Manitowoc 31000

Service/Maintenance Manual

Grove   Manitowoc   National Crane   Potain

Reference Only

SERVICE/MAINTENANCE MANUAL

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

31000

Model Number

31001Ref

Serial Number

This Manual is divided into the following sections:

NOTICE

The serial number of the crane and its attachments (i.e. luffing jib) is the only method your Manitowoc dealer or the Manitowoc Crane Care Lattice Team has of providing you with correct parts and service information.

The serial number is located on a crane identification plate attached to the operator cab and applicable attachments. Refer to the Nameplate and Decal Assembly Drawing in Section 3 of The Operator Manual manual for the exact location of the crane identification plates.

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

WARNING

Avoid unsafe operation and maintenance!

- The crane and its attachments shall be operated and maintained by trained and experienced personnel. Manitowoc is not responsible for qualifying these personnel.
- Do not operate or work on the crane or its attachments without first reading and understanding the instructions contained in:
  - The Operator Information Manual and the Service Manual supplied with crane.
  - The Operator Information Manual supplied with the attachments.
- Store the Operator Information Manuals and the Service Manual in the operator cab.

  If any manual is missing from the cab, contact your Manitowoc dealer for a new one.

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THE ORIGINAL LANGUAGE OF THIS PUBLICATION IS ENGLISH

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See end of this manual for Alphabetical Index

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SECTION 1
INTRODUCTION

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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 Crane Care in Manitowoc.

SAFETY MESSAGES

General Safety

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

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

Safety Alert Symbol

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

Signal Words

DANGER

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

WARNING

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

CAUTION

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

CAUTION

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

NOTE: Highlights operation or maintenance procedures.

SAFE MAINTENANCE PRACTICES

WARNING

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

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

Maintenance Instructions

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

Crane maintenance and repair shall be performed by personnel who by reason of training and experience are

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thoroughly familiar with the crane's operation and required maintenance. These personnel shall ***read Operator Manual and Service Manual before attempting any maintenance procedure***. If there is any question regarding maintenance procedures or specifications, contact your Manitowoc dealer for assistance.

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

Safe Maintenance Practices

1. Perform 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 or on to a boom rest if possible; otherwise securely fasten boom from movement by wind or other outside forces (see Wind Conditions in capacity chart manual).

   d. Move all controls to off and secure all functions against movement by applying or engaging all brakes, pawls, or other locking devices.

   e. Stop engines and render starting means inoperative.

   f. Place a warning sign at start controls alerting other personnel that crane is being serviced and engines shall 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 engines are running, unless absolutely necessary.

If engines must be run, keep your clothing and all parts of your body away from moving parts. ***Maintain constant verbal communication between person at controls and person performing maintenance or repair procedure***.

3. Wear clothing that is relatively tight and belted.

4. Wear appropriate eye protection and approved hard hat.

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

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

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

Lift tools and other equipment which cannot be carried in pockets or tool belts onto and off crane with hand lines or hoists.

6. Boom, mast and back stay are not intended as ladders. Do not attempt to climb lattice work of boom, mast or back stay to get to maintenance points. If boom, mast or back stay are 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 caps while coolant is hot or under pressure. Stop engines, 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 both engines before refueling crane.

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

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

18. Mobile fueling the crane from tank trucks and tank wagons shall be in compliance with federal, state and local regulations and licensing. Best Management Practices shall be used when fueling the crane.

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19. Hydraulic oil can also be flammable. Do not smoke or allow open flames in area when filling hydraulic tanks.
20. Never handle wire rope with bare hands. Always wear heavy-duty gloves to prevent being cut by broken wires.
21. Use extreme care when handling coiled pendants. Stored energy can cause coiled pendants to uncoil quickly with considerable force.
22. When inflating tires, use a tire cage, a clip-on inflator, and an extension hose which permits standing well away from tire.
23. Only use cleaning solvents which are non-volatile and non-flammable.
24. Do not attempt to lift heavy components by hand. Use a hoist, jacks, or blocking to lift components.
25. Use care while welding or burning on crane. Cover all hoses and components with non-flammable shields or blankets to prevent a fire or other damage.
26. To prevent damage to crane parts (bearings, cylinders, swivels, slewing ring, computers, etc.), perform 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).

NOTE: A 60 amp "temporary welder" outlet is provided for powering a welder.

27. Disconnect and lock power supply switch before attempting to service high voltage electrical components and before entering tight areas (such as carbody openings) containing high voltage components.
28. When assembling and disassembling booms, jibs, or masts on ground (with or without support of boom rigging pendants or straps), securely block each section to provide adequate support and alignment.

    Do not go under boom, jib, or mast sections while connecting bolts or pins are being removed.
29. Unless authorized in writing by Manitowoc, do not alter crane in any way that affects crane's performance (to include welding, cutting, or burning of structural members or changing pressures and flows of air/hydraulic components). Doing so will invalidate all warranties and capacity charts and make crane owner/user liable for any resultant accidents.
30. ***Keep crane clean.*** Accumulations of dirt, grease, oil, rags, paper, and other waste will not only interfere with safe operation and maintenance but also create a fire hazard.
31. Store tools, oil cans, spare parts, and other necessary equipment in tool boxes. Do not allow these items to lie around loose in operator cab, engine enclosure, or on walkways and stairs.
32. Do not store flammable materials on crane.
33. Do not return crane to service at completion of maintenance or repair procedures until all guards and covers have been reinstalled, trapped air has been bled from hydraulic systems, safety devices have been reactivated, and all maintenance equipment has been removed.
34. Perform a function check to ensure proper operation at completion of maintenance or repair.

ENVIRONMENTAL PROTECTION

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

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

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

When filling and draining crane components: do not pour waste fluids onto the ground, down any drain, or into any source of water.

- Always drain waste fluids into leak proof containers that are clearly marked with what they contain.
- Always fill or add fluids with a funnel or a filling pump.
- Immediately wipe up any spills.

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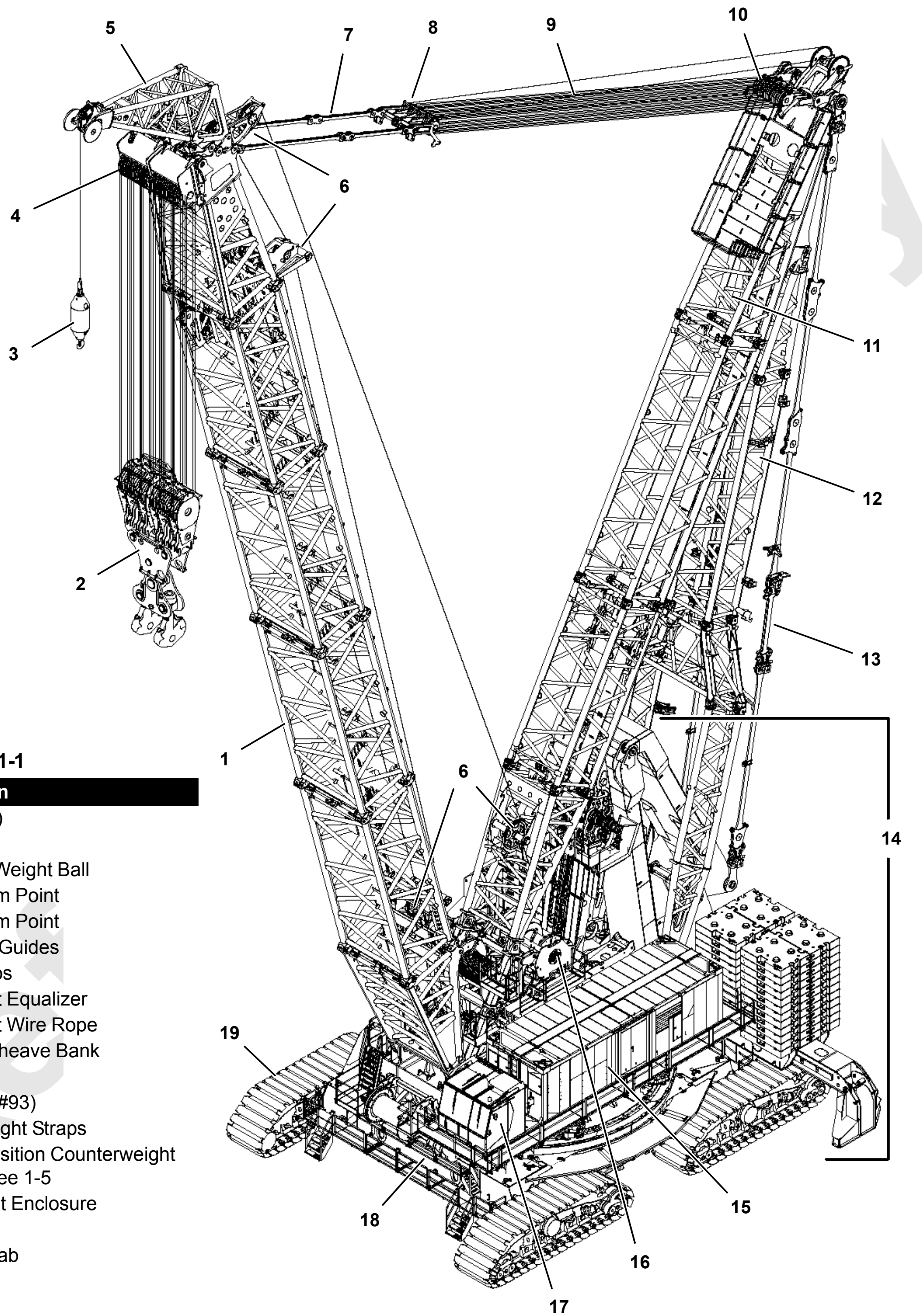
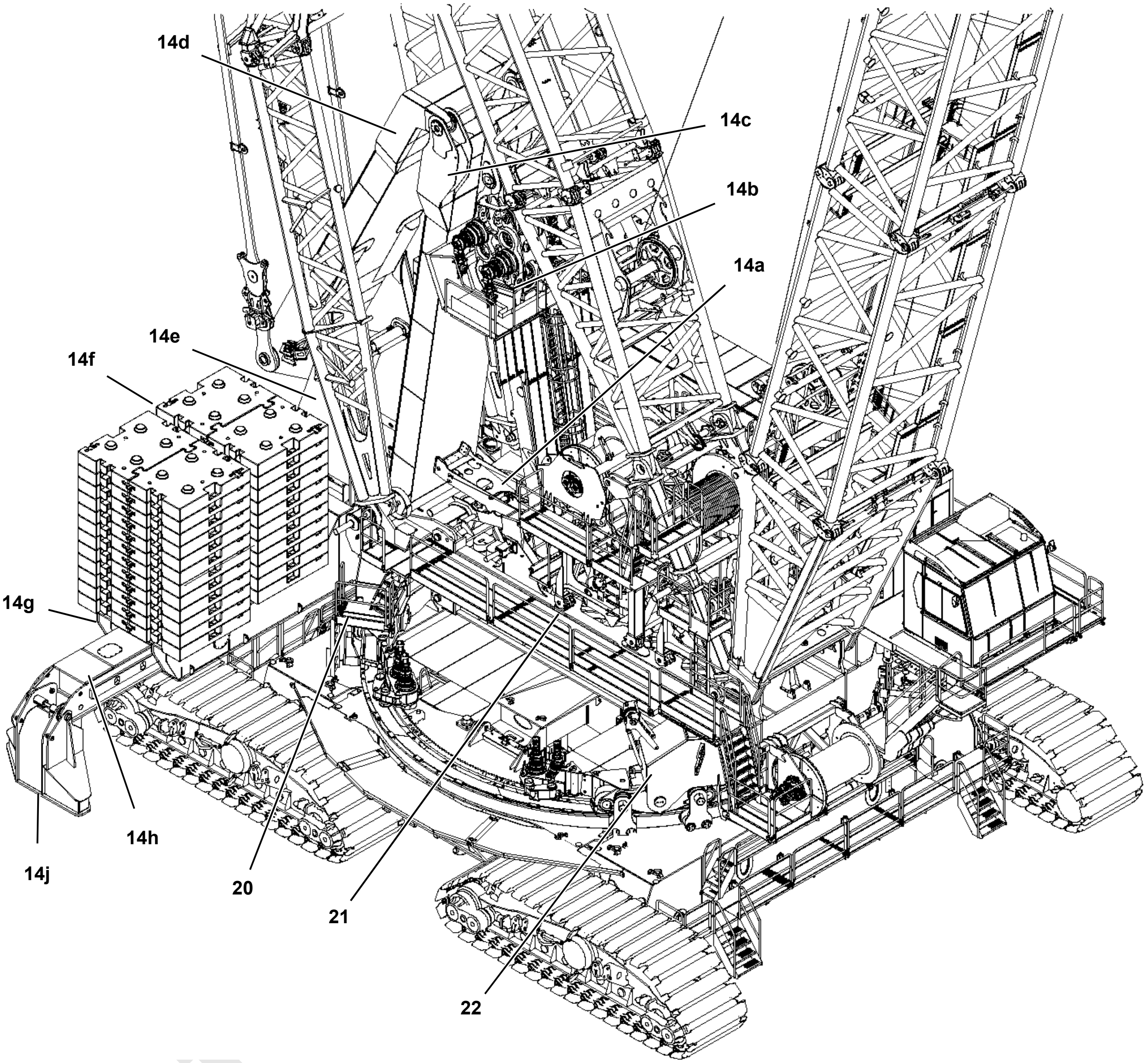
IDENTIFICATION AND LOCATION OF MAJOR COMPONENTS



Legend for Figure 1-1

Item	Description
1	Boom (#90)
2	Hook Block
3	Hook-and-Weight Ball
4	Lower Boom Point
5	Upper Boom Point
6	Wire Rope Guides
7	Boom Straps
8	Boom Hoist Equalizer
9	Boom Hoist Wire Rope
10	Mast Top Sheave Bank
11	Mast (#92)
12	Backhitch (#93)
13	Counterweight Straps
14	Variable Position Counterweight (VPC) — See 1-5
15	Power Plant Enclosure
16	Drums
17	Operator Cab
18	Carbody
19	Crawler (4)

FIGURE 1-1



Legend for FIGURE 1-1 continued

Item	Description	Item	Description
14a	VPC Actuator Frame	14g	Counterweight Tray
14b	VPC Actuator	14h	Counterweight Beam
14c	VPC Pivot Frame	14j	Counterweight Pad
14d	VPC Counterweight Frame	20	Rear Roller Carrier
14e	Counterweight Center Tray	21	Rotating Bed
14f	Counterweight Boxes	22	Front Roller Carrier

FIGURE 1-1 continued

GENERAL ABBREVIATIONS

Abbreviations listed are used throughout this manual.

A	Amber Light
ACR	Air Conditioning Relay
AI	Analog Input
AL	Auto Lube Pump
ALT	Alternator
AMP	Amperes (Electrical Current)
AS	Angle Sensor
AUX	Auxiliary
BH	Boom Hoist
CAB	Operators Cab
CAN	Controller Area Network
CCW	Counter Clockwise
CW	Clockwise
CWT	Counterweight
CYL	Cylinder
DISP	Displacement
ECOR	Electronic Compensated Over Ride (Motor)
EDC	Electrohydraulic Displacement Control (Pump)
EFC	Electronic Fuel Control
EPIC	Electrical Processed Independent Control
ER	Ether Relay
ES	Ether Start
EXT	Extend
FS	Fuel Solenoid
FSR	Fuel Solenoid Relay
G	Green Light
GND	Ground (Electrical)
GPM	Gallons Per Minute
HDC	Hydraulic Displacement Control
HS	Hydraulic Solenoid
HYD	Hydraulic
LD	Load Drum
LJ	Luffing Jib
LS	Limit Switch
LT	Left Travel
MAX	Maximum
M/C	Motor Control
MINI	Minimum
NC	Normally Closed
NO	Normally Open
PC	Pilot Control
P/C	Pump Control
PCOR	Pressure Compensated Over-Ride
PCP	Pressure Control Pilot (Motor)
PCR	Pressure Compensated Regulator
PCV	Pressure Control Valve
PPU	Portable Power Unit
PSI	Pounds Per Square Inch
PWR	Power (Electrical)
R	Red Light
RCL	Rated Capacity
Ret	Retract
RPM	Revolutions Per Minute
RT	Right Travel
S	Swing
SOL	Solenoid
SS	Starter Solenoid or Speed Sensor
VDC	Volts Direct Current
VPC	Variable Position Counterweight
W	White Light

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GENERAL CRANE OPERATION

See Figure 1-2 for the following procedure.

This section describes the standard and optional equipment available for Model 31000 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 cab (see Main Display Folio 2207 Operation manual).

Two diesel engines provide power to operate system pumps through two pump drive transmissions. In a closed-loop hydraulic system, high-pressure hydraulic fluid from the system pumps drive hydraulic motors or cylinders. Pressure develops within the closed-loop system while resistance to movement of the load on motor or cylinder is overcome. When movement begins, pump volume displacement maintains motor speed or cylinder movement. The spent hydraulic fluid from the motor outlet returns to pump input. The crane closed loop systems are swing, right travel, left travel, boom/mast hoist, variable position counterweight, and load drums.

Enabled means hydraulic fluid ***can flow*** in a system or electrical component ***is on***. ***Disabled*** means hydraulic fluid ***is blocked*** in a system or electrical component ***is off***. Each hydraulic solenoid valve is assigned an HS number for identification purposes only. See Section 2 for solenoid valve table identification.

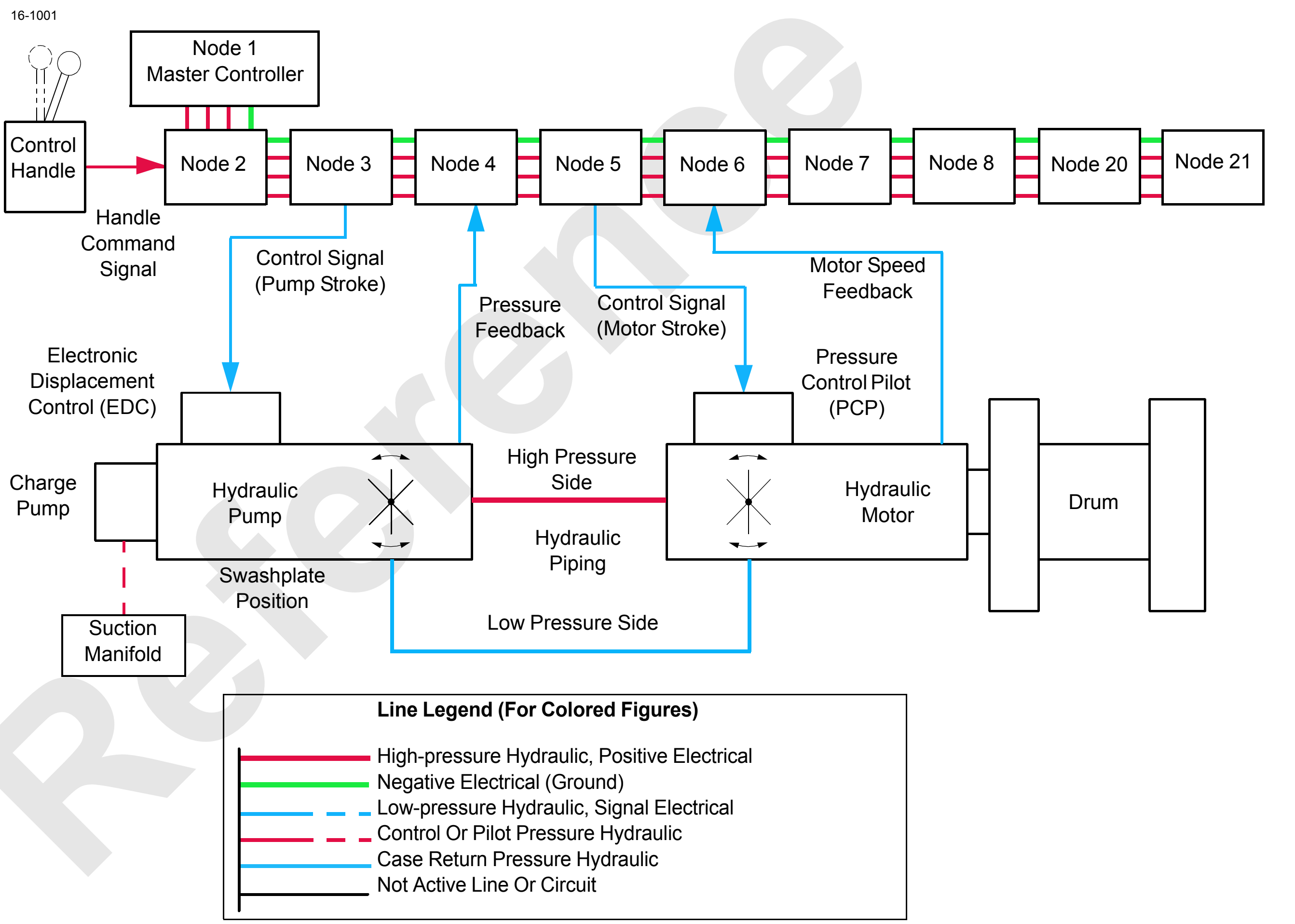

FIGURE 1-2

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SECTION 2
HYDRAULIC SYSTEM

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SECTION 2
HYDRAULIC SYSTEM

HYDRAULIC SCHEMATICS

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

HYDRAULIC SYSTEM – GENERAL

This section contains hydraulic system maintenance, adjustment, and test procedures for the hydraulic system and related components on the Model 31000.

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

Contact Manitowoc Crane Care at the factory for a explanation of any procedure not fully understood.

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

CAUTION

Avoid Hydraulic System Damage!

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

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

Hydraulic Components

High-pressure piston pumps driven by two multi-pump drive transmissions 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 two separate desiccant breathers, suction strainer, return filters, diffuser, temperature sensor, level sight gauge and level sensor, and pressure ports.

The suction section has a 100 micron mesh strainer that allows fluid bypass around strainer at 3 psi (0,21 bar) if it becomes plugged. The breather protects the tank from excessive pressures or vacuum. Breather valves open at 50 psi, (3,45 bar).

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

Tank hydraulic strainers and filters remove contaminants from fluid. System filtration does not transform deteriorated fluid into purified quality fluid. A program to test or replace hydraulic fluid at scheduled times must be established for efficient operation of all hydraulic systems.

Shut-off Valve

Hydraulic shut-off valves are located between tank and suction manifold and the tank and return line. Close these shut-off valves when performing maintenance on hydraulic systems. ***Open shut-off valves before starting engine.***

Manifold

Manifold supplies fluid to all system pumps. When shut-off valves are open, fluid flows from tank to pumps through suction manifold. Pump supplies hydraulic fluid to filter manifold. Charge filters must be changed when system fault alarm is enabled and fault display indicates that filters need to be serviced.

Return Manifolds

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

Hydraulic Fluid Cooler

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

Hydraulic Pumps

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

Two pumps, one on the primary engine and one on the secondary engine drive the drum, swing, travel and VPC motors.

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

Each pump contains:

- Charge pump.

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- 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 rotor type gear charge pump that is internally mounted on the end of each pump system drive shaft. System charge pump draws fluid directly from manifold and delivers it to closed-loop system at a charge pressure of approximately 350 psi (24 bar). Charge pressure depends on engine load/speed, pressure relief valve settings, and hydraulic system efficiency.

When a system control handle is moved, a node controller sends a variable 0 to 28 volt output to pump EDC as required for handle command direction. Pump EDC tilts swash plate 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.

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

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

Charge Pressure

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

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

Hydraulic Motors

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

Variable displacement low torque/high speed, bent axis piston hydraulic motors are used in the travel, boom hoist, variable position counterweight (VPC) and load drum systems. The swing system motor is a fixed displacement, low torque/high speed, straight axial piston hydraulic motor. Each motor contains a cylinder block, pistons, output shaft, and internal or external flushing valve. Boom hoist, load drum, and VPC motors have an EDC that controls output speed/torque of the motor.

Motor cylinder block with bent 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 swash plate. The motor piston ends are connected to output flange face and do not ride around the axis of rotating flange face like the pump pistons.

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

Pressure Monitoring

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

Basic Operation

See Figure 2-1 or Figure 2-2 for the following procedure.

When a control handle is moved from neutral, an input voltage in the handle command direction is sent to node-1 controller. The selected component node controller sends a variable 0 to 28 volt output that is divided by a 220 ohm resistor and applied to pump external EDC (Electrical Displacement Control). The output current magnetizes an armature (Figure 2-1) and starts to block one of the orifice ports, depending on command direction.

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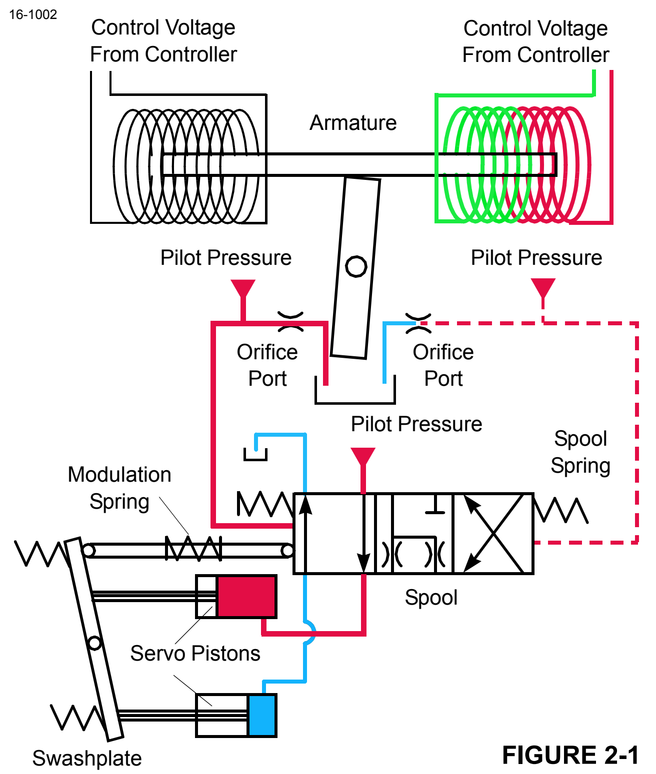

FIGURE 2-1

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 swash plate, stroking the pump in selected command direction. As swash plate 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 2-2), shifting spool to open a line for fluid pressure. Servo check valve (2) is spring loaded with an opening pressure of 750 psi (52 bar). Hydraulic fluid from pressure limiting relief valve flows through exhaust port of displacement control valve (3).

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

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

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

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

Each variable displacement motor, except travel, begins operation at maximum displacement (high torque, low speed) and shifts to minimum displacement (low torque, high speed) if torque requirement is low. The motor remains in maximum displacement until servo PC valve (10) receives a command from motor control valve (11) to direct system pressure and flow from shuttle valve (12) to minimum displacement side of servo cylinder (13) that shifts motor. As the motor control 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. The computer monitors the pressure and electronically de-strokes the motor to maximum displacement for safe load handling when the pressure becomes too high in the closed loop circuit by sending a signal to the proportional motor control valve. Hoist and VPC Motor displacement is controlled by the EDC. The Master Node monitors closed loop pressure and shifts the motor electronically to low speed, maximum displacement through the proportional motor control solenoid.

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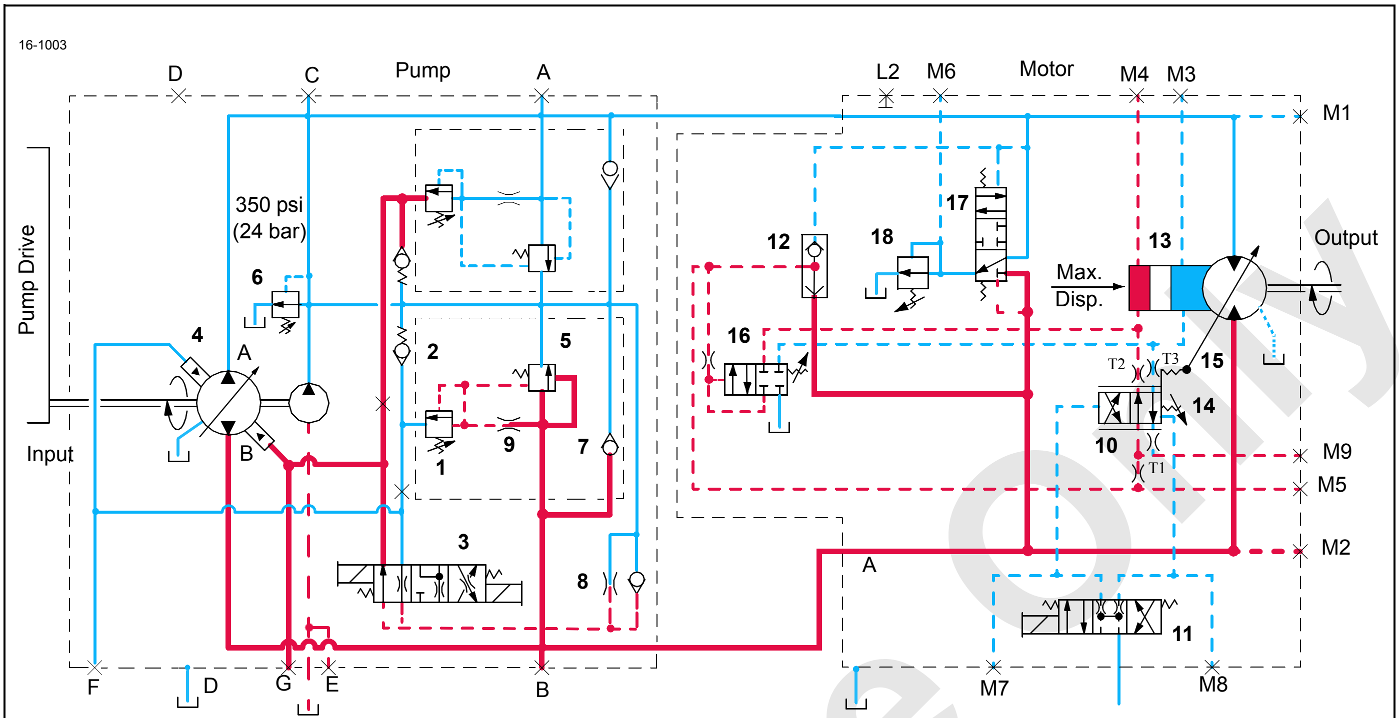


FIGURE 2-2

The travel motors have a PCOR (Pressure Compensating Over-Ride) valve (16) that is enabled when system pressure of 3,915 (340 bar) is reached. When system pressure exceeds the PCOR setting, the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

The travel motor servo is opposite of other system motors and is commonly referred to as having a reverse logic PC spool. The travel variable displacement motors begin operation at minimum displacement (low torque, high speed). The motor shifts to maximum displacement (high torque, low speed) when starting torque is required and back to minimum displacement when in motion if load is below a preset pressure of 3,915 psi (270 bar). Depending on motor system, servo uses low pressure accessory system pressure to perform the shifting operation. Servo control fluid shifts shuttle valve and servo control valve before entering servo cylinder.

Continuous changing of closed-loop fluid occurs through leakage in pumps, motors, and loop flushing valves. Motor case fluid drainage lubricates the motor and provides a re-circulation of hydraulic fluid to control heat in closed-loop system. Motors also have an internal or external loop flushing (purge) system that consists of control valve (17) and relief valve (18). If system pressure is above 200 psi (14 bar), loop flushing removes 4 g/m (15 L/m) of hot fluid from system for added cooling and purification. If system pressure is under 200 psi (14 bar) loop flush is disabled.

Accessory Source

The Drum 6/LF Crawler pump (Pump 9) is the source of pressure for accessory system components. The programmable controller controls the pump output pressure to the accessory system functions by monitoring pressure sending feedback.

Drum 6/LF Crawler (Pump 9)supplies hydraulic fluid to operate the following:

- **Carbody accessories** (jacking cylinders and pin pusher cylinders are utilized during crane assembly and disassembly and primarily powered by the PPU, Portable Power Unit).
- **Rotating bed accessories** (seat tilt cylinder, rigging winches, pin cylinders, VPC assist cylinder, backhitch pins, counterweight beam cylinders, and counterweight pins).
- **Miscellaneous accessory** (rotating bed pins, drum mounting pins, boom butt pins, carrier pins, backhitch pins, counterweight tray pins, VPC rod pins, and pin cylinders).

Drum 6/LF Crawler pump (Pump 9) pressure is reduced from 3,000 to 500 psi (400 psi at standby) by the reducing valve for travel brake, travel two-speed, swing brake, and drum 6 brake.

Reference Only

CHECKING AND REPLACING HYDRAULIC HOSES

CAUTION

Burn Hazard!

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

Ensure that the hydraulic hoses are depressurized before loosening any connections.

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

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

   If any of these conditions exist, address them appropriately.

See Table 2-1 below for the following items.

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

Table 2-1 Climate Zone Classification:

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

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

HYDRAULIC SYSTEM – MAINTENANCE

Safety

- Lower or securely block hydraulically operated attachments and loads before servicing. Do not rely on controls to support attachments or loads.
- Stop engine and relieve hydraulic pressure to zero before servicing or disconnecting any part of hydraulic system. After stopping engine, operate controls in both directions to relieve pressure.
- Before servicing hydraulic system, attach warning sign to engine start controls to warn other personnel not to start engine.
- Do not perform hydraulic system maintenance, adjustment or repair procedures unless authorized to do so. 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***.

Reference Only

- 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 drum top. Also clean faucet or pump used to remove oil from drum.
- Only use clean transfer containers.
- Do not take oil from storage until oil is needed. If oil cannot be used immediately, keep transfer container tightly covered.

Storing And Handling Parts

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

HYDRAULIC SOLENOID VALVE IDENTIFICATION

In this section a hydraulic system that is ***open*** means fluid can flow in the circuit. Each hydraulic solenoid valve in this section is assigned an HS number for identification and troubleshooting purposes. Table 2-2 identifies each hydraulic solenoid valve. Table 2-3 identifies the proportional hydraulic solenoid motor control for each motor. Table 2-4 identifies each pump and its closed loop circuit; see Figure 2-34 and Figure 2-35 for pump location.

Function Identification

Table 2-2 Solenoid Valve

HS-56	Drum 3 Left Side Brake Release
HS-57	Drum 5 Diverter Valve
HS-58	Drum 6 Diverter Valve
HS-59	Travel 2-Speed
HS-60	Travel Brake Release
HS-61	Drum 6 Brake Release
HS-62	Swing Brake Release
HS-63	Drum 1 Left Side Brake Release
HS-64	Swing House Roller Greaser Valve
HS-65	VPC Guide Roller Greaser Valve
HS-66	VPC Rack/Pinion Greaser Valve
HS-67	VPC Pivot Frame Greaser Valve
HS-68	Boom Butt Greaser Valve
HS-69	Assist Cylinder Extend
HS-70	Assist Cylinder Retract
HS-71	Counterweight Beam Cylinder Extend
HS-72	Counterweight Beam Cylinder Retract
HS-73	Counterweight Beam Pin Locks L-Release
HS-74	Counterweight Beam Pin Locks R-Release
HS-75	VPC Left Side 1 Motor Control 1
HS-76	VPC Right Side 3 Motor Control 3
HS-77	VPC Actuator Brake
HS-78	VPC Left Side 2 Motor Control 2
HS-79	VPC Right Side 4 Motor Control 4
HS-80	Drum 0 Right Side Spool IN
HS-81	Drum 0 Right Side Spool OUT
HS-82	Drum 0 Left Side Spool IN
HS-83	Drum 0 Left Side Spool OUT
HS-84	Drum 4 Left Side Brake Release
HS-85	Drum 4 Left Side Pawl Retract
HS-86	Drum 4 Left Side Paul Extend
HS-87	Backhitch Pins Retract
HS-88	Backhitch Pins Extend
HS-89	Drum 2 Left Side Brake Release
HS-90	Cab Seat Raise
HS-91	Cab Seat Lower
HS-92	Hydraulic Generator Bypass Valve
HS-93	Drum 5 Right Side Brake Release
HS-94	Drum 5 Right Side Pawl Retract
HS-95	Drum 5 Right Side Pawl Extend

Reference Only

Motor Control Identification

Table 2-3 Proportional Solenoid Valve

HS-37	Drum 3 LS1 Motor Control 1
HS-38	Drum 3 LS2 Motor Control 2
HS-39	Drum 3 RS 3 Motor Control 3
HS-40	Drum 3 RS 4 Motor Control 4
HS-41	Drum 1 LS1 Motor Control 1
HS-42	Drum 1 LS2 Motor Control 2
HS-43	Drum 1 RS3 Motor Control 3
HS-44	Drum 1 RS4 Motor Control 4
HS-45	Drum 4 RS3 Motor Control 3
HS-46	Drum 4 RS4 Motor Control 4
HS-47	Drum 4 LS1 Motor Control 1
HS-48	Drum 4 LS2 Motor Control 2
HS-49	Drum 2 RS3 Motor Control 3
HS-50	Drum 2 RS4 Motor Control 4
HS-51	Drum 2 LS1 Motor Control 1
HS-52	Drum 2 LS2 Motor Control 2
HS-53	Drum 5 RS1 Motor Control 1
HS-54	Drum 5 RS2 Motor Control 2
HS-55	Drum 6 LS Motor Control 1

Pump Identification

Table 2-4 Pump Identification

Pump 1	Primary Swing
Pump 2	Secondary Swing
Pump 3	Primary Drum 2
Pump 4	Secondary Drum 1
Pump 5	Primary Drum 1
Pump 6	Secondary Drum 4
Pump 7	Primary Drum 4
Pump 8	RF Track
Pump 9	LF Track/Drum 6/System Accessory
Pump 10	Secondary Drum 3
Pump 11	RR Track/ Drum 5
Pump 12	LR Track
Pump 13	Primary VPC Actuator
Pump 14	Secondary VPC Actuator
Pump 15	Primary Drum 3
Pump 16	Secondary Drum 2

INSPECTING SYSTEM

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

A good inspection program will include the following checks:

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

NOTE: For detailed instructions on accessing the display screens in the cab, see Main Display Manual.

2. Check hydraulic oil level daily when oil is cold by looking at oil level sight gauge on hydraulic tank (7, Figure 2-27) and hydraulic tank display on information screen in cab (Figure 2-3).

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

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

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

Hydraulic Tank Level and Temperature Display

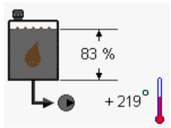


FIGURE 2-3

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 2-4). ***Fill tank immediately.***

HYDRAULIC FLUID LOW Fault Icon

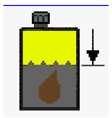


FIGURE 2-4

NOTE: Fill tank manually through plug opening (2a, Figure 2-27) or by pumping oil through power-fill coupling (2b) with owner supplied portable pump.

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

Reference Only

3. Only use approved hydraulic oil in system (see Section 9 in this manual).
4. Replace the desiccant breather cartridges (4, Figure 2-27), replace cartridge with a new one when all of the desiccant beads turn dark green (they are gold when new).
5. Clean exterior of system often; do not let dirt accumulate on or around any part of system.
6. Check for external leaks. Leaks are not only unsafe; they also attract dirt and in some cases allow air and water to enter system. Do not return leakage oil back to hydraulic tank.

   Do not to use your hands to check for leaks.

   - Look for oil leaking from fittings and from between parts that are bolted together. Tighten loose fittings and attaching bolts to proper torque; do not 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 the pump can also indicate cavitation (pump being starved of oil). This condition is caused by the following problems:

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

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

   If oil temperature in tank goes above 180°F (82°C), a fault alarm will come on and a fault symbol will appear on the active display. HYDRULIC RESERVOIR TEMPERATURE icon will appear on fault display (Figure 2-5).

HYDRAULIC RESERVOIR TEMPERATURE Fault Icon

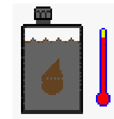


FIGURE 2-5

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

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

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

Replacing Desiccant Breather

This crane has two desiccant breathers, located on the hydraulic tank.

See Figure 2-6 for the following procedure.

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

Current Production Desiccant Breather

FIGURE 2-6

Replacing Filters

This crane has four hydraulic filters, as shown in Figure 2-27:

- Filter 1 (4 each return): 12-micron absolute which filter oil to all charge pumps.

Reference Only

If a filter is too dirty, a fault alarm will come on and a fault symbol will appear on the active display. HYDRULIC FILTER icon and corresponding filter number will appear on fault display (Figure 2-7).

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

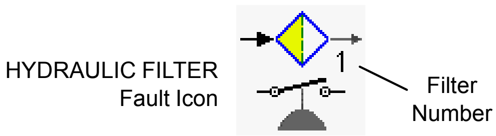


FIGURE 2-7

CAUTION

Avoid Hydraulic System Damage!

Original Equipment Manufacturers' filter elements – available from Manitowoc Crane Care – 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 Crane Care will reject warranty claims for damaged hydraulic components if proper hydraulic filter elements are not used.

See Figure 2-27 and 2-8 for the following procedure.

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

1. Stop engine.

WARNING

Burn Hazard!

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

Hot oil can escape when you remove either filter cover.

RELIEVE PRESSURE through air valve (5, Figure 2-27) on tank before servicing.

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

   Do not attempt to clean or reuse element.

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

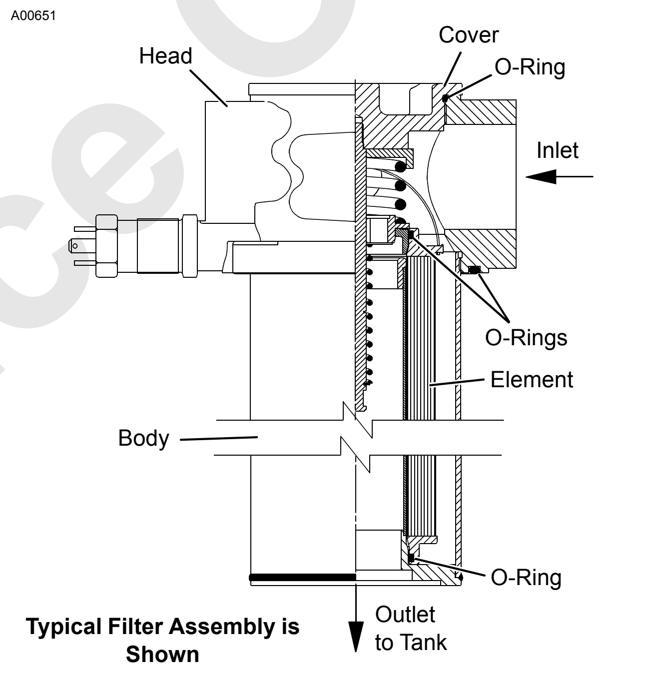


FIGURE 2-8

Changing Hydraulic Oil

See Figure 2-27 for the following procedure.

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

Reference Only

1. Operate crane until hydraulic oil is at normal operating temperature. This will help prevent impurities from settling in system. Stop engine.

2. Attach a rubber hose to hydraulic oil drain pipe under the power plant enclosure (Figure 2-9). Insert end of hose into a suitable container to catch hydraulic oil. See Section 9 of this manual for hydraulic system capacity.

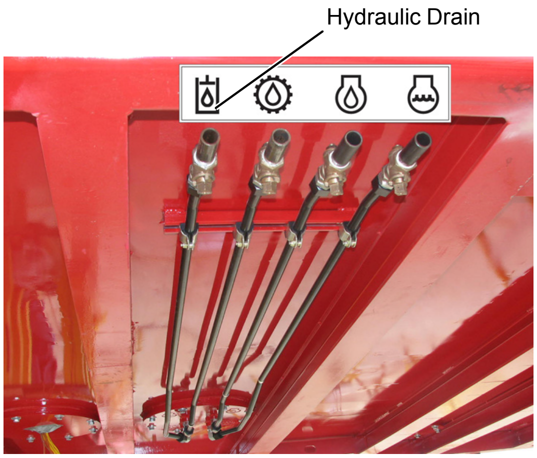


FIGURE 2-9

3. Open drain valve (11, Figure 2-27) at the tank and valve under the power plant enclosure. Drain tank completely.

Remove three side panels to access the hydraulic tank access covers (6, Figure 2-27). Panels are attached with Button Head tamper proof screws. The special Button Head tools (Figure 2-11) are located inside the wall storage cabinet mounted in the Operator Cab (Figure 2-10).

FIGURE 2-10

4. Clean all dirt from access cover (6, Figure 2-27) on side of tank and remove cover. ***Take care to prevent dust and wind-blown dirt from entering tank while covers are off.***

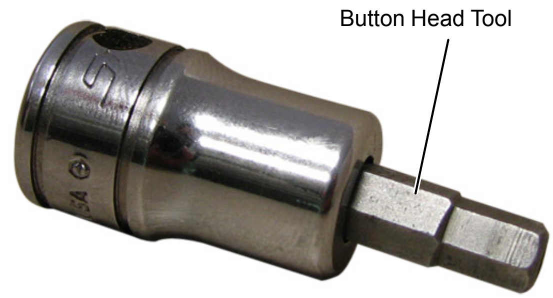


FIGURE 2-11

5. Flush out any sediment inside tank.

6. When tank is completely drained, close hydraulic tank drain valve (11, Figure 2-27) and let remaining hydraulic fluid drain from piping under the power plant enclosure. Then close drain valve under enclosure (Figure 2-9). Remove and store rubber hose.

7. Carefully inspect suction filters (four inside tank) for damaged or clogged holes and for sludge, gum or lacquer formation. If necessary, clean as follows:

   a. Remove clean out access covers (12, Figure 2-27) from bottom of tank.

   b. Using a wrench, remove suction filter from inside tank.

   c. Soak in clean, nonflammable solvent. Brush off outer surface, and flush from inside out. Discard if damaged.

   d. Securely reinstall suction filter.

8. Use new seals and securely fasten access covers to tank.

9. Reinstall three access side panels. Panels are attached with Button Head tamper proof screws.

10. Replace all four filter elements as instructed earlier in this section.

11. Install new desiccant breather if indicated (see instructions earlier in this section).

12. Make sure main shutoff valves are fully opened (9, Figure 2-27), with handle locking pin engaged.

13. At engine, check that both engine clutches are engaged. (Figure 2-12).

14. Determine vent bleed ports (Figure 2-14), and remove plugs or caps.

Reference Only

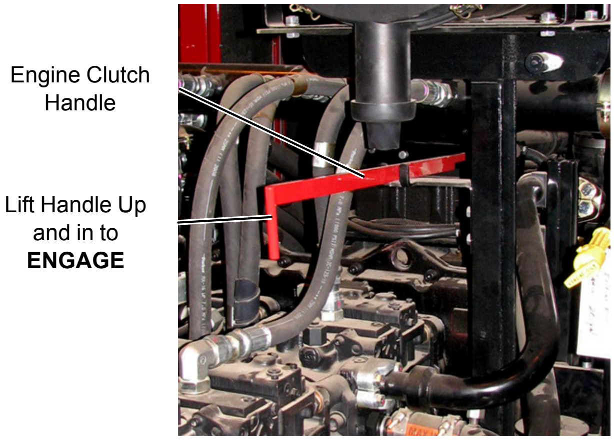


FIGURE 2-12

CAUTION

Avoid Damage to Hydraulic System!

The desiccant breather check valves could be damaged during hydraulic tank filling. The check valves setting allows 2 psi (0.14 bar) maximum pressure to remain in the tank to force oil into the charge system.

15. Depress air valve (5, Figure 2-27) on hydraulic tank, when filling through power fill coupling.

16. Fill hydraulic tank to ***FULL COLD LEVEL –*** 87-90% – while watching hydraulic tank display on information screen, or viewing sight gauge on hydraulic tank. (7, Figure 2-27). Use proper hydraulic oil (see Section 9 of this manual).

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

Fill tank by pumping oil through power-fill coupling (3, Figure 2-27) with an owner supplied portable pump or manually through plug opening (2, Figure 2-27). ***Use new hydraulic oil filtered through a 10-micron filter.***

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

17. Observe sight level gauge (7, Figure 2-27) on hydraulic tank and make sure tank fills to **full mark**.

NOTE: Hydraulic oil will exit bleed ports at lowest point first.

18. Securely install bleed plugs or caps as soon as clear oil appears at each bleed port opening.

19. To fill highest piping apply 2 psi (0.14 bar) owner supplied air pressure to air valve (5, Figure 2-27) on hydraulic tank, while observing highest vent bleed ports (Figure 2-14).

20. Securely install bleed plugs or caps as soon as clear oil appears at highest remaining bleed port openings.

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

21. Make sure each desiccant breather cap contains two air valves (Figure 2-13).

NOTE: Air valves are not interchangeable and must be installed as shown.

High Pressure Exhaust (Heavy Spring)

Low Pressure Suction (Light Spring)

FIGURE 2-13

CAUTION

Avoid Damage to Pumps!

Open **four** hydraulic tank shut-off valves (9, Figure 2-27) before starting engine. Failing to perform this step will result in damage to pumps from cavitation.

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

23. 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.

Reference Only

Hydraulic System Bleed Port Identification and Location

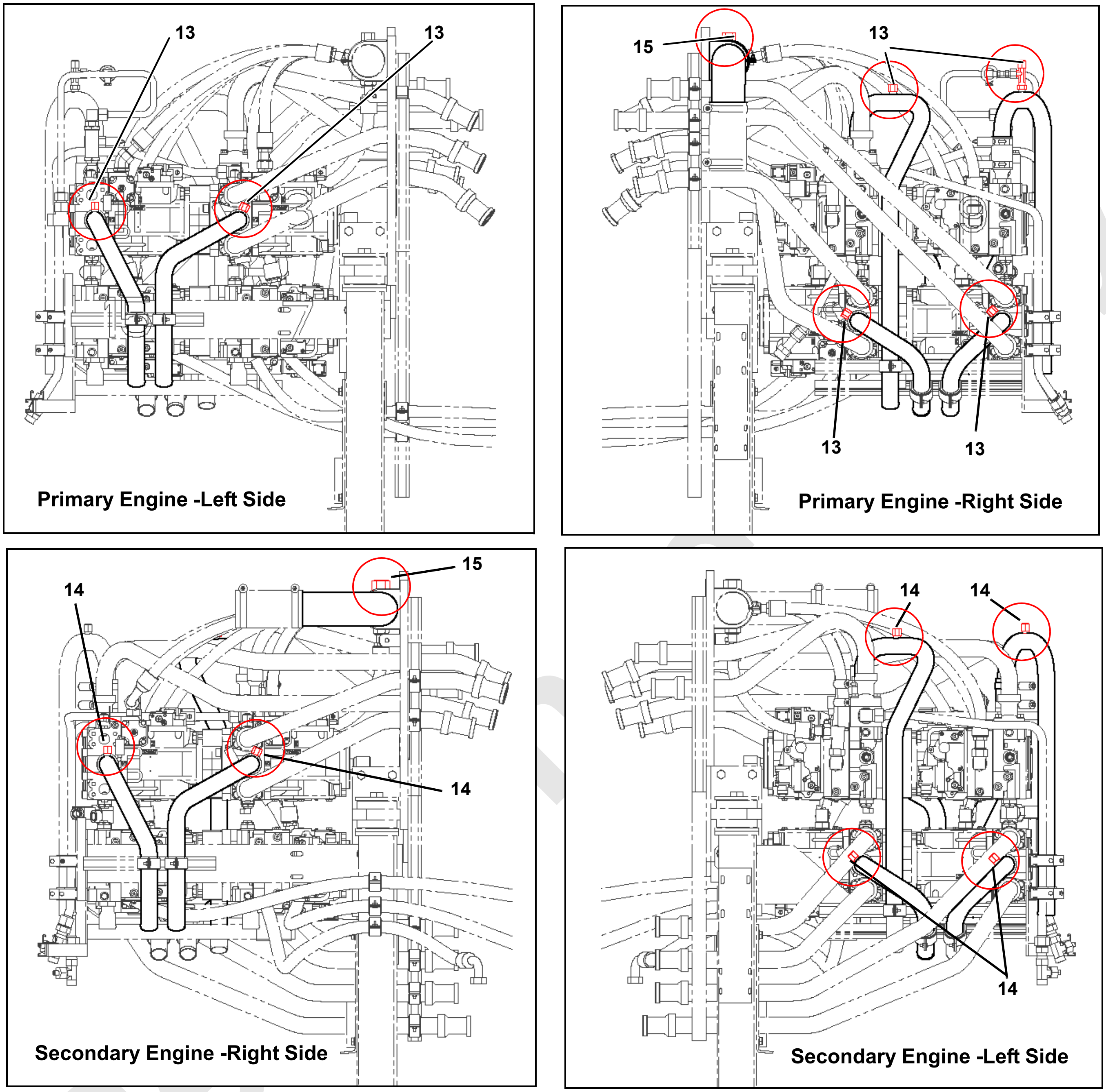


FIGURE 2-14

Servicing Pumps

It is not necessary to drain the hydraulic tank when servicing the hydraulic pumps. To service the pumps, close shut-off valves (9, Figure 2-27) in the pump suction manifold.

NOTE: Open the valves prior to starting the engine after servicing the pumps.

Tightening Hydraulic Connections

- Make sure fittings and O-rings being used are proper size and style.
- Flush sealing surfaces with clean hydraulic oil to remove any dirt.

- Carefully inspect threads and sealing surfaces for nicks, gouges, and other damage. Do not use damaged parts; they will leak.
- Carefully inspect O-rings for cuts and other damage. Do not use damaged O-rings; they will leak.
- Always lubricate O-rings when assembling on fittings.
- Be careful not to cut O-rings when assembling them to fittings. Use thimble as shown in Figure 2-15 when assembling O-ring over threads.

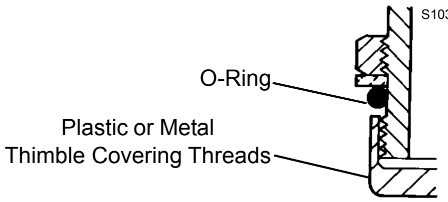


FIGURE 2-15

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 FTE-fluorocarbon 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 2-5 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 2-16, 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 2-16, View B.

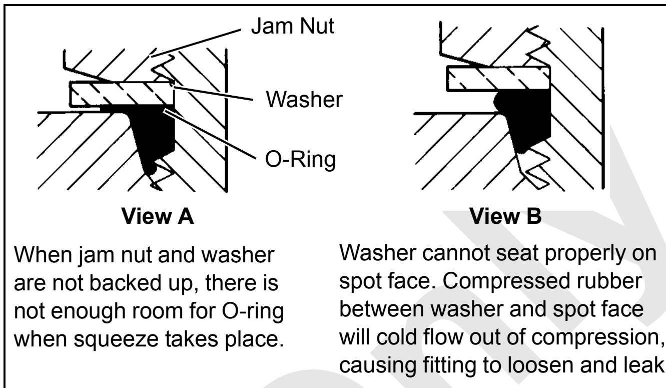


FIGURE 2-16

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 2-17, View A.

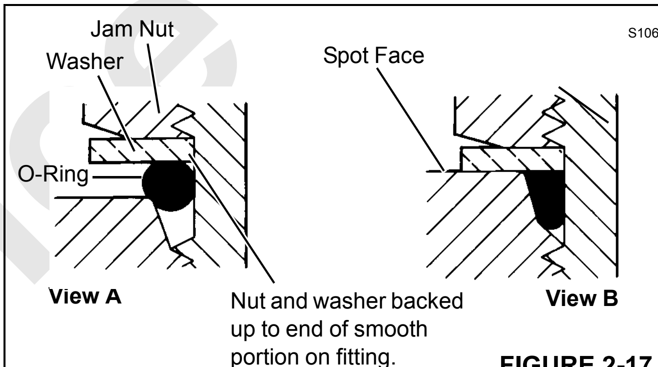


FIGURE 2-17

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 2-17, 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 2-17, View B.

Table 2-6 Straight Thread Leakage

Causes	Cures
Jam nut and washer not backed up at assembly, causing O-ring to be pinched.	Replace O-ring and tighten fitting properly.
O-ring cut.	Replace.
O-ring wrong size.	Replace with proper size.

Reference Only

Causes	Cures
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 2-18).

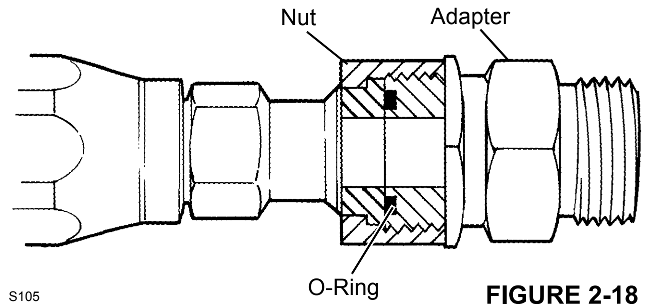


FIGURE 2-18

2. Lubricate threads.
3. Tighten nut to torque value given in Table 2-7.

Table 2-7 ORS Assembly Torque

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

Table 2-8 ORS Leakage

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

Split Flange Connection

1. Lubricate and install O-ring in shoulder groove (see Figure 2-19). 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 2-19) to 1/3 of torque given in Table 2-9.
3. Repeat step 2 to 2/3 of final torque. Repeat step 2 to final torque.

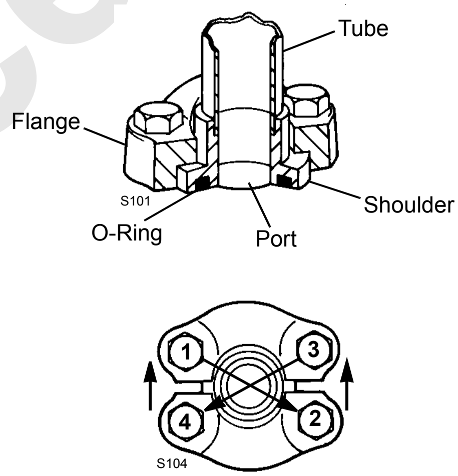
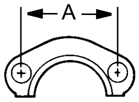


FIGURE 2-19

Reference Only

Table 2-9 Split Flange Assembly Torque

"A" Dimension inch  S102	Flange Size	Torque	
		in-Lb	Nm
Standard Pressure Series			
1-1/2	-08	175 – 225	20 – 25
1-7/8	-12	225 – 350	25 – 40
2-1/16	-16	325 – 425	37 – 48
2-5/16	-20	425 – 550	48 – 62
2-3/4	-24	550 – 700	62 – 79
3-1/16	-32	650 – 800	73 – 90
3-1/8	-24	1400 – 1600	158 – 181
3-13/16	-32	2400 – 2600	271 – 294
High Pressure Series			
1-9/16	-08	175 – 225	20 – 25
2	-12	300 – 400	34 – 45
2-1/4	-16	500 – 600	57 – 68
2-5/8	-20	750 – 900	85 – 102

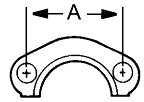
"A" Dimension inch  S102	Flange Size	Torque	
		in-Lb	Nm
3-1/8	-24	1400 – 1600	158 – 181
3-13/16	-32	2400 – 2600	271 – 294

Table 2-10 Split Flange Leakage

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

Reference Only

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 2-20, View A).
3. Using wrenches, tighten connector nut the number of flats shown in Table 7 (Figure 2-20, View B).

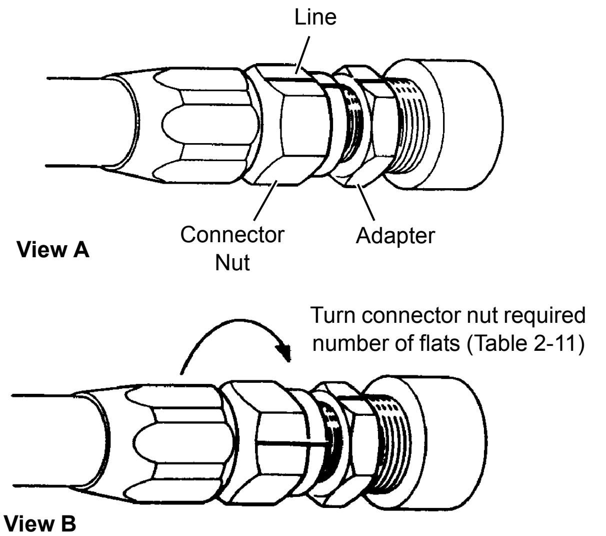


FIGURE 2-20

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

Table 2-11 SAE 37° Flare Tightening

Connector Nut Size inch across flats	**Fitting Size**	**Adapter Flats to Rotate**
9/16	-04	2-1/2
5/8	-05	2-1/2
11/16	-06	2
7/8	-08	2
1	-10	1-1/2 – 2
1-1/4	-12	1
1-1/2	-16	3/4 – 1
2	-20	3/4 – 1
2-1/4	-24	1/2 – 3/4

Table 2-12 SAE 37° Flare Leakage

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

Reference Only

Coupling Repair

The Quick Disconnect female coupling ends contain a replaceable valve cartridge and o-rings, the male end contains a seal and o-rings and both may be repaired if they leak or malfunction.

CAUTION

Burn Hazard!

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

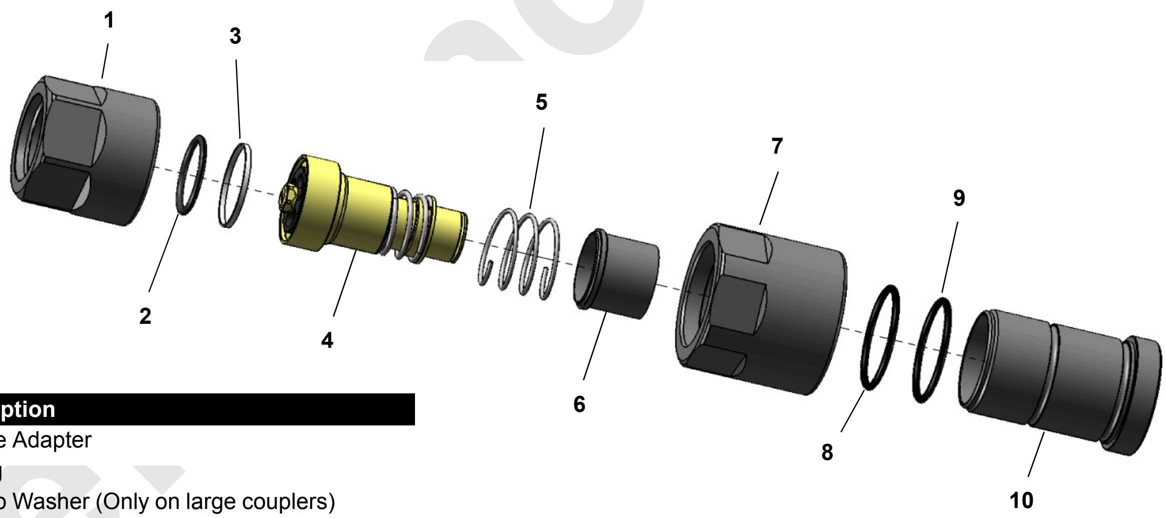
When disconnecting the hose, make sure you bleed-off all pressure from the hose before performing any maintenance.

Female Screwed Flat Face Coupling Cartridge Replacement (Cartridge Kit)

See Figure 2-21 for the following procedure.

1. Pull threaded sleeve (7) to the open position where the o-rings are exposed.
2. Install coupler into a fixture or a bench vice and using a hand torch, heat the female adapter (1) to approximately 250° C, until the coupler body (10) can be separated from the female adapter. Remove the female adapter from the coupling body.
3. Disassemble the female coupler as shown in Figure 2-21.
4. Clean the coupler body (10) and female adapter (1) threads of all residual thread locking compound.
5. Insert coupler body (10) into threaded sleeve (7) and re-install into fixture or bench vise.
6. Assemble the replacement cartridge assembly (4), o-rings, valve spring, bushing, and back washer if present, as shown in Figure 2-21 and loosely tighten the female adapter (1) to the coupler body (10). Check for proper operation of the coupler.
7. Remove the female adapter (1) and apply loctite #271 thread locking compound around entire circumference of the male threads on the coupler body.
8. Install the female adapter onto the coupler and tighten. Refer to torque chart (Table 2-13) for proper torque.
9. Remove from fixture or vise and check for leaks.

NOTE: Thread locking compound will develop a full cure in 24 hours.



Item	Description
1	Female Adapter
2	O-Ring
3	Backup Washer (Only on large couplers)
4	Cartridge (with or without spring)
5	Valve Spring
6	Bushing
7	Threaded Sleeve
8	O-Ring 1
9	O-Ring 2
10	Coupling Body

FIGURE 2-21

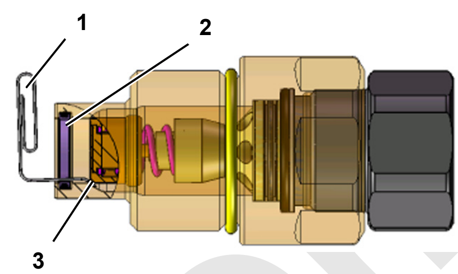
Male Screwed Flat Face Nipple and Push to Connect APM Nipple

O-Rings and Backup Washer Replacement (Seal Kit)

See Figure 2-23 for the following procedure.

1. Using a blunt, non-marring object, depress valve face until seals are exposed.
2. Bend a positioning clip as shown in Figure 2-22 and inset between valve face and body, captivating the valve face.
3. Use an o-ring pick to remove "U" cup and nitrile o-ring from retaining groove.
4. Remove the clip and extract worn seals.
5. Lubricate the new o-ring and seal with hydraulic fluid.
6. Repeat step 1, but insert the "U" cup seal and o-ring onto the bent portion of the positioning clip before captivating the valve face.
7. Gently work the o-ring and "U" cup seal into the retaining groove until seated.
8. Remove positioning clip bringing the valve face into the proper position.
9. Remove from fixture or vise and check for leaks.

NOTE: Thread locking compound will develop a full cure in 24 hours.



Item	Description
1	Positioning Clip
2	U-cup Seal & O-ring
3	Valve Face

FIGURE 2-22

Item	Description
1	Body O-Ring
2	U-Cup Seal
3	U-Cup O-Ring
4	Male Coupler
5	Positioning Clip
6	Alternate O-Ring and Backup Washer

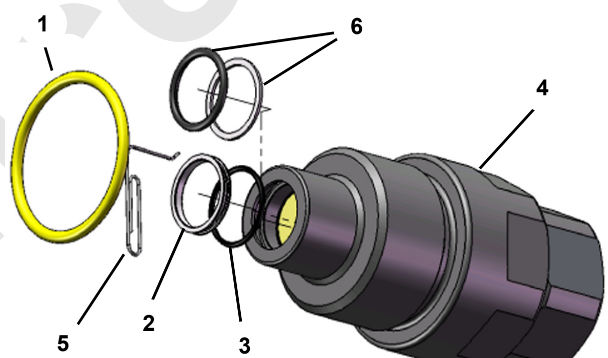


FIGURE 2-23

Reference Only

Reference Only

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Male Screwed Flat Face Nipple Cartridge Replacement (Cartridge Kit)

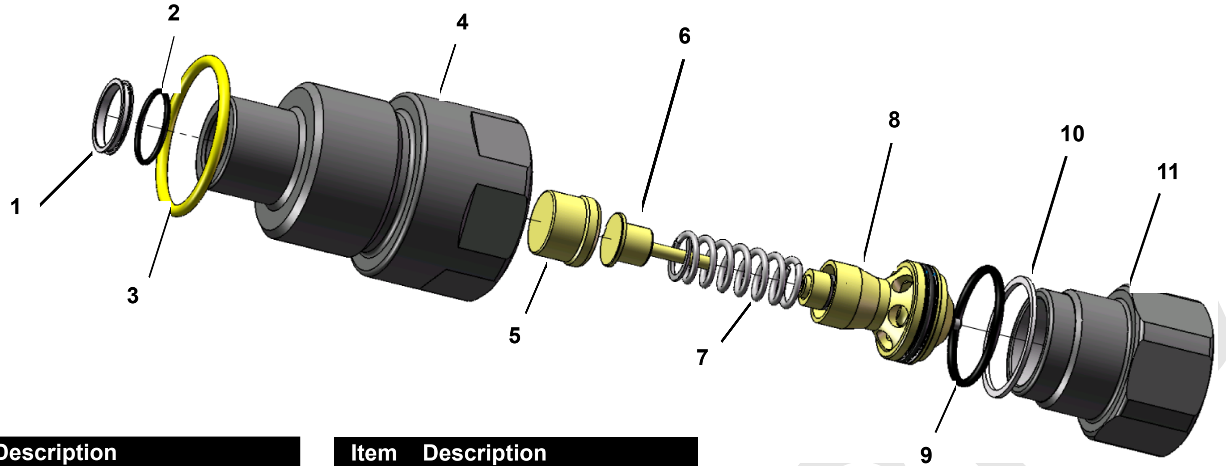
See Figure 2-24 for the following procedure.

1. Using a fixture or vise, remove female adapter from male coupler body.
2. Disassemble coupler as shown in Figure 2-24.
3. Clean the coupler body (4) and female adapter (11) threads of all residual thread locking compound using a suitable solvent. Let dry thoroughly before assembly.
4. Insert coupler body (4) into a female coupler sleeve and insert into fixture or vise.
5. Assemble replacement cartridge assembly (8) as shown in Figure 2-24, and loosely tighten the female adapter (11) to the coupler body (4), checking for proper operation of the coupler.
6. Remove female adapter and apply Loctite #271 thread locking compound around the entire circumference of the male threads on the female adapter.
7. Install female adapter on to coupler and tighten. Refer to Table 2-13 for proper torque.
8. Remove from fixture or vise and check for leaks.Threadlocking compound will develop a full cure in 24 hours.

Table 2-13 Hydraulic Coupling Torque

Part Number	Description	Torque
81003913	Female 12 Screwed Flat Face /12 ORB	95 lbft (130Nm)
81003914	Male 12 Screwed Flat Face /12 ORB	Not Applicable
81004196	Female.50 Push to Connect /12 ORB	75 lbft (100Nm)
81004195	Male.50 Push to Connect / 8 ORB	Not Applicable
81004279	Female 24 Screwed / 20 Flange Code 62	162 lbft (220Nm)
81004280	Male 24 Screwed / 20 Flange Code 62	325 lbft (440Nm)
81011470	Female 24 Screwed /20 Flange W/14	162 lbft (220Nm)
81011471	Male 24 Screwed / 20 Flange W/M14	325 lbft (440Nm)
81004856	Female 24 Screwed / 24 Flange Code 62	162 lbft (220Nm)
81004857	Male 24 Screwed / 24 Flange Code 62	325 lbft (440Nm)
81005206	Female 1.00 Screwed Flat Face / 16 ORB	120 lbft (160Nm)
81005205	Male 1.00 Screwed Flat Face /16 ORDB	135 lbft (180Nm)
81005208	Female 1-1/4 Screwed Flat Face / 20 ORB	132 lbft (180Nm)
81005207	Male 1-1/4 Screwed Flat Face /20 ORB	265 lbft (360Nm)

Reference Only



Item	Description
1	U-Cup Seal
2	Seal O-Ring
3	Body O-Ring
4	Coupler Body
5	Bushing

Item	Description
6	Spring Guide Piston
7	Valve Spring
8	Valve Assembly
9	O-Ring
10	Backup Washer
11	Female Adapt

FIGURE 2-24

Reference Only

Female Push to Connect Coupling Seal Kit Replacement

See Figure 2-26 for the following procedure.

NOTE: Use of Spline Key (Figure 2-25) is recommended to avoid damage to locking balls in the coupler.

1. If available install Locking Ball Spline Key (8) into coupler body. Slightly rotate and push in until ball engagement is made.
2. Place coupler into a fixture or a bench vice. Remove the female adapter from locking ball body.
3. Disassemble coupler as shown in Figure 2-26, and place coupler body into vise
4. Assemble the replacement cartridge assembly (4), o-rings, valve spring, piston, and back washer if present, as shown in Figure 2-26 and loosely tighten the female adapter (1) to the locking ball assembly (7). Check for proper operation of the coupler.
5. Tighten the female adapter onto the coupler. Refer to torque chart (Figure 2-13) for proper torque.
6. Remove from fixture or vise and check for leaks.

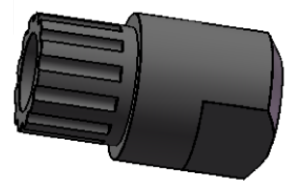
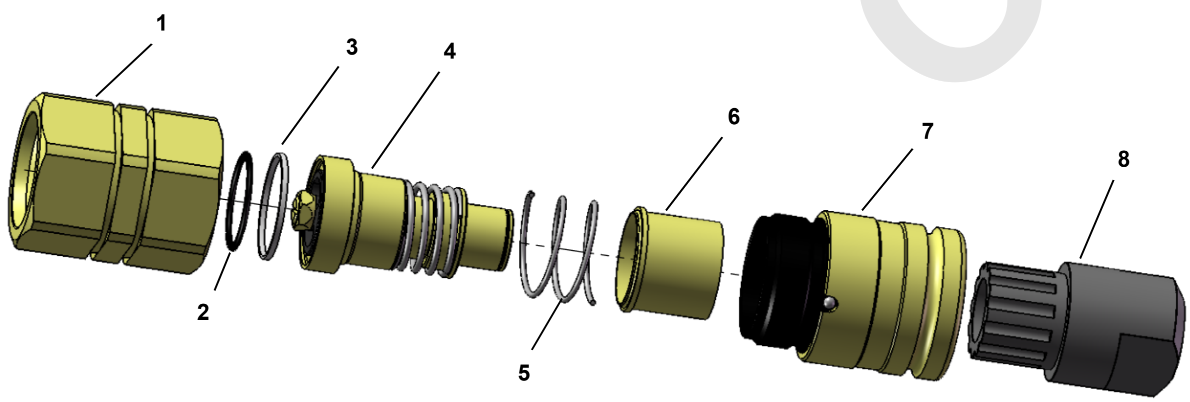


FIGURE 2-25



Item	Description
1	A-HD Female Adapter
2	O-Ring
3	TFE Backup Washer
4	Valve Cartridge
5	Valve Spring
6	Piston
7	Locking Ball Assembly
8	Spline Key

FIGURE 2-26

Reference Only

HYDRAULIC COMPONENT IDENTIFICATION

Hydraulic Tank Identification

Item	Description	Item	Description
1	Hydraulic Filters (Return)(4 each)	9	Shut-Off Valve Handle (shown closed)
2	Fill Plug (manual fill port)	10	Locking Pin (Shut-Off Valve)
3	Power-Fill Coupling	11	Hydraulic Tank Drain Valve
4	Desiccant Breather (2)	12	Tank Clean Out Access Covers (3)
5	Air Valve (for venting air)	13	Vent Cap (6 Primary Engine, Figure 2-1B)
6	Access Covers (3 each)	14	Vent Cap (6 Secondary Engine, Figure 2-1B)
7	Hydraulic Sight Level Gauge	15	Vent Cap (Charge Pressure Manifold, Figure 2-1B)
8	Hydraulic Temperature Gauge		

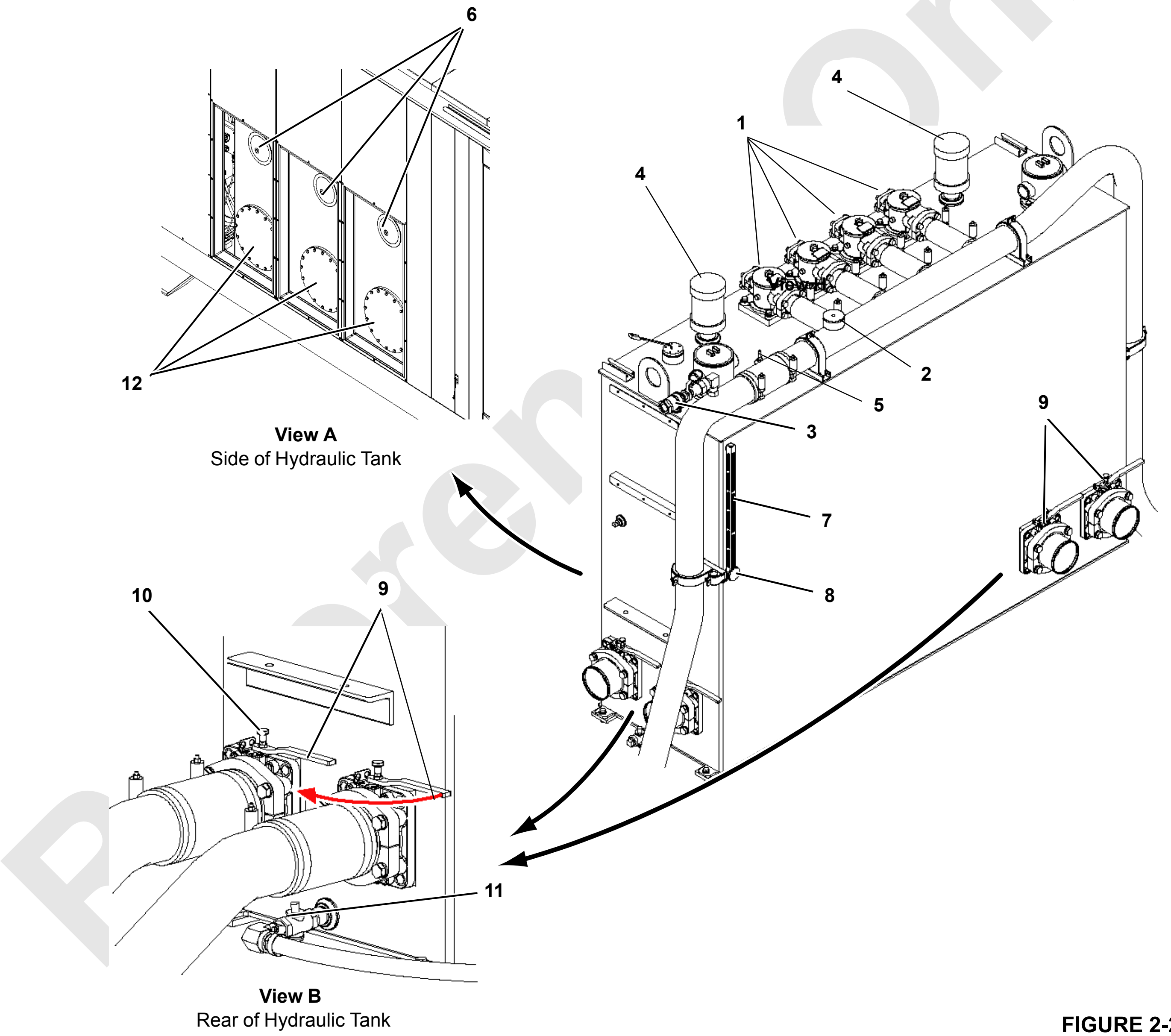
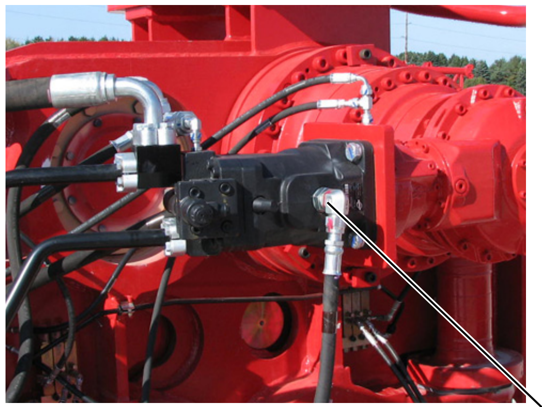
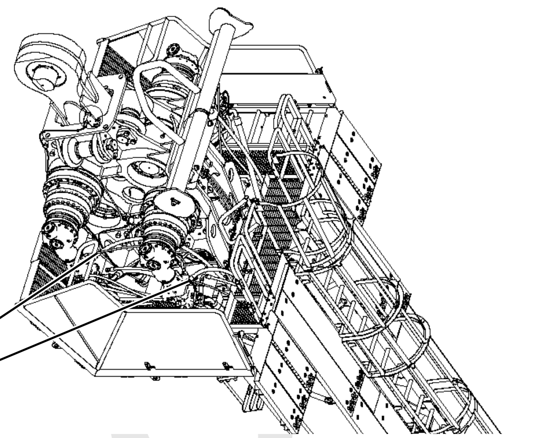


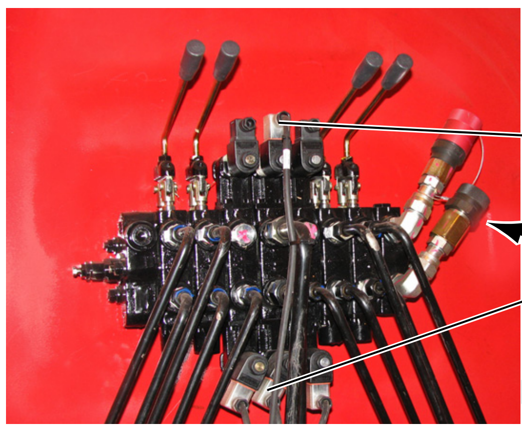
FIGURE 2-27

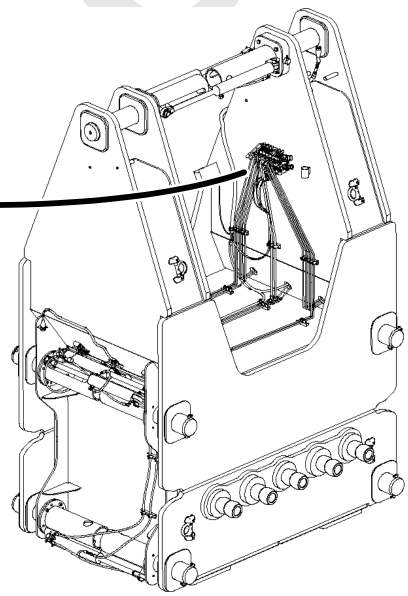
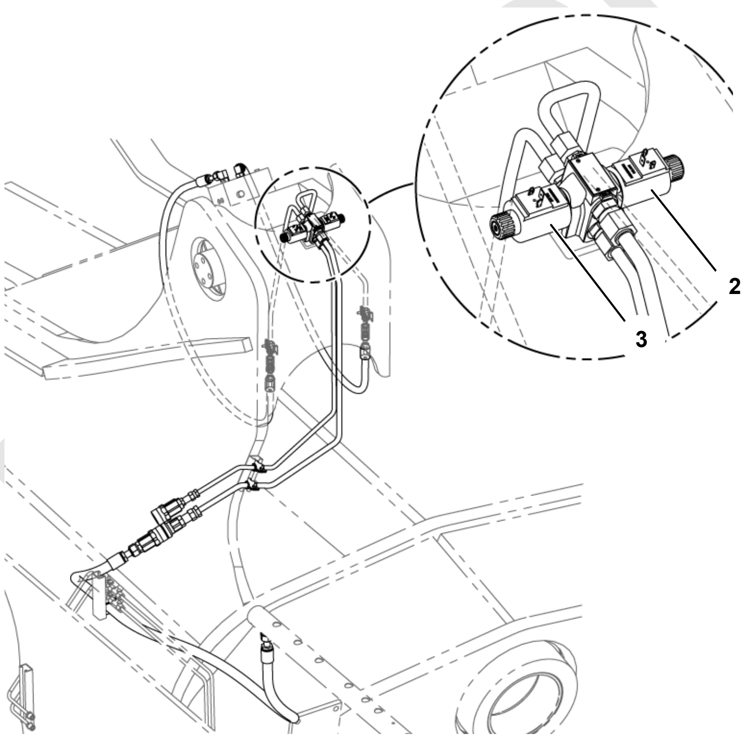
Preview Only

VPC Motor & Solenoid Identification

Actuator - Variable Position Counterweight (VPC)

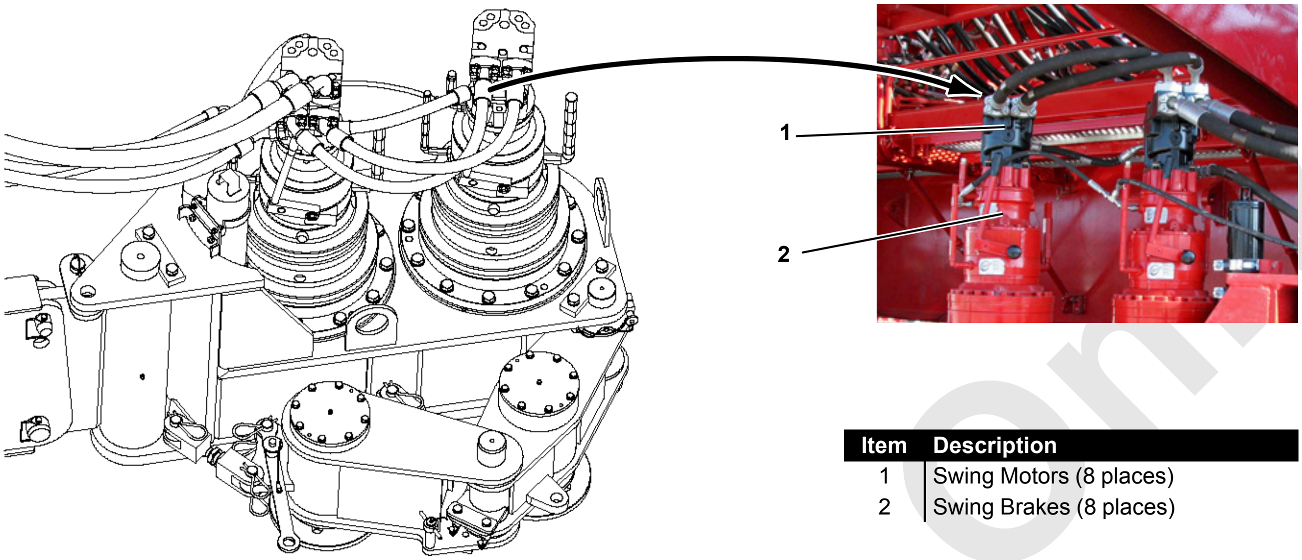


Item	Case Drain Ports
1	Actuator Motor (4 places)
Item	**Solenoid Valves**
2	VPC Assist Cylinder - Retract
3	VPC Assist Cylinder - Extend
4	Counterweight Beam Cylinder Extend
5	Counterweight Beam Cylinder Retract

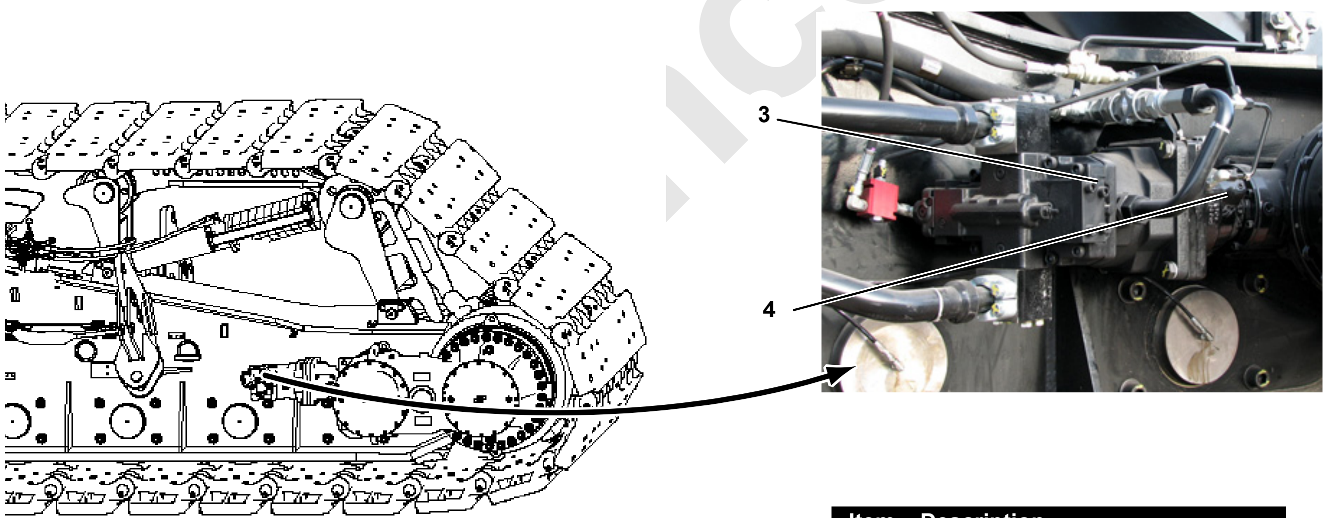
FIGURE 2-28

Swing & Travel Motor Identification



Swing Motor

Item	Description
1	Swing Motors (8 places)
2	Swing Brakes (8 places)

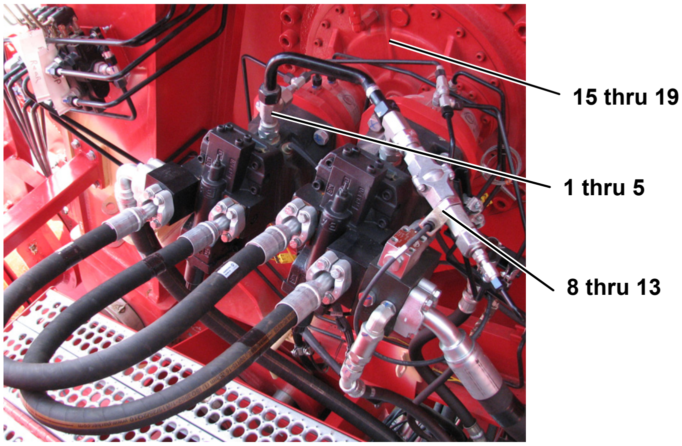


Travel Motors

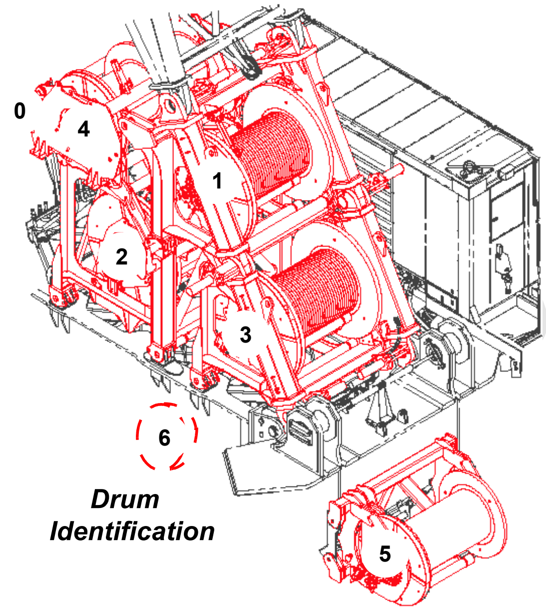
Item	Description
3	Travel Motors(8 places)
4	Travel Brakes (8 places)

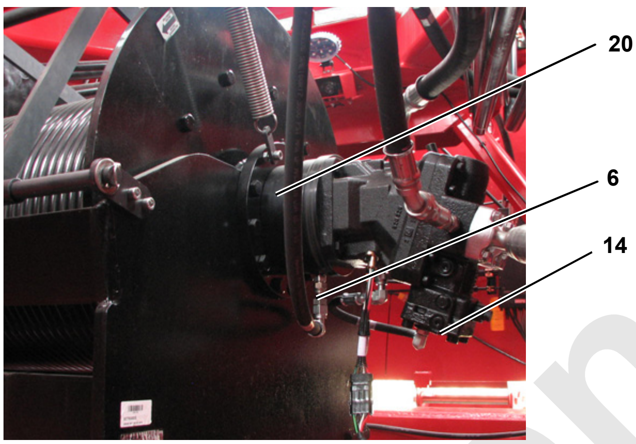
FIGURE 2-29

Drum Shaft Motor Identification

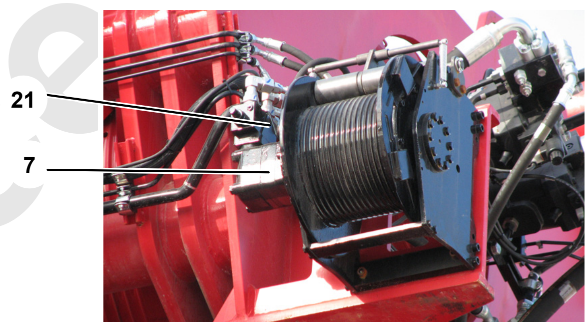


Typical Hoist Motors 1, 2, 3, 4, 5





Rigging Winch (6) Motor



Rigging Winch (0)

Reference

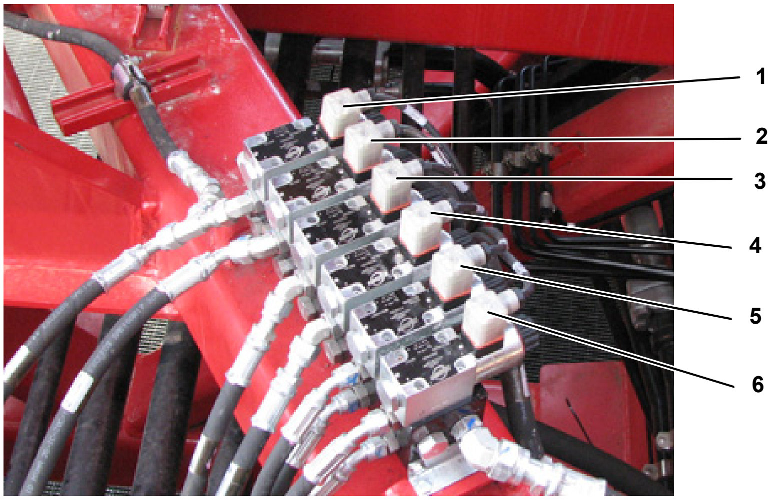
Item	Description Case Drain Ports
1	Main Load Hoist #1 Motor (Qty 4)
2	Main Load Hoist #2 Motor (Qty 4)
3	Whip/Aux Load Hoist Motor (Qty 4)
4	Boom Hoist Motor (Qty 4)
5	Luffing Hoist Motor (Qty 2)
6	Rigging Winch Drum 6 (Qty 1)
7	Rigging Winch Drum 0 (Qty 2)
	Brake Solenoid Valves
8	Electric Connector (typical)
9	Main Load Hoist #1 Motor
10	Main Load Hoist #2 Motor
11	Whip/Aux Load Hoist Motor
12	Boom Hoist Motor
13	Luffing Hoist Motor
14	Rigging Winch Drum 6

Item	Description Brakes
15	Main Load Hoist #1 Motor (Qty 4)[1]
16	Main Load Hoist #2 Motor (Qty 4)[1]
17	Whip/Aux Load Hoist Motor (Qty 4)[1]
18	Boom Hoist Motor (Qty 4)[1]
19	Luffing Hoist Motor (Qty 2)[1]
20	Rigging Winch Drum 6 (Qty 1)[1]
21	Rigging Winch Drum 0 (Qty 2)

[1] Brakes are located between planetary and hydraulic motor.

FIGURE 2-30

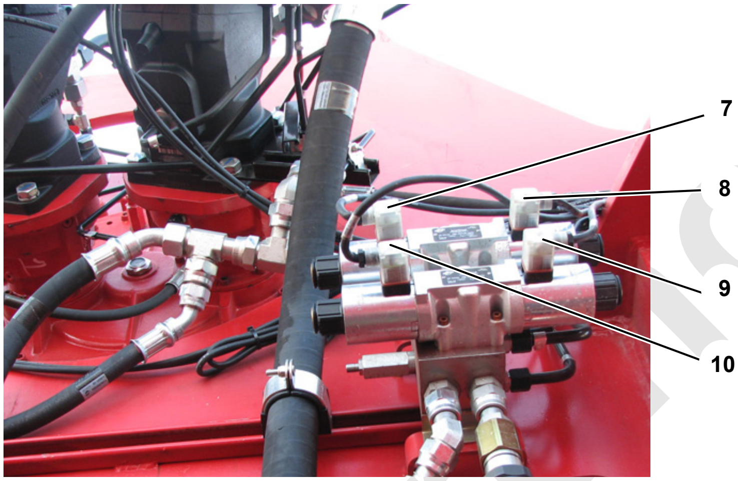
Solenoid Valve Identification



Item	Description
1	Swing Brake Release Solenoid
2	Drum 6 Brake Release Solenoid
3	Travel Brake Release Solenoid
4	Travel 2-Speed Solenoid
5	Drum 6 Diverter Valve Solenoid
6	Drum 5 Diverter Valve Solenoid

Solenoid Bank

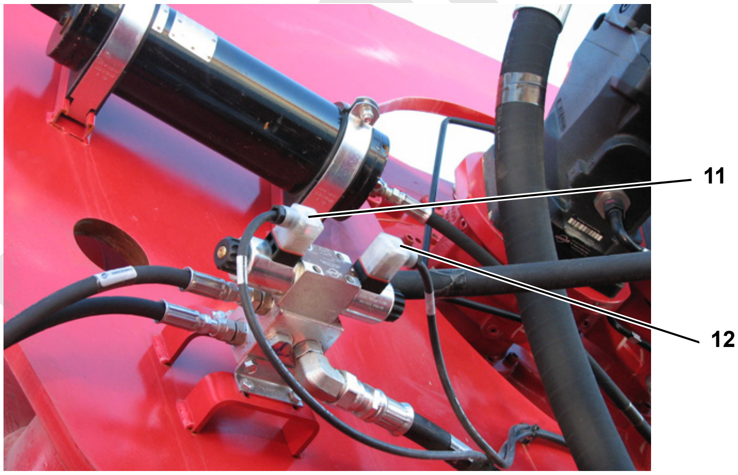
Located on Rotating Bed (Back Right Side near VPC Actuator)



Item	Description
7	Drum 0 Left Spool In Solenoid
8	Drum 0 Left Spool Out Solenoid
9	Drum 0 Right Spool Out Solenoid
10	Drum 0 Right Spool In Solenoid

Drum 0 Spool Solenoids

Located on Drum 4 Housing (Left Side)



Item	Description
11	Drum Pawl Extend Solenoid
12	Drum Pawl Retract Solenoid

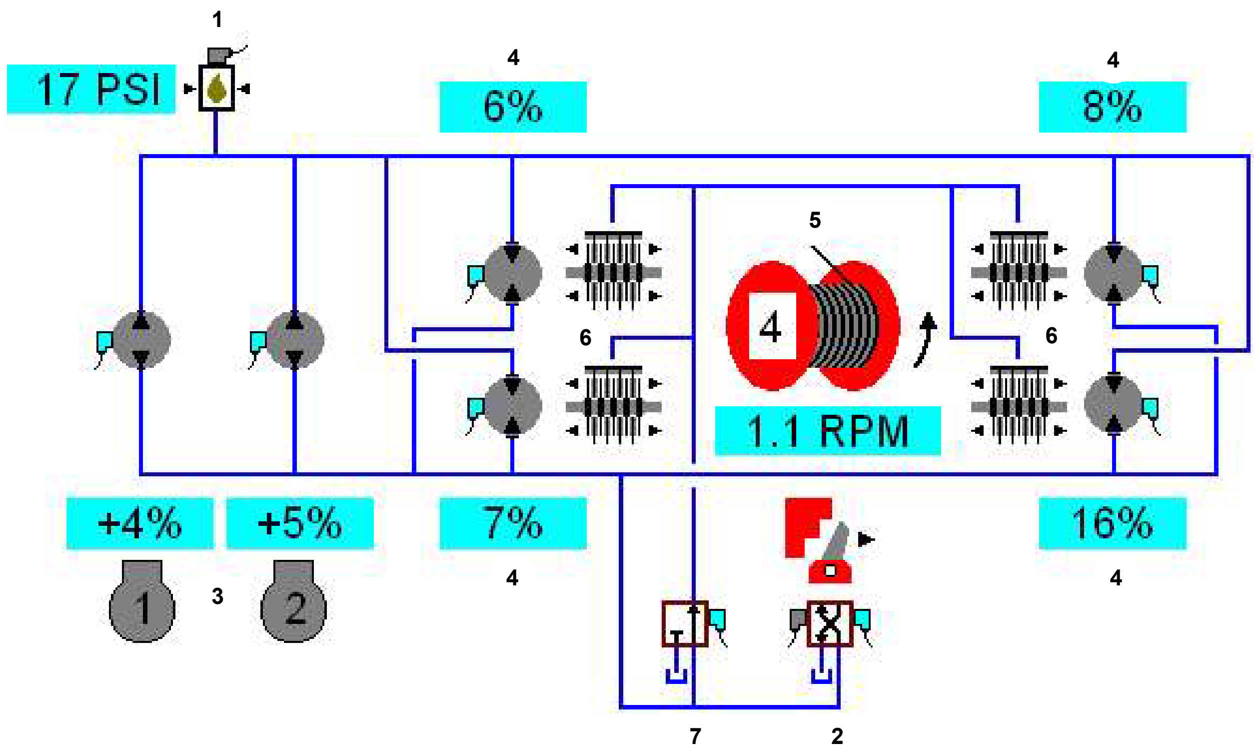
Typical Drum Pawl Solenoids

Located on Drum 4 & 5 Housing (Left Side)

FIGURE 2-31

Reference Only

Function Diagnostic Screen (Typical)

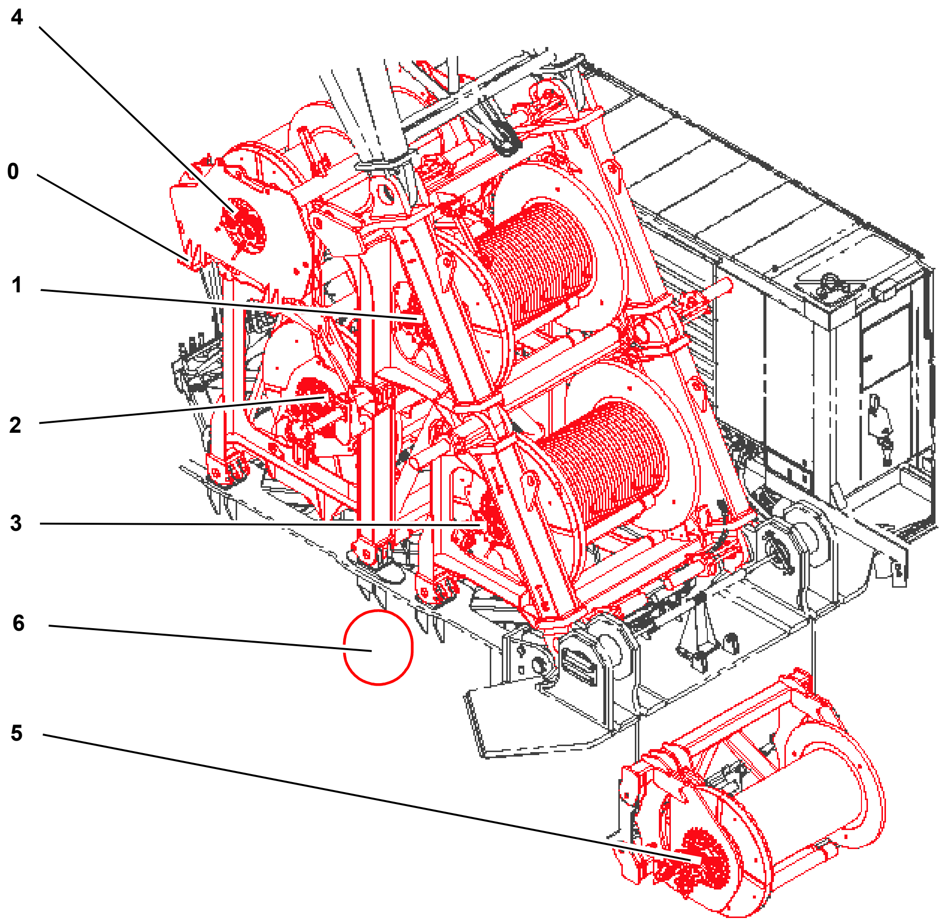


Item	Description	Item	Description
1	Pressure Sender (high pressure)	5	Drum Speed
2	Drum Pawl	6	Parking Brake
3	Pump Command	7	Brake Solenoid
4	Motor Command		

FIGURE 2-32

Reference

Drum Identification

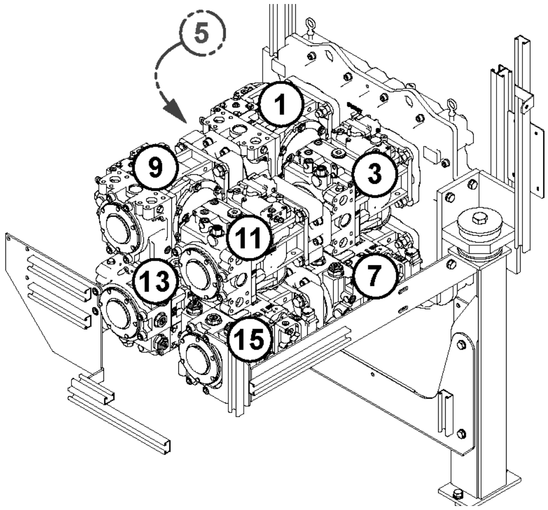


Drum No.	Description
1	Main Load Hoist #1
2	Main Load Hoist #2
3	Whip/Aux Load Drum
4	Boom Hoist
5	Luffing Hoist
6	Rigging Winch (not shown)
0	Rigging Winch (2 places, not shown)

FIGURE 2-33

Reference Only

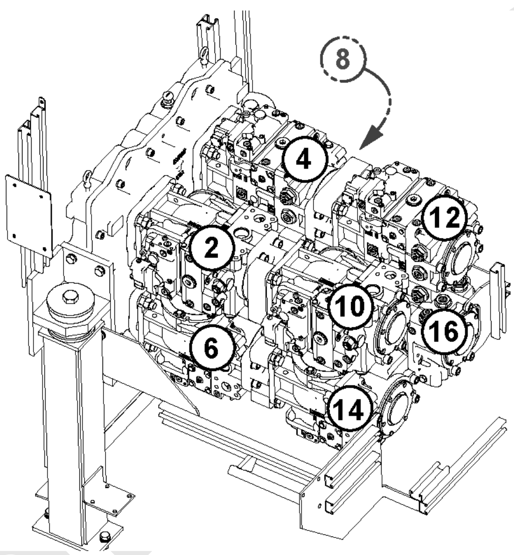
Primary Pump Identification



Pump	Description
1	Swing Pump
3	Drum 2 Pump
5	Drum 1 Pump
7	Drum 4 Pump
9	Left Front Crawler and Drum 6 Pump
11	Right Rear Crawler and Drum 5 Pump
13	VPC Actuator Pump
15	Drum 3 Pump

FIGURE 2-34

Secondary Pump Identification



Pump	Description
2	Swing Pump
4	Drum 1 Pump
6	Drum 4 Pump
8	Right Front Crawler
10	Drum 3 Pump
12	Left Rear Crawler
14	VPC Actuator Pump
16	Drum 2 Pump

FIGURE 2-35

Reference Only

Reference Only

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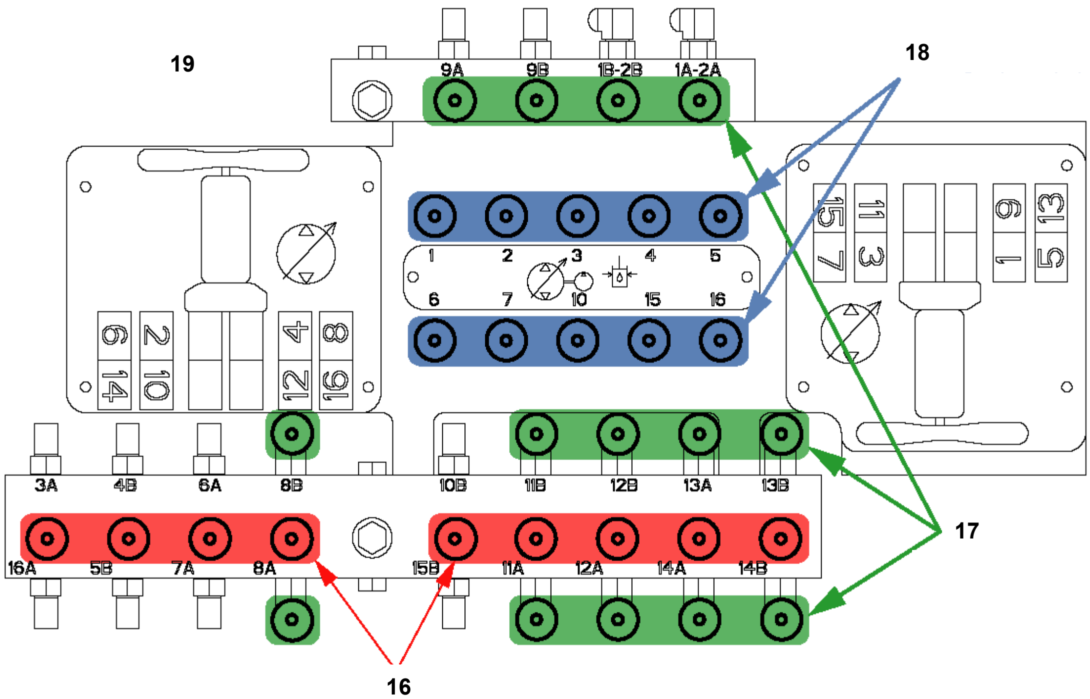
Pressure Gauge Test Port Identification



Item	Description
1	Swing Pump Charge Pump Pressure
2	Swing Pump Charge Pump Pressure
3	Drum 2 Pump Charge Pump Pressure
4	Drum 1 Pump Charge Pump Pressure
5	Drum 1 Pump Charge Pump Pressure
6	Drum 4 Pump Charge Pump Pressure
7	Drum 4 Pump Charge Pump Pressure
10	Drum 3 Pump Charge Pump Pressure
15	Drum 3 Pump Charge Pump Pressure
16	Drum 2 Pump Charge Pump Pressure
9A	Left Front Crawler Port A Forward
9B	Left Front Crawler Port B Reverse
1A-2A	Swing Pumps 1 & 2 Port A Swing Left
1B-2B	Swing Pumps 1 & 2 Port B Swing Right
3A-16A	Drum 2 Port A Up
4B-5B	Drum 1 Port B Up
6A-7A	Drum 4 Port A Up

Item	Description
8A	Right Front Crawler Port A Forward
8B	Right Front Crawler Port B Reverse
10B-15B	Drum 3 Port B Up
11A	Right Rear Crawler Port A Reverse
11B	Right Rear Crawler Port B Forward
12A	Left Rear Crawler Port A Reverse
12B	Left Rear Crawler Port B Forward
13A-14A	Counterweight Pump Port A Out
12B	Left Rear Crawler Port B Forward
13B-14B	Counterweight Pump Port B In
Dual Function Pumps	
9	Drum 6 Port A Up
11	Drum 5 Port A Up

FIGURE 2-36

NOTE: Color Coded red ports (16) are for highest pressure reading at indicated function, green ports (17) are for reading pressure at indicated port, and blue ports (18) are for reading charge pressure for indicated function.

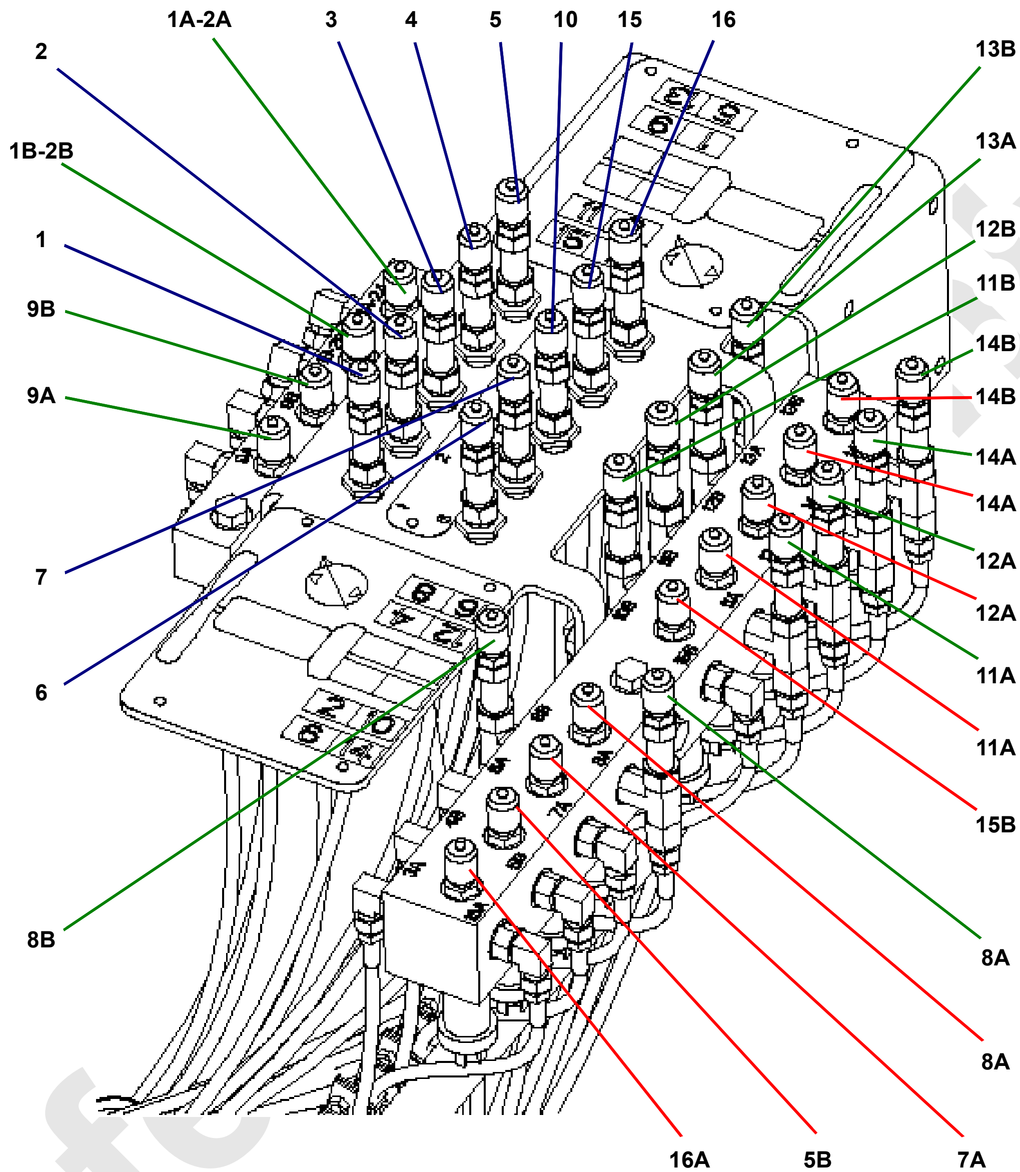
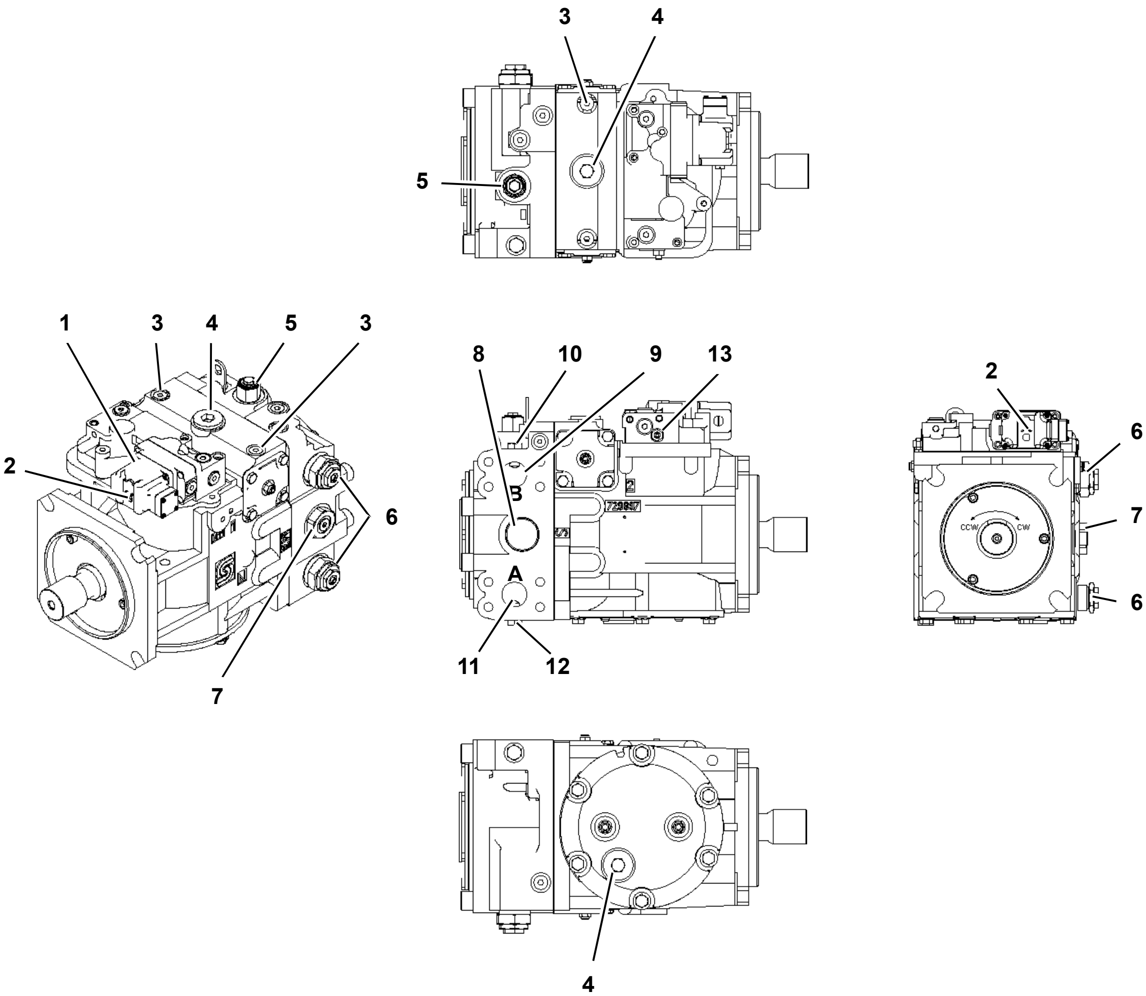


FIGURE 2-36 continued

Reference Only

Pump Components



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

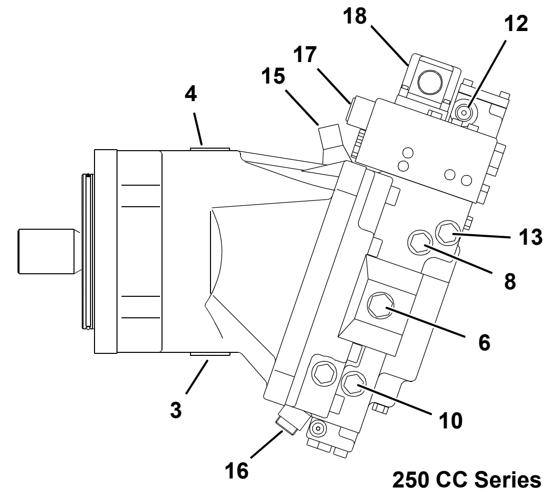
NOTE 1: Both Sides of Pump.

