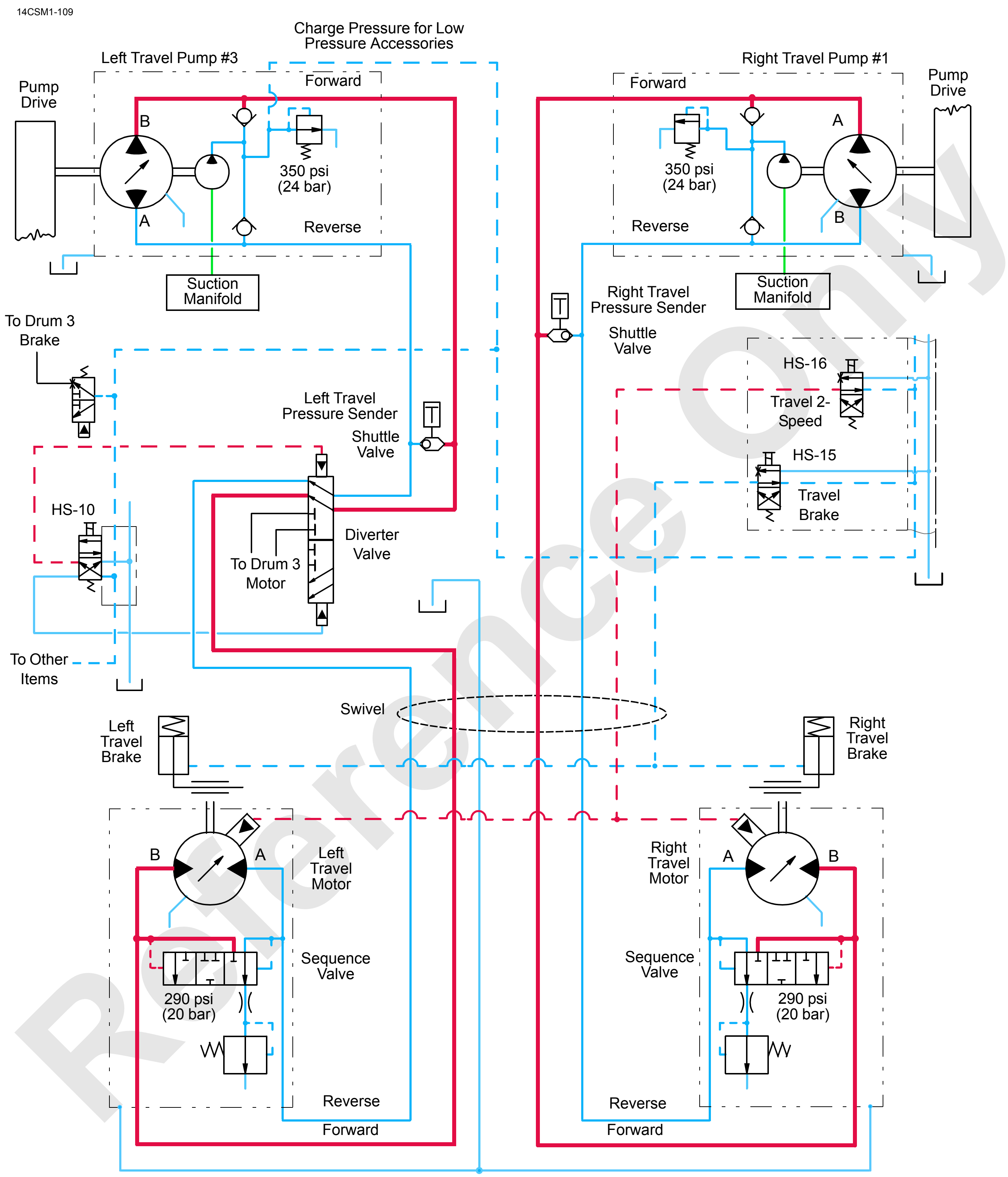
14CSM1-109
Charge Pressure for Low Pressure Accessories
Left Travel Pump #3
Pump Drive
Forward
B
350 psi (24 bar)
A
Reverse
Suction Manifold
To Drum 3 Brake
Left Travel Pressure Sender
Shuttle Valve
HS-10
Diverter Valve
To Drum 3 Motor
To Other Items
Right Travel Pump #1
Pump Drive
Forward
A
350 psi (24 bar)
B
Reverse
Suction Manifold
Right Travel Pressure Sender
Shuttle Valve
HS-16
Travel 2-Speed
HS-15
Travel Brake
Swivel
Left Travel Brake
Right Travel Brake
B
A
Left Travel Motor
Sequence Valve
290 psi (20 bar)
Reverse
Forward
Right Travel Motor
A
B
Sequence Valve
290 psi (20 bar)
Reverse
Forward
Reference Only

FIGURE 1-16

DRUM 4 (BOOM HOIST) SYSTEM

See Figures 1-17 and 1-18.

Drum 4 (boom hoist) is mounted at rear of rotating bed and controls the boom when crane is configured as a liftcrane. One hydraulic pump drives one motor gearbox at end of drum 4. Hydraulic connections between the pump and motor forms a closed-loop system that is controlled with control handle movement and node controllers. Drum 4 control handle is inoperable when park brake is applied.

In *liftcrane* configuration drum 4 (boom hoist) is controlled with control handle on left side console. In *luffing jib* configuration, boom hoist is controlled with control handle 3/4 on far right of right side console, while the luffing jib hoist is controlled by control handle on left side console.

Charge pressure from system pump supplies hydraulic make-up fluid to closed-loop. Low-side pressure supplies hydraulic pilot pressure to operate motor servo. A pressure sender in high-pressure side of system provides pressure information to node 1 controller. A fixed orifice between pump ports A and B allows for smooth drum operation.

When a drum motor rotates, a speed sensor mounted at motor monitors rotor movement and sends an input voltage to node 1 controller to control drum operation. Node 2 controller sends a 24 volt output to rotation indicator in control handle. As drum rotates, a rotation indicator on top of control handle pulsates with a varying frequency to indicate drum rotational speed. 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.

Drum 4 Brake and Pawl

Hydraulic pressure to operate drum 4 brake is from low-pressure side of system. Hydraulic charge pressure to operate drum pawl is from drum 3/left travel charge pump at approximately 350 psi (24 bar).

When drum 4 brake switch is in ***on - park*** position, brake release solenoid HS-11 is disabled to apply brake to drum 4 pawl ***in*** solenoid HS-12 is enabled to keep pawl engaged to drum flange. Drum 4 pump does not stroke in response to control handle movement.

When drum 4 brake switch is in ***off - park*** position, node 3 controller sends a zero volt output signal to disable pawl ***in*** solenoid HS-12 and a 24 volt output to enable pawl ***out*** solenoid HS-13 in the pawl out direction. Drum 4 brake remains applied to drum until node 3 controller sends a 24 volt output to brake solenoid HS-11 to release brake. Boom hoist circuit is active, waiting for a control handle command.

Raising Boom

When drum 4 control handle is moved back for booming ***up***, an input voltage of 2.4 volts or less is sent to node 1 controller. Node 4 controller sends a variable 0 to 24 volt output that is divided by resistors and applied to drum 4 pump EDC. Node 4 controller also sends a variable 0 to 24 volt output that is applied to motor PCP. Node 1 controller checks that boom up limit switch is closed and that no system fault is present.

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-11. Brake solenoid shifts to block drain port and opens port to low-pressure side of system to release drum 4 brake.

Pump EDC tilts swashplate in ***up*** direction as hydraulic fluid flow is from pump outlet port A to motor inlet port. Return fluid is from motor outlet port to pump inlet port B.

Node 4 controller output voltage to pump EDC and motor PCP is relative to control handle movement. As control handle is moved back, pump swashplate angle is increased. When system pressure exceeds the ECOR (Electric Compensating Over-Ride) valve setting of 3600 psi (248 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The ECOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When ECOR valve closes, control of motor returns to servo PC valve.

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

When drum 4 control handle is moved toward neutral position, node 1 controller compensates for hydraulic system leakage or changing engine speed. This shifts motor back to maximum displacement for slower output speed to slow drum rotation.

When drum 4 control handle is moved to neutral position, node 4 controller sends a zero output voltage to pump EDC that moves swashplate to center position. Node 1 controller stores 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-11. 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 4 controller sends a zero volt output to pump EDC to de-stroke pump.

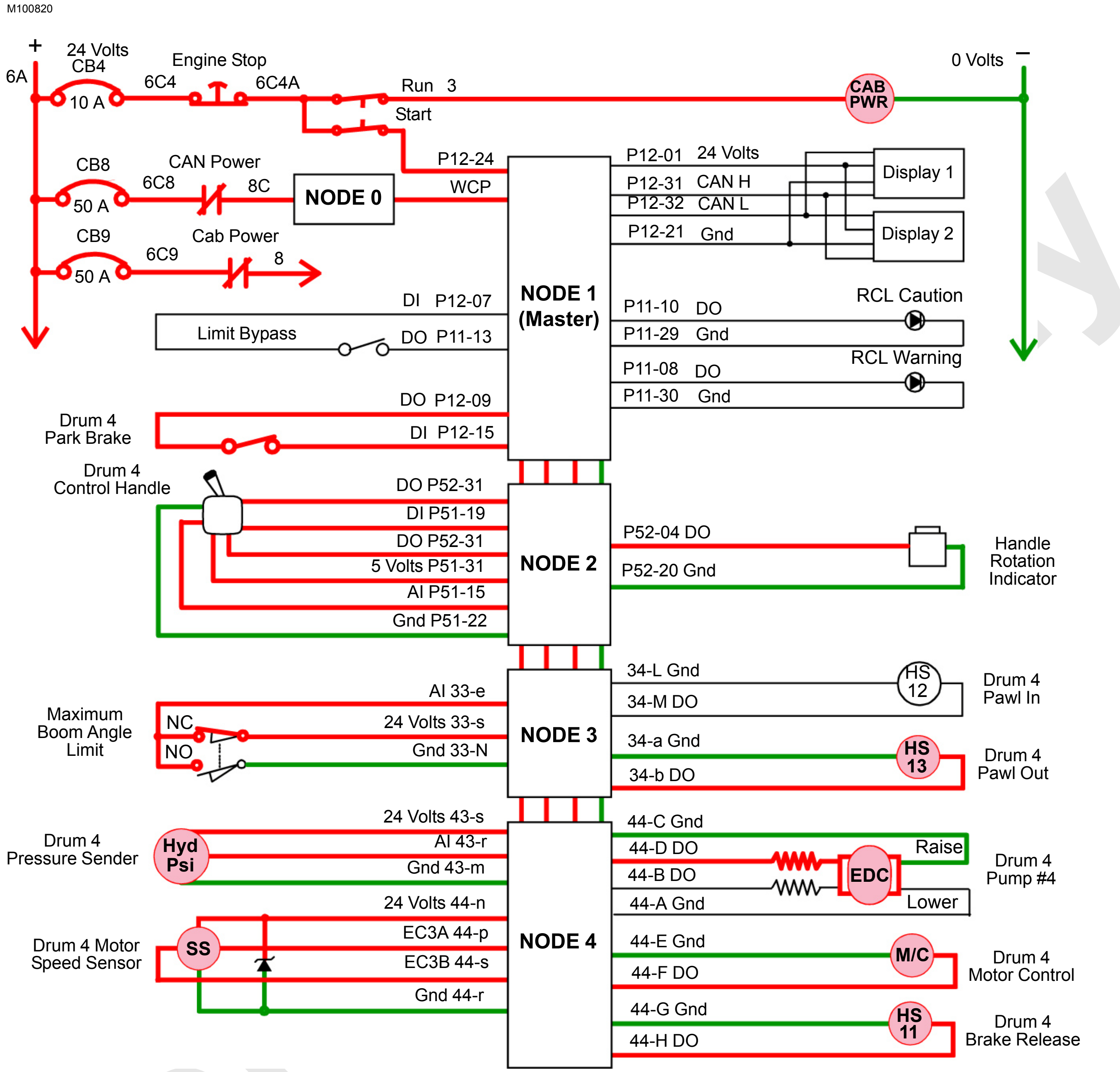

FIGURE 1-17

Lowering Boom

When drum 4 control handle is moved forward for booming ***down***, an input voltage of 2.6 volts or more is sent to node 1 controller. Node 4 controller sends a variable 0 to 24 volt output that is divided by resistors and applied to pump EDC.

Node 4 controller also sends a variable 0 to 24 volt output that is applied to motor PCP. Node 1 controller checks that boom up limit switch is closed and that no system fault is present.

Pump EDC tilts swashplate in ***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-11. Brake solenoid shifts to block drain port and opens port to low-pressure side of system to release drum 4 brake.

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

Node 4 controller output voltage to pump EDC and to motor PCP is relative to control handle movement. As control handle is pushed forward, pump swashplate angle is increased. When system pressure exceeds the ECOR (Electric Compensating Over-Ride) valve setting of 3600 psi (248 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The ECOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When ECOR valve closes, control of the motor returns to servo PC valve.

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

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 1 controller compensates for hydraulic system leakage or changing engine speed. This shifts motor back to maximum displacement for slower output speed to slow drum rotation.

When control handle is moved to neutral position, node 4 controller sends a zero output voltage to drum 4 pump EDC that moves swashplate to center position. Node 1 controller stores 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-11. Drum 4 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 zero volt output to pump EDC to de-stroke pump.

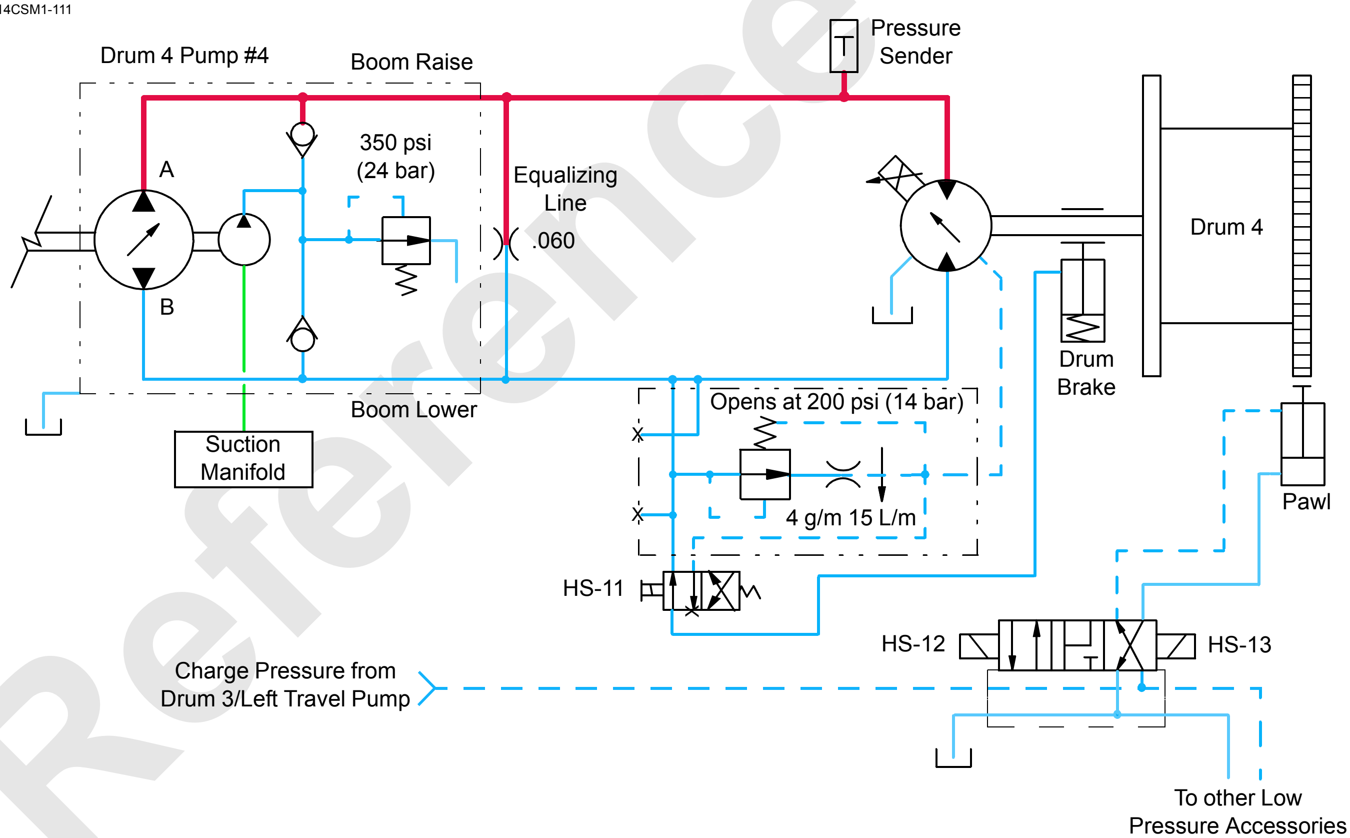

FIGURE 1-18

DRUM 1 (FRONT DRUM) SYSTEM

See Figures 1-19 and 1-20.

Drum 1 is located at front of rotating bed. One hydraulic pump drives one motor gearbox on end of drum. Hydraulic connections between and pump and motor forms a closed-loop system that is controlled with control handle movement and node controllers. The first load drum control handle on right side console operates drum 1. The control handle is inoperable when drum 1 park brake is applied. Low-pressure side of drum 1 pump is the pressure source for high pressure setup and accessory controls.

Charge pressure from system pump supplies hydraulic make-up fluid to closed-loop. Low-side pressure supplies hydraulic pilot pressure to operate motor servo. A pressure sender in high-pressure side of pump leg provides system pressure information to node 1 controller. A pressure sender in low-pressure side of pump leg provides accessory system information to node 1 controller. A fixed orifice between pump ports A and B allows for smooth drum operation.

When drum 1 motor rotates, a speed sensor at motor rotor (non free fall) or the drum flange (free fall) monitors and sends an input voltage to node 1 controller to control drum operation. 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. 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.

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-1 is disabled so brake is applied to drum shaft. Drum 1 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-1 remains applied. Brakes remain applied until node 3 controller sends a 24 volt output to release the brake. The drum circuit is active, waiting for a control handle command.

Raising Load

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 4 controller sends a variable 0 to 24 volt output that is divided by resistors and applied to drum 1 pump EDC in the raising direction. Node 3 controller sends a variable 0 to 24 volt output that is applied to drum 1 motor PCP. Node 1 controller checks that all limit switches are closed and that no system faults are present.

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 3 controller sends a 24 volt output to enable drum 1 brake release solenoid HS-1. Drum brake solenoid shifts to block drain port and opens port to low-pressure side of drum system to release brake from drum shaft.

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

Node 4 controller output voltage to pump EDC and node 3 controller output voltage to motor PCP is relative to control handle movement. As control handle is moved back, an output voltage increases pump swashplate angle.

When system pressure exceeds the ECOR (Electric Compensating Over-Ride) valve setting of 3600 psi (248 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The ECOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When ECOR valve closes, control of 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 hydraulic fluid flow through the pump.

When drum 1 control handle is moved toward neutral position, node 1 controller compensates for hydraulic system leakage or changing engine speed. This shifts motor back to maximum displacement for slower output speed to slow drum rotation.

When drum 1 control handle is moved to neutral position, node 4 controller sends a zero output voltage to pump EDC that moves swashplate to center position. Node 1 controller stores load holding pressure in pressure memory. After control handle center switch opens, node 3 controller sends a zero output to disable drum 1 brake release solenoid HS-1. 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 4 controller sends a zero volt output to pump EDC to de-stroke pump.

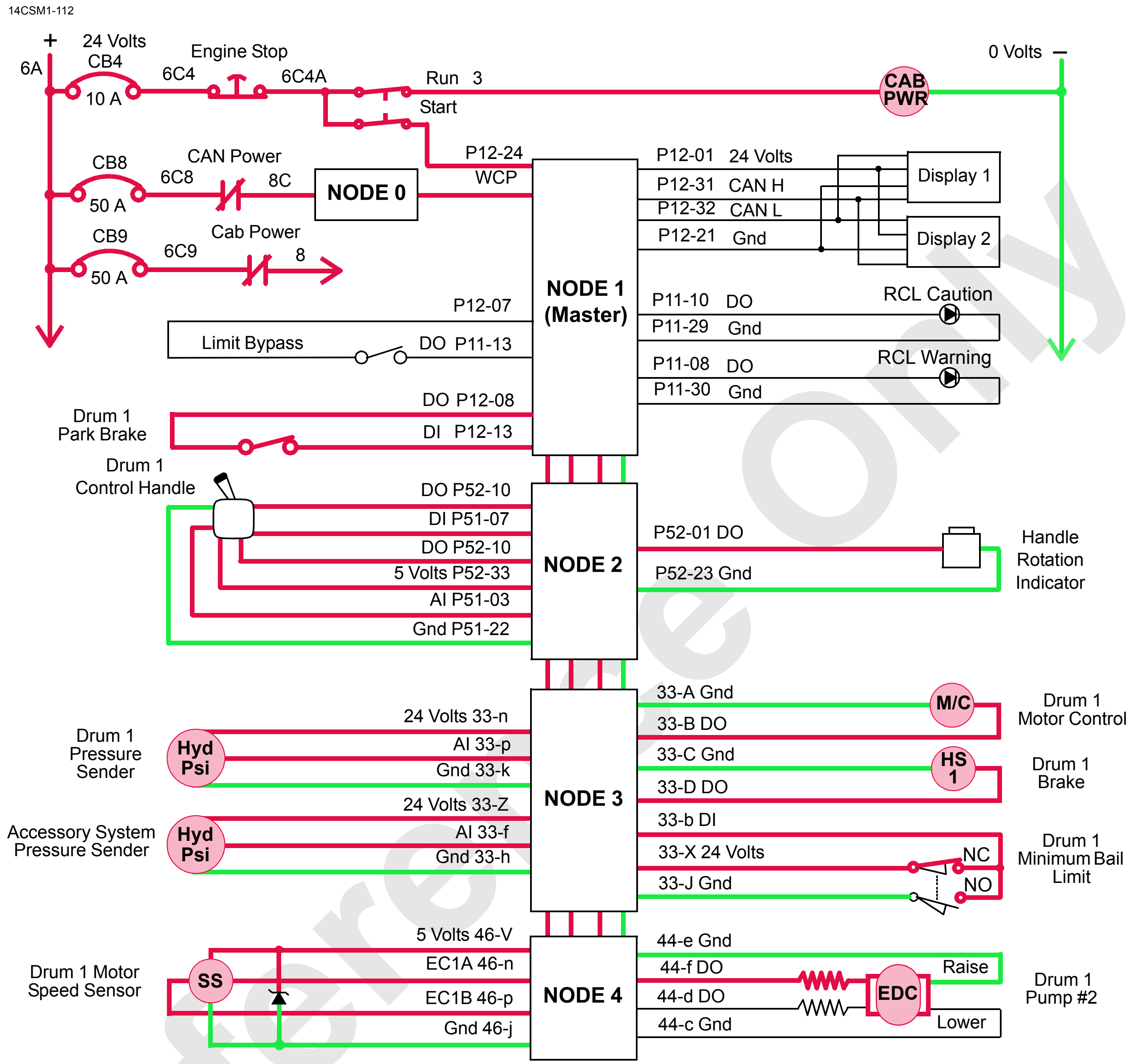
14CSM1-112
+
24 Volts
CB4
6A
10 A
Engine Stop
6C4
6C4A
Run 3
Start
0 Volts –
CAB PWR
CB8
CAN Power
6C8
8C
50 A
NODE 0
P12-24
WCP
CB9
Cab Power
6C9
8
50 A
NODE 1 (Master)
P12-01 24 Volts
P12-31 CAN H
P12-32 CAN L
P12-21 Gnd
Display 1
Display 2
P12-07
Limit Bypass
DO P11-13
P11-10 DO
P11-29 Gnd
RCL Caution
P11-08 DO
P11-30 Gnd
RCL Warning
DO P12-08
Drum 1 Park Brake
DI P12-13
Drum 1 Control Handle
DO P52-10
DI P51-07
DO P52-10
5 Volts P52-33
AI P51-03
Gnd P51-22
NODE 2
P52-01 DO
P52-23 Gnd
Handle Rotation Indicator
NODE 3
33-A Gnd
33-B DO
M/C
Drum 1 Motor Control
33-C Gnd
33-D DO
HS 1
Drum 1 Brake
33-b DI
33-X 24 Volts
33-J Gnd
NC
NO
Drum 1 Minimum Bail Limit
24 Volts 33-n
AI 33-p
Gnd 33-k
Drum 1 Pressure Sender
Hyd Psi
24 Volts 33-Z
AI 33-f
Gnd 33-h
Accessory System Pressure Sender
Hyd Psi
5 Volts 46-V
EC1A 46-n
EC1B 46-p
Gnd 46-j
Drum 1 Motor Speed Sensor
SS
NODE 4
44-e Gnd
44-f DO
44-d DO
44-c Gnd
EDC
Raise
Lower
Drum 1 Pump #2

FIGURE 1-19

Lowering Load

See Figures 1-19 and 1-20.

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 4 controller sends a variable 0 to 24 volt output that is divided by resistors and applied to pump 4 EDC in ***raising*** direction. Node 3 controller sends a variable 0 to 24 volt output that is applied to motor PCP. Node 1 controller checks that all limit switches are closed and that 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 3 controller sends a 24 volt output to enable drum 1 brake release solenoid HS-1. Drum brake solenoid shifts to block drain port and opens port to low-pressure side of drum 1 system to release brake from drum shaft.

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

Node 4 controller output voltage to pump EDC and node 3 controller output voltage to motor PCP is relative to control handle movement. As control handle is moved back, an output voltage increases pump swashplate angle.

When system pressure exceeds the ECOR (Electric Compensating Over-Ride) valve setting of 3600 psi (248 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The ECOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When ECOR 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 hydraulic fluid flow through the pumps.

When drum 1 control handle is moved toward neutral position, node 1 controller compensates for hydraulic system leakage or changing engine speed. This shifts motor back to maximum displacement for slower output speed to slow drum rotation.

When drum 1 control handle is moved to neutral position, node 4 controller sends a zero output voltage to pump EDC that moves swashplate to center position. Node 1 controller stores load holding pressure in pressure memory. After control handle center switch opens, node 3 controller sends a zero output to disable drum 1 brake release solenoid HS-1. 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 4 controller sends a zero volt output to pump EDC to de-stroke pump.

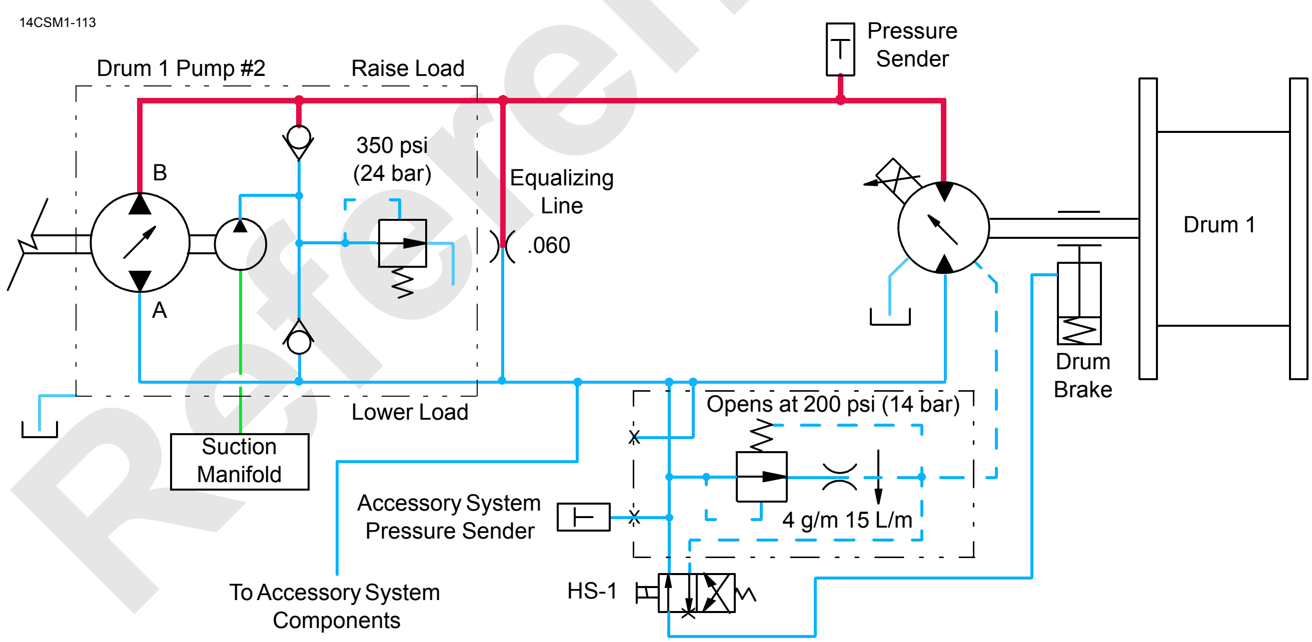

FIGURE 1-20

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DRUM 2 (REAR DRUM) SYSTEM

See Figures 1-21 and 1-22.

Drum 2 is located at the middle top of rotating bed. One hydraulic pump drives one motor gearbox on end of drum. Hydraulic connections between the pump and motor forms a closed-loop system that is controlled with control handle movement and node controllers. The center load drum control handle on right side console operates drum 2. The control handle is inoperable when drum 2 park brake is applied.

Charge pressure from system pump supplies hydraulic make-up fluid to closed-loop. Low-pressure side supplies hydraulic pilot pressure to operate motor servo. A pressure sender in high-pressure side of pump leg provides system pressure information to node 1 controller. A fixed orifice between pump ports A and B allows smooth drum operation.

When load drum 2 motor rotates, a speed sensor at motor rotor (non free fall) or the drum flange (free fall) monitors and sends an input voltage to node 1 controller to control drum operation. Node 2 controller sends an output voltage to rotation indicator in control handle. As drum rotates faster, rotation indicator on top of control handle pulsates with a varying frequency that indicates drum rotational speed. 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.

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-4 is disabled so brake is applied to 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-4 remains applied. Brake remains applied until node 4 controller sends a 24 volt output to release brake. Drum circuit is active, waiting for a control handle command.

Raising Load

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 4 controller sends a variable 0 to 24 volt output that is divided by resistors and applied to drum 2 pump EDC in the ***raising*** direction. Node 4 controller sends a variable 0 to 24 volt output that is 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 ***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 4 controller sends a 24 volt output to enable drum 2 brake release solenoid HS-4. Drum brake solenoid shifts to block drain port and opens port to low-pressure side of drum system to release brake from drum shaft.

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

Node 4 controller output voltage to pump EDC and 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 ECOR (Electric Compensating Over-Ride) valve setting of 3600 psi (248 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The ECOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When ECOR 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 pump.

When drum 2 control handle is moved to toward neutral position, node 1 controller compensates for hydraulic system leakage or changing engine speed. This shifts motor back to maximum displacement for slower output speed to slow drum rotation.

When drum 2 control handle is moved to neutral position, node 4 controller sends a zero output voltage to pump EDC that moves swashplate to center 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 drum 2 brake release solenoid HS-4. Drum brake solenoid valve shifts to block pilot pressure to brakes and opens a line to tank. When brake applies, an input signal is sent to node 1 controller. Node 4 controller sends a zero volt output to pump EDC to de-stroke pump.

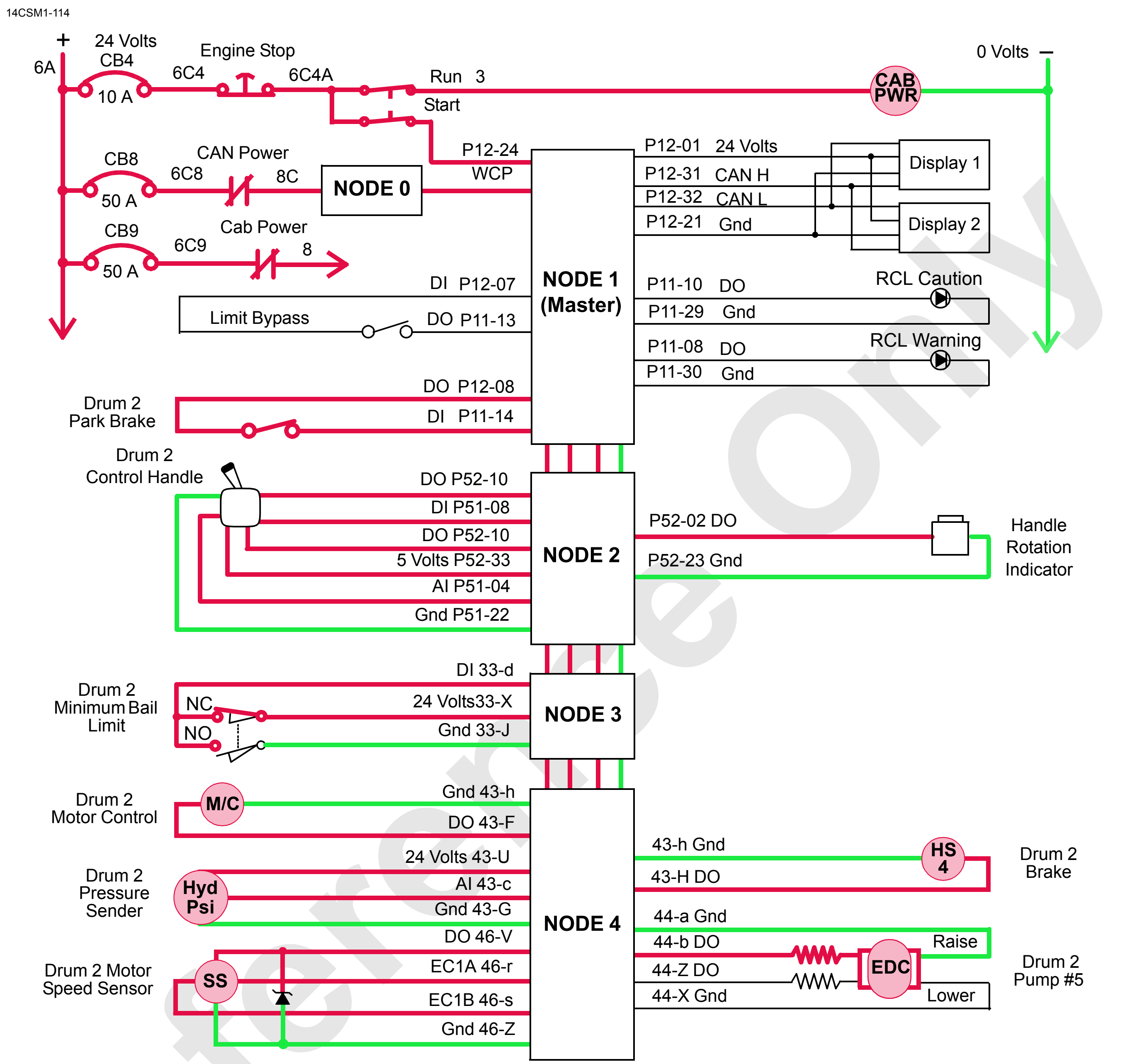
14CSM1-114
+ 24 Volts
6A
CB4
10 A
Engine Stop
6C4
6C4A
Run 3
Start
CAB PWR
0 Volts –
CB8
CAN Power
6C8
8C
50 A
NODE 0
P12-24
WCP
CB9
Cab Power
6C9
8
50 A
DI P12-07
Limit Bypass
DO P11-13
NODE 1 (Master)
P12-01 24 Volts
P12-31 CAN H
P12-32 CAN L
P12-21 Gnd
Display 1
Display 2
P11-10 DO
RCL Caution
P11-29 Gnd
P11-08 DO
RCL Warning
P11-30 Gnd
DO P12-08
Drum 2 Park Brake
DI P11-14
Drum 2 Control Handle
DO P52-10
DI P51-08
DO P52-10
5 Volts P52-33
AI P51-04
Gnd P51-22
NODE 2
P52-02 DO
P52-23 Gnd
Handle Rotation Indicator
DI 33-d
Drum 2 Minimum Bail Limit
NC
NO
24 Volts33-X
Gnd 33-J
NODE 3
Drum 2 Motor Control
M/C
Gnd 43-h
DO 43-F
Drum 2 Pressure Sender
Hyd Psi
24 Volts 43-U
AI 43-c
Gnd 43-G
DO 46-V
Drum 2 Motor Speed Sensor
SS
EC1A 46-r
EC1B 46-s
Gnd 46-Z
NODE 4
43-h Gnd
HS 4
43-H DO
Drum 2 Brake
44-a Gnd
44-b DO
Raise
EDC
44-Z DO
44-X Gnd
Lower
Drum 2 Pump #5

FIGURE 1-21

Lowering Load

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 0 to 24 volt output that is divided by resistors and applied to drum 2 pump EDC in ***raising*** direction. Node 4 controller sends a variable 0 to 24 volt output that is 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 ***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 4 controller sends a 24 volt output to enable drum 2 brake release solenoid HS-4. Drum brake solenoid shifts to block drain port and opens port to low-pressure side of drum system to release brake from drum shaft.

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

Node 4 controller output voltage to pump EDC and 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 ECOR (Electric Compensating Over-Ride) valve setting of 3600 psi (248 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The ECOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When ECOR 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 pump.

When drum 2 control handle is moved toward neutral position, node 1 controller compensates for hydraulic system leakage or changing engine speed. This shifts motor back to maximum displacement for slower output speed to slow drum rotation.

When drum 2 control handle is moved to neutral position, node 4 controller sends a zero output voltage to pump EDC that moves swashplate to center position. Node 1 controller stores 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-4. Drum brake solenoid valve shifts to block pilot pressure to brakes and opens a line to tank. When brake applies, an input signal is sent to node 1 controller. Node 4 controller sends a zero volt output to pump EDC to de-stroke pump.

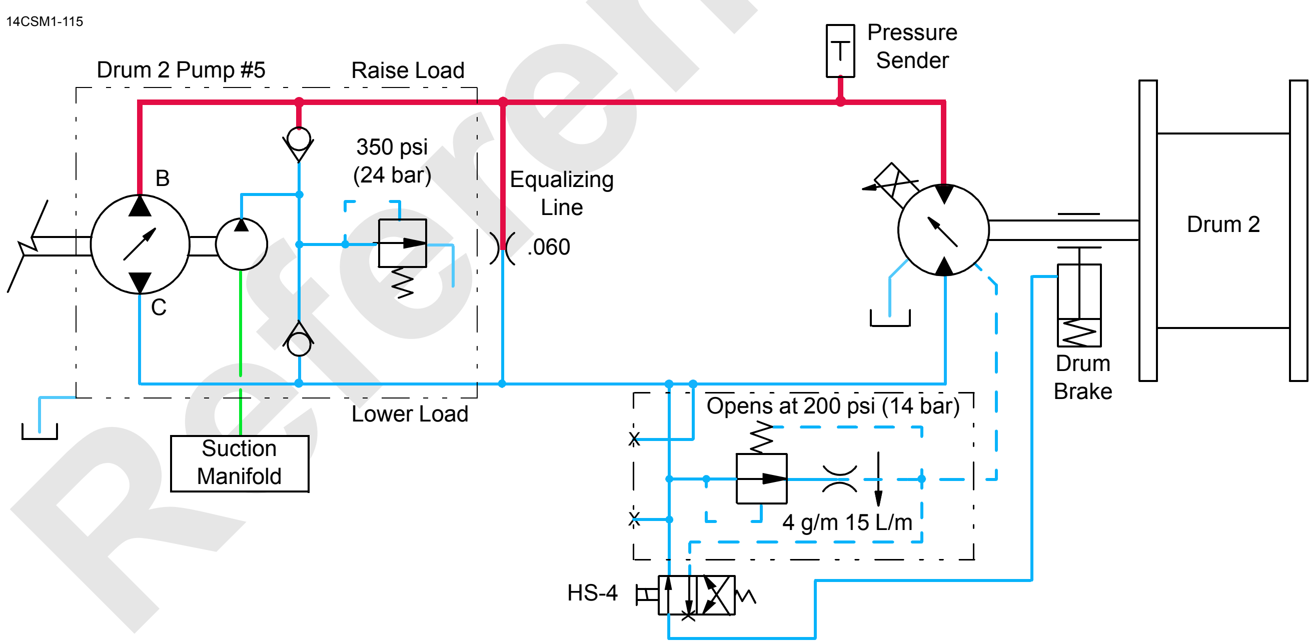

FIGURE 1-22

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DRUM 1 AND DRUM 2 - FREE FALL (OPTIONAL)

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

The front drum, rear drum or both drums can be equipped with free fall option. In free fall, the left clutch/brake pedal operates the front drum while right clutch/brake pedal operates the rear drum when lowering the load. When *hoisting* in free fall, the drum control handles operate the same as in normal operation. See Drum 1 and Drum 2 System topics for a description of front and rear drum operation.

An engine-driven hydraulic gear pump supplies hydraulic fluid at 3,000 psi (207 bar) to operate front/rear drum free fall systems.

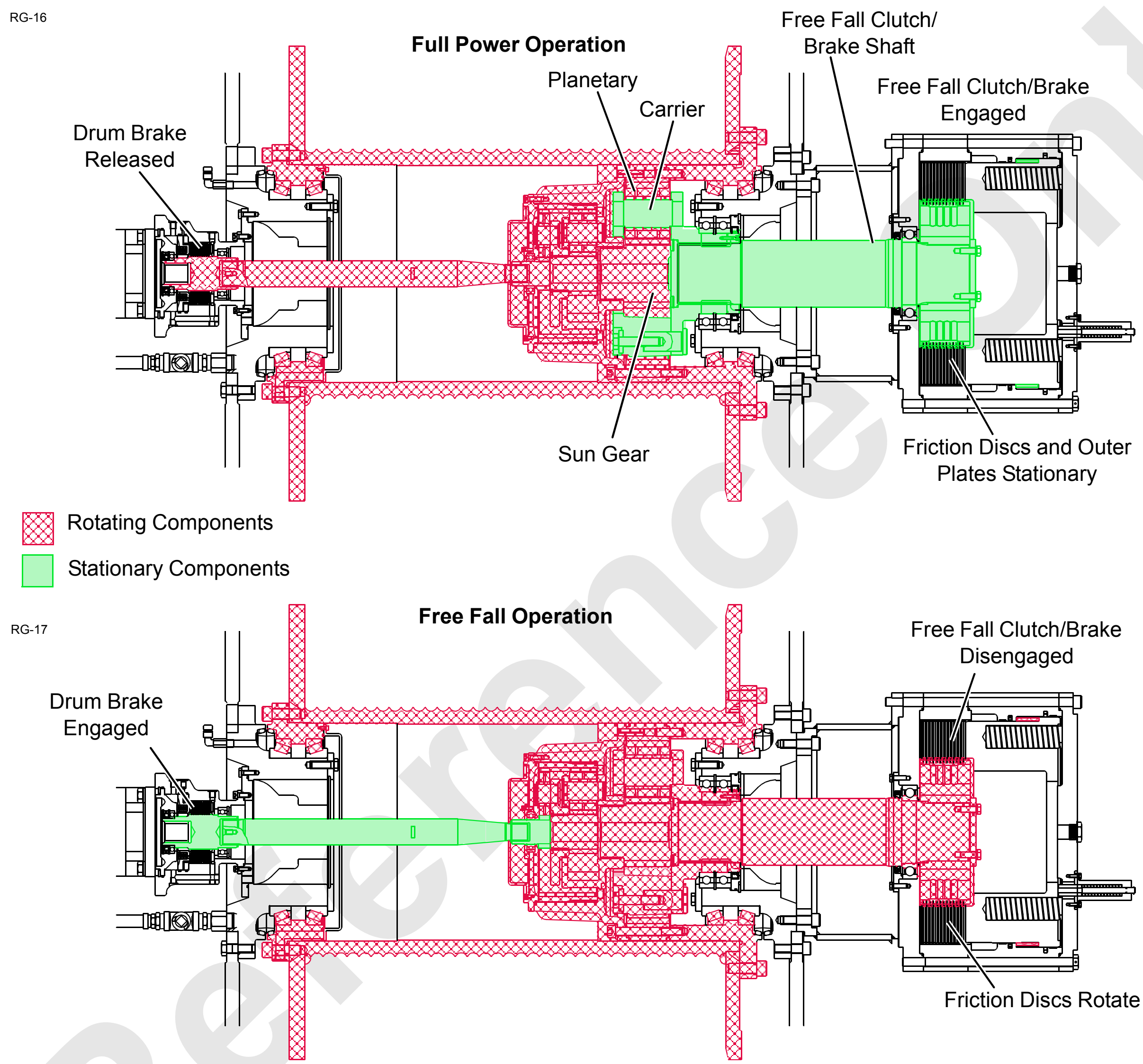


FIGURE 1-23

When free fall is not active, hydraulic fluid flows through the freefall enable directional control valve to tank. System pressure is not high enough to release spring-applied clutch/brakes. A pressure sender for each free fall drum in manifold provides system pressure information to node-1 controller.

Front or rear drum pump and motor case drains are connected together and routed to system drum clutch/brake housing. Case drain cooling fluid enters the center of clutch/brake housing and exits at top of housing. From clutch/brake housing outlet the cooling fluid returns to tank.

When clutch/brake is applied, the shaft is engaged with drum planetary gears (Figure 1-23). In full power, the drum is powered from the motor shaft through planetary gears to rotate the drum. The free fall clutch/brake shaft is attached to the third planet gear carrier and does not rotate when operating in full power.

Clutch/brake pedal can remain applied during normal operation as clutch/brake pedal is disabled until the node-3 controller selects free fall.

Clutch/brake springs are hydraulically released by the clutch/brake pedal and the node-3 controller. The clutch/brake shaft and third planet gear carrier are free to rotate, allowing drum to free fall around main drive shaft (Figure 1-23). Clutch/brake pedal pressure controls drum speed as the clutch/brake proportional valve controls releasing spring pressure to friction discs and outer plates of the clutch/brake.

Free Fall — Hoisting

See Figures 1-24 and 1-25.

The following description is for *front* drum while operating in free fall. Operation of rear drum is the same, except for different drum, brake, pawl and clutch/brake.

Front drum hoisting in free fall operates the same as full power (See Drum 1 (Front Drum) System topic). When hoisting the load, free fall clutch/brake is applied.

WARNING

Falling Load Hazard

When operating in free fall, load will lower uncontrolled if front drum clutch/brake pedal is not applied.

Be ready to apply drum clutch/brake pedal so lowering speed can be controlled and load can be stopped immediately, when necessary.

Begin applying front free fall drum clutch/brake pedal as control handle is moved to neutral position. When control handle neutral switch opens, an input signal to node-1 controller. Node-3 controller sends a zero output voltage to disable drum 1 brake solenoid valve HS-1 and to apply drum brake before pump de-strokes.

Free Fall — Lowering

See Figures 1-24 and 1-25.

When front drum brake is applied, node-3 controller sends a 24 volt output signal to shift free fall enable solenoid valve HS-6, blocking flow to tank.

WARNING

Falling Load Hazard

When operating in free fall, load will lower uncontrolled if front drum clutch/brake pedal is not applied.

Be ready to apply front drum clutch/brake pedal so lowering speed can be controlled and load can be stopped immediately, when necessary.

When the front clutch/brake pedal is released, an input signal is sent to the node-1 controller. Node-3 controller sends a variable 0 to 24 volt output signal to the front drum clutch/brake proportional valve HS-2. Up to 3,000 psi (207 bar) of pressure pushes against piston to start compressing clutch/brake springs to release the clutch/brake.

Hydraulic pressure to piston is in direct proportion to clutch/brake pedal movement as controlled by node-1 and node-3 controllers. The clutch/brake proportional valve HS-2 pulsates on/off between brake and tank, depending on command or back-pressure. Moving clutch/brake pedal fully applies clutch/brake without slipping.

CAUTION

Clutch/Brake Motor Damage

Do not move a drum handle in either direction from neutral while a load is free falling. First stop the load with drum clutch/brake pedal. Damage to clutch/brake and/or motor drive system could occur.

Do not turn free fall off or turn off drum brake while a load is free falling. Stop loads with clutch/brake pedal, then turn free fall off or turn off drum brake.

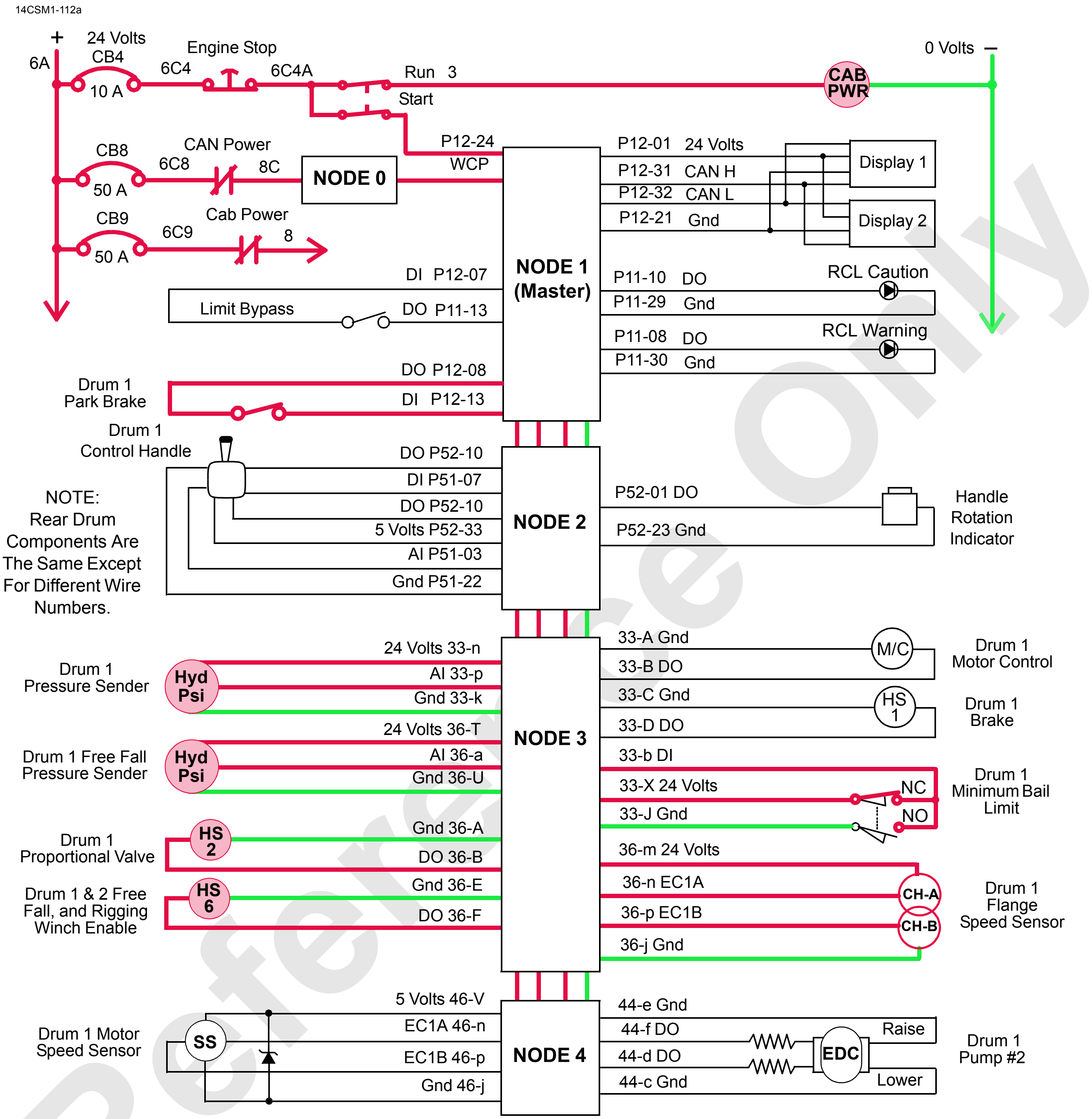

14CSM1-112a
+
6A
24 Volts
CB4
10 A
Engine Stop
6C4
6C4A
Run 3
Start
0 Volts –
CAB PWR
CB8
CAN Power
6C8
8C
50 A
NODE 0
P12-24
WCP
CB9
Cab Power
6C9
8
50 A
P12-01 24 Volts
P12-31 CAN H
P12-32 CAN L
P12-21 Gnd
Display 1
Display 2
NODE 1 (Master)
DI P12-07
Limit Bypass
DO P11-13
P11-10 DO
P11-29 Gnd
RCL Caution
P11-08 DO
P11-30 Gnd
RCL Warning
Drum 1 Park Brake
DO P12-08
DI P12-13
Drum 1 Control Handle
DO P52-10
DI P51-07
DO P52-10
5 Volts P52-33
AI P51-03
Gnd P51-22
NODE 2
P52-01 DO
P52-23 Gnd
Handle Rotation Indicator
NOTE: Rear Drum Components Are The Same Except For Different Wire Numbers.
Drum 1 Pressure Sender
Hyd Psi
24 Volts 33-n
AI 33-p
Gnd 33-k
Drum 1 Free Fall Pressure Sender
Hyd Psi
24 Volts 36-T
AI 36-a
Gnd 36-U
NODE 3
33-A Gnd
33-B DO
M/C
Drum 1 Motor Control
33-C Gnd
33-D DO
HS 1
Drum 1 Brake
33-b DI
33-X 24 Volts
33-J Gnd
NC
NO
Drum 1 Minimum Bail Limit
Drum 1 Proportional Valve
HS 2
Gnd 36-A
DO 36-B
Drum 1 & 2 Free Fall, and Rigging Winch Enable
HS 6
Gnd 36-E
DO 36-F
36-m 24 Volts
36-n EC1A
36-p EC1B
36-j Gnd
CH-A
CH-B
Drum 1 Flange Speed Sensor
Drum 1 Motor Speed Sensor
SS
5 Volts 46-V
EC1A 46-n
EC1B 46-p
Gnd 46-j
NODE 4
44-e Gnd
44-f DO
44-d DO
44-c Gnd
EDC
Raise
Lower
Drum 1 Pump #2
Reference Only

FIGURE 1-24

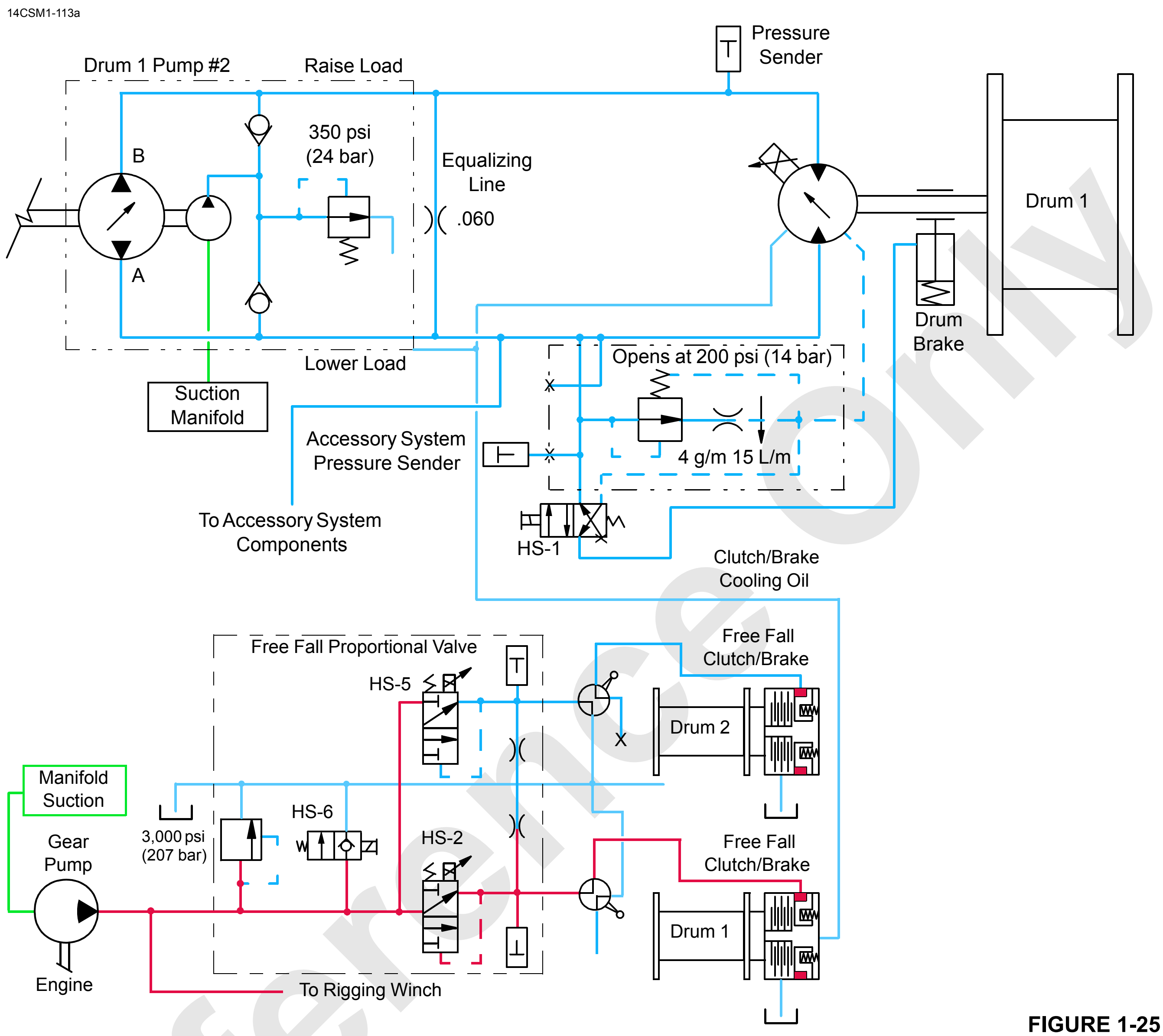

14CSM1-113a
Drum 1 Pump #2
Raise Load
Pressure
Sender
B
350 psi
(24 bar)
Equalizing
Line
.060
Drum 1
A
Drum
Brake
Lower Load
Opens at 200 psi (14 bar)
Suction
Manifold
Accessory System
Pressure Sender
4 g/m 15 L/m
To Accessory System
Components
HS-1
Clutch/Brake
Cooling Oil
Free Fall Proportional Valve
Free Fall
Clutch/Brake
HS-5
Drum 2
Manifold
Suction
HS-6
Gear
Pump
3,000 psi
(207 bar)
HS-2
Free Fall
Clutch/Brake
Drum 1
Engine
To Rigging Winch

FIGURE 1-25

DRUM 3 (AUXILIARY/LUFFING JIB) SYSTEM

See Figures 1-26 and 1-27.

Drum 3 is located in the boom butt. Drum 3 can be configured for either luffing jib operation or as an auxiliary load 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 end of drum shaft. The left travel pump is dedicated to operate drum 3 though a diverging valve. Left travel and drum 3 can not be operated at the same time. Hydraulic connections between and pump and motor form a closed-loop system that is controlled with control handle movement and node controllers.

The far load drum control handle 3/4 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 and the boom hoist operates with far load drum control handle 3/4 on the right side console. Drum 3 control handle is inoperable when drum 3 park brake is applied.

Charge pressure from system pump supplies hydraulic make-up fluid to closed-loop. Low-side pressure supplies hydraulic pilot pressure to operate motor servo. A pressure sender in high-pressure side of pump leg provides system pressure information to node 1 controller. A fixed orifice between pump ports A and B allows for smooth drum operation.

When drum 3 motor rotates, a speed sensor at motor rotor monitors and sends an input voltage to node 1 controller to control drum operation. 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. 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.

Drum 3 Brake and Pawl

Hydraulic pressure to operate drum 3 brake and drum pawl is from low-pressure side of system. When drum 3 brake switch is in ***on - park*** position, drum brake release solenoid HS-7 is disabled so brake is applied to drum shaft. Drum 3 pawl ***in*** solenoid HS-9 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-7 remains applied until node 3 controller sends a 24 volt output to release the brake. Node 3 controller also sends a zero volt output signal to drum 3 pawl ***in*** solenoid HS-9 and a 24 volt output to enable pawl ***out*** solenoid HS-8 to release pawl. Drum 3 circuit is active, waiting for a control handle command.

Raising

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 3 controller sends a 24 volt output to enable drum 3/left travel diverting solenoid HS-10 to shift selector valve to open port to drum 3 motor and close port to left travel motor. This also shifts directional control valve to open port to drum 3 pawl solenoid. Node 3 controller sends a 24 volt output to enable drum 3 pawl out solenoid HS-08 to shift valve and open port to disengage pawl.

Node 4 controller sends a variable 0 to 24 volt output that is divided by resistors and applied to drum 3 pump EDC in the ***raising*** direction. Node 3 controller sends a variable 0 to 24 volt output that is applied to drum 3 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 ***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 3 controller sends a 24 volt output to enable drum 3 brake release solenoid HS-7. Drum brake solenoid shifts to block drain port and opens port to low-pressure side of drum system to release brake from drum shaft.

Drum 3 pump EDC tilts swashplate in ***raising*** direction as hydraulic fluid flow is from pump outlet port B to motor inlet port. Return fluid flow is from motor outlet port to pump inlet port A.

Node 4 controller output voltage to pump EDC and node 3 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 ECOR (Electric Compensating Over-Ride) valve setting of 3600 psi (248 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The ECOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When ECOR 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 hydraulic fluid flow through the pump.

When drum 3 control handle is moved to toward neutral position, node 1 controller compensates for hydraulic system leakage or changing engine speed. 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 4 controller sends a zero output voltage to pump EDC that moves swashplate to center position. Node 1 controller stores the load holding pressure in pressure memory. After drum 3 control handle center switch opens, node 3 controller sends a zero output voltage to disable drum brake release solenoid HS-7. Drum brake solenoid valve shifts to block pilot pressure to brake and opens a line to tank. Brake applies before drum pump de-stroke.

Drum 3/left travel to diverting solenoid HS-10 remains enabled until left travel handle is moved.

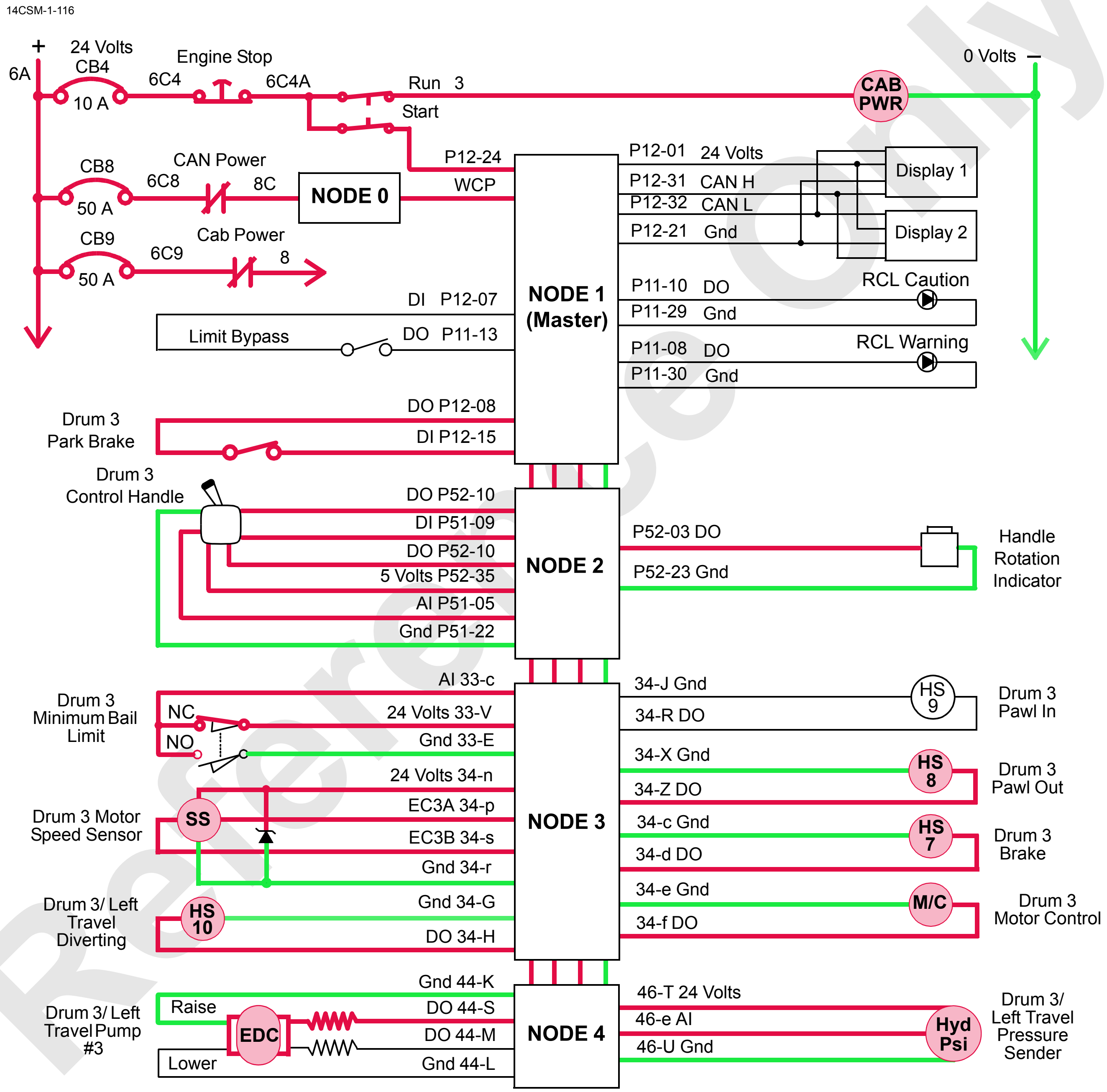


FIGURE 1-26

Lowering

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 drum 3/left travel diverting solenoid HS-10. Node 3 controller sends a variable 0 to 24 volt output that is divided by resistors and applied to drum 3 pump EDC in ***raising*** direction. Node 3 controller sends a variable 0 to 24 volt output that is applied to drum 3 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 ***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 3 controller sends a 24 volt output to enable drum 3 brake release solenoid HS-7. Drum brake solenoid shifts to block drain port and opens port to low-pressure side of drum system to release brake from drum shaft.

Drum 3 pump EDC tilts swashplate in ***lowering*** direction as hydraulic fluid flow is from pump outlet port A to motor inlet port. Return fluid is from motor outlet port to pump inlet port B.

Node 4 controller output voltages to pump EDC and node 3 controller output voltage to motor PCP is relative to control handle movement. As control handle is moved back, an output voltage increases pump swashplate angle.

When system pressure exceeds the ECOR (Electric Compensating Over-Ride) valve setting of 3600 psi (248 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The ECOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When ECOR 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 hydraulic fluid flow through the pump.

When drum 3 control handle is moved toward neutral position, node 1 controller compensates for hydraulic system leakage or changing engine speed. This shifts motor back to maximum displacement for slower output speed to slow drum rotation.

When control handle is moved to neutral position, node 4 controller sends a zero output voltage to pump EDC that moves swashplate to center position. Node 1 controller stores the load holding pressure in pressure memory. After control handle center switch opens, Node 3 controller sends a zero output to disable brake release solenoid HS-7. 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 zero volt output to drum 3 pump EDC to de-stroke pump.

Drum 3/left travel diverting solenoid HS-10 remains enabled until left travel handle is moved.

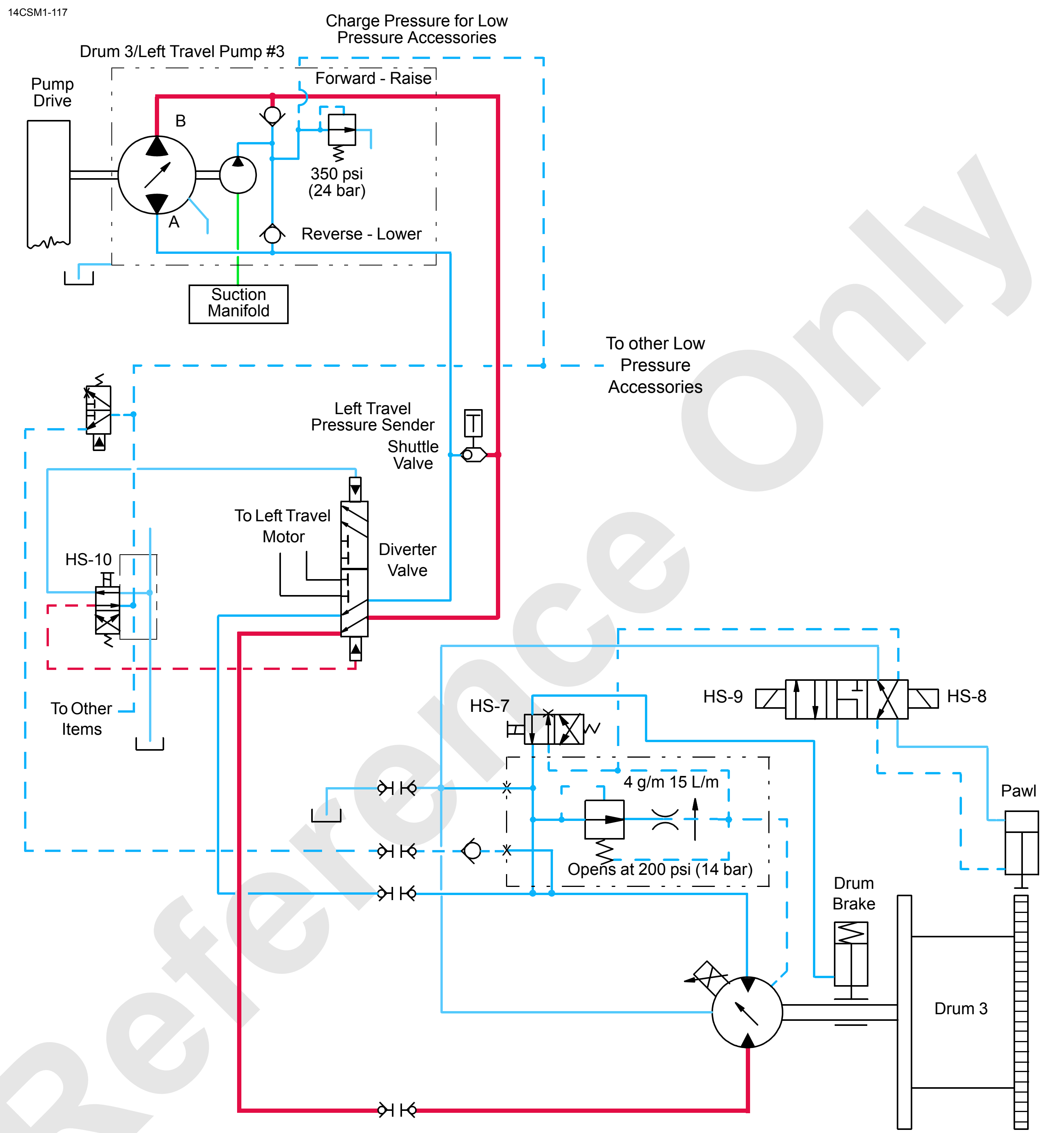

14CSM1-117
Charge Pressure for Low Pressure Accessories
Drum 3/Left Travel Pump #3
Pump Drive
Forward - Raise
B
350 psi (24 bar)
A
Reverse - Lower
Suction Manifold
To other Low Pressure Accessories
Left Travel Pressure Sender
Shuttle Valve
To Left Travel Motor
Diverter Valve
HS-10
To Other Items
HS-7
HS-9
HS-8
4 g/m 15 L/m
Opens at 200 psi (14 bar)
Pawl
Drum Brake
Drum 3

FIGURE 1-27

UPPER ACCESSORY SYSTEM

Upper accessory system components includes gantry cylinders, mast raising cylinders, boom hinge pin cylinder, and cab tilt cylinder. Lower accessory system components includes crawler pins and four carbody jacks.

