# Manitowoc 18000

## Service/Maintenance Manual

Grove     Manitowoc     National Crane     Potain

# SERVICE/MAINTENANCE MANUAL

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

**18000**

Crane Model Number

**18001Ref**

Crane Serial Number

This manual is divided into the following sections:



## NOTICE

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

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

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

## ⚠ WARNING

**To prevent death or serious injury:**

- Avoid unsafe operation and maintenance.

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

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



Published 12-05-17, Control # 035-23



1 2 3 4 5 6 7 8 9 10

*THE ORIGINAL LANGUAGE OF THIS PUBLICATION IS ENGLISH*

*See end of this manual for Alphabetical Index*

## SECTION 1 . . . . . . . . . . Introduction

Published 12-05-17, Control # 035-23

# SECTION 1
# INTRODUCTION

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# SECTION 1
# INTRODUCTION

## WARNING

**California Proposition 65**

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

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

**California Spark Arrestor**

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

## CONTINUOUS INNOVATION

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

## SAFETY MESSAGES

### General

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

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

### Safety Alert Symbol

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

### Signal Words

**DANGER**

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

**WARNING**

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

**CAUTION**

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

**CAUTION**

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

**NOTE:** Highlights operation or maintenance procedures.

## SAFE MAINTENANCE PRACTICES

### WARNING

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

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

### Maintenance Instructions

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

Crane maintenance and repair must be performed by personnel who by reason of training and experience are thoroughly familiar with the crane's operation and required maintenance. These personnel shall ***read the Operator Manual and Service/Maintenance Manual before attempting any maintenance procedure***. If there is any question regarding maintenance procedures or specifications, contact your Manitowoc dealer for assistance.

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

### Safe Maintenance Practices

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

   If engine must be run, keep your clothing and all parts of your body away from moving parts. ***Maintain constant verbal communication between person at controls and person performing maintenance or repair procedure***.
3. Wear clothing that is relatively tight and belted.
4. Wear appropriate eye protection and approved hard hat.
5. Never climb onto or off a moving crane. ***Climb onto and off crane only when it is parked and only with operator's permission***.

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

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

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

14. Avoid battery acid contact with skin and eyes. If contact occurs, flush area with water and immediately consult a doctor.
15. Stop engine before refueling crane.
16. Do not smoke or allow open flames in refueling area.
17. Use a safety-type can with an automatic closing cap and flame arrestor for refueling.
18. Hydraulic oil can also be flammable. Do not smoke or allow open flames in area when filling hydraulic tanks.
19. Never handle wire rope with bare hands. Always wear heavy-duty gloves to prevent being cut by broken wires.
20. Use extreme care when handling coiled pendants. Stored energy can cause coiled pendants to uncoil quickly with considerable force.
21. When inflating tires, use a tire cage, a clip-on inflator, and an extension hose which permits standing well away from tire.
22. Only use cleaning solvents which are non-volatile and non-flammable.
23. Do not attempt to lift heavy components by hand. Use a hoist, jacks, or blocking to lift components.
24. Use care while welding or burning on crane. Cover all hoses and components with non-flammable shields or blankets to prevent a fire or other damage.
25. To prevent damage to crane parts (bearings, cylinders, swivels, slewing ring, computers, etc.), perform the following steps ***before welding on crane***:
    - Disconnect all cables from batteries.
    - Disconnect output cables at engine junction box.
    - Attach ground cable from welder directly to part being welded and as close to weld as possible.

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

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

## ENVIRONMENTAL PROTECTION

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

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

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

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

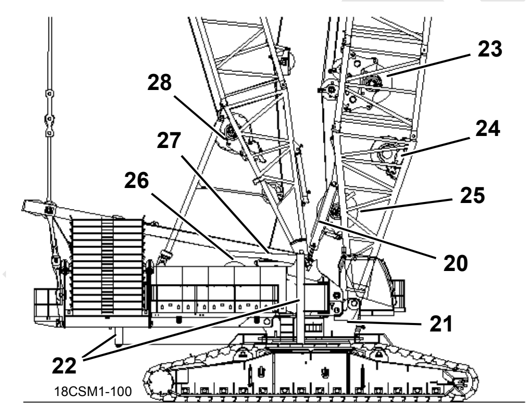
- Always drain waste fluids into leak proof containers that are clearly marked with what they contain.
- Always fill or add fluids with a funnel or a filling pump.
- Immediately wipe up any spills.

# IDENTIFICATION AND LOCATION OF COMPONENTS

See Figures 1-1 through 1-13 for graphic identification of crane components.

## Basic Crane

| Item | Description |
|---|---|
| 1 | Boom Top |
| 2 | Load Block |
| 3 | Boom Insert |
| 4 | Boom Insert (with Drum 1) |
| 5 | Boom Butt (with Drums) |
| 6 | Operator’s Cab |
| 7 | Upperworks |
| 8 | Lowerworks |
| 9 | Right Side Crawler |
| 10 | Upper Counterweights |
| 11 | Live Mast |
| 12 | Mast Stop |
| 13 | Mast Straps |
| 14 | Main Mast |
| 15 | Main Hoist Wire Rope |
| 16 | Whip Line Wire Rope |
| 17 | Boom Hoist Wire Rope |
| 18 | Equalizer |
| 19 | Boom Straps |
| 20 | Telescopic Boom Stop |
| 21 | Adapter Frame |
| 22 | Jacks |
| 23 | Main Hoist (Drum 1) |
| 24 | Luffing Jib Hoist (Drum 6) |
| 25 | Main Hoist (Drum 2) |
| 26 | Mast Hoist (Drum 5) |
| 27 | Whip Line Hoist (Drum 3) |
| 28 | Boom Hoist (Drum 4) |