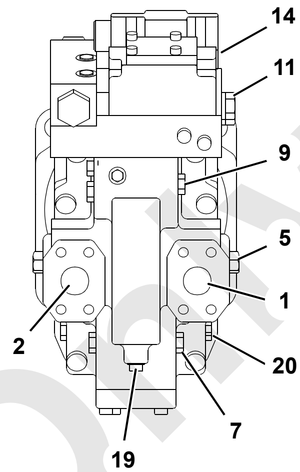
NOTE 2: Valve is Directly Opposite Port it Protects.

FIGURE 2-37

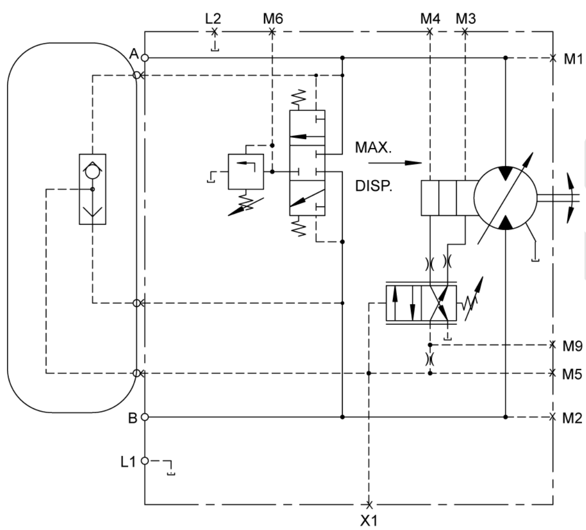
Motor Components

A1188

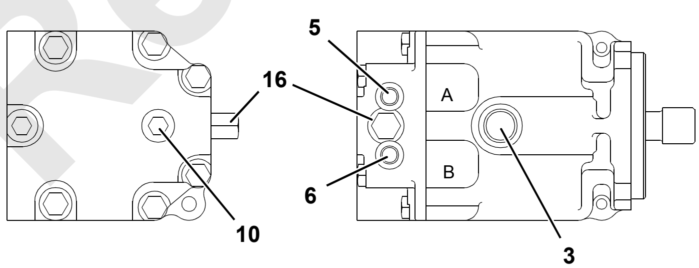




250 CC Series 51 Travel Motor with Reverse Logic Servo Spool and PC Control



Item	Port	Description
1	A	Main System Pressure
2	B	Main System Pressure
3	L1	Case Pressure/Case Drain
4	L2	Case Pressure/Case Drain
5	M1	Gauge Port A
6	M2	Gauge Port B
7	M3	Servo Pressure Gauge Port for Minimum Displacement
8	M4	Servo Pressure Gauge Port for Maximum Displacement
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
21		Speed Sensor Port
22		Electrohydraulic Proportional Motor Control

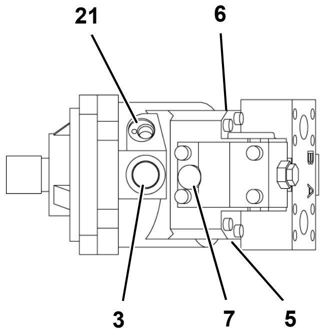


55 CC Series 90 Swing Motor

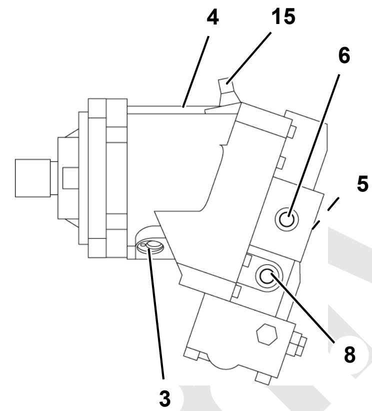
FIGURE 2-38

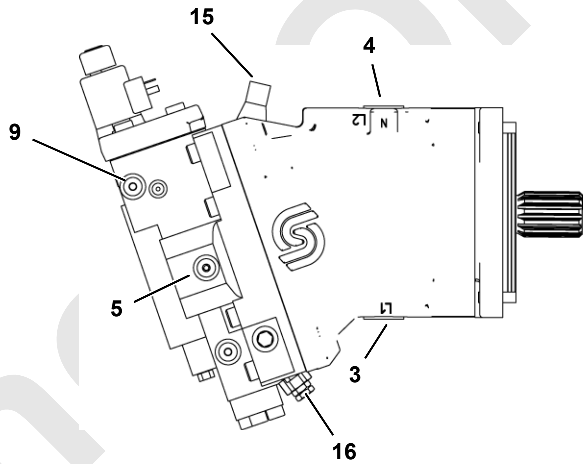
Reference Only

Motor Components Continued

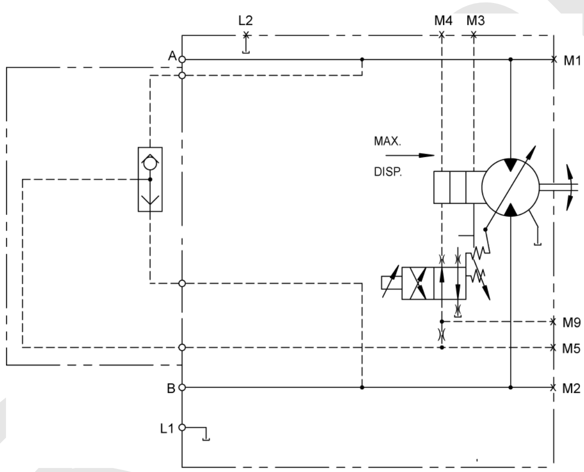


80 CC Series 51 Winch Motor





160 CC Series 51 Hoist and VPC Motor
With Correct Logic Servo Spool, EDC
Control, and No Internal Loop Flush



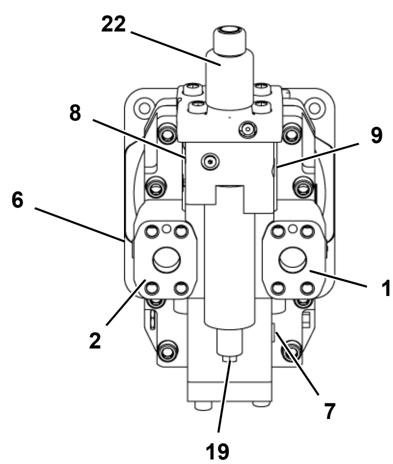


FIGURE 2-38 continued

NOTE: Servo spool with correct logic start motor in low speed maximum displacement and servo spool with reverse logic start motor in high speed minimum displacement.

Reference Only

HYDRAULIC SYSTEM SPECIFICATIONS

Table 2-14 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 4/5 - B	6,090 (420)	5500 (379)	350 (24)	20.9
	Lower	Pump 4/5 - A				
Drum 2	Hoist	Pump 3/16 - A				
	Lower	Pump 3/16 - B				
Drum 3	Up	Pump 10/15 - B				
	Down	Pump 10/15 - A				
Drum 4	Up	Pump 6/7 - A				
	Down	Pump 6/7 - B				
Drum 5 [7]	Up	Pump 11- A				
Drum 6 [7]	Up	Pump 9- A				20.5
Variable Position Counterweight	Out	Pump 13/14 - A				NA
	In	Pump 13/14 - B				
Swing	Left	Pump 1/2 - A				0.44
	Right	Pump 1/2 - B				
Front Right Crawler	Forward	Pump 8 - B		5,900 (407)		2.5 High Speed 0.63 Low Speed at Tumbler
	Reverse	Pump 8 - A				
Front Left Crawler [7]	Forward	Pump 9 - B				
	Reverse	Pump 9 - A				
Rear Right Crawler [7]	Forward	Pump 11 - A				
	Reverse	Pump 11 - B				
Rear Left Crawler	Forward	Pump 12 - A				
	Reverse	Pump 12 - B				
Accessory System [4 & 5]	NA	NA	3,000 (207)	NA	NA	NA
Carbody Control System [6, 2]	NA	NA		NA	NA	NA

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

Reference Only

ACCESSORY SYSTEM CHECKS

Computer Controlled Accessory System Functions

Computer controlled accessories include:

- Cab Seat Tilt (switch in cab).
- Rigging Winch Drum 0 (hand-held remote).
- Back Hitch Pins (hand-held remote).
- VPC Actuator Assist Cylinder (hand-held remote).
- Counterweight Beam Pin Locks (switch in cab).
- Counterweight Beam Cylinder (switch in cab).
- Function Parking Brake (switch in cab).

To operate these accessory functions, use the controls on the hand-held remote control, switches in the operator cab as noted next to each function, or with the Portable Hydraulic Power Unit when necessary. Computer controlled accessory functions must be turned on through the crane controller prior to accessory system checks. Reference the 31000 Operator Manual for detailed accessory system function operation.

NOTE: Accessory system checks are only necessary during crane set up, when troubleshooting an accessory function, or when replacing an accessory component that involves opening the hydraulic lines for that function.

Back Hitch Pins

Perform the following procedure during crane set up only.

1. Fully **extend** and **retract** back hitch pin three to four times to remove air from cylinders.
2. Scroll to accessory diagnostic screen to verify that 3,000 psi (206 bar) is present when cylinders are fully extended and retracted (stalled).
3. When controls are off, cylinders must not retract. If they do, contact Manitowoc Crane Care.

Cab Seat Tilt

Perform the following procedure when troubleshooting the seat tilt cylinder.

1. Fully **extend** and **retract** cylinder three to four times to remove air from cylinder.
2. Scroll to accessory diagnostic screen to verify that 3,000 psi (206 bar) is present when cylinder is fully extended and retracted (stalled).
3. When controls are off, cylinder must not retract.

Counterweight Beam Cylinders

Perform the following procedure while in counterweight beam set up function mode.

1. Fully **extend** and **retract** cylinders three to four times to remove air from cylinder
2. Scroll to accessory diagnostic screen to verify that 3,000 psi (206 bar) is present when pins are fully engaged and disengaged (stalled).

Counterweight Beam Pin Locks

Perform the following procedure

1. Fully **engage** and **disengage** pins three to four times to remove air from cylinders.
2. Scroll to accessory diagnostic screen to verify that 3,000 psi (206 bar) is present when cylinder is fully extended and retracted (stalled).

VPC Actuator Assist Cylinder

Perform the following procedure during crane set up only.

1. Fully **extend** and **retract** VPC Actuator Assist Cylinder three to four times to remove air from cylinder.
2. Scroll to accessory diagnostic screen to verify that 3,000 psi (206 bar) is present when cylinder is fully extended and retracted (stalled).

Rigging Winch (Drum 0)

1. Enable rigging winches (see instructions in Section 3 of Crane Operator Manual).
2. Operate winch several times in both directions to make sure it is operating properly and to remove air from system.
3. Scroll to accessory diagnostic screen for drum 0 diagnostics to verify that 3,000 psi (206 bar) is present when operating drum 0.

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.

Reference Only

Drum Brake

1. Scroll to drum diagnostic screen to monitor drum component icons.
2. One at a time turn **off** each drum park and attempt to move the drum by moving control handle in both directions.
3. Drums must move freely.
4. Dum screen should indicate that drum park brake selected is released.
5. Move control handle to off, turn on selected drum park.
6. Drum handle should be inoperable.
7. Drum screen should indicate no handle or pump commands and that selected drum 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. Press to operate travel motors in HIGH speed.
6. Press to operate travel motors in LOW speed.

NOTE: Travel motors will shift immediately from high to low when low speed is selected. The travel motors will not shift from low to high when high speed is selected until (1) the engine speed is at high idle, and (2) the hydraulic pressure is low enough to allow the motors to shift from low to high speed.

7. Bring crawlers to a complete stop, move control handles to off, and turn on travel park.
8. Travel handles should be inoperable.
9. Travel screen should indicate no handle or pump commands and that travel park brakes are applied.

2

Reference Only

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 drive gear tumbler at front of one crawler and at rear of other crawler (Figure 2-39).
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 2-14.
5. If speed is not within specified range, contact Manitowoc Crane Care.

.

FIGURE 2-39

Swing and Drum Speeds

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

Check operating speed on the diagnostic screens (Figure 2-32) 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 2-14. If proper speeds are not indicated, contact Manitowoc Crane Care.

Reference Only

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 **Main Display Operation Manual.** The hydraulic system tests and screens are repeated here.

The Pressure Test and Calibration Screen (see Figure 2-41) is used to initiate and monitor the four hydraulic test and calibration procedures.

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

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

Level 1 — Test data box highlighted blue.

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

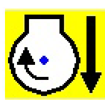
All test and calibration procedures must be run at a particular engine speed. If a test is started at the wrong speed, the appropriate prompt shown below appears in the data box and the procedure is aborted.

Engine Off

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

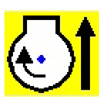
Engine Low Idle

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



Engine High Idle

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



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

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

Pressure Sender Test

See Figure 2-40 for the following procedure.

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

Perform this test when:

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

Be aware that if there is any residual pressure in the system during the calibration process, the display pressure reading in the cab may not reflect actual system pressure.

Test pressure senders as follows:

1. Stop both engines and turn both crane engine switches to ***RUN*** position.
2. Press  or  until the Pressure Test and Calibration Screen icon appears in the screen selection box.

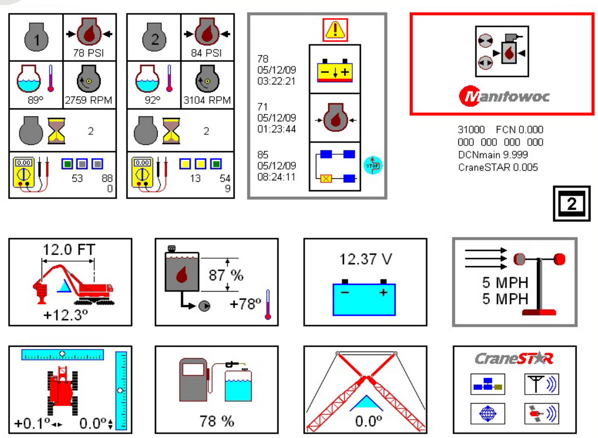


FIGURE 2-40

3. Next, press  to make the Pressure Test and Calibration Test screen appear (Figure 2-41).

Reference Only

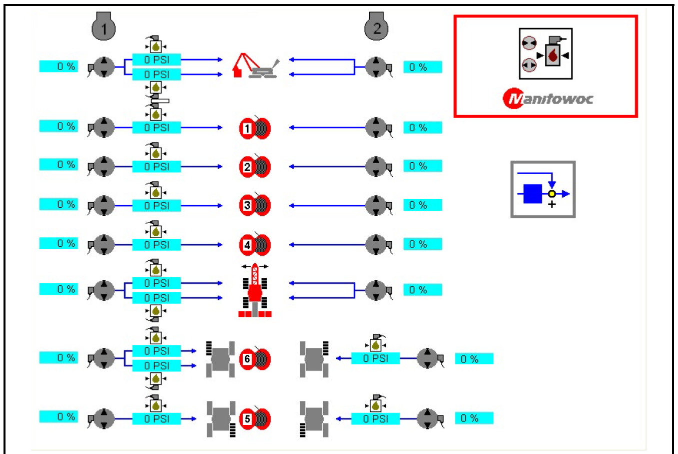


FIGURE 2-41

4. Press  to make a **blue** border appear around the Pressure Test and Calibration Test icon.

5. Then press  or  until a **blue** border appears around the icon as shown (Figure 2-42).

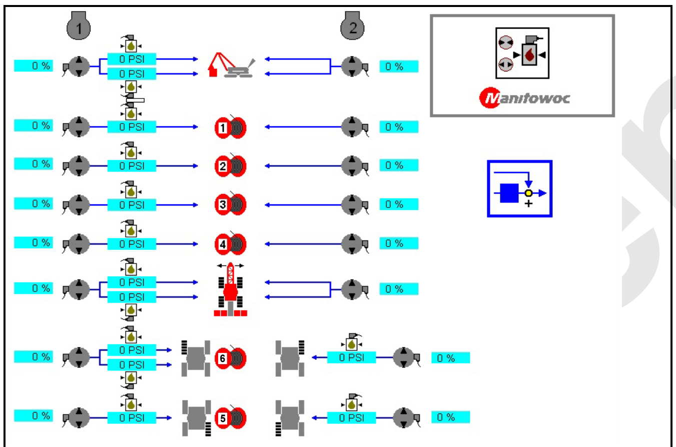


FIGURE 2-42

6. Press  to make a **red** border appear around the icon.

7. Then press  or  until the Pressure Sender Test icon appears as shown (Figure 2-43).

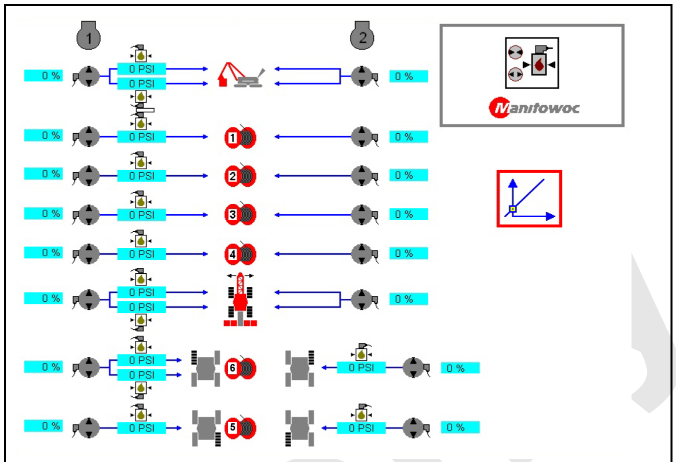


FIGURE 2-43

8. Press  to start the Pressure Sender Test.

NOTE: During the test, the following icons may appear:

-  = the crane engine is on and must be turned off to continue the test.
-  = an open circuit fault. This fault must be serviced immediately.
-  = a short-to-ground fault. This fault must be serviced immediately.
- 324 PSI = if a value appears in yellow, then it is out of range.

9. Test starts and percent of completion is displayed in data box (Figure 2-44).

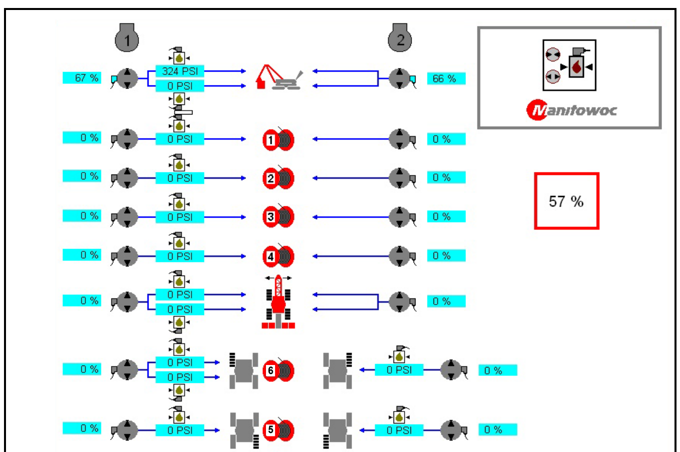
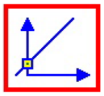


FIGURE 2-44

Reference Only

Manitowoc Crane Care

10. When the test is done, the Pressure Sender Test icon  will reappear on the screen.

NOTE: 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.

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 checks:

- Perform pressure sender test.
- Attach an accurate hydraulic pressure gauge to the quick-coupler at the suspect pressure transducer.
- 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.

Reference Only

Control Calibration

See Figure 2-45 for the following procedure.

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

Perform this calibration when:

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

Calibrate controls as follows:

1. Apply ***all*** park brakes with switches on control console.
   - Swing park switch.
   - Drums 1 through 6 park switches.
   - Travel park switches.
2. Start and run both engines at HIGH IDLE.
3. Press  or  until the Pressure Test and Calibration Screen icon appears in the screen selection box. (Figure 2-45).

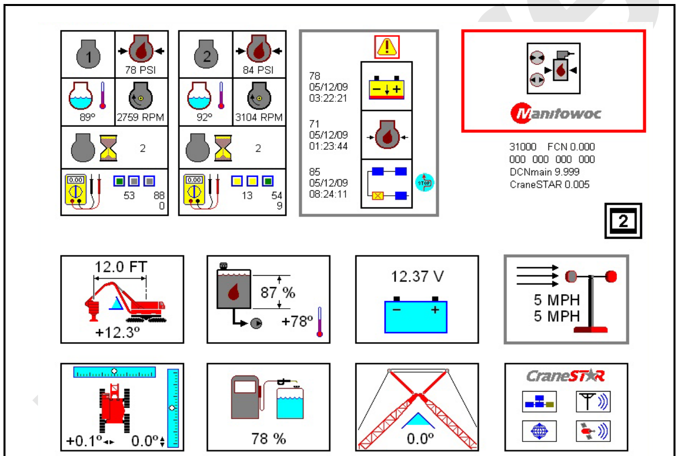


FIGURE 2-45

4. Next, press  to make the Pressure Test and Calibration Test screen appear. (Figure 2-46).

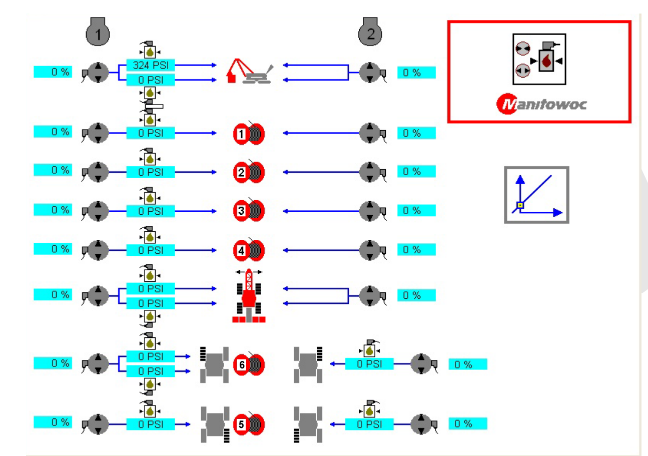


FIGURE 2-46

5. Press  to make a **blue** border appear around the Pressure Test and Calibration Test icon.
6. Then press  or  until a **blue** border appears around the icon shown (Figure 2-47).

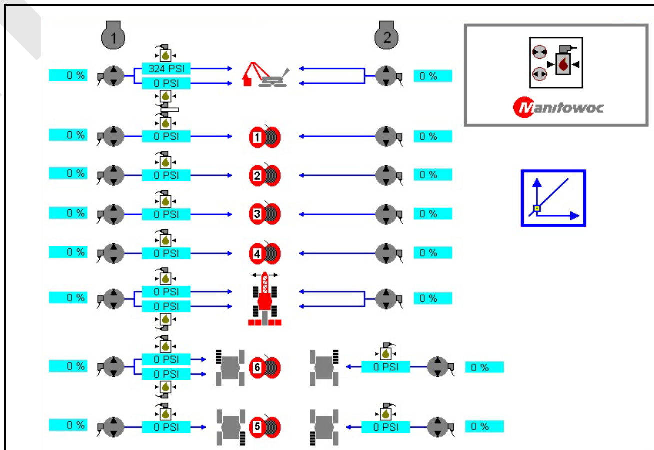


FIGURE 2-47

7. Press  to make a **red** border appear around the icon.
8. Then press  or  until the Pressure Sender Test icon appears as shown below (Figure 2-48).

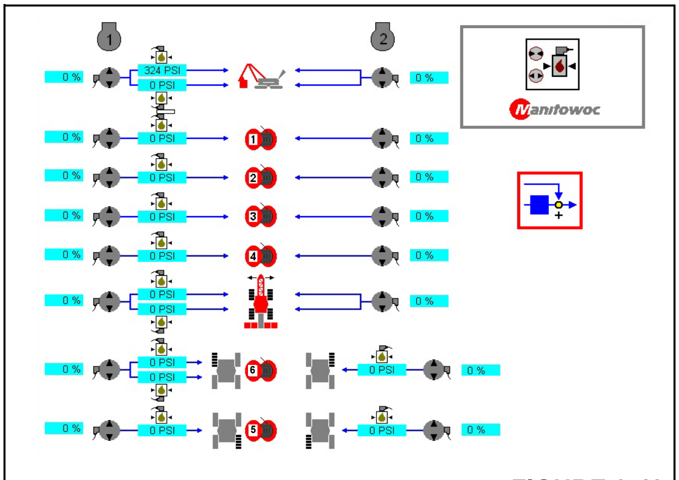


FIGURE 2-48

9. Press  to start the Control Calibration Test. ([Figure 2-49](#)).

10. During the test, the following icons may appear:

-  = the crane engine is *running too slow*. Increase engine speed.
-  = the crane engine is *running too fast*. Decrease engine speed.
-  = an open circuit fault. This fault must be serviced immediately.
-  = a short-to-ground fault. This fault must be serviced immediately.
- 324 PSI = if a value appears in yellow, then it is out of range.

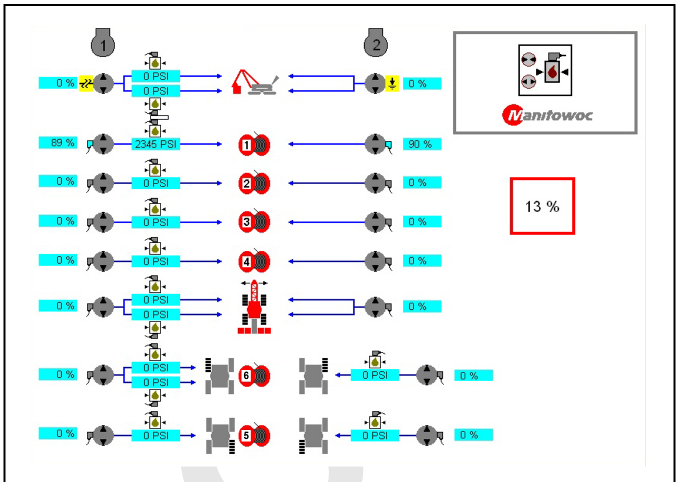
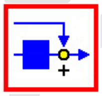


FIGURE 2-49

NOTE: Calibration starts and percent of completion is displayed in data box.

11. When the test is done, the Control Calibration Test icon  will reappear on the screen

NOTE: 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.

Reference

High Pressure Test

See Figure 2-50 for the following procedure.

The high pressure test checks the ability of all hoist functions (drums 1 through 5) to reach and hold high pressure. This test generally is used only as a shop procedure on new cranes. It can also be used in the field to test hydraulic components for leakage 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 hoist hydraulic circuits (drums 1 through 5). Defective brakes may allow unintended motion during test. Move the crane to an area where such motion is not a hazard.

Use a signal person to monitor functions operator cannot see.

Be prepared to stop engine if unintended motion occurs.

Test high pressure as follows:

1. Apply ***all*** park brakes with switches on control console.
   - Swing park switch
   - Drums 1 through 6 park switches
   - Travel park switches
2. Start and run both engines at HIGH IDLE.
3. Press or until the Pressure Test and Calibration Screen icon appears in the screen selection box (Figure 2-50).

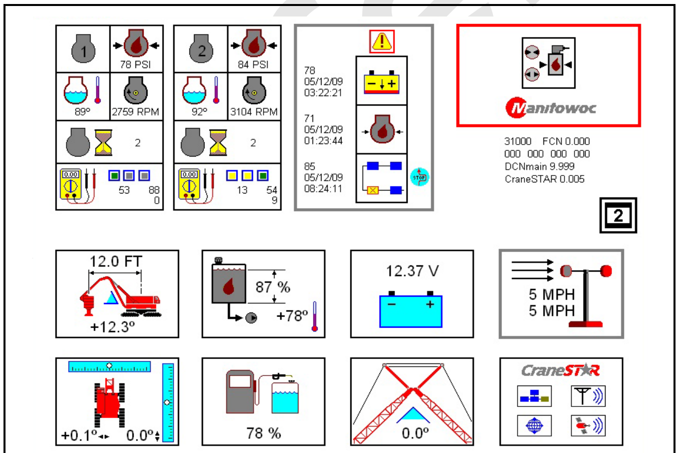


FIGURE 2-50

4. Next, press to make the Pressure Test and Calibration Test screen appear (Figure 2-51).

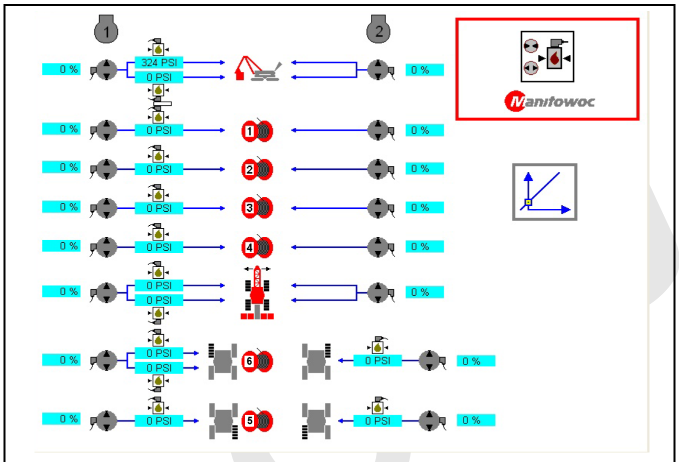


FIGURE 2-51

5. Press to make a **blue** border appear around the Pressure Test and Calibration Test icon
6. Then press or until a **blue** border appears around the icon shown (Figure 2-52)

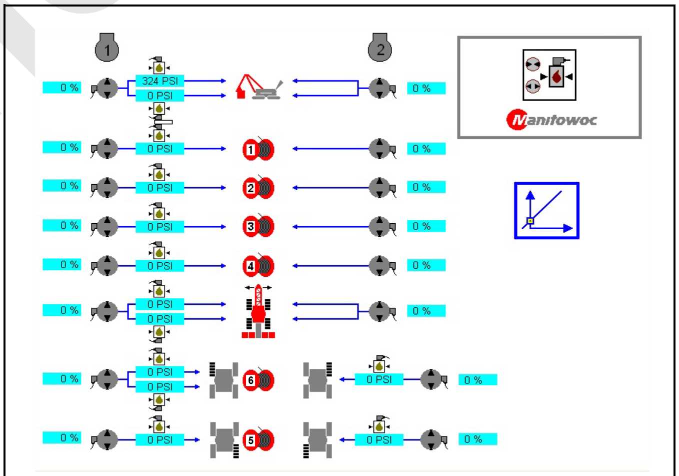


FIGURE 2-52

7. Press to make a **red** border appear around the icon.
8. Then press or until the High Pressure Test icon appears as shown (Figure 2-53).

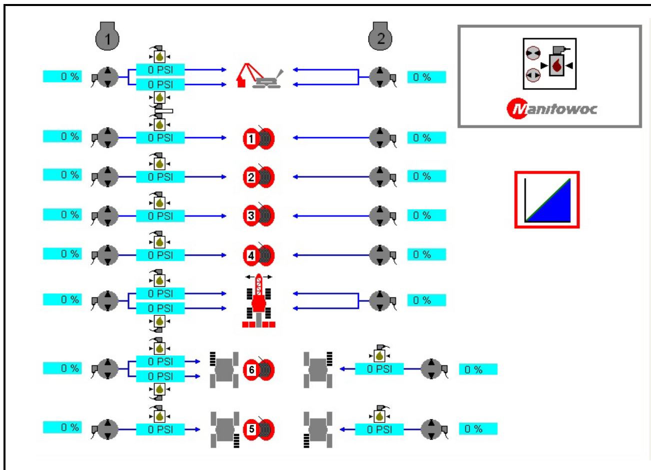


FIGURE 2-53

9. Press  to start the High Pressure Test. ([Figure 2-54](#)).

10. During the test, the following icons may appear:

-  = the crane engine is *running too slow*. Increase engine speed.
-  = the crane engine is *running too fast*. Decrease engine speed.
-  = an open circuit fault. This fault must be serviced immediately.
-  = a short-to-ground fault. This fault must be serviced immediately.
- 324 PSI = if a value appears in yellow, then it is out of range.

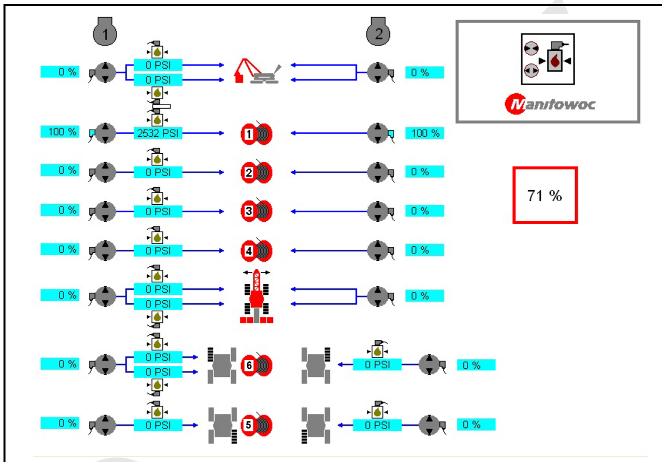
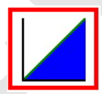


FIGURE 2-54

11. 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 hoist 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.

Reference

Charge Pressure Test

See Figure 2-55 for the following procedure.

The charge pressure test checks the ability of all primary cane functions to build proper charge pressure. This test generally is used only as a shop procedure on new cranes. It can also be used as a quick way to test hydraulic components in the primary hydraulic circuits. Charge pump pressure must be within 275 to 400 psi (19 to 27 bar).

Test charge pressure as follows:

1. Apply ***all*** park brakes with switches on control console.
    - Swing park switch
    - Drums 1 through 6 park switches
    - Travel park switches
2. Start and run both engines at LOW IDLE.
3. Press  or  until the Pressure Test and Calibration Screen icon appears in the screen selection box (Figure 2-55).

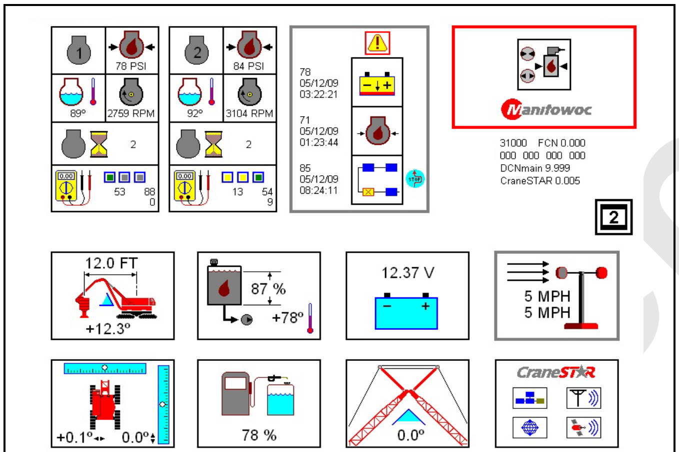


FIGURE 2-55

4. Next, press  to make the Pressure Test and Calibration Test screen appear (Figure 2-56).

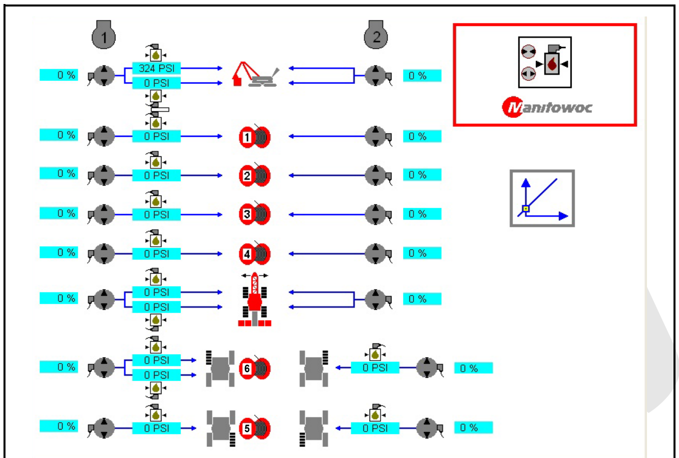


FIGURE 2-56

5. Press  to make a **blue** border appear around the Pressure Test and Calibration Test icon.
6. Then press  or  until a **blue** border appears around the icon shown (Figure 2-57).

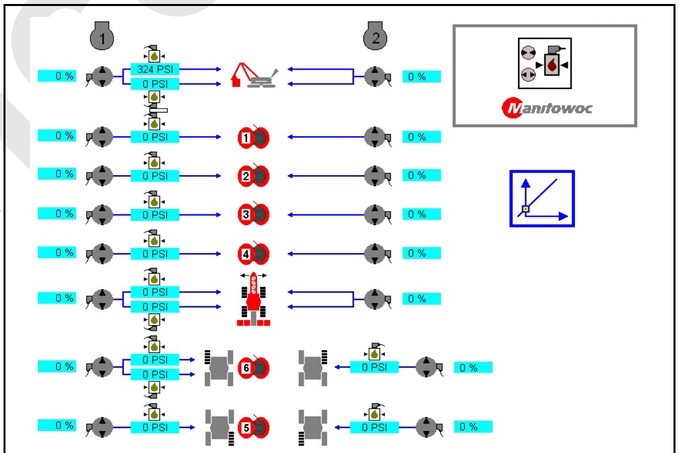


FIGURE 2-57

7. Press  to make a **red** border appear around the icon
8. Then press  or  until the Charge Pressure Test icon appears as shown (Figure 2-58).

Reference Only

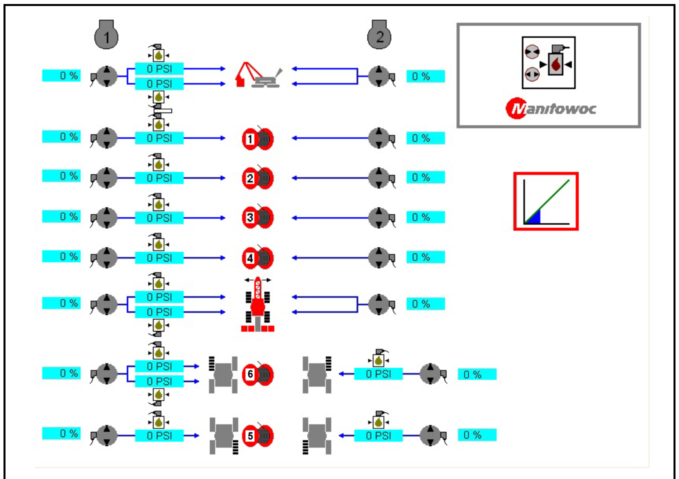


FIGURE 2-58

9. Press  to start the Charge Pressure Test. (Figure 2-59).

10. During the test, the following icons may appear:

-  = the crane engine is *running too slow*. Increase engine speed.
-  = the crane engine is *running too fast*. Decrease engine speed.
-  = an open circuit fault. This fault must be serviced immediately.
-  = a short-to-ground fault. This fault must be serviced immediately.
- 324 PSI = if a value appears in yellow, then it is out of range.

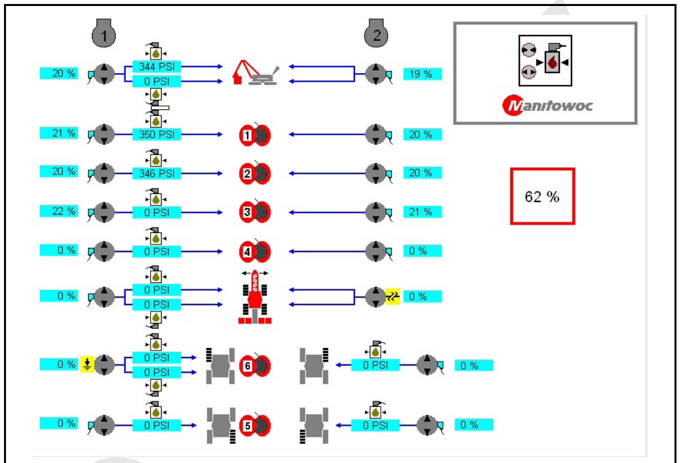
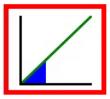


FIGURE 2-59

11. 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.

Reference

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 2-60 for the following procedure.

1. Scroll to diagnostic screen for corresponding function (see Figure 2-32).

2. Disconnect electric connector from corresponding brake solenoid valve (see Figure 2-30).

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 up direction) for all drums.

4. Do not demand any more than 20% handle command.

5. Pressure on screen should indicate pressure specified in Table 2-14.

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 2-14 and Figure 2-37 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.

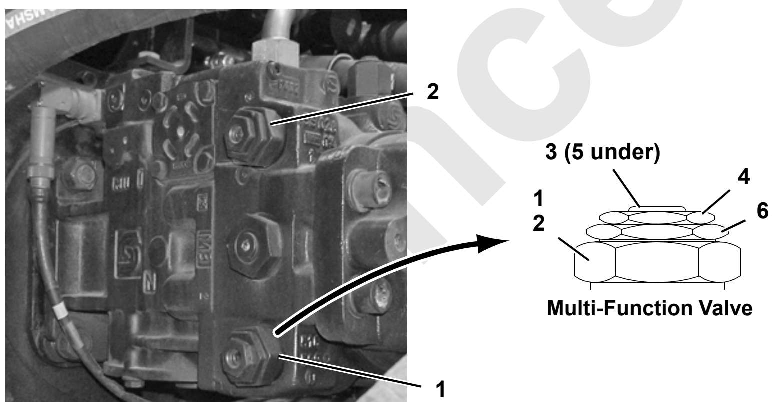
8. Hold adjusting screw (5) in position and securely tighten lock nut (4).

9. Install protective cap (3).

10. Reconnect electric connector to corresponding brake solenoid valve (see Figure 2-30).

Typical Pump Installation

A1161



P1537a

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

Wrench Size

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

FIGURE 2-60

Reference Only

Charge Pressure Adjustment

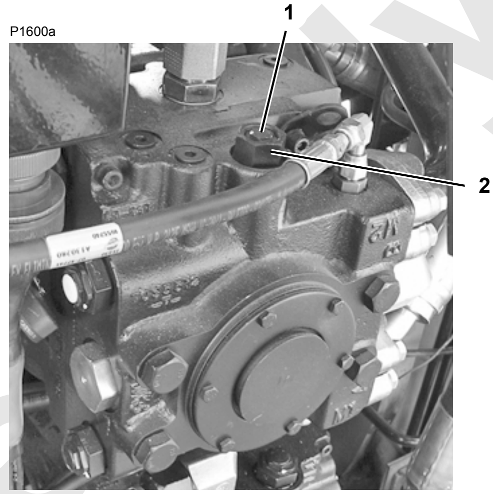
The following adjustment is only required when a system fails the Charge Pressure Test described in this section.

1. Scroll to diagnostic screen for corresponding function (see Figure 2-32).
2. Start and run engine at high idle. With function in neutral, system pressure on diagnostic screen should read 320 to 370 psi (22 to 26 bar).
3. If specified pressure is not indicated, stop engine and connect an accurate 0 to 1,000 psi (0 to 69 bar) hydraulic pressure gauge to coupler at corresponding pressure sender (see Figure 2-36).
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 2-61 for the following procedure.

   a. Loosen lock nut (2).
   b. Adjust adjusting screw (1).
      - Turn **IN** to **INCREASE** pressure.
      - Turn **OUT** to **DECREASE** pressure.
   c. Once specified pressure is indicated, hold adjusting screw (1) in position and securely tighten lock nut (2).
6. Stop engine and remove gauge from transducer gauge port.



Typical Pump Installation

Item	Description	Hex Wrench Size
1	Adjusting Screw	1/2 inch hex
2	Lock Nut Series 030-100	1-1/16 inch
	Lock Nut Series 130-250	1-5/8 inch

FIGURE 2-61

Reference Only

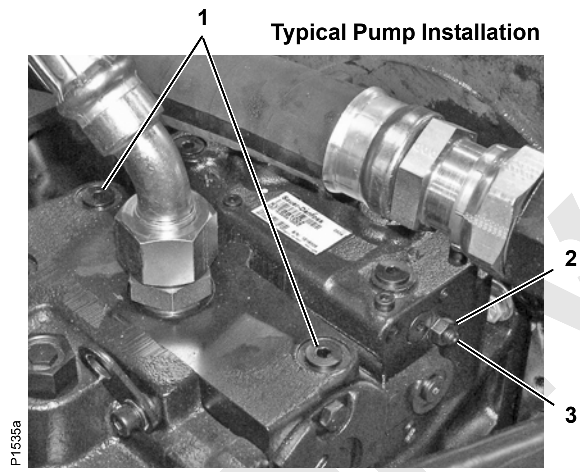
Pump Neutral Adjustment

See Figure 2-62 for the following procedure.

To adjust pump neutral:

1. Park all crane functions and stop engine.
2. Disconnect electric connector from pump EDC (see Figure 2-37).
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.
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).

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 2-62

Reference Only

Motor Leakage Test

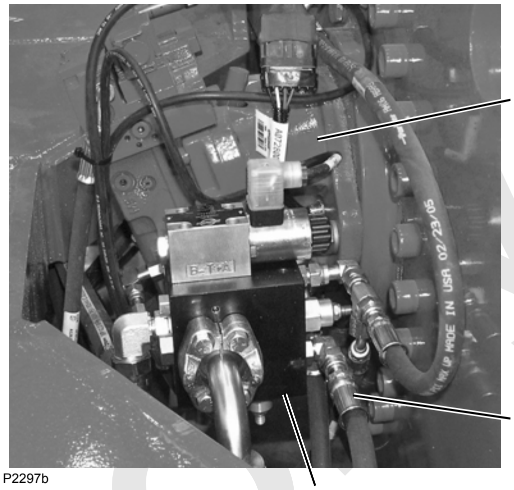
Perform the following test if troubleshooting indicates the need:

- Low Charge Pressure
- Sluggish Operation
- Excessive Heat

See Figure 2-63 for the following procedure.

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

Typical Motor Installation



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

FIGURE 2-63

Loop Flushing Valve Adjustment

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

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

Manual Override Tests

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

DANGER

Falling or Moving Load Hazard!

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

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

Reference Only

Pump or Motor Override

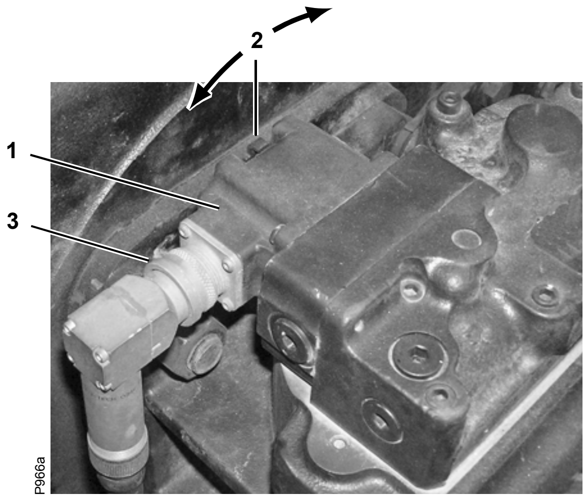
See Figure 2-64 for the following procedure.

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

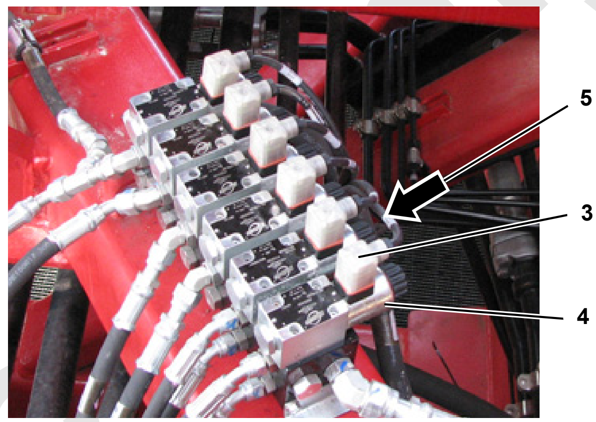
Solenoid Valve Override

See Figure 2-64 for the following procedure.

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



Typical Pump or Motor Installation



Typical Solenoid Valve Installation

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

FIGURE 2-64

Reference Only

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.

See Figure 2-36 for identification of pressure senders.

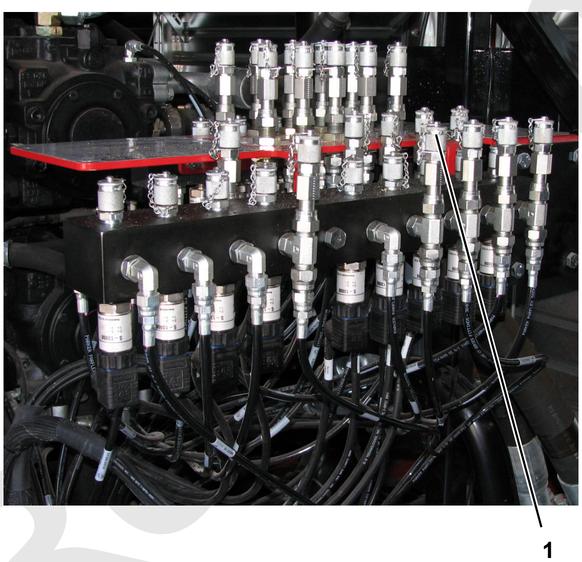
1. Lower all loads to ground.
2. Move all control handles to off and park all crane functions.
3. ***Stop engine.***
4. Place a suitable container under pressure senders to catch oil leakage.

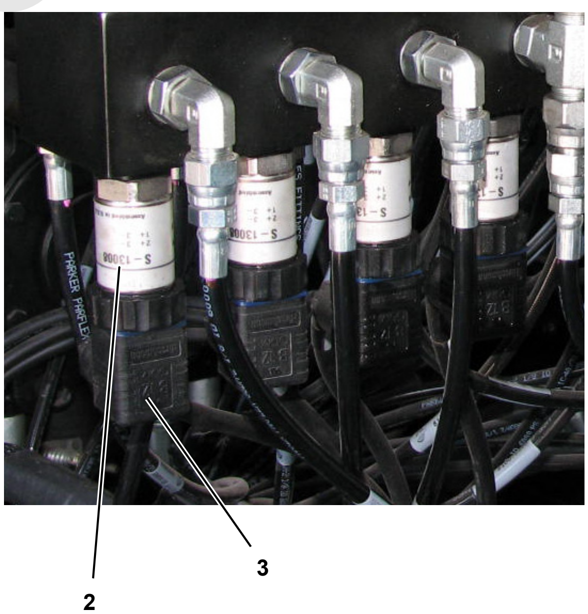
Perform steps 5 – 9 only at faulty pressure senders.

5. Disconnect electric plug from pressure senders (Figure 2-65).
6. ***Slowly loosen*** pressure senders only enough to allow any remaining pressure to exhaust.
7. Remove pressure senders.
8. Install new pressure senders and connect electric cords.

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

Pressure Senders Located in Engine Enclosure





Item	Description
1	Typical Coupler
2	Pressure Sender
3	Electric Connector

FIGURE 2-65

Reference Only

Disc Brake Operational Test

There is no physical way to check the disc brakes for travel, boom hoist, load drums, and swing. Therefore, an operational test of each brake must be performed weekly. Figure 2-30 and Figure 2-31 shows the brake and brake solenoid valve locations.

NOTE: See Table 2-14 system pressure specifications.

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

1. Disconnect electric connector for brake being checked.
2. Start and run engine at low idle (850 to 950 rpm).
3. Select corresponding Liftcrane Boom Capacity Chart on the RCL screen.
4. Turn off park switch on control console for function being checked.
5. Access diagnostic screen (Figure 2-32) for function being checked – Drum, Boom Hoist, Swing, or Travel.

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

CAUTION

Overheating Hazard!

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

WARNING

Falling Load/Moving Crane Hazard!

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

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

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

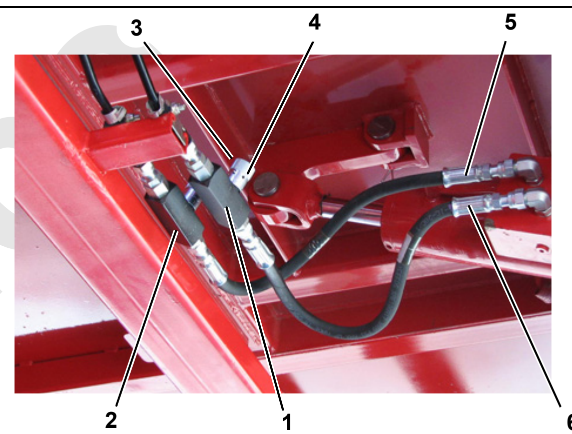
Seat Tilt Adjustment

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

See Figure 2-66 for the following procedure.

NOTE: Before tilting the seat, ensure that the tilt lock located behind the operator seat is in the unlocked position. Engage lock when done tilting seat into desired position.

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



Under Cab right side

Item	Description
1	Tilt DOWN Flow Control Valve
2	Tilt UP Flow Control Valve
3	Adjusting Knob
4	Set Screw
5	RETRACT Hydraulic Hose
6	EXTEND Hydraulic Hose

FIGURE 2-66

SECTION 2 INSERTS

The following publications are provided at the end of this section:

- Drawing 81006438 Hydraulic Schematic

Reference Only

Reference Only

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SECTION 3
ELECTRICAL SYSTEM

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SECTION 3
ELECTRICAL SYSTEM

ELECTRICAL SCHEMATICS

Electrical schematics are located at the end of this section.

CHECKING AND REPLACING ELECTRICAL COMPONENTS

WARNING

Electrocution Hazard!

Severe electric shock can cause death or serious injury. Crane owner/user must make provisions for turning off electrical power supply and generators before performing any maintenance on the electrical system.

1. Visually inspect all electrical harnesses and cables every month or at 200 hours of service life for the following:

  a. Damaged, cut or deteriorated harness loom covering.

  b. Damaged, cut or abraded individual wires or cable insulation.

  c. Exposed bare copper conductors.

  d. Kinked, crushed, flattened harnesses or cables.

  e. Blistered, soft, degraded wires and cables.

  f. Cracked, damaged, or badly corroded battery terminal connections.

  g. Inspect all machine ground connections for damaged terminals or excessive corrosion.

  h. Other signs of significant deterioration.

  If any of these conditions exist, evaluate the harness for repair or replacement.

2. At the same service interval, visually inspect all Controller Area Network (CAN) nodes and electrical junction boxes for the following:

  a. Damaged or loose connectors.

  b. Damaged or missing electrical clamps or tie straps.

  c. Excessive corrosion or dirt on the junction boxes.

  d. Loose junction box mounting hardware.

  If any of these conditions exist, address them appropriately.

  See Table 3-1 below for the following items.

3. Harness and battery cables operating in ***Zone C*** are recommended to be replaced after 10,000 hours of service life.

4. Harness and cables operating in ***Zone A*** and ***B*** with high ambient temperatures and high duty circuits could see electrical service life reduced by 25% to 40%. It is recommended to replace these assemblies after 8,000 hours of service life.

5. Harness and cable assemblies operating in ***Zone D*** and ***E*** should expect a degrade of mechanical properties and long term exposure to these cold temperatures will negatively impact service life. It is recommended for these electrical harnesses and cable assemblies to be inspected to step 1 above as service life may be more than 10,000 hours.

6. Harness and cable assemblies operating in salt water climates could see a significant reduction in service life. Therefore it is recommended for these electrical harnesses and cable assemblies to be inspected to step 1 above as service life may be more than 8,000 hours.

Table 3-1 Climate Zone Classification

Item	Description
A	Tropical Moist: All months average above 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

Reference Only

CIRCUIT BREAKER, JUNCTION BOXES & NODE LOCATIONS

This section contains the fuse and circuit breaker locations for the 31000 Crane.

WARNING

Electrocution Hazard!

Severe electric shock can cause death or serious injury. Crane owner/user must make provisions for turning off electrical power supply and generators before performing any maintenance on the electrical system.

Cab Load Center

See Figure 3-1 for the following location.

The cab load center is located in the operator cab, behind the operators seat, in the rear console, behind an access panel. The cab load center contains circuit breakers and fuses.

Cab Load Center Access Panel

FIGURE 3-1

Primary Engine Node 30 Controller Panel

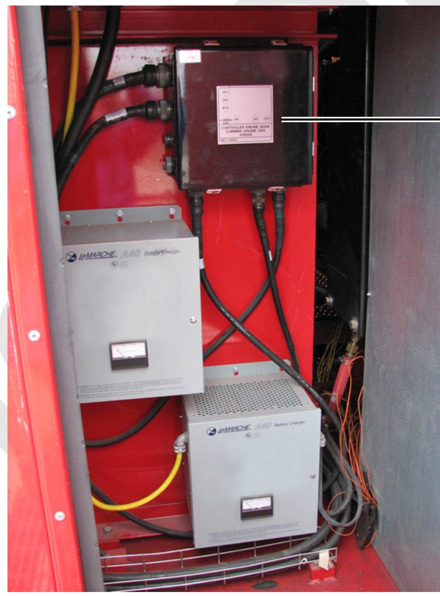
See Figure 3-2 for the following locations.

The primary engine node controller panel is mounted in the engine Node-30 controller box in the rear enclosure access in rear enclosure (see section 7). A circuit board in the node controller contains relays, circuit breakers and fuses.

Secondary Engine Node 31 Controller Panel

See Figure 3-3 for the following locations.

The secondary engine node controller panel is mounted in the engine Node-31 controller box in left side, front panel in enclosure (see section 7). A circuit board in the node controller contains relays, circuit breakers and fuses.



Primary Engine Node Controller

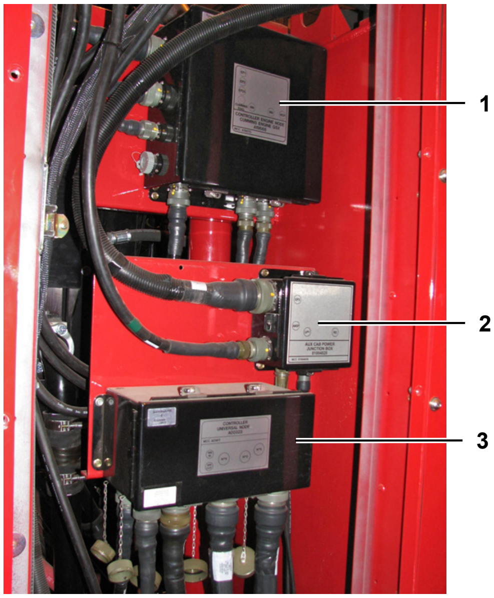
FIGURE 3-2

Aux Cab Power Junction Box

See Figure 3-3 for the following locations.

Aux Cab Power Junction Box is located below the secondary engine Node-31 controller box in left side, front panel in enclosure (see section 7). The circuit board contains circuit breakers and fuses.

Reference Only



Item	
1	Secondary Engine Node Controller
2	Aux Cab Power Junction Box
3	Node 3

FIGURE 3-3

Alternator Output Circuit Breaker

See Figure 3-4 for the following locations.

The alternator output circuit breakers are located on the alternator side of each engine, near the alternator. The 120A, automatic reset circuit breaker protects the 24 volt output of the alternator to the starter solenoid. Refer to **CB0** in the Batteries/Starter electrical schematic.

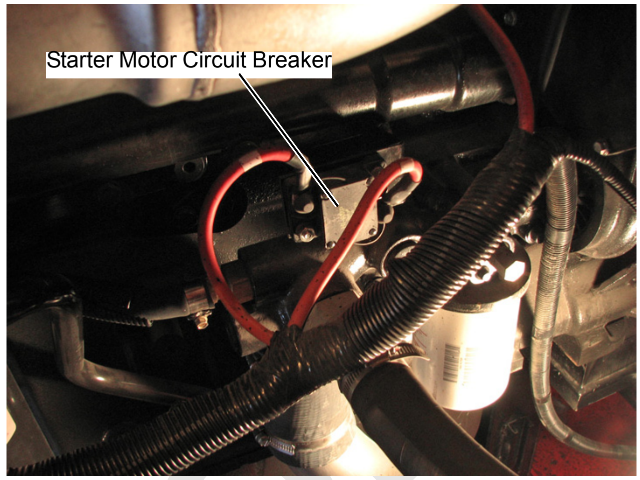


FIGURE 3-4

Main Load

See Figure 3-7 for the following locations.

The Main Load AC Center Circuit Breaker Panel is located between the operator cab and the power plant enclosure, on the Power Plant enclosure (see section 7).

The circuit breaker panel door will contain either the standard panel decal or the international panel decal (see Figure 3-15).

Cold Weather AC Load Center

See Figure 3-7 for the following locations.

The cold weather AC load center is located between the operator cab and the power plant enclosure, on the Power Plant enclosure (see section 7).

Bus Interface Node Controller

See Figure 3-22 for the following locations.

The Bus Interface Node is connected between the main CAN bus network on the rotating bed and the boom CAN bus network. Its function is to reduce the boom CAN bus network baud rate to conform with the baud rate requirements of the longer length boom cables.

Can Bus Tee Junction Box

See Figure 3-22 for the following locations.

There are two CAN bus Tee junction boxes. The CAN bus Tee junction box provides a connection point for the set-up remote.

Reference O

A/C Motor Junction Box

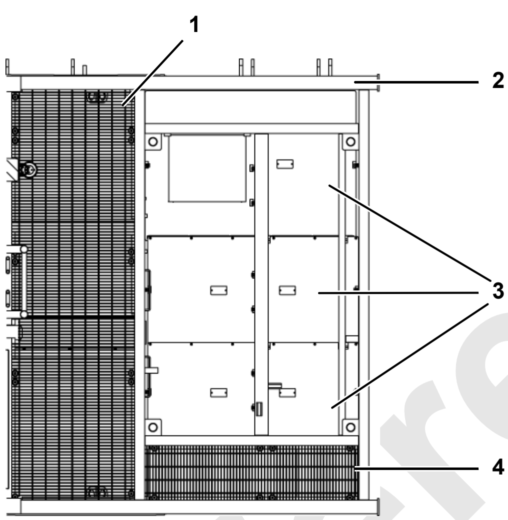
See Figure 3-6 for the following procedure.

The A/C (air conditioner) motor junction box is mounted underneath the operator cab next to the A/C compressor and motor. The 240 VAC main load center supply voltage is transferred through the junction box to the compressor motor by a 24 VDC coil contact relay. The motor relay is activated by the compressor clutch voltage signal from the A/C electronic control unit in the cab. The clutch signal current also flows through a timed delay relay set at 10 seconds to engage the compressor clutch after the motor has started.

Maintenance Access

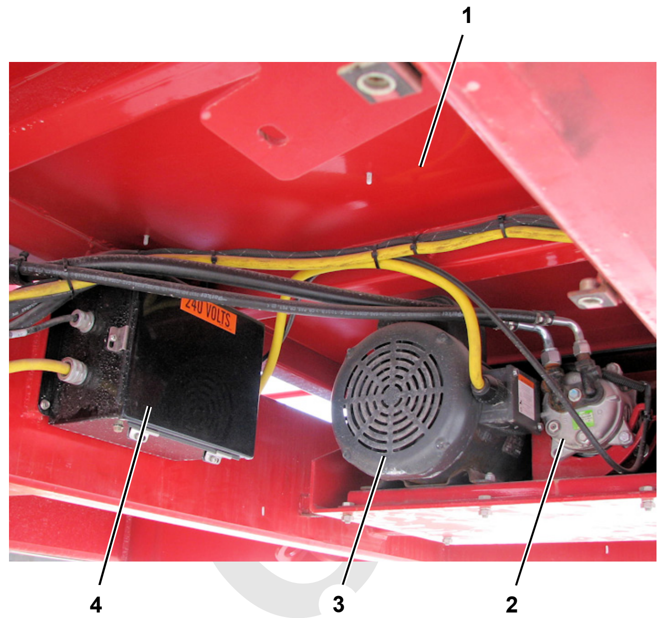
See Figure 3-5 for the following procedure.

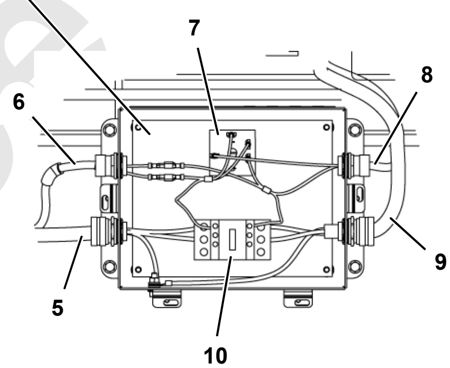
Access to the A/C junction box, compressor, and motor can be obtained through the three access panels below the operator cab. The access panels are bolted to the operator cab enclosure frame.



Item	Description
1	Cab Platform Rear
2	Cab Enclosure Frame Front
3	Access Panels
4	Cab Platform Right Side

FIGURE 3-5





Item	Description
1	Operator Cab Floor
2	A/C Compressor
3	A/C Motor
4	A/C Junction Box
5	From Load Center
6	From Clutch Signal
7	Compressor Clutch Delay Relay
8	To Compressor Clutch
9	240VAC to Motor
10	Motor Relay

FIGURE 3-6

A/C Circuit Breaker Junction Box

The A/C circuit breaker junction box is mounted in the engine enclosure next to the hydraulic tank (see Figure 3-9)

Reference Only

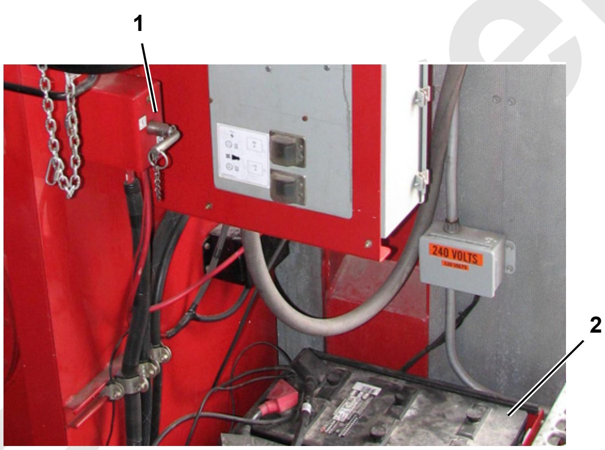
Main Load Center Circuit Breakers

Cold Weather Load Center Circuit Breakers

FIGURE 3-7

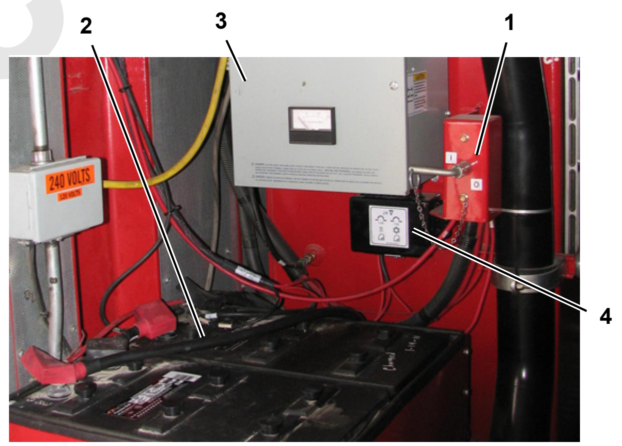
Battery Disconnect Switch

A battery disconnect switch is provided for each engine to disconnect the batteries from the engines. The disconnect switch is located above each battery bank.



Item	Description
1	Battery Disconnect, Primary Engine (shown ON)
2	Battery Bank, Primary Engine

FIGURE 3-8



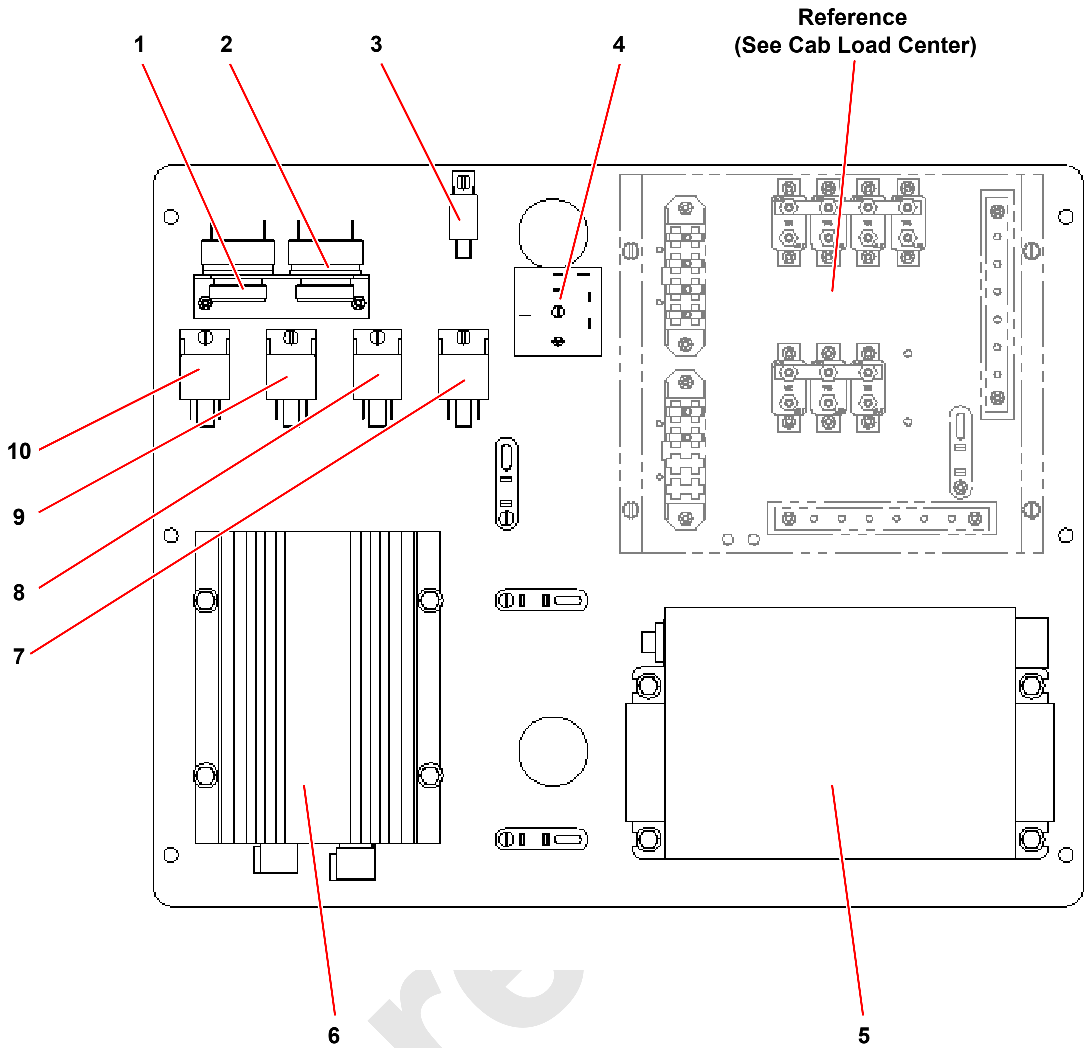
Item	Description
1	Battery Disconnect, Secondary Engine (shown ON)
2	Battery Bank, Secondary Engine
3	Battery Charger, Secondary Engine
4	A/C Circuit Breaker Junction box • 15 amp Heater • 20 amp Air Conditioner

FIGURE 3-9

Place the switch handle horizontally for ON, and vertically for OFF. Use the switch to disconnect the batteries when servicing the electrical control system.

Reference Only

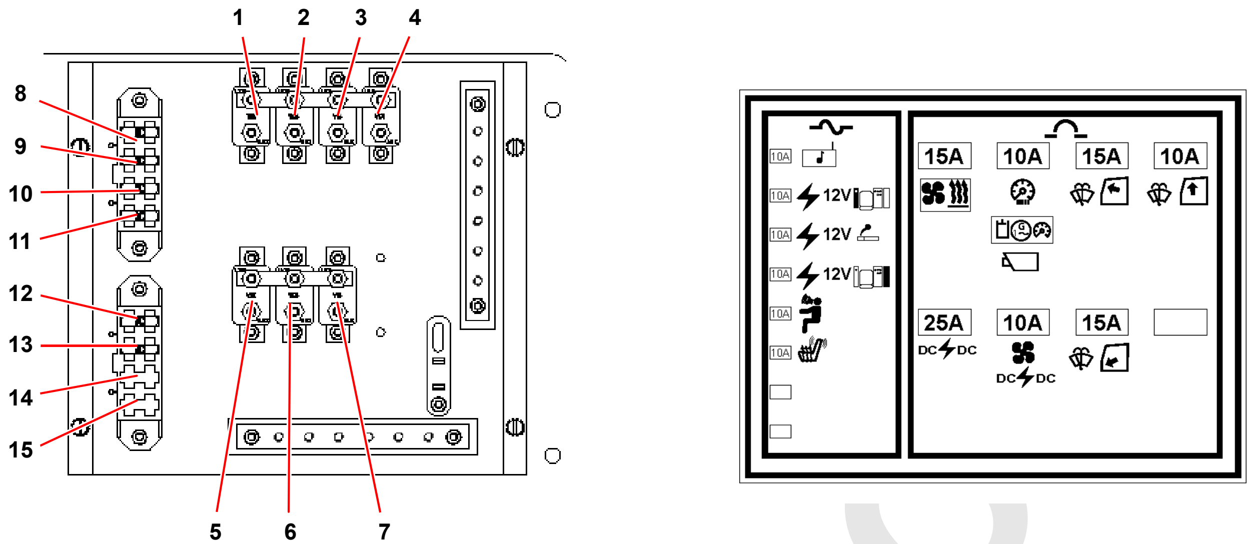
Rear Console Electrical Control



Item	Description	Item	Description
1	RCL/RCI Alarm - Buzzer Alarm	6	DC Converter
2	System Alarm - Buzzer Alarm	7	Lower Wiper Low Speed Relay
3	Top Wiper Relay	8	Lower Wiper High Speed Relay
4	Louver Time Delay	9	Front Wiper Low Speed Relay
5	Side Console Node 2	10	Front Wiper High Speed Relay

FIGURE 3-10

Cab Load Center



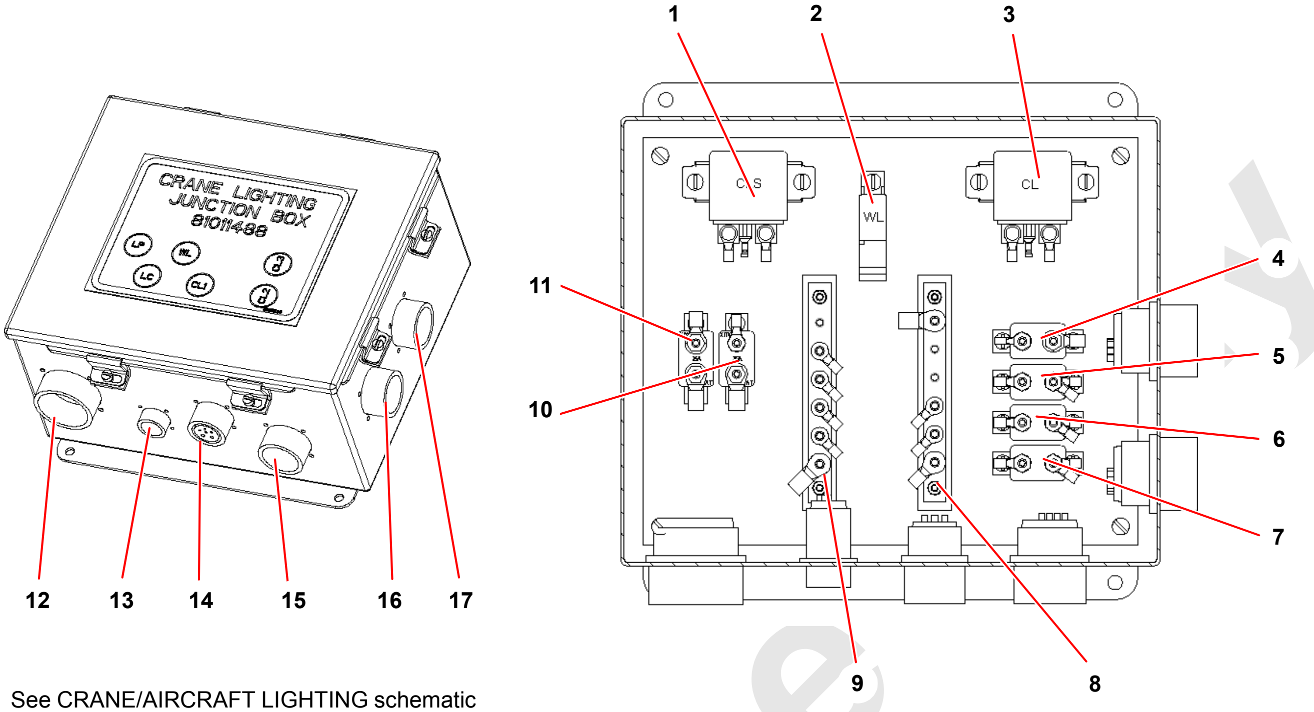
Item	Circuit Breaker	Amp Size	Description	Item	Circuit Breaker	Amp Size	Description
1	CB-1	15	Heater	8	A1A2F1	10	Radio
2	CB-2	10	Panel Lights/Cameras/Hyd Genset Meter	9	A1A2F2	10	Power Point Left Console
3	CB-3	15	Upper Wipers	10	A1A2F3	10	Power Point Right Console
4	CB-4	10	Roof Wipers	11	A1A2F4	10	Power Point Fixed Console
5	CB-5	25	24 Volts/13.8 Volts Converter	12	A1A2F5	10	PA System
6	CB-6	10	Fans/Tablet PC	13	A1A2F6	10	Seat Heater/Massager
7	CB-7	15	Lower Wipers	14	Spare	-	Spare
				15	Spare	-	Spare

FIGURE 3-11

Reference

3

Crane Lighting Junction Box

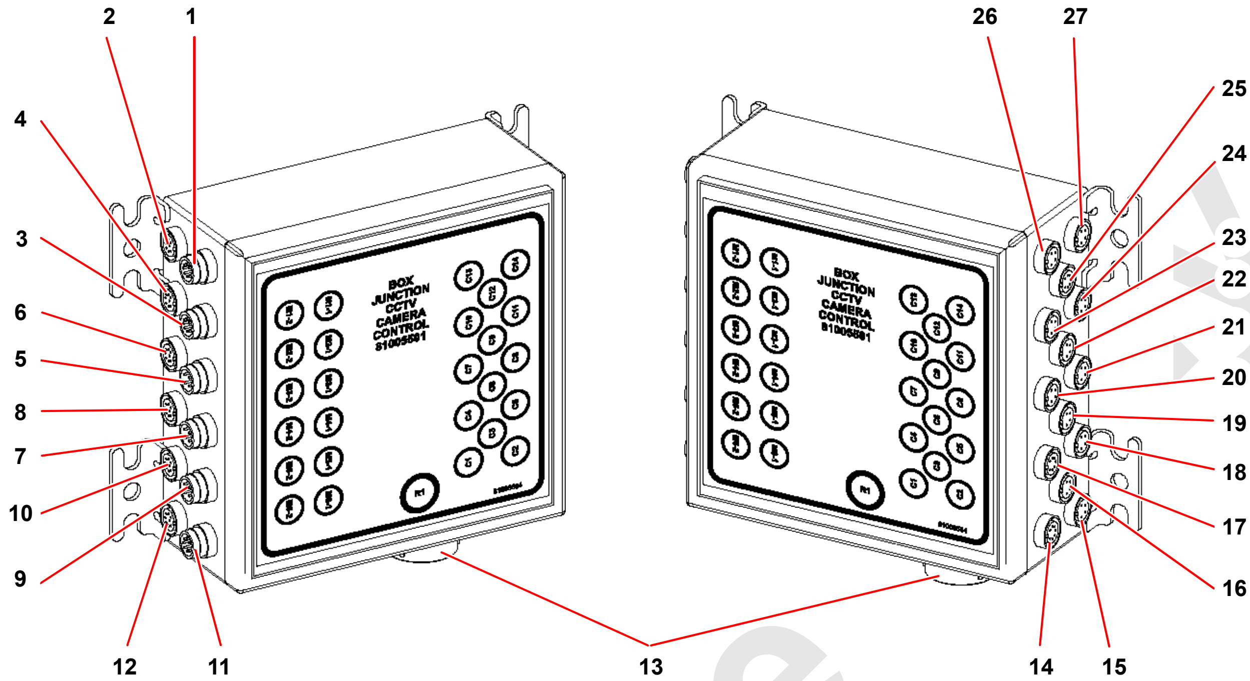


See CRANE/AIRCRAFT LIGHTING schematic

Item	Circuit Breaker	Amp Size	Description	Item	Circuit Breaker	Amp Size	Description
1	CLS	50	Relay 24V	10		25	Main Primary
2	WL	10	Relay 24V	11		25	Main Secondary
3	CL	50	Relay 24V	12			LP Receptacle
4	CBWL	10	Circuit Breaker 24V	13			LC Receptacle
5	CBCL3	15	Circuit Breaker 24V	14			WL Receptacle
6	CBCL2	15	Circuit Breaker 24V	15			CL1 Receptacle
7	CBCL1	15	Circuit Breaker 24V	16			CL2 Receptacle
8			Secondary Ground Bus	17			CL3 Receptacle
9			Primary Ground Bus				

FIGURE 3-12

CCTV Camera Control Junction Box



Item	Connector Number	Description	Item	Connector Number	Description
1	MI-1	Monitor 1, 7-Pin Connector	15	C2	Camera Input, 4-Pin (Drum 6)
2	MI-2	Monitor 1, 8-Pin Connector	16	C3	Camera Input, 4-Pin (CTWT)
3	M2-1	Monitor 2, 7-Pin Connector	17	C4	Camera Input, 7-Pin
4	M2-2	Monitor 2, 8-Pin Connector	18	C5	Camera Input, 4-Pin (Drum 1)
5	M3-1	Monitor 3, 4-Pin Connector	19	C6	Camera Input, 4-Pin (Drum 2)
6	M3-2	Monitor 3, 8-Pin Connector	20	C7	Camera Input, 4-Pin
7	M4-1	Monitor 4, 4-Pin Connector	21	C8	Camera Input, 4-Pin (Drum 4)
8	M4-2	Monitor 4, 8-Pin Connector	22	C9	Camera Input, 4-Pin (Drum 3)
9	M5-1	Monitor 5, 4-Pin Connector	23	C10	Camera Input, 4-Pin (Drum 5)
10	M5-2	Monitor 5, 8-Pin Connector	24	C11	Camera Input, 4-Pin (Enclosure)
11	M6-1	Spare, 7-Pin Connector	25	C12	Camera Input, 7-Pin Connector
12	M6-2	Spare, 8-Pin Connector	26	C13	Camera Input, 4-Pin Connector
13	R1	31 Pin Connector	27	C14	Camera Input, 4-Pin Connector
14	C1	Camera Input, 7 Pin (Boom)			

FIGURE 3-13

Reference

CCTV Camera Control Junction Box Pin Identification

See Figure 3-13 for the following locations.

The following pin identification table identifies pin inputs and outputs on the CCTV Camera Control junction box.

CCTV Pin Identification Table

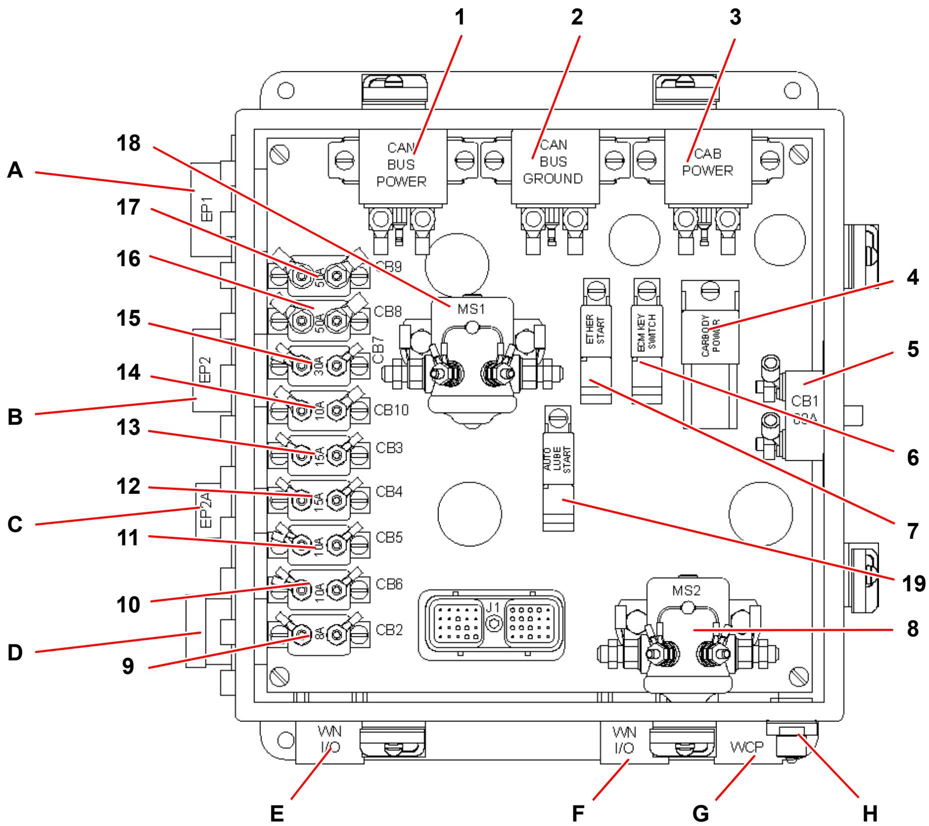
Table 3-2

Pin	System Operation
	R1
1	Monitor 1 Zoom Out
2	Monitor 1 Zoom In
3	Monitor 1 Camera 3 Activated
4	Monitor 1 Camera 2 Activated
5	Monitor 1 Reverse Activated
6	Monitor 2 Zoom Out
7	Monitor 2 Zoom In
8	Monitor 2 Camera 3 Activated
9	Monitor 2 Camera 2 Activated
10	Monitor 2 Reverse Activated
11	Monitor 3 Camera 3 Activated
12	Monitor 3 Camera 2 Activated
13	Monitor 3 Camera 1 Activated
14	Monitor 4 Camera 3 Activated
15	Monitor 4 Camera 2 Activated
16	Monitor 4 Camera 1 Activated
17	Monitor 5 Camera 3 Activated
18	Monitor 5 Camera 2 Activated
19	Monitor 5 Camera 1 Activated
20	Monitor 6 Zoom Out
21	Monitor 6 Zoom In
22	Monitor 6 Camera 3 Activated
23	Monitor 6 Camera 2 Activated
24	Monitor 6 Camera Reverse, Camera 1 Activated
25	NC
26	NC
27	24 VDC
28	Ground
29	NC
30	NC
31	NC
Pin	**System Operation**
	M2
1	Power 18-32 VDC
2	Ground
3	Reverse for 10 inch Monitor Camera 1 Activated for 7 inch Monitor
4	Camera 2 Activated
5	Camera 3 Activated
6	Zoom In
7	Zoom Out
8	NC
	M1-1, M2-1, M6-1
1	Video Signal
2	Video Ground
3	24 VDC
4	Power Ground
5	Serial RX
6	Serial TX
7	NC
	M3-1, M4-1, M5-1
1	Video Signal
2	Video Ground
3	12 VDC
4	Power Ground
	C2, C3, C5, thru C11, C13, C14
1	Video Signal
2	Video Ground
3	12 VDC
4	Power Ground
	C1, C4, C12
	Video Signal
	Video Ground
	24 VDC
	Power Ground
	Serial RX
	Serial TX
	NC

Reference Only

Manitowoc Crane Care

Engine Node Controller Hardware Identification



Item	Circuit Breaker	Amp Size	Description
1	-	50A	CAN Bus Power Relay
2	-	50A	CAN Bus Ground Relay
3	-	50A	Cab Power Relay
4	CUAL	40A	Auto Lube Relay
5	CB-1	60A	Main System 24/28 Volt Power
6	CUECM	10A	ECM Power (Cummins)[1] Relay
7	CUES	10A	Ether Start (Cummins) Relay
8	MS2	50A	Starter Solenoid (left side)
9	CB-2	8A	Engine (ECM) Key Switch
10	CB-6	10A	ECM (Cummins)[1]
11	CB-5	10A	ECM (Cummins)[1]
12	CB-4	15A	Engine Bus Key Switch - Start
13	CB-3	15A	Ether Start
14	CB-10	10A	Auto Lube Tracks

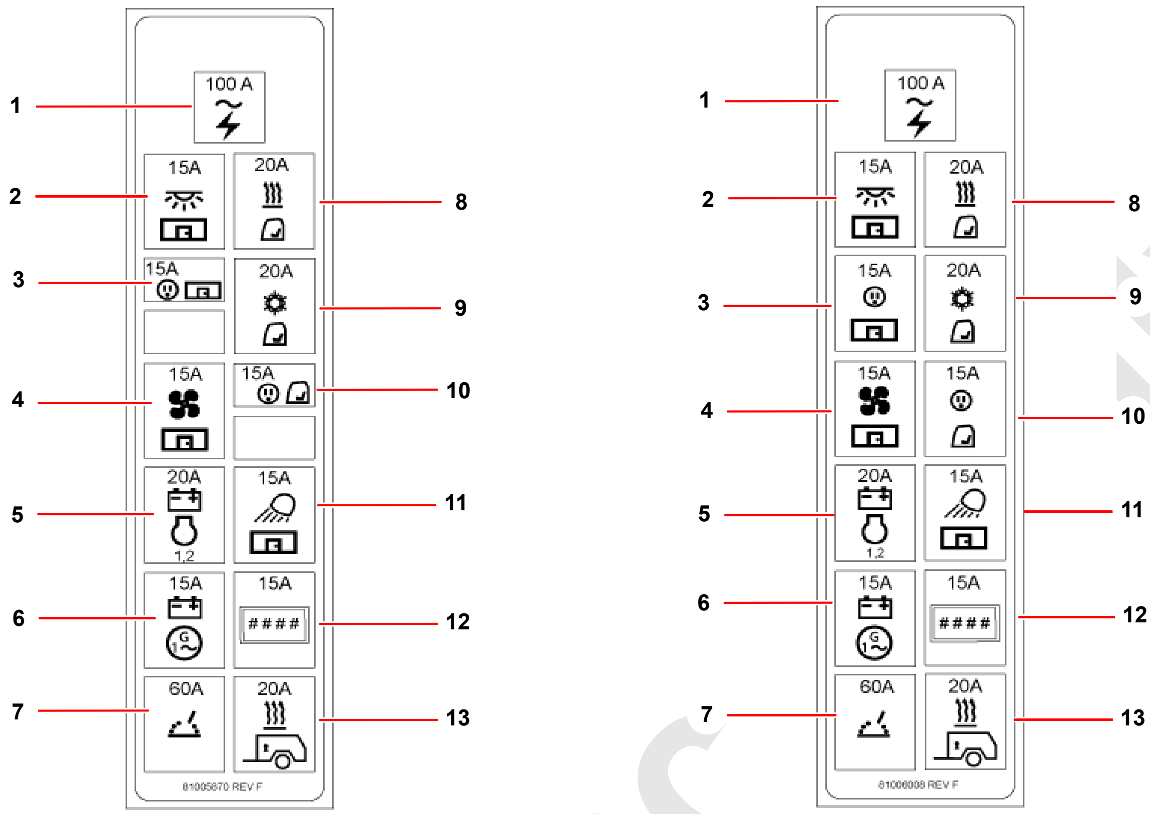
Item	Circuit Breaker	Amp Size	Description
15	CB-7	30A	Engine Start Solenoid
16	CB-8	50A	Can System Power
17	CB-9	50A	Cab Power
18	MS1	50A	Starter Solenoid (right side)
19	CUES	10A	Auto Lube Start Relay

Item	Connector	Description
A	EP1	Engine Power I/O
B	EP2	Engine Control I/O
C	EP2A	Auto Lube Tracks Power
D	-	Engine Diagnostic Receptacle
E	WN I/O	CAN Cable Termination
F	WN I/O	CAN Cable Termination
G	WCP	Cab Power Cable I/O
H	-	Program Receptacle

[1] Electronic Control Module (ECM)

FIGURE 3-14

Main Load AC Center Circuit Breaker Panel



Standard
120/240VAC 60Hz

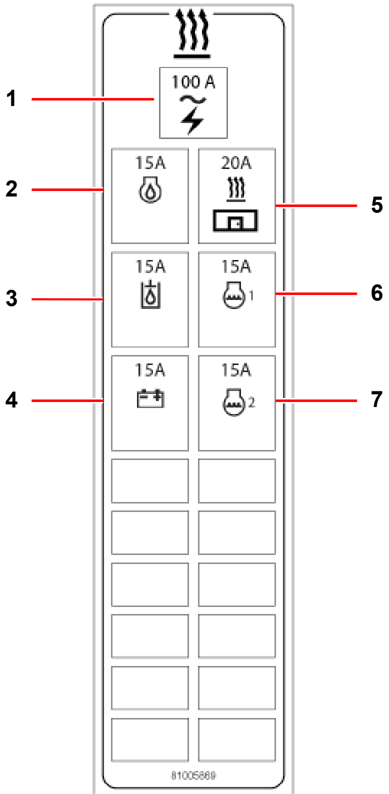
International
240VAC 50Hz

Item	Amps	Name
1	100A circuit breaker	Main circuit
2	15A circuit breaker	Power plant enclosure inside lights
3	15A circuit breaker	Power plant enclosure power outlets
4	15A circuit breaker	Power plant enclosure fan
5	20A circuit breaker	Primary and Secondary engine battery chargers
6	15A circuit breaker	Diesel generator battery charger
7	60A circuit breaker	Temporary welding
8	20A (standard) 15A (international)	Operator cab heater
9	20A circuit breaker	Operator cab air conditioner
10	15A circuit breaker	Operator cab power outlets
11	15A circuit breaker	Power plant enclosure outside lights
12	15A circuit breaker	Front and rear external LED display signs
13	20A circuit breaker	Hydraulic power unit heater

FIGURE 3-15

Reference Only

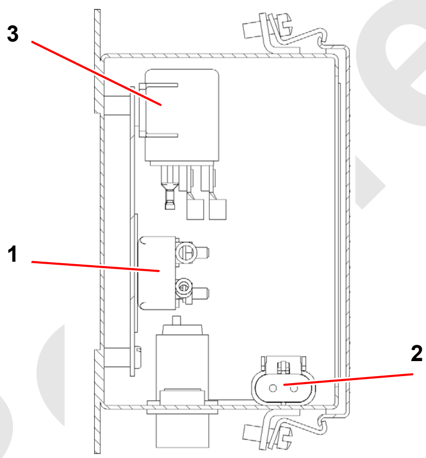
Cold Weather AC Load Center



1	100A circuit breaker	Main circuit breaker
2	15A circuit breaker	Engine oil heaters
3	15A circuit breaker	Hydraulic fluid heaters
4	15A circuit breaker	Battery pad heaters
5	20A circuit breaker	Power plant enclosure heater
6	15A circuit breaker	Primary Engine coolant heater
7	15A circuit breaker	Secondary Engine coolant heater

FIGURE 3-16

Aux Cab Power Junction Box



Item	Circuit Breaker	Amp Size	Description
1	CB-11	50A	Aux Cab Buss
2	-	5A	CraneSTAR TSU
3	-	50A	Relay - Aux Cab Power

FIGURE 3-17

Reference Only

ROTATING BED ANGLE SENSOR

General

Rotating bed angle sensor (2, Figure 3-18) is located inside the rotating bed — on left side under the drums. The angle sensor sends electronic signals to the main display indicating crane levelness in both directions.

Adjustment

Adjust the angle sensor at the following intervals:

- When a new sensor is installed.
- Anytime the angle indicated in the main display is in question.

1. Travel the crane onto a firm level surface. The 31000 roller path must be level within a tolerance of 1/2 in 10 ft (13 mm in 3 m) — 1/4° — for all lifting applications.
2. Make sure mounting bracket (1) is clean before attaching sensor (2).
3. Attach sensor (2) to mounting bracket (1) as shown in View A.

   Screws (3), washers (4, 5, and 6), and lock nut (7) must be installed in the exact order shown.

4. Tighten screws (3).
5. Place a digital level on top of sensor (1).
6. Adjust the screws so the sensor is level to within plus or minus 0.25°.

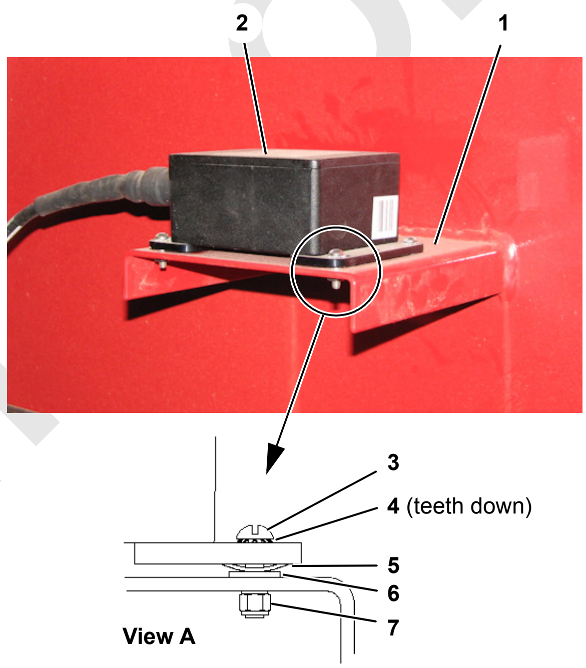


FIGURE 3-18

Item	Description
1	Mounting Bracket
2	Rotating Bed Angle Sensor (dual axis)
3	Screw (4)
4	External Tooth Lock Washer (countersunk) (4)
5	Wave Washer (4)
6	Flat Washer (4)
7	Lock Nut (4)

Reference Only

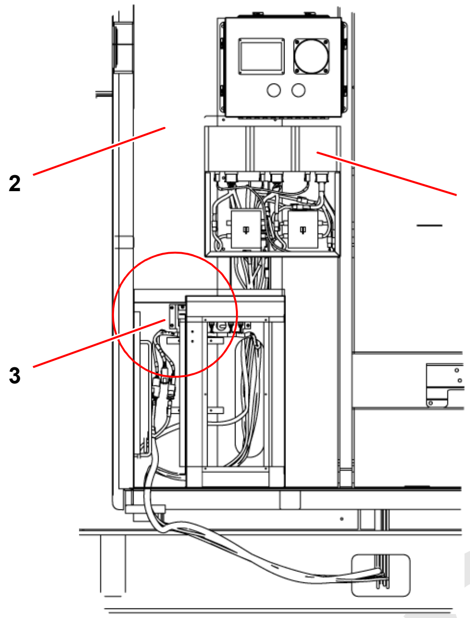
FIRE SUPPRESSION CONTROL RELAYS

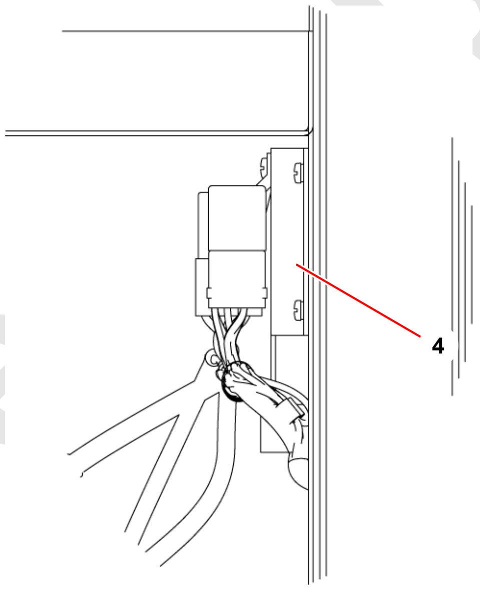
See Figure 3-19 for the following procedure.

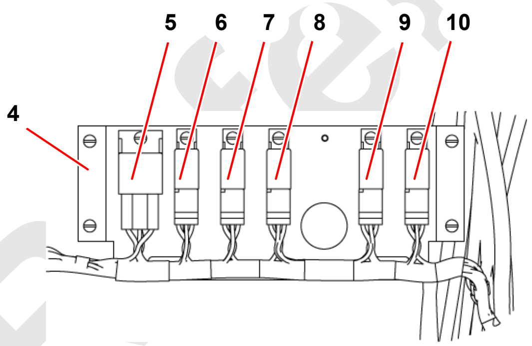
The Fire Suppression System is monitored by its stand alone control system and the master node. Six separate circuits are controlled independently of each other and can be activated at different times by the control system.

Troubleshoot corresponding relay when circuit fails during Fire Suppression test sequence procedure. See section 7 of this service manual and the Kidde Sentinel SA1 Vehicle Fire Protection System Manual for maintenance test procedures and recommended weekly and semi annual inspection intervals.

Fire Suppression Control Relay Component Identification







Item	Description
1	Fire Suppression Control Panel
2	Operator Cab
3	Fire Suppression Control Relays
4	Relay Mounting Bracket
5	Strobe, Power Plant Enclosure
6	Input Signal, Power Plant Fire Suppression
7	Power Plant Intake Louvers
8	Generator Emergency Stop
9	Strobe, Generator Area
10	Input Signal, Generator Fire Suppression

FIGURE 3-19

Reference Only

ELECTRICAL CONTROL SYSTEM OVERVIEW

See Figure 3-20 for the following procedure.

The crane's boom, load lines, swing, crawler tracks, and accessory components are controlled electronically with the CAN bus (Controller Area Network) technology. The 28 volt CAN bus programmable controller system uses remote nodes that contain controllers. The node controllers communicate with Node-1 (master) controller by sending data packets over a two-wire bus line. The data packets are tagged with addresses that identify system components. Node-1 controller compares these input data packet signals with programming directives and data information. Node-1 controller then provides appropriate output voltage commands to the remote node controllers.

Each node controller receives and sends both analog and digital input/output voltages. Analog input/output voltages are either AC or DC variable voltages or currents. Digital input/output voltages are zero volts (no voltage) or 28 volts.

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

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

CAN Bus Overview Diagram (Typical)

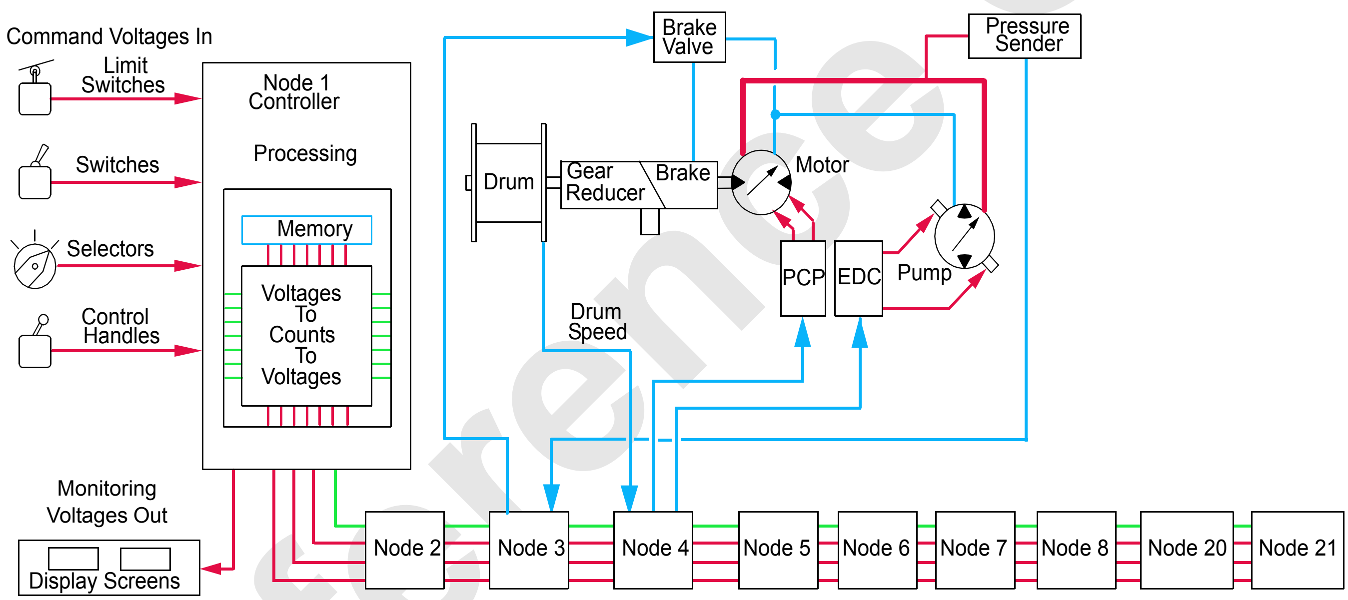


FIGURE 3-20

Electrical Power to Operator Cab

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

- Engine control module (ECM1 & ECM2).
- CAN bus system power relay (CAN PWR).
- CAN bus system ground relay (CAN GND).
- Cab power relay (CAB PWR). When cab power relay is enabled, power is available to operate crane controls.
- Air conditioning system relay (A/C CLUTCH).

Crane Display Screens

The display screens contain the RCL/RCI display and Main display. Use the menu screen to selected RCL/RCI and crane functions. Reference Folio 2207 for Main Display Operation.

Pressure Senders and Speed Sensors

Hydraulic pressure senders monitor drum system pressures, right/left travel system pressure, swing right/left system pressure, VPC system pressure, and accessory pressures.

Reference Only

Manitowoc Crane Care

Remote node controllers receive 0 to 5 volt input signals for each system pressure sender. Pressure senders transmit drum holding pressure information to Node-1 controller.

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

System Faults

Node-1 controller monitors and enables an alarm if any system fault is detected and displays the fault on the crane information screen (see F2207 Main Display Operation manual).

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

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

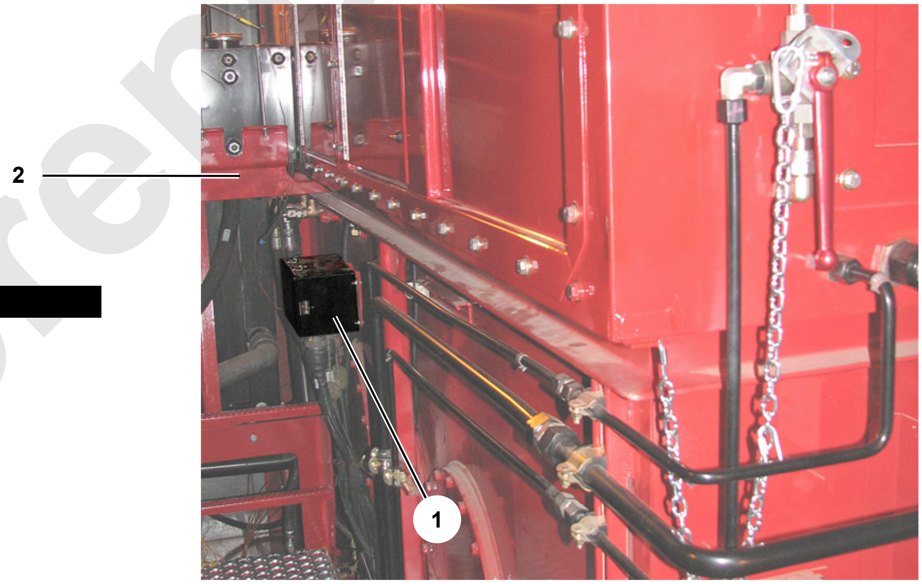
Brake and Drum Pawl Operation

All load drums, boom hoist, travel, and swing park brakes are spring-applied and hydraulically released. Drums 4 and 5 have drum pawls that are released with the selected park switch. When the operator places the selected brake switch in OFF - park position, the selected drum pawl is disengaged from drum. Place selected brake switch in ON - park position to apply pawl to drum.

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

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

Node 4 Location and Identification



Item	Description
1	Node-4
2	Engine Enclosure Interior

FIGURE 3-21

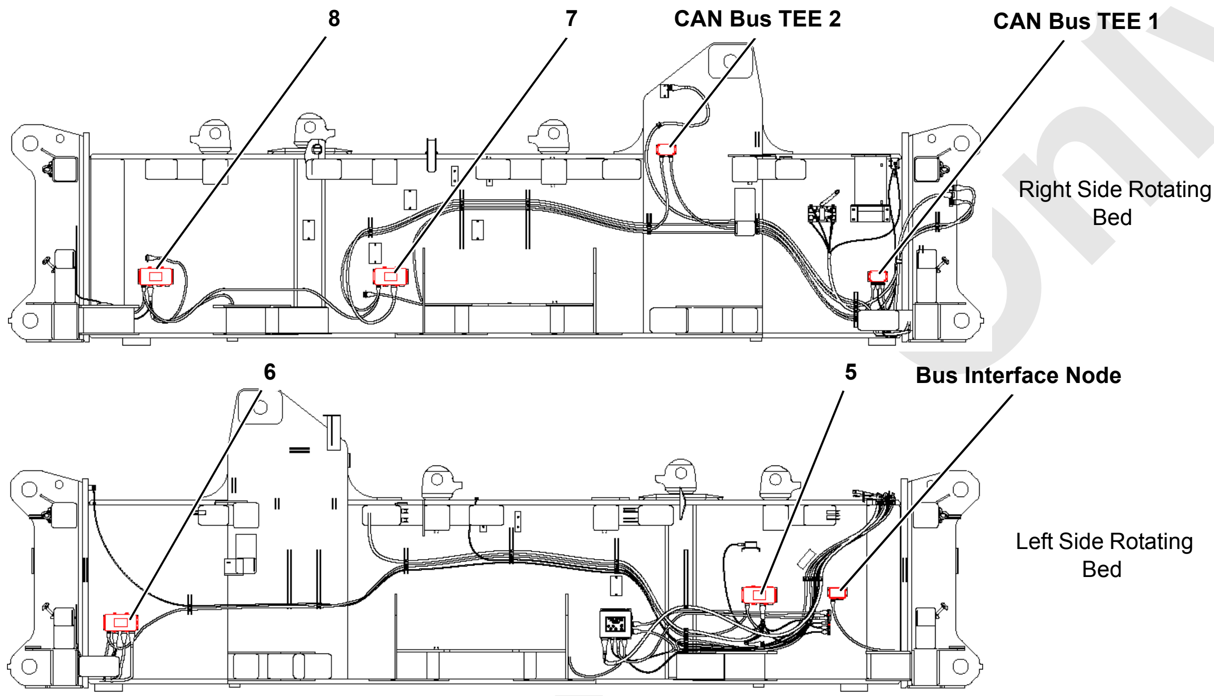
Reference Only

3

TEST VOLTAGES

The Model 31000 operating system is an EPIC® (Electrical Processed Independent Control) 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. A hand-held remote connected to the CAN TEE is used for operating setup items.Test voltages are sorted by nodes (reference Electrical Schematic 81000614 in this section). The nodes are listed and identified in Figure 3-22.

CAN Bus Node to Component Identification Diagram



Node Number	Node to Component Identification
CAB CAN Bus	
1	Master Node (Cab - Right Side Console)
2	Handles and Cab Controls (Cab - Right Side Console)
POWERPLANT ENCLOSURE CAN Bus	
3	Primary Pump Controls and Pressure Sensors (Enclosure Outside- See Figure 3-3)
4	Secondary Pump Controls, Cab Seat Tilt Raise/Lower, Hyd-, Engine 1 Exhaust Damper, Air Intake Damper, Vacuum Alarm and Senders (Enclosure Inside - See Figure 3-21)
30	Primary Engine (Enclosure Outside Access- See Figure 3-2)
31	Secondary Engine (Enclosure Outside Access - SeeFigure 3-3)
ROTATING BED CAN Bus (See Figure 3-22)	
5	Alarms, Limits, Boom Angle Sensor, Rotating Bed Level Sensor, and Drum 1 and 3 Motor Control
6	Drums 2, 4, 5, VPC, Greaser Valves, Counterweight Tray, and Adapter Frame Pins
7	Swing, Travel, VPC Angle Sensors, VPC Position Alarm, and Drum 1 and 4 Motor Control
8	Drum 5 and Drum 6
TEE 1	Auto Lube Pump/Valve
TEE 2	VPC Remote Setup
BIN	Bus Interface Node
BOOM MAIN Bus	
20	Mounted on Boom Top - Boom Block Up, Block Level Sensor, Wind Speed, Luffing Jib Stop, & Load Limits
21	Mounted on Jib Top - Luffing Jib Block Up, Block Level Sensor, & Load Limits

FIGURE 3-22

Reference Only

Pump and Motor Control Test Voltages

Table 3-3

Pumps	Hoist Motors	VPC Motors	Travel Motors
0 to 25.4 Volts (At Node)	3.8 to 16.2 Volts (at Node)	3.8 Volts (at Node)	0 or 28 Volts (at Node)[2]
0 to 2.0 Volts (At Pump)	3.8 to 16.2 Volts (at Motor)	3.8 Volts (at Motor)	0 or 28 Volts (at Motor)[2]
1 to 100 mA[1]	180 mA to 750mA[1]	180mA[1,3]	0 or 1500 mA[1]

Table 3-3 Notes	
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	**VPC motors are held in max displacement, low speed at all times by the Master Node.**
4	**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.**

Reference Only

Abbreviations

The following abbreviations are used in this section.