When a high pressure accessory system component is enabled, an input signal is sent to node 1 controller. Node 1 controller sends a variable 0 to 24 volt signal to low-pressure side of drum 1 pump EDC. Drum 1 pump provides system pressure of up to 4,000 psi (275 bar) depending on system enabled.

Gantry System

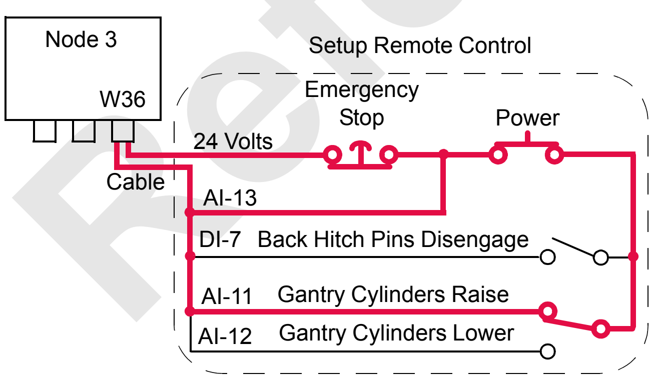
See Figures 1-28, 1-29, and 1-30.

Each gantry cylinder has a counterbalance valve at each cylinder port. These valves ensure smooth control when raising or lowering gantry and locks cylinder in place when gantry is at a desired position or if a hydraulic line fails. Gantry accessory valve is *motor spool* where both cylinder ports and tank port of valve spool section are connected in center position. This prevents premature opening of load equalizing valves. The accessory system pressure sender monitors accessory system pressure.

Gantry raising and lowering is controlled by gantry cylinders switch on setup remote control. Power is available to setup remote control when cable is plugged into W36 receptacle on node 3, remote control ***on*** is selected on remote control function screen, and engine is running.

Select a liftcrane mast capacity chart when using gantry for setup. Mast and gantry controls will not operate properly and mast operating limits will remain off until proper capacity chart is selected.

Remove existing W36 cable and plug setup remote cable into receptacle. Pressing power button completes power supply circuit to setup remote control switches.



14CSM1-118

FIGURE 1-28

A gantry down fault appears on Main display, Information screen if gantry maximum limit switch circuit is not closed. Raise gantry with gantry cylinders switch until gantry maximum limit switch is closed.

Gantry Cylinders Raise

NOTE: Gantry back hitch pins must be disengaged before raising or lowering gantry. See Back Hitch Pin Cylinders topic in this section. The mast will raise with gantry.

Move gantry cylinders toggle ***up*** and hold to ***raise*** gantry (extend cylinders). An input voltage is sent to node 1 controller. Node 3 controller sends a 24 volt output to enable gantry cylinders raise solenoid HS-24 and shifts valve to ***raise*** position. Solenoid valve shifts to block tank port and open port to low-pressure side of drum 1 pump. Node 4 controller sends a variable 0 to 24 volt output to enable low-pressure side of drum 1 pump EDC.

Hydraulic fluid from low-pressure side of drum 1 pump flows to gantry cylinder raise solenoid HS-24 of upper accessory valve and through free-flow check valve sections on side A of load equalizing valve. From equalizing valve, fluid enters counterbalance valves and piston end of gantry cylinders, extending cylinder rods to raise gantry.

Free-flow check valve sections on side B of counterbalance valves block fluid exhausting from rod end of gantry cylinders. Fluid passes through flow restrain sections of counterbalance valve that have a relief setting of 3,500 psi (240 bar). Counterbalance valves act as a deceleration control and operate with a 5:1 pilot ratio of the relief valve pressure, permitting the valves to open when pressure in the piston end of cylinders is approximately 700 psi (48 bar). Exhaust fluid from side B of both counterbalance valves combines and fluid passes through non-restrictive part of load equalizing valve before entering accessory system valve. Hydraulic fluid exits through the gantry valve section and returns to tank.

Free-flow check valve sections on side B of load equalizing valve block the flow. Hydraulic fluid then passes through flow restrain section of valve that is preset at 4,000 psi (275 bar). Load equalizing valve operates with a 1.5:1 pilot ratio of the relief valve pressure, permitting valve to open when fluid pressure on side A of the valve is approximately 2680 psi (185 bar). Restraining section on side B of load equalizing valve opens, controlling fluid out of both cylinders and ensuring cylinder actuation is balanced.

When gantry is fully raised the back hitch pins automatically engage and gantry maximum limit switch closes sending an input signal node 1 controller. Node 4 controller sends a zero volt output signal to drum 1 pump EDC to de-stroke the pump. Node 3 controller sends an output signal to shift gantry cylinder raise solenoid HS-24 to center position. The next step in sequence is raising mast (see Mast System topic in this section).

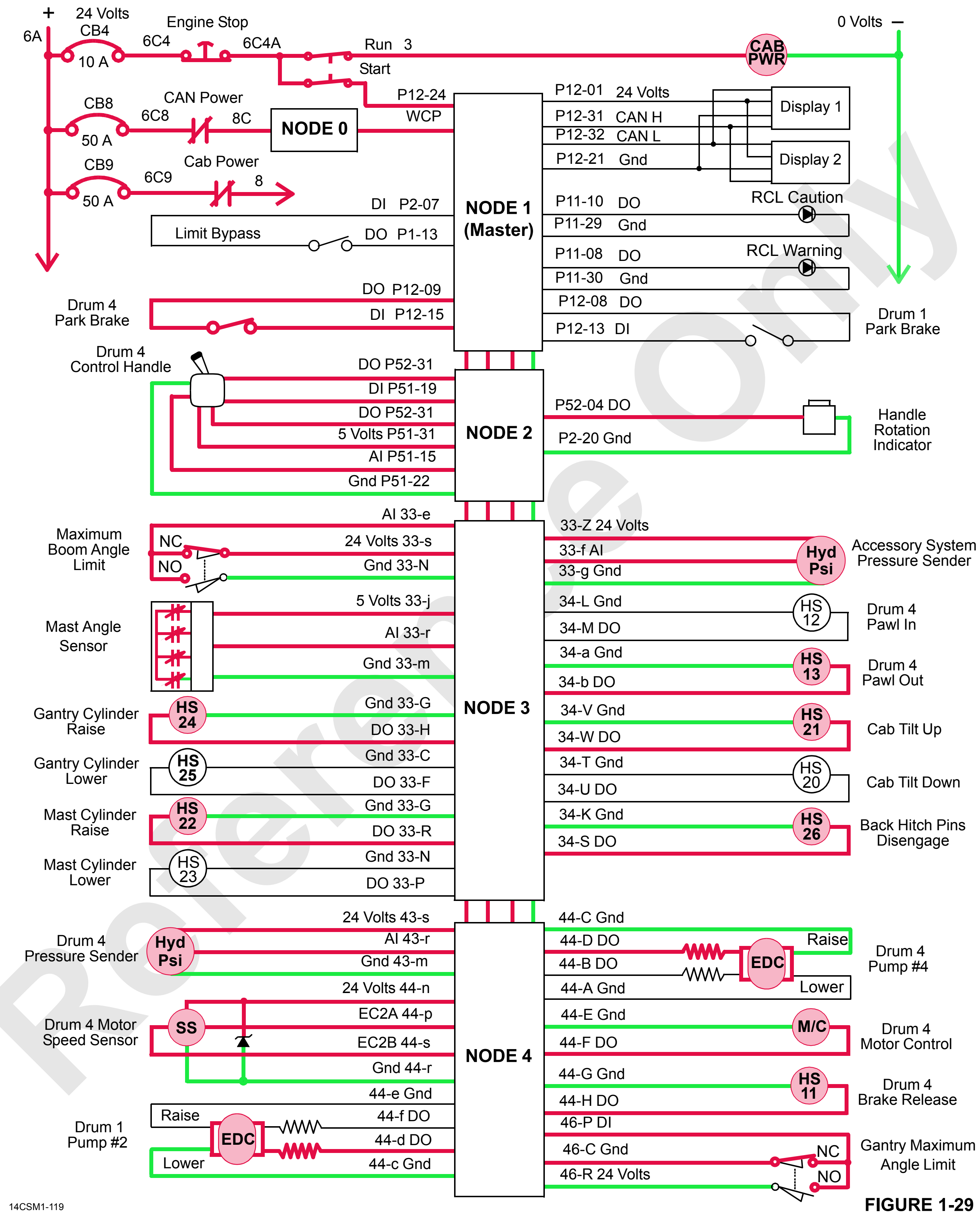

24 Volts
CB4
6A
10 A
Engine Stop
6C4
6C4A
Run 3
Start
0 Volts
CAB PWR
CB8
CAN Power
6C8
8C
50 A
NODE 0
CB9
Cab Power
6C9
8
50 A
P12-24
WCP
NODE 1 (Master)
P12-01 24 Volts
P12-31 CAN H
P12-32 CAN L
P12-21 Gnd
Display 1
Display 2
DI P2-07
Limit Bypass
DO P1-13
P11-10 DO
P11-29 Gnd
RCL Caution
P11-08 DO
P11-30 Gnd
RCL Warning
DO P12-09
DI P12-15
Drum 4 Park Brake
P12-08 DO
P12-13 DI
Drum 1 Park Brake
Drum 4 Control Handle
DO P52-31
DI P51-19
DO P52-31
5 Volts P51-31
AI P51-15
Gnd P51-22
NODE 2
P52-04 DO
P2-20 Gnd
Handle Rotation Indicator
AI 33-e
Maximum Boom Angle Limit
NC
NO
24 Volts 33-s
Gnd 33-N
5 Volts 33-j
Mast Angle Sensor
AI 33-r
Gnd 33-m
Gantry Cylinder Raise
HS 24
Gnd 33-G
DO 33-H
Gantry Cylinder Lower
HS 25
Gnd 33-C
DO 33-F
Mast Cylinder Raise
HS 22
Gnd 33-G
DO 33-R
Mast Cylinder Lower
HS 23
Gnd 33-N
DO 33-P
NODE 3
33-Z 24 Volts
33-f AI
33-g Gnd
Hyd Psi
Accessory System Pressure Sender
34-L Gnd
34-M DO
HS 12
Drum 4 Pawl In
34-a Gnd
34-b DO
HS 13
Drum 4 Pawl Out
34-V Gnd
34-W DO
HS 21
Cab Tilt Up
34-T Gnd
34-U DO
HS 20
Cab Tilt Down
34-K Gnd
34-S DO
HS 26
Back Hitch Pins Disengage
24 Volts 43-s
AI 43-r
Gnd 43-m
Drum 4 Pressure Sender
Hyd Psi
24 Volts 44-n
EC2A 44-p
Drum 4 Motor Speed Sensor
SS
EC2B 44-s
Gnd 44-r
44-e Gnd
Raise
44-f DO
Drum 1 Pump #2
EDC
44-d DO
Lower
44-c Gnd
NODE 4
44-C Gnd
44-D DO
44-B DO
44-A Gnd
EDC
Raise
Lower
Drum 4 Pump #4
44-E Gnd
44-F DO
M/C
Drum 4 Motor Control
44-G Gnd
44-H DO
HS 11
Drum 4 Brake Release
46-P DI
46-C Gnd
46-R 24 Volts
NC
NO
Gantry Maximum Angle Limit
14CSM1-119

FIGURE 1-29

Gantry Cylinders Lower

NOTE: Gantry back hitch pins must be disengaged before raising or lowering gantry. See Back Hitch Pin Cylinders topic in this section. The mast will lower with gantry.

Move gantry cylinders toggle ***down*** and hold to ***lower*** gantry (retract cylinders). An input voltage is sent to node 1 controller. Node 3 controller sends a 24 volt output to enable gantry cylinders lower solenoid HS-25 and shifts valve to ***lower*** position. Solenoid valve shifts to block tank port and open port to low-pressure side of drum 1 pump. Node 4 controller sends a variable 0 to 24 volt output to enable low-pressure side of drum 1 pump EDC.

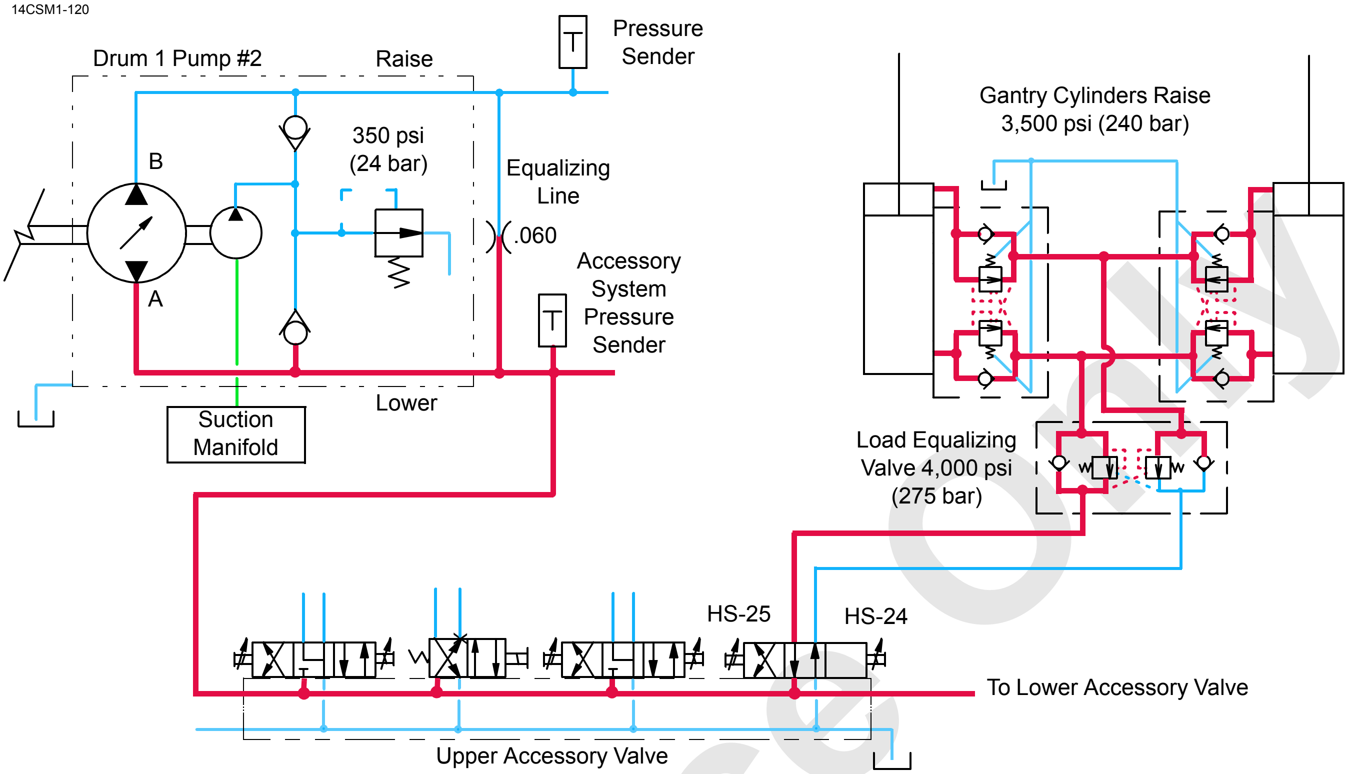
Hydraulic fluid from low-pressure side of drum 1 pump flows to gantry cylinders lower solenoid HS-25 of upper accessory valve and through free-flow check valve sections on side B of load equalizing valve. From equalizing valve, fluid enters counterbalance valves and rod end of gantry cylinders, retracting cylinder rod to lower the gantry.

Free-flow check valve sections on side A of counterbalance valves block fluid exhausting from piston end of gantry cylinders. Fluid passes through flow restrain sections of counterbalance valve that has a relief setting of 3,500 psi (240 bar). Counterbalance valves operate with a 5:1 pilot ratio of the relief valve pressure, permitting valve to open when fluid pressure in rod end of the cylinders is approximately 700 psi (48 bar). Exhaust fluid from side A of counterbalance valves combines and free-flow check valve section on side A of load equalizing valve blocks the flow. Hydraulic fluid then passes through flow restrain section of valve that is preset at 4,000 psi (275 bar).

Load equalizing valve operates with a 1.5:1 pilot ratio of the relief valve pressure. This permits valve to open when the hydraulic pressure on side B of load equalizing valves is approximately 2680 psi (185 bar). Restraining section on side A of load equalizing valve opens, controlling fluid out of both cylinders and ensuring cylinder actuation is balanced. Hydraulic fluid exits through gantry valve section and returns to tank.

When gantry is fully lowered, release gantry cylinders switch. An input signal node 1 controller. Node 4 controller sends a zero volt output signal to drum 1 pump EDC to de-stroke the pump. Node 3 controller sends an output signal to shift gantry cylinder lower solenoid HS-25 to center position.

14CSM1-120



14CSM1-121

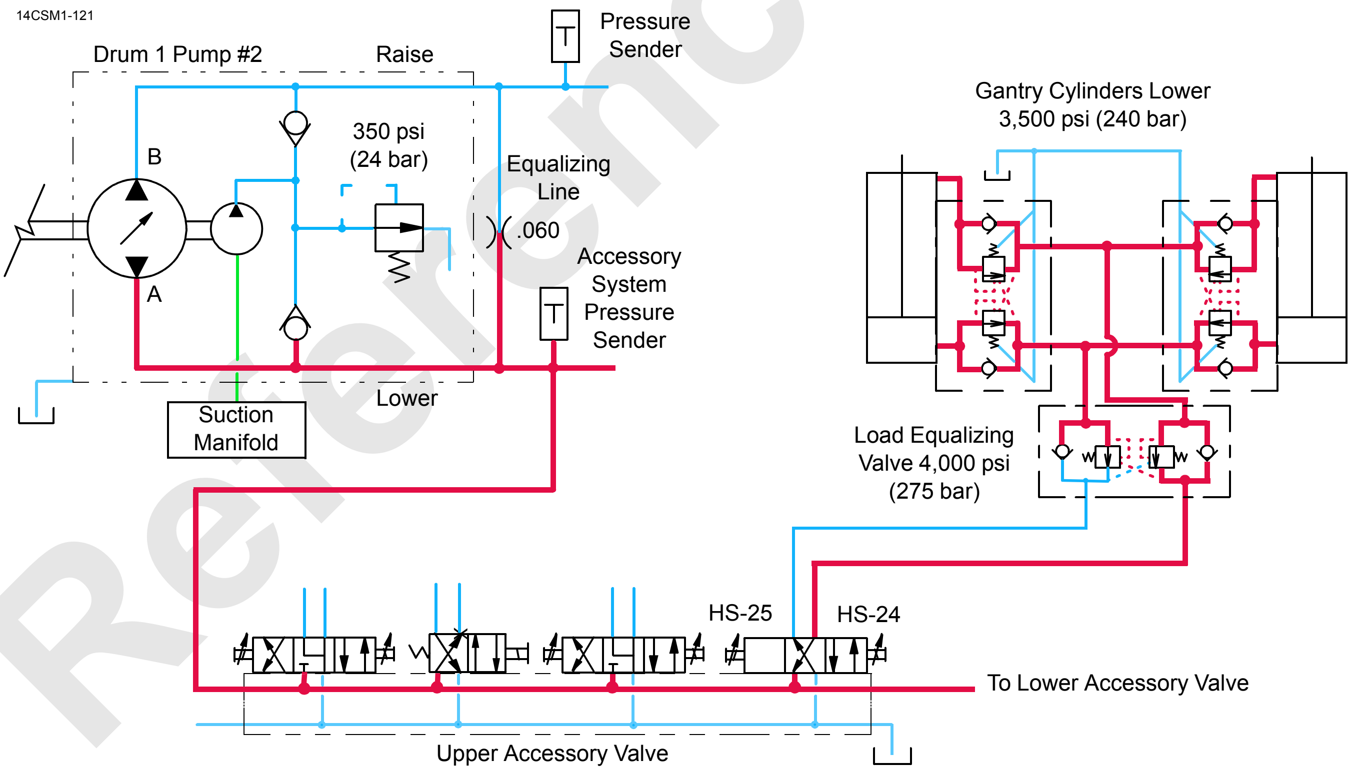


FIGURE 1-30

Mast System

See Figures 1-29 and 1-31.

The mast is rectangular shaped structure that supports the boom. The mast is also used for crane assembly and disassembly. Mast raising cylinders provide assistance to lift and lower mast during reeving of mast and gantry sheaves.

The mast-raising/lowering sequence is controlled automatically by the computer program and boom hoist control handle. See Drum 4 (Boom Hoist) System topic in this section for boom hoist operation.

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

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

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 the mast from structural damage caused by twisting. Load equalizing valves also provides support resistance against mast to ensure control of the unit while rotating. When an accessory valve spool shifts, supply flow to the other accessory valves is limited. The accessory system pressure sender monitors accessory system pressure.

When mast switch is placed in ***raise*** position and held, an input voltage is sent to node 1 controller. Node 3 controller sends a 24 volt output to enable mast cylinders raise solenoid HS-22 and shifts valve to ***raise*** position. Node 4 controller also sends a variable 24 volt output signal to drum 1 pump EDC to stroke the pump in low-pressure direction to provide accessory system pressure. See automatic raising/lowering procedure below for complete cylinder operation.

When mast switch is released, solenoid HS-22 returns to center position. Node 4 controller sends a zero volt output signal to drum 1 pump EDC to de-stroke the pump.

When mast switch is placed in ***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-23 and shifts valve to ***lower*** position. Node 4 controller also sends a variable 24 volt output signal to drum 1 pump EDC to stroke the pump in low-pressure direction to provide accessory system pressure. See automatic raising/lowering procedure below for complete cylinder operation.

When mast switch is released, solenoid HS-23 returns to center position. Node 4 controller sends a zero volt output signal to drum 1 pump EDC to de-stroke the pump.

Mast Raising

Use Rated Capacity Indicator/Limiter, Diagnostic screen to select the Liftcrane Mast Handling Capacity Chart. Mast and gantry controls will not operate and mast operating limits remain off until the Liftcrane Mast Handling Capacities Chart is selected.

Raise gantry to working position until back hitch pins automatically engage.

Use mast switch on overhead console in cab to raise mast assist arms to at least 35° and stop.

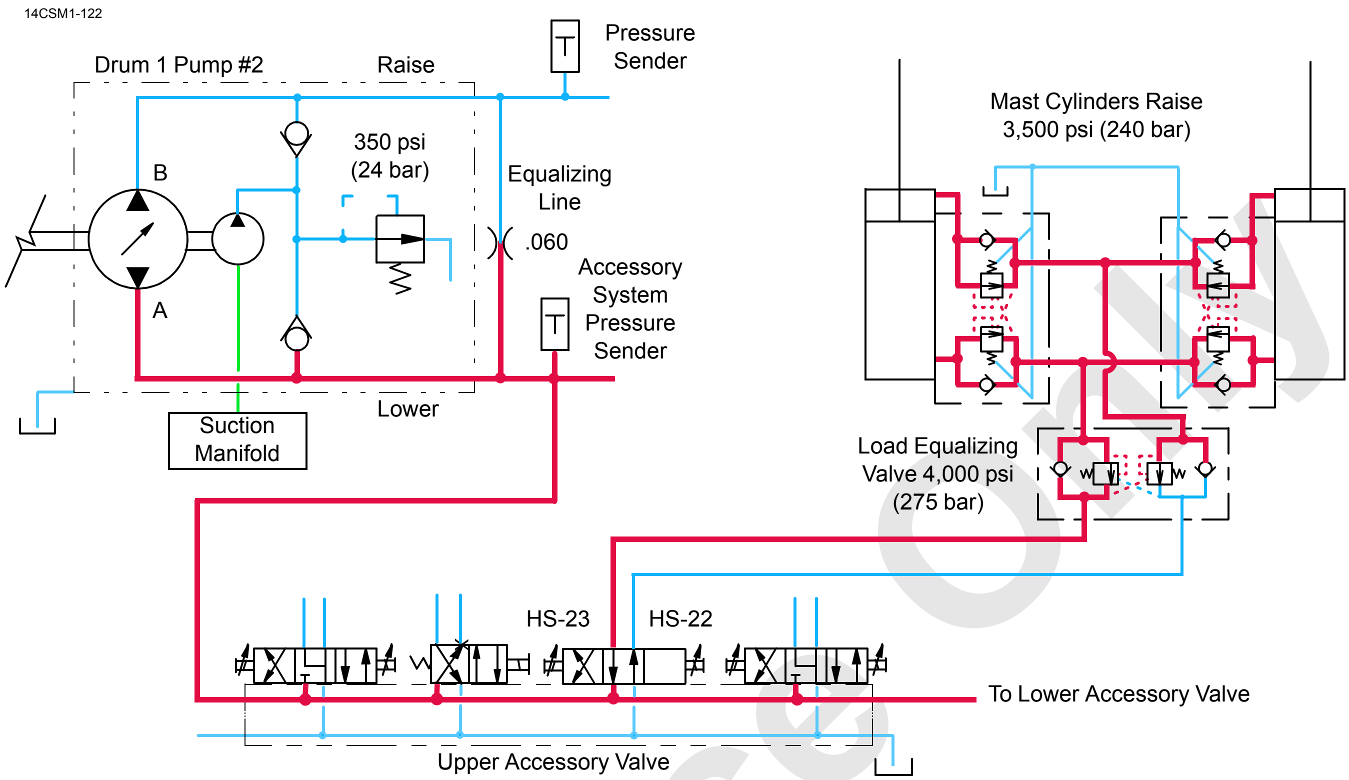
Move drum 4 (boom hoist) control handle forward to continue automatic mast raising procedure. Node 4 controller sends a variable 24 volt output signal to drum 1 pump EDC to stroke pump in low-pressure direction. Node 3 controller sends a 24 volt output to enable mast cylinders raise solenoid valve HS-22 in extend (mast raising) direction. Solenoid valve shifts to block tank port and open port to low-pressure side of drum 1 pump.

Mast assist arm extend automatically as mast raises from transport position. Drum 4 pays out wire rope between drum 4 and gantry sheaves. A speed sensor at motor 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 mast.

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 3,500 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 free-flow check valve section on side **B** of load equalizing valve blocks the flow.

Fluid then passes through valve flow restrain section that is preset at 4,000 psi (275 bar). Load equalizing valve operates with a 1.5:1 pilot ratio of the relief valve pressure, permitting valve to open when hydraulic pressure on side A of load-equalizing valve is approximately 2680 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.


14CSM1-122
Drum 1 Pump #2
Raise
Pressure Sender
B
A
350 psi (24 bar)
Equalizing Line
.060
Accessory System Pressure Sender
Lower
Suction Manifold
Mast Cylinders Raise 3,500 psi (240 bar)
Load Equalizing Valve 4,000 psi (275 bar)
HS-23
HS-22
To Lower Accessory Valve
Upper Accessory Valve

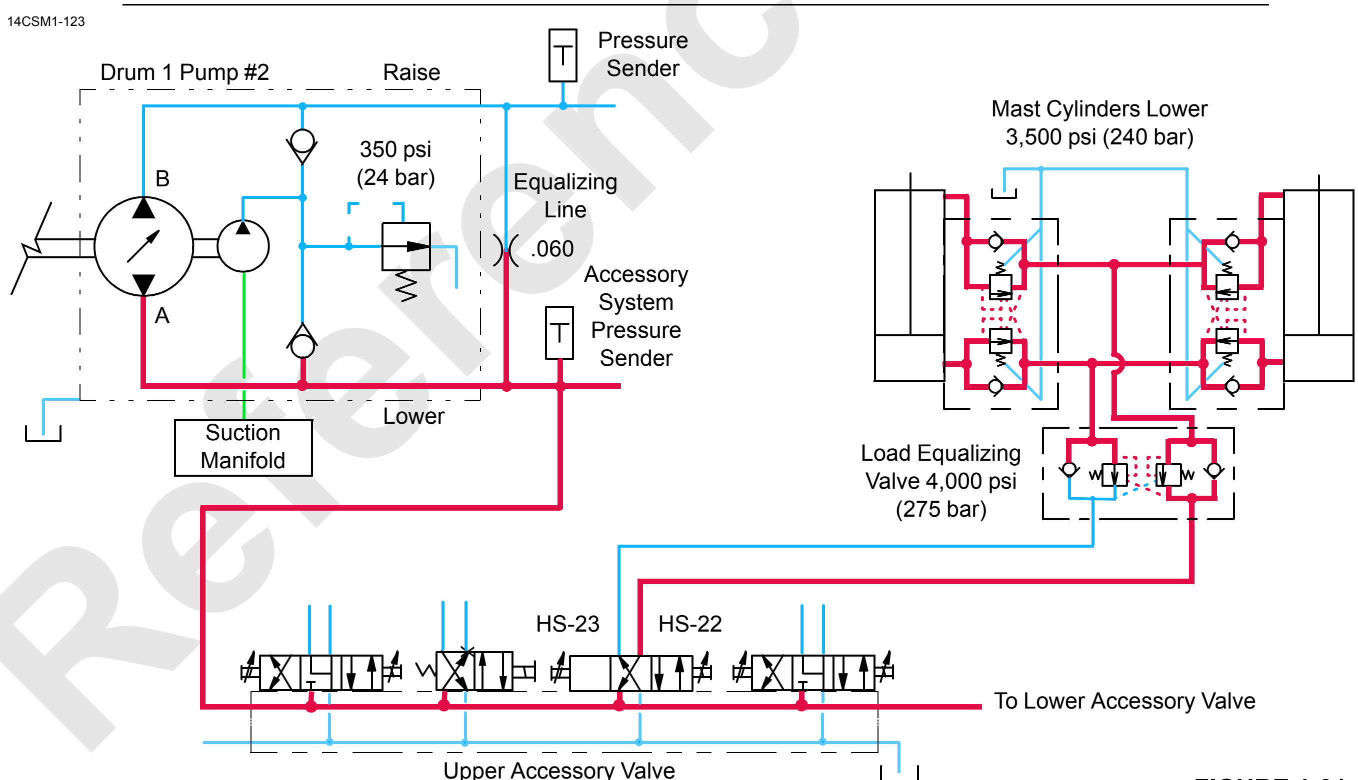

14CSM1-123
Drum 1 Pump #2
Raise
Pressure Sender
B
A
350 psi (24 bar)
Equalizing Line
.060
Accessory System Pressure Sender
Lower
Suction Manifold
Mast Cylinders Lower 3,500 psi (240 bar)
Load Equalizing Valve 4,000 psi (275 bar)
HS-23
HS-22
To Lower Accessory Valve
Upper Accessory Valve

FIGURE 1-31

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

Node 3 controller monitors mast angle sensor when mast is moving. Diagnostic screen monitors mast operating angle. When mast is raised to operating range, move boom hoist handle to center position.

Node 4 controller sends a zero volt output signal to drum 1 pump EDC to de-stroke the pump. Node 3 controller sends a zero output voltage to shift spool of mast cylinders raise solenoid valve HS-22 to center position.

Mast Lowering

The following drum raising operation is for drum 4 while lowering mast from setup working position to gantry. Node 3 controller monitors the mast angle sensor.

Use Rated Capacity Indicator/Limiter, Diagnostic screen to select the Liftcrane Mast Handling Capacity Chart. Mast controls will not operate and the mast operating limits remain off until Liftcrane Mast Handling Capacities Chart is selected.

Use mast switch on overhead console in cab to raise mast assist arms until cylinders stall and stop.

Move drum 4 (boom hoist) control handle back for automatic mast-lowering procedure. Node 4 controller sends a variable 24 volt output signal to drum 1 pump EDC to stroke pump in low-pressure direction. Node 3 controller sends a 24 volt output to enable mast cylinders lower solenoid valve HS-23 in retract (mast lower) direction. Solenoid valve shifts to block tank port and open port to low-pressure side of drum 1 pump.

As mast lowers toward transport position, drum 4 hauls in wire rope between mast drum and gantry sheaves.

From accessory valve, 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 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 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 cylinders to ensuring cylinder operation is balanced.

When mast cylinders are retracting, node 3 controller monitors drum 4 speed sensor and mast angle sensor when mast is moving. Node 1 controller maintains a speed that is proportional to accessory system hydraulic pressure applied to mast cylinders.

When mast reaches approximately 35°, move boom hoist handle to center position. Retract back hitch pins and lower gantry with gantry cylinders switch on remote control. When gantry is in shipping position, use mast switch on overhead console in cab to lower mast assist arms fully.

When mast switch is released, node 3 controller sends a zero output voltage to drum 1 pump EDC that moves swashplate to center position. Node 4 controller sends a zero output voltage to shift spool of mast cylinders lower solenoid valve HS-23 to center position.

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Boom Hinge Pins

See Figures 1-29 and 1-32.

During normal operation boom hinge pins solenoid valve is disabled where boom hinge pins are extended with keeper plate holding hinge pins in place. Rod end port of cylinder is open to tank. Boom hinge pins switch is on overhead console in cab. Boom hinge pins can not be disengaged until keeper plate and pin from cylinder is removed. Accessory system pressure sender monitors accessory system pressure.

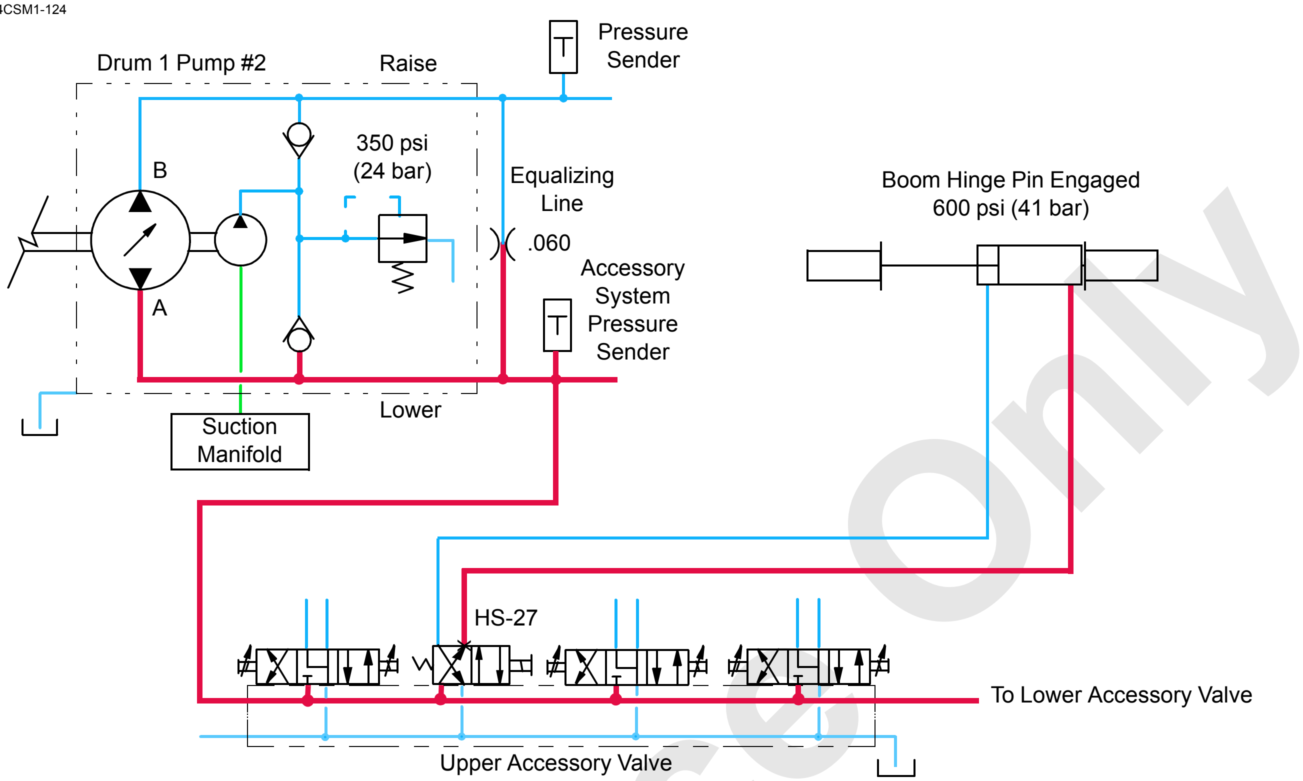
When boom hinge pins switch is placed in ***engage*** position, an input voltage is sent to node 1 controller. Node 3 controller sends a 24 volt output to enable boom hinge pins solenoid HS-27 and shifts valve to ***engage*** (normal) position. Node 4 controller sends a variable 0 to 24 volt output to enable low-pressure side of drum 1 pump EDC.

Hydraulic fluid pressure at approximately 600 psi (41 bar) flows to boom hinge pins upper accessory valve. Hydraulic fluid leaves the accessory valve and enters piston end of boom pin cylinder, extending cylinder rod to engage 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 normal position. Node 4 controller sends a zero output signal to disable low-pressure side of drum 1 pump.

When boom hinge pins switch is placed in ***disengage*** position and held, an input voltage is sent to node 1 controller. Node 3 controller sends a 24 volt output to enable boom hinge pins solenoid HS-27 and shifts valve to ***disengage*** position. Node 4 controller sends a variable 0 to 24 enable low-pressure side of drum 1 pump EDC.

Hydraulic fluid pressure at approximately 600 psi (41 bar) flows to boom hinge pins upper accessory valve. Hydraulic fluid leaves the accessory valve and enters rod end of boom pin cylinder, retracting cylinder rod to disengage 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 engaged (normal) position.

14CSM1-124



14CSM1-125

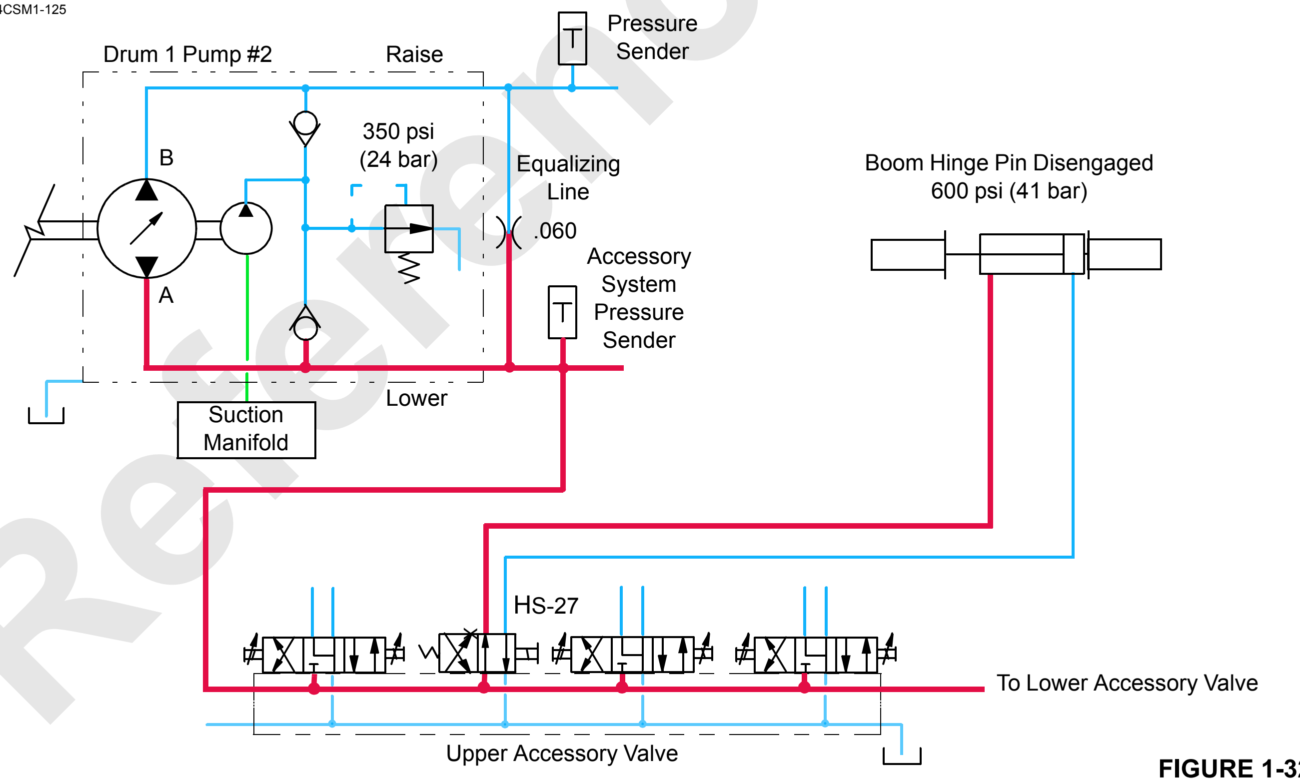


FIGURE 1-32

Cab Tilt

See Figures 1-29 and 1-33.

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. The accessory system pressure sender monitors accessory system pressure. Cab tilt switch is on 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-21 and shifts valve to ***up*** position. Node 4 controller sends a variable 0 to 24 volt output to enable low-pressure side of drum 1 pump EDC.

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to cab tilt upper 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.

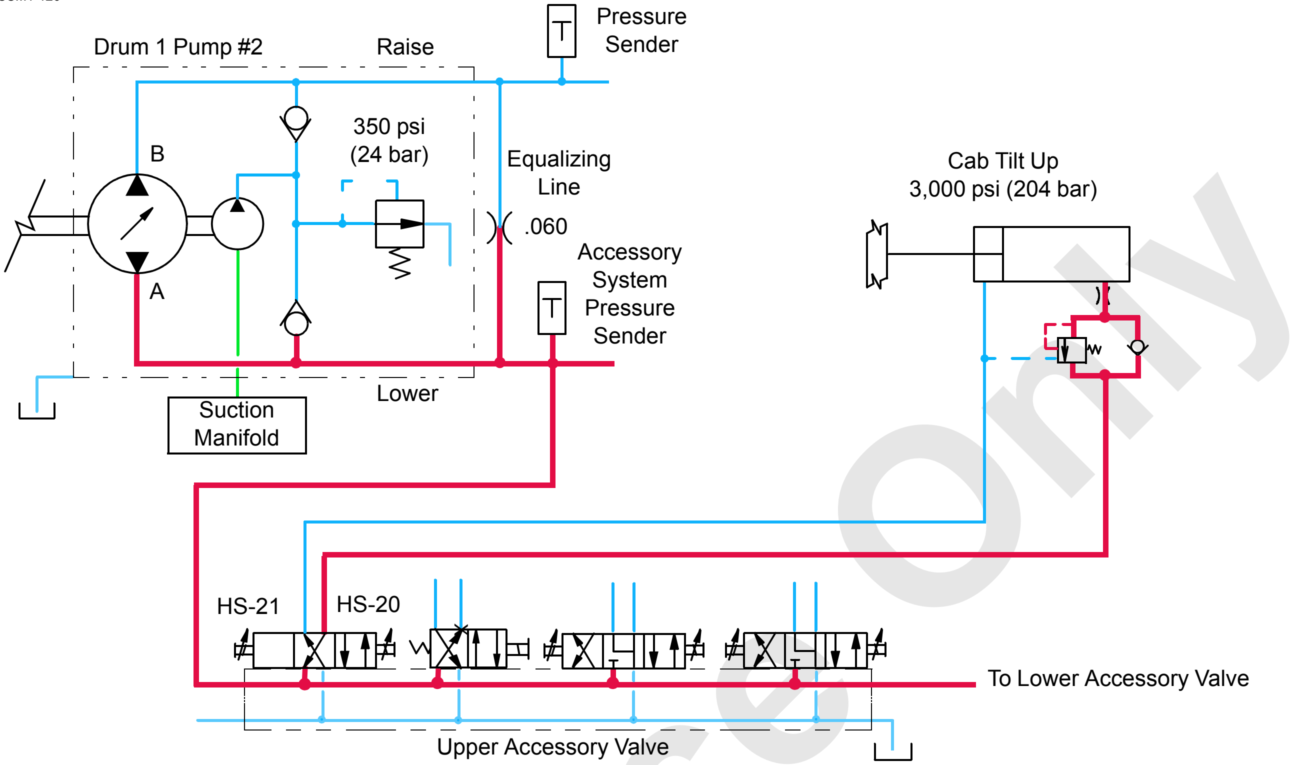
Hydraulic fluid from rod end of cylinder exits upper accessory valve and returns to tank. When cab tilt switch is released, node 3 controller sends a 24 volt output to disable cab tilt up solenoid HS-21 and shifts valve to center position. Node 4 controller sends a variable 0 to 24 volt output to disable low-pressure side of drum 1 pump.

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 cab tilt ***lower*** solenoid HS-20 and shifts valve to ***lower*** position. Node 4 controller sends a variable 0 to 24 volt output to enable low-pressure side of drum 1 pump EDC.

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to cab tilt upper accessory valve. Hydraulic fluid exits valve and enters rod end of cylinder, retracting cylinder rod to lower cab front.

Hydraulic fluid from piston end of cylinder enters free-flow check valve before entering upper accessory system valve and returns to tank. When cab tilt switch is released, node 3 controller sends a 24 volt output to disable cab tilt up solenoid HS-20 and shifts valve to center position. Node 4 controller sends a variable 0 to 24 volt output to disable low-pressure side of drum 1 pump.

14CSM1-126



14CSM1-127

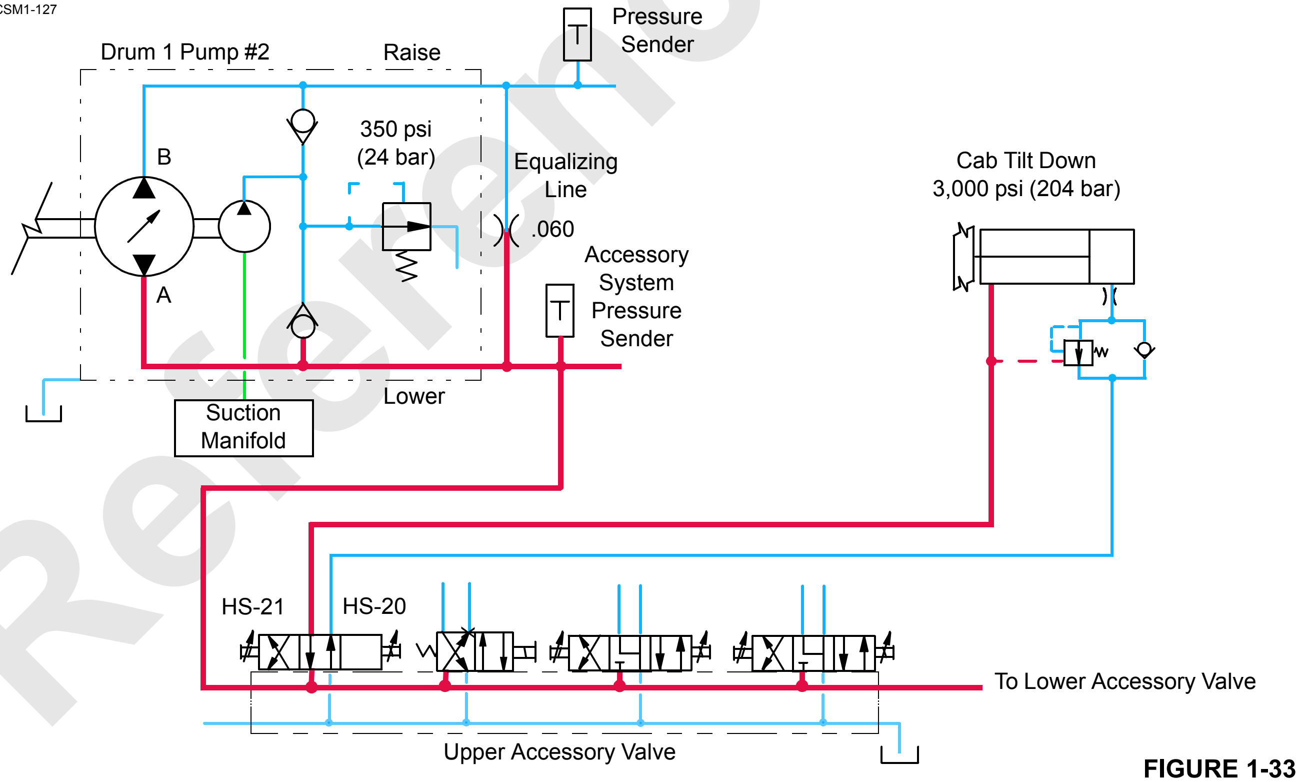


FIGURE 1-33

LOWER ACCESSORY SYSTEM

The lower accessory valve system includes crawler pin pusher cylinders and carbody jack cylinders that are enabled by return-to-center hand levers. Output flow from the lower accessory system passes through control levers and back to tank when all of the levers are centered.

When a control lever is manually enabled, flow to the carbody enable pressure sender is blocked by the control lever. System pressure bleeds out through orifice and system pressure drops, sending an input signal to the node 1 controller. Node 4 controller then sends a 24 volt variable output to drum 1 pump EDC to stroke the pump in the low-pressure side direction. A level is mounted on carbody near manual control levers.

Carbody Jacking System

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

WARNING

Collapsing Hazard

Keep carbody as level as possible while jacking. Operating jacking cylinder with rotating bed more than 3° out of level can cause structural damage to jacking cylinders and possible collapse of rotating bed.

Each carbody jacking cylinder has a counterbalance valve at cylinder ports. Counterbalance valves ensure smooth control when raising or lowering the carbody/rotating bed. Counterbalance valves lock 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 cylinders and shields them from mechanical overloading.

When a jacking cylinder control valve handle is not enabled, it assumes a neutral position and hydraulic fluid passage to 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 load in position by the counterbalance valve.

Carbody Jacking Cylinder Raise

See Figure 1-34.

Any or all jacking cylinders can be operated at the same time, but jacking will not be level. The following description of operation is for both right side jacking cylinders.

Move jacking levers back to ***raise*** position to raise jacking cylinder. This shifts selected lower accessory valves to block charge pressure to carbody pressure sender. System pressure bleeds out through orifice and system pressure drops, sending an input signal to the node 1 controller.

Node 4 controller sends a variable 28 output voltage to drum 1 pump EDC that tilts pump swashplate to stroke pump in the low-pressure side direction. Hydraulic fluid flows through upper accessory system valve to lower accessory valve where system pressure approximately 3,100 psi (215 bar).

Hydraulic fluid exits valve section of lower accessory valve into counterbalance valve. Hydraulic fluid then enters piston end of jacking cylinders, extending cylinders to raise the right side of carbody.

Hydraulic fluid rod end of the jacking cylinders is blocked by free-flow check valve section of counterbalance valve and flows through flow restraining section that has a relief setting of 3,500 psi (240 bar).

Counterbalance valve acts as a deceleration control and functions with a 3:1 pilot ratio of relief pressure. This permits valve to open when the pressure in rod end of cylinders is approximately 1175 psi (81 bar). Restraining section of counterbalance valves open, controlling the fluid out of jacking cylinders. 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 returns to tank.

Move selected levers back to neutral position when desired height is reached. When system pressure beyond lower accessory valve increases, an input signal to the node 1 controller. Node 4 controller sends a zero output voltage to drum 1 pump that returns pump swashplate to neutral and de-strokes the pump.

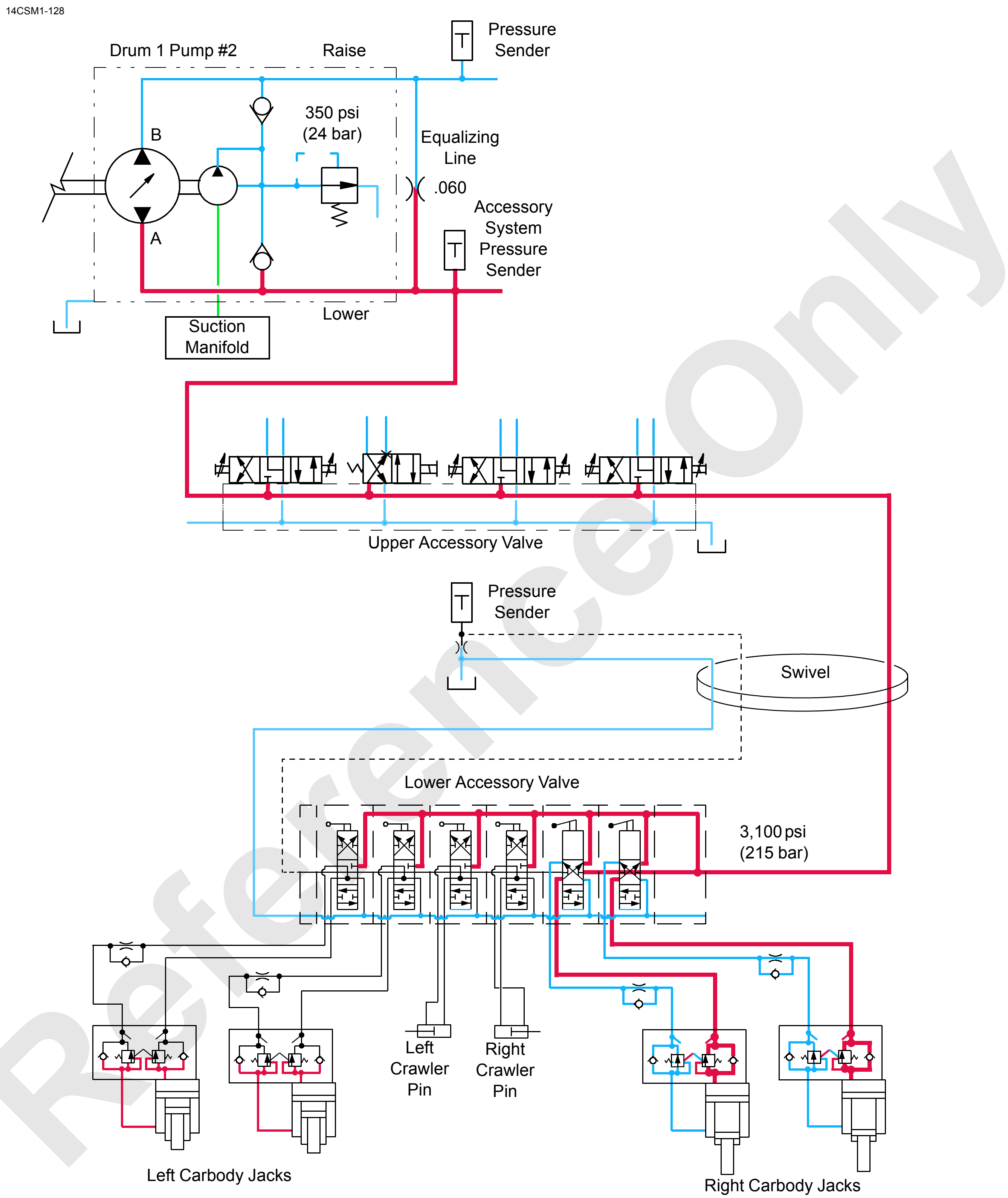

14CSM1-128
Drum 1 Pump #2
Raise
Pressure Sender
350 psi (24 bar)
B
A
Equalizing Line
.060
Accessory System Pressure Sender
Suction Manifold
Lower
Upper Accessory Valve
Pressure Sender
Swivel
Lower Accessory Valve
3,100 psi (215 bar)
Left Crawler Pin
Right Crawler Pin
Left Carbody Jacks
Right Carbody Jacks
Reference Only

FIGURE 1-34

Carbody Jacking Cylinder Lower

See Figure 1-35.

Move jacking levers forward to ***lower*** position to lower jacking cylinders. This shifts selected lower accessory valve to block charge pressure to carbody pressure sender. System pressure bleeds out through orifice and system pressure drops, sending an input signal to the node 1 controller.

Node 4 controller sends a variable 28 output voltage to drum 1 pump EDC that tilts pump swashplate to stroke pump in low-pressure side direction. Hydraulic fluid flows through upper accessory system valve to lower accessory valve where system pressure is approximately 3,100 psi (215 bar).

Hydraulic fluid exits valve section of lower accessory valve and flows through restraining section of flow control valve. Restraining section controls rate of speed for cylinders to retract by limiting the velocity of fluid before passing through free-flow check valve section of counterbalance valves.

Hydraulic fluid then flows into rod end of jacking cylinders. Hydraulic pressure entrapped by cylinder counterbalance valves at piston end of jacking cylinder supports the weight and gravitational force of carbody. Node 1 controller monitors accessory system pressure sender to control jacking cylinder speed rate.

Hydraulic fluid exhausting from piston end of jacking cylinders is blocked by free-flow check valve section of counterbalance valve and flows through the flow restraining section that has a relief setting of 3,500 psi (240 bar).

Counterbalance valve acts as a deceleration control and functions with a 3:1 pilot ratio of relief pressure. This permits valves to open when the pressure in piston end of cylinders is approximately 1175 psi (81 bar). Restraining section of counterbalance valves open that controls fluid out of jacking cylinders to lower accessory valve. Hydraulic fluid leaving lower accessory valve is returned to tank.

Move control levers back to neutral position when desired height is reached. When system pressure beyond lower accessory valve increases, an input signal to the node 1 controller. Node 4 controller sends a zero output voltage to drum 1 pump that returns pump swashplate to neutral and de-strokes the pump.

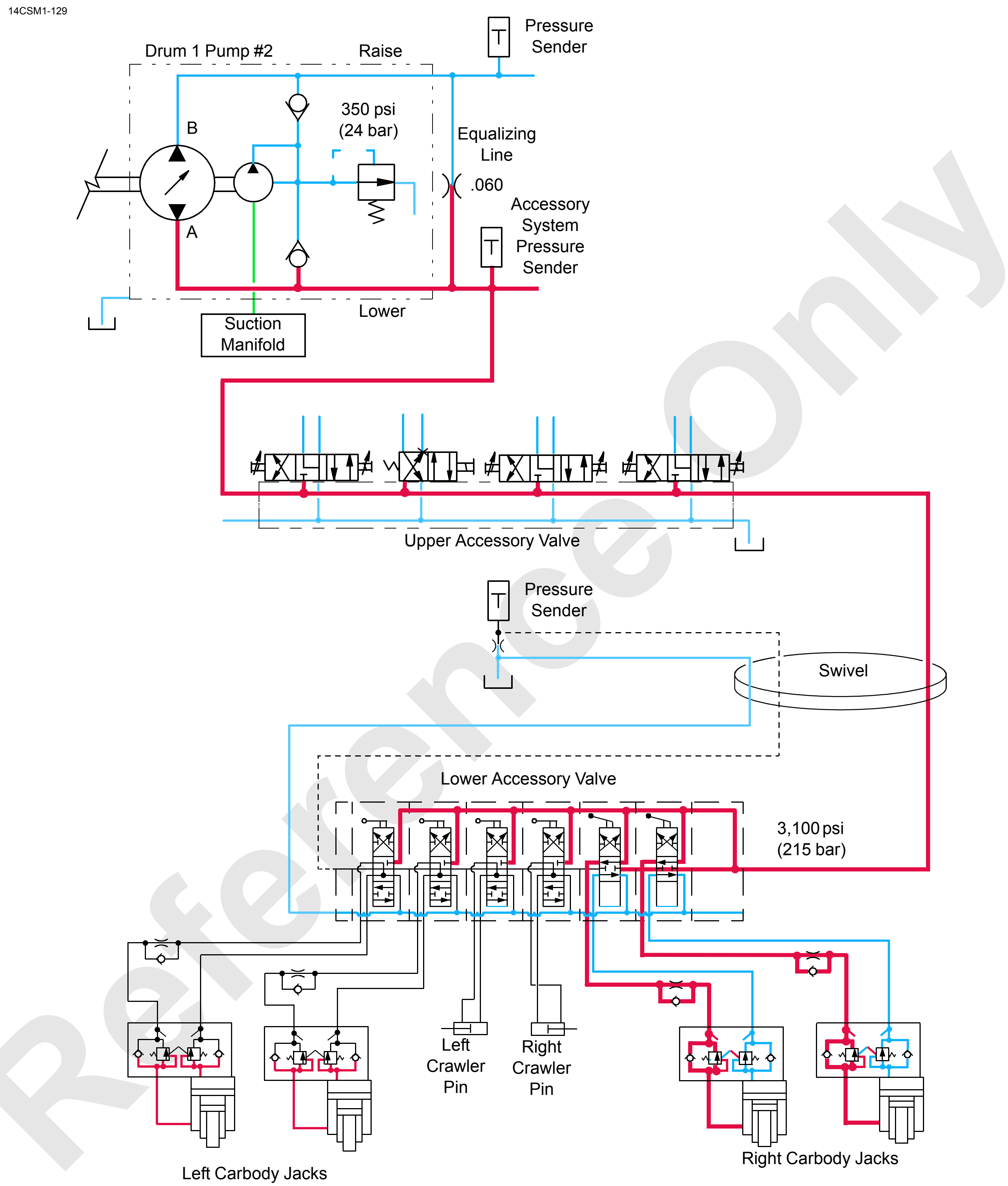

14CSM1-129
Drum 1 Pump #2
Raise
Pressure
Sender
B
350 psi
(24 bar)
Equalizing
Line
.060
A
Accessory
System
Pressure
Sender
Suction
Manifold
Lower
Upper Accessory Valve
Pressure
Sender
Swivel
Lower Accessory Valve
3,100 psi
(215 bar)
Left
Crawler
Pin
Right
Crawler
Pin
Left Carbody Jacks
Right Carbody Jacks

FIGURE 1-35

Crawler Pin Cylinders

Left and right crawler pin pusher cylinder operation is controlled with hydraulic valve handles on carbody and computer programming. The following description of operation is for right side crawler pin pusher cylinder. Operation of both pin cylinders is the same.

Crawler Pin Cylinders Extend

See Figure 1-36.

Move right crawler pin lever ***back*** to ***extend*** crawler pin pusher cylinder into crawler track frame. This shifts selected lower accessory valve to block charge pressure to carbody pressure sender. System pressure bleeds out through orifice and system pressure drops, sending an input signal to node 1 controller.

Node 4 controller sends a variable 28 output voltage to drum 1 pump EDC that tilts pump swashplate to stroke pump in low-pressure side direction. Hydraulic fluid flows through upper accessory system valve to lower accessory valve where system pressure approximately 3,100 psi (215 bar).

Hydraulic fluid enters piston end of crawler pin pusher cylinders extending cylinder rod, rotating assembly lever to secure crawler frame to carbody. Hydraulic fluid exhausting from rod end of crawler pin pusher cylinder returns to lower accessory valve and is returned to tank.

When control lever is moved back to neutral position, system pressure beyond lower accessory valve increases, an input signal to the node 1 controller. Node 4 controller sends a zero output voltage to drum 1 pump EDC that returns pump swashplate to neutral and de-strokes the pump.

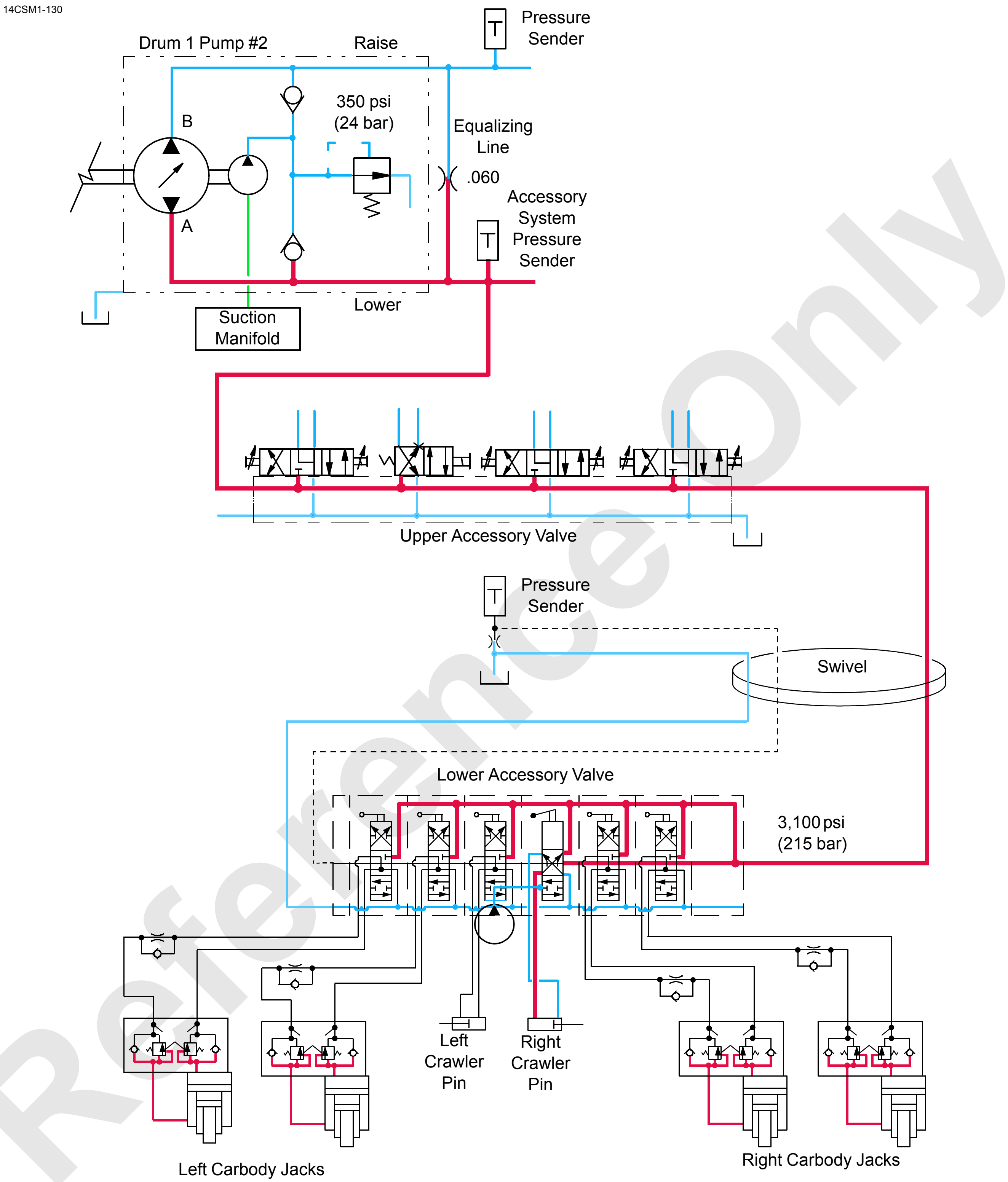

14CSM1-130
Drum 1 Pump #2
Raise
Pressure
Sender
350 psi
(24 bar)
B
A
Equalizing
Line
.060
Accessory
System
Pressure
Sender
Lower
Suction
Manifold
Upper Accessory Valve
Pressure
Sender
Swivel
Lower Accessory Valve
3,100 psi
(215 bar)
Left
Crawler
Pin
Right
Crawler
Pin
Left Carbody Jacks
Right Carbody Jacks

FIGURE 1-36

Crawler Pin Cylinders Retract

Move right crawler pin lever ***forward*** to **retract** crawler pin pusher cylinder from crawler track frame. This shifts selected lower accessory valve to block charge pressure to carbody pressure sender. System pressure bleeds out through orifice and system pressure drops, sending an input signal to node 1 controller.

Node 4 controller sends a variable 28 output voltage to drum 1 pump EDC that tilts pump swashplate to stroke pump in low-pressure side direction. Hydraulic fluid flows through upper accessory system valve to lower accessory valve where system pressure is approximately 3,100 psi (215 bar).

Hydraulic fluid enters rod end of crawler pin cylinder, retracting cylinder rod, releasing crawler track frame from carbody. Hydraulic fluid exhausting from piston end of crawler pin cylinder returns to lower accessory valve and is returned to tank.

When control lever is moved back to neutral position, system pressure beyond lower accessory valve increases, an input signal to the node 1 controller. Node 4 controller sends a zero output voltage to drum 1 pump EDC that returns pump swashplate to neutral and de-strokes the pump.

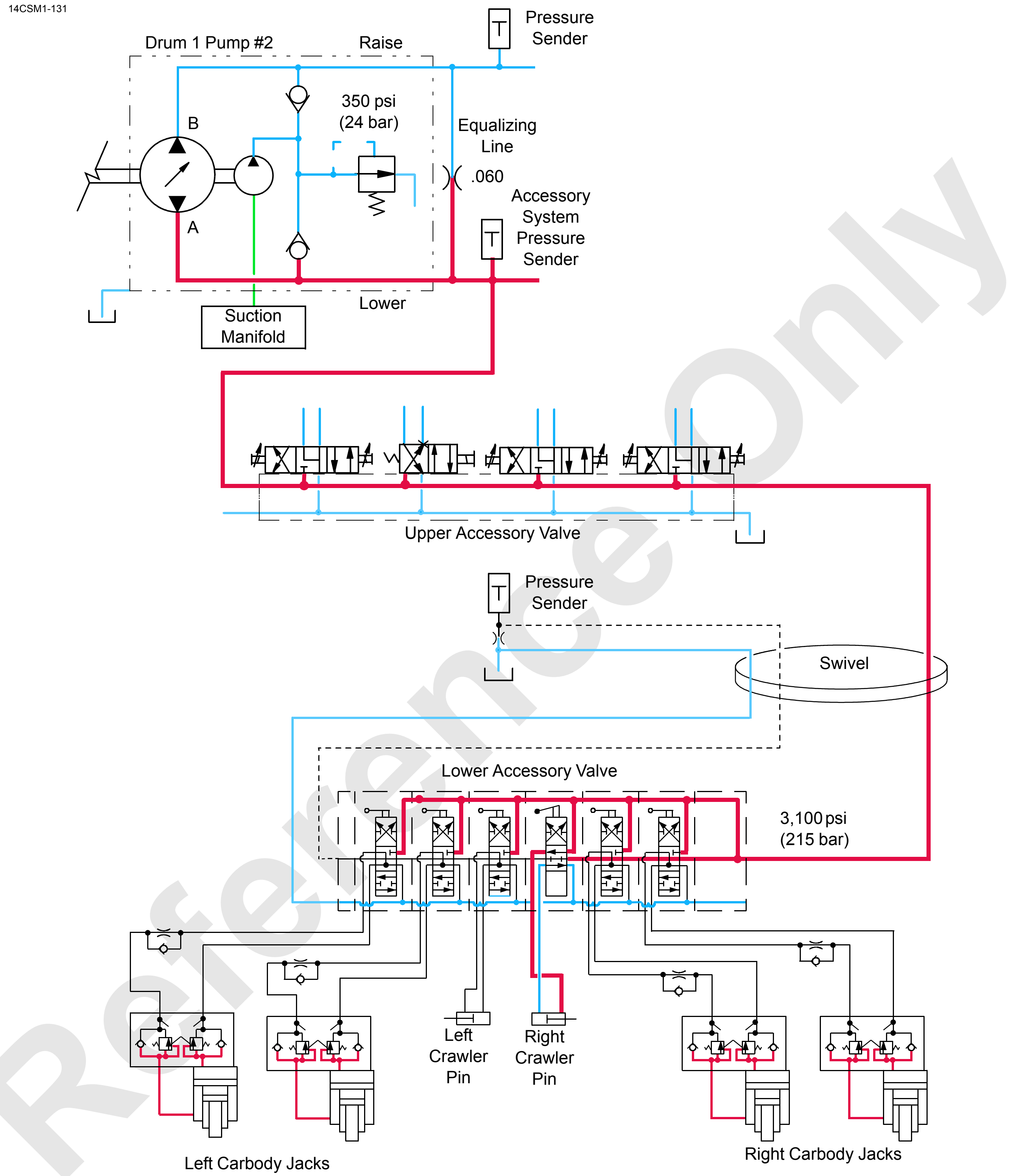

14CSM1-131
Drum 1 Pump #2
Raise
Pressure
Sender
B
350 psi
(24 bar)
Equalizing
Line
.060
Accessory
System
Pressure
Sender
A
Lower
Suction
Manifold
Upper Accessory Valve
Pressure
Sender
Swivel
Lower Accessory Valve
3,100 psi
(215 bar)
Left
Crawler
Pin
Right
Crawler
Pin
Left Carbody Jacks
Right Carbody Jacks

FIGURE 1-37

Back Hitch Pin Cylinders

See Figures 1-29, 1-38, and 1-39.