Drum Locations

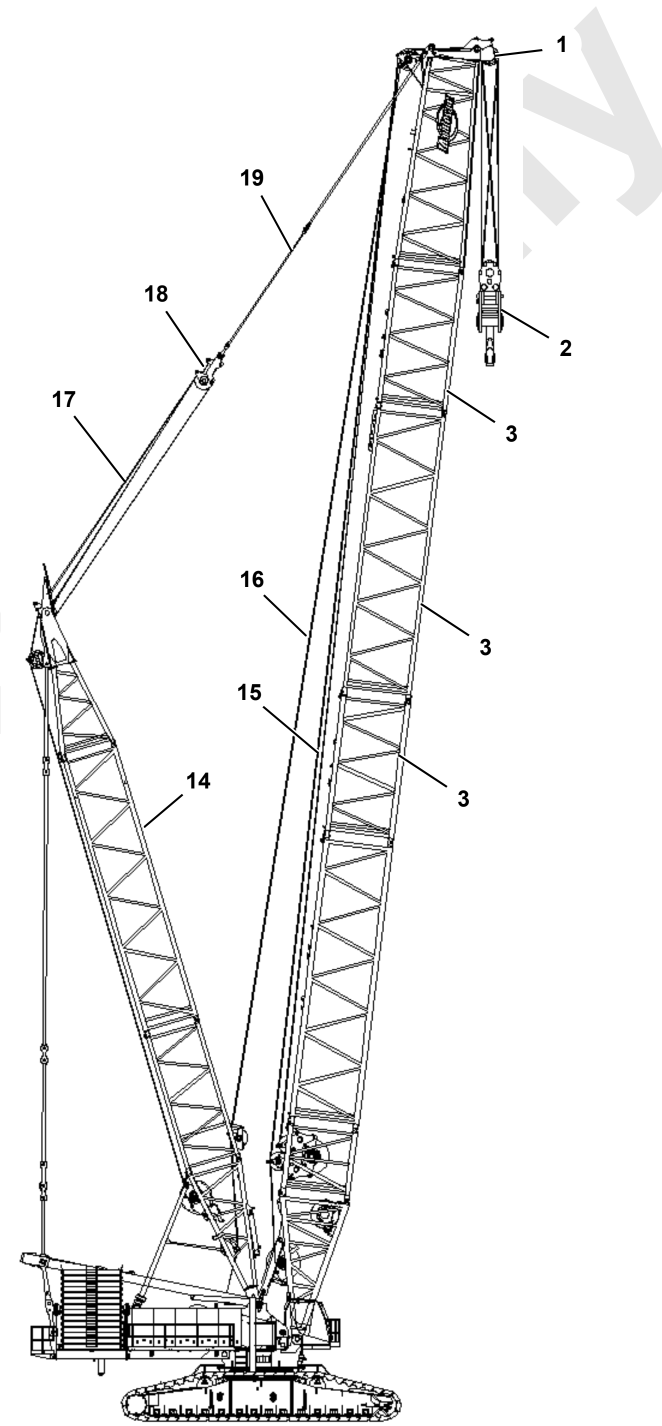
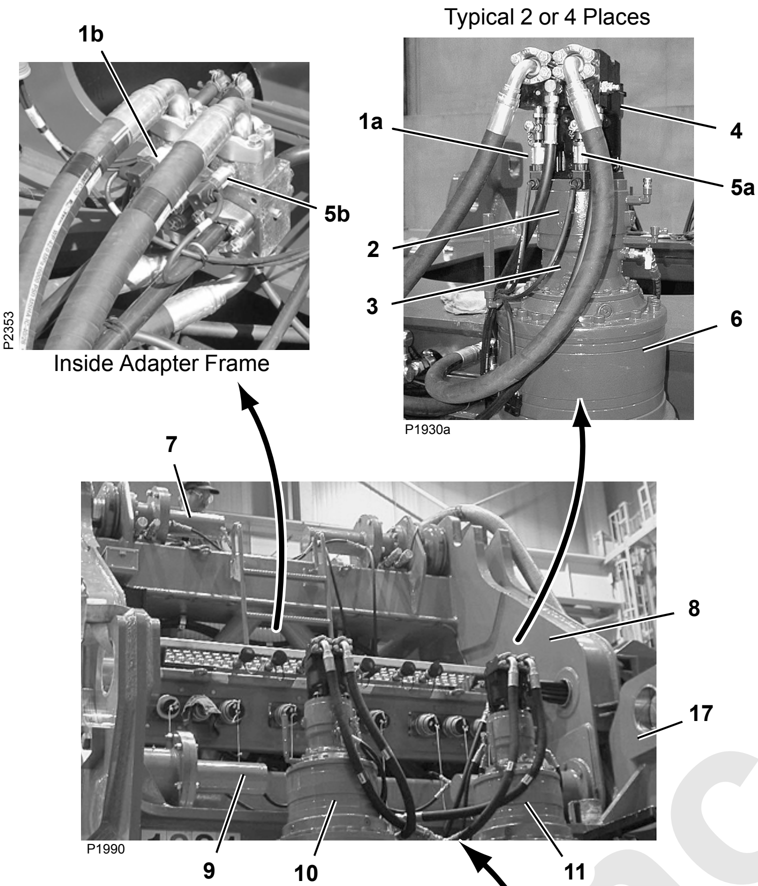