1 BAR	=	14.5 PSI
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
Comm	=	Communication
CPU	=	Central Processing Unit
DC	=	Direct Current
DI	=	Digital Input
Dn	=	Down
DO	=	Digital Output
EC	=	Encoder Control
EDC	=	Electrohydraulic Displacement Control
ENC	=	Encoder Number Count

GND	=	Ground
ID	=	Identification
I/O	=	Input/Output
L.E.D.	=	Light Emitting Diode
mA	=	Milliampere
Max	=	Maximum
Min	=	Minimum
N/A	=	Not Applicable
N/C	=	No Connection
NO	=	Number
NS	=	Node Select
Opt	=	Optional
PCOR	=	Pressure Compensator Override
Press	=	Pressure
psi	=	Pounds per Square Inch
psig	=	psi gauge OR pressure above atmospheric
RCL	=	Rated Capacity Indicator/Limiter
RPM	=	Revolutions Per Minute
V	=	Volt or Volts
VDC	=	Volts Direct Current
W	=	Wire

Reference Only

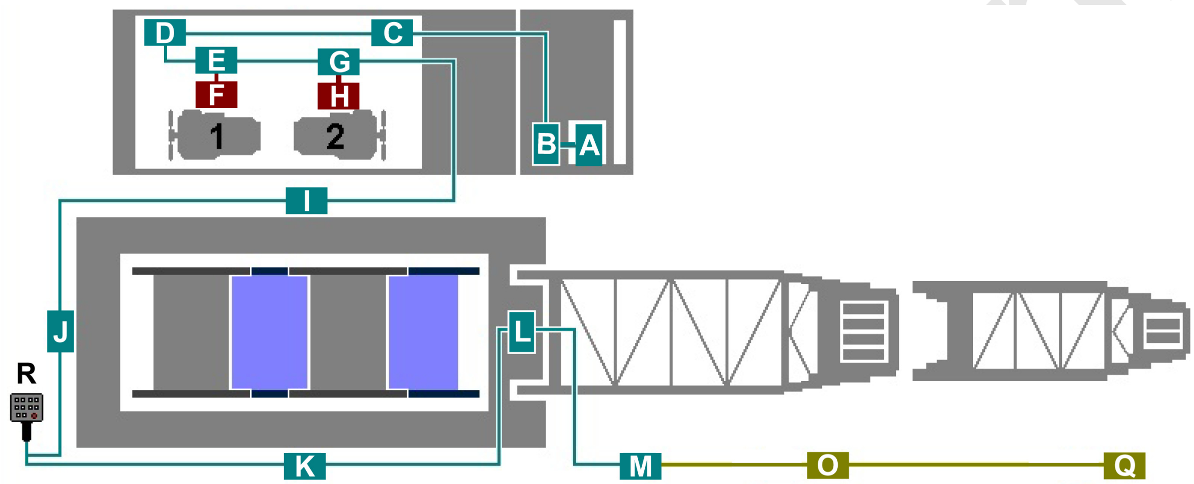
NODE DIAGNOSTICS (CAN BUS DIAGNOSTIC SCREEN)

NOTE: For detailed diagnostic information, reference Folio 2207, Main Display Operation.

The Can bus diagnostic display component identification is located on Figure 3-23. Refer to **CAN Bus Node to Component Identification**, Figure 3-22, to identify the major functions controlled by individual node and their physical location on the crane.

CAN Bus Node Diagnostic Display Diagram

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



A	Node 1 Master Node (FCN)	J	Node 6
B	Node 2	K	Node 7
C	Node 3	L	Node 8
D	Node 4	M	BIN Node
E	Engine Node 30	N	Not Used
F	Engine 1 ECM (Engine Control Module)	O	Boom Node 20
G	Engine Node 31	P	Not Used
H	Engine 2 ECM (Engine Control Module)	Q	Jib Node 21
I	Node 5	R	Remote Control (If the remote control is not enabled, then this icon will not appear.

FIGURE 3-23

NODE 1 - Master Node (Front Console)

Reference Electrical Schematic 81000614 - Sheets 11 & 14

Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
J1A - P11	**Receptacle – Front Console**			
1101/P11-1	28 Volts	28V CAN System Bus - Power to Node 1	28 Volts	
1102/P11-2	28 Volts	28V CAN System Bus	28 Volts	
1103/P11-3	DI-12	Keypad - Scroll UP	0 Volts Off; 28 Volts On	CAN188-4-8
1104/P11-4	DI-14	Keypad - Scroll DOWN	0 Volts Off; 28 Volts On	CAN188-4-32
1105/P11-5	DI-31	Keypad - EXIT	0 Volts Off; 28 Volts On	CAN188-6-64
1106/P11-6	DI-9	Keypad - ENTER	0 Volts Off; 28 Volts On	CAN188-4-1
1107/P11-7	DO-1	28V Bus	28 Volts Nominal	CAN188-1-1
1108/P11-8	DO-3	RCL/RCI Warning LED	0 Volts Off; 28 Volts On	CAN188-1-4
1109/P11-9	DO-8	N/C	N/A	
1110/P11-10	DO-6	RCL/RCI Caution LED	0 Volts Off; 28 Volts On	CAN188-1-32
1111/P11-11	28 Volts	Keypad Power	28 Volts	
1112/P11-12	Signal	N/C	N/A	
1113/P11-13	DI-11	N/C	N/A	
1114/P11-14	DI-13	VPC- ON/Off	0 Volts Off; 28 Volts On	CAN188-4-5
1115/P11-15	DI-32	Drum 3 Park-ON	0 Volts Off; 28 Volts On	CAN188-6-128
1116/P11-16	DI-10	Keypad - CONFIRM	0 Volts Off; 28 Volts On	CAN188-4-2
1117/P11-17	DO-2	N/C	N/A	
1118/P11-18	DO-4	N/C	N/A	
1119/P11-19	DO-7	N/C	N/A	
1120/P11-20	DO-5	N/C	N/A	
1121/P11-21	Ground	CAN System Ground	Ground	
1122/P11-22	Ground	CAN System Ground	Ground	
1123/P11-23	DI-28	Crane Set-up	0 Volts Off; 28 Volts On	CAN188-6-8
1124/P11-24	DI-30	Swing Park - ON	0 Volts Off; 28 Volts On	CAN188-6-32
1125/P11-25	DI-15	Seat -Tilt UP	0 Volts Off; 28 Volts On	CAN188-4-64
1126/P11-26	DI-25	Seat - Tilt DOWN	0 Volts Off; 28 Volts On	CAN188-6-1
1127/P11-27	Ground	CAN System Ground	Ground	
1128/P11-28	Ground	CAN System Ground	Ground	
1129/P11-29	Ground	CAN System Ground	Ground	
1130/P11-30	Ground	CAN System Ground	Ground	
1131/P11-31	CAN-H	CAN - H Data Line	N/A	
1132/P11-32	CAN-L	CAN - L Data Line	N/A	
1133/P11-33	DI-27	Keypad - DISPLAY 1 (RCL/RCI)	0 Volts Off; 28 Volts On	CAN188-6-4
1134/P11-34	DI-29	Keypad - DISPLAY 2 (Main)	0 Volts Off; 28 Volts On	CAN188-6-16
1135/P11-35	DI-16	N/C	N/A	
1136/P11-36	DI-26	N/C	N/A	

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
1137/P11-37	Ground	CAN System Ground	Ground	
1138/P11-38	Ground	CAN System Ground	Ground	
1139/P11-39	Ground	CAN System Ground	Ground	
1140/P11-40	Ground	CAN System Ground	Ground	
J2B - P12		**Receptacle – Front Console**		
1201/P12-1	28 Volts	28V CAN System Bus	28 Volts	
1202/P12-2	28 Volts	N/C	N/A	
1203/P12-3	DI-4	Drum 6 Park - ON	0 Volts Off; 28 Volts On	CAN188-3-8
1204/P12-4	DI-6	Travel Cruise - ON	0 Volts Off; 28 Volts On	CAN188-3-32
1205/P12-5	DI-23	Travel 2 Speed - FAST	0 Volts Off; 28 Volts On	CAN188-5-64
1206/P12-6	DI-2	N/C	N/A	
1207/P12-07	DO-9	28V Bus	28 Volts Nominal	CAN188-2-1
1208/P12-8	DO-11	28V Bus	28 Volts Nominal	CAN188-2-4
1209/P12-9	DO-16	28V Bus	28 Volts Nominal	CAN188-2-128
1210/P12-10	DO-14	28V Bus	28 Volts Nominal	CAN188-2-32
1211/P12-11	28 Volts	N/C	N/A	
1212/P12-12	Signal	N/C	N/A	
1213/P12-13	DI-3	Drum 1 Park - ON	0 Volts Off; 28 Volts On	CAN188-3-4
1214/P12-14	DI-5	Drum 2 Park - ON	0 Volts Off; 28 Volts On	CAN188-3-16
1215/P12-15	DI-24	Drum 4 Park - ON	0 Volts Off; 28 Volts On	CAN188-5-128
1216/P12-16	DI-1	Drum 5 Park - ON	0 Volts Off; 28 Volts On	CAN188-3-1
1217/P12-17	DO-10	28V Bus	28 Volts Nominal	CAN188-2-2
1218/P12-18	DO-12	N/C	N/A	
1219/P12-19	DO-15	N/C	N/A	
1220/P12-20	DO-13	N/C	N/A	
1221/P12-21	Ground	CAN System Ground	Ground	
1222/P12-22	Ground	CAN System Ground	Ground	
1223/P12-23	DI-20	Engine 2 Start	0 Volts Off; 28 Volts On	CAN188-5-8
1224/P12-24	DI-22	Engine 1 Start	0 Volts Off; 28 Volts On	CAN188-5-32
1225/P12-25	DI-7	Travel Park - ON	0 Volts Off; 28 Volts On	CAN188-3-64
1226/P12-26	DI-17	N/C	N/A	
1227/P12-27	Ground	CAN System Ground	Ground	
1228/P12-28	Ground	CAN System Ground	Ground	
1229/P12-29	Ground	CAN System Ground	Ground	
1230/P12-30	Ground	CAN System Ground	Ground	
1231/P12-31	CAN-H	CAN - H Data Line	N/A	
1232/P12-32	CAN-L	CAN - L Data Line	N/A	
1233P12-33	DI-19	Engine 1 RUN	28 Volts Nominal	CAN188-5-4
1234/P12-34	DI-21	Engine 2 RUN	28 Volts Nominal	CAN188-5-16

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
1235/P12-35	DI-8	Counter Weight Beam - RETRACT	0 Volts Off; 28 Volts On	CAN188-3-128
1236/P12-36	DI-18	Counter Weight Beam- EXTEND	0 Volts Off; 28 Volts On	CAN188-5-2
1237/P12-37	Ground	CAN System Ground	Ground	
1238/P12-38	Ground	CAN System Ground	Ground	
1239/P12-39	Ground	CAN System Ground	Ground	
1240/P12-40	Ground	CAN System Ground	Ground	

Reference Only

NODE 2 - Handles and Cab Controls

Reference Electrical Schematic 81000614- Sheets 11, 12, 13 and 15.

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
J1A-P1	Receptacle			
2101/P51-1	CAN-H	CAN-H Data Line	N/A	
2102/P51-2	CAN-L	CAN-L Data Line	N/A	
2103/P51-3	AI-2	Handle H1 - Drum 1 Signal	Raise 2.4 - 0.5 Volts; Lower 2.6 - 4.5 Volts	CAN0-4[1]
2104/P51-4	AI-5	Handle H2 - Drum 2 Signal	Raise 2.4 - 0.5 Volts; Lower 2.6 - 4.5 Volts	CAN1-2[1]
2105/P51-5	AI-10	Handle H3 - Drum 3 Signal	Lower 2.6 - 4.5 Volts; Raise 2.4 - 0.5 Volts	CAN2-4[1]
2106/P51-6	AI-14	Engine Hand Throttle	Low Idle 0.5 Volts; High Idle 4.5 Volts	CAN3-4[1]
2107/P51-7	DI-10	Handle H1 DIR-Signal	0 to 28 Volts	CAN71-2-2
2108/P51-8	DI-11	Handle H2 DIR-Signal	0 to 28 Volts	CAN71-2-4
2109/P51-9	DI-2	Handle H3 DIR-Signal	0 to 28 Volts	CAN71-1-2
2110/P51-10	DI-3	Swing Brake Release	0 Volts Off; 28 Volts On	CAN71-1-4
2111/P51-11	CAN-H	CAN-H Data Line	N/A	
2112/P51-12	CAN-L	CAN-L Data Line	N/A	
2113/P51-13	AI-4	Handle 5 Left - Travel Signal	Forward 2.6 - 4.5 Volts; Reverse 2.4 - 0.5 Volts	CAN0-8[1]
2114/P51-14	AI-6	Handle 6 Right - Travel Signal	Forward 2.6 - 4.5 Volts; Reverse 2.4 - 0.5 Volts	CAN1-4[1]
2115/P51-15	AI-9	Handle H4Y Boom/LJ - Signal	Raise 2.4 - 0.5 Volts; Lower 2.6 - 4.5 Volts	CAN2-2[1]
2116/P51-16	AI-13	Handle H4X Swing - Signal	Left 2.4 - 0.5 Volts; Right 2.6 - 4.5 Volts	CAN3-2[1]
2117/P51-17	DI-9	Handle 5 Left Travel DIR - Signal	0 to 28 Volts	CAN71-2-1
2118/P51-18	DI-12	Handle 6 Right Travel DIR - Signal	0 to 28 Volts	CAN71-2-8
2119/P51-19	DI-1	Handle H4Y DIR - Signal	0 to 28 Volts	CAN71-1-1
2120/P51-20	DI-4	Handle H4X DIR - Signal	0 to 28 Volts	CAN71-1-8
2121/P51-21	Ground	CAN System Ground	Ground	
2122/P51-22	Ground	Node 2	Analog Ground	
2123/P51-23	AI-1	Engine Foot Throttle	Low Idle 2.7 – 3.0 Volts; High Idle 0.9 – 1.0 Volts	CAN0-2[1]
2124/P51-24	AI-8	N/C	N/A	
2125/P51-25	AI-12	Power Plant Fire Suppression	0 to 28 Volts	CAN2-2-128
2126/P51-26	AI-16	Generator Fire Suppression	0 to 28 Volts	CAN3-2-128
2127/P51-27	DI-16	Hydraulic Generator Emergency Stop	0 to 28 Volts	CAN71-2-128
2128/P51-28	DI-7	Counterweight Lock Pins RETRACT	0 to 28 Volts	CAN71-1-64
2129/P51-29	DI-15	Boom (System) Limit Bypass	0 to 28 Volts	CAN71-2-64

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
2130/P51-30	DI-14	Open/Not Used		
2131/P51-31	5 Volts DC	CAN Bus 5 Volts	5 Volts	
2132/P51-32	Node 1	NS 01 Node 2 ID	0 Volts (With **Jumper**)	
2133/P51-33	Node 2	N/C	N/A	
2134/P51-34	AI-7	N/C	N/A	
2135/P51-35	AI-11	N/C	N/A	
2136/P51-36	AI-15	N/C	N/A	
2137/P51-37	DI-8	Seat Safety Switch	0 Volts Off; 28 Volts On	CAN71-1-128
2138/P51-38	DI-6	Louver Switch	0 Volts Off; 28 Volts On	CAN71-1-32
2139/P51-39	DI-13	Camera Lights	0 Volts Off; 28 Volts On	CAN71-2-16
2140/P51-40	DI-5	Manual Lube Switch	0 to 28 Volts	CAN71-1-16
J2B-P2	**Receptacle - Handles**			
2201/P52-1	DO-7	H1 Rotation Indicator (Thumper)	0 Volts Off; 28 Volts On	CAN40-1-64
2202/P52-2	DO-3	H2 Rotation Indicator (Thumper)	0 Volts Off; 28 Volts On	CAN40-1-4
2203/P52-3	DO-6	H3 Rotation Indicator (Thumper)	0 Volts Off; 28 Volts On	CAN40-1-32
2204/P52-4	DO-2	H4 Rotation Indicator (Thumper)	0 Volts Off; 28 Volts On	CAN40-1-2
2205/P52-5	DO-5	RCL/RCI Beacon GREEN	0 Volts Off; 28 Volts On	CAN40-1-16
2206/P52-6	DO-13	28V Bus	28 Volts Nominal	CAN40-2-16
2207/P52-7	DO-16	28V Bus	28 Volts Nominal	CAN40-2-128
2208/P52-8	DO-9	28V Bus	28 Volts Nominal	CAN40-2-1
2209/P52-9	DO-19	28V Bus	28 Volts Nominal	CAN40-3-4
2210/P52-10	DO-12	28V Bus	28 Volts Nominal	CAN40-2-8
2211/P52-11	DO-4	RCL/RCI Beacon RED	0 Volts Off; 28 Volts On	CAN40-1-8
2212/P52-12	DO-8-1	28V Bus	28 Volts Nominal	CAN40-1-128
2213/P52-13	DO-8-2	28V Bus	28 Volts Nominal	CAN40-1-128
2214/P52-14	Ground	CAN System Ground	Ground	
2215/P52-15	DO-1	RCL/RCI Beacon AMBER	0 Volts Off; 28 Volts On	CAN40-1-1
2216/P52-16	DO-22	System Operating ALARM	0 Volts Off; 28 Volts On	CAN40-3-32
2217/P52-17	DO-24	RCL/RCI Cab Audible ALARM	0 Volts Off; 28 Volts On	CAN40-3-128
2218/P52-18	DO-10	H2 Drum Display	0 Volts Off; 28 Volts On	CAN40-2-2
2219/P52-19	DO-18	H3 Drum Display	0 Volts Off; 28 Volts On	CAN40-3-2
2220/P52-20	Ground	CAN System Ground	Ground	
2221/P52-21	DO-8-3	N/C	N/A	
2222/P52-22	DO-8-4	N/C	N/A	
2223/P52-23	Ground	CAN System Ground	Ground	
2224/P52-24	Ground	CAN System Ground	Ground	
2225/P52-25	Ground	CAN System Ground	Ground	
2226/P52-26	DO-15	28V Bus	28 Volts Nominal	CAN40-2-64
2227/P52-27	DO-14	28V Bus	28 Volts Nominal	CAN40-2-32

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
2228/P52-28	DO-11	N/C	28 Volts Nominal	
2229/P52-29	DO-17	N/C	28 Volts Nominal	
2230/P52-30	Ground	CAN System Ground	Ground	
2231/P52-31	DO-8-5	28V Bus	28 Volts Nominal	CAN40-1-128
2232/P52-32	DO-8-6	28V Bus	28 Volts Nominal	CAN40-1-128
2233/P52-33	5 Volts DC	CAN Bus 5 Volts	5 Volts DC Nominal	
2234/P52-34	5 Volts DC	N/C	N/A	
2235/P52-35	5 Volts DC	N/C	N/A	
2236/P52-36	DO-21	H4 Drum Display	0 Volts Off; 28 Volts On	CAN40-3-16
2237/P52-37	DO-23	Power to Foot Throttle	28 Volts Nominal	CAN40-3-64
2238/P52-38	DO-20	H1 Drum Display	0 Volts Off; 28 Volts On	CAN40-3-8
2239/P52-39	5 Volts DC	N/C	N/A	
2240/P52-40	5 Volts DC	N/C	N/A	
J3-P3	**Receptacle - Power**			
P53-A	Ground	CAN Ground	Ground	
P53-B	Ground	CAN Ground	Ground	
P53-C	Ground	Chassis Ground	Ground	
P53-D	Ground	N/C	Ground	
P53-E	28 Volts	CAN Power	28 Volts Nominal	
P53-F	28 Volts	CAN Power	28 Volts Nominal	

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

Reference Only

NODE 3 - Drum Pumps, Alarms, Sensors and Accessories

Reference Electrical Schematic 81000614 - Sheets 16, 21 & 22

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
WN-A	28 Volts	CAN Bus Power	28 Volts Nominal	
WN-C	CAN-H	CAN High Wire Transmission	N/A	
WN-D	Ground	CAN Bus Ground	Ground	
WN-E	DI-2	Container Shorting Plug		
WN-F	CAN-L	CAN Low Wire Transmission	N/A	
J3/W33		**Receptacle – Swing Pump, Alarms and Sensors**		
33-A	Ground	VPC Actuator - Retract PSI Sensor Return	Ground	
33-B	DO-1	VPC Actuator - Retract PSI Sensor Supply	28 Volts Nominal	CAN41-1-1
33-C	Ground	CAN System GRD Bus	Ground	
33-D	DO-2	Enclosure Camera Light	N/A	CAN41-1-2
33-E	Ground	VPC Actuator Pump #14	Ground	
33-F	DO-3	VPC Actuator Pump #14 (Extend on Pump Port A)	See Table 3-3 for Values	CAN91-1
33-G	Ground	VPC Actuator Pump #14	Ground	
33-H	DO-4	VPC Actuator Pump #14 (Retract on Pump Port B)	See Table 3-3 for Values	CAN91-1
33-J	Ground	**Jumper** to Node Select Cab Auxiliary Power Relay (K1)	Ground	
33-K	NS-1	N/C	N/A	
33-L	NS-2	Node 2 Select **Jumper** to Ground	0 Volts (With **Jumper**)	
33-M	NS-3	N/C	N/A	
33-N	Ground	Hydraulic Fluid Level Sensor Hydraulic Fluid Temperature Sensor	Ground	
33-P	DO-6	Sensor Power Supply	28 Volts Nominal	CAN41-1-32
33-R	DO-5	Cab Aux Power	28 Volts Nominal	CAN41-1-16
33-S	NS-4	N/C	N/A	
33-T	DI-3	Hydraulic Return Filter Alarm	0 Volts Off; 28 Volts On	CAN73-1-4
33-U	28 Volts	Hydraulic Fluid Level Sensor	28 Volts Nominal	
33-V	28 Volts	Hydraulic Fluid Temperature Sensor	28 Volts Nominal	
33-W	DI-4	N/C	N/A	
33-X	28 Volts	Side A Left Front Track/Drum 6/System Accessories Pressure Sensor	28 Volts Nominal	
33-Z	28 Volts	Side B Left Front Track/Drum 6 Pressure Sensor	28 Volts Nominal	
33-a	AI-1	N/C	N/A	
33-b	AI-2	VPC Actuator - Retract Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN4-4[1]
33-c	AI-3	Hydraulic Fluid Level Sensor	1 Volt Empty; 3.5 Volts Full	CAN4-6[1]
33-d	AI-4	Hydraulic Fluid Temperature Sensor	Non-linear (see Drawing)	CAN4-8[1]
33-e	AI-5	Side A Left Front Track/Drum 6/System Accessories Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN5-2[1]

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
33-f	AI-6	Side B Left Front Track/Drum 6/Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN5-4 [1]
33-g	Ground	Swing Right CW Pressure Sensor	Ground	
33-h	Ground	Swing Left CCW Pressure Sensor	Ground	
33-j	5 Volts	N/C	N/A	
33-k	Ground	Side A Left Front Track/Drum 6/System Accessories Pressure Sensor	Ground	
33-m	Ground	Side B Left Front Track/Drum 6/System Accessories Pressure Sensor	Ground	
33-n	28 Volts	Swing Right CW Pressure Sensor	28 Volts Nominal	
33-p	AI-7	Swing Right CW Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN5-6[1]
33-r	AI-8	Swing Left CCW Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN5-8[1]
33-s	28 Volts	Swing Left CCW Pressure Sensor	28 Volts Nominal	
J4/W34	**Receptacle – Pump Controls**			
34-A	Ground	Swing Pump #2	Ground	
34-B	DO-11	Swing Pump #2 (Right on Pump Port B)	See Table 3-3 for Values	CAN91-3
34-C	Ground	Swing Pump #2	Ground	
34-D	DO-12	Swing Pump #2 (Left on Pump Port A)	See Table 3-3 for Values	CAN91-3
34-E	Ground	Drum 1 Pump #4	Ground	
34-F	DO-13	Drum 1 Pump #4 (Raise on Pump Port B)	See Table 3-3 for Values	CAN91-5
34-G	Ground	Drum 1 Pump #4	Ground	
34-H	DO-14	Drum 1 Pump #4 (Lower on Pump Port A)	See Table 3-3 for Values	CAN91-5
34-J	Ground	Drum 4 Pump #6	Ground	
34-K	Ground	Right Front Travel Pump #8	Ground	
34-L	Ground	Right Front Travel Pump #8	Ground	
34-M	DO-17	Right Front Travel Pump #8 (Forward on Pump Port B)	See Table 3-3 for Values	CAN101-1
34-N	Ground	Drum 4 Pump #6	Ground	
34-P	DO-16	Drum 4 Pump #6 (Raise on Pump Port A)	See Table 3-3 for Values	CAN91-7
34-R	DO-15	Drum 4 Pump #6 (Lower on Pump Port B)	See Table 3-3 for Values	CAN91-7
34-S	DO-18	Right Front Travel Pump #8 (Reverse on Pump Port A)	See Table 3-3 for Values	CAN101-1
34-T	Ground	Drum 3 Pump #10	Ground	
34-U	DO-19	Drum 3 Pump #10 (Raise on Pump Port B)	See Table 3-3 for Values	CAN101-3
34-V	Ground	Drum 3 Pump #10	Ground	
34-W	DO-20	Drum 3 Pump #10 (Lower on Pump Port A)	See Table 3-3 for Values	CAN101-3
34-X	Ground	Left Rear Travel Pump #12	Ground	
34-Z	DO-21	Left Rear Travel Pump #12 (Reverse on Pump Port B)	See Table 3-3 for Values	CAN101-5
34-a	Ground	Left Rear Travel Pump #12	Ground	
34-b	DO-22	Left Rear Travel Pump #12 (Forward on Pump Port A)	See Table 3-3 for Values	CAN101-5
34-c	Ground	Drum 2 Pump #16	Ground	
34-d	DO-23	Drum 2 Pump #16 (Lower on Pump Port B)	See Table 3-3 for Values	CAN101-7
34-e	Ground	Drum 2 Pump #16	Ground	

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
34-f	DO-24	Drum 2 Pump #16 (Raise on Pump Port A)	See Table 3-3 for Values	CAN101-7
34-g	Ground	**Jumper** to Node Select 2	Ground	
34-h	NS-1	N/C	N/A	
34-j	NS-2	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
34-k	NS-3	N/C	N/A	
34-m	NS-4	N/C	N/A	
34-n	28 Volts	N/C	N/A	
34-p	EC3A	N/C	N/A	
34-r	Ground	N/C	N/A	
34-s	EC3B		Encoder EC3B	
J6/W36	**Receptacle – Exhaust Damper and Pressure Sensors**			
36-A	Ground	Left Rear Travel Pressure Sensor	Ground	
36-B	DO-7	Left Rear Travel Pressure Sensor Power	28 Volts Nominal	CAN41-1-64
36-C	Ground	VPC Actuator - Extend Pressure Sensor	Ground	
36-D	DO-8	VPC Actuator - Extend PSI Sensor Power	28 Volts Nominal	CAN41-1-128
36-E	Ground	Engine 2 Air Exhaust Damper #1 and #2	Ground	
36-F	DO-9	Engine 2 Air Exhaust Damper #1	0 Volts Off; 28 Volts On	CAN41-2-1
36-G	Ground	**Jumper** to Node Select 2	Ground	
36-H	DO-10	Engine 2 Air Exhaust Damper #2	0 Volts Off; 28 Volts On	CAN41-2-2
36-J	DI-8	Engine 2 Air Exhaust Damper Closed	0 Volts Off; 28 Volts On	CAN73-1-128
36-K	NS-1	N/C	N/A	
36-L	NS-2	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
36-M	NS-3	N/C	N/A	
36-N	NS-4	N/C	N/A	
36-P	DI-7	Shore Power Lock (Connected)	0 Volts Off; 28 Volts On	CAN73-1-64
36-R	28 Volts	Right Front Travel Pressure Sensor Supply	28 Volts Nominal	
36-S	28 Volts	Drum 2 Pressure Sensor Supply	28 Volts Nominal	
36-T	28 Volts	Drum 1 Pressure Sensor Supply	28 Volts Nominal	
36-U	Ground	Drum 1 & 2 Pressure Sensor	Ground	
36-V	5 Volts	N/C	N/A	
36-W	Ground	Drum 4 Pressure Sensor	Ground	
36-X	28 Volts	Drum 4 Pressure Sensor Supply	28 Volts Nominal	
36-Z	Ground	Right Front Travel Pressure Sensor Right Rear Travel/Drum 5 Pressure Sensor	Ground	
36-a	AI-9	Drum 2 Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN6-2[1]
36-b	AI-10	Drum 1 Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN6-4[1]
36-c	AI-11	Left Rear Travel Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN6-6[1]
36-d	AI-12	VPC Actuator - Extend Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN6-8[1]
36-e	AI-13	Drum 4 Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN7-2[1]
36-f	AI-14	Right Front Travel Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN7-4[1]

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
36-g	28 Volts	Drum 3 Pressure Sensor Supply	28 Volts Nominal	
36-h	AI-15	Drum 3 Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN7-6[1]
36-j	Ground	Drum 3 Pressure Sensor	Ground	
36-k	AI-16	Right Rear Travel/Drum 5 Pressure Sensor	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN7-8[1]
36-m	28 Volts	Right Rear Travel/Drum 5 Pressure Sensor	28 Volts Nominal	
36-n	EC1A	N/C	N/A	
36-p	EC1B	N/C	N/A	
36-r	EC2A	N/C	N/A	
36-s	EC2B	N/C	N/A	

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

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Reference Only

NODE 4 - Drum Pumps, Dampers, Hydraulic Generator and Sensors

Reference Electrical Schematic 81000614 - Sheets 16, 23 & 24

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
WN-A	28 Volts	CAN Bus Power	28 Volts Nominal	
WN-C	CAN-H	CAN High Wire Transmission	N/A	
WN-D	Ground	CAN Bus Ground	Ground	
WN-F	CAN-L	CAN Low Wire Transmission	N/A	
J3/W43	**Receptacle – Exhaust Damper and VPC Components**			
43-A	Ground	Cab Seat - Raise	Ground	
43-B	DO-1	Cab Seat - Raise (HS-90)	0 Volts Off; 28 Volts On	CAN43-1-1
43-C	Ground	Cab Seat - Lower	Ground	
43-D	DO-2	Cab Seat - Lower (HS-91)	0 Volts Off; 28 Volts On	CAN43-1-2
43-E	Ground	VPC Actuator Pump #13	Ground	
43-F	DO-3	VPC Actuator Pump #13 (Extend on Pump Port A)	See Table 3-3 for Values	CAN93-1
43-G	Ground	VPC Actuator Pump #13	Ground	
43-H	DO-4	VPC Actuator Pump #13 (Retract on Pump Port B)	See Table 3-3 for Values	CAN93-1
43-J	Ground	Engine 1 Air Exhaust Damper #3	Ground	
43-K	NS-1	N/C	N/A	
43-L	NS-2	N/C	N/A	
43-M	NS-3	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
43-N	Ground	Engine 1 Air Exhaust Damper #4	Ground	
43-P	DO-6	Engine 1 Air Exhaust Damper #4	0 Volts Off; 28 Volts On	CAN43-1-32
43-R	DO-5	Engine 1 Air Exhaust Damper #3	0 Volts Off; 28 Volts On	CAN43-1-16
43-S	NS-4	N/C	N/A	
43-T	DI-3	N/C	N/A	
43-U	28 Volts	N/C	N/A	
43-V	28 Volts	Engine 1 Air Exhaust Damper #3 and #4	28 Volts Nominal	
43-W	DI-4	Engine 1 Air Exhaust Damper Closed	0 Volts Off; 24 Volts On	CAN77-1-8
43-X	28 Volts	N/C	N/A	
43-Z	28 Volts	N/C	N/A	
43-a	AI-1	N/C	N/A	
43-b	AI-2	N/C	N/A	
43-c	AI-3	N/C	N/A	
43-d	AI-4	N/C	N/A	
43-e	AI-5	N/C	N/A	
43-f	AI-6	N/C	N/A	
43-g	Ground	Engine Fuel Level Sensor	Ground	
43-h	Ground	**Jumper** to Node Select 3	Ground	

Reference Only

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Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
43-j	5 Volts	N/C	N/A	
43-k	Ground	N/C	N/A	
43-m	Ground	N/C	N/A	
43-n	28 Volts	Engine Fuel Level Sensor	28 Volts Nominal	
43-p	AI-7	Engine Fuel Level Sensor	1 Volt Empty; 4 Volts Full	CAN13-6[1]
43-r	AI-8	Hydraulic Vacuum Alarm	0 Volts Off; 28 Volts On	CAN13-2-128
43-s	28 Volts	Hydraulic Vacuum Alarm	28 Volts Nominal	
J4/W44	**Receptacle – Drum, Swing and Track Pumps**			
44-A	Ground	Swing Pump #1	Ground	
44-B	DO-11	Swing Pump #1 (Right on Pump Port B)	See Table 3-3 for Values	CAN93-3
44-C	Ground	Swing Pump #1	Ground	
44-D	DO-12	Swing Pump #1 (Left on Pump Port A)	See Table 3-3 for Values	CAN93-3
44-E	Ground	Drum 2 Pump #3	Ground	
44-F	DO-13	Drum 2 Pump #3 (Lower on Pump Port B)	See Table 3-3 for Values	CAN93-5
44-G	Ground	Drum 2 Pump #3	Ground	
44-H	DO-14	Drum 2 Pump #3 (Raise on Pump Port A)	See Table 3-3 for Values	CAN93-5
44-J	Ground	Drum 1 Pump #5	Ground	
44-K	Ground	Drum 4 Pump #7	Ground	
44-L	Ground	Drum 4 Pump #7	Ground	
44-M	DO-17	Drum 4 Pump #7 (Lower on Pump Port B)	See Table 3-3 for Values	CAN94-1
44-N	Ground	Drum 1 Pump #5	Ground	
44-P	DO-16	Drum 1 Pump #5 (Lower on Pump Port A)	See Table 3-3 for Values	CAN93-7
44-R	DO-15	Drum 1 Pump #5 (Raise on Pump Port B)	See Table 3-3 for Values	CAN93-7
44-S	DO-18	Drum 4 Pump #7 (Raise on Pump Port A)	See Table 3-3 for Values	CAN94-1
44-T	Ground	Left Front Track/Drum 6/System Accessory Pump #9	Ground	
44-U	DO-19	Left Front Track/Drum 6/System Accessory Pump #9 (Forward/Raise on Pump Port B)	See Table 3-3 for Values	CAN94-3
44-V	Ground	Left Front Track/Drum 6/System Accessory Pump #9	Ground	
44-W	DO-20	Left Front Track/Drum 6/System Accessory Pump #9 (Reverse/Lower on Pump Port A)	See Table 3-3 for Values	CAN94-3
44-X	Ground	Right Rear Track/Drum 5 Pump #11	Ground	
44-Z	DO-21	Right Rear Track/Drum 5 Pump #11 (Reverse/Lower on Pump Port B)	See Table 3-3 for Values	CAN94-5
44-a	Ground	Right Rear Track/Drum 5 Pump #11	Ground	
44-b	DO-22	Right Rear Track/Drum 5 Pump #11 (Forward/Raise on Pump Port A)	See Table 3-3 for Values	CAN94-5
44-c	Ground	Drum 3 Pump #15	Ground	
44-d	DO-23	Drum 3 Pump #15 (Raise on Pump Port B)	See Table 3-3 for Values	CAN94-7
44-e	Ground	Drum 3 Pump #15	Ground	

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
44-f	DO-24	Drum 3 Pump #15 (Lower on Pump Port A)	See Table 3-3 for Values	CAN94-7
44-g	Ground	**Jumper** to Node Select 3	Ground	
44-h	NS-1	N/C	N/A	
44-j	NS-2	N/C	N/A	
44-k	NS-3	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
44-m	NS-4	N/C	N/A	
44-n	28 Volts	N/C	N/A	
44-p	EC3A	N/C	N/A	
44-r	Ground	N/C	N/A	
44-s	EC3B	N/C	N/A	
J6/W46	**Receptacle – Hydraulic Generator and Intake Damper**			
46-A	Ground	N/C		
46-B	DO-7	Hydraulic-Generator Emergency Stop	0 Volts Off; 28 Volts On	CAN43-1-64
46-C	Ground	Hydraulic-Generator Bypass Valve	Ground	
46-D	DO-8	Hydraulic-Generator Bypass Valve (HS-92)	0 Volts Off; 28 Volts On	CAN43-1-128
46-E	Ground	N/C	N/A	
46-F	DO-9	Air Intake Dampers All Open	0 Volts Off; 28 Volts On	CAN43-2-1
46-G	Ground	N/C	N/A	
46-H	DO-10	N/C	N/A	
46-J	DI-8	N/C	N/A	
46-K	NS-1	N/C	N/A	
46-L	NS-2	N/C	N/A	
46-M	NS-3	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
46-N	NS-4	N/C	N/A	
46-P	DI-7	Air Intake Damper 1-6	0 Volts Off; 28 Volts On	CAN77-1-64
46-R	28 Volts	N/C	N/A	
43-S	28 Volts	Hydraulic-Generator Fluid Level Switch	28 Volts Nominal	
46-T	28 Volts	N/C	N/A	
46-U	Ground	**Jumper** to Node Select 3	Ground	
46-V	5 Volts	N/C	N/A	
46-W	Ground	N/C	N/A	
46-X	28 Volts	N/C	N/A	
46-Z	Ground	N/C	N/A	
46-a	AI-9	Hydraulic-Generator Fluid Level Switch	0 Volts Off; 28 Volts On	CAN14-2-16
46-b	AI-10	N/C	N/A	
46-c	AI-11	Hydraulic-Generator Emergency Stop	28 Volts Nominal	CAN14-2-64
46-d	AI-12	N/C	N/A	
46-e	AI-13	N/C	N/A	
46-f	AI-14	N/C	N/A	

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Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
46-g	28 Volts	N/C	N/A	
46-h	AI-15	N/C	N/A	
46-j	Ground	N/C	N/A	
46-k	AI-16	Hydraulic Genset High Temp Switch	0 Volts Off; 28 Volts On	CAN15-2-128
46-m	28 Volts	Hydraulic Genset High Temp Switch	28 Volts Nominal	
46-n	EC1A	N/C	N/A	
46-p	EC1B	N/C	N/A	
46-r	EC2A	N/C	N/A	
46-s	EC2B	N/C	N/A	

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

Reference Only

NODE 5 - Alarms, Pump Controls, Travel, Swing, Sensors and Limits

Reference Electrical Schematic 81000614 - Sheets 16 & 25.

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
WN-A	28 Volts	CAN Bus Power	28 Volts Nominal	
WN-C	CAN-H	CAN High Wire Transmission	N/A	
WN-D	Ground	CAN Bus Ground	Ground	
WN-F	CAN-L	CAN Low Wire Transmission	N/A	
J3/W53	**Receptacle – Boom Angle Sensor, Brakes, Alarm**			
53-A	Ground	Drum 5 Diverter Valve	Ground	
53-B	DO-1	Drum 5 Diverter Valve (HS-57)	0 Volts Off; 28 Volts On	CAN46-1-1
53-C	Ground	Drum 6 Diverter Valve	Ground	
53-D	DO-2	Drum 6 Diverter Valve (HS-58)	0 Volts Off; 28 Volts On	CAN46-1-2
53-E	Ground	Travel 2-Speed	Ground	
53-F	DO-3	Travel 2-Speed (HS-59)	0 Volts Off; 28 Volts On	CAN46-1-4
53-G	Ground	Travel Brake Release	Ground	
53-H	DO-4	Travel Brake Release (HS-60)	0 Volts Off; 28 Volts On	CAN46-1-8
53-J	Ground	Drum 6 Brake Release	Ground	
53-K	NS-1	N/C	N/A	
53-L	NS-2	N/C	N/A	
53-M	NS-3	N/C	N/A	
53-N	Ground	Swing Brake Release	Ground	
53-P	DO-6	Swing Brake Release (HS-62)	0 Volts Off; 28 Volts On	CAN46-1-32
53-R	DO-5	Drum 6 Brake Release (HS-61)	0 Volts Off; 28 Volts On	CAN46-1-16
53-S	NS-4	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
53-T	DI-3	Drum 3 Minimum Bail	0 Volts Off; 28 Volts On	CAN83-1-4
53-U	28 Volts	Drum 3 Minimum Bail	28 Volts Nominal	
53-V	28 Volts	Maximum Boom Angle - Right Side	28 Volts Nominal	
53-W	DI-4	Maximum Boom Angle - Right Side	0 Volts Off; 28 Volts On	CAN83-1-8
53-a	AI-1	N/C	N/A	
53-b	AI-2	N/C	N/A	
53-c	AI-3	N/C	N/A	
53-d	AI-4	Boom Angle Sensor 1	2.2 Volts @ 30^{o}; 4.3 Volts @ 80^{o}	CAN24-8[1]
53-e	AI-5	N/C	N/A	
53-f	AI-6	N/C	N/A	
53-g	Ground	N/C	Ground	
53-h	Ground	Maximum Boom Angle Drum 3 Minimum Bail	Ground	
53-j	5 Volts	Boom Angle Sensor 1	5 Volts Nominal	
53-k	Ground	Boom Angle Sensor 1	Ground	

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
53-m	Ground	Rotating Bed Level Sensor	Ground	
53-n	28 Volts	N/C	28 Volts Nominal	
53-p	AI-7	Rotating Bed Pitch Level Sensor	1.0 Volts @ -4^o (high on rear); 9.0 Volts @ 4^o (high on front)	CAN25-6[1]
53-r	AI-8	Rotating Bed Roll Level Sensor	1.0 Volts @ -4^o (high on rear); 9.0 Volts @ 4^o (high on front)	CAN25-8[1]
53-s	28 Volts	Rotating Bed Level Sensor	28 Volts Nominal	
J4/W54	**Receptacle – Drum 3, Alarm**			
54-A		N/C	N/A	
54-B		N/C	N/A	
54-C		N/C	N/A	
54-D		N/C	N/A	
54-E		N/C	N/A	
54-F		N/C	N/A	
54-G	Ground	Drum 3 Left Side Brake Release	Ground	
54-H	DO-14	Drum 3 Left Side Brake Release (HS-56)	0 Volts Off; 28 Volts On	CAN46-2-32
54-J		N/C	N/A	
54-K		N/C	N/A	
54-L	Ground	Drum 3 Right Side Motor Control 3 and 4	Ground	
54-M	DO-17	Drum 3 Right Side Motor Control 3 and 4	See Table 3-3 for Values	CAN96-7
54-N	Ground	Drum 3 Left Side Motor Control 1 and 2	Ground	
54-P	DO-16	Drum 3 Left Side Motor Control 1 and 2	See Table 3-3 for Values	CAN96-5
54-R		N/C	N/A	
54-S		N/C	N/A	
54-T		N/C	N/A	
54-U		N/C	N/A	
54-W		N/C	N/A	
54-X		N/C	N/A	
54-Z		N/C	N/A	
54-a		N/C	N/A	
54-b	DO-22	N/C	N/A	
54-c	Ground	N/C	N/A	
54-d	DO-23	N/C	N/A	
54-e		N/C	N/A	
54-f		N/C	N/A	
54-g	Ground	**Jumper** to Node Select 4	Ground	
54-h		N/C	N/A	
54-j		N/C	N/A	

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Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
54-k		N/C	N/A	
54-m	NS-4	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
54-n	28 Volts	Drum 3 Motor Speed Sensor	28 Volts Nominal	
54-p	EC3A	Drum 3 Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN83-6[1]
54-r	Ground	Drum 3 Motor Speed Sensor	Ground	
54-s	EC3B	Drum 3 Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN83-6[1]
J6/W56	**Receptacle – Drum 1 Components**			
56-A	Ground	Drum 1 Brake Release - Left Side	Ground	
56-B	DO-7	Drum 1 Brake Release - Left Side (HS-63)	0 Volts Off; 28 Volts On	CAN46-1-64
56-C	Ground	Drum 4 Camera Lights **Jumper** to Node Select 4	Ground	
56-D	DO-8	Drum 4 Camera Lights	0 Volts Off; 28 Volts On	CAN46-1-128
56-E	Ground	Drum 1 Left Side Motor Control 1 and 2	Ground	
56-F	DO-9	Drum 1 Left Side Motor Control 1 and 2	See Table 3-3 for Values	CAN96-1
56-G	Ground	Drum 1 Right Side Motor Control 3 and 4	Ground	
56-H	DO-10	Drum 1 Right Side Motor Control 3 and 4	See Table 3-3 for Values	CAN96-3
56-J	DI-8	VPC Actuator in Mast Pocket	0 Volts Off; 28 Volts On	CAN83-1-128
56-K	NS-1	N/C	N/A	
56-L	NS-2	N/C	N/A	
56-M	NS-3	N/C	N/A	
56-N	NS-4	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
56-P	DI-7	Drum 1 Minimum Bail Limit	0 Volts Off; 28 Volts On	CAN83-1-64[1]
56-R	28 Volts	VPC Actuator (mast pocket)	28 Volts Nominal	
56-S	28 Volts	Boom Nitrogen Left Cylinder Pressure	28 Volts Nominal	
56-T	28 Volts	Drum 1 Nitrogen Cylinder Pressure - R Side	28 Volts Nominal	
56-U	Ground	Drum 1 Minimum Bail Limit - Right Side Drum 1 Nitrogen Cylinder Pressure - R Side	Ground	
56-V	5 Volts	N/C	5 Volts DC	
56-W	Ground	Boom Nitrogen Left & Right Cylinder Pressure/ Maximum Boom Angle	Ground	
56-X	28 Volts	Drum 1 Minimum Bail Limit - Right Side	28 Volts Nominal	
56-Z	Ground	VPC Actuator (mast pocket)	Ground	
56-a	AI-9	Boom Nitrogen Left Cylinder Pressure	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN26-2[1]
56-b	AI-10	Boom Nitrogen Right Cylinder Pressure	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN26-4[1]
56-c	AI-11	Drum 1 Nitrogen Cylinder Pressure - R Side	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN26-5[1]
56-d	AI-12	N/C		

Reference Only

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Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
56-e	AI-13	N/C	N/A	
56-f	AI-14	N/C	N/A	
56-g	28 Volts	Drum 1 Motor Speed Sensor	28 Volts Nominal	
56-h	AI-15	N/C	N/A	
56-j	Ground	Drum 1 Motor Speed Sensor	Ground	
56-k	AI-16	N/C	N/A	
56-m	28 Volts	Boom Nitrogen Right Cylinder Pressure	28 Volts Nominal	
56-n	EC1A	Drum 1 Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN82-2[2]
56-p	EC1B	Drum 1 Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN82-2[2]
56-r	EC2A	N/C	N/A	
56-s	EC2B	N/C	N/A	

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

3

Reference Only

NODE 6 - VPC, Counterweight Beam, and Auto Lube

Reference Electrical Schematic 81000614 - Sheets 16, 26 & 27

Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
WN-A	28 Volts	CAN Bus Power	28 Volts Nominal	
WN-C	CAN-H	CAN High Wire Transmission	N/A	
WN-D	Ground	CAN Bus Ground	Ground	
WN-F	CAN-L	CAN Low Wire Transmission	N/A	
J3/W63	**Receptacle – Counterweight Beams**			
63-A	Ground	CWT Beam Cylinder - Extend	Ground	
63-B	DO-1	CWT Beam Cylinder - Extend (HS-71)	0 Volts Off, 28 Volts On	CAN42-1-1
63-C	Ground	CWT Beam Cylinder - Retract	Ground	
63-D	DO-2	CWT Beam Cylinder - Retract (HS-72)	0 Volts Off, 28 Volts On	CAN42-1-2
63-E	Ground	CWT Beam Pin Locks - Left Side	Ground	
63-F	DO-3	CWT Beam Pin Locks - Left Side (HS-73)	0 Volts Off, 28 Volts On	CAN42-1-4
63-G	Ground	CWT Beam Pin Locks - Right Side	Ground	
63-H	DO-4	CWT Beam Pin Locks - Right Side (HS-74)	0 Volts Off, 28 Volts On	CAN42-1-8
63-J	Ground	VPC Warning Light - Left and Right	Ground	
63-K	NS-1	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
63-L	NS-2	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
63-M	NS-3	N/C	N/A	
63-N	Ground	VPC Position Alarm 2	Ground	
63-P	DO-6	VPC Position Alarm 2	28 Volts Nominal	CAN42-1-32
63-R	DO-5	VPC Warning Light - Left and Right	28 Volts Nominal	CAN42-1-16
63-S	NS-4	N/C	N/A	
63-T	DI-3	N/C		
63-U	28 Volts	N/C	N/A	
63-V	28 Volts	Counterweight Left Beam Max Retract	28 Volts Nominal	
63-W	DI-4	N/C		
63-X	28 Volts	Counterweight Right Beam - Extend/Retract	28 Volts Nominal	
63-Z	28 Volts	N/C	N/A	
63-a	AI-1	Counterweight Left Beam - Extend	0 Volts Off, 28 Volts On	CAN8-2-16
63-b	AI-2	Counterweight Left Beam - Retract	0 Volts Off, 28 Volts On	CAN8-2-32
63-c	AI-3	Counterweight Left Beam Max Retract	0 Volts Off, 28 Volts On	CAN8-2-64
63-d	AI-4	N/C	N/A	
63-e	AI-5	Counterweight Right Beam - Extend	0 Volts Off, 28 Volts On	CAN9-2-16
63-f	AI-6	Counterweight Right Beam - Retract	0 Volts Off, 28 Volts On	CAN9-2-32
63-g	Ground	**Jumper** to Node Select 1 and 2	Ground	
63-h	Ground	N/C	Ground	
63-j	5 Volts	N/C	N/A	
63-k	Ground	Counterweight Right/Left Beam Max Retract	Ground	

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Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
63-m	Ground	N/C	N/A	
63-n	28 Volts	Counterweight Left Beam - Extend/Retract	28 Volts Nominal	
63-p	AI-7	Counterweight Right Beam Max Retract	0 Volts Off, 28 Volts On	CAN9-2-64
63-r	AI-8	N/C	N/A	
63-s	28 Volts	Counterweight Right Beam Max Retract	28 Volts Nominal	
J4/W64	**Receptacle – VPC Actuator, Backhitch and Rigging Winch**			
64-A	Ground	N/C	N/A	
64-B	DO-11	N/C	N/A	
64-C	Ground	Swing/VPC Auto Lubrication Pump	Ground	
64-D	DO-12	Swing/VPC Auto Lubrication Pump	0 Volts Off; 28 Volts On	CAN42-2-8
64-E	Ground	Swing House Roller Greaser Valve	Ground	
64-F	DO-13	Swing House Roller Greaser Valve (HS-64)	0 Volts Off; 28 Volts On	CAN42-2-16
64-G	Ground	VPC Guide Roller Greaser Valve	Ground	
64-H	DO-14	VPC Guide Roller Greaser Valve (HS-65)	0 Volts Off; 28 Volts On	CAN42-2-32
64-J	Ground	VPC Rack/Pinion Greaser Valve	Ground	
64-K	Ground	N/C	N/A	
64-L	Ground	Boom Butt Greaser Valve	Ground	
64-M	DO-17	Boom Butt Greaser Valve (HS-68)	0 Volts Off; 28 Volts On	CAN42-3-1
64-N	Ground	VPC Pivot Frame Greaser Valve	Ground	
64-P	DO-16	VPC Pivot Frame Greaser Valve (HS-67)	0 Volts Off; 28 Volts On	CAN42-2-128
64-R	DO-15	VPC Rack/Pinion Greaser Valve (HS-66)	0 Volts Off; 28 Volts On	CAN42-2-64
64-S	DO-18	N/C	N/A	
64-T	Ground	N/C	N/A	
64-U	DO-19	N/C	N/A	
64-V	Ground	N/C	N/A	
64-W	DO-20	N/C	N/A	
64-X	Ground	N/C	N/A	
64-Z	DO-21	N/C	N/A	
64-a	Ground	VPC Actuator Assist Cyl - Extend	Ground	
64-b	DO-22	VPC Actuator Assist Cyl - Extend (HS-69)	0 Volts Off; 28 Volts On	CAN42-3-32
64-c	Ground	VPC Actuator Assist Cyl - Retract	Ground	
64-d	DO-23	VPC Actuator Assist Cyl - Retract (HS-70)	0 Volts Off; 28 Volts On	CAN42-3-64
64-e	Ground	VPC Assist Cylinder in Cradle	N/A	
64-f	DO-24	N/C	N/A	
64-g	Ground	**Jumper** to Node Select 1 and 2	Ground	
64-h	NS-1	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
64-j	NS-2	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
64-k	NS-3	N/C	N/A	
64-m	NS-4	N/C	N/A	

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
64-n	28 Volts	N/C	N/A	
64-p	EC3A	N/C	N/A	
64-r	Ground	N/C	N/A	
64-s	EC3B	VPC Assist Cylinder in Cradle	EC3B	CAN75-2-32
J6/W66		**Receptacle – VPC Actuator**		
66-A	Ground	VPC Left Side1&2 Motor Control 1&2	Ground	
66-B	DO-7	VPC Left Side1&2 Motor Control 1&2 (HS-75 and HS-78)	See Table 3-3 for Values	CAN92-1
66-C	Ground	VPC Right Side 3&4 Motor Control 3&4	Ground	
66-D	DO-8	VPC Right Side 3&4 Motor Control 3&4 (HS-76 and HS-79))	See Table 3-3 for Values	CAN92-3
66-E	Ground	VPC Actuator Brake	Ground	
66-F	DO-9	VPC Actuator Brake (HS-77)	0 Volts Off; 28 Volts On	CAN42-2-1
66-G	Ground	VPC Actuator Max Retract	Ground	
66-H	DO-10	N/C	N/A	
66-J	DI-8	VPC Actuator Max Extend	0 Volts Off, 28 Volts On	CAN75-1-128
66-K	NS-1	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
66-L	NS-2	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
66-M	NS-3	N/C	N/A	
66-N	NS-4	N/C	N/A	
66-P	DI-7	VPC Actuator Max Retract	0 Volts Off, 28 Volts On	CAN75-1-64
66-R	28 Volts	VPC Rack & Pinion Grease PSI	28 Volts Nominal	
66-S	28 Volts	VPC Actuator Max Extend	28 Volts Nominal	
66-T	28 Volts	VPC Actuator Max Retract	28 Volts Nominal	
66-U	Ground	**Jumper** to Node Select	Ground	
66-V	5 Volts	N/C	N/A	
66-W	Ground	VPC Actuator Max Extend	Ground	
66-X	28 Volts	VPC Guide Roller PSI	28 Volts Nominal	
66-Z	Ground	VPC Guide Roller PSI VPC Actuator Rack/Pinion Grease Pressure	Ground	
66-a	AI-9	N/C	N/A	
66-b	AI-10	N/C	N/A	
66-c	AI-11	N/C	N/A	
66-d	AI-12	N/C	N/A	
66-e	AI-13	VPC Guide Roller Grease PSI	1 Volt @ 0 psi; 5 Volts @ 5,000 psi	CAN11-1[1]
66-f	AI-14	VPC Actuator Rack/Pinion Grease Pressure	1 Volt @ 0 psi; 5 Volts @ 5,000 psi	CAN11-3[1]
66-g	28 Volts	VPC Actuator RS3 Motor Speed Sensor	28 Volts Nominal	

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Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
66-h	AI-15	N/C	N/A	
66-j	Ground	VPC Actuator RS3 Motor Speed Sensor	Ground	
66-k	AI-16	N/C	N/A	
66-m	28 Volts	N/C	N/A	
66-n	EC1A	VPC Actuator RS3 Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN74-2[2]
66-p	EC1B	VPC Actuator RS3 Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN74-2[2]
66-r	EC2A	N/C	N/A	
66-s	EC2B	N/C	N/A	

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

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NODE 7 - Drum Controls, Swing, Backhitch

Reference Electrical Schematic 81000614 - Sheets 16, 29 & 30

Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
WN-A	28 Volts	CAN Bus Power	28 Volts Nominal	
WN-C	CAN-H	CAN High Wire Transmission	N/A	
WN-D	Ground	CAN Bus Ground	Ground	
WN-F	CAN-L	CAN Low Wire Transmission	N/A	
J3/W73	**Receptacle – House Rollers, Swing Angle, Actuator Pins, and Backhitch Pins**			
73-A	Ground	Backhitch Pins - Retract	Ground	
73-B	DO-1	Backhitch Pins - Retract (HS-87)	0 Volts Off, 28 Volts On	CAN44-1-1
73-C	Ground	Backhitch Pins - Extend	Ground	
73-D	DO-2	Backhitch Pins - Extend (HS-88)	0 Volts Off, 28 Volts On	CAN44-1-2
73-E	Ground	Left/Right Rear House Roller Load Pin	Ground	
73-F	DO-3	Rear Left/Right Swing/Travel Alarm	0 Volts Off, 28 Volts On	CAN44-1-4
73-G	Ground	Rear Left/Right Swing/Travel Alarm	Ground	
73-H	DO-4	Rear Left/Right Swing/Travel Alarm	0 Volts Off, 28 Volts On	CAN44-1-8
73-J	Ground	VPC Position/Fault Alarm	Ground	
73-K	NS-1	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
73-L	NS-2	N/C		
73-M	NS-3	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
73-N	Ground	VPC Left/Right Angle Sensor Counterweight Frame Grease PSI Actuator Secured	Ground	
73-P	DO-6	VPC Fault Alarm 1 (Near Rotating Bed)	0 Volts Off, 28 Volts On	CAN44-1-16
73-R	DO-5	VPC Position Alarm 1	0 Volts Off, 28 Volts On	CAN44-1-16
73-S	NS-4	N/C	N/A	
73-T	DI-3	Shorting Plug Installed to 73-U	28 Volts Nominal	CAN79-1-4
73-U	28 Volts	Shorting Plug Installed to 73-T	28 Volts Nominal	
73-V	28 Volts	Left Rear House Roller Load Pin	28 Volts Nominal	
73-W	DI-4	Shorting Plug Installed to 73-Z	28 Volts Nominal	CAN79-1-8
73-X	28 Volts	Right Rear House Roller Load Pin	28 Volts Nominal	
73-Z	28 Volts	Shorting Plug Installed to 73-W	28 Volts Nominal	
73-a	AI-1	N/C	N/A	
73-b	AI-2	N/C	N/A	
73-c	AI-3	Left Rear House Roller Load Pin	1.5 Volts @ 0 kip; 4.7 Volts @ 1,800 kip	CAN16-6[1]
73-d	AI-4	Right Rear House Roller Load Pin	1.5 Volts @ 0 kip; 4.7 Volts @ 1,800 kip	CAN16-8[1]
73-e	AI-5	VPC Left Angle Sensor	4.5 Volts @ 10°; 1.7 Volts @ 80°	CAN17-2[1]
73-f	AI-6	VPC Right Angle Sensor	0.4 Volts @ 10°; 3.3 Volts @ 80°	CAN17-4[1]
73-g	Ground	Node Select Jumper to Ground	N/A	

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Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
73-h	Ground	Left Rear House Roller Load Pin	N/A	
73-j	5 Volts	VPC Left/Right Angle Sensor	5 Volts Nominal	
73-k	Ground	Right Rear House Roller Load Pin	N/A	
73-m	Ground	Left Backhitch Pin Engaged Right Backhitch Pin Engaged	Ground	
73-n	28 Volts	Actuator Secured	28 Volts Nominal	
73-p	AI-7	Actuator Secured	0 Volts Off; 28 Volts On	CAN17-2-64
73-r	AI-8	Counterweight Frame Grease PSI	1 Volt @ 0 psi; 5 Volts @ 5,000 psi	CAN17-8[1]
73-s	28 Volts	Counterweight Frame Grease PSI	28 Volts Nominal	
J4/W74	**Receptacle – Drum 4 and Rigging Winch 0**			
74-A	Ground	Drum 4 Pawl Left Side - Retract	Ground	
74-B	DO-11	Drum 4 Pawl Left Side - Retract (HS-85)	0 Volts Off; 28 Volts On	CAN44-2-4
74-C	Ground	Drum 4 Pawl Left Side - Extend	Ground	
74-D	DO-12	Drum 4 Pawl Left Side - Extend (HS-86)	0 Volts Off; 28 Volts On	CAN44-2-8
74-E	Ground	N/C	N/A	
74-F	DO-13	N/C	N/A	
74-G	Ground	Drum 4 Left Side Brake Release	Ground	
74-H	DO-14	Drum 4 Left Side Brake Release (HS-84)	0 Volts Off, 28 Volts On	CAN44-2-32
74-J	Ground	N/C	N/A	
74-K	Ground	N/C	Ground	
74-L	Ground	Drum 4 Left Side Motor Control 1 & 2	Ground	
74-M	DO-17	Drum 4 Left Side Motor Control 1 & 2	0 Volts Off, 28 Volts On	CAN94-5
74-N	Ground	Drum 4 Right Side Motor Control 3 & 4	Ground	
74-P	DO-16	Drum 4 Right Side Motor Control 3 & 4	0 Volts Off, 28 Volts On	CAN94-7
74-R	DO-15	N/C	N/A	
74-S	DO-18	N/C	N/A	
74-T	Ground	Drum 0 Rigging Winch RS - Spool In	Ground	
74-U	DO-19	Drum 0 Rigging Winch RS - Spool In (HS-80)	0 Volts Off, 28 Volts On	CAN44-3-4
74-V	Ground	Drum 0 Rigging Winch RS - Spool Out	Ground	
74-W	DO-20	Drum 0 Rigging Winch RS - Spool Out (HS-81)	0 Volts Off, 28 Volts On	CAN44-3-8
74-X	Ground	Drum 0 Rigging Winch LS - Spool In	Ground	
74-Z	DO-21	Drum 0 Rigging Winch LS - Spool In (HS-82)	0 Volts Off, 28 Volts On	CAN44-3-16
74-a	Ground	Drum 0 Rigging Winch LS - Spool Out	Ground	
74-b	DO-22	Drum 0 Rigging Winch LS - Spool Out (HS-83)	0 Volts Off, 28 Volts On	CAN44-3-32
74-c	Ground	Drum 1 Camera Light	Ground	
74-d	DO-23	Drum 1 Camera Light	0 Volts Off, 28 Volts On	CAN44-3-64
74-e	Ground	N/C	N/A	
74-f	DO-24	N/C	N/A	
74-g	Ground	**Jumper** to Node Select 1 and 3	Ground	

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Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
74-h	NS-1	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
74-j	NS-2	N/C	N/A	
74-k	NS-3	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
74-m	NS-4	N/C	N/A	
74-n	28 Volts	Drum 4 Right Side Motor Speed Sensor	28 Volts Nominal	
74-p	EC3A	Drum 4 Right Side Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN79-6 [2]
74-r	Ground	Drum 4 Right Side Motor Speed Sensor	Ground	
74-s	EC3B	Drum 4 Right Side Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN79-6[2]
J6/W76	**Receptacle – Drum 2**			
76-A	Ground	Drum 2 Brake Release - Left Side	Ground	
76-B	DO-7	Drum 2 Brake Release - Left Side (HS-89)	0 Volts Off; 28 Volts On	CAN44-1-64
76-C	Ground	Drum 2 Camera Light	Ground	
76-D	DO-8	Drum 2 Camera Light	0 Volts Off, 28 Volts On	CAN44-1-128
76-E	Ground	Drum 2 Right Side Motor Control 3 and 4	Ground	
76-F	DO-9	Drum 2 Right Side Motor Control 3 and 4	0 Volts Off; 28 Volts On	CAN94-3
76-G	Ground	Drum 2 Left Side Motor Control 1 and 2	Ground	
76-H	DO-10	Drum 2 Left Side Motor Control 1 and 2	0 Volts Off; 28 Volts On	CAN94-1
76-J	DI-8	Drum 4 Minimum Bail Limit - Right Side	0 Volts Off; 28 Volts On	CAN79-1-128
76-K	NS-1	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
76-L	NS-2	N/C	N/A	
76-M	NS-3	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
76-N	NS-4	N/C	N/A	
76-P	DI-7	Drum 2 Minimum Bail Limit	0 Volts Off; 28 Volts On	CAN79-1-64
76-R	28 Volts	N/C	N/A	
76-S	28 Volts	N/C	N/A	
76-T	28 Volts	Drum 2 Minimum Bail Limit	28 Volts Nominal	
76-U	Ground	Node Select Jumper to Ground	Ground	
76-V	5 Volts	N/C	N/A	
76-W	Ground	Drum 2 Minimum Bail Limit and Drum 2 Nitrogen Cylinder Press - Right Side	Ground	
76-X	28 Volts	Drum 4 Minimum Bail Limit - Right Side	28 Volts Nominal	
76-Z	Ground	Drum 4 Minimum Bail Limit - Right Side	Ground	
76-a	AI-9	N/C	N/A	
76-b	AI-10	N/C	N/A	
76-c	AI-11	N/C	N/A	
76-d	AI-12	N/C	N/A	
76-e	AI-13	N/C	N/A	
76-f	AI-14	Drum 2 Nitrogen Cylinder Press - Right Side	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	CAN19-4[1]
76-g	28 Volts	Drum 2 Right Side Motor Speed Sensor	28 Volts Nominal	
76-h	AI-15	N/C	N/A	

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Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
76-j	Ground	Drum 2 Right Side Motor Speed Sensor	Ground	
76-k	AI-16	N/C	N/A	
76-m	28 Volts	Drum 2 Nitrogen Cylinder Press - Right Side	28 Volts Nominal	
76-n	EC1A	Drum 2 Right Side Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN78-2[2]
76-p	EC1B	Drum 2 Right Side Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN78-2[2]
76-r	EC2A	N/C	N/A	
76-s	EC2B	N/C	N/A	

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

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NODE 8 - Drum Controls, Swing/Travel, Beacons & Alarms

Reference Electrical Schematic 81000614 - Sheets 16 & 31

Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
WN-A	28 Volts	CAN Bus Power	28 Volts Nominal	
WN-C	CAN-H	CAN High Wire Transmission	N/A	
WN-D	Ground	CAN Bus Ground	Ground	
WN-E	DI-2	Boom Shorting Plug		CAN85-1-2
WN-F	CAN-L	CAN Low Wire Transmission	N/A	
J3/W83	**Receptacle – Front House Rollers and Drum Cameras**			
83-A	Ground	Node Select **Jumper** to Ground	Ground	
83-B	DO-1	N/C	N/A	
83-C	Ground	Drum 3 Camera Lights	Ground	
83-D	DO-2	Drum 3 Camera Lights	0 Volts Off, 28 Volts On	CAN47-1-2
83-E	Ground	Drum 5 Camera Lights	Ground	
83-F	DO-3	Drum 5 Camera Lights	0 Volts Off, 28 Volts On	CAN47-1-4
83-G	Ground	Left/Right Rear House Roller Load Pin	Ground	
83-H	DO-4	N/C	N/A	
83-J	Ground	N/C	Ground	
83-K	NS-1	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
83-L	NS-2	N/C	N/A	
83-M	NS-3	N/C	N/A	
83-N	Ground	Right Front House Roller Load Pin	N/A	
83-P	DO-6	N/C	N/A	
83-R	DO-5	N/C		
83-S	NS-4	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
83-T	DI-3	Left Rear House Roller Load Pin	0 Volts Off, 28 Volts On	CAN85-1-4
83-U	28 Volts	Left Rear House Roller Load Pin	28 Volts Nominal	
83-V	28 Volts	Right Rear House Roller Load Pin	28 Volts Nominal	
83-W	DI-4	Right Rear House Roller Load Pin	0 Volts Off, 28 Volts On	CAN85-1-8
83-X	28 Volts	Swing House Roller Grease Pressure	28 Volts Nominal	
83-Z	28 Volts	N/C	N/A	
83-a	AI-1	Left Rear House Roller Load Pin	1.0 Volt @ 0 kip; 4.7 Volts @ 3,600 kip	CAN28-2[1]
83-b	AI-2	N/C	N/A	
83-c	AI-3	N/C	N/A	
83-d	AI-4	N/C	N/A	
83-e	AI-5	Swing House Roller Grease Pressure	1.0 Volt @ 0 psi; 5.0 Volts @ 5000 psi	CAN29-2[1]
83-f	AI-6	Right Rear House Roller Load Pin	1.0 Volt @ 0 kip; 4.7 Volts @ 3,600 kip	CAN29-4[1]
83-g	Ground	Left Rear House Roller Load Pin	Ground	

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
83-h	Ground	Right Front House Roller Load Pin	Ground	
83-j	5 Volts	N/C	N/A	
83-k	Ground	Left Front House Roller Load Pin	Ground	
83-m	Ground	Left Front House Roller Load Pin Swing House Roller Grease Pressure	Ground	
83-n	28 Volts	Right Front House Roller Load Pin	28 Volts Nominal	
83-p	AI-7	Right Front House Roller Load Pin	1.0 Volt @ 0 kip; 4.7 Volts @ 3,600 kip	CAN29-6[1]
83-r	AI-8	Left Front House Roller Load Pin	1.0 Volt @ 0 kip; 4.7 Volts @ 3,600 kip	CAN29-8[1]
83-s	28 Volts	Left Front House Roller Load Pin	28 Volts Nominal	
J4/W84	**Receptacle – Drum 5**			
84-A	Ground	Front Right RCL/RCI Tower Lights (Green)	Ground	
84-B	DO-11	Front Right RCL/RCI Tower Lights (Green)	0 Volts Off; 28 Volts On	CAN47-2-8
84-C	Ground	Front Right RCL/RCI Tower Lights (Amber)	Ground	
84-D	DO-12	Front Right RCL/RCI Tower Lights (Amber)	0 Volts Off; 28 Volts On	CAN47-2-128
84-E	Ground	Front Right RCL/RCI Tower Lights (Red)	Ground	
84-F	DO-13	Front Right RCL/RCI Tower Lights (Red)	0 Volts Off; 28 Volts On	CAN47-2-16
84-G	Ground	Front Left Motion Alarm	Ground	
84-H	DO-14	Front Left Motion Alarm	0 Volts Off; 28 Volts On	CAN47-2-32
84-J	Ground	Front Right Motion Alarm	Ground	
84-K	Ground	N/C	N/A	
84-L	Ground	N/C	N/A	
84-M	DO-17	Front Left LMI Alarm	0 Volts Off; 28 Volts On	CAN47-3-1
84-N	Ground	N/C	N/A	
84-P	DO-16	Front Right LMI Alarm	0 Volts Off; 28 Volts On	CAN47-2-122
84-R	DO-15	Front Right Motion Alarm	0 Volts Off; 28 Volts On	CAN47-2-64
84-S	DO-18	N/C	N/A	
84-T	Ground	N/C	N/A	
84-U	DO-19	N/C	N/A	
84-V	Ground	N/C	N/A	
84-W	DO-20	N/C	N/A	
84-X	Ground	N/C	N/A	
84-Z	DO-21	N/C	N/A	
84-a	Ground	N/C	N/A	
84-b	DO-22	Drum 6 Motor Control	See Table 3-3 for Values	CAN47-3-32
84-c	Ground	N/C	N/A	
84-d	DO-23	N/C	N/A	

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Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
84-e	Ground	Drum 6 Camera Light	Ground	
84-f	DO-24	Drum 6 Camera Light	0 Volts Off; 28 Volts On	CAN47-3-128
84-g	Ground	**Jumper** to Node Select 1 and 4	Ground	
84-h	NS-1	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
84-j	NS-2	N/C	N/A	
84-k	NS-3	N/C	N/A	
84-m	NS-4	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
84-n	28 Volts	Drum 6 Motor Speed Sensor	28 Volts Nominal	
84-p	EC3A	Drum 6 Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN85-6[2]
84-r	Ground	Drum 6 Motor Speed Sensor	Ground	
84-s	EC3B	Drum 6 Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN85-6[2]
J6/W86	**Receptacle – Drum 6 Components**			
86-A	Ground	Drum 5 RS Pawl Retract	Ground	
86-B	DO-7	Drum 5 RS Pawl Retract (HS-94)	0 Volts Off, 28 Volts On	CAN47-1-64
86-C	Ground	Drum 5 RS Pawl Extend	Ground	
86-D	DO-8	Drum 5 RS Pawl Extend (HS-95)	0 Volts Off, 28 Volts On	CAN47-1-128
86-E	Ground	Drum 5 RS Brake Release	Ground	
86-F	DO-9	Drum 5 RS Brake Release (HS-93)	0 Volts Off, 28 Volts On	CAN47-2-1
86-G	Ground	Drum 5 RS Motor Control 1/2	Ground	
86-H	DO-10	Drum 5 RS Motor Control 1/2	0 Volts Off, 28 Volts On	CAN97-1
86-J	DI-8	Drum 5 Minimum Bail Limit	0 Volts Off, 28 Volts On	CAN85-1-128
86-K	NS-1	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
86-L	NS-2	N/C	N/A	
86-M	NS-3	N/C	N/A	
86-N	NS-4	Node Select **Jumper** to Ground	0 Volts (With **Jumper**)	
86-P	DI-7	N/C	N/A	
86-R	28 Volts	Drum 5 Minimum Bail Limit	28 Volts Nominal	
86-S	28 Volts	N/C	N/A	
86-T	28 Volts	N/C	N/A	
86-U	Ground	**Jumper** to Node Select 1 and 4	Ground	
86-V	5 Volts	N/C	N/A	
86-W	Ground	Swing Motor speed Sensor	Ground	
86-X	28 Volts	N/C	N/A	
86-Z	Ground	Drum 5 Minimum Bail Limit	Ground	
86-a	AI-9	N/C	N/A	
86-b	AI-10	N/C	N/A	
86-c	AI-11	N/C	N/A	
86-d	AI-12	N/C	N/A	

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Pin ID No.	CAN Bus Packet Type	Description	Test Voltages	Packet No.
86-e	AI-13	N/C	N/A	
86-f	AI-14	N/C	N/A	
86-g	28 Volts	Drum 5 Right Side Speed Sensor	N/A	
86-h	AI-15	N/C	N/A	
86-j	Ground	Drum 5 Right Side Speed Sensor	N/A	
86-k	AI-16	N/C	N/A	
86-m	28 Volts	Swing Motor Speed Sensor	N/A	
86-n	EC1A	Drum 5 Right Side Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN84-2[2]
86-p	EC1B	Drum 5 Right Side Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN84-2[2]
86-r	EC2A	Swing Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN84-4[2]
86-s	EC2B	Swing Motor Speed Sensor	1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving	CAN84-4[2]

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

3

Reference Only

NODE 20 - Boom Block Up, Block Sensor, Wind Speed & Limits

Reference Electrical Schematic 81000614 - Sheets 32

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
J3		**Receptacle – Upper Block-Up**		
203-A	Ground	**Jumper**	Ground	
203-B	DO-1	N/C	N/A	
203-C	Ground	**Jumper**	Ground	
203-D	DO-2	Wind Speed	28 Volts Nominal	CAN48-1-2
203-E	Ground	N/C	N/A	
203-F	DO-3	N/C	N/A	
203-G	Ground	Minimum Jib Angle Maximum Jib Angle	Ground	
203-H	DO-4	N/C	N/A	
203-J	Ground	Wind Speed	Ground	
203-K	NS-1	**Jumper**		
203-L	NS-2	N/C	N/A	
203-M	NS-3	**Jumper**		
203-N	Ground	Angle Sensor	Ground	
203-P	DO-6	N/C	N/A	
203-R	DO-5	N/C	N/A	
203-S	NS-4	**Jumper**		
203-T	DI-3	Block-Up Limit - Lower Boom Point	0 Volts Off; 28 Volts On	CAN87-1-4
203-U	28 Volts	Block-Up Limit - Lower Boom Point	28 Volts Nominal	
203-V	28 Volts	N/C	N/A	
203-W	DI-4	N/C	N/A	
203-X	28 Volts	N/C	N/A	
203-Z	28 Volts	Minimum Jib Angle Maximum Jib Angle	28 Volts Nominal	
203-a	AI-1	Right Load Strap Sensor #1	0.5 Volts @ 0 kip; 4.7 Volts @ 1,000 kip	CAN32-2[1]
203-b	AI-2	N/C	N/A	
203-c	AI-3	Angle Sensor	2.2 Volts @ 30^{o}; 4.3 Volts @ 80^{o}	CAN32-6[1]
203-d	AI-4	Wind Speed	0.9 Volts @ 0 mph 4.7 Volts @100 mph	CAN32-8[1]
203-e	AI-5	N/C	N/A	
203-f	AI-6	Left Load Strap Sensor #2	0.5 Volts @ 0 kip; 4.7 Volts @ 1,000 kip	CAN33-4[1]
203-g	Ground	Right Load Strap Sensor #1	Ground	
203-h	Ground	Right Load Strap Sensor #1	Ground	
203-j	5 Volts	Angle Sensor	5 Volts	
203-k	Ground	Left Load Strap Sensor #2	Ground	
203-m	Ground	Left Load Strap Sensor #2	Ground	
203-n	28 Volts	Right Load Strap Sensor #1	28 Volts Nominal	

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
203-p	AI-7	Minimum Jib Angle	0 Volts Off; 28 Volts On	CAN33-2-64
203-r	AI-8	Maximum Jib Angle	0 Volts Off; 28 Volts On	CAN33-2-128
203-s	28 Volts	Left Load Strap Sensor #2	28 Volts Nominal	
J4 - BL2		**Receptacle – Upper Block-Up**		
BL2-A	Ground	N/C	N/A	
BL2-B	DO-11	N/C	N/A	
BL2-C	Ground	N/C	N/A	
BL2-D	DO-12	N/C	N/A	
BL2-E	Ground	N/C	N/A	
BL2-F	DO-13	N/C	N/A	
BL2-G	Ground	N/C	N/A	
BL2-H	DO-14	N/C	N/A	
BL2-J	Ground	N/C	N/A	
BL2-K	Ground	N/C	N/A	
BL2-L	Ground	N/C	N/A	
BL2-M	DO-17	N/C	N/A	
BL2-N	Ground	N/C	N/A	
BL2-P	DO-16	N/C	N/A	
BL2-R	DO-15	N/C	N/A	
BL2-S	DO-18	N/C	N/A	
BL2-T	Ground	N/C	N/A	
BL2-U	DO-19	N/C	N/A	
BL2-V	Ground	N/C	N/A	
BL2-W	DO-20	N/C	N/A	
BL2-X	Ground	N/C	N/A	
BL2-Z	DO-21	N/C	N/A	
BL2-a	Ground	N/C	N/A	
BL2-b	DO-22	N/C	N/A	
BL2-c	Ground	N/C	N/A	
BL2-d	DO-23	N/C	N/A	
BL2-e	Ground	N/C	N/A	
BL2-f	DO-24	N/C	N/A	
BL2-g	Ground	Drum 3 Proximity Sensor A	N/A	
BL2-h	NS-1	N/C	N/A	
BL2-j	NS-2	N/C	N/A	
BL2-k	NS-3	N/C	N/A	
BL2-m	NS-4	N/C	N/A	
BL2-n	28 Volts	Drum 3 Proximity Sensor A and B	28 Volts Nominal	
BL2-p	ENC-3A	Drum 3 Proximity Sensor A	+ value raise; - value lower	CAN87-3[2]
BL2-r	Ground	Drum 3 Proximity Sensor B	Ground	
BL2-s	ENC-3B	Drum 3 Proximity Sensor B	+ value raise; - value lower	CAN87-3[2]

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
J6 - WUBP		**Receptacle – Upper Block-Up**		
WUBP-A	Ground	N/C	N/A	
WUBP-B	DO-7	N/C	N/A	
WUBP-C	Ground	Drum 1 Proximity Sensor A and B	Ground	
WUBP-D	DO-8	N/C	N/A	
WUBP-E	Ground	N/C	N/A	
WUBP-F	DO-9	N/C	N/A	
WUBP-G	Ground	Upper Boom Point Load Sensor - Left	Ground	
WUBP-H	DO-10	N/C	N/A	
WUBP-J	DI-8	N/C	N/A	
WUBP-K	NS-1	N/C	N/A	
WUBP-L	NS-2	N/C	N/A	
WUBP-M	NS-3	N/C	N/A	
WUBP-N	NS-4	N/C	N/A	
WUBP-P	DI-7	Block-Up Limit - Upper Boom Point	0 Volts Off; 28 Volts On	CAN87-1-64
WUBP-R	28 Volts	Upper Point **Jumper**	28 Volts Nominal	
WUBP-S	28 Volts	Block-Up Limit - Upper Boom Point	28 Volts Nominal	
WUBP-T	28 Volts	Upper Boom Point Load Sensor - Left	28 Volts Nominal	
WUBP-U	Ground	Upper Boom Point Load Sensor - Left	Ground	
WUBP-V	5 Volts	N/C	N/A	
WUBP-W	Ground	Upper Boom Point Load Sensor - Right	Ground	
WUBP-X	28 Volts	Upper Boom Point Load Sensor - Right	28 Volts Nominal	
WUBP-Z	Ground	Upper Boom Point Load Sensor - Right	Ground	
WUBP-a	AI-9	N/C	N/A	
WUBP-b	AI-10	Upper Boom Point Load Sensor - Left	0.5 Volts @ 0 kip; 4.7 Volts @ 950 kip	CAN34-4[1]
WUBP-c	AI-11	N/C	N/A	
WUBP-d	AI-12	Upper Boom Point Load Sensor - Right	0.5 Volts @ 0 kip; 4.7 Volts @ 950 kip	CAN34-8[1]
WUBP-e	AI-13	Upper Point **Jumper**	28 Volts Nominal	
WUBP-f	AI-14		N/A	
WUBP-g	28 Volts	Drum 1 Proximity Sensor A and B	28 Volts Nominal	
WUBP-h	AI-15	N/C	N/A	
WUBP-j	Ground	Drum 2 Proximity Sensor A and B	Ground	
WUBP-k	AI-16	N/C	N/A	
WUBP-m	28 Volts	Drum 2 Proximity Sensor A and B	28 Volts Nominal	
WUBP-n	ENC-1A	Drum 1 Proximity Sensor A	+ value raise; - value lower	CAN86-1[2]
WUBP-p	ENC-1B	Drum 1 Proximity Sensor B	+ value raise; - value lower	
WUBP-r	ENC-2A	Drum 2 Proximity Sensor A	+ value raise; - value lower	CAN86-3[2]
WUBP-s	ENC-2B	Drum 2 Proximity Sensor B	+ value raise; - value lower	
206-E	Ground	Left Jib Stop Cylinder Transducer	Ground	
206-G	Ground	Right Jib Stop Cylinder Transducer	Ground	
206-T	28 Volts	Left Jib Stop Cylinder Transducer	28 Volts Nominal	

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
206-X	28 Volts	Right Jib Stop Cylinder Transducer	28 Volts Nominal	
206-a	AI-9	Left Jib Stop Cylinder Transducer	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	
206-c	AI-11	Right Jib Stop Cylinder Transducer	1 Volt @ 0 psi; 5 Volts @ 7,500 psi	
J7		**Receptacle – CAN Out**		
207-A	28 Volts	CAN Bus System	28 Volts Nominal	
207-B	DI-1	N/C	N/A	
207-C	CAN-H	CAN High Wire Transmission		
207-D	Ground	CAN System Bus	Ground	
207-E	DI-2	Boom Top Shorting Plug	N/A	CAN87-1-2
207-F	CAN-L	CAN Low Wire Transmission		

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

Reference Only

NODE 21 - Luffing Jib, Block Up, Block Sensor, Limits

Reference Electrical Schematic 81000614 - Sheet 40

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
J3		**Receptacle – Lower Block Up**		
213-A	Ground	**Jumper**	Ground	
213-C	Ground	**Jumper**	Ground	
213-D	DO-2	Wind Speed	28 Volts Nominal	CAN49-1-2
213-J	Ground	Wind Speed	Ground	
213-L	NS-2	**Jumper**		
213-M	NS-3	**Jumper**		
213-N	Ground	Angle Sensor	Ground	
213-S	NS-4	**Jumper**		
213-T	DI-3	Block-Up Limit-Lower Boom Point	0 Volts Off; 28 Volts On	CAN89-1-4
213-U	28 Volts	Block-Up Limit-Lower Boom Point	28 Volts Nominal	
213-a	AI-1	Right Load Strap Sensor #1	0.5 Volts @ 0 kip; 4.7 Volts @ 1,000 kip	CAN37-4[1]
213-c	AI-3	Angle Sensor	2.2 Volts @ 30^o; 4.3 Volts @ 80^o	CAN36-6[1]
213-d	AI-4	Wind Speed	0.9 Volts @ 0 mph 4.7 Volts @ 100 mph	CAN36-8[1]
213-f	AI-6	Left Load Strap Sensor #2	0.5 Volts @ 0 kip; 4.7 Volts @ 1,000 kip	CAN36-2[1]
213-g	Ground	Right Load Strap Sensor #1	Ground	
213-h	Ground	Right Load Strap Sensor #1	Ground	
213-j	5 Volts	Angle Sensor	5 Volts	
213-k	Ground	Left Load Strap Sensor #2	Ground	
213-m	Ground	Left Load Strap Sensor #2	Ground	
213-n	28 Volts	Right Load Strap Sensor #1	28 Volts Nominal	
213-s	28 Volts	Left Load Strap Sensor #2	28 Volts Nominal	
J4-BL2		**Receptacle – Upper Block-Up**		
BL2-g	Ground	Drum 3 Proximity Sensor A	Ground	
BL2-n	28 Volts	Drum 3 Proximity Sensor A and B	28 Volts Nominal	
BL2-p	ENC3-A	Drum 3 Proximity Sensor A	+ value raise; - value lower	CAN89-3[2]
BL2-r	Ground	Drum 3 Proximity Sensor B	Ground	
BL2-s	ENC3-B	Drum 3 Proximity Sensor B	+ value raise; - value lower	CAN89-3[2]
J6-WUBP		**Receptacle – Upper Block-Up**		
WUBP-C	Ground	Drum 1 Proximity Sensor A and B	Ground	
WUBP-G	Ground	Upper Boom Point Load Sensor - Left	Ground	
WUBP-P	DI-7	Block-Up Limit - Upper Boom Point	0 Volts Off; 28 Volts On	CAN89-1-64
WUBP-R	28 Volts	Upper Boom Point **Jumper**	28 Volts Nominal	
WUBP-S	28 Volts	Block-Up Limit - Upper Boom Point	28 Volts Nominal	

Reference Only

Pin ID No.	CAN Bus Packet Type	Description	Test Voltage	Packet No.
WUBP-T	28 Volts	Upper Boom Point Load Sensor - Left	28 Volts Nominal	
WUBP-U	Ground	Upper Boom Point Load Sensor - Left	Ground	
WUBP-W	Ground	Upper Boom Point Load Sensor - Right	Ground	
WUBP-X	28 Volts	Upper Boom Point Load Sensor - Right	28 Volts Nominal	
WUBP-Z	Ground	Upper Boom Point Load Sensor - Right	Ground	
WUBP-b	AI-10	Upper Boom Point Load Sensor - Left	0.5 Volts @ 0 kip; 4.7 Volts @ 950 kip	CAN38-4[1]
WUBP-d	AI-12	Upper Boom Point Load Sensor - Right	0.5 Volts @ 0 kip; 4.7 Volts @ 950 kip	CAN38-8[1]
WUBP-e	AI-13	Upper Boom Point **Jumper**	28 Volts Nominal	
WUBP-g	28 Volts	Drum 1 Proximity Sensor A and B	28 Volts Nominal	
WUBP-j	Ground	Drum 2 Proximity Sensor A and B	Ground	
WUBP-m	28 Volts	Drum 2 Proximity Sensor A and B	28 Volts Nominal	
WUBP-n	ENC1-A	Drum 1 Proximity Sensor A	+ value raise; - value lower	CAN88-1[2]
WUBP-p	ENC1-B	Drum 1 Proximity Sensor B	+ value raise; - value lower	
WUBP-r	ENC2-A	Drum 2 Proximity Sensor A	+ value raise; - value lower	CAN88-3[2]
WUBP-s	ENC2-B	Drum 2 Proximity Sensor B	+ value raise; - value lower	
J7		**Receptacle – CAN Out**		
217-A	28 Volts	CAN Bus System	28 Volts Nominal	
217-B	DI-1	N/C	N/A	
217-C	CAN-H	CAN High Wire Transmission		
217-D	Ground	CAN System Bus	Ground	
217-E	DI-2	Boom Top Shorting Plug		CAN89-1-2
217-F	CAN-L	CAN Low Wire Transmission		

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

* Packet number depends on specific attachment used.

Reference Only

NODE 30 & 31- Engine Node Controller

Reference Electrical Schematic 81000614 - Sheets 35

Pin ID No.	CAN ID No.	CAN Bus Packet Type	Description	Test Voltage
P1			**40 Pin Connector**	
P1-1	0101	28 Volts	Ignition Signal	28 Volts Nominal
P1-2	0102	Ground	CAN Bus Ground Relay Coil - High (0102)	Ground
P1-3	CAN40-1-1 CAN41-1-1	28 Volts	Ether Relay Coil - High (0103) Node 30 Ether Relay Coil - High (0103) Node 31	28 Volts Nominal
P1-4	CAN40-1-2 CAN41-1-2	28 Volts	ECM Power Relay Coil - High (0104) Node 30 ECM Power Relay Coil - High (0104) Node 31	28 Volts Nominal
P1-5	CAN41-1-4	28 Volts	Carbody Power Relay Coil (0105)	28 Volts Nominal
P1-6	CAN41-1-8	28 Volts	Auto Lube Relay - High (0106)	28 Volts Nominal
P1-7			DO-5	
P1-8			DO-6	
P1-9			DO-7	
P1-10	CAN40-1-128 CAN41-1-128	28 Volts	MS1 and MS2 Start Relay Coil - High(0110) Node 30 MS1 and MS2 Start Relay Coil - High(0110) Node 31	28 Volts Nominal
P1-11	0	Ground	Battery Ground	Ground
P1-12	0112	Ground	CAN Bus Ground Relay Coil - Low	Ground
P1-13			DO-1 (Ground)	
P1-14	0114	Ground	ECM Power Relay Coil - Low	Ground
P1-15	0115	Ground	Carbody Power Relay Coil	Ground
P1-16	0116	Ground	Auto Lube Relay - High	Ground
P1-17			DO-5 (Ground)	
P1-18			DO-6 (Ground)	
P1-19	0119	Ground	Ether Relay Coil - Low	Ground
P1-20	0120	Ground	MS1 and MS2 Start Relay Coil - Low	Ground
P1-21	OC	Ground	CAN Bus Ground - Switched	Ground
P1-22	0122	Ground	CAN Bus Power Relay Coil - Low	Ground
P1-23			DI-4	
P1-24			DI-3	
P1-25	0125	Ground	Digital Input - Node Select (EP2-T)	Ground
P1-26			DI-1	
P1-27			AI-4	
P1-28			AI-3	
P1-29	RS232GND	Ground	Program Ground	Ground
P1-30	RS232PE	Signal	Program Enable	N/A
P1-31	8C	28 Volts	CAN Bus Power Relay	28 Volts Nominal
P1-32	0132	28 Volts	CAN Power Relay Coil - High	28 Volts Nominal
P1-33	3	28 Volts	Ignition Signal	28 Volts Nominal

Reference Only

Manitowoc Crane Care

Pin ID No.	CAN ID No.	CAN Bus Packet Type	Description	Test Voltage
P1-34			AI-2	
P1-35			Ai-1	
P1-36	J1939H	Signal	Communication – High	N/A
P1-37	J1939L	Signal	Communication – Low	N/A
P1-38			AI-1 Ground	
P1-39	RS232TX	Signal	Program Transmit	N/A
P1-40	RS232RX	Signal	Program Receive	N/A

Reference Only

CHECKING ELECTRICAL INPUTS/OUTPUTS

Troubleshoot components on main display, system diagnostic screen first. Any further testing could be performed with in-line test boards at universal nodes or Manitowoc Unit Tester at all nodes. The in-line test boards or Manitowoc Unit Tester can be ordered from your Manitowoc dealer.

Node number and pin numbers for each component to be checked is contained in node Test Volt tables.

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

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

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

8. To test for amperes:
   - Select correct amperes range on meter.
   - Connect meter leads across test board problem component terminal.
   - Enable test component and check ampere reading on meter.
9. To test for a communication problem on a universal node use a communication in-line test board:
   - Engines must be off and engine key (Primary/ Secondary) engine switch in ***run*** position, with all brakes and locks engaged.
   - Access desired node to install communication in-line test board.
   - Remove cable from node at W1 or W7 connector.
   - Connect the communication in-line test board between cable and universal node connector.
   - Check between terminals C (CAN high) to D (ground) ***or*** F (CAN low) to D (ground).
   - A reading of 1 to 3 volts indicates normal communication between nodes.
   - A reading of a steady 0 or 2.5 volts can indicate no communication on CAN Bus.

Control Handle Voltages

Troubleshooting control handles can be performed ***only*** on digital display screen. See individual component screens and CAN bus screen in Crane Diagnostics topic in this section.

Enable the test control handle and check the handle voltage on system screen.

Voltages outside the listed range may indicate a problem with the control handle, electrical circuit, or electrical components.

Handle center switch (CS) status is also shown on system digital display screen.

Table 3-4 Controller Handle Voltage

Controller Handle	Acceptable Voltage (DC)
Swing	Left 2.4 To 0.5 Volts Right 2.6 To 4.5 Volts
Boom Hoist	Raise 2.4 To 0.5 Volts Lower 2.6 To 4.5 Volts
Main Hoist 1	Raise 2.4 To 0.5 Volts Lower 2.6 To 4.5 Volts
Main Hoist 2	Raise 2.4 To 0.5 Volts Lower 2.6 To 4.5 Volts
Whip Line Hoist	Raise 2.6 To 4.5 Volts Lower 2.4 To 0.5 Volts
Mast Hoist	Raise 2.6 To 4.5 Volts Lower 2.4 To 0.5 Volts
Luffing Jib Hoist	Raise 2.4 To 0.5 Volts Lower 2.6 To 4.5 Volts
Right and Left Travel	Forward 2.6 To 4.5 Volts Reverse 2.4 To 0.5 Volts
Engine Hand Throttle	Low Idle 0.5 Volts High Idle 4.5 Volts
Engine Foot Throttle (Not Shown)	Low Idle 2.9 To 3.0 Volts High Idle 0.9 To 1.0 Volts

Reference Only

Digital Output Disable Fault

The control system is capable of detecting an open or short circuit in most of the system's digital outputs. When ***Fault 84-Digital Output Disable*** is shown in fault section of the information screen, check for DOD fault in packets 60-64, 66-69, and 208:

1. Scroll through the listed DOD packets.
2. Banks 1, 2, and 3 of the CAN bus diagnostic screen should display number 255.
3. If a number less than 255 is displayed in banks 1, 2, and 3, reference the Bank Identifier Numbers in the following tables to determine which circuit(s) have been turned ***off***.
4. Use following DOD fault tables to determine what outputs are disabled.
5. Troubleshoot indicated outputs for short to ground, short to shield, or other possible problem.

Reference Only

Table 3-5 DOD Fault Table

DOD Packet 60	Description
60-1-2	H4 Rotation Indicator
60-1-4	H2 Rotation Indicator
60-1-32	H3 Rotation Indicator
60-1-64	H1 Rotation Indicator
60-1-128	Cab 1 Supply Sensor
60-2-2	H2 Display
60-3-2	H3 Display
60-3-4	Cab 2 Supply Sensor
60-3-8	H1 Display
60-3-16	H4 Display
60-3-32	RCL/RCI Cab Audible Alarm
60-3-64	Cab 2 Supply Sensor
60-3-128	System Fault Alarm
DOD Packet 61	**Description**
61-1-1	Node 2 Sensor Supply
61-1-16	Cab Auxiliary Power Relay
61-1-32	Node 2 Sensor Supply
61-1-64	Node 2 Sensor Supply
61-1-128	Node 2 Sensor Supply
61-2-1	Exhaust Dampers, Engine 2 (Secondary
61-2-2	Exhaust Dampers, Engine 2 (Secondary)
DOD Packet 62	**Description**
62-1-1	Counterweight Beam - Extend
62-1-2	Counterweight Beam- Retract
62-1-4	Left Cwt Beam- Pins Out
62-1-8	Right Cwt Beam- Pins Out
62-1-16	VPC Motion Light
62-1-32	VPC Motion Alarm 2
62-2-1	VPC Actuator Brake
62-2-16	Swing Grease Valve
62-2-32	VPC Roller Grease Valve
62-2-64	Rack and Pinion Grease Valve
62-2-128	VPC Swing Grease Pump
62-3-32	VPC Assist - Extend
62-3-64	VPC Assist - Retract 1
62-3-128	VPC Assist - Retract 2
DOD Packet 63	**Description**
63-1-1	Seat Tilt - Up
63-1-2	Seat Tilt - Down
63-1-16	Exhaust Dampers, Engine 1 (Primary)
63-1-32	Exhaust Dampers, Engine 1 (Primary)
63-1-64	Hydraulic Generator Emergency Stop Supply
63-1-128	Hydraulic Generator Bypass
63-2-1	Air Intake Damper
63-2-2	Fire Detection Supply
DOD Packet 64	**Description**
64-1-1	Backhitch Pins - Out
64-1-2	Backhitch Pins - In
64-1-4	Rear Motion Alarm

DOD Packet 64	Description
64-1-8	Right Extend RCL/RCI Alarm
64-1-16	VPC Near Rotating Bed Alarm
64-1-32	VPC Position Alarm 1
64-1-64	Drum 2 Brake
64-1-128	Drum 2 Camera Light
64-2-4	Drum 4 Pawl - Out
64-2-32	Drum 4 Brake
64-2-128	Drum 4 Pawl - In
64-3-4	Drum 0 Right Side - Haul In
64-3-8	Drum 0 Right Side - Pay Out
64-3-16	Drum 0 Left Side - Haul In
64-3-32	Drum 0 Left Side - Pay Out
64-3-64	Drum 1 Camera Lights
DOD Packet 66	**Description**
66-1-1	Drum 5 Diverter
66-1-2	Drum 6 Diverter
66-1-4	Travel 2 Speed
66-1-8	Travel Brake
66-1-16	Drum 6 Brake
66-1-32	Swing Brake Release
66-1-64	Drum 1 Brake
66-1-128	Drum 4 Camera Lights
66-2-32	Drum 3 Brake
DOD Packet 67	**Description**
67-1-4	Drum 3 Camera Lights
67-1-16	Drum 5 Camera Lights
67-1-64	Drum 5 Pawl- Out
67-1-128	Drum 5 Pawl - In
67-2-1	Drum 5 Brake
67-2-2	Front Right External RCL/RCI Alarm
67-2-4	External RCL/RCI Light - No Alarm (Green)
67-2-16	External RCL/RCI Light - Overload (Red)
67-2-32	Front Motion Alarms
67-2-64	Front Motion Alarms
67-2-128	External RCL/RCI Light - Warning (Amber)
67-3-1	Front Left External RCL/RCI Alarm
67-3-128	Drum 6 Camera Lights
DOD Packet 68	**Description**
68-1-2	Boom Sensor Supply
DOD Packet 69	**Description**
69-1-2	Luffing Jib Sensor Supply
DOD Packet 208	**Description**
208-1-4	RCL/RCI Overload Caution (Amber LED)
208-1-32	RCL/RCI Maximum Load Warning (Red LED)

Reference Only

Table 3-6 Bank Identifier Numbers

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

Dark shaded boxes indicate ON; white boxes OFF.

Reference Only

Table 3-7 Bank Identifier Numbers (continued)

	1	2	4	8	16	32	64	128
130		■						■
131	■	■						■
132			■					■
133	■		■					■
134		■	■					■
135	■	■	■					■
136				■				■
137	■			■				■
138		■		■				■
139	■	■		■				■
140			■	■				■
141	■		■	■				■
142		■	■	■				■
143	■	■	■	■				■
144					■			■
145	■				■			■
146		■			■			■
147	■	■			■			■
148			■		■			■
149	■		■		■			■
150		■	■		■			■
151	■	■	■		■			■
152				■	■			■
153	■			■	■			■
154		■		■	■			■
155	■	■		■	■			■
156			■	■	■			■
157	■		■	■	■			■
158		■	■	■	■			■
159	■	■	■	■	■			■
160						■		■
161	■					■		■
162		■				■		■
163	■	■				■		■
164			■			■		■
165	■		■			■		■
166		■	■			■		■
167	■	■	■			■		■
168				■		■		■
169	■			■		■		■
170		■		■		■		■
171	■	■		■		■		■
172			■	■		■		■

	1	2	4	8	16	32	64	128
173	■		■	■		■		■
174		■	■	■		■		■
175	■	■	■	■		■		■
176					■	■		■
177	■				■	■		■
178		■			■	■		■
179	■	■			■	■		■
180			■		■	■		■
181	■		■		■	■		■
182		■	■		■	■		■
183	■	■	■		■	■		■
184				■	■	■		■
185	■			■	■	■		■
186		■		■	■	■		■
187	■	■		■	■	■		■
188			■	■	■	■		■
189	■		■	■	■	■		■
190		■	■	■	■	■		■
191	■	■	■	■	■	■		■
192							■	■
193	■						■	■
194		■					■	■
195	■	■					■	■
196			■				■	■
197	■		■				■	■
198		■	■				■	■
199	■	■	■				■	■
200				■			■	■
201	■			■			■	■
202		■		■			■	■
203	■	■		■			■	■
204			■	■			■	■
205	■		■	■			■	■
206		■	■	■			■	■
207	■	■	■	■			■	■
208					■		■	■
209	■				■		■	■
210		■			■		■	■
211	■	■			■		■	■
212			■		■		■	■
213	■		■		■		■	■
214		■	■		■		■	■
215	■	■	■		■		■	■

	1	2	4	8	16	32	64	128
216				■	■		■	■
217	■			■	■		■	■
218		■		■	■		■	■
219	■	■		■	■		■	■
220			■	■	■		■	■
221	■		■	■	■		■	■
222		■	■	■	■		■	■
223	■	■	■	■	■		■	■
224						■	■	■
225	■					■	■	■
226		■				■	■	■
227	■	■				■	■	■
228			■			■	■	■
229	■		■			■	■	■
230		■	■			■	■	■
231	■	■	■			■	■	■
232				■		■	■	■
233	■			■		■	■	■
234		■		■		■	■	■
235	■	■		■		■	■	■
236			■	■		■	■	■
237	■		■	■		■	■	■
238		■	■	■		■	■	■
239	■	■	■	■		■	■	■
240					■	■	■	■
241	■				■	■	■	■
242		■			■	■	■	■
243	■	■			■	■	■	■
244			■		■	■	■	■
245	■		■		■	■	■	■
246		■	■		■	■	■	■
247	■	■	■		■	■	■	■
248				■	■	■	■	■
249	■			■	■	■	■	■
250		■		■	■	■	■	■
251	■	■		■	■	■	■	■
252			■	■	■	■	■	■
253	■		■	■	■	■	■	■
254		■	■	■	■	■	■	■
255	■	■	■	■	■	■	■	■

Dark shaded boxes indicate ON; white boxes OFF.

Reference Only

DIELECTRIC GREASE

Dielectric Grease Application Procedure

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 (female) connector ***and only on the O-ring for a pin (male) connector.***

FIGURE 3-24

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

- On a 3 pin connector a 1/16 inch (1,59 mm) bead is required.
- On a 24 pin connector a 1/8 inch (3,18 mm) bead is required.
- On a 37 pin connector a 3/16 inch (4,76 mm) bead is required.

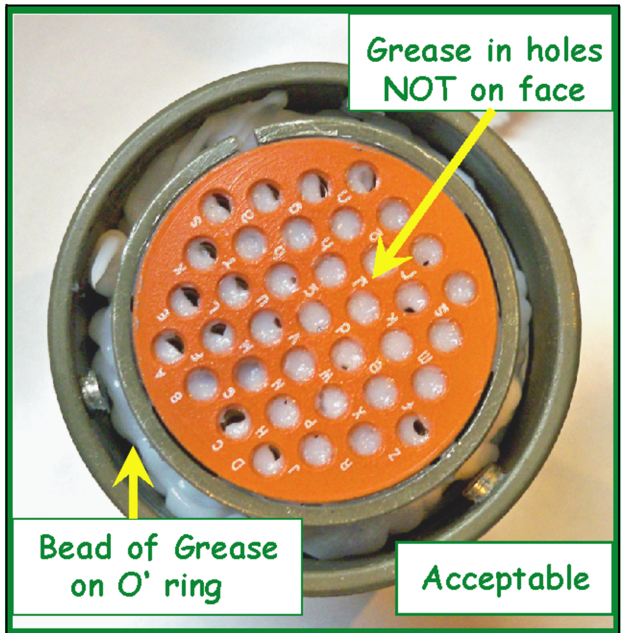


FIGURE 3-25

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 3-26

Reference

CONNECTOR PIN IDENTIFICATION

This section is provided to assist service and maintenance personnel in identifying connector pins for all Brad Harrison type connectors used on Manitowoc cranes:

- Extension cords with plug on both ends — M (male) one end and F (female) other end.
- Cords with plug on only one end — either M (male) or F (female).
- Receptacles — either M (male) or F (female).