During normal operation back hitch pins solenoid valve is disabled where cylinders are extended with keeper pins holding pins in place. Rod end port of cylinder is open to tank. Back hitch pins switch is on setup remote control. Back hitch pins can not be disengaged until keeper pins are removed. Pressure source for operating back hitch pins cylinders is charge pressure from drum 3/left travel pump.

Power is available to setup remote control when cable is plugged into W36 receptacle on node 3, remote control ***on*** is selected on remote control function screen, and engine is running. Remove existing W36 cable and plug setup remote cable into receptacle. Pressing power button completes power supply circuit to setup remote control switches.

When back hitch pins switch is in ***engaged*** (normal) position, cylinder rods are extended to engage back hitch pins. Hydraulic fluid from rod end of cylinders returns to tank.

When back hitch pins switch is placed in ***disengage*** position and held, an input voltage is sent to node 1 controller. Node 3 controller sends a 24 volt output to enable back hitch pins solenoid HS-26 and shifts valve to ***disengage*** position.

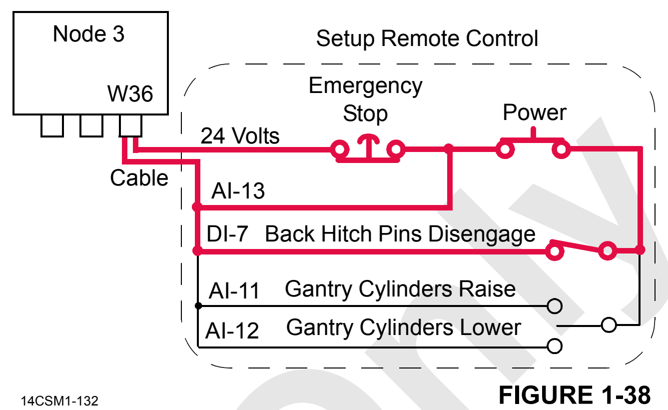


FIGURE 1-38

Hydraulic charge pressure at approximately 350 psi (24 bar) flows from drum 3/left travel pump to rod end of back hitch cylinders, retracting cylinder rods to disengage back hitch pins. Hydraulic fluid from piston end of cylinders returns to tank. When boom hinge pins switch is released, valve returns to engaged (normal) position.

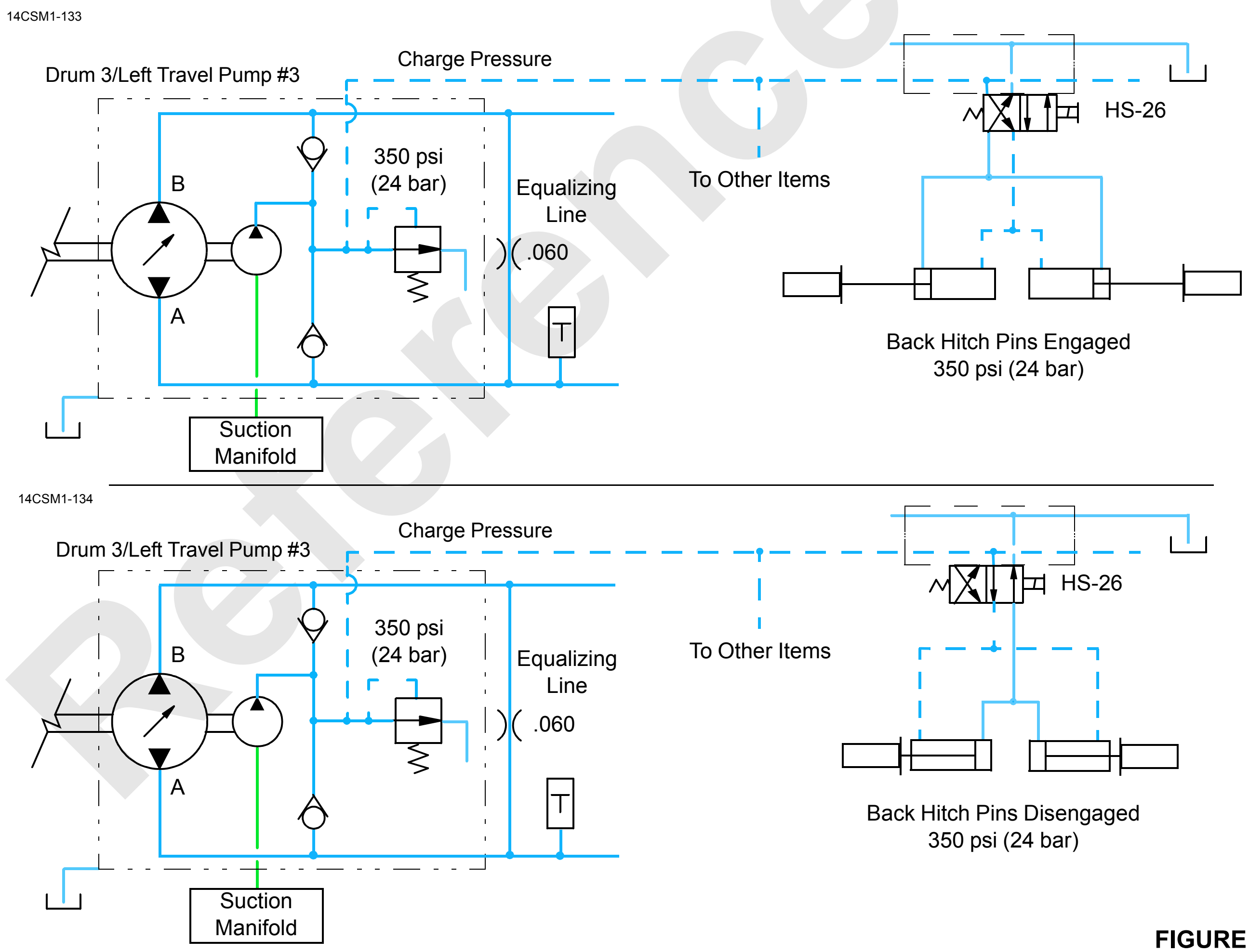


FIGURE 1-39

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Hydraulic Engine Cooling Fan

See Figures 1-40 and 1-41

The variable-speed cooling fan is powered by a hydraulic motor. An engine-mounted pump supplies the flow to run the fan motor. As engine load increases, the fan speed will also increase to meet the cooling requirements of the engine.

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

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

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

Fan speed is determined by the greatest demand of four inputs: coolant temperature, air intake temperature (IMT), hydraulic oil temperature and the state of the air conditioning clutch. The system monitors these inputs every ten seconds and adjusts the fan speed depending on the input readings.

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

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.

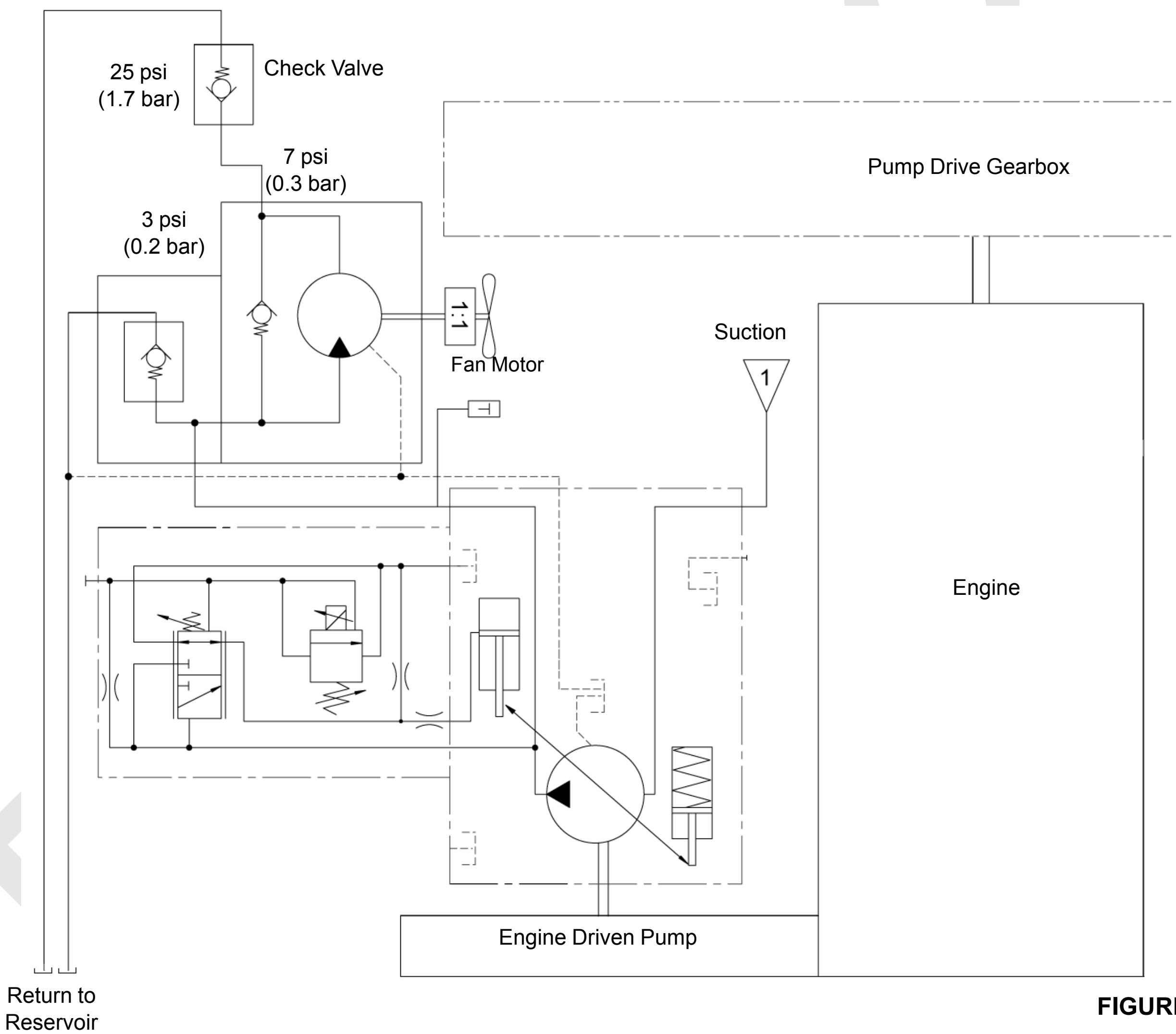

FIGURE 1-40

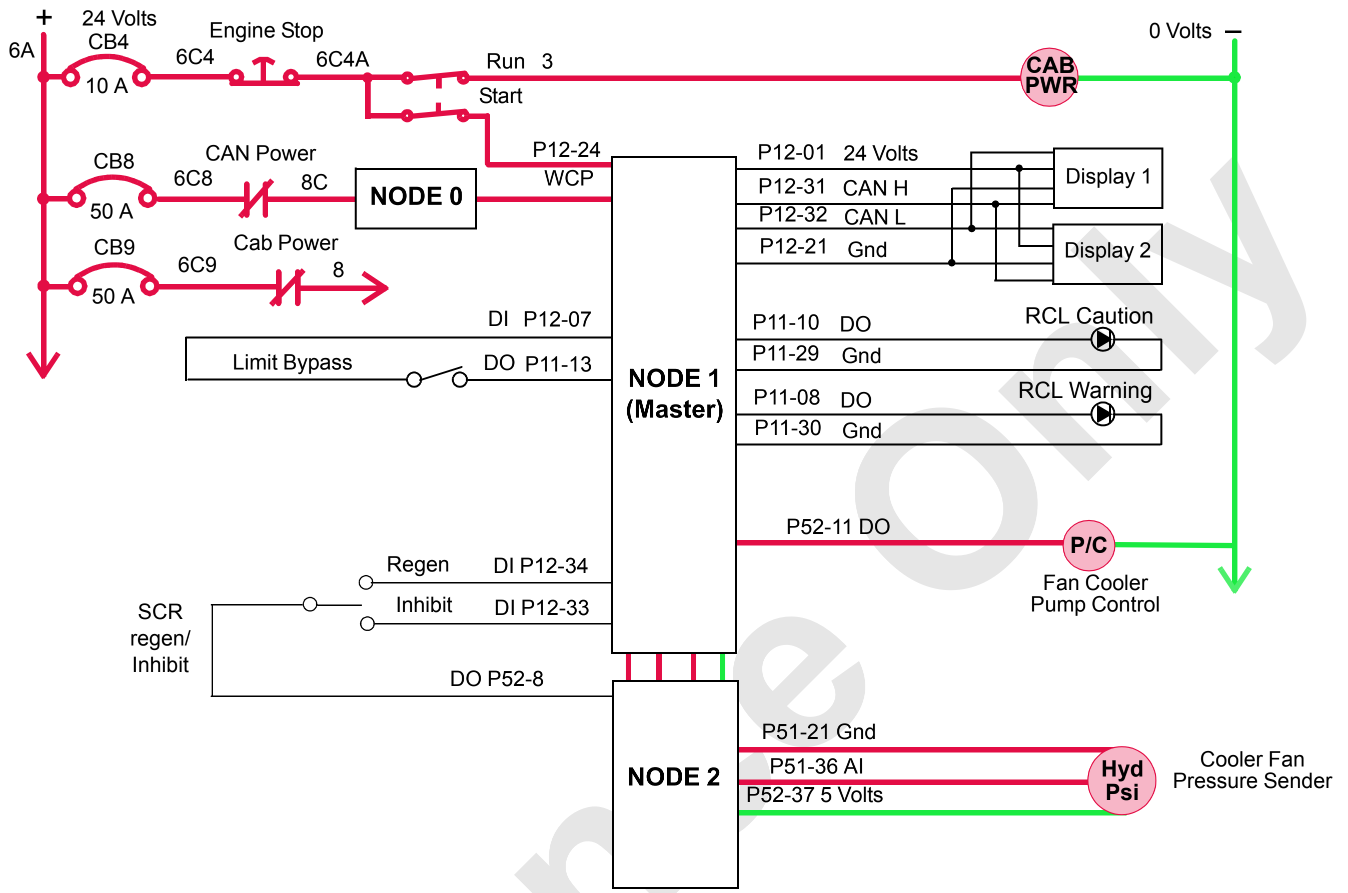
+
24 Volts
CB4
6A
10 A
Engine Stop
6C4
6C4A
Run 3
Start
0 Volts –
CAB PWR
CB8
50 A
CAN Power
6C8
8C
NODE 0
P12-24
WCP
CB9
50 A
Cab Power
6C9
8
P12-01 24 Volts
P12-31 CAN H
P12-32 CAN L
P12-21 Gnd
Display 1
Display 2
DI P12-07
Limit Bypass
DO P11-13
NODE 1 (Master)
P11-10 DO
P11-29 Gnd
RCL Caution
P11-08 DO
P11-30 Gnd
RCL Warning
P52-11 DO
P/C
Fan Cooler Pump Control
Regen
DI P12-34
Inhibit
DI P12-33
SCR regen/ Inhibit
DO P52-8
NODE 2
P51-21 Gnd
P51-36 AI
P52-37 5 Volts
Hyd Psi
Cooler Fan Pressure Sender

FIGURE 1-41

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SECTION 2
HYDRAULIC SYSTEM

TABLE OF CONTENTS

SECTION 2
HYDRAULIC SYSTEM

This section contains hydraulic system maintenance, adjustment, calibration, and test procedures for the hydraulic system and related components on the Model 14000.

Only 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 14000 Operator Manual.

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

The adjustment, calibration, and test procedures described in this section were made to the crane before it was shipped from the factory. These procedures must be performed by field personnel only when parts are replaced or when instructed by a Manitowoc dealer.

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.

HYDRAULIC SCHEMATICS

Hydraulic schematics are attached at the end of this section.

INSPECTING HYDRAULIC HOSES

WARNING

Burn Hazard

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

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

Every Month or 200 Hours

1. Visually inspect all hydraulic hose assemblies for the following:
   - Leaks at hose fittings or in hose.
   - Damaged, cut or abraded cover.
   - Exposed reinforcement.
   - Kinked, crushed, flattened or twisted hose.
   - Hard, stiff, heat cracked or charred hose.
   - Blistered, soft, degraded, or loose cover.
   - Cracked, damaged or badly corroded fittings.
   - Fitting slippage on hose.
   - Other signs of significant deterioration.

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

2. Visually inspect all other hydraulic components and valves for the following:
   - Leaking ports.
   - Leaking valve sections or manifolds and valves installed into cylinders or onto motors.
   - Damaged or missing hose clamps, guards, or shields.
   - Excessive dirt and debris around hose assemblies.

   If any of these conditions exist, address them appropriately.

Degradation Due to Extreme Environment

Table 2-1. Climate Zone Classification

Zone	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

Salt Environment

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

Zone A and B

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

Zone C

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

Zone D and E

Inspect hydraulic hose assemblies per Step 1. Cold temperatures will negatively impact service life of hose assemblies operating in these climate zones.

High Duty Circuits

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

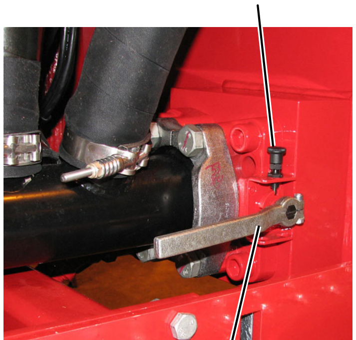
HYDRAULIC SYSTEM—MAINTENANCE

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. And then, make sure all applicable instructions have been read and are thoroughly understood.
- Do not alter specified pressure settings. Higher than specified pressures can cause structural or hydraulic failure. Lower than specified pressures can cause loss of control.
- Never check for hydraulic leaks with 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.



Item	Description	Item	Description
1	Return Filter	6a	Tank Suction Shut-Off Valve
2a	Stand Pipe (in return line)	6b	Locking Pin
2b	Power Fill Coupling	7	Drain Valve
3	Desiccant Breather	8	Return Line Cap
4	Air Valve (for venting air)	9	Hydraulic Tank Level Gauge
5	Access Cover (sides and bottom)		

FIGURE 2-1

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 them.
- Fittings, hoses, and tubes that are not equipped with shipping caps or plugs must be carefully cleaned before they are used. Flush fittings, hoses, and tubes with clean hydraulic oil. Then seal all openings until use at assembly.
- Do not use rags to plug openings. Use clean plastic shipping plugs and caps.

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

   Full (Cold) Level
   (approximately 60°F (16°C)
   Screen should read 90 to 94%.

   Full (Hot) Level
   (approximately 180°F (82°C)
   Screen should read 100%.

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

3. If oil level drops to 60%, fault alarm will come on and fault *Hydraulic Fluid Low* icon will appear on fault screen (Figure 2-2). ***Fill tank immediately.***

HYDRAULIC FLUID LOW
Fault Icon

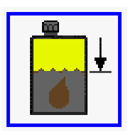


FIGURE 2-2

4. Fill tank through stand pipe at top of tank (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. Hydraulic system could be contaminated from unfiltered oil.

   Open air valve (4) to release pressure before filling through stand pipe.

5. Only use approved hydraulic oil in system (see Section 9 or Lubrication Folio 2129).
6. Replace desiccant breather cartridge (3) with a new one when all desiccant beads turn dark green (they are gold when new). See Replacing Desiccant Breather topic in this section (Figure 2-4).
7. Clean exterior of system often; do not let dirt accumulate on or around any part of system.
8. 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 overtighten.
   - 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 a 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).

9. 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) or below 70° (21°C), a fault alarm will come on and fault *Hydraulic Fluid Temperature* icon will appear on fault display (Figure 2-3).

HYDRAULIC FLUID
TEMPERATURE Fault Icon

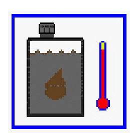


FIGURE 2-3

10. 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 Cartridge

See Figure 2-4 for 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.

FIGURE 2-4

Replacing Filter

This crane has one hydraulic return filter (1, Figure 2-1) 12-micron absolute which filters all oil returning to tank.

If a filter is dirty, a fault alarm comes on and a fault symbol appears on active display. *Hydraulic Filter* icon and corresponding filter number appears on fault display (Figure 2-5).

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

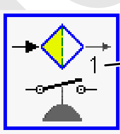


FIGURE 2-5

CAUTION

Avoid Hydraulic System Damage

Original Equipment Manufacturers' filter elements – available from Manitowoc – 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.

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

Return Filter

See Figure 2-1 and 2-6 for following procedure.

Replace return filter element when FILTER 1 fault comes on and at each oil change interval.

WARNING

Burn Hazard

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

Hot oil can escape when you remove stand pipe plug, filter cover, or breather.

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

---

1. Stop engine.
2. Clean outside of filter head in area around fill cap.
3. Remove fill cap. ***Use care not to damage O-rings.***

   Fill cap has a hexagon stud for easy removal.
4. Lift cap and filter out of body and discard element.

   Do not attempt to clean or reuse element.

   Do not operate crane without filter element installed.
5. Twist and pull filter element to disconnect the element.
6. Lubricate O-ring at both ends of new element with clean hydraulic oil and install element over stem in housing.
7. If necessary, replace O-ring in fill cap.

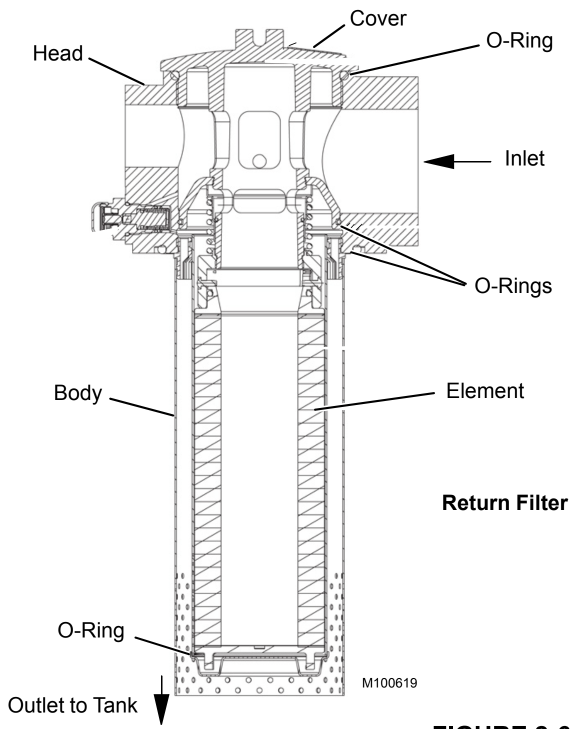


FIGURE 2-6

8. Reinstall fill cap and securely tighten.

9. Start engine and allow hydraulic system to return to normal operating pressure and temperature. Check filter fill cap and return line cap for leaks. Tighten as required.

10. Stop engine, check hydraulic tank level, and refill as required.

Changing Oil

See Figure 2-1 *for* following procedure.

CAUTION

In the Event of a Catastrophic Failure of a Hydraulic Component

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

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

WARNING

Burn Hazard

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

Hot oil can escape when you remove the stand pipe plug, filter cover, or breather.

Relieve pressure through air valve on tank before servicing.

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 suspend impurities so they can be removed with the oil.
2. Stop engine. Lock out/Tag out the crane.
3. Open the air valve (4) to relieve pressure in tank.
4. Attach a rubber hose to pipe on drain valve (7) and insert end of hose into a suitable container to catch hydraulic oil. See Section 9 or Lubrication Folio 2129 for hydraulic system capacity.
5. Open drain valve (7) and drain tank completely.
6. Clean all dirt from stand pipe cap (2a) and remove cap. ***Take care to prevent dust and wind-blown dirt from entering tank while stand pipe cap is off.***
7. Flush out any sediment inside tank.
8. Carefully inspect suction filter (inside tank) for damaged or clogged holes and for sludge, gum, or lacquer formation. If necessary, clean as follows:
   a. Remove cover (5) from bottom of tank.
   b. Remove suction filter from inside tank.
   c. Soak in clean, nonflammable solvent. Flush from inside out. Discard if damaged.
   d. Securely reinstall suction filter.
9. Using new seals, securely fasten access covers to tank.
10. Replace desiccant breather when indicated (see Replacing Desiccant Breather Cartridge in this section).
11. Replace return filter element (1) as instructed earlier in this section.
12. Fully close drain valve (7) and remove rubber hose.
13. If power-filling, clean and then remove the return line cap (8) from return manifold. This will allow air to escape.
14. Fill through stand pipe (2a) or through power fill coupling (2b). ***Use new hydraulic oil filtered through a 10-micron filter.***

CAUTION

Avoid Tank Damage

When filling through power fill coupling, open air valve (4) on top of tank to release pressure.

---

15. Fill to Cold Full level (9) on hydraulic tank gauge.
16. Fill pump cases at return line cap (8) in return line until manifold will not take any more oil. ***Use new hydraulic oil filtered through a 10-micron filter.***
17. Install and securely tighten return line cap (8) as soon as oil appears.
18. Check for hydraulic leaks and correct if found.
19. Fill hydraulic tank to ***FULL COLD LEVEL***—90 to 94%—while watching hydraulic tank display on information screen. Use proper hydraulic oil (see Section 9 or Lubrication Folio 2129).

    Do not fill tank to 100%. Oil will flow out of breather when the system heats up.
20. Check tank level and refill as required.
21. Start engine and allow hydraulic system to return to normal operating pressure and temperature. Check for leaks and tighten parts as required.
22. 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 the tank suction shut-off valve (6a, Figure 2-1).

Open the suction shut-off valve before starting engine after servicing the pumps.

CAUTION
Avoid Damage to Pumps

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

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 2-7 when assembling O-ring over threads.

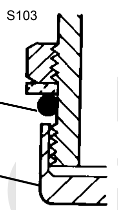


FIGURE 2-7

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.

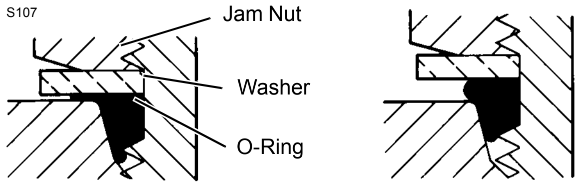
Table 2-2
Pipe Thread Leakages

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 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 2-8, 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 2-8, 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.

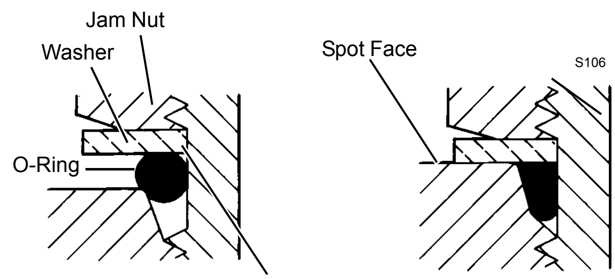
View B

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 2-8

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 2-9, View A.



View A

Nut and washer backed up to end of smooth portion on fitting.

View B

FIGURE 2-9

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 2-9, 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 2-9, View B.

Table 2-3
Straight Thread Troubleshooting

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

ORS Connection

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

1. Lubricate and install O-ring in adapter groove (Figure 2-10).

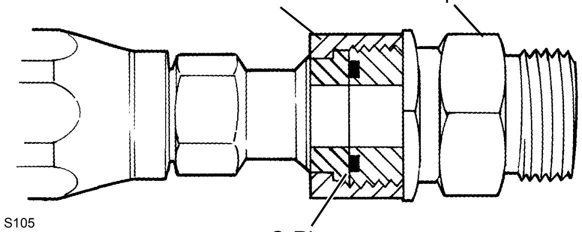


FIGURE 2-10

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

Table 2-4
ORS Assembly Torque

Nut Size Across Flats in (mm)	**Fitting Size**	**Torque**	
		In-Lb	Nm
5/8 (15.88)	-04	120 – 145	14 – 16
13/16 (20.65)	-06	203 – 245	23 – 28
15/16 (23.83)	-08	380 – 470	43 – 53
1-1/8 (28.58)	-10	550 – 680	62 – 77
1-3/8 (34.93)	-12	763 – 945	86 – 107
1-5/8 (41.28)	-16	1110 – 1260	125 – 142
1-7/8 (47.63)	-20	1500 – 1680	170 – 190

Table 2-5
ORS Troubleshooting

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

Split Flange Connection

1. Lubricate and install O-ring in shoulder groove (see Figure 2-11). 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 2-11) 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.

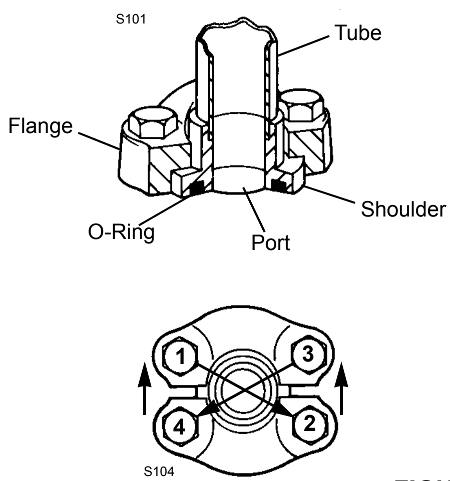


FIGURE 2-11

Table 2-6
Split Flange Assembly Torque

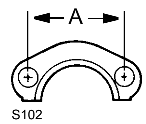
A Dimension inch (mm) 	**Flange Size**	**Torque**	
		in-lb	Nm
Standard Pressure Series			
1-1/2 (38.1)	-08	175 – 225	20 – 25
1-7/8 (47.625)	-12	225 – 350	25 – 40
2-1/16 (52.39)	-16	325 – 425	37 – 48
2-15/16 (74.61)	-20	425 – 550	48 – 62
2-3/4 (69.85)	-24	550 – 700	62 – 79
3-1/16 (77.79)	-32	650 – 800	73 – 90
3-1/8 (79.38)	-24	1400 – 1600	158 – 181
3-13/16 (96.84)	-32	2400 – 2600	271 – 294
High Pressure Series			
1-9/16 (39.67)	-08	175 – 225	20 – 25
2 (50.8)	-12	300 – 400	34 – 45
2-1/4 (57.15)	-16	500 – 600	57 – 68
2-5/8 (66.68)	-20	750 – 900	85 – 102
3-1/8 (79.38)	-24	1400 – 1600	158 – 181
3-13/16 (96.84)	-32	2400 – 2600	271 – 294

Table 2-7
Split Flange Troubleshooting

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 2-12, View A).
3. Using wrenches, tighten connector nut the number of flats shown in Table 7 (Figure 2-12, View B).

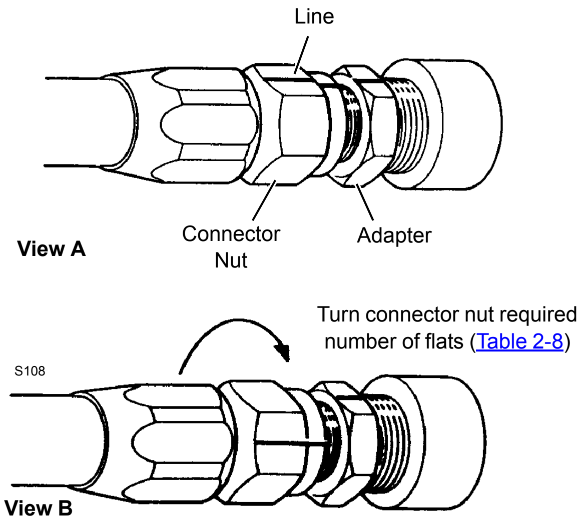


FIGURE 2-12

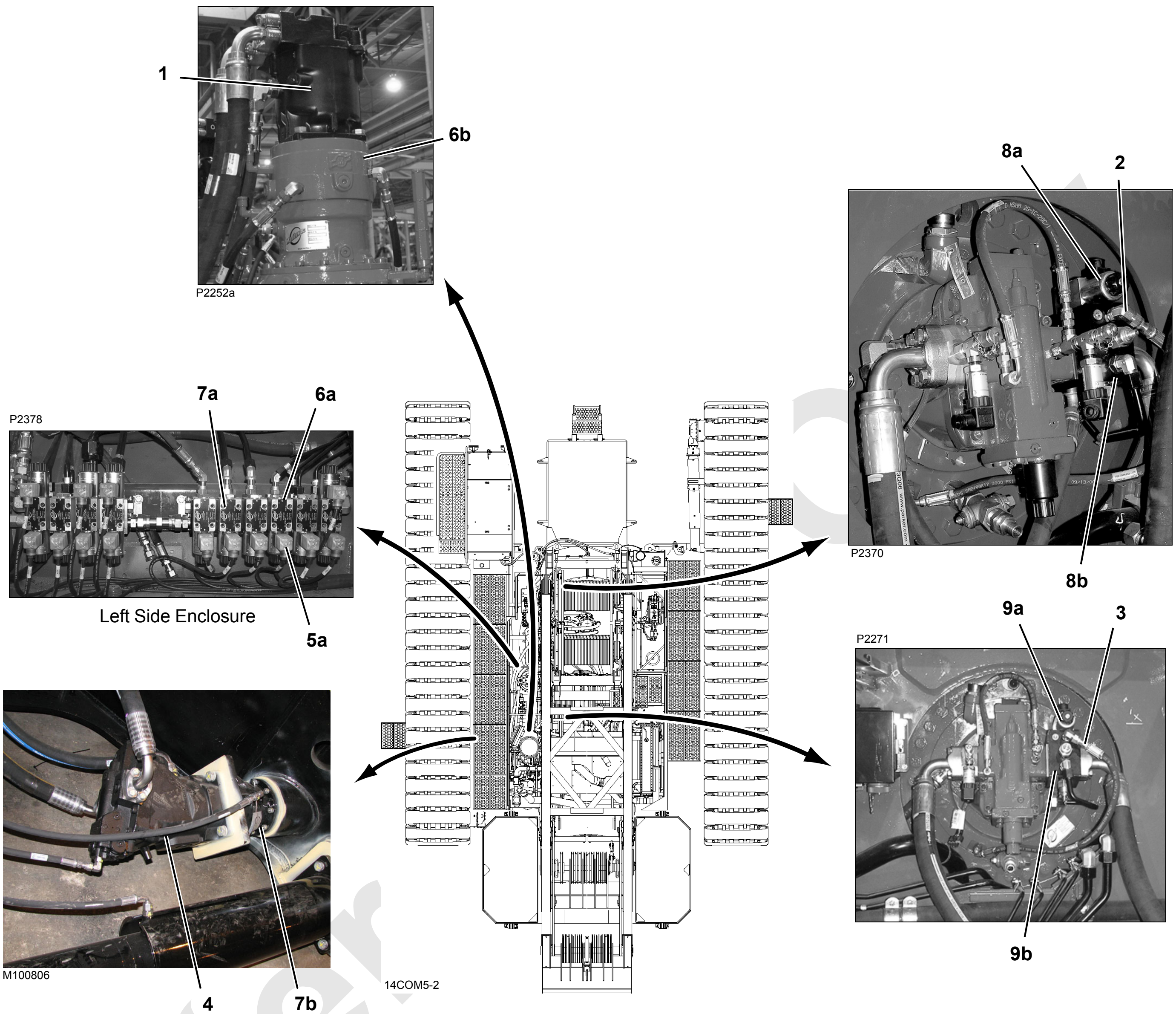
4. Misalignment of marks will show how much nut has been tightened, and best of all that it has been tightened.

Table 2-8
SAE 37°Flare Tightening

Connector Nut Size Across Flats - inch (mm)	**Fitting Size**	**Adapter Flats to Rotate**
9/16 (14.29)	-04	2-1/2
5/8 (15.88)	-05	2-1/2
11/16 (17.46)	-06	2
7/8 (22.23)	-08	2
1 (24.5)	-10	1-1/2 – 2
1-1/4 (31.75)	-12	1
1-1/2 (38.1)	-16	3/4 – 1
2 (50.8)	-20	3/4 – 1
2-1/4 (57.15)	-24	1/2 – 3/4

Table 2-9
SAE 37° Flare Troubleshooting

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



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

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

FIGURE 2-13

SHOP PROCEDURES

Initial Oil Fill

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

1. If equipped with free fall drums, fill front and rear drum pump cases with oil as follows:
   a. Disconnect hydraulic hose and remove fitting from case drain port in top of both pumps.
   b. Fill both pump cases to level of case drain port. ***Use new hydraulic oil filtered through a 10-micron filter.***
   c. Reinstall fittings and reconnect hydraulic lines.
2. Fill all motor cases with oil (Figure 2-13).
   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.
3. ***Open*** hydraulic tank shut off valve 6a, Figure 2-1).
4. Open return line cap (8) in return line (Figure 2-1).
5. Make sure drain valve (7, Figure 2-1) is closed.
6. At engine, disengage engine clutch (Figure 2-14).

FIGURE 2-14

7. Fill through stand pipe in return line (2a, Figure 2-1) or through power fill coupling (2b). ***Use new hydraulic oil filtered through a 10-micron filter.***
8. Open air valve (4) on top of tank to release pressure when filling through power fill coupling.
9. Fill to Cold Full level (9) on hydraulic tank gauge.
10. Fill pump cases at return line cap (8) in return line until manifold will not take any more oil. ***Use new hydraulic oil filtered through a 10-micron filter.***
11. Install and securely tighten return line cap (8) as soon as clear oil appears.
12. Check for hydraulic leaks and correct if found.

Initial Start-Up

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

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

WARNING

Burn Hazard

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

Hot oil can escape when you remove the stand pipe plug, filter cover, or breather.

Relieve pressure through air valve on tank before servicing.

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 (6a, Figure 2-1) is fully open. ***Pumps can be damaged from cavitation if this step is not performed.***
3. Disconnect electrical (DIN) connectors (5) from solenoids.
4. At engine, disengage engine clutch (Figure 2-14).
5. Start engine at lowest possible speed and make necessary adjustments before engaging clutch.
6. ***Slowly*** engage and disengage clutch and check for charge pressure.

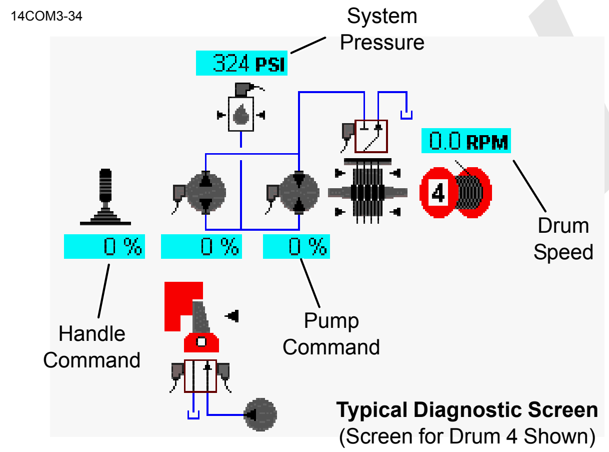
CAUTION

Equipment Damage

Check pump pressures 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 (see Figure 2-15), 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 (22 to 25.5 bar).
   b. If pump pressures are not within specified range, ***stop engine immediately***. Determine cause of faulty pressure and correct.
8. Stop engine.
9. Reconnect electrical (DIN) connectors removed in step 3.
10. Start and run engine at low idle.
11. With engine at low idle, extend and retract all cylinders three times: gantry cylinders, mast cylinders, back hitch pins, cab tilt, boom hinge pin, carbody jacks, and crawler pins.

    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 2-2). ***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.
16. Perform System Calibration and Test in this section.



Typical Diagnostic Screen
(Screen for Drum 4 Shown)

FIGURE 2-15

2

High Pressure Accessory System Checks

To operate these items, use the remote control, overhead console switches, and manual handles on carbody. High pressure accessories include:

- Live mast cylinders.
- Gantry cylinders.
- Boom hinge pin cylinder.
- Cab tilt cylinder.
- Carbody jacking cylinders.
- Crawler pin cylinders.

Gantry Cylinders

Access remote control in left side enclosure and connect to node 3 controller, connector W36.

1. Use gantry toggle to ***raise*** and ***lower*** gantry several times to remove air from system.
2. Scroll to Diagnostic screen to verify that 4,000 psi (275 bar) is present when gantry is extended.

Live Mast Cylinders

Perform the following procedure when the mast is lowered.

1. Use mast arm cylinder switch on overhead panel in cab.
2. Fully raise and lower mast cylinders three to four times to remove air from mast cylinders.
3. Scroll to Diagnostic screen to verify that 4,000 psi (275 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.

Boom Hinge Pin Cylinder

Use boom hinge pin switch on overhead panel in cab.

1. Fully engage and disengage pins three to four times to remove air from cylinders.
2. Scroll to Diagnostic screen to verify that 600 psi (41 bar) is present when pins are fully engaged.

Cab Tilt Cylinder

Use cab tilt switch on right side panel in cab.

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 2,000 psi (138 bar) is present when cylinders are fully engaged and that 600 psi (41 bar) is present when disengaged (stalled).
3. When control is off, cylinders must not retract. If they do, contact the Manitowoc Crane Care Lattice Team.

Carbody Jacking Cylinders

Perform the following procedure when 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 approximately 3,100 psi (214 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 Pin Cylinders

Perform the following procedure before connecting 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 3,100 psi (214 bar) is present when pins are fully engaged and disengaged (stalled).

Low Pressure Accessory System Checks

The left travel/drum 3 charge pump is the pressure source for low pressure accessory system. Set pressure to the value specified in Table 2-10.

The low pressure accessory system controls the swing brake, travel brake, travel 2-speed, drum 3/left travel diverting valve, back hitch pins, and boom hoist (drum 4) pawl.

Drum Pawls

Place each drum park switch in ***on – park*** and ***off – park*** positions.

Observe that each drum pawl engages and disengages correctly.

Swing Brake

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

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

Travel Brakes

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

1. Scroll to 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.

Back Hitch Pins

Access setup remote control in left side enclosure and connect to node 3 controller, connector W36.

1. Fully engage and disengage pins three to four times to remove air from cylinders.
2. Scroll to Diagnostic screen to verify that 350 psi (24 bar) is present when pins are fully engaged.

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 crawler roller at front of one crawler and at rear of other crawler (Figure 2-16).
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.

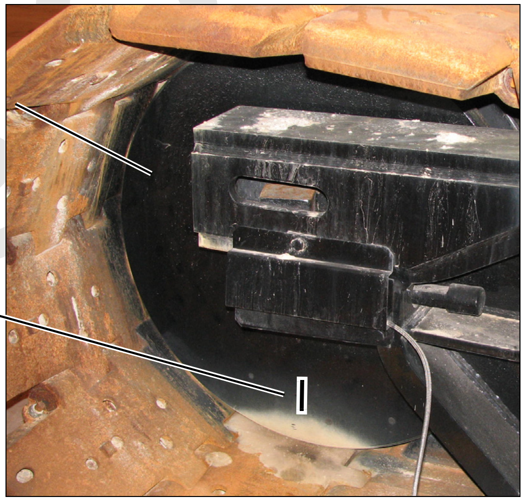


FIGURE 2-16

Swing and Drum Speeds

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

Check operating speed on the diagnostic screens (Figure 2-15) 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.

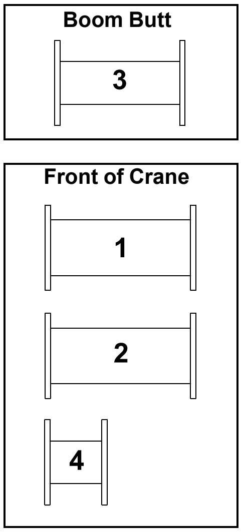
HYDRAULIC SYSTEM SPECIFICATIONS

Table 2-10 Hydraulic System Specifications

Function	Direction	Pump-Port	System Pressure 1 [1] psi (bar)	System Pressure 2 [2] psi (bar)	Charge Pressure	Speed [3] rpm
Drum 1	Hoist	Pump 2 - B[8]	6,090 (420) Up 3,770 (260) Down	NA	350 (24)	48 - 53
	Lower/Accessory	Pump 2 - A[8]		NA		42 - 50
Drum 2	Hoist	Pump 5 - B[8]		NA		48 - 53
	Lower	Pump 5 - A		NA		42 - 50
Drum 3 [7]	Up	Pump 3 - A[8]		NA		39 - 43
	Down	Pump 3 - B		NA		34 - 41
Drum 4	Up	Pump 4 - A[8]		NA		39 - 43
	Down	Pump 4 - B		NA		34 - 41
Swing	Left	Pump 6 - B[8]	6,090 (420)	NA		2.3
	Right	Pump 6 - A[8]		NA		
Right Crawler	Forward	Pump 1 - B[8]	6,090 (420)	5,900 (407)		11 at Tumbler
	Reverse	Pump 1 - A		5,900 (407)		
Left Crawler [7]	Forward	Pump 3 - A[8]		5,900 (407)		11 at Tumbler
	Reverse	Pump 3 - B		5,900 (407)		
Low Pressure Accessory System [4]	NA	NA	NA	NA		NA
High Pressure Accessory System [5]	NA	NA	NA	600 (41) to 3.500 (241)		NA
Carbody Control System [6]	NA	NA	NA	3,000 (207)		NA

Notes	
NA	Not Applicable.
1	Controlled by multi-function valves in each pump.
2	Controlled by crane's programmable controller.
3	Speeds based on engine at high idle, no load (no rope on drums), and handles moved fully forward or back. Speeds can very plus or minus 5%.
4	Swing brake, travel brakes, travel two speed, left travel/auxiliary hoist diverting valve, back hitch pins disable, and boom hoist pawl.
5	Live mast cylinders, gantry raise cylinders, boom hinge pins, cab tilt. Accessory system pressure is from low pressure side of front drum pump #5. Computer controls pump pressure depending on accessory selected.
6	Crawler pins and carbody jacks (manual handles). System pressure is enabled with system pressure sender and controlled by computer.
7	Pump used for left crawler or drum 3 (auxiliary) function. Computer selects first handle moved.
8	Pressure sender system port location. Travel system pressure sender is between each leg port.

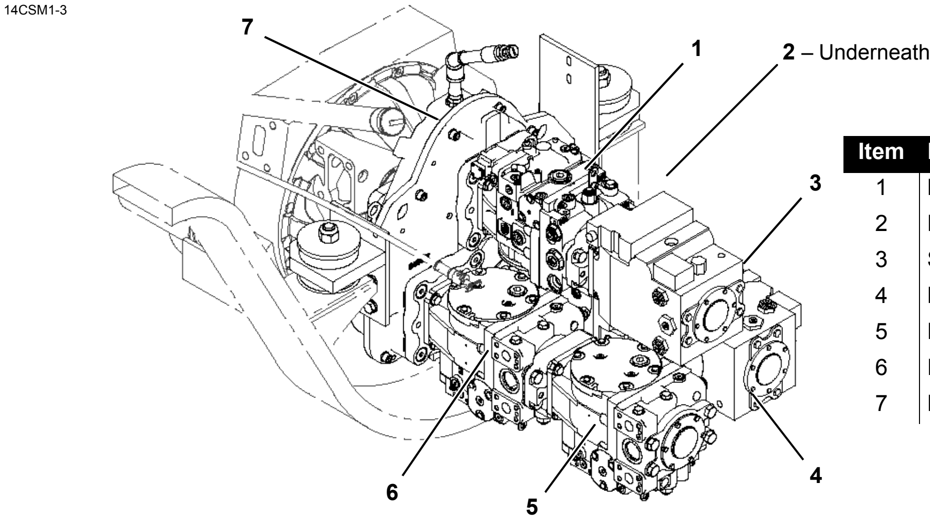
DRUM IDENTIFICATION



Drum No.	Description
1	Front Load Drum
2	Rear Load Drum
3	Luffing/Auxiliary Load Drum
4	Boom Hoist - Standard

FIGURE 2-17

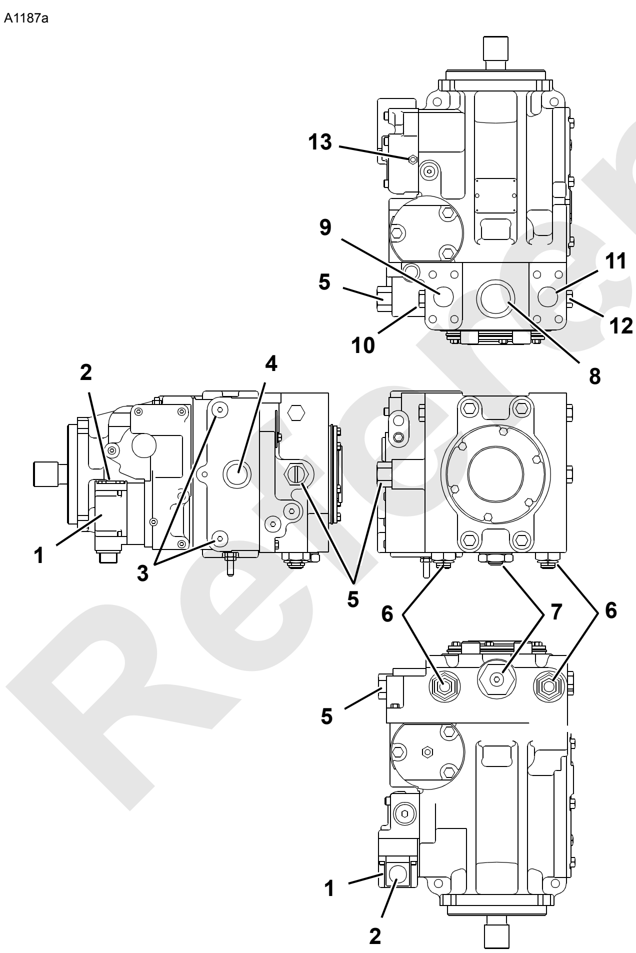
PUMP IDENTIFICATION



Item	Description	Pump #
1	Left Crawler and Drum 3 Pump	3
2	Right Crawler Pump	1
3	Swing Pump	6
4	Boom Hoist Pump	4
5	Rear (Drum 2) Pump	5
6	Front (Drum 1) Pump	2
7	Pump Drive	NA

FIGURE 2-18

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

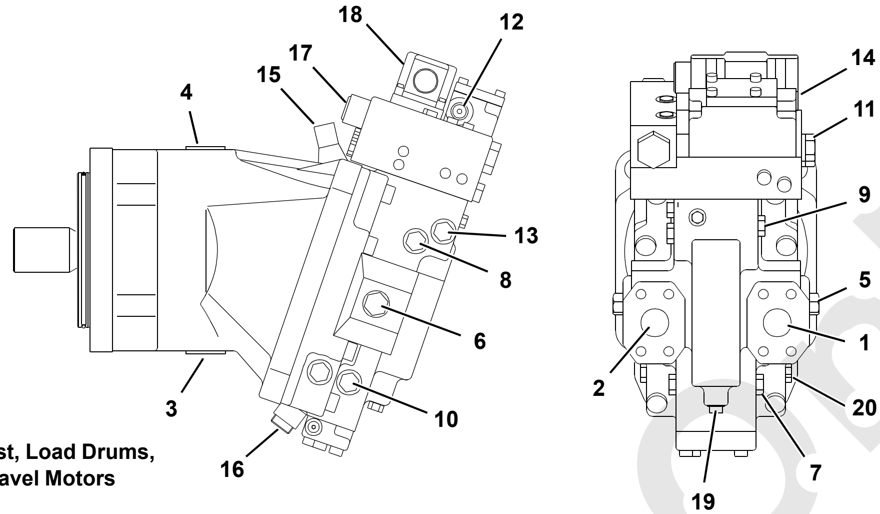
NOTE 1 Both Sides of Pump.

NOTE 2 Valve is Directly Opposite Port it Protects.

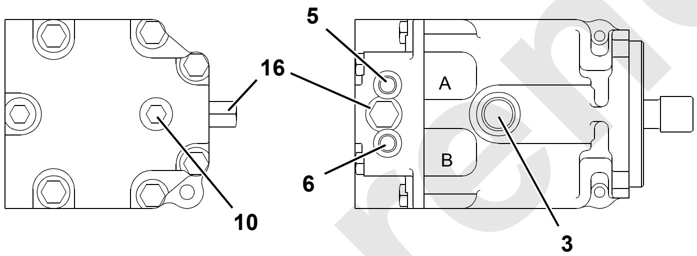
FIGURE 2-19

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 2-20

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 of this manual).

Pressure Test and Calibration Screen

NOTE: To understand operation of the main display and touch pad controls, read instructions in Section 3 of this manual.

The Pressure Test and Calibration Screen (see Figure 2-21) initiates and monitors the four hydraulic test and calibration procedures described in this section.

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

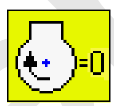
Pressure Test and Calibration screen operates on two ***levels***.

Level 1 — Test data box highlighted blue.

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

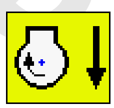
All test and calibration procedures must be run at a particular engine speed. If a test is started at the wrong speed, the appropriate prompt shown below appears in the data box and the procedure is aborted.

Engine Off



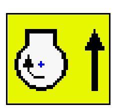
A yellow engine pressure **0** icon indicates that test must be run with engine off.

Engine Low Idle

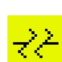


A yellow engine pressure **down arrow** icon indicates that test must be run with engine at low idle.

Engine High Idle



A yellow engine pressure **up arrow** icon indicates that 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 2-21 for following procedure.

The pressure sender test calculates the zero-pressure output level for each pressure sender.

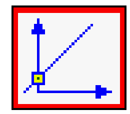
Perform this test when:

- 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 below.

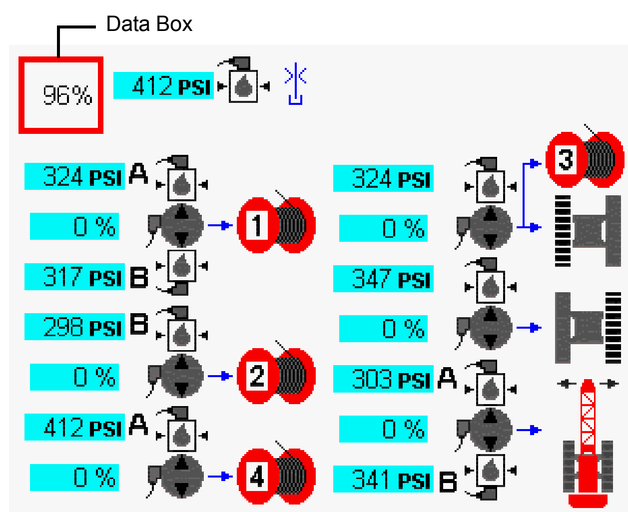
Test pressure senders as follows:

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.



14COM3-51

FIGURE 2-21

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 Section 2 of the Service Manual).
- 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 2-22 for following procedure.

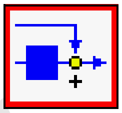
Control calibration calculates the pump threshold command level for all drum and swing functions.

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.

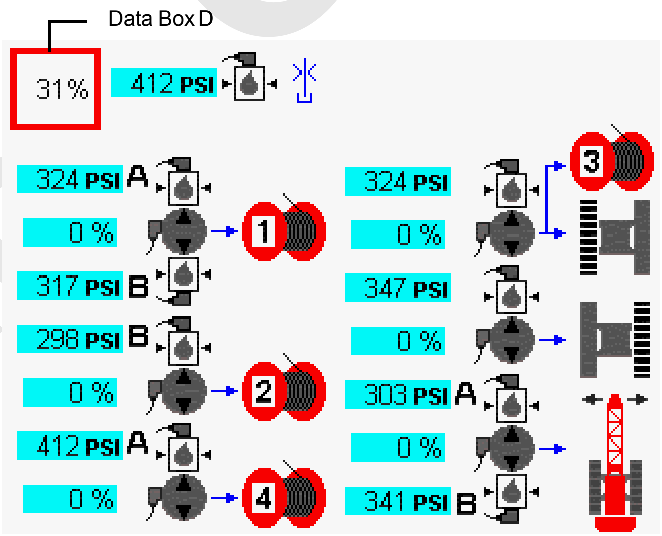


FIGURE 2-22

High Pressure Test

See Figure 2-23 *for* 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

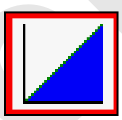
This test generates maximum pressure in the main hydraulic circuits. Defective brakes may allow unintended motion during test. Move the crane to an area where such motion is not a hazard.

We recommend an observer to monitor functions the 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.

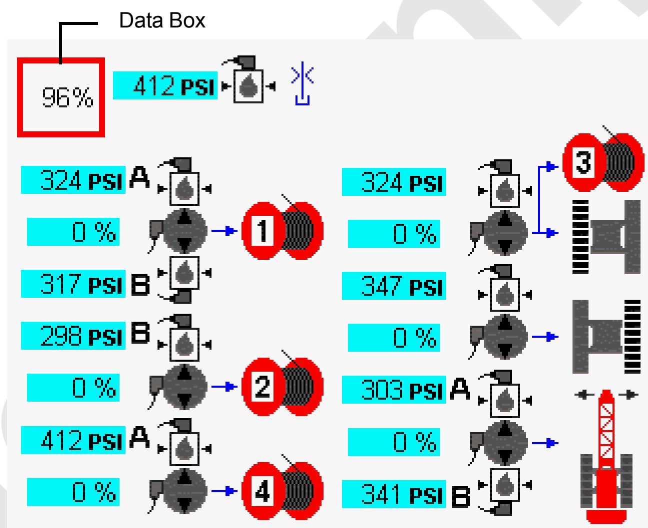


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FIGURE 2-23

Published 09-05-14, Control # 226-02

Manitowoc Crane Care

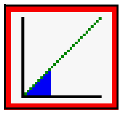
Charge Pressure Test

See Figure 2-24 for 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.

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.

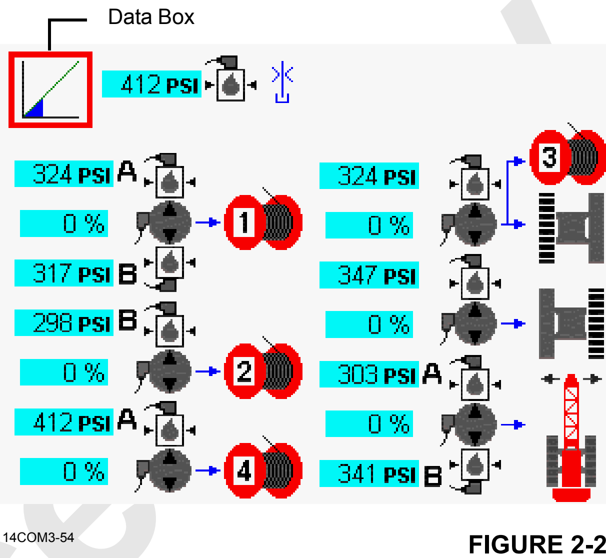


FIGURE 2-24

High Pressure Adjustment

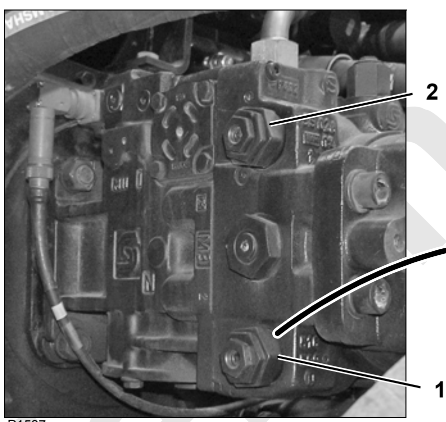
The following adjustment is only required when a system fails the High Pressure Test described in this section.

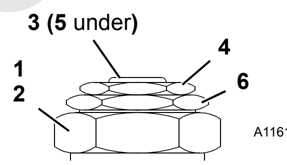
Unless otherwise specified, see Figure 2-25 for following procedure.

1. Scroll to diagnostic screen for corresponding function (see Figure 2-15).
2. Disconnect electrical (DIN) connector from corresponding brake solenoid valve (see Figure 2-13).
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 2-19 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 steps 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 electrical (DIN) connector to corresponding brake solenoid valve (see Figure 2-13).

Typical Pump Installation





Multi-Function Valve

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 2-25

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 2-15).
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 25.5 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.
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:

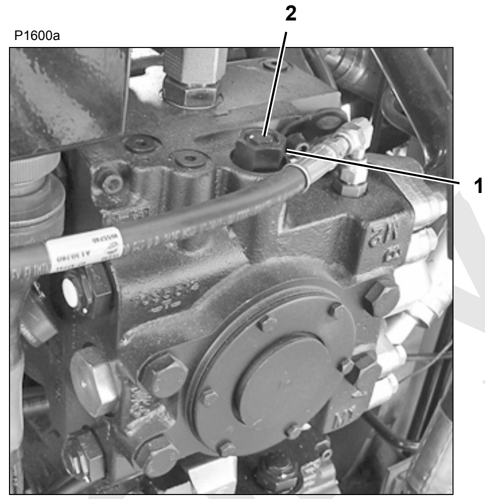
   See Figure 2-26 for following procedure.

   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.



Typical Pump Installation

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

FIGURE 2-26

2

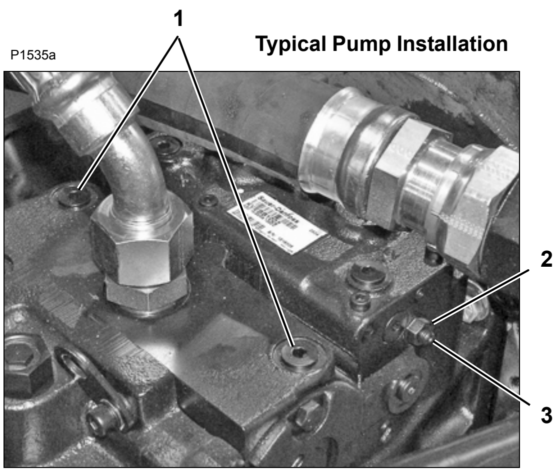
Pump Neutral Adjustment

See Figure 2-27 *f*or following procedure.

To adjust pump neutral:

1. Park all crane functions and stop engine.
2. Disconnect electrical (DIN) connector from pump EDC (see Figure 2-29).
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
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 2-27

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).

Motor Leakage Test

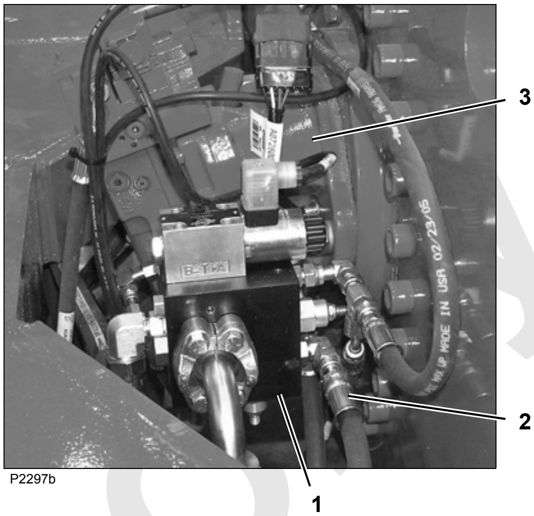
Perform the following test if troubleshooting indicates the need:

- Low Charge Pressure
- Sluggish Operation
- Excessive Heat

See Figure 2-28 for following procedure.

1. Stop engine.
2. Install an accurate flow meter in highest case drain port (see Figure 2-13) 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.

Typical Motor Installation



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

FIGURE 2-28

8. Monitor flow meter. Under all operating conditions, leakage should not be more than 5-1/2 to 6-1/2 gpm (21 to 24 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.

Low Pressure Accessory Adjustment

See Figure 2-29 for following procedure.

Left travel/drum 3 charge pump #3 is the pressure source for low pressure accessory systems — swing brake, travel brake, travel 2-speed, back hitch pins, boom hoist pawl, and left travel/drum 3 diverter.

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 approximately 350 psi (24 bar).
3. Apply brake by moving control handle to off — pressure should be zero.
4. If pressure is not between 320 to 370 psi (22 to 25.5 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. Repeat above steps until gauge reads no higher than 375 psi (26 bar).
   e. Hold adjusting screw in position and securely tighten locknut.
5. Stop engine, remove gauge, and reconnect hydraulic lines.

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 have manual overrides that allow electrical problems to be isolated from mechanical problems when troubleshooting hydraulic system problems.

DANGER

Falling or Moving Load Hazard

To prevent unexpected movement of loads or 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

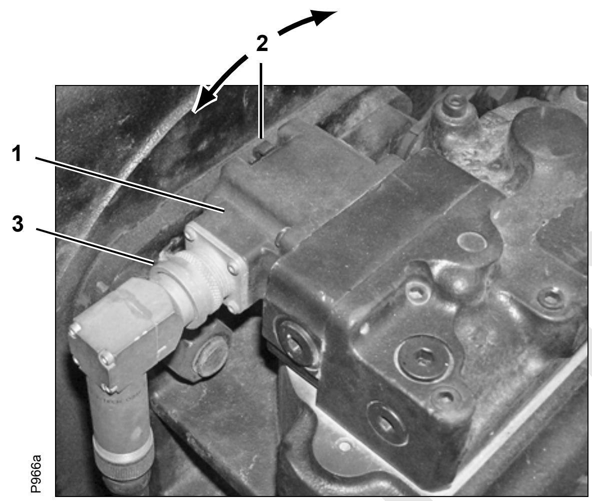
See Figure 2-29 *f*or following procedure.

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.

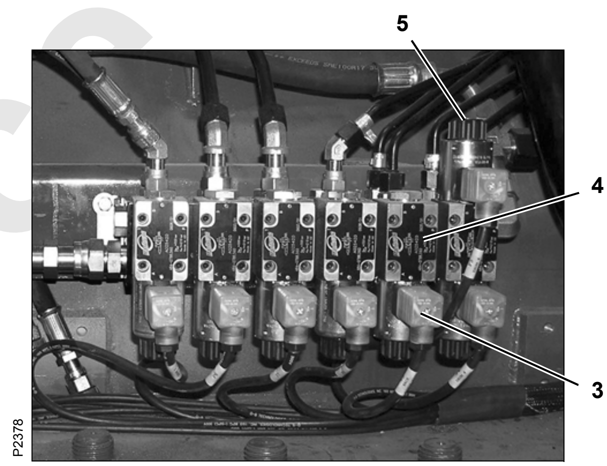
Solenoid Valve Override

See Figure 2-29 for 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 Installation



Typical Solenoid Valve Installation

Item	Description
1	Pump EDC/Motor PCP
2	Manual Override
3	Electrical (DIN) Connector
4	Solenoid Valve
5	Manual Override (though end cap)

FIGURE 2-29

Pressure Sender Replacement

WARNING

High Pressure Oil Hazard

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

Hydraulic pressure senders monitor system pressure in each hydraulic system and are located near each system motor. Follow steps below to replace a faulty pressure sender.

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 faulty pressure senders to catch oil leakage.

Perform steps 5 – 9 only at faulty pressure sender.

5. Disconnect electrical (DIN) connector from pressure sender.
6. ***Slowly loosen*** pressure sender only enough to allow any remaining pressure to exhaust.
7. Remove pressure sender.
8. Install new pressure sender and connect electrical (DIN) connector.

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

Disc Brake Operational Test

There is no physical way to check the disc brakes for travel, boom hoist, load drums, and swing. An operational test of each brake must be performed weekly. Figure 2-13 shows brake and brake solenoid valve locations.

NOTE: See Table 2-10 system pressure specifications.

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

1. Disconnect electrical (DIN) connector for brake being checked.
2. Start and run engine at low idle.
3. Select corresponding Liftcrane Boom Capacity Chart on Rated Capacity Indicator/Limiter screen.
4. Turn off park switch on control console for function being checked.
5. Access diagnostic screen (Figure 2-15) for function being checked – Drum, Boom Hoist, Swing, or Travel.

NOTE: For front or rear load drum, make sure *free fall* is ***Off***.

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 gearbox manufacturer's manual for disc brake repair instructions.

8. Reconnect electrical (DIN) connectors 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.

SECTION 3
ELECTRIC SYSTEM

TABLE OF CONTENTS

SECTION 3
ELECTRIC SYSTEM

ELECTRICAL DRAWINGS AND SCHEMATICS

Electrical schematics are located at the end of this Section.

INSPECT ELECTRICAL COMPONENTS

DANGER

Electric Shock Hazard

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

Every Month or 200 Hours

1. Visually inspect all electrical harnesses and cables for the following:
   - Damaged, cut, or deteriorated harness loom covering.
   - Damaged, cut, or abraded individual wires or cable insulation.
   - Exposed bare copper conductors.
   - Kinked, crushed, flattened harnesses or cables.
   - Blistered, soft, degraded wires and cables.
   - Cracked, damaged, or badly corroded battery terminal connections.
   - Inspect all machine ground connections for damaged terminals or excessive corrosion.
   - Other signs of significant deterioration.

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

   If any of these conditions exist, address them appropriately.

Degradation Due to Severe Environment

Table 3-1 Climate Zone Classification

Zone	Description
A	Tropical Moist: All months average above 18° C. Latitude: 15° - 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

Zone A and B

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

Zone C

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

Zone D and E

Cold temperatures will negatively impact service life. Regularly inspect electrical harnesses and cable assemblies per Step 1.

Salt Environment

Harness and cable assemblies operating in salt water climates could see a significant reduction in service life. Regularly inspect electrical harnesses and cable assemblies per Step 1.

CIRCUIT BREAKERS

Engine Node

See Figure 3-1

Circuit breakers CB-1 through CB-9 are mounted in engine node 0 controller box in left side enclosure.

Operator's Cab

See Figure 3-1

Circuit breakers CB1 through CB4 and fuses F1 through F4 are mounted in rear console behind operator's seat.

Intake Air Heater

The 120 amp circuit breaker (CB17) and high-power-relay contactor for the two intake air "grid" heaters located in the grid heater junction box mounted in the engine compartment.

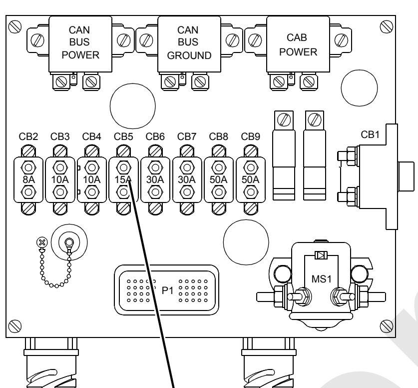
Aftertreatment Load Center

The junction box for the Tier 4 engine aftertreatment loads is located below the DEF tank. It contains relays and circuit breakers 10, 11, and 12 for DEF hose and supply module heaters.