FIGURE 1-1

## Front

| Item | Description |
|---|---|
| 1a | Swing Right Pressure Sender (past production) |
| 1b | Swing Right Pressure Sender (current production) |
| 2 | Swing Brake |
| 3 | Swing Lock |
| 4 | Swing Motor |
| 5a | Swing Left Pressure Sender (past production) |
| 5b | Swing Left Pressure Sender (current production) |
| 6 | Swing Gearbox |
| 7 | Mast Hinge Pin Cylinder |
| 8 | Rotating Bed |
| 9 | Adapter Frame Pins Cylinder |
| 10 | Right Front Swing Drive |
| 11 | Left Front Swing Drive |
| 12 | Operator’s Cab |
| 13 | Carbody (Front and Rear) Counterweights |
| 14 | Grease (Crawler and Turntable Bearing) Reservoir |
| 15 | Turntable (with External Ring Gear) Bearing |
| 16 | Right Swing Drive Gear |
| 17 | Adapter Frame |
| 18 | Node-6 Controller |
| 19 | Crane Level Sensor |



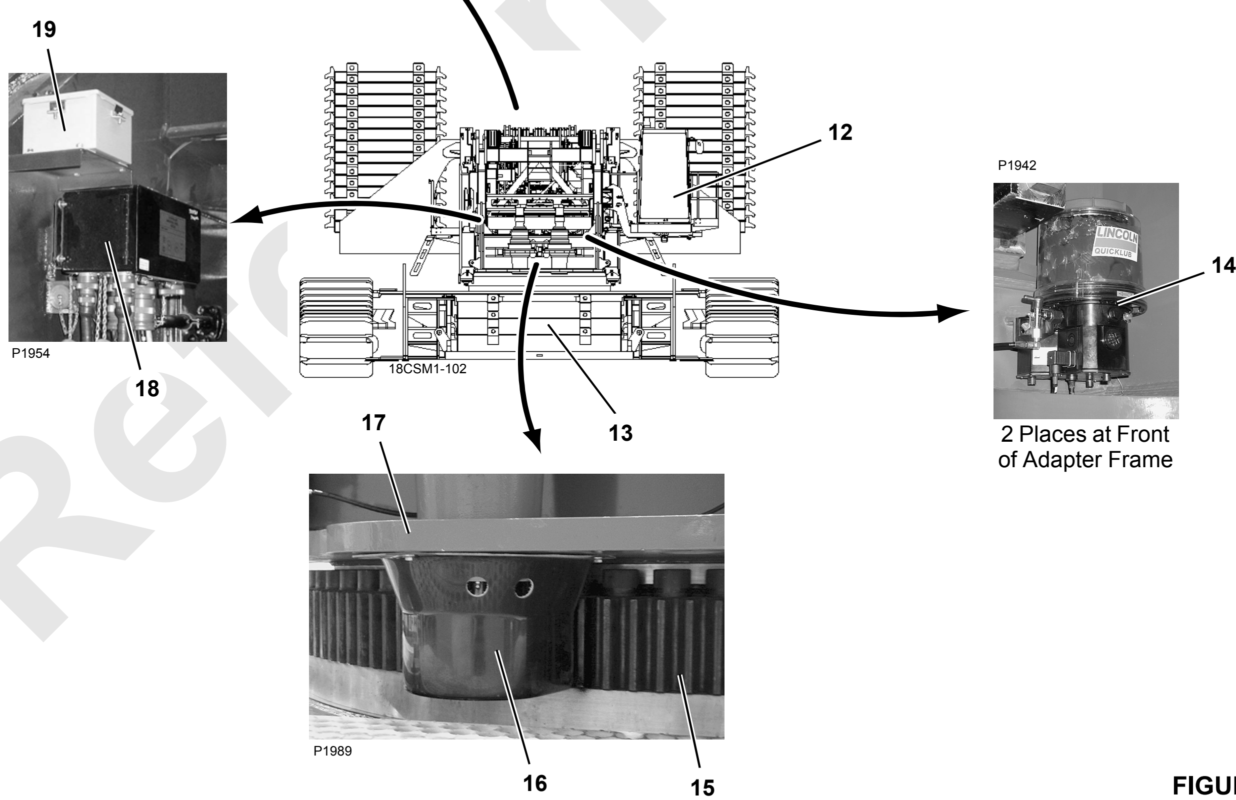




FIGURE 1-2

### Top

| Item | Description | Item | Description | Item | Description |
|---|---|---|---|---|---|
| 1* | Charge Filter (2) | 9 | Engine Air Cleaner (Tier 3) | 17 | Travel 2-Speed Solenoid Valve |
| 2 | Engine Oil Fill Tube | 10 | Engine Exhaust Stack (Tier 3) | 18 | Adapter Frame Accumulator |
| 3 | Engine | 11 | Whip Line Hoist Motor (Drum 3) | 19 | Accessory Pressure Switch |
| 4 | Engine Coolant Radiator | 12 | Whip Line Hoist (Drum 3) | 20 | Swivel |
| 5 | Mast Assist Arms | 13 | Engine Cover | 21 | Node-7 Controller |
| 6 | Live Mast | 14 | Swing Brake Solenoid Valve | 22 | Pump Inlet Manifold |
| 7 | Mast Stop | 15 | Swing Lock Solenoid Valve | 23 | Mast Hoist Motor (Drum 5) |
| 8 | Mast Butt | 16 | Travel Brake Solenoid Valve | 24 | Mast Hoist (Drum 5) |