Mini-Change Type Connectors

2-Pole Plugs

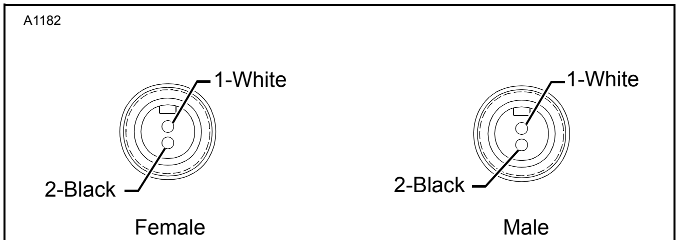


FIGURE 3-27

Extension:

Length	Plug	Part #
3 ft (0,9 m)	M/F	477485
3 ft (0,9 m)	M/F	A02087
6 ft (1,8 m)	M/F	477486
6 ft (1,8 m)	M/F	477491
8 ft (2,4 m)	M/F	477390
10.4 ft (3,1 m)	M/F	477391
12 ft (3,7 m)	M/F	477487
12 ft (3,7 m)	M/F	477492
12 ft (3,7 m)	M/F	911046
15 ft (4,6 m)	M/F	477493
15.4 ft (4,7 m)	M/F	477392
19.4 ft (5,9 m)	M/F	477393
20.4 ft (6,2 m)	M/F	477394
21.4 ft (6,5 m)	M/F	477395
24 ft (7,3 m)	M/F	477338
25.4 ft (7,7 m)	M/F	477396
30.4 ft (9,6 m)	M/F	477397
35 ft (10,7 m)	M/F	477479
40.4 ft (12,3 m)	M/F	477398
60 ft (18,3 m)	M/F	477438
65 ft (19,8 m)	M/F	911031
70 ft (21,3 m)	M/F	477494
130 ft (40,0 m)	M/F	477354
130 ft (40,0 m)	M/F	477562
150 ft (45,7 m)	M/F	477561
205 ft (62,5 m)	M/F	911028
210 ft (64,0 m)	M/F	477371
325 ft (99,1 m)	M/F	477420

Plug With Cord:

Length	Plug	Part #
3 ft (0,9 m)	M	572334
3 ft (0,9 m)	F	572444
3 ft (0,9 m)	M	572514
3 ft (0,9 m)	F	572518
3 ft (0,9 m)	M	911879
6 ft (1,8 m)	M	572335
6 ft (1,8 m)	F	572485
6 ft (1,8 m)	F	572515
6 ft (1,8 m)	M	572592
12 ft (3,7 m)	M	572336
12 ft (3,7 m)	F	572345
12 ft (3,7 m)	F	572573
15 ft (4,6 m)	M	572416
15 ft (4,6 m)	F	572497
15 ft (4,6 m)	F	572509
20 ft (6,1 m)	F	572406
20 ft (6,1 m)	M	572572
20 ft (6,1 m)	M	572574
30 ft (9,1 m)	F	477389
50 ft (15,2 m)	F	572407
100 ft (30,5 m)	F	A05250

Receptacle:

Plug	Part #
F	589650
F 90°	589651
M	589654
M 90°	589944

Reference Only

3-Pole Plugs

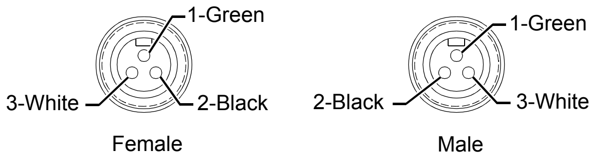


FIGURE 3-28

Extension

Length	Plug	Part #
3 ft (0,9 m)	M/F	477445
12 ft (3,7 m)	M/F	477333
25 ft (7,6 m)	M/F	572434
30 ft (9,1 m)	M/F	572502
35 ft (10,7 m)	M/F	572480
40 ft (12,2 m)	M/F	572410

Plug With Cord

Length	Plug	Part #
3 ft (0,9 m)	M	572324
3 ft (0,9 m)	F	572495
3 ft (0,9 m)	F	572519
3 ft (0,9 m)	F	572531
6 ft (1,8 m)	M	572325
6 ft (1,8 m)	F	572499
12 ft (3,7 m)	M	572326
12 ft (3,7 m)	F	572498
12 ft (3,7 m)	M	572516
12 ft (3,7 m)	F	572587
15 ft (4,6 m)	M	297998
15 ft (4,6 m)	M	572511
15 ft (4,6 m)	F	572550
20 ft (6,1 m)	M	572488
20 ft (6,1 m)	F	572489
25 ft (7,6 m)	M	572372
25 ft (7,6 m)	F	572510
25 ft (7,6 m)	M	572594
30 ft (9,1 m)	F	572477
30 ft (9,1 m)	M	572491
30 ft (9,1 m)	F	572576
35 ft (10,7 m)	M	572386
50 ft (15,2 m)	M	572402
50 ft (15,2 m)	M	572591
50 ft (15,2 m)	F	A00954

Receptacle

Plug	Part #
F	589635
F 90°	589636
M	589871
M 90°	589938

4-Pole Plugs

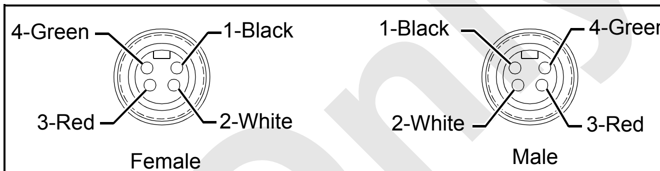


FIGURE 3-29

Extension

Length	Plug	Part #
12 ft (3,7 m)	M/F	477449

Plug With Cord

Length	Plug	Part #
3 ft (0,9 m)	M	572330
3 ft (0,9 m)	M	572508
3 ft (0,9 m)	F	572532
6 ft (1,8 m)	M	572331
6 ft (1,8 m)	M	572419
6 ft (1,8 m)	F	572513
6 ft (1,8 m)	F	572521
12 ft (3,7 m)	M	572332
12 ft (3,7 m)	F	572527
15 ft (4,6 m)	M	572599
20 ft (6,1 m)	F	572417
25 ft (7,6 m)	M	572374
30 ft (9,1 m)	F	572577
50 ft (15,2 m)	M	572441

Receptacle

Plug	Part #
F	589630
F 90°	589638
M	589872
F	589908

Reference Only

5-Pole Plugs

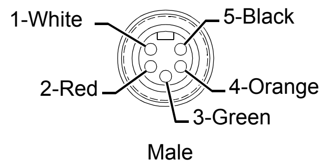


FIGURE 3-30

Plug With Cord:

Length	Plug	Part #
15 ft (4,6 m)	M	572398

Receptacle:

Plug	Part #
F 90°	589839

6-Pole Plugs

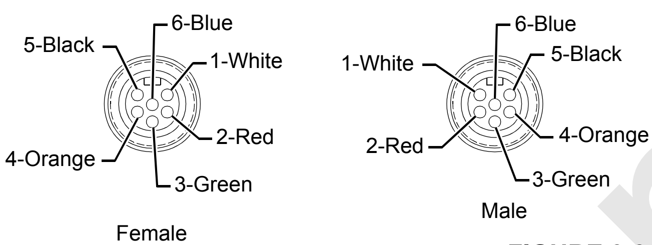


FIGURE 3-31

Extension:

Cord	Plug	Part #
20 ft (6,1 m)	M/F	572400
80 ft (24,4 m)	M/F	477426
130 ft (40,0 m)	M/F	477444
200 ft (61,0 m)	M/F	477419
210 ft (64,0 m)	M/F	477443
350 ft (106,7 m)	M/F	477399

Plug With Cord

:

Length	Plug	Part #
3 ft (0,9 m)	F	572520
3 ft (0,9 m)	F	572528
3 ft (0,9 m)	M	572569
6 ft (1,8 m)	M	572442
6 ft (1,8 m)	F	572517
12 ft (3,7 m)	M	572415
12 ft (3,7 m)	F	572568
20 ft (6,1 m)	M	572391
30 ft (9,1 m)	F	A02463
50 ft (15,2 m)	M	572500

Receptacle

Plug	Part #
F	589805
M	589836
F 90°	589974

8-Pole Plugs

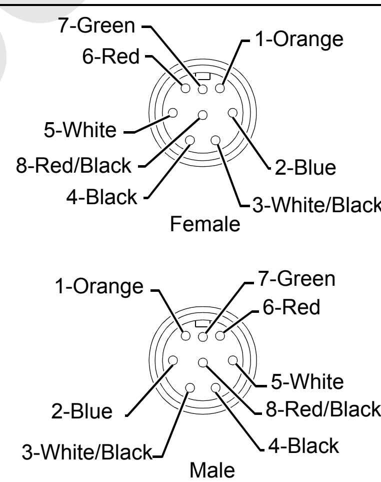


FIGURE 3-32

Plug With Cord:

Length	Plug	Part #
12 ft (3,7 m)	M	572512
12 ft (3,7 m)	M	572529

Receptacle:

Plug	Part #
F	589933

Reference Only

10-Pole Plugs

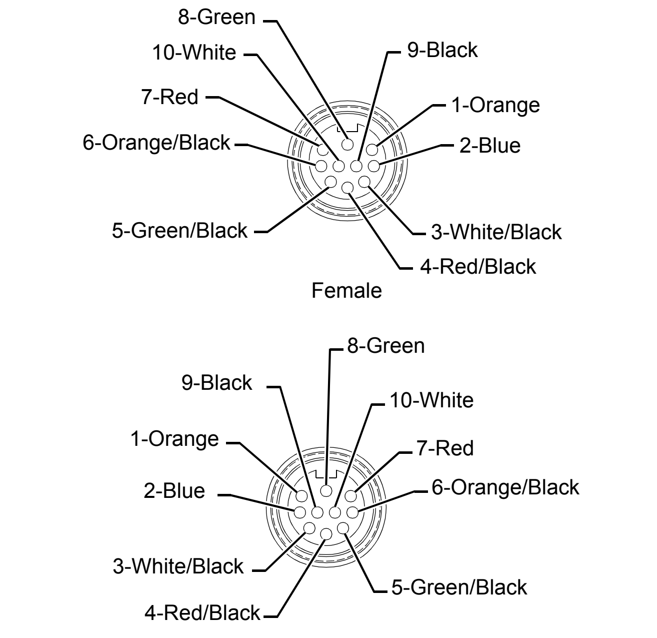


FIGURE 3-33

Extension:

Length	Plug	Part #
12 ft (3,7 m)	M/F	477484
25 ft (7,6 m)	M/F	477466
35 ft (10,7 m)	M/F	477467
45 ft (13,7 m)	M/F	477476
300 ft (91,4 m)	M/F	477413
300 ft (91,4 m)	M/F	477414

Plug With Cord:

Length	Plug	Part #
12 ft (3,7 m)	M	572443
25 ft (7,6 m)	M	572399

Receptacle:

Plug	Part #
F	589869
M	589969

12-Pole Plugs

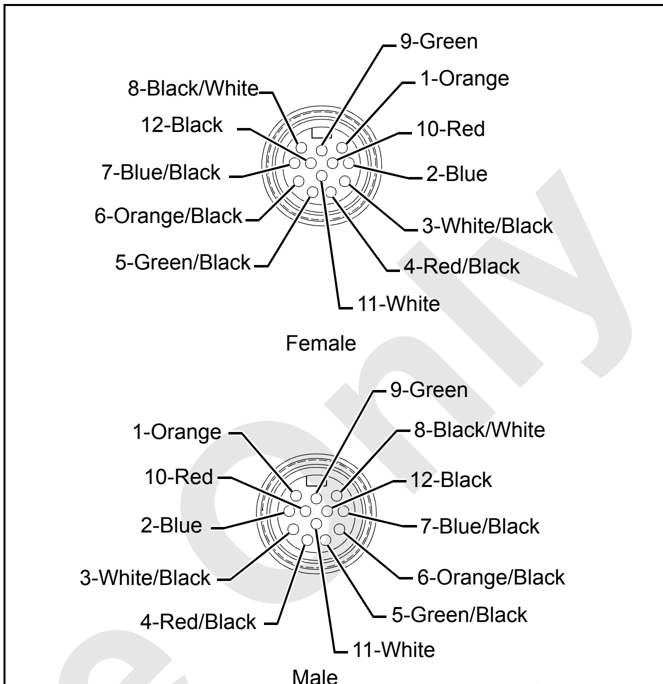


FIGURE 3-34

Extension:

Length	Plug	Part #
21 ft (6,4 m)	M/F	A03688
27 ft (8,2 m)	M/F	477468
38 ft (12,0 m)	M/F	477469
41.5 ft (12,6 m)	M/F	477441
350 ft (107,0 m)	M/F	477442
400 ft (122,0 m)	M/F	477481

Plug With Cord:

Length	Plug	Part #
6 ft (1,8 m)	F	572327
12 ft (3,7 m)	F	572389
20 ft (6,1 m)	M	572507
25 ft (7,6 m)	F	572382

Reference Only

Receptacle

Plug	Part #
M	589646
F	589915

Micro-Change Type Connectors

4-Pole Plugs

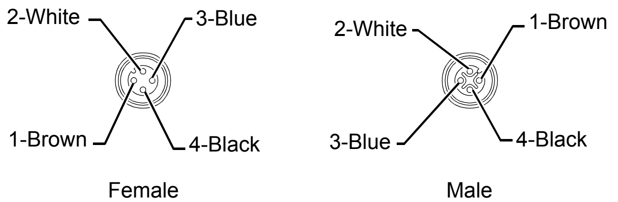


FIGURE 3-35

Extension

:

Length	Plug	Part #
3 ft (0,9 m)	M/F	477463
6.6 ft (2,0 m)	F/F	477447
6.6 ft (2,0 m)	M/F	477475
6.6 ft (2,0 m)	F/F 90°	477488
6.6 ft (2,0 m)	M/F 90°	477489
13.1 ft (4,0 m)	F/F	477473
13.1 ft (4,0 m)	M/F	477474
16.4 ft (5,0 m)	M/F	477436
16.4 ft (5,0 m)	F/F	477478
19.7 ft (6,0 m)	M/F	477339
32.8 ft (10,0 m)	M/F	477433
32.8 ft (10,0 m)	F/F	477554
90 ft (27,4 m)	F/F	477453
131.2 ft (40,0 m)	M/F	477334
150.9 ft (46,0 m)	M/F	477560
400 ft (122,0 m)	M/F	477439

Plug With Cord

:

Length	Plug	Part #
3.28 ft (1,0 m)	F	572575
6 ft (1,8 m)	F 90°	572504
6.6 ft (2,0 m)	F	572418
9.8 ft (3,0 m)	F	572586
13.1 ft (4,0 m)	M	572474
13.1 ft (4,0 m)	F	572476
16 ft (4,9 m)	F	572472
16 ft (4,9 m)	F 90°	572501
16.4 ft (5,0 m)	M	572475
23 ft (7,0 m)	F	572503
32.8 ft (10,0 m)	M	A01666
32.8 ft (10,0 m)	F	A02673

Receptacle:

Plug	Part #
M	589870
F	589908

Quick-Change Type Connectors

2-Pole Plugs

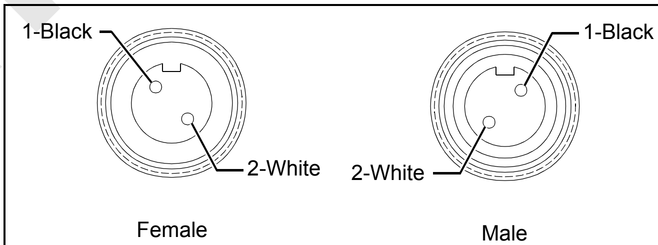


FIGURE 3-36

Extension

Length	Plug	Part #
25 ft (7,6 m)	M/F	477479

Plug With Cord

:

Length	Plug	Part #
6 ft (1,8 m)	F	572432
30 ft (9,1 m)	F	572565

Reference Only

Manitowoc Crane Care

Receptacle

:

Plug	Part #
M	589862
M	589963

3-Pole Plugs

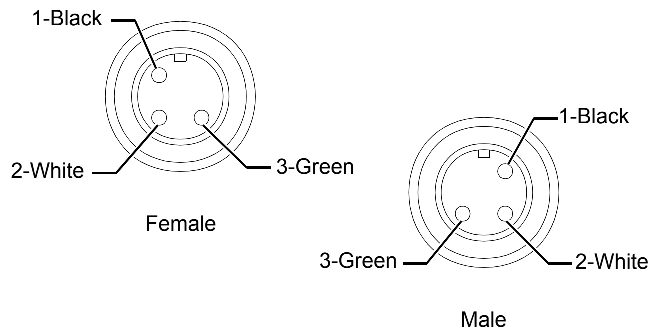


FIGURE 3-37

Extension:

Length	Plug	Part #
8 ft (2,4 m)	M/F	477416
12 ft (3,7m)	M/F	477432
20 ft (6,1 m)	M/F	477430
45 ft (13,7 m)	M/F	477448

Plug With Cord:

Length	Plug	Part #
12 ft (3,7 m)	F	572403
12 ft (3,7 m)	M	572437
12 ft (3,7 m)	M	572552

Length	Plug	Part #
25 ft (7,6 m)	F	572478
35 ft (7,6 m)	F	572597
50 ft (15,2 m)	M	572438

Receptacle:

Plug	Part #
M	589853
F	589861
M	589862
F	589866
M	589942
F	589952

4-Pole Plugs

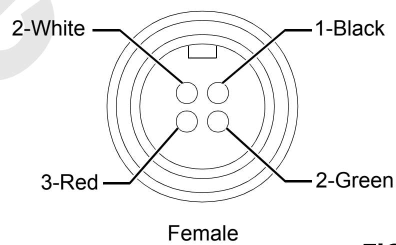


FIGURE 3-38

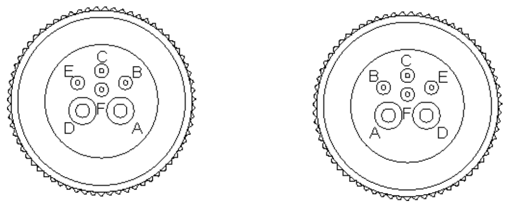
Plug With Cord:

Length	Plug	Part #
20 ft (6,1 m)	F	572566

Reference Only

CAN Bus Network Connectors and Plugs

Junction Box Can Bus Tee Set-up Receptacle



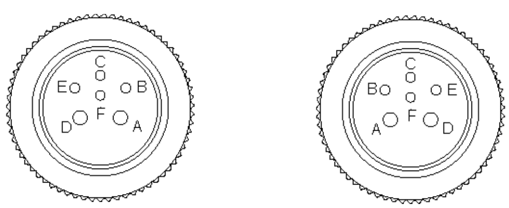
Junction Box
Can Bus Tee
Set-up Remote Socket
589977

Junction Box
Can Bus Tee
Plug
589976

FIGURE 3-39

Item	Part #
Junction Box Plug	589976
Junction Box Socket	589977

Set-up Remote Plug and Network Cables Socket



Network Cable
Socket
572609

Set-up
Remote Plug
572610

FIGURE 3-40

Item	Part #
Set-up Remote Plug	572610
Network Cable Socket	572609

Item	Length	Part #
Cable WN04	4	A03417
Cable WN05	5	81000667
Cable WN06	6	A01510
Cable WN07	7	A03413
Cable Wn08	8	A01511
Cable WN10	10	A03414
Cable WN12	12	A01512
Cable WN14	14	A01513
Cable WN16	16	A01514
Cable WN18	18	A03416
Cable WN20	20	A03415
Cable WN22	22	A13127
Cable WN24	24	A03418
Cable WN26	26	A06704
Cable WN30	30	A06482
Cable WN32	32	81007045
Cable WN48	48	81002881

Reference Only

SECTION 3 INSERTS

The following publications are provided at the end of this section:

- Drawing 81000612 Electrical System Wiring Diagram
- Drawing 81000614 Electrical Schematic
- Drawing 81003390 Electrical Schematic AC Load Distribution Sht 1, 8-11
- Drawing 81003381 Electrical Schematic AC Input Sources Sht 6 and 7
- Drawing 81003603 Heater/AC schematic, Cab Sht 2
- A19667 24VDC Power Plant Wiring Secondary Sht 5

Reference Only

Reference Only

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SECTION 4
BOOM

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Reference Only

SECTION 4
BOOM

BOOM HOIST SYSTEM OPERATION

See Figure 4-1 and Figure 4-2 for the following procedure.

NOTE: Theory of operation assumes drum 4 speed limit is set to 100%. See F2207 drum 4 function mode screen procedure for more information.

Boom hoist, drum 4 is mounted above drum 2 on the rotating bed and controls the boom. Pump 6 and pump 7 drive four separate hydraulic motors, two on each end of the boom hoist drum shaft. The boom hoist drum is controlled with control handle movement monitored by Node-1 and output voltage signals from Node-3 and Node-4 to pump 6 and pump 7 EDC. Drum 4 control handle is located on the left side console.The control handle is inoperable when park brake is applied.

Hydraulic charge pressure from closed loop charge pump supplies hydraulic make-up fluid to low-pressure side of each boom hoist pump. A pressure sender, monitored by Node-3, in high-pressure side of boom hoist system provides pressure information to Node-1. Low pressure side of closed loop supplies hydraulic pilot pressure to operate motor servos. A fixed orifice between pump ports A and B allows for smoother drum operation.

When boom hoist motors rotate, the speed sensor mounted on the right side motor monitors rotor movement and sends an input voltage to Node-7. Node-2 controller responds by sending a 28 volt output to rotation indicator in control handle. As boom hoist drum rotates faster, the rotation indicator on top of control handle pulsates with a varying frequency to indicate drum rotational speed. The handle command in percent from neutral is shown on Drum 4 Diagnostic Screen.

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

Boom Hoist Brake and Pawl

Hydraulic pressure to operate boom hoist brake and drum 4 pawl is from low-pressure side of closed loop. There is a total of four brakes, one for each motor.

When boom hoist brake switch is in on - park position, hoist brake release solenoid HS-84 is disabled to apply brakes to drum. Hoist pawl solenoid HS-86 is enabled to keep pawl applied to drum flange. Hoist pump does not stroke in response to control handle movement.

When hoist brake switch is in off - park position, Node-7 controller sends a zero volt output signal to pawl extend solenoid HS-86 and a 28 volt output to pawl retract solenoid HS-85. The brakes remain applied to drum until Node-7 controller sends a 28 volt output to brake solenoid to release brakes. Boom system circuit is active, waiting for a control handle command.

Raising Boom

When boom hoist control handle is moved back for booming ***up***, an input voltage of 2.4 volts or less is sent to Node-1 controller. Node-3 and Node-4 send a variable zero to 25.4 volt output that is divided by a 220 ohm resistor and applied to pump 6 and pump 7 EDC. Node-7 sends a variable 3.8 (0% motor command) to 16.2 volt (100% motor command) output to each boom hoist proportional motor control solenoid HS-45, HS-46, HS-47, and HS-48. Node-1 controller checks for system faults.

Pump EDC tilts swash plate in the ***up*** direction to satisfy pressure memory. Node-1 controller compares boom holding pressure to value in pressure memory. When closed loop pressure is high enough, Node-7 controller sends a 28 volt output to brake release solenoid HS-84. The brake solenoid shifts to block drain port and opens port to low-pressure side of closed loop to release drum 4 brakes.

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

Node-3 and Node-4 output voltage to boom hoist pump 6 and pump 7 EDC simultaneous with Node-7 output voltage to each proportional motor control solenoid HS-45, HS-46, HS-47, and HS-48 is relative to control handle movement. As control handle is moved back, pump swash plate angle is increased and motor control solenoids begin to shift motor to high speed (100% motor command).

When closed loop pressure exceeds the Node-1 controlled ECOR maximum pressure setting, Node-7 controller responds and shifts the motor control solenoids to direct flow from shuttle valve into maximum displacement side of servo cylinder. Motor displacement and output torque increase while Node-7 shifts motor control into low speed (0% motor command) to prevent pump or motor damage. When pressure falls below the Node-1 controlled ECOR maximum pressure setting, Node-7 will shift the motor control solenoid to direct flow from shuttle valve into minimum displacement side of servo cylinder. Boom hoist motors will resume high speed (100% motor command).

4

Reference Only

Node controllers continuously balance the boom hoist closed loop pressure and monitor motor displacement. If motor torque requirements are not above the ECOR maximum pressure setting of Node-1 controller, displacement remains in minimum (100% motor command for high speed) when control handle is fully pulled back (+100% handle command). Node-1 controller monitors motor displacement and controls motor speed by regulating the hydraulic fluid flow through the pumps.

When boom hoist control handle is moved to neutral position (0%), Node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-3 and Node-4 send a zero output voltage to hoist pump 6 and pump 7 EDC that moves swash plate to center position. Node-7 shifts the boom hoist motors back to maximum displacement (0% motor command) for slower output speed to slow drum rotation.

After control handle is in neutral position (0% handle command), Node-1 stores the load holding pressure in pressure memory. When control handle center switch opens, Node-7 sends a zero output voltage to disable brake release solenoid HS-84. Drum 4 brake solenoid valve shifts to block pilot pressure from brakes and opens a line to tank. Brakes apply before drum pump de-strokes.

When brakes apply, an input signal is sent to Node-1 controller. Node-3 and Node-4 controller send a zero volt output to pump EDC to de-stroke pumps. Node-7 controller sends a 3.8 volt output to each motor control solenoid (0% motor command).

Lowering Boom (Drum 4)

When boom hoist control handle is moved forward for booming ***down***, an input voltage of 2.6 volts or more is sent to Node-1. Node-3 and Node-4 send a variable zero to 25.4 volt output that is divided by a 220 ohm resistor and applied to pump 6 and pump 7 EDC.

Node-7 sends a variable 3.8 (0% motor command) to 16.2 volt (100% motor command) to each proportional motor control solenoid HS-45, HS-46, HS-47, and HS-48. Node-1 controller checks for system faults.

The pump EDC tilts swash plate in the ***up*** direction to satisfy pressure memory. Node-1 controller compares drum 4 holding pressure to value in pressure memory. When closed loop pressure is high enough, Node-7 controller sends a 28 volt output to brake release solenoid HS-84. The brake solenoid shifts to block drain port and opens port to low-pressure side of closed loop to release boom hoist drum brakes.

When brakes are released, the pump EDC tilts the swash plate to stroke pumps in the ***down*** direction. In the down direction, hydraulic fluid flow is from pump ports to motor ports. Return fluid is from motor outlet ports to pump inlet ports.

Node-3 and Node-4 controller output voltage to the pump 6 and pump 7 EDC simultaneous with Node-7 output voltage to each proportional motor control solenoid HS-45, HS-46, HS-47, and HS-48 is relative to control handle movement. As control handle is pushed forward, pump swash plate angle is increased and motor control solenoids begin to shift motor to high speed (100% motor command).

When closed loop pressure exceeds the Node-1 controlled ECOR maximum pressure setting, Node-7 controller responds and shifts the motor control solenoids to direct flow from shuttle valve into maximum displacement side of servo cylinder. Motor displacement and output torque increase while Node-7 shifts motor control into low speed (0% motor command) to prevent pump or motor damage. When pressure falls below the Node-1 controlled ECOR maximum pressure setting, Node-7 will shift the motor control solenoid to direct flow from shuttle valve into minimum displacement side of servo cylinder. Boom hoist motors will resume high speed (100% motor command).

Node controllers continuously balance the boom hoist closed loop pressure and monitor motor displacement. If motor torque requirements are not above the ECOR maximum pressure setting of Node-1 controller, displacement remains in minimum (100% motor command for high speed) when control handle is fully pushed forward(-100% handle command). Node-1 controller monitors motor displacement and controls motor speed by regulating the hydraulic fluid flow through the pumps.

The weight of boom attempts to drive motor faster than return fluid can return to low-pressure side of pump. Closed loop charge pump maintains fluid supply at a positive pressure to motor. Pump swash plate 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 to neutral position (0% handle command), Node-1 controller compensates for hydraulic closed loop leakage or changing engine speed. Node-3 and Node-4 controller send a zero output voltage to hoist pump 6 and pump 7 EDC that moves swash plate to center position. Node-7 shifts the boom hoist motors back to maximum displacement (0% motor command) for slower output speed to slow drum rotation.

After control handle is in neutral position (0% handle command), Node-1 stores the load holding pressure in pressure memory. When control handle center switch opens, Node-7 sends a zero output voltage to disable brake release solenoid HS-84. Drum 4 brake solenoid valve shifts to block pilot pressure from brakes and opens a line to tank. Brakes apply before drum pumps de-stroke.

When brakes apply, an input signal is sent to Node-1 controller. Node-3 and Node-4 send a zero volt output to pump EDC to de-stroke pumps. Node-7 sends a 3.8 volt output (0% motor command) to each motor control proportional solenoid.

Reference Only

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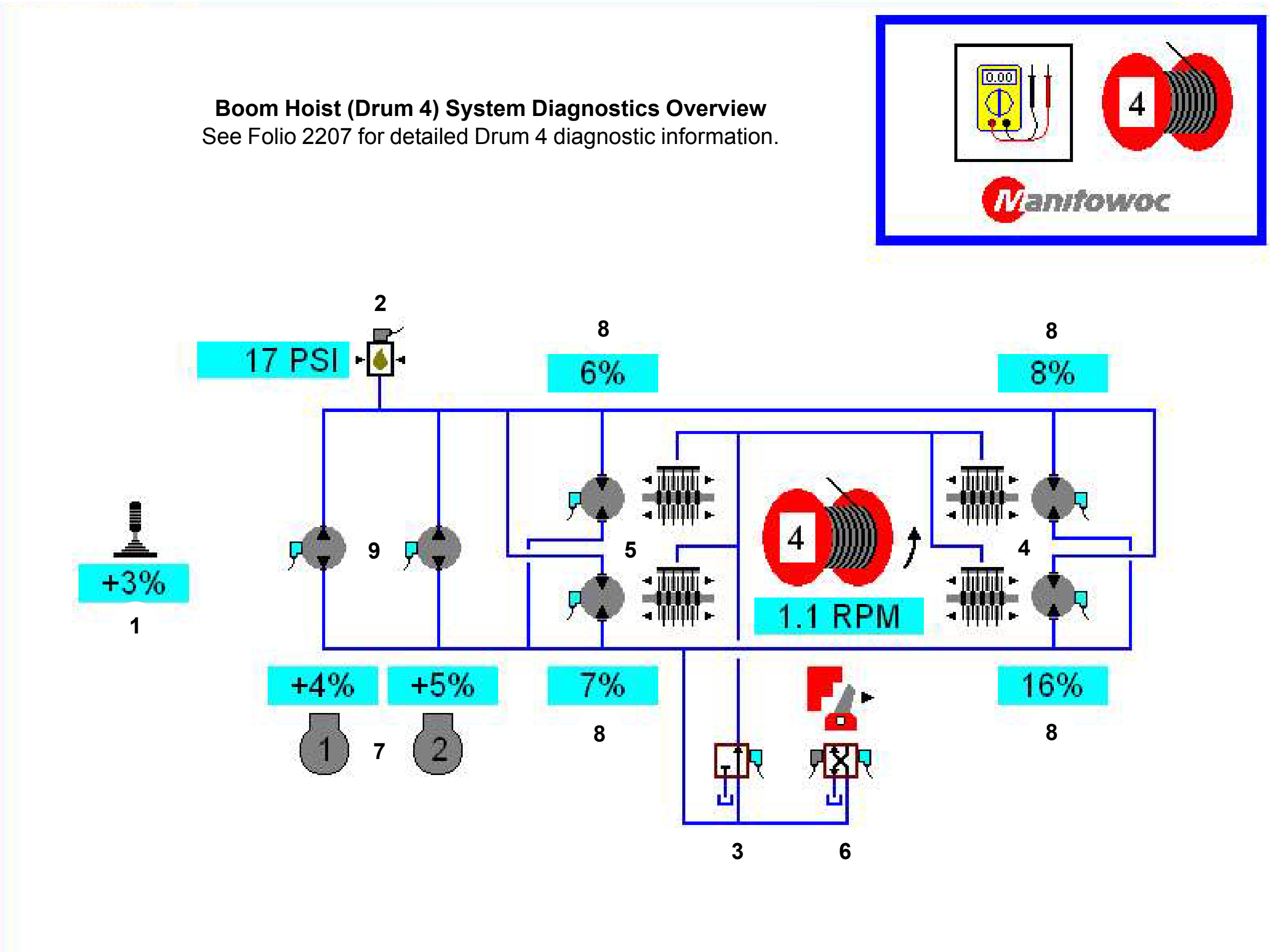


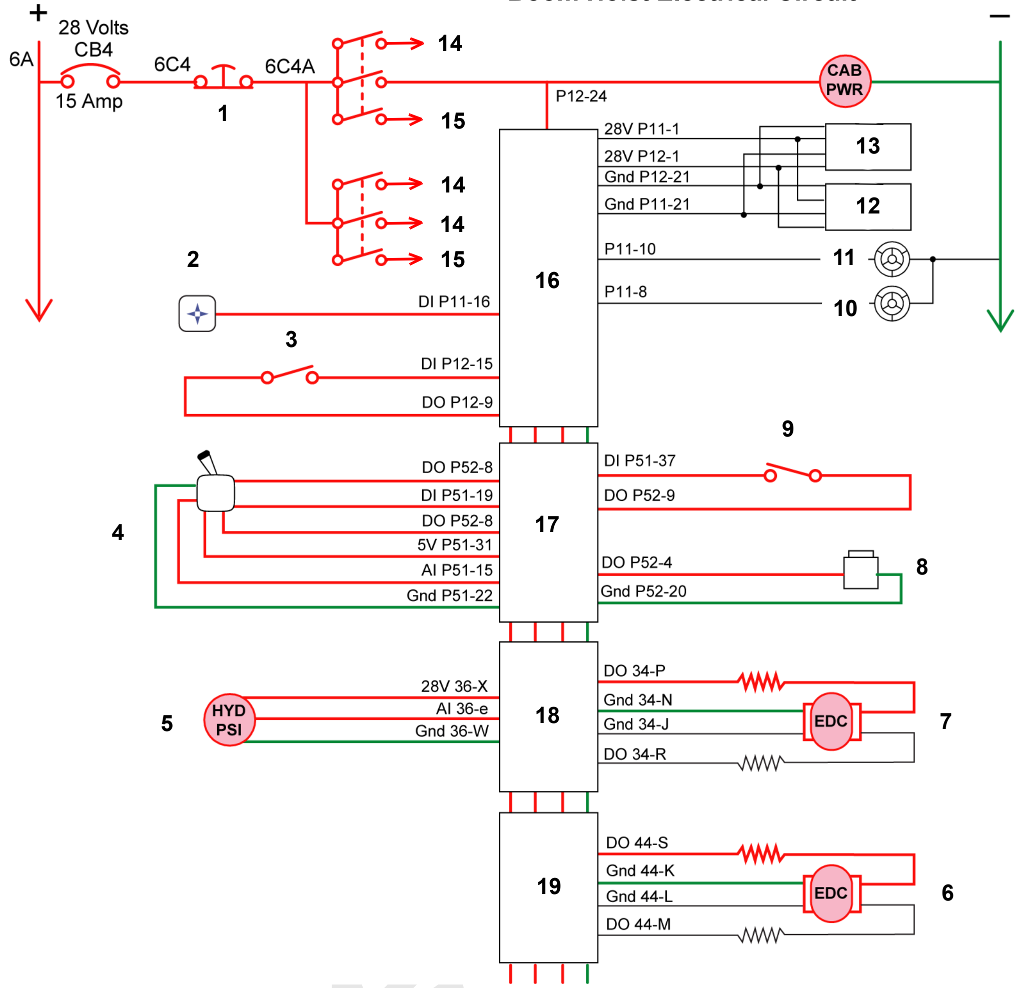
Legend for Figure 4-1

Item	Description	Item	Description
1	Boom Hoist Control Handle	6	HS-85 and HS-86
2	Pressure Sender (high pressure)	7	Percentage of Pump Command
3	HS-84	8	Percentage of Motor Command
4	HS-45 and HS-46	9	Pump 6 and Pump 7
5	HS-47 and HS-48		

FIGURE 4-1

Reference Only

Boom Hoist Electrical Circuit



Legend for Figure 4-2

Item	Description	Item	Description
1	Engine Stop	11	Caution Fault Alarm
2	Confirm Chart and Crane Mode	12	RCL Display
3	Drum 4 Park Brake Switch	13	Main Display
4	Drum 4 Control Handle	14	Run
5	Drum 4 Pressure Sender	15	Start
6	Drum 4 Pump 7	16	Master Node 1
7	Drum 4 Pump 6	17	Side Console Node 2
8	Drum 4 Handle Rotation Indicator	18	Universal Node 3
9	Seat Switch	19	Universal Node 4
10	RCL Warning Alarm		

FIGURE 4-2

Boom Hoist Electrical Circuit continued

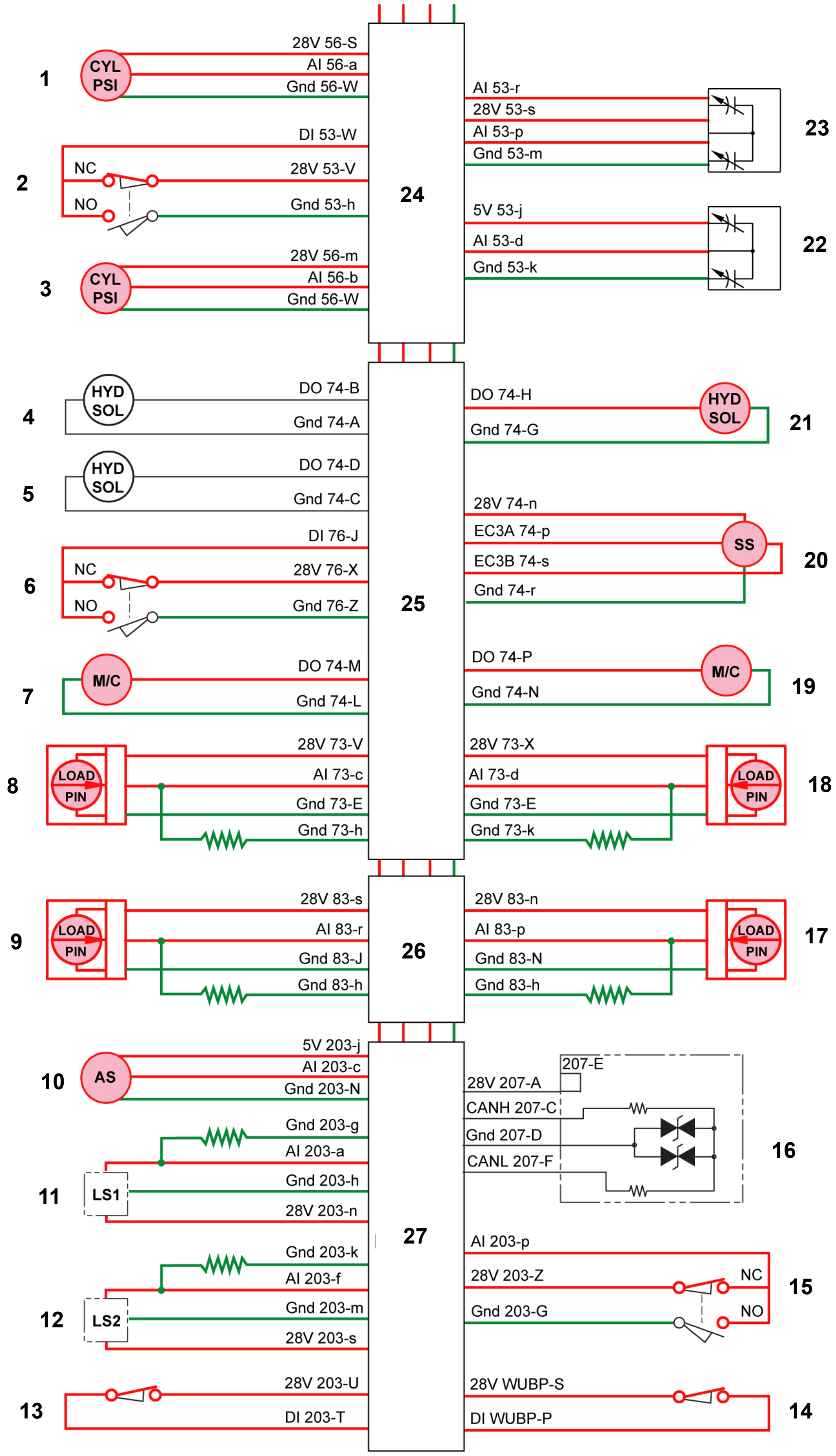


FIGURE 4-2 continued

Legend for FIGURE 4-2 continued

Item	Description	Item	Description
1	Boom Nitrogen Left Cylinder	15	Minimum Jib Angle
2	Maximum Boom Angle Limit	16	CAN Bus Terminator Plug
3	Boom Nitrogen Right Cylinder	17	Right Front House Roller Load Pin
4	Drum 4 Pawl Retract HS-85	18	Right Rear House Roller Load Pin
5	Drum 4 Pawl Extend HS-86	19	Drum 4 Motor Control HS-45 and HS-46
6	Drum 4 Bail Limit	20	Drum 4 Speed Sensor
7	Drum 4 Motor Control HS-47 and HS-48	21	Drum 4 Brake Release HS-84
8	Left Rear House Roller Load Pin	22	Boom Angle Sensor
9	Left Front House Roller Load Pin	23	Rotating Bed Level Sensor
10	Boom Angle Sensor	24	Universal Node 5
11	Right Load Strap	25	Universal Node 7
12	Left Load Strap	26	Universal Node 8
13	Lower Block Up Limit	27	Universal Boom Top Node 20
14	Upper Block Up Limit		

Reference Only

AUTOMATIC BOOM STOP

Maximum Operating Angles

WARNING

Falling Attachment Hazard!

Do not operate crane unless automatic boom stop is properly adjusted and operational. Do not adjust MAX operating angle higher than specified. Boom could be pulled over backwards or collapse.

Boom stop limit switch (5, Figure 4-4) automatically stops the boom and applies the boom hoist brake when the boom is raised to ***Angle A*** (see Table 4-1 and Figure 4-3).

Table 4-1 Maximum Boom Angle

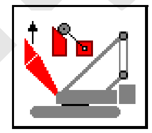
Angle A	Attachment
84.5°	#90 Boom without Jib #90-91 Boom
86.5°	#90 Boom with #91 Luffing Jib #90 Boom with #91 Fixed Jib

Operation

See Figure 4-4 for the following procedure.

When the boom is below the maximum angle, limit switch (5) is closed and the boom hoist can be operated.

When the boom is raised to the maximum angle, boom butt (1) pushes adjusting rod (2a or 2b) (see Table 4-2) in and actuator rod (4) opens limit switch (5). Boom hoist operation stops automatically because the open limit switch turns off power to the boom hoist electric circuit. The boom hoist pump shifts to neutral and the brake applies to stop boom movement.



The Boom Up limit fault will appear on the Main Display at maximum boom angle.

Maintenance

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

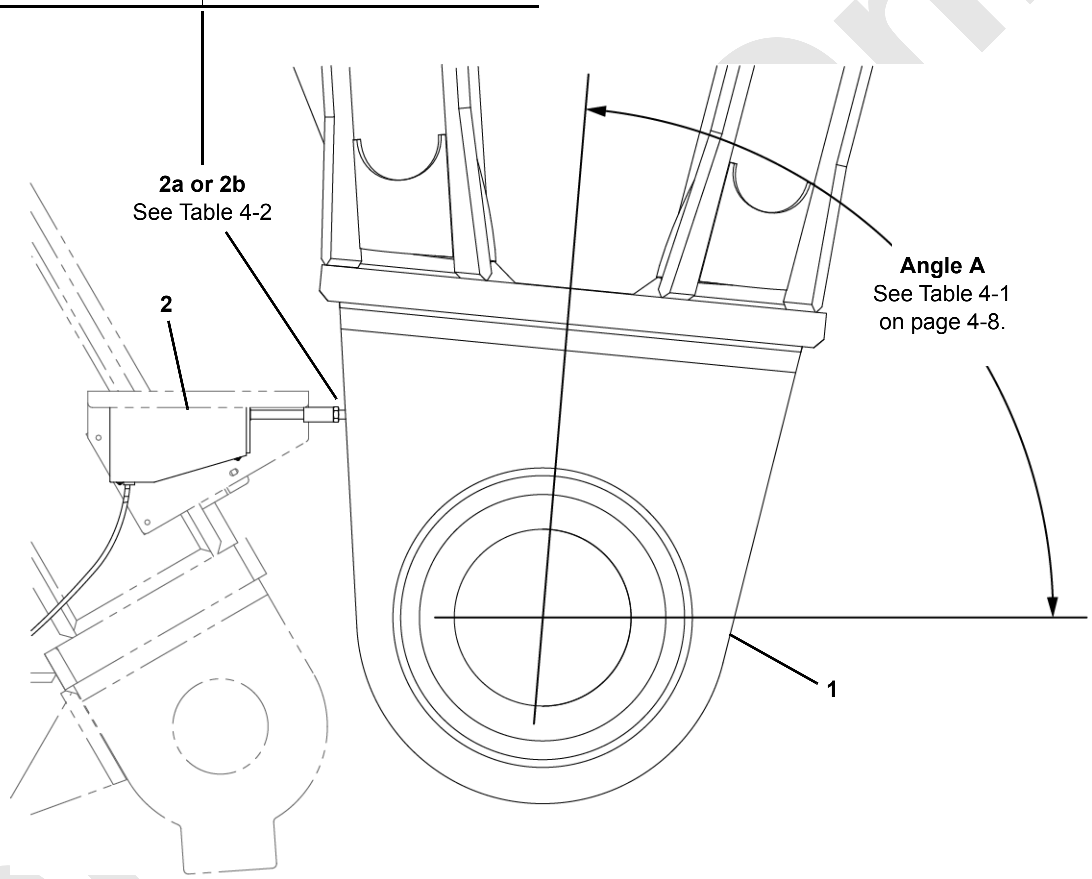
Once the automatic boom stop is properly adjusted, it should not require periodic adjustment. Adjustment is required, however, when:

- The fixed jib or luffing jib is installed or removed.
- Parts are replaced.

Reference Only

Table 4-2 Adjusting Rod Identification

Adjusting Rod and Length	
2a Boom Only	**2b** With Fixed Jib or Luffing Jib
4-1/8 in (104,78 mm)	3-1/2 in (88,9 mm)



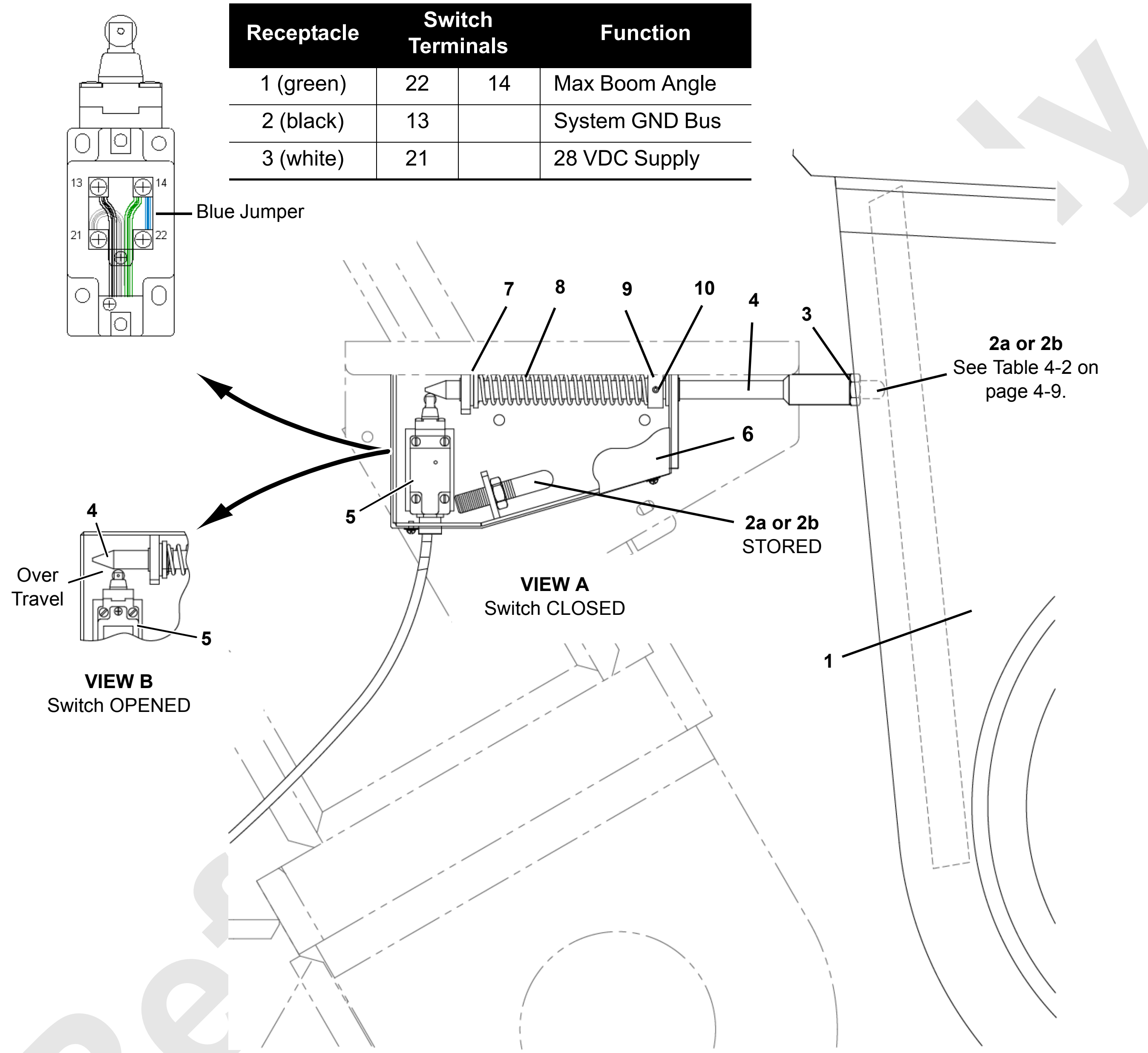
Item	Description
1	Boom Butt
2	Switch Assembly

FIGURE 4-3

Reference Only

Limit Switch Wiring

Receptacle	Switch Terminals		Function
1 (green)	22	14	Max Boom Angle
2 (black)	13		System GND Bus
3 (white)	21		28 VDC Supply



Item	Description	Item	Description
1	Boom Butt	6	Cover
2a	Adjusting Rod – Boom only	7	Spring Washer
2b	Adjusting Rod – Boom with Luffing Jib (see Table 4-2)	8	Spring
3	Jam Nut	9	Spring Washer
4	Actuator Rod with Coupling	10	Dowel Pin 1/4 in (6,35 mm) Diameter
5	Limit Switch	11	Digital Level (see Figure 4-5)

FIGURE 4-4

Adjustment

Boom Angle A	Digital Level Angle
84.5°	75.4°
86.5°	77.4°

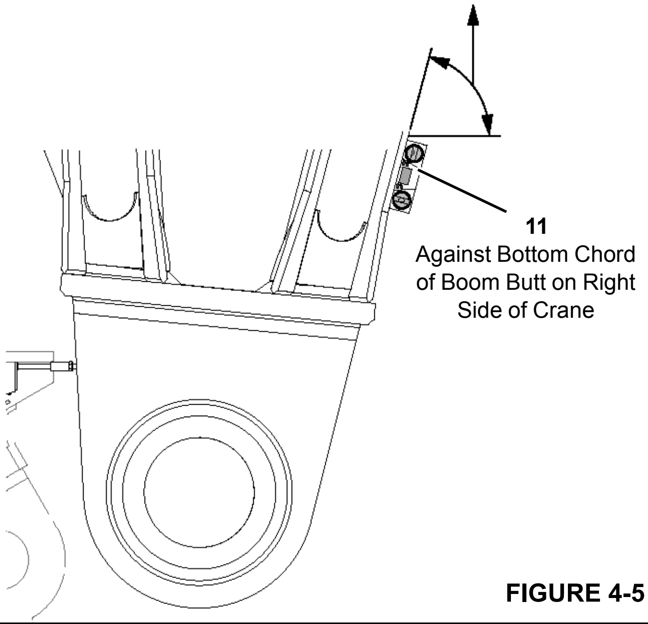


FIGURE 4-5

1. Park the crane on a firm level surface or level the crane by blocking under the crawlers.
2. Make sure the proper adjusting rod is installed in the boom stop limit switch (see Table 4-2):
   - Rod (2a) for BOOM ONLY.
   - Rod (2b) for boom WITH FIXED JIB or LUFFING JIB.
3. Raise the boom to specified **Angle A** (Table 4-1) while monitoring the angle on the Load Moment Indicator (LMI) screen on the front-console display.
4. Verify that the boom is at the proper **Angle A**:
   a. Place an accurate digital level (11) on the boom butt as shown in Figure 4-5. The corresponding **Digital Level Angle** should appear on the digital level.
   b. Raise or lower the boom as necessary.
5. If the boom stops at the specified angle, further adjustment is not needed.
   - If the boom stops before reaching the specified angle, go to step 6.
   - If the boom reaches the specified angle before it stops, go to step 7.

See Figure 4-4 for the remaining steps.

6. If the boom stops before reaching the specified angle:
   a. Loosen jam nut (3, View B).
   b. Turn adjusting rod (2a or 2b) all the way into actuator rod coupling (4).
   c. Boom up slowly until the boom reaches specified angle as indicated on the Digital Level Angle.
   d. Turn adjusting rod (2a or 2b) out against boom butt (1) until limit switch (5) “clicks” to actuate.
   e. Tighten jam nut (3).
7. If the boom reaches the specified angle before it stops:
   a. Loosen jam nut (3, View B).
   b. Turn adjusting rod (2a or 2b) out against boom butt (1) until limit switch (5) “clicks” to actuate.
   c. Tighten jam nut (3).
8. Check that actuator rod (4) over-travels the limit switch as shown in View A.
9. Test the adjustment as follows:
   a. Lower the boom several degrees below the specified Angle A.
   b. Slowly raise the boom.
   c. ***Boom must stop at specified Angle A.*** If the boom does not stop at the specified angle:
      - The Boom Up limit fault will appear on the Main Display at maximum boom angle.
      - Stop raising the boom (move control handle to off).
      - Lower the boom several degrees below the specified angle.

   d. Repeat adjustment steps 2 through 9.

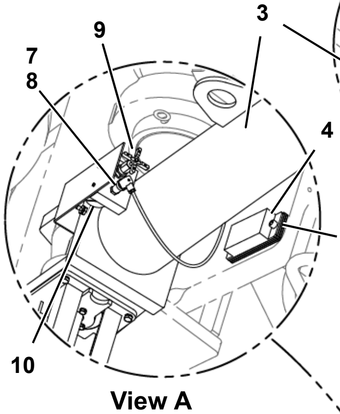
Actuator Rod Replacement

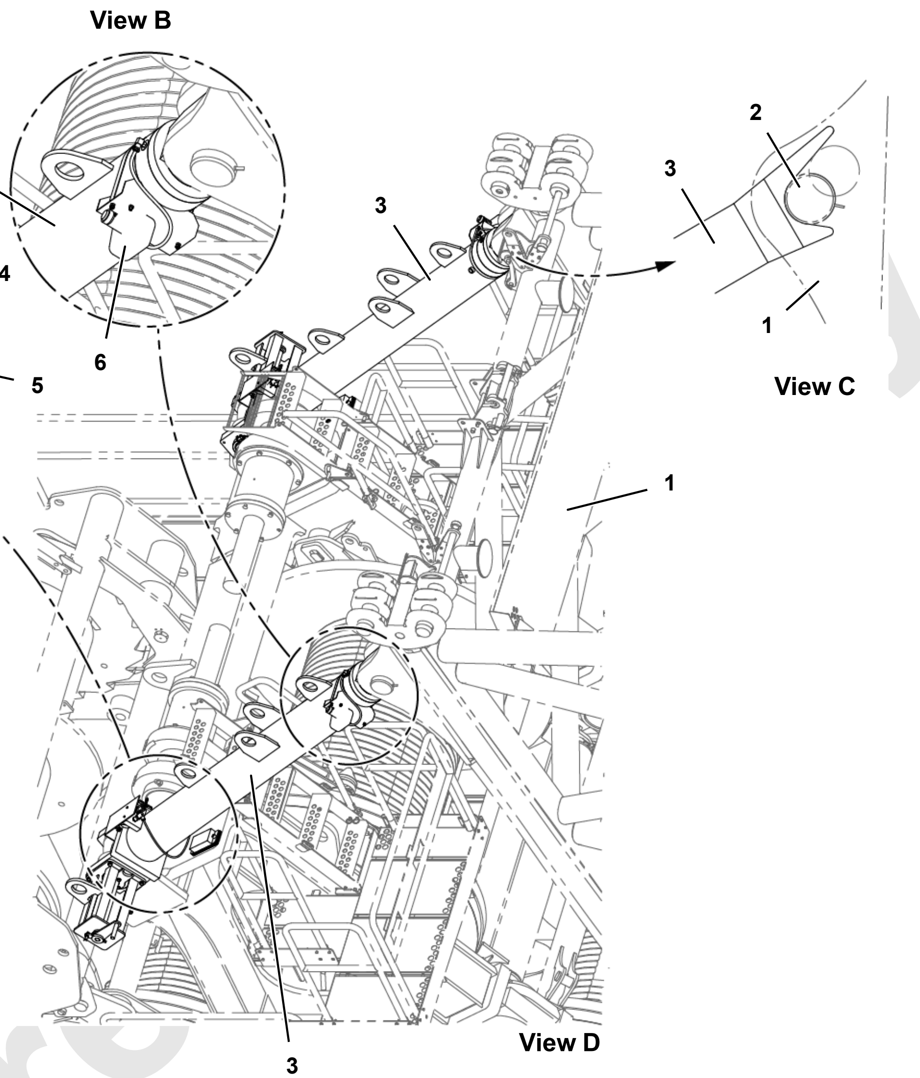
See Figure 4-4, View B for the following procedure.

1. Remove damaged actuator rod with coupling (4).
2. Slide spring washers (7 and 9) and spring (8) over new actuator rod with coupling (4) while sliding the actuator rod into the bracket assembly.
3. Position actuator rod (4) so the tapered end just touches limit switch (5) roller (View B). The actuator rod must not depress the limit switch roller.
4. Drill a 1/4 in (6,35 mm) hole through spring washer (9) and actuator rod (4).
5. Install dowel pin (10).
6. Install proper adjusting rod (2a or 2b).
7. Adjust the boom stop.

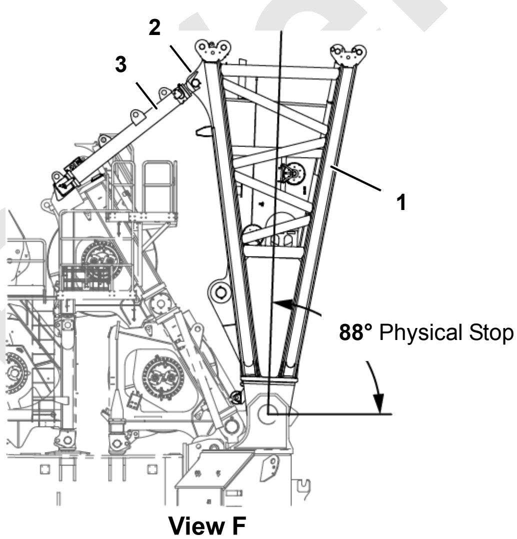
4

Reference Only





Item	Description
1	Boom Butt
2	Stop Tube
3	Boom Stop (left and right)
4	Rubber Bumper
5	Shims
6	Reservoir with Check Valve
7	Electric Plug
8	Pressure Transducer
9	Flow Control Valve
10	Pressure Gauge



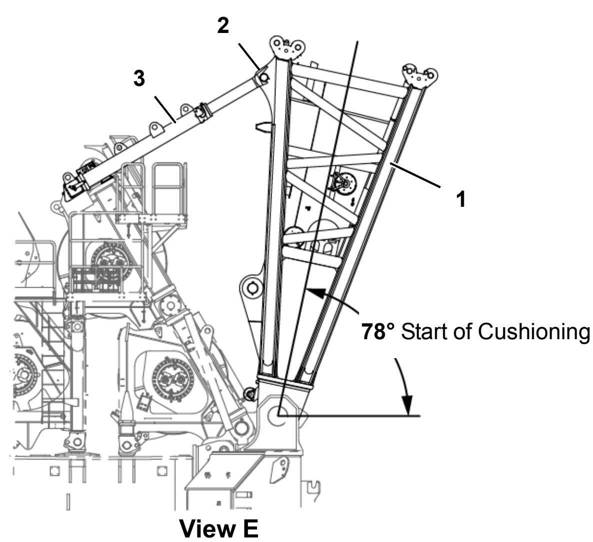


FIGURE 4-6

PHYSICAL BOOM STOP

General

WARNING

Falling Attachment Hazard!

Physical boom stops must be installed and pinned in working position for all crane operations.

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

The physical boom stops (Figure 4-6):

- Assist in stopping the boom smoothly at any angle above 78° (View E).
- Assist in preventing the boom rigging from pulling the boom back when traveling or setting loads with the boom at any angle above 78°.
- Assist in moving the boom forward when lowering the boom from any angle above 78°.
- Provide a physical stop at 88° (View F).

Boom Stop Operation

- The physical boom stops are mounted on Drum 1 and rest on boom stop bumpers (4) until they contact the boom as the boom is raised.
- When the boom is raised to 78°, the nitrogen in the boom stops is compressed to cushion boom raising.
- As the boom is raised higher, compression increases to exert greater force against the boom.
- If for any reason the boom is raised to 88°, the boom stops compress fully to provide a physical stop.
- Each boom stop is equipped with pressure transducer (8) to monitor internal pressure.

Boom Stop Bumper Adjustment

See Figure 4-6 for the following procedure.

1. Adjust each boom stop bumper (4, View A) up or down with up to four shims (5) to provide proper contact between boom stop rod end (3, View C) and stop tube (2) as boom butt (1) is raised. Two shims at each bumper are nominal.
2. When the boom butt is raised to 77.5°, the rod ends should bottom against the stop tubes as shown in View C).

Boom Stop Leak Detector

See Figure 4-6 for the following procedure.

1. Check for oil in reservoirs (6, View B) ***daily***. Any leakage from the boom stops will accumulate in the reservoirs.
   - When a reservoir reaches 1/3 full, the leaking boom stop should be removed from the crane for overhaul evaluation.
   - If a noticeable amount of oil leaks into a reservoir every time the rod is compressed into the boom stop, evaluate the condition of the leaking boom stop and overhaul it if necessary.

Boom Stop Pressure Check

1. Check pressure of both boom stops ***weekly*** (see Table 4-2). Check either in the accessory diagnostic screen of the main display or at pressure gauge (10, View A) with the boom stops extended. If pressure readings are off, contact Manitowoc Crane Care.
2. If pressure drops below 1,000 psi (69 bar) the corresponding boom stop fault will come on. See Main Display Publication (F2207) and Contact Manitowoc Crane Care.

Table 4-2 Boom Stop Pressure

Pressure	Ambient Temperature
1,365 PSI	80°F (94.1 Bar @ 27°C)
1,340 PSI	70°F (92.4 Bar @ 21°C)
1,315 PSI	60°F (90.6 Bar @ 15.5°C)

WARNING

Hazardous Material!

Boom stops are filled nitrogen and hydraulic oil under pressure.

Failure to properly discharge nitrogen and hydraulic oil could cause injury to personnel. The discharge procedure must be performed by a qualified hydraulic technician who is thoroughly familiar with nitrogen charged accumulators and how to fill or discharge them.

Do not attempt to overhaul boom stops unless you have been trained in proper procedure.

Boom Stop Filling Procedure

Contact Manitowoc Crane Care.

Boom Stop Overhaul Procedure

Contact Manitowoc Crane Care.

Reference Only

Boom Stop Pressure Transducer Replacement

See Figure 4-6, View A for the following procedure.

WARNING

High Pressure Hazard!

Fully close flow control valve (9) to remove pressure from pressure transducer (8) before removing pressure transducer.

1. Fully close flow control valve (9).
2. Disconnect electric plug (7) from pressure transducer (8).
3. Remove pressure transducer (8) using a 1 inch hex wrench.
4. Apply a bead of RTV-162 Silicon to hex sealing surface of new pressure transducer (8).
5. Install pressure transducer (8) so pressure transducer is tight.
6. Reconnect electric plug (7) and tighten connector screw.
7. Open flow control valve (9).

Boom Stop Installation and Removal

See 31000 Operator Manual for boom stop installation and removal instructions.

Reference Only

Reference Only

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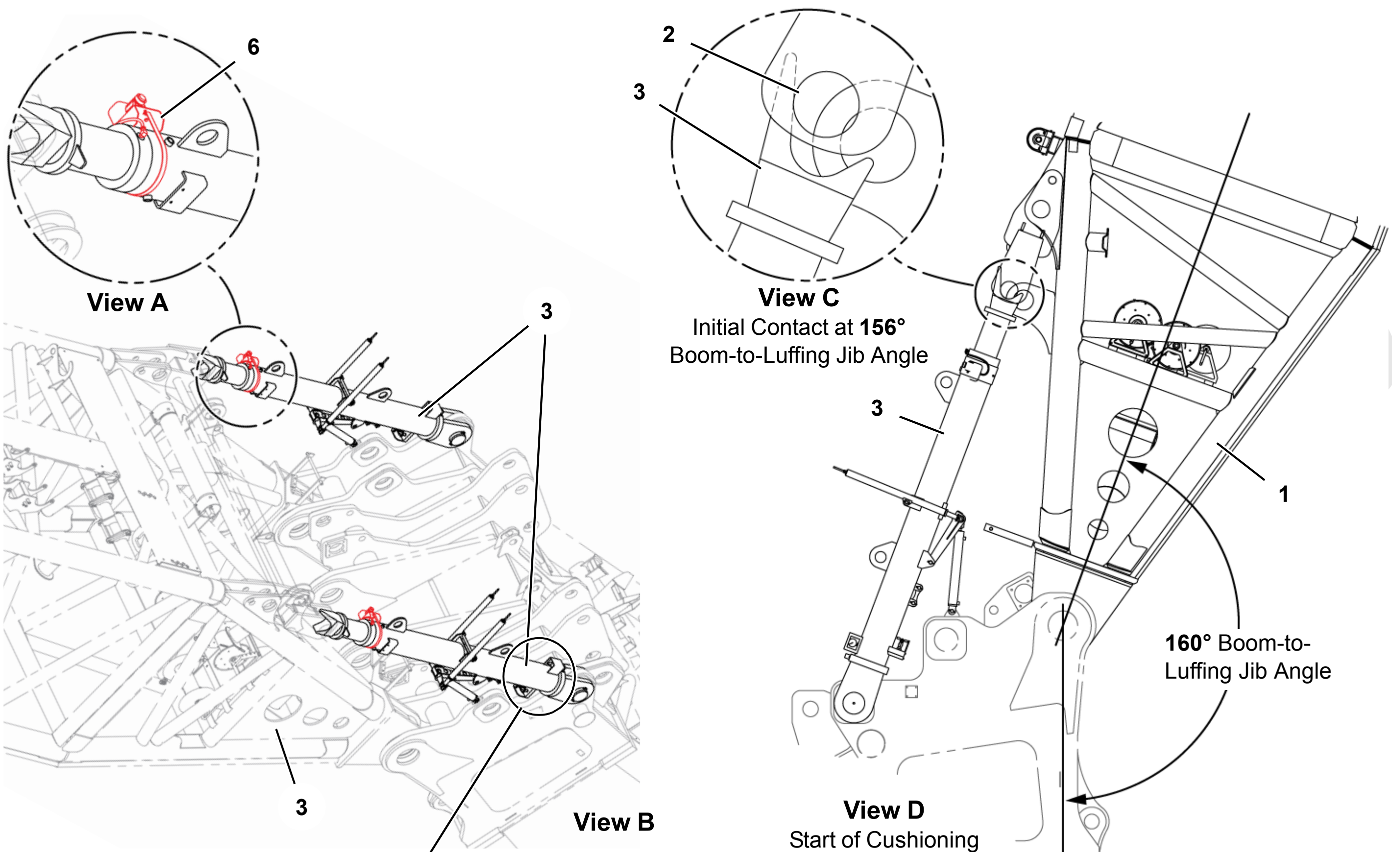
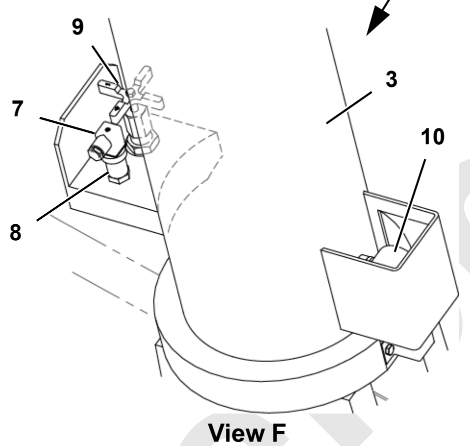




Item	Description
1	Jib Butt
2	Stop Pin
3	Jib Stop (left and right)
4, 5	Not Used
6	Reservoir with Check Valve
7	Electric Plug
8	Pressure Transducer
9	Flow Control Valve
10	Pressure Gauge

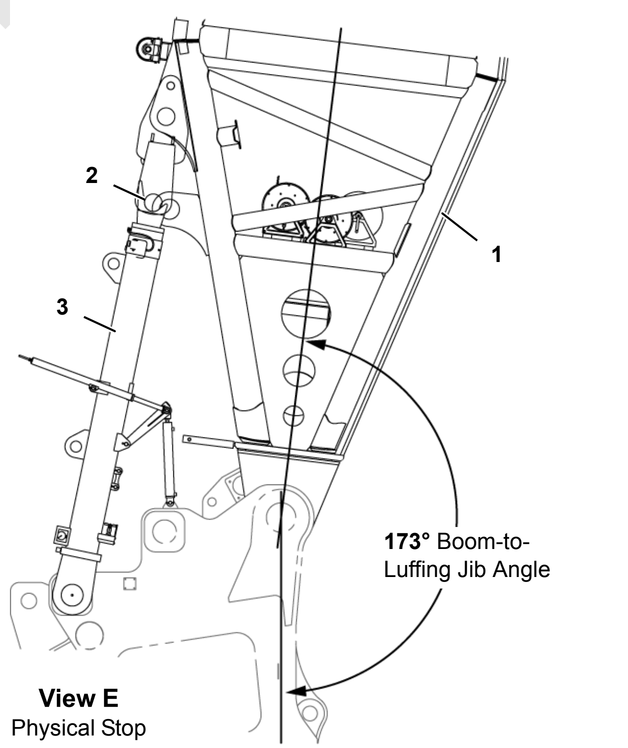


FIGURE 4-7

PHYSICAL LUFFING JIB STOP

General

WARNING

Falling Attachment Hazard!

Physical luffing jib stops must be installed and pinned in working position for all crane operations with luffing jib.

Physical luffing jib stops do not automatically stop luffing jib at maximum operating angle. Automatic jib stops must be installed and properly adjusted (see Luffing Jib Operator Manual.

The physical luffing jib stops (Figure 4-7):

- Assist in stopping the luffing jib smoothly at any boom-to-luffing jib angle above 160° (View D).
- Assist in preventing the jib rigging from pulling the luffing jib back when traveling or setting loads with the jib at any boom-to-luffing jib angle above 160°.
- Assist in moving the jib forward when lowering the luffing jib from any boom-to-luffing jib angle above 160°.
- Provide a physical jib stop at boom-to-luffing jib angle of 173° (View E).

Jib Stop Operation

See Figure 4-7 for the following procedure.

- When the luffing jib is raised to a boom-to-luffing jib angle of 156°, jib stops (3) contact stop pins (2) in the jib butt.
- When the luffing jib is raised to a boom-to-luffing jib angle of 160°, the nitrogen in the jib stops is compressed to cushion jib raising.
- As the luffing jib is raised higher, compression increases to exert greater force against the jib.
- If for any reason the luffing jib is raised to a boom-to-luffing jib angle of 173°, the jib stops compress fully to provide a physical stop.
- Each jib stop is equipped with pressure transducer (8) to monitor internal pressure.

Jib Stop Leak Detector

See Figure 4-7 for the following procedure.

Check for oil in reservoirs (6, View A) each time the luffing jib is lowered to ground level. Any leakage from the jib stops will accumulate in the reservoirs.

When a reservoir reaches 1/3 full, the leaking jib stop should be removed from the crane for overhaul evaluation.

Jib Stop Pressure Check

1. Check pressure of both jib stops ***weekly*** (see Table 4-3). Check either in the accessory diagnostic screen of the main display or at pressure gauge (10, View A) with the jib stops extended. If pressure readings are off, contact Manitowoc Crane Care.
2. If pressure drops below 1,000 psi (69 bar) the corresponding jib stop fault will come on. See Main Display Publication (F2207) and Contact Manitowoc Crane Care.

Table 4-3 Luffing jib Stop Pressure

Pressure	Ambient Temperature
3,155 PSI	80°F (218 Bar @ 27°C)
3,100 PSI	70°F (214 Bar @ 21°C)
3,040 PSI	60°F (210 Bar @ 15.5°C)

WARNING

Hazardous Material!

Hazardous Material!

Jib stops are filled nitrogen and hydraulic oil under pressure.

Failure to properly discharge nitrogen and hydraulic oil could cause injury to personnel. The discharge procedure must be performed by a qualified hydraulic technician who is thoroughly familiar with nitrogen charged accumulators and how to fill or discharge them.

Do not attempt to overhaul jib stops unless you have been trained in proper procedure.

Jib Stop Filling Procedure

Contact Manitowoc Crane Care.

Jib Stop Overhaul Procedure

Contact Manitowoc Crane Care.

Jib Stop Pressure Transducer Replacement

See Figure 4-7, View A for the following procedure.

WARNING

High Pressure Hazard!

Fully close flow control valve (9) to remove pressure from pressure transducer (8) before removing pressure transducer.

Reference Only

1. Fully close flow control valve (9).
2. Disconnect electric plug (7) from pressure transducer (8).
3. Remove pressure transducer (8) using a 1 inch hex wrench.
4. Apply a bead of RTV-162 Silicon to hex sealing surface of new pressure transducer (8).
5. Install pressure transducer (8) so pressure transducer is tight.
6. Reconnect electric plug (7) and tighten connector screw.
7. Open flow control valve (9).

Luffing Jib Stop Installation and Removal

See 31000 Luffing Operator Manual for jib stop installation and removal instructions.

BOOM AND LUFFING JIB ANGLE SENSOR CALIBRATION

See Figure 4-9 for the following procedure.

Boom angle sensors are located on boom butt, boom top, and jib top.

Boom and luffing jib angles are calibrated automatically by the master controller as part of the load indicator calibration procedure (see separate Rated Capacity Indicator/Limiter manual for instructions).

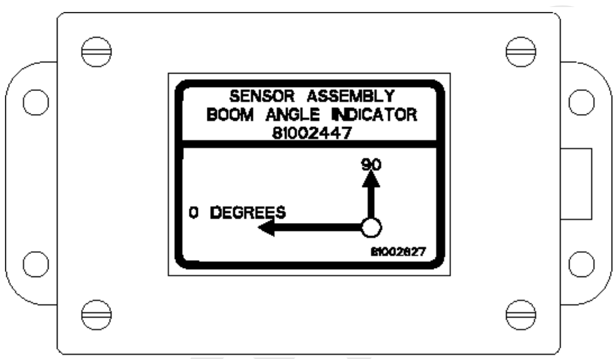
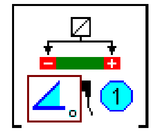


FIGURE 4-8

Boom Angle Indicator

A boom angle sending unit (Figure 4-8) houses a solid state sensor that sends output signals to the master controller. The master controller uses the signals for the following purposes:

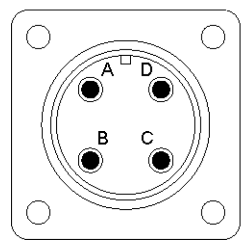
- Allows operator to monitor boom angle on display screens during crane setup.
- A defective sensor will be indicated on the LMI display.



Installing A New Boom Angle Sensor

1. Strip sensor leads to 0.5 in (14 mm) and fold back on itself to increase thickness of lead, and to have a 0.25 in (7 mm) stripped length on the lead.
2. Insert leads into the crimp barrel of the receptacles's pin contact.(see Figure 4-9,View A for pin location).
3. Scribe line on boom angle sensor must be orientated to the mounting plate as shown in Figure 4-9 view B.
4. Securely tighten mounting screws to lock angle.

View A



As seen from inside enclosure

P317

Sensor Wire Color	Receptacle Contact ID	Sensor Function
Red	J1-A	Supply Voltage
Green	J1-B	Output 1 - 0 to 5VDC
Black	J1-C	Ground, Power, & Signal
White	J1-D	Output 2 - 0 to 10VDC

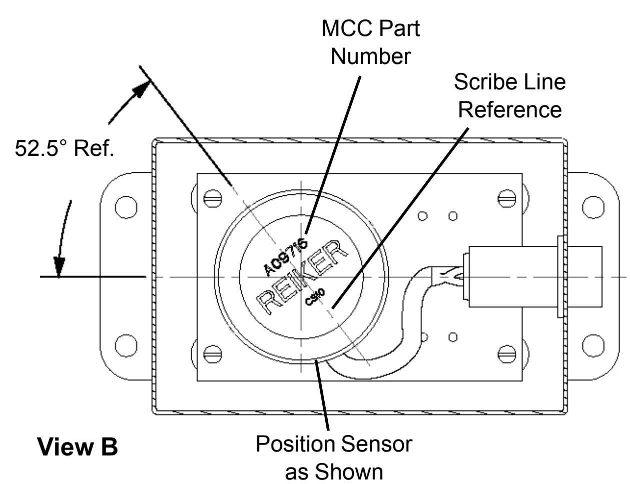


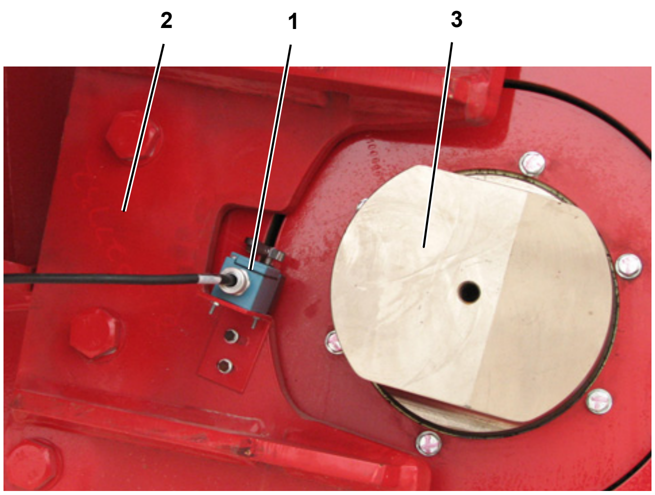
FIGURE 4-9

Reference Only

ACTUATOR MAST POCKET LIMIT SWITCH

See Figure 4-10 for the following description.

The Mast Pocket Actuator is mounted on the Raising Mast Frame assembly. When the VPC Actuator attaches to the Raising Mast Frame during set-up, to raise the mast, the head of the VPC actuator arm will trigger the limit switch as it is sitting in the pocket of the mast raising frame. See chapter 9 for limit switch replacement procedure.



Legend for Figure 4-10

Item	Description
1	Mast Pocket Actuation Limit Switch
2	Mast Raising Frame
3	VPC Actuator

FIGURE 4-10

REMOVING UPPER BOOM POINT

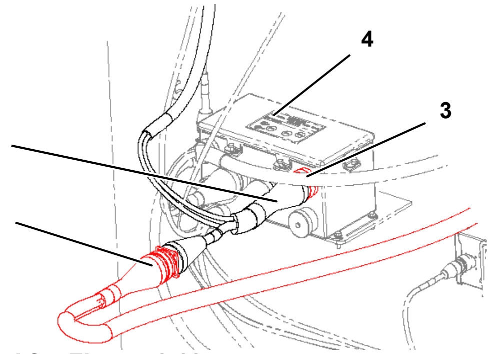
See Figure 4-11 for the following procedure.

The universal boom top node controller is equipped with terminating plug.

NOTE: CAN-OUT (WN OUT) plug on universal node controller must have a terminator installed when no luffing jib or fixed jib is installed.

If Upper Boom Point is removed from boom, proceed as follows:

1. Disconnect boom point electric cable WUBP-P1, (1, Figure 4-11) from universal node (4) receptacle W6 (3).
2. Disconnect electric cable BL-P1, (2, Figure 4-11) from electrical cable WUBP-J1(1) and move electric cable BL-P1 (2) to receptacle W6 (3) on universal node.
3. Secure cable WUBP-P1 (1) to upper boom point.



Legend for Figure 4-11

Item	Description	Item	Description
1	Cable (WUBP-P1)	3	Receptacle W6
2	Cable (BL-P1)	4	Universal Node

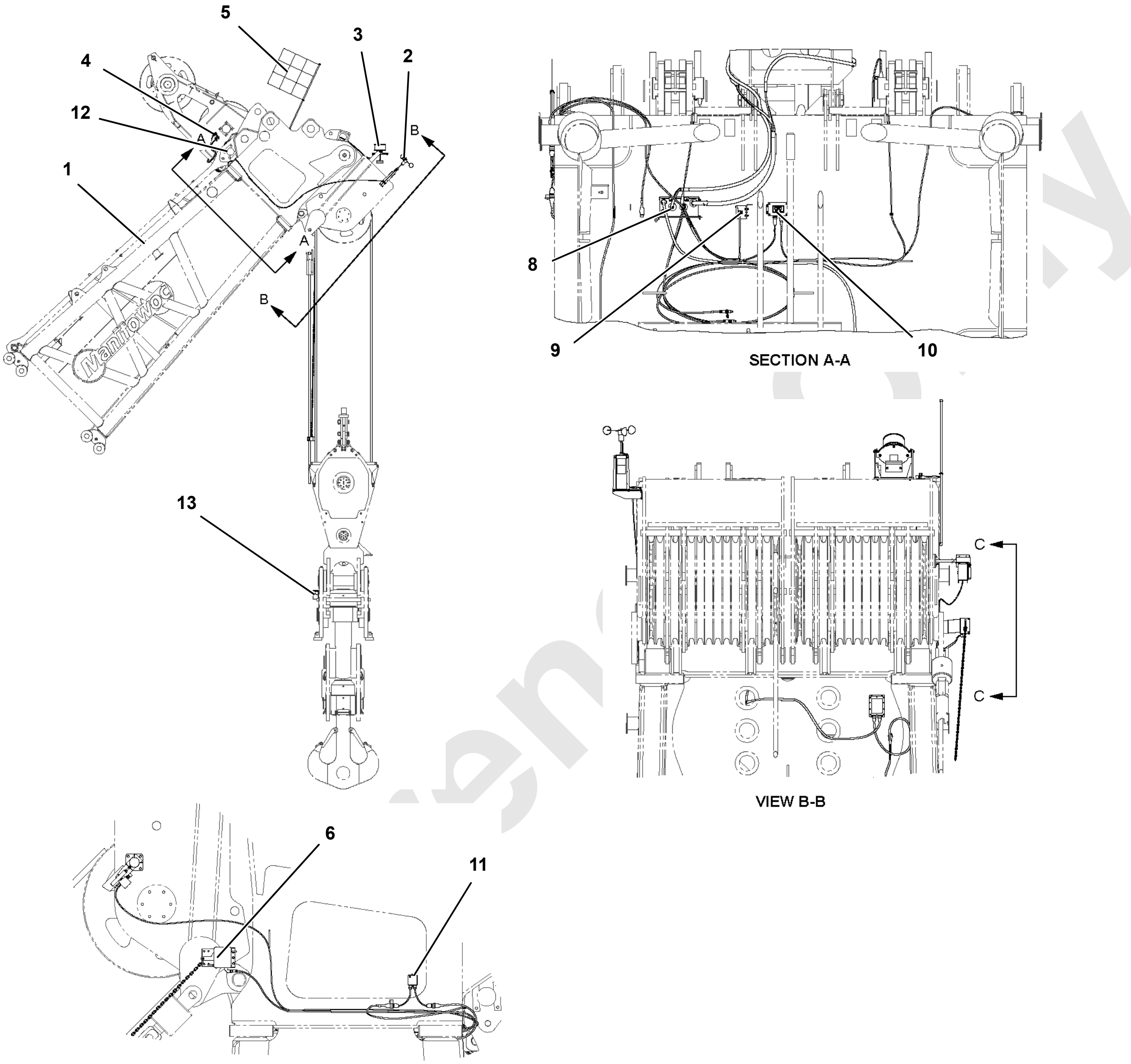
FIGURE 4-11

Reverse above steps to reconnect upper boom point.

NOTE: **Failing to perform above steps will prevent load drum from hoisting, boom from lowering and the operating limit alarm will sound in the operator cab.**

Reference Only

BOOM COMPONENTS

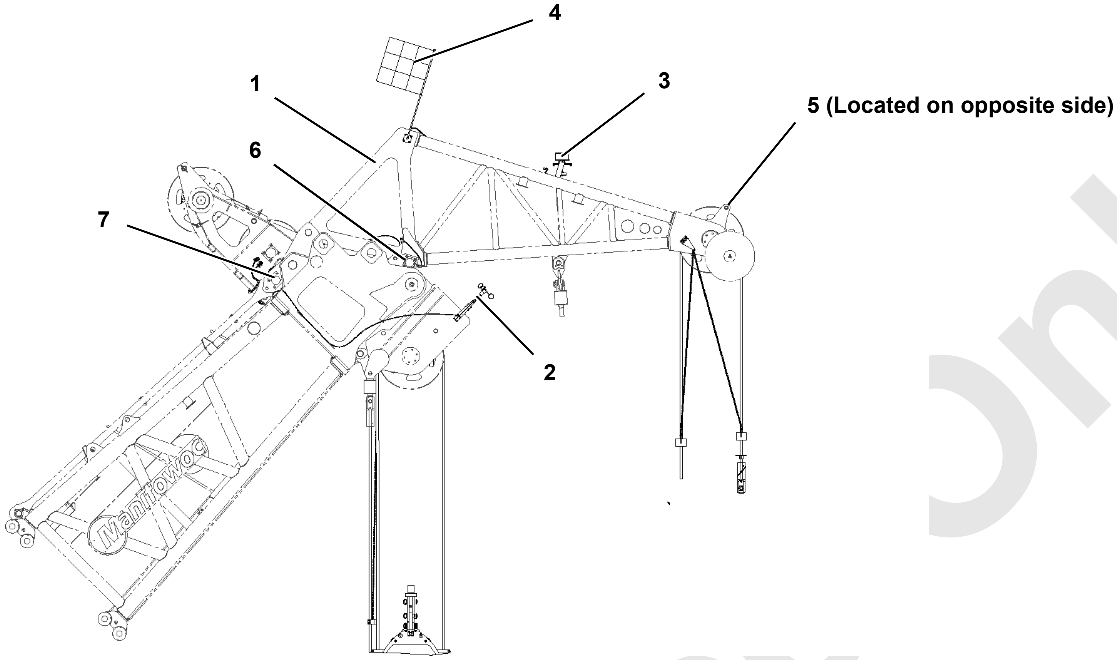


Legend for Figure 4-12

Item	Description	Item	Description
1	#90 Boom Top	8	Universal Node Controller
2	Wind Speed Indicator Sensor	9	Boom Angle Indicator Sensor
3	Aircraft Warning Light	10	Wind Speed Controller
4	Block Level Indicator	11	Aircraft Warning Controller
5	Aircraft Warning Flag	12	Boom Strap Load Sensor (Left and Right)
6	Block-Up Limit Switch	13	Block Level Transmitter
7	Not Used		

FIGURE 4-12

UPPER BOOM POINT COMPONENTS



Legend for Figure 4-13

Item	Description	Item	Description
1	#90 Upper Boom Point	5	Block-Up Limit Switch (not shown)
2	Wind Speed Indicator Sensor	6	Boom Point Load Sensor (Left and Right)
3	Aircraft Warning Light	7	Boom Strap Load Sensor (Left and Right)
4	Aircraft Warning Flag		

FIGURE 4-13

Reference Only

AIRCRAFT WARNING LIGHT

See Figure 4-12 and Figure 4-13 for the following procedure.

The aircraft warning light is mounted on a self leveling bracket at one of three locations; the boom top, upper boom point, or the highest location on the boom when configured with fixed or luffing jib.

A switch in the cab is used to turn the aircraft warning light on and off. This switch is intended to be used when servicing the light or any condition where the boom is attached and wired, but the light is to be off.

The Aircraft warning light controller mounted on the boom top controls the power to the aircraft warning light

Aircraft Warning Light Controller

See Figure 4-14 for the following procedure.

The aircraft warning light controller is located on boom top (11, Figure 4-12).

There are four factory set DIP switches located in the aircraft warning light controller.

The DIP switches are set at the factory and must not be changed. If light is replaced, make sure switches are set to the following settings:

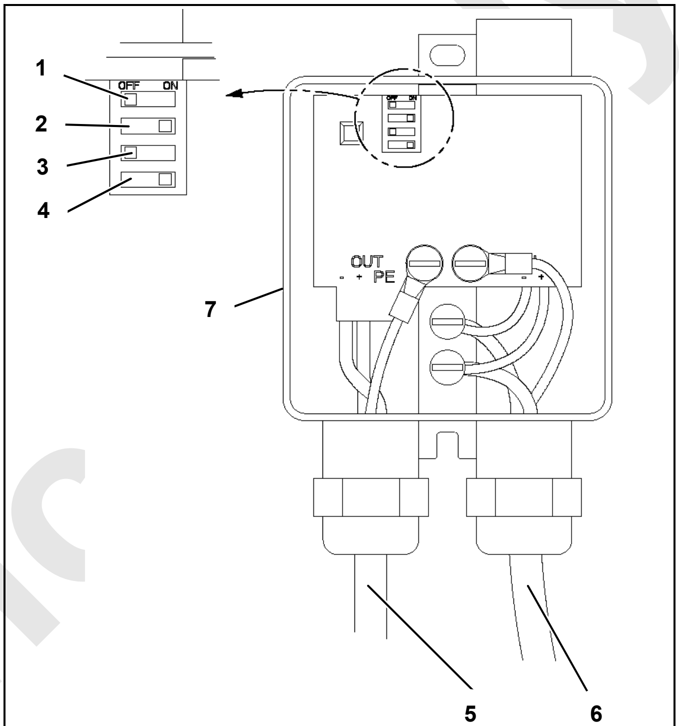
- DIP Switch 1: OFF
- DIP Switch 2: ON
- DIP Switch 3: OFF
- DIP Switch 4: ON

Aircraft Warning Light Fuse Replacement & Flashing Switch

See Figure 4-15 and Figure 4-16 for the following procedure.

Aircraft warning light fuse and flashing switch are located inside the warning light. Access the fuse and switch as follows:

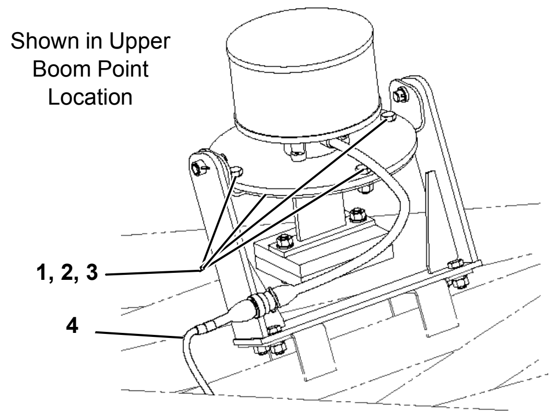
1. Disconnect aircraft warning light electrical cable.
2. Remove four warning light to self leveling bracket mounting Capscrew (1), washers (2), hex nuts (3) Figure 4-15 to remove light from self leveling bracket.
3. Using a 3/16 in allen wrench (4, Figure 4-16), remove three cap head socket screws (3, Figure 4-16) to access fuse and flashing switch (1, 2, Figure 4-16).
4. The two position switch (2, Figure 4-16) should be in the steady (S) position.
5. Remove fuse holder (2, Figure 4-16) to replace GMA 3A 5x20 mm fuse.
6. Reassemble aircraft warning light with three cap head socket screws, attach aircraft warning light to self leveling bracket with four mounting Capscrew, washers, hex nuts and reconnect aircraft warning light electrical cable.



Legend for Figure 4-14

Item	Description
1	Dip Switch 1
2	Dip Switch 2
3	Dip Switch 3
4	Dip Switch 4
5	Cable W-OUT
6	Cable W-IN
7	Controller, Aircraft Light

FIGURE 4-14



Legend for Figure 4-15

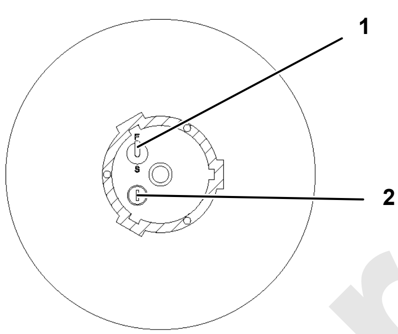
Item	Description
1	Capscrew, Aircraft Light (4)
2	Washer, Aircraft Light (4)
3	Hex nut, Aircraft Light (4)
4	Cable (WWLRE) Boom Point

FIGURE 4-15

WARNING

Aircraft warning light is not designed to operate for extended periods in steady burn mode. When switch is set to (S) use with external flasher controller only.

Aircraft Warning Light LED Replacement Diagram



Bottom View Junction
Box Removed

Legend for Figure 4-16

Item	Description
1	Switch, F = Flash S = Steady
2	Fuse Holder
3	Cap Head Socket Screw (3)
4	Allen Wrench, 3/16 in

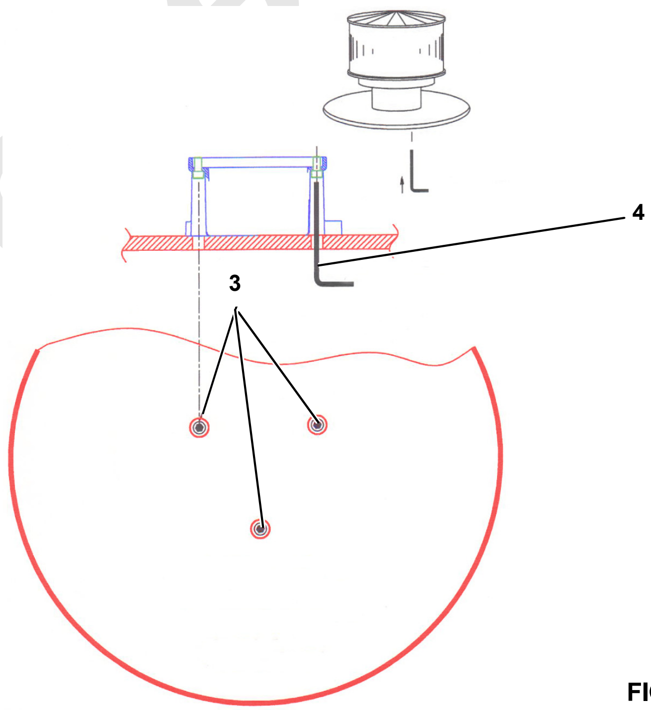


FIGURE 4-16

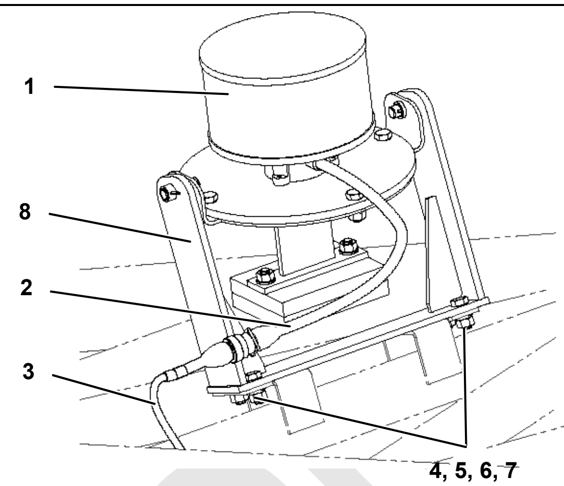
Reference Only

Upper Boom Point Aircraft Warning Light Installation

See Figure 4-12, Figure 4-13, and Figure 4-17 for the following procedure.

When an upper boom point is used, the self leveling bracket and light assembly must be removed from the boom top location and moved to the upper boom point location. The aircraft warning light cable on the boom top will be removed or secured and not used.

1. Disconnect aircraft warning light cable **WWLRE** on **boom top** from **W-OUT** cable (5, Figure 4-14) on aircraft light controller (7, Figure 4-14) and disconnect top end of **boom top** aircraft warning light cable (4, Figure 4-15) from the aircraft warning light.
2. Cap and secure the **boom top** aircraft warning light cable to the boom top, or remove cable.
3. Attach lower end of **boom point** warning light cable **WWLRE2** to **W-OUT** cable (5, Figure 4-14) on aircraft light controller (7, Figure 4-14).
4. Remove four Capscrew, washers, lock washers, and hex nuts (4, 5, 6, 7, Figure 4-17) from self leveling bracket (8, Figure 4-17) and re-install bracket and light assembly with removed hardware onto the upper boom point.
5. Connect warning light cable (2, Figure 4-17) to upper **boom point** cable **WWLRE2** (3, Figure 4-17) on the boom point.



Legend for Figure 4-17

Item	Description
1	Aircraft Warning Light
2	Cable, Warning Light
3	Cable (WWLRE2) Upper Boom Point
4	Capscrew, Self Level Bracket (4)
5	Washer, Self Level Bracket (4)
6	Lockwasher, Self Level Bracket (4)
7	Hex Nut, Self Level Bracket (4)
8	Bracket, Self Leveling

FIGURE 4-17

Reference Only

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; however, frequent and periodic inspections can help reveal the potential for failure. Straps are to be inspected regularly by a ***qualified person*** as part of the crane's preventive maintenance program. Dated records should also be kept.

Strap repairs are prohibited*.* Perform only the maintenance indicated in this section. For inspection procedures not covered in this Service Manual, contact your Manitowoc dealer or the factory.

WARNING

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

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

Inspection

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

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

Frequent Inspection

Visually inspect all straps once each work shift for obvious damage 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, the strap must be checked to make sure it is within the specifications given in this section.

Periodic Inspection

The periodic inspection must be performed at least monthly. During this inspection, the entire length of the strap must be inspected to assure that it is within specifications. ***The 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 the strap is safe.

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

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

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

Cranes Not In Regular Use

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

Identifying Straps

To aid in identification, the part number is stamped into both ends of each strap as shown in Figure 4-18.

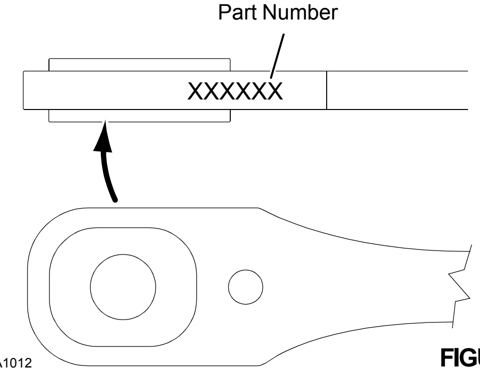


FIGURE 4-18

Reference Only

Replacement Specifications

Any strap not within the specifications listed in Table 4-4 must be replaced.

Table 4-4 Strap Specifications

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, backhitch or other crane components.

Condition	Reference	Allowable Tolerance or Deviation	Corrective Action
Dent	Figure 4-19	<1/8 in 3,175 mm	Monitor condition.
		≥ 1/8 in 3,175 mm	Remove strap from service.
Kink	Figure 4-20	None	Remove strap from service.
Crack or Break	Figure 4-21	None	Remove strap from service.
Corrosion or Abrasion	Figure 4-22	<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 4-23	Varies depending on strap length	Remove strap from service if deviation exceeds maximum allowed.
Flatness (includes twisted straps)	Figure 4-24	Varies depending on strap length.	Remove strap from service if deviation exceeds maximum allowed.
Elongated Holes	Figure 4-25	None	Remove strap from service.
Length	Figure 4-26	None	Remove strap from service.

< = less than
≥ = equal to or greater than

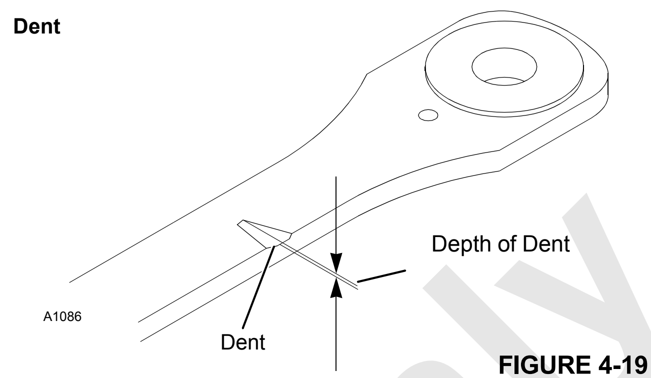


FIGURE 4-19

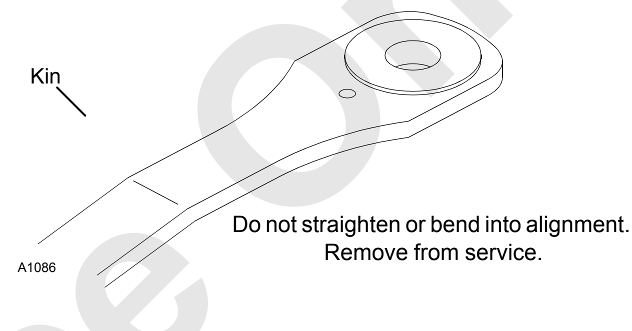


FIGURE 4-20

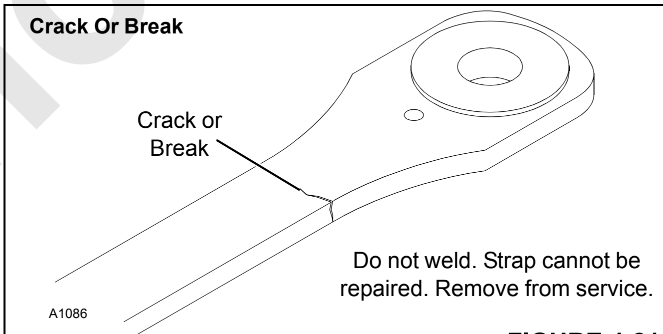


FIGURE 4-21

Corrosion Or Abrasion

See Figure 4-22 for the following procedure.

For quick identification by repair workers, clearly mark damaged areas with brightly colored tape.

1. Sandblast to remove corrosion. **Do not grind!**
2. Determine reduction in thickness.
3. If reduction is less than 6% of strap thickness, paint strap to maintain continuous protective coating.
4. If reduction is 6% or more, remove strap from service.

Reference Only

Corrosion or Abrasion

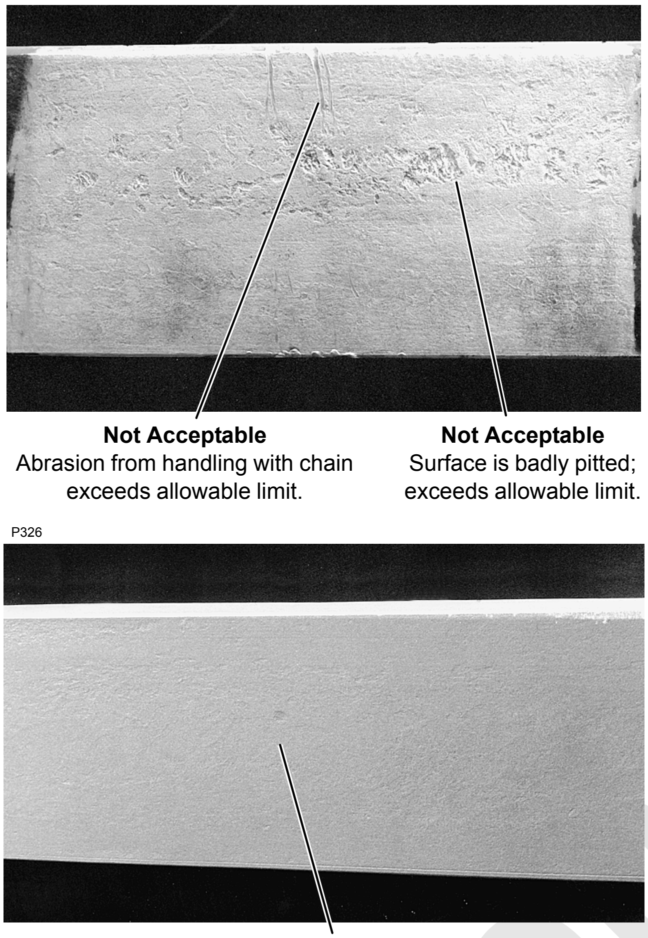


FIGURE 4-22

Straightness

See Figure 4-23 for the following procedure.

1. Stretch a line (string or wire) from pin storage hole at one end of strap.
2. Stretch the 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.
5. If deviation from straight is greater than maximum allowed as listed in Table 4-5, remove strap from service.

Table 4-5 Strap Straightness

Strap Length (L)	Maximum Deviation Allowed
5 to <10 ft (1,5 to <3,0 m)	1/16 in (1,5 mm)
10 to <20 ft (13,0 to <6,1 m)	1/8 in (3,2 mm)
20 to <30 ft (6,1 to <9,1 m)	1/4 in (6,4 mm)
30 to <40 ft (9,1 to <12,2 m)	3/8 in (9,5 mm)
40 to <50 ft (12,2 to <15,2 m)	1/2 in (12,7 mm)

< = less than

Straightness (gradual or sweeping bend)

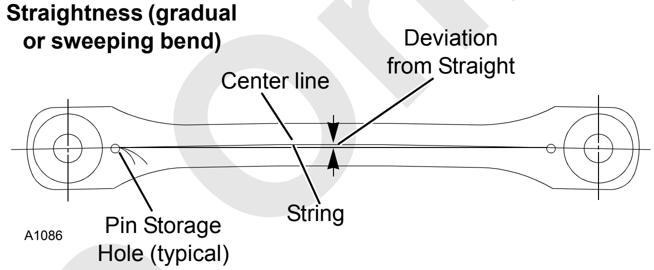


FIGURE 4-23

Flatness

See Figure 4-24 for the following procedure.

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

   If deviation from straight is greater than maximum allowed, remove strap from service.
6. Remove line. Turn strap over.
7. Repeat steps 1-5 above.

Flatness (includes twisted straps)

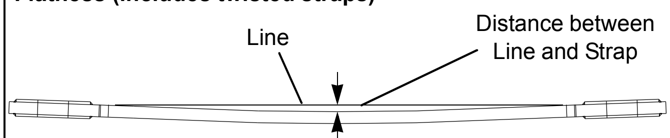


FIGURE 4-24

Reference Only

Elongated Hole

See Figure 4-25 for the following procedure.

1. Insert pin into hole.
2. Push pin tight against edge of hole along horizontal center line. Measure dimension between pin and hole (View A).
3. Push pin tight against edge of hole along vertical center line. Measure dimension between pin and hole (View B).

   If dimensions A and B are not identical, hole is elongated. Remove strap from service.

   If two dimensions are identical, but greater than 1/32 in (0,8 mm), contact Crane Care Customer Service at factory.
4. If deviation is greater than maximum allowed as listed in Table 4-6, remove strap from service.

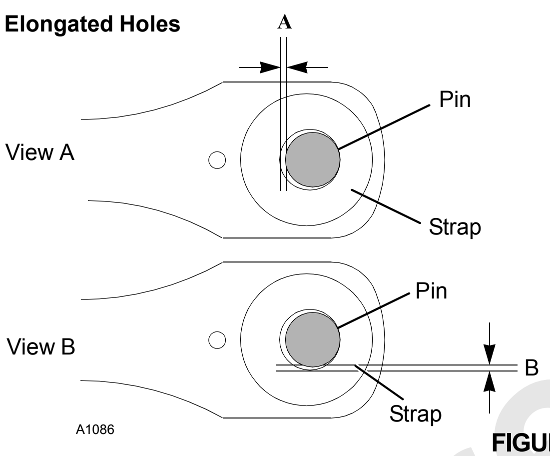


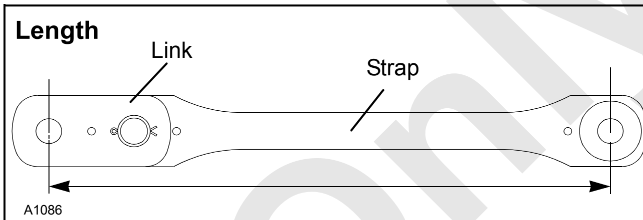
FIGURE 4-25

Table 4-6 Elongated Hole

Strap Length (L) in feet (meter)	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)	9/16 in (14,3 mm)	1/2 in (12,7 mm)
3 to <4 (0,9 to <1,2)	5/8 in (15,9 mm)	9/16 in (14,3 mm)
4 to <5 (1,2 to <1,5)	3/4 in (19,1 mm)	11/16 in (17,5 mm)
5 to <6 (1,5 to <1,8)	13/16 in (20,6 mm)	3/4 in (19,1 mm)
6 to <7 (1,8 to <2,1)	7/8 in (22,2 mm)	3/4 in (19,1 mm)
7 to <8 (2,1 to <2,4)	15/16 in (23,8 mm)	3/4 in (19,1 mm)
9 to <9 (2,4 to <2,7)	1 in (25,4 mm)	3/4 in (19,1 mm)
9 to <10 (2,7 to <3,0)	1 in (25,4 mm)	7/8 in (22,2 mm)
10 to <12 (3,0 to<3,7)	1 in (25,4 mm)	1 in (25,4 mm)
≥ 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 4-26

Stored Straps

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

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

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

Removing 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

Signed and dated copies of the inspection for each strap must be kept on file at all times as they may be required to verify warranty or product liability claims.

A recommended inspection checklist form is included. If no damage is found or the damage is within specification, check the box next to the item to indicate that its specific condition was evaluated and found acceptable. If the damage is not within specification, indicate so in the box next to the item (for example: **D** to indicate damage).

Reference Only

BOOM, JIB, BACKHITCH, AND MAST INSPECTION/REPAIR

Contact Crane Care in Manitowoc for inspection and repair information.

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SECTION 5
HOISTS

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SECTION 5

HOISTS

MAIN HOIST

See Figure 5-1 through Figure 5-6 for the following procedure.

NOTE: Theory of operation assumes load drum speed limit is set to 100%. See F2207 load drum function mode screen procedure for more information. Load Drum 1, 2, and 3 similar.

System Components

Load drum 1 is located on the rotating bed mounted above drum 3. Pump 4 and pump 5 drive four separate motors mounted in pairs on two gearboxes located on each end of the drum shaft. Hydraulic connections between pumps and motors form a closed-loop system that is controlled with control handle movement monitored by Node-1 and through output voltage signals from Node-3 and Node-4 to pump EDC. The right console control handles operate the load drums. The control handles are inoperable when corresponding drum park brake is applied.

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

When load drum motors rotate, a speed sensor at one motor rotor monitors and sends an input voltage to Node-1 controller. Node-2 controller responds by sending a 28 volt output to rotation indicator in control handle. As drum rotates faster, the rotation indicator on top of control handle pulsates with a varying frequency to indicate drum rotational speed. The handle command in percent from neutral is shown on Drum 1 Diagnostic Screen.

Motor cooling is achieved by the continuous exchange of closed-loop fluid that occurs through leakage in pump, motor, and external sequence/flow valve. Sequence/flow valve (loop flush) 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.

Main Hoist Brake

Hydraulic pressure to operate drum 1 brake is from low-pressure side of closed loop. There is a total of four brakes; one for each motor. Load drums do not have a pawl.

When drum 1 brake switch is in on - park position, drum brake release solenoid HS-63 is disabled to apply brakes to drum shaft. Drum 1 pumps do not stroke in response to control handle movement.

When drum 1 brake switch is placed in off - park position, brakes remain applied to drum shaft until Node-5 controller sends a 28 volt output to solenoid HS-63 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-3 and Node-4 controller send a variable zero to 25.4 volt output that is divided by a 220 ohm resistor and applied to pump 4 and pump 5 EDC in the ***raising*** direction. Both pumps supply hydraulic fluid to drum 1 motors. Node-5 controller sends a variable 3.8 (0% motor command) to 16.2 volt (100% motor command) output to each drum 1 proportional motor control solenoid HS-41, HS-42, HS-43, and HS-44. Node-1 controller checks for system faults.

Pump EDC tilts swash plate in the ***raising*** direction to satisfy pressure memory. Node-1 controller compares drum holding pressure to value in pressure memory. When closed loop pressure is high enough, Node-5 controller sends a 28 volt output to enable drum 1 brake release solenoid HS-63. Drum 1 brake solenoid shifts to block drain port and opens port to low-pressure side of closed loop to release brakes from drum shaft.

The pump EDC continues to tilt swash plate in the ***raising*** direction as hydraulic fluid flow is from pump ports to motor ports. Return fluid is from motor outlet ports to pump inlet ports.

Node-3 and Node- 4 controller output voltage to pump 4 and pump 5 EDC simultaneous with Node-5 controller output voltage to each proportional motor control solenoid HS-41, HS-42, HS-43, and HS-44 is relative to control handle movement. As control handle is moved back, pump swash plate angle is increased and motor control solenoids begin to shift drum 1 motors to high speed (100% motor command).

When closed loop pressure exceeds the Node-1 controlled ECOR maximum pressure setting, Node-5 controller responds and shifts the motor control solenoids to direct flow from shuttle valve into maximum displacement side of servo cylinder. Motor displacement and output torque increase while Node-5 shifts motor control into low speed (0% motor command) to prevent pump or motor damage. When pressure falls below the Node-1 controlled ECOR maximum

Reference Only

pressure setting, Node-5 will shift the motor control solenoid to direct flow from shuttle valve into minimum displacement side of servo cylinder. Load drum motors will resume high speed (100% motor command).

Node controllers continuously balance drum 1 closed loop pressure and monitor motor displacement. If motor torque requirements are not above the ECOR maximum pressure setting of Node-1 controller, displacement remains in minimum (100% motor command for high speed) when control handle is fully pulled back (+100% handle command). Node-1 controller monitors motor displacement and controls motor speed by regulating the hydraulic fluid flow through the pumps.

When drum 1 control handle is moved to neutral position (0%), Node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-3 and Node-4 controller send a zero output voltage to each drum 1 pump EDC that moves swash plate to center position. Node-5 controller responds by shifting the motor controls back to maximum displacement (0% motor command) for slower output speed to slow drum rotation.

After control handle is moved to neutral position (0% handle command), Node-1 controller stores the load holding pressure in pressure memory. When control handle center switch opens, Node-5 controller sends a zero output voltage to disable drum 1 brake release solenoid HS-63. Drum 1 brake solenoid valve shifts to block pilot pressure to brakes and opens a line to tank. Brakes apply before drum pumps de-stroke.

When brakes apply, an input signal is sent to Node-1 controller. Node-3 and Node-4 controller send a zero volt output to each pump EDC to de-stroke pumps. Node-5 controller sends a 3.8 volt output to each motor control solenoid (0% motor command).

Lowering Load

When drum 1 control handle is moved forward for ***lowering***, an input voltage of 2.6 volts or more is sent to Node-1 controller. Node-3 and Node-4 controller send a variable zero to 25.4 volt output that is divided by a 220 ohm resistor and applied to pump 4 and pump 5 EDC in the ***raising*** direction. Node-5 sends a variable 3.8 (0% motor command) to 16.2 volt (100% motor command) to each drum 1 proportional motor control solenoid HS-41, HS-42, HS-43, and HS-44. Node-1 controller checks for system faults.

Pump EDC tilts swash plate in the ***raising*** direction to satisfy pressure memory. Node-1 controller compares drum 1 holding pressure to value in pressure memory. When closed loop pressure is high enough, Node-5 controller sends a 28 volt output to enable drum 1 brake release solenoid HS-63. Drum brake solenoid shifts to block drain port and opens port to low-pressure side of closed loop to release drum 1 brakes.

When brakes are released, the pump EDC tilts swash plate to stroke pumps in the ***lowering*** direction. Hydraulic fluid flow is from pump ports to motor ports. Return fluid is from motor outlet ports to pump inlet ports.

Node-3 and Node-4 controller output voltage to pump 4 and pump 5 EDC simultaneous with and Node-5 output voltage to each proportional motor control solenoid HS-41, HS-42, HS-43, and HS-44 is relative to control handle movement. As control handle is moved forward, pump swash plate angle is increased and motor control solenoids begin to shift motor to high speed (100% motor command).

When closed loop pressure exceeds the Node-1 controlled ECOR maximum setting, Node-5 controller responds and shifts the motor control solenoids to direct flow from shuttle valve into maximum displacement side of servo cylinder. Motor displacement and output torque increase while Node-5 shift motor control into low speed (0% motor command) to prevent pump or motor damage. When pressure falls below the Node-1 controlled ECOR maximum pressure setting, the Node-5 will shift the motor control solenoid to direct flow from shuttle valve into minimum displacement side of servo cylinder. Load drum motors will resume high speed (100% motor command).

Node controllers continuously balance drum 1 closed loop pressure and monitor motor displacement. If motor torque requirements are not above the ECOR maximum pressure setting of Node-1 controller, displacement remains in minimum (100% motor command for high speed) when control handle is fully pushed forward (-100% handle command). Node-1 controller monitors motor displacement and controls motor speed by regulating the hydraulic fluid flow through the pumps.

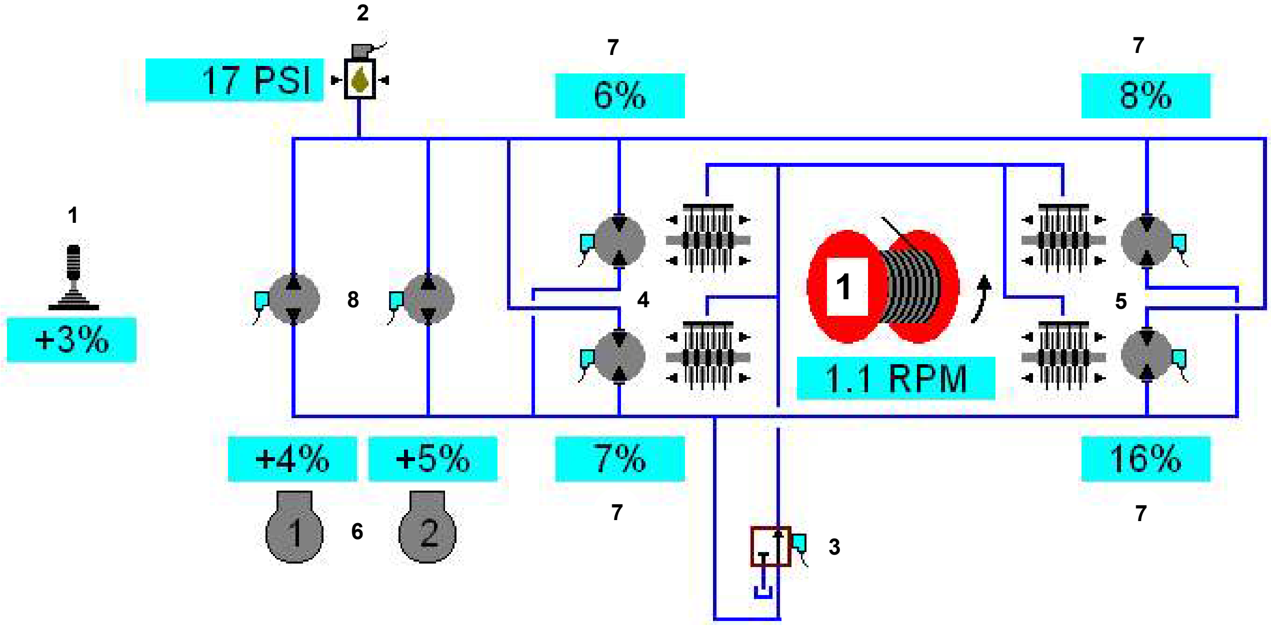
When drum 1 control handle is moved to neutral position (0% handle command), Node-1 controller compensates for hydraulic closed loop leakage or changing engine speed. Node-3 and Node 4 controller send a zero output voltage to pump 4 and pump5 EDC that moves swash plate to center position. Node-5 controller responds by shifting the motors back to maximum displacement (0% motor command) for slower output speed to slow drum rotation.

When control handle is moved to neutral position (0% handle command), Node-1 controller stores the load holding pressure in pressure memory. When control handle center switch opens, Node-5 controller sends a zero output voltage to disable brake release solenoid HS-63. Drum 1 brake solenoid valve shifts to block pilot pressure from brakes and opens a line to tank. Brakes apply before drum pumps de-stroke.

When brakes apply, an input signal is sent to Node-1 controller. Node-3 and Node-4 controller send a zero volt output to each drum pump EDC to de-stroke pumps. Node-5 controller sends a 3.8 volt output to each motor control solenoid (0% motor command).

Reference Only

MAIN HOIST (DRUM 1) SYSTEM DIAGNOSTICS OVERVIEW

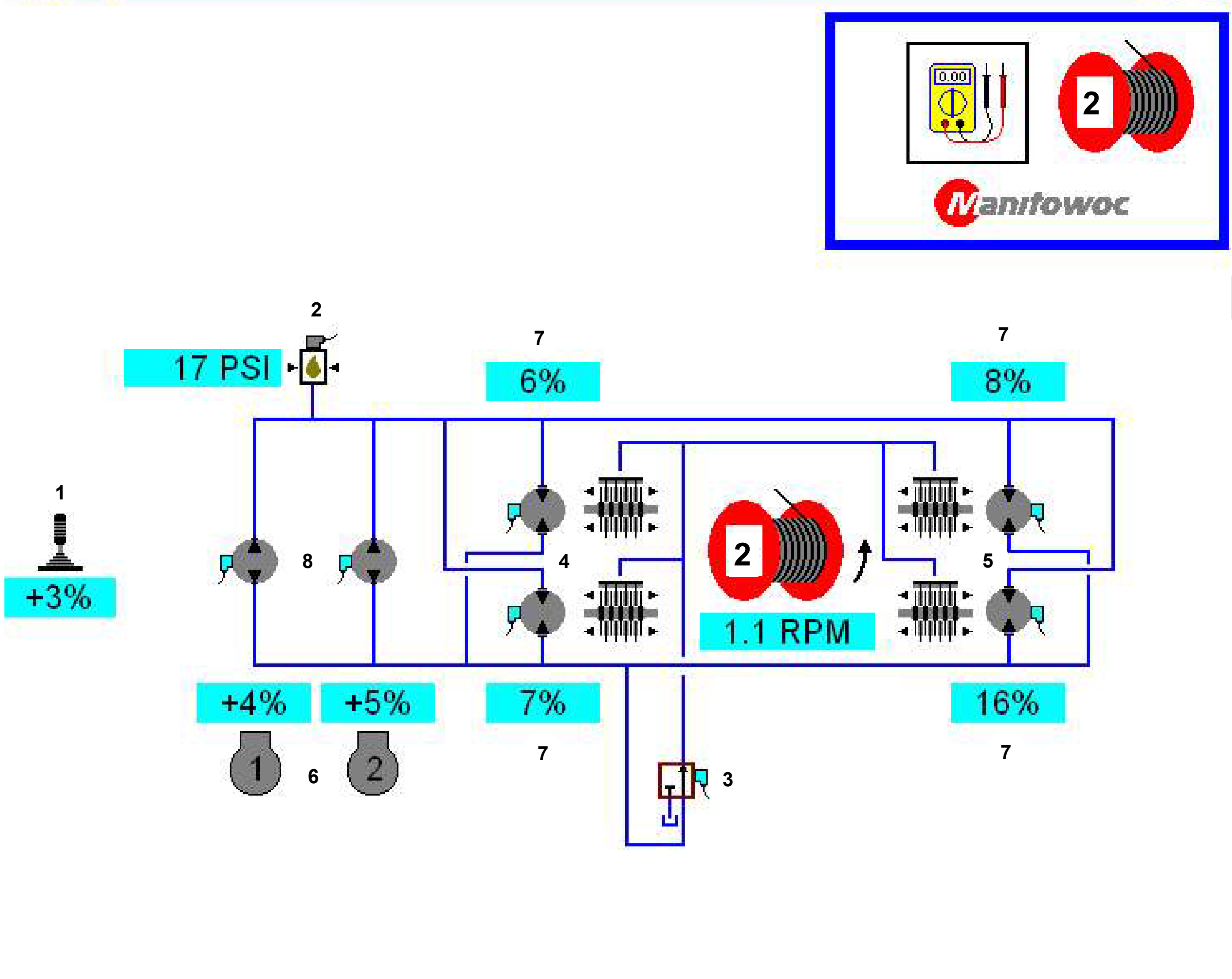


Item	Description	Item	Description
1	Main Hoist Control Handle	5	HS-43 and HS-44
2	Pressure Sender (high pressure)	6	Percentage of Pump Command
3	HS-63	7	Percentage of Motor Command
4	HS-41 and HS-42	8	Pump 4 and Pump 5

FIGURE 5-1

NOTE: See Folio 2207 for detailed Drum 1 diagnostic information.