Circuit Breaker	Amps	Items Protected
CB10	15	DEF Supply Module Heater
CB11	10	
CB12	15	DEF Hose Heaters

A16276

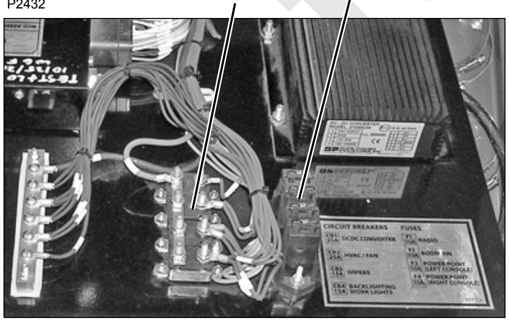
Right Side Enclosure



Circuit Breakers

Fuses

P2432



Rear Console at Back of Cab

Circuit Breaker	Amps	Wire No.	Items Protected
Located next to aftertreatment load center			
CB-0	120	6B	Alternator Circuit
Located in node 0			
CB-1	60	6A	Main System 24 Volt Power
CB-2	8	6C2	ECM Key Switch (Cummins)
CB-3	10	6C3	Cummins Diagnostics
CB-4	10	6C4	Key Switch (Cummins)
CB-5	15	6C5	Air Compressor Clutch
CB-6	30	6C6	Cummins ECM
CB-7	30	6C7	Starter Solenoid
CB-8	50	6C8	CAN-Bus Power
CB-9	50	6C9	Cab Power

Circuit Breaker	Amps	Items Protected
CB1	25	DC Converter
CB2	25	Air Conditioning/Heater Fan
CB3	15	Front and Overhead Wiper
CB4	15	Back Lighting / Work Lights
F1	10	Radio
F2	10	Boom RIN
F3	10	Power Point (Left Console)
F4	10	Power Point (Right Console)

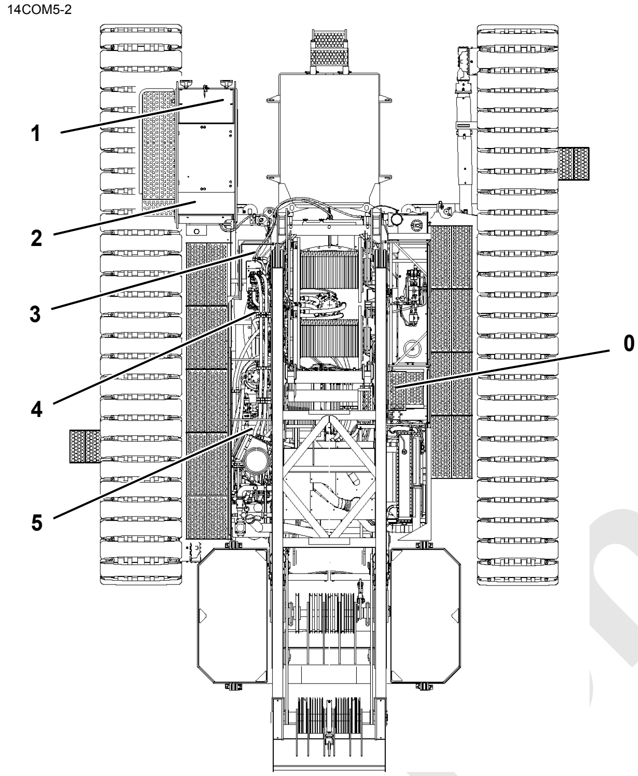
FIGURE 3-1

Published 09-05-14, Control # 226-02

TEST VOLTAGES

On the following pages are Tables with test voltages sorted by nodes. The nodes are listed and identified in Figure 3-2.

The Model 14000 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.



Node	Description
1	Master (Front Console)
2	Handles and Cab Controls
3	Drum 1, 2, and 3, Alarms, Sensors, Accessories and Free Fall
4	Drum 4, Pumps, and Accessories
5	Swing Limit and Temperature Sensor
0	Engine and Circuit Breakers
RIN (Boom)	Mounted on Boom – Block-Up, Angle Indicator, Wind Speed, and Load Sensor.

FIGURE 3-2

Component—Node Cross-Reference

This list may be useful when using the following Tables. 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
Alarms	Nodes1, 3 & 4
Air Conditioning Clutch	Node 1
Auto Lube Pumps	Node 4
Block Up Limit (Boom)	Boom Node
Block Up Limit (Luffing Jib)	Luffing Jib Node
Cab Switches and Controls	Nodes 1 & 2
Cab Power	Node 0
Cab Tilt	Node 3
Control Handles	Nodes 1 & 2
Boom Hoist (Drum 4) Components	Nodes 3 & 4
Engine Control Module	Node 0
Engine Fuel Level Sensor	Node 3
Filters	Nodes 4
Free Fall Components	Node 3
Hydraulic Fluid Level and Temperature	Node 4
Hydraulic Vacuum Switch	Node 4
Limits	Nodes 3 & 4
Front Drum Components	Nodes 3
Rear Drum Components	Nodes 3 & 4
Auxiliary/Luffing (Drum 3) Components	Node 3
Pressure Senders	Nodes 3 & 4
Swing Components	Nodes 3 & 4
Throttle (Hand and Foot)	Node 2
Travel Components	Nodes 4
Wind Speed Indicator (Boom)	Boom Node
Wind Speed Indicator (Luffing Jib)	Luffing Jib Node

Node Table Heading Descriptions

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

Connector codes—for example, **34-R**—are interpreted 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), digital output (DO), etc.

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

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

CAN Packet Number—indicates location of items for all nodes except node 0 which does not have CAN packet numbers.

For example, in Master Node 1, ***CAN92-6-32*** (Swing Park Switch):

CAN92 is the ***packet*** location number.

Number ***6*** is the ***bank*** where information is stored.

Number ***32*** is the ***identifier*** for that item.

Table 3-2 Pump and Motor Values

Pumps	Hoist Motors	Travel Motors
0 to 25.4 Volts (at Node)	3.8 to 14 Volts (at Node)	0 or 28 Volts (at Node) [2]
0 to 2.0 Volts (at Pump)	3.8 to 14 Volts (at Motor)	0 or 28 Volts (at 2-Speed Solenoid) [2]
1 to 100 mA [1]	180 mA to 600 mA[1, 3]	0 or 1500 mA [1]

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

[2] Travel motor control is two-speed. When the travel motor control solenoid is energized, the motor is locked in max displacement. When the motor control solenoid is de-energized, the pressure compensator will shift the motor to min displacement. The Master Node will only de-energize the coil if the 2-Speed Travel Switch is in the high speed position and the engine RPM is above 1500. The pressure compensator override will begin to shift motor back to max displacement, low speed as the closed loop pressure reaches or exceeds 3915 to 4200 PSI (270 to 290 BAR) in order to stabilize and hold the pressure constant protecting the motor from over heating and catastrophic failure.

[3] The Master Node regulates displacement of the hoist motors by the EDC control on the motor. 180 mA the coil is at rest and the motor is in max displacement. 750 mA the coil is fully energized and the motor is in min displacement.

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
M/C	=	Motor Control
N/A	=	Not Applicable
N/C	=	No Connection
NO	=	Number
NS	=	Node Select
Opt.	=	Optional
P	=	Pin
P/C	=	Pump Control
RCL	=	Rated Capacity Indicator/Limiter
V	=	Volt or Volts
VDC	=	Volts Direct Current
W	=	Wire

Checking Electrical Inputs/Outputs Using the Test Box

Troubleshoot components on the main display, system diagnostic screen first. Perform additional testing with the Electrical Test Kit at universal nodes or Manitowoc Unit Tester at all nodes. The Electrical Test Kit or Manitowoc Unit Tester can be ordered from your Manitowoc dealer.

The breakout test kit provides a breakout of the node signals to easily probed bayonet connections. Each node connector (2) Figure 3-3, page 3-6 is keyed uniquely and requires a matching keyed test harness assembly (4) from the Electrical Test Kit.

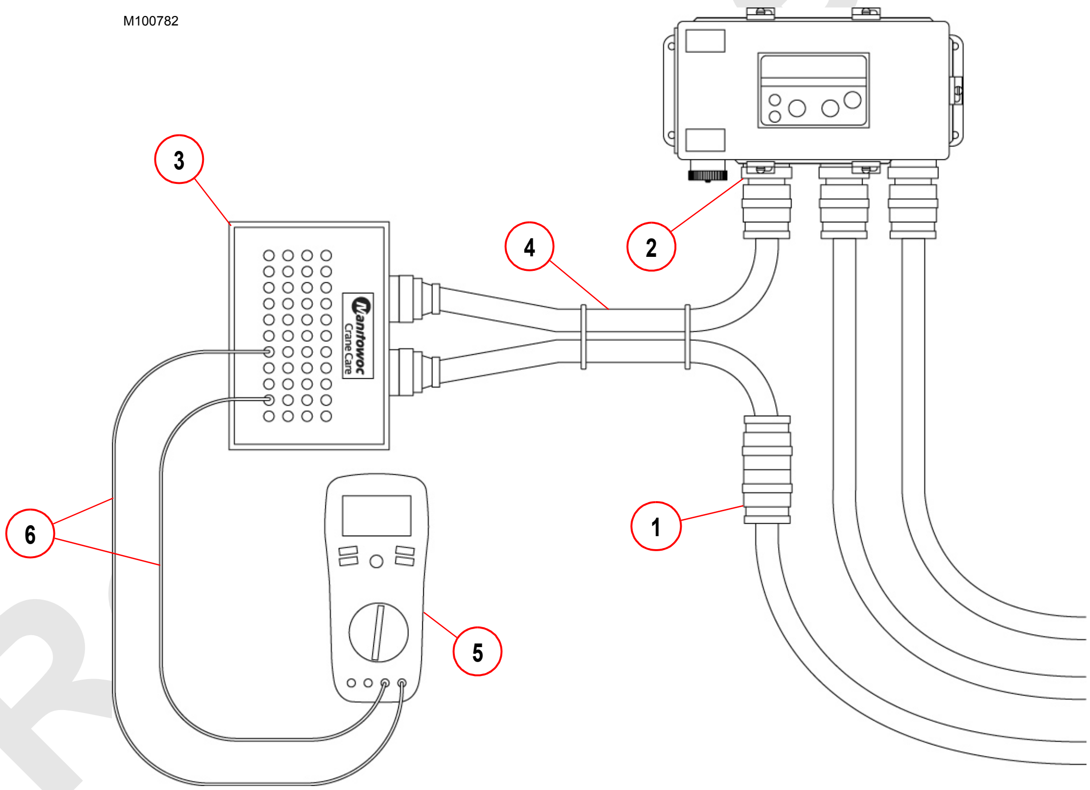
The output terminals of the electrical test box (3) are labeled A1 through 40V, corresponding to node connector (2) pin numbers. Both a number and letter are included in each designator because some systems number the pin connections and others letter the connections. Use either the numbers or letters as they apply to your system.

I/O node and pin numbers are contained in the Test Volt tables.

To probe a fault at a universal node with the Electrical Test Kit:

1. Shutdown the engine and turn the engine key switch to off.
2. Determine which signal contains the suspected fault.
3. Disconnect the node cable (1) from the node connector (2) containing the signal of the suspected fault.
4. Connect the electrical test box (3) and test harness (4) between the node connector (2) and disconnected node cable (1).
5. Turn the engine key switch to on and activate the suspected fault.
6. Use a multimeter (5) and bayonet test probes (6) to probe signals at the test box (3) as needed in conjunction with toggling node outputs.

FIGURE 3-3 TEST BOX SETUP



Item	Description
1	Node Cable
2	Node Connector
3	Breakout Box
4	CANbus W3, W4, or W6 Test Harness

Item	Description
5	Multimeter
6	Bayonet Test Probes

Checking Electrical Inputs/Outputs Using the Test Board

Troubleshoot components on the main display, system diagnostic screen first. Perform additional testing with the Electrical Test Kit at universal nodes or Manitowoc Unit Tester at all nodes. The Electrical Test Kit or Manitowoc Unit Tester can be ordered from your Manitowoc dealer.

The breakout test kit provides a breakout of the node signals to easily probed terminal connections. Each node connector (2) Figure 3-4, page 3-7 is keyed uniquely and requires a matching keyed test board assembly (3) from the Electrical Test Kit.

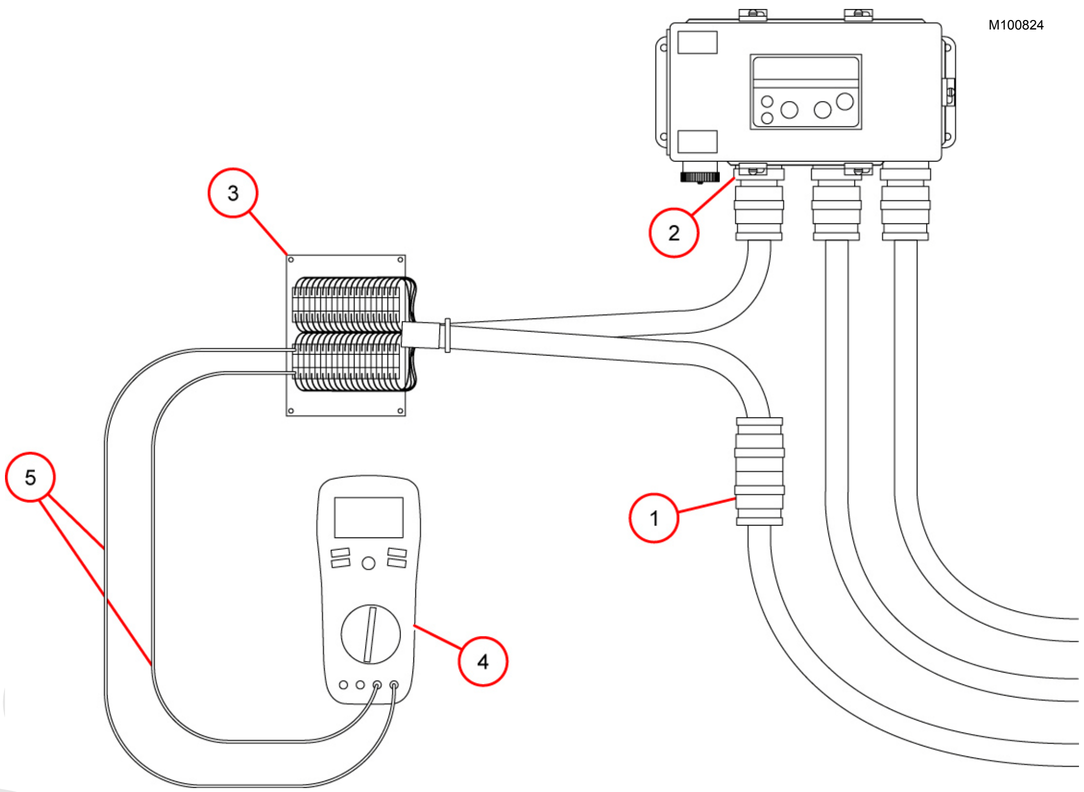
The output terminals of the electrical test board assembly (3) are labeled A through V, corresponding to node connector (2) pin numbers.

I/O node and pin numbers are contained in the Test Volt tables under Test Voltages Tables on page 3-8.

To probe a fault at a universal node with the Electrical Test Kit:

1. Shutdown the engine and turn the engine key switch to off.
2. Determine which signal contains the suspected fault.
3. Disconnect the node cable (1) from the node connector (2) containing the signal of the suspected fault.
4. Connect the electrical test board assembly (3) between the node connector (2) and disconnected node cable (1).
5. Turn the engine key switch to on and activate the suspected fault.
6. Use a multimeter (4) and needle test probes (5) to probe signals at the test board assembly (3) as needed in conjunction with toggling node outputs.

FIGURE 3-4 TEST BOARD SETUP



Item	Description
1	Node Cable
2	Node Connector
3	Test Board Assembly
4	Multimeter
5	Needle Test Probes

Test Voltages Tables

Node 1—Master (Front Console)

See Electrical Schematic A17144, Sheets 5 and 15 (at end of this section).

Connector Number	Function Type	Description	Test Voltages	CAN Packet Number
J1	**Receptacle Front Console – (Not Used Terminals are Omitted)**			
P11-1	24 Volts	Input Power	24 Volts Nominal	
P11-3	DI-12	Display Scroll Up Switch	0 Volts Off; 24 Volts On	CAN92-4-8
P11-4	DI-14	Display Scroll Down Switch	0 Volts Off; 24 Volts On	CAN92-4-32
P11-5	DI-31	Display Exit Switch	0 Volts Off; 24 Volts On	CAN92-6-64
P11-6	DI-9	Display Enter Switch	0 Volts Off; 24 Volts On	CAN92-4-1
P11-8	DO-3	RCL Warning L.E.D.	0 Volts Off; 24 Volts On	CAN92-1-4
P11-10	DO-6	RCL Caution L.E.D.	0 Volts Off; 24 Volts On	CAN92-1-32
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	CAN92-4-4
P11-15	DI-32	Load/Luffing Jib (Drum 3) Park Switch	0 Volts Off; 24 Volts On	CAN92-6-128
P11-16	DI-10	Confirm Switch	0 Volts Off; 24 Volts On	CAN92-4-2
P11-21	Ground	Ground to Node 2 and Displays 1 & 2	Ground	
P11-24	DI-30	Swing Park Switch	0 Volts Off; 24 Volts On	CAN92-6-32
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 from Node 2	N/A	
P11-32	CANL	CAN Low Data Line from Node 2	N/A	
P11-33	DI-27	Display 1	0 Volts Off; 24 Volts On	CAN92-6-4
P11-34	DI-29	Display 2	0 Volts Off; 24 Volts On	CAN92-6-16
J2	**Receptacle – Front Console (Not Used Terminals are Omitted)**			
P12-1	24 Volts	Input Power	24 Volts Nominal	
P12-7	DO-9	System Limit Bypass/Swing Park Switch	24 Volts Nominal	CAN92-2-1
P12-8	DO-11	Drums 1, 2, and 3 Park Switches	24 Volts Nominal	CAN92-2-4
P12-9	DO-16	Drum 4/Travel Park Switches	24 Volts Nominal	CAN92-2-128
P12-11	24 Volts	Gauge Panel	24 Volts Nominal	
P12-13	DI-3	Front Drum (Drum 1) Park Switch	0 Volts Off; 24 Volts On	CAN92-3-4
P12-14	DI-5	Rear Drum (Drum 2) Park Switch	0 Volts Off; 24 Volts On	CAN92-3-16
P12-15	DI-24	Boom Hoist (Drum 4) Park Switch	0 Volts Off; 24 Volts On	CAN92-5-128
P12-17	DO-10	Overhead Panel	24 Volts Nominal	CAN92-2-2
P12-21	Ground	Ground to Node 2 and Displays 1 & 2	Ground	
P12-24	DI-22	Engine Run/Start	0 Volts Off; 24 Volts On	CAN92-5-32
P12-25	DI-7	Travel Park Switch	0 Volts Off; 24 Volts On	CAN92-3-64
P12-26	DI-17	Boom Hinge Pins Disengage	0 Volts Off; 24 Volts On	CAN92-5-1
P12-31	CANH	CAN High Data Line to Graphical Display	N/A	
P12-32	CANL	CAN Low Data Line to Graphical Display	N/A	
P12-33	DI-19	SCR Inhibit	0 Volts Off; 24 Volts On	CAN92-5-4
P12-34	DI-21	SCR Regen Initiate	0 Volts Off; 24 Volts On	CAN92-5-16
P12-35	DI-8	Mast Cylinders Retract Switch	0 Volts Off; 24 Volts On	CAN92-3-128
P12-36	DI-18	Mast Cylinders Extend Switch	0 Volts Off; 24 Volts On	CAN92-5-2

Node 2—Handles and Cab Controls

See Electrical Schematic A17144, Sheets 5 through 8 and 16 (at end of this section).

Connector Number	Function Type	Description	Test Voltages	CAN Packet Number
J1	Receptacle – Controls (Not Used Terminal are Omitted)			
P51-1	CAN-H	CAN High Data Line	N/A	
P51-2	CAN-L	CAN Low Data Line	N/A	
P51-3	AI-2	Handle (H1) Input Signal	Raise 2.4 – 0.5 Volts; Lower 2.6 – 4.5 Volts	CAN0-4[1]
P51-4	AI-5	Handle (H2) Input Signal	Raise 2.4 – 0.5 Volts; Lower 2.6 – 4.5 Volts	CAN1-2[1]
P51-5	AI-10	Handle (H3) Input 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) Center Switch	0 Volts Off; 24 Volts On	CAN36-2-2
P51-8	DI-11	Handle (H2) Center Switch	0 Volts Off; 24 Volts On	CAN36-2-4
P51-9	DI-2	Handle (H3) Center Switch	0 Volts Off; 24 Volts On	CAN36-1-2
P51-10	DI-3	Swing Holding Brake Switch	0 Volts Off; 24 Volts On	CAN36-1-4
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 Input Signal	Forward 2.6 – 4.5 Volts; Reverse 2.4 – 0.5 Volts	CAN0-8[1]
P51-14	AI-6	Right Travel Handle Input Signal	Forward 2.6 – 4.5 Volts; Reverse 2.4 – 0.5 Volts	CAN1-4[1]
P51-15	AI-9	Handle (H4) Input Signal	Raise 2.4 – 0.5 Volts; Lower 2.6 – 4.5 Volts	CAN2-2[1]
P51-16	AI-13	Swing Handle Input Signal	Left 2.4 – 0.5 Volts; Right 2.6 – 4.5 Volts	CAN3-2[1]
P51-17	DI-9	Left Track Center Switch	0 Volts Off; 24 Volts On	CAN36-2-1
P51-18	DI-12	Right Track Center Switch	0 Volts Off; 24 Volts On	CAN36-2-8
P51-19	DI-1	Handle (H4) Center Switch	0 Volts Off; 24 Volts On	CAN36-1-1
P51-20	DI-4	Swing Handle Center Switch	0 Volts Off; 24 Volts On	CAN36-1-8
P51-21	Ground	Foot Throttle and Handles	Ground	
P51-22	AI Ground	Handles, Pedals, Hydro-Fan Pressure Sender, 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]
P51-24	AI-8	Right Travel Pedal	Forward 2.6 – 4.5 Volts; Reverse 2.4 – 0.5 Volts	CAN1-8[1]
P51-25	AI-12	Left Travel Pedal	Forward 2.6 – 4.5 Volts; Reverse 2.4 – 0.5 Volts	CAN2-8[1]
P51-29	DI-15	Travel Speed	0 Volts Off; 24 Volts On	CAN36-2-64
P51-30	DI-14	Travel Cruise	0 Volts Off; 24 Volts On	CAN36-2-32
P51-31	5 Volts DC	Handles, Throttle, Hydro-Fan Pressure Sender, and Pedal Power	5 Volts	
P51-32	NS1	Node Select 1 Jumper to Ground	0 Volts (With Jumper)	

P51-34	AI-7	Right Free Fall Brake Pedal	Forward 2.6 – 4.5 Volts; Reverse 2.4 – 0.5 Volts	CAN1-6[1]
P51-35	AI-11	Left Free Fall Brake Pedal	Forward 2.6 – 4.5 Volts; Reverse 2.4 – 0.5 Volts	CAN2-6[1]
P51-36	A1-15	Hydro-Fan Pressure Sender	1 Volt at 0 psi, 5 Volts at 7,000 psi	CAN3-6[1]
P51-37	DI-8	Seat Safety Switch	0 Volts Off; 24 Volts On	CAN36-1-128
P51-38	DI-6	Cab Tilt - Down	0 Volts Off; 24 Volts On	CAN36-1-32
P51-39	DI-13	Cab Tilt - Up	0 Volts Off; 24 Volts On	CAN36-2-16
P51-40	DI-5	Air Conditioning - On	0 Volts Off; 24 Volts On	CAN36-1-16
J2	**Receptacle – Controls (Not Used Terminal are Omitted)**			
P52-1	DO-7	Handle (H1) Rotation Indicator	24 Volts Nominal	CAN20-1-64
P52-0	DO-3	Handle (H2) Rotation Indicator	24 Volts Nominal	CAN20-1-4
P52-3	DO-6	Handle (H3) Rotation Indicator	24 Volts Nominal	CAN20-1-32
P52-4	DO-2	Handle (H4) Rotation Indicator	24 Volts Nominal	CAN20-1-2
P52-6	DO-13	Engine Coolant Temperature	24 Volts Nominal	CAN20-2-16
P52-7	DO-16	Engine Oil Pressure	24 Volts Nominal	CAN20-2-128
P52-8	DO-9	Cab Tilt, Cruise, Travel Speed Switch	0 Volts Off, 24 Volts On	CAN20-2-1
P52-9	DO-19	Load Drums and Travel Reverse Direction	0 Volts Off, 24 Volts On	CAN20-3-4
P52-10	DO-12	Load Drums and Travel Forward Direction	0 Volts Off, 24 Volts On	CAN20-2-8
P52-11	DO-4	Hydro-Fan Pump Control	0 Volts Off, 24 Volts On	CAN20-1-8
P52-15	DO-1	Rated Capacity Indicator/Limiter Beacon	0 Volts Off, 24 Volts On	CAN20-1-1
P52-16	DO-22	Rated Capacity Indicator/Limiter Fault Alarm	0 Volts Off, 24 Volts On	CAN20-3-32
P52-17	DO-24	System Operation Alarm	0 Volts Off, 24 Volts On	CAN20-3-128
P52-20	Ground	Handle (H4) Rotation Indicator	Ground	
P52-23	Ground	Handle Rotation Indicator	Ground	
P52-31	DO-8	Boom Hoist and Swing Direction, Seat Switch	0 Volts Off, 24 Volts On	CAN20-1-128
P52-33	5 Volts DC	Right Console Handle Power	5 Volts DC Nominal	
P52-37	DO-23	Foot Throttle Output	24 Volts Nominal	CAN20-3-64
P52-38	DO-20	Engine Fuel Level	24 Volts Nominal	CAN20-3-8
J3	**Receptacle – Gauge Panel (Not Used Terminal are Omitted)**			
P53-A	Ground	To Node 3	24 Volts Nominal	
P53-B	Ground	CAN System Ground	Ground	
P53-E	24 Volts DC	Power to Node 3	Ground	
P53-F	24 Volts	System Volts DC	24 Volts Nominal	

[1] Lower 4 bits are the most significant bits of the analog value.

Node 3—Drum 1, 2 & 3, Alarms, Sensors, and Accessories

See Electrical Schematic A17144, Sheets 8, 9, 17 and 18 (at end of this section).

Receptacle Number	Function Type	Description	Test Voltages	CAN Packet Number
J7-WN04		I/O Cable — From Node 5 to Node 3	N/A (option)	
J7-WN08		I/O Cable — From Node 4 to Node 3	N/A	
J1-WN10		I/O Cable — From Node 3 to Node 2	N/A	
J3/W33	**Receptacle — Drum 1, Gantry, Mast, Pressure Senders, Limits, and Angles**			
33-A	Ground	Drum 1 Motor Control	Ground	
33-B	DO-1	Drum 1 Motor Control	See Table 3-2 for Values	CAN21-1-1
33-C	Ground	Drum 1 Brake/Gantry Cylinder - Retract	Ground	
33-D	DO-2	Drum 1 Brake Release	0 Volts Off; 24 Volts On	CAN21-1-2
33-E	Ground	Drum 3 Minimum Bail	Ground	
33-F	DO-3	Gantry Cylinder - Retract	0 Volts Off; 24 Volts On	CAN21-1-4
33-G	Ground	Gantry Cylinder - Extend/Mast Cylinder - Extend	Ground	
33-H	DO-4	Gantry Cylinder - Extend	0 Volts Off; 24 Volts On	CAN21-1-8
33-J	Ground	Drum 1 Minimum Bail/Drum 2 Minimum Bail	Ground	
33-L	NS-2	Node Select 2 Jumper to Ground	0 Volts (With Jumper)	
33-N	Ground	Mast Cylinder - Retract/Max. Boom Angle Limit	Ground	
33-P	DO-6	Mast Cylinder - Retract	0 Volts Off; 24 Volts On	CAN21-1-32
33-R	DO-5	Mast Cylinder - Extend	0 Volts Off; 24 Volts On	CAN21-1-16
33-V	24 Volts	Drum 3 Minimum Bail	24 Volts Nominal	
33-X	24 Volts	Drum 1 Minimum Bail/Drum 2 Minimum Bail	24 Volts Nominal	
33-Z	24 Volts	Accessory System Pressure Sender	24 Volts Nominal	
33-b	AI-2	Drum 1 Minimum Bail	0 Volts Off; 24 Volts On	CAN4-2-32
33-c	AI-3	Drum 3 Minimum Bail	0 Volts Off; 24 Volts On	CAN4-2-64
33-e	AI-5	Maximum Boom Angle Limit	0 Volts Off; 24 Volts On	CAN5-2-16
33-d	AI-4	Drum 2 Minimum Bail	0 Volts Off; 24 Volts On	CAN4-2-128
33-f	AI-6	Accessory System Pressure Sender	1 Volt at 0 psi, 5 Volts at 7,000 psi	CAN5-2-32
33-g	Ground	Jumper to Node Select 2	Ground	
33-h	Ground	Accessory System Pressure Sender	Ground	
33-j	5 Volts	Mast Angle Sensor	5 Volts Nominal	
33-k	Ground	Drum 1 Pressure Sender	Ground	
33-m	Ground	Mast Angle Sensor	Ground	
33-n	24 Volts	Drum 1 Pressure Sender	24 Volts Nominal	
33-p	AI-7	Drum 1 Pressure Sender	1 Volt at 0 psi, 5 Volts at 7,000 psi	CAN5-2-64
33-r	AI-8	Mast Angle Sensor	Variable 0 to 5 Volts	CAN5-2-128
33-s	24 Volts	Maximum Boom Angle Limit	24 Volts Nominal	
J4/W34	**Receptacle - Drum 3, Travel Brakes, Swing Brakes, Pawls, Cab Tilt, and Back Hitch Pins**			
34-A	Ground	Travel Brake Release	Ground	
34-B	DO-11	Travel Brake Release	0 Volts Off; 24 Volts On	CAN21-2-4

34-C	Ground	Travel 2-Speed	Ground	
34-D	DO-12	Travel 2-Speed	0 Volts Off; 24 Volts On	CAN21-2-8
34-E	Ground	Swing Brake Release	Ground	
34-F	DO-13	Swing Brake Release	0 Volts Off; 24 Volts On	CAN21-2-16
34-G	Ground	Drum 3 Converter	Ground	
34-H	DO-14	Drum 3 Converter	0 Volts Off; 24 Volts On	CAN21-2-32
34-J	Ground	Drum 3 Pawl - In	Ground	
34-K	Ground	Back Hitch Pins Disengage	Ground	
34-L	Ground	Drum 4 Pawl - In	Ground	
34-M	DO-17	Drum 4 Pawl - In	0 Volts Off; 24 Volts On	CAN21-3-1
34-N	Ground	Boom Hinge Pin Puller	Ground	
34-P	DO-16	Boom Hinge Pin Puller	0 Volts Off; 24 Volts On	CAN21-2-128
34-R	DO-15	Drum 3 Pawl - In	0 Volts Off; 24 Volts On	CAN21-2-64
34-S	DO-18	Back Hitch Pins Disengage	0 Volts Off; 24 Volts On	CAN21-3-2
34-T	Ground	Cab Tilt Down	Ground	
34-U	DO-19	Cab Tilt Down	0 Volts Off; 24 Volts On	CAN21-3-4
34-V	Ground	Cab Tilt Up	Ground	
34-W	DO-20	Cab Tilt Up	0 Volts Off; 24 Volts On	CAN21-3-8
34-X	Ground	Drum 3 Pawl - Out	Ground	
34-Z	DO-21	Drum 3 Pawl - Out	0 Volts Off; 24 Volts On	CAN21-3-16
34-a	Ground	Drum 4 Pawl - Out	Ground	
34-b	DO-22	Drum 4 Pawl - Out	0 Volts Off; 24 Volts On	CAN21-3-32
34-c	Ground	Drum 3 Brake Release	Ground	
34-d	DO-23	Drum 3 Brake Release	0 Volts Off; 24 Volts On	CAN21-3-64
34-e	Ground	Drum 3 Motor Control	Ground	
34-f	DO-24	Drum 3 Motor Control	See Table 3-2 for Values	CAN21-3-128
34-g	Ground	Jumper to Node Select 2	Ground	
34-j	NS-2	Node Select 2 Jumper to Ground	0 Volts (With Jumper)	
34-n	24 Volts	Drum 3 Speed Sensor	24 Volts Nominal	
34-p	EC3A	Drum 3 Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN38-3[2]
34-r	Ground	Drum 3 Speed Sensor	Ground	
34-s	EC3B	Drum 3 Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN38-3[2]
J6/W36	**Receptacle - Drum 1 and 2 Free Fall (optional items)**			
36-A	Ground	Drum 1 Proportional Valve A	Ground	
36-B	DO-7	Drum 1 Proportional Valve A	0 Volts Off; 24 Volts On	CAN21-1-64
36-C	Ground	Drum 2 Proportional Valve B	Ground	
36-D	DO-8	Drum 2 Proportional Valve B	0 Volts Off; 24 Volts On	CAN21-1-128
36-E	Ground	Drum 1 and 2 Free Fall Enable Rigging Winch Enable	Ground	
36-F	DO-9	Drum 1 and 2 Free Fall Enable Rigging Winch Enable	0 Volts Off; 24 Volts On	CAN21-2-1
36-G	Ground	Drum 2 Free Fall Enable/Jumper to NS-2	Ground	
36-L	NS-2	Node Select 2 Jumper to Ground	0 Volts (With Jumper)	
36-P	DI-7	Remote Control - Back Hitch Pins	0 Volts Off; 24 Volts On	CAN38-1-64

36-S	24 Volts	Remote Control - Power	24 Volts Nominal	
36-T	24 Volts	Drum 1 Free Fall Pressure Sender A	24 Volts Nominal	
36-U	Ground	Drum 1 Free Fall Pressure Sender A	Ground	
36-W	Ground	Drum 2 Free Fall Pressure Sender B	Ground	
36-X	24 Volts	Drum 2 Flange Encoder	24 Volts Nominal	
36-Z	Ground	Drum 2 Flange Encoder	Ground	
36-a	AI-9	Drum 1 Free Fall Pressure Sender A	0 Volts Off; 24 Volts On	CAN6-2-16
36-b	AI-10	Drum 2 Free Fall Pressure Sender B	0 Volts Off; 24 Volts On	CAN6-2-128
36-c	AI-11	Remote Control - Gantry Cylinders - Raise	0 Volts Off; 24 Volts On	CAN6-2-64
36-e	AI-13	Remote Control - Emergency Stop	0 Volts Off; 24 Volts On	CAN7-2-16
36-d	AI-12	Remote Control - Gantry Cylinders - Lower	0 Volts Off; 24 Volts On	CAN6-2-128
36-g	24 Volts	Drum 2 Free Fall Pressure Sender B	24 Volts Nominal	
36-j	Ground	Drum 1 Flange Encoder	Ground	
36-m	24 Volts	Drum 1 Flange Encoder	24 Volts Nominal	
36-n	EC1A	Drum 1 Flange Encoder	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN37-1[2]
36-p	EC1B	Drum 1 Flange Encoder	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN37-1[2]
36-r	EC-2A	Drum 2 Flange Encoder	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN-37-3[2]
36-s	EC-2B	Drum 2 Flange Encoder	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN37-3[2]

[2] The number in the indicated bank should increase with device rotation and decrease with rotation in opposite direction.

Node 4—Drum 4, Pumps, and Accessories

See Electrical Schematic A17144, Sheets 10, 17 and 18 (at end of this section).

Receptacle Number	Function Type	Description	Test Voltages	CAN Packet Number
J7-WN14		I/O Cable — From Node 4 to Engine Node	N/A	
J1-WN08		I/O Cable — From Node 4 to Node 3	N/A	
J3/W43	**Receptacle - Drum 2 and Pressure Senders**			
43-A	Ground	Rigging Winch - Retract/Pay Out	Ground	
43-B	DO-1	Rigging Winch - Retract	0 Volts Off; 24 Volts On	CAN23-1-1
43-C	Ground	Carbody Enable Pressure Sender	Ground	
43-D	DO-2	Rigging Winch - Pay Out	0 Volts Off; 24 Volts On	CAN23-1-2
43-E	Ground	Swing/Travel Alarm/Jumper to Node Select 3	Ground	
43-F	DO-3	Drum 2 Motor Control	See Table 3-2 for Values	CAN23-1-4
43-G	Ground	Drum 2 Pressure Sender	Ground	
43-H	DO-4	Drum 2 Brake Release	0 Volts Off; 24 Volts On	CAN23-1-8
43-J	Ground	Engine Fuel Level Sensor	Ground	
43-M	NS-3	Node Select 3 Jumper to Ground	0 Volts (With Jumper)	
43-N	Ground	Rigging Winch Brake	Ground	
43-P	DO-6	Right Side Swing/Travel Alarm	0 Volts Off; 24 Volts On	CAN23-1-32
43-R	DO-5	Rigging Winch Brake	0 Volts Off; 24 Volts On	CAN23-1-16
43-U	24 Volts	Drum 2 Pressure Sender	24 Volts Nominal	
43-V	24 Volts	Engine Fuel Level Sensor	24 Volts Nominal	
43-X	24 Volts	Carbody Enable Pressure Sender	24 Volts Nominal	
43-Z	24 Volts	Swing Left Pressure Sender	24 Volts Nominal	
43-c	AI-3	Drum 2 Pressure Sender	1 Volt at 0 psi, 5 Volts at 7,000 psi	CAN12-6[1]
43-d	AI-4	Engine Fuel Level Sensor	1.8 Volts Full; 4.1 Volts Empty	CAN12-8[1]
43-e	AI-5	Carbody Enable Pressure Sender	1 Volt at 0 psi, 5 Volts at 7,000 psi	CAN13-2[1]
43-f	AI-6	Swing Left Pressure Sender	1 Volt at 0 psi, 5 Volts at 7,000 psi	CAN13-4[1]
43-g	Ground	Swing Left Pressure Sender	Ground	
43-h	Ground	Drum 2 Motor Control/Brake Release	Ground	
43-k	Ground	Swing Right Pressure Sender	Ground	
43-m	Ground	Drum 4 Pressure Sender	Ground	
43-n	24 Volts	Swing Right Pressure Sender	24 Volts Nominal	
43-p	AI-7	Swing Right Pressure Sender	1 Volt at 0 psi, 5 Volts at 7,000 psi	CAN13-6[1]
43-r	AI-8	Drum 4 Pressure Sender	1 Volt at 0 psi, 5 Volts at 7,000 psi	CAN13-8[1]
43-s	24 Volts	Drum 4 Pressure Sender	24 Volts Nominal	
J4/W44	**Receptacle – Drum 4, and Pump Controls**			
44-A	Ground	Drum 4/Pump 4	Ground	
44-B	DO-11	Drum 4 - Pump 4	0 Volts Off; 24 Volts On	CAN23-2-4

44-C	Ground	Drum 4 - Pump 4	Ground	
44-D	DO-12	Drum 4 - Pump 4	0 Volts Off; 24 Volts On	CAN23-2-8
44-E	Ground	Drum 4 Motor Control	Ground	
44-F	DO-13	Drum 4 Motor Control	See Table 3-2 for Values	CAN23-2-16
44-G	Ground	Drum 4 Brake Release	Ground	
44-H	DO-14	Drum 4 Brake Release	0 Volts Off; 24 Volts On	CAN23-2-32
44-J	Ground	Swing - Pump 6	Ground	
44-K	Ground	Left Travel/Drum 3 - Pump 3	Ground	
44-L	Ground	Left Travel/Drum 3 - Pump 3	Ground	
44-M	DO-17	Left Travel/Drum 3 - Pump 3	0 Volts Off; 24 Volts On	CAN23-3-1
44-N	Ground	Swing - Pump 6	Ground	
44-P	DO-16	Swing - Pump 6	0 Volts Off; 24 Volts On	CAN23-2-128
44-R	DO-15	Swing - Pump 6	0 Volts Off; 24 Volts On	CAN23-2-64
44-S	DO-18	Left Travel/Drum 3 - Pump 3	0 Volts Off; 24 Volts On	CAN23-3-2
44-T	Ground	Right Travel - Pump 1	Ground	
44-U	DO-19	Right Travel - Pump 1	0 Volts Off; 24 Volts On	CAN23-3-4
44-V	Ground	Right Travel - Pump 1	Ground	
44-W	DO-20	Right Travel - Pump 1	0 Volts Off; 24 Volts On	CAN23-3-8
44-X	Ground	Drum 2 - Pump 5	Ground	
44-Z	DO-21	Drum 2 - Pump 5	0 Volts Off; 24 Volts On	CAN23-3-16
44-a	Ground	Drum 2 - Pump 5	Ground	
44-b	DO-22	Drum 2 - Pump 5	0 Volts Off; 24 Volts On	CAN23-3-32
44-c	Ground	Drum 1 - Pump 2	Ground	
44-d	DO-23	Drum 1 - Pump 2	0 Volts Off; 24 Volts On	CAN23-3-64
44-e	Ground	Drum 1 - Pump 2	Ground	
44-f	DO-24	Drum 1 - Pump 2	0 Volts Off; 24 Volts On	CAN23-3-128
44-g	Ground	Jumper to Node Select 4	Ground	
44-k	NS-3	Node Select 3 Jumper to Ground	0 Volts (With Jumper)	
44-n	24 Volts	Drum 4 Speed Sensor	24 Volts Nominal	
44-p	EC3A	Drum 4 Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN42-3[2]
44-r	Ground	Drum 4 Speed Sensor	Ground	
44-s	EC3B	Drum 4 Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN42-3[2]
J6/W46	**Receptacle – Sensors, Pressure Senders, Alarms, and Auto Lube**			
46-A	Ground	Crawler Track/Swing Bearing Auto Lube	Ground	
46-B	DO-7	Swing Bearing Auto Lube	0 Volts Off; 24 Volts On	CAN23-1-64
46-C	Ground	Gantry Maximum Angle Limit Hydraulic Fluid Level	Ground	
46-D	DO-8	Hydraulic Fluid Level	0 Volts Off; 24 Volts On	CAN23-1-128
46-E	Ground	Left Side RCL Capacity Alarm/ Jumper to Node Select 3	Ground	
46-F	DO-9	Crawler Track Automatic Lubrication	0 Volts Off; 24 Volts On	CAN23-2-1
46-G	Ground	Hydraulic Fluid Temperature Sensor	Ground	
46-H	DO-10	Left Side RCL Capacity Alarm	0 Volts Off; 24 Volts On	CAN23-2-2
46-M	NS-3	Node Select 3 Jumper to Ground	0 Volts (With Jumper)	

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46-P	DI-7	Gantry Maximum Angle Limit	0 Volts Off; 24 Volts On	CAN40-1-64
46-R	24 Volts	Gantry Maximum Angle Limit	24 Volts Nominal	
46-S	24 Volts	Hydraulic Vacuum Set Point	24 Volts Nominal	
46-T	24 Volts	Left Travel Pressure Sender	24 Volts Nominal	
46-U	Ground	Left Travel Pressure Sender	Ground	
46-V	5 Volt	Drum 1 & 2 Motor Speed Sensor	Variable 0 to 5 Volts	
46-W	Ground	Right Travel Pressure Sender	Ground	
46-X	24 Volts	Hydraulic Fluid Level/Temperature Sensor	24 Volts Nominal	
46-Z	Ground	Drum 2 Motor Speed Sensor	Ground	
46-a	AI-9	Hydraulic Vacuum Set Point	0 Volts Off; 24 Volts On	CAN14-2-16
46-c	AI-11	Hydraulic Return Filter Alarm	0 Volts Off; 24 Volts On	CAN14-2-64
46-e	AI-13	Left Travel Pressure Sender	1 Volt at 0 psi, 5 Volts at 7,000 psi	CAN15-2[1]
46-f	AI-14	Hydraulic Fluid Temperature Sensor	Variable 1 to 4 Volts	CAN15-4[1]
46-g	24 Volts	Right Travel Pressure Sender	24 Volts Nominal	
46-h	AI-15	Right Travel Pressure Sender	1 Volt at 0 psi, 5 Volts at 7,000 psi	CAN15-6[1]
46-j	Ground	Drum 1 Motor Speed Sensor	Ground	
46-k	AI-16	Hydraulic Fluid Level	Variable 0 to 24 Volts	CAN15-8[1]
46-m	24 Volts	Hydraulic Return Filter Alarm	24 Volts Nominal	
46-n	EC1A	Drum 1 Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN41-1[2]
46-p	EC1B	Drum 1 Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN41-1[2]
46-r	EC-2A	Drum 2 Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN41-3[2]
46-s	EC-2B	Drum 2 Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN41-3[2]

[1] Lower four bits are the most significant bit of the analog value.

[2] The number in the indicated bank should increase with device rotation and decrease with rotation in opposite direction.

Node 5—Swing Limits (Optional)

See Electrical Schematic A17144, Sheets 11, 17 and 19 (at end of this section).

Receptacle Number	Function Type	Description	Test Voltages	CAN Packet Number
J1-WN04		I/O Cable — From Node 3	N/A	
J7-WN06		I/O Cable — To Node 4	N/A	
J6/W56	**Receptacle – Swing Limits, Air Temperature Sender**			
56-D	DO-8	Air Temperature Sender or Terminal Plug	24 Volts Nominal	CAN29-1-128
56-E	Ground	Swing Motor Encoder	Ground	
56-F	DO-9	Swing Motor Encoder	24 Volts Nominal	CAN29-2-1
56-H	DO-10	Swing Limit Switch	24 Volts Nominal	CAN29-2-2
56-J	DI-8	Right Swing Limit Switch	0 Volts Off, 24 Volts On	CAN55-1-128
56-N	NS4	Node Select 5 Jumper to Ground	0 Volts (With Jumper)	
56-P	DI-7	Left Swing Limit Switch	0 Volts Off, 24 Volts On	CAN55-1-64
56-U	Ground	Ground to Node 4	Ground	
56-W	Ground	Air Temperature Sender or Terminal Plug	Ground	
56-b	AI-10	Air Temperature Sender or Terminal Plug	0 Volts Off, 24 Volts On	CAN18-4
56-n	EC1A	Swing Motor Encoder	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN43-1
56-p	EC1B	Swing Motor Encoder	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN43-1

Boom Remote Input Node

See Electrical Schematic A17144, Sheet 12 (at end of this section).

Receptacle/ RIN ID	Wire No.	Description	Test Voltage
J1	**Receptacle – Input/Output**		
301A	P1A	System Power	12 Volts Nominal
301B	P1B	Data Out	Variable 0 to 12 Volts
301C	P1C	System Ground	Ground
J2	**Receptacle – Input/Output to Wind Speed RIN**		
302A	P5A	System Power	12 Volts Nominal
302B	P5B	Data In	Variable 0 to 12 Volts
302C	P5C	System Ground	Ground
J3	**Receptacle – Boom Items**		
303G	P6WT	Block-Up Limit 1 - Lower	0 Volts Off; 12 Volts On
303E	P6BK	Block-Up Limit 1 - Lower	CAN84-2-128
303N	P9WT	Block-Up Limit 2 - Upper	0 Volts Off; 12 Volts On
303H	P9BK	Block-Up Limit 2 - Upper	CAN84-2-64
303P	P3WT	Block-Up Limit 3 - Fixed	0 Volts Off; 12 Volts On
303L	P3BK	Block-Up Limit 3 - Fixed	CAN84-4-128
303B	P4WT	Maximum Jib Angle Limit	10 Volts Off; 12 Volts On
303A	P4GN	Maximum Jib Angle Limit	CAN84-4-64
303C	P5C	Maximum Jib Angle Limit	Ground
303B	P4WT	Minimum Jib Angle Limit	10 Volts Off; 12 Volts On
303K	P2BK	Minimum Jib Angle Limit	CAN84-4-32
303C	P5C	Minimum Jib Angle Limit	Ground
303J	P7BN	Load Sensor 1	2 to 20 Micro Amps
303D	P7WT	Load Sensor 1	AC 2
303F	P7BK	Load Sensor 1	Ground
303R	P8BN	Load Sensor 2	2 to 20 Micro Amps
303M	P8WT	Load Sensor 2	AC 1
303S	P8BK	Load Sensor 2	Ground
P	**Receptacle – Angle Sensor**		
P10	P10	Boom Angle Sensor	Ground
P11	P11	Boom Angle Sensor	AR 1
P12	P12	Boom Angle Sensor	5 Volts Nominal

Luffing Jib Remote Input Node

See Electrical Schematic A17144, Sheet 12 (at end of this section).

Receptacle/ RIN ID	Wire No.	Description	Test Voltage
J1	**Receptacle – Input/Output**		
311A	P1A	System Power	12 Volts Nominal
311B	P1B	Data Out	Variable 0 to 12 Volts
311C	P1C	System Ground	Ground
J2	**Receptacle – Input/Output to Wind Speed RIN**		
312A	P5A	System Power	12 Volts Nominal
312B	P5B	Data In	Variable 0 to 12 Volts
312C	P5C	System Ground	Ground
J3	**Receptacle – Boom Items**		
313G	P6WT	Block-Up Limit 4	0 Volts Off; 12 Volts On
313E	P6BK	Block-Up Limit 4	CAN-85-2-128
313N	P9WT	Block-Up Limit 3	0 Volts Off; 12 Volts On
313H	P9BK	Block-Up Limit 3	CAN-85-2-64
313J	P7BN	Load Sensor 3	12 Volt Nominal
313D	P7WT	Load Sensor 3	AC 2
313F	P7BK	Load Sensor 3	Ground
313R	P8BN	Load Sensor 4	12 Volts Nominal
313M	P8WT	Load Sensor 4	AC 1
313S	P8BK	Load Sensor 4	Ground
P	**Receptacle – Angle Sensor**		
P10	P10	Jib Angle Sensor	Ground
P11	P11	Jib Angle Sensor	AR 1
P12	P12	Jib Angle Sensor	5 Volts Nominal

Node 0—Engine

See Electrical Schematic A17144, Sheet 13 (at end of this section).

Receptacle/ Pin No.	Wire No.	Function Type	Description
J1	**Battery Power**		
J1-A	0	Ground	Battery Ground
J1-B	6 - 1	24 Volts	Battery Power
J2	**Engine Control**		
J2-A	0	Ground	Battery Ground
J2-B	6C6	24 Volts	ECM Power
J2-C	6C6	24 Volts	ECM Power
J2-D	0	Ground	Battery Ground
J2-E	6C7A	24 Volts	MS1 Relay - Switched
J2-F	6C7A	24 Volts	MS1 Relay - Switched
J2-G	0	Ground	Battery Ground
J2-H	6C2A	24 Volts	ECM Key Switch - Switched
J2-J	6C5A	24 Volts	Air Conditioning Clutch - Switched
J2-V	J1939H	Signal	Communication - High
J2-W	J1939L	Signal	Communication - Low
J2-Y	J1939S	Ground	Battery Ground
J3	**CAN Bus Communication and Power**		
J3-A	8C	24 Volts	CAN Bus Power - Switched
J3-C	CANH	Signal	CAN Communications - High
J3-D	0C	Ground	CAN Bus Ground - Switched
J3-F	CANL	Signal	CAN Communications - Low
J4	**CAN Bus Communication and Power**		
J4-A	8C	24 Volts	CAN Bus Power - Switched
J4-C	CANH	Signal	CAN Communications - High
J4-D	0C	Ground	CAN Bus Ground - Switched
J4-F	CANL	Signal	CAN Communications - Low
J5	**Operator’s Cab**		
J5-A	8	24 Volts	CAB Power - Switched
J5-B	6C4	24 Volts	Key Switch Power
J5-C	6C4	24 Volts	Key Switch Power
J5-D	0	Ground	Battery Ground
J5-E	3	Signal	Key Switch Signal
J5-F	12F2	24 Volts	Boom Node Power
J6	**Cummins Engine Diagnostics**		
J6-A	0	Ground	Battery Ground
J6-B	6C3	24 Volts	Cummins Diagnostic Power
J6-C	J1939H	Signal	SAE J1939 Communication - High
J6-D	J1939L	Signal	SAE J1939 Communication - Low
J6-E	J1939S	Ground	SAE J1939 Communication - Shield
J7	**Program Download**		
J7-1	RS232TX	Signal	RS232 Program Transmit

J7-2	RS232RX	Signal	RS232 Program Receive
J7-3	RS232PE	Signal	RS232 Program Enable
J7-4	RS232GND	Ground	RS232 Program Ground
J8	**Boom Cable**		
J8-A	12F2	24 Volts	Boom Node Power
J8-B	0126	DI Signal	Boom Node Digital Input
J8-C	0	Ground	Battery Ground
P1	**Receptacle – 40 Pin**		
P1-1	3	24 Volts	Ignition Signal
P1-2	0102	Ground	CAN Bus Ground Relay Coil - High
P1-4	0104	24 Volts	ECM Key Switch Relay Coil - High
P1-7	0107	24 Volts	Air Conditioning Clutch Relay Coil - High
P1-10	0110	Ground	MS1 Relay Coil - High
P1-11	0	Ground	Battery Ground
P1-12	0112	Ground	CAN BUS Relay Coil - Low
P1-14	0114	Ground	ECM Key Switch Relay Coil - Low
P1-17	0117	Ground	Air Conditioning Clutch Relay Coil - Low
P1-20	0120	Ground	MS1 Relay Coil - Low
P1-21	OC	Ground	CAN BUS Ground - Switched
P1-22	0122	Ground	CAN BUS Power Relay Coil - Low
P1-26	0126	DO Signal	Boom Node
P1-29	RS232GND	Ground	Program Ground
P1-30	RS232PE	Signal	Program Enable
P1-31	8C	24 Volts	CAN BUS Power - Switched
P1-32	0132	24 Volts	CAN BUS Power Relay Coil - High
P1-33	3	24 Volts	Battery Power
P1-36	J1939H	Signal	SAE J1939 Communication – High
P1-37	J1939L	Signal	SAE J1939 Communication – Low
P1-39	RS232TX	Signal	Program Transmit
P1-40	RS232RX	Signal	Program Receive

Table 3-3 Digital Input Reference Chart

CAN Packet Number	Item Description (Node Number)		CAN Packet Number	Item Description (Node Number)
CAN36-1-1	Handle (H4) Direction Signal (N2)		CAN84-4-64	Maximum Jib Angle Limit (N20)
CAN36-1-2	Handle (H3) Direction Signal (N2)		CAN84-4-128	Block-Up Limit 3 - Fixed (N20)
CAN36-1-4	Swing Holding Brake Switch (N2)		CAN85-2-64	Block-Up Limit 3 (N21)
CAN36-1-8	Swing Handle Direction Signal (N2)		CAN85-2-128	Block-Up Limit 4 (N21)
CAN36-1-16	Air Conditioning - On (N2)		CAN92-3-4	Front Drum (Drum 1) Park Switch (N1)
CAN36-1-32	Cab Tilt - Down (N2)		CAN92-3-16	Rear Drum (Drum 2) Park Switch (N1)
CAN36-1-128	Seat Safety Switch (N2)		CAN92-3-64	Travel Park Switch (N1)
CAN36-2-1	Left Track Direction Signal (N2)		CAN92-3-128	Mast Cylinders Retract Switch (N1)
CAN36-2-2	Handle (H1) Direction Signal (N2)		CAN92-4-1	Display Enter Switch (N1)
CAN36-2-4	Handle (H2) Direction Signal (N2)		CAN92-4-2	Confirm Switch (N1)
CAN36-2-8	Right Track Direction Signal (N2)		CAN92-4-4	Limit Bypass Switch (N1)
CAN36-2-16	Cab Tilt - Up (N2)		CAN92-4-8	Display Scroll Up Switch (N1)
CAN36-2-32	Travel Cruise (N2)		CAN92-4-16	Not used
CAN36-2-64	Travel Speed (N2)		CAN92-4-32	Display Scroll Down Switch (N1)
CAN38-1-64	Remote Control - Back Hitch Pins (N3)		CAN92-5-4	SCR Regen Inhibit (N1)
CAN40-1-64	Gantry Maximum Angle Limit (N4)		CAN 92-5-16	SCR Regen Initiate (N1)
CAN55-1-64	Left Swing Limit Switch (N5)		CAN92-5-32	Engine Run/Start (N1)
CAN55-1-128	Right Swing Limit Switch (N5)		CAN92-6-4	Display 1 (N1)
CAN84-2-64	Block-Up Limit 2 - Upper Point (N20)		CAN92-6-16	Display 2 (N1)
CAN84-2-128	Block-Up Limit 1- Lower Point (N20)		CAN92-6-64	Display Exit Switch (N1)
CAN84-4-32	Minimum Jib Angle Limit (N20)		CAN92-6-128	Load/Luffing (Drum 3) Park Switch (N1)

Table 3-4 Digital Output Reference Chart

CAN Packet Number	Item Description (Node Number)	CAN Packet Number	Item Description (Node Number)
CAN20-1-1	Rated Capacity Indicator/Limiter Beacon (N2)	CAN21-3-16	Drum 3 (Auxiliary/Luffing) Pawl - Out (N3)
CAN20-1-2	Handle 4 Rotation Indicator (N2)	CAN21-3-32	Drum 4 (Boom Hoist) Pawl - Out (N3)
CAN20-1-4	Handle 2 Rotation Indicator (N2)	CAN21-3-64	Drum 3 (Auxiliary/Luffing) Brake (N3)
CAN20-1-8	Cooler Fan Pump Control (N2)	CAN21-3-128	Drum 3 (Auxiliary/Luffing) Motor Control (N3)
CAN20-1-32	Handle 3 Rotation Indicator (N2)	CAN23-1-1	Rigging Winch - Haul In (N4)
CAN20-1-64	Handle 1 Rotation Indicator (N2)	CAN23-1-2	Rigging Winch - Pay Out (N4)
CAN20-1-128	Seat Switch (N2)	CAN23-1-4	Drum 2 (Rear Drum) Motor (N4)
CAN20-2-1	Right Console (N2) (N2)	CAN23-1-8	Drum 2 (Rear Drum) Brake (N4)
CAN20-2-16	Engine Coolant Temperature (N2)	CAN23-1-16	Rigging Winch Brake (N4)
CAN20-2-64	Engine Fuel Level (N2) (N2)	CAN23-1-32	Right Side Swing/Travel Alarm (N4)
CAN20-2-128	Engine Oil Pressure Gauge (N2)	CAN23-1-64	Swing Auto Lubrication (N4)
CAN20-3-32	Rated Capacity Indicator/Limiter Alarm (N2)	CAN23-1-128	Hydraulic Fluid Level (N4)
CAN20-3-64	Foot Throttle (N2)	CAN23-2-1	Travel Auto Lubrication (N4)
CAN20-3-128	System Fault Alarm (N2)	CAN23-2-2	Rated Capacity Indicator/Limiter Alarm (N4)
CAN21-1-1	Drum 1 (Front Drum) Motor Control (N3)	CAN23-2-4	Drum 4 (Boom Hoist) Pump - Raise (N4)
CAN21-1-2	Drum 1 (Front Drum) Brake Solenoid (N3)	CAN23-2-8	Drum 4 (Boom Hoist) Pump - Lower (N4)
CAN21-1-4	Gantry Cylinders Retract Switch (N3)	CAN23-2-16	Drum 4 (Boom Hoist) Motor (N4)
CAN21-1-8	Gantry Cylinders Extend Switch (N3)	CAN23-2-32	Drum 4 (Boom Hoist) Brake (N4)
CAN21-1-16	Mast Cylinders Retract Switch (N3)	CAN23-2-64	Swing Pump - Right (N4)
CAN21-1-32	Mast Cylinders Extend Switch (N3)	CAN23-2-128	Swing Pump - Left (N4)
CAN21-1-64	Drum 1 (Front Drum) Free Fall Pulse (N3)	CAN23-3-1	Left Track Pump - Forward (N4)
CAN21-1-128	Drum 2 (Rear Drum) Free Fall Pulse (N3)	CAN23-3-2	Left Track Pump - Reverse (N4)
CAN21-2-1	Free Fall and Rigging Winch Enable (N3)	CAN23-3-4	Right Track Pump - Reverse (N4)
CAN21-2-4	Travel Brake (N3)	CAN23-3-8	Right Track Pump - Forward (N4)
CAN21-2-8	Travel 2-Speed (N3)	CAN23-3-16	Drum 2 (Rear Drum) Pump - Lower (N4)
CAN21-2-16	Swing Brake (N3)	CAN23-3-32	Drum 2 (Rear Drum) Pump - Raise (N4)
CAN21-2-32	Drum 3 (Auxiliary/Luffing) Diverter (N3)	CAN23-3-64	Drum 1 (Front Drum) Pump - Lower (N4)
CAN21-2-64	Drum 3 (Auxiliary/Luffing) Pawl - In (N3)	CAN23-3-128	Drum 1 (Front Drum) Pump - Raise (N4)
CAN21-2-128	Boom Hinge Pins Disengage (N3)	CAN29-1-128	Air Temperature Sender /Terminal Plug (N5)
CAN21-3-1	Drum 4 (Boom Hoist) Pawl - In (N3)	CAN29-2-1	Swing Motor Encoder (N5)
CAN21-1-32	Mast Cylinders Extend Switch (N3)	CAN29-2-2	Swing Limit Switch (N5)
CAN21-1-64	Drum 1 (Front Drum) Free Fall Pulse (N3)	CAN92-1-4	RCL Warning L.E.D. (N1)
CAN21-1-128	Drum 2 (Rear Drum) Free Fall Pulse (N3)	CAN92-1-32	RCL Caution L.E.D. (N1)
CAN21-2-1	Free Fall and Rigging Winch Enable (N3)	CAN92-2-1	System Limit Bypass/Swing Park Switch (N1)
CAN21-2-4	Travel Brake (N3)	CAN92-2-2	Overhead Panel (N1)
CAN21-3-2	Back Hitch Pins Disengage (N3)	CAN92-2-4	Drums 1, 2 and 3 Park Switches (N1)
CAN21-3-4	Cab Tilt Down Switch (N3)	CAN92-2-128	Drum 4/Travel Park Switches (N1)
CAN 21-3-8	Cab Tilt Up Switch (N3)	CAN92-6-32	Swing Park Switch (N1)

DISPLAYS

Navigation and Settings

See Figure 3-5

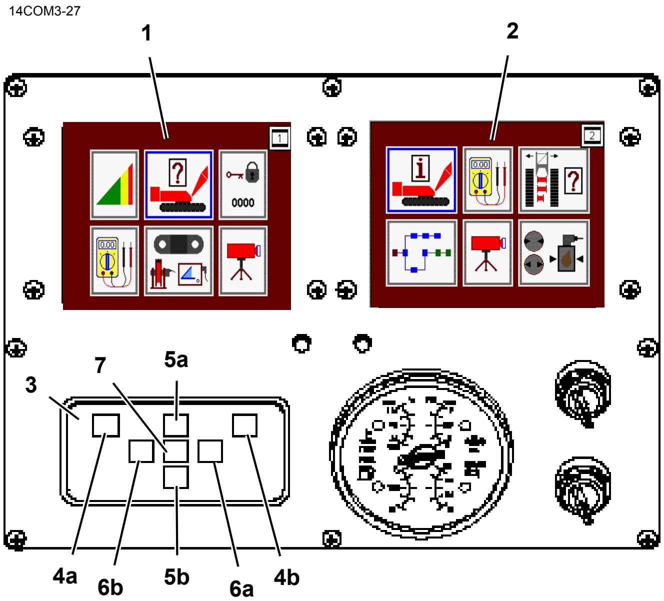

FIGURE 3-5

Item	Description
1	Rated Capacity Indicator/Limiter Display
2	Main Display
3	Display Touch Pad Controls
4a and 4b	Display Select Buttons
5a and 5b	Select Buttons
6a and 6b	Enter/Exit Buttons
7	Confirm Buttons

Rated Capacity Indicator/Limiter Display

Rated Capacity Indicator/Limiter display is on the left side of front console. (See stand-alone Rated Capacity Indicator/ Limiter manual for operation.)

Main Display

The main display is on the right side of the front console (see Main Display on page 3-25).

Display Touch Pad Controls

Contains all screen controls required to operate the Rated Capacity Indicator/Limiter display and Main display screens.

Display Select Buttons

4a. Press this button to select Rated Capacity Indicator/ Limiter display.

4b. Press this button to select Main display.

Select Buttons

Use the green Select touch pad buttons to select screen images, icons or data boxes, and values or icons within data boxes. Button (5a) scrolls up and button (5b) scrolls down.

Enter/Exit Buttons

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

Use Enter button to enter a screen or go to the next level. Use Exit button to exit a screen or level.

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 display contrast, proceed as follows:

1. Press desired display button (4a or 4b) and confirm button (7) at same time to select the desired display.
2. Release confirm button (first) and then release display button.
3. Press top select button (5a) to lighten display, or press bottom select button (5b) to darken display.
4. Press enter button (6a) to increase color intensity, or press exit button (6b) to decrease color intensity.
5. Press confirm button.

Factory Default Display Settings

1. Press desired display button (4a or 4b) and confirm button (7) at the same time to select the desired display.
2. Press select buttons (5a and 5b) at the same time to return to the factory default display settings.
3. Press confirm button.

Blank Display

If a display goes blank, try the following procedure to restore at the display. ***Do not return a display to Manitowoc until this procedure has been tried.***

1. Press desired display button (4a or 4b) and confirm button (7) at the same time.
2. Press select buttons (5a and 5b) at the same time to return to the factory default display settings.
3. Press confirm button.

Main Display

The basic components for the main display are the Information screen, Diagnostic screens, Function Mode 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.

"Manitowoc" Screen

The initial view displayed at crane startup is the "Manitowoc" screen, shown in Figure 3-6. This screen displays the following program items:

- Model/Program Number (14000 FCN number shown).
- Con Number (009 000 000 008 shown).
- Screen Program Number (GUI 2.007 shown).

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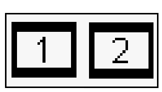
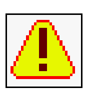
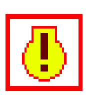
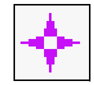
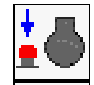
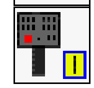
FIGURE 3-6

Screen Prompts

Screen prompts can appear on a selected screen if a fault condition exist or to prompt or confirm certain operator actions when required by the system. Prompt descriptions and icons are shown below.

- The RCL Display is selected by pressing and holding the Confirm key, then key 1, then releasing the Confirm key. 

  The Main Display is selected by pressing and holding the Confirm key, then key 2, then releasing the Confirm key.
- Yellow alert symbol is displayed if a system fault occurs. For more information, see the 14000 Operator Manual. 
- Engine prompt. For more information, see the 14000 Operator Manual. 
- Purple confirm prompt appears when the operator must start certain test routines from the screen and to confirm data when required. 
- Engine stopped symbol is displayed when engine is stopped. 
- Remote control symbol is displayed when remote control operation is selected. 

Menu Screen

See Figure 3-7

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.

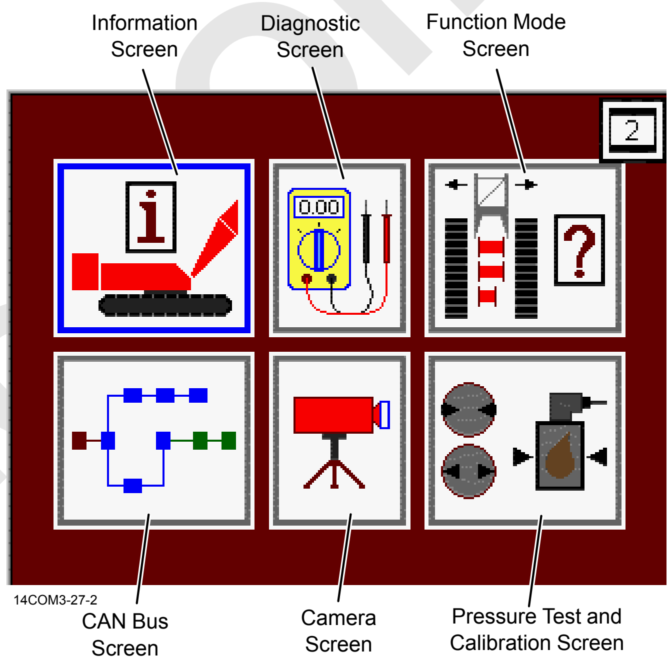


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FIGURE 3-7

The Menu screen shows six screen icons:

Information Screen icon

Diagnostic Screen icon

Function Mode Screen icon

CAN Bus Screen icon

Camera Screen icon

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

Information screen shows all the general crane information required for viewing during normal operation, including faults. For details on the information screen, see the 14000 Operator Manual.

Crane Faults

Table 3-5 lists the *Operating Limit* faults that can appear in the fault information screen. Operating limits faults will stop crane operation in the direction of the fault. ***Corrective action must be take before continuing crane operation.***

Table 3-6 lists the *System Faults* that can appear in the fault information screen. System faults will not stop crane operation. ***Correct all faults as soon as possible.***

Table 3-5 Operating Limits

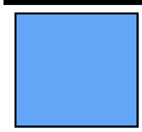
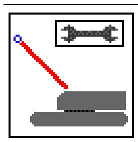
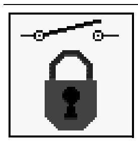
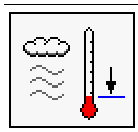
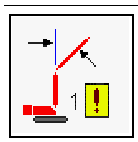
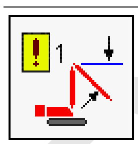
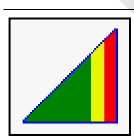
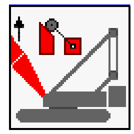
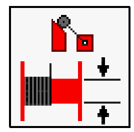
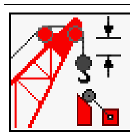
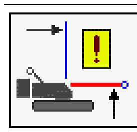
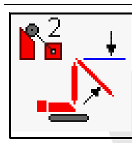
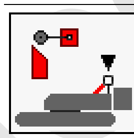
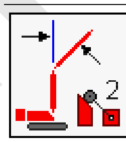
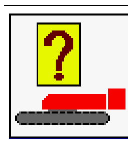
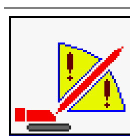
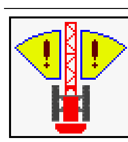
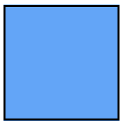
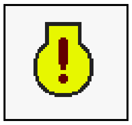
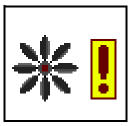
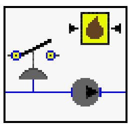
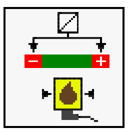
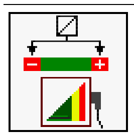
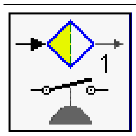
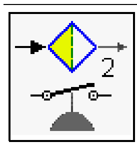
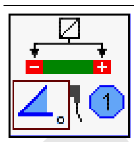
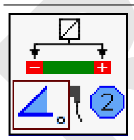
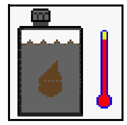
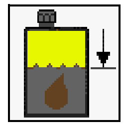
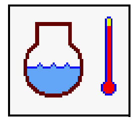
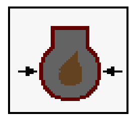
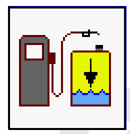
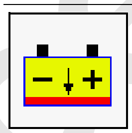
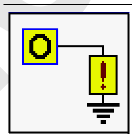
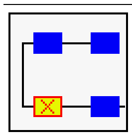
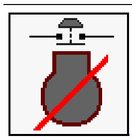
Item	Description
	0-No Fault.
	6-Setup Mode — Indicates setup mode is on (Liftcrane Mast Capacities chart is selected in configuration screen of RCL).
	34-Function Parked — Function inoperable because it is parked. Turn indicated park switch off or sit down in operator's seat.
	45-Air Temperature Low — Ambient temperature is below -22°F (-30°C). Crane engine allowed to start, but boom down and hoist up functions are locked out.
	49-Jib Maximum Up 1 Angle — This is a programmed limit which is activated at 168° by angle sensors in the boom and jib node controllers. Lower luffing jib to correct fault.
	50-Jib Maximum Down 1 Angle — This is a programmed limit which is activated by angle sensors in the boom and jib node controllers. This limit does not stop the luffing jib from lowering. It only turns on the alarm when the angle is reached. Raise luffing jib to correct fault.
	54-Rated Capacity Indicator/Limiter — Stops all drums. Land load or raise boom/jib.
	55-Boom Maximum 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 — Switch stops load drum and boom. Lower load or raise boom.
	66-Mast Too Far Forward — Live mast is below 172°. Raise live mast. Further lowering is not intended - ***mast will fall***.
	67-Jib Maximum Down Limit — This limit stops the luffing jib from lowering when the switch is contacted. Raise luffing jib to correct fault.
	72-Gantry Down — When setup mode is on, live mast cannot be operated above 80° if gantry up switch is open. For any other mode, operation of drum 4 is not allowed if gantry down switch is open.
	73-Jib Maximum Up 2 Limit — This limit is activated by a limit switch when maximum up angle is reached. This limit stops the luffing hoist in the up direction when the boom to luffing jib angle is 171°. Lower luffing jib to correct fault.
	80-Invalid Configuration — Make sure selected Rated Capacity Indicator/Limiter configuration for load drums is correct.
	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.