*Cranes prior to s/n 18001082

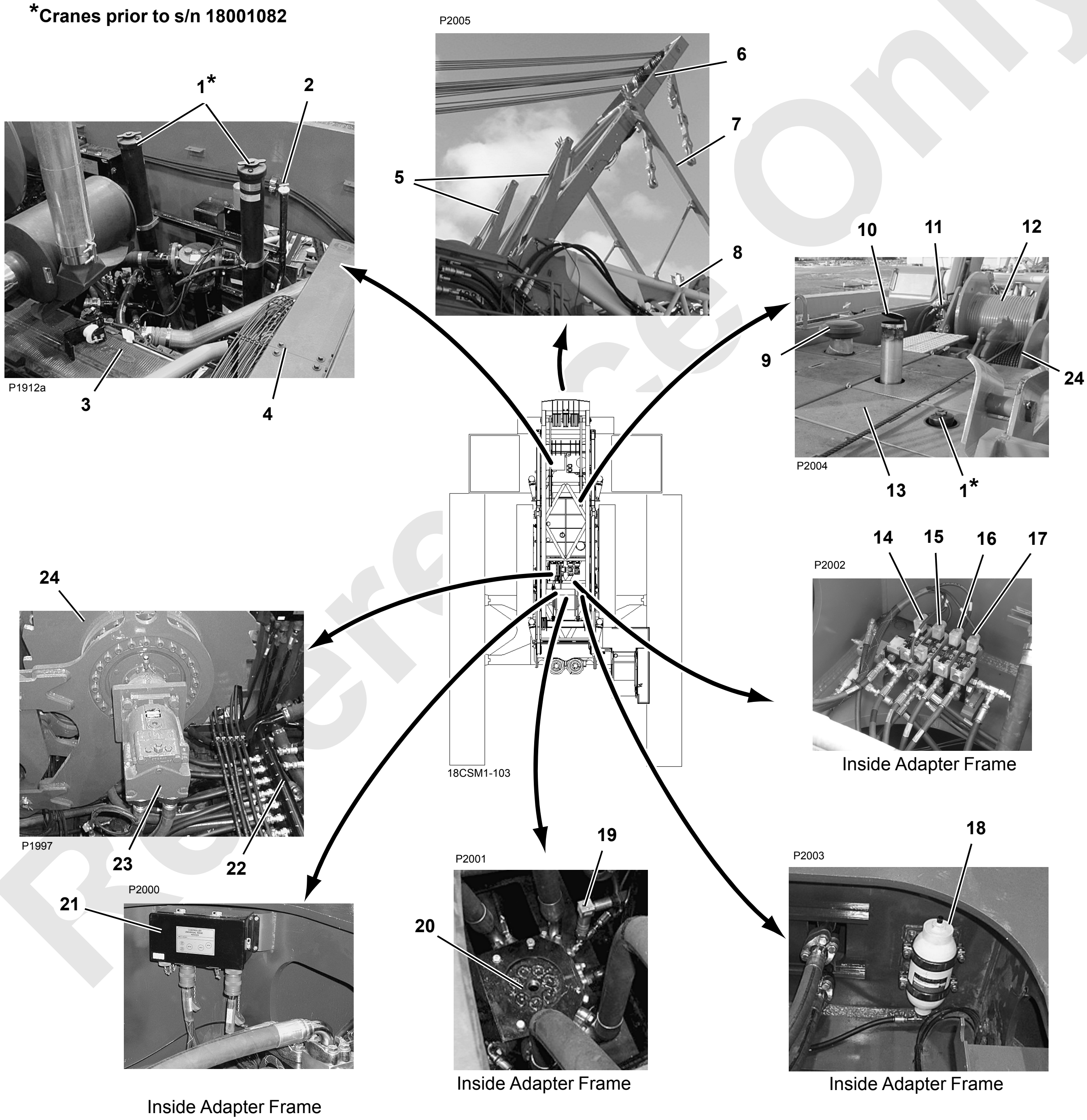



FIGURE 1-3

## Left Side

| Item | Description | Item | Description | Item | Description |
|---|---|---|---|---|---|
| 1 | Mast Pins Solenoid Valves | 14 | Node-3 Controller | 27* | Boom Hoist A Pump (Drum 4) |
| 2 | Front Adapter Frame Pins Solenoid Val. | 15 | Node-4 Controller | 28* | Swing Pump (Optional) |
| 3 | Rear Adapter Frame Pins Solenoid Val. | 16* | Supercharge/Accessory Pump | 29* | Supercharge Pump |
| 4 | Cab Tilt Solenoid Valves | 17* | Boom Hoist B Pump (Drum 4) | 30 | Accessory System Pressure Sender |
| 5 | Boom Hinge Pins Solenoid Valves | 18* | Pump Drive | 31 | Not Used |
| 6 | Air Cleaner Service Indicator | 19* | Main Hoist Pump (Drums 1 and 3) | 32 | Load Drums 2 and 5 Pressure Sender |
| 7 | Left Front Jack Solenoid Valves | 20* | Main Hoist Pump (Drum 2) | 33 | Left Travel Pressure Sender |
| 8 | Left Rear Jack Solenoid Valves | 21* | Swing Pump | 34 | Right Travel Pressure Sender |
| 9 | Right Rear Jack Solenoid Valves | 22* | Left Travel Pump | 35 | Load Drums 1 and 3 Pressure Sender |
| 10 | Right Front Jack Solenoid Valves | 23* | Luffing Jib Hoist Pump (Drum 6) | 36 | Boom Hoist Pressure Sender |
| 11 | Live Mast Solenoid Valves | 24* | Right Travel Pump | 37 | Luffing Jib Hoist Pressure Sender |
| 12 | Rigging Winch Solenoid Valves | 25* | Main Hoist Pump (Drums 2 and 5) | 38 | High Pressure Accessory Pressure Sender |
| 13* | Engine Node-0 Controller (Past Production) | 26* | Main Hoist Pump (Drum 1) | | |