MAIN HOIST (DRUM 2) SYSTEM DIAGNOSTICS OVERVIEW

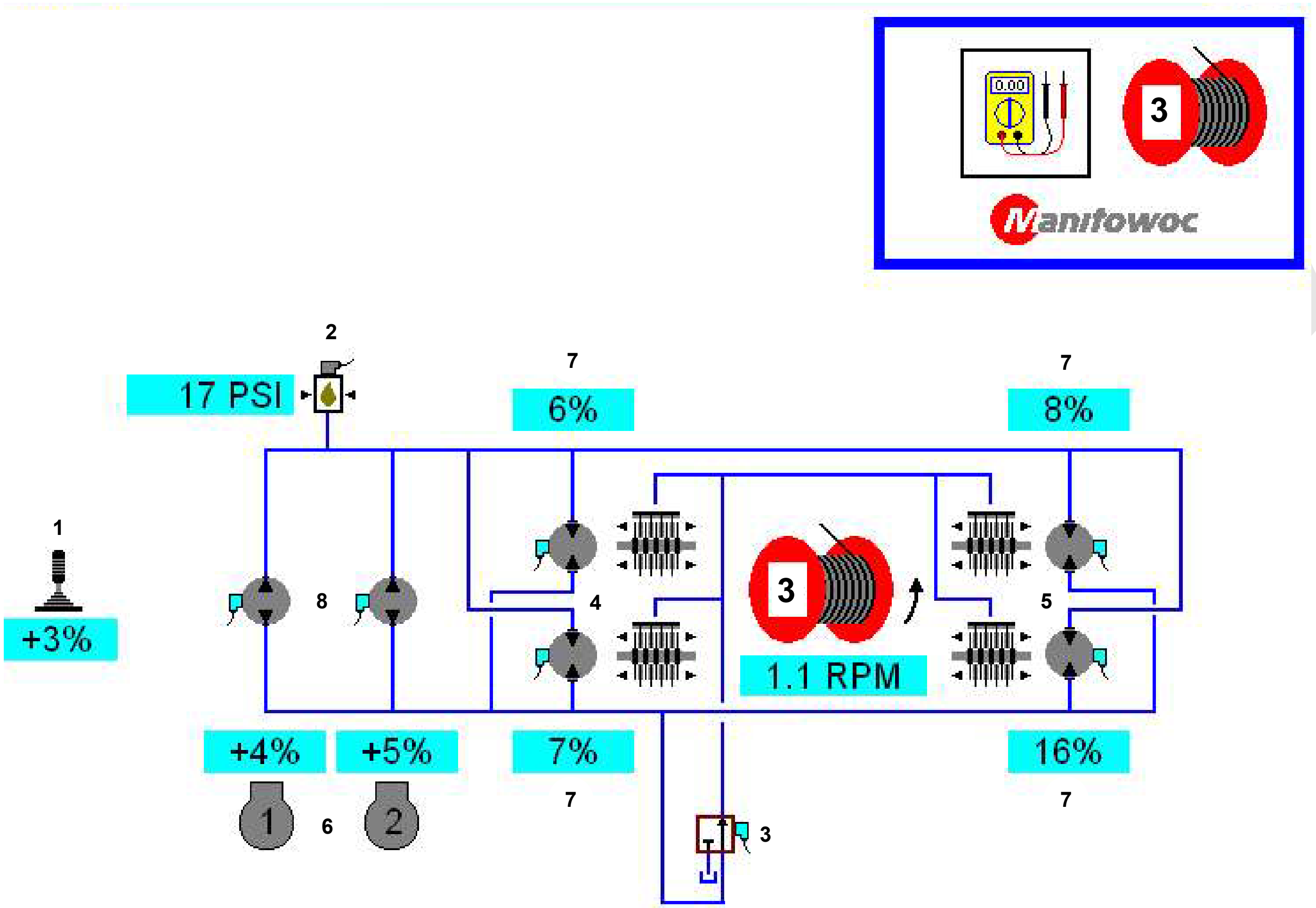


Item	Description	Item	Description
1	Main Hoist Control Handle	5	HS-49 and HS-50
2	Pressure Sender (high pressure)	6	Percentage of Pump Command
3	HS-89	7	Percentage of Motor Command
4	HS-51 and HS-52	8	Pump 3 and Pump 16

FIGURE 5-2

NOTE: See Folio 2207 for detailed Drum 2 diagnostic information.

MAIN HOIST (DRUM 3) SYSTEM DIAGNOSTICS OVERVIEW

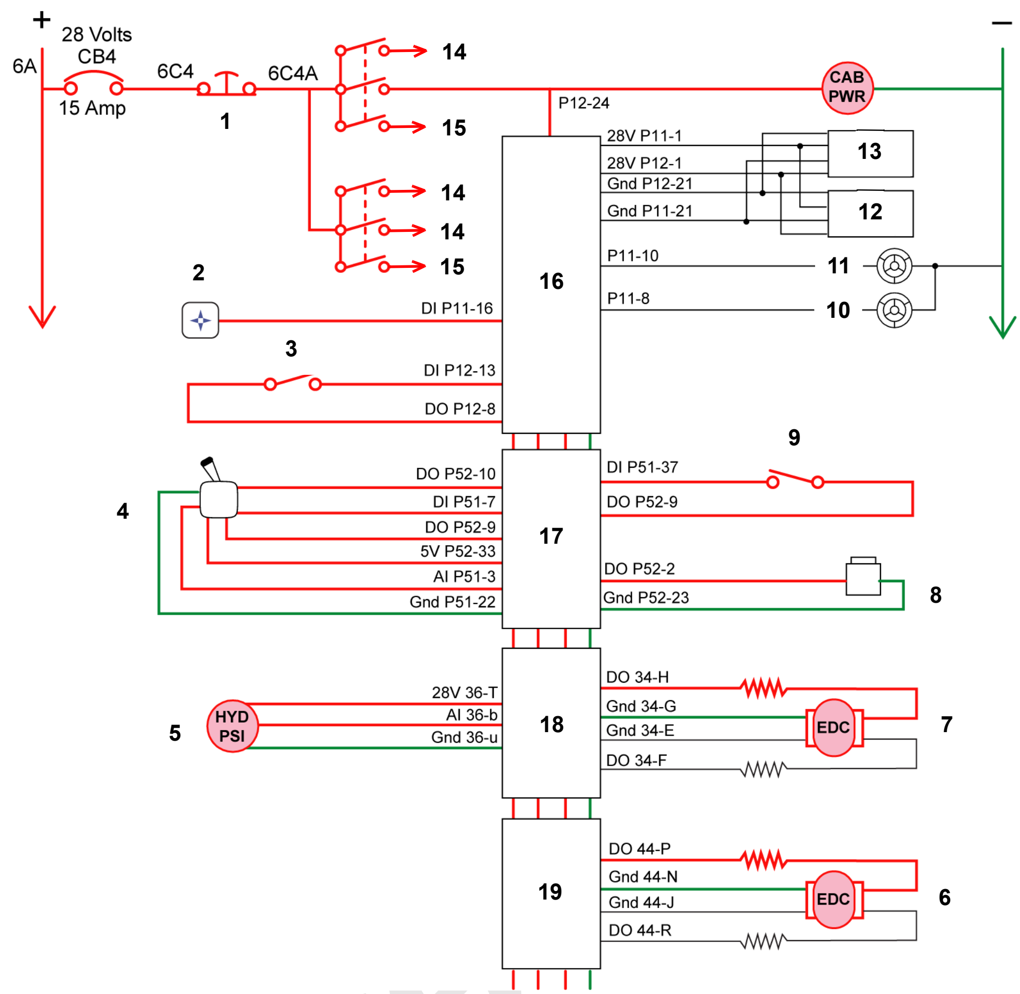


Item	Description	Item	Description
1	Drum 3 Control Handle	5	HS-39 and HS-40
2	Pressure Sender (high pressure)	6	Percentage of Pump Command
3	HS-56	7	Percentage of Motor Command
4	HS-37 and HS-38	8	Pump 10 and Pump 15

FIGURE 5-3

NOTE: See Folio 2207 for detailed Drum 3 diagnostic information.

MAIN HOIST (DRUM 1) ELECTRICAL CIRCUIT



Item	Description	Item	Description
1	Engine Stop	11	Caution Fault Alarm
2	Confirm Chart and Crane Mode	12	RCL Display
3	Drum 1 Park Brake Switch	13	Main Display
4	Drum 1 Control Handle	14	Run
5	Drum 1 Pressure Sender	15	Start
6	Drum 1 Pump 5	16	Master Node 1
7	Drum 1 Pump 4	17	Side Console Node 2
8	Drum 1 Handle Rotation Indicator	18	Universal Node 3
9	Seat Switch	19	Universal Node 4
10	RCL Warning Alarm		

FIGURE 5-4

Main Hoist (Drum 1) Electrical Circuit (Cont)

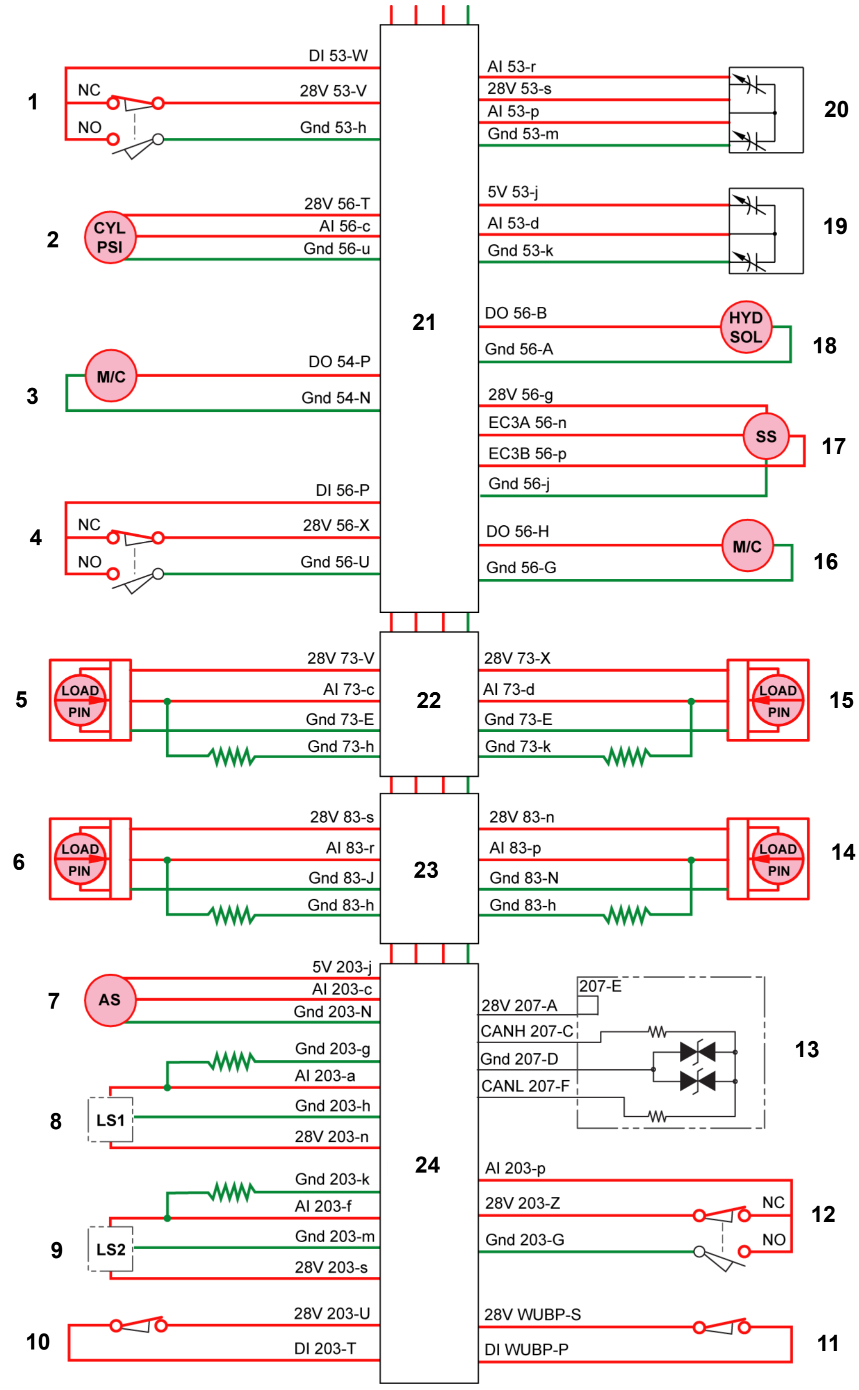


FIGURE 5-4 continued

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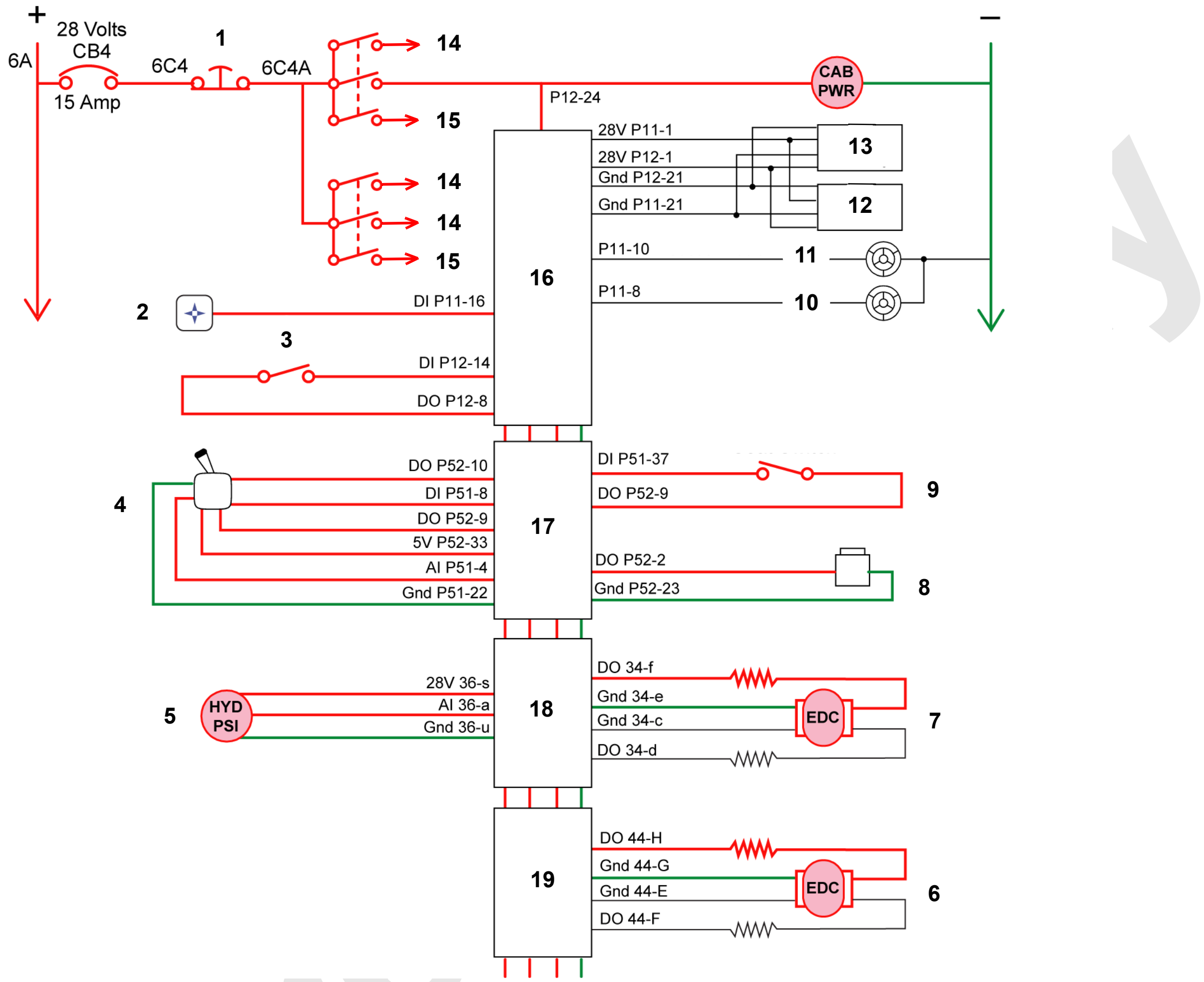
Main Hoist (Drum 1) Electrical Circuit (Cont)

Item	Description	Item	Description
1	Maximum Boom Angle Limit	13	CAN Terminator Plug
2	Drum 1 Nitrogen Cylinder Right Side	14	Right Front House Roller Load Pin
3	Drum 1 Motor Control HS-41 and HS-42	15	Right Rear House Roller Load Pin
4	Drum 1 Minimum Bail Limit	16	Drum 1 Motor Control HS-43 and HS-44
5	Left Rear House Roller Load Pin	17	Drum 1 Speed Sensor
6	Left Front House Roller Load Pin	18	Drum 1 Brake Release HS-63
7	Boom Angle Sender	19	Boom Angle Sensor
8	Right Load Strap	20	Rotating Bed Level Sensor
9	Left Load Strap	21	Universal Node 5
10	Lower Block Up Limit	22	Universal Node 7
11	Upper Block Up Limit	23	Universal Node 8
12	Minimum Jib Angle	24	Universal Boom Top Node 20

FIGURE 5-4 continued

Reference Only

MAIN HOIST (DRUM 2) ELECTRICAL CIRCUIT



Item	Description	Item	Description
1	Engine Stop	13	Main Display
2	Confirm Chart and Crane Mode	14	Run
3	Drum 2 Park Brake	15	Start
4	Drum 2 Control Handle	16	Master Node 1
5	Drum 2 Pressure Sender	17	Side Console Node 2
6	Drum 2 Pump 3	18	Universal Node 3
7	Drum 2 Pump 16	19	Universal Node 4
8	Drum 2 Handle Rotation Indicator		
9	Seat Switch		
10	RCL Warning Alarm		
11	Caution Fault Alarm		
12	RCL Display		

FIGURE 5-5

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Main Hoist (Drum 2) Electrical Circuit (Cont)

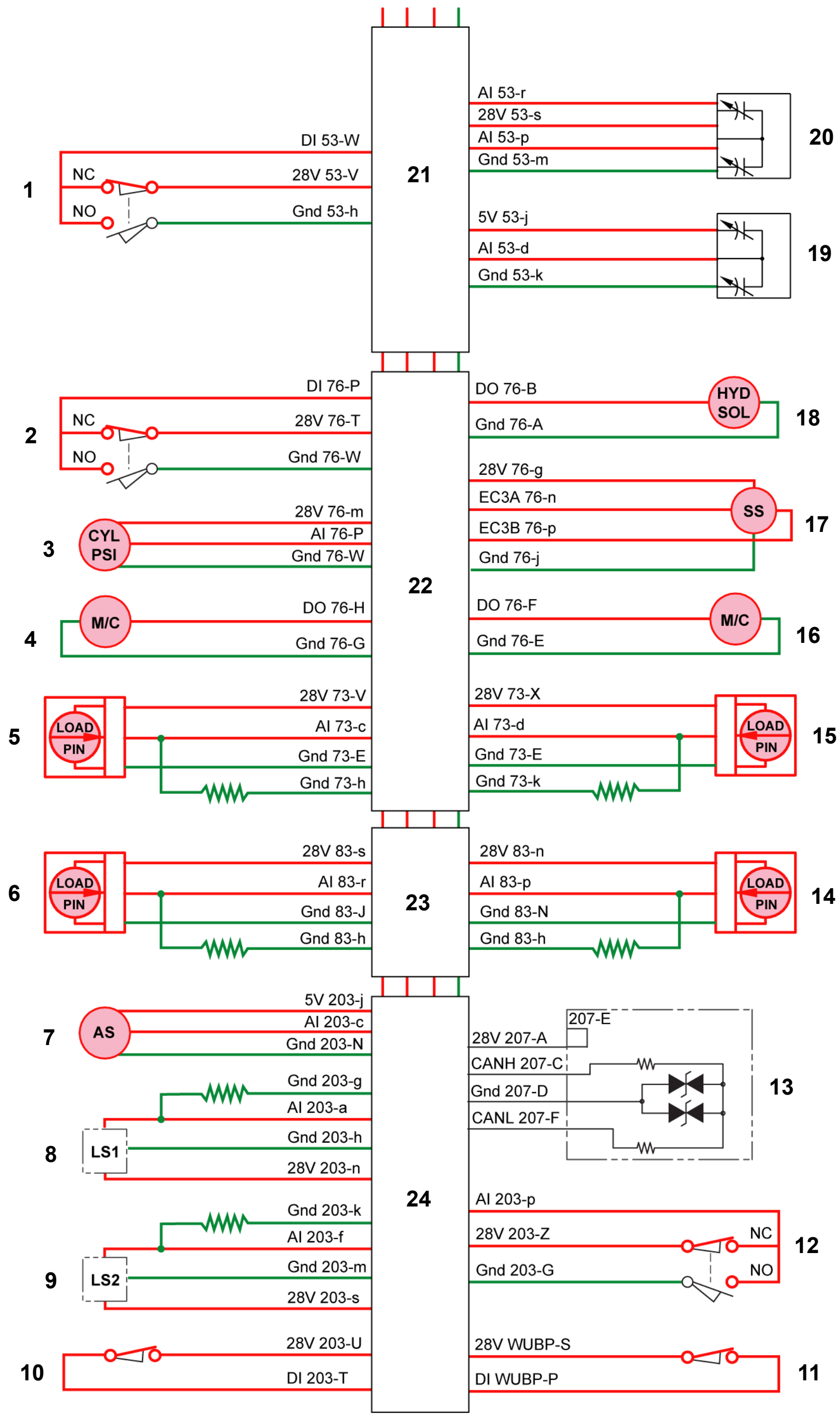


FIGURE 5-5 continued

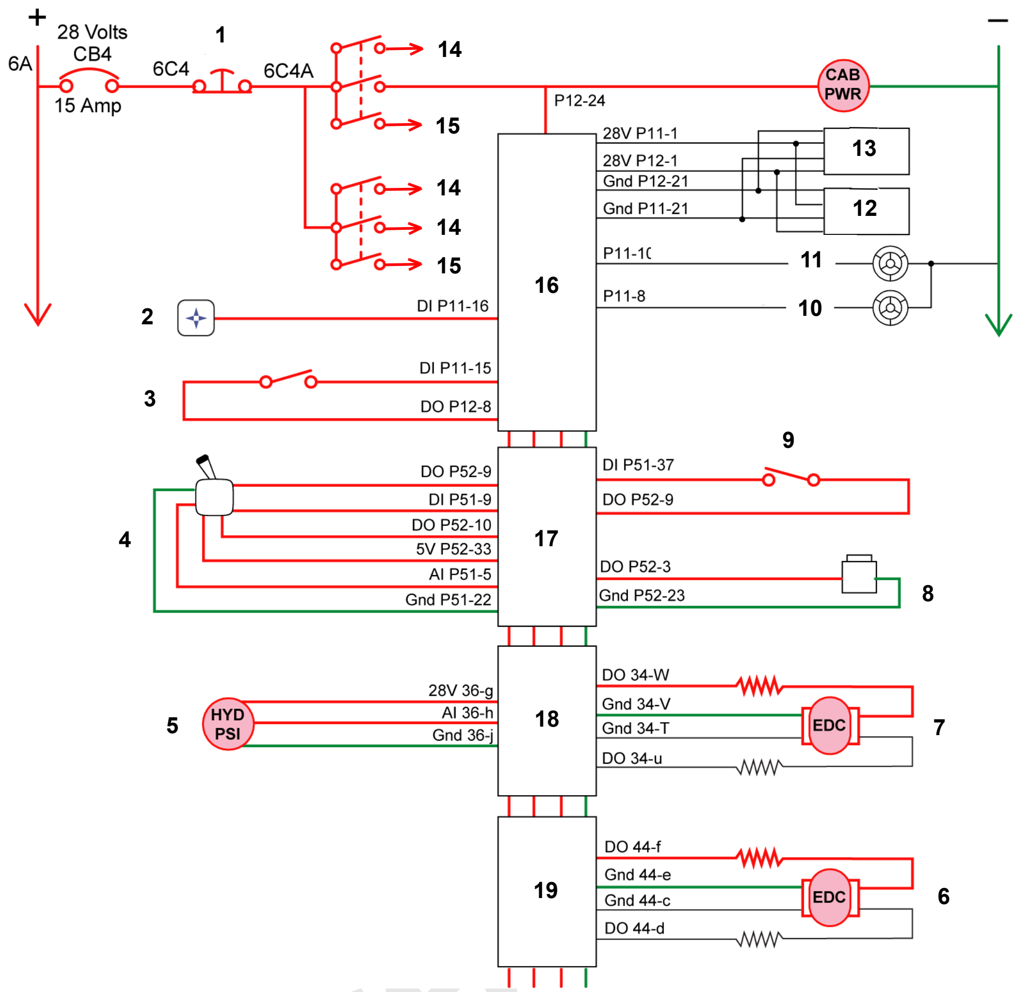
Main Hoist (Drum 2) Electrical Circuit (Cont)

Item	Description	Item	Description
1	Maximum Boom Angle Limit	13	CAN Terminator Plug
2	Drum 2 Minimum Bail Limit	14	Right Front House Roller Load Pin
3	Drum 2 Nitrogen Cylinder Right Side	15	Right Rear House Roller Load Pin
4	Drum 2 Motor Control HS-51 and HS-52	16	Drum 2 Motor Control HS-49 and HS-50
5	Left Rear House Roller Load Pin	17	Drum 2 Speed Sensor
6	Left Front House Roller Load Pin	18	Drum 2 Brake Release HS-89
7	Boom Angle Sender	19	Boom Angle Sensor
8	Right Load Strap	20	Rotating Bed Level Sensor
9	Left Load Strap	21	Universal Node 5
10	Lower Block Up Limit	22	Universal Node 7
11	Upper Block Up Limit	23	Universal Node 8
12	Minimum Jib Angle	24	Universal Boom Top Node 20

FIGURE 5-5 continued

Reference Only

MAIN HOIST (DRUM 3) ELECTRICAL CIRCUIT



Item	Description	Item	Description
1	Engine Stop	13	Main Display
2	Confirm Chart and Crane Mode	14	Run
3	Drum 3 Park Brake	15	Start
4	Drum 3 Control Handle	16	Master Node 1
5	Drum 3 Pressure Sender	17	Side Console Node 2
6	Drum 3 Pump 15	18	Universal Node 3
7	Drum 3 Pump 10	19	Universal Node 4
8	Drum 3 Handle Rotation Indicator		
9	Seat Switch		
10	RCL Warning Alarm		
11	Caution Fault Alarm		
12	RCL Display		

FIGURE 5-6

Manitowoc Crane Care

Main Hoist (Drum 3) Electrical Circuit (Cont)

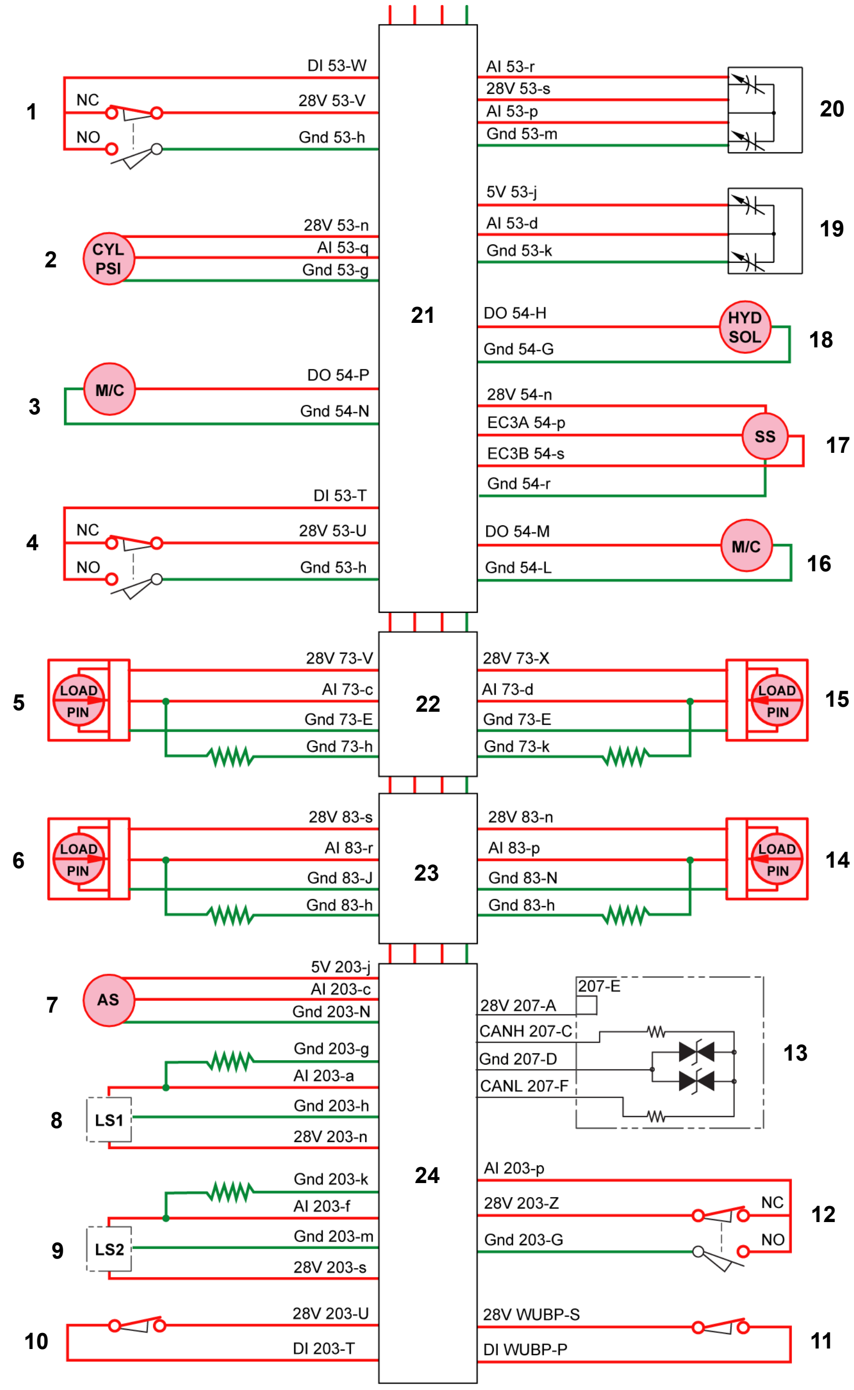


FIGURE 5-6 continued

Main Hoist (Drum 3) Electrical Circuit (Cont)

Item	Description	Item	Description
1	Maximum Boom Angle Limit	13	CAN Terminator Plug
2	Drum 3 Nitrogen Cylinder Right Side	14	Right Front House Roller Load Pin
3	Drum 3 Motor Control HS-37 and HS-38	15	Right Rear House Roller Load Pin
4	Drum 3 Minimum Bail Limit	16	Drum 3 Motor Control HS-39 and HS-40
5	Left Rear House Roller Load Pin	17	Drum 3 Speed Sensor
6	Left Front House Roller Load Pin	18	Drum 3 Brake Release HS-56
7	Boom Angle Sender	19	Boom Angle Sensor
8	Right Load Strap	20	Rotating Bed Level Sensor
9	Left Load Strap	21	Universal Node 5
10	Lower Block Up Limit	22	Universal Node 7
11	Upper Block Up Limit	23	Universal Node 8
12	Minimum Jib Angle	24	Universal Boom Top Node 20

FIGURE 5-6 continued

Reference Only

LUFFING DRUM 5 (OPTIONAL)

System Components

See Figure 5-7 and Figure 5-8 for the following procedure.

The luffing drum 5, when equipped, is located in the front of the rotating bed. One hydraulic pump drives two motors on the gearbox located on the right side of the drum shaft. The right rear travel pump is dedicated to operate drum 5 though diverting valve HS-57. The right rear track and drum 5 cannot 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. When configured as a luffing jib the control handle on left side console operates drum 5. The control handle is inoperable when drum 5 park brake is applied.

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

When load drum 5 motors rotate, a speed sensor at motor rotor monitors and sends an input voltage to Node-1 controller. Node-2 controller sends an output voltage to rotation indicator in control handle. As drum rotates faster, the rotation indicator on top of control handle pulsates with a varying frequency that indicates drum rotational speed. The handle command in percent from neutral is shown on Diagnostic Screen.

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

Load Drum 5 Brake and Pawl

Hydraulic pressure to operate drum 5 brake and pawl is from low-pressure side of closed loop.

When drum 5 brake switch is in on - park position, drum brake release solenoid HS-93 is disabled so brake is applied to drum shaft. Drum 5 pawl in solenoid HS-95 is enabled to keep pawl applied to drum flange. Drum pump does not stroke in response to control handle movement.

When drum 5 brake switch is placed in off - park position, brakes remain applied until Node-8 controller sends a 28 volt output to release the brake. Node-8 controller sends a zero volt output signal to drum pawl in solenoid HS-95 and a 28 volt output to enable pawl out solenoid HS-94 to release pawl. The drum circuit is active, waiting for a control handle command.

Raising

When drum 5 control handle is moved back for ***raising***, an input voltage of 2.6 volts or more is sent to Node-1 controller. Node-5 controller sends a 28 volt output to enable right rear travel to drum 5 diverting solenoid HS-57. Node-4 controller sends a variable zero to 25.4 volt output that is divided by a 220 ohm resistor and applied to pump 11 EDC in the ***raising*** direction. Node-8 controller sends a variable 3.8 to 16.2 volt output to both proportional motor control solenoids HS-53 and HS-54. Node-1 controller checks that drum block-up limit switches are closed and no system faults are present.

Pump EDC tilts swash plate 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-8 controller sends a 28 volt output to enable drum 5 brake release solenoid HS-93. Drum brake solenoid shifts to block drain port and opens port to low-pressure side of closed loop to release brake from drum shaft.

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

Node-4 controller output voltage to pump EDC and Node-8 controller output voltage to proportional motor control solenoids HS-53 and HS-54 are relative to control handle movement. As control handle is moved back, an output voltage increases the pump swash plate angle.

When closed loop pressure exceeds the computer controlled ECOR maximum pressure setting, Node-8 controller responds and shifts the motor control valve to direct flow from shuttle valve into maximum displacement side of servo cylinder. Motor displacement and output torque increase while Node-8 shifts motor control into low speed (0% motor command) to prevent pump or motor damage. When pressure falls below the computer controlled ECOR maximum pressure setting, Node-8 will shift the motor control solenoid valve to direct flow from shuttle valve into minimum displacement side of servo cylinder. Load drum motors will resume high speed (100% motor command).

Node controllers continuously balance drum system pressures and monitor motor displacement. If motor torque requirements are not above the ECOR maximum pressure setting of Node-1 controller, displacement remains in minimum (100% motor command for high speed) when control handle is fully pulled back (+100% handle command). Node-1 controller monitors motor displacement and controls motor speed by regulating the hydraulic fluid flow through the pumps.

When drum control handle is moved to neutral position (0% handle command), Node-1 controller compensates for hydraulic closed loop leakage or changing engine speed. Node-4 controller sends a zero output voltage to pump 11 EDC that moves swash plate to center position. Node-8

Reference Only

controller begins to shift the motor control back to maximum displacement for slower output speed to slow drum rotation.

When control handle is moved to neutral position, Node-1 controller stores the load holding pressure in pressure memory. After drum 5 control handle center switch opens, Node-8 controller sends a zero output voltage to disable drum brake release solenoid HS-93. Drum brake solenoid valve shifts to block pilot pressure to brake and opens a line to tank. Brake applies before drum pump de-stroke.

When brake applies, an input signal is sent to Node-1 controller. Node-4 controller sends a 0 volt output to pump EDC to de-stroke pump. Node-8 controller sends a 3.8 volt output to motor control.

Right rear travel to drum 5 diverting solenoid HS-57 remains enabled until right travel handle is moved.

Lowering

When drum 5 control handle is moved forward for ***lowering***, an input voltage of 2.4 volts or Less is sent to Node-1 controller. Node-5 controller sends a 28 volt output to enable right rear travel to drum 5 diverting solenoid HS-57. Node-4 controller sends a variable zero to 25.4 volt output that is divided by a 220 ohm resistor and applied to pump 11 EDC in the ***raising*** direction. Node-8 controller sends a variable 3.8 to 16.2 volt output to motor control HS-53 and HS-54. Node-1 controller checks that drum block-up limit switches are closed and no system faults are present.

Pump EDC tilts swash plate in the ***raising*** direction to satisfy pressure memory. Node-1 controller compares drum holding pressure to value in pressure memory. When closed loop pressure is high enough, Node-8 controller sends a 28 volt output to enable drum 5 brake release solenoid HS-93. Drum brake solenoid shifts to block drain port and opens port to low-pressure side of closed loop to release brake from drum shaft.

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

Node-4 controller output voltage to pump EDC and Node-8 controller output voltage to proportional motor control solenoids HS-53 and HS-54 are relative to control handle movement. As control handle is moved back, an output voltage increases the pump swash plate angle.

When closed loop pressure exceeds the computer controlled ECOR maximum pressure setting, Node-8 controller responds and shifts the motor control valve to direct flow from shuttle valve into maximum displacement side of servo cylinder. Motor displacement and output torque increase while Node-8 shifts motor control into low speed (0% motor command) to prevent pump or motor damage. When pressure falls below the computer controlled ECOR maximum pressure setting, Node-8 will shift the motor control solenoid valve to direct flow from shuttle valve into minimum displacement side of servo cylinder. Load drum motors will resume high speed (100% motor command).

Node controllers continuously balance drum system pressures and monitor motor displacement. If motor torque requirements are not above the ECOR maximum pressure setting of Node-1 controller, displacement remains in minimum (100% motor command for high speed) when control handle is fully pushed forward (-100% handle command). Node-1 controller monitors motor displacement and controls motor speed by regulating the hydraulic fluid flow through the pumps.

When drum control handle is moved to neutral position, Node-1 controller compensates for hydraulic closed loop leakage or changing engine speed. Node-4 controller sends a zero output voltage to pump 11 EDC that moves swash plate to center position. Node-8 controller begins to shift the motor control back to maximum displacement for slower output speed to slow drum rotation.

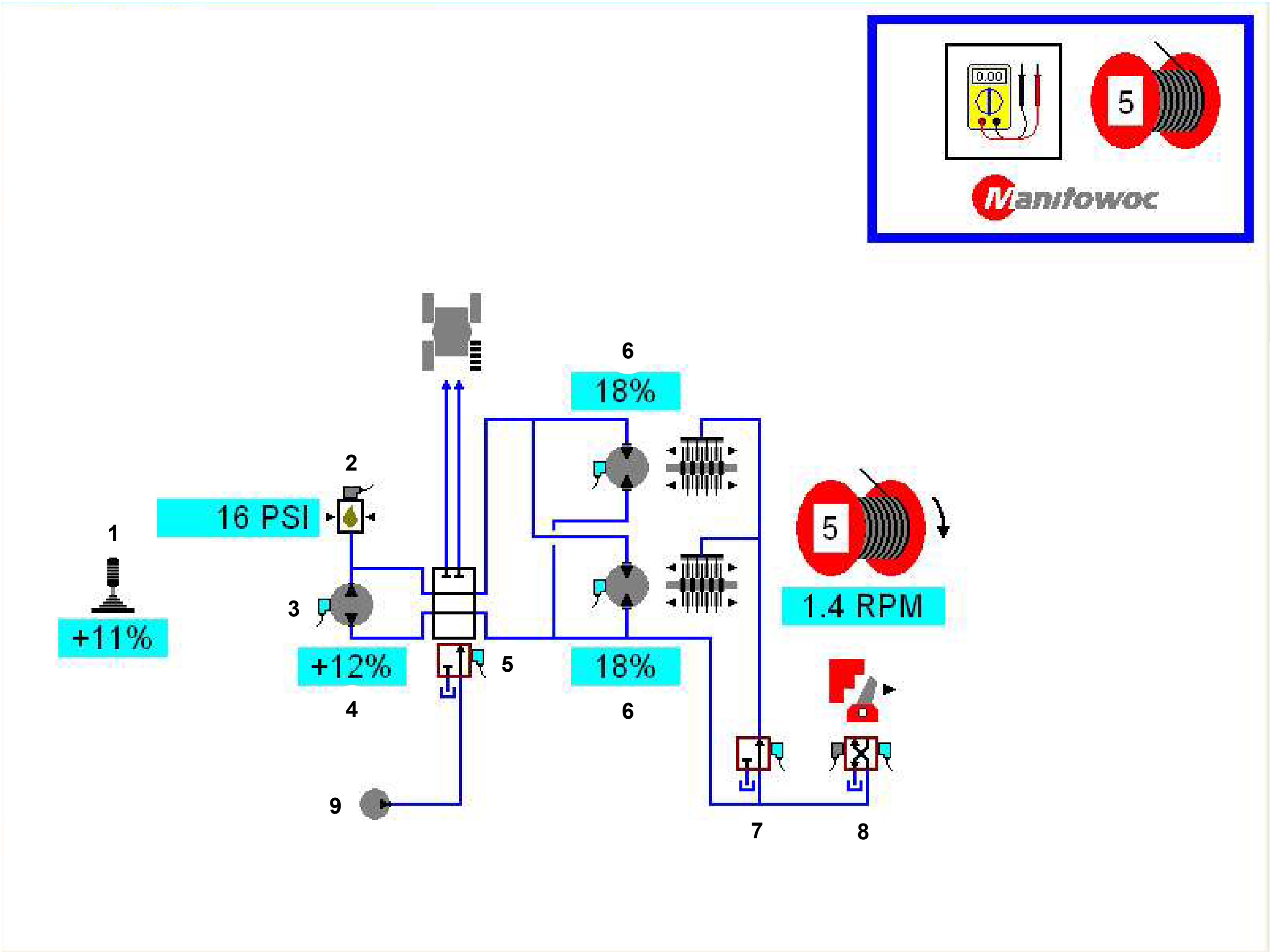
When control handle is moved to neutral position, Node-1 controller stores the load holding pressure in pressure memory. After drum 5 control handle center switch opens, Node-8 controller sends a zero output voltage to disable drum brake release solenoid HS-93. Drum brake solenoid valve shifts to block 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 0 volt output to pump 11 EDC to de-stroke pump. Node-8 controller sends a 3.8 volt output to motor control HS-53 and HS-54.

Right rear travel to drum 5 diverting solenoid HS-57 remains enabled until right travel handle is moved.

Reference Only

LUFFING HOIST (DRUM 5) DIAGNOSTICS OVERVIEW



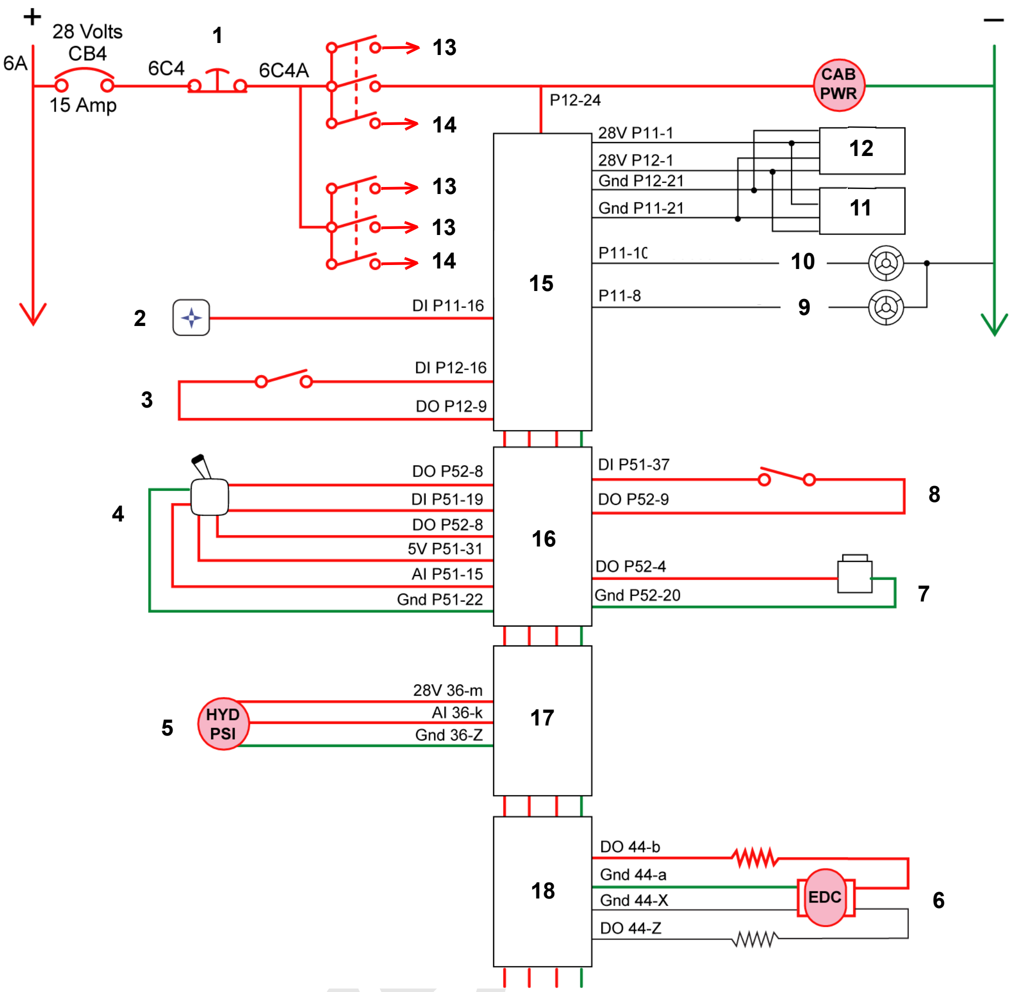
Item	Description	Item	Description
1	Drum 5 Control Handle	6	Percentage of Motor Command
2	Pressure Sender (high pressure)	7	Drum 5 Brake Valve HS-93
3	Pump 11	8	Drum 5 Pawl HS-94 and HS-95
4	Percentage of Pump Command	9	Accessory Pump 9
5	Diverting Valve HS-57		

FIGURE 5-7

NOTE: See Folio 2207 for detailed Drum 5 diagnostic information.

Reference

LUFFING HOIST (DRUM 5) ELECTRICAL CIRCUIT



Item	Description	Item	Description
1	Engine Stop	11	RCL Display
2	Confirm Chart and Crane Mode	12	Main Display
3	Drum 5 Park Brake Switch	13	Run
4	Drum 5 Control Handle	14	Start
5	Drum 5 Pressure Sender	15	Master Node 1
6	Drum 5 Pump 11	16	Side Console Node 2
7	Drum 5 Handle Rotation Indicator	17	Universal Node 3
8	Seat Switch	18	Universal Node 4
9	RCL Warning Alarm		
10	Caution Fault Alarm		

FIGURE 5-8

Reference Only

Luffing Hoist (Drum 5) Electrical Circuit (Cont)

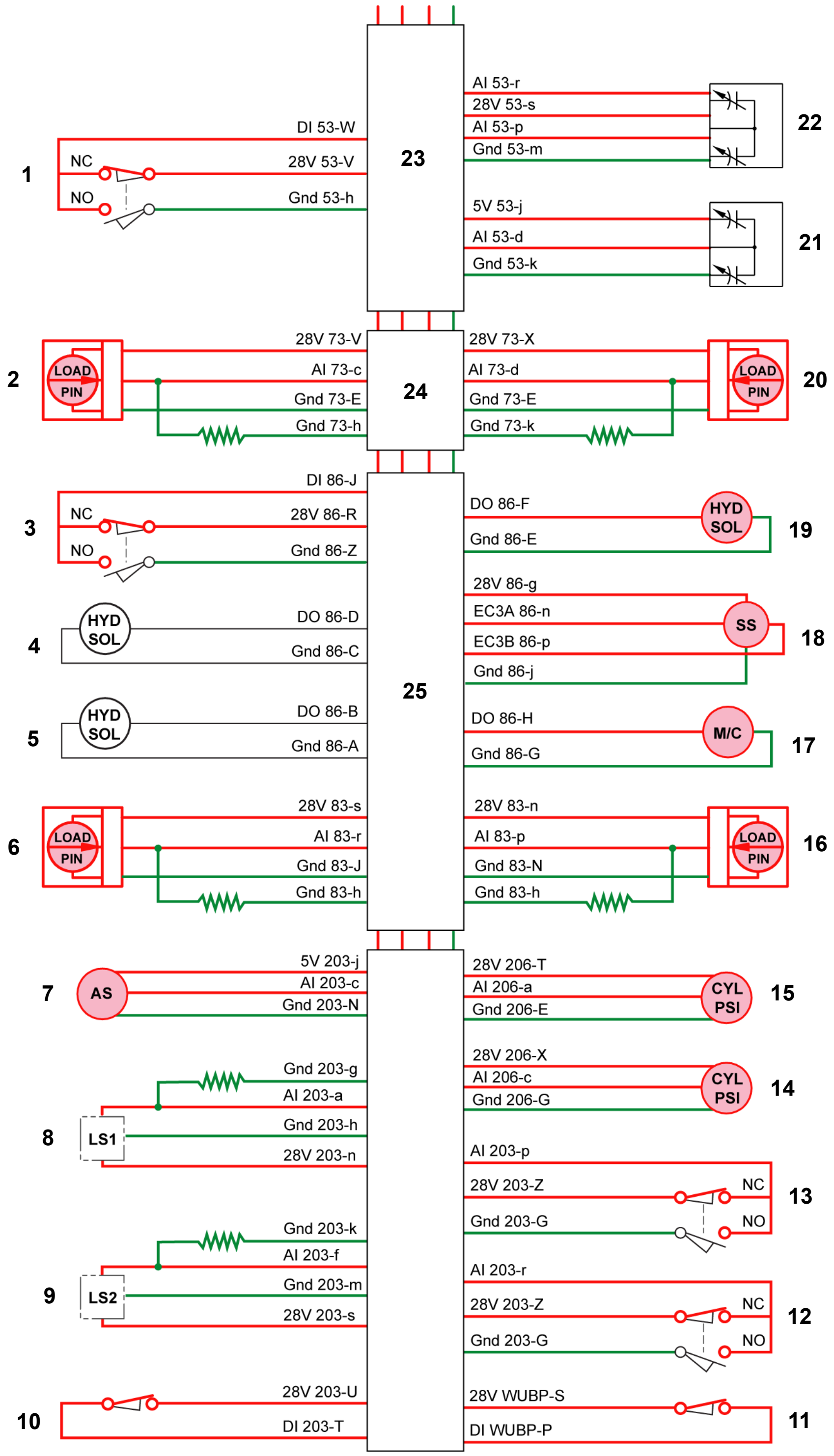
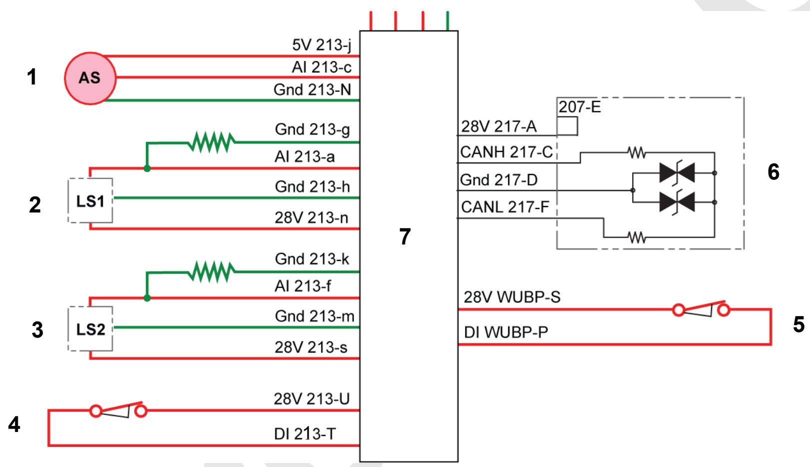


FIGURE 5-8 continued

Luffing Hoist (Drum 5) Electrical Circuit (Cont)

Item	Description	Item	Description
1	Maximum Boom Angle Limit	14	Right Jib Stop Cylinder Transducer
2	Left Rear House Roller Load Pin	15	Left Jib Stop Cylinder Transducer
3	Drum 5 Minimum Bail Limit	16	Right Front House Roller Load Pin
4	Drum 5 Pawl Extend HS-95	17	Drum 5 Motor Control HS-53 and HS-54
5	Drum 5 Pawl Retract HS-94	18	Drum 5 Speed Sensor
6	Left Front House Roller Load Pin	19	Drum 5 Brake Release HS-93
7	Boom Angle Sender	20	Right Rear House Roller Load Pin
8	Right Load Strap	21	Boom Angle Sensor
9	Left Load Strap	22	Rotating Bed Level Sensor
10	Lower Block Up Limit	23	Universal Node 5
11	Upper Block Up Limit	24	Universal Node 7
12	Maximum Jib Angle	25	Universal Node 8
13	Minimum Jib Angle	26	Universal Boom Top Node 20



Item	Description	Item	Description
1	Boom Angle Sensor	5	Upper Block Up Limit
2	Right Load Strap	6	CAN Terminator
3	Left Load Strap	7	Universal Jib Node 21
4	Lower Block Up Limit		

FIGURE 5-8 continued

Reference Only

LOAD DRUM IDENTIFICATION

Drum	Description
0	Rigging Winch — 1/2 in (12,7 mm)
1	Main Load Hoist #1
2	Main Load Hoist #2
3	Whip/Auxiliary Hoist
4	Boom Hoist
5	Luffing Hoist
6	Rigging Winch (19 mm)

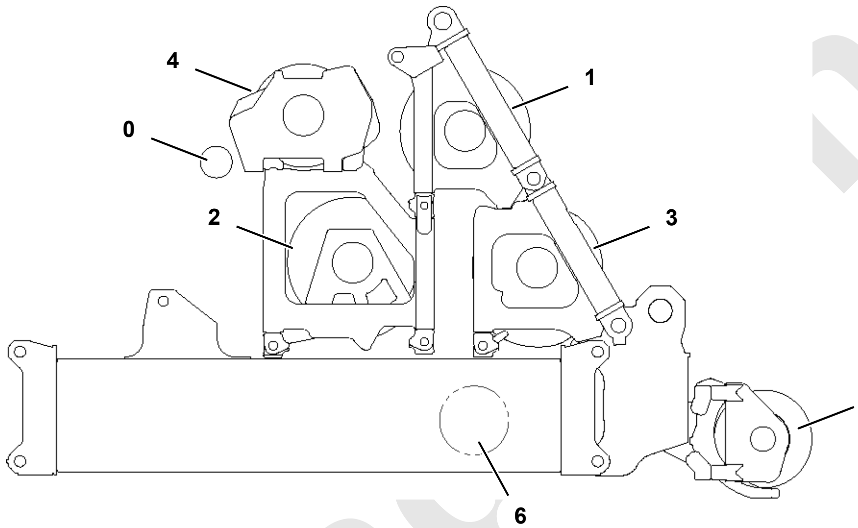


FIGURE 5-9

DRUM GUARDS

See Figure 5-10 and Figure 5-11 for the following procedure.

Four drum guards (1) are mounted on each of the main hoist drum assemblies and boom hoist assembly. Each guard is held in place with two 8 mm hex head cap screws (2) that are 70 mm in length. One guard must be removed to gain access to the second oil drain (3) on the drum shaft located on the bottom of the drum. Replace guard when finished draining.

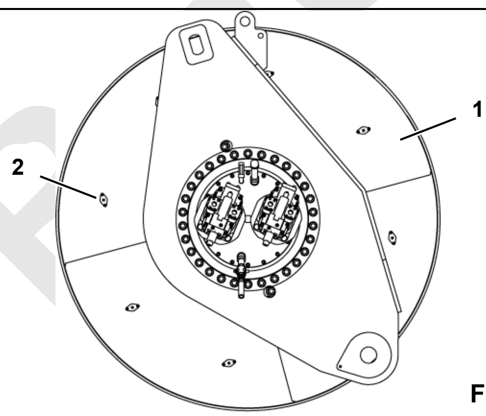


FIGURE 5-10

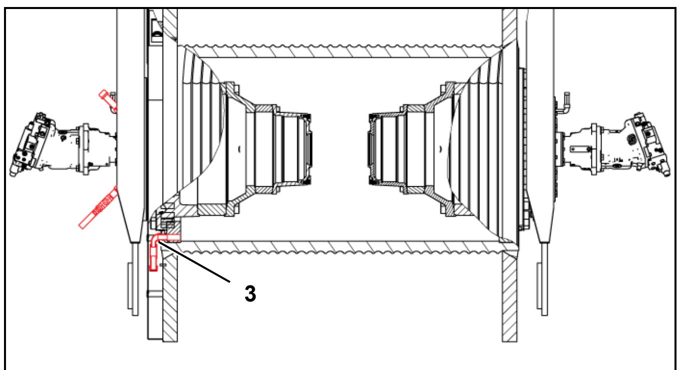


FIGURE 5-11

BOOM/LUFFING HOIST PAWL

See Figure 5-12 for the following procedure.

The boom hoist (Drum 4) and luffing hoist (Drum 5) have a drum pawl (1) which is a positive locking device. When engaged, the pawl prevents the boom hoist or luffing hoist drum from turning in the down direction.

The pawl is controlled by the respective drum park switch in the operator cab:

- When park is turned ON, the pawl engages. The actuator cylinder (4) extends and spring (10) force rotates the pawl (1) into engagement with the ratchet (8).
- When park is turned OFF, the pawl (1) disengages. The actuator cylinder (4) retracts, and the cam lever (2) rotates to disengage the pawl (1) from the ratchet.

  It may be necessary to hoist slightly to fully disengage the pawl from the ratchet.

Pawl Adjustment

See Figure 5-13 for the following procedure.

The only maintenance required is to visually check the pawl (2) for proper operation. This should be done daily when the boom and luffing hoists are in use.

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

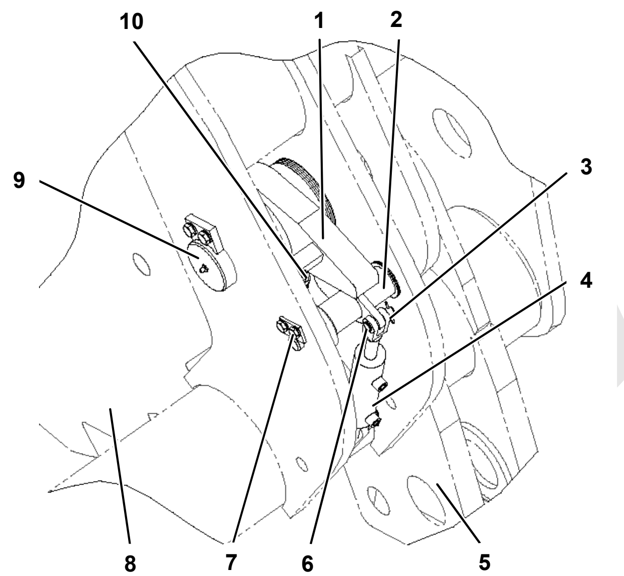
In some cases, the pawl (2) may come to rest on the top of a ratchet tooth. There must be enough spring tension to pull the pawl (2) into the root of a ratchet tooth if the drum starts to turn in the down direction.

Adjust spring (3) with two jam nuts (5) on the eye bolt (4) to assure enough spring (3) tension to fully seat pawl (2) in ratchet (1) tooth.

WARNING

Falling Boom Hazard!

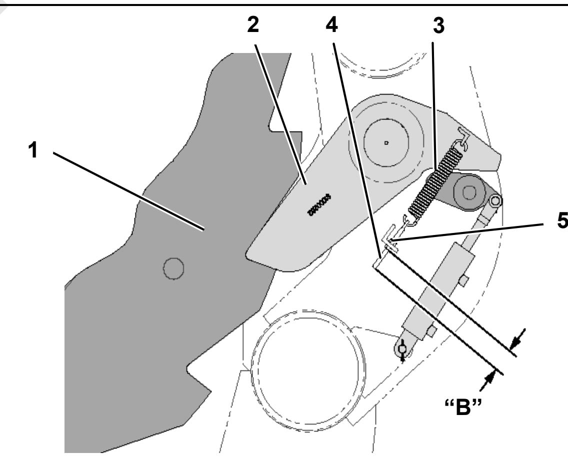
Land loads and lower boom onto blocking at ground level before performing steps in this section. There is no positive means of holding boom up when pawl is being serviced.



Item	Description	Item	Description
1	Pawl	6	Pin
2	Cam Lever	7	Pin
3	Cotter Pin	8	Ratchet
4	Actuator Cylinder	9	Pin
5	Drum Frame	10	Spring

Boom Hoist Shown - Luffing Hoist Similar

FIGURE 5-12



Item	Description	Item	Description
1	Ratchet	4	Eye Bolt
2	Pawl	5	Jam Nut (2)
3	Spring		

Pawl shown fully engaged with actuator extended.

FIGURE 5-13

Reference

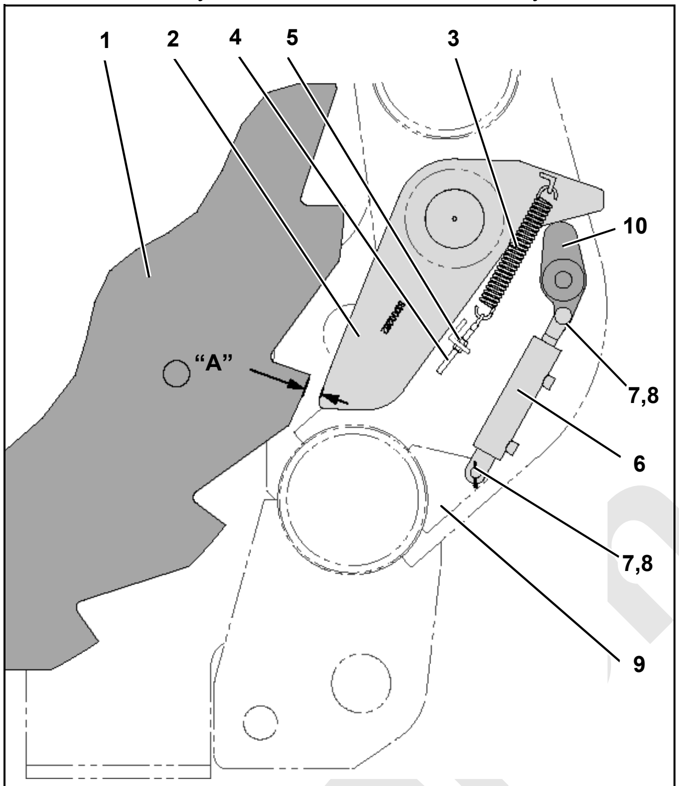
Pawl Actuator Removal

See Figure 5-14 for the following procedure.

1. With pawl engaged in ratchet, loosen jam nuts (5) and back out adjusting eye bolt (4) until the spring (3) is fully relaxed.
2. Turn **OFF** Drum (4 or 5) park to **DISENGAGE** pawl (2) and stop engine. Pawl actuator (6) will retract.

NOTE: It may be necessary to hoist slightly before the pawl will fully disengage.

3. Disconnect hydraulic hoses from actuator cylinder.



Pawl shown disengaged with actuator retracted.

Item	Description	Item	Description
1	Ratchet	6	Actuator Cylinder
2	Pawl	7	Cotter Pin (2)
3	Spring	8	Actuator Pin (2)
4	Eye Bolt	9	Drum Frame
5	Jam Nut (2)	10	Cam Lever

FIGURE 5-14

4. Remove cotter pins from actuator cylinder pins (7).

DANGER

Moving Part Hazard!

The spring preloads the pawl. Do not proceed to step 4 until step 1 is performed. Parts will fall with sudden and dangerous force if spring preload is not relieved.

DANGER

Pinch Point Hazard!

Pawl, spring and cam lever are loose. To prevent crushing injury to hands, keep hands clear of all other parts while removing actuating cylinder.

5. Carefully remove actuator cylinder pins (8) securing actuator cylinder (6) to drum frame (9) and cam lever (10).
6. Remove actuator cylinder (6).

Pawl Actuator Installation and Adjustment

See Figure 5-14 for the following procedure.

1. Install actuator cylinder (6) onto drum frame (9) and cam lever (10) with actuator cylinder pins (8). Secure with cotter pins (7).
2. Check Dimension **A** (Figure 5-14). See Table 5-1.
   a. Install hydraulic hoses to actuator cylinder (6).
   b. Turn on Drum (4 or 5) park to extend pawl actuator (6).

Table 5-1 Pawl Adjustment

Dimension	Boom Hoist	Luffing Hoist
A	1.0 in (25,7mm)	1.0 in (25,7 mm)
B	1.7 in (43,3mm)	1.77 in (45 mm)

   c. Rotate pawl (2) by hand into drum and attach spring (3).
   d. Adjust eye bolt (4, Figure 5-14) for dimension **B** in Table 5-1 to maintain sufficient pawl pressure.
   e. Securely tighten jam nuts (5). Reference dimension **A** between pawl (2) and ratchet (1).

5

Reference Only

SPEED SENSOR

The hydraulic motors for the hoists (boom hoist, main load #1, main load #2, whip/aux load, luffing hoist) VPC actuator and swing have a speed sensor. For those functions having more than one motor, only one of the motors has a speed sensor.

Each speed sensor monitors rotational speed and direction of the corresponding function's motor. The sensor sends a signal to a universal node controller that transmits the information to the crane's master controller. The master controller uses the information to control the crane function.

Speed Sensor

WARNING

Burn Hazard!

Hot oil will drain from motor port when sensor is removed. Wait for hydraulic oil to cool before removing sensor.

When removing the speed sensor from a motor, be careful to contain the hydraulic fluid that will drain from the motor. After installing a new sensor, add clean hydraulic oil to the level of the motor's top case drain port ***before starting engine***.

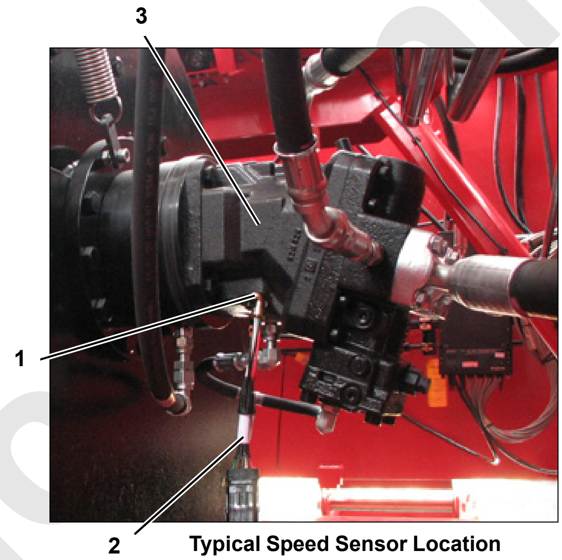
Speed Sensor Replacement

See Figure 5-15 for the following procedure.

The speed sensors are not adjustable.

1. Bring corresponding function to a complete stop, land suspended load if load drum is being serviced, and PARK function.
2. Disconnect sensor cable connector from wire harness, remove bolt securing sensor and remove faulty sensor and o-ring from motor.
3. Install new sensor with o-ring and secure with bolt.
4. Connect sensor cable to crane wire harness.
5. Operate drum motor and check for a steady drum speed and direction (rpm) signal on corresponding drum's diagnostic screen in cab.

Item	Description
1	Speed Sensor
2	Cable
3	Motor



Typical Speed Sensor Location

FIGURE 5-15

Reference Only

Manitowoc Crane Care

MINIMUM BAIL LIMIT

See Figure 5-16, Figure 5-17, and Figure 5-18 for the following procedure.

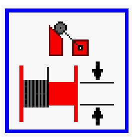
The minimum bail limit assembly on Drum 1 (main hoist #1), Drum 2 (main hoist #2), Drum 3 (whip/aux load hoist), Drum 4 (boom hoist)— is a protective device which limits how much wire rope can be spooled off the drums.

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

The fault box on the main information screen will indicate fault number 57 with this minimum bail limit icon.

NOTE: 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.

Bail Limit Weekly Maintenance

1. Check minimum bail limit switch for proper operation. Pay out wire rope from drum. Drum should stop with approximately 3 to 4 wraps of wire rope remaining on first layer.
2. The fault box on the main information screen will indicate fault number 57 with the minimum bail limit icon. Adjust limit switch if necessary.

NOTE: Refer to specific drum adjustment procedure.

3. Check that cap screws holding rollers on lever shaft are tight.
4. Check tension of return springs. If necessary, adjust eyebolts so springs hold rollers snug against wire rope drum wrap.

Bail Limit Adjustment

Drum 1 (main hoist #1) and Drum 2 (main hoist #2)

See Figure 5-16 View A for the following procedure.

1. Pay out wire rope until rollers are against bare drum with 3 to 4 wraps of wire rope remaining on first layer.
2. Loosen jam nut (5) and turn adjusting screw (6) in (toward mounting plate) until fault box on the main information screen indicates fault number 57.
3. Turn adjusting screw (6) out against limit switch roller (7) until limit switch clicks open and stop. Fault box on the main information screen does not show a fault. Limit switch should be at approximate dimension 1.7 in (43,5 mm) shown in Figure 5-16.
4. Spool several wraps of wire rope onto drum. Then pay out wire rope. Drum must stop with 3 to 4 wraps of wire rope remaining first layer.

   Repeat adjustment steps if necessary.
5. Tighten jam nut (5) against mounting plate (8) to lock adjustment.
6. Check that return springs (9) have sufficient tension to hold rollers (2) snugly against bare drum (4). Adjust eyebolts (10) to 1.38 in (35 mm) if necessary.
7. Tighten two eye bolt jam nuts (11) to lock adjustment.

Drum 3 (whip/aux load hoist)

See Figure 5-16 View B and C for the following procedure.

1. When installing a new limit switch, remove the lever (13) and roller (7) from old limit switch and install on new limit switch. Do not tighten set screw (12); lever (13) must freely rotate to position after limit switch is mounted.
2. During adjustment, loosen setscrew (12) in limit switch lever to allow the lever (13) to freely rotate.
3. Pay out wire rope until rollers are against bare drum with 3 to 4 wraps of wire rope remaining on first layer.
4. Hold limit switch roller (7) and lever (13) against actuating plate (14).
5. Turn limit switch shaft (15) CLOCKWISE (when viewing shaft) only enough to click limit switch open and hold.
6. Securely tighten setscrew (12) to lock adjustment.

NOTE: Limit switch arm must rotate 26^{o} to trip.

7. Spool six to seven wraps of wire rope onto drum. Then pay out wire rope. Drum must stop with 3 to 4 wraps of wire rope remaining first layer.

   Repeat adjustment steps if necessary.

Reference Only

8. Check that return springs (9) have sufficient tension to hold rollers (2) snugly against bare drum (4). Adjust eyebolts (10) to 1.38 in (35 mm) if necessary.

9. Tighten two eye bolt jam nuts (11) to lock adjustment.

Drum 4 (boom hoist)

See Figure 5-17 for the following procedure.

1. When installing a new limit switch, remove the lever (11) and roller (6) from old limit switch and install on new limit switch. Do not tighten set screw (10); lever (11) must freely rotate to position after limit switch is mounted.

2. During adjustment, loosen setscrew (10) in limit switch lever to allow the lever (10) to freely rotate.

3. Pay out wire rope until rollers are against bare drum with 3 to 4 wraps of wire rope remaining on first layer.

4. Hold limit switch roller (6) and lever (11) against actuating plate (12).

5. Turn limit switch shaft (13) CLOCKWISE (when viewing shaft) only enough to click limit switch open and hold.

6. Securely tighten setscrew (12, Figure 5-16, View C) to lock adjustment.

NOTE: Limit switch arm must rotate 26^{o} to trip.

7. Spool six to seven wraps of wire rope onto drum. Then pay out wire rope. Drum must stop with 3 to 4 wraps of wire rope remaining first layer.

Repeat adjustment steps if necessary.

8. Check that return springs (8) have sufficient tension to hold rollers (2) snugly against bare drum (4). Adjust eyebolts (9) to 1.38 in (35 mm) if necessary.

9. Tighten two eye bolt jam nuts (5) to lock adjustment.

Drum 5 (luffing hoist)

See Figure 5-18 for the following procedure.

1. When installing a new limit switch, remove the lever (11) and roller (6) from old limit switch and install on new limit switch. Do not tighten set screw (10); lever (11) must freely rotate to position after limit switch is mounted.

2. During adjustment, loosen setscrew (10) in limit switch lever to allow the lever (10) to freely rotate.

3. Pay out wire rope until rollers are against bare drum with 3 to 4 wraps of wire rope remaining on first layer.

4. Hold limit switch roller (6) and lever (11) against actuating plate (12).

5. Turn limit switch shaft (13) CLOCKWISE (when viewing shaft) only enough to click limit switch open and hold.

6. Securely tighten setscrew (12, Figure 5-16, View C) to lock adjustment.

NOTE: Limit switch arm must rotate 26^{o} to trip.

7. Spool six to seven wraps of wire rope onto drum. Then pay out wire rope. Drum must stop with 3 to 4 wraps of wire rope remaining first layer.

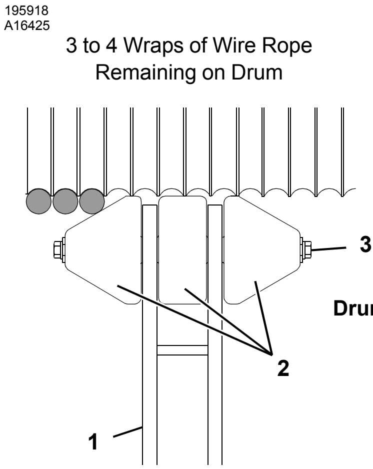
Repeat adjustment steps if necessary.

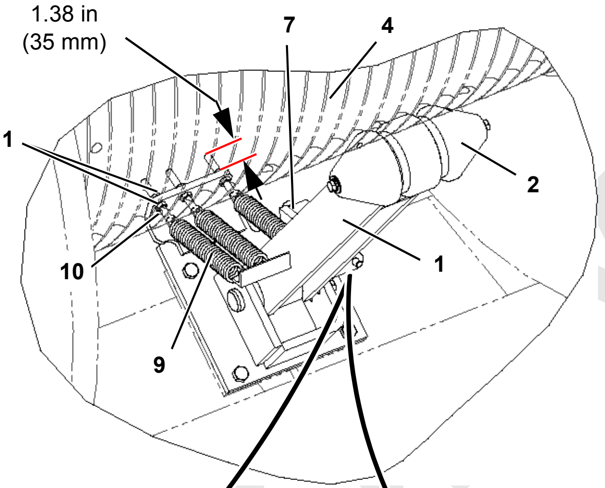
8. Check that return springs (8) have sufficient tension to hold rollers (2) snugly against bare drum (4). Adjust eyebolts (9) to 1.38 in (35 mm) if necessary.

9. Tighten two eye bolt jam nuts (5) to lock adjustment.

Reference Only

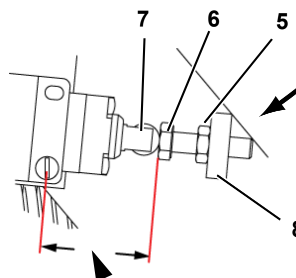
Drum 1, 2, and 3 Minimum Bail Limit Adjustment Diagrams



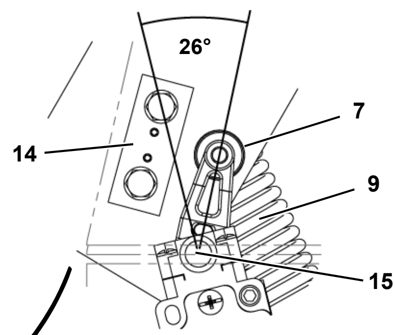


Drum 1 — Main Hoist — Shown
Drum 2 and 3 Similar

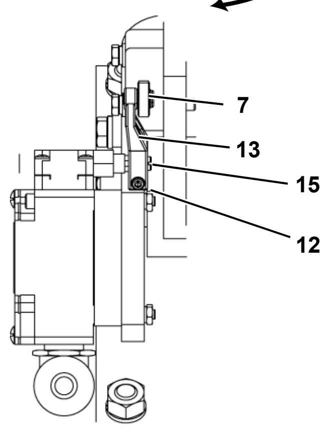
Item	Description
1	Lever
2	Rollers
3	Cap Screw
4	Drum
5	Jam Nut
6	Adjusting Screw
7	Limit Switch Roller
8	Mounting Plate
9	Return Spring (3)
10	Eyebolt (3)
11	Eyebolt Jam Nut (6)
12	Setscrew, Lever
13	Lever, Switch
14	Plate, Actuating
15	Shaft, Limit Switch



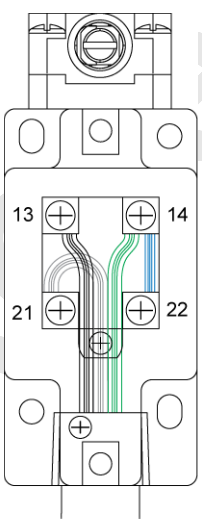
View A
Drum 1 & 2 Adjustment



View B
Drum 3 Adjustment



View C
Drum 3 Adjustment



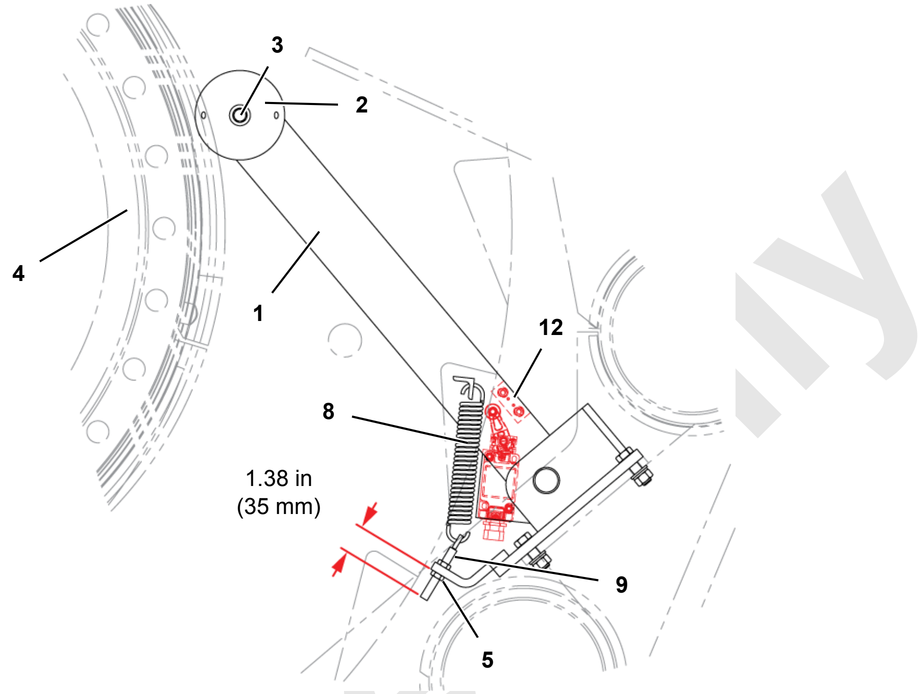
View D
Limit Switch Wiring Diagram

FIGURE 5-16

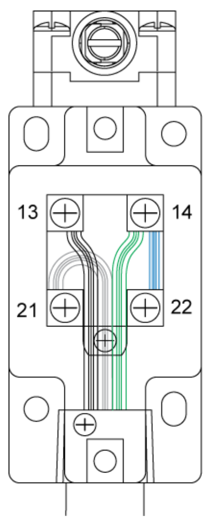
Reference Only

Drum 4 Minimum Bail Limit Adjustment Diagram

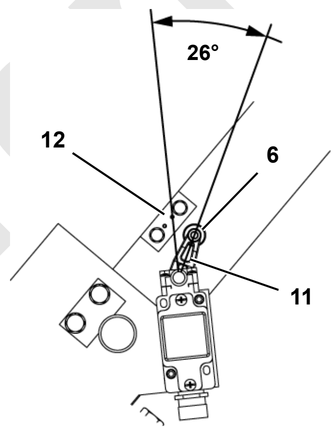
Item	Description
1	Lever
2	Rollers
3	Cap Screw
4	Drum
5	Jam Nut, Eyebolt (6)
6	Limit Switch Roller
7	Mounting Plate
8	Return Spring (3)
9	Eyebolt (3)
10	Setscrew, Lever
11	Lever, Switch
12	Plate, Actuating
13	Shaft, Limit Switch



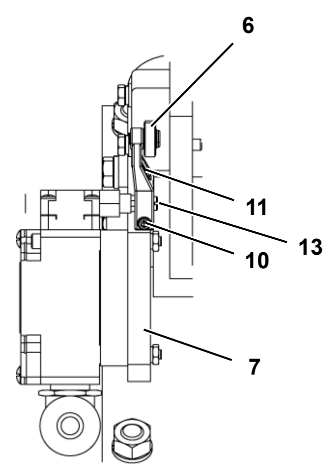
View A



View B
Limit Switch Wiring Diagram



View C



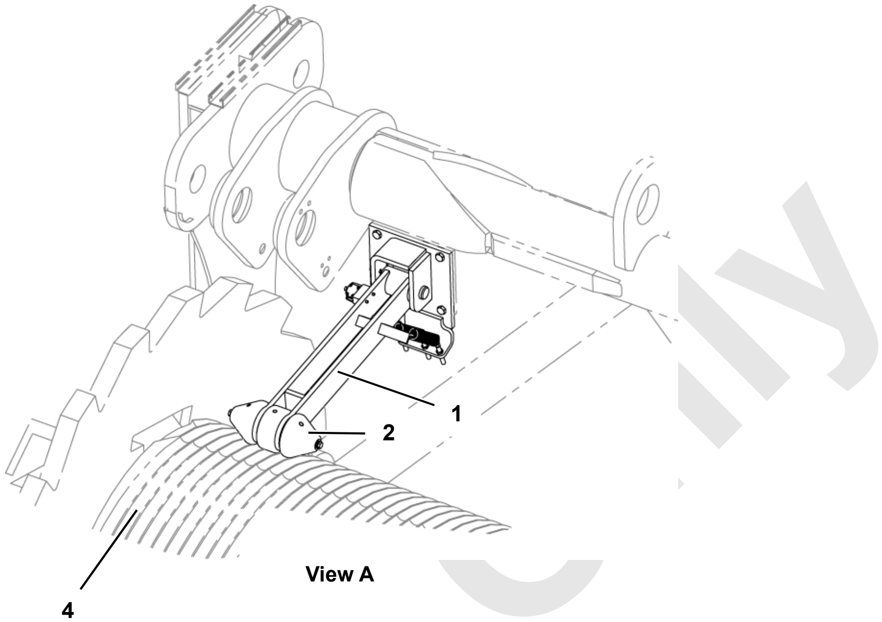
View D

FIGURE 5-17

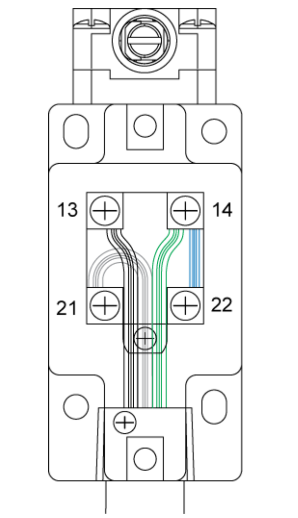
Reference Only

Drum 5 Minimum Bail Limit Adjustment Diagram

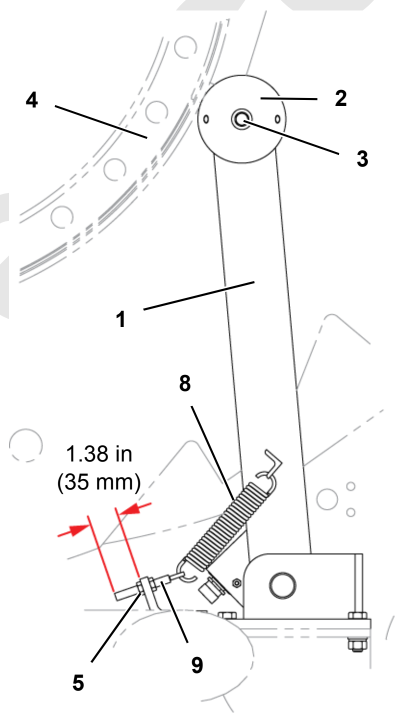
Item	Description
1	Lever
2	Rollers
3	Cap Screw
4	Drum
5	Jam Nut, Eyebolt (6)
6	Limit Switch Roller
7	Mounting Plate
8	Return Spring (3)
9	Eyebolt (3)
10	Setscrew, Lever
11	Lever, Switch
12	Plate, Actuating
13	Shaft, Limit Switch



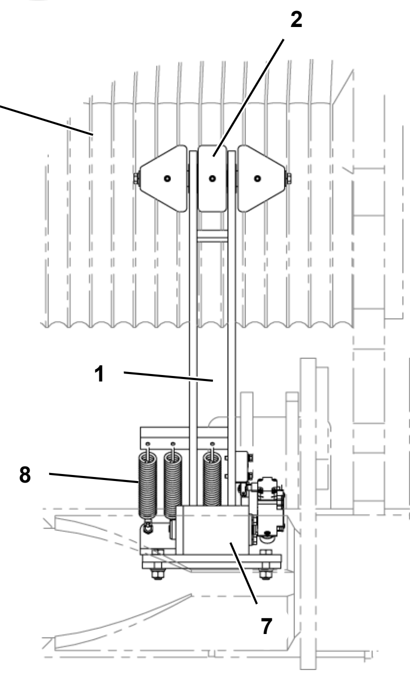
View A



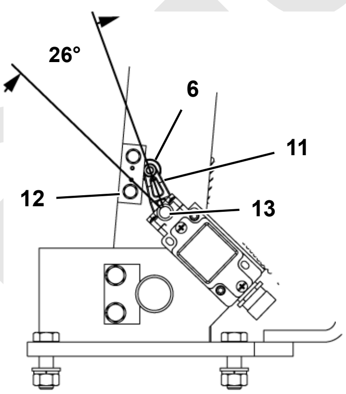
View D
Limit Switch Wiring Diagram



View C



View B



View E

FIGURE 5-18

For Reference Only

DRUM ROLLER PRESSURE ASSEMBLY

See Figure 5-19 for the following procedure.

The drum roller pressure devices maintain pressure on the cables as they are wound onto the drums. The pressure is maintained with an oil filled, nitrogen charged, spring accumulator.

The drum roller pressure devices on the drums are basically the same. However, the adjustment dimensions and accumulator pressures vary from drum to drum.

Spring Accumulator Pressure

See Figure 5-19 for the following procedure.

The spring accumulator cylinder (3) is filled with 7.5 in^3 (0.13 qts) of hydraulic oil to keep the rod seals lubricated.

Accumulator cylinders for drums 1, 2, and 3 are then pre-charged with nitrogen gas to 1800 psi @ 70°F (124 Bar @ 21°C).

Accumulator cylinder for drum 5 is pre-charged with nitrogen gas to 1200 psi @ 70°F (83 Bar @ 21°C).

NOTE: If recharge is necessary due to loss of oil or gas, recharge must be performed by a qualified hydraulic repair facility

For drums 1, 2, and 3 normal accumulator pressure ranges between 1400 and 2400 psi depending on temperature and rod position (see Table 5-2).

For drum 5 normal accumulator pressure ranges between 900 and 1600 psi depending on temperature and rod position (see Table 5-3).

Table 5-2 Accumulator Pressure Ranges - Drums 1-2-3

Ambient Temperature °F (°C)	Typical Accumulator Pressure Range psi (Bar)
-30 (-34)	1460 - 1750 (101 - 121)
0 (-18)	1560 - 1870 (108 - 129)
30 (-1)	1660 - 1990 (114 - 137)
60 (16)	1770 - 2120 (122 - 146)
90 (32)	1870 - 2240 (129 - 154)
120 (49)	1970 - 2360 (136 - 163)

Table 5-3 Accumulator Pressure Ranges - Drum 5

Ambient Temperature °F (°C)	Typical Accumulator Pressure Range psi (Bar)
-30 (-34)	970 - 1170 (67 - 81)
0 (-18)	1040 - 1250 (72 - 86)
30 (-1)	1100 - 1330 (76 - 92)
60 (16)	1170 - 1410 (81 - 97)
90 (32)	1240 - 1500 (86 - 103)
120 (49)	1310 - 1580 (90 - 109)

Regularly check gauge (7, Figure 5-19) on nitrogen spring accumulator body (3) to ensure that pressure rollers (1) are operating as intended.

Drum Roller Pressure Adjustment

See Figure 5-19 for the following procedure.

1. Load the pressure rollers by slowly turning down the threaded rod (5) on the nitrogen spring accumulator (3) to dimension **"A"** for each drum as shown in Table 5-4.

DANGER

Pinch Point Hazard!

Nitrogen spring accumulator will apply pressure to the pressure roller. To prevent crushing injury to hands, keep hands clear of all other parts while working on pressure actuator cylinder.

2. Ensure that the rod of the cylinder positioner (8) is properly in the groove of the nitrogen spring accumulator (3) to keep the cylinder body from rotating when turning down the threaded rod (5). Lock rod (5) at dimension "A" with locknut (6).

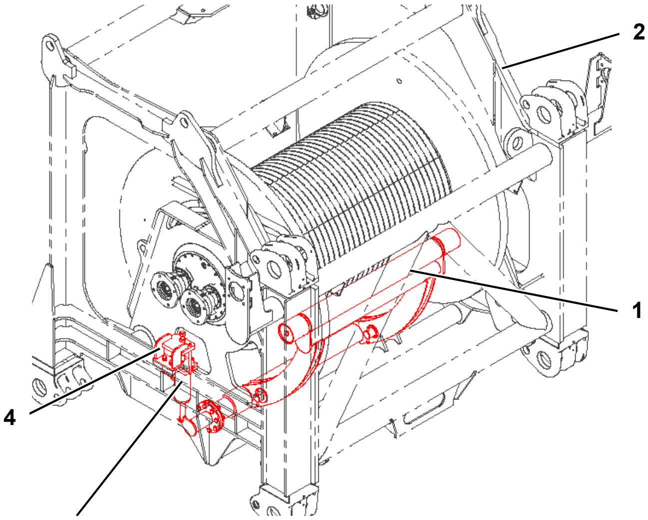
Table 5-4 Adjustment "A" Dimension

Drum No.	"A" Dimension in (mm)
1 - Main Load Hoist #1	3.27 (83,0)
2 - Main Load Hoist #2	2.95 (75,0)
3 - Whip/Aux Load	2.75 (70,0)
5 - Luffing Hoist	3.03 (77,0)

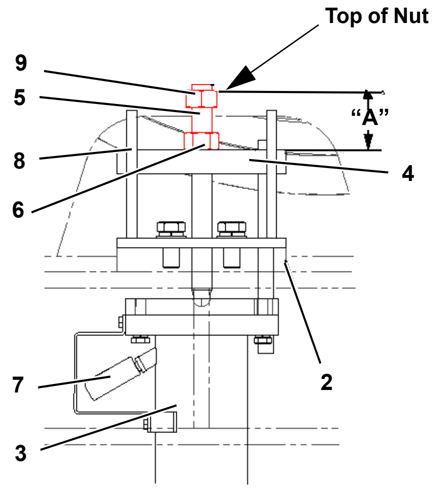
Dimension is the same with or without rope

NOTE: Dimension "A" is from top of cylinder bracket (4) to top of rod nut (9)

Reference Only



Typical Pressure Roller



Typical Pressure Cylinder Adjustment

Item	Description	Item	Description
1	Pressure Roller Assembly	6	Jam Nut
2	Drum Frame	7	Pressure Gauge
3	Nitrogen Spring Accumulator	8	Cylinder Positioner
4	Cylinder Bracket	9	Rod Nut
5	Threaded Rod		

FIGURE 5-19

Reference Only

BLOCK LEVEL SENSOR

The block level sensors ensure that the load block remains level when two load lines - Drums 1 and 2 - are routed to the load block. Located on the #90 and #91 boom tops, the sensors monitor sheave rotation speed. The crane's programmable controller uses signals from the sensors to equalize the rotation speed of the drums so the load block remains level.

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

Sensor Configurations

See Figure 5-20, Figure 5-21, Figure 5-22, Figure 5-23, and Figure 5-24 for the following procedure.

The sensors are configured according to the sheaves configuration. Refer to Figure 5-20 for sensor configuration overview. Refer to Figure 5-21 for end sheave sensor set-up and refer to Figure 5-24 for upper sheave configuration and sensor set-up.

Sensor Adjustment

See Figure 5-20 for the following procedure.

Sensor adjustments are the same for all the sheaves.

1. Loosen Capscrew (7) and adjust slotted sensor bracket (5) as close to fixed sensor bracket (4) as possible.
2. Tighten Capscrew (7).
3. Loosen jam nut (6) securing sensor (2) to bracket (4) and (5).
4. Turn sensor (2) in or out as needed until dimension between end of sensor and proximity sensor target plate (3) is 1/4 in (6 mm) to 23/64 in (9 mm) gap as shown in View A.

NOTE: The LED (8) on the sensor will turn ON when sensor detects passing target plate.

5. Tighten jam nuts (6).
6. Check for proper operation without load. Drums should operate at same speed and load block should remain level.
7. Readjust sensor if required.

Sensor Mounting Location

See Figure 5-21, Figure 5-22, Figure 5-23, or Figure 5-24 for the following procedure.

The lower sheaves on the guide wire rope assembly can be set-up for different rope configurations. The sensors are mounted in different locations depending on the configuration.

For configuration 1 two sensors are mounted on the guide wire frame and two sensors are mounted on the sensor mounting bracket as shown in Figure 5-21 View A with boom only.

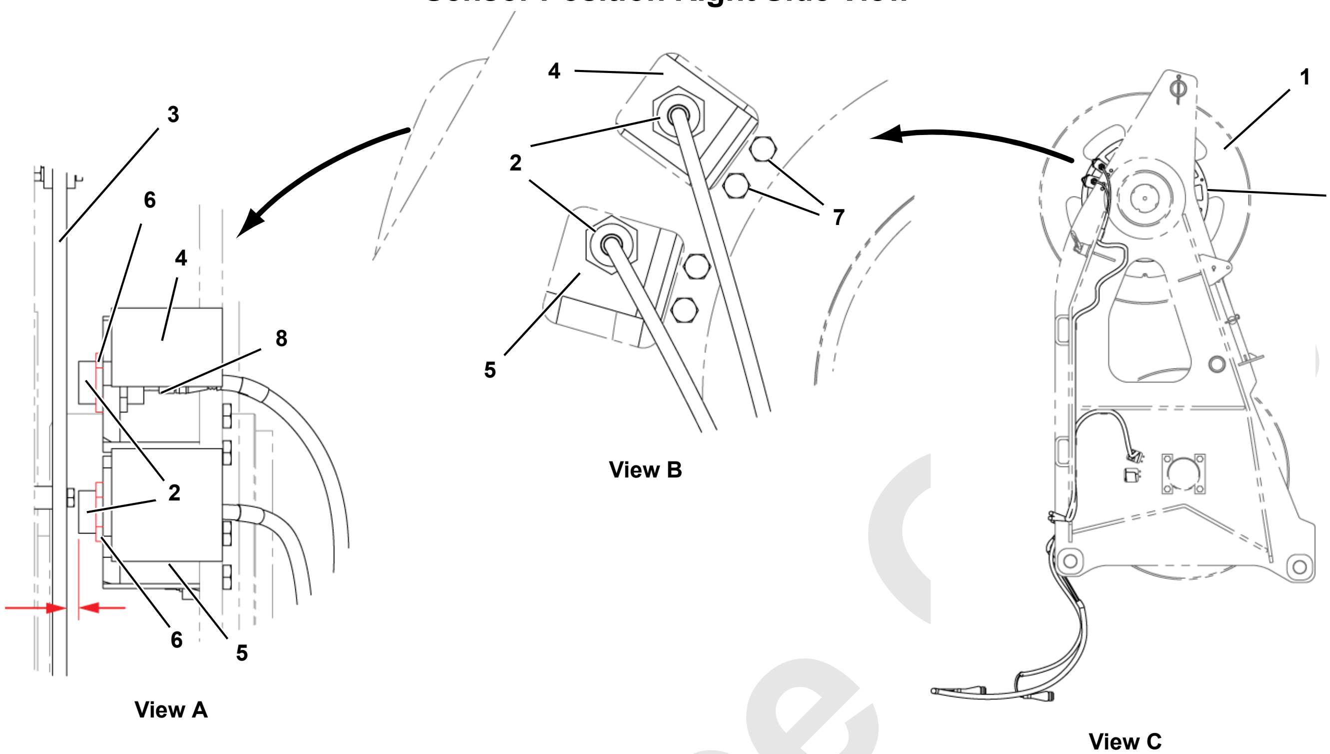
For configurations 2 and 3 all sensors are mounted on a sensor mounting bracket on each side of the sheaves as shown in Figure 5-22 View B with boom only.

For Configurations with Luffing Jib or Fixed jib, see Figure 5-23.

Reference chapter 4 of the crane Operator Manual for correct configuration and sheave locations in respect to boom rigging and assembly instructions.

Reference Only

Sensor Position Right Side View



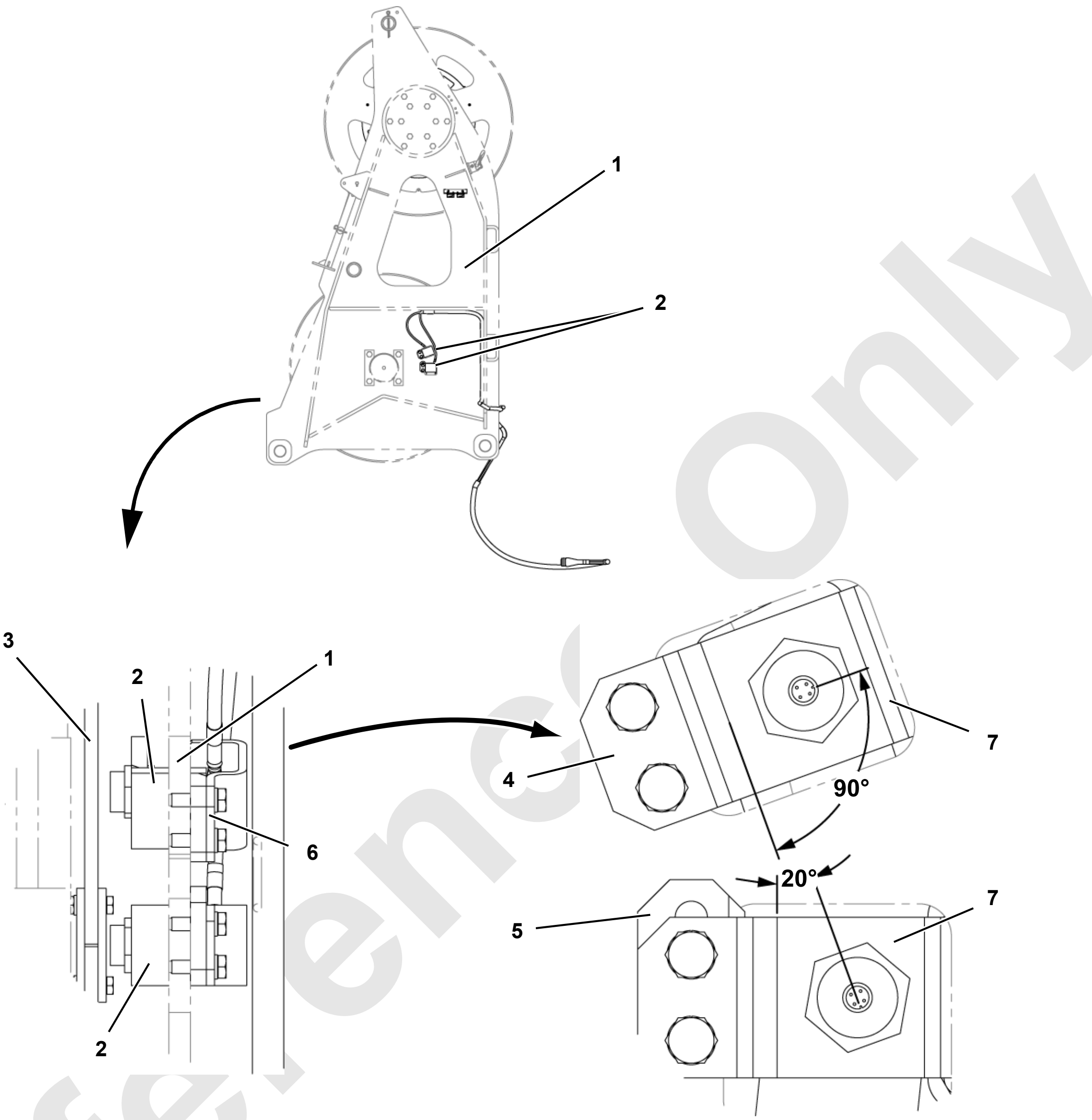
Item	Description	Item	Description
1	End Sheave	5	Proximity Sensor Bracket and Cover Slotted
2	Sensor	6	Jam Nut
3	Target Plate	7	Cap Screw
4	Proximity Sensor Bracket and Cover	8	LED (not shown, located on sensor under bracket)
		9	Sensor Gap With Target Plate (6 mm to 9 mm)

FIGURE 5-20

Right Side View #90 Top With Boom Only or #91 Top

Reference

Sensor Position Left Side View Configuration 1



View A
Configuration 1 Only

Item	Description	Item	Description
1	Guide Wire Rope Assembly	4	Proximity Sensor Bracket
2	Sensor	5	Proximity Sensor Bracket Slotted
3	Target Plate	6	Sensor Mounting Bracket
		7	Sensor Connector Key Orientation

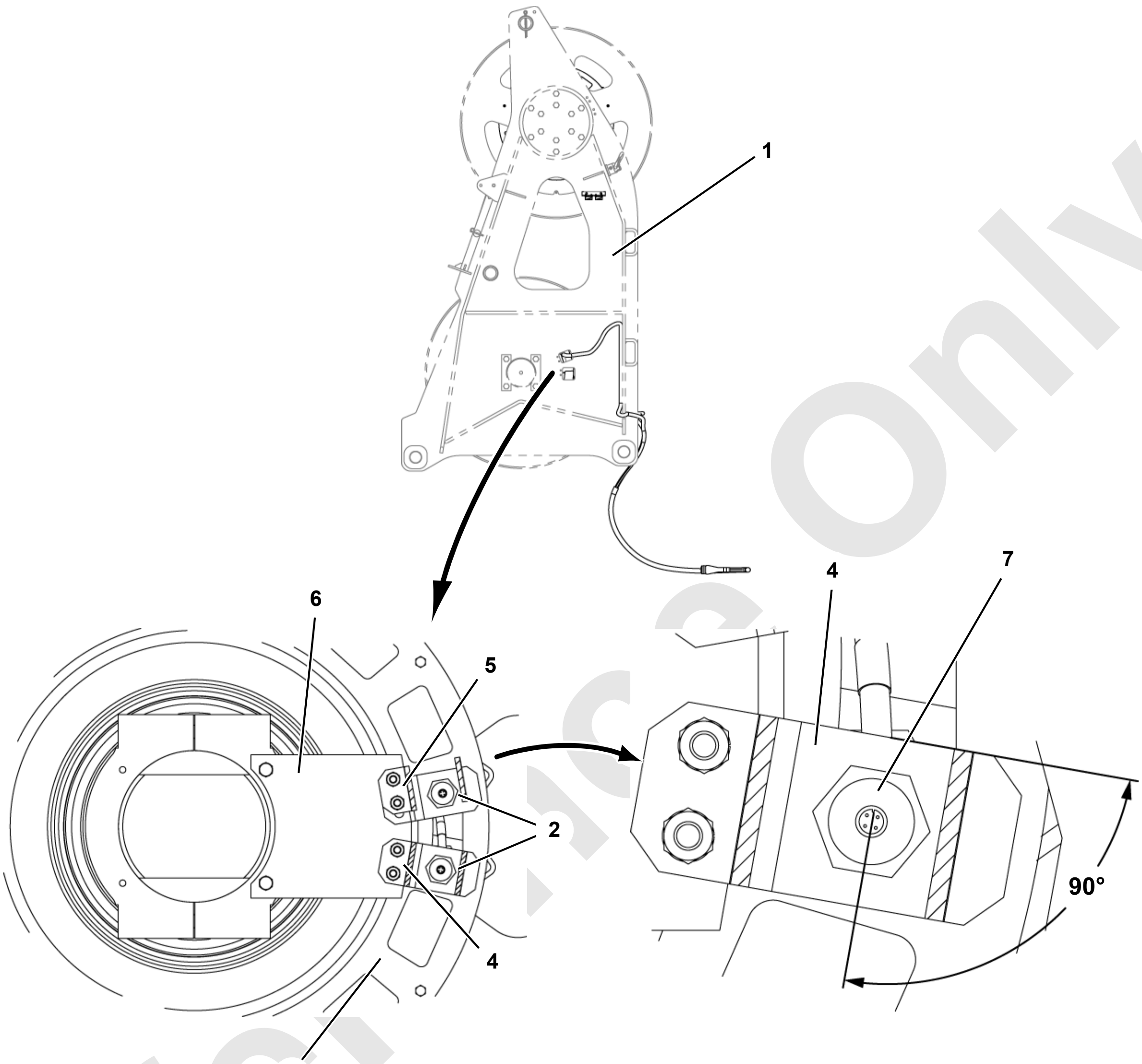
FIGURE 5-21

Left Side View #90 Top With Boom Only or #91 Top

Configuration 1 Only

Reference Only

Sensor Position Left Side View Configurations 1 and 2



View B
Configurations 2 and 3 only

Item	Description	Item	Description
1	Guide Wire Rope Assembly	4	Proximity Sensor Bracket
2	Sensor	5	Proximity Sensor Bracket Slotted
3	Target Plate	6	Sensor Mounting Bracket
		7	Sensor Connector Key Orientation

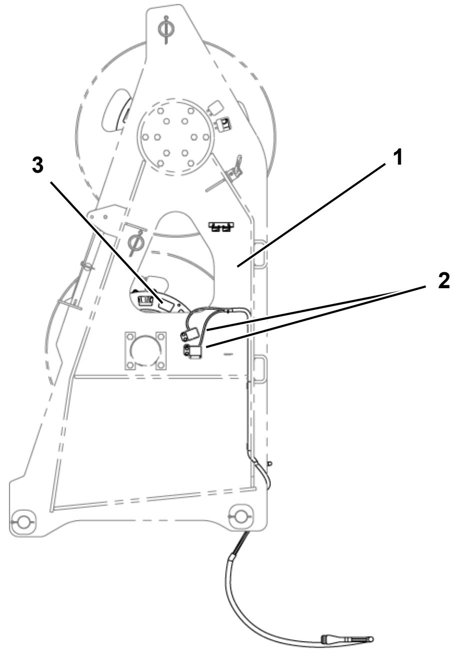
Reference Only

FIGURE 5-22

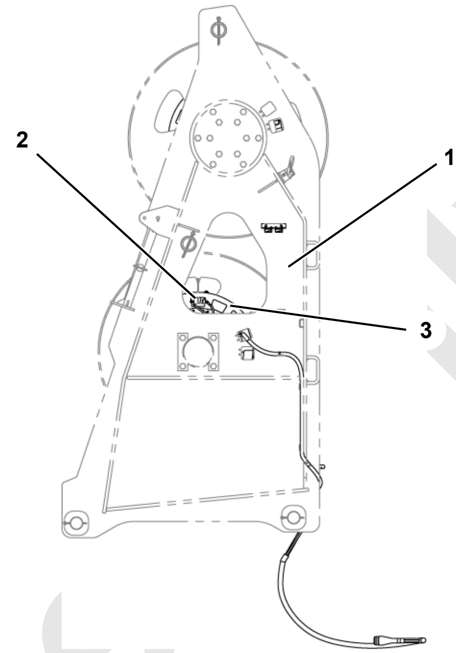
Left Side View #90 Top With Boom Only or #91 Top

Configurations 2 and 3 Only

Sensor Position Left Side View With Jib



View C
Configuration 1 only



View D
Configurations 2 and 3 only

Item	Description	Item	Description
1	Guide Wire Rope Assembly	3	Target Plate
2	Sensor		

FIGURE 5-23

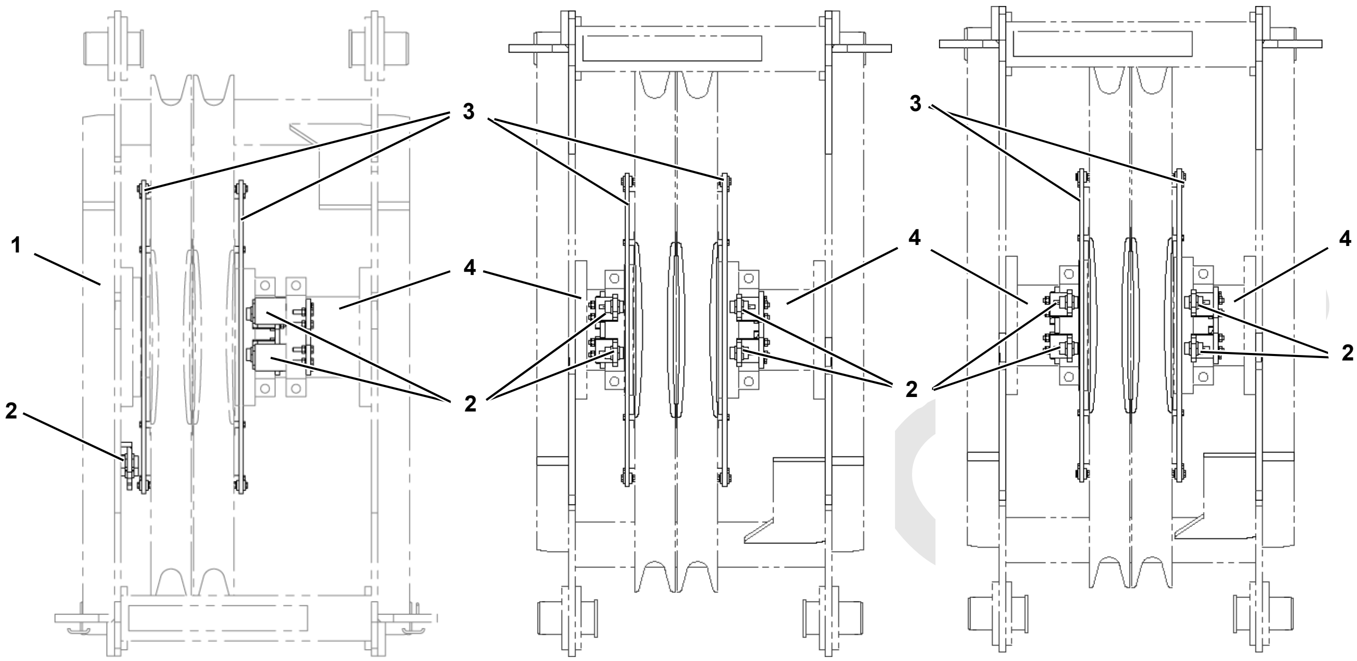
Left Side View #90 Boom Top With Luffing Jib or Fixed Jib

All Configurations

Reference Only

Manitowoc Crane Care

Sensor Position Top View All Configurations



Configuration 1

- drum 1 is used with single boom point and one drum/ lead line operation.
- drum 1 is used with two boom points and two drum/ lead line operation.
- drum 2 and drum 3 are used for two drum/lead line operations with one or two boom points and drum 1 is disabled

Configuration 2

- drum 1 is used with single boom point and two drum/ lead line operation.
- drum 1 is used with two boom points and two drum/ lead line operation.

Configuration 3

- drum 1 is used with drum 3 for two drum/lead line operation for single or two boom points and drum 2 is disabled.

Viewed from upper boom top looking toward boom butt. Configuration description is for reference.

Item	Description	Item	Description
1	Guide Wire Rope Frame	3	Target Plate
2	Sensor	4	Sensor Mounting Bracket

FIGURE 5-24

Reference

BLOCK-UP LIMIT CONTROL

Definition

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

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

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

The block-up limit controls must be installed according to Boom Wiring and Limits drawing.

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 slowdown line speed to allow block-up limit control to function properly.

The block-up limit control consists of the following components:

- See Figure 5-25 for # 90 boom.
- See Figure 5-26 for #90 with upper boom point.

1. Normally closed limit switch assembly fastened at the following locations:
   a. boom point.
   b. Upper boom point.
2. Weights freely suspended by chains from each limit switch actuating lever (weight encircles load line as shown).
3. Lift block fastened to load line for single part line.

Operation

See Figure 5-25 and Figure 5-26 for the following procedure.

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. The load can be hoisted and the boom can be lowered.

When the weight is lifted by the lift block, 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 hoist pumps stroke to off. At the same time, the load drum and boom parking brakes apply to stop the load drum from hoisting and the boom from lowering.