Table 3-6 System Faults

Item	Description
	0-No Fault.
	10-Engine Alert Prompt (Check Engine Lamp) — Engine needs to be serviced at earliest opportunity.
	30-Hydraulic Fan — Indicates a short in the fan pump wiring or the fan pressure sender is out of range. Fault 84 (Digital Output Disable) or Fault 41 (Transducer Voltage) will turn on at the same time.
	40-Hydraulic Vacuum Switch — Suction vacuum has increased above 5 inches Hg.
	41-Transducer Voltage — Indicates a pressure transducer is not within the allowable range, high or low.
	42-Rated Capacity Indicator/Limiter Sensor Voltage— If a load sensing pin or load sensing sheave are not within allowable range — high or low, programmable controller will prevent crane operation.
	61-Filter 1 — Return Filter — Filter is dirty or plugged. Replace element or clean filter.
	62-Filter 2 — Suction Filter — Filter is dirty or plugged. 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 70°F (21°C) or above 180°F (82°C).
	69-Hydraulic Fluid Level Low — Hydraulic oil at 60% full hot or cold. Fill tank.
	70-Engine Coolant Temperature — Engine coolant temperature above 225°F (107°C). Engine will automatically de-rates itself if this temperature is reached.
	71-Engine Oil Pressure Low — Oil pressure below 7.25 psi (0.5 bar).
	75-Fuel Level Low — Five percent fuel remaining in tank. Fill tank as soon as possible to prevent engine stoppage.
	78-Battery Voltage Low — Battery voltage below 18 volts. Determine cause of fault and correct.
	84-Digital Output Disable Fault — Digital output signal has a short circuit between computer node and output device. See CAN Bus screen information and Tables 3-7 and 3-8 to identify problem component.
	85-CAN bus Communication Error — One or more computer nodes are not communicating correctly. See CAN Bus screen to identify node(s).
	88-Remote Emergency Shutdown — Remote emergency stop shut down switch is pushed. Pull switch up to reset and allow engine to start.

Diagnostic Screens

Diagnostic screens 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 electrical tester shown (see Figure 3-7). Use Select buttons to highlight individual crane functions.

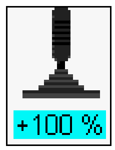
Level 2 — Shows Diagnostic screen for highlighted crane functions.

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

Component Information Icons

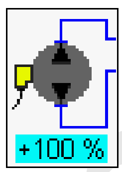
Each Diagnostic screen component icon is identified and described in the following paragraphs.

Control Handle



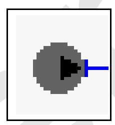
Displays system control handle command in percent from neutral with +raise and –lower for drums, +right and –left for swing, and +forward and –reverse for travel.

Variable Closed-Loop Pump



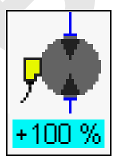
Pump command from neutral (0%) to +/-% of full displacement for drums, swing, and travel.

Gear Pump



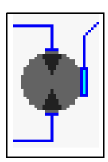
Accessory pump or system charge pump.

Variable Closed-Loop Motor



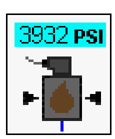
Displays motor command with 0% maximum displacement and 100% minimum displacement.

Closed Loop Variable Motor with Remote Pilot



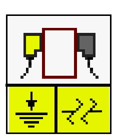
Displays two-speed motor with remote pilot. This motor type is used for shifting motor speeds automatically when selected.

System Pressure Sender



Displays hydraulic pressure (psi/bar).

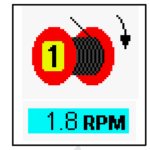
DIN Electrical Connector



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.

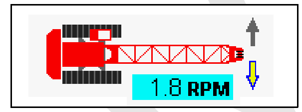
NOTE: Variable outputs may show a yellow icon at all times.

Drum Speed



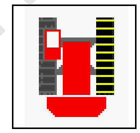
Displays drum speed in revolutions per minute (rpm). Drum direction is also shown.

Swing Status



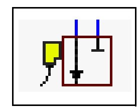
Displays status of swing. Swing right (shown) or swing left arrow is yellow when swing is enabled. Swing speed is shown in revolutions per minute (rpm).

Track Symbol



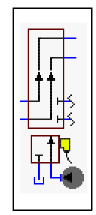
Shows travel function. Travel (right shown) is yellow when function is operating.

Valve Status



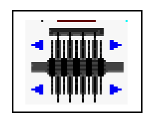
Displays status of a valve.

Pilot Valve



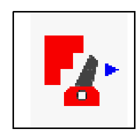
Displays status of an external piloted valve — a diversion valve would be an example of piloted valve.

Disc Brake



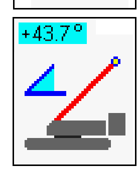
Displays disc brake status — applied or released (shown).

Drum Pawl



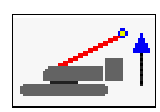
Displays pawl status — engaged or disengaged (shown).

Mast Angle



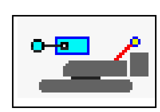
Displays mast angle in degrees mast is positioned above transport position.

Mast Raise Status



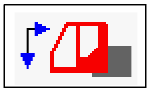
Displays command state of mast raise cylinders.

Gantry Down Limit Status



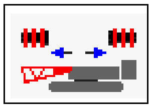
Displays command state of gantry movement and gantry down limit switch— Open or closed (shown).

Cab Tilt Status



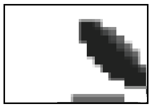
Displays command state of cab tilt cylinder — cab up or down (shown).

Boom Hinge Pin Status



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

Cooling Fan Status



Displays command state of cooling fan speed status as a percentage of maximum rpm.

Engine Diagnostics

See the 14000 Operator Manual.

Drum Diagnostic Screens

Select drum icon in screen ***level 1*** as shown Figure 3-8. Press Enter button to go to ***level 2***.

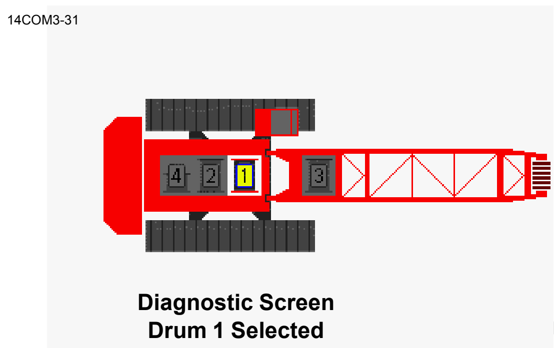


FIGURE 3-8

In drum example shown in Figure 3-9, drum 1 function is shown lowering. Load drum 2 operation is similar.

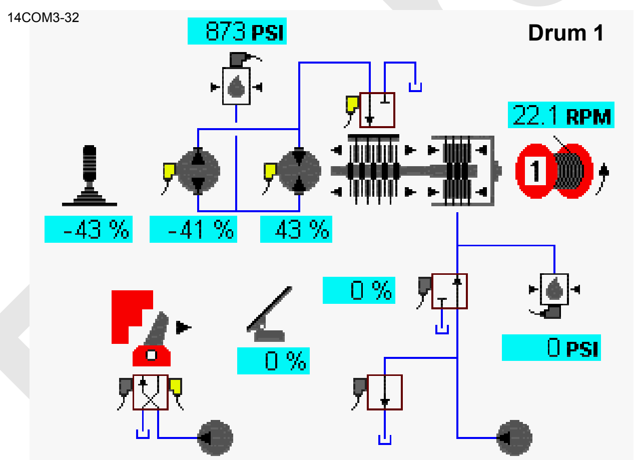


FIGURE 3-9

For load drum 3, left travel pump is dedicated to operate drum 3 motor through diverting valve when drum 3 is selected (Figure 3-10). Drum 3 is inoperable when traveling. Drum 3 can be configured as load drum or luffing jib.

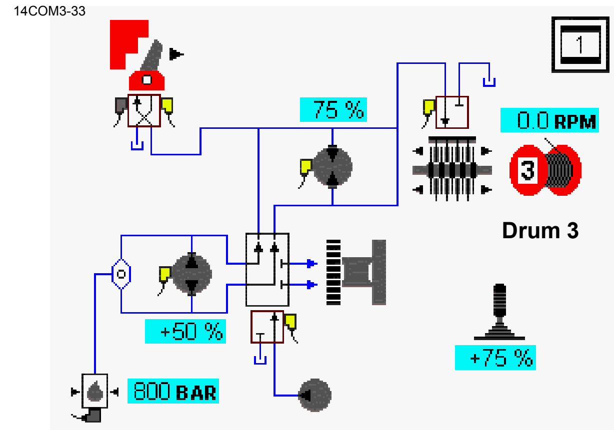


FIGURE 3-10

In drum example shown in Figure 3-11, drum 4 function is shown not operating.

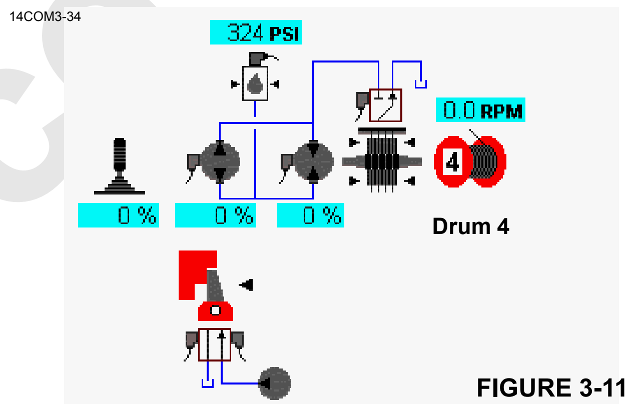


FIGURE 3-11

Swing Diagnostic Screen

Select swing icon in screen ***level 1*** as shown in Figure 3-12. Press Enter button to go to ***level 2***.

14COM3-35

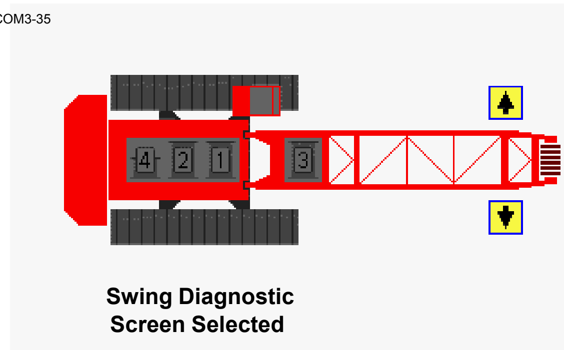
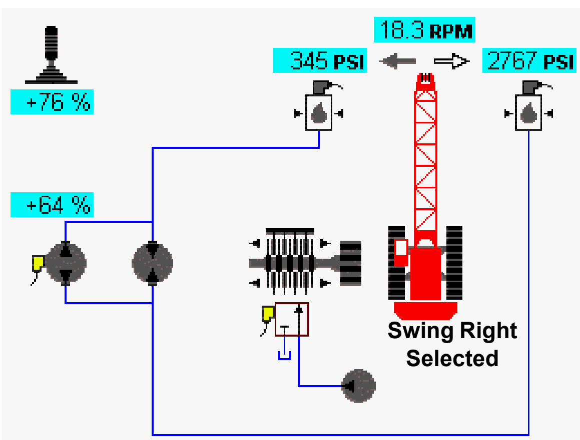


FIGURE 3-12

Swing system icons are displayed in Figure 3-13. The example shows how swing function might appear when swinging right. Arrow symbols near each pressure sender indicate which sender monitors swing right and swing left pressures.



14COM3-36

FIGURE 3-13

Travel Diagnostic Screen

Select travel icon in screen ***level 1*** as shown in Figure 3-14. Press Enter button to go to ***level 2***.

14COM3-37

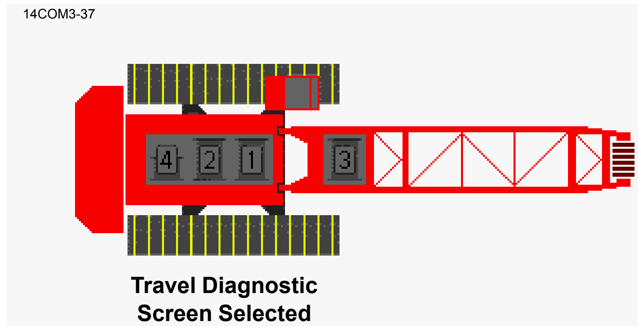
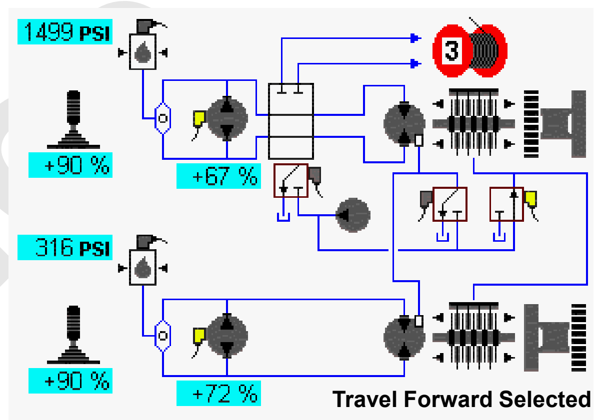


FIGURE 3-14

In travel system example shown in Figure 3-15. Left travel pump is dedicated to operate drum 3 through diverting valve if drum 3 is selected. When left crane travel is enabled, drum 3 is disabled.

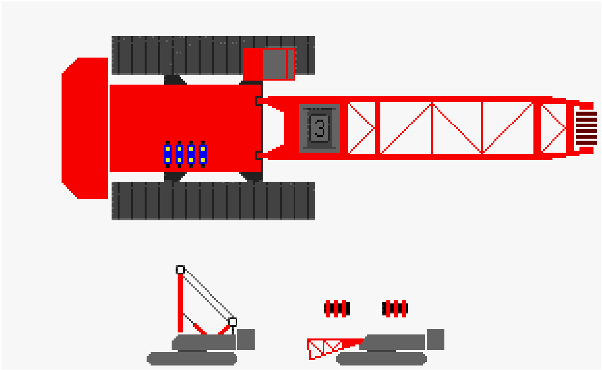


14COM3-38

FIGURE 3-15

Accessory Diagnostic Screen

Select mast cylinders and boom pin icons in screen ***level 1*** as shown in Figure 3-16. Press Enter button to go to ***level 2***.

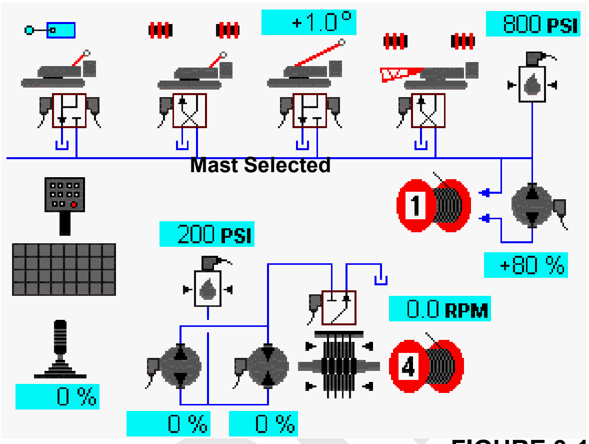


14COM3-39

FIGURE 3-16

In level 2, there are two diagnostic screens.

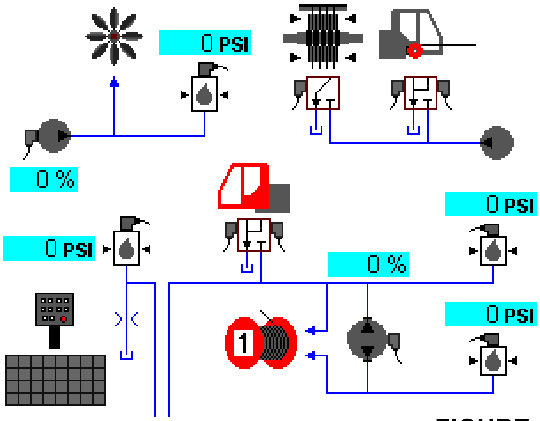
In diagnostic screen one, gantry cylinders up/down with up limit switch, back hitch pins, mast arm cylinders and boom hinge pins are shown (Figure 3-17).



14COM3-40

FIGURE 3-17

In diagnostic screen two, rigging winch, cab tilt and the cooling fan system are shown (Figure 3-18).



MAINSCREEN 4V

FIGURE 3-18

3

Function Mode Screens

The Function Mode screens are used to enable/disable modes and to set operating parameters 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 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.

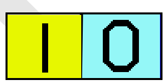
Level 4 — The selected mode or limit data box highlighted green. Use Select buttons to adjust the value, shown in data box.

To enable/disable modes or to set operating parameters for 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 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 4 from screen shown below.

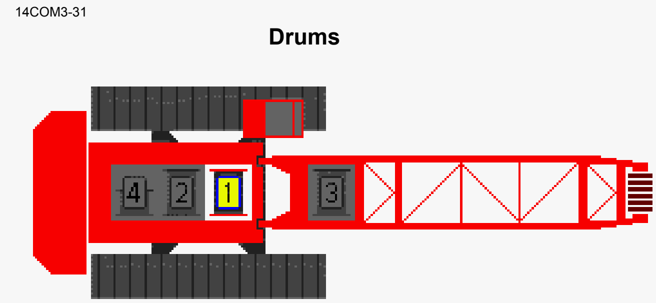


FIGURE 3-19

Swing Functions

Select swing functions from screen shown below.

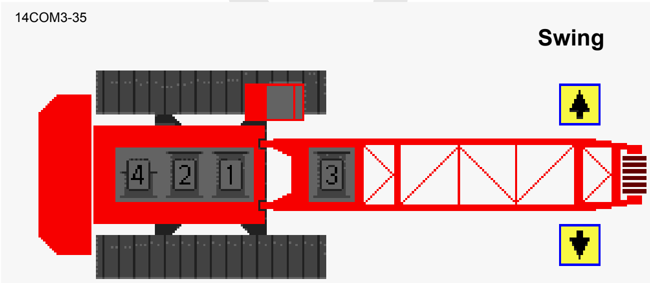


FIGURE 3-20

Travel Functions

Select travel functions from screen shown below.

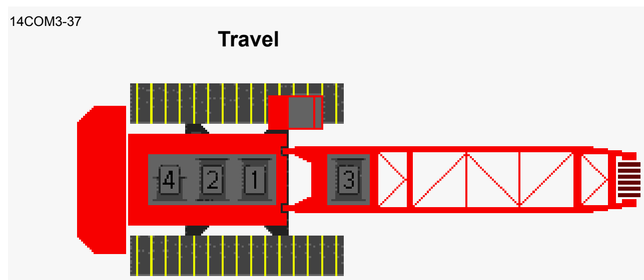


FIGURE 3-21

Remote Control Functions

Select remote control functions from screen below

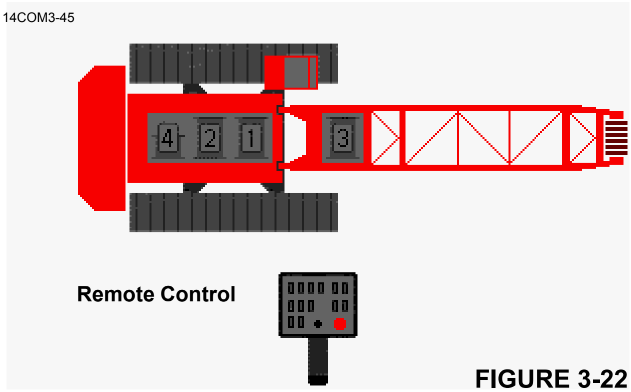
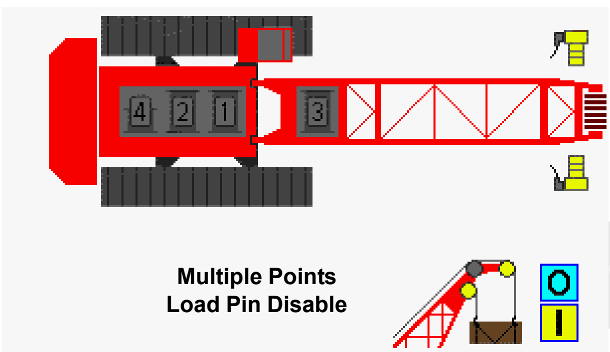


FIGURE 3-22

Multiple Points or Load Pin Disable Functions

Select multiple points or load pin disable functions from screen below.



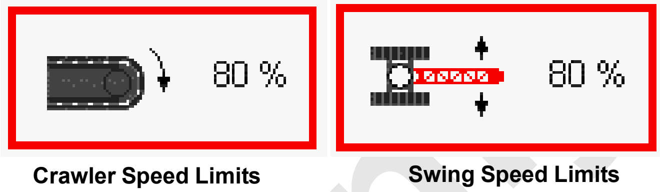
14COM3-90

FIGURE 3-23

Swing or Track Speed Limits

See Figure 3-24 in following procedure.

Swing and crawler speeds can be selected. In ***level 3***, the value shown in these data boxes can be adjusted with Select buttons to limit the function speed between 25% and 100% of maximum capability.



14COM3-46b

FIGURE 3-24

3

Drum Functions

See Figure 3-25 in following procedure.

In ***level 3***, the ***Drum Speed*** value can be changed with Select buttons to limit function speed between 25% and 100% of maximum capability.

In ***level 3*** use Select buttons to turn on/off ***Rigging Winch*** option.

In ***level 3*** use Select buttons to turn on/off selected drum ***Free Fall***.

In ***level 3*** use Select buttons to adjust ***Drum Slip*** for each drum to match the type of operation being performed.

- In most applications 100% slip should be selected so that load line pays out freely when a load is lowered with the brake pedal.
- For applications like pile driving, adjust slip so hammer follows the pile at the desired rate of speed.
- The corresponding brake pedal can be applied to stop the drum regardless of the slip adjustment. Likewise, the corresponding control handle can be pulled back or pushed forward to hoist or lower the load with full power.

In ***level 3*** use Select buttons to adjust ***Pedal Response*** between 0% and 100% to suit operator's needs. A high setting increases pedal movement required to control a small load and decreases pedal movement required to control a heavy load.

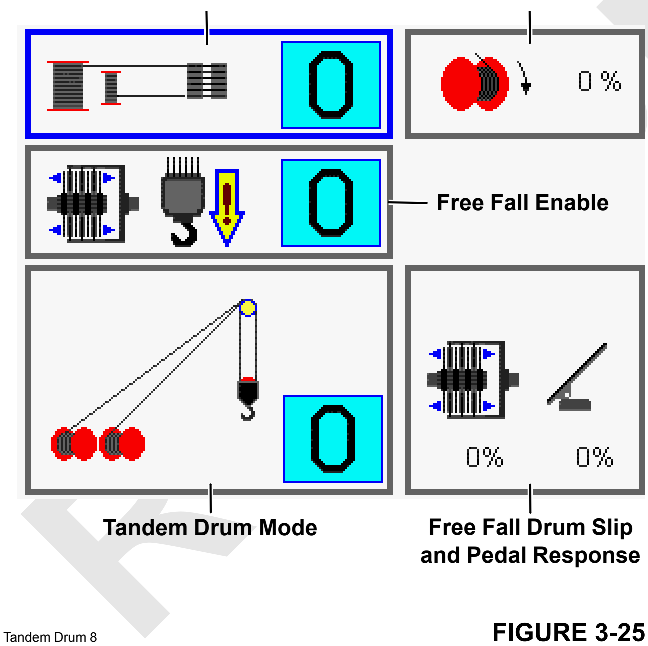


FIGURE 3-25

Swing Torque

See Figure 3-26 in following procedure.

In ***level 3***, value shown in this data box can be adjusted with Select buttons to swing torque between 25% and 100% of maximum capability.

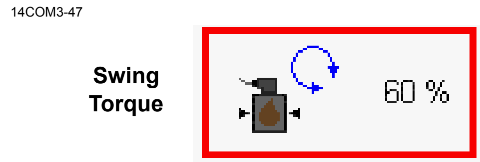


FIGURE 3-26

Boom or Swing Motion Limiter Mode

See Figure 3-27 in following procedure.

NOTE: Motion limiter mode data boxes do not appear unless crane has this option.

In ***level 3***, use Select buttons to enable or disable the motion limiter mode. When in ***level 3*** with 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.

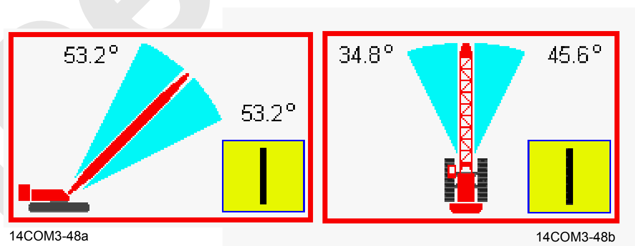


FIGURE 3-27

Remote Control

See Figure 3-28 in following procedure.

In ***level 3***, use Select buttons to enable or disable remote control.

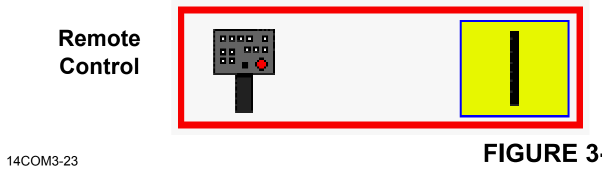


FIGURE 3-28

Multiple Points or Load Pin Disable Functions

See Figure 3-29 in following procedure.

Multiple points can be selected when two load points are used to lift a single load. Go to Rated Capacity Indicator/ Limiter screen and enter pass code (0064) to unlock access to multiple points screen. In ***level 3***, enter multiple points screen and select ***On*** (I).

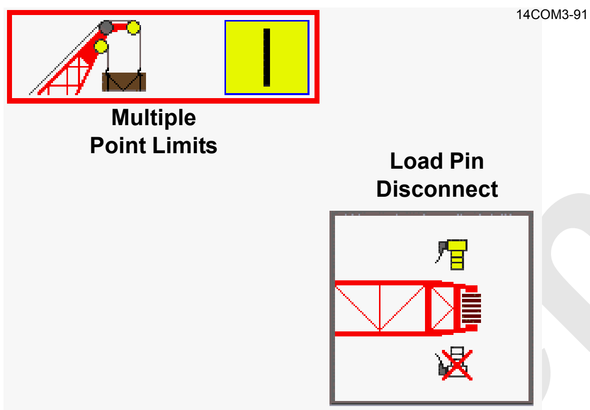


FIGURE 3-29

If a load pin disable fault (42) occurs, load sensing with one load sensor is an option. Go to Rated Capacity Indicator/ Limiter screen and enter pass code (0064) to unlock access to load pin disable screen. In ***level 3***, enter load pin disable screen and select sensor to be disabled. Top sensor icon is left side of boom and bottom sensor icon (with red X) is right side of boom.

Fan Function

See Figure 3-30 in 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.). **This minimum is set by the manufacturer and should only be adjusted by the manufacturer.**

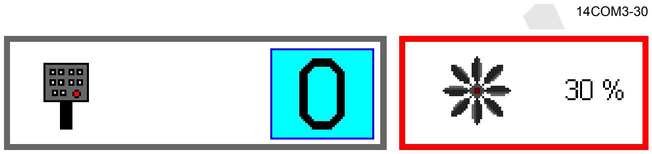


FIGURE 3-30

3

CAN Bus Diagnostic Screen

See Figure 3-31 for following procedure.

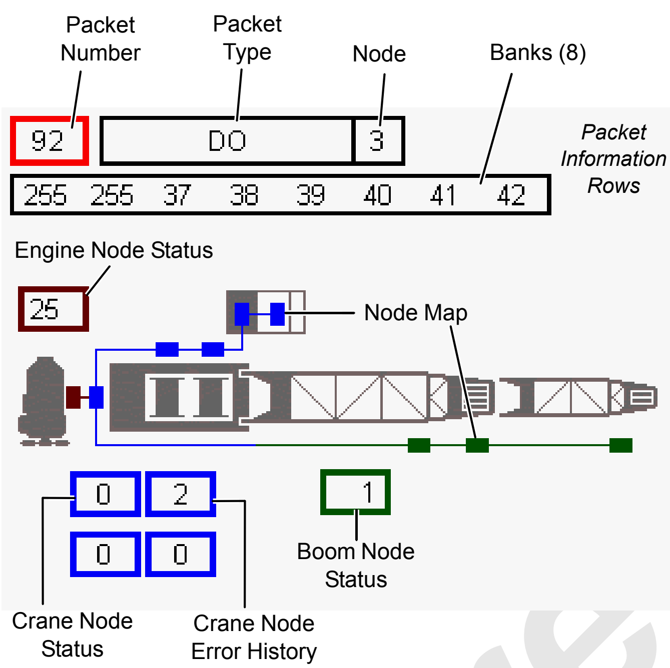
The CAN bus diagnostic screen is for technicians. The screen displays CAN bus packet and node information, engine status, history status, and boom status.

The CAN Bus screen operates on two levels:

Level 1 — Packet number box highlighted blue.

Level 2 — Packet number box highlighted red.

14COM3-50



Node Map Color Key

- Blue = crane/engine node
- Brown = engine ECM
- Green = boom, fixed jib, luffing jib nodes
- Yellow = a non-communicating node

FIGURE 3-31

Packet Information Boxes

The first box of the top row the example screen contains the Packet Number. Enter the desired packet number by using Select buttons.

Packet Type (DO, DI, AO, AI, ENC, or PWM) is displayed on top middle data box.

The associated Node (3) is indicated in top right data box.

In the box in the second row, the content of the packet is displayed in eight “banks.” Cross-reference the number that appears in a bank to Table 3-8 to determine the identity or status of the associated input or output.

Each input or 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.

Many packets are not easily interpreted by other than factory technical personnel and their content is not discussed in this publication.

Also see Using the CAN Bus Screen to Troubleshoot a Digital Output Fault on page 3-37.

Engine Node Status Box

Displays engine node (ECM) bus status. This information is for factory use only. The number displayed should be under 64.

Crane Status Box

Displays crane errors. The number displayed in top box corresponds to the following:

- Number 0 = Crane status normal.
- Number 1 = Node 2 is not communicating.
- Number 2 = Node 3 is not communicating.
- Number 4 = Node 4 is not communicating.
- Number 8 = Node 5 is not communicating.
- Number 32 - Bin node is not communicating.
- Number 64 - RIN (remote input node) node is not communicating.
- Number 128 = Engine node is not communicating.

NOTE: The bottom box is not used at this time.

Status History Box

Errors since power was last cycled.

Boom Node Status Box

Displays boom top and luffing jib communication. The box indicates what nodes may be available on the bus:

- Number 0 = No nodes detected.
- Number 1 = boom top node is present.
- Number 2 = luffing jib node is present.
- Number 3 = boom top and luffing node is present.

The status of the boom RIN shorting plug is shown at CAN 113-4-

- Number 32 = plug not installed.
- Number 33 = plug installed.

The status of the RIN system between the boom top RIN and the luffing jib RIN is shown at CAN 84-8-

- Number 0 = signal low (open circuit: for example, shorting plug not connected to boom top RIN).
- Number 64 = signal high (no communication).
- Number 128 = signal okay (RIN is communicating properly).

Using the CAN Bus Screen to Troubleshoot a Digital Output Fault

Fault 84 occurs when the control system detects an open or short circuit in one of the system's digital outputs (most digital outputs are monitored for fault 84).

If fault 84 is shown in fault section of Information screen, use following procedure:

See Figure 3-31 for following procedure.

1. Scroll through Packet Numbers 30, 31, and 33.
2. Banks 1, 2, and 3 should display number 255. If a number less than 255 is displayed, there is a digital output error.
   a. On Table 3-8, look up the number that appears on the display.
   b. If, for example, the number 21 appears in Bank 1 of Packet Number 31, look up 21 on Table 3-8. Note that the values 1, 4, and 16 are not shaded.
   c. Go to Table 3-7 and determine the outputs associated with 31-1-1, 31-1-4, and 31-1-16.
   d. Investigate indicated outputs for short to ground, short to shield, or other problem.

Camera Screen (Optional)

The camera screen (not shown) displays camera options and items for selecting and operating. Camera options include up to three different cameras to monitor drum spooling and area behind crane.

Use Select buttons to select camera screen on Menu screen. Press Enter button to access screen.

Use Select buttons to select desired camera view.

Press Exit button until Menu screen appears.

Pressure Test and Calibration Screen

Pressure Test and Calibration Screen is used to initiate and monitor four hydraulic test and calibration procedures. For instructions, refer to Section 2.

Table 3-7 Digital Output Disable

CAN Packet Number	Item Description
30-1-1	Rated Capacity Indicator/Limiter Beacon
30-1-2	Handle 4 Rotation Indicator
30-1-4	Handle 2 Rotation Indicator
30-1-8	Cooler Fan Pump
30-1-32	Handle 3 Rotation Indicator
30-1-64	Handle 1 Rotation Indicator
30-1-128	Seat Switch and Left Handle Center Switch
30-2-1	Right Console
30-2-8	Right Console and Handle Center Switch
30-2-16	Engine Coolant Temperature
30-2-128	Engine Oil Pressure Gauge
30-3-32	Rated Capacity Indicator/Limiter Alarm
30-3-64	Foot Throttle
30-3-128	System Fault Alarm
31-1-1	Drum 1 (Front Drum) Motor Control
31-1-2	Drum 1 (Front Drum) Brake Solenoid=
31-1-4	Gantry Cylinders Retract Switch
31-1-8	Gantry Cylinders Extend Switch
31-1-16	Mast Cylinders Retract Switch
31-1-32	Mast Cylinders Extend Switch
31-1-64	Drum 1 (Front Drum) Free Fall Pulse
31-1-128	Drum 2 (Rear Drum) Free Fall Pulse
31-2-1	Free Fall and Rigging Winch Enable
31-2-4	Travel Brake
31-2-8	Travel Motor
31-2-16	Swing Brake
31-2-32	Drum 3 (Auxiliary/Luffing) Diverter
31-2-64	Drum 3 (Auxiliary/Luffing) Pawl - In
31-2-128	Boom Hinge Pins Disengage
31-3-1	Drum 4 (Boom Hoist) Pawl - In
31-3-2	Back Hitch Pins Disengage
31-3-4	Cab Tilt Down Switch
31-3-8	Cab Tilt Up Switch
31-3-16	Drum 3 (Auxiliary/Luffing) Pawl - Out
31-3-32	Drum 4 (Boom Hoist) Pawl - Out
31-3-64	Drum 3 (Auxiliary/Luffing) Brake
31-3-128	Drum 3 (Auxiliary/Luffing) Motor
33-1-1	Rigging Winch - Haul In
33-1-2	Rigging Winch - Pay Out
33-1-4	Drum 2 (Rear Drum) Motor
33-1-8	Drum 2 (Rear Drum) Brake
33-1-16	Rigging Winch Brake
33-1-32	Right Side Swing/Travel Alarm
33-1-64	Swing Auto Lubrication
33-1-128	Hydraulic Fluid Level
33-2-1	Travel Auto Lubrication
33-2-2	Rated Capacity Indicator/Limiter Alarm
33-2-4	Drum 4 (Boom Hoist) Pump - Raise
33-2-8	Drum 4 (Boom Hoist) Pump - Lower
33-2-16	Drum 4 (Boom Hoist) Motor
33-2-32	Drum 4 (Boom Hoist) Brake
33-2-64	Swing Pump - Right
33-2-128	Swing Pump - Left
33-3-1	Left Track Pump - Forward
33-3-2	Left Track Pump - Reverse
33-3-4	Right Track Pump - Reverse
33-3-8	Right Track Pump - Forward
33-3-16	Drum 2 (Rear Drum) Pump - Lower
33-3-32	Drum 2 (Rear Drum) Pump - Raise
33-3-64	Drum 1 (Front Drum) Pump - Lower
33-3-128	Drum 1 (Front Drum) Pump - Raise

Table 3-8 Bank Identifier Numbers

Dark shaded boxes indicate ON; white boxes OFF.

	1	2	4	8	16	32	64	128
1	ON							
2		ON						
3	ON	ON						
4			ON					
5	ON		ON					
6		ON	ON					
7	ON	ON	ON					
8				ON				
9	ON			ON				
10		ON		ON				
11	ON	ON		ON				
12			ON	ON				
13	ON		ON	ON				
14		ON	ON	ON				
15	ON	ON	ON	ON				
16					ON			
17	ON				ON			
18		ON			ON			
19	ON	ON			ON			
20			ON		ON			
21	ON		ON		ON			
22		ON	ON		ON			
23	ON	ON	ON		ON			
24				ON	ON			
25	ON			ON	ON			
26		ON		ON	ON			
27	ON	ON		ON	ON			
28			ON	ON	ON			
29	ON		ON	ON	ON			
30		ON	ON	ON	ON			
31	ON	ON	ON	ON	ON			
32						ON		
33	ON					ON		
34		ON				ON		
35	ON	ON				ON		
36			ON			ON		
37	ON		ON			ON		
38		ON	ON			ON		
39	ON	ON	ON			ON		
40				ON		ON		
41	ON			ON		ON		
42		ON		ON		ON		
43	ON	ON		ON		ON		
44			ON	ON		ON		
45	ON		ON	ON		ON		
46		ON	ON	ON		ON		
47	ON	ON	ON	ON		ON		
48					ON	ON		
49	ON				ON	ON		
50		ON			ON	ON		
51	ON	ON			ON	ON		
52			ON		ON	ON		
53	ON		ON		ON	ON		
54		ON	ON		ON	ON		
55	ON	ON	ON		ON	ON		
56				ON	ON	ON		
57	ON			ON	ON	ON		
58		ON		ON	ON	ON		
59	ON	ON		ON	ON	ON		
60			ON	ON	ON	ON		
61	ON		ON	ON	ON	ON		
62		ON	ON	ON	ON	ON		
63	ON	ON	ON	ON	ON	ON		
64							ON	
65	ON						ON	
66		ON					ON	
67	ON	ON					ON	
68			ON				ON	
69	ON		ON				ON	
70		ON	ON				ON	
71	ON	ON	ON				ON	
72				ON			ON	
73	ON			ON			ON	
74		ON		ON			ON	
75	ON	ON		ON			ON	
76			ON	ON			ON	
77	ON		ON	ON			ON	
78		ON	ON	ON			ON	
79	ON	ON	ON	ON			ON	
80					ON		ON	
81	ON				ON		ON	
82		ON			ON		ON	
83	ON	ON			ON		ON	
84			ON		ON		ON	
85	ON		ON		ON		ON	
86		ON	ON		ON		ON	
87	ON	ON	ON		ON		ON	
88				ON	ON		ON	
89	ON			ON	ON		ON	
90		ON		ON	ON		ON	
91	ON	ON		ON	ON		ON	
92			ON	ON	ON		ON	
93	ON		ON	ON	ON		ON	
94		ON	ON	ON	ON		ON	
95	ON	ON	ON	ON	ON		ON	
96						ON	ON	
97	ON					ON	ON	
98		ON				ON	ON	
99	ON	ON				ON	ON	
100			ON			ON	ON	
101	ON		ON			ON	ON	
102		ON	ON			ON	ON	
103	ON	ON	ON			ON	ON	
104				ON		ON	ON	
105	ON			ON		ON	ON	
106		ON		ON		ON	ON	
107	ON	ON		ON		ON	ON	
108			ON	ON		ON	ON	
109	ON		ON	ON		ON	ON	
110		ON	ON	ON		ON	ON	
111	ON	ON	ON	ON		ON	ON	
112					ON	ON	ON	
113	ON				ON	ON	ON	
114		ON			ON	ON	ON	
115	ON	ON			ON	ON	ON	
116			ON		ON	ON	ON	
117	ON		ON		ON	ON	ON	
118		ON	ON		ON	ON	ON	
119	ON	ON	ON		ON	ON	ON	
120				ON	ON	ON	ON	
121	ON			ON	ON	ON	ON	
122		ON		ON	ON	ON	ON	
123	ON	ON		ON	ON	ON	ON	
124			ON	ON	ON	ON	ON	
125	ON		ON	ON	ON	ON	ON	
126		ON	ON	ON	ON	ON	ON	
127	ON	ON	ON	ON	ON	ON	ON	
128								ON
129	ON							ON

Table 3-8 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.

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 3-32

The size of the grease bead on the O-ring is as follows:

- On a 3-pin connector a 1/16 inch (1.5 mm) bead is required.
- On a 24-pin connector a 1/8 inch (3 mm) bead is required.
- On a 37-pin connector a 3/16 inch (5 mm) bead is required.

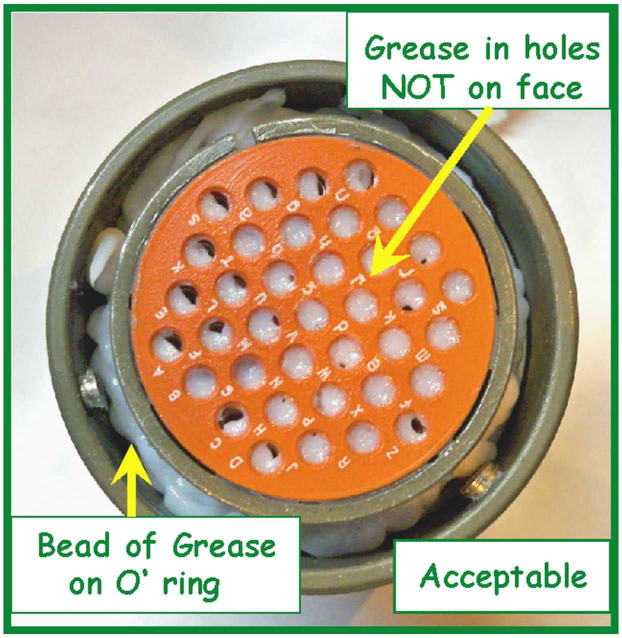


FIGURE 3-33

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 3-34

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SECTION 4
BOOM

TABLE OF CONTENTS

4

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SECTION 4
BOOM

AUTOMATIC BOOM STOP (LIMIT SWITCH)

WARNING

Falling Attachment Hazard

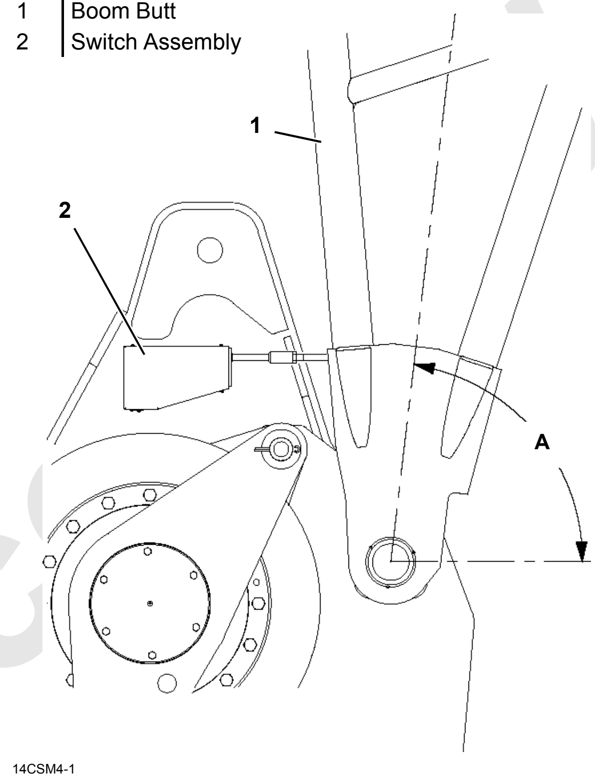
Do not operate crane unless boom stop is properly adjusted and operational. Do not adjust maximum operating angle higher than specified. Boom could be pulled over backward or collapse, causing death or serious injury.

Boom stop limit switch (6, Figure 4-2) stops the boom and applies the boom hoist brake when the boom is raised to ***Angle A*** shown in Figure 4-1.

Maintenance

At least once weekly, check that the boom stop limit switch stops the boom at the specified maximum angle. If not, replace any worn or damaged parts and/or adjust the boom stop.

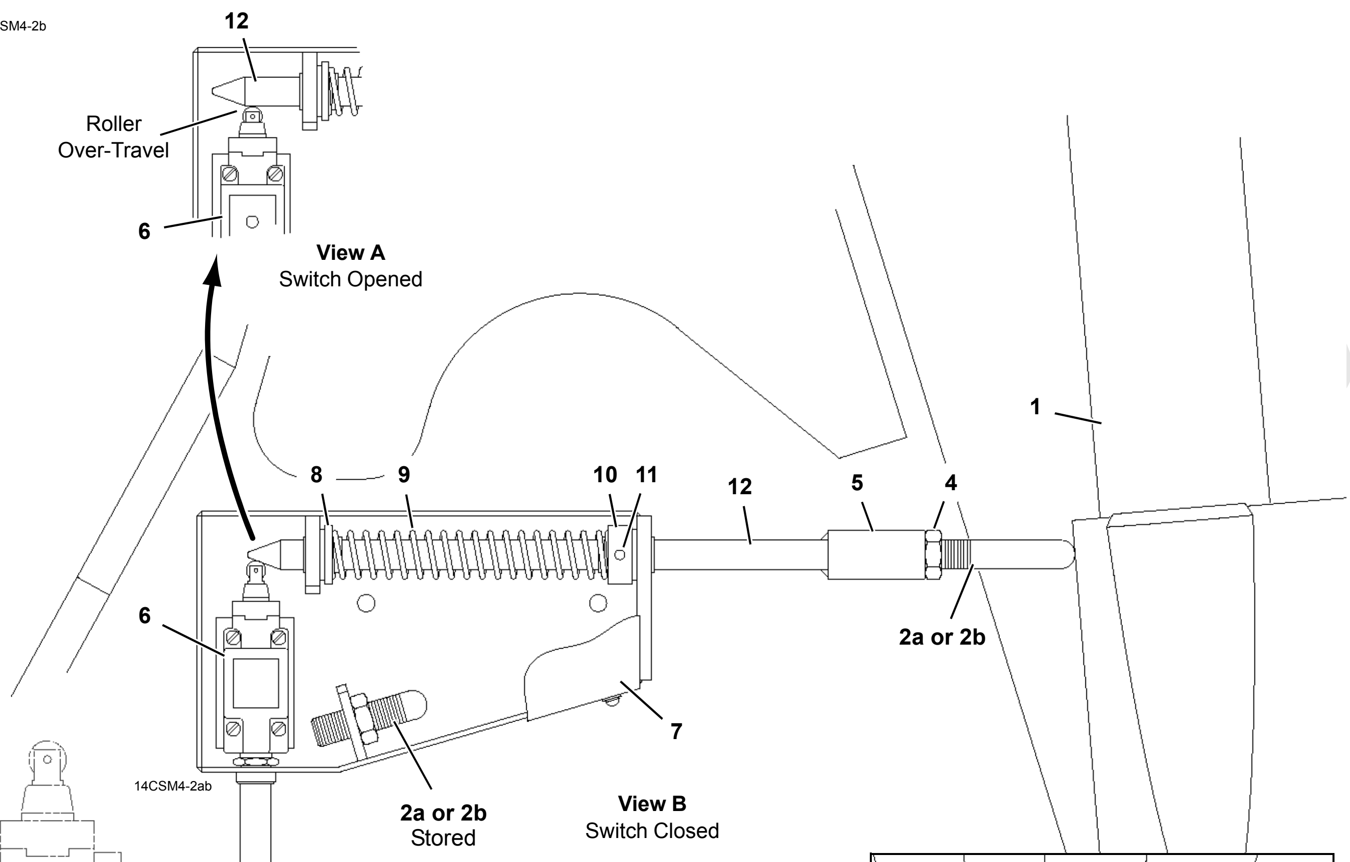
Item	Description
1	Boom Butt
2	Switch Assembly

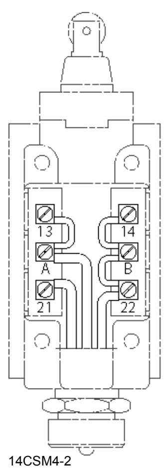


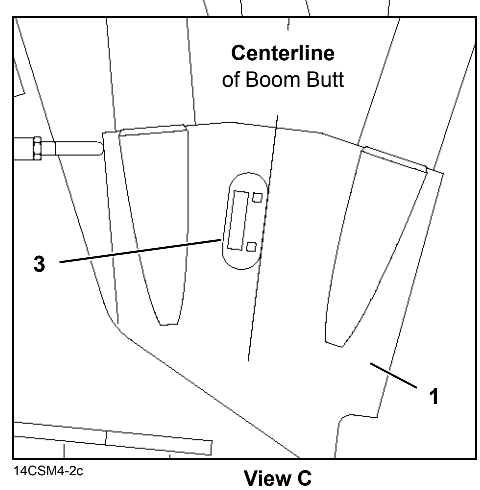
A	84° for #76 Boom WITHOUT Luffing Jib
	88.5° for #76 Boom WITH Luffing Jib

FIGURE 4-1

4







View C
Right Outboard Leg

Limit Switch Wiring

Wire	Switch Terminals			Function
1 (green)	22		14	Max Angle
2 (black)		13		GND
3 (white)	21			24 VDC Supply

Item	Description	Item	Description
1	Boom Butt	7	Cover
2a	84° Adjusting Rod – 5-1/4 in (133 mm) Long	8	Spring Washer
2b	88.5° Adjusting Rod – 3-1/2 in (88 mm) Long	9	Spring
3	Digital Protractor-Level	10	Spring Washer
4	Jam Nut	11	Dowel Pin 1/4 in (6 mm) Diameter
5	Coupling	12	Actuator Rod
6	Limit Switch		

FIGURE 4-2

Adjustment

See Figure 4-2 for following procedure.

The following instructions assume that the Rated Capacity Indicator/Limiter (RCL) is installed and properly calibrated.

During the following procedure, boom angle is monitored on the working screen of the RCL and on a digital protractor-level.

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

- Parts are replaced.
- Luffing jib is installed or removed.

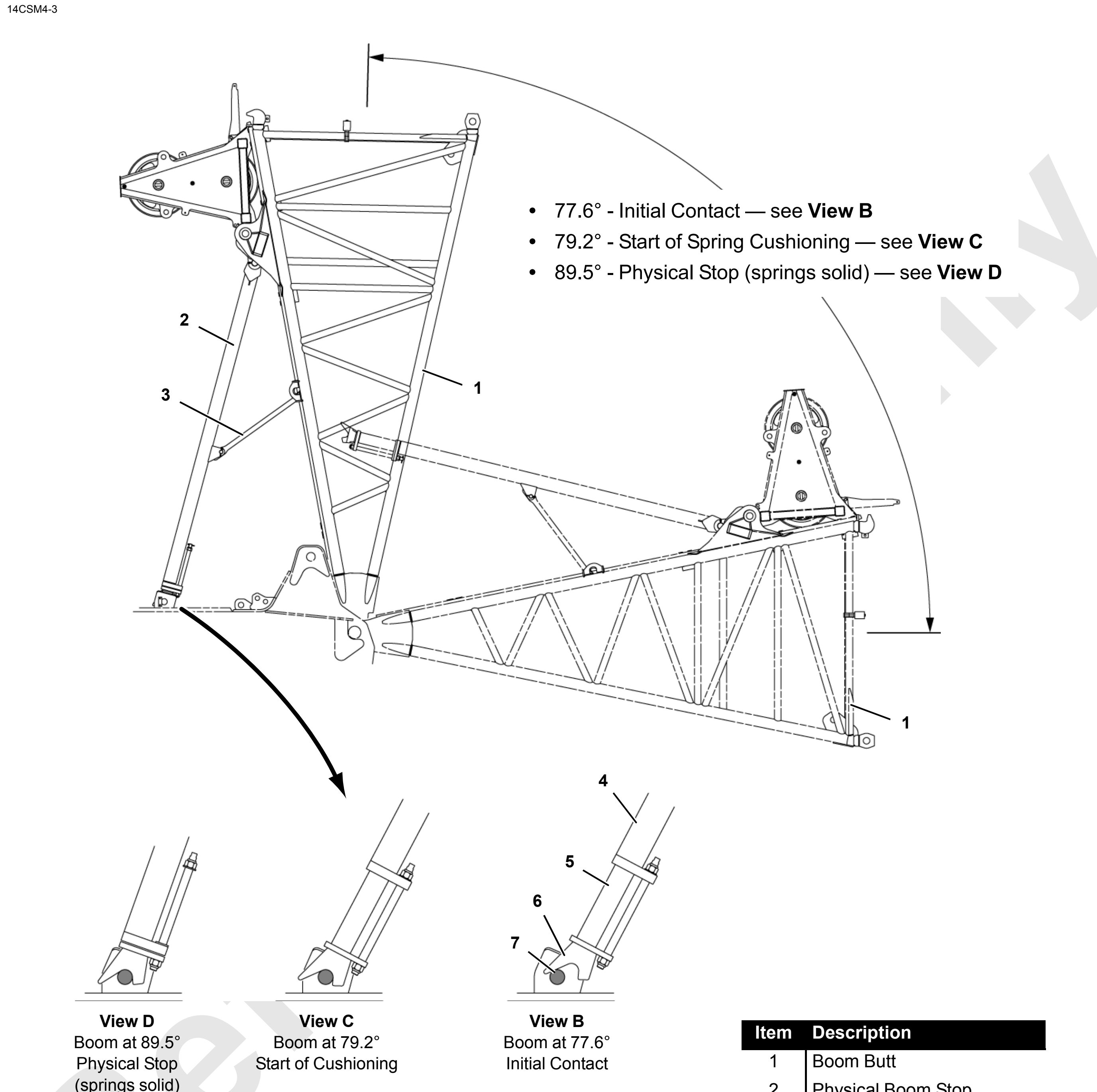
1. Park crane on a firm level surface or level crane by blocking under crawlers.
2. Make sure proper adjusting rod is installed:
   - Rod (2a) for boom WITHOUT LUFFING JIB.
   - Rod (2b) for boom WITH LUFFING JIB.
3. Boom up slowly while monitoring boom angle on RCL working screen.
4. Stop booming up when boom reaches specified ***Angle A*** (Figure 4-1).

   Verify boom angle with an accurate digital protractor-level (3, View C) held on center line of boom butt. Angle on protractor-level should be within 1° of angle on RCL working screen. If not, calibrate RCL.
   - If boom stops at specified angle, further adjustment is not needed.
   - If boom stops before reaching specified angle, go to step 5.
   - If boom reaches specified angle before it stops, go to step 6.
5. If boom stops before reaching specified angle:
   - **a.** Loosen jam nut (4, View B).
   - **b.** Turn adjusting rod (2a or 2b) all the way into coupling (5).
   - **c.** Boom up slowly until boom reaches specified angle.
   - **d.** Turn adjusting rod (2a or 2b) out against boom butt (1) until limit switch (6) "clicks" open.
   - **e.** Tighten jam nut (4).
6. If boom reaches specified angle before it stops:
   - **a.** Loosen jam nut (4, View B).
   - **b.** Turn adjusting rod (2a or 2b) out against boom butt (1) until limit switch (6) "clicks" open.
   - **c.** Tighten jam nut (4).
7. Check that actuator rod (12) over-travels limit switch as shown in View A.
8. Boom down and then back up. ***Boom must stop at specified angle. If boom fails to stop, repeat steps 3 through 7.***

Actuator Rod Replacement

See Figure 4-2, View B for following procedure.

1. Remove damaged actuator rod (12).
2. Slide spring washers (8 and 10) and spring (9) over new actuator rod while sliding new actuator rod into bracket assembly.
3. Position actuator rod (12) so tapered end just touches limit switch (6) roller (View B). Actuator rod must not depress limit switch roller.
4. Drill 1/4 in (6 mm) hole through spring washer (10) and actuator rod (12).
5. Install dowel pin (11).
6. Install proper adjusting rod (2a or 2b) and adjust as needed for correct maximum angle.



Item	Description
1	Boom Butt
2	Physical Boom Stop
3	Strut
4	Outer Tube
5	Inner Tube
6	Rod End
7	Boom Stop Pin

FIGURE 4-3

PHYSICAL BOOM STOP

WARNING

Physical boom stops must be installed for all crane operations.

Physical boom stops do not automatically stop boom at maximum operating angle. Boom stop limit switch must be installed and properly adjusted.

See Figure 4-3 for following procedure.

Two physical boom stops serve the following purposes:

- Assist in stopping boom smoothly at any angle above 77.6°.
- Assist in preventing boom rigging from pulling boom back when traveling or setting loads with boom at any angle above 77.6°.
- Assist in moving boom forward when lowering boom from any angle above 77.6°.
- Provide a physical stop at 89.5°.

Operation

When boom is raised to 77.6°, springs in boom stop tubes begin to compress.

As boom is raised higher, spring compression increases to exert greater force against boom.

If for any reason boom is raised to 89.5°, boom stop springs fully compress to provide a physical stop.

Adjustment

Struts (3) have slotted ends that do not require adjustment.

BOOM AND LUFFING JIB ANGLE INDICATOR

An angle indicator potentiometer is located inside the node controller mounted on the boom top and the luffing jib top. Boom and luffing jib angles are calibrated automatically by the crane's programmable controller as part of load indicator calibration procedure (see Rated Capacity Indicator/Limiter Operation Manual for instructions).

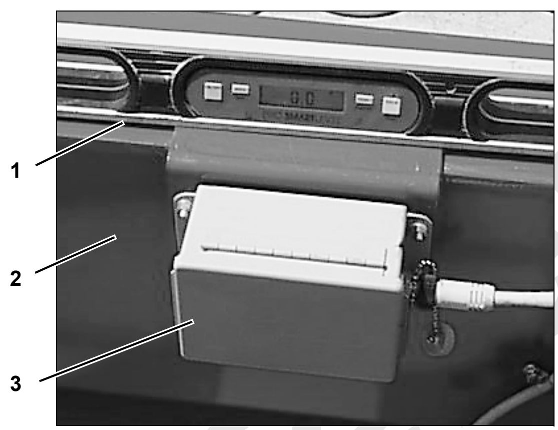
MAST ANGLE

See Figure 4-4 for following procedure.

Mast Angle Sensor

Mast angle sending unit (3, Figure 4-4) houses a solid-state sensor (4, Figure 4-5) 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 mast raising cylinder and levers during crane setup.
- Allow operator to monitor mast angle on the display during crane setup.



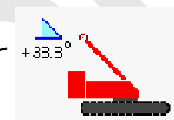
Item	Description
1	Digital Protractor-Level
2	Left Mast Leg
3	Angle Sending Unit
4	Mast Angle Sensor
5	Scribe Line

FIGURE 4-4

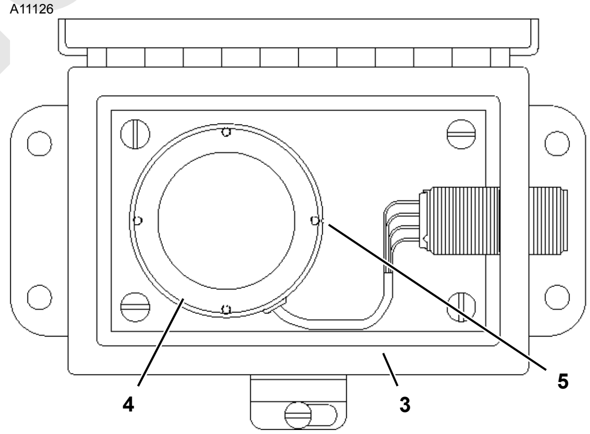
Adjusting Mast Angle

The mast angle sensor was set at the factory and should not require periodic adjustment. Adjustment is required if parts are replaced.

1. Park crane on a firm level surface or level crane by blocking under crawlers.
2. Lower mast (2) to transport position.
3. Place digital protractor-level (1, Figure 4-4) on mast and note mast angle.
4. Go to MAST ANGLE on information screen of main display. Note mast angle.



5. Angle noted in steps 3 and 4 must match within 1°.
6. If necessary, loosen mounting screws and rotate sending unit (3) in mounting slots until reading on display matches angle on level.
7. Securely tighten mounting screws to lock adjustment.



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 4-5

GANTRY LIMIT SWITCH

The gantry has a limit switch (3, Figure 4-6) which provides a digital input to the crane's programmable control for mast raising operation.

Operation

When gantry (1) is less than fully raised, limit switch (3) is open.

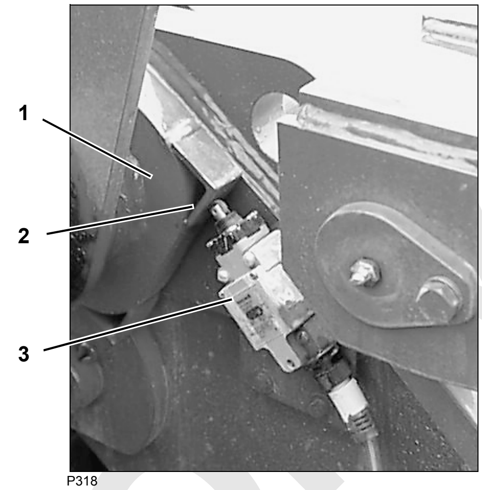
When gantry is fully raised, actuator (2) closes limit switch (3).

Check limit switch for proper operation each time crane is assembled.

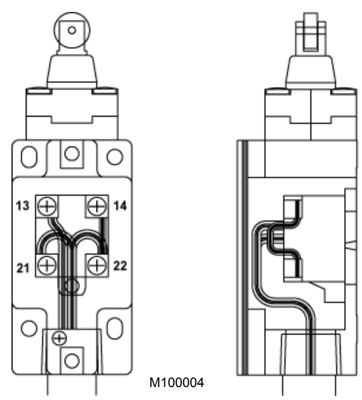
Adjustment

The gantry limit switch was set at the factory and should not require periodic adjustment. Adjustment is required if parts are replaced.

1. Park crane on a firm level surface or level crane by blocking under crawlers.
2. Fully raise gantry (see mast raising procedure in Section 4 of Operator Manual).
3. Loosen screws securing limit switch (3) to frame.
4. Slide limit switch down.
5. Slide limit switch up against actuator (2) until switch "clicks" closed.
6. Hold limit switch in place and tighten mounting screws.
7. Test limit switch for proper operation by lowering and then raising gantry.



Item	Description
1	Right Gantry Leg
2	Actuator
3	Limit Switch



Limit Switch Wiring

Wire	Switch Terminals			Function
1 (green)	22		14	Max Angle
2 (black)		13		Ground
3 (white)	21			24 VDC Supply

FIGURE 4-6

4

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 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 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 4-7.

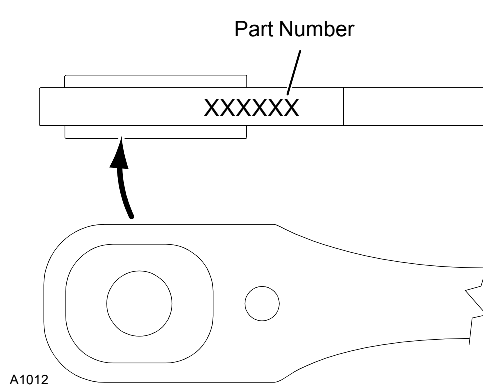


FIGURE 4-7

Replacement Specifications

Any strap not within specifications listed in Table 4-1 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 4-1
Strap Specifications

Condition	Reference	Allowable Tolerance or Deviation	Corrective Action
Dent	Figure 4-8	< 0.12 in (3.2 mm)	Monitor condition.
		≥ 0.12 in (3.2 mm)	Remove strap from service.
Kink	Figure 4-9	None	Remove strap from service.
Crack or Break	Figure 4-10	None	Remove strap from service.
Corrosion or Abrasion	Figure 4-11	<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 4-12	Varies depending on strap length	Remove strap from service if deviation exceeds maximum allowed.
Flatness (includes twisted straps)	Figure 4-13	Varies depending on strap length.	Remove strap from service if deviation exceeds maximum allowed.
Elongated Holes	Figure 4-14	None	Remove strap from service.
Length	Figure 4-15	None	Remove strap from service.

< = less than
≥ = equal to or greater than

Dent

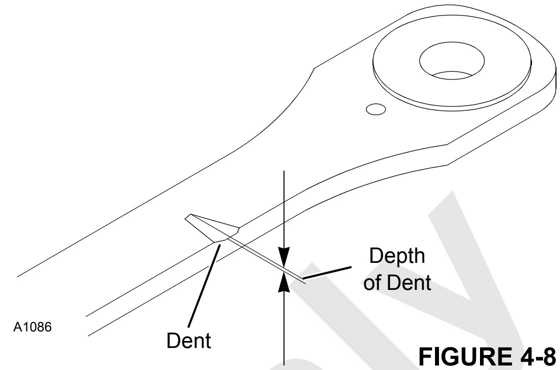


FIGURE 4-8

Kink

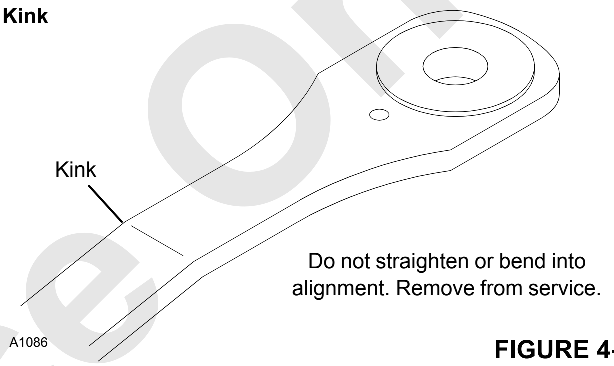


FIGURE 4-9

Crack or Break

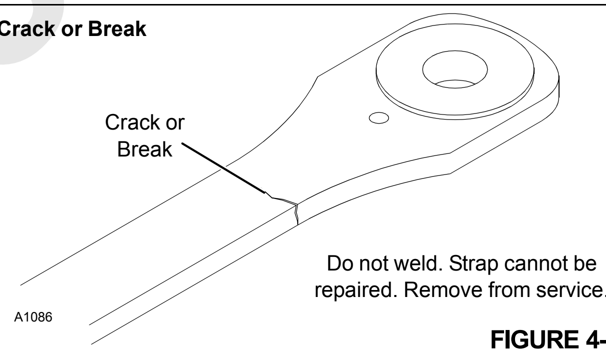


FIGURE 4-10

Corrosion or Abrasion

See Figure 4-11 for 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.

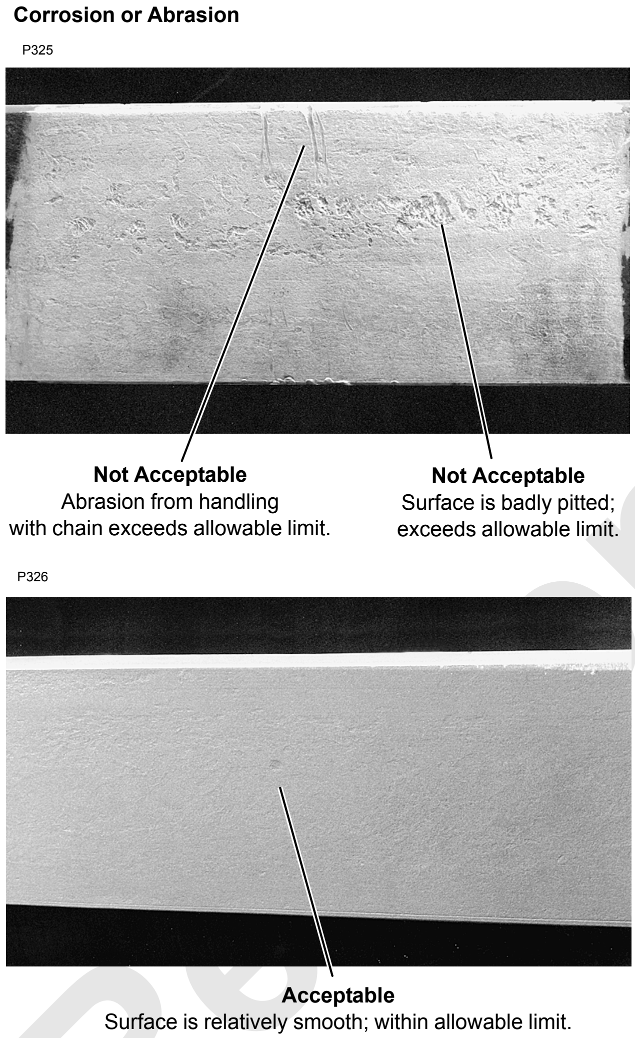


FIGURE 4-11

Straightness

See Figure 4-12 for 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)	0.125 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	

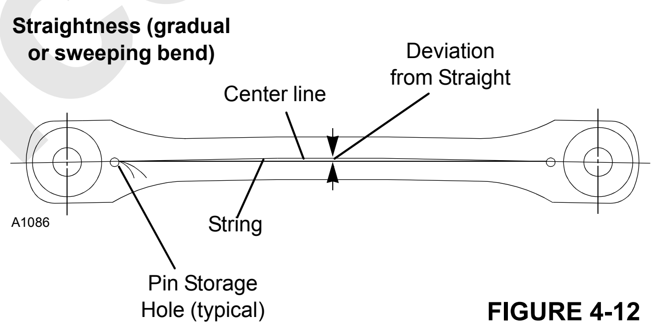


FIGURE 4-12

Flatness

See Figure 4-13 for 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.

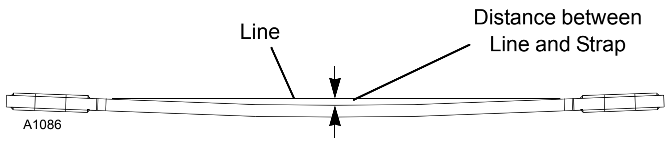


FIGURE 4-13

Elongated Hole

See Figure 4-14 for 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 the Manitowoc Crane Care Lattice Team.