*Cranes prior to s/n 18001082

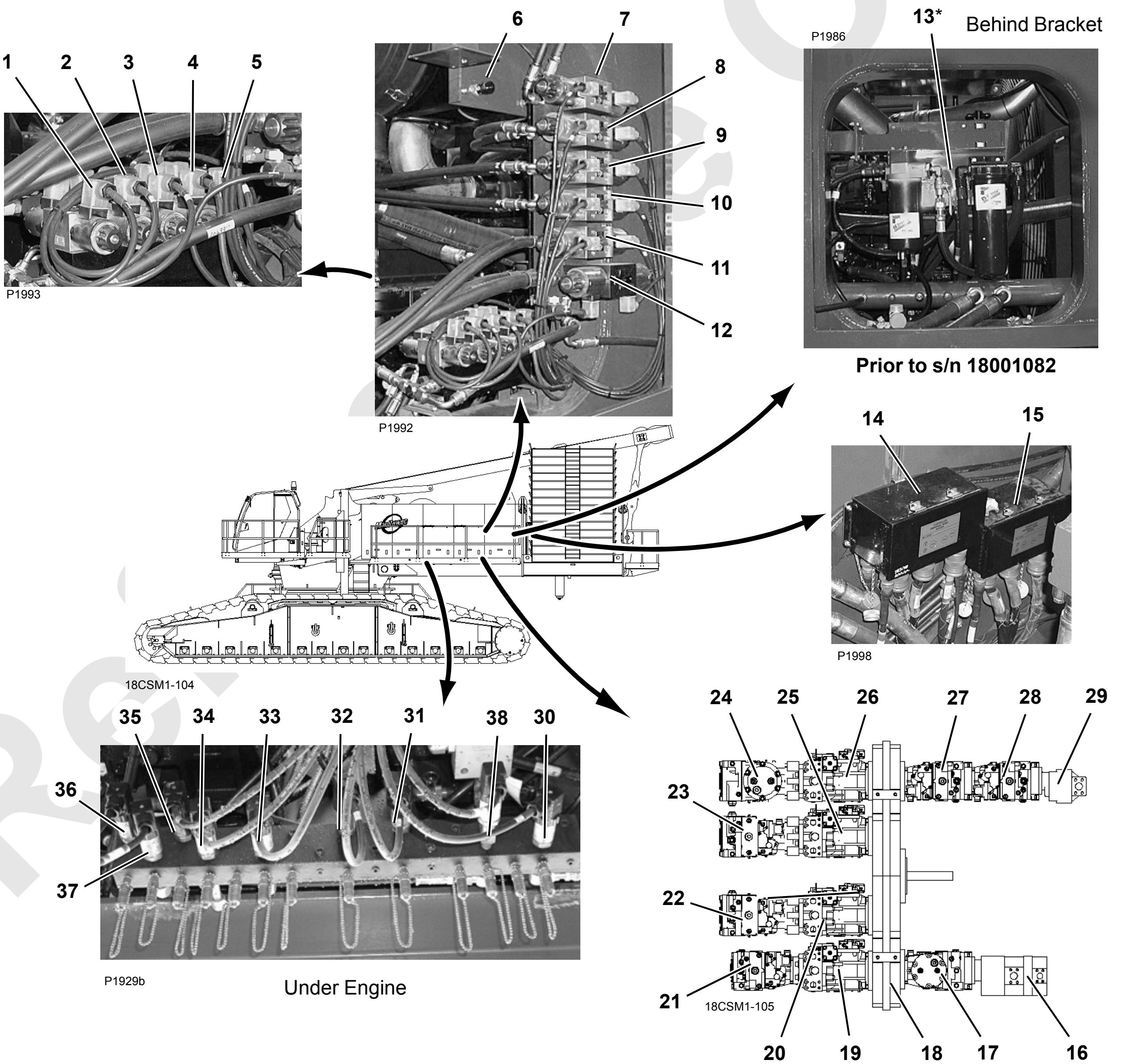
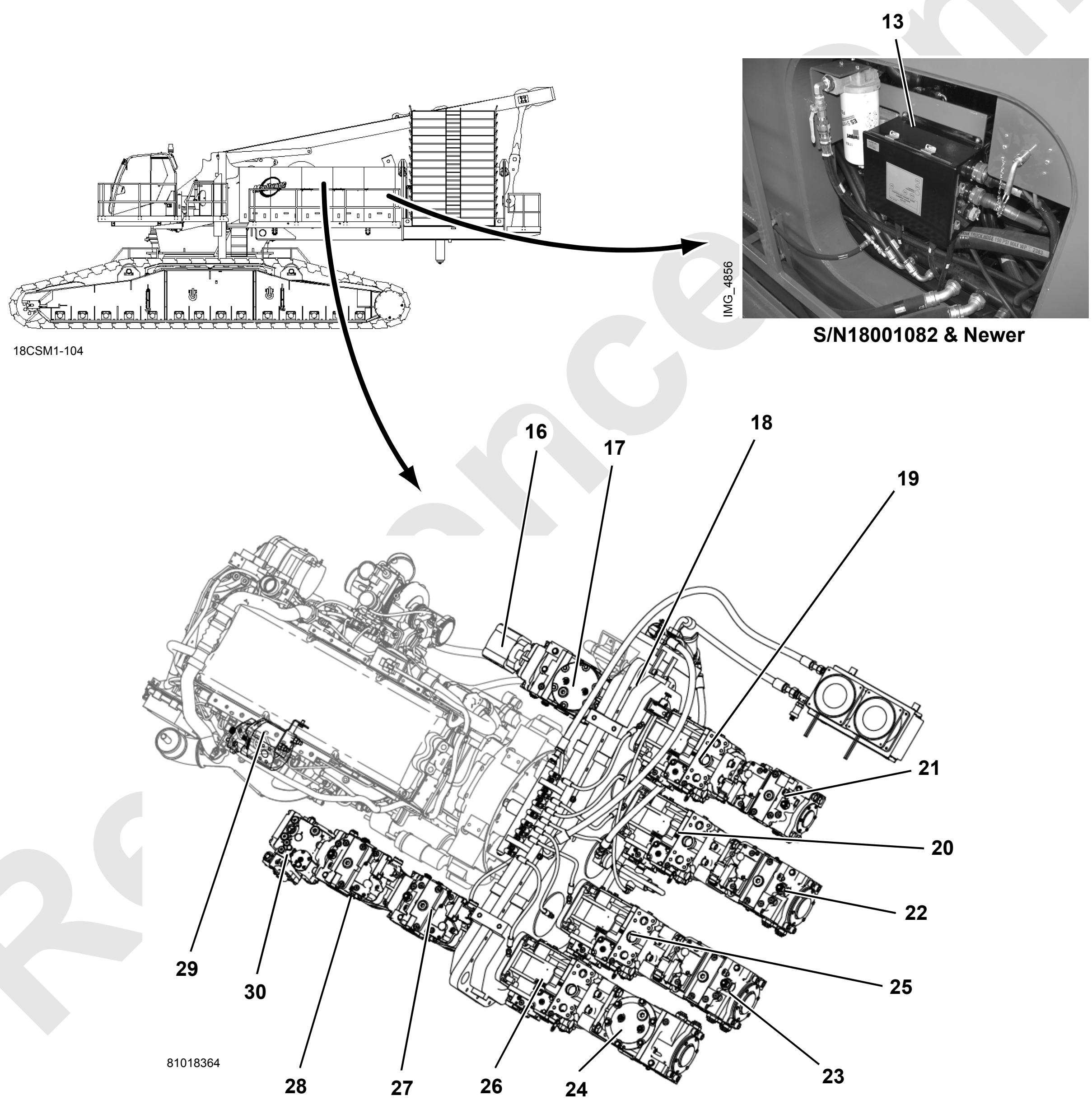