Reference Only

Block-Up Limit Assembly Components

Item	Description	Item	Description
1	#90 Boom	6	Anchor Weight Shackle
2	Block Level Indicator	7	Block-Up Limit Switch
3	Block Level Controller	8	Not Used
4	Chain, 17 ft (5,18 m)	9	Universal Node Controller
5	Actuator Weight		

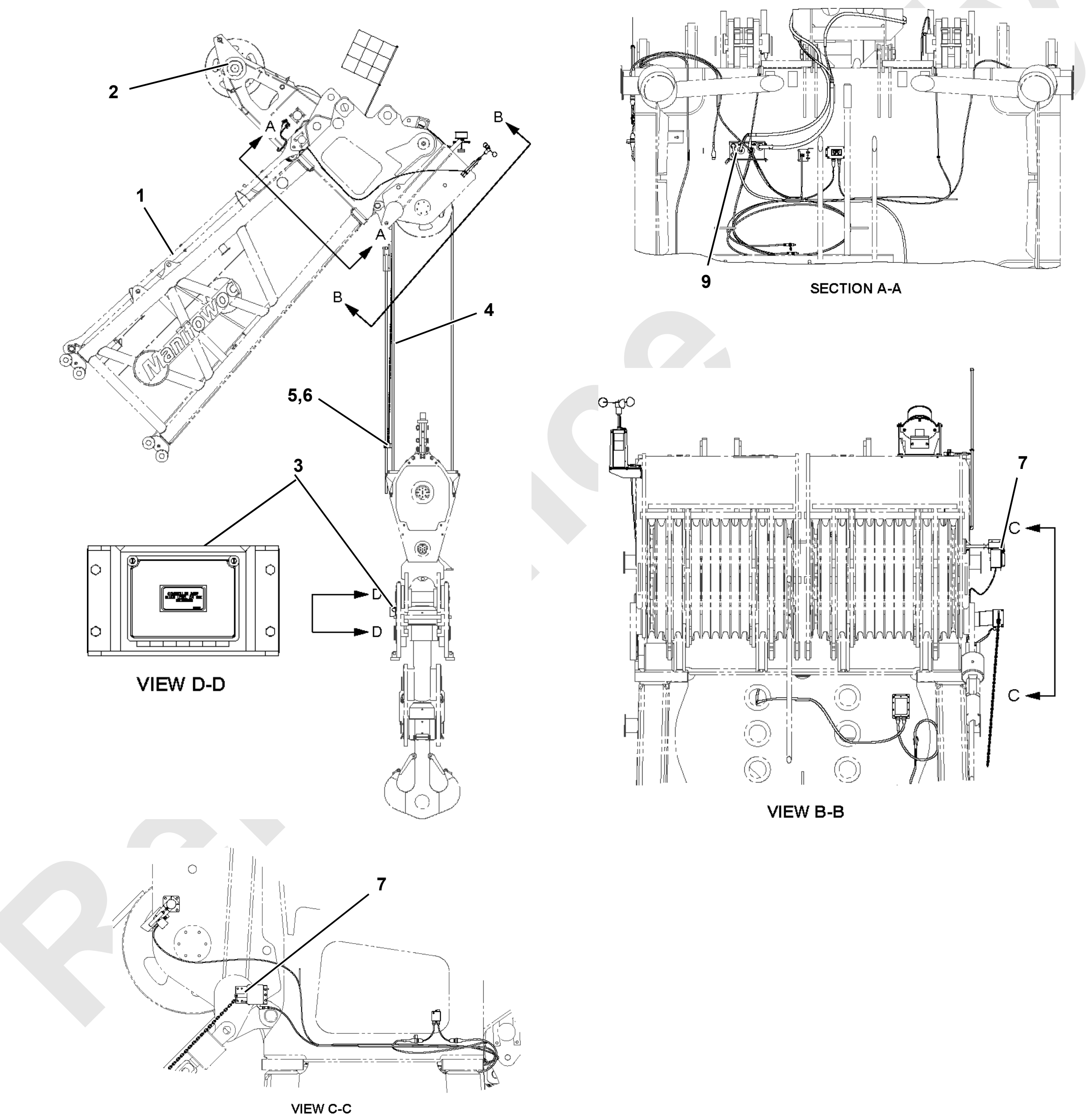


FIGURE 5-25

Boom Point Block-Up Limit Component Locations

Item	Description	Item	Description
1	#90 Boom	5	Chain, 12 ft (3,66 m)
2	Chain, 17 ft (5,18 m)	6	Lift Block for 50 mm Wire Rope[1]
3	Actuator Weight	7	Block-Up Limit Switch
4	Anchor Weight Shackle		

[1] Only required for single part line

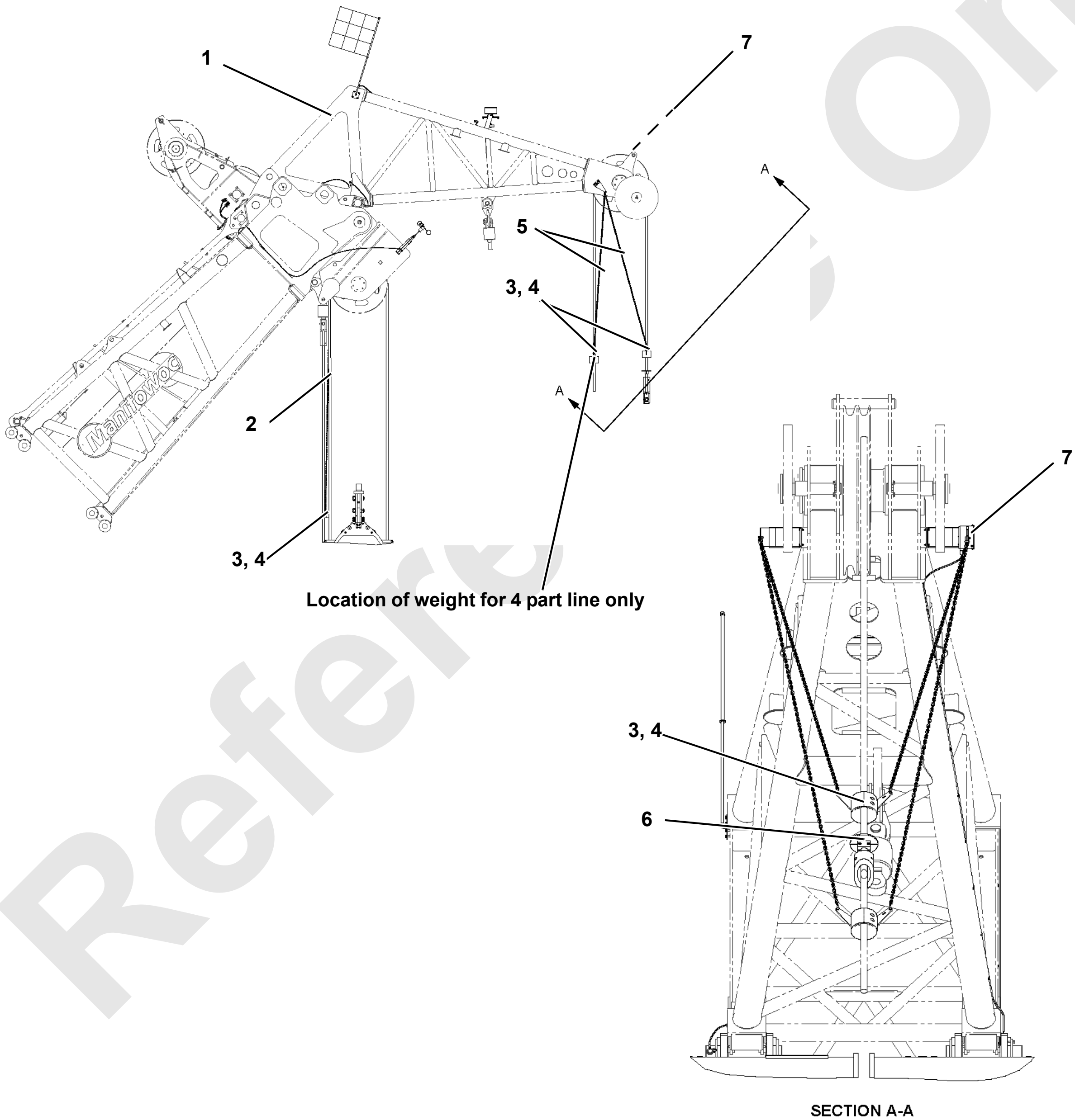


FIGURE 5-26

Reference Only

BLOCK-UP LIMIT MAINTENANCE

Inspect and test the block-up limits ***weekly or every 40 hours of operation***, as follows:

CAUTION

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 onto blocking at ground level and 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, each chain, each shackle and each connecting pin for excessive or abnormal wear. Make sure cotter pins for shackles are installed and spread.
   d. Inspect entire length of each electric cable for damage.
   e. Check that electric cables are clear of all moving parts on boom and jib and that cables are securely fastened to boom and jib with nylon straps.
   f. Check that all plugs are securely fastened.
2. Test block-up limits for proper operation using either of 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 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 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.

Block-Up Limit Switch Adjustment

See Figure 5-27 and Figure 5-28 for assembly component break down.

NOTE: Block-Up limit assembly A06154 is used on crane serial numbers 31001001 and 31001002. Block-Up limit assembly 81015941 is used on 31001003 and newer. Identify block-up limit switch for correct adjustment procedure.

Block-Up Limit Adjustment for Assembly A06154

See Figure 5-27 for the following procedure.

Lower boom onto blocking at ground level and adjust each limit switch as follows:

1. Remove block-up limit assembly cover (11) to gain access to internal components.
2. Adjust springs (3) tension so there is enough force to lift weight of chain and rotate actuating lever (7) when weight is lifted.
3. Loosen setscrew (2) in limit switch lever (9) so lever is free to rotate.
4. Manually lift weight to allow actuating lever (7) to rotate upward.
5. Hold lever at Dimension A.
6. Hold roller (8) on limit switch lever against actuating lever while performing step 7.
7. Turn limit switch shaft (10) ***clockwise only enough to just actuate switch.*** Then securely tighten setscrew (2) in limit switch lever (9).
8. Turn limit switch shaft ***counterclockwise*** for right hand version.

Test limit switch for proper operation (see Maintenance topic); repeat adjustment steps until limit switch operates properly. Install block-up limit assembly cover when testing is complete.

5

Reference Only

Block-Up Limit Adjustment for Assembly 81015941

See Figure 5-29 for the following procedure.

Lower boom onto blocking at ground level and adjust each limit switch as follows:

1. Remove block-up limit assembly cover to gain access to internal components.
2. Adjust both spring tensions so there is enough force to lift weight of chain and rotate actuating lever (5) when weight is lifted.
3. Loosen setscrew (2) in limit switch lever (7) so lever is free to rotate.
4. Manually lift weight to allow actuating lever (7) to rotate upward.
5. Hold lever at Dimension A.
6. Hold roller (6) on limit switch lever (7) against actuating lever (5) while performing step 7.
7. Turn limit switch shaft (8) ***clockwise only enough to just actuate switch.*** Then securely tighten setscrew (2) in limit switch lever (7).
8. Turn limit switch shaft ***counterclockwise*** for right hand version.

Test limit switch for proper operation (see Maintenance topic); repeat adjustment steps until limit switch operates properly. Install block-up limit assembly cover when testing is complete.

Block-Up Limit Switch Replacement

NOTE: Limit switch replacement procedure for block-up limit assembly A06154 is similar to 81015941.

See Figure 5-28 for the following procedure.

1. Remove block-up limit assembly cover (11).
2. Remove four mounting screws on limit switch (13).
3. Remove limit switch terminal cover, exposing internal wiring connections.
4. Remove the two terminal connections and cord grip with elbow (1) from the limit switch (13).
5. Loosen set screw (2) and remove limit switch lever (9).
6. Install wiring and cord grip onto replacement limit switch. Connect the black wire to limit switch terminal #21 and the white wire to terminal #22. Lead wires must be stripped to 0.25 in (6,35 mm) to properly fit the terminal board U-Clamp screw terminations.
7. Replace limit switch terminal cover.
8. Install limit switch lever (9).
9. Install limit switch (13) onto block-up limit assembly with four mounting screws.
10. Perform block-up limit adjustment procedure.
11. Install block-up limit assembly cover (11).

Reference Only

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Block-Up Limit Switch A06154 Component Identification

Item	Description
1	Elbow with Connector
2	Setscrew
3	Spring
4	Enclosure
5	Eye Bolt
6	Grease Fitting
7	Actuating Lever
8	Roller
9	Limit Switch Lever
10	Limit Switch Shaft
11	Cover
12	Jam Nut

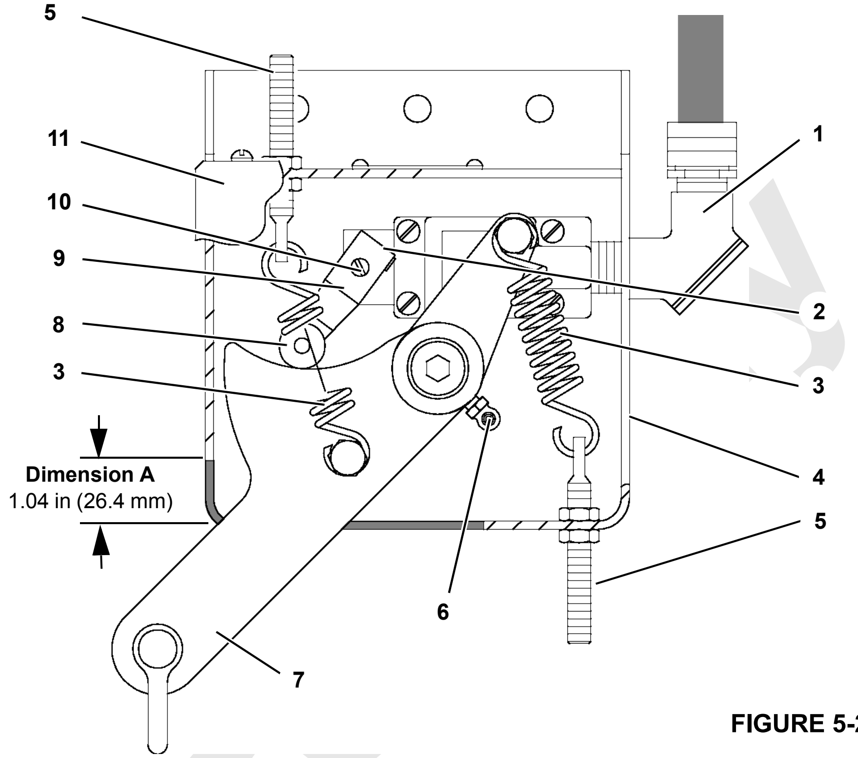

FIGURE 5-27

Block-Up Limit Switch 81015941 Component Identification

Item	Description
1	Elbow with Connector
2	Setscrew
3	Spring
4	Enclosure
5	Eye Bolt
6	Grease Fitting
7	Actuating Lever
8	Roller
9	Limit Switch Lever
10	Limit Switch Shaft
11	Cover
12	Jam Nut
13	Limit Switch

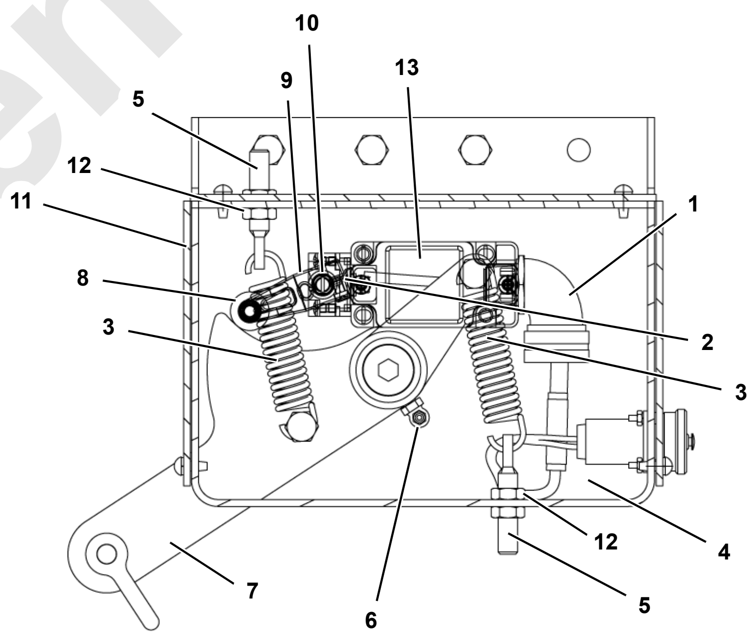

FIGURE 5-28

Block-Up Limit Switch 81015941 Showing Actuator Trip Point

Item	Description
1	Elbow with Connector
2	Setscrew
3	Enclosure
4	Grease Fitting
5	Actuating Lever
6	Roller
7	Limit Switch Lever
8	Limit Switch Shaft

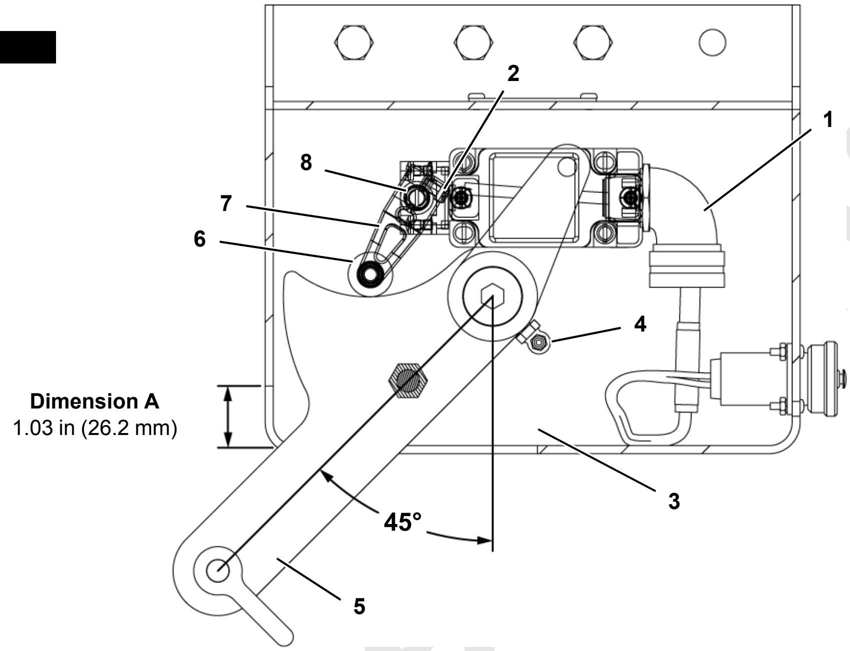

FIGURE 5-29

Reference Only

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Reference Only

WIRE ROPE LUBRICATION

Refer to the Lubrication manual for recommendations.

WIRE ROPE INSPECTION AND REPLACEMENT

General

The inspection and replacement guidelines which follow comply with United States regulations.

It is impossible to predict when a wire rope will fail; however, frequent and periodic careful inspection by a qualified inspector will indicate when the potential for failure exists.

Keeping Records

A signed and dated report of the wire rope's condition at each periodic inspection must be kept on file at all times. The report must cover all inspection points listed in this section. The information in the records can then be used to establish data which can be used to determine when a wire rope should be replaced.

It is recommended that the wire rope inspection program include reports on the examination of wire rope removed from service. This information can be used to establish a relationship between visual inspection and the rope's actual internal condition at the time of removal from service.

Inspecting Wire Rope

Frequent Inspection

Visually inspect all running ropes in service once each work shift and observe the rope during operation. Pay particular attention to areas of the rope where wear and other damage is likely to occur:

- Pick-Up Points — sections of 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.

Inspect all rope which can be reasonably expected to be in use during operation for obvious damage which poses an immediate hazard, such as the following:

1. Rope distortion such as kinking, crushing, unstranding, bird caging, main strand displacement, and core protrusion.

   Loss of rope diameter and unevenness of the outer strands indicate that the rope should be replaced.
2. Corrosion (clean and lubricate).
3. Broken or cut strands.
4. Broken wires (see Periodic Inspection for additional information).
5. Core failure in rotation resistant rope (indicated by lay lengthening and reduction in diameter).

Periodic Inspection

The periodic inspection interval must be determined by a qualified inspector and be based on the following factors:

- Expected rope life as indicated by the rope manufacturer or past experience as determined by the qualified inspector.
- Severity of the environment the rope is operated in.
- Size, nature, and frequency of lifts.
- The rope's exposure to shock loading and other abuse.
- Rope maintenance practices.

The periodic inspection must be performed at least annually.

During the periodic inspection, the entire length of wire rope must be inspected for the following types of damage. Any damage found must be recorded and a determination made as to whether continued use of the rope is safe.

1. All points listed under frequent inspection.
2. Reduction in rope diameter below the nominal diameter caused by loss of core support, internal or external corrosion, or wear of the outside wires.
3. Severely corroded or broken wires at end attachments.
4. Severely corroded, cracked, bent, worn, or improperly applied end attachments.

Rope Not In Regular Use

Wire rope must be given a complete inspection if it has been idle for a month or more due to shutdown or storage of the crane on which the rope is installed. The inspection must be performed by a qualified inspector looking for the damage identified under both Frequent and Periodic Inspection.

Replacing Wire Rope

The final decision as to when a wire rope should be replaced is the responsibility of the qualified inspector. Discovery of the following conditions is sufficient reason for questioning a wire rope's safety and for replacing it.

Reference Only

Wire Rope Diameter

Measure and record the diameter of a new wire rope after initial loading for comparison with future inspections. A reduction in rope diameter is often the first outward sign that the wire rope core is damaged. When reduction in diameter is noted, the rope must be removed from service.

Measure the rope's diameter across crowns of the strands so the true diameter is measured as shown in Figure 5-30

Wire rope shall be taken out of service when reduction from nominal diameter is more than 5 percent.

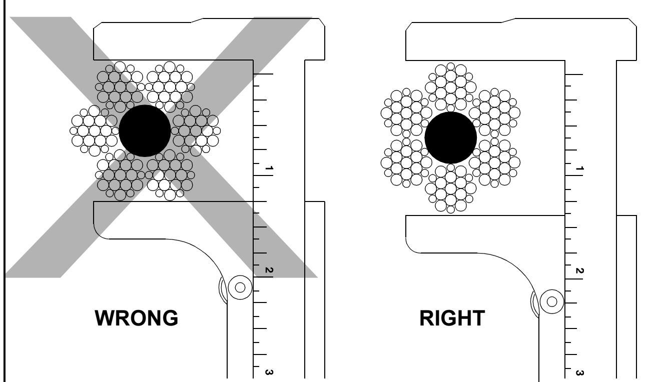


FIGURE 5-30

Broken Wires

Thoroughly clean the wire rope so breaks can be seen. Relax the rope, move it off "pick-up points," and flex it as much as possible. Use a sharp awl to pick and probe between wires and strands, lifting any wire which appears loose or moves excessively.

Wire rope shall be taken out of service when it has following number of broken wires.

See Figure 5-31 for an explanation of lay length.

- Running Ropes (working lines) — six randomly distributed broken wires in one lay length, three broken wires in one strand of one lay length, or more than one broken wire at end attachment (see Figure 5-18, Wedge Socket and Button Cable).
- Rotation Resistant Rope — two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in thirty rope diameters.
- Standing Ropes (pendants) — more than two broken wires in one lay length in sections beyond the end attachment, or more than one broken wire at the end attachment (see Figure 5-32).
- Any Rope — one outer wire broken at the point of contact with the core. The broken wire protrudes or loops out of the rope structure.

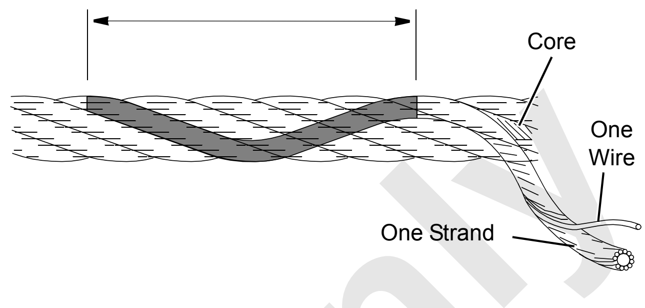


FIGURE 5-31

WARNING

Replace wire rope when more than one broken wire appears at point marked by arrow.

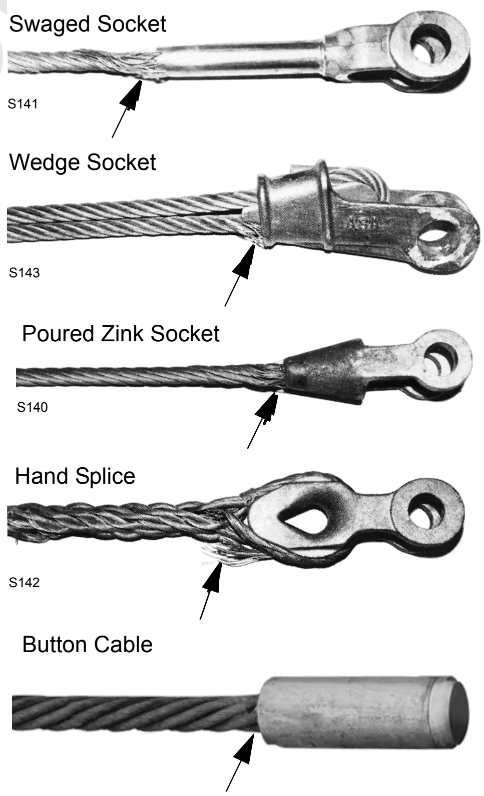


FIGURE 5-32

Reference Only

Wear and Other Damage

See Figure 5-34 for examples of wire rope damage.

It is normal for the outer wires of the rope to wear first because of friction.

Wire rope shall be taken out of service if:

- Rope core protrudes from between outer strands.
- Severe corrosion – indicated by pitting – exists.
- Obvious damage exists from any heat source to include – but not limited to – welding, power line strike, or lighting.
- Kinking, crushing, bird caging, or any other damage resulting in distortion of wire rope structure exists.

WARNING

Falling Load Hazard!

Wire rope can break if following precaution is not observed:

- Replacement wire rope must meet specifications given in Wire Rope Specifications Chart (load lines) or Boom Rigging Drawing supplied with your crane.

Large Diameter Rope (50mm)

Large diameter rope (50mm) may show gapping between outer layer strands. This is due to the outer strands laying in the opposite lay as the core, allowing the outer strands to move over the core after a sheave, and stiff lubricant not filling in. This is normal for this size of rope. See Figure 5-33.

Make sure gaps in the rope are filled with lubricant.

FIGURE 5-33

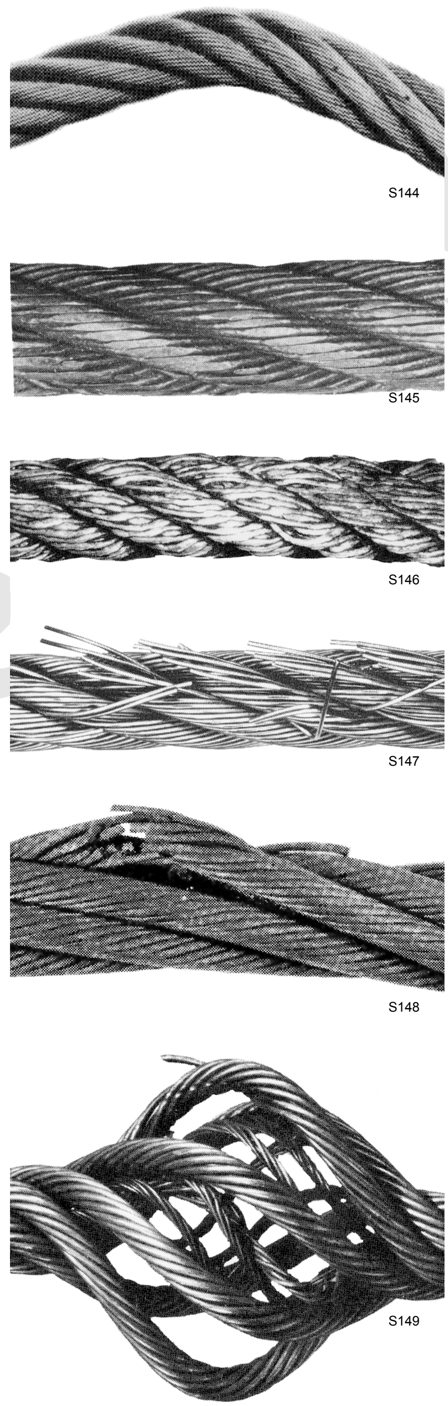


FIGURE 5-34

SHEAVE, ROLLER, AND DRUM INSPECTION

Perform the following inspections WEEKLY.

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

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

   Boom hoist and load hoist sheaves have grease and relief fitting for periodic regreasing.

   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 5-35. 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 5-36.
7. Make sure sheaves, drums, and rollers are properly lubricated according to lubrication instructions in Operator Manual.

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

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

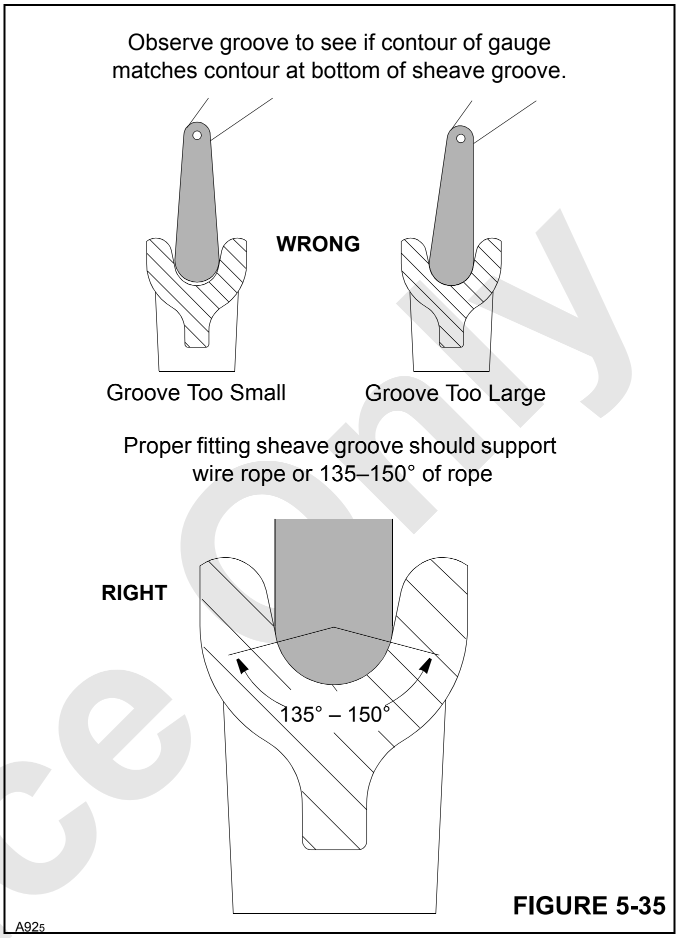


FIGURE 5-35

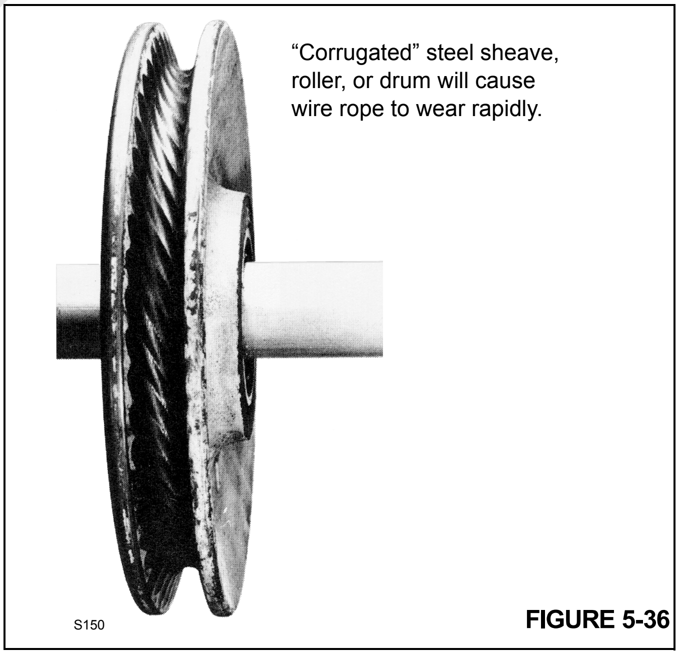


FIGURE 5-36

NOTE: For some sheaves, the seals are an integral part of the bearing. Therefore, if a seal is damaged during repacking, the complete bearing may have to be replaced.

5

Reference Only

Distributing Wire Rope Wear

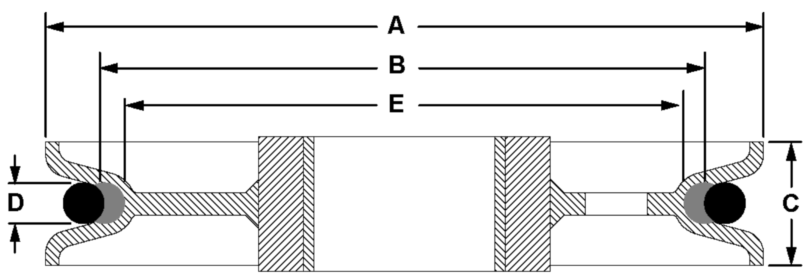
Wire rope wear at the “critical wear points” can be reduced and the life of the wire rope extended by moving the rope at regular intervals so different sections of rope are subjected to the wear points. This practice can also help correct spooling problems and rope vibration.

To move the wire rope, cut off a piece of wire rope at the drum and refasten it. The piece cut off should be long enough to move wire rope at least one full drum wrap.

If the wire rope is too short to allow cutting off a piece of it, reverse the rope end for end and refasten it.

SHEAVE INSPECTION CRITERIA

Sheave (19MM Rope)



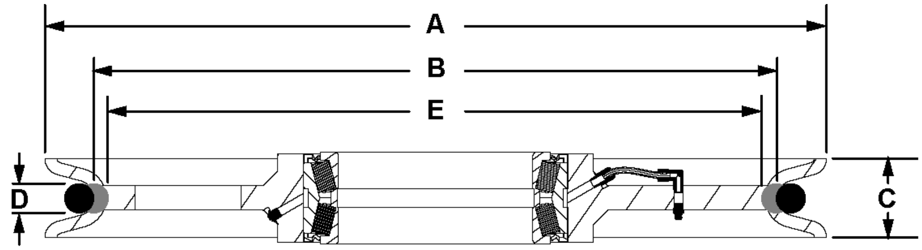
SHEAVE DATA									
Sheave Part No.	A Outside Diameter		B Tread Diameter [1]		C Width		D Rope Diameter		Used on
	inch	mm	inch	mm	inch	mm	inch	mm	
81001331	16.00	406,4	13.38	339,9	2.75	69,9	3/4	19	2
REPLACEMENT DATA									
E = B - 3/16 in (4,8 mm) Maximum from Original Tread Diameter									

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

[2] #90 Boom Equalizer, Guide Wire Equalizer, Guide Wire Rigging Winch, Rigging Winch Equalizer, Mast Butt #92

Reference Only

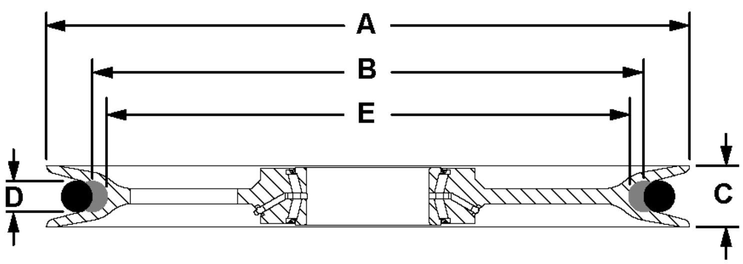
Sheave (34MM Rope)



SHEAVE DATA									
Sheave Part No.	A Outside Diameter		B Tread Diameter [1]		C Width		D Rope Diameter		Used on
	inch	mm	inch	mm	inch	mm	inch	mm	
81002745	32.19	817,6	28.13	714,5	3.25	82,6	1.34	34	Mast, #90 Equalizer
81002747	48.00	1219,2	43.32	1100,3	3.25	82,6	1.34	34	#92 Mast Top
REPLACEMENT DATA									
E = B - 3/16 in (4,8 mm) Maximum from Original Tread Diameter									

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

Sheave (50MM Rope)

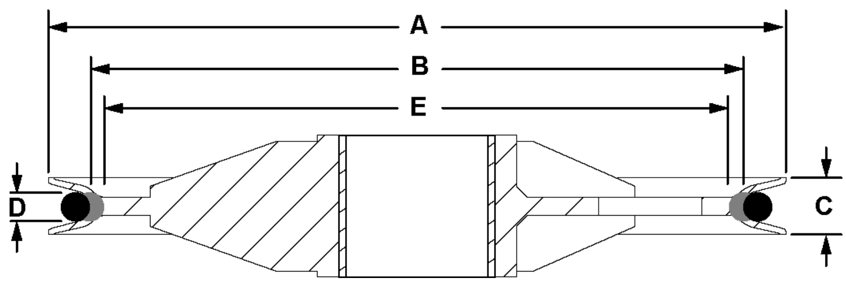


SHEAVE DATA									
Sheave Part No.	A Outside Diameter		B Tread Diameter [1]		C Width		D Rope Diameter		Used on
	inch	mm	inch	mm	inch	mm	inch	mm	
81000169	42.00	1066,8	36.00	914,4	4.00	101,6	1.97	50	#90 Equalizer Wire Rope Guide
A18785	52.00	1320,8	46.00	1168,4	4.00	101,6	1.97	50	2
81003886	52.00	1320,8	46.00	1168,4	4.00	101,6	1.97	50	#90 Boom Wire Rope Guide
81000440	52.00	1320,8	46.00	1168,4	4.00	101,6	1.97	50	#90 Boom Wire Rope Guide (2)
REPLACEMENT DATA									
E = B - 3/16 in (4,8 mm) Maximum from Original Tread Diameter									

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

[2] #90 - 91RH Lower Boom Point, #90 - 91Upper Boom Point, #90 Guide Wire Rope

Sheave (50MM Rope)



SHEAVE DATA									
Sheave Part No.	A Outside Diameter		B Tread Diameter [1]		C Width		D Rope Diameter		Used on
	inch	mm	inch	mm	inch	mm	inch	mm	
A18954	52.00	1320,8	36.00	1168,4	4.00	101,6	1.97	50	#90 Boom Wire Rope Guide
REPLACEMENT DATA									
E = B - 3/16 in (4,8 mm) Maximum from Original Tread Diameter									

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

Reference Only

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 5-37) 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.

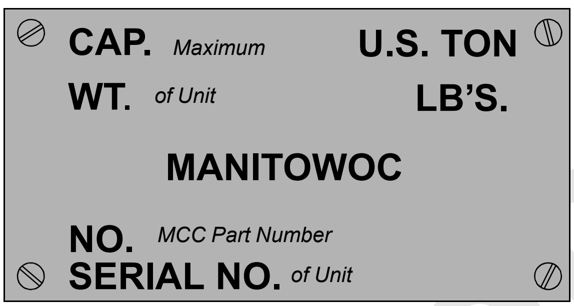


FIGURE 5-37

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 5-38 and 5-39):

1. Clean the load block or the hook-and-weight ball.
2. Lubricate the sheaves (if fittings provided), the hook trunnion, the hook swivel, and any other part equipped with a grease fitting at the intervals specified in the "Lubrication Guide."
3. Tighten loose tie-bolts, cap screws, and set screws. Check that all cotter keys are installed and opened.
4. Check the sheaves for uneven wear in the grooves and on the flanges. Check for loose or wobbly sheaves. These conditions indicate faulty bearings or bushings.
5. Check the fit of the wire rope in the groove of each sheave. An oversize wire rope can crack the lip of the sheave flange causing rapid wear of the wire rope and sheave. The groove must be larger than the wire rope, and the groove must be free of rough edges and burrs.
6. Check that the hook, the trunnion, and the swivel rotate freely without excessive play. Faulty operation indicates faulty bushings or bearings or inadequate lubrication.
7. Check the swivel of the hook-and-weight ball for the following conditions:
    - Overloading: Spin the swivel by hand; if the motion is rough or has a ratchet-like effect, the swivel bearings are damaged.
    - Side loading: The swivel will turn freely in one spot and lock-up in another. This condition can also be checked by looking at the gap (see Figure 5-38) between the barrel and shank (swivel must be removed from weight ball to check); if the gap is wide on the side and closed on the other, damage is present.
8. Check the load block for signs of overloading: spread side plates, elongated holes, bent or elongated tie-bolts, and cracks.
9. Check all welds for defects and cracks.
10. Check the wire rope for wear and broken wires at the point the wire rope enters the dead-end socket. Check the socket for cracks. Tighten the wire-rope clips at the dead end of the wire rope.
11. Check that each hook has a latch and that the hook latch operates properly. ***The latch must not be wired open or removed.***

WARNING

Falling Load Hazard!

To prevent load from dropping the hook latch must retain slings or other rigging in hook under slack conditions. Hook latch is not intended as anti-fouling device, and caution must be taken to prevent hook latch from supporting any part of load. Slings or other rigging must be seated in hook when handling load; they must never be in position to foul hook latch.

12. Inspect each hook and shackle for damage as shown in Figure 5-40.
13. See ASME B30-10 Standard and to your specific hook replacement guidelines.

    ASME (formerly ANSI) standards, are available by mail from the ASME, 22 Law Drive, Fairfield, New Jersey, 07004-2900 (call toll free – US & Canada 800-843-2763,

Reference Only

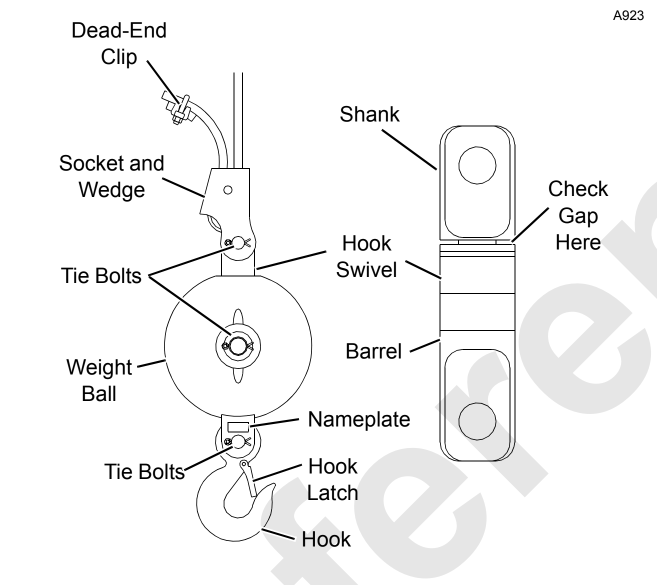
Mexico 95-800-843-2763, Universal 973-882-1167 or fax 973-882-1717 or 973-882-5155 or E-mail *infocentral@asme.org*).

14. Contact the supplier of your hooks, shackles, blocks, and other rigging for repair instructions.
15. Check each hook and shackle at least yearly for cracks using a dye penetrant test, MAG particle test, ultrasonic test, or by X-ray.

WARNING

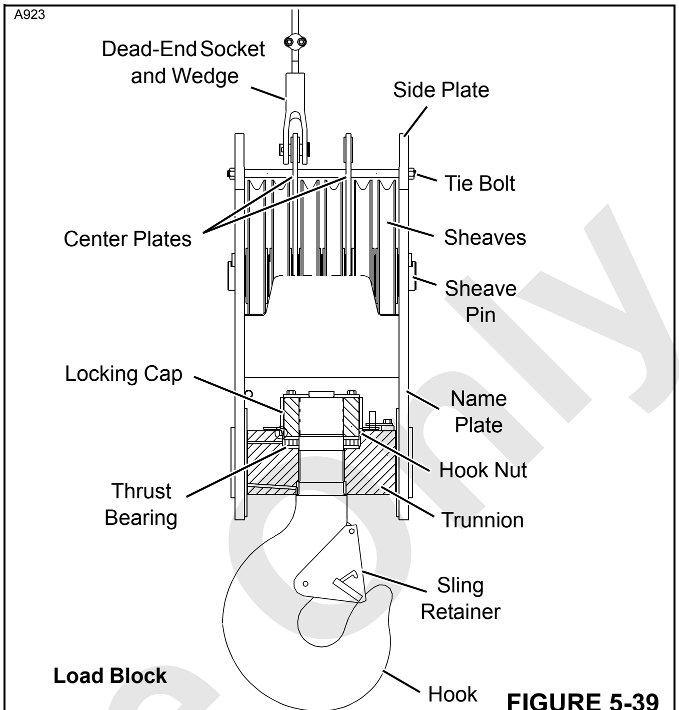
Falling Load Hazard!

To prevent load from dropping due to hook or shackle failure do not attempt to repair cracks in hooks and shackles by welding. Furthermore, do not weld on any load bearing component unless proper welding methods are used (contact Manitowoc Crane Care for material and welding specifications).



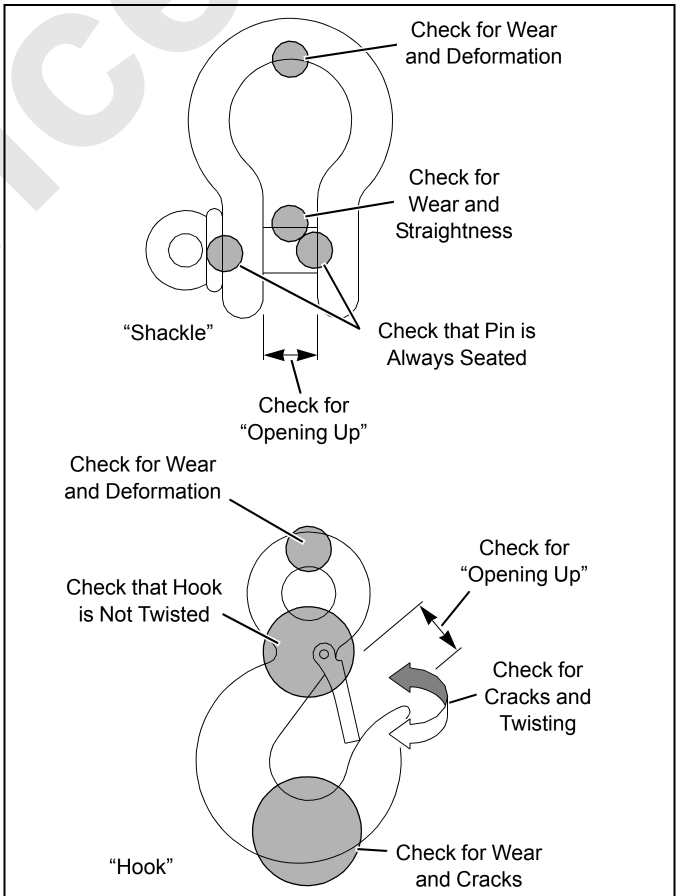
Hook-and-Weight Ball

FIGURE 5-38



Load Block

FIGURE 5-39



Hook and Shackle Inspection

FIGURE 5-40

Reference Only

SECTION 6
SWING SYSTEM

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6

Reference Only

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SECTION 6
SWING SYSTEM

SWING SYSTEM OPERATION OVERVIEW

See Figure 6-1, Figure 6-2, and Figure 6-3 for the following procedure.

Two hydraulic swing pumps drive eight separate swing motors. The hydraulic motors drive gearboxes that mesh with tooth gears and turn rotating bed to swing. The swing system is controlled with swing control handle movement and node controllers. Swing control handle is inoperable when swing brake is applied. Rotating bed is free to coast if swing control handle is in neutral position and swing brake is released.

The swing motors are controlled directly by the output fluid volume of the swing pump. Swing motors are fixed displacement. Swing pressure senders monitor the pressure on swing left and swing right sides of closed loop system. An orifice across swing motor ports A and B allow smoother fluid flow when shifting swing directions. Continuous changing of closed-loop fluid occurs through leakage in pumps and motors.

Swing speed is monitored by a sensor at one hydraulic motor. Swing speed and swing torque can be selected for type of work being performed on Function Mode screen in Main Display Operation manual (see F2207 for procedure).

When swing control handle is moved from OFF, an input signal is sent to Node-1 controller. Node-7 and Node-8 controllers send a 28 volt signal to enable the front and rear swing/travel alarms. When Swing control handle is moved to OFF, an input signal is sent to Node-1 controller. Node-7 and Node-8 controllers send a zero volt output signal to disable the front and rear swing/travel alarms.

Swing Brake

The swing system has a spring-applied hydraulically released brake on each swing gearbox planetary. The source hydraulic pressure for releasing the swing brake is from pump 9, accessory pump at 400 to 500 psi (28 to 35 bar). For swing brake operation the system pressure must be above 200 psi (14 bar) to fully release the brake. If system pressure is below 200 psi (14 bar), swing brake could be partially applied and damage may occur to the swing system. If brake pressure or electrical power is lost when operating, the swing brake is applied. If the primary engine is not running, the swing brake will remain applied.

After startup, place swing brake switch in OFF - park position. An input voltage is sent to Node-1 controller. Node-5 responds by sending a 28 volt output to enable the swing brake solenoid HS-62. Swing brake valve shifts to hydraulically release swing brake from shaft.

Before crane shutdown, place swing brake switch in ON - park position. An input voltage is sent to Node-1 controller. Node-5 controller sends a zero output voltage to disable swing brake solenoid HS-62. Swing brake valve shifts to block fluid to brake and swing brake is applied to eight gearboxes. Fluid from brake flows to tank.

Swing Right or Left

When swing control handle is moved to the ***left***, an input voltage of 2.4 volts or less is sent to Node-1 controller. Node-3 and Node-4 controllers send a variable zero to 28 volt output that is divided by a 220 ohm resistor and applied to swing pump 1 and pump 2 EDC. Pump EDC tilts swash plate relative to handle movement. Fluid flows from pump ports to motor ports, moving rotating bed to left.

When swing control handle is moved to ***right***, an input voltage of 2.6 volts or more is sent to Node-1 controller. Node-3 and Node-4 controllers send a variable zero to 28 volt output that is divided by a 220 ohm resistor and applied to swing pump 1 and pump 2 EDC. Pump EDC tilts swash plate relative to control handle movement. Fluid flows from pump ports to motor ports, moving rotating bed to the right.

As swing control handle is moved to neutral position, Node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-3 and Node-4 controllers send a zero output voltage to move pump swash plate to centered position.

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

Swing Holding Brake Switch

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

When holding brake switch is pressed in and held, an input voltage is sent to Node-1 controller. Node-5 controller sends a zero output voltage to shift swing brake solenoid HS-62. Swing brake valve shifts to block fluid to brake and swing brake is applied.

When swing holding brake switch is released, an input voltage is sent to Node-1 controller. Node-5 controller sends a 28 volt output to shift swing brake solenoid HS-62. Swing brake valve shifts, allowing system pressure to hydraulically release park brake.

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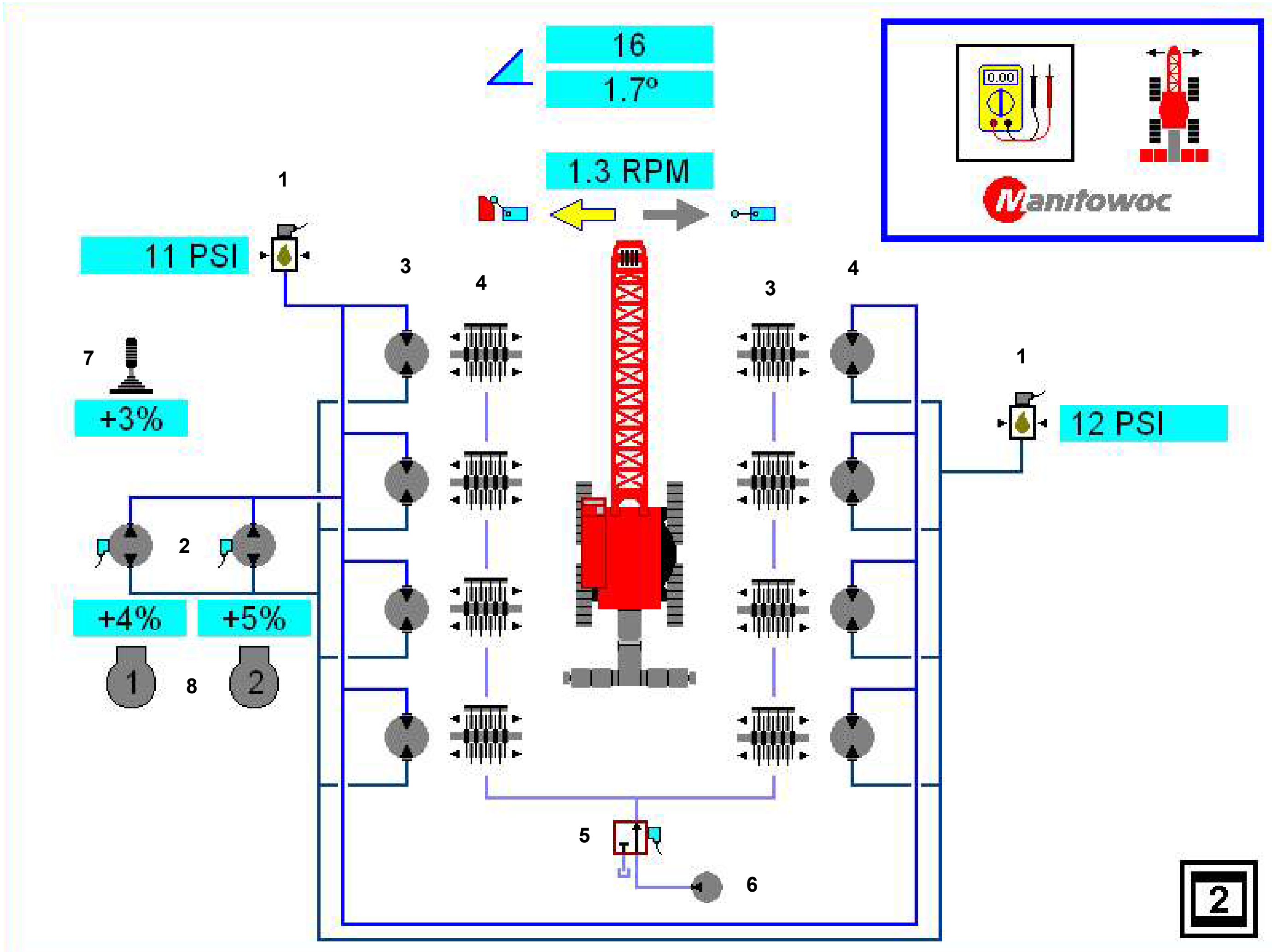
Reference Only

SWING SYSTEM DIAGNOSTICS OVERVIEW



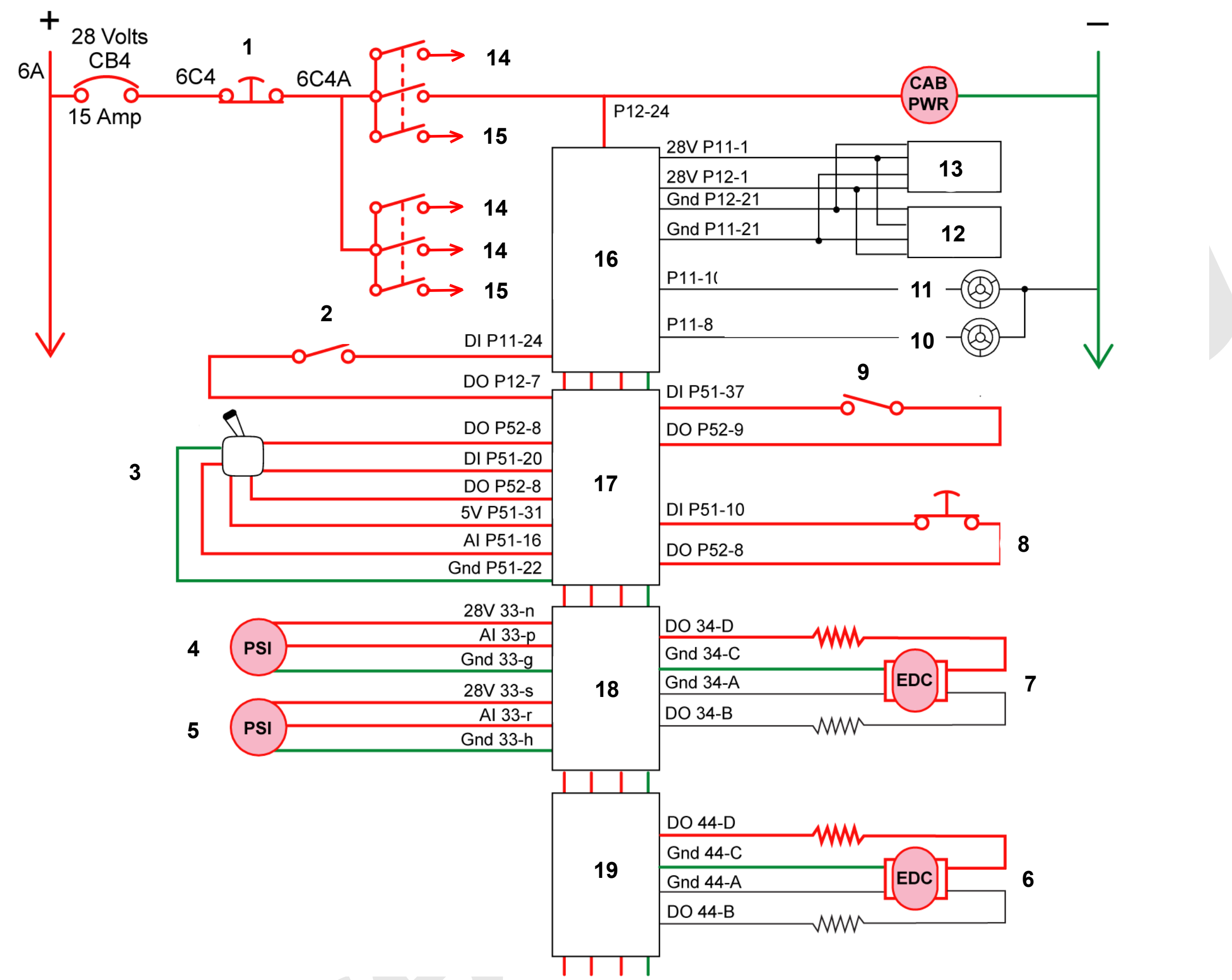
Item	Description	Item	Description
1	Pressure Sender	5	Swing Brake Control Valve HS-62
2	Swing Pumps	6	Accessory Pump (Low-Pressure)
3	Swing Motors	7	Swing Control Handle
4	Swing Brakes	8	Percentage of Pump Command

FIGURE 6-1

NOTE: See Folio 2207 for detailed swing diagnostic information.

Ref

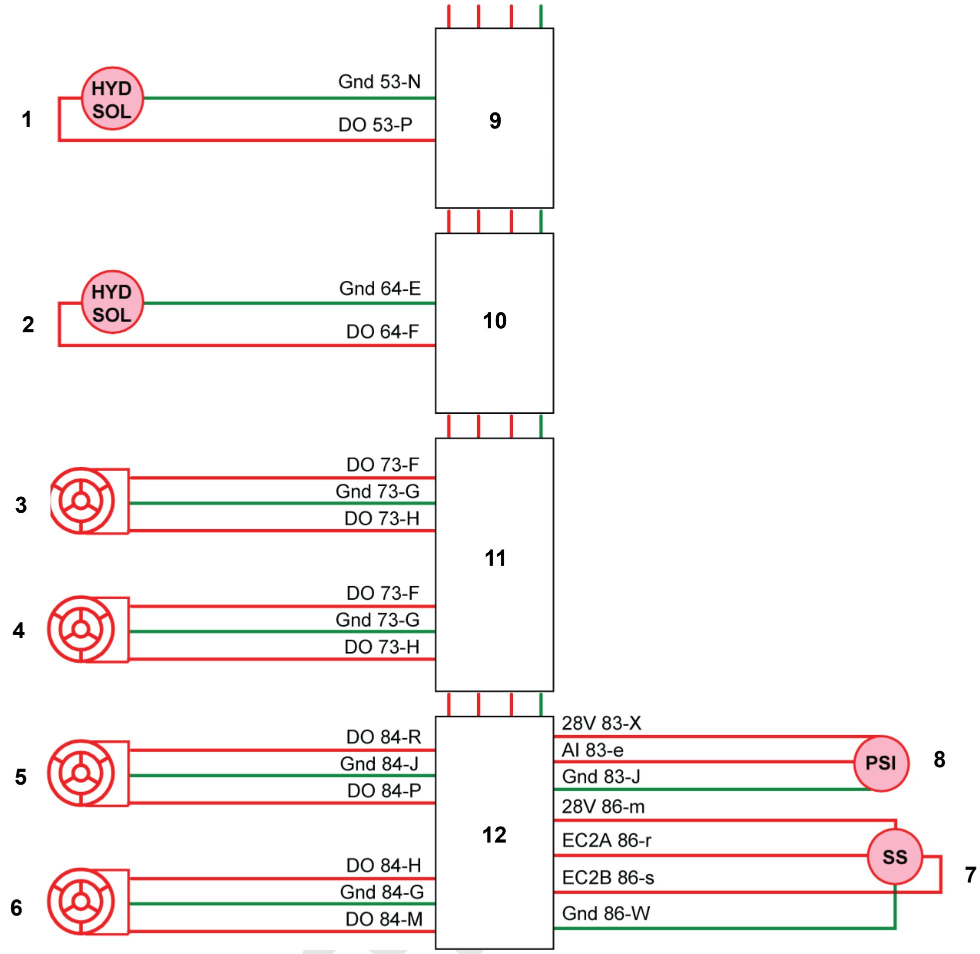
SWING SYSTEM ELECTRICAL SCHEMATIC



Item	Description	Item	Description
1	Engine Stop	11	Caution Fault Alarm
2	Swing Park Brake Switch	12	RCL Display
3	Swing Control Handle	13	Main Display
4	Swing Right Pressure Sender CW	14	Run
5	Swing Left Pressure Sender CCW	15	Start
6	Swing Pump 1	16	Master Node 1
7	Swing Pump 2	17	Side Console Node 2
8	Swing Holding Brake Switch	18	Universal Node 3
9	Seat Switch	19	Universal Node 4
10	RCL Warning Alarm		

FIGURE 6-2

SWING SYSTEM ELECTRICAL SCHEMATIC (CONT)



Item	Description	Item	Description
1	Swing Brake Release HS-62	7	Swing Motor Speed Sensor
2	Swing House Roller Greaser HS-64	8	Swing House Roller Greaser
3	Rear Right Swing/Travel Alarm	9	Universal Node 5
4	Rear Left Swing/Travel Alarm	10	Universal Node 6
5	Front Right Swing/Travel Alarm	11	Universal Node 7
6	Front Left Swing/Travel Alarm	12	Universal Node 8

FIGURE 6-3

Reference

MANUAL RELEASE OF SWING BRAKE

See Figure 6-4 for the following procedure.

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

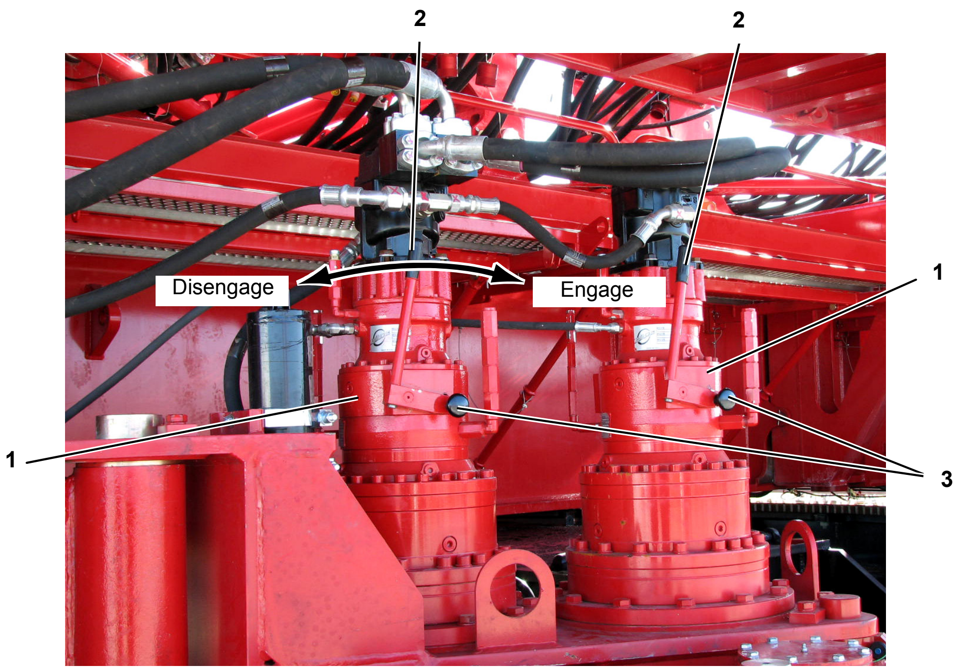
The Weather Vaning disconnect handle (2) on each gear box (1) is used to manually release the swing brakes on each swing drive assembly.

WARNING

Unexpected Crane Movement!

Crane can swing suddenly when swing brake is released on all four swing drive assemblies. Before releasing swing brake, make sure swing park switch is **ON** and remaining swing drive assemblies have the Weather Vaning handle **Engaged**.

The procedure given in this section is for servicing one swing drive assembly at a time only. Swing brake must be fully operational when operating crane.

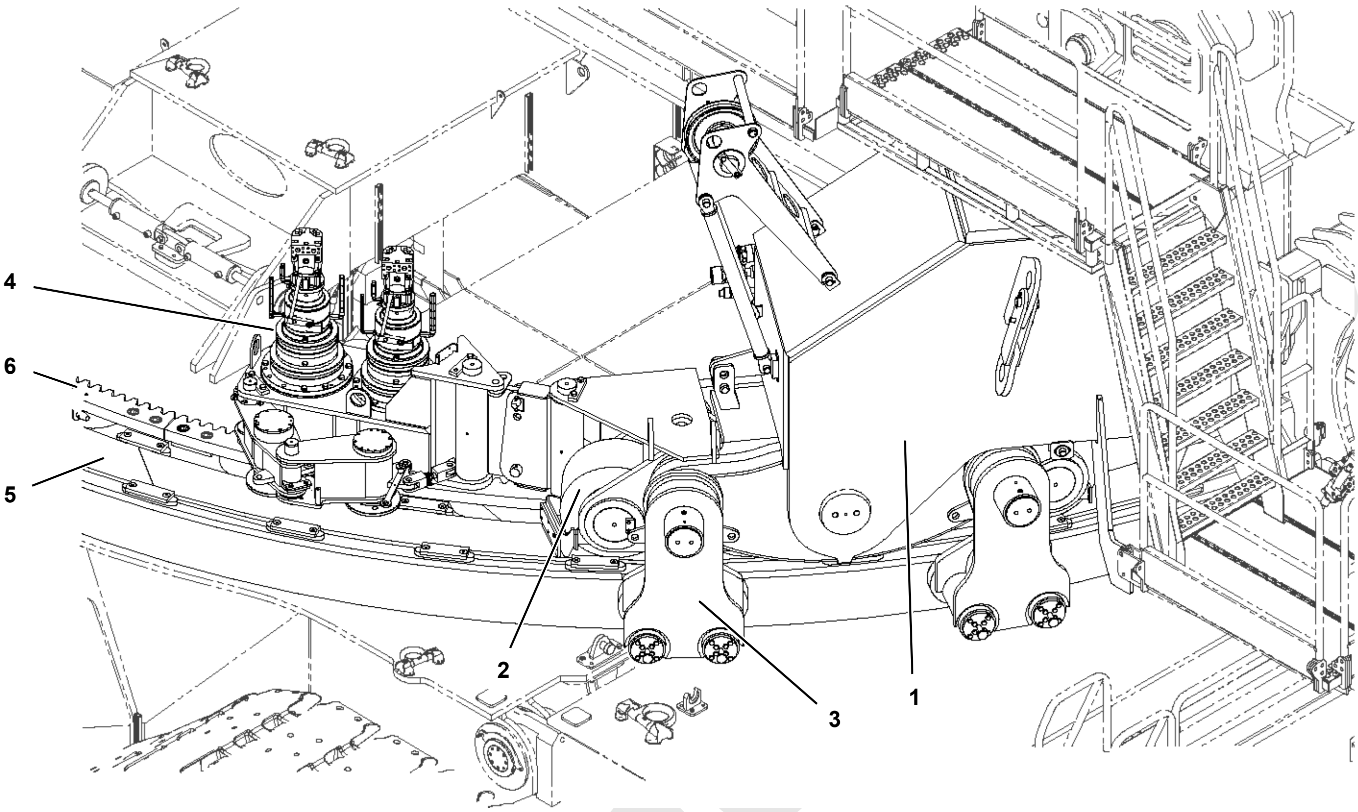


Item	Description	Item	Description
1	Gear Box	3	Knob - Engage/Disengage
2	Weather Vaning Disconnect Handle		

FIGURE 6-4

Reference Only

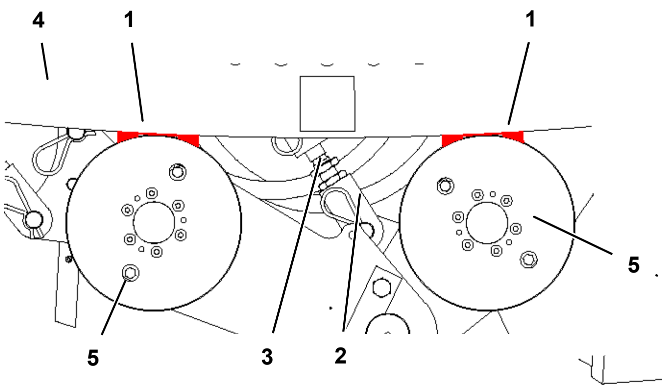
SWING MAJOR COMPONENT IDENTIFICATION

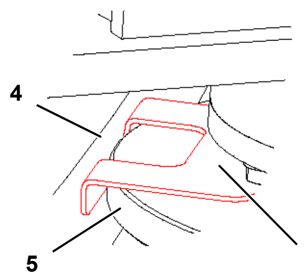


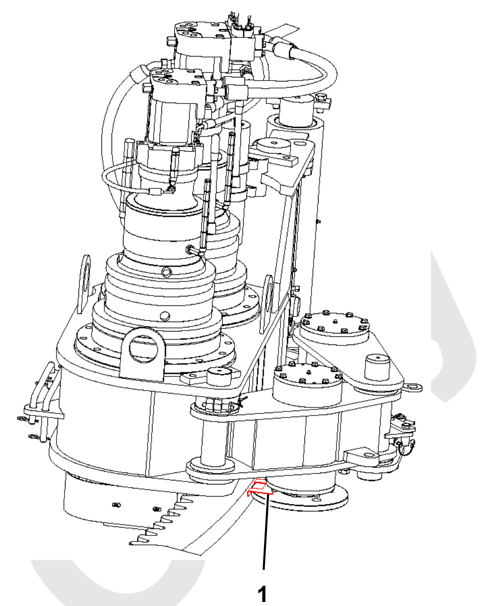
Item	Description
1	Front Roller Carrier (rear similar)
2	House Rollers (8 each roller carrier)
3	Hook Rollers (8 each roller carrier)
4	Swing Drives (2 dual-drives each roller carrier)
5	Roller Path with Wear Plates
6	Ring Gear

FIGURE 6-5

Reference







Item	Description
1	Adjustment Gauge
2	Inside Turnbuckle
3	Jam Nut
4	Ring Gear
5	Swinger Guide

FIGURE 6-6

BACKLASH ADJUSTMENT

See Figure 6-6 for the following procedure.

There are two swing motor and gear box assemblies on each of the swing drive assemblies. The swing planetary gearbox is equipped with a mechanical disengagement system. When the system is disengaged, the reduction gear is free.

CAUTION

Avoid damage to crane!

To prevent the crane from swinging, make sure swing park switch is **ON**. Do not use the weather vaning disconnect lever to mechanically disengage more than one swing drive assembly at a time.

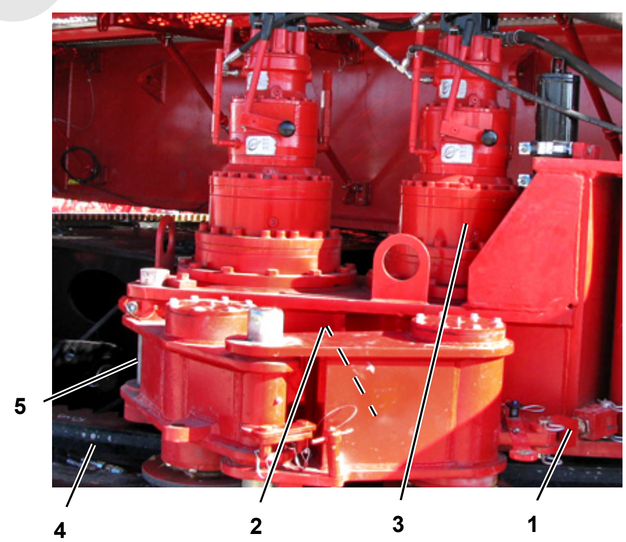
The backlash adjustment is performed on each of the swing drive assemblies.

CAUTION

Avoid damage to parts!

Make sure swing motor and gear box are at a complete stop before engaging or disengaging swing brake to prevent damage to the swing drive.

1. Pull knob (3, Figure 6-4) out to move Weather Vaning handle on each gearbox to a vertical, disengaged position. Release the knob so it seats in the upper detent hole.
2. Install the adjustment gauges between swinger guides and the ring gear (Items 1, 4, and 5 Figure 6-6).

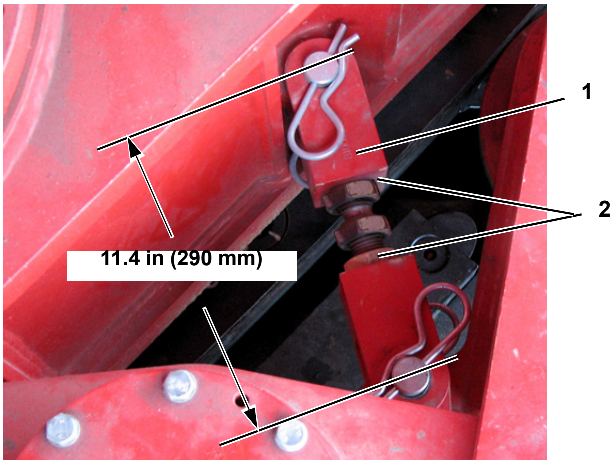


Item	Description
1	Outside Turnbuckle
2	Inside Turnbuckle
3	Swing Drive
4	Roller Path
5	Gauge Storage Location

FIGURE 6-7

Reference

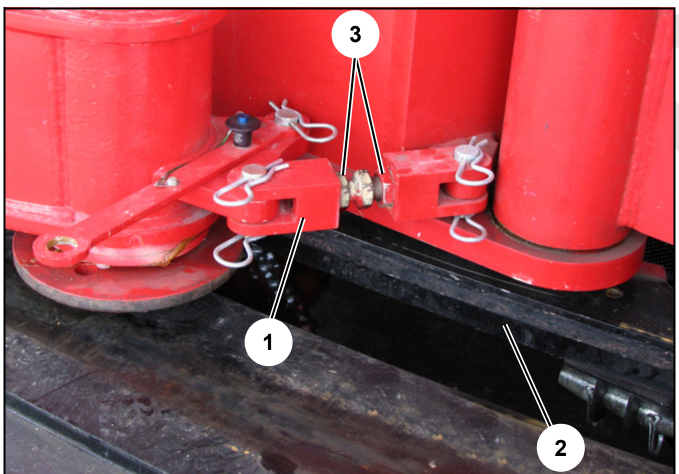
3. Adjust the inside turnbuckle (2, Figure 6-8) so that the effective length (pin center to pin center) Figure 6-8 is approximately 11.4 in (290 mm).



Item	Description
1	Inside Turnbuckle
2	Jam Nut

FIGURE 6-8

4. Adjust the outside turnbuckle (1, Figure 6-9) so that the outside pinion is in mesh with the ring gear and adjustment gauge (1, Figure 6-6) is in contact with the ring gear (4) outside diameter.



Item	Description
1	Outside Turnbuckle
2	Ring Gear
3	Jam Nut

FIGURE 6-9

5. Back on the inside turnbuckle (1, Figure 6-8), adjust the turnbuckle so the inside pinion is in mesh with the ring gear (4, Figure 6-6) and adjustment gauge (1) is in contact with the ring gear outside diameter.

6. Repeat step 4 and 5.

7. Remove and store the gauges (1, Figure 6-6).

8. Loosen turnbuckles only as needed to remove gauges. Set turnbuckles back to adjusted position after gauges are removed and tighten both jam nuts (2, Figure 6-8) on inside turnbuckle and both jam nuts (3, Figure 6-9) on outside turnbuckle.

NOTE: Maximum allowable backlash is 0.102 in (2,59 mm). This corresponds to a guide roller gap of 0.150 in (3,79 mm).

9. Pull knob (3, Figure 6-4) out to move Weather Vaning handle on each gearbox to an engaged position. Release the knob so it seats in the lower detent hole.

NOTE: Motors may need to be jogged to fully engage gearboxes.

PARALLEL ADJUSTMENT

See Figure 6-10 for the following procedure.

Item	Description
1	Set Screw (Near Side)
2	Set Screw (Far Side)
3	Jam Nut
4	Swing Drive Outside Pivot
5	Swing Drive Inside Pivot

FIGURE 6-10

1. Adjust two set screws (1) near side and (2) far side so single ear of swing drive outside pivot (4) is approximately centered between the 2 ears of swing drive inside pivot (5).

NOTE: Swing drive must be parallel to the roller path.

2. Tighten jam nut (3) on set screws (1) and (2).

Reference Only

Manitowoc Crane Care

RING GEAR

Each ring gear segment is attached to the carbody with five metric M42 x 4.5 x 180 long grade 12.9 socket head Capscrew and five M42 x 4.5 class 12 heavy hex nut.

Torque the nut onto the capscrew to 3600 Ft-lbs (4900 Nm).

CAUTION

Avoid damage to parts!

Make sure ring gear segment mounting nuts and bolts are not loose. Proper torque must be maintained to prevent damage to the crane.

NOTE: There are four locations that have a gusset plate between a pair of bolts. These locations have a retainer welded over the nuts. At these locations torque the cap screw heads. All other locations torque the nut.

Wear Plates

CAUTION

Avoid damage to parts!

Do not place anything on roller path. Make sure roller path is clear of all parts and debris that will damage the wear plate and the rollers.

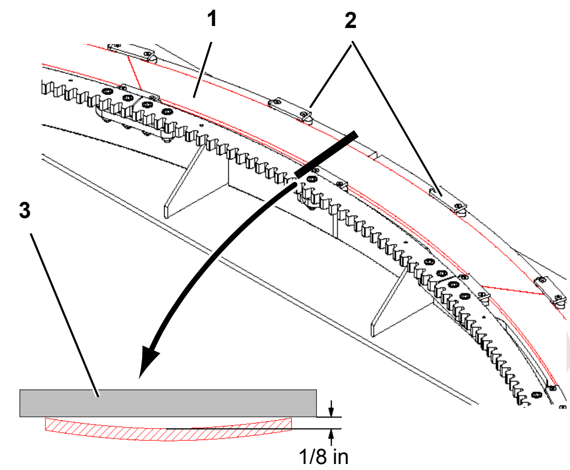
The house rollers rotate on the carbody roller path wear plates. Rollers and wear plate must be inspected daily for obstructions, damage and wear.

Checking Wear Plate

See Figure 6-11 for the following procedure.

1. Measure wear plate flatness by placing a straight edge (3) across the wear plate (1), midway between two wear plate keeper plates (2). Measurement should be on roller path, two to three feet away from roller.
2. Use a feeler gauge to measure the gap between the straight edge (3) and the wear plate (1). Gap should be 1/8 in (3,18 mm) or less. If wear plate warp exceeds 1/8 in (3,18 mm), contact Manitowoc Crane Care at 1-888-499-7278.

NOTE: If wear plates are replaced, apply a thin coat of #2 grease to the wear plate area on the top surface of the roller path prior to installation.



Item	Description
1	Wear Plate
2	Keeper Plates
3	Straight Edge

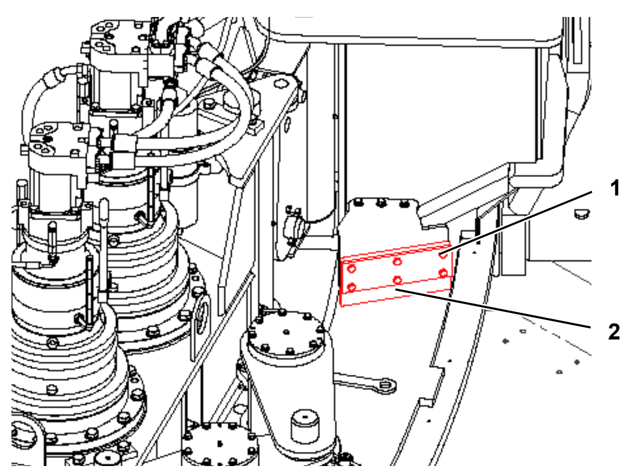
FIGURE 6-11

Wear Plate Wipers

See Figure 6-12 for the following procedure.

The carbody contains four adjustable wipers to wipe the roller path wear plates during swing operation.

1. Loosen six capscrews (1) on wiper bracket.
2. Adjust roller path wiper (2) so it is flush with the roller ring wear plate.



Item	Description
1	Capscrews
2	Wiper

FIGURE 6-12

6

Reference

Wear Plate Keeper

See Figure 6-13 for the following procedure.

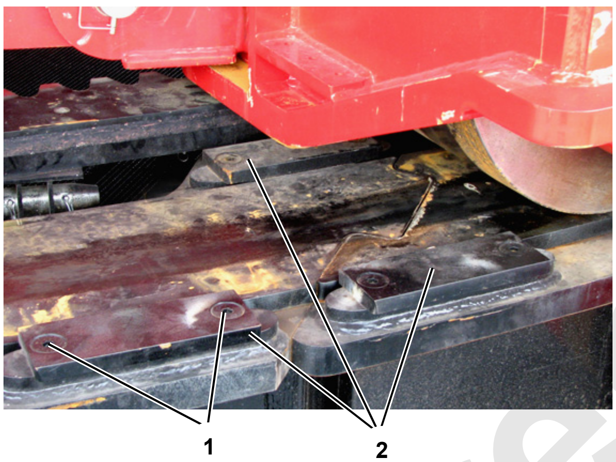
There are sixty four wear plate keepers (2) located near the ring gear on the front, rear and side beams of the carbody. Each wear plate keeper is attached to the carbody with two metric M20 2.5 x 40 x 10.9 flat head socket screw (1).

The socket head screws (1) are locktited and torqued to 330 ft-lb (450 Nm).

CAUTION

Avoid damage to parts!

Make sure wear plate keeper mounting bolts are not loose. Proper torque must be maintained to prevent damage to the crane.



Item	Description
1	Flat head Socket Screw
2	Wear Plate Keepers

FIGURE 6-13

SWING MOTOR SPEED SENSOR REPLACEMENT AND ADJUSTMENT

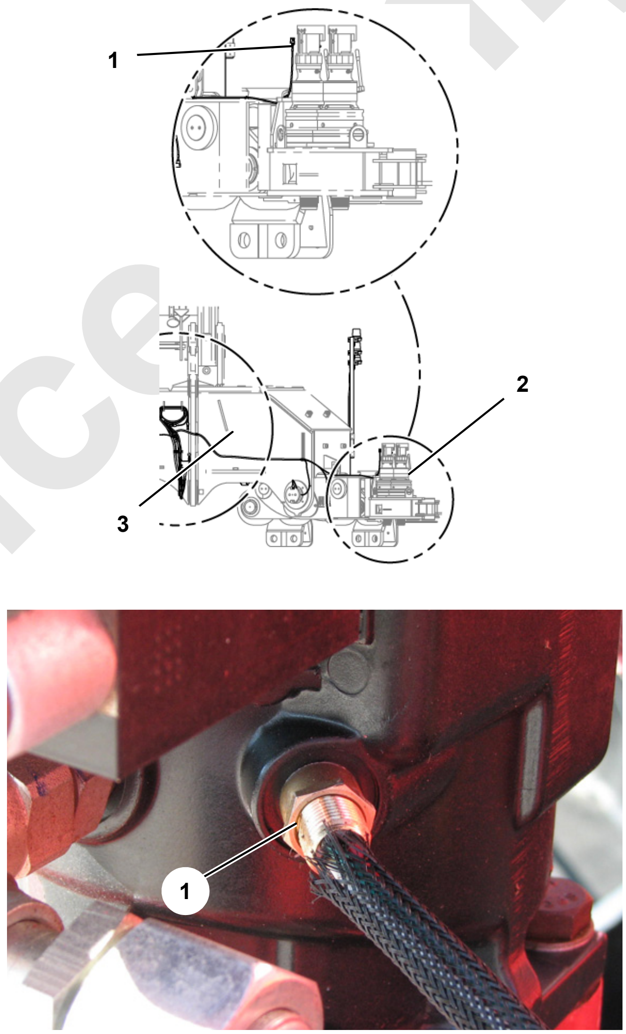
See Figure 6-14 for the following procedure.

Swing motor speed sensor adjustment is located on one swing motor mounted on the front house roller carrier assembly.

1. Bring swing function to a complete stop and PARK function.
2. Disconnect sensor cable connector from wire harness and loosen the sensor lock nut.
3. Unscrew sensor from motor case.
4. Install new sensor and o-ring by turning in sensor (CW) by hand until sensor bottom end gently touches the speed ring.
5. Back sensor out (CCW) 1/4 turn. Continue backing out until the flats are 22° either side of motor shaft centerline.

NOTE: Do not back out the sensor more than 3/4 of a turn from when the sensor touched the speed ring.

6. Torque locknut to approximately 10 ft-lb (6,72 m/kg).



Item	Description
1	Speed Sensor
2	Right Front Swing Drives
3	Front House Roller Carrier

FIGURE 6-14

ROTATING BED ROLLER CARRIER EQUALIZER REMOVAL

NOTE: This procedure is best accomplished during the crane disassembly procedure.

⚠ WARNING

Unexpected Crane Movement!

Crane can swing suddenly when swing brake is released on all four swing drive assemblies. Before releasing swing brake, make sure swing park switch is **ON** and remaining swing drive assemblies have the Weather Vaning handle **Engaged**.

The procedure given in this section is for servicing one swing drive assembly at a time only. Swing brake must be fully operational when operating crane.

⚠ WARNING

Unstable Crane Structure

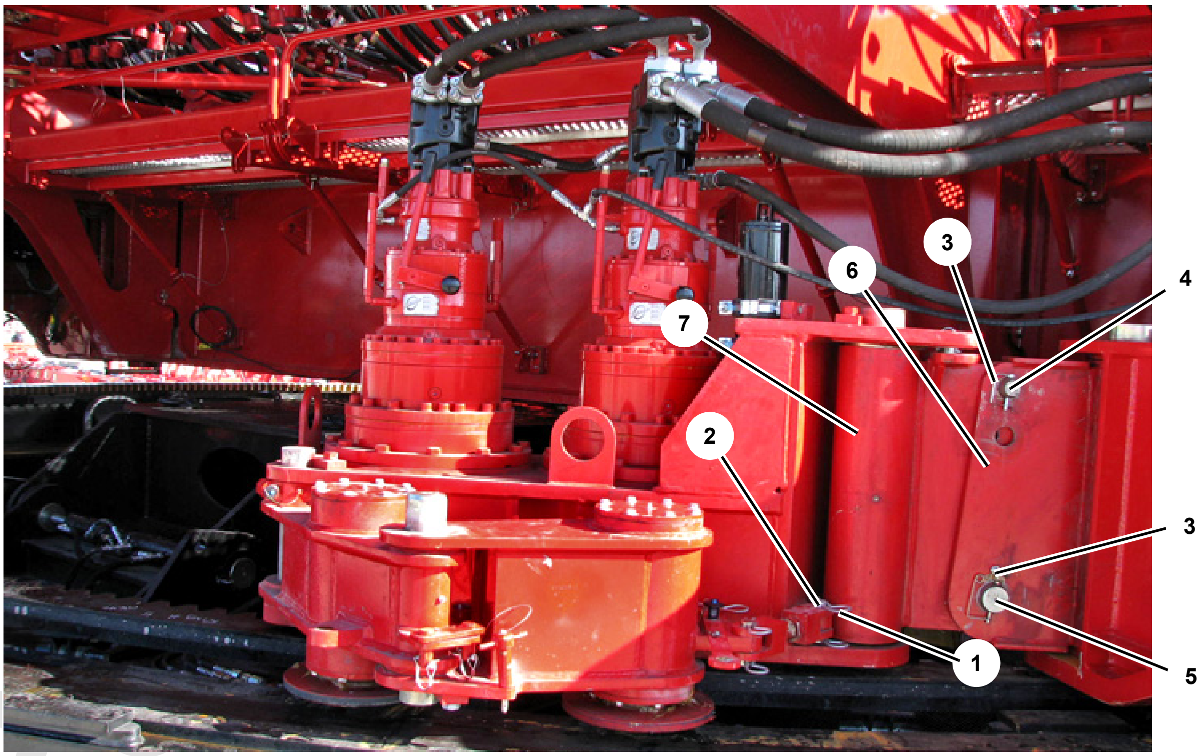
Maintenance on the roller carriers would only be done during teardown of the crane. To avoid excess weight on carrier assembly jacks and creating an unstable crane structure, crane boom, mast, backhitch, VPC, drums and rope, and cab/power plant must be removed from the crane prior to roller carrier removal.

Carrier assembly jacks must only lift rotating bed, front roller carrier with swing drives and rear roller carrier with swing drives. Any other assemblies left on the crane will make the crane unstable.

Front Roller Carrier

Swing Drive

See Figure 6-15 for the following procedure.



Item	Description	Item	Description
1	Cotter Pin	5	Pin
2	Turnbuckle Pin	6	Inside Pivot
3	Hair Cotter Pin	7	Outside Pivot
4	Pin		

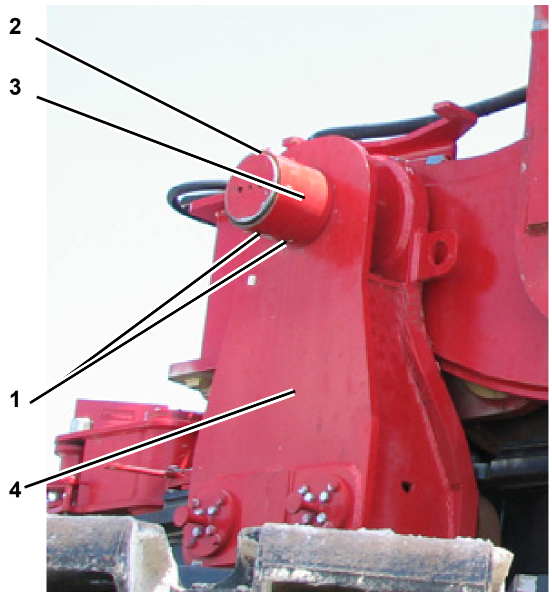
FIGURE 6-15

1. Remove the swing drive from the equalizer by first removing hydraulic hoses from swing drive.
2. Remove cotter pins (1) on turnbuckle, remove pins (2) and rotate swing drive from ring gear.

3. Support swing drive and remove hair pins (3) from two outside drive (7) pivot pins (4, 5). Remove pivot pins and remove swing drive.

Hook Roller

See Figure 6-16 for the following procedure



Item	Description
1	Cotter Pin (2
2	Hook Pin (2)
3	Hook Spacer Tube
4	Hook Roller Assembly

FIGURE 6-16

1. Remove two cotter pins, (1) from hook pins, (2).
2. Remove hook pins, (2) and remove hook spacer tube, (3).
3. Remove hook roller assembly (4) using appropriate lifting equipment.

Pivot Pin

See Figure 6-17 through Figure 6-20 for the following procedure.

It is necessary to remove the inboard roller pivot pin and replace it with a short shaft in order to remove the equalizer.

An equalizer shaft tool is located on its storage position on the front roller carrier. It is secured to the storage bracket by two capscrews. The equalizer shaft tool and the two capscrews are used to assist in the removal of the front roller carriers.

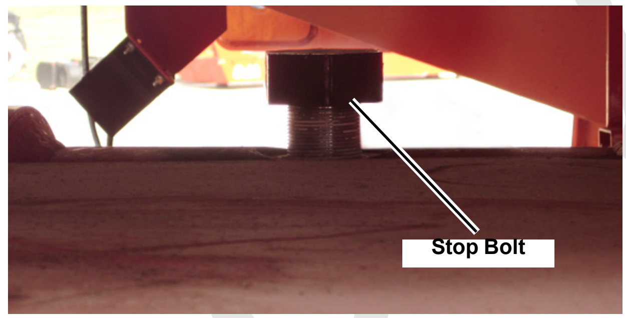


FIGURE 6-17

1. Remove pivot pin stop bolt from top of roller assembly, (Figure 6-17).

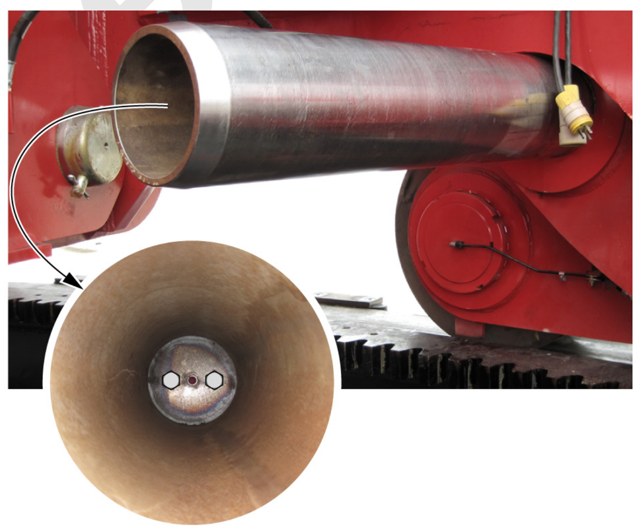
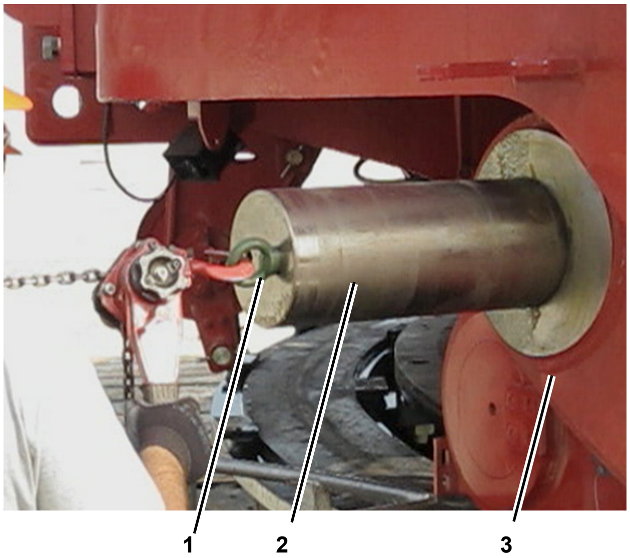


FIGURE 6-18

2. Install the equalizer shaft tool to the pivot pin on the inside of the front roller assembly using the two equalizer shaft tool capscrews (Figure 6-18).

NOTE: Use a 36 in socket extension to install capscrews.

Reference Only



Item	Description
1	Eye Bolt
2	Pivot Pin
3	Pivot Frame

FIGURE 6-19

3. Install eye-bolt, (1, Figure 6-19) into outside end of pivot pin (2).
4. Pull pivot pin (2) until equalizer shaft tool is flush with equalizer frame.

NOTE: It may be necessary to adjust carrier assembly jacks up or down to release tension on pivot pin.

WARNING

Unstable Crane Structure

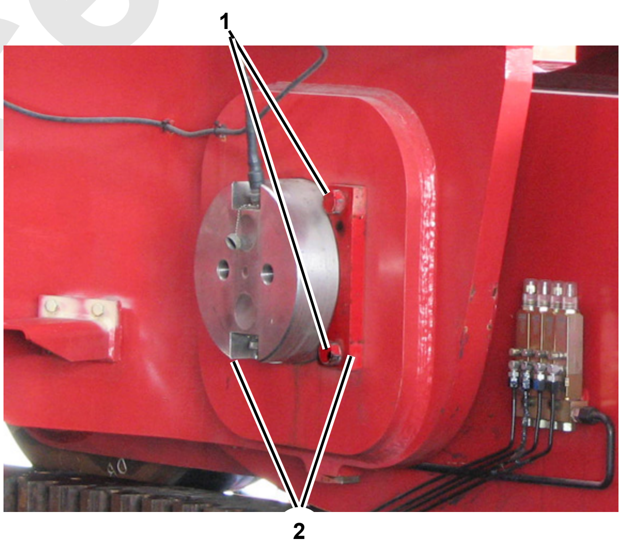
Maintenance on the roller carriers would only be done during teardown of the crane. To avoid excess weight on rotating bed jacks and creating an unstable crane structure, crane boom, mast, backhitch and VPC must be removed from the crane prior to roller carrier removal.

FIGURE 6-20

5. Remove two capscrews securing shaft tool to pivot pin and remove pivot pin (Figure 6-20).

Load Pin Removal

See Figure 6-21 and Figure 6-22 for the following procedure.



Item	Description
1	Capscrew (4)
2	Keeper Plate (2)

FIGURE 6-21

Reference Only

1. Remove capscrews (1, Figure 6-21) and remove two keeper plates (2) from load pin.

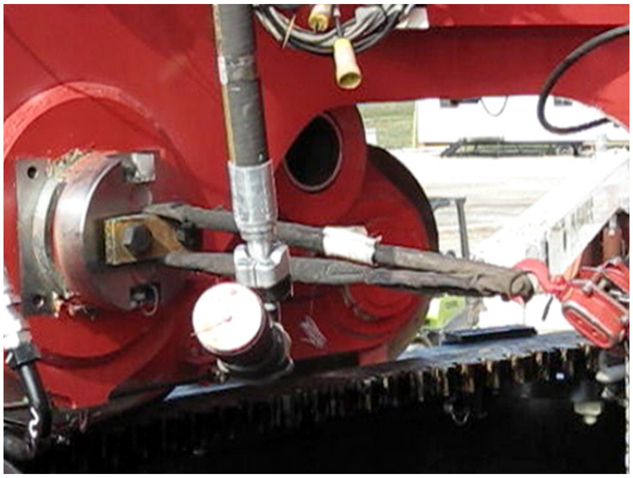


FIGURE 6-22

2. Attach plate or eye-bolts to inside of load pin. Support and remove load pin (Figure 6-22).

NOTE: It may be necessary to adjust carrier assembly jacks up or down to release tension on load pin.

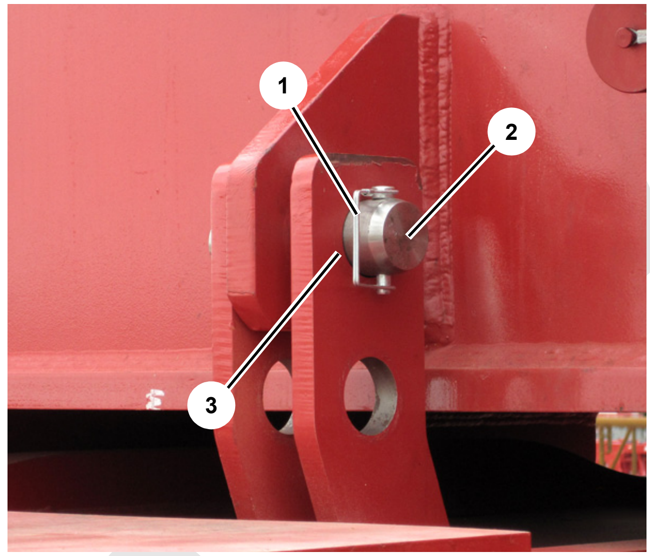
WARNING

Unstable Crane Structure

Maintenance on the roller carriers would only be done during teardown of the crane. To avoid excess weight on rotating bed jacks and creating an unstable crane structure, crane boom, mast, backhitch and VPC must be removed from the crane prior to roller carrier removal.

Equalizer Frame Removal

See Figure 6-23 through Figure 6-26 for the following procedure.



Item	Description
1	Hair Cotter Pin
2	Pin
3	Top Hole

FIGURE 6-23

1. Remove hair cotter pin (1, Figure 6-23) and remove pin (2) from top hole (3). Pull equalizer frame until pin can be reinserted into free top hole with sling attached. Secure with hair cotter pin.

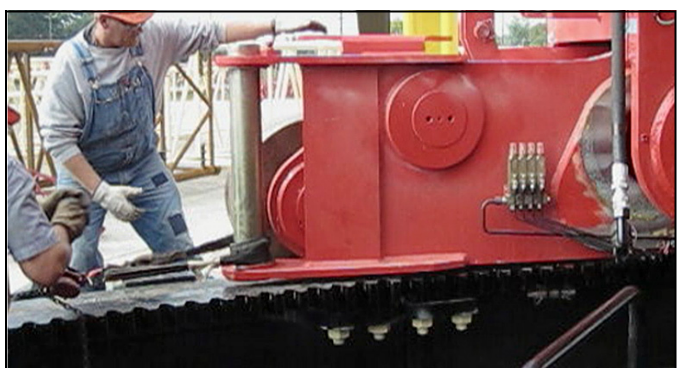


FIGURE 6-24

2. Attach lifting sling to pin and lift equalizer frame enough to allow the equalizer frame to be pulled from the roller carrier (Figure 6-24).

Reference

FIGURE 6-25

3. Pull equalizer frame from carrier far enough to place a lifting shaft in the load pin bores (Figure 6-25).

FIGURE 6-26

4. Using proper lifting equipment, lift and remove equalizer frame from crane (Figure 6-26).

Reference Only

Rear Roller Carrier

WARNING

Unexpected Crane Movement!

Crane can swing suddenly when swing brake is released on all four swing drive assemblies. Before releasing swing brake, make sure swing park switch is **ON** and remaining swing drive assemblies have the Weather Vaning handle **Engaged**.

The procedure given in this section is for servicing one swing drive assembly at a time only. Swing brake must be fully operational when operating crane.

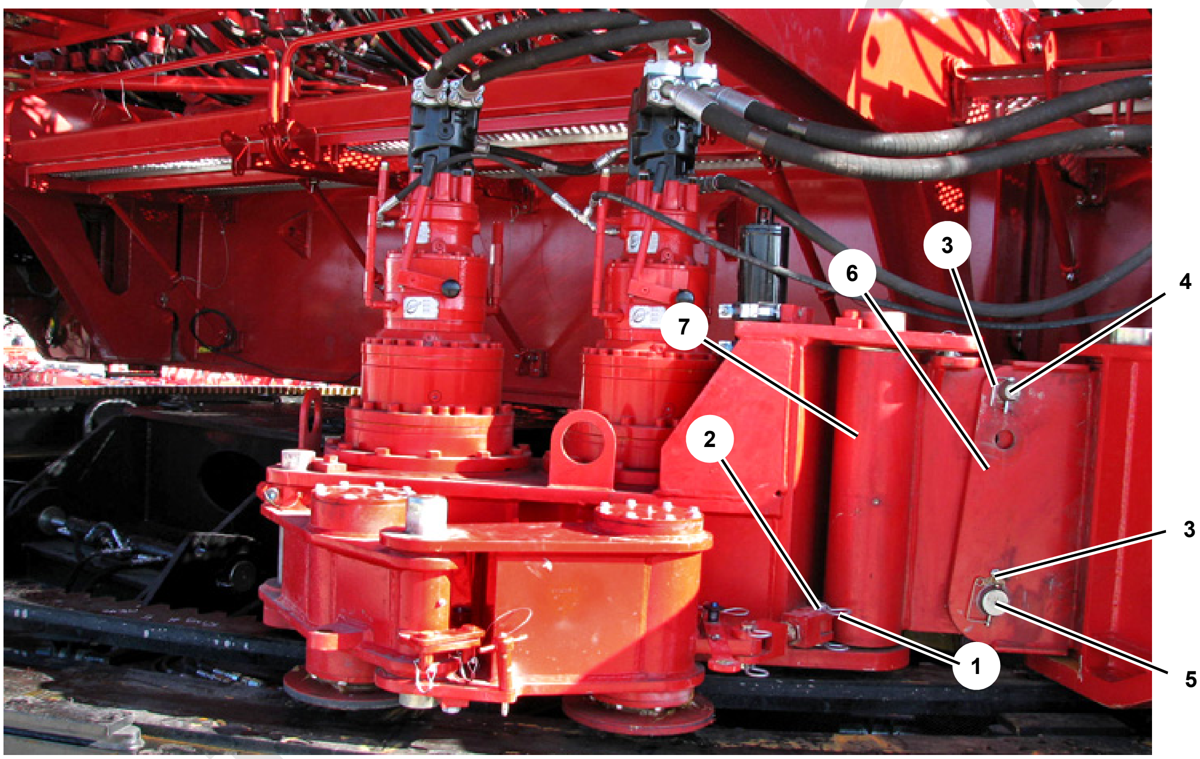
WARNING

Unstable Crane Structure

Maintenance on the roller carriers would only be done during teardown of the crane. To avoid excess weight on rotating bed jacks and creating an unstable crane structure, crane boom, mast, backhitch and VPC must be removed from the crane prior to roller carrier removal.

Swing Drive

See Figure 6-27 for the following procedure.



Item	Description	Item	Description
1	Cotter Pin	5	Pin
2	Turnbuckle Pin	6	Inside Pivot
3	Hair Cotter Pin	7	Outside Pivot
4	Pin		

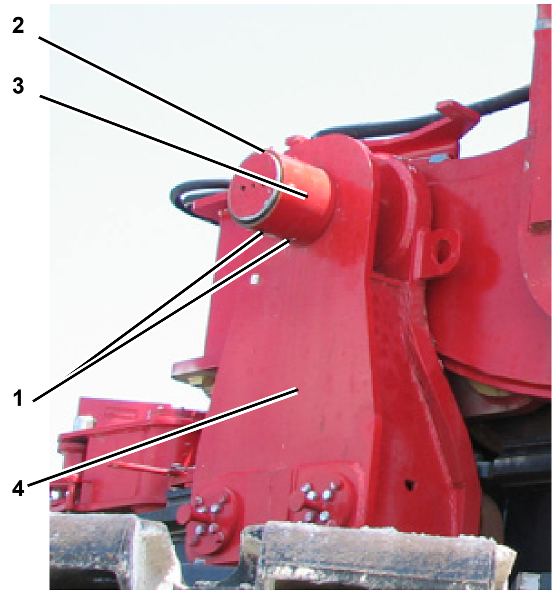
FIGURE 6-27

1. Remove the swing drive from the equalizer by first removing hydraulic hoses from swing drive.
2. Remove cotter pins (1) on turnbuckle, remove pins (2) and rotate swing drive from ring gear.
3. Support swing drive and remove hair pins (3) from two outside drive (7) pivot pins (4, 5). Remove pivot pins and remove swing drive.

Reference Only

Hook Roller

See Figure 6-28 for the following procedure.



Item	Description
1	Cotter Pin (2
2	Hook Pin (2)
3	Hook Spacer Tube
4	Hook Roller Assembly

FIGURE 6-28

1. Remove two cotter pins (1) from hook pins (2).
2. Remove hook pins (2) and remove hook spacer tube (3).
3. Remove hook roller assembly (4) using appropriate lifting equipment.

Pivot Pin

See Figure 6-29 through Figure 6-31 for the following procedure.

It is necessary to remove the inboard roller pivot pin and replace it with a short shaft in order to remove the equalizer.

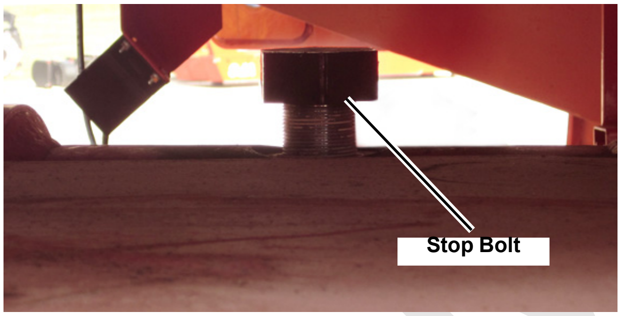
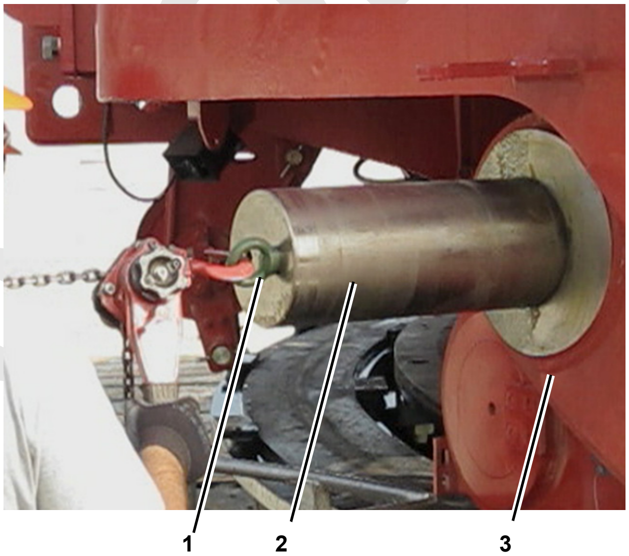


FIGURE 6-29

1. Remove pivot pin stop bolt (Figure 6-29) from top of roller assembly.



Item	Description
1	Eye Bolt
2	Pivot Pin
3	Pivot Frame

FIGURE 6-30

2. Install eye-bolt, (1, Figure 6-30) into end of pivot pin (2) and remove the pivot pin.

NOTE: An equalizer shaft tool is located on its storage position on the front roller carrier. It is secured to the storage bracket by two capscrews. The equalizer shaft tool is used to assist in the removal of the back roller carriers.

6

Reference Only

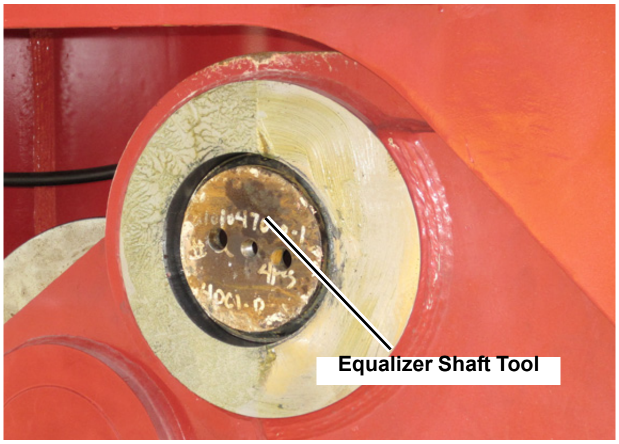


FIGURE 6-31

3. Install the equalizer shaft tool from the outside of the front roller assembly to replace the pivot pin.

4. Push equalizer shaft tool into the equalizer until it is flush with equalizer frame (Figure 6-31).

NOTE: It may be necessary to adjust carrier assembly jacks up or down to release tension on pivot pin.

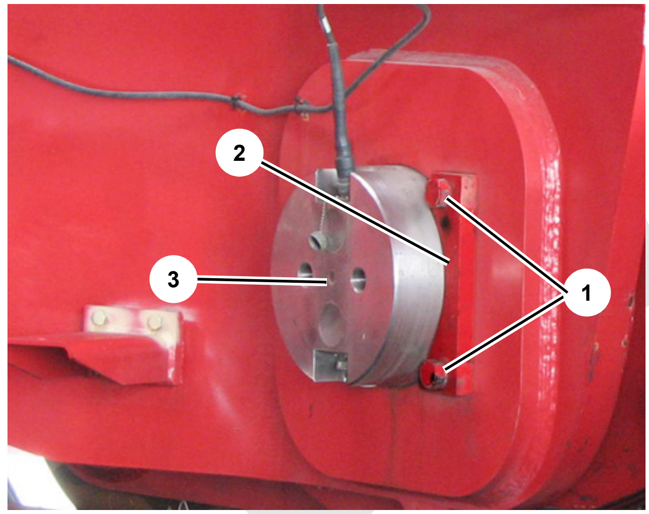
WARNING

Unstable Crane Structure

Maintenance on the roller carriers would only be done during teardown of the crane. To avoid excess weight on rotating bed jacks and creating an unstable crane structure, crane boom, mast, backhitch and VPC must be removed from the crane prior to roller carrier removal.

Load Pin Removal

See Figure 6-32 and Figure 6-33 for the following procedure.



Item	Description
1	Capscrews (2)
2	Keeper Plate (1)
3	Load Pin

FIGURE 6-32

1. Remove capscrews (1, Figure 6-32) and remove the keeper plate (2) from load pin (3).

FIGURE 6-33

2. Attach plate or eye-bolts to inside of load pin. Support the load pin and remove load pin (Figure 6-33).

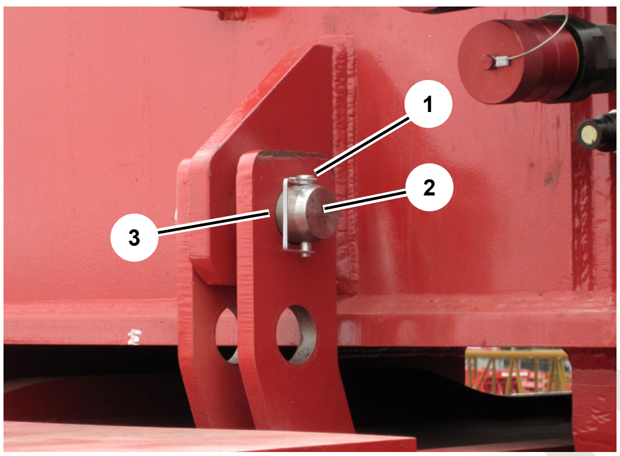
NOTE: It may be necessary to adjust carrier assembly jacks up or down to release tension on load pin.

WARNING
Unstable Crane Structure

Maintenance on the roller carriers would only be done during teardown of the crane. To avoid excess weight on rotating bed jacks and creating an unstable crane structure, crane boom, mast, backhitch and VPC must be removed from the crane prior to roller carrier removal.

Equalizer Frame Removal

See Figure 6-34 through Figure 6-37 for the following procedure.



Item	Description
1	Hair Cotter Pin
2	Pin
3	Top Hole

FIGURE 6-34

1. Remove hair cotter pin (1, Figure 6-34) and remove pin, (2) from upper hole (3). Pull equalizer frame and reinsert pin in hole and insert hair cotter pins.

FIGURE 6-35

2. Attach lifting sling to pin and use to raise frame to assist removal (Figure 6-35).
3. Pull equalizer frame from carrier far enough to place a lifting shaft in the load pin bores, (Figure 6-36).

FIGURE 6-36

Reference O

4. Using proper lifting equipment, lift and remove equalizer frame from crane (Figure 6-37).

FIGURE 6-37

Reference Only

REAR HOUSE ROLLER LOAD PIN HARNESS

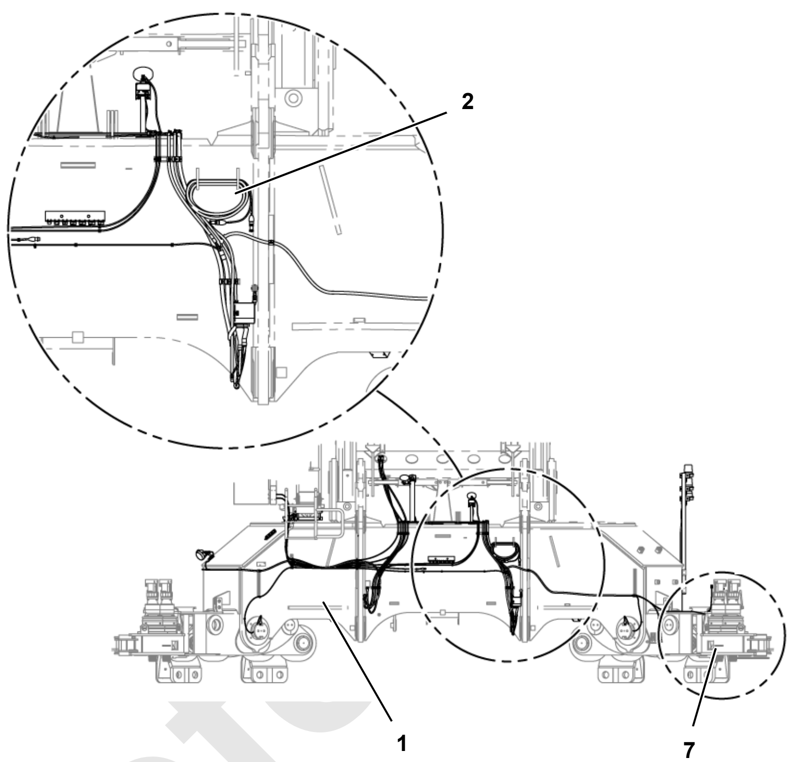
See Figure 6-38 for the following procedure.

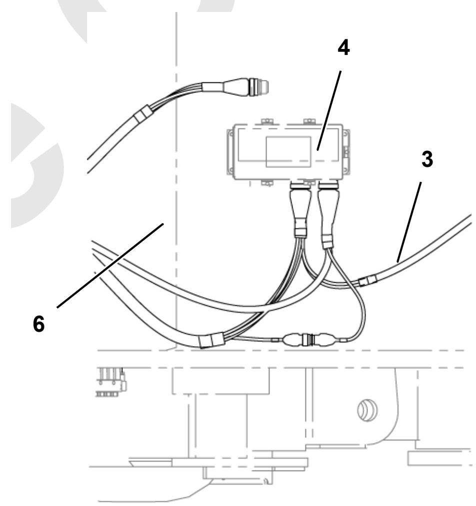
Storage

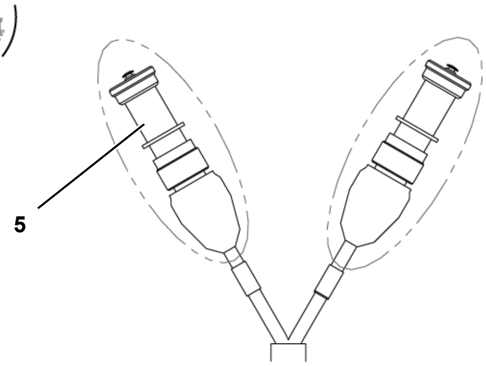
W83 Harness from Node-8 has a spare cable for the rear house roller load pins that is stored with shorting plugs installed when not in use. The W83 cable with P10 and P11 connections is for temporary use and is stored on the inside of the front house roller carrier assembly.