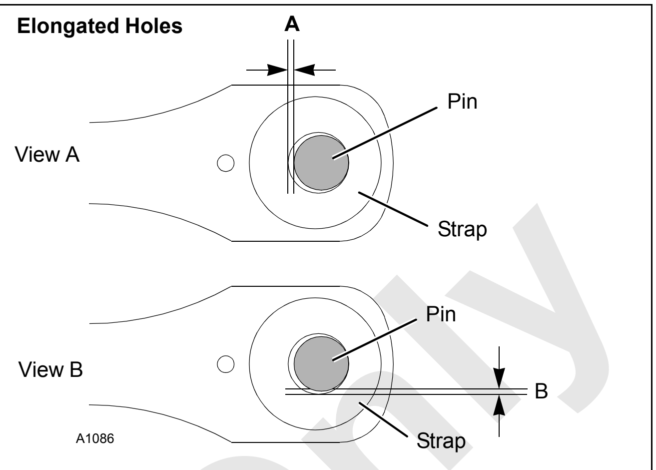
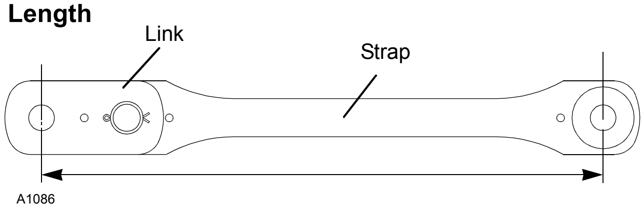


FIGURE 4-14

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 (17.5)
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 4-15

Storing Straps

Straps should be stored in a protected area. If stored in 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).

LATTICE SECTION INSPECTION AND LACING REPLACEMENT

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

SECTION 5
HOISTS

TABLE OF CONTENTS

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SECTION 5
HOISTS

FREE FALL CLUTCH/BRAKE

See Figure 5-1 for following procedure.

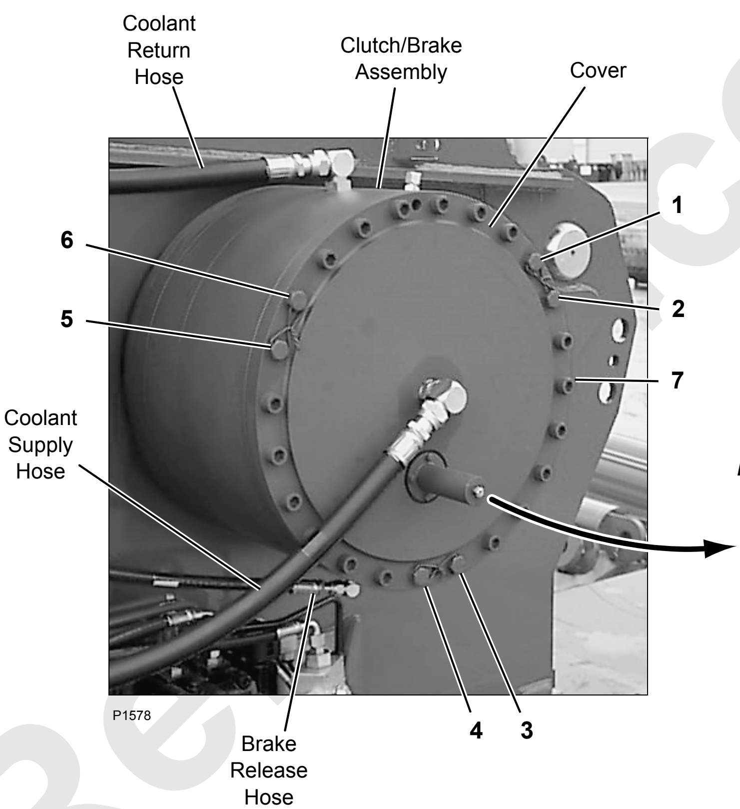
Either the front or the rear load drum can be equipped with a free fall clutch/brake.

Inspection

Inspect wear indicator with ***brake applied.*** Note that wear indicator moves in as brake discs wear.

Replace brake discs when indicated in Figure 5-1.

DANGER
Falling Load Hazard
Free fall clutch/brake will not hold load if brake discs are worn. To prevent load from falling, inspect each wear indicator **weekly** and replace discs when indicated.



Item	Identification
1- 6	Hex Head Capscrews
7	Socket Head Capscrews

with **Brake Applied:**
- 7.7 mm (0.30 in) – Brake Discs **OKAY**
- 1.5 mm (0.06 in) – **REPLACE** Brake Discs

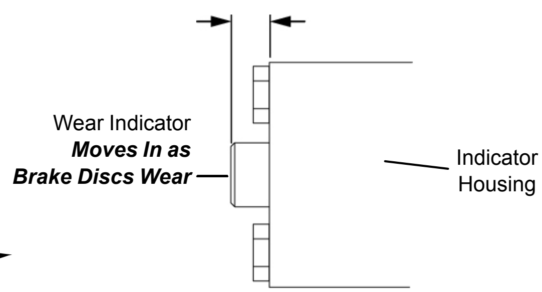


FIGURE 5-1

Overhaul

See Figure 5-1 for following procedure.

To overhaul either clutch/brake assembly, proceed as follows:

DANGER

Flying Object Hazard

Brake springs are preloaded. Clutch/brake assembly can fly apart with dangerous force.

To prevent death or serious injury, read following instructions before disassembling clutch/brake.

---

1. Lower all loads to ground and stop engine.
2. Open machinery enclosure door on right side of crane.
3. Disconnect hydraulic lines from clutch/brake ports. *Catch oil leakage from hoses and ports in a container as hoses are disconnected*.
4. Securely attach slings from assist crane to clutch/brake assembly.

   The assembly has four tapped holes—two in top of unit and two in cover—to which lifting eyes can be threaded (3/4 inch-10 UNC threads).

   The assembly weighs 1,650 lb. (748 kg).

WARNING

Falling Load Hazard

Do not perform step 5 until clutch/brake assembly is supported with slings from assist crane.

Clutch/brake assembly may fall off mounting adapter.

---

5. Remove eighteen socket head cap screws (7) and remove Clutch/brake assembly from crane.

   Do not loosen or remove hex head cap screws (1 – 6) until clutch/brake assembly is removed from crane.

6. Drain oil from clutch/brake assembly. A plug is provided in bottom of unit.
7. Place clutch/brake assembly on a workbench and securely block it with shaft pointing down.
8. Remove wire from hex head cap screws (1 – 6).
9. Loosen cap screws (1, 3, and 5) two full turns.
10. Loosen cap screws (2, 4, and 6) two full turns.
11. Repeat steps 9 and 10 until all spring preload is released.
12. Remove cover clutch/brake assembly.
13. The unit can now be disassembled and repaired as required. (See Brake Assembly—Free Fall drawing.)
    - Reverse the assembly steps to disassemble the clutch/brake assembly.
    - Read and perform all steps on the assembly drawing.
    - Replace all seals any time the unit is disassembled to replace brake discs.
14. Reassemble clutch/brake assembly as instructed in Brake Assembly—Free Fall drawing.
15. Reinstall clutch/brake assembly on crane. Reverse steps 2 – 5 above.
    - For proper mounting orientation, see Drum Shaft Assembly drawing at the end of this Section.
    - Once the splines in the shaft are engaged with the drum planetary, it may be necessary to rotate the clutch/brake assembly to align mounting holes. Apply up to 3,000 psi (207 bar) hydraulic pressure with a portable pump to the brake release port in bottom of unit. The assembly can then be rotated by hand to align mounting holes.
16. Test clutch/brake assembly for proper operation with free fall on and off:
    - With brake applied, check distance between ring on wear indicator and edge of indicator housing. It should be approximately 9/32 in (7 mm).

Clutch/brake must hold rated load of 29,500 lb. (13,381 kg) single line pull, both while hoisting load and while holding load in position with brake applied.

DRUM 4 PAWL

Drum 4 (boom hoist) has a drum pawl which, when engaged, prevents the drum from turning in the down direction.

The pawl is controlled by Drum 4 park switch in the operator's cab:

- When Drum 4 Park is turned ON, the pawl engages. Hydraulic cylinder (3, View A) extends and spring force (6) rotates pawl (2) into engagement with ratchet (1).
- When Drum 4 Park is turned OFF, the pawl disengages. Hydraulic cylinder (3, View B) retracts and cam (5) rotates pawl (2) out of engagement with ratchet (1).

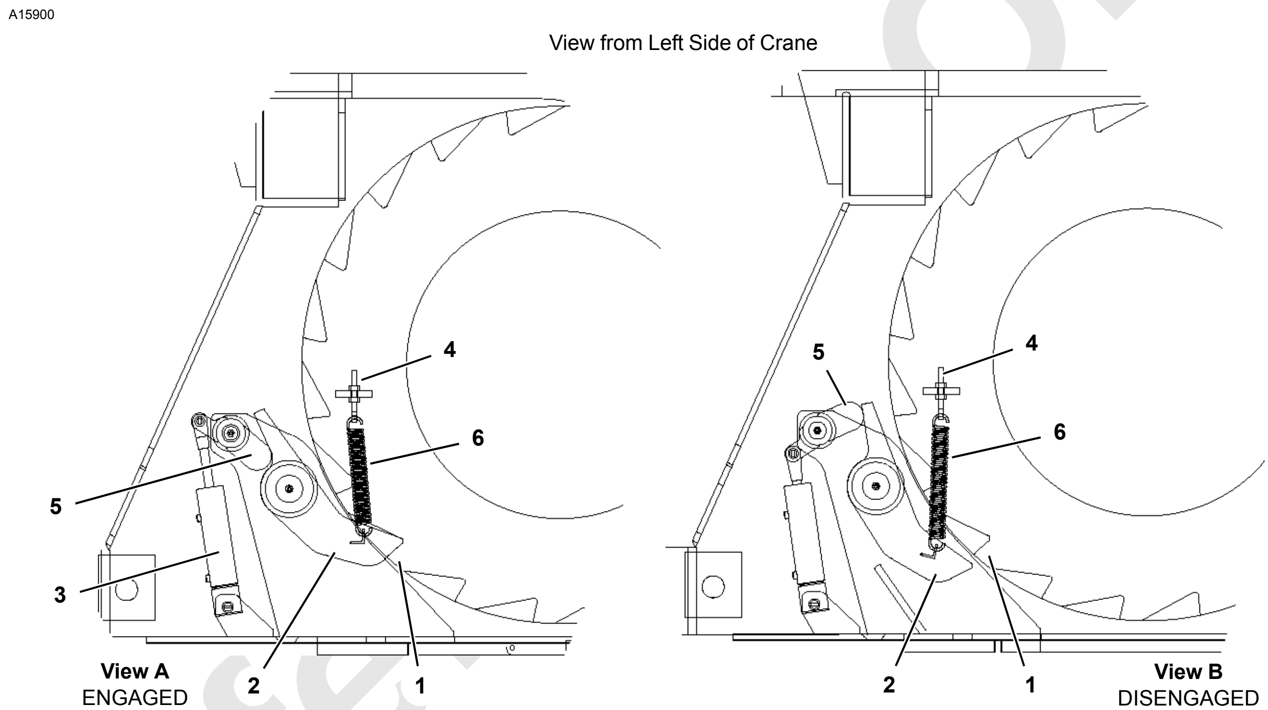
NOTE: It may be necessary to boom up slightly to fully disengage pawl (2) from ratchet (1).

Maintenance

The only maintenance required is to visually check the pawl for proper operation. This should be done daily when the boom hoist is in use.

If necessary, adjust eye bolt (4) so spring (6) has sufficient tension to fully engage pawl (2) with ratchet (1).

In some cases, pawl (1) 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 down direction.



Item	Description
1	Ratchet
2	Pawl
3	Hydraulic Cylinder
4	Eye Bolt
5	Cam
6	Spring

FIGURE 5-2

DRUM 3 PAWL

Drum 3 (luffing hoist or auxiliary drum in boom butt) has a drum pawl which, when engaged, prevents the drum from turning in the down direction.

The pawl is controlled by Drum 3 park switch in the operator's cab:

- When Drum 3 Park is turned ON, the pawl engages. Hydraulic cylinder (1, View A) extends and spring (2) rotates pawl (3) into engagement with ratchet (4).
- When Drum 3 Park is turned OFF, the pawl disengages. Hydraulic cylinder (1, View B) retracts and spring (2) rotates pawl (3) out of engagement with ratchet (4).

NOTE: It may be necessary to hoist slightly to fully disengage pawl (3) from ratchet (4).

Maintenance

The only maintenance required is to visually check the pawl for proper operation. This should be done daily when the hoist is in use.

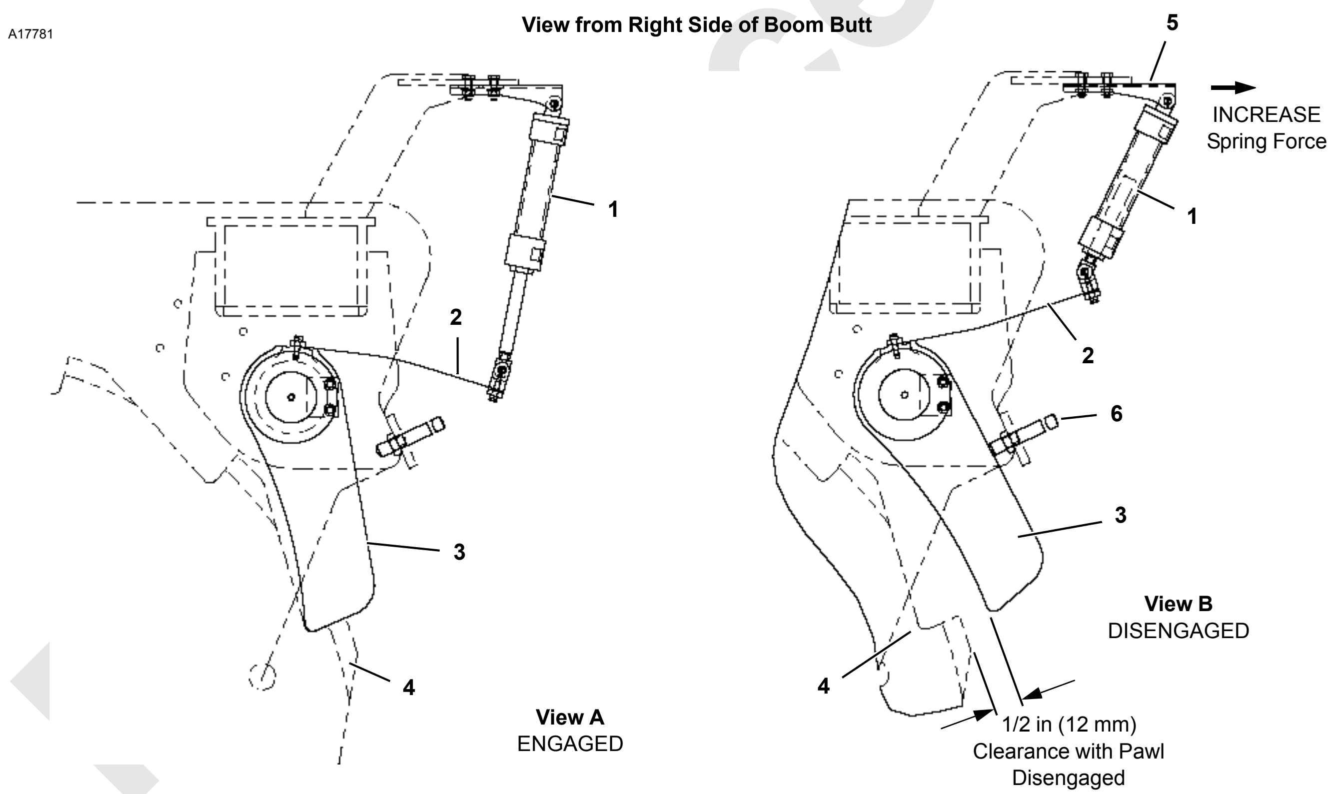
Adjustment

See View B for following procedure.

Adjustment is required only if the cylinder or other parts are removed for repair or replacement.

NOTE: To remove cylinder (1), disengage pawl, loosen adjusting screw (6) lock nut, and back out adjusting screw to relieve spring (2) force.

1. Back out adjusting screw (6) fully.
2. Disengage pawl.
3. Loosen bracket (5) screws and position bracket so screws are centered in bracket slots.
4. Securely tighten bracket screws.
5. Turn adjusting screw in (against pawl) until clearance specified in View B is obtained.
6. Check pawl for proper operation. Make sure there is enough spring force to hold pawl disengaged at specified clearance.
7. If necessary repeat adjustment steps. Moving bracket in direction of arrow will increase spring force.



Item	Description	Item	Description
1	Hydraulic Cylinder	4	Ratchet
2	Spring	5	Adjusting Screw with Lock Nut
3	Pawl	6	Bracket with Cap Screws, Nuts, and Washers

FIGURE 5-3

SPEED SENSOR

The hydraulic motor for each hoist drum 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 information to the crane's master controller. The master controller uses this information to control crane functions.

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***.

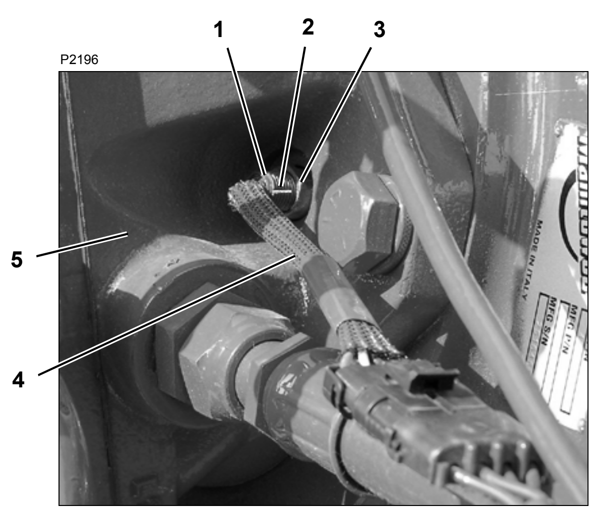
Adjustment

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 one 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.

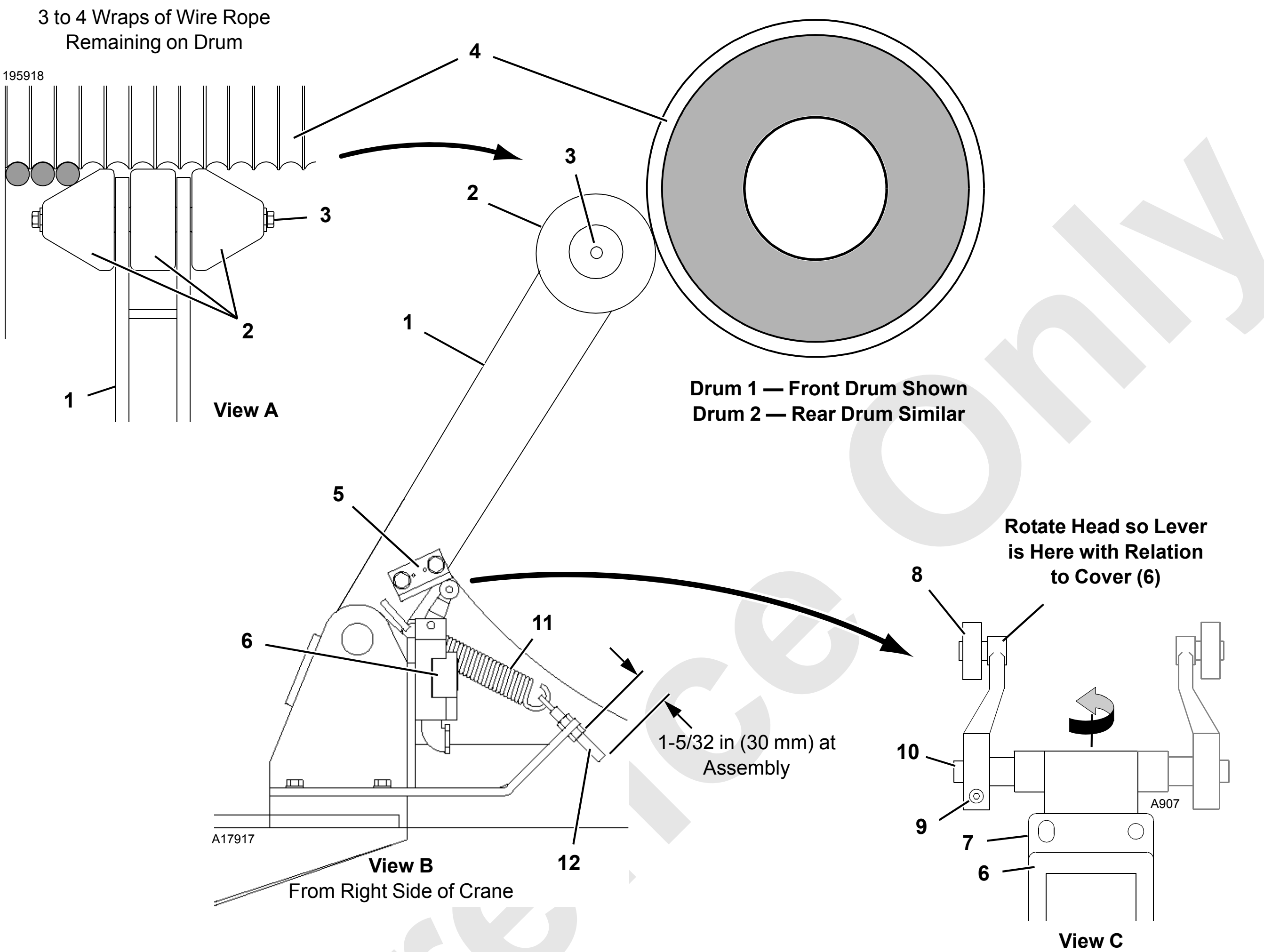
   If necessary, turn sensor out slightly until drum speed (rpm) is steady at low and high rpm.
7. Hold sensor in position and securely tighten lock nut.

Item	Description
1	Speed Sensor
2	Notch
3	Lock Nut
4	Cable
5	Motor



Typical Speed Sensor Installation at Drums 1, 2, 3, and 4

FIGURE 5-4



Item	Description	Item	Description
1	Lever	7	Limit Switch
2	Rollers	8	Limit Switch Lever with Roller
3	Cap Screw	9	Setscrew
4	Drum	10	Limit Switch Shaft
5	Actuator	11	Return Spring
6	Limit Switch Cover	12	Eyebolt

Limit Switch Wiring

Receptacle	Switch Terminals			Function
1 (green)	22	B	14	Max Angle
2 (black)	A	13		System Ground
3 (white)	21			24 VDC Supply

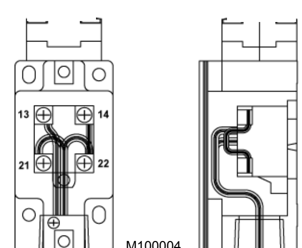


FIGURE 5-5

MINIMUM BAIL LIMIT

See Figure 5-5 for following instructions.

The optional minimum bail limit assembly on Drum 1 and 2 (front and rear) is a protective device which limits how much wire rope can be spooled off each drum.

The minimum bail limit stops the corresponding drum when there are 3 to 4 wraps of wire rope remaining on the first layer (View A).

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.

   Pay out wire rope from drum (4). Drum should stop with approximately 3 to 4 wraps of wire rope remaining on first layer. Adjust limit switch (6) if necessary.

2. Check that cap screws (3) holding rollers (2) on lever shaft are tight.
3. Check that return spring (11) has sufficient tension to hold rollers (2) snugly against bare drum. Adjust eyebolts (12) if necessary.

Limit Switch Head Position

When installing a new limit switch, reposition the head as follows (View C):

1. Remove four screws attaching head to body.
2. Rotate head (90° increments) so lever (8) is positioned as shown.
3. Install and securely tighten screws to attach head to body.

Adjustment

1. Land load for drum being adjusted.
2. Loosen setscrew (9, View C) in limit switch lever (8) so lever is free to rotate.
3. Pay out wire rope until bail limit rollers (2) are against bare drum with 3 to 4 full wraps of wire rope remaining on drum.
4. Hold roller on limit switch lever (8) against actuating plate (5, View B).
5. Turn limit switch shaft (10) CLOCKWISE (when viewing shaft) *only enough to click limit switch open and hold*.
6. Securely tighten setscrew (9) to lock adjustment.
7. Spool six to seven wraps of wire rope onto load drum.
8. Pay out wire rope from load drum. Drum must stop when there are three to four wraps of wire rope remaining on drum.
9. If necessary, repeat adjustment.

BLOCK-UP LIMIT

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 (or luffing jib) from lowering when a load is hoisted a predetermined distance.

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 must 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 5-6):

1. Normally closed limit switch assembly fastened at the following locations:

   Lower boom point.
   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 5-6 and 5-7 for component identification.

For a wiring diagram of the system, see Section 3 of this manual.

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.

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. See Section 4 of the Operator Manual for instructions.

WARNING

Falling Boom Hazard

Do not attempt to lower the boom to the ground without reading and understanding the procedures and precautions in Section 4 of the 14000 Operator Manual.

2. Carefully inspect 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, chain, shackle and 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.
3. Raise the boom according to the instructions in Section 4 of the 14000 Operator Manual.

Item	Description	Item	Description
1	Wire Rope Guide	10	Upper Boom Point
2	Load Cell (RCL)	11	Weight
3	Wind Speed Transmitter	12	Lift Block
4	Lower Boom Point	13	Weight Ball
5	Block-Up Limit Switch	14	Shackle
6	Chain	15	Pin
7	Weight	16	Boom Node
8	Lift Block	17	Lug (weight storage)
9	Load Block		

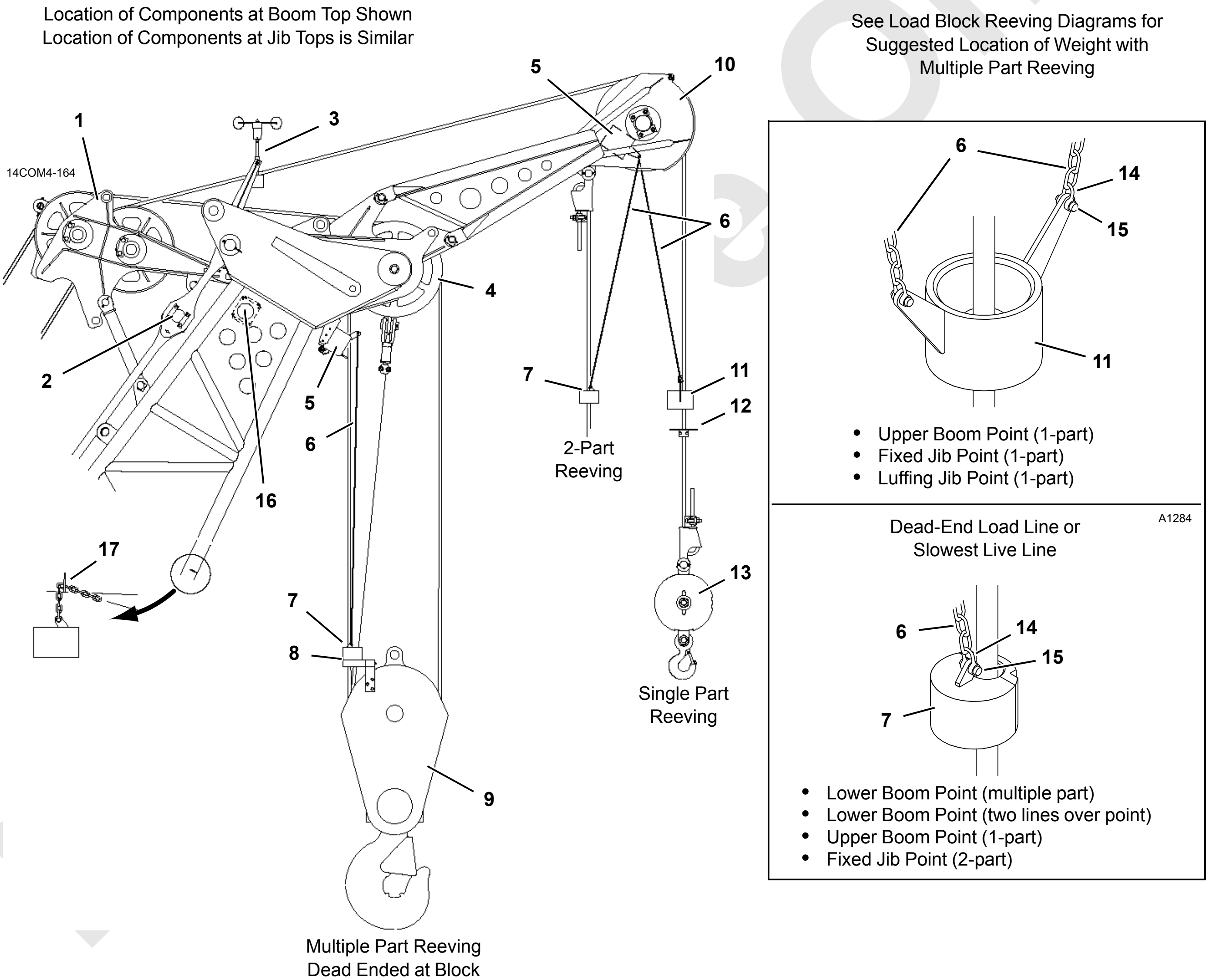


FIGURE 5-6

4. Test block-up limits for proper operation using either of 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.

Spring Tension Checking and Adjustment

See Figure 5-7 for following procedure.

Adjust limit switch spring tension so there is enough force to lift the *weight of the chain* and rotate the actuating lever when the weight is lifted.

1. Lower boom onto blocking at ground level.
2. Remove cover (11) from the limit switch housing.
3. Allow the weight of **only the chain** to pull down on the lever. The spring should rotate the actuating lever past the trip-point shown in Figure 5-7.

   - If the actuating lever does not rotate past the trip point, troubleshoot the cause.
   - If the spring tension is found to be insufficient, either replace the spring (3) or adjust the eye bolt (4) as needed, then retest.

Trip Setting Adjustment or Switch Replacement

See Figure 5-7 for following procedure.

1. Lower the boom onto blocking at the ground level.
2. Remove the cover (11) from the block-up limit switch enclosure (4).
3. If installing a new switch, remove the limit switch.

   Then, remove the limit switch lever (9) and install it onto the new limit switch. Do not tighten the lever onto the switch yet.

   Install the new limit switch and any other removed components.
4. Set the trip point of the limit switch:

   a. Temporarily unhook the spring from the actuating lever (7). Hold the actuating lever at the Trip Position shown in Figure 5-7.

   b. With the screw (2) loose, hold the roller (8) of the limit switch lever (9) against the actuating lever (7).

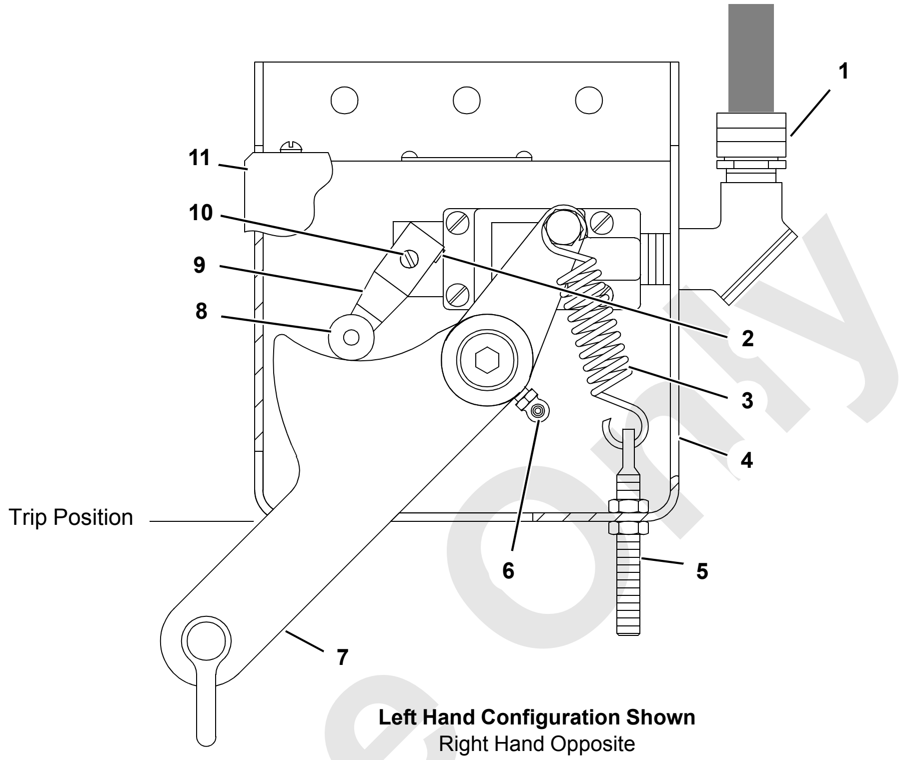
   c. Turn the switch shaft (10) counter-clockwise (for right-hand configuration) or clockwise (for left-hand configuration) only enough to “click” the limit switch open. Then securely tighten the screw (2) in the limit switch lever.

   d. Pull the actuating lever downward past the Trip Position. Then slowly raise the actuating lever while listening for the switch to trip. The switch should trip at the position shown in Figure 5-7. Readjust and retest as necessary.

   e. Place the spring back onto the actuating lever.
5. Reinstall the enclosure cover. Test the limit switch for proper operation (see "Weekly Maintenance”).

Limit Switch for
Lower Boom Point and Jib Point

Item	Description
1	Elbow with Cord Gripper
2	Screw
3	Spring
4	Enclosure
5	Adjusting Screw (Spring Tension)
6	Grease Fitting
7	Actuating Lever
8	Roller
9	Limit Switch Lever
10	Limit Switch Shaft
11	Cover



Left Hand Configuration Shown
Right Hand Opposite

FIGURE 5-7

WIRE ROPE INSPECTION AND REPLACEMENT

The following information is from various wire rope manufacturers and includes inspection, replacement, and maintenance guidelines for wire rope as established by ANSI/ASME B30.5, federal regulations, and Manitowoc Cranes.

Wire Rope Lubrication

Refer to the Lubrication Guide in this manual for recommendations.

Maintain a Wire Rope Condition Report

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

After initial loading of a new rope, measure and record its diameter for comparison with future inspections. Measure the rope's diameter across the crowns of the strands so the true diameter is measured as shown in Figure 5-9.

Wire rope removed from service should be examined and a corresponding report kept. This information can be used to establish a relationship between visual inspection and the rope's actual internal condition at the time of its removal from service. See Replacement Criteria on page 14 for inspection guidelines.

Required Inspection Intervals

The frequency of wire rope inspection shall be:

- Daily (see Daily Inspection)

and, **at minimum:**

- Yearly (see Periodic Comprehensive Inspection)

Wire Rope Care and Replacement Guidelines

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

   Welding spatter shall never be allowed to come in contact with the wire rope or wire rope ends. In addition, be sure that the wire rope is not an electrical path during other welding operations.
5. Wire ropes are manufactured from special steels. If heating a wire rope assembly is absolutely necessary for removal, the entire wire rope assembly shall be discarded.
6. On systems equipped with two or more wire rope assemblies operating as a matched set, they shall be replaced as an entire set.
7. Do not paint or coat wire ropes with any substance except approved lubricants.

Daily Inspection

Wire rope should be inspected in accordance with ANSI/ ASME B30.5 and OSHA 29 CFR 1926.1413. A running record of the condition of each wire rope the wire rope should be noted in the equipment inspection log (see Maintain a Wire Rope Condition Report).

WARNING

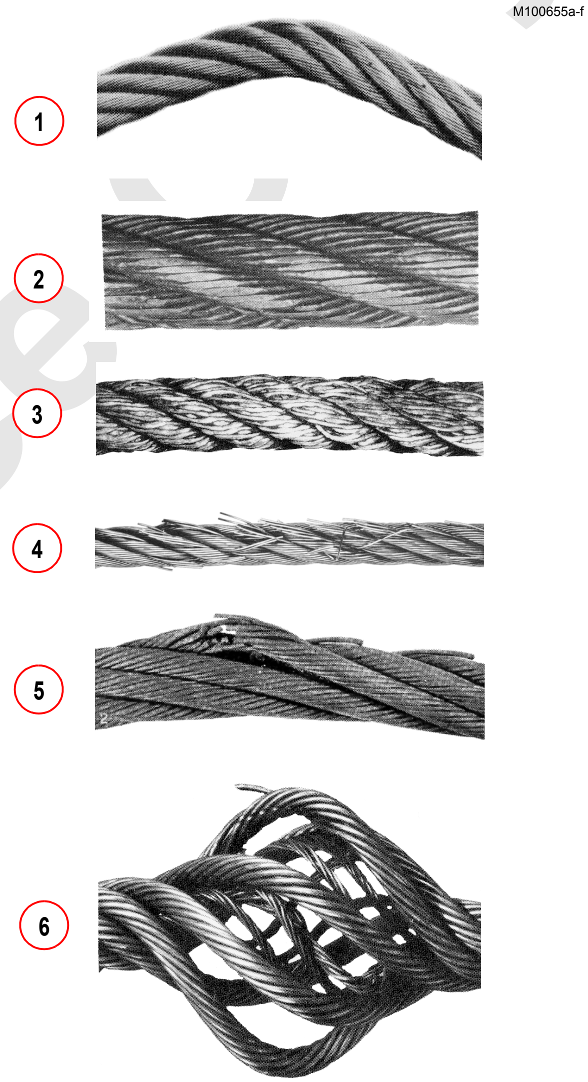
Personal Injury Hazard

Prior to conducting an inspection of wire rope:

- Always lock out equipment power when removing or installing wire rope assemblies.
- Always use safety glasses for eye protection.
- Wear protective clothing, gloves, and safety shoes as appropriate.
- Use supports and clamps to prevent uncontrolled movement of wire rope, parts, and equipment.

See Figure 5-8

1. Each work day, prior to crane work, visually inspect all rope that can reasonably be expected to be used that day. Check for obvious damage, including:
   - Rope defects such as shown in Figure 5-8.
   - Loss of rope diameter (see Reduction in Rope Diameter).
   - Broken wires—Record the number, distribution and type of broken wires (see Broken Rope Wires).
   - Internal wear or broken wires for ropes operating on synthetic sheaves. Common indicators of internal deterioration include localized reduction in rope diameter, corrosion between the strands, localized lengthening of lay, wire displacement, or wire distortion.
   - End fitting wear/abrasion.
   - Minor or general corrosion.
   - Areas that deteriorate more rapidly, such as flange points, crossover points, and repetitive pickup points on drums.
   - Take special care to observe boom hoist ropes and rotation-resistant ropes for evidence of core failure or other deterioration (remove from service). Internal deterioration of rotation-resistant ropes may not be readily observable.
2. Throughout the day, observe wire rope during operation, particularly:
   - Pick-up Points—Sections of wire rope that are repeatedly stressed during each lift, such as those sections in contact with sheaves.
   - End Attachments—The point where a fitting is attached to the wire rope or the point where the wire rope is attached to the drum.
   - Abuse Points—The point where the wire rope is subjected to abnormal scuffing and scraping.



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

FIGURE 5-8

Periodic Comprehensive Inspection

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

The inspection must include:

- All points listed under Daily Inspection.
- Inspection of rope diameter (see Reduction in Rope Diameter).
- Comprehensive examination for broken wires (see Broken Rope Wires).
- End connections: Check for broken wires or severely corroded, cracked, bent, worn, or improperly applied end connections.
- Areas subjected to rapid deterioration such as:

  Sections in contact with saddles, equalizer sheaves, or other sheaves where wire rope travel is limited.

  Sections of wire rope at or near terminal ends where corroded or broken wires may protrude.
- Inspection of boom sheaves, hook block sheaves, gantry/mast sheaves, boom extension/jib sheaves, jib strut sheaves, and hoist drums for wear.

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

Any damage of the wire rope found must be recorded and a determination made as to whether to continued use of the rope is safe. Refer to Replacement Criteria.

⚠ DANGER

Falling Load Hazard

- As a wire rope approaches the end of its useful life, inspections should be performed more frequently.
- All wire rope will eventually deteriorate to a point where it is no longer usable.
- A comprehensive inspection of each wire rope must be performed at least once a year.

Determining Frequency of Inspection

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

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

NOTE: Inspection intervals may also be pre-determined by state and local regulatory agencies.

Replacement Criteria

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

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

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

Reduction in Rope Diameter

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

New Wire Rope—After initial loading, measure and record the diameter of any new wire rope for comparison to future inspections. See "Maintain a Wire Rope Condition Report."

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

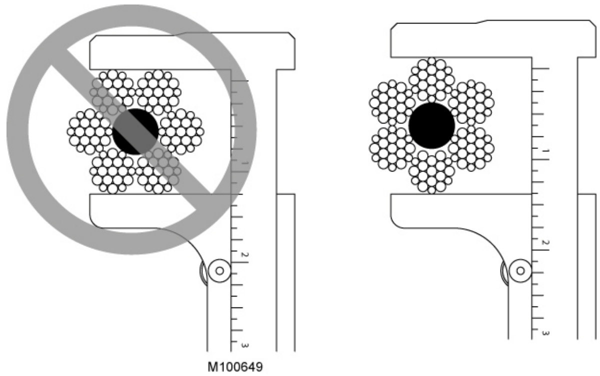


FIGURE 5-9

Broken Rope Wires

When conducting the Periodic Comprehensive Inspection, thoroughly clean the wire rope so breaks can be seen. Relax the rope, move it off "pick-up points," and flex it as much as possible. Use a sharp awl to pick and probe between wires and strands, lifting any wire which appears loose or moves excessively. **Do not open strands of rotation-resistant rope.**

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

NOTE: The Daily Inspection does not require that the rope be cleaned or probed.

The wire rope shall be taken out of service when it has the following number of broken wires:

See Figure 5-11 for an explanation of lay length.

- Running Ropes—six randomly broken wires in one lay length or three broken wires in one strand in one lay length.
- Standing Ropes (Pendants)—more than two broken wires in one lay length in sections beyond the end attachment, or more than one broken wire at the end attachment (see Figure 5-10).
- Rotation-resistant Rope—two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters.
- All Ropes—one outer wire broken at the point of contact with the core and protrudes or loops out of the rope structure—additional inspection is required.
- End Attachments (Figure 5-10)—when more than one broken wire appears at the attachment, replace the rope or cut off the affected area and reattach the fitting.

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

⚠ WARNING
Falling Load Hazard
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

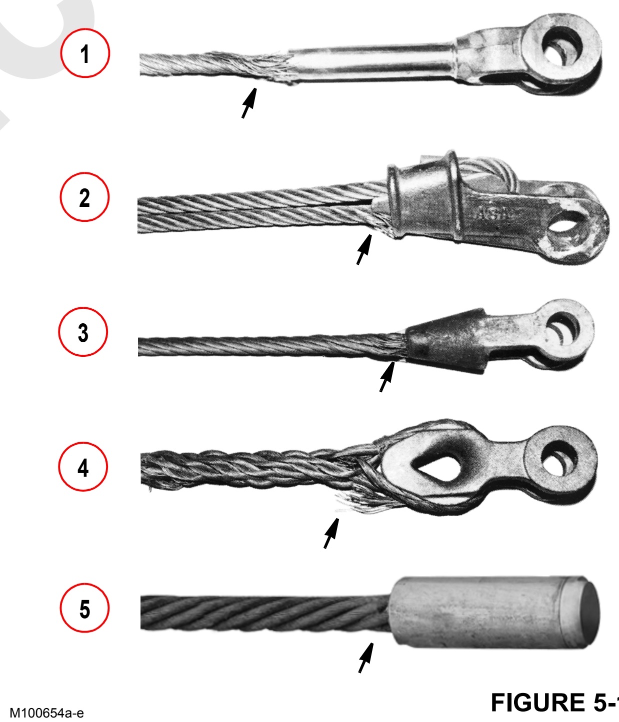
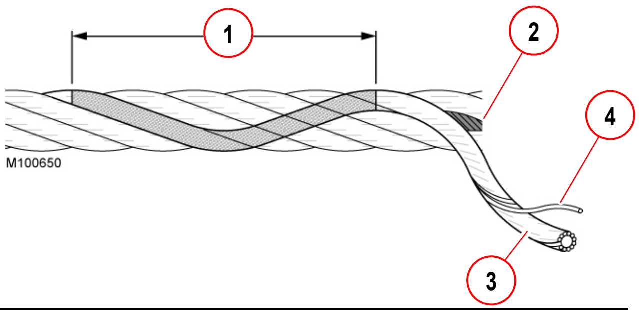


FIGURE 5-10



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

FIGURE 5-11

Rope That Has Been Idle a Month or More

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

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

DANGER

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 worn end and refasten. 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.

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 following the 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.
7. Inspect nylon sheaves for excessive tread diameter wear at locations **E** in Figure 5-15. Measure at three places to check for uneven wear.

   Wear must not exceed the limits given in the table. **Replace worn or damaged sheaves.**

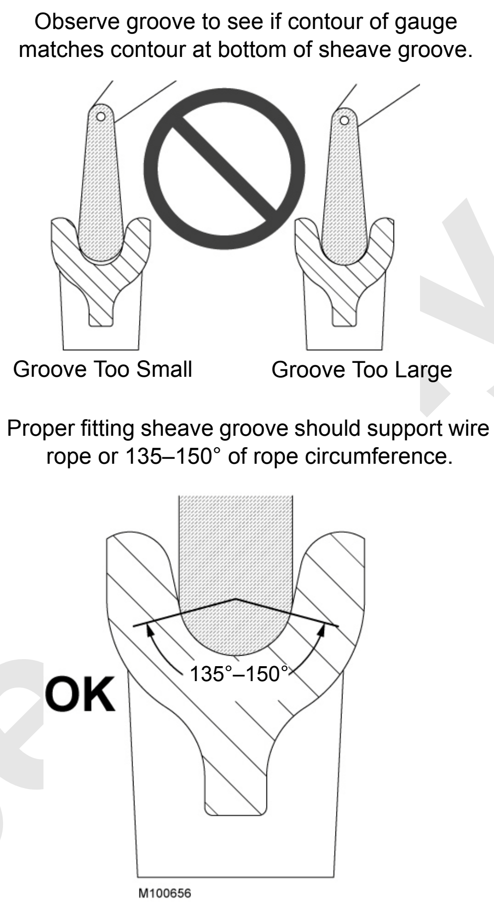


FIGURE 5-12

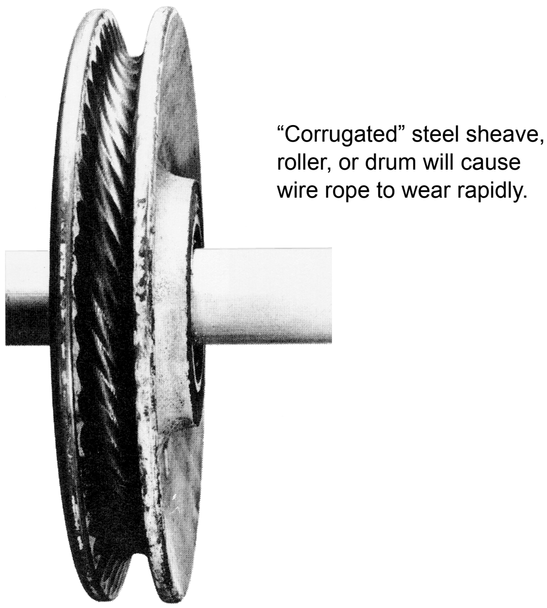


FIGURE 5-13

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**.

NOTE: Depending on the type of wire rope used, It is normal for nylon sheaves to show the wire rope print. ***Do not remachine nylon sheaves***.

NOTE: Nylon sheaves cannot be accurately inspected using conventional methods such as sheave gauges.

Due to the characteristics of nylon sheaves, the nylon material will actually move to better support the wire rope as the sheave wears normally.

Nylon sheave properties will be degraded in temperatures above 140° F (60° C).

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

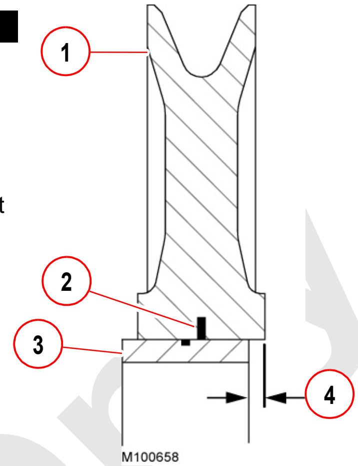


FIGURE 5-14

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 in this manual).

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

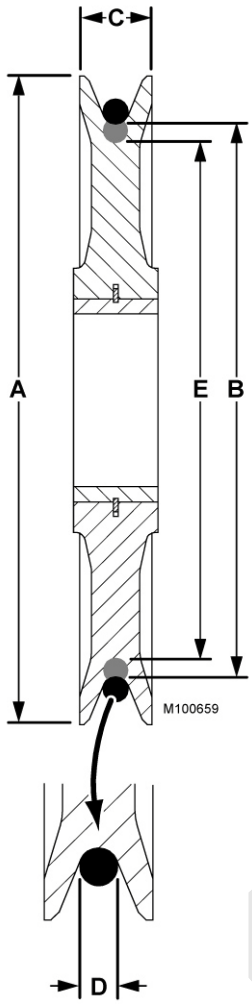
Due to application and design variations, it is not possible to give specific grease repacking intervals or the life expectancy of components.

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.

E = Replacement dimension

E = B – 3/16 in (5 mm) (maximum)

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



PLASTIC SHEAVE DATA

Sheave Part No.	A Outside Diameter		B Tread Diameter		C Width		D Rope Diameter	
	inch	mm	inch	mm	inch	mm	inch	mm
912738 631056	13.19	335.0	11.42	290.1	1.77	45.0	5/8	16
631054	13.19	335.0	11.42	290.1	1.77	45.0	7/8	22
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	1.94	50.8	7/8	22
631527	19.25	489.0	16.63	422.4	1.94	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 631520	23.00	584.2	20.13	511.0	2.25	57.2	7/8	22
631084 A00083	23.00	584.2	20.13	511.0	2.50	63.5	7/8	22
631102	23.00	584.2	20.13	511.0	2.50	63.5	1	25
631082 631103 A00051	27.00	685.8	23.00	584.2	3.00	76.2	1	25
631096 A00050	27.00	685.8	23.00	584.2	3.00	76.2	1.18	28
631100	30.00	762.0	27.00	685.8	3.00	76.2	1-1/8	29

FIGURE 5-15

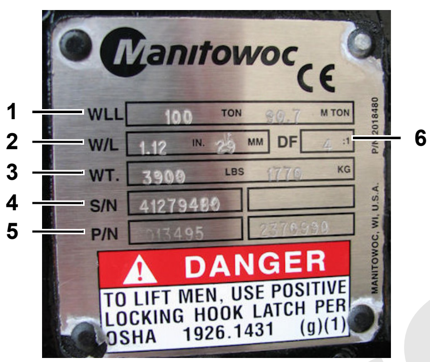
LOAD BLOCK AND HOOK-AND-WEIGHT BALL INSPECTION

WARNING

Falling Load Hazard

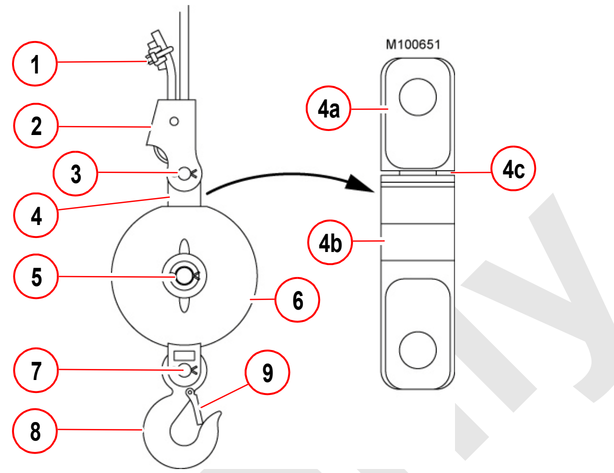
To prevent load from dropping due to structural failure of load block or hook-and-weight ball:

- 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 5-16) 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.



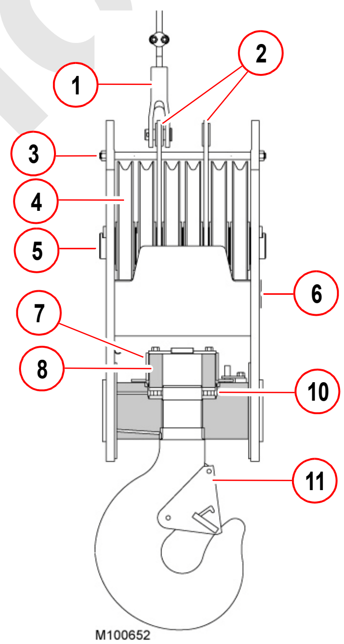
Item	Description
1	Working Load Limit (ton (US and metric)
2	Wire Rope Diameter (in and mm)
3	Block Weight (lb and kg)
4	Block Serial Number
5	Block Part Number (OEM and Manitowoc)
6	Design Factor

FIGURE 5-16



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 5-17



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 5-18

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 Figures 5-17 and 5-18):

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 checking the gap (4c, Figure 5-17) 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 0.02 in (0.5 mm) to 0.05 in (1.3 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.***
12. 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. 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).

⚠ WARNING

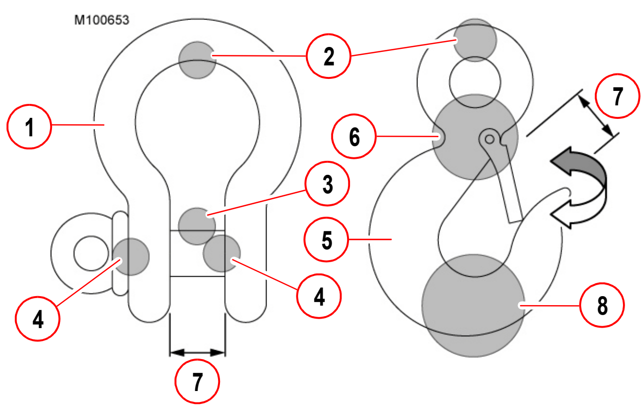
Falling Load Hazard

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.

13. Inspect each hook and shackle for damage as shown in Figure 5-19.
14. 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, 0700-2900
   - **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*).
15. Contact the supplier of your hooks, shackles, blocks, and other rigging for repair instructions.



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

FIGURE 5-19

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SECTION 6
SWING

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6

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SECTION 6
SWING

MANUAL RELEASE OF SWING BRAKE

See Figure 6-1

The hydraulic swing brake must be released when the swing planetary is removed and reinstalled to allow alignment of the gear teeth in the swing shaft with the teeth in the ring gear.

⚠ WARNING

Unexpected Crane Movement

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 must be fully operational when operating crane.

NOTE: This crane does not have a swing lock.

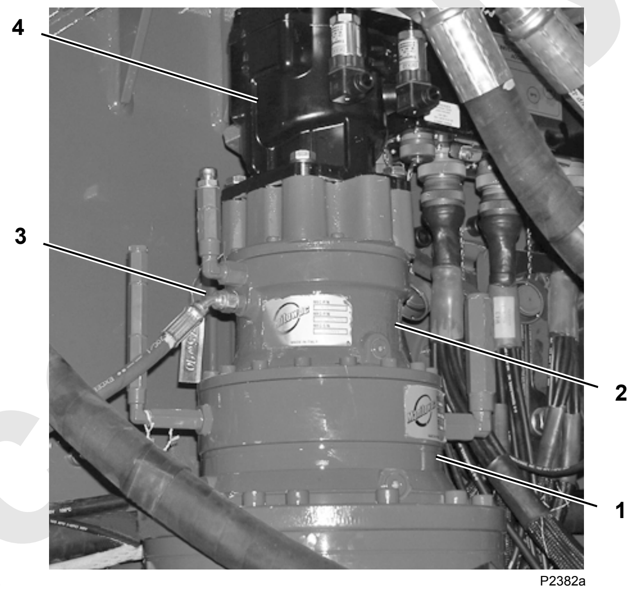
A hydraulic hand pump *with pressure gauge* is needed to manually release the swing brake.

1. Disconnect hoses from fitting at brake release port.
2. Attach hand pump to brake release port.
3. Pressurize brake to 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 24 bar when releasing swing brake.



Item	Description
1	Swing Planetary
2	Swing Brake
3	Brake Release Port (06 ORS Fitting)
4	Swing Motor

FIGURE 6-1

6

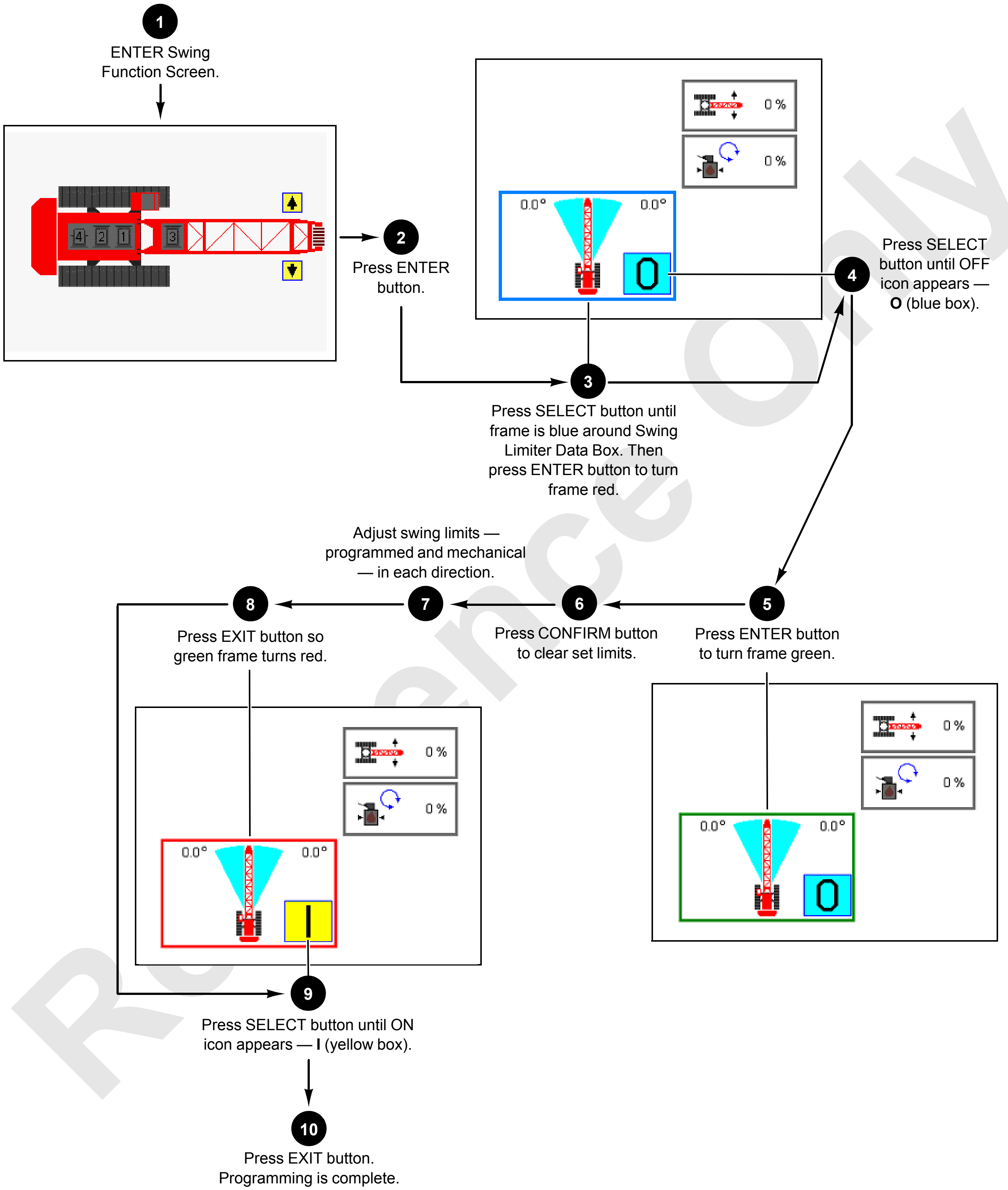

1
ENTER Swing Function Screen.
4 2 1 3
2
Press ENTER button.
0 %
0 %
0.0°
0.0°
0
3
Press SELECT button until frame is blue around Swing Limiter Data Box. Then press ENTER button to turn frame red.
4
Press SELECT button until OFF icon appears — **O** (blue box).
Adjust swing limits — programmed and mechanical — in each direction.
8
7
6
5
Press EXIT button so green frame turns red.
Press CONFIRM button to clear set limits.
Press ENTER button to turn frame green.
0 %
0 %
0.0°
0.0°
0 %
0 %
0.0°
0.0°
0
9
Press SELECT button until ON icon appears — **I** (yellow box).
10
Press EXIT button. Programming is complete.

FIGURE 6-2

SWING LIMITER (OPTIONAL)

The swing limiter allows the operator to limit how far the upperworks can be swung in either direction. Two types of limits are provided:

- Programmable limits which stop the upperworks hydraulically (bring upperworks to a smooth, controlled stop). These limits determine the swing working area.
- Mechanical limits (limit switches) which provide a backup to the programmable limits. The mechanical limits apply the swing brake to stop swing motion if the programmable limits fail to stop the swing motion.

NOTE: The programmed swing limits remain in computer memory when the engine is stopped. If the swing limits are on when the engine is stopped, they will still be on when the engine is restarted.

CAUTION

Structural Damage Hazard

Mechanical swing limits can not be turned off. If programmed swing limits are turned off, swing limiter brackets (5, Figure 6-3) must be removed. Otherwise, swing brake will apply when limit switch contacts either actuator. Upperworks will come to an abrupt stop, possibly causing damage to components.

WARNING

Crushing Injury Hazard

Two people are required to perform following steps: an operator to operate crane and program limits and a mechanic to install and adjust mechanical limits.

To prevent crushing injuries to mechanic:

- Maintain constant communication between operator and mechanic while mechanic is installing and adjusting mechanical limits.
- Operator — do not swing upperworks until instructed to do so by mechanic.
- Mechanic — stay well clear of moving parts while upperworks is being swung.

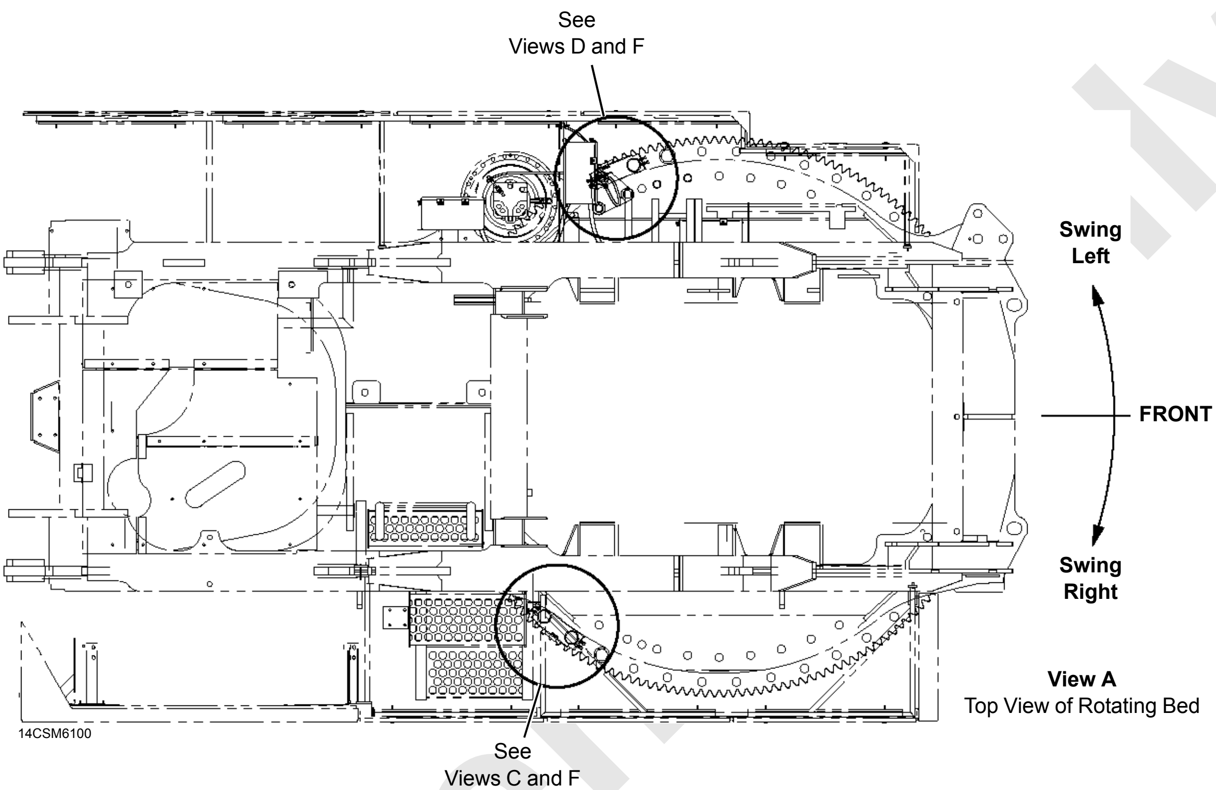
Adjustment

1. Perform steps 1 through 5, Figure 6-2 in main display.
2. Press CONFIRM button to clear previously set limits, step 6.
3. Adjust swing limits (step 7, Figure 6-2):
   a. Swing upperworks to desired position at one end of work area and stop. The computer remembers this position.
   b. Turn on swing park.
   c. Install first swing limiter bracket (5, View F) on outer turntable bearing bolts (6) ***closest to first working limit***.
   d. Install and securely tighten clamps (7, View F) to secure bracket (5) vertically.
   e. Tighten set screws (8, View F) against outer turntable bearing bolts (6).
   f. Loosen cap screws (9, View C or D) and slide actuator (10) against roller on limit switch lever (11) until limit switch “clicks” closed — the limit switch lever rotates approximately 18° before the switch closes.

      Make sure limit switch lever is on proper side of actuator as shown in Views C and D.
   g. Securely tighten cap screws (9).
   h. Swing upperworks to desired position at other end of work area and stop. The computer remembers this position.
   i. Turn on swing park.
   j. Install second swing limiter bracket (5, View F) on outer turntable bearing bolts (6) ***closest to second working limit***.
   k. Install and securely tighten clamps (7, View F) to secure bracket (5) vertically.
   l. Tighten set screws (8, View F) against outer turntable bearing bolts (6).
   m. Loosen cap screws (9, View C or D) and slide actuator (10) against roller on limit switch lever (11) until limit switch “clicks” closed — the limit switch lever rotates approximately before the switch closes.

      Make sure limit switch lever is on proper side of actuator as shown in Views C and D.
   n. Securely tighten cap screws (9).
4. Perform steps 8 through 10, Figure 6-2 to complete programming.

6



View A
Top View of Rotating Bed

Item	Description	Item	Description
1	Swing Planetary	7	Clamp (2)
2	Limit Switch Bracket (1)	8	Set Screws (8)
3	Limit Switch (1)	9	Cap Screws (4)
4	Inner Turntable Bearing Bolts	10	Actuator (2)
5	Swing Limiter Bracket (2)	11	Limit Switch Lever (1)
6	Outer Turntable Bearing Bolts		

Quantities given in parenthesis.

FIGURE 6-3

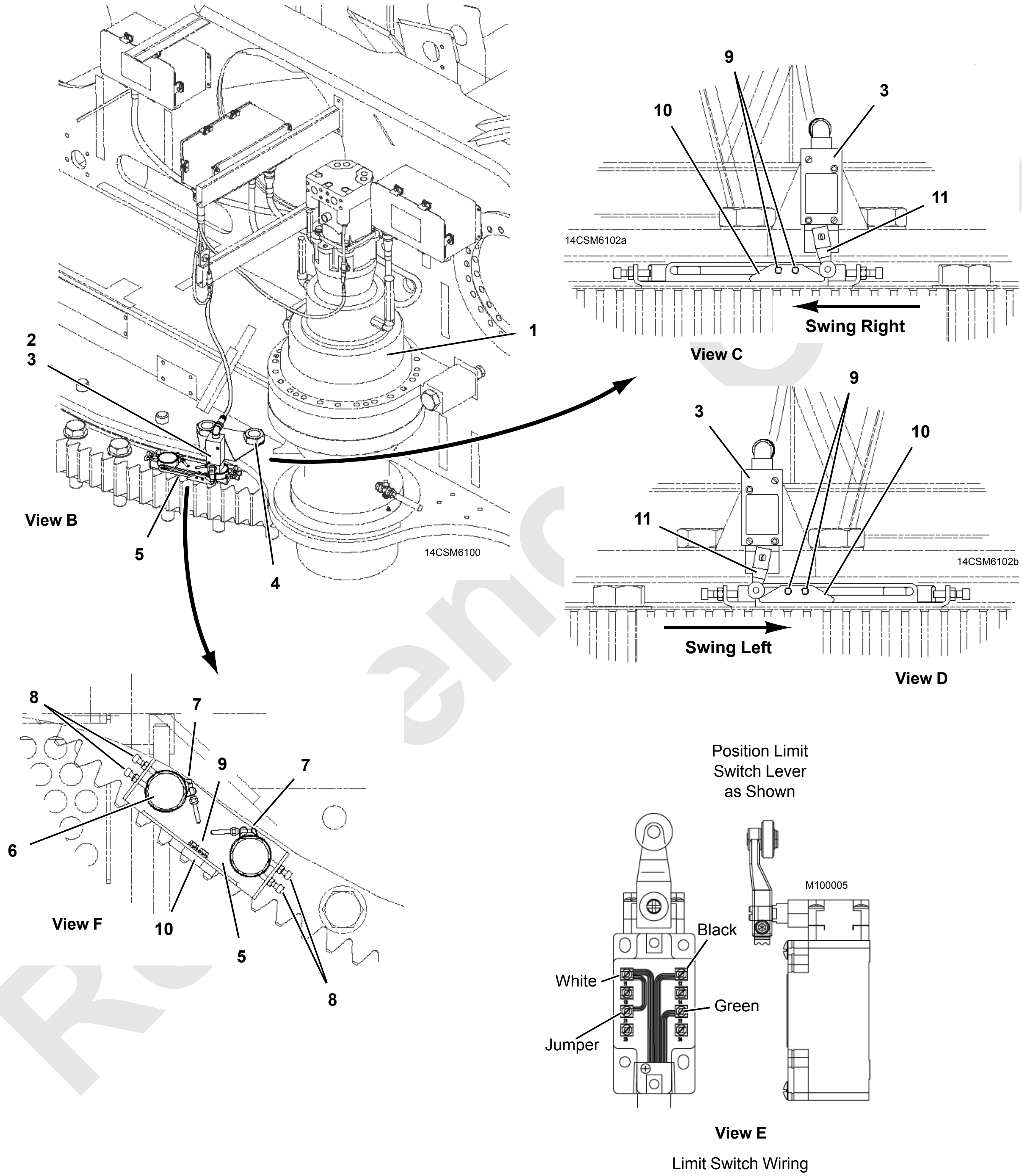


FIGURE 6-3 continued

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SECTION 7
POWER TRAIN

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SECTION 7
POWER TRAIN

BATTERIES

Safety

WARNING

Explosion Hazard

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.

Chemical Burn Hazard

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

Seek medical attention in event of an electrolyte burn.

Always wear eye protection when servicing batteries.

Battery gases are explosive

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

Jump-Starting a Battery

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

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

Causes of Battery Failure

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

Overcharging

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

Excessive heat is the result of overcharging. Overheating causes the plates to warp which can damage 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 or Discharged

Undercharging can cause a type of sulfate to develop on the plates. The sulfate reduces battery capacity and causes strains in the positive plates which cause plate buckling. Buckled plates can pinch the separators and cause a short circuit.

Furthermore, an undercharged battery is not only unable to deliver power, but may freeze (see Table 7-1).