FIGURE 1-4

## Left Side – S/N18001082 & Newer

| Item | Description | Item | Description |
|---|---|---|---|
| | **Current Production** | 23 | Luffing Jib Hoist Pump (Drum 6) |
| 13 | Engine Node-0 Controller (S/N 18001082 & Newer) | 24 | Right Travel Pump |
| 16 | Pump Drive Accessory Pump | 25 | Main Hoist Pump (Drums 2 and 5) |
| 17 | Boom Hoist B Pump (Drum 4) | 26 | Main Hoist Pump (Drum 1) |
| 18 | Pump Drive | 27 | Boom Hoist A Pump (Drum 4) |
| 19 | Main Hoist Pump (Drums 1 and 3) | 28 | Swing Pump (Optional) |
| 20 | Main Hoist Pump (Drum 2) | 29 | Engine Drive Accessory Pump |
| 21 | Swing Pump | 30 | Cooler Fan Pump (Tier 4 Equipped) |
| 22 | Left Travel Pump | | |



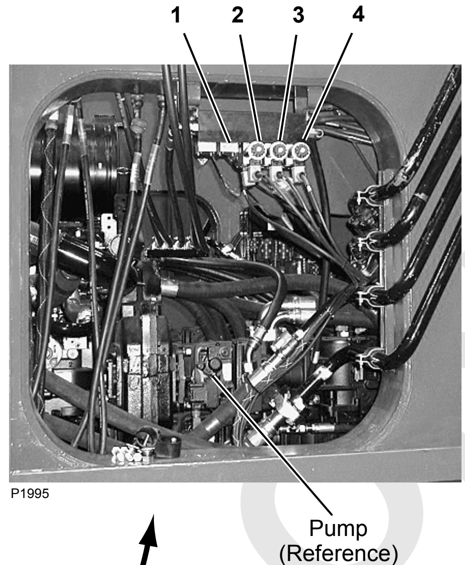

S/N18001082 & Newer

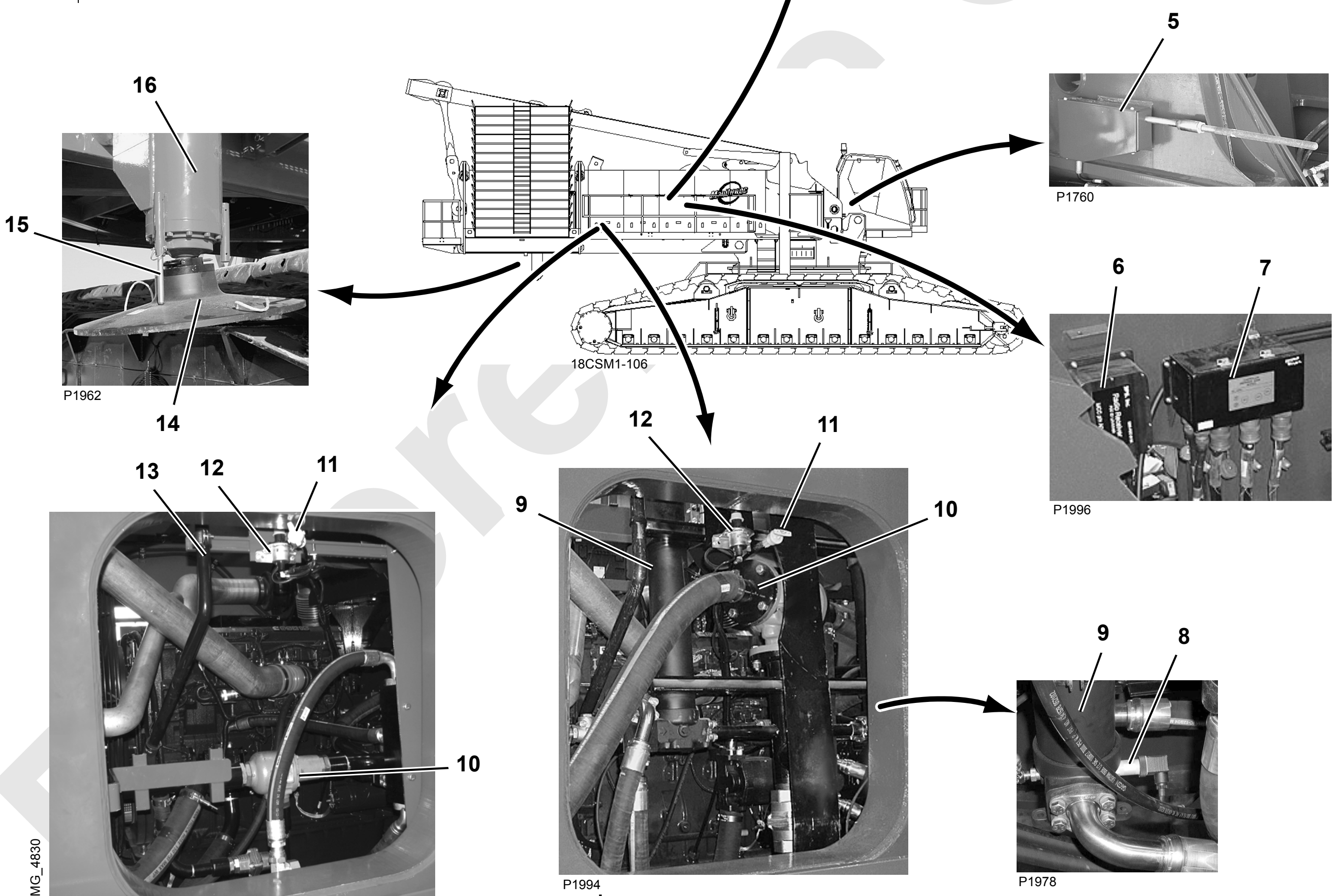
S/N18001082 & Newer

FIGURE 1-5

## Right Side

| Item | Description |
|---|---|
| 1 | Mast Hoist (Drum 5) Brake Solenoid Valve |
| 2 | Mast Hoist (Drum 5) Pawl Solenoid Valve |
| 3 | Drum 3 Diverting Solenoid Valve |
| 4 | Drum 5 Diverting Solenoid Valve |