Connection Procedure

This cable is provided in case of W75 cable failure. W75 P1 and P3 connect to the rear house roller load pins located on the rear house roller carrier assembly. After it has been determined that W75 cable has failed, disconnect the P1 and P3 connections from the rear house roller load pins and store. Remove W83 P10 and P11 harness from storage and route cable to rear house roller load pins. Secure cable routing and install W83 P10 into left rear house roller load pin connection and W83 P11 into right rear house roller load pin connection. Store shorting plugs by connecting them to W75 P1 and P3 connections. After W75 cable is replaced, store W83 cable back on inside of front house roller carrier assembly and reinstall shorting plugs into P10 and P11.







Item	Description
1	Front House Roller Carrier Assembly
2	W83 P10 and P11 Storage Location
3	W83 P10 and P11 Cable
4	Node-8
5	W83 Shorting Plug
6	Right Side Front Rotating Bed
7	Right Side Swing Motors

FIGURE 6-38

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Reference Only

SECTION 7
POWER TRAIN

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Reference Only

Published 07-24-15, Control # 077-03

SECTION 7
POWER TRAIN

ENGINE CONTROLS OVERVIEW

See engine manufacturer's manual for detailed operation and maintenance instructions.

Each engine is started and stopped with an engine key switch. Engine clutch levers for pump drives, located on each engine, must be manually engaged for normal operation.

Crane function's speed depends on engine speed and system control handle movement. Engine speed is controlled with the hand throttle or foot throttle and is monitored with a speed sensor. Node-1, engine Node-30, and engine Node-31 controls and processes engine information and displays the information on the main display.

The emergency stop button located in the cab, when pushed down (enabled), bypasses normal crane shutdown and kills both engines in the event of an urgent situation. All brakes apply and any functions stop abruptly. Reference operating controls and procedures in the 31000 Operator Manual for crane start up procedures after the emergency stop button has been enabled.

POWER PLANT PANEL IDENTIFICATION

Item	Description
1	Cab Door
2	Main 100A AC Load Center Access
3	Cold Weather AC Load Center
4	Manual Transfer Switch, Volt Meter
5	Fire Extinguisher Storage
6	Exhaust Fan Access
7	Secondary Engine Node, Aux Cab Power Jct Box, Controller Universal Node 3 Access
8	Hydraulic Tank Cleanout Access
9	Hydraulic Tank Cleanout Access
10	Hydraulic Tank Cleanout Access
11	Power Plant Access Door
12	Power Plant Access Door
13	Diesel Generator Louver
14	Diesel Fuel Tank Fill Access
15	Diesel Generator Battery Access
16	Diesel Generator Fan Louver
17	Primary Engine Controller Node 30, Diesel Generator 12v Battery Charger, Primary Engine 24v Battery Charger
18	Primary Engine Fan Cooling Louver and Damper
19	Primary Engine Right Side Access
20	Primary Engine Right Side Access
21,22,23	Power Plant Louver and Damper
24	Secondary Engine Right Side Access
25	Secondary Engine Right Side Access
26	Cab, Lower Works, Camera Connections
27	Emergency Cab Exit

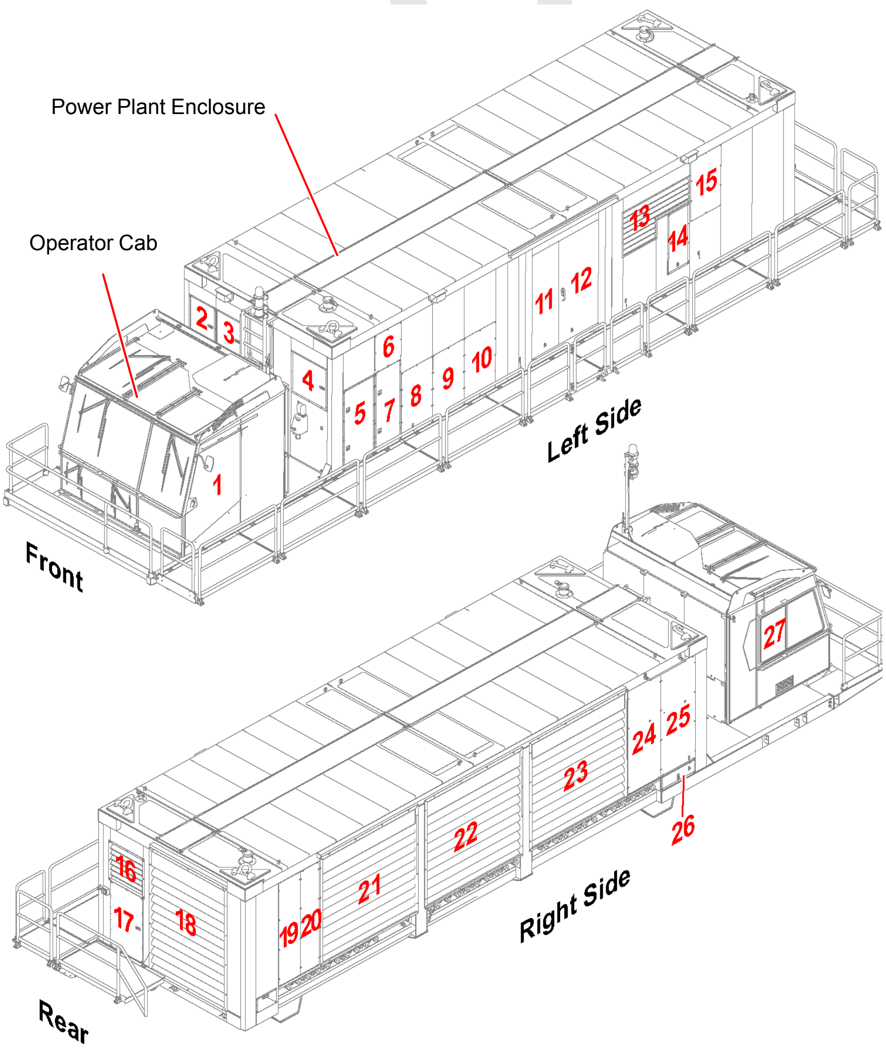


FIGURE 7-1

Reference Only

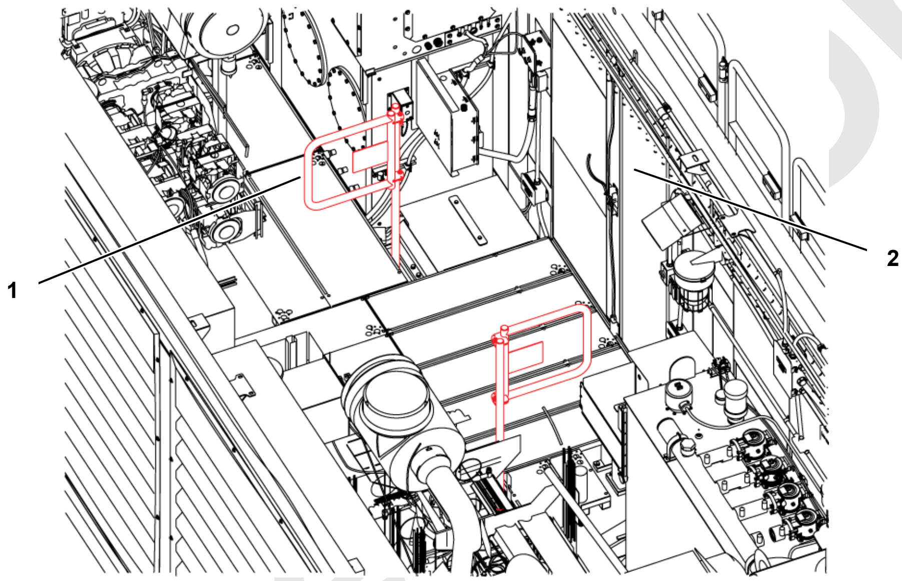
7

POWER PLANT ENCLOSURE SAFETY BARRICADE

Two safety barricades ([Figure 7-3]) with warning signs restrict access to the primary and secondary engines inside the power plant enclosure (Figure 7-2). Barricade may be opened to access engines. Use caution as hot engine surfaces may be present.

Make sure safety barricades are closed prior to leaving power plant enclosure.

FIGURE 7-2

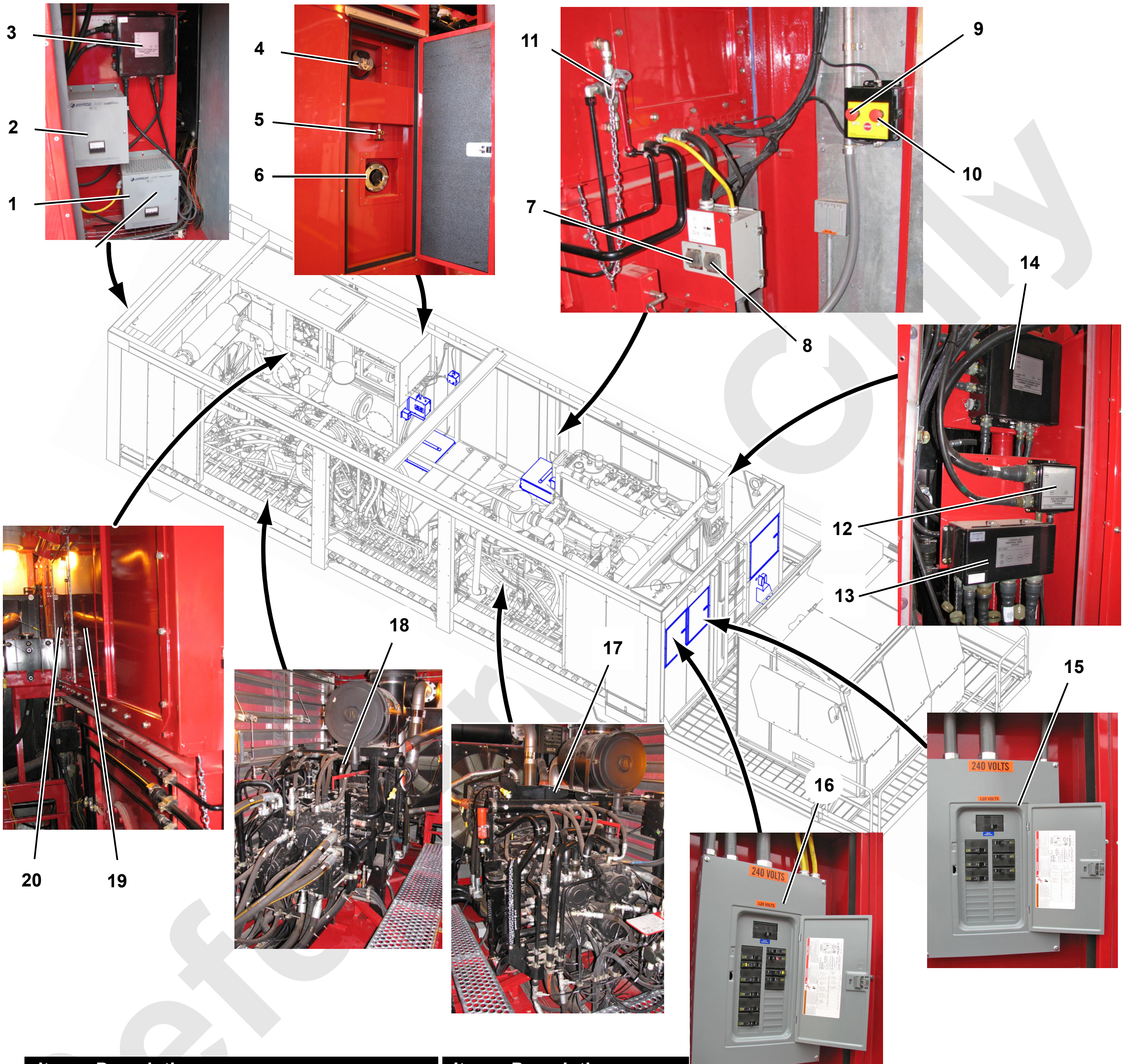


Item	Description
1	Safety Barricade
2	Enclosure Entrance

FIGURE 7-3

Reference Only

POWER PLANT ENCLOSURE IDENTIFICATION

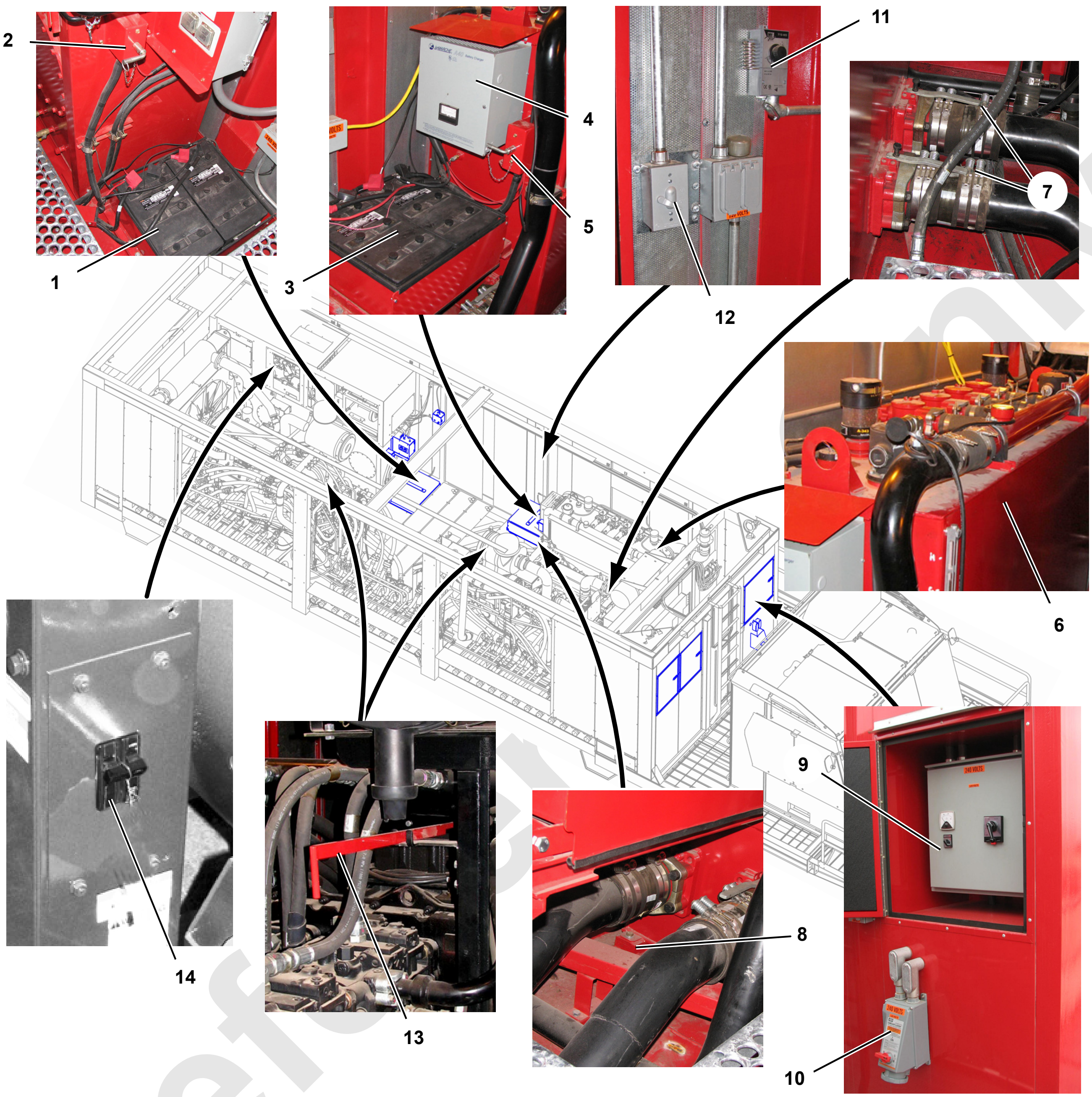


Item	Description	Item	Description
1	Primary Battery Charger	11	Hydraulic Generator Shut-Off Valve
2	Diesel Generator Battery Charger	12	Auxiliary Cab Power Junction Box
3	Primary Engine Node Controller	13	Universal Node Controller
4	Manual Diesel Fuel Fill	14	Secondary Engine Node Controller
5	Spill Drain	15	Cold Weather Load Center
6	Fast Diesel Fuel Fill	16	Main Load Center Circuit Breakers
7	Hydraulic Generator Fan Breaker	17	Secondary Engine
8	Hydraulic Generator Shut Off Switch	18	Primary Engine
9	Diesel Generator Emergency Stop	19	Hydraulic Generator
10	Hydraulic Generator Emergency Stop	20	Diesel Generator

FIGURE 7-4

7

Power Plant Enclosure Identification Continued



Item	Description	Item	Description
1	Primary Battery	8	Hydraulic Tank Drain Valve (hidden)
2	Primary Battery Disconnect	9	Manual Transfer Switch
3	Secondary Battery	10	Utility Power Switch
4	Secondary Battery Charger	11	Enclosure Heater Switch
5	Secondary Battery Disconnect	12	Enclosure Light Switch
6	Hydraulic Fluid Tank	13	Engine Clutch Levers (Typical)
7	Hydraulic Tank Shut-Off Valves (2 places)	14	Diesel Generator Output Breaker

FIGURE 7-5

Reference Only

BATTERY MAINTENANCE

Safety Information

WARNING

Battery Gases Are Explosive!

Batteries can explode with great violence and spraying of acid if a spark or flame is brought too near them. The room or compartment in which batteries are stored must be ventilated and away from flames or sparks.

Avoid sparks while charging batteries; do not disturb connections between the batteries until the charger is OFF.

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

Improper use of a booster battery to start a crane when the normal battery is inadequate presents a definite explosion hazard. To minimize this hazard, the following procedure is suggested:

1. First connect both jumper cables to the battery on the crane to be started. Do not allow ends of cables to touch.
2. Then connect the positive cable to the positive terminal of the booster battery.
3. Finally, connect the remaining cable to the frame or block of the starting vehicle. ***Never*** connect it to the grounded terminal of the starting vehicle.

On-Board Battery Chargers

The batteries will be charged by the three on-board battery chargers when:

- AC utility power is connected to the crane,
- primary engine is operating the hydraulic generator,
- diesel generator is operated.

Causes Of Battery Failure

Overcharging

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

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

Undercharging

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

Table 7-1 Battery Freeze Points

State of Charge	Specific Gravity	Freeze Point °C
100%	1.26	-57
75%	1.23	-38
50%	1.20	-26
25%	1.17	-19
DISCHARGED	1.11	-8

The sulfate condition can eventually be converted to metallic lead which can short the positive and negative plates. These small shorts can cause low cell voltage when the battery is charged.

Lack of Water

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

Hold-Downs

Loose hold-downs will allow the batteries to vibrate in the holder. This can cause cracks or wear in the container and cause acid to leak. Leaking acid corrodes terminals and cables causing high resistance battery connections. This weakens the power of the battery. Overtightened hold-downs can also distort or crack the container.

Overloads

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

Multiple Battery System

Multiple battery systems are connected either in series or in parallel. **Always refer to wiring diagram for correct connection**.

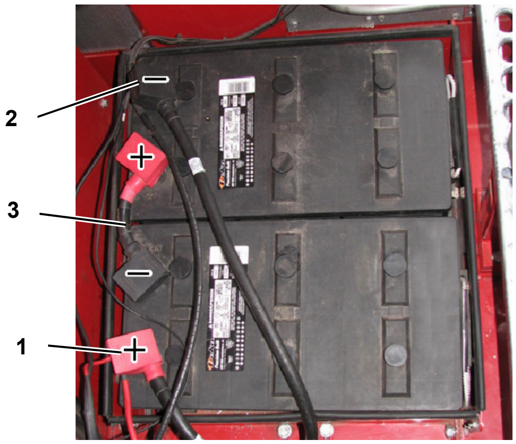
NOTE: Installing batteries with reversed electrical connections will not only damage batteries but also the crane's electrical system, voltage regulator, and/or alternator.

The 31000 has two twelve volt batteries in two battery banks; one for each engine. Both battery banks are connected in series. The series connection provides 24 volts of direct current to each engine.

Reference Only

The negative cable connects to the negative terminal of one battery and the positive cable connects to the positive terminal of the second battery,

The two batteries are connected in series by a short connecting cable from the positive terminal of the first battery to the negative terminal of the second battery, Figure 7-6.

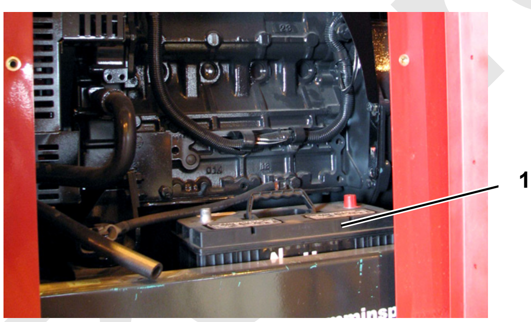


Item	Description
	Series Connected Batteries
1	Positive Battery Cable
2	Negative Battery Cable
3	Connecting Cable

FIGURE 7-6

Diesel Generator Battery Location

The diesel generator has one twelve volt battery located on the outboard side of the generator. Access by removing the outside access panel Figure 7-7.



Item	Description
1	Diesel Generator Battery

FIGURE 7-7

Maintenance

Weekly – Check Electrolyte Level

1. Clean the top of the battery before removing the vent caps. Keep foreign material out. Confirm that the plates in each cell are completely covered with electrolyte.
2. Distilled water should be used. Drinking water is, however, satisfactory. Water with a high mineral content (well, creek, pond) must not be used.
3. Never overfill the cells. Overfilling will cause electrolyte to pump out, and corrosion damage will result.

   Any spills on painted or metal surfaces must be immediately cleaned and acid neutralized with baking soda or ammonia.
4. Look for heavy deposits of black lead like mineral on the bottom of the vent caps. This indicates that active material is being shed (a indication of overcharging).

   An excessive amount of water consumption also indicates overcharging.
5. Sulfuric acid must never be added to a cell unless it is known that acid has been spilled out or otherwise lost — **consult your battery dealer for instructions**.

Every 2 Months – Test Batteries

Before testing a battery determine that the alternator is putting out current, that the current is flowing to the battery, and that the voltage delivered is within acceptable limits.

Hydrometer Test

1. The electrolyte level in each cell must be at its proper height to get reliable readings. Confirm that the plates in each cell are completely covered with electrolyte.
2. Readings should not be taken immediately after water is added. The solution must be thoroughly mixed by charging.
3. Likewise, readings should not be taken after a battery has been discharged at a high rate, such as cranking.
4. When reading a hydrometer, hold the barrel vertical with the float freely suspended.
5. Draw the electrolyte in and out several times to bring the float temperature to that of the electrolyte.
6. Take the reading across the bottom of the liquid level; disregard curvature of the liquid.
7. Readings must be temperature corrected. Subtract 0.004 from the reading for each 6° below 27°C. Add 0.004 for each 6° above 27°C.

NOTE: It is the electrolyte temperature which is important, not air temperature.

Reference Only

8. Temperature corrected hydrometer readings may be explained as shown in Table 7-2.

Table 7-2 Hydrometer Readings

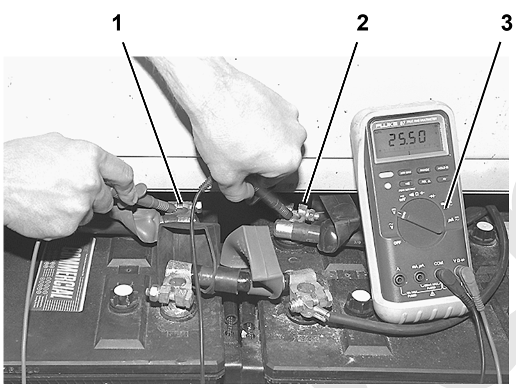
Hydrometer Reading — Specific Gravity.	% Charge
1.260 – 1.280 =	100%
1.230 – 1.250 =	75%
1.200 – 1.220 =	50%
1.170 – 1.190 =	25%
1.140 – 1.160 =	Very little useful capacity
1.110 – 1.130 =	Discharged

If any two cells show more than 0.050 specific gravity variation, try to recharge the battery. If the variation persists, the battery should be replaced

For more specific hydrometer test information, see the instructions provided with your hydrometer.

Open-Circuit Voltage Test

A sensitive voltmeter (Figure 7-8) can be used to determine a battery's state-of-charge as shown in Table 7-3.



Item	Description
1	Positive Lead
2	Negative Lead
3	Meter 24VDC

FIGURE 7-8

The open circuit test is not as reliable in determining a battery's condition as the hydrometer test. This test is acceptable for stored batteries, but not ones in use.

This test must not be performed on batteries being charged or delivering power; charging causes an increase in voltage which may persist for an extended period.

Table 7-3 Open Circuit Cell Voltage

% Charge	Specific Gravity	Approximate Open Circuit Cell Voltage
100	1.260	2.10
75	1.230	2.07
50	1.200	2.04
25	1.170	2.01
Discharged	1.110	1.95

NOTE: Detailed test information is provided by the meter manufacturer.

High Resistance Test

When cranking, a voltage drop of more than 0.2 volts between the starting motor cable and ground can cause hard starting regardless of a battery's condition. The voltage drop can be caused by a poor contact between the cable terminal and ground or between the clamp terminal and the battery post. Poor start-switch contacts and frayed, broken, or corroded cables can also be the cause.

Quarterly

1. Thoroughly clean the batteries and the holder with baking soda.
2. If provided, make sure the drain holes are open in the holder. If water collects in the holder, drill drain holes.
3. Clean the posts and terminals. The posts can be tightly coated with grease to prevent corrosion.
4. Make sure the hold-downs are in good condition; replace faulty parts.
5. Replace frayed, broken, or corroded cables.
6. Replace the batteries if their containers are cracked or worn to the point they leak.
7. Ensure a good tight contact between the clamp terminals and battery posts.

Make sure the hold-downs are tight enough to prevent battery movement but not so tight to cause distortion.

Charging

The battery should be at room temperature when recharging. Before a battery is recharged, it must be thoroughly cleaned. Take care not to allow dirt to enter the cells.

A battery should be recharged in the way it was discharged. If it was discharged over a long period of time, it should be recharged slowly at 6 to 10 amperes for up to 10 hours. A rule-of-thumb value for a slow rate is a current equal to about one-half the number of plates per cell in the battery. A battery

Reference Only

with 13 plates per cell, should, therefore be charged at 7 amperes.

If a battery was discharged rapidly (cranking until dead), it can be recharged on a fast charger with an output of up to 40 amperes for a maximum of 2 hours. If the electrolyte temperature reaches 52°C or if it gases violently, the charging current must be reduced or halted to avoid battery damage.

For optimum charging results, adhere to the charger manufacturer's instructions.

Storage

When the crane is left idle for prolonged periods, it should be run periodically to charge the batteries.

When storing a battery, make sure it is at least 75% charged to prevent the possibility of freezing.

Follow your battery dealer's recommendations.

Battery Disconnect Switch

Two battery disconnect switches are provided for each battery bank to disconnect the batteries when servicing the electrical control system. The disconnect switch is located above each battery bank. See Figure 7-5.

CAUTION

Engine Damage!

To avoid possible engine fault codes and undesirable operation, make sure engine ignition switch has been off two 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.

See Section 3 of Crane Operator Manual for operation of the battery disconnect switch.

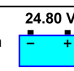
Onboard Battery Chargers

There are two 24 VDC battery chargers, one for each engine battery set, and one 12 VDC battery charger for the diesel generator battery. The chargers supply continual charge to the batteries with the primary engine running the hydraulic generator, diesel generator running or connection to external utility power.

The operation of the battery chargers is automatic. Once the battery becomes fully charged, the output current will automatically decrease to a very low trickle charge to prevent overcharging of the batteries.

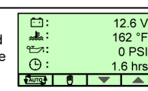
Battery voltages for the primary and secondary engine batteries are displayed on the 31000 "Information Screen". Refer to Table 7-4.

Table 7-4 Primary and Secondary Battery Charge

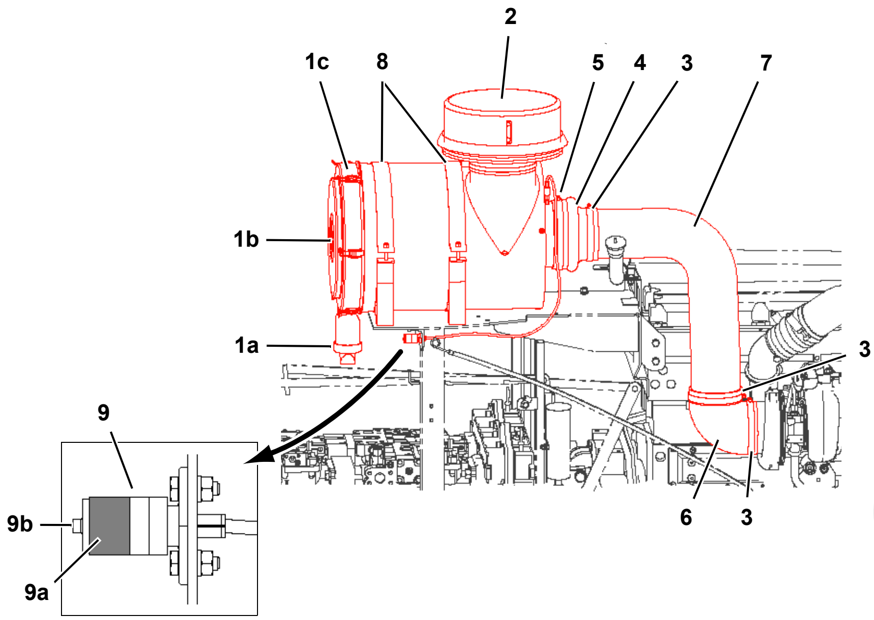
Primary and Secondary Engine Batteries (24V) Charging			
OCV*	**State of Charge**	**Recharge Time (Hrs)**	**Notes**
25.2 V	100%	-	*OCV = Open Circuit Voltage (The battery voltage displayed on a 31000's "Information Screen".)  **Recharge Time (at 20A) = charging time depends on battery age, temperature, capacity, and charger efficiency.
24.8 V	75%	1.3	
24.4 V	50%	2.7	
24.0 V	25%	4.3	
23.6 V	0%	5.7	

Battery voltage for the diesel generator battery is displayed on the diesel generator remote control panel. Refer to Table 7-5.

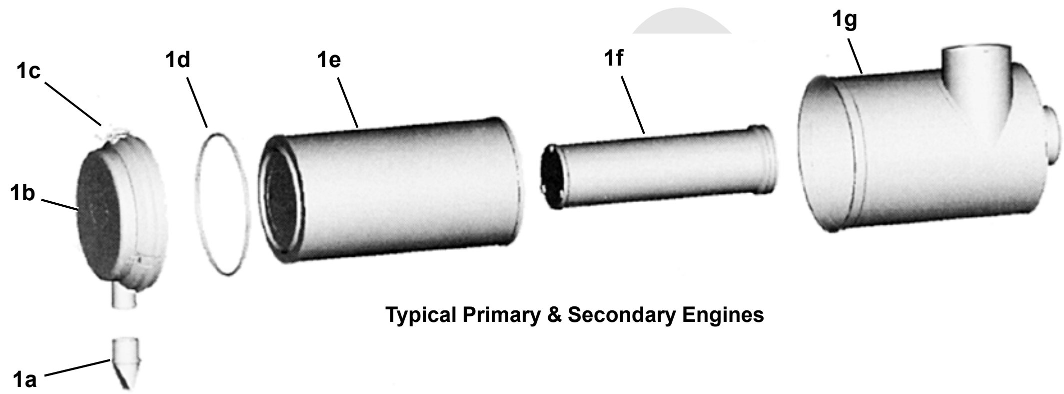
Table 7-5 Diesel Generator Battery Charge

Diesel Generator Engine Battery (12V) Charging			
OCV*	**State of Charge**	**Recharge Time (Hrs)**	**Notes**
12.6 V	100%	–	*OCV = Open Circuit Voltage (The battery voltage displayed on the diesel generator remote control panel.)  **Recharge Time (at 20A) = charging time depends on battery age, temperature, capacity, and charger efficiency.
12.4 V	75%	1.3	
12.2 V	50%	2.7	
12.0 V	25%	4.3	
11.8 V	0%	5.7	

Reference Only



Item	Description
1	Air Cleaner Assembly
1a	Evacuator™ Valve
1b	Service Cover
1c	Latch
1d	O-Ring
1e	Primary Filter
1f	Safety Filter
1g	Housing
2	Inlet Cap
3	Clamp (3 each)
4	Rubber Reducer
5	Clamp
6	Rubber Elbow
7	Tube
8	Mounting Bands
9	Service Indicator
9a	Service Window
9b	Reset Button



Typical Primary & Secondary Engines

A02258
A10577

FIGURE 7-9

7

ENGINE AIR CLEANER MAINTENANCE

See Figure 7-9 for the following procedure.

The air cleaner is mounted horizontally and fastened to engine air intake with rubber elbow (6), tube (7) and reducer (4). Servicing the air cleaner is an important maintenance function:

- Clogged air cleaner filters will prevent adequate air flow to the engine, causing poor starting and increased exhaust emissions.
- An improperly installed or damaged air cleaner can allow dirty air to be drawn directly into the engine.

Either condition can cause engine damage.

Inspection

To maintain engine protection and filter service life, inspect the following areas at regular intervals:

Daily

Check service indicator (9) with engine running. The indicator gives a visual indication when it is time to replace the filters.

- A red flag in indicator window (9a) extends as the filters become plugged. ***Replace filters when red flag locks in place at end of indicator.***
- The red flag remains locked in place after the engine is stopped. When the filters are replaced, push button (9b) **IN** to reset the indicator.

Reference Only

Monthly

1. Inspect rubber fittings (4 and 6) between air cleaner and engine for cracks or other damage which might allow unfiltered air to enter engine. Replace worn or damaged parts.
2. Check housing (1g) for dents or other damage that may allow unfiltered air to enter engine. Replace housing if damaged.
3. Check for loose clamps (3, 5) and bands (8). Tighten loose parts.
4. Inspect inlet cap (2) for obstructions. Clean as required.
5. Check that Evacuator valve (1a) is open.

CAUTION

Engine Damage!

STOP ENGINE before servicing air cleaner, or unfiltered air will be drawn directly into engine.

Do not attempt to clean and reuse old filters. Discard old filters and install a new ones.

Service

1. Release Seal Carefully:

   Unlatch and remove service cover (1b). The air cleaner has two filters: primary (1e) and safety (1f). The filters should be removed gently to reduce the amount of dust dislodged. There will be some initial resistance, similar to breaking the seal on a jar. Gently move the end of the primary filter back and forth to break the seal.

2. Avoid Dislodging Dust from Filters:

   Gently pull primary filter (1e) off outlet tube and out of housing (1g). Avoid knocking filter against housing.

   Repeat steps for safety filter (1f).

3. Clean Sealing Surfaces in Housing:

   Use a clean cloth to wipe sealing surfaces clean. Dust on sealing surfaces could hinder an effective seal and cause leakage. Make sure all contamination is removed before new filters are installed.

4. Clean Inside of Outlet Tube:

   Carefully wipe inside of outlet tube with a clean cloth. Dirt accidentally transferred to inside of outlet tube will reach engine and cause wear (engine manufacturers say that it takes only a few grams of dirt to destroy an engine). Be careful not to damage sealing area of tube.

5. Check Old Filters for Leak Clues:

   Visually inspect old filters for any signs of leaks. A streak of dust on clean side of filter is a telltale sign. Remove any cause of leaks before installing new filter.

6. Inspect New Filters for Damage:

   Inspect new filters, paying attention to inside of open end, which is sealing area. ***Never*** install damaged filters.

7. Install Filters by Hand:

   Insert new safety filter (1e) carefully and seal it by hand, making certain filter is completely seated in housing (1g).

   Repeat this step for primary filter (1e). Make sure O-ring (1d) is installed.

8. Install Service Cover:

   Once filter is in place, put service cover (1b) back on, making sure Evacuator valve (1a) points in direction shown. Fasten latches (1c). Cover should go on without extra force.

   Never use latches on cover to force filters into air cleaner! It is tempting to assume cover will do the job of sealing the filter – but it will not! Using latches to push filters in could cause damage to housing and will void warranty.

Reference Only

ENGINE CLUTCH ADJUSTMENT

See Figure 7-10 for the following procedure.

A disc-type manually operated clutch is mounted between each engine and its pump drive on this crane. The clutch allows each pump drive to be disconnected from it's engine, thereby reducing engine load and making start-up easier in cold weather. The clutch can be engaged or disengaged while the engine is running or off.

CAUTION!

Parts Damage!

Do not run engine longer than 20 minutes with clutch disengaged. Clutch release bearing can be damaged.

Operation

1. Grease clutch monthly. See Section Lubrication Guide.
2. At least once each month, disengage and engage the clutch several times with engine running. This practice will clean the disc surfaces and prevent the clutch discs from seizing.
3. When disengaging clutch, check free travel. Readjust clutch when free travel decreases to less than 3/4 inch (19 mm).

Adjustment

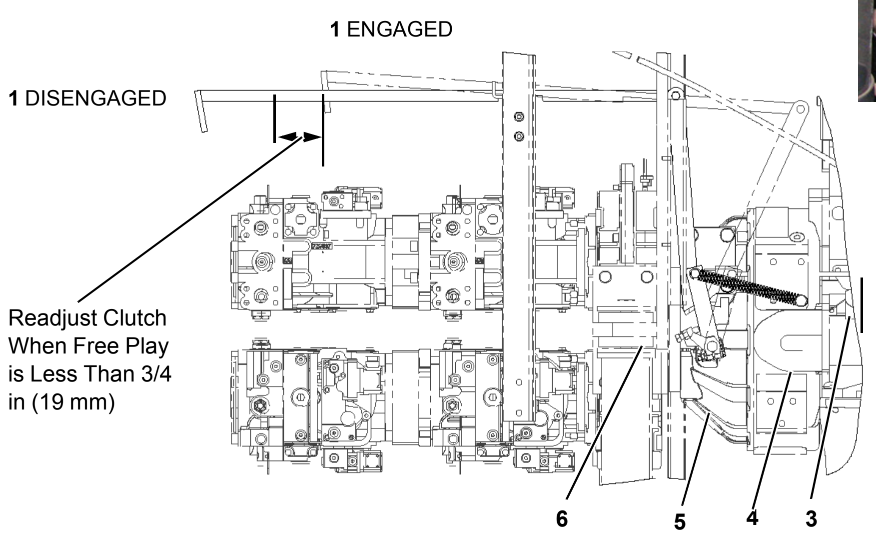
The clutch is adjusted internally through the clutch cover plate located on the bottom of the clutch housing. See the clutch manufacturer's manual for adjustment instructions.

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	Clutch Cover Plate
6	Pump Drive



View From Side of Engine

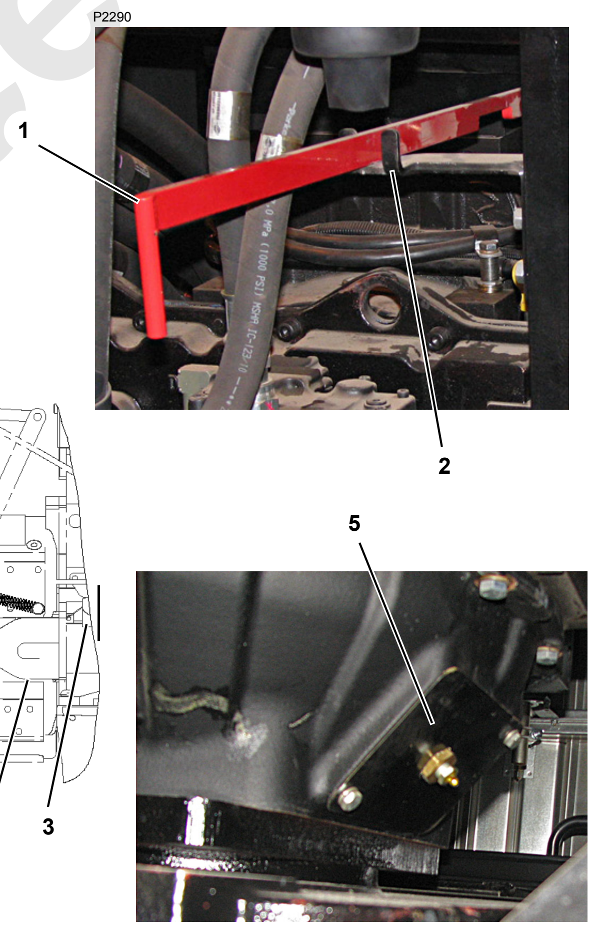


FIGURE 7-10

ENGINE THROTTLE ADJUSTMENT

The engine throttle assembly consists of an electronic hand throttle controller in the left console and an electronic foot throttle controller on the cab floor. There is no mechanical linkage between the controllers.

Electronic signals from the throttle controllers are transmitted to the crane's programmable controller, and the programmable controller increases and decreases engine speed accordingly.

Hand Throttle Controller

The hand throttle controller does not require adjustment, and is not repairable.

Foot Throttle Controller

See Figure 7-11 for the following procedure.

The foot throttle controller was properly assembled and calibrated at initial installation and should not require further attention.

Assemble and calibrate the foot throttle controller as follows if it is repaired or replaced.

Foot Throttle Controller Assembly

1. To assemble shaft (4) and torsion spring (5) into housing (1), first assemble spring onto shaft placing one end of spring into hole in head of shaft.
2. Insert shaft (4) into cavity in bottom of housing (1), through bearing (9), and into pedal (2).

   Lug on outboard end of spring (5) must stay engaged with hole in housing (1) (Section A-A).
3. Rotate pedal (2) as needed and install roll pins (11) through holes in pedal and shafts (Pedal Position ***A***).
4. Install setscrew (16). Do not insert deep enough to contact head on shaft (4).
5. Rotate pedal approximately 20° to position **B** (low idle). At this time flat on head of shaft (4) should be parallel with surface X on housing. Finish turning in setscrew (16) until it contacts flat on head of shaft (Section A-A).

Foot Throttle Controller Calibration

Supply voltage to be 25.0 to 26.0 VDC.

1. Turn potentiometer (7) shaft fully CW as viewed from shaft end (zero volts out).
2. With pedal (4) 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 (3) and tighten setscrew (17).
3. Rotate pedal to high idle Position **C**, hold in place using setscrew (16), and rotate potentiometer housing to obtain an output of 0.90 to 1.00 VDC.
4. Apply silicone sealant RTV-162 (MCC #622201) between housing (1) and potentiometer (7). Do not get sealant on shaft (3). Allow sealant to cure one to two hours before proceeding to next step.
5. After sealant has cured, check output for 0.90 to 1.00 VDC in high idle position C.
6. Remove setscrew (16), apply LOCTITE #242 (MCC #622293) to threads, and adjust setscrew to obtain a low idle position B output reading of 2.90 to 3.00 VDC.

Engine Speed Calibration

Engine speed is calibrated automatically by the crane's programmable controller:

- HIGH IDLE = 1,800 rpm
- LOW IDLE = 1,050 rpm

Legend for Figure 7-11

Item	Qty.	Description	Item	Qty.	Description
1	1	Foot Pedal Housing	11	2	Roll Pin (3/16 in Diameter X 1-1/2 in Long)
2	1	Foot Pedal	12	1	3-Pole Male Receptacle
3	1	Foot Pedal Shaft (right)	13	1	Resistor (220 Ohm, 1Watt)
4	1	Foot Pedal Shaft (left)	14	2	Hex Head Cap Screw (3/8 in-16UNC x 3/4 in Long)
5	1	Torsion Spring	15	2	Flat Head Screw (#6-32UNC x 1/2 in Long)
6	1	Receptacle Mounting Bracket	16	1	Allen Head Set Screw (5/6 in-18UNC x 3/4 in Long)
7	1	Potentiometer	17	1	Allen Head Set Screw (#6-32UNC x 3/16 in Long)
8	1	Zener Diode (22 VDC, 5 Watt)	18	2	Lock Washer (3/8 in)
9	2	Roller Bearing	19	1	Cab Floor
10	1	Conduit Nut (1/2 in)			

Reference Only

Foot Throttle Component Identification

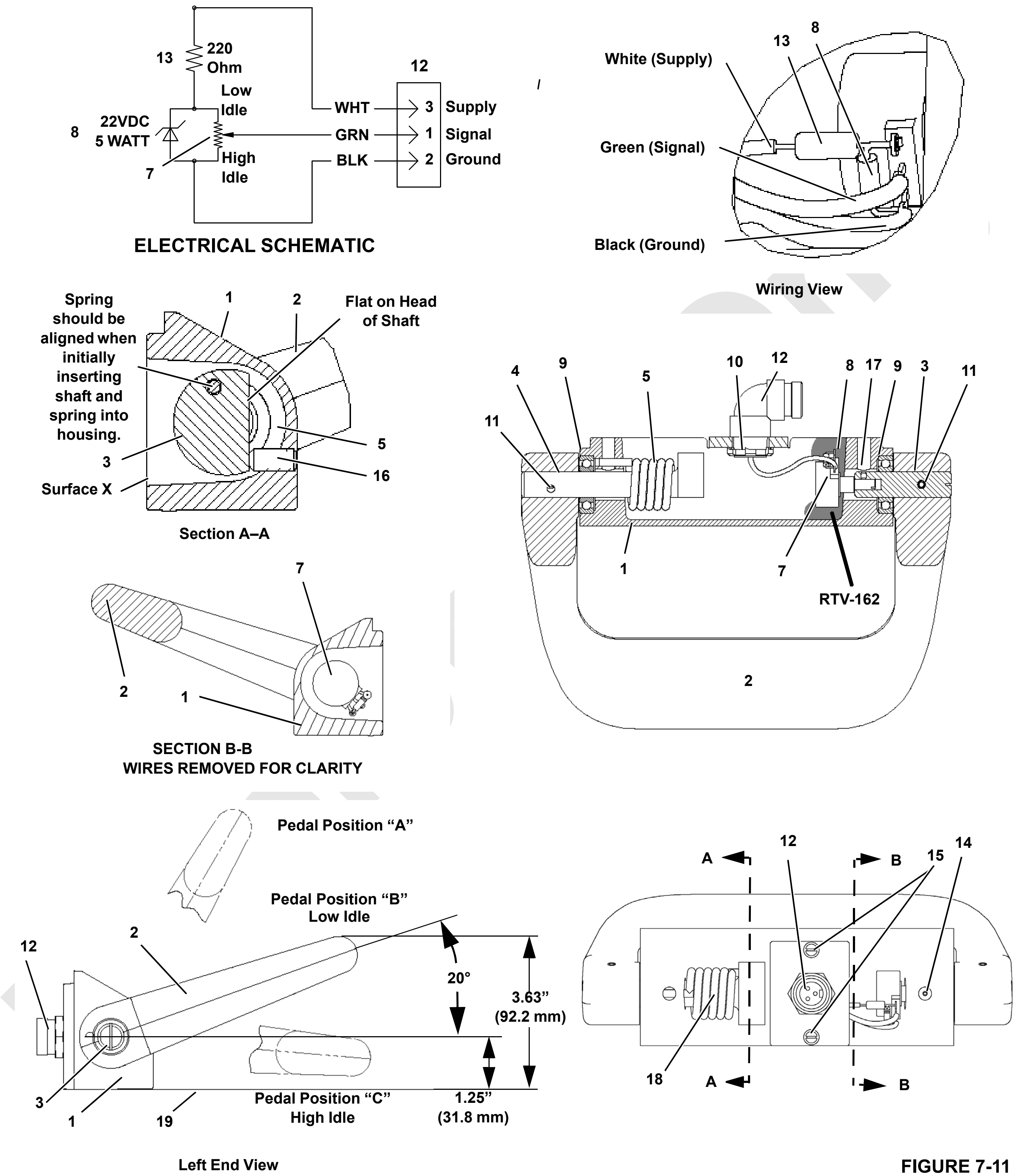


FIGURE 7-11

HYDRAULIC POWER GENERATOR

The hydraulic generator supplies AC power to the main load center although it ***does not*** supply AC power to the cold weather load center. When the primary engine is running, the remote mounted pump on the left side of the primary engine will supply hydraulic pressure to the generator motor. The hydraulic generator can be shut off with the manual bypass valve or with the emergency stop button located in the engine enclosure or the operator cab. When the emergency stop button is pushed, node-4 sends a 24 volt signal to enable the hydraulic generator bypass solenoid valve HS-92 to shut down the hydraulic generator. Node-4 will also enable HS-92 to shut down the hydraulic generator when the engine is below 900 RPM.

NOTE: Reference the Harrison Hydra-Gen Operation and Maintenance Manual for manufacturer's specified maintenance intervals. Reference the 31000 Operator Manual for additional detailed operation procedures and F2201 for recommended lubrication procedures.

CAUTION

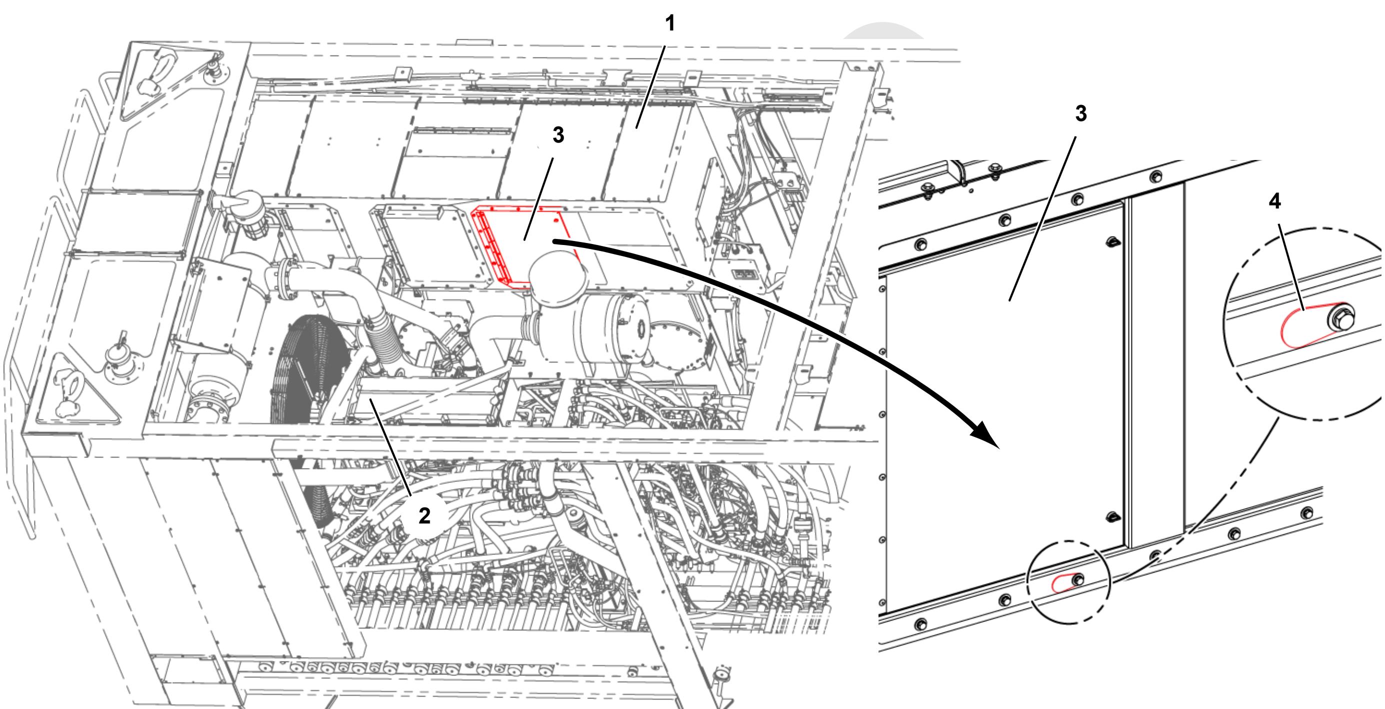
Burn Hazard!

Close and lock out the hydraulic generator bypass valve when performing maintenance on the hydraulic power generator.

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

When disconnecting hoses, make sure you bleed-off all pressure from the hose before performing any maintenance.

Hydraulic Generator Component Identification

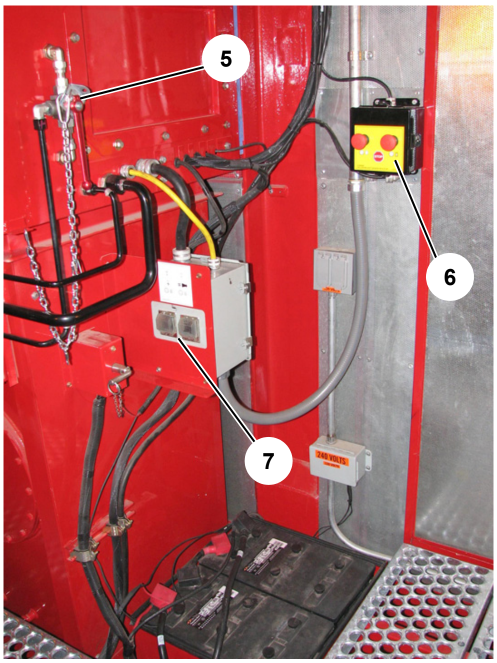


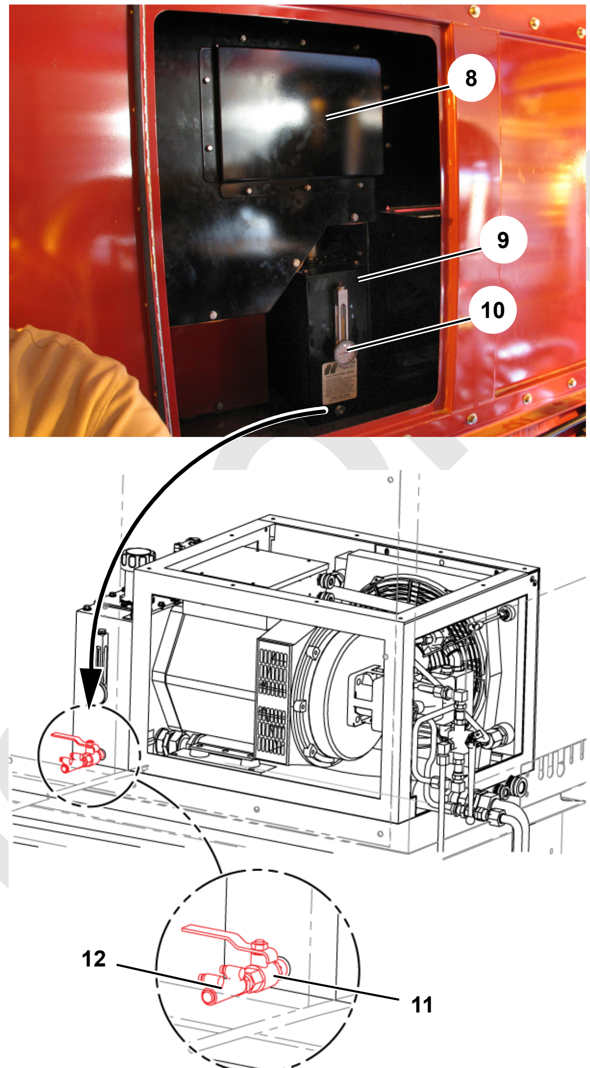
Item	Description
1	Hydraulic Generator Enclosure
2	Primary Engine
3	Hydraulic Generator Access Cover
4	Drain Hole Access Cover

FIGURE 7-12

Reference Only

Hydraulic Generator Component Identification (Cont)





Item	Description
5	Hydraulic Generator Bypass Valve
6	Hydraulic Generator Emergency Stop
7	Hydraulic Generator Circuit Breakers
8	Reservoir Fill Cap/Breather/Filter Access Cover
9	Hydraulic Reservoir
10	Sight Glass/Temperature Gauge
11	Reservoir Drain Valve
12	Hose/Hose Clamp

FIGURE 7-12 continued

Hydraulic Generator Reservoir

See Figure 7-12 for the following procedure.

Reservoir Drain and Hydraulic Filter

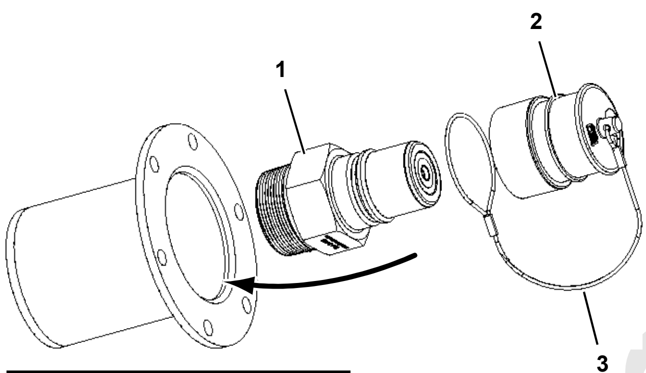
Reference the Harrison Hydra-Gen Operator Manual for the recommended service interval of the hydraulic oil, hydraulic oil filter, and replacement procedures. Fill and bleed system with ISO VG15 hydraulic oil or equivalent. The hydraulic reservoir drain valve (11) is mounted on the hydraulic generator reservoir and is located below the reservoir sight gauge (10).

Hydraulic oil drain procedure:

1. Open hydraulic generator access cover (3).
2. Loosen hose clamp (12) and remove hose from end of reservoir drain valve (11) exposing the 0.50” NPT male barb fitting.
3. Open cover plate to access drain hole (4).
4. Route 0.50” (12,7 mm) customer supplied hose through drain hole (4) and attach to barb fitting. Hose must be long enough to reach drain container.
5. Open reservoir drain valve (11) to release hydraulic oil into suitable waste oil container.
6. Close reservoir drain valve (11) when reservoir sight gauge (10) is empty and hydraulic oil stops draining.

7. Replace hose and hose clamp (12) on reservoir drain valve (11) barb and tighten hose clamp.
8. Open reservoir access cover (8).
9. Service fill cap, breather, and hydraulic filter per the manufacturer's recommended maintenance procedures.
10. Fill reservoir (9) according to manufacturer's recommended fill procedure.
11. Replace reservoir access cover (8).
12. Replace drain hole cover plate (4).
13. Close hydraulic generator access door (3).

POWER PLANT FUEL SYSTEM



Item	Description
1	Receiver Assembly
2	Receiver Cover
3	Lanyard
4	Fast Fill Nozzle

FIGURE 7-13

Engine Diesel Fuel

The engine diesel fuel line contains fuel shut-off valves for each engine located at the diesel fuel tank. The primary engine contains a shut-off valve at the engine fuel filter.

Refer to Operating Controls and Procedures manual for location of valves.

Refer to diesel engine manual for fuel filter replacement, interval and procedures.

Diesel Generator Fuel

The diesel generator fuel line contains a fuel shut-off valve.

Refer to diesel generator manual for fuel filter and fuel filter screen replacement, interval and procedures.

Diesel Fuel Tank

Fast Fill Receiver

See Figure 7-13 for the following procedure.

The fast fill receiver (1) on diesel fuel tank should be replaced when the anodize on the receiver starts to wear off.

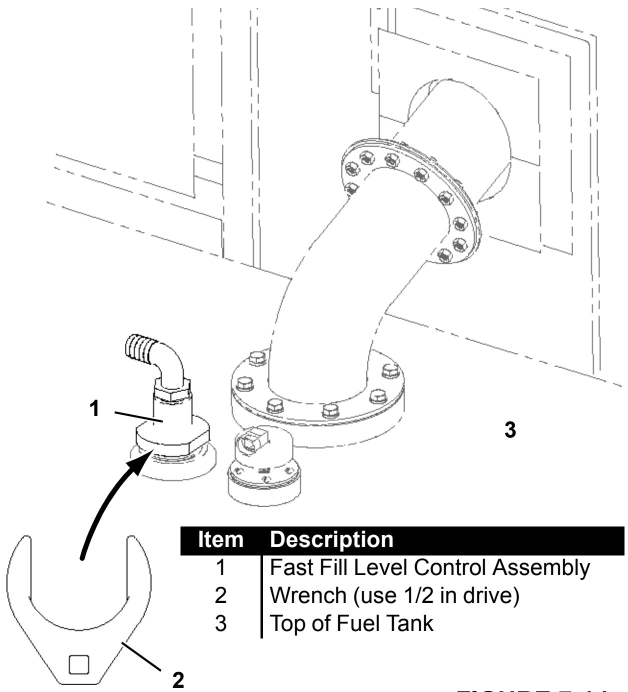
1. Place a 5 gallon (18 liter) bucket under fuel fill to catch fuel as receiver assembly is removed.
2. Use a 2.5 in (63,5 mm) wheel bearing locknut socket to remove the receiver assembly.
3. Loop receiver cover lanyard (3) over threads and located nearest hex flats of new receiver assembly.
4. Apply teflon paste thread sealant to male threads and install the new receiver assembly. Torque 48 to 59 ft lb (65 Nm to 80 Nm) using wheel bearing locknut socket.

Fast Fill Nozzle

See Figure 7-13 for the following procedure.

The fast fill fuel tank receiver can only be used with a "ZN Series" fast fill fuel nozzle (4) that is customer supplied. Performance characteristics include high rate diesel fueling up to 150 gallons per minute. The Wiggins Model ZZ9A1 is shown in Figure 7-13 for reference and is compatible with the fast fill receiver that is installed on the fuel tank fill neck. See the manufacturer's operation manual for the fast fill nozzle that is to be considered for use with the fast fill receiver.

Fast Fill Level Control Assembly



Item	Description
1	Fast Fill Level Control Assembly
2	Wrench (use 1/2 in drive)
3	Top of Fuel Tank

FIGURE 7-14

To remove fast fill level control assembly (1, Figure 7-14), Manitowoc provides wrench (2). The wrench is stored in The Portable Power Unit's tool box.

POWER PLANT COOLING SYSTEM

Engine Cooling

The each engine cooler unit consists of the charge air cooler, radiator, hydraulic oil cooler, surge tank, fan, louvers, and fuel cooler.

The cooling system capacity for each engine is approximately 26 gallons. Initial fill included forty units of diesel coolant additive (DCA) added to the coolant.

Refer to diesel engine manual for engine maintenance procedures.

The cooling system has three drain points.

- Radiator drain.
- Bottom radiator pipe drain.
- Floor drain point

Changing Coolant

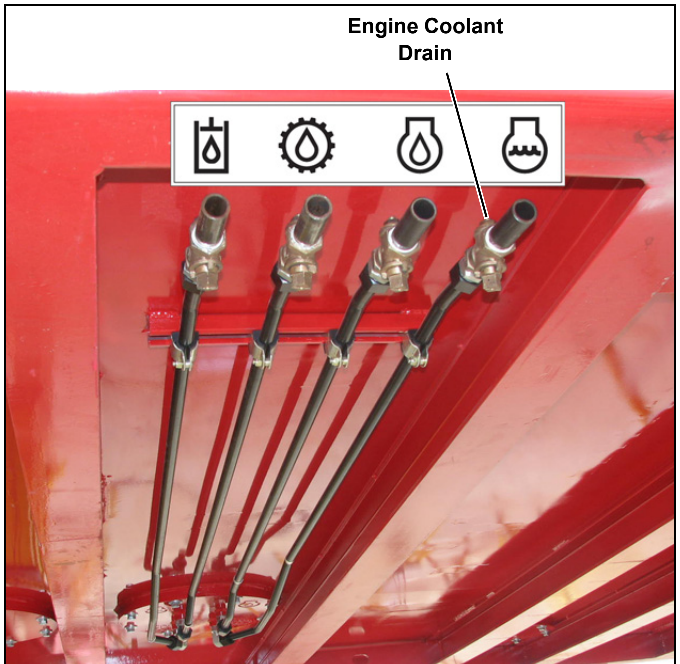


FIGURE 7-15

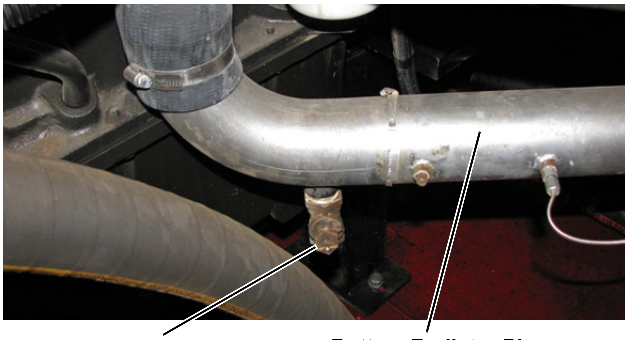
1. Attach a rubber hose to engine coolant drain pipe under the power plant enclosure (Figure 7-15). Insert end of hose into a suitable container to catch coolant. See Lubrication Guide for coolant system capacity.

FIGURE 7-16

2. Open radiator coolant drain cock (Figure 7-16) at the tank and open valve under the power plant enclosure. Drain tank completely.
3. Open petcock valve located on the upper radiator pipe Figure 7-18.

7

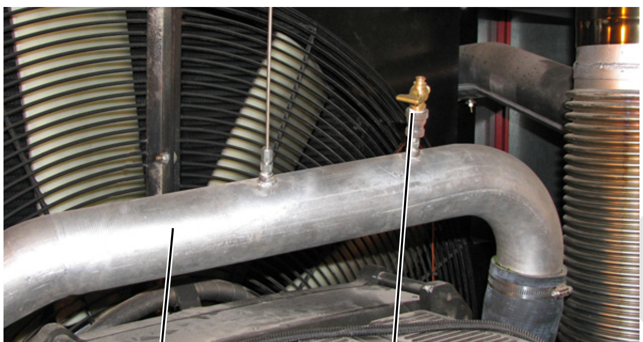
Reference



Drain Cock & Plug **Bottom Radiator Pipe**

FIGURE 7-17

4. Place a suitable container under the bottom radiator pipe. Remove plug from pipe drain cock (Figure 7-17) and open drain cock to drain any remaining coolant.
5. Close all drains and remove power plant drain hose prior to filling coolant system.



Upper Radiator Pipe Petcock Valve

FIGURE 7-18

6. A petcock bleed valve located on the upper radiator pipe (Figure 7-18) must be open when filling the system with coolant to vent the air. Maximum fill rate is 5 GPM.
7. Refer to engine manual for type of coolant and frequency of maintenance.
8. Close the petcock bleed valve when coolant appears at valve.
9. Continue to add coolant to FULL (COLD) LEVEL sight glass (see Figure 7-19) on coolant expansion tank.

CAUTION

Engine Damage!

Maintaining electrical grounds is an essential aspect of cooling-system maintenance, because stray electrical currents can cause problems in cooling systems. Regularly check ground connections for the batteries and starter.

Engine Coolant Filter

Refer to diesel engine manual for coolant filter replacement, interval and procedures.

Engine Coolant Expansion Tank

Each engine coolant expansion tank contains two sight gauges (Figure 7-19). Both sight gauges should show green.

Table 7-6 Expansion Tank Sight Glass

IF	Then
Top & Bottom Sight Glasses are **NOT** Green	Tank is empty
Top Sight Glass is **NOT** Green	Tank needs coolant
Both Sight Glasses are Green	Tank is full

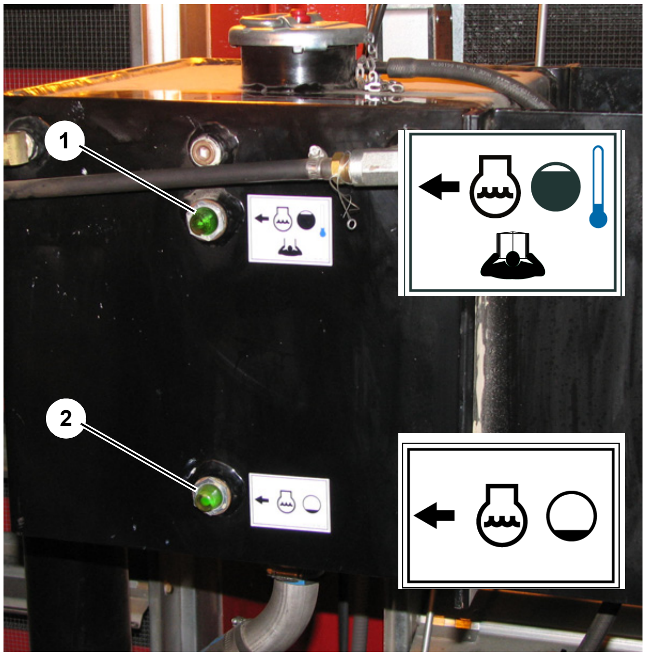
The top decal indicates:

- Engine Coolant
- Sight Glass Full
- When Cold
- See Manual

The bottom decal indicates:

- Engine Coolant
- Sight Glass Empty

Reference Only



Item	Description
1	Top Sight Glass
2	Bottom Sight Glass

FIGURE 7-19

Diesel Generator Coolant

Refer to diesel generator manual for coolant capacity, interval, and procedures.

Louver Control Time Delay Adjustment

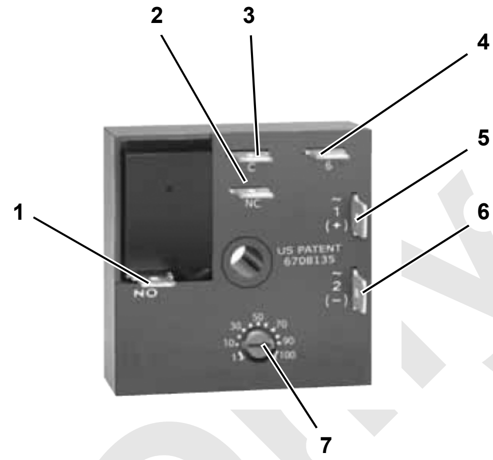
See Figure 7-20 for the following procedure.

The Power Plant Enclosure Louvers are controlled by a louver open / closed rocker switch located on right console. A time delay relay holds the enclosure louvers open for 120 minutes after engine shut down. This provides time for the plant enclosure to ventilate.

The Louver Control Time Delay relay is factory adjusted and only needs adjustment when replaced.

The Louver Control Time Delay relay is located on the Electrical Control Assembly in the rear console. (See Electric Section).

1. Access the electrical control assembly in the rear console.
2. Locate the Louver Time Delay relay (See Electric Section).
3. Turn adjustment selector (7) to select 120 minutes.



Item	Description
1	Normally Open (NO) Spade
2	Normally Closed (NC) Spade
3	Common (C) Spade
4	Input 6 Spade
5	Power 1 (+) Spade
6	Ground 2 (1) Spade
7	Delay Adjustment

FIGURE 7-20

Cold Weather Package

The cold weather package provides heater elements for the following:

- two 2000 watt hydraulic oil reservoir heaters.
- four 75 watt battery pad heaters.
- two 500 watt engine lube oil heaters.
- two 1500 watt engine coolant heaters.
- one 3000 watt enclosure heater.
- Diesel generator coolant heater
- Diesel generator engine oil heater

The engine oil heater is not supplied with a thermostat. and is not to be used above 30° F(-1°C).

Thermostat settings are as follows:

Table 7-7 Cold Weather Thermostat Settings

Item	Deg. ON	Deg. OFF
Hydraulic Oil	60°F (0°C)	100° F (37.8°C)
Engine Coolant	100°F (37.8°C)	120°F (48.9°C)

Reference Only

7

MOBILE POWER WASHING

Waste Water

Before and after repairs are performed or any time you want to have your machine thoroughly cleaned use a high-pressure washer to remove everyday dirt, debris and built-up grime.

Mobile Power Washers including power washing using water only, may discharge a large amount of wastewater. Wastewater discharged from power washers is considered industrial wastewater and is controlled by most states.

Wastewater generated by power washers can contain contaminants like detergents, oils, dirt, metals, solvents or other chemicals that can be carried directly into creeks, rivers, wetlands or other surface waters, polluting the water and threatening aquatic life.

Power washing also removes debris that can clog storm sewer inlets and grates or even prevent storm water drainage to the sewer.

Storm sewers may direct runoff water directly to a lake or stream, and require a permit to use.

Storm sewers may or may not be connected to a wastewater treatment plant, and require a permit to use.

Permits may be required by local and state agencies. Before power washing;

- Contact local and state agencies to find out what the regulations are for your area. Do Not power wash until you know the regulations.
- Find out if storm and sanitary sewers are combined or separate systems. Prevent wastewater from discharging to storm sewers if storm and sanitary sewers system are separate. Do Not wash equipment in any area that drains to a storm sewer.
- Equipment should be washed in grassy, vegetated, or gravel areas so that the wastewater can seep into the ground. Do Not power wash equipment on saturated ground or on days when rain is probable.
- Contaminated wastewater must not run off site and must be contained according to local and state permitting agencies. This may differ from local to local.
- If you are discharging wastewater to a sanitary sewer publicly owned treatment works (POTW), contact the POTW to obtain permission.

Exterior Surface Power Wash Considerations

Before allowing water to contact any electrical components, make sure components, wiring, nodes, switches are protected from moisture.

The exterior of the Power Plant Enclosure may be pressure washed being careful around items such as customer decals and crane model number decals. Spray should be directed perpendicular to the enclosure surface around and on louvers and dampers.

Do not spray directly into the louvers - to minimize water intrusion.

Make sure all doors and access panels are installed and closed prior to spraying the exterior.

Spray lightly over items such as external electrical junction boxes, AC utility power plug receiver, nodes, and hydraulic quick disconnects.

Sealed Bearing Power Wash Considerations

DO NOT hold the power wash pressure stream on any sealed bearing for an extended period of time. Spraying indirectly across the sealed bearings is highly recommended. Pay extra close attention to the following critical bearing areas when pressure washing:

- House Carrier Roller Bearings
- VPC Actuator Roller and Pinion Assemblies
- Crawler Rollers (top and bottom)
- Sheaves
- Carbody Crawler Trunnion to Bushing Interface (when installed 4 EA)

Re-Lubrication Considerations

Prior to shipment, it is recommended the following be re-lubricated if grease is removed from power washing:

- Carbody Ring Gear
- VPC Actuator

Interior Power Plant Enclosure Power Wash Considerations

Carefully pressure wash **only** the containment floor.

Be careful pressure washing the floor around the radiator core, fuel hoses, engine electrical, etc.

Be careful pressure washing around the battery boxes.

The containment floor has (3) 17" diameter clean-out covers with 1" NPT plugs for controlled removal of contained fluids.

The raised floor grating in the container may be pressure washed being careful around engine plumbing, radiator cores, electrical, etc.

Reference Only

CAUTION

Equipment Damage!

Equipment damage can result if water spray is allowed to enter electrical components, junction boxes, nodes, conduit connections and electrical connectors. DO NOT direct spray on any of these components.

- Do not pressure wash the walls. The walls have a perforated sheet metal surface, filled with noise insulation. They will soak up water.
- Do not pressure wash the ceiling. The ceiling has a perforated sheet metal surface, filled with noise insulation.
- DO NOT allow water to contact space unit heater.
- DO NOT allow water to contact battery chargers.
- DO NOT allow water to contact junction boxes.
- DO NOT allow water to contact engine heater junction boxes located under engines.
- DO NOT allow water to contact engine nodes, universal nodes, or DIN connectors.
- DO NOT power wash near desiccant breathers on the hydraulic oil tank.

DANGER

Electrical Shock Hazard!

Avoid electrical shock by ensuring that the battery cables are disconnected from the batteries before power washing.

FIRE SUPPRESSION SYSTEM

Description and Operation

The Fire Suppression System monitors two zones; the power plant enclosure and the generator area. See Section 3 of the 31000 Operator Manual for detailed operation and component identification table.

Maintenance

Reference the Kidde Sentinel SA1 Vehicle Fire Protection System Manual for maintenance procedures and recommended weekly and semi annual inspection intervals. System inspections to be performed and documented in the daily crane log by a trained technician. Replacement time table for the fire suppression canisters are10 years from the date code in the lower right corner of the product label.

Daily Inspection

- Check all three fire suppression system control panels and power supply boards for obvious damage. Verify the system power LED is illuminated.
- Check all six fire suppression canisters for damage, compromised positioning, or obstruction.
- Check all four flame sensors for damage, compromised positioning, or obstruction.

Maintenance Bypass

Directly below the three fire suppression system control panels are two maintenance bypass switches. Each of the two zones can be bypassed with the key switch. The fire suppression system (both zones) should be put in bypass mode at any time maintenance is to be carried out in the power plant enclosure or the generator area. Most importantly, if welding is being conducted inside of each zone, the bypass mode must be turned on. During bypass mode, the fire suppression system will not allow a discharge via the detection system. While the system is in bypass mode the fire suppression control panels will indicate a trouble signal on their display caused by the open circuit created by the bypass switch. Return both bypass switches to active after all maintenance procedures in both zones have been completed.

Component Identification

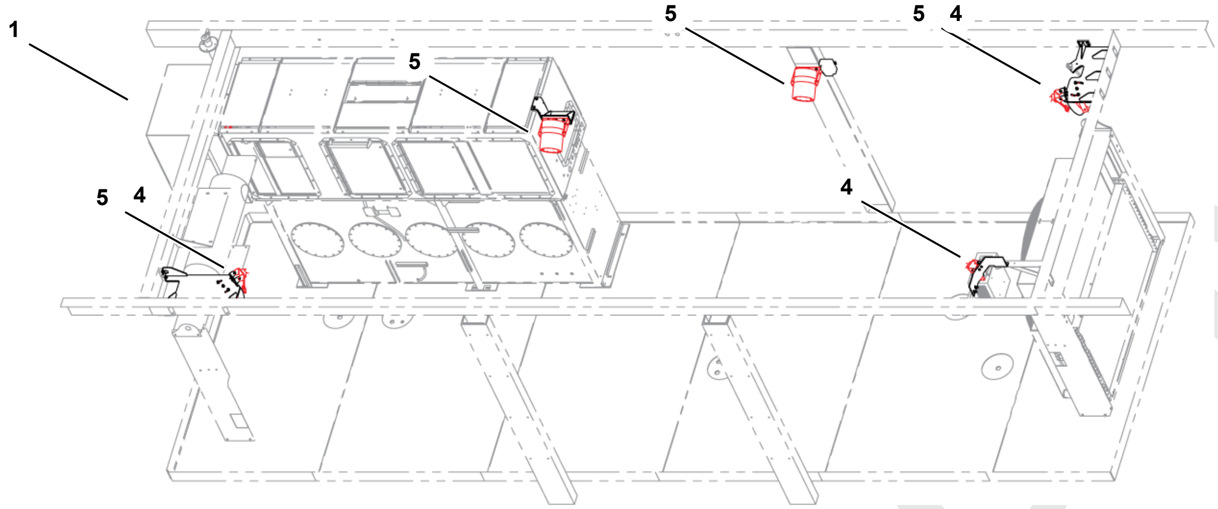
See Figure 7-21 for identification and location of the fire suppression system major components.

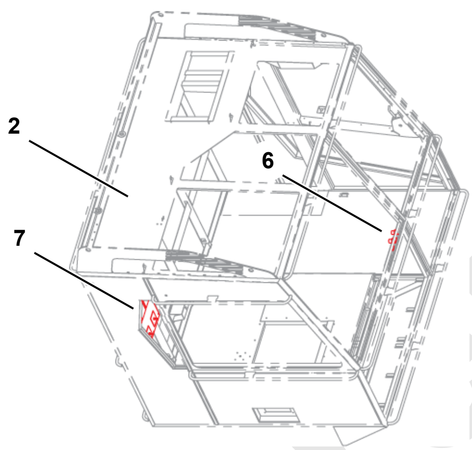
Maintenance Discrepancies

If discrepancies are noted and further maintenance is necessary as a result of the daily inspection, contact the local Kidde Fire Systems Distributor for service and/or repair. Fire Suppression System component modifications or alterations are not authorized.

Reference Only

Fire Suppression Component Identification





Item	Fire Suppression Component Location
1	Engine Enclosure
2	Operator Cab
3	Generator Area
4	Flame Sensor
5	Fire Suppression Canister
6	Push Button Manual Release
7	Controller Sentinel SA-1 and Bypass Switch

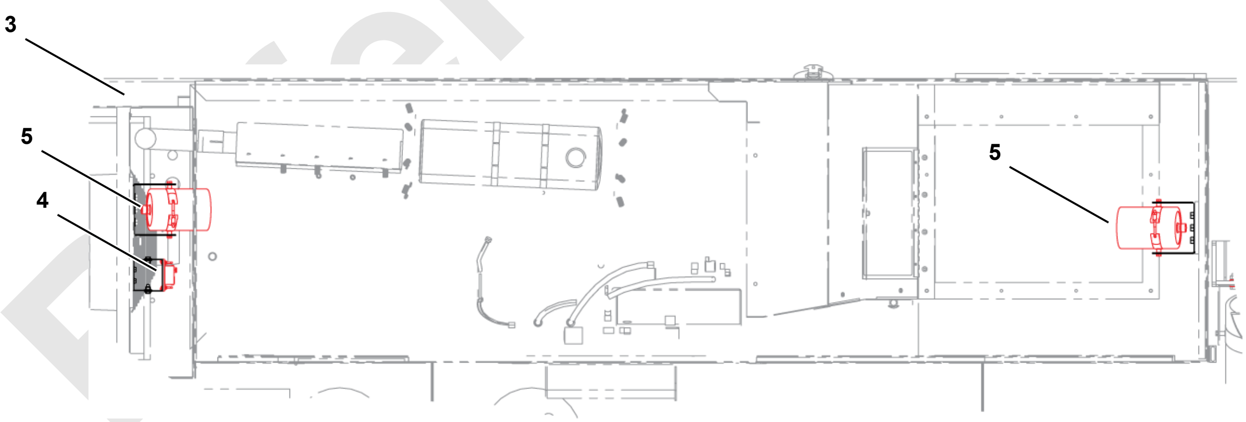


FIGURE 7-21

Manitowoc Crane Care

STORAGE AND MAINTENANCE ACCESS PANELS

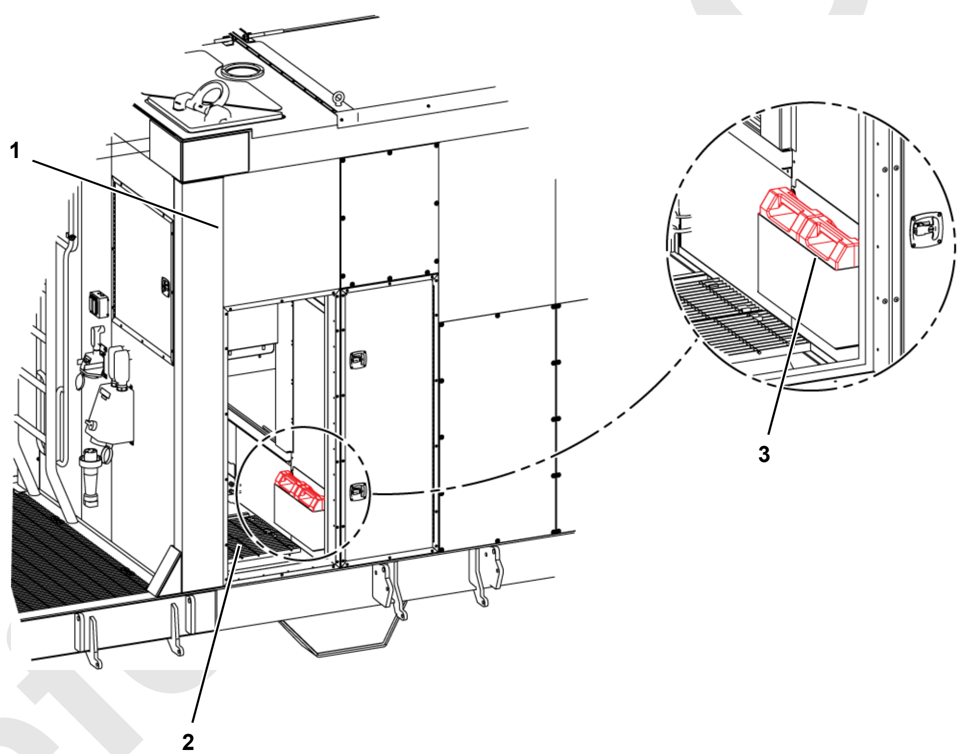
See Figure 7-22 for the following procedure.

Access panels for storage or maintenance on the engine enclosure are mounted in two ways. Panels with hinges for frequent and unrestricted access areas or unhinged panels for less frequent and confined space access areas. To aid in the removal of the unhinged access panels, vacuum cup handle assemblies are supplied and located in the fire extinguisher storage compartment (see Figure 7-1, item 5). It is recommended for the removal of larger access panels without hinges to use the vacuum cups with handles. The recommended procedure for removal of an unhinged panel requires two people.

1. One person to hold the panel in place after securing the vacuum cups to the unhinged panel while the second person removes the panel fasteners.
2. After all the panel fasteners have been safely removed, each person to grip one vacuum cup with two hands, carefully remove the access panel from its mounting location.
3. Store access panel in safe location during maintenance procedures.
4. Immediately remount access panels when maintenance procedures have been completed.

NOTE: Reverse removal procedure to re-mount access panel.

Vacuum Cup Component Identification



Item	Vacuum Cup Component Location
1	Engine Enclosure
2	Fire Extinguisher Storage Compartment
3	Vacuum Cup Storage Cases

FIGURE 7-22

Reference Only

Reference Only

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SECTION 7 INSERTS

The following publications are provided at the end of this section:

- Drawing 81013746 Sheet 1 and 5 Electric Control Assembly Fire Suppression

Reference Only

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Reference Only

SECTION 8
UNDER CARRIAGE

TABLE OF CONTENTS

8

Reference Only

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Reference Only

SECTION 8
UNDER CARRIAGE

TRAVEL SYSTEM OPERATION

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

Each travel hydraulic pump drives a crawler system motor and gearbox. Each hydraulic pump and motor is controlled with travel control handle movement and node controllers. Travel control handles are inoperable when travel park brake is applied. The gearbox for each crawler is driven by direct drive from motor output to planetary drive gearbox input.

The left front travel pump is dedicated to operate drum 6 through diverting valve HS-58 if drum 6 is selected. The right rear travel pump is dedicated to operate drum 5 through diverting valve HS-57 if drum 5 is selected.

To ensure that crane travels in a straight line forward or reverse direction, each travel drive closed loop pump and motor have shuttle valves and pressure senders that monitor hydraulic pressure. When traveling, Node-3 controller monitors pressure information from pressure senders and adjusts displacement of travel pumps to maintain equal pressure in each hydraulic travel drive closed loop.

The source of hydraulic pressure for releasing the travel brakes and enabling motor servo systems (2 speed control) is from L/F travel/drum 6/accessory pump 9 at 400 to 500 psi (35 bar). Continuous changing of closed-loop fluid occurs through leakage in pump, motor, and loop flushing valves that remove 5 g/m (19 L/m) of fluid when system pressure is above 200 psi (14 bar).

The travel pump output (speed limit) can be programmed for 25% to 100% of rated volume on the Travel Function Mode screen — see F2207 Main Display Operation manual.

Swing/Travel Alarm

When either travel control handle is moved from off, an input signal is sent to Node-1 controller. Node-7 and Node-8 controllers send a 28 volt signal to enable the left and right swing/travel alarms. When both travel control handles are moved to off, an input signal is sent to Node-1 controller. Node-7 and Node-8 controllers send a zero volt output signal to disable the left and right side swing/travel alarms.

Travel Brakes

Hydraulic pressure for releasing the travel brakes is output pressure from travel/drum 6/accessory pump 9 at 400 to 500 (28 to 35 bar) to travel brake release solenoid HS-60. For travel brake operation the system pressure must be above 200 psi (14 bar) for travel brakes to fully release from each travel motor shaft. If system pressure is below 200 psi (14 bar), travel brake could be partially applied and damage the brake. If brake pressure or electrical power is lost when operating, the travel brakes apply.

When travel brake switch is in on - park position, travel brakes are applied to hold crane in position. Travel brake valve HS-60 is open to allow hydraulic flow from the brake to tank.

When travel brake switch is in off - park position, an input signal is sent to Node-1 controller. Travel system circuit is enabled, waiting for a travel control handle command. When travel control handle is moved an input signal is sent to Node-1 controller. Node-5 controller sends a 28 volt output to enable travel brake release solenoid HS-60. Brake valve shifts to block tank port and supplies low pressure hydraulic fluid from travel/drum 6/accessory pump 9 to release crawler brakes. If hydraulic source (primary engine) brake pressure or electrical power is lost when operating, brakes apply.

Travel Forward and Reverse

When a travel control handle is moved in ***forward*** direction, an input voltage of 2.6 or more volts is sent to Node-1 controller. Node-3 and Node-4 controller send a variable zero to 24 volt output that is divided by a 220 ohm resistor and applied to selected travel pump EDC. Node-5 controller sends a 24 volt output to enable travel brake release solenoid HS-60 releasing both all four crawler brakes before travel pump(s) strokes.

The travel pump EDC tilts pump swash plate in the ***forward*** direction. Hydraulic fluid flow is from selected pump ports through swivel to motor ports. Node-3 and Node-4 controller output voltage to travel pump EDC is relative to control handle movement.

When a travel control handle is moved in ***reverse*** direction, an input voltage of 2.4 volts or less is sent to Node-1 controller. Node-3 and Node-4 controller send a variable zero to 24 volt output that is divided by a 220 ohm resistor and applied to selected travel pump EDC. Node-5 controller sends a 24 volt output to enable travel brake solenoid HS-60 releasing all four crawler brakes before travel pump(s) strokes.

The travel pump EDC tilts the pump swash plate in the ***reverse*** direction. Hydraulic fluid flow is from selected pump ports through swivel to motor ports. Node-3 and Node-4 controller output voltage to selected travel pump EDC is relative to selected control handle movement.

Travel motors are variable displacement, two speed that shift internally with an adjustable spring in each motor by 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

Reference Only

starting. When crawler begins to move, a high closed loop pressure shifts the PCOR (Pressure Compensated Over-Ride) spool placing travel motor in maximum displacement (high torque, low speed) position for breakaway torque.

As travel control handle is moved to neutral position, Node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-3 and Node-4 controller send a zero output voltage to pump EDC to move swash plate to center position. After travel control handle command is off for a preset time, the Node-5 controller sends a zero output voltage to disable travel brake solenoid HS-60. Travel brake valve shifts to block pilot pressure to brakes and opens a line to tank. Travel brakes apply.

Two-Speed Travel Operation

Travel two-speed switch allows operator to select ***low (turtle)*** speed when smoother starts and precise control over the load is required. Low speed places travel motor in maximum displacement (high torque, low speed) position and prevents motor from shifting to high speed. When travel two-speed switch is in ***low (turtle)*** speed position, Node-5 controller sends a 28 volt output to enable two-speed travel solenoid HS-59, shifting valve and directing hydraulic source pressure from L/F Travel/drum 6/accessory pump 9 at 400 to 500 (28 to 35 bar) to P/C (Pressure/ Compensated) valve. The P/C valve shifts PCOR (Pressure Compensated Over-Ride) spool placing travel motor in maximum displacement (high torque, low speed) position. Travel motors remain in this position until travel speed switch is placed in ***high (rabbit)*** speed position and engine speed is more than 1500 RPM.

Place travel two-speed switch in ***high (rabbit)*** speed when maximum available travel speed is required (normal operation). Node-5 disables the two-speed solenoid valve HS-59 and blocks hydraulic source pressure from L/F Travel/ drum 6/accessory pump 9 at 400 to 500 (28 to 35 bar) to travel two speed motor control. When travel two-speed switch is in ***high (rabbit)*** speed position, travel motors shift to minimum displacement (low torque, high speed) automatically if engine speed is above 1500 rpm and system pressure is below 3,915 psi (270 bar). If engine is below 1500 RPM, Node-5 enables the two-speed travel solenoid HS-59 even though travel two-speed switch is in ***high (rabbit)*** position. When travel two-speed solenoid HS-59 is enabled, two speed motor control shifts into maximum displacement (low speed) by removing hydraulic source pressure from L/F Travel/drum 6/accessory pump 9 at 400 to 500 (28 to 35 bar) to P/C valve. This allows motor to operate in PCOR mode. Travel motor will stay locked in low speed, maximum displacement by Node-5 until engine goes above 1500 RPM.

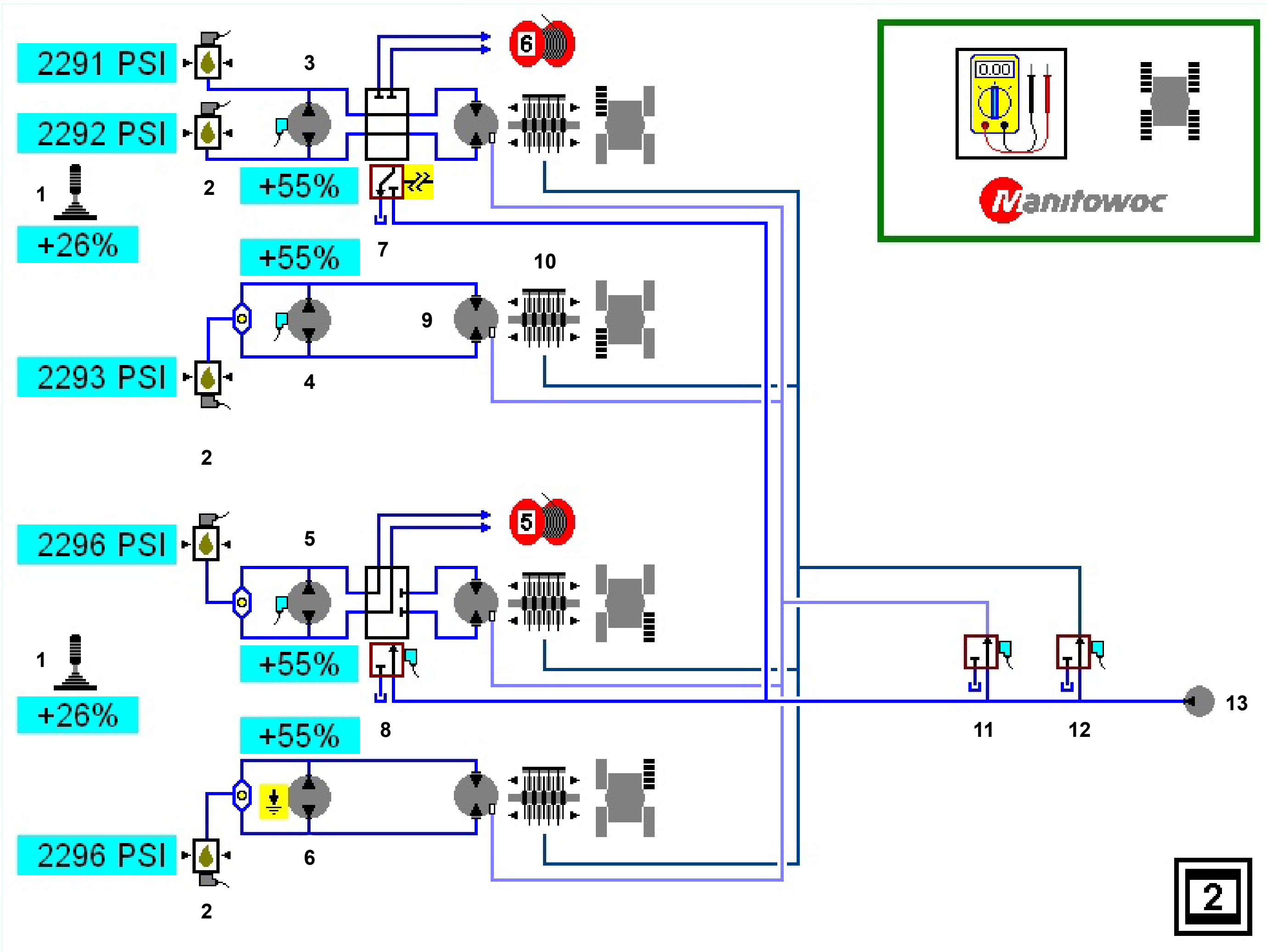
Travel Cruise

When the travel cruise switch is moved to ***cruise*** position, an input signal is sent to Node-1 one controller. Node-3 and Node-4 controller send an output signal to travel pumps to lock-in selected flow requirements and direction.

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

Reference Only

TRAVEL DIAGNOSTIC DISPLAY



Item	Description	Item	Description
1	Travel Control Handle	8	Drum 5 Diverter Valve HS-57
2	Travel Pressure Sender	9	Travel Motor (4 places)
3	L/F Travel/Accessory/Drum 6 Pump 9	10	Travel Brake (4 places)
4	L/R Travel Pump 12	11	Travel Two Speed Valve HS-59
5	R/R Travel and Drum 5 Pump 11	12	Travel Brake Release Valve HS-60
6	R/F Travel Pump 8	13	Accessory Pump (low pressure)
7	Drum 6 Diverter Valve HS-58		

FIGURE 8-1

8

Ref

TRAVEL ELECTRICAL SCHEMATIC

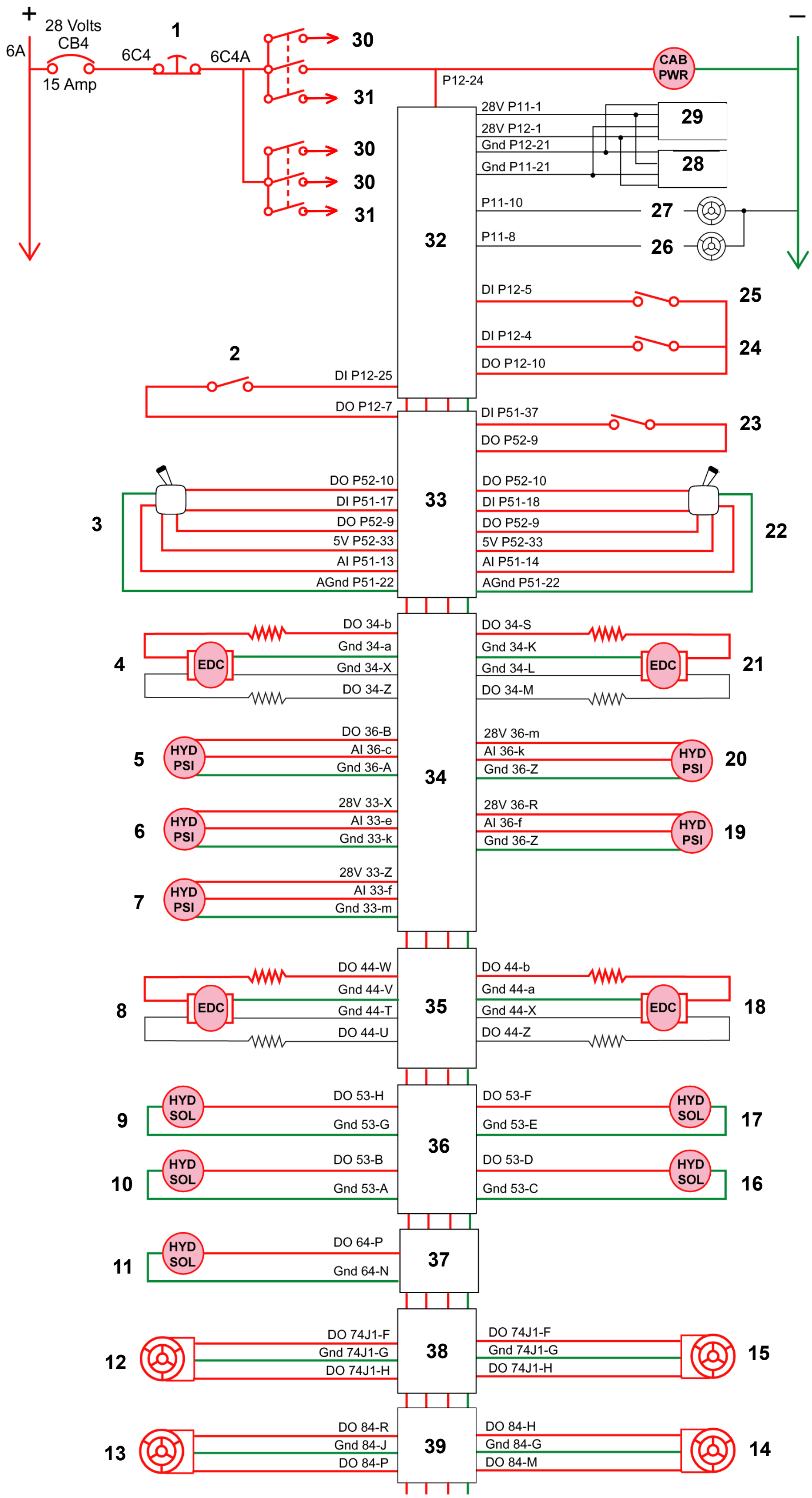


FIGURE 8-2

Published 07-24-15, Control # 077-03

Manitowoc Crane Care

Travel Electrical Schematic (Cont)

Item	Description	Item	Description
1	Engine Stop	21	Pump 8 Right Front Track
2	Travel Park Brake Switch	22	Right Travel Control Handle
3	Left Travel Control Handle	23	Seat Switch
4	Pump 12 Left Rear Track	24	Travel Cruise Switch
5	Left Rear Track Pressure Sender	25	Travel 2-Speed Switch
6	Left Front Track Pressure Sender “A” Port	26	RCL Warning Alarm
7	Left Front Track Pressure Sender “B” Port	27	Caution Fault Alarm
8	Pump 9 Left Front Track	28	RCL Display
9	Travel Brake Release Solenoid HS-60	29	Main Display
10	Drum 5 Diverter Valve Solenoid HS-57	30	Run
11	VPC Pivot Frame Greaser Valve Solenoid	31	Start
12	Right Rear Swing/Travel Alarm	32	Master Node 1
13	Right Front Swing/Travel Alarm	33	Side Console Node 2
14	Left Front Swing/Travel Alarm	34	Universal Node 3
15	Left Rear Swing/Travel Alarm	35	Universal Node 4
16	Drum 6 Diverter Valve Solenoid HS-58	36	Universal Node 5
17	Travel 2-Speed Valve Solenoid HS-59	37	Universal Node 6
18	Pump 11 Right Rear Track	38	Universal Node 7
19	Right Front Track Pressure Sender	39	Universal Node 8
20	Right Rear Track Pressure Sender		

FIGURE 8-2 continued

NOTE: See Folio 2207 for detailed travel diagnostic information.

Reference Only

8

CRAWLER ADJUSTMENT

Maintenance

Crawler wear cannot be eliminated, but the rate of wear can be reduced through regular preventive maintenance, as follows:

- Lubricate crawlers as instructed in Lubrication Guide.
- Keep crawlers clean and avoid dirt build-up when cutting.
- Keep all mounting bolts tight (see Parts Manual for applicable torque values).
- Keep treads properly adjusted.
- Inspect crawler gear cases, crawler frames, rollers, and treads on a regular basis as instructed in the maintenance check list.
- Look for oil leaks, excessive wear, cracks, and other damage. Broken or cracked parts can indicate that the treads are adjusted too tight.
- Repair or replace damaged parts immediately to prevent further damage.

Track Adjustment Guideline

Tread Slack Inspection

See Figure 8-3 for the following procedure.

Check crawler tread slack at the top center of each crawler. Maintain approximate equal tread slack at all four crawlers.

1. Perform track slack inspection independently on each crawler.
2. Travel forward or reverse on a firm level surface so all tread slack is on top of the crawler between the top two track tensioner idler rollers (2, Figure 8-3).
3. Place straight edge (4) on the top of the crawler extending to each top track tensioner idler roller (2). Measure gap (5) between straight edge and top of tread at lowest point in the track sag. Maximum allowable track tension sag is 3 in (76 mm).
4. Adjust crawler track tension if gap exceeds 3 in (76 mm).
5. Repeat steps 1 through 4 for each crawler.

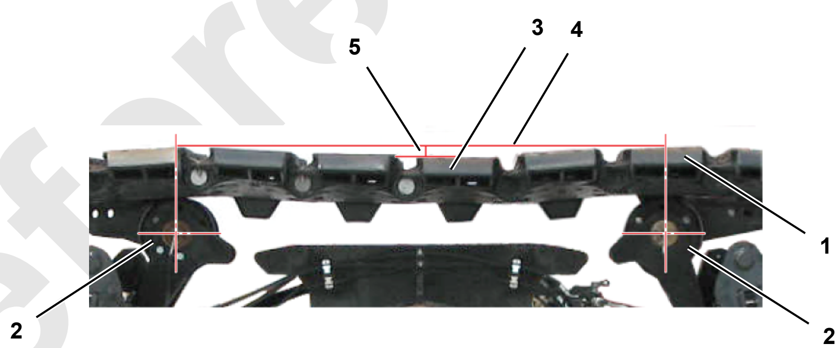
NOTE: Travel surface requirements for track tension inspection must be firm, level, and uniformly supporting. Reference 31000 Travel Specification Chart maximum allowable travel conditions.

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.

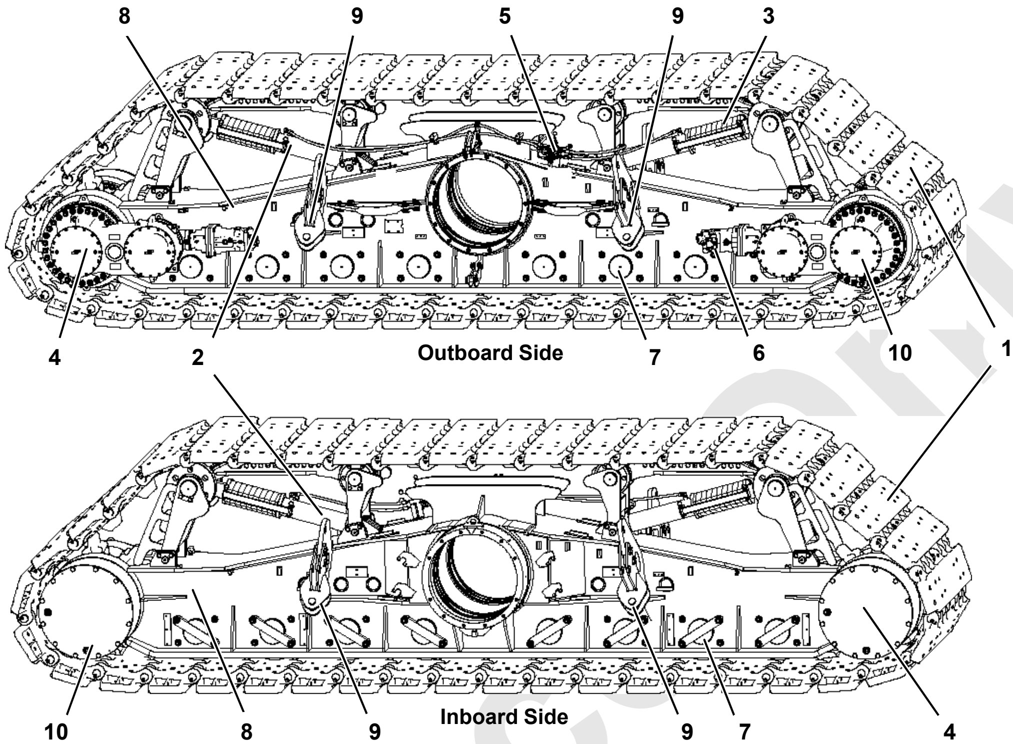


Item	Description
1	Crawler Shoe
2	Tensioner Assembly Top Idler Roller
3	Track Tension Sag
4	Straight Edge
5	Gap

FIGURE 8-3

Reference Only

Crawler Component Identification



Item	Description
1	Crawler Shoe (42)
2	Tension Assembly
3	Shims
4	Drive Assembly - Left Hand
5	Valve Assembly
6	Hydraulic Motor
7	Idler Shaft and Roller (8)
8	Crawler Frame
9	Lifting Lever
10	Drive Assembly - Right Hand

FIGURE 8-4

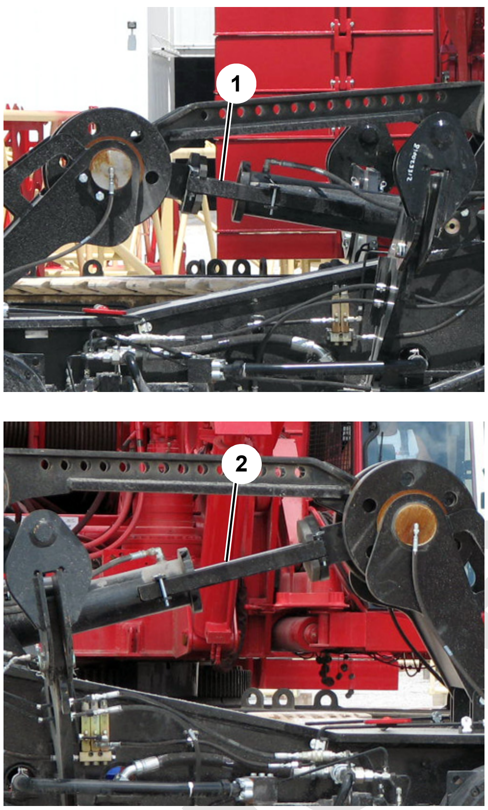
Reference Only

Track Tension Adjustment Procedure

See Figure 8-5 through Figure 8-14 for the following procedure.

Tensioner Adjustment

NOTE: There are two sources of accessory hydraulic oil for the purpose of tensioning a crawler track. Either the crane accessory hydraulic system or the Portable Power Unit (PPU) can be used as alternate methods of tensioning and will be discussed in two separate procedures. See Figure 8-5 for tensioner adjustment position reference.



Item	Description
1	Crawler Tensioner Extended Half Way
2	Crawler Tensioner Extended Fully

FIGURE 8-5

Crawler tensioning procedures are with crawler guards removed for clarity. See Figure 8-6 for view with crawler guards installed.

Reference F2220 for PPU operation.

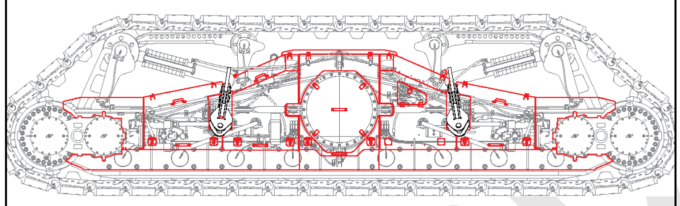
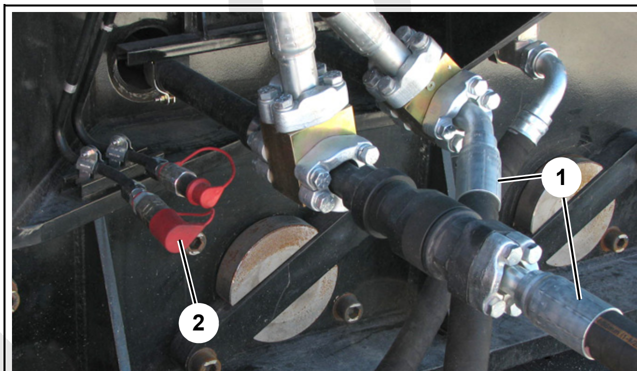


FIGURE 8-6

Method One Crane Accessory Hydraulic System

1. Thoroughly clean crawler to be adjusted.

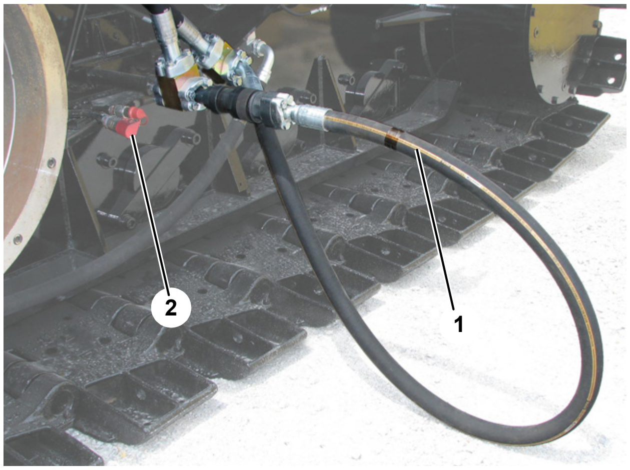


Item	Description
1	Crawler High Pressure Lines
2	Crawler Brake Quick Disconnect Coupler

FIGURE 8-7

2. Cross port crawler drive motors to allow back driving of tumbler.
   - Disconnect crawler high pressure lines (1, Figure 8-7), male nipple and female coupler quick disconnect at carbody to crawler connections. (inboard side of crawler).
   - Connect the male and female high pressure crawler lines together (1, Figure 8-8).

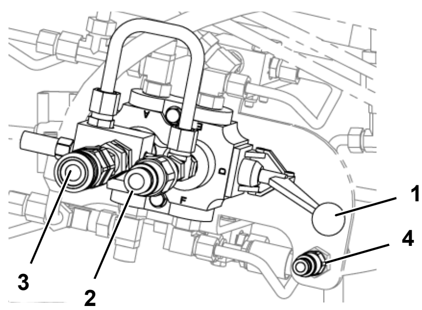
Reference Only



Item	Description
1	Cross Ported High Pressure Hose
2	Crawler Brake Quick Disconnect Coupler

FIGURE 8-8

3. Disconnect hydraulic brake line, inboard side of crawler, from brake quick coupler connection (2, Figure 8-8).



Item	Description
1	Track Tensioner Select Valve
2	Nipple
3	Coupler
4	Crawler Brake Release Nipple

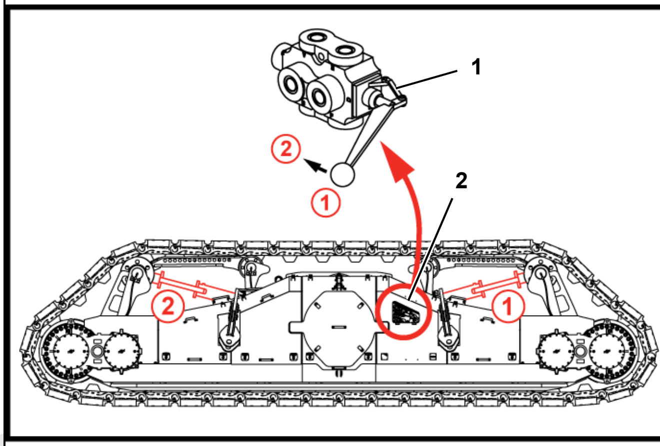
FIGURE 8-9

4. Enable the accessory pump for manual controls (reference Crane Set Up Function Mode screen in F2207 for procedure to enable the accessory pump).

5. Connect the static accessory hydraulic hoses between the rotating bed and the carbody. See crane operator manual for accessory set up procedures between rotating bed and carbody.

NOTE: Accessory hydraulic connections between the carbody and rotating bed are static (fixed) and MUST be disconnected prior to crane slewing.

6. Actuate right or left tensioning cylinder with the track tensioner select valve (1, Figure 8-9). Reference decal on track tensioner select valve cover (2) for handle select position (Figure 8-10).