Table 7-1. Battery Freeze Points

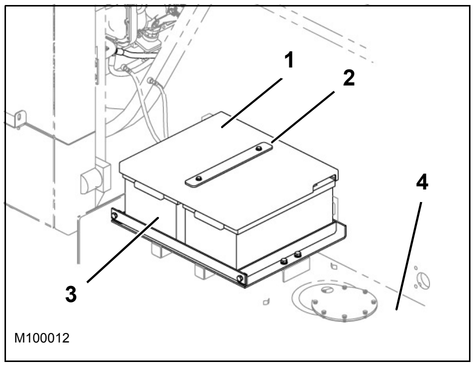
State of Charge	Specific Gravity	Freeze Point °F (°C)
100%	1.26	-70 (-57)
75%	1.23	-36 (-38)
50%	1.20	-15 (-26)
25%	1.17	-2 (-19)
0%	1.11	18 (-8)

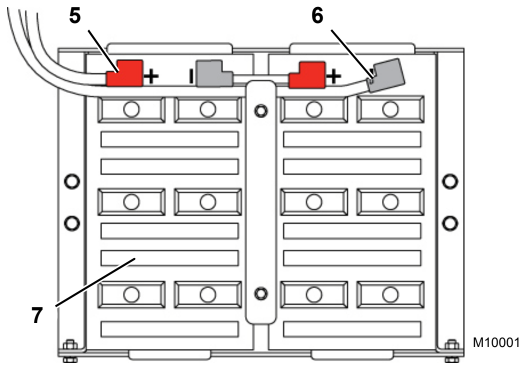
Lack of Water

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

Loose 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 at the battery connections which weakens the battery. Hold-downs can also distort or crack the container.





Item	Description
1	Battery Box Cover
2	Battery Mount Clamp
3	Battery
4	Fuel Tank
5	Positive Terminal
6	Negative Terminal
7	Rubber Insulating Strip (10)

FIGURE 7-1

Overloads

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

Multiple Battery System

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

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

Maintenance

WARNING

Personal Injury Hazard

Each battery weighs 59 lbs (27 kg). Use proper lifting procedures.

Checking Battery State-of-Charge

Special equipment is required to properly determine the condition of a battery that has been in service. However, a voltmeter can be used to determine a battery's state-of-charge by checking the voltage between the battery terminals (Figure 7-2) (Table 7-2).

This open-circuit test is the simplest test but not as accurate in determining a battery's condition as a hydrometer test. The advantage is that the cell covers do not need to be opened, eliminating the possibility of cell contamination and electrolyte spill.

NOTE Do not use this test method if the battery has been recently charged by a charger or alternator. Recent charging places a high surface charge voltage which is not a true indication of actual battery voltage.

Item	Description
1	Test Leads on Battery Terminals
2	Voltmeter

FIGURE 7-2

Table 7-2. Open Circuit Voltage

State-of-Charge	Specific Gravity	Approximate Open-Circuit Voltage (24V System)
100%	1.260	25.2
75%	1.230	24.8
50%	1.200	24.4
25%	1.170	24.0
0%	1.110	23.6

Consult the manual provided with the test meter for detailed test information.

Troubleshooting—Slow Cranking

If the starter cranks too slowly and the battery is charged and in good condition, do a voltage-drop test to make sure the starter connections are good.

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 Battery Maintenance

- Thoroughly clean the batteries and the holder with a baking soda/water solution.
- If provided, make sure the drain holes are open in the holder. If water collects in the holder, drill drain holes.
- Clean the posts and terminals. Lightly coat the posts with petroleum jelly to prevent corrosion.
- Replace frayed, broken, or corroded cables.
- Replace the batteries if their containers are cracked or worn to the point they leak.
- Ensure a good tight contact between the clamp terminals and battery posts.
- Make sure the hold-downs are tight enough to prevent battery movement but not so tight to cause distortion.

BATTERY DISCONNECT SWITCH

CAUTION

Engine Damage

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

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

The battery disconnect switch (Figure 7-3) is located on the right side next to the engine controller box.

The switch disconnects the engine controller (Node 0) from the positive side of the battery. Since the rest of the crane's control system is powered through Node 0, opening the disconnect switch effectively removes power from the entire control system.

To operate the battery disconnect switch:

- Turn handle COUNTERCLOCKWISE to DISCONNECT the control system to the battery (handle horizontal/ removable).
- Turn handle CLOCKWISE to CONNECT the control system from the battery (handle vertical).

The following are reasons for using the disconnect switch:

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

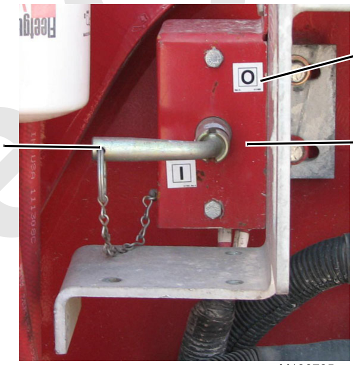


FIGURE 7-3

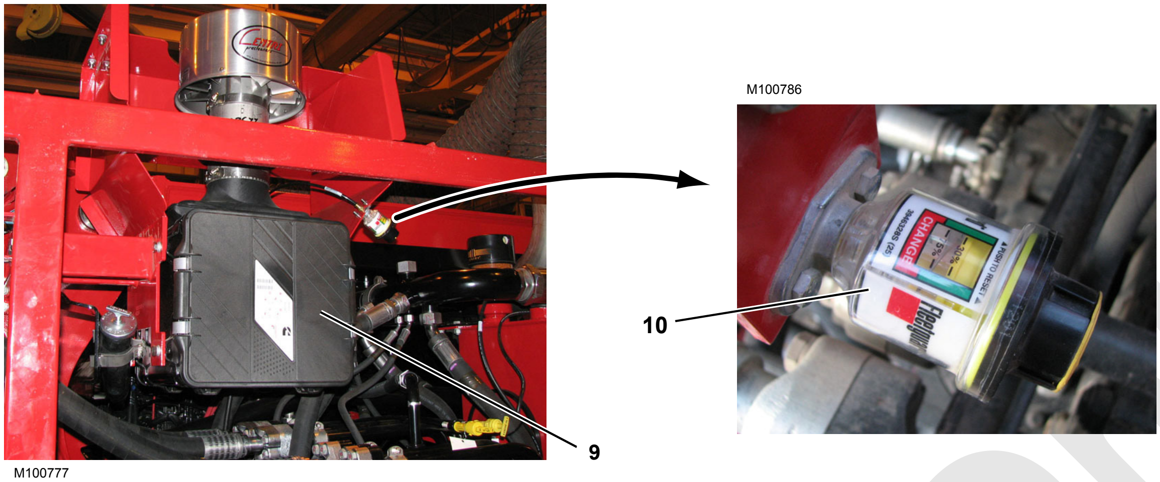
CAUTION

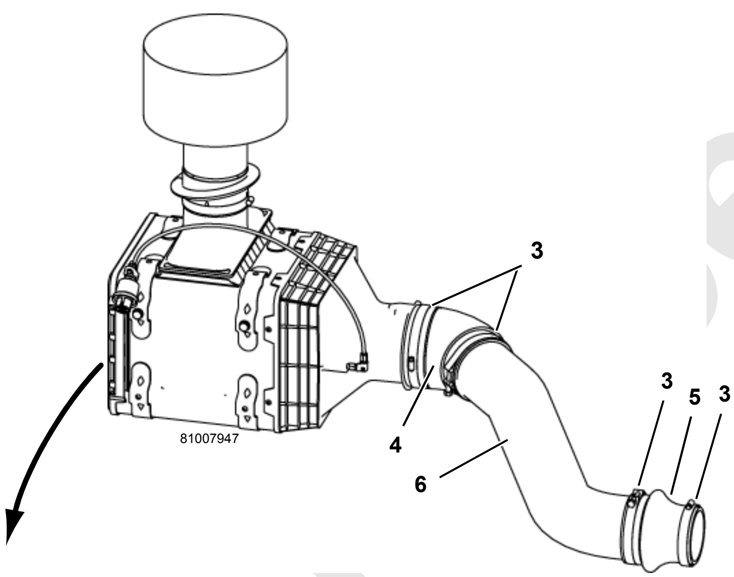
Potential Control System Damage

Before Welding:

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

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





Item	Description
1	Air Inlet Cap with Pre-Cleaner
2	Air Cleaner Housing
3	Clamp
4	Rubber Elbow
5	Rubber Reducer
6	Steel Tube
7	Secondary Filter
8	Primary Filter (2)
9	Service Cover
10	Service Indicator

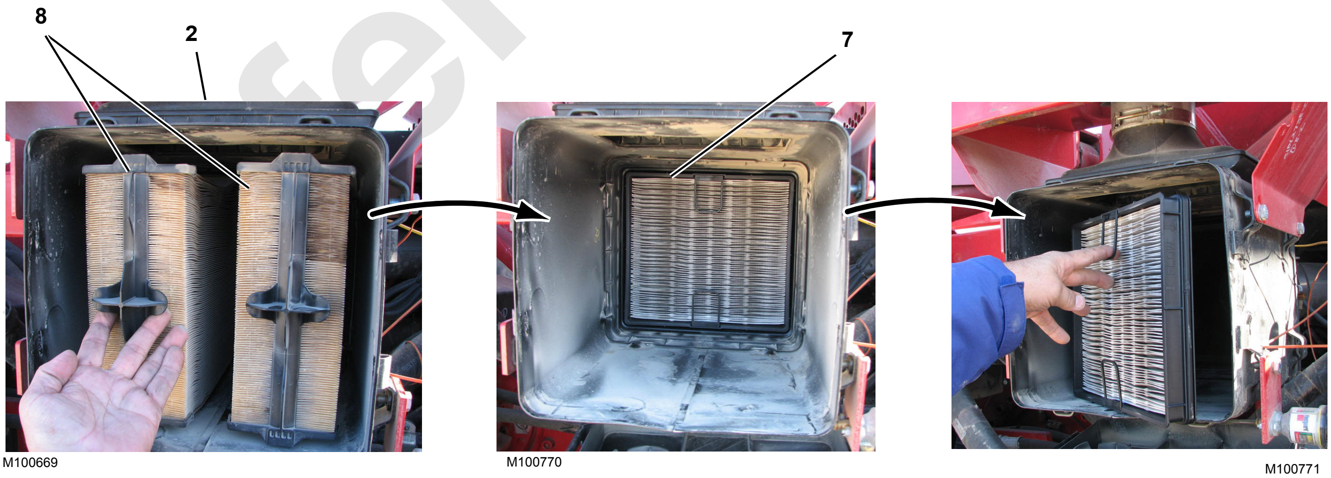


FIGURE 7-4

AIR CLEANER

See Figure 7-4

The air cleaner filters (7 and 8) require periodic maintenance.

- 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 filters at the specified intervals:

Daily

Check service indicator (10) with engine running. The indicator gives a visual indication when it is time to replace the filters.

A yellow flag in indicator window extends as the filters become plugged. Replace filters when yellow indicator reaches red zone at end of indicator.

The yellow flag remains locked in place after the engine is stopped. The indicator reset button on the top of the indicator can be pressed at any time. When the engine is running, the indicator will return to the proper reading.

Monthly

- Inspect rubber reducer (5) and elbow (4) between air cleaner and engine for cracks or other damage which might allow unfiltered air to enter engine. Replace worn or damaged parts.
- Check housing (2) for dents or other damage that may allow unfiltered air to enter engine. Replace housing if damaged.
- Check for loose clamps and bands (3). Tighten loose parts.
- Inspect inlet cap (1) for obstructions. Clean as required.

CAUTION

Potential Engine Damage

- Stop engine before servicing air cleaner. Otherwise, unfiltered air will be drawn directly into engine. Never operate engine without an air cleaner.
- Before servicing, clean the fittings, mounting hardware, and the area around the component(s) to be removed.
- 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 engine damage.

Changing the Filters

The air cleaner has two primary filters (8) and one secondary filter (7).

1. Remove service cover (9) carefully.
2. Remove the primary filters gently in order to reduce the amount of dust dislodged. There will be some initial resistance, similar to breaking the seal on a jar. Using the tabs on the filters, move the end of filter back and forth to break seal.

   Avoid dislodging dust from filters.

NOTE The secondary filter should be replaced every third time the primary filters are replaced. Inspect the secondary filter and replace as necessary.

3. Remove secondary filter by pulling on the plastic ring tabs.
4. Clean sealing surfaces in housing.

   Use a clean cloth to wipe clean sealing surfaces and inside of housing. Dust on the sealing surfaces could render seal ineffective and cause leakage. Ensure all contamination is removed before new filters are installed.
5. 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. It takes only a few grams of dirt to destroy an engine). Be careful not to damage sealing area of tube.
6. Visually inspect old filters for leaks. A streak of dust on clean side of filter is a telltale sign. Remove any cause of leaks before installing new filter.

7

7. Inspect the new filters, especially the sealing area. Never install damaged filters.
8. Install a new secondary filter (7) (if required) carefully and gently push into back of housing. Apply pressure to all four corners and tabs to make sure filter is completely secure in housing.
9. Repeat this step for primary filters (8).
10. Install service cover (9), making sure that the O-ring is in place. Fasten latches. Cover should go on without extra force. Push reset button on service indicator.

    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 damage housing and will void warranty.

ENGINE CLUTCH

See Figure 7-5 for following procedure.

A disc-type manually operated clutch is mounted between the engine and the pump drive. The clutch allows the pump drive to be disconnected from the engine, reducing engine load and making start-up easier in cold weather. The clutch can be engaged or disengaged while the engine is running or stopped.

CAUTION

Parts Damage

Do not run engine longer than 20 minutes with clutch disengaged. Clutch release bearing can be damaged.

Lubrication and Inspection

See Figure 7-5

1. Grease clutch monthly.
2. At least once each month, disengage and engage the clutch several times with engine running. Ensure all pawls and seizing locks are engaged before disengaging clutch. This practice cleans disc surfaces and prevent discs from seizing.
3. When disengaging clutch, check free travel. If not, readjust. If less than 0.75 in (19 mm), adjust per clutch manufacturer's manual.

Adjustment

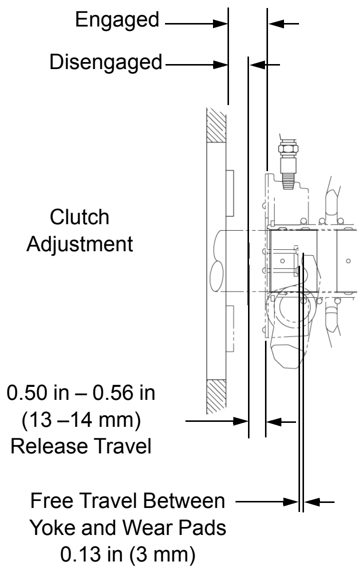
The clutch is adjusted internally through the hand hole on top of the clutch housing. See the clutch manufacturer's manual for adjustment instructions.

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	Hand Hole Cover
6	Pump Drive



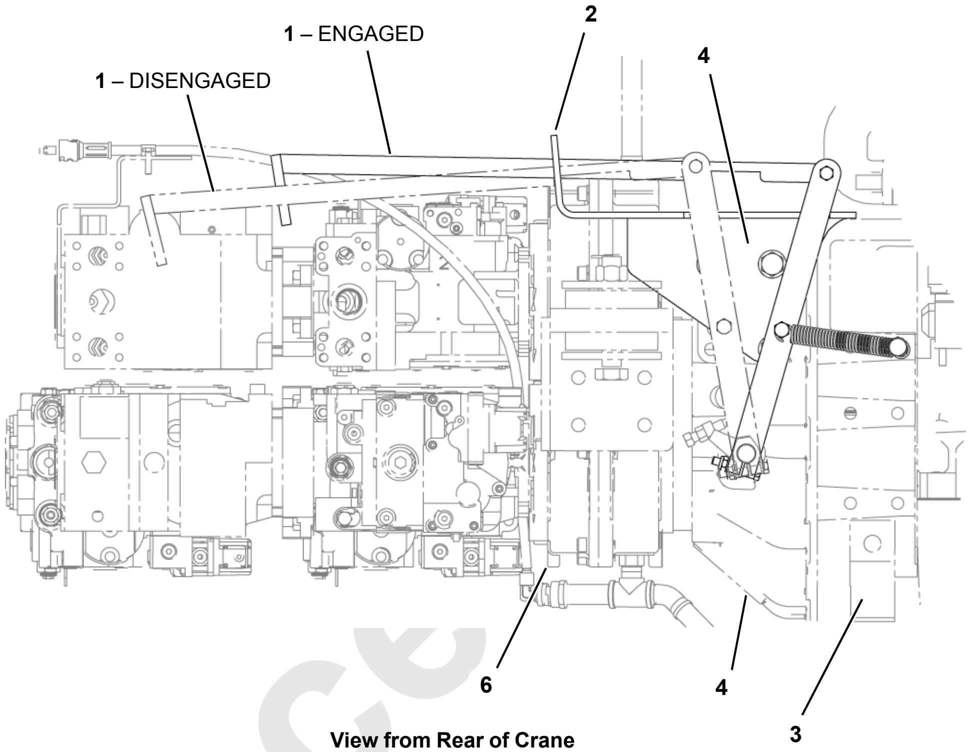


FIGURE 7-5

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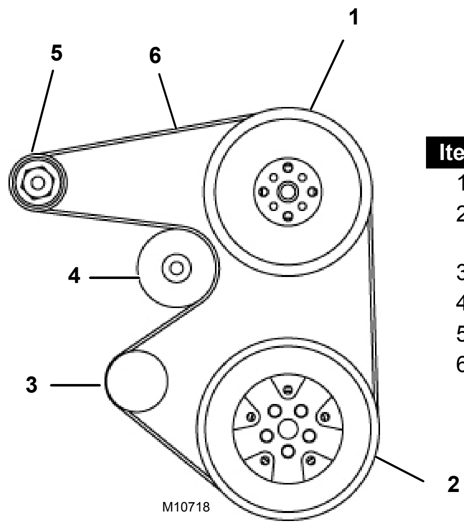
ENGINE BELT ROUTING

See Figure 7-6

Engine belt routing is shown to help service personnel when installing a new belt on engine.



Item	Description
1	Idler
2	Crankshaft Pulley
3	Tensioner
4	Water Pump
5	Alternator
6	Belt

FIGURE 7-6

ENGINE ENCLOSURE

See Figure 7-7

WARNING

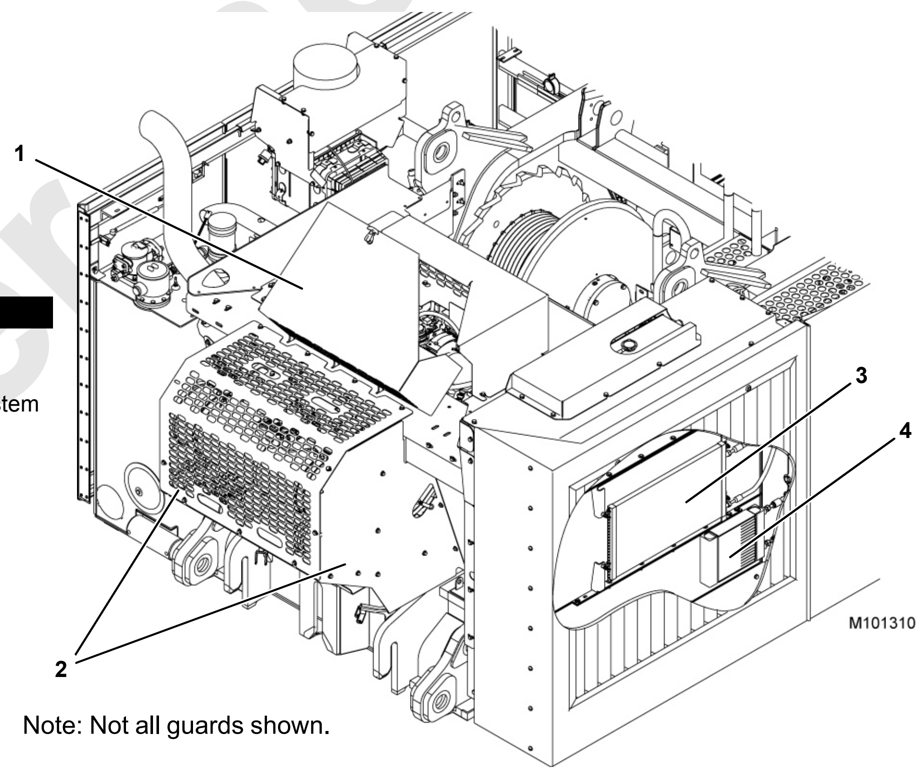
Fall Hazard

Do not step on any part of the engine enclosure. It can collapse. You can lose your balance and fall.

Death or serious injury can result.

The enclosure has covers and guards that can be pivoted open or removed to allow access for engine service. Do not operate the crane without all covers and guards in place and securely fastened.

Item	Description
1	Engine Cover with Latch
2	Engine Guards
3	Condenser for Air Conditioning System
4	Engine Fuel System Cooler



Note: Not all guards shown.

FIGURE 7-7

Published 09-05-14, Control # 226-02

COOLER ASSEMBLY

See Figure 7-7 and Figure 7-8

WARNING

Burn Hazard

Do not remove the radiator fill cap from a hot engine. Allow the engine to cool below 120° F (50° C) before adding coolant.

Material Hazard

Coolant is toxic. Do not ingest. If not reused, dispose of in accordance with all local and other applicable environmental regulations.

CAUTION

Maintain Coolant Additive

The required Supplemental Coolant Additive (SCA) concentration must be maintained to prevent engine damage.

A Supplemental Coolant Additive must be used in the cooling system to prevent liner pitting and for scaling protection.

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

CAUTION

Potential Engine Damage

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

Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool below 120° F (50° C) before adding coolant.

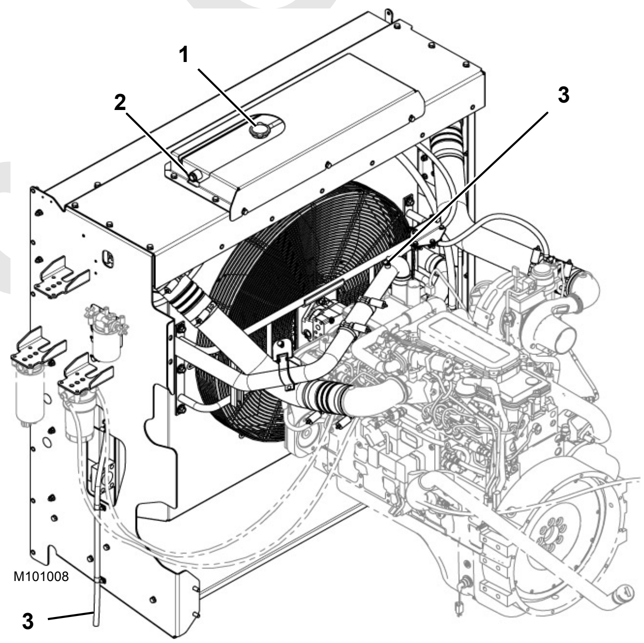
Check the Coolant Level

On a daily basis, check coolant level by using the sight glass (2, Figure 7-8) located on the top of the radiator. Coolant should be visible in the glass.

1. Open the access cover. Place a heavy cloth over the pressure cap (1), then turn (do not depress) the cap. Wait for pressure to escape, then remove the cap.
2. Add coolant to the radiator.
3. When coolant is visible in the sight glass (2), install the cap.

NOTE: Maximum fill rate is 3 GPM (11 liters/min).

4. Run the engine until normal operating temperature is reached.
5. When engine is cool, re-check the coolant level. If needed, add coolant until it is visible in the sight glass.



Item	Description
1	Radiator Fill Cap
2	Coolant Level Sight Glass
3	Upper Radiator Tube
4	Radiator Drain Tube

FIGURE 7-8

Fill and Deaerate a Drained Cooling System

1. Open the air bleed valve located on the upper radiator tube (3, Figure 7-8, page 7-9).
2. Open the two air bleed valves located in the coolant hose manifold in the aftertreatment exhaust system (see Figure 7-9, page 7-13).
3. Check that the cab heater valves (lower right side of the engine) are open. In the cab, place the heat control to maximum.

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

4. Close the drain valve (left side of the radiator).
5. Open the access cover and remove the pressure cap.
6. Add a coolant additive to the radiator.

CAUTION
Maintain Coolant Additive

A proper concentration of a Supplemental Coolant Additive (SCA) must be maintained to prevent engine damage.

A Supplemental Coolant Additive must be used in the cooling system to prevent liner pitting and for scaling protection.

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

NOTE: Maximum fill rate is 3 GPM (11 liters/min).

7. Add a 50-50 mix of water and ethylene glycol to the radiator.

   While filling the radiator, watch the three air bleed valves. When coolant appears at the valves, close the valves.

NOTE: The capacity of the cooling system is approximately 12 gallons (45 liters).

8. When coolant is visible in the sight glass, wait 2-3 minutes, then add coolant again as needed.

WARNING
Chemical and Burn Hazard

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

Coolant is toxic. Do not ingest. If not reused, dispose of in accordance with all local and other applicable environmental regulations.

9. Start the engine and run until the thermostat opens.

   Do not stand near the radiator while the engine is running with the pressure cap removed.

10. Reduce engine speed to low idle for two minutes to cool down engine components, then turn off the engine.
11. When the engine has cooled, add coolant until it is visible in the sight glass. Install the pressure cap and close the access door.

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7

EXHAUST AFTERTREATMENT SYSTEM

Figure 7-9 on page 7-13

WARNING

Hot Exhaust Surfaces and Inhalation Hazards

Extremely hot surfaces and exhaust gasses can cause death or serious injury. Allow engine and exhaust system to cool before servicing.

The engine exhaust is treated to significantly reduce the amount of harmful by-products of combustion from contaminating breathable air.

Starting at the engine, the primary components of the exhaust system are the:

- Diesel Oxidation Catalyst (DOC) module
- DRT Module with DEF dosing module
- Selective Catalytic Reduction (SCR) module

These are briefly described in the following paragraphs.

DOC Module

The primary function of the Diesel Oxidation Catalyst (DOC) module (8) is to oxidize remaining hydrocarbons in the exhaust to carbon dioxide. It incorporates a NO_x (nitrogen oxide) sensor, a dual pressure (dP) sensor, and two temperature sensors.

There is no maintenance requirement for the DOC module.

DRT Module

Between the DOC and the SCR is the Decomposition Reactor Tube (DRT) (6).

Mounted on the DRT is the DEF dosing module (7). The dosing module injects a liquid mixture of urea and water called Diesel Exhaust Fluid (DEF) into the exhaust stream ahead of the SCR inlet. Coolant lines run through the dosing module to keep it cool and operable.

There is no maintenance requirement for the DRT module.

SCR Module

The primary function of the Selective Catalytic Reduction (SCR) module (9) is to reduce NO_x content to nitrogen. The DEF injected at the DRT module enters the SCR where the urea and de-ionized water participate in a chemical reaction which results in the desired content of the exhaust emissions.

The SCR incorporates a catalyst, two temperature sensors, an ammonia (NH_3) sensor, and a NO_x sensor.

There is no maintenance requirement for the SCR module.

Excessive NO_x Warning System

CAUTION

Loss of Power or Engine Shutdown Hazard

If NO_x emissions exceed legislated limits, the operator will be alerted by warning lights and audible warnings. If the condition is not corrected in a set amount of time, an engine derate and shutdown sequence will begin.

For more information, refer to Section 3 of the 14000 Operator Manual.

If an excessive NO_x warning is issued, check anything that might cause an elevated NO_x level, such as:

- Disconnect tank level or quality sensor
- Blocked DEF hose or dosing module
- Disconnected dosing module
- Disconnected supply module
- Disconnected SCR wiring harness
- Disconnected NO_x sensor
- EGR valve malfunction

Aftertreatment Protection System

The Cummins Aftertreatment Protection System (APS) continually monitors exhaust gas temperatures. In event of excessive exhaust temperatures, the APS will illuminate the High Exhaust System Temperature (HEST) lamp.

Item	Description
1	Coolant Manifold Block
2	Air Bleed Valves
3	Coolant Flow Control Solenoid Valve
4	DEF Supply Module
5	DEF Tank (see Figure 7-10)
6	DRT Module
7	DEF Dosing Module
8	DOC Module
9	SCR Module

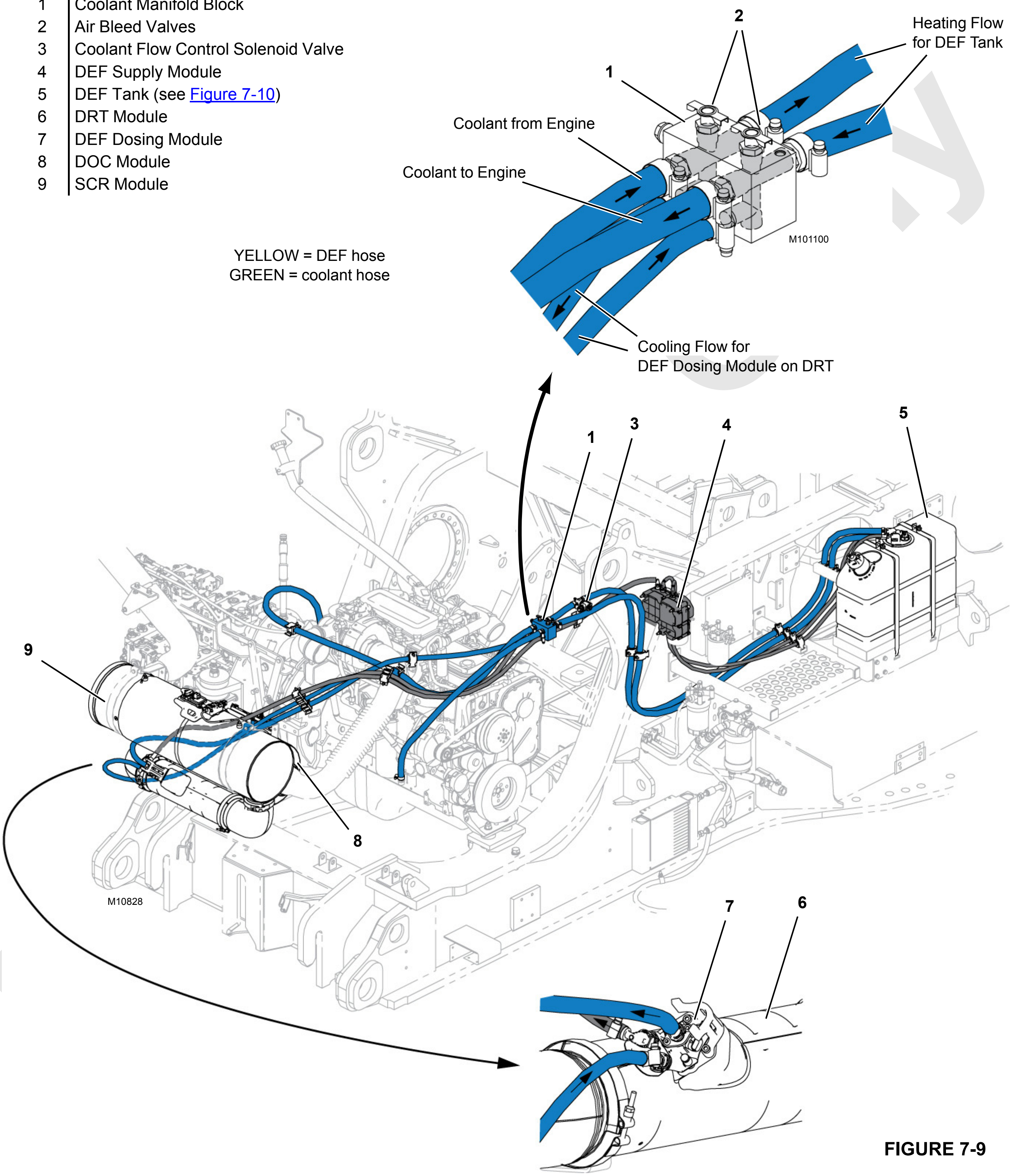

FIGURE 7-9

DEF Dosing System

The diesel exhaust fluid (DEF) is supplied to the DEF dosing module (7, Figure 7-9) by a DEF delivery system.

DEF Delivery Heating/Cooling System

Engine Coolant

Warm coolant from the engine is routed to a manifold (1) where it splits into two paths: one delivers coolant to the heat exchanger in the DEF tank (5) to keep the DEF warm or to unthaw, and the other delivers coolant to the dosing module (7) to keep it from overheating. See Figure 7-9 for hose routing and coolant flow direction.

A solenoid valve (3) adjusts coolant flow according to temperature of the DEF in the DEF tank. If the tank temperature drops below 25° F (–4° C), this solenoid valve will be commanded open by the ECM, and engine coolant will flow through the heat exchanger in the DEF tank.

24 VDC Heating Elements

To keep the DEF flowing during cold temperatures, one electric heating element is in the DEF supply module and one heating element is installed in each DEF line. These elements come on if the ambient air temperature sensor reads a temperature below 25° F (–4° C).

Maintenance Heating Cycle

The DEF dosing module will not prime the system until every component is completely defrosted. If ambient conditions continue to be cold after the system has primed, the ECM will command a maintenance heating cycle to prevent the DEF system from refreezing. This feature will cycle the heating on and off to the DEF lines, DEF tank, and dosing module.

NOTE: DEF will freeze at 12° F (–11° C) and when frozen will expand by 7%. There are no approved additives to improve the freezing point.

DEF Supply Module

The DEF supply module (4, Figure 7-9) is an electronically operated pump and metering system controlled by the ECM. The module pumps DEF to the dosing module which is mounted on the DRT.

At engine shutdown, the supply module will enter a purge cycle to prevent DEF from being left in the system, and in cold climates, potentially freezing. When it is in a purge cycle, an audible click and pumping sound will be heard from the module, and the module will pull out all of the DEF in the system and return the unused DEF to the DEF tank.

The supply module is heated electrically (see above) and has a 10-micron filter that requires periodic cleaning and inspection. For filter maintenance intervals, refer to the supplied Cummins engine manual.

WARNING

Personal Injury or Equipment Damage Hazard

Do not remove hoses from or attempt to service the DEF supply module without first consulting the engine manufacturer's instructions. Personal injury and/or equipment damage may result.

CAUTION

Use Only Approved Replacement Parts

DEF system components are designed to withstand freezing and to be compatable with DEF fluid and other unique characteristics of the system. Use of non-approved replacement parts may result in system damage.

Diesel Exhaust Fluid (DEF)

WARNING

Chemical Hazard

DEF contains urea. Do not get DEF in your eyes. In case of contact, immediately flush eyes with large amounts of water for a minimum of 15 minutes. Do not swallow. In the event the DEF is ingested, contact a physician immediately.

NOTE: Do not store DEF for long periods of time. DEF will deteriorate relative to time and temperature. Low-quality DEF may require the tank to be drained and the system purged.

NOTE: DEF consists of 32% urea and 68% de-ionized water. A constant mist of DEF, equal to 2-3% of fuel used, is injected into the DRT. This is about 10 gallons of DEF per 2-3 tankfuls of fuel.

The engine control module monitors DEF quality via a sensor in the tank. If poor quality DEF is sensed, an error code will be set.

CAUTION

Loss of Power or Engine Shutdown Hazard

If poor-quality DEF or a low-level condition is sensed, an error code will be set. These conditions can lead to engine power being reduced (de-rated) by the ECM. If the condition persists, engine shutdown may occur.

For more information, refer to Fault Level Indicators in Section 3 of the 14000 Operator Manual.

DEF Tank

See Figure 7-10

DEF quality, level, and temperature are monitored by the engine control module via sensors in the tank.

The DEF can be heated by engine coolant which is circulated through a heat exchanger in the tank. If the tank temperature drops below 25° F (–4° C), the DEF tank coolant solenoid valve will be commanded open by the ECM, and engine coolant will flow through the heat exchanger.

There is a 40-micron filter in the DEF supply (suction) pipe. For filter maintenance intervals, refer to the Cummins engine manual.

A drain valve is provided in case the tank needs to be emptied of poor-quality DEF.

The DEF tank capacity is 10 gallons.

Item	Description
1	10 Gallon DEF Tank
2	Drain Valve
3	Hose and Electrical Fittings
4	Fill Cap

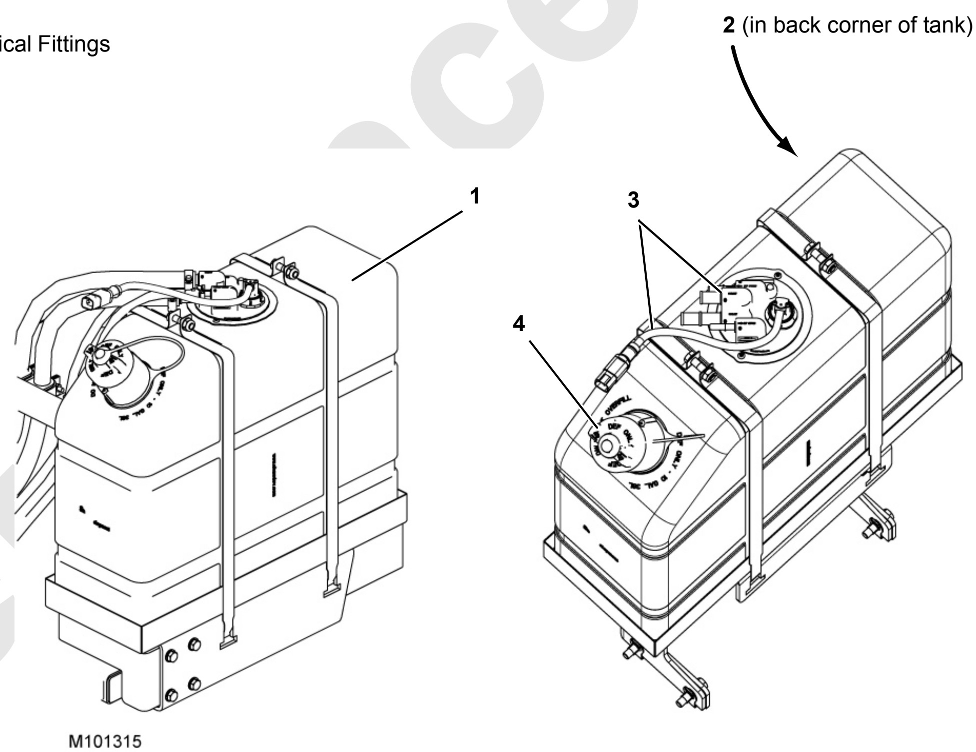

FIGURE 7-10

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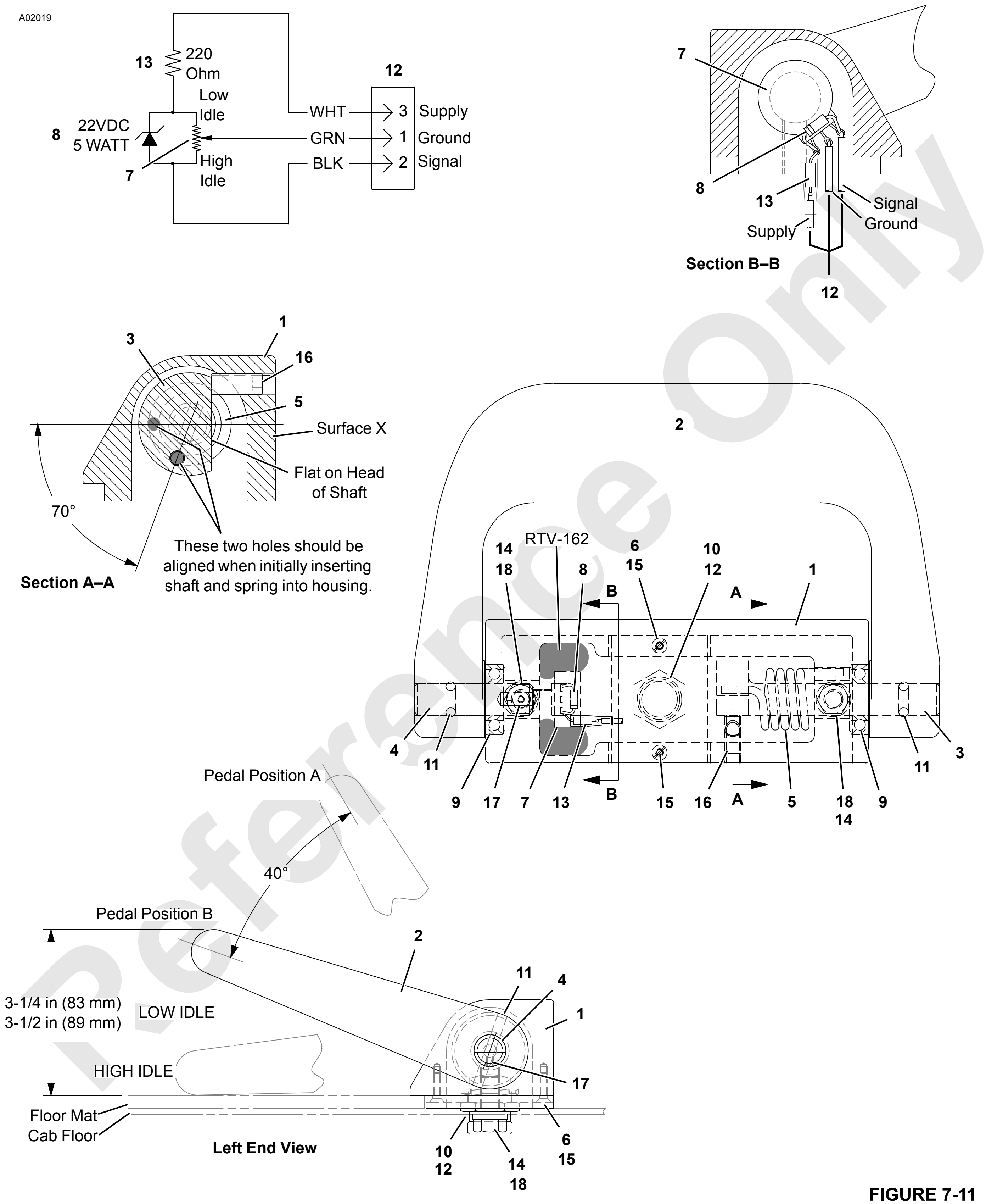
A02019
13
220
Ohm
Low
Idle
22VDC
5 WATT
8
7
High
Idle
WHT
GRN
BLK
12
3 Supply
1 Ground
2 Signal
7
8
13
Supply
Signal
Ground
Section B–B
12
1
3
16
5
Surface X
Flat on Head
of Shaft
70°
These two holes should be
aligned when initially inserting
shaft and spring into housing.
Section A–A
2
14
18
RTV-162
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 7-11

ENGINE THROTTLE

The engine throttle assembly consists of an electronic hand throttle control in the left console and an electronic foot throttle control on the cab floor. There is no mechanical linkage between the throttle controls.

Electronic signals from the throttle controls are transmitted to the crane's programmable controller, and the programmable controller increases and decreases engine speed accordingly.

Hand Throttle Control

The hand throttle control does not require adjustment and is not repairable.

Foot Throttle Control

See Figure 7-11 for following procedure.

NOTE The foot throttle control was properly assembled and calibrated at the initial installation and should not require further attention.

NOTE: If there is a problem with the foot throttle, it is best to either replace it or send the unit to the Manitowoc Crane Care Lattice Team for repair.

However, if field disassembly was done, use the following procedure to re-assemble and calibrate the throttle control.

Foot Throttle Control Assembly and Calibration

The following must be done on a clean work bench.

1. To assemble right-side 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 left-side 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 (11) 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 set screw (16) until it contacts flat on head of shaft (Section A-A).
7. Install potentiometer (6) and calibrate the foot throttle:
   a. Re-solder the control wires to the potentiometer and resistor leads.
   b. With a supply voltage of 25.0 to 26.0 VDC, turn potentiometer (7) shaft fully CCW as viewed from shaft end (zero volts out).
   c. 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 (17).
   d. 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.
   e. Apply silicone sealant RTV-162 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.
   f. After sealant has cured, check output for 0.90 to 1.00 VDC in high idle position.
   g. Remove setscrew (16), apply Loctite 242 to threads, and adjust setscrew to obtain a low idle position output reading of 2.90 to 3.00 VDC.
8. Install assembly onto crane.

Component Identification for Figure 7-11

Item	Qty.	Description	Item	Qty.	Description
1	1	Foot Pedal Housing	10	1	Conduit Nut
2	1	Foot Pedal	11	2	Roll Pin
3	1	Foot Pedal Shaft (right)	12	1	Receptacle
4	1	Foot Pedal Shaft (left)	13	1	Resistor, 220 ohm
5	1	Torsion Spring	14	2	Cap Screw
6	1	Receptacle Mounting Bracket	15	2	Flat Head Screw
7	1	Potentiometer	16	1	Set Screw
8	1	Zener Diode	17	1	Set Screw
9	2	Roller Bearing	18	2	Lock Washer

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SECTION 8
UNDER CARRIAGE

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SECTION 8
UNDER CARRIAGE

PROCEDURES START ON *page 8-3*

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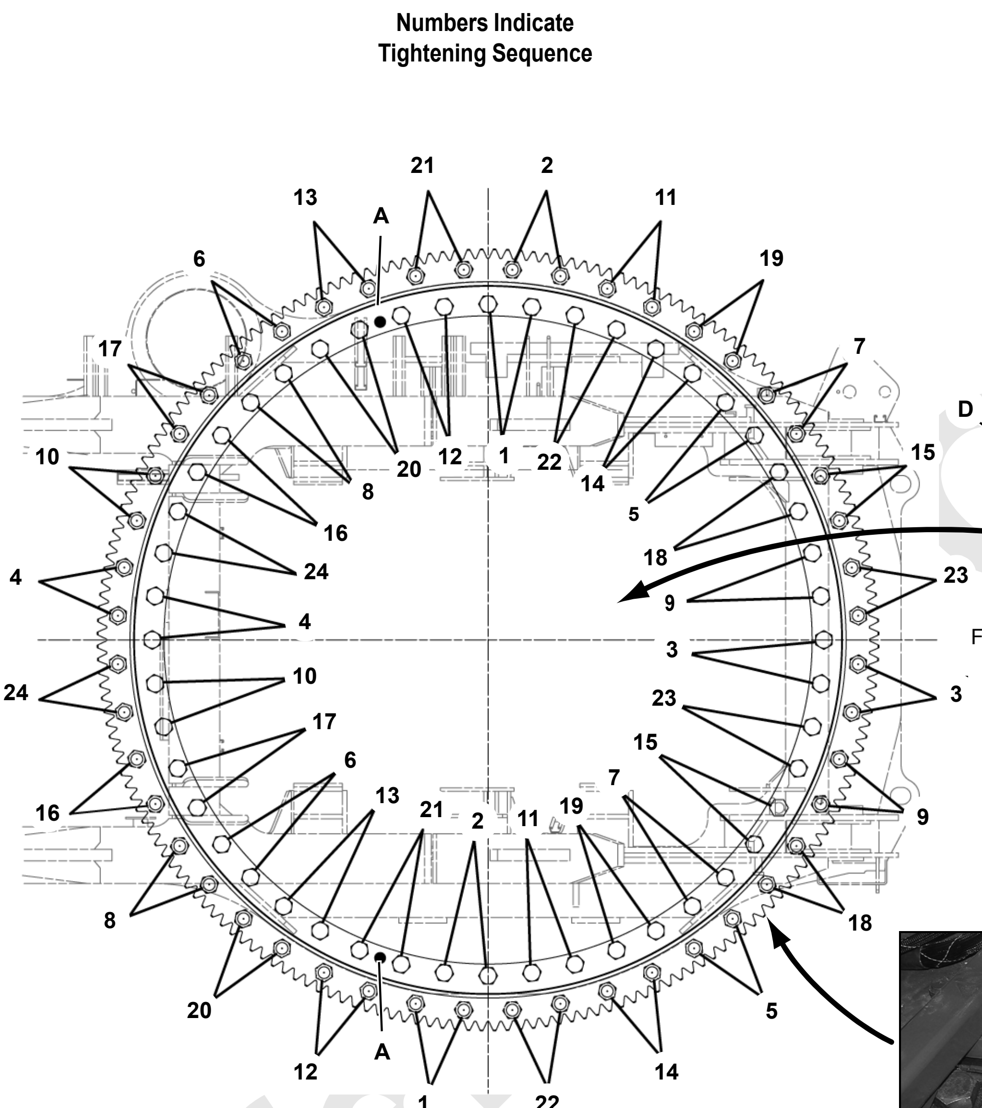
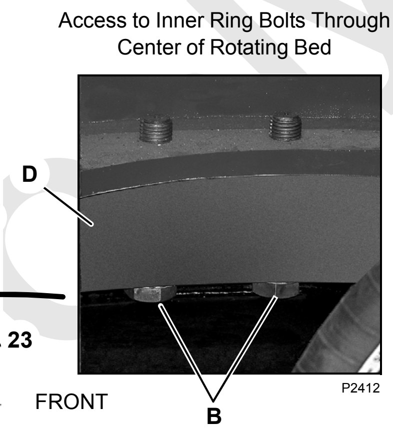
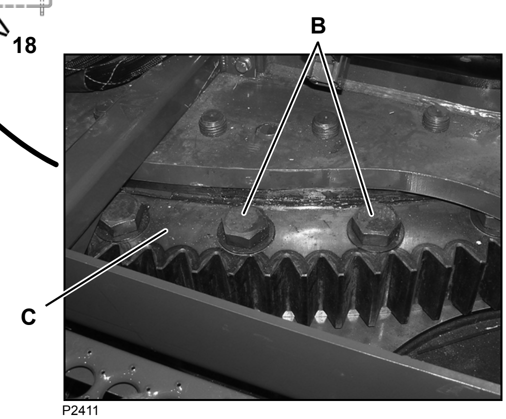






A - Dowel Pin (2 places)
B - 1-1/2 in 6 UNC x 8 in Long Grade 8 Bolt with Flat Steel Washers
- 48 places Outer Ring
- 48 places Inner Ring

C - Outer Ring
D - Inner Ring

FIGURE 8-1

TURNTABLE BEARING INSTALLATION

The outer ring can be installed in any position with relation to carbody.

Two dowel pins are installed in the inner ring as shown in Figure 8-1 to locate the inner ring on 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 rotating bed to torque inner turntable bearing bolts.

- Maintain constant communication between operator and mechanic while mechanic is inside rotating bed.
- 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 turntable bearing bolts, lubricate following with Never-Seez (MCC No. 361010) or an equivalent antiseizing lubricant:

- Threads of each bolt.
- Underside of head of each bolt.
- Both sides of each washer.

Torque Values

Torque each turntable bearing bolt to 2,100 ft-lb (2 848 Nm).

When new bolts are installed, torque bolts in two steps:

- FIRST to 600 ft-lb (814 Nm).
- SECOND to 2,100 ft-lb (2 848 Nm).

Torque Sequence

Torque two bolts at a time in the numbered sequence given in Figure 8-1.

Torque Intervals

INITIAL OPERATION: torque all bolts to specified value after first 50 hours of operation.

YEARLY or every 2,000 hours of operation (whichever comes first): torque all bolts to specified value.

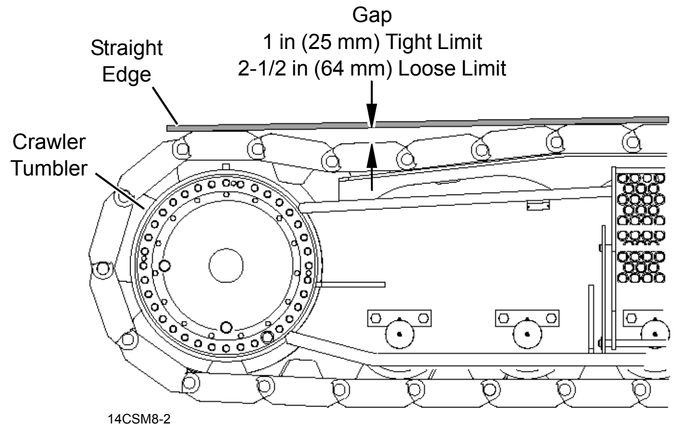
Bolt Replacement

If at yearly inspection interval, one or more bolts are found to be torqued to less than 1,680 ft-lb (2 278 Nm), replace each loose bolt and washer. Also replace the bolts and washers on each side of each loose bolt.

If at yearly inspection interval nine or more bolts in either ring are found to be torqued to less than 1,680 ft-lb (2 278 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.

8



Item	Description
1	Bolt and Nut
2	Cover
3	Jack Cylinder
4	Support
5	Rod
6a	Shim - 0.134 in (3,4 mm)
6b	Shim - 0.250 in (6,4 mm)

Item	Description
7	Tread
8	Crawler Roller
9	Intermediate Roller
10	Hand Pump
11	Center Punch A
12	Center Punch Line B

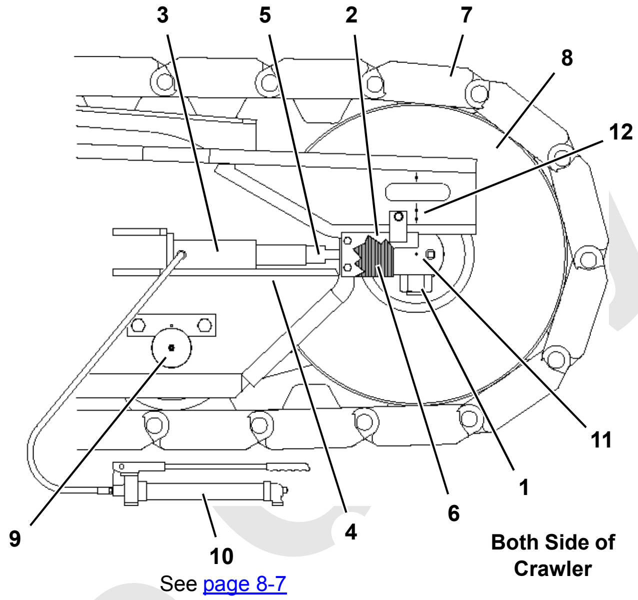


FIGURE 8-2

CRAWLER ADJUSTMENT

See Figure 8-2 for following procedures.

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 Folio 2129.
- 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 treads are adjusted too tight.
- Repair or replace damaged parts immediately to prevent further damage.

Tread Slack Adjustment

Adjustment Guideline

Check tread slack at 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.
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 in (25 mm) tight limit to 2-1/2 in (64 mm) 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.

Adjustment Procedure

Adjust tread slack at roller end of each crawler.

1. Thoroughly clean crawler to be adjusted.
2. Loosen bolt on each side of crawler roller.
3. Remove covers from both sides of crawler frame.
4. Place jacking cylinder on support.
5. Jack against rod an equal amount on both sides of crawler frame.
6. Add or remove an equal thickness of shims on both sides of crawler frame.
7. Remove jacking cylinder.
8. Travel crane forward or reverse to tighten shims.
9. Check that dimension from center punch in shaft to center punch line in crawler frame is same on both sides of crawler to within 1/8 in (3,0 mm).

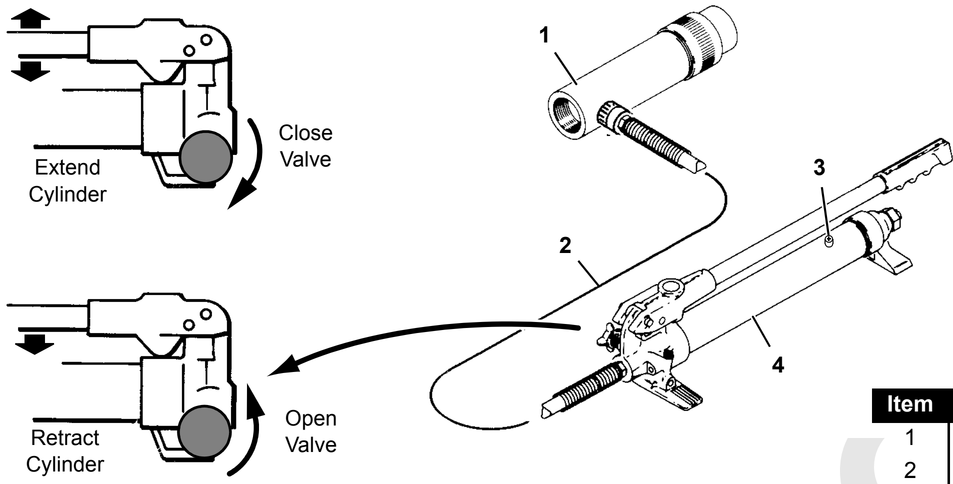
CAUTION

Parts Wear!

Crawler roller and tumbler must be square with crawler frame within 1/8 in. (3,0 mm); or parts will wear rapidly.

10. Check for proper adjustment (see Adjustment Guideline) and readjust as required (steps 4 through 9).
11. Tighten nuts on bolts at crawler roller to 1,000 ft-lb (1 356 Nm) lubricated with Never-Seez or an equivalent oil and graphite mixture.
12. Install cover on both sides of crawler frame.

NOTE: Extreme limit of tread adjustment occurs when bolts are tight against front end of the slots in crawler frame. One crawler tread can be removed when this limit is reached.



Item	Description
1	Cylinder
2	Hose
3	Vent.Fill Valve
4	Pump

FIGURE 8-3

HYDRAULIC HAND PUMP

See Figure 8-3 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. Place pump in horizontal position on a flat surface.
   c. Using a screw driver, remove vent/fill cap.
   d. Add hydraulic oil until reservoir is 2/3 full. ***Do not overfill.***
   e. Securely reinstall vent/fill cap.
   f. Test operation and remove air from system, if required. Recheck level after removing air.

Air Removal

1. Close valve finger tight only.
2. Position pump higher than cylinder and position cylinder so rod is down.
3. Operate pump to fully extend cylinder rod.
4. Open valve and retract cylinder rod to force oil and trapped air back into pump.
5. Repeat steps until cylinder operates smoothly. ***Erratic operation indicates air in system.***

Operation

1. Before using pump:
   a. Check that all fittings are tight and leak free.
   b. Check oil level.
2. To pressurize cylinder and extend rod, close valve by turning clockwise until finger tight only. Then pump handle up and down.

   Pressure will be maintained until valve is opened.

   To reduce handle effort at high pressure, use short strokes. Maximum leverage is obtained in last five degrees of stroke.
3. To 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***.

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SECTION 9
LUBRICATION

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SECTION 9
LUBRICATION

LUBRICATION

See F2250 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 at the factory can also provide assistance.***

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 must 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 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 completion of maintenance or repair operations.

The following warnings apply to all troubleshooting operations.

Manitowoc can not foresee all hazards that may occur. You must 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.

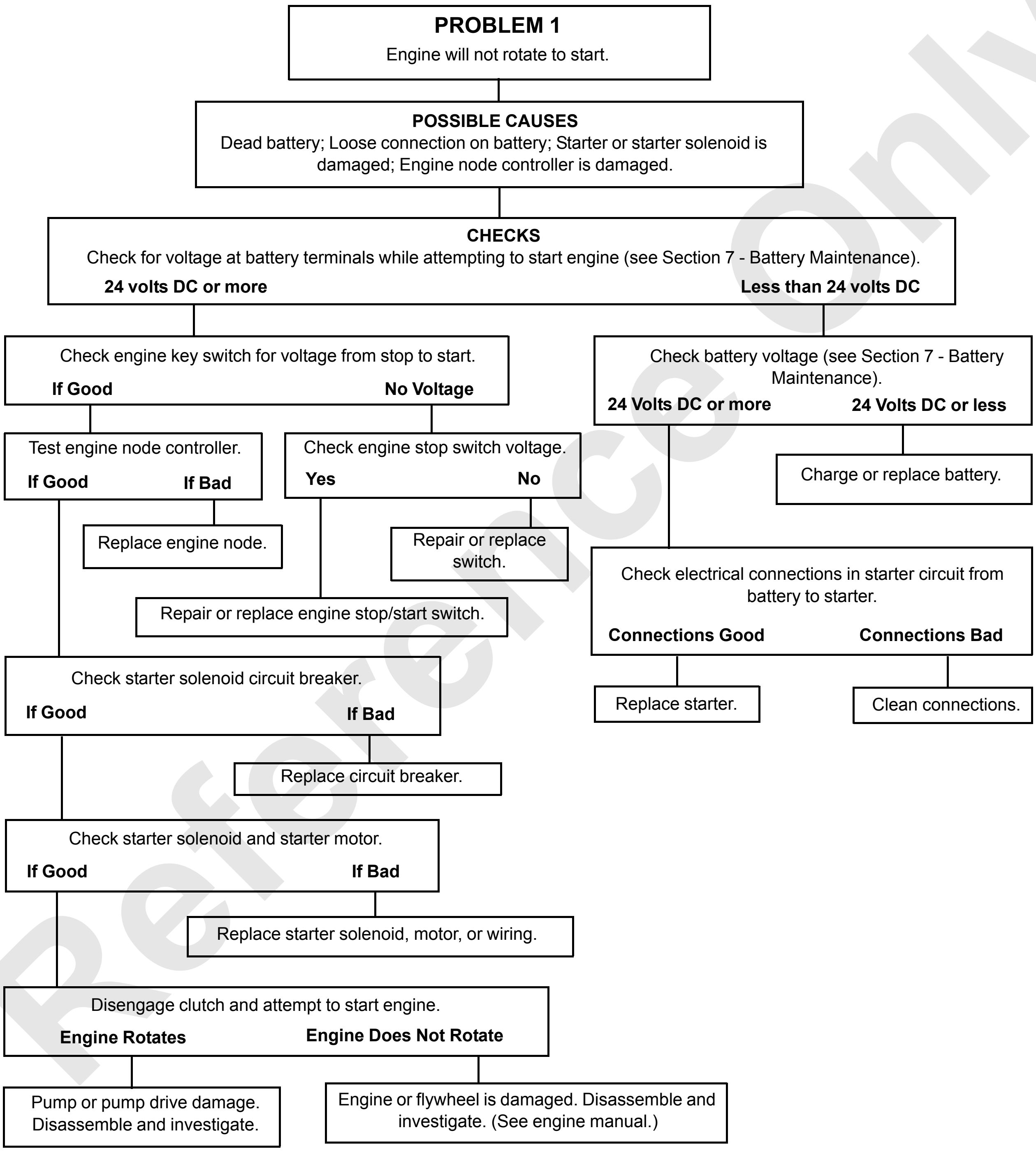
GENERAL TROUBLESHOOTING

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 correct pressure range when checking hydraulic circuits.
- Check pressures at specified hydraulic component ports.
- Use the Rated Capacity Indicator/Limiter display and Main display for checking pump, motor, handle, brake, etc. components.
- Use in-line test boards or Manitowoc Universal Tester/ CAN Node Adaptor (available from your Manitowoc dealer) for further testing of computer nodes and electrical circuits.

TROUBLESHOOTING CHARTS

Troubleshooting Charts provides 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 at the factory 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

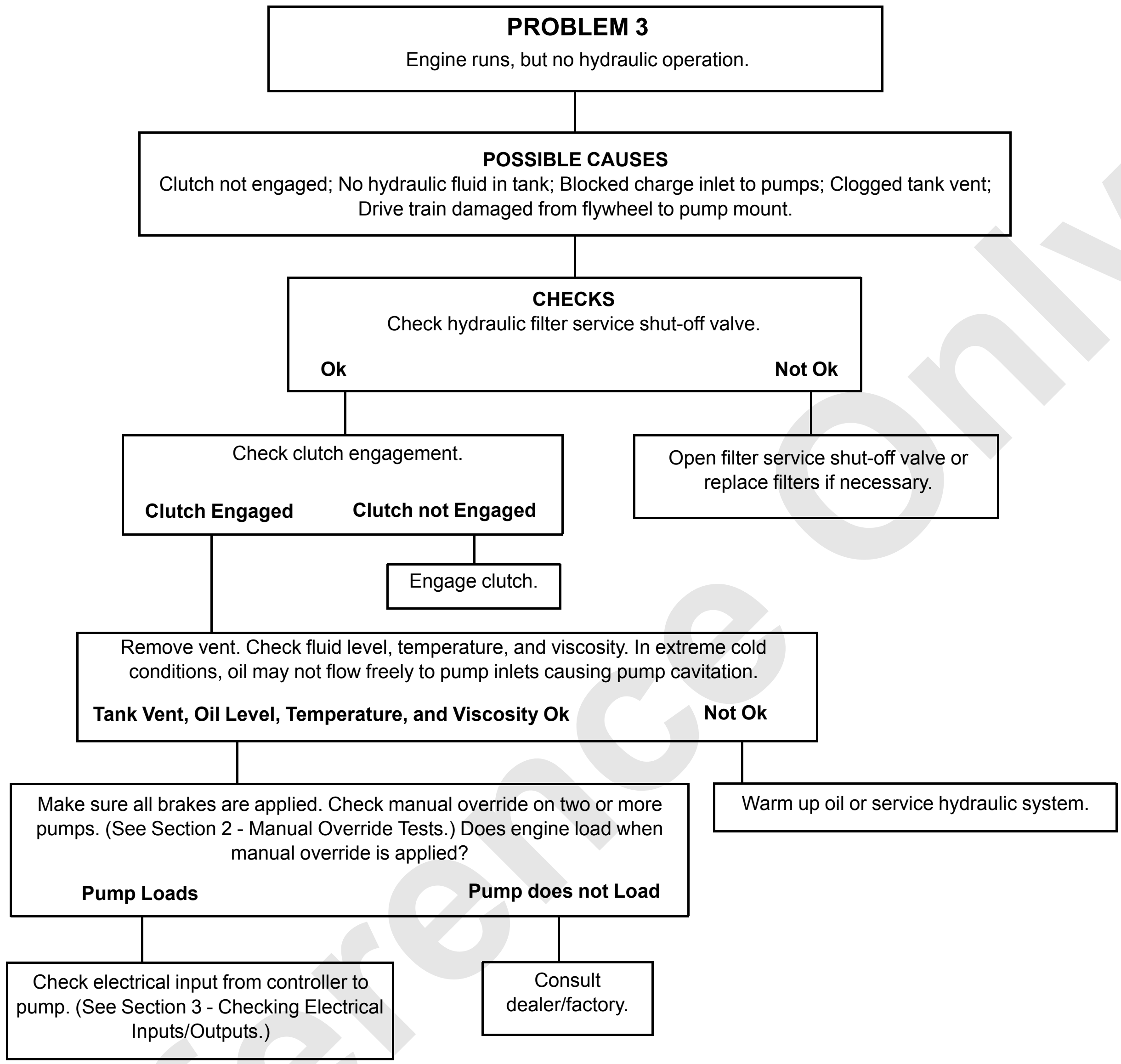
Repair or replace injector pump.

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 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.)

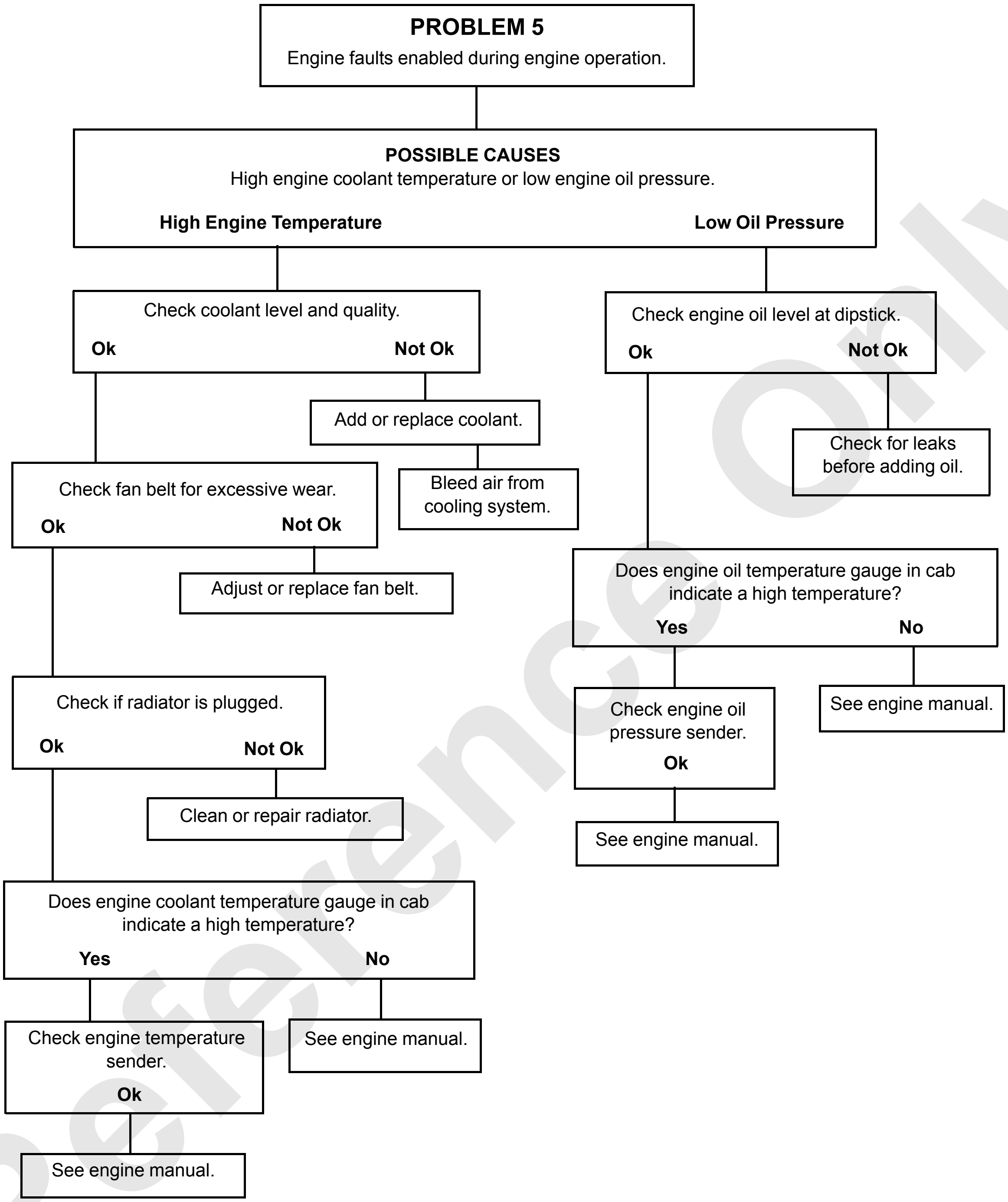
Ok

Connect voltmeter between alternator 24-volt terminal and ground terminal. Take reading with cab power *on* and engine running.

- **Zero Volts DC** — Repair wiring or connections.
- **24 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.
Bleed air from cooling system.
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 24 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 dealer/factory.

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.