| 5 | Boom Stop Maximum Up Limit Switch |
| 6 | Hand-Held Radio Remote Receiver |
| 7 | Node-5 Controller |
| 8* | Charge Filter Alarm Sensor |
| 9* | Charge Filter (2) |
| 10 | Hydraulic Thermo Bypass Valve |
| 11 | Engine Oil Dipstick |
| 12 | Ether Starting Aid |
| 13 | Engine Oil Fill |
| 14 | Jack Pad |
| 15 | Jack Pad Support Rod |
| 16 | Rotating Bed Jack (2) |
| | ***Cranes prior to s/n 18001082** |



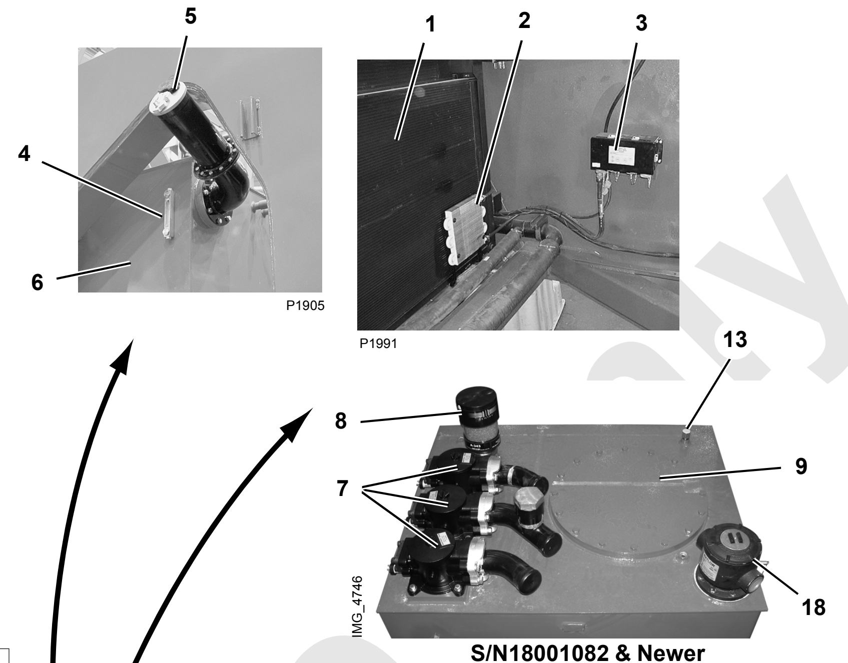

**S/N18001082 & Newer**

***Cranes prior to s/n 18001082**

**FIGURE 1-6**

### Rear

| Item | Description |
|---|---|
| 1 | Hydraulic Fluid Cooler |
| 2 | Fuel Cooler |
| 3 | Node 9 Controller |
| 4 | Fuel Level Gauge |
| 5 | Fuel Tank Fill Cap |
| 6 | Fuel Tank |
| 7 | Hydraulic Tank Return Filters |
| 8 | Hydraulic Tank Breather |
| 9 | Access Tank Clean-Out Cover |
| 10 | Air Bleed Valves |
| 11 | Hydraulic Liquid Level Gauge |
| 12 | Hydraulic Tank |
| 13 | Liquid Level Switch |
| 14 | Hydraulic Tank Shut Off Valves (2) |
| 15 | Live Mast Straps |
| 16 | Mast Sheaves |
| 17 | Live Mast |
| 18 | Hydraulic Tank Heater |