Item	Description
1	Track Tensioner Select Valve
2	Track Tensioner Select Valve Cover

FIGURE 8-10

7. Connect one 9,14 m (30 ft) double hose extension with quick disconnects to the accessory quick disconnect ports on the side carbody beam (2, Figure 8-11).

NOTE: The Hand-Held Crane Set Up Tool and hose extensions are stored in the PPU storage box.

8. Connect the inlet side (3, Figure 8-13) of the hand-held crane set up tool (1) to the hose extension (2) from the accessory ports on the side carbody beam.

9. Connect hose assembly (6, Figure 8-13) between quick coupler (5) on hand-held crane set up tool and crawler brake release nipple on bulkhead of track tensioner select valve (4, Figure 8-9).

10. Connect the hydraulic accessory pressure outlet hoses (4, Figure 8-13) of the crane set up tool to the bulkhead connections of the track tensioner select valve (2, 3 Figure 8-9).

11. Use the crane set up tool valve assembly and the track tensioner select valve to extend the left and right track tensioner cylinder (4, Figure 8-12) to an equal height on both sides. Proper tension is attained at full cylinder force of 207 Bar (3000 PSI).

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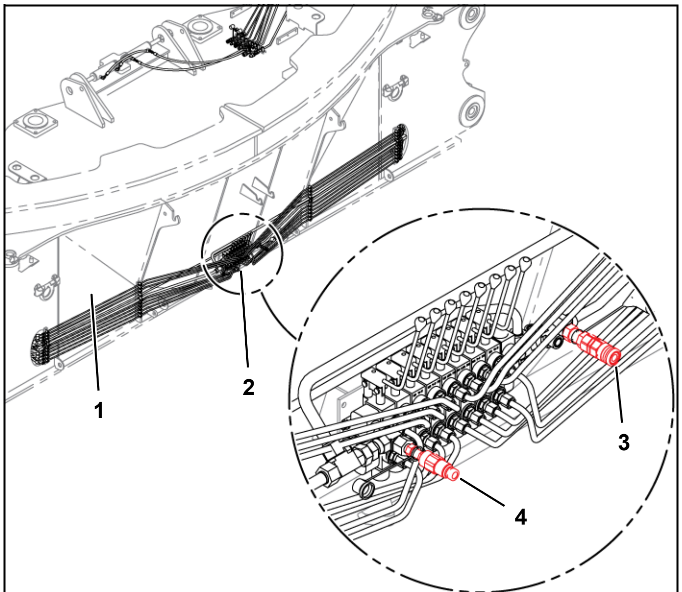
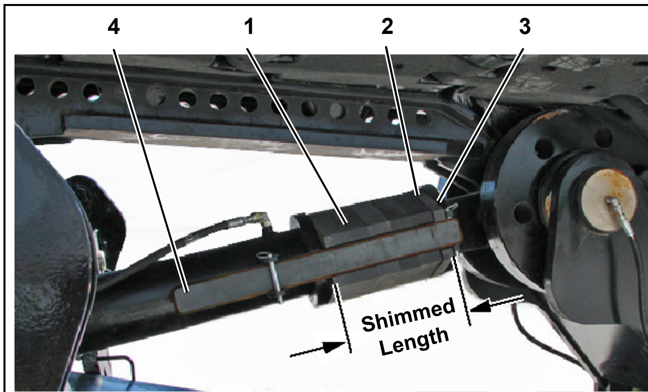


Item	Description
1	Side Carbody Beam
2	Accessory Quick Disconnect Ports
3	Accessory Quick Disconnect Coupler
4	Accessory Quick Disconnect Nipple

FIGURE 8-11



Item	Description
1	Track Tensioner 50,8 mm Shim
2	Track Tensioner 25,4 mm Shim
3	Cylinder Rod End
4	Tensioner Cylinder

FIGURE 8-12

12. Add 2 in (50,8 mm) shims (1, Figure 8-12) as needed equally on both tensioners. Install additional 1 in (25,4 mm) shim (2, Figure 8-12) if there is sufficient space.

NOTE: The shim length of each tensioner must be equal, within 1 in (25,4 mm).

13. Retract each tensioner (4, Figure 8-12) until rod end (3, Figure 8-12) contacts shims.

14. Disconnect the crane set up tool hoses from the bulkhead on the tensioner selector valve.

15. Disconnect the static accessory hoses between the carbody and the rotating bed. These hoses must be disconnected before slewing the crane.

16. Reconnect inboard crawler high pressure lines to carbody.

17. Reconnect inboard crawler brake line to carbody.

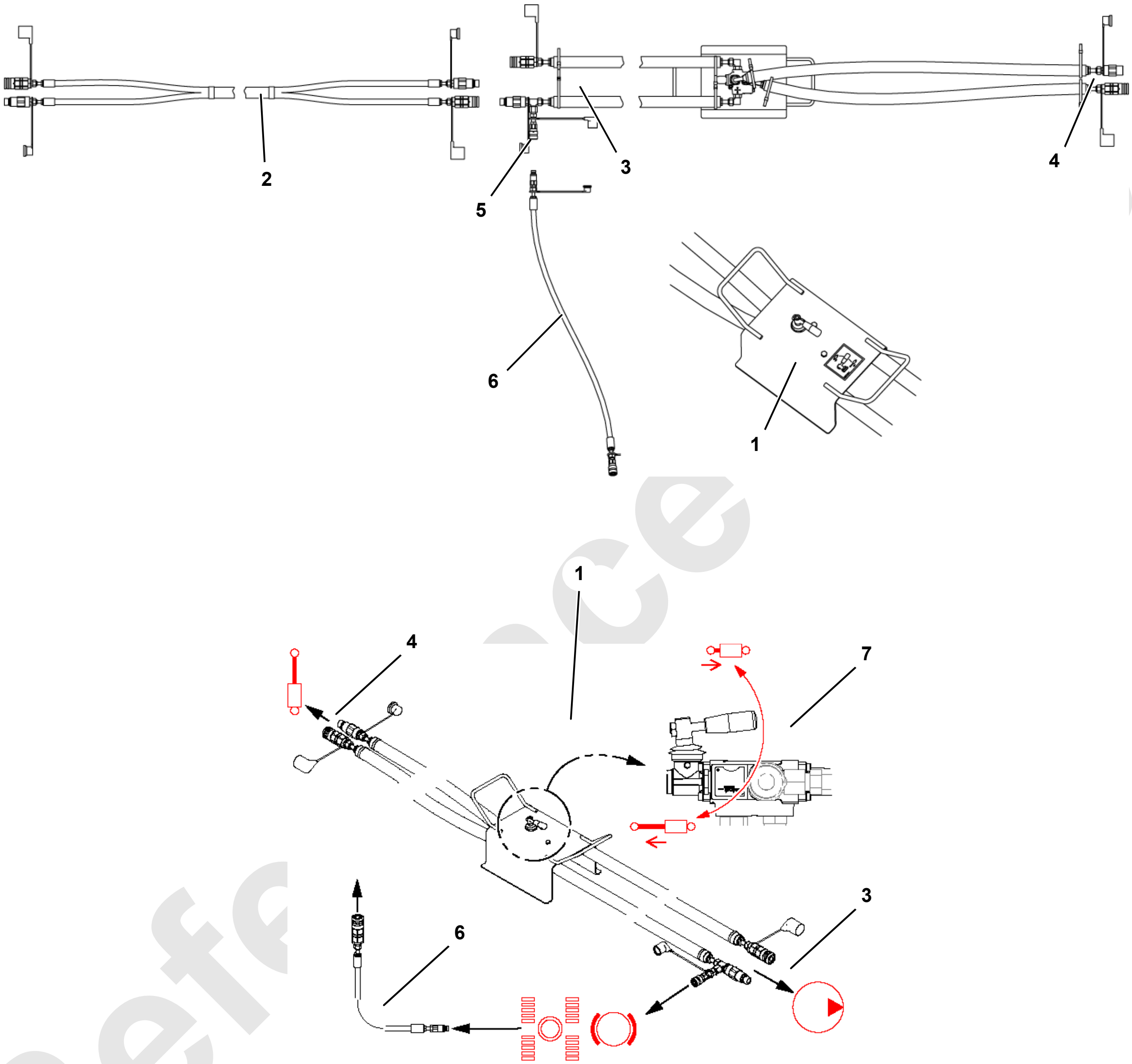
18. Disable the accessory pump for manual controls.

19. Store Hand-Held Crane Set Up Tool and hose extensions in PPU storage box.

NOTE: When not in use store excess shims in tool box on crawler.

Reference Only

Valve Directional Control Hand-Held Crane Set Up Tool Component Identification



Item	Description
1	Hand-Held Crane Set Up Tool
2	9,14 m (30 ft) Hose Extension Assembly
3	Crane Set Up Tool Hydraulic Inlet
4	Crane Set Up Tool Hydraulic Outlet
5	Quick Disconnect Crawler Brake
6	Hose Extension Crawler Brake
7	Directional Control Valve

FIGURE 8-13

Method Two Portable Power Unit (PPU)

1. Thoroughly clean crawler to be adjusted.
2. Cross port crawler drive motors to allow back driving of tumbler.
   - Disconnect crawler high pressure lines (1, Figure 8-7), male nipple and female coupler quick disconnect at carbody to crawler connections. (inboard side of crawler).
   - Connect the male and female high pressure crawler lines together (1, Figure 8-8).
3. Disconnect hydraulic brake line, inboard side of crawler, from brake quick coupler connection (2, Figure 8-8).
4. Position the PPU near the crawler assembly requiring track tensioning.
5. Connect the inlet side (3, Figure 8-13) of the hand-held crane set up tool (1) to the ISO 46 hydraulic hose reel on the PPU.

NOTE: The Hand-Held Crane Set Up Tool and hose extensions are stored in the PPU storage box.

6. Connect hose assembly (6, Figure 8-13) between quick coupler (5) on hand-held crane set up tool and crawler brake release nipple on bulkhead of track tensioner select valve (4, Figure 8-9).
7. Connect the hydraulic accessory pressure outlet hoses (4, Figure 8-13) of the crane set up tool to the bulkhead connections of the track tensioner select valve (2, 3 Figure 8-9).
8. Start the PPU. Reference F2220 Portable Power Unit Operation and Maintenance Manual for start up and operation procedures.
9. Use the crane set up tool valve assembly and the track tensioner select valve to extend the left and right track tensioner cylinder (4, Figure 8-12) to an equal height on both sides. Proper tension is attained at full cylinder force of 207 Bar (3000 PSI).
10. Add 2 in (50,8 mm) shims (1, Figure 8-12) as needed equally on both tensioners. Install additional 1 in (25.4 mm) shim (2, Figure 8-12) if there is sufficient space.

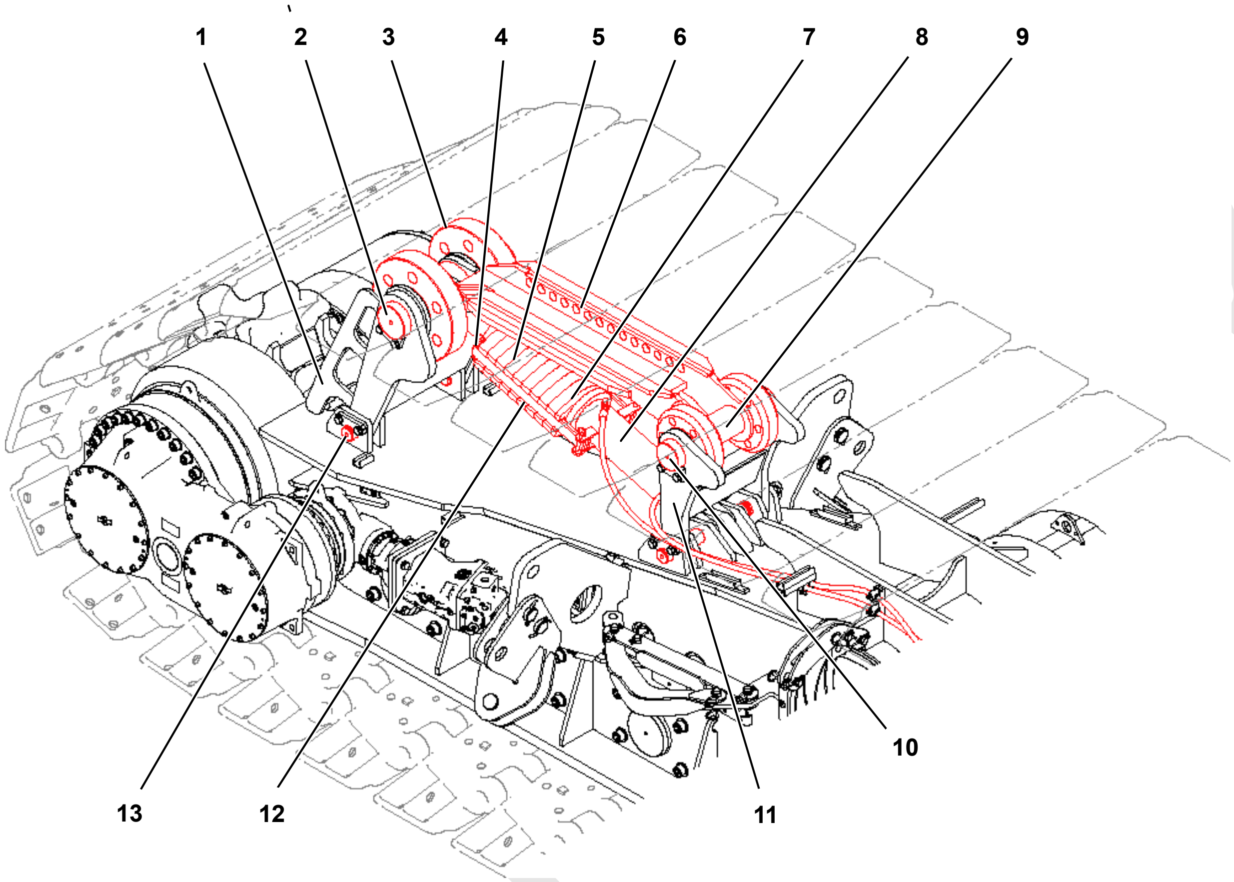
NOTE: The shim length of each tensioner must be equal, within 1 in (25,4 mm).

11. Retract each tensioner (4, Figure 8-12) until rod end (3, Figure 8-12) contacts shims.
12. Shut down PPU. Reference F2220 Portable Power Unit Operation and Maintenance Manual for shut down procedures.
13. Disconnect the crane set up tool hoses from the bulkhead on the tensioner selector valve.
14. Reconnect inboard crawler high pressure lines to carbody.
15. Reconnect inboard crawler brake line to carbody.
16. Store Hand-Held Crane Set Up Tool and hose extensions in PPU storage box.

NOTE: When not in use store excess shims in tool box on crawler.

Reference Only

Tensioner Component Identification



Item	Description	Item	Description
1	Pivot Frame	8	Tensioner Cylinder
2	Roller Shaft (152,40 mm)	9	Idler Roller
3	Idler Roller	10	Roller Shaft (125,43 mm)
4	Hitch Pin	11	Pivot Frame
5	Shim, 2 in (50,8 mm)	12	Shim Retainer Bar
6	Tensioner Connecting Link Frame	13	Keeper Pin
7	Shim, 1 in (25,4 mm)		

FIGURE 8-14

Reference Only

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SECTION 9
VARIABLE POSITION COUNTERWEIGHT (VPC)

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Reference Only

9

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SECTION 9
VARIABLE POSITION COUNTERWEIGHT (VPC)

GENERAL

VPC Components

See Figure 9-1 for the following procedure.

The Variable Position Counterweight (VPC) system maintains an optimum crane load moment by automatically positioning the full compliment of crane counterweight between the fully retracted position of 27 ft, 6 in (8,38 m) and fully extended position of 95 ft, 1 in (29,0 m)

The VPC is 949 ton of counterweight comprised of a 3-piece counterweight tray and forty-two 20 ton (44,000 lb) counterweight boxes.

The VPC counterweight assembly consists of the following components:

- **Counterweight Assembly -** suspended from a fixed mast by straps. The counterweight tray is connected to the counterweight frame and pivot frame and attached to the rear rotating bed of the crane. A telescopic actuating beam attaches to the pivot frame and the rear of the crane to provide variable positioning of the counterweight tray.
- **Counterweight Beams (optional)** - extend to provide stability to the counterweight.
- **Actuator Beam –** extends and retracts the counterweight assembly from the fixed mast. The counterweight system is suspended from the mast by straps. The actuator beam automatically extends and retracts the counterweight assembly in response to changes in load (weight of lifted load and boom angle).
- **Rising Frame** - assists the actuator beam and provides a cradle position for the actuator beam.

Load Sensing Pins are mounted in the front and rear house rollers and in the straps on the boom top and jib top. The Load sensing pins monitor the crane's load.

CAN-Bus Programmable Controller – monitors and operates the attachment's electrical and hydraulic systems. Automatically extends and retracts the counterweight assembly in response to signals from load sensing pins and boom or main hoist control handle. See Electrical Schematics in Section 3 of Service Manual.

VPC System Operation

See Figure 9-2 and Figure 9-3 for the following procedure.

Pump 13 and pump 14 drive four separate motors mounted on four gearboxes; one motor per gearbox. Gearboxes are located on the VPC actuator for extend and retract functions. Hydraulic connections between pumps and motors form a closed-loop system that is controlled by Node-1 and through output voltage signals from Node-3 and Node-4 to pump EDC. The VPC is inoperable when the VPC stop switch in the operator cab is turned on.

Hydraulic charge pressure from closed loop charge pump supplies hydraulic make-up fluid to low-pressure side of each pump. A pressure sender in high-pressure side (actuator extend) and low pressure side (actuator retract) provides closed loop pressure feedback information to Node-1 controller. Low pressure side of loop supplies hydraulic pilot pressure to operate motor servos. A fixed orifice between pump ports A and B allows for smoother operation.

When VPC motors rotate, a speed sensor at one motor rotor monitors and sends an input voltage to Node-1 controller. VPC diagnostic screen on crane display will show if actuator is in extend or retract and at what speed it is moving during active function.

Motor cooling is achieved by the continuous exchange of closed-loop fluid that occurs through leakage in pump, motor, and external sequence/flow valve. Sequence/flow valve (loop flush) 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.

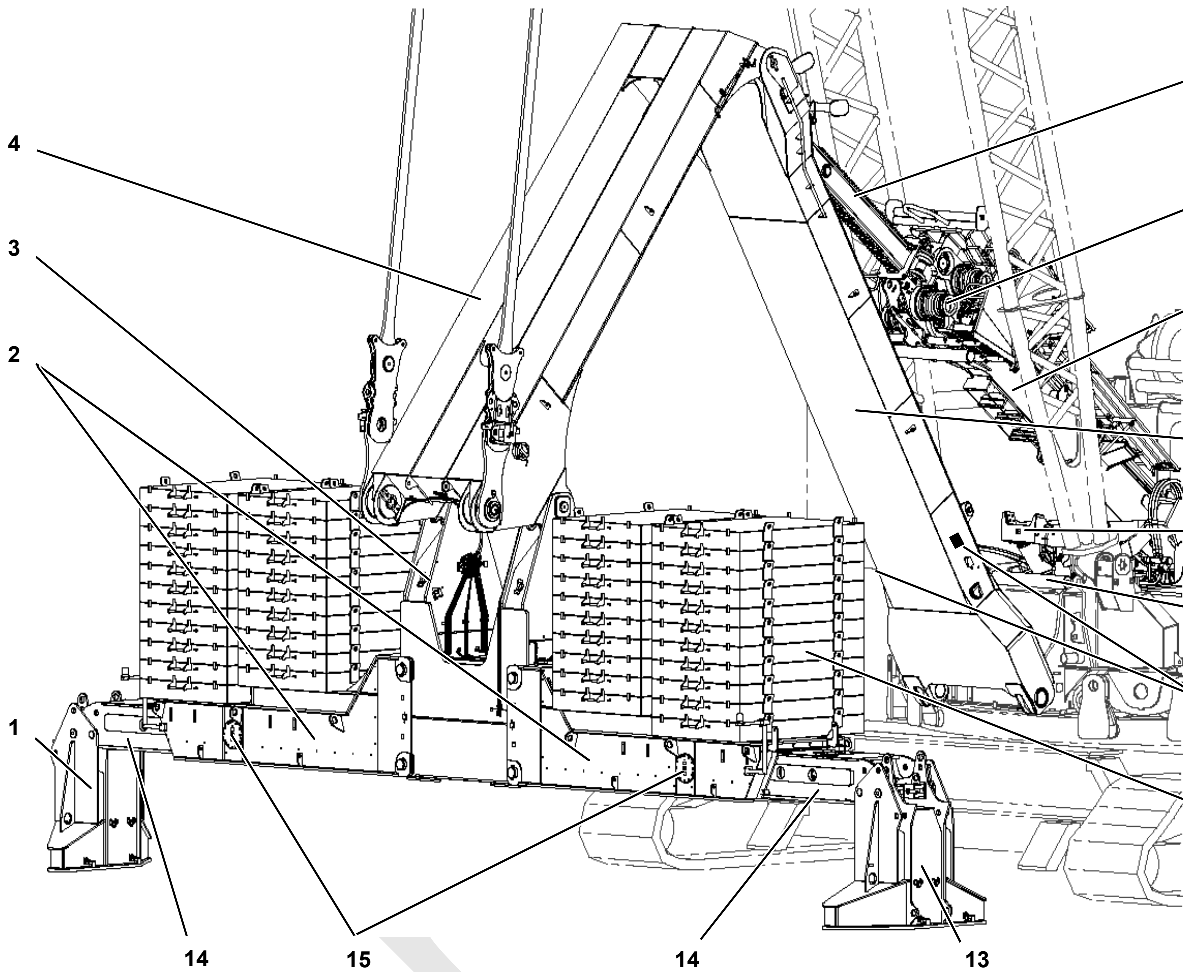
VPC Brake

Hydraulic pressure to operate VPC brakes are from low-pressure side of closed loop. There is a total of four brakes; one for each motor.

VPC actuator planetary brakes are controlled by Node-6. The VPC brake release solenoid HS-77 is disabled to apply brakes. Node-6 enables brake release solenoid HS-77 after VPC pumps are on stroke to extend or retract actuator and have achieved pressure memory values stored in Node-1.

Reference Only

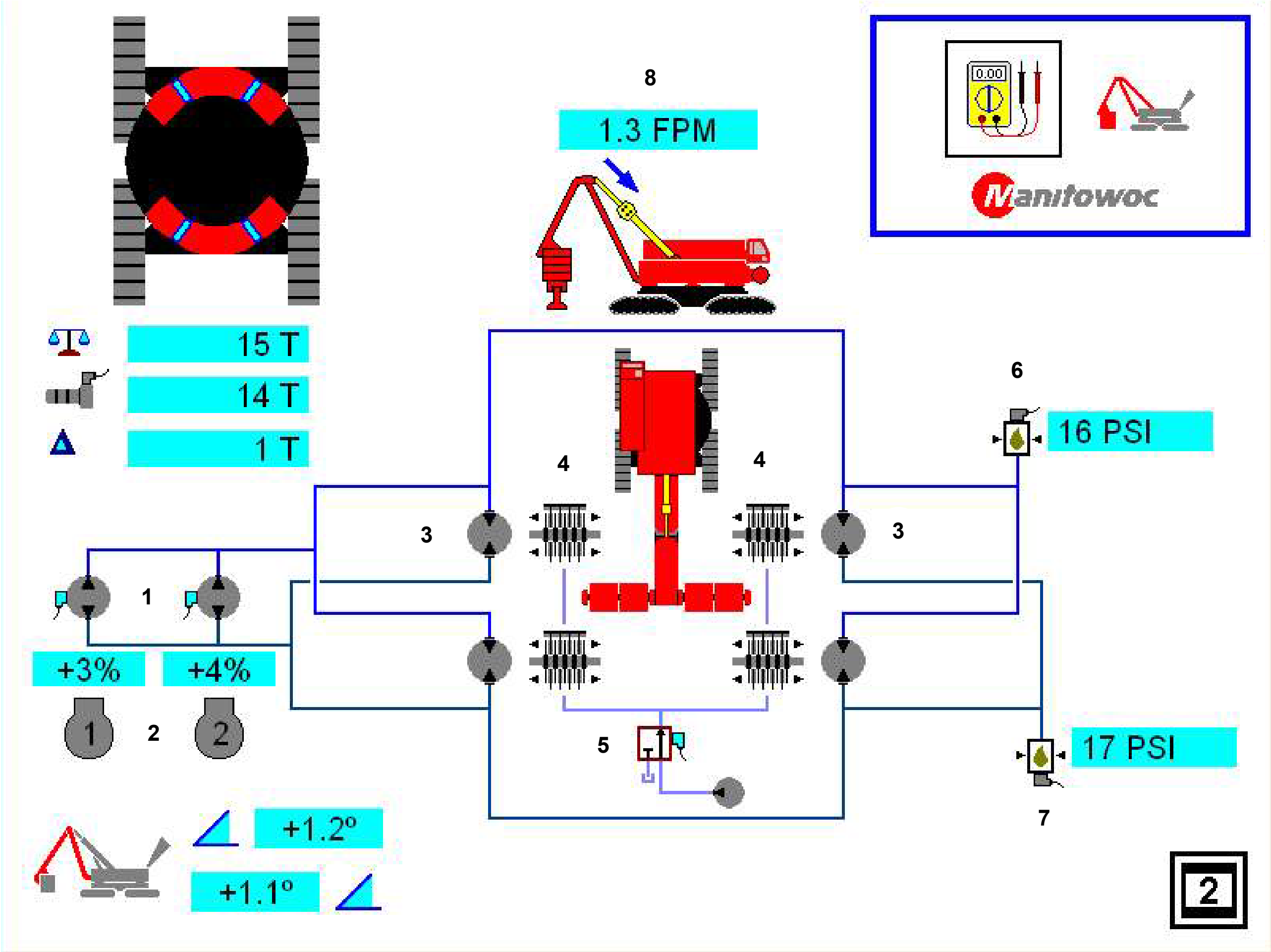
VPC COMPONENT IDENTIFICATION



Item	Description	Item	Description
1	Counterweight Pad, Left	9	Upper Rising Frame
2	Counterweight Tray, Left & Right	10	Lower Rising Frame
3	Center Tray	11	Angle Sensor, Left & Right
4	Counterweight Frame	12	Counter Weights
5	Actuator Beam	13	Counterweight Pad, Right
6	Actuator Motors	14	Counterweight Beam
7	Actuator Outer Box	15	Counterweight Beam Pin Indicator
8	Pivot Frame		

FIGURE 9-1

VPC SYSTEM DIAGNOSTICS OVERVIEW



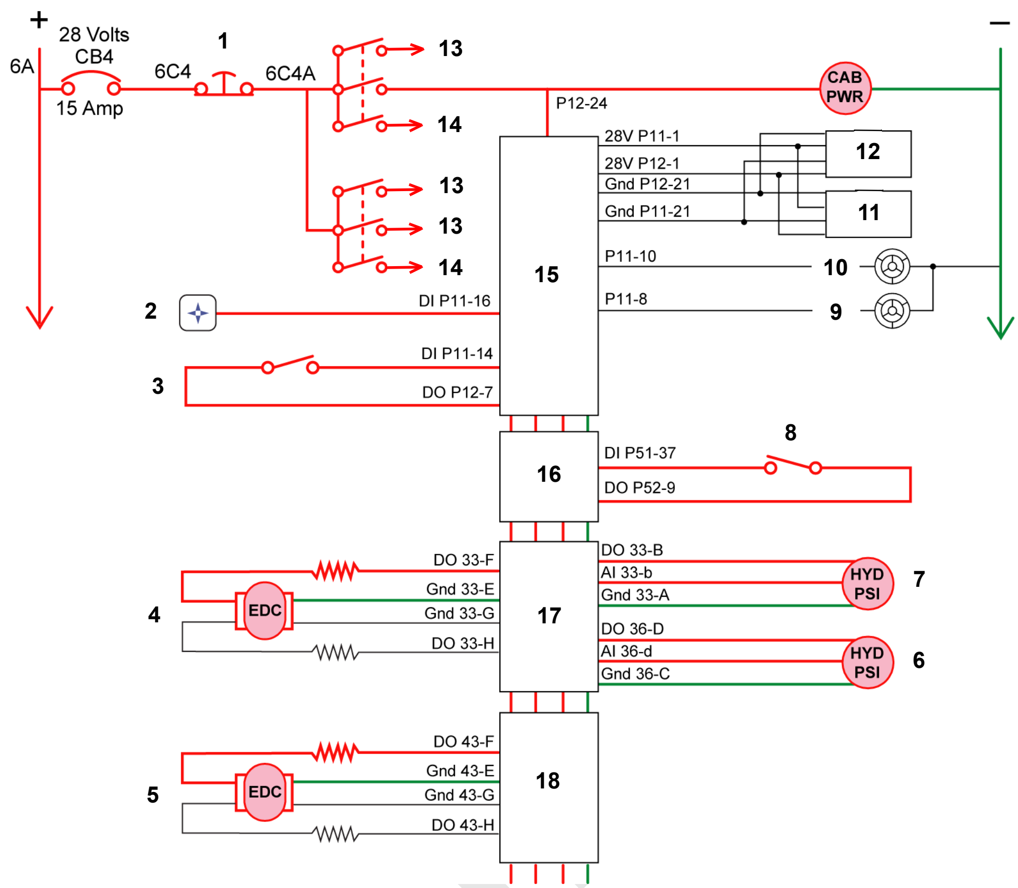
Item	Description	Item	Description
1	VPC Actuator Pump 13 and 14	5	VPC Actuator Brake Solenoid HS-77
2	Percentage of Pump Command	6	VPC Actuator Extend Hydraulic PSI
3	VPC Actuator Motor	7	VPC Actuator Retract Hydraulic PSI
4	VPC Actuator Brake	8	VPC Actuator Direction and Speed

FIGURE 9-2

NOTE: See Folio 2207 for detailed VPC diagnostic information.

Reference

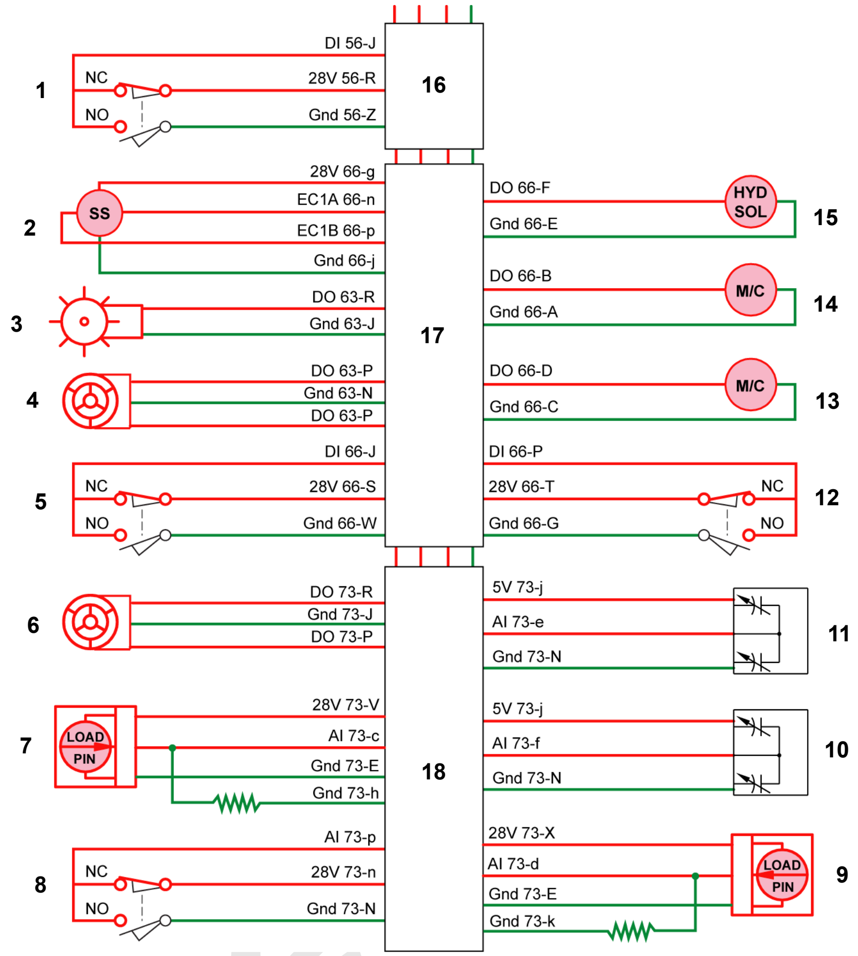
VPC ELECTRICAL SCHEMATIC



Item	Description	Item	Description
1	Engine Stop	11	RCL Display
2	Confirm Chart and Crane Mode	12	Main Display
3	VPC On/Off	13	Run
4	Pump 14 VPC Actuator	14	Start
5	Pump 13 VPC Actuator	15	Master Node 1
6	Pressure Sender VPC Actuator Extend	16	Side Console Node 2
7	Pressure Sender VPC Actuator Retract	17	Universal Node 3
8	Seat Switch	18	Universal Node 4
9	RCL Warning Alarm		
10	Caution Fault Alarm		

FIGURE 9-3

VPC Electrical Schematic (cont)



Item	Description	Item	Description
1	LS VPC Actuator in Mast Pocket	11	VPC Left Side Angle Sensor
2	VPC Actuator Motor Speed Sensor	12	LS VPC Actuator Max Retract
3	VPC Warning Lights	13	VPC Motor Control HS-76 and HS-79
4	VPC Position Alarm	14	VPC Motor Control HS-75 and HS-78
5	LS VPC Actuator Max Extend	15	VPC Actuator Brake HS-77
6	VPC Position Fault Alarm	16	Universal Node 5
7	Left Rear Hook Roller Load Pin	17	Universal Node 6
8	VPC Actuator Pivot Arm Secured	18	Universal Node 7
9	Right Rear Hook Roller Load Pin		
10	VPC Right Angle Sensor		

FIGURE 9-4

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NOTE: VPC motors are variable displacement but held at low speed (maximum displacement) at all times.

VPC EXT/RET LIMIT SWITCH

See Figure 9-5 for the following procedure.

The EXT/RET limit switch is activated by the Assist Beam extension and retraction. The switch should only need to be adjusted when it is replaced.

Limit Switch Adjustment

NOTE: Wiring diagram applies to both extend and retract limit switches.

1. Extend VPC to maximum extended position.
2. Adjust limit switch bracket (8) and arm (3) position to trip the limit switch at 0.59 in (15 mm) BEYOND maximum working positions of the Actuator.
3. Retract VPC to minimum retracted position. Limit switch should trip at 0.59 in (15 mm) BEYOND minimum working position.
4. Limit switch arm (3) must rotate 26° to trip the switch.
5. Ensure that arm travels greater than 60° from free position with over travel to guarantee the positive opening of the normally closed contacts at 55°.
6. With switches properly positioned, apply Loctite and tighten capscrews (5), lock washers (6), flat washers (7) and hex nuts (4).

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Item	Description	Item	Description
1	Extend Limit Switch	6	Lockwasher
2	Retract Limit Switch	7	Flat Washer
3	Limit Switch Arm	8	Bracket, Limit Switch
4	Nut, Hex	9	Beam, Inner Box
5	Capscrew		

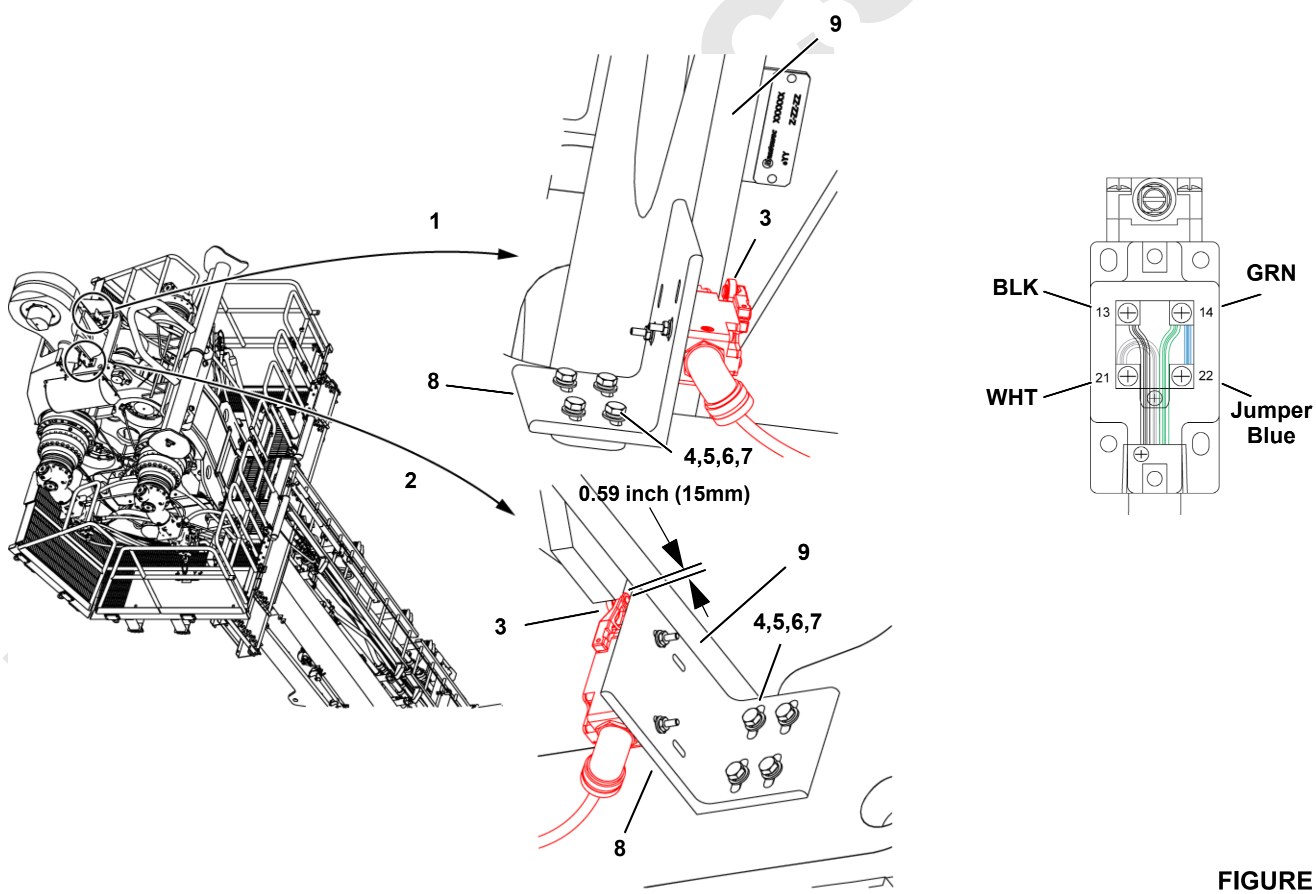


FIGURE 9-5

VPC SECURED LIMIT SWITCH

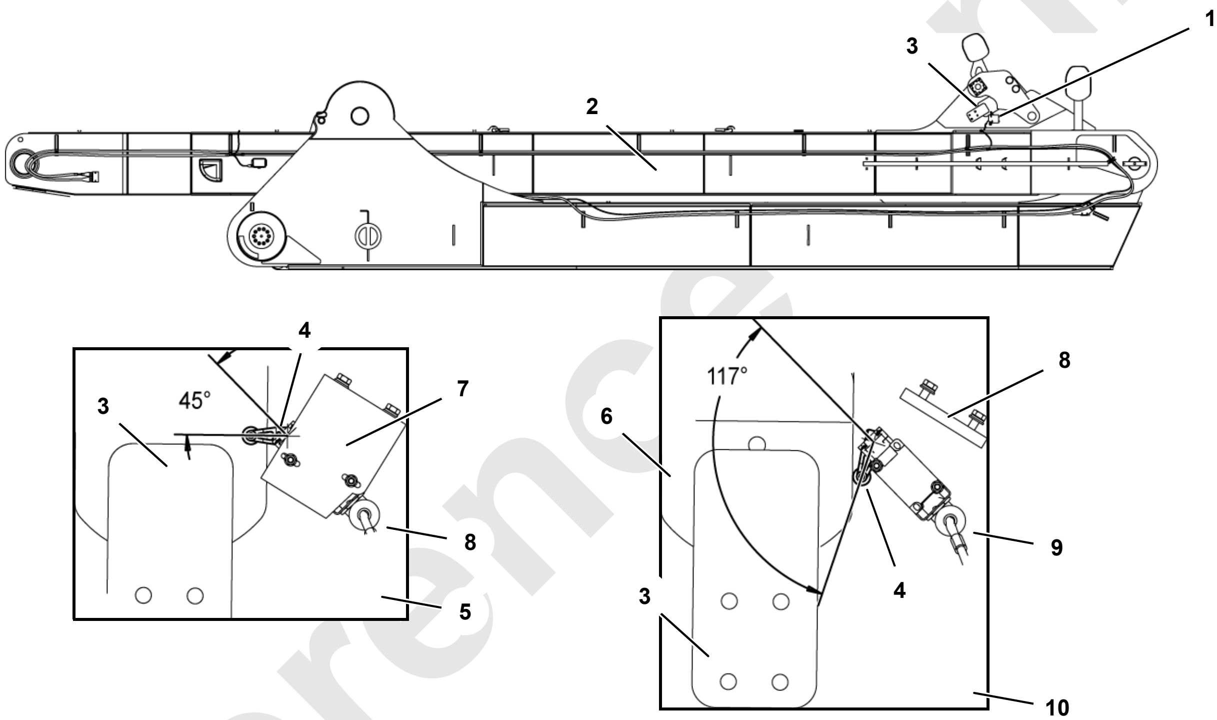
See Figure 9-6 for the following procedure.

The VPC Secured Limit Switch is activated when the VPC Actuator is seated in the pivot frame catch assembly. The switch should only need adjustment when replaced.

1. Mount the limit switch arm (4) in relation to the VPC pivot frame catch (3) such that it is rotated 45° in respect to the limit switch in the switch free position (5).
2. The limit switch arm must rotate 26° to trip the limit switch.
3. Adjust switch mounting so that total arm (4) travel when the fully seated VPC actuator (6) is approximately 72° as shown in the switch activated view (10).
4. Total arm travel angle must be greater than 55° to ensure the positive opening of the normally closed contacts of the limit switch.

NOTE: Maximum arm travel is 85°.

Reference Only



Item	Description	Item	Description
1	Limit Switch	6	VPC Actuator
2	VPC Pivot Frame	7	Limit Switch Mounting Bracket
3	VPC Pivot Frame Catch	8	Mounting Bracket Removed for Clarity
4	Limit Switch Arm	9	W77P5 Connection
5	Switch Free Position View	10	Switch Activated Position View

FIGURE 9-6

VPC Secured Limit Switch Wiring

See Figure 9-7 for the following procedure

1. W77P5 connection lead wires must be stripped 0.25 in (6,35 mm) to properly fit the limit switch terminal board U-clamp screw terminals.
2. Connect color coded lead wires to limit switch as shown.

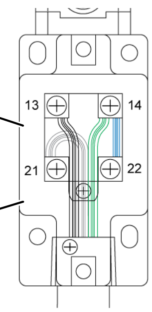


FIGURE 9-7

Reference Only

VPC ASSIST CYLINDER CRADLE LIMIT SWITCH

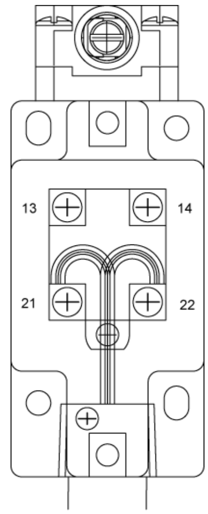
See Figure 9-9 for the Cradle limit switch wiring.

The Assist Cylinder Cradle limit switch is actuated by the actuator box when it is in the cradle position. The switch should only need to be adjusted when it is replaced.

Limit Switch Adjustment

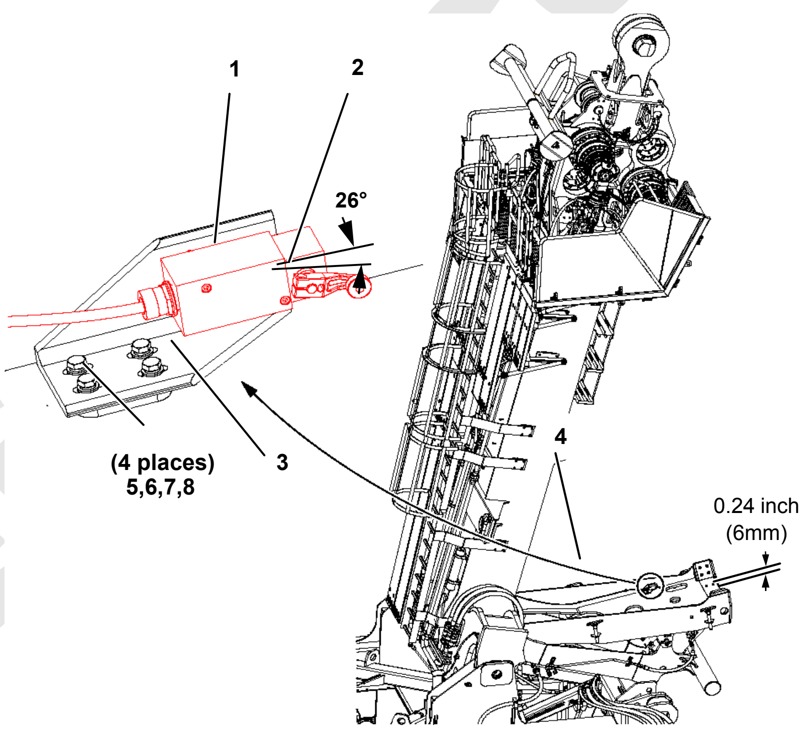
See Figure 9-8 for the limit switch wiring.

1. Extend VPC to maximum extended position.
2. Adjust limit switch bracket (3) and arm (2) position so limit switch (1) trips when nylon bearing pad is 0.24 inch (6 mm) away from contacting actuator outer box weldment.
3. Limit switch arm must rotate 26° to trip the switch.
4. Apply Loctite and tighten capscrew (5), lockwasher (6), flat washer (7) and nut (8).



Item	Description
21	WHT VPC Assist Cyl Cradle
22	BLK C-Sys Gnd Bus

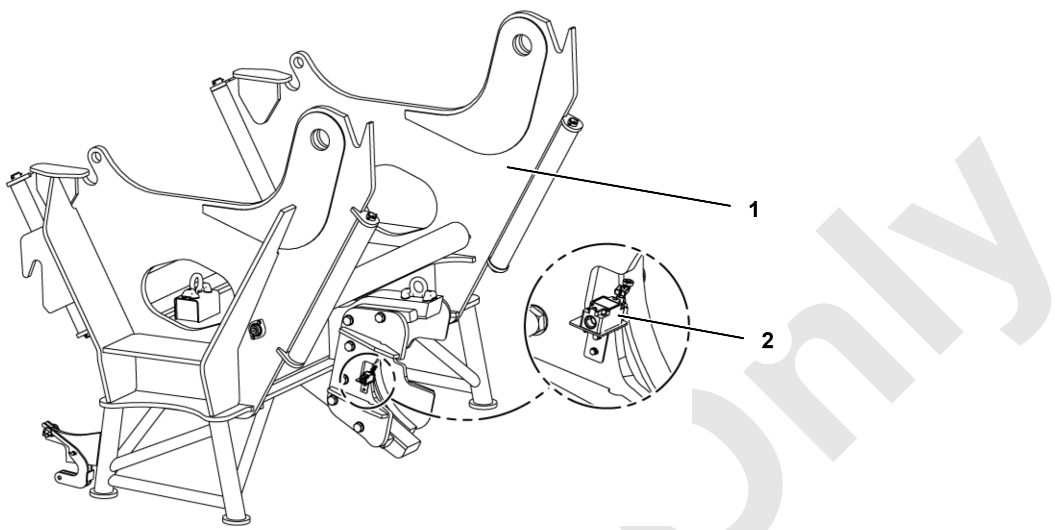
FIGURE 9-8



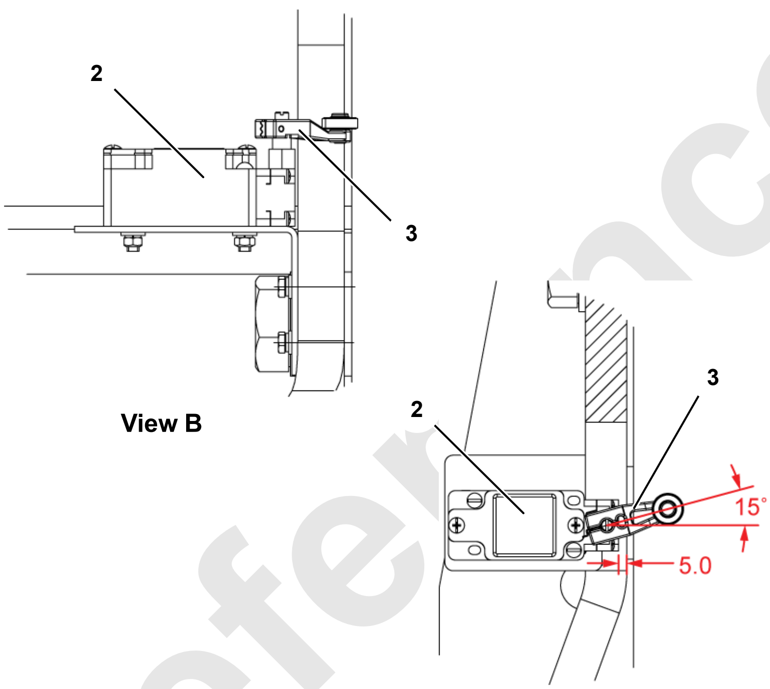
Item	Descriptionn	Item	Description
1	Limit Switch	5	Capscrew
2	Limit Switch Arm	6	Lockwasher
3	Bracket, Limit Switch	7	Flat Washer
4	Upper Rinsing Frame	8	Nut, Hex

FIGURE 9-9

VPC ACTUATOR SEATED IN THE MAST RAISING FRAME



View A



View B

View C

Item	Description
1	Mast Raising Frame Assembly
2	Limit Switch
3	Limit Switch Arm

FIGURE 9-10

Reference Only

Limit Switch Adjustment

See Figure 9-10 for the following procedure.

NOTE: Limit Switch to actuate when VPC actuator is seated in the mast raising frame.

Mount the limit switch arm (3) such that it is rotated 15° with respect to the limit switch (2) in the actuate free position as shown in View C.

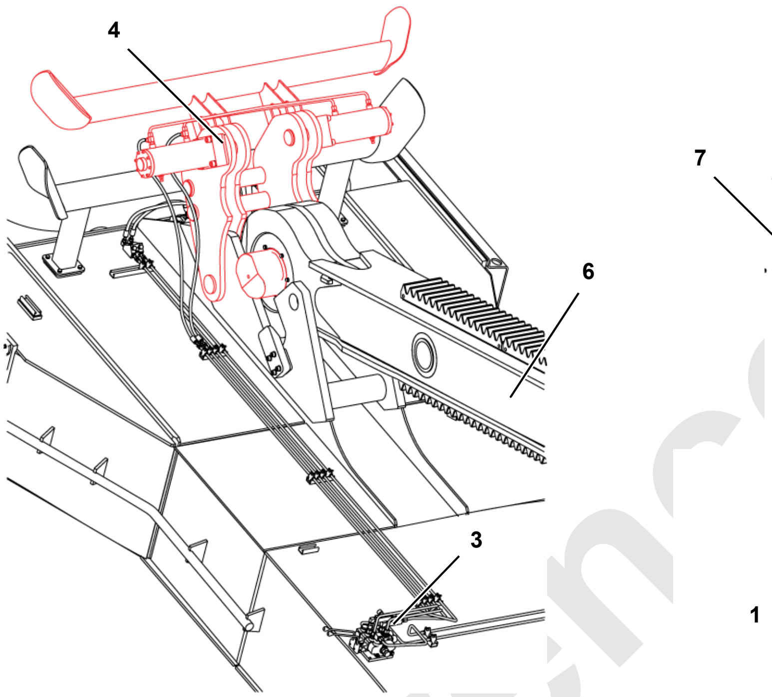
Arm must rotate 26° to actuate switch. Adjust switch mounting so that switch is 5 mm from inside surface of raising frame as shown in View C. Total arm travel when VPC is fully seated will range from 55°-72°. Total travel angle must be greater than 55° to ensure the positive opening of the normally closed contacts. Note that maximum arm travel is 85°.

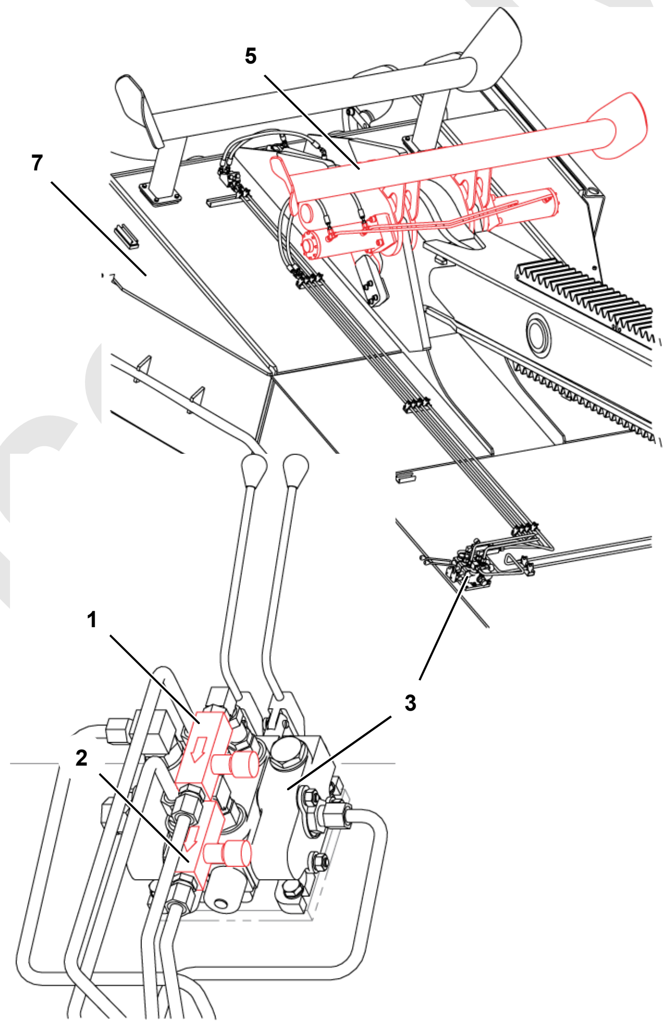
PIVOT FRAME ACTUATOR CATCH ASSEMBLY

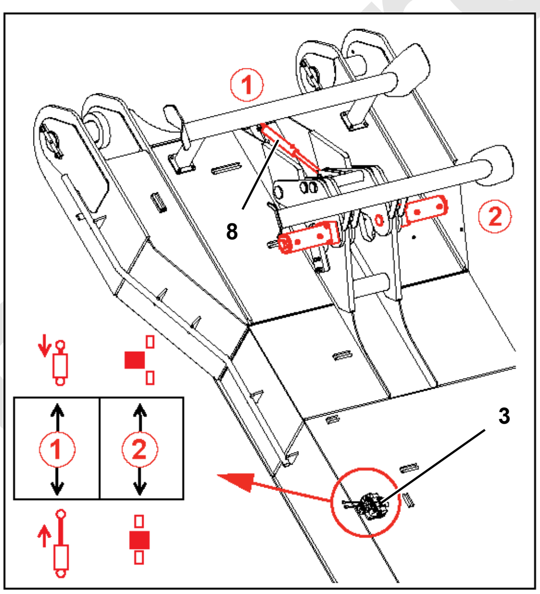
See Figure 9-11 for the following procedure.

Latch Cylinder Speed Control

The catch assembly for the actuator mounted on the pivot frame assembly has manual valve controls (3) to actuate the latch cylinder (8) and the locking cylinders. The operator can adjust the speed of the latch cylinder (8) by opening or closing the flow control valves (1, 2) mounted on the manual control valve block (3). The desired variable speed is determined and set by the operator by extending and retracting the latch cylinder prior to installing the VPC Actuator (6) into the catch. The flow control (1) closest to the valve handle is for clamp closure and by turning the flow control knob in, the clamp closure speed will be reduced. Clamp opening is controlled by the flow control (2) farthest from the valve control lever.







Item	Description
1	Flow Control Clamp Closure
2	Flow Control Clamp Opening
3	Manual Valve Control Block
4	Latch Assembly Open
5	Latch Assembly Closed
6	VPC Actuator
7	VPC Pivot Frame
8	Latch Cylinder

FIGURE 9-11

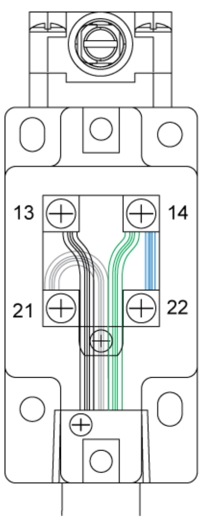
COUNTERWEIGHT BEAM LIMIT SWITCH

NOTE: Counterweight Beam may or may not be present. The following limit switch adjustments apply to counterweight Beam installed.

There are two limit switches on the counterweight tray used to indicate the position of the counterweight tray. A switch should only need to be adjusted when it is replaced.

Limit Switch Adjustment (First Stop Position) CWT Beam Max Retract

See Figure 9-12 for limit switch wiring- 1st stop.



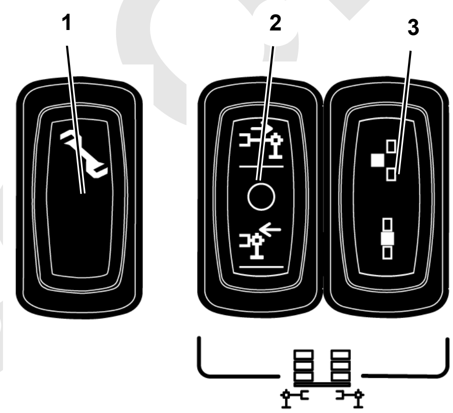
Item	Description
13	BLK C-Sys Gnd Bus
22	BLU Jumper
14	GRN CWT L/R Beam Max Ret and BLU Jumper
21	WHT Sys 28VDC

FIGURE 9-12

1. Press Crane Setup switch (1, Figure 9-13) on the Main Screen to perform these steps.
2. Press Counterweight Beam Pin momentary switch (3, Figure 9-13) and at the same time, press counterweight beam switch (2, Figure 9-13) to RETRACT the Counterweight Beam.

NOTE: The counterweight beam pin momentary switch (3, Figure 9-13) can be released once the counterweight Beam switch (2, Figure 9-13) is pushed to RETRACT and starts to retract the counterweight Beam. The beam pin is spring loaded and will engage the first detent it encounters if the momentary switch is released.

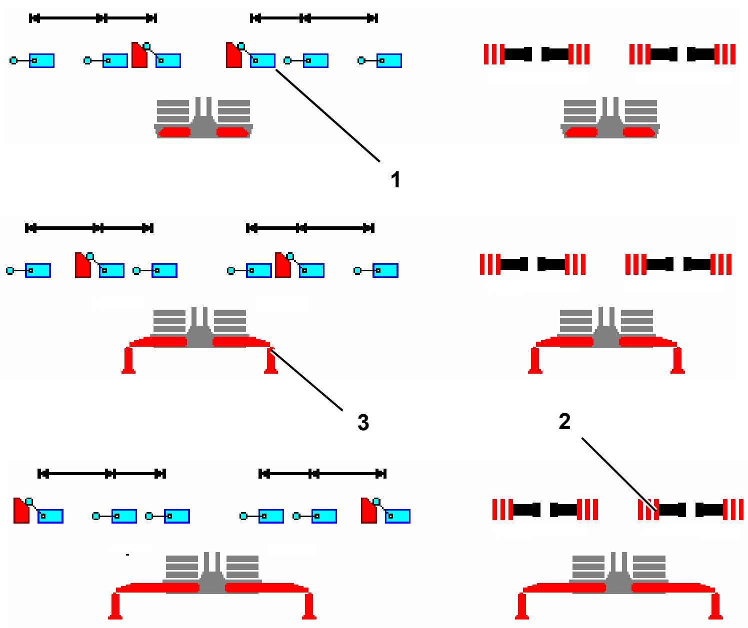
3. Observe the main screen as an indication of the location of the counterweight beam and counterweight beam pin. Refer to Figure 9-14 for indication that counterweight beam pin is RETRACTED or ENGAGED and the indicated position of counterweight beam.



Item	Description
1	Crane Setup
2	Switch, Counterweight Beam
3	Momentary Switch, Counterweight Beam Pins

FIGURE 9-13

Reference Only



- Counterweight Beam Position 1
- Limit Switch Position 1
- Counterweight Beam Pins Retracted

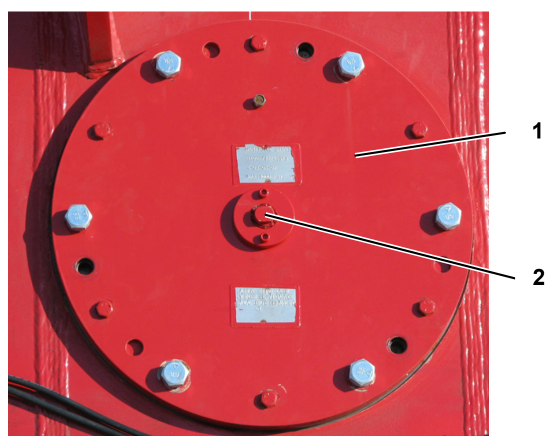
- Counterweight Beam Position 2
- Limit Switch Position 2
- Counterweight Beam Pins

- Counterweight Beam Position 3
- Limit Switch Position 3
- Counterweight Beam Pins

Item	Description	Item	Description
1	Limit Switches	3	Counterweight Beam Position
2	Counterweight Beam Pin		

FIGURE 9-14

NOTE: Counterweight beam pin state is indicated by observing the counterweight beam pins indicator (Figure 9-15) located on the counterweight tray. If the indicator pins are OUT, the counterweight beam pin is NOT engaged. If the counterweight beam counterweight beam indicator pins are IN, the counterweight beam pin is ENGAGED.



Item	Description
1	Cover Plate
2	Indicator Pin

FIGURE 9-15

See Figure 9-17 for the following procedure.

4. Remove 16 capscrews (11) and lock washers (12) and remove cover plate (3) to access the limit switch.

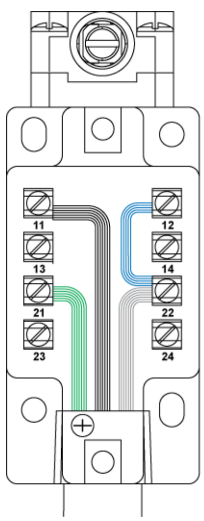
5. Replace the limit switch.

Reference Only

6. Loosen allen head capscrew on the switch arm (5).
7. Adjust limit switch arm (5) position to trip the limit switch (4) when counterweight beam (2) is in the first stop position.
8. Tighten allen head capscrew on switch arm.
9. Readjust as necessary.
10. Install counterweight tray cover plate with 16 capscrews (11) and lockwashers (12).

Limit Switch Adjustment (Second Stop Position) CWT Beam Ext/Ret

See Figure 9-16 for limit switch wiring- 2nd/3rd stop.



Item	Description
22	WHT Sys 28VDC and BLU Jumper
21	GRN CWT Beam EXT
11	BLK CWT Beam RET
12	BLU Jumper

FIGURE 9-16

1. Press Crane Setup switch (1, Figure 9-13) on the Main Screen to perform these steps.
2. Press counterweight beam pin momentary switch (3, Figure 9-13) and at the same time, press counterweight Beam switch (2, Figure 9-13) to EXTEND the counterweight beam to position 2.

NOTE: The counterweight beam pin momentary switch (3, Figure 9-13) can be released once the counterweight Beam switch (2, Figure 9-13)is pushed to EXTEND and starts to extend the counterweight beam. The counterweight beam pin is spring loaded and will engage the first detent it encounters if the momentary switch is released.

3. Observe the main screen as an indication of the location of the counterweight beam and counterweight beam pin. Refer to Figure 9-14 for indication that counterweight beam pin is RETRACTED or ENGAGED and the position of counterweight beam.

NOTE: Counterweight beam pin state can also be checked by observing the counterweight beam pins indicator (Figure 9-15) located on the counterweight tray. If the indicator pins are OUT, the counterweight beam pin is NOT engaged. If the counterweight beam indicator pins are IN, the counterweight beam pin is ENGAGED.

4. Loosen allen head capscrew on the switch arm (5).
5. Adjust limit switch arm (5) to activate limit switch (4) when counterweight beam is in second stop position.
6. Tighten allen head capscrew on switch arm (5).
7. Readjust as necessary.

Limit Switch Adjustment (Third Stop Position) CWT Beam Ext/Ret

See Figure 9-16 for Limit Switch Wiring- 2nd/3rd stop

1. Press Crane Setup switch (1, Figure 9-13) on the Main Screen to perform these steps.
2. Press counterweight beam pin momentary switch (3, Figure 9-13) and at the same time, press counterweight Beam switch (2, Figure 9-13) to EXTEND the counterweight beam to position 3.

NOTE: The counterweight beam pin momentary switch (3, Figure 9-13) can be released once the counterweight Beam switch (2, Figure 9-13) is pushed to EXTEND and starts to extend the counterweight beam. The counterweight beam pin is spring loaded and will engage the first detent it encounters if the momentary switch is released.

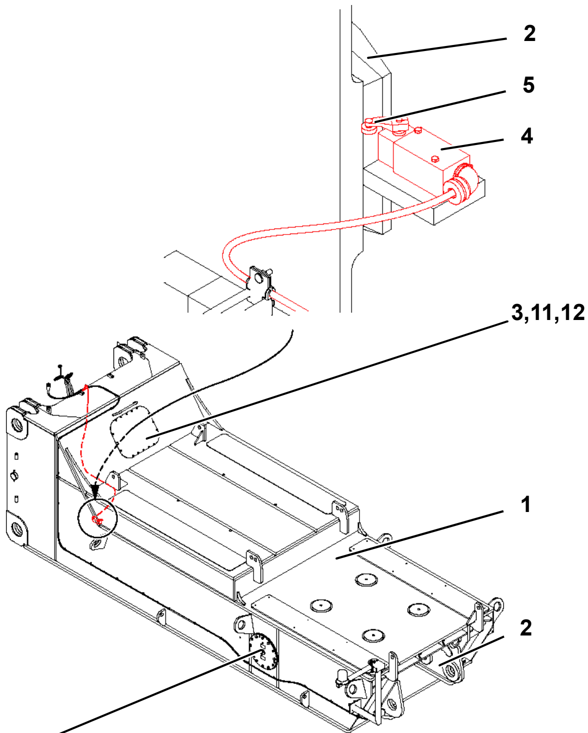
3. Observe the main screen as an indication of the location of the counterweight beam and counterweight beam pin. Refer to Figure 9-14 for indication that counterweight beam pin is RETRACTED or ENGAGED and the position of counterweight beam.

NOTE: Counterweight beam pin state can also be checked by observing the counterweight beam pins indicator (Figure 9-15) located on the tray. If the indicator pins are OUT, the counterweight beam pin is NOT engaged. If the counterweight beam indicator pins are IN, the counterweight beam pin is ENGAGED.

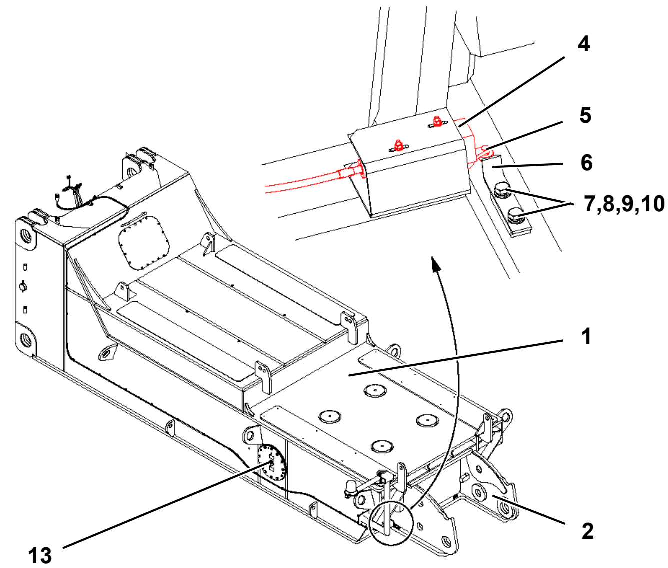
See Figure 9-17 for the following procedure.

4. Loosen allen head capscrew on the switch arm (5).
5. Adjust limit switch arm (5) to activate limit switch (4) when counterweight beam (2) is in third stop position.
6. Tighten allen head capscrew on switch arm (5).
7. Readjust as necessary.

Reference Only

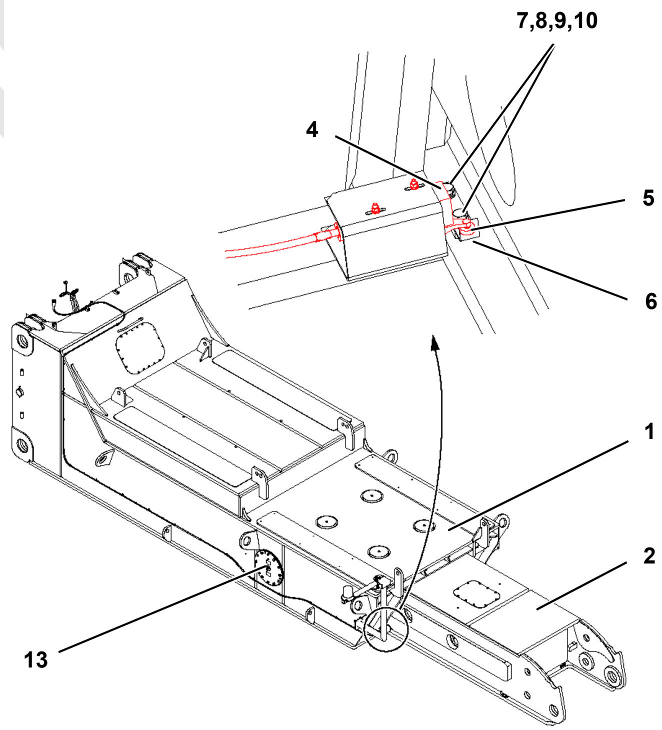


First Stop Position



Second Stop Position

Item	Description
1	Counterweight Tray
2	Counterweight Beam
3	Cover Plate
4	Limit Switch
5	Limit Switch Arm
6	Switch Activation Bracket
7	Capscrew
8	Flat Washer
9	Lockwasher
10	Nut
11	Capscrew, Cover
12	Lockwasher, Cover
13	Lock Pin



Third Stop Position

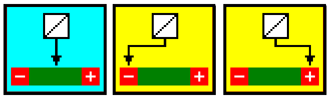
FIGURE 9-17

Reference

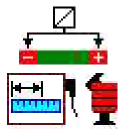
VPC ANGLE SENSORS

A sending unit for each sensor houses a solid state sensor that sends output signals to the master controller. The master controller uses the signals for the following purpose:

- A defective sensor will be indicated on the RCI display.



- A defective counterweight position sensor or a fault in the VPC position encoder will show in the fault list on the Main display.



VPC Left Angle Sensor

The Left VPC Angle Sensor, Figure 9-18 is located on the left side of the pivot frame.

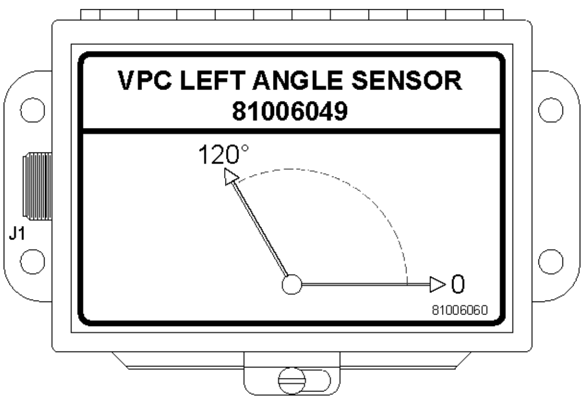


FIGURE 9-18

VPC Right Angle Sensor

The Right VPC Angle Sensor, Figure 9-19 is located on the right side of the pivot frame.

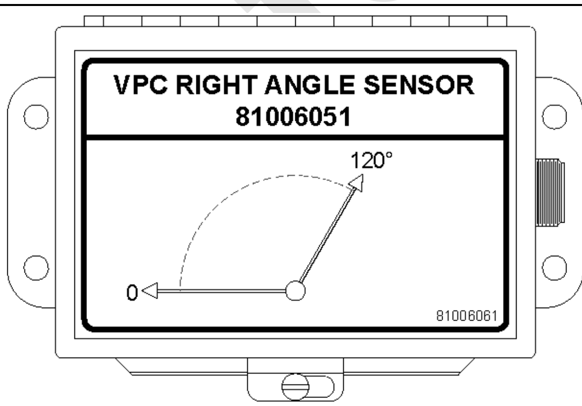


FIGURE 9-19

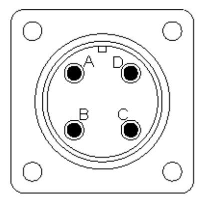
Left or Right Angle Sensor Installation

For VPC Left Angle sensor, see Figure 9-20 for the following procedure.

For VPC Right Angle sensor see Figure 9-21 for the following procedure.

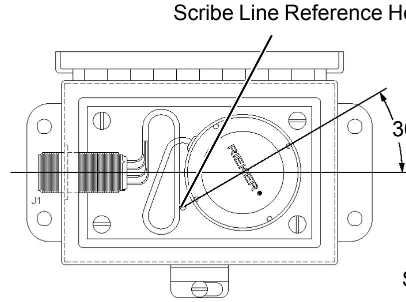
1. Strip sensor leads to 0.5 in (14 mm) and fold back on itself to increase thickness of lead, and to have a 0.25 in (7 mm) stipped length on the lead.
2. Insert leads into the crimp barrel of the receptacles's pin contact.(see Figure 9-20 and Figure 9-21), View A for pin location).
3. Scribe line on boom angle sensor must be orientated to the mounting plate as shown in Figure 9-20 and Figure 9-21 View B.
4. Securely tighten mounting screws to lock angle.

View A



As seen from inside enclosure

Sensor Wire Color	Receptacle Contact ID	Sensor Function
Red	J1-A	Supply Voltage
Green	J1-B	Output 1 - 0 to 5VDC
Black	J1-C	Ground, Power, & Signal
White	J1-D	Output 2 - 0 to 10VDC

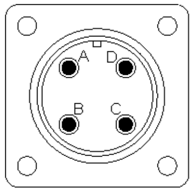


View B

Left Angle Sensor

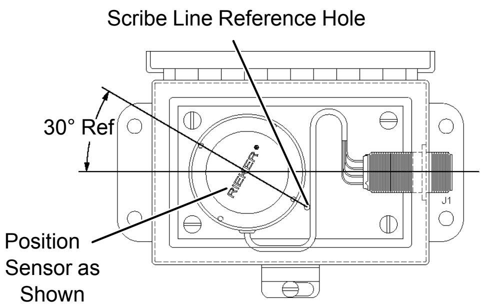
FIGURE 9-20

View A



As seen from inside enclosure

Sensor Wire Color	Receptacle Contact ID	Sensor Function
Red	J1-A	Supply Voltage
Green	J1-B	Output 1 - 0 to 5VDC
Black	J1-C	Ground, Power, & Signal
White	J1-D	Output 2 - 0 to 10VDC



View B

Right Angle Sensor **FIGURE 9-21**

Angle Sensor Calibration

NOTE: Calibration must be performed when the following conditions exist:

- The Master Node has been replaced or reprogrammed.
- The VPC angle sensor has been replaced.
- Crane assembly and set up are being performed.
- The main display angle is in error in relation to the physical VPC angle.

Reference Folio 2207 for detailed VPC function mode screens and calibration procedures.

Reference Only

Reference Only

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SECTION 10
ACCESSORIES

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SECTION 10
ACCESSORIES

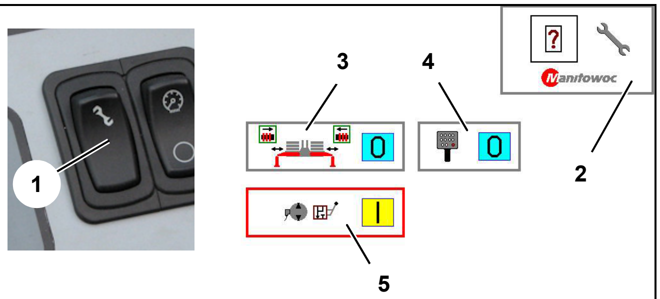
ACCESSORY SYSTEM COMPONENTS

Accessory System Computer Controlled Functions

General

See Figure 10-1 for the following procedure.

Computer controlled accessory system components includes CWT beam pin locks, CWT beam cylinder, VPC actuator assist cylinder, rigging winch Drum 0 and Drum 6, operator cab seat tilt, and backhitch pins.



Item	Description
1	Set Up Switch
2	Set Up Function Mode Display Screen
3	Enable CWT Beam Set Up Switches
4	Enable Set Up Remote
5	Enable Manual Controls

FIGURE 10-1

Pump 9 located on the primary power plant is the hydraulic pressure source to operate accessory system components. The accessory system is enabled through the setup function mode screen, Figure 10-1 (reference Folio 2207 or 31000 Operator Manual for detailed procedure to enable the accessory system). The Set Up Function Mode screen can be accessed quickly by pressing the Set Up Switch located next to the display keypad, Figure 10-1. Some accessory functions are exclusively controlled from the hand held remote. When an accessory system component is enabled, an input signal is sent from Node-1 controller to enable the accessory pump 9.The accessory system pressure increases to operate selected component. An overview of each accessory function will be discussed. For detailed accessory function operation, reference the 31000 Operator Manual.

CWT Beam Pin Locks

See Figure 10-2 and Figure 10-5 for the following procedure.

Item	Description
1	CWT Pin Lock Switch
2	CWT Beam Cylinder Ext/Ret Switch

FIGURE 10-2

CWT Beam Pin Locks can be retracted by the corresponding switch on the console.This switch is only used during set up mode and must be enabled through the accessory function mode screen. Enable the CWT Beam Set Up Switches in the accessory function mode screen for hydraulic system operation of the counterweight beam pin locks, Figure 10-1. The left and right pin locks are disengaged through solenoid valves HS-73 and HS-74 by signal from Node-6. Pin locks are spring loaded and will reengage once the momentary console switch is released. Reference Folio 2207 and the 31000 Operator Manual for a detailed procedure for retracting the counterweight beam pin locks.

CWT Beam Cylinder

See Figure 10-2 and Figure 10-5 for the following procedure.

The left and right counterweight beams can be moved into three different positions. First stop is fully retracted, second stop is the retracted position, and the third stop is the extended position. Access the accessory diagnostic screen, Figure 10-5 to view the limit switch position of the counterweight beam. The counterweight beam ext/ret switch is only used during set up mode and must be enabled through the accessory function mode screen. Enable the CWT Beam Set Up Switches in the accessory function mode screen for hydraulic system operation of the counterweight beam extend and retract. Node-6 sends signal to solenoid valve HS-71 to extend the counterweight beam or HS-72 to retract the counterweight beam. Reference Folio 2207 and the 31000 Operator Manual for detailed procedure to extend or retract the counterweight beams during crane set up.

Reference Only

VPC Actuator Assist Cylinder

See Figure 10-3 for the following procedure.

Item	Description
1	Drum 0 Pay In/Pay Out
2	VPC Actuator Extend/Retract
3	Emergency Stop
4	VPC Assist Cylinder
5	Backhitch Pins Extend/Retract
6	Drum 0 Select

FIGURE 10-3

The VPC actuator assist cylinder is used during set up to raise the VPC actuator assembly for mast installation into the pocket of the mast raising frame. Enable Set Up Remote on the Set UP Function Mode Screen, Figure 10-1 to extend and retract the assist cylinder. Node-6 sends signal to solenoid valve HS-69 to extend the assist cylinder or HS-70 to retract the assist cylinder. Accessory system pump 9 is hydraulic source flow. Reference Folio 2207 and the 31000 Operator Manual for detailed procedure to extend or retract the VPC assist cylinder during crane set up.

Rigging Winch (Drum 0)

See Figure 10-3 and Figure 10-5 for the following procedure.

Two Drum 0 rigging winches are mounted on each side of drum 4 on the rotating bed. Drum 0 is used during set up of the backhitch and controlled exclusively by the Set Up Remote. Enable Set Up Remote in the Set UP Function Mode Screen of the crane display, Figure 10-1 to spool in or out with the rigging winches. Output signal from Node-7 to solenoid valves HS-80 and HS-81 control the right side rigging winch spooling. Output signal from Node-7 to solenoid valves HS-82 and HS-83 control the left side rigging winch spooling. Drum 0 brake is enabled when spooling solenoid is actuated. Accessory system pump 9 is hydraulic source flow. Reference Folio 2207 and the 31000 Operator Manual for detailed operational procedures for drum 0.

Rigging Winch (Drum 6)

See Figure 10-6 for the following procedure.

Drum 6 is mounted under the main load hoists on the rotating bed. Drum 6 is used exclusively for moving the boom equalizer on the mast butt during set up and reeving the hook block. Enable rigging winch mode on the crane display to activate Drum 6. The boom hoist handle on the left console in the operator cab control's drum 6 pay in and pay out functions. Node-5 sends a 28 volt signal to diverter valve HS-58 to enable left front travel pump 9 hydraulic flow to drum 6 motor. Node-8 sends a 28 volt signal to enable drum 6 brake release valve HS-61. Drum circuit is active waiting for handle command. Pump command and motor command are relative to handle command. Drum 6 parking brake remains applied when parking brake switch in cab is turned on. Reference Folio 2207 and the 31000 Operator Manual for detailed operational procedures for drum 6.

Reference Only

Operator Cab Seat Tilt

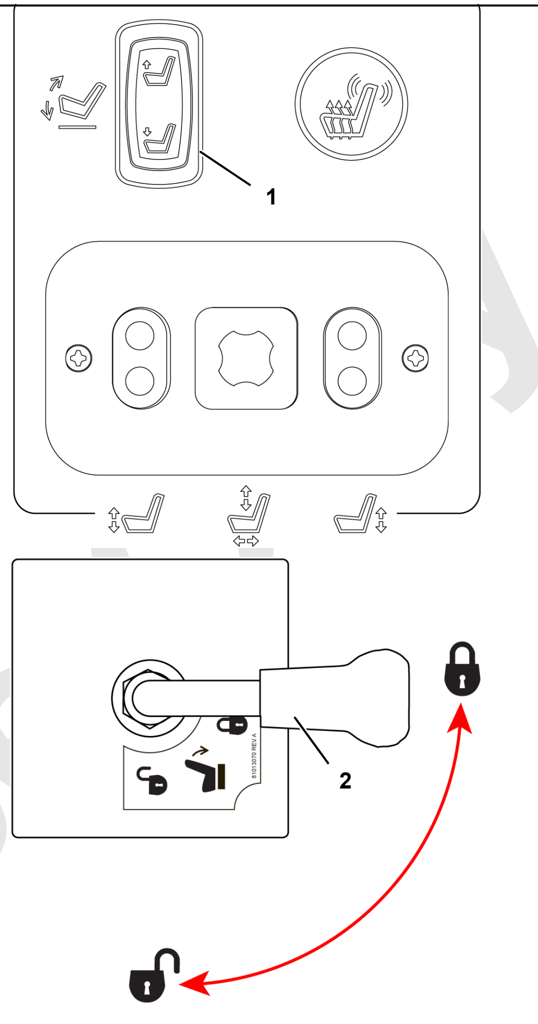
See Figure 10-4 and Figure 10-7 for the following procedure.

The Seat Tilt switch located on the right hand console in the operator cab enables hydraulic solenoid valves HS-90 and HS-91 to raise and lower the front of the seat from level. Seat tilt switch sends 28 volt input signal to Node-1. Node-4 responds and sends 28 volt output voltage to solenoid valve HS-90 to raise the front of the seat and HS-91 to lower the front of the seat. Source flow for seat tilt hydraulic cylinder is accessory pump 9.

NOTE: Before tilting the seat, ensure that the tilt lock located behind the operator seat is in the unlocked position. Engage lock when done tilting seat into desired position.

Reference Folio 2207 and the 31000 Operator Manual for detailed operational procedures of the seat tilt function.

Reference chapter 2 of the 31000 Service/Maintenance Manual for seat tilt speed adjustment.



Item	Description
1	Seat Tilt Switch
2	Seat Lock

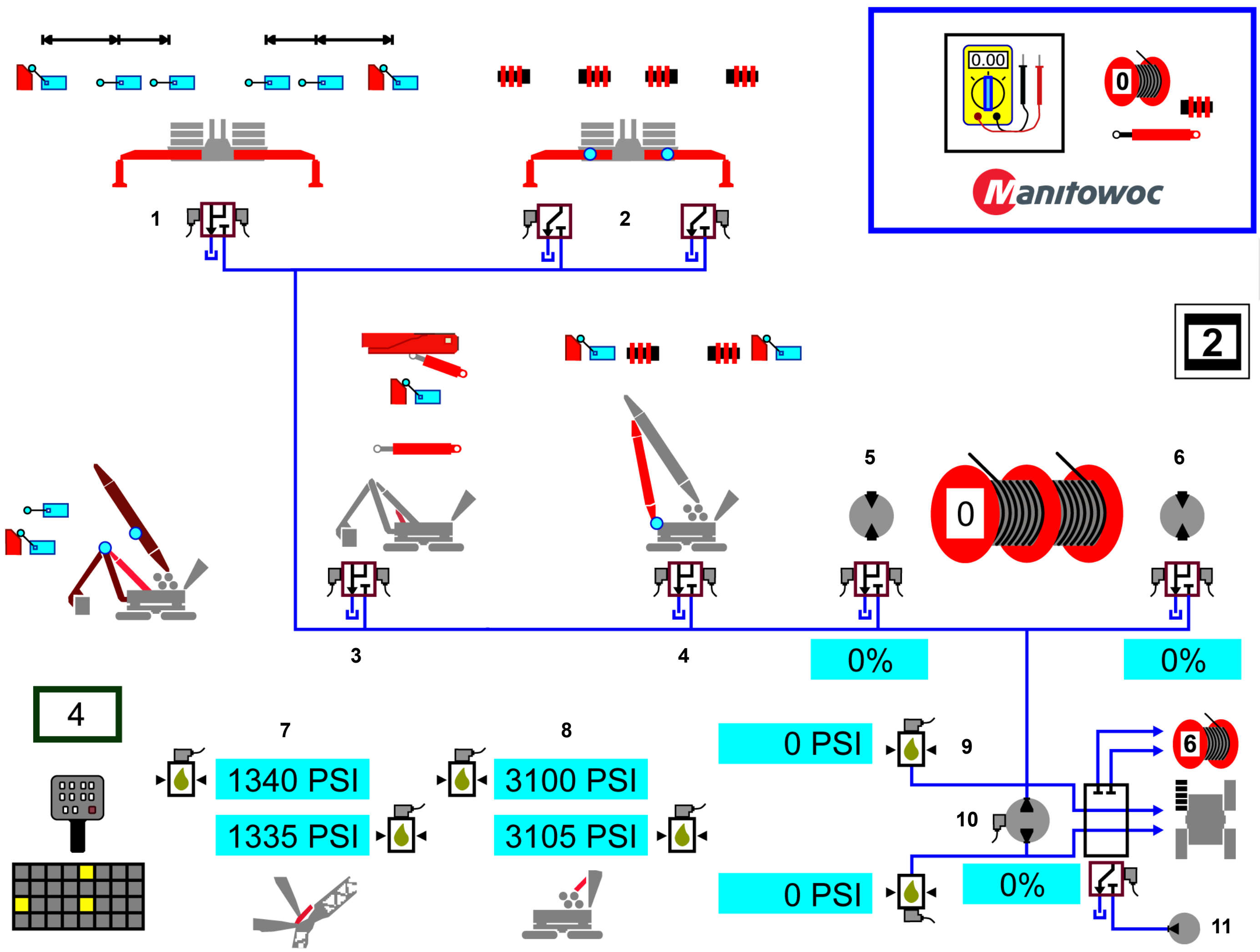
FIGURE 10-4

Backhitch Pins

See Figure 10-3 and Figure 10-5 for the following procedure.

Two pins are mounted on each side of the butt section of the backhitch for securing the backhitch to the rotating bed. The backhitch pins are controlled exclusively by the Set Up Remote. Enable Set Up Remote in the Set UP Function Mode Screen of the crane display, Figure 10-1 to extend or retract the backhitch pins during crane assembly. Output signal from Node-7 to solenoid valve HS-87will extend the backhitch pin cylinders. Output signal from Node-7 to solenoid valve HS-88 will retract the backhitch pin cylinders. Accessory system pump 9 is hydraulic source flow. Reference Folio 2207 and the 31000 Operator Manual for detailed operational procedures for the backhitch pins.

Accessory System Diagnostics Overview

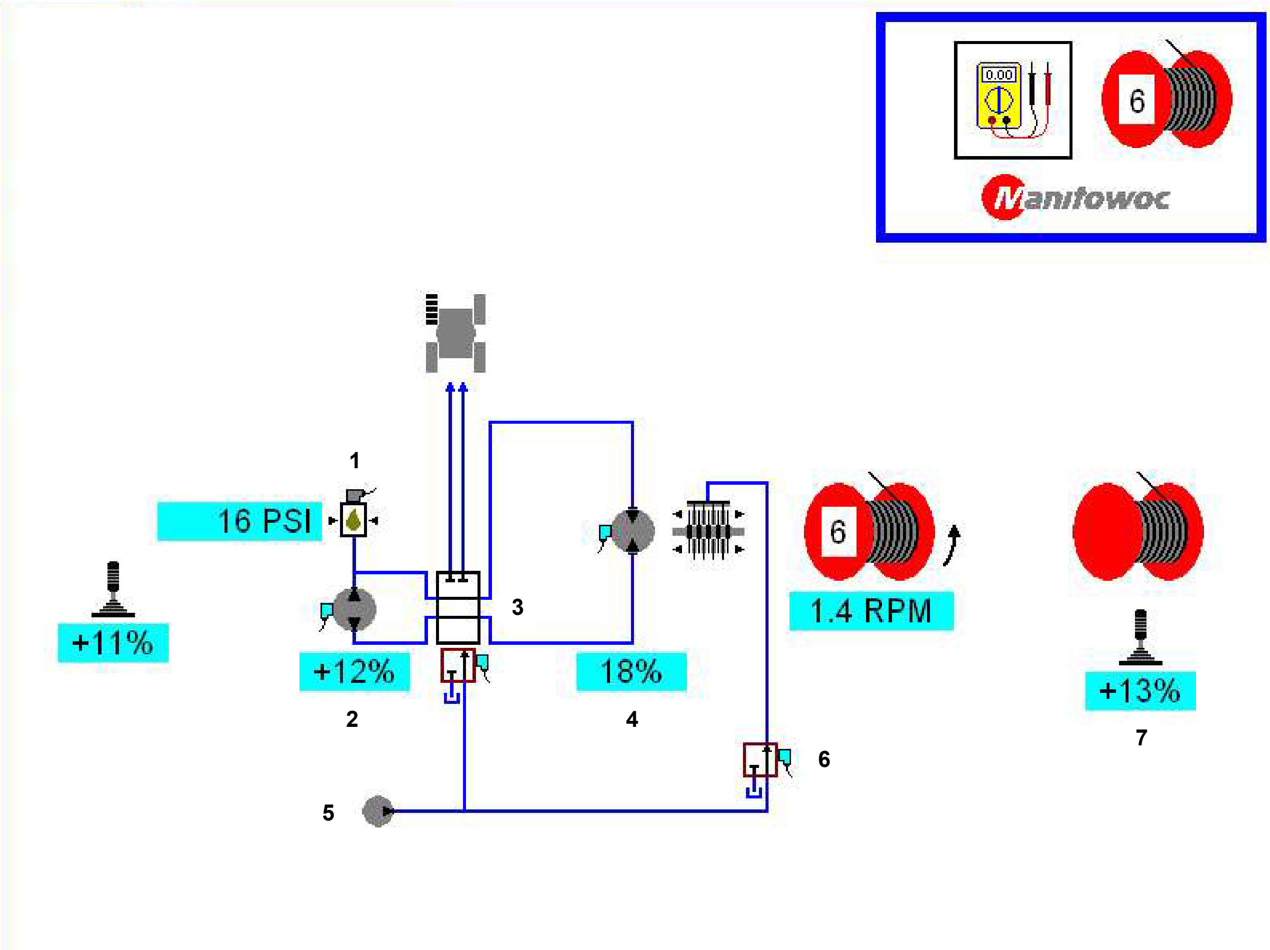


Item	Description	Item	Description
1	CWT Beams Ext/Ret Solenoid HS-71/HS-72	7	Luffing Jib Physical Stop Pressure Sensor L/R
2	CWT Beam Pin Lock Release Solenoid HS-73/HS-74	8	Boom Physical Stop Pressure Sensor L/R
3	VPC Assist Cylinder Ext/Ret Solenoid HS-69/HS-70	9	Pump 9 Pressure Sensor Side A
4	Backhitch Pin Ext/Ret Solenoid HS-88/HS-87	10	Pump 9
5	Drum 0 Left Side Spool IN/OUT HS-82/HS-83	11	Accessory Pump (Low Pressure)
6	Drum 0 Right Side Spool IN/OUT HS-80/HS-81		

FIGURE 10-5

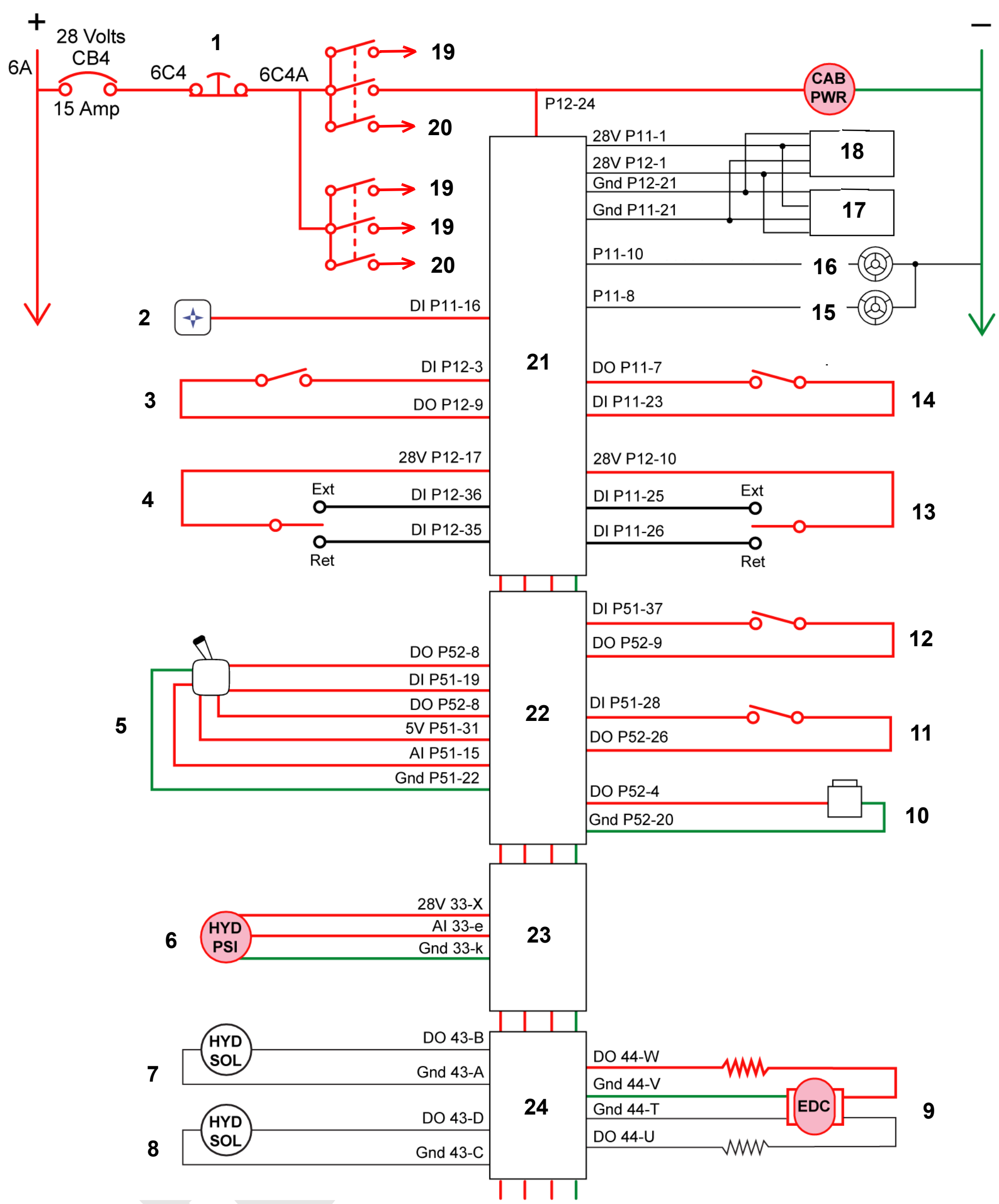
Reference

Rigging Winch (Drum 6) System Diagnostics Overview



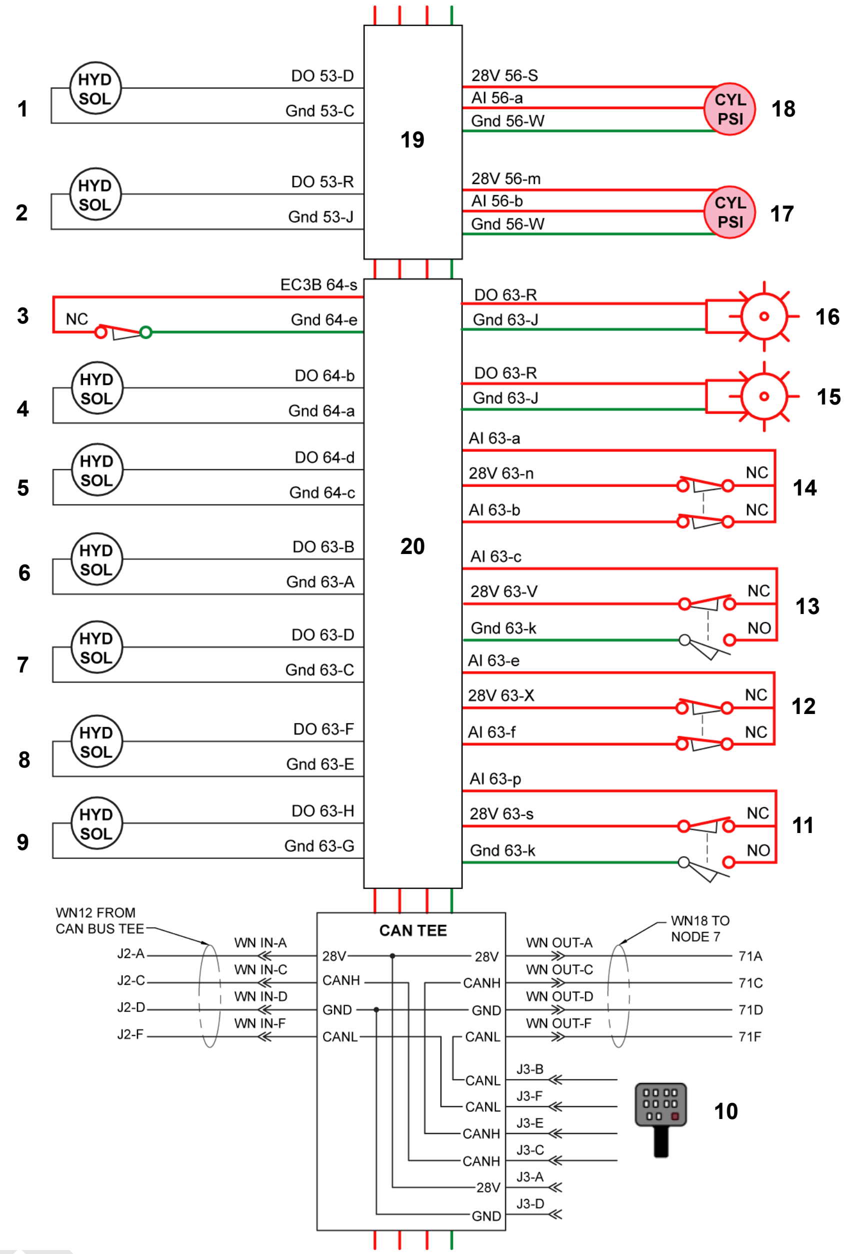
Item	Description	Item	Description
1	Pressure Sensor	5	Accessory Pump 9
2	Pump Command	6	Drum 6 Brake Valve HS-61
3	Diverter Valve HS-58	7	Drum 6 Handle Command
4	Motor Command		

FIGURE 10-6



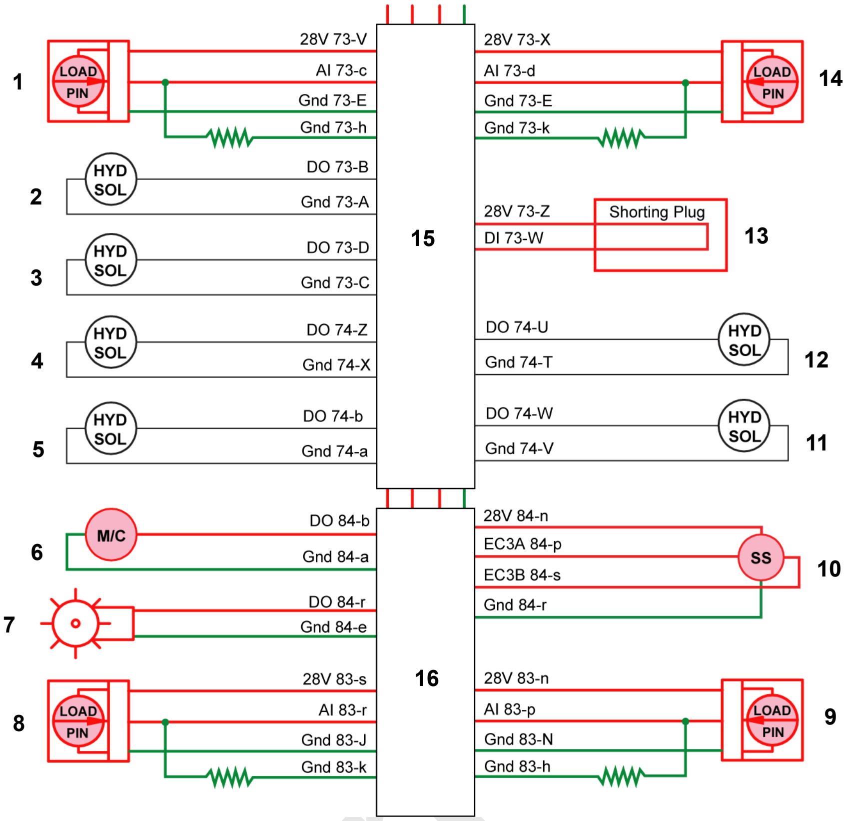
Item	Description	Item	Description
1	Engine Stop	13	Seat Tilt Switch
2	Confirm Chart and Crane Mode	14	Crane Setup Function Mode Switch
3	Drum 6 Park Brake Switch	15	RCL Warning Alarm
4	Counterweight Beam Extend/Retract Switch	16	Caution Fault Alarm
5	Drum 6 Control Handle	17	RCL Display
6	Accessory/Drum 6 Pressure Sensor	18	Main Display
7	Cab Seat Raise Solenoid Valve HS-90	19	Run
8	Cab Seat Lower Solenoid Valve HS-91	20	Start
9	Pump 9 EDC Control	21	Master Node 1
10	Drum 6 Handle Rotation Indicator	22	Side Console Node 2
11	Counterweight Beam Locking Pins Switch	23	Universal Node 3
12	Seat Switch	24	Universal Node 4

FIGURE 10-7



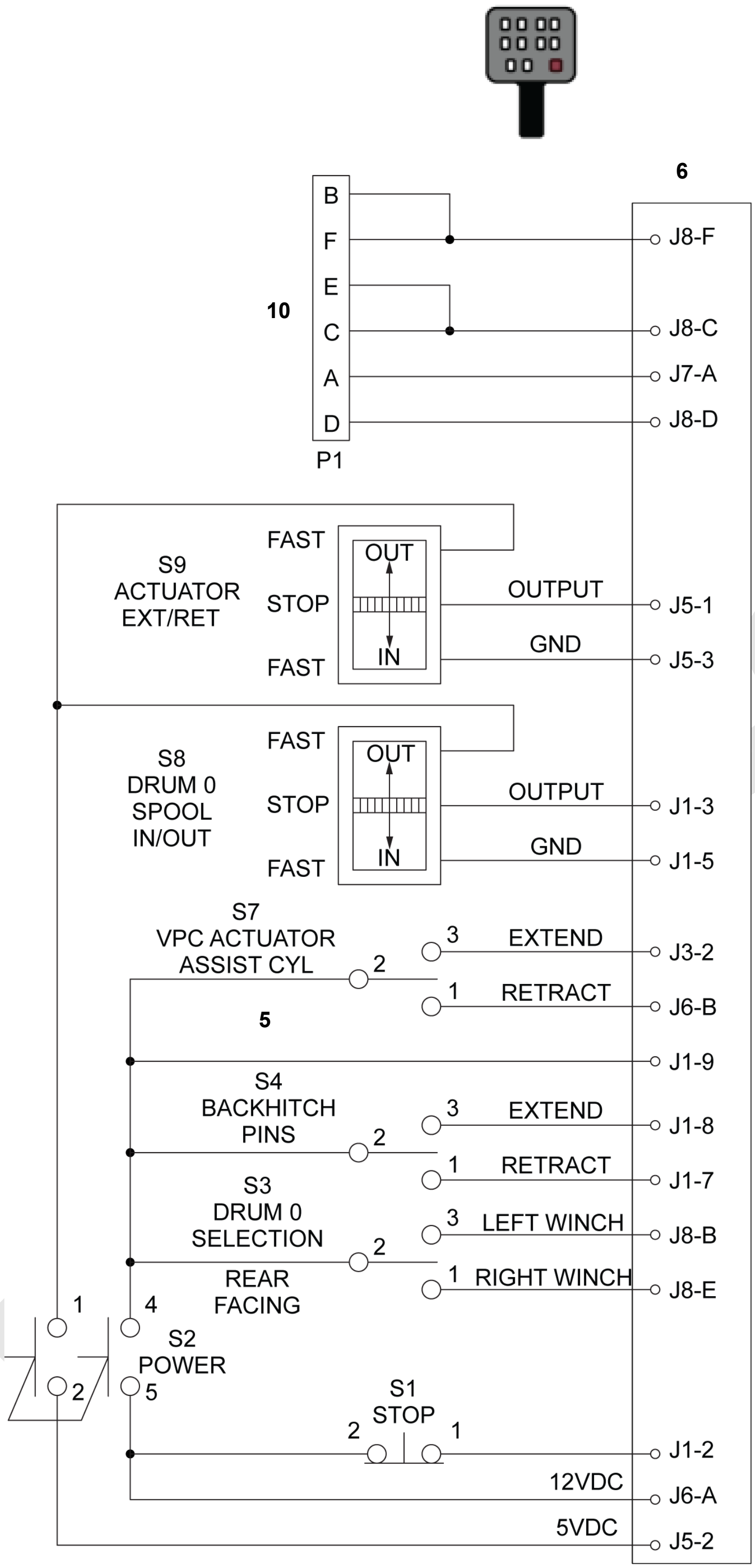
Item	Description	Item	Description
1	Drum 6 Diverter Solenoid Valve HS-58	13	CWT Left Beam Max Retract Limit Switch
2	Drum 6 Brake Release Solenoid Valve HS-61	14	CWT Left Beam Extend/ Retract Limit Switch
3	Assist Cylinder Cradle Limit Switch	15	VPC Right Side Warning Light
4	Assist Cylinder Extend Solenoid Valve HS-69	16	VPC Left Side Warning Light
5	Assist Cylinder Retract Solenoid Valve HS-70	17	Physical Boom Stop Right Side Nitrogen Cylinder
6	CWT Beam Cylinder Extend Solenoid Valve HS-71	18	Physical Boom Stop Left Side Nitrogen Cylinder
7	CWT Beam Cylinder Retract Solenoid Valve HS-72	19	Universal Node 5
8	CWT Beam Left Pin Locks Release Solenoid Valve HS-73	20	Universal Node 6
9	CWT Beam Right Pin Locks Release Solenoid Valve HS-74		
10	Hand Held Remote		
11	CWT Right Beam Max Retract Limit Switch		
12	CWT Right Beam Extend/Retract Limit Switch		

FIGURE 10-7 continued



Item	Description	Item	Description
1	Left Rear House Roller Load Pin	9	Right Front House Roller Load Pin
2	Backhitch Pins Retract Solenoid Valve HS-87	10	Drum 6 Motor Speed Sensor
3	Backhitch Pins Extend Solenoid Valve HS-88	11	Drum 0 Right Side Spool Out Solenoid Valve HS-81
4	Drum 0 Left Side Spool In Solenoid Valve HS-82	12	Drum 0 Right Side Spool In Solenoid Valve HS-80
5	Drum 0 Left Side Spool Out Solenoid Valve HS-83	13	Shorting Plug Right Backhitch Pins Engaged
6	Drum 6 Motor Control	14	Right Rear House Roller Load Pin
7	Drum 6 Camera Lights	15	Universal Node 7
8	Left Front House Roller Load Pin	16	Universal Node 8

FIGURE 10-7 continued



Item	Description
S1	Emergency Stop Switch
S2	Remote Power Switch
S3	Drum 0 Selection Switch Left/Right Winch
S4	Backhitch Pins Ext/Ret Switch
5	Remote Enable
6	Hand Held Remote Circuit Board Connections
S7	VPC Actuator Assist Cylinder Ext/Ret Switch
S8	Drum 0 Spool In/Out Switch
S9	Actuator Ext/Ret Switch
10	CAN Bus Input Connection

FIGURE 10-7 continued

10

Accessory System Manual Controlled Functions

There are two alternate systems for the manually controlled accessory system functions. The Portable Power Unit (PPU) or the Accessory Pump 9 on the primary engine.

Portable Power Unit

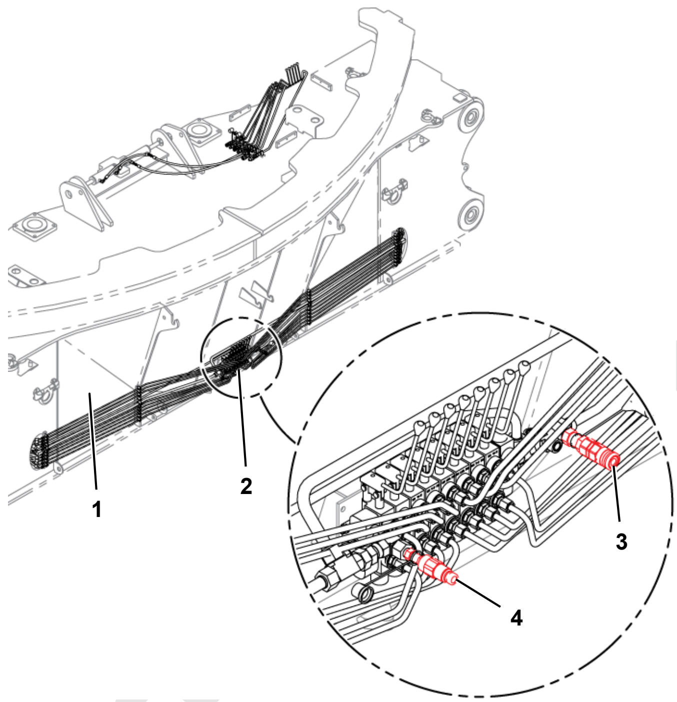
To enable manual hydraulic controls for accessory functions with the PPU, see the Crane Operator Manual and F2220 for detailed operation and maintenance procedures.

CAUTION

Avoid Hydraulic System Damage!

Do not connect hydraulic hoses from PPU cable reel to hydraulic couplers at either outboard carbody valve (Figure 10-8).

Valve will be damaged when PPU is started.



Item	Description
1	Side Carbody Beam
2	Accessory Quick Disconnect Ports
3	Accessory Quick Disconnect Coupler
4	Accessory Quick Disconnect Nipple

FIGURE 10-8

Accessory Pump 9

Primary engine hydraulic pump 9 is the source flow for accessory system manual hydraulic controls and isolated functions. Reference F2207 Crane Display Operation Manual for procedure to activate pump 9 for manual hydraulic controls.

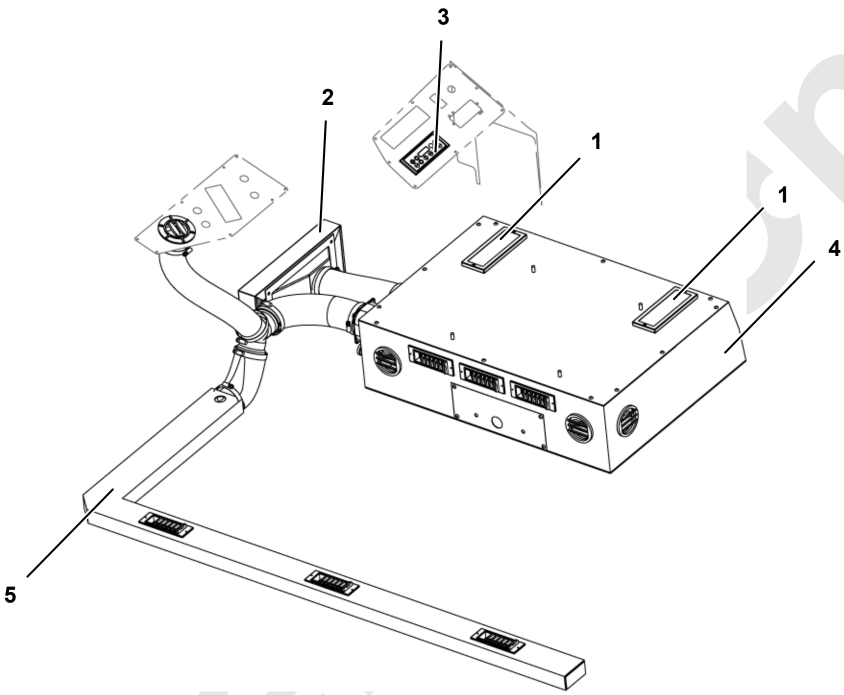
Reference

OPERATOR CAB HEATER

See Figure 10-9 for the following procedure.

Located on the top of the heater pedestal base unit mounted in the operator cab are two air recirculation filters. One fresh air intake filter is mounted on the right side of the cab. Regular inspection intervals of the filter elements are recommended during months of continued use. Replace filters as necessary when an apparent reduction in air flow is noticeable or when the filters have obvious and excessive dirt and dust accumulation on the filter element.

1. Remove two mounting screws on filter element.
2. Position replacement filter element on heater pedestal with foam side up.
3. Secure replacement filter with two mounting screws.



Item	Description
1	Recirculation Heater Filter
2	Fresh Air Intake Filter
3	Heater Control Console
4	Heater Pedestal Base
5	Heater Duct

FIGURE 10-9

Reference Only

Reference Only

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ALPHABETICAL INDEX

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