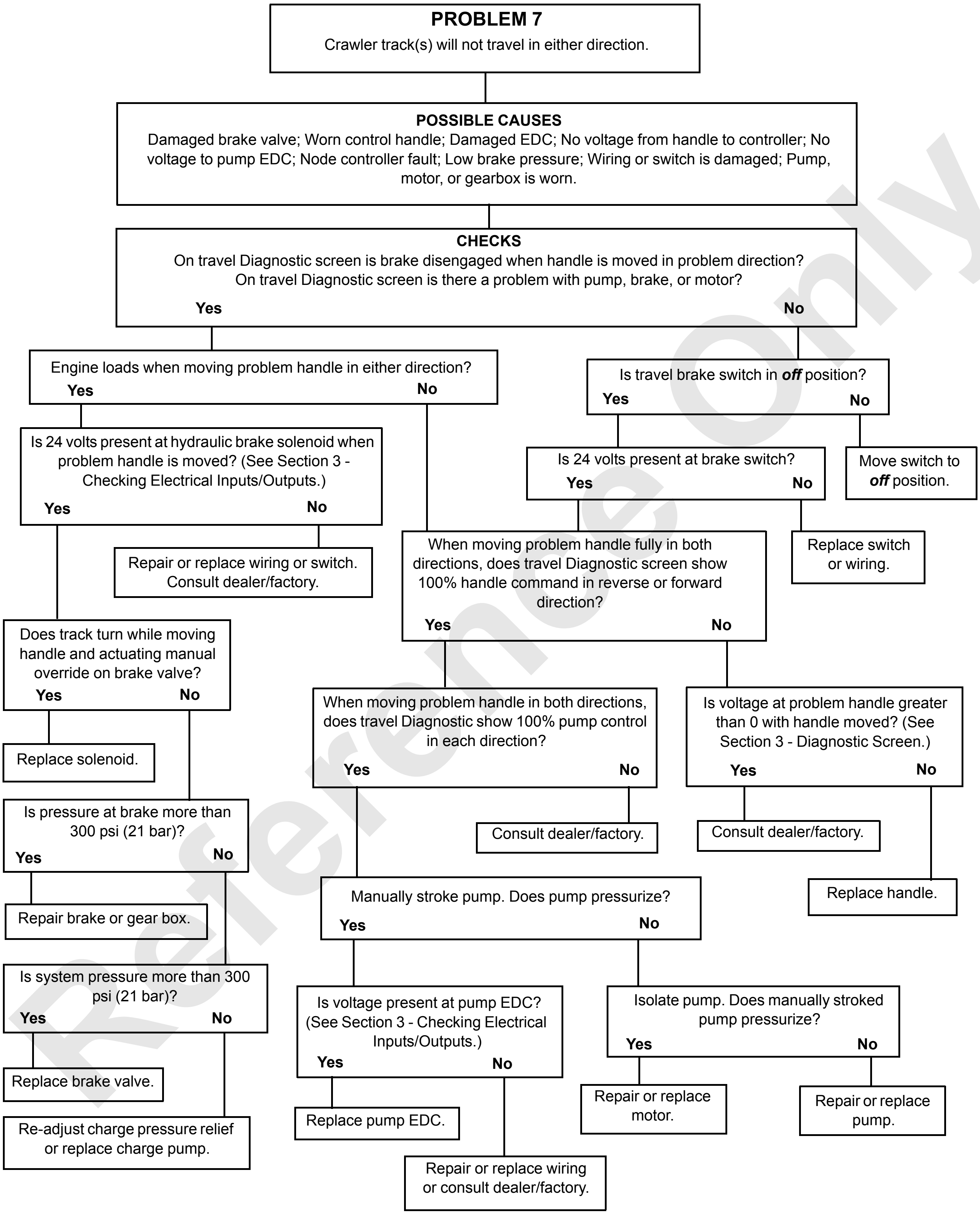
Slow speed is at required speed.

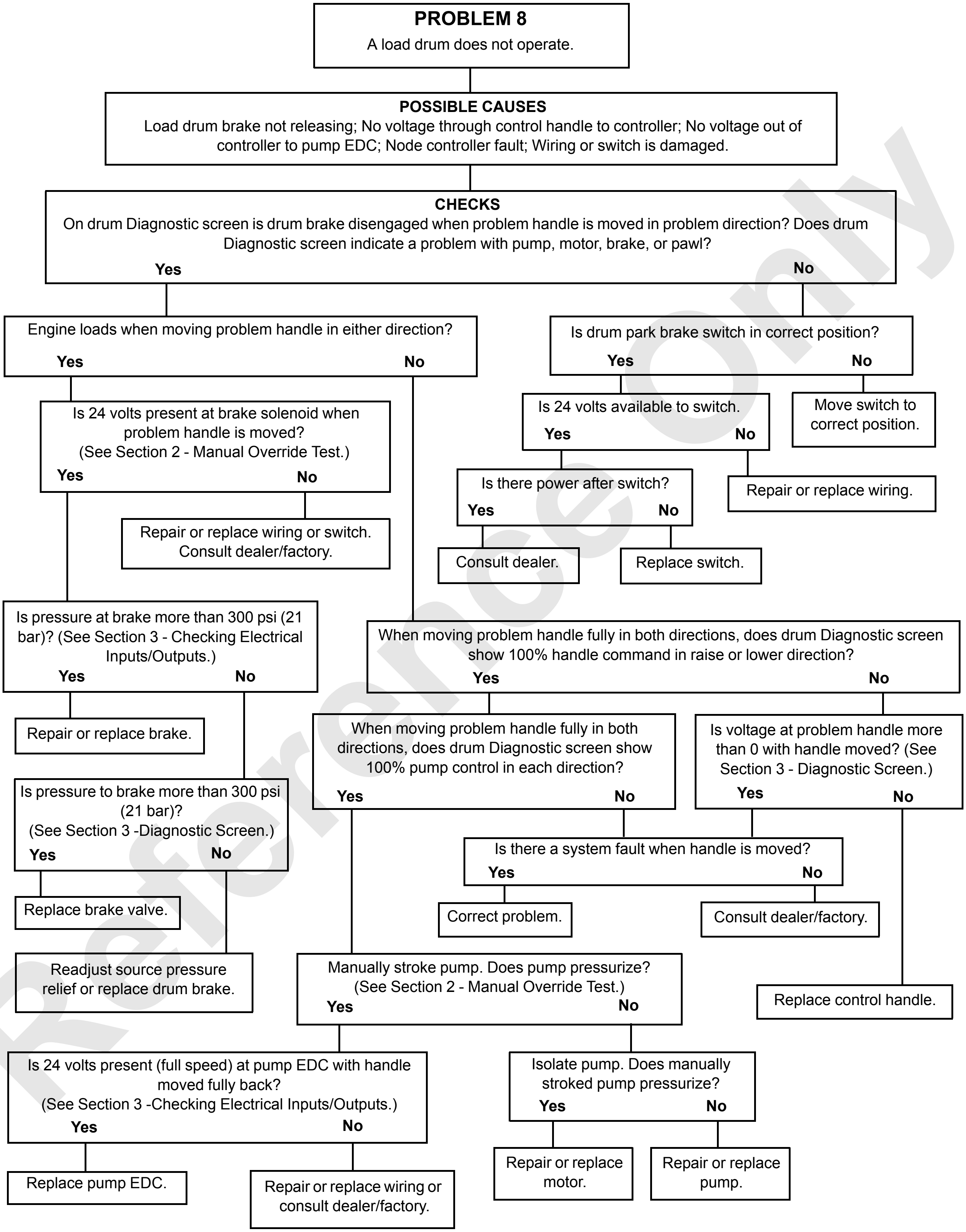
Brake partially applied. Check brake pressure source.

Yes **No**

Check brake and accessory pump output.

Check for pump or motor leakage. (See Section 2 - Motor Leakage Test.)


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 travel brake switch in off position?
Yes
No
Is 24 volts present at hydraulic brake solenoid when problem handle is moved? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Is 24 volts present at brake switch?
Yes
No
Move switch to off position.
Repair or replace wiring or switch. Consult dealer/factory.
When moving problem handle fully in both directions, does travel Diagnostic screen show 100% handle command in reverse or forward direction?
Yes
No
Replace switch or wiring.
Does track turn while moving handle and actuating manual override on brake valve?
Yes
No
When moving problem handle in both directions, does travel Diagnostic show 100% pump control in each direction?
Yes
No
Is voltage at problem handle greater than 0 with handle moved? (See Section 3 - Diagnostic Screen.)
Yes
No
Replace solenoid.
Consult dealer/factory.
Consult dealer/factory.
Is pressure at brake more than 300 psi (21 bar)?
Yes
No
Replace handle.
Manually stroke pump. Does pump pressurize?
Yes
No
Repair brake or gear box.
Is system pressure more than 300 psi (21 bar)?
Yes
No
Is voltage present at pump EDC? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Replace brake valve.
Repair or replace motor.
Repair or replace pump.
Re-adjust charge pressure relief or replace charge pump.
Replace pump EDC.
Repair or replace wiring or consult dealer/factory.


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 24 volts present at brake solenoid when problem handle is moved? (See Section 2 - Manual Override Test.)
Yes
No
Is 24 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/factory.
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 dealer/factory.
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 24 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 or consult dealer/factory.
Repair or replace motor.
Repair or replace pump.

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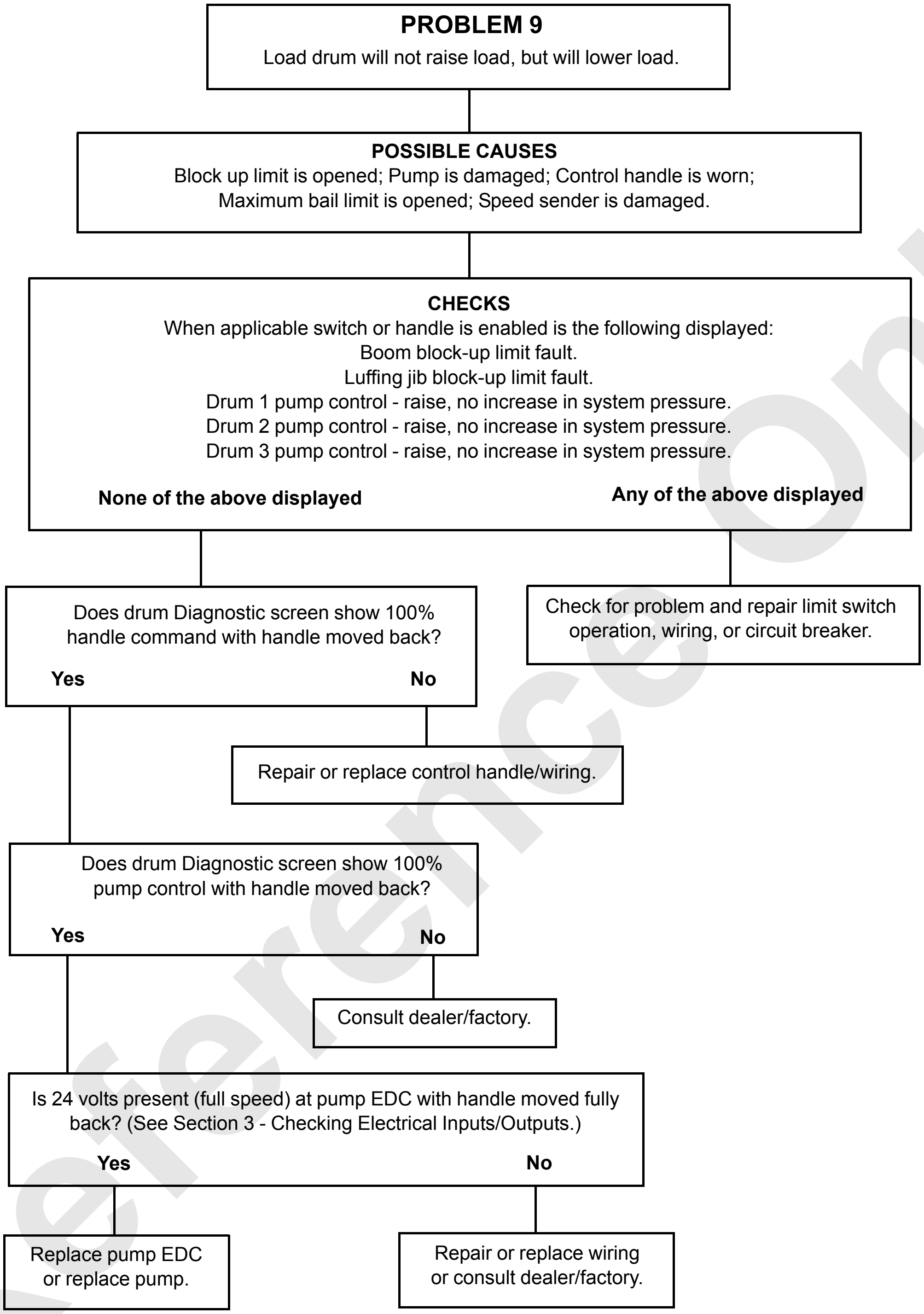
PROBLEM 9
Load drum will not raise load, but will lower load.
POSSIBLE CAUSES
Block up limit is opened; Pump is damaged; Control handle is worn;
Maximum bail limit is opened; Speed sender is damaged.
CHECKS
When applicable switch or handle is enabled is the following displayed:
Boom block-up limit fault.
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 dealer/factory.
Is 24 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 or consult dealer/factory.

PROBLEM 10

Load drum will not lower load, but will raise load.

POSSIBLE CAUSES

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 dealer/factory.

Yes: Is 24 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 or consult dealer/factory.

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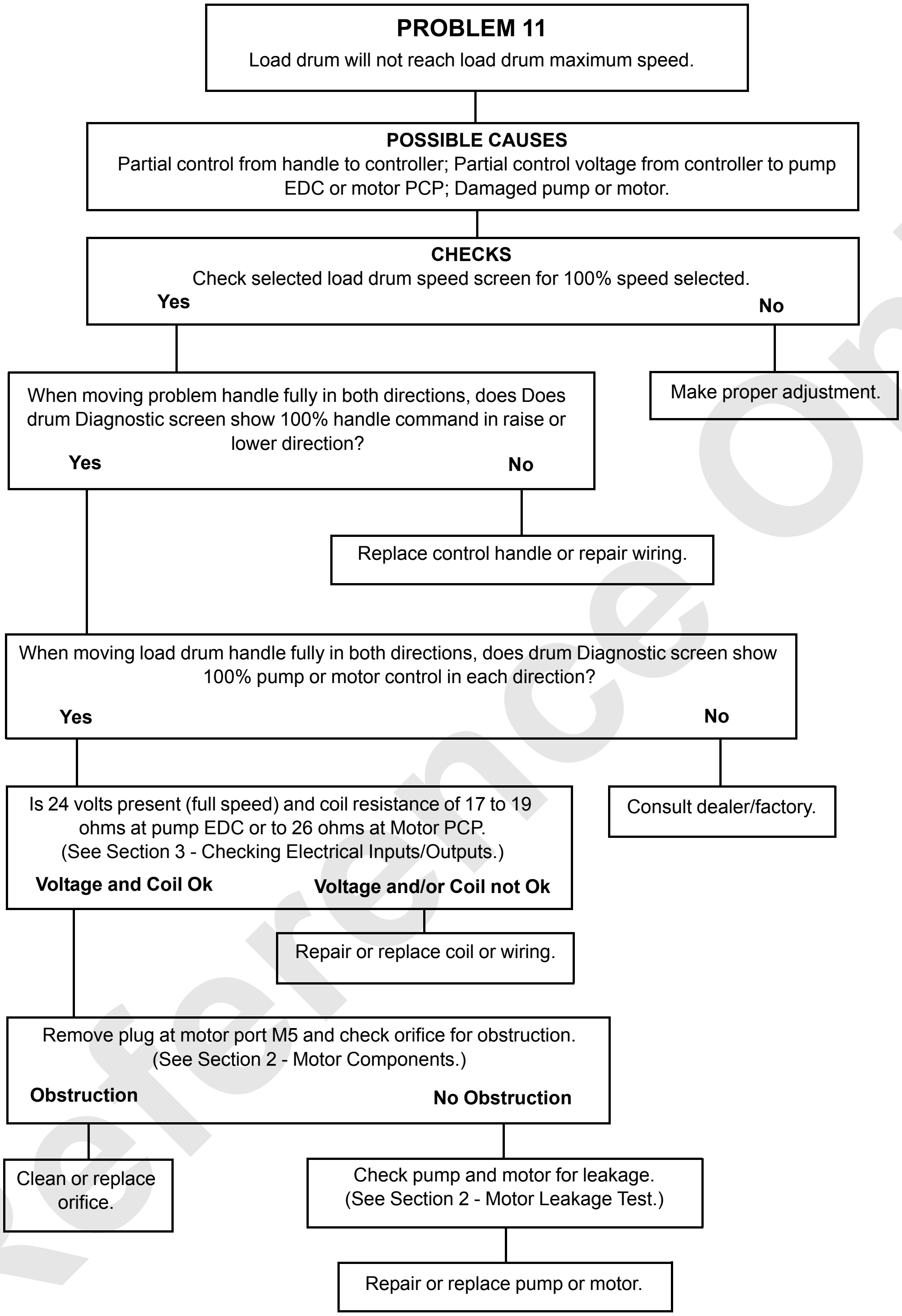
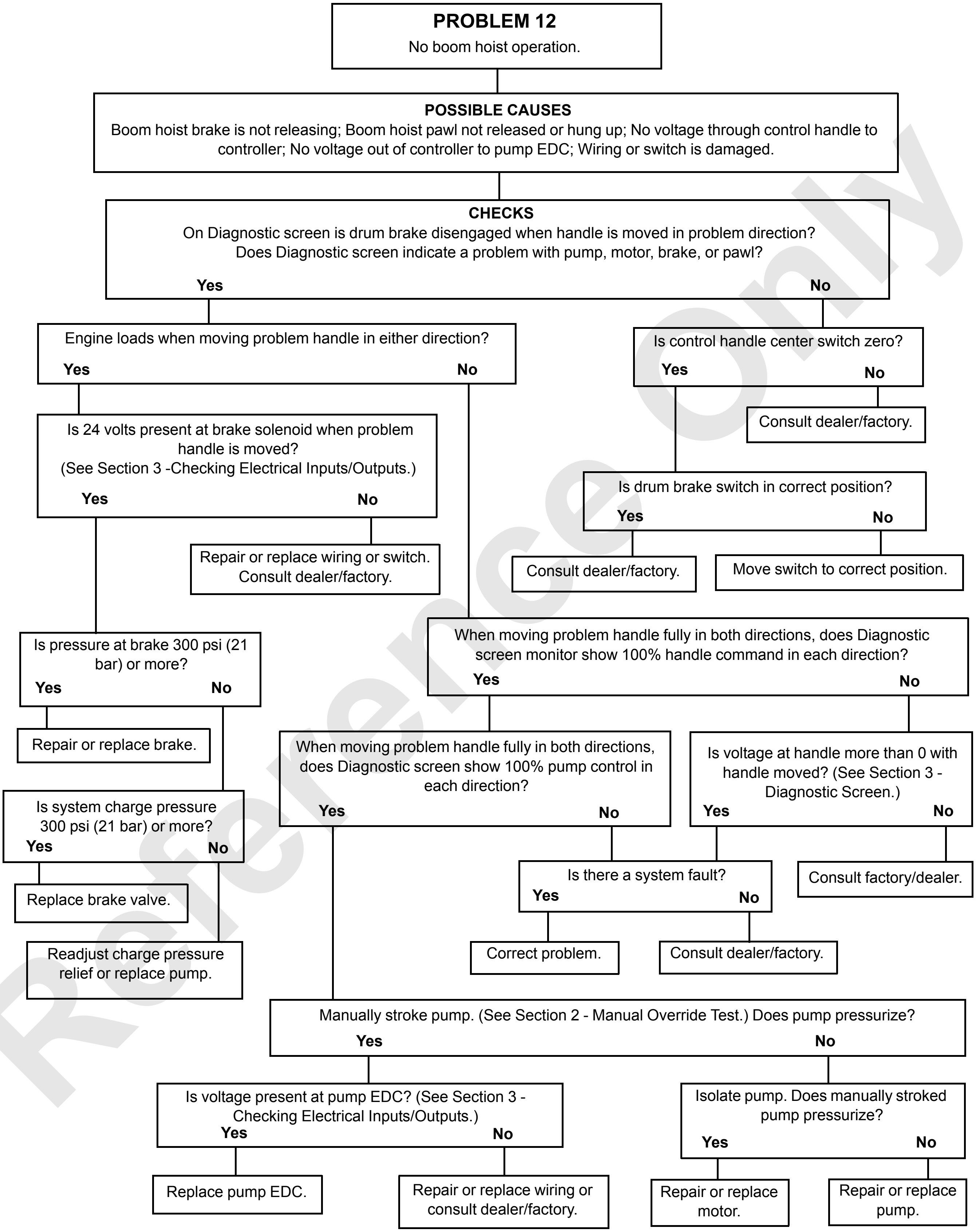

PROBLEM 11
Load drum will not reach load drum maximum speed.
POSSIBLE CAUSES
Partial control from handle to controller; Partial control voltage from controller to pump EDC or motor PCP; Damaged pump or motor.
CHECKS
Check selected load drum speed screen for 100% speed selected.
Yes
No
Make proper adjustment.
When moving problem handle fully in both directions, does 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 dealer/factory.
Is 24 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 hoist operation.
POSSIBLE CAUSES
Boom hoist brake is not releasing; Boom 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/factory.
Is 24 volts present at brake solenoid when problem handle is moved?
(See Section 3 -Checking Electrical Inputs/Outputs.)
Yes
No
Is drum brake switch in correct position?
Yes
No
Repair or replace wiring or switch.
Consult dealer/factory.
Consult dealer/factory.
Move switch to correct position.
Is pressure at brake 300 psi (21 bar) or more?
Yes
No
When moving problem handle fully in both directions, does Diagnostic screen monitor show 100% handle command in each direction?
Yes
No
Repair or replace brake.
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 system charge pressure 300 psi (21 bar) or more?
Yes
No
Is there a system fault?
Yes
No
Consult factory/dealer.
Replace brake valve.
Correct problem.
Consult dealer/factory.
Readjust charge pressure relief or replace pump.
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
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Replace pump EDC.
Repair or replace wiring or consult dealer/factory.
Repair or replace motor.
Repair or replace pump.

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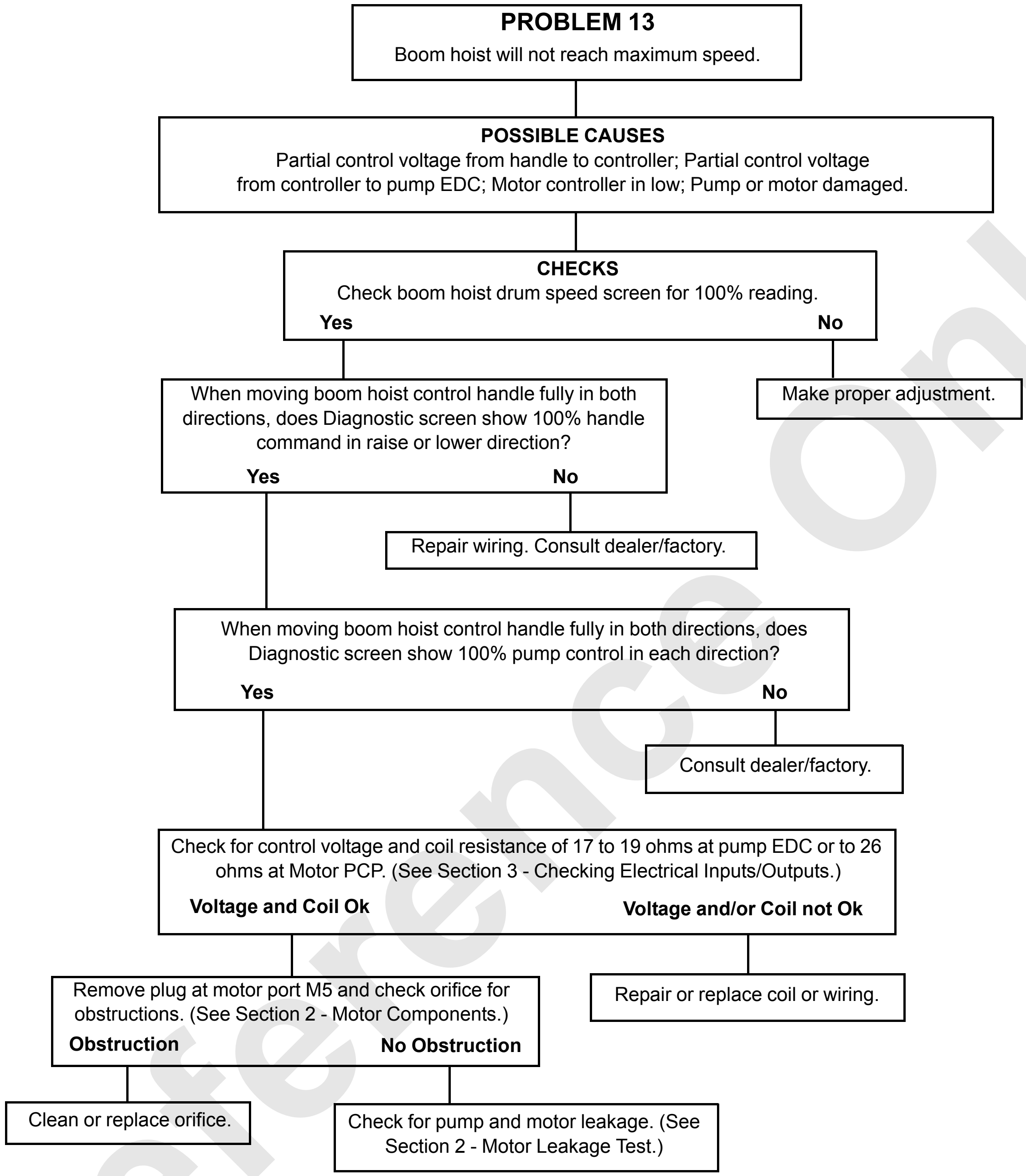
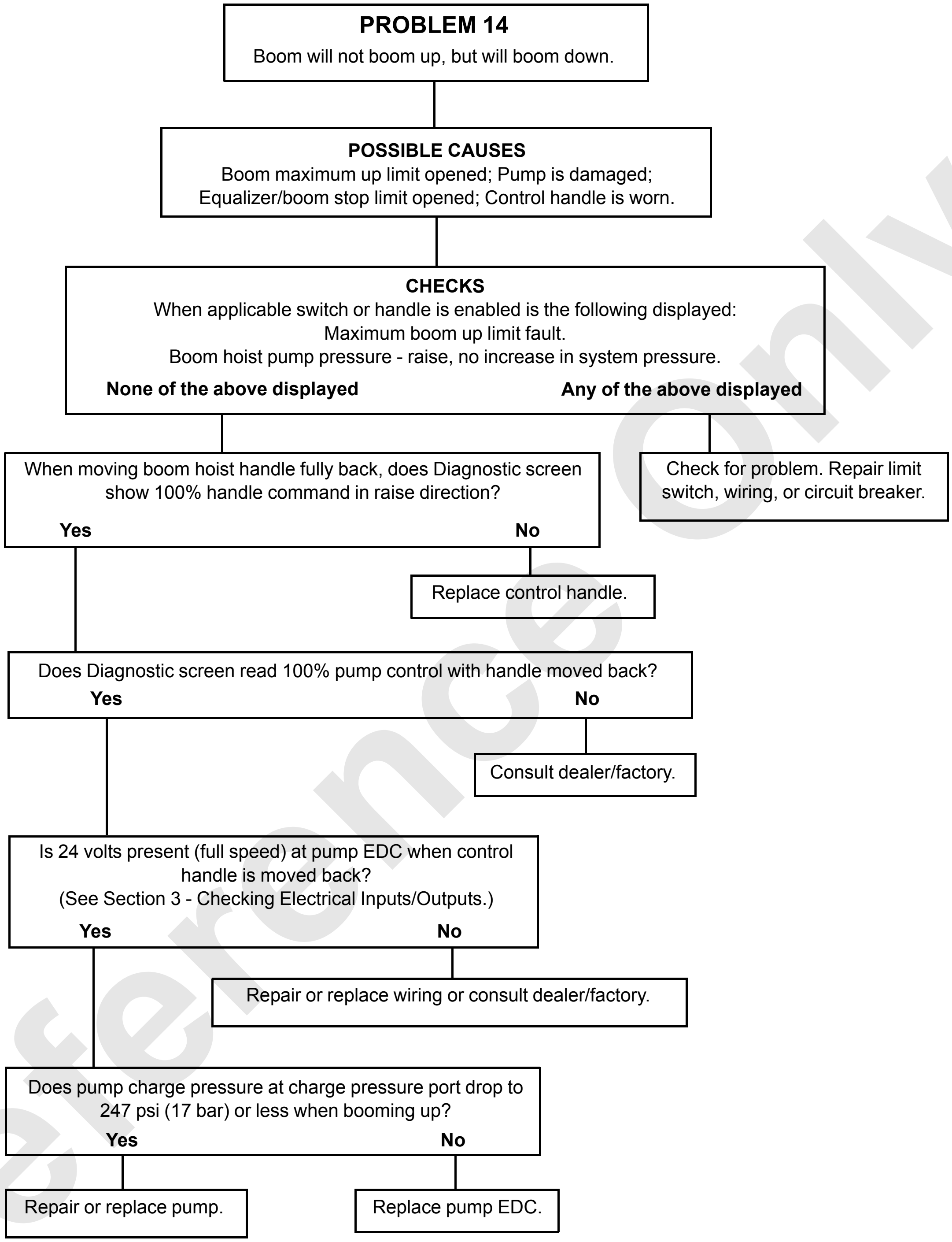

PROBLEM 13
Boom hoist will not reach maximum speed.
POSSIBLE CAUSES
Partial control voltage from handle to controller; Partial control voltage from controller to pump EDC; Motor controller in low; Pump or motor damaged.
CHECKS
Check boom hoist drum speed screen for 100% reading.
Yes
No
Make proper adjustment.
When moving boom hoist control handle fully in both directions, does Diagnostic screen show 100% handle command in raise or lower direction?
Yes
No
Repair wiring. Consult dealer/factory.
When moving boom hoist control handle fully in both directions, does Diagnostic screen show 100% pump control in each direction?
Yes
No
Consult dealer/factory.
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
Repair or replace coil or wiring.
Remove plug at motor port M5 and check orifice for obstructions. (See Section 2 - Motor Components.)
Obstruction
No Obstruction
Clean or replace orifice.
Check for pump and motor leakage. (See Section 2 - Motor Leakage Test.)


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 hoist pump pressure - raise, no increase in system pressure.
None of the above displayed
Any of the above displayed
When moving boom hoist handle fully back, does Diagnostic screen show 100% handle command in raise direction?
Yes
No
Check for problem. Repair limit switch, wiring, or circuit breaker.
Replace control handle.
Does Diagnostic screen read 100% pump control with handle moved back?
Yes
No
Consult dealer/factory.
Is 24 volts present (full speed) at pump EDC when control handle is moved back?
(See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Repair or replace wiring or consult dealer/factory.
Does pump charge pressure at charge pressure port drop to 247 psi (17 bar) or less when booming up?
Yes
No
Repair or replace pump.
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 hoist pump - raise, no increase in system pressure.
Boom hoist drum pawl in fault.

- **Any of the above displayed**: Check for problem. Repair limit switch or wiring.
- **None of the above displayed**: On boom hoist screen, is boom hoist pawl out when moving brake park switch?
  - **No**: Repair or replace switch or wiring to controller.
  - **Yes**: Visually check pawl.
    - **In**: Replace or repair pawl.
    - **Out**: When moving boom hoist handle fully in forward directions, does Diagnostic screen show 100% handle command in lower direction?
      - **No**: Replace control handle or repair wiring.
      - **Yes**: Does Diagnostic screen show 100% pump control with handle moved fully forward?
        - **No**: Consult dealer/factory.
        - **Yes**: Is 24 volts present (full speed) at pump EDC when control handle is moved forward? (See Section 3 - Checking Electrical Inputs/Outputs.)
          - **No**: Repair or replace wiring or consult dealer/factory.
          - **Yes**: Can boom pump be manually stroked down? (See Section 2 -Manual Override Test.)
            - **Yes**: Replace pump EDC.
            - **No**: Repair or replace pump.

PROBLEM 16

No swing operation, but engine loads.

POSSIBLE CAUSES

Mechanical hang-up; Solenoid failure; Wiring fault.

CHECKS

When applicable switch or handle is enabled is the following displayed:
Swing brake disengaged?

- **Yes** → Check for 24 volts DC to swing brake solenoid valve. (See Section 3 - Checking Electrical Inputs/Outputs.)
  - **Voltage** → Check low-pressure source at brake valve for 500 psi (35 bar) with a 0 to 1,000 psi (0 to 69 bar) gauge.
    - **247 psi (17 bar) or more** → Repair or replace swing brake or gearbox.
    - **247 psi (17 bar) or less** → Set pump low-pressure source relief to 500 psi (35 bar). Is 500 psi (35 bar) obtained?
      - **No** → Replace relief valve or pump.
  - **No Voltage** → Repair or replace switch or wiring. Consult dealer/factory.
- **No** → Consult dealer/factory.

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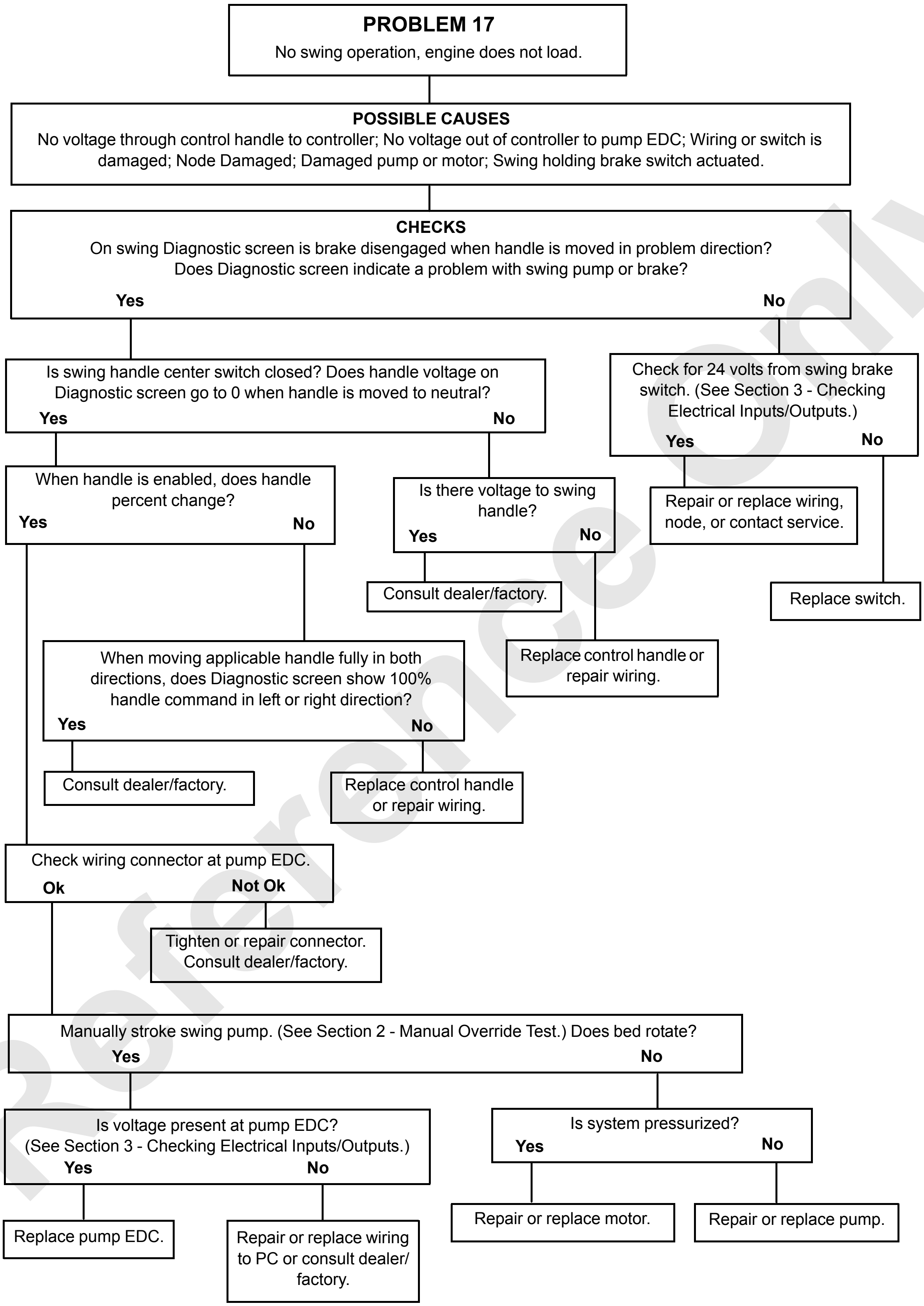
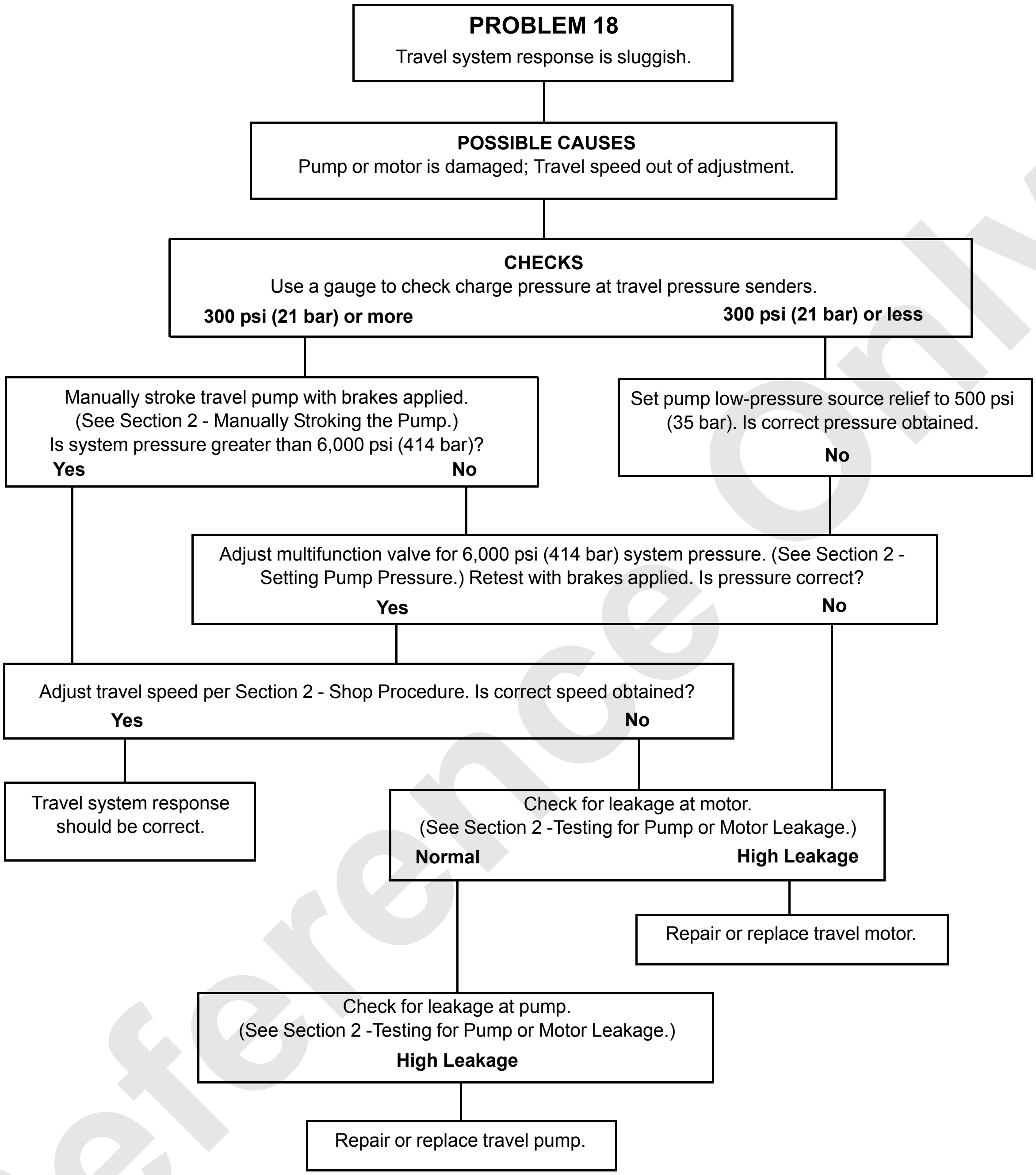
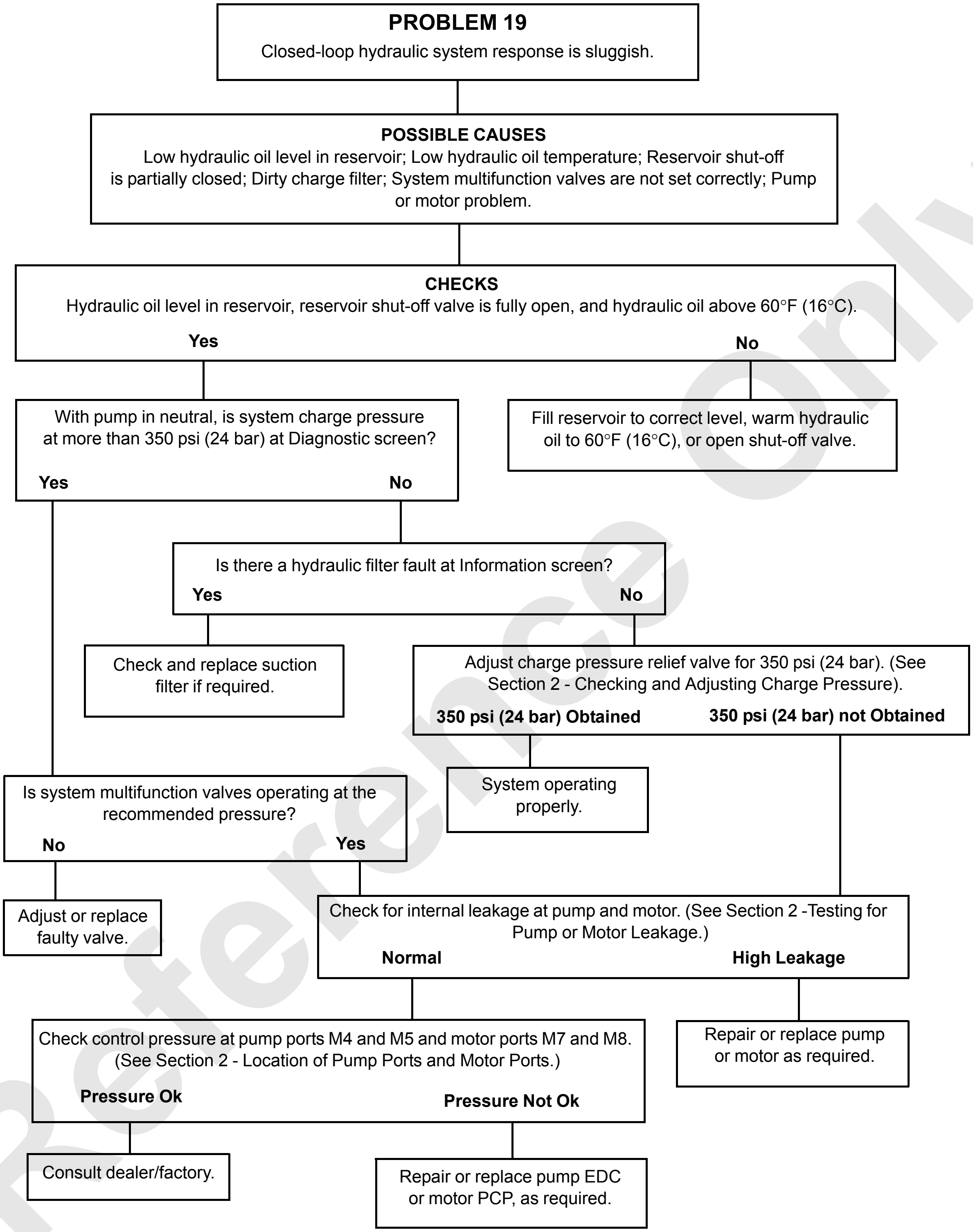

PROBLEM 17
No swing operation, engine does not load.
POSSIBLE CAUSES
No voltage through control handle to controller; No voltage out of controller to pump EDC; Wiring or switch is damaged; Node Damaged; Damaged pump or motor; Swing holding brake switch actuated.
CHECKS
On swing Diagnostic screen is brake disengaged when handle is moved in problem direction? Does Diagnostic screen indicate a problem with swing pump or brake?
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 24 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 dealer/factory.
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 dealer/factory.
Replace control handle or repair wiring.
Check wiring connector at pump EDC.
Ok
Not Ok
Tighten or repair connector. Consult dealer/factory.
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 to PC or consult dealer/ factory.
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 correct?
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.


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
System operating properly.
Is system multifunction valves operating at the recommended pressure?
No
Yes
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 dealer/factory.
Repair or replace pump EDC or motor PCP, as required.

PROBLEM 20

Hydraulic system is operating hot.

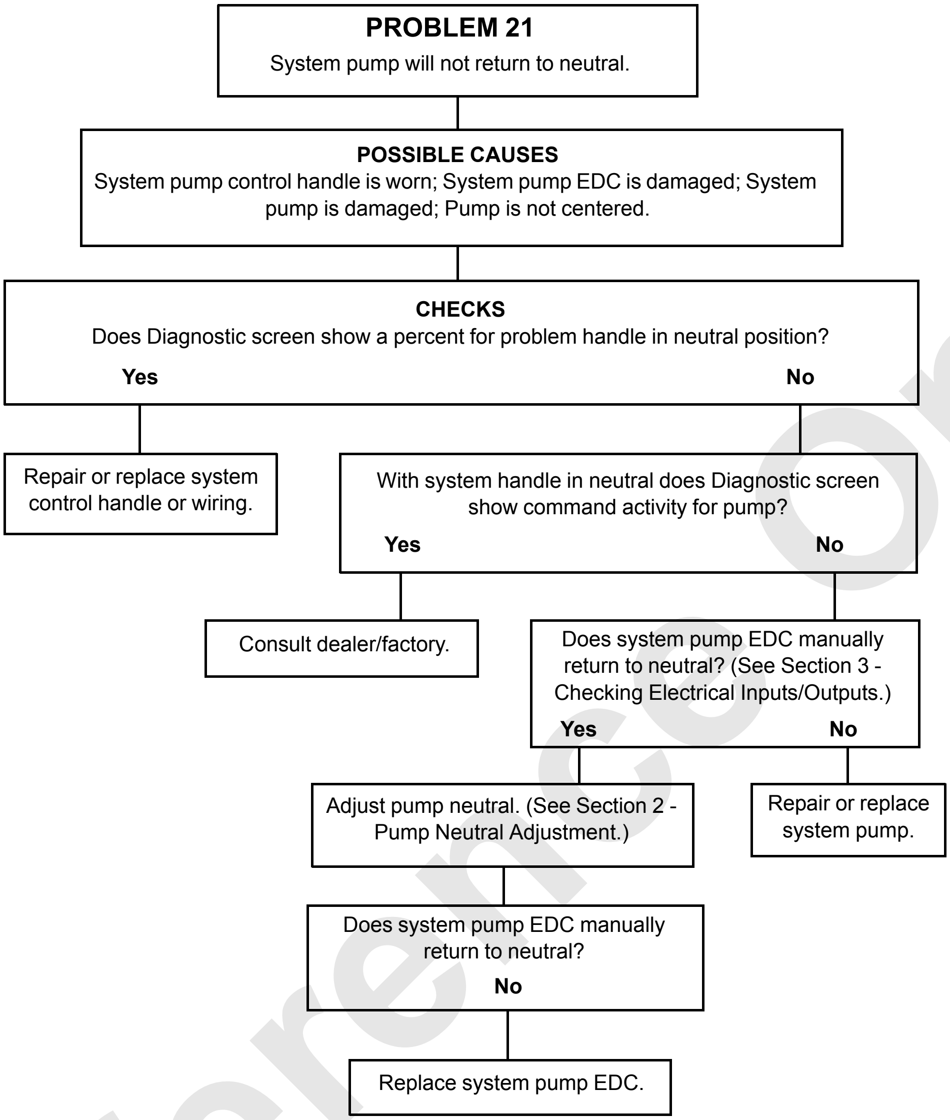
POSSIBLE CAUSES

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?

- **No** → Fill tank to full level or open shut-off valve.
- **Yes** → Is heat exchanger radiator clean?
  - **No** → Clean, repair or replace heat exchanger radiator.
  - **Yes** → Is charge pressure 350 psi (24 bar) at system pressure sensor?
    - **No** → Are suction filters clean?
      - **No** → Replace filters.
      - **Yes** → Adjust charge pressure relief valve for 350 psi (24 bar). (See Section 2 - Checking and Adjusting Charge Pressure.)
        - **350 psi (24 bar) obtained** → System should be at correct temperature.
        - **350 psi (24 bar) not obtained** → Check for internal leakage at pump and motor (below).
    - **Yes** → Are system multifunction valves operating at the recommended system pressures?
      - **No** → Adjust or replace problem valve. (See Section 2 -Setting Pump Pressure.)
      - **Yes** → Check for internal leakage at pump and motor. (See Section 2 -Testing for Pump or Motor Leakage.)
        - **High Leakage** → Repair or replace pump or motor, as required.
        - **Normal** → Is system operating pressure excessive?
          - **Yes** → Locate and reduce load on motor transmission.
          - **No** → 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
No
Repair or replace system control handle or wiring.
With system handle in neutral does Diagnostic screen show command activity for pump?
Yes
No
Consult dealer/factory.
Does system pump EDC manually return to neutral? (See Section 3 - Checking Electrical Inputs/Outputs.)
Yes
No
Adjust pump neutral. (See Section 2 - Pump Neutral Adjustment.)
Repair or replace system pump.
Does system pump EDC manually return to neutral?
No
Replace system pump EDC.

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.

- **Damage** → Repair damage. Test and adjust.
- **No Damage** → 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 hoist pawl in.
  - Boom hoist pawl out.

If pawl is not moving

Is there voltage applied to pawl valve? (See Section 3 -Checking Electrical Inputs/Outputs.)

- **No** → Check wiring. Consult dealer/factory.
- **Yes** → When enabling problem pawl switch, check pawl cylinder for 350 psi (24 bar) or more at valve cylinder ports.
  - **Pressure** → Check for binding or faulty cylinder. → Repair or replace control valve.
  - **No Pressure** → Readjust source charge pressure relief valve. Does this solve problem?
    - **No** → Repair or replace pump. Consult factory.

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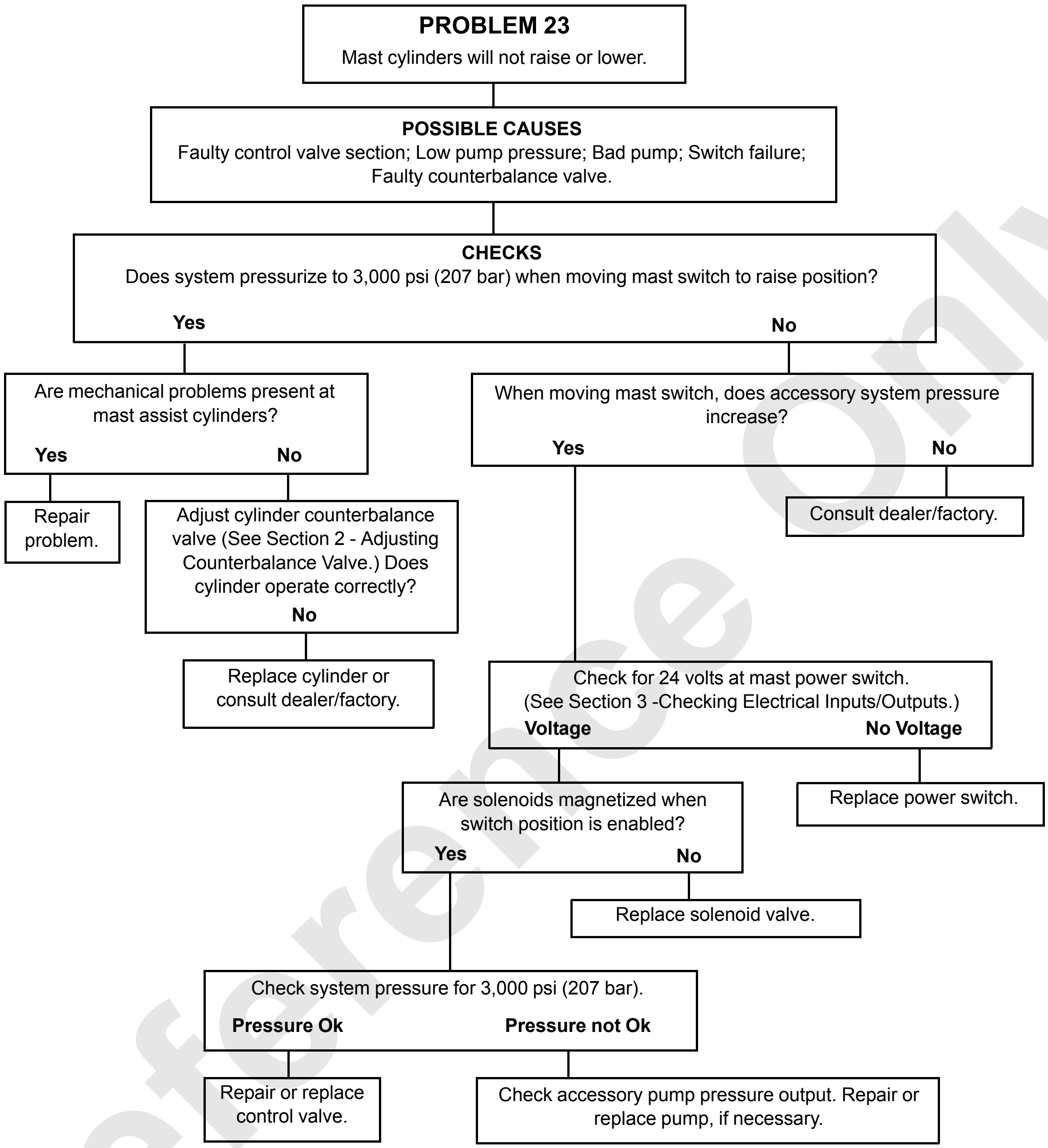
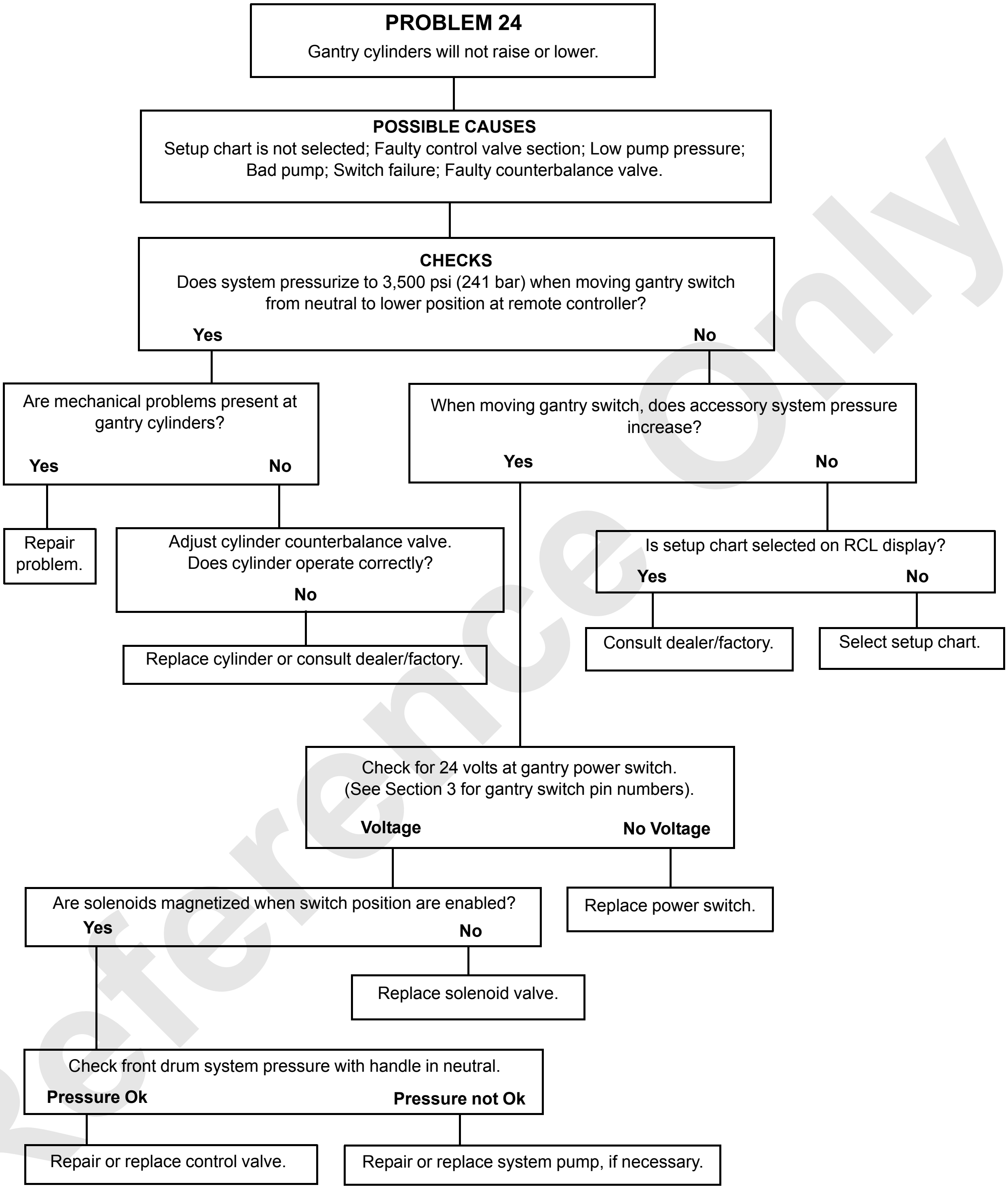

PROBLEM 23
Mast cylinders will not raise or lower.
POSSIBLE CAUSES
Faulty control valve section; Low pump pressure; Bad pump; Switch failure; Faulty counterbalance valve.
CHECKS
Does system pressurize to 3,000 psi (207 bar) when moving mast switch to raise position?
Yes
No
Are mechanical problems present 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 or consult dealer/factory.
When moving mast switch, does accessory system pressure increase?
Yes
No
Consult dealer/factory.
Check for 24 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 pump pressure output. Repair or replace pump, if necessary.


PROBLEM 24
Gantry cylinders will not raise or lower.
POSSIBLE CAUSES
Setup chart is not selected; Faulty control valve section; Low pump pressure; Bad pump; Switch failure; Faulty counterbalance valve.
CHECKS
Does system pressurize to 3,500 psi (241 bar) when moving gantry switch from neutral to lower position at remote controller?
Yes
No
Are mechanical problems present at gantry cylinders?
Yes
No
Repair problem.
Adjust cylinder counterbalance valve. Does cylinder operate correctly?
No
Replace cylinder or consult dealer/factory.
When moving gantry switch, does accessory system pressure increase?
Yes
No
Is setup chart selected on RCL display?
Yes
No
Consult dealer/factory.
Select setup chart.
Check for 24 volts at gantry power switch. (See Section 3 for gantry switch pin numbers).
Voltage
No Voltage
Replace power switch.
Are solenoids magnetized when switch position are enabled?
Yes
No
Replace solenoid valve.
Check front drum system pressure with handle in neutral.
Pressure Ok
Pressure not Ok
Repair or replace control valve.
Repair or replace system pump, if necessary.

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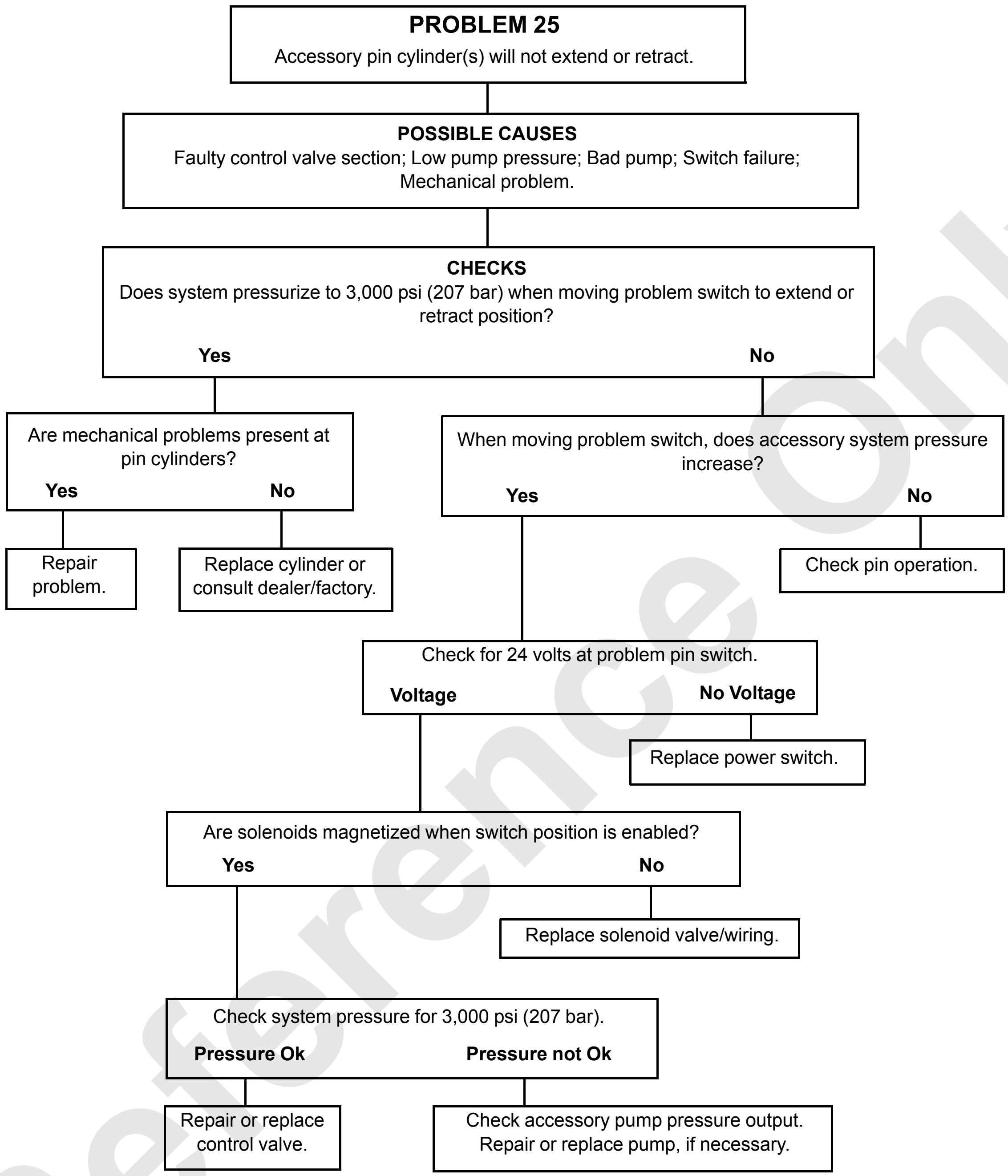
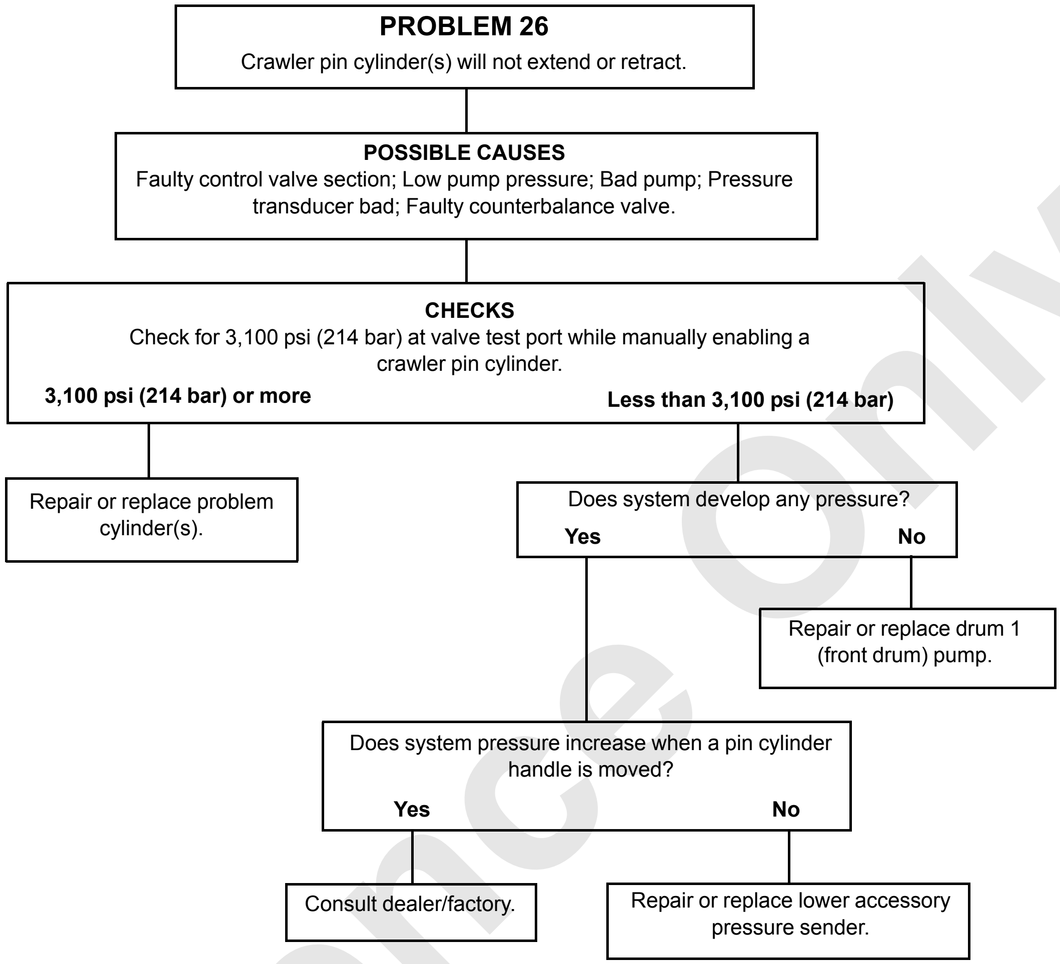
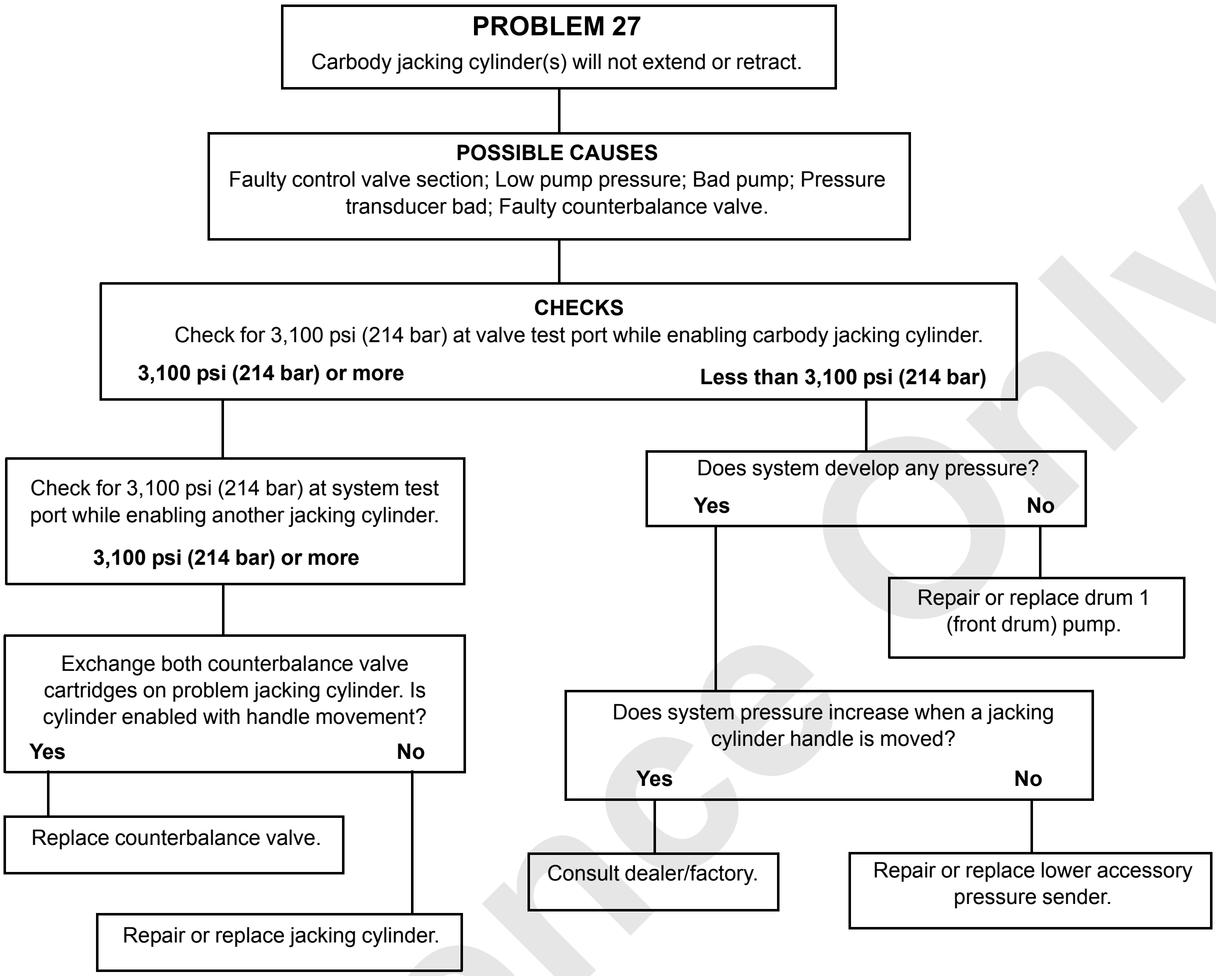

PROBLEM 25
Accessory pin cylinder(s) will not extend or retract.
POSSIBLE CAUSES
Faulty control valve section; Low pump pressure; Bad pump; Switch failure; Mechanical problem.
CHECKS
Does system pressurize to 3,000 psi (207 bar) when moving problem switch to extend or retract position?
Yes
No
Are mechanical problems present at pin cylinders?
Yes
No
Repair problem.
Replace cylinder or consult dealer/factory.
When moving problem switch, does accessory system pressure increase?
Yes
No
Check pin operation.
Check for 24 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 pump pressure output. Repair or replace pump, if necessary.


PROBLEM 26
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 3,100 psi (214 bar) at valve test port while manually enabling a crawler pin cylinder.
3,100 psi (214 bar) or more
Less than 3,100 psi (214 bar)
Repair or replace problem cylinder(s).
Does system develop any pressure?
Yes
No
Repair or replace drum 1 (front drum) pump.
Does system pressure increase when a pin cylinder handle is moved?
Yes
No
Consult dealer/factory.
Repair or replace lower accessory pressure sender.


PROBLEM 27
Carbody 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 3,100 psi (214 bar) at valve test port while enabling carbody jacking cylinder.
3,100 psi (214 bar) or more
Less than 3,100 psi (214 bar)
Check for 3,100 psi (214 bar) at system test port while enabling another jacking cylinder.
3,100 psi (214 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.
Does system develop any pressure?
Yes
No
Repair or replace drum 1 (front drum) pump.
Does system pressure increase when a jacking cylinder handle is moved?
Yes
No
Consult dealer/factory.
Repair or replace lower accessory pressure sender.

ALPHABETICAL INDEX