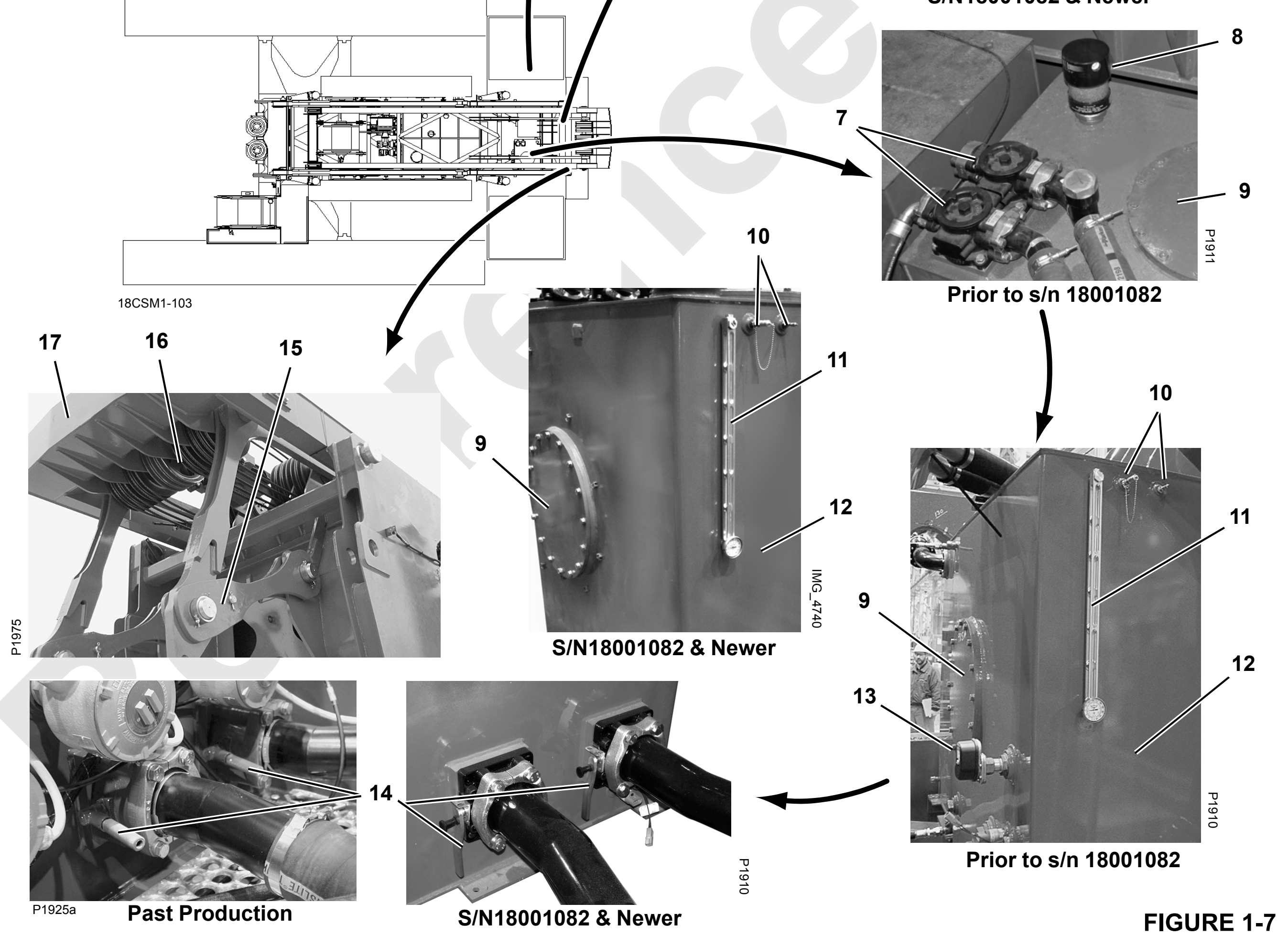




FIGURE 1-7

### Carbody/Crawler

| Item | Description |
|---|---|
| 1 | Crawler Drive Universal Joint (2) |
| 2 | Carbody |
| 3 | Crawler Drive Shaft (2) |
| 4 | Crawler Drive Shaft Guard |
| 5 | Crawler Roller Lubrication Block |
| 6 | Crawler Input Gearbox (2) |
| 7 | Crawler Idler Roller (14 each Crawler) |
| 8 | Crawler Output Gearbox (2) |
| 9 | Crawler Track |
| 10 | Crawler Motor (2 each Crawler) |
| 11 | Travel Brake (2 each Crawler) |
| 12 | Crawler Drive Gearbox (2) |
| 13 | Crawler Pins Cylinder (2) |
| 14 | Carbody Pedestal |
| 15 | Right Crawler Pins Handle |
| 16 | Left Crawler Pins Handle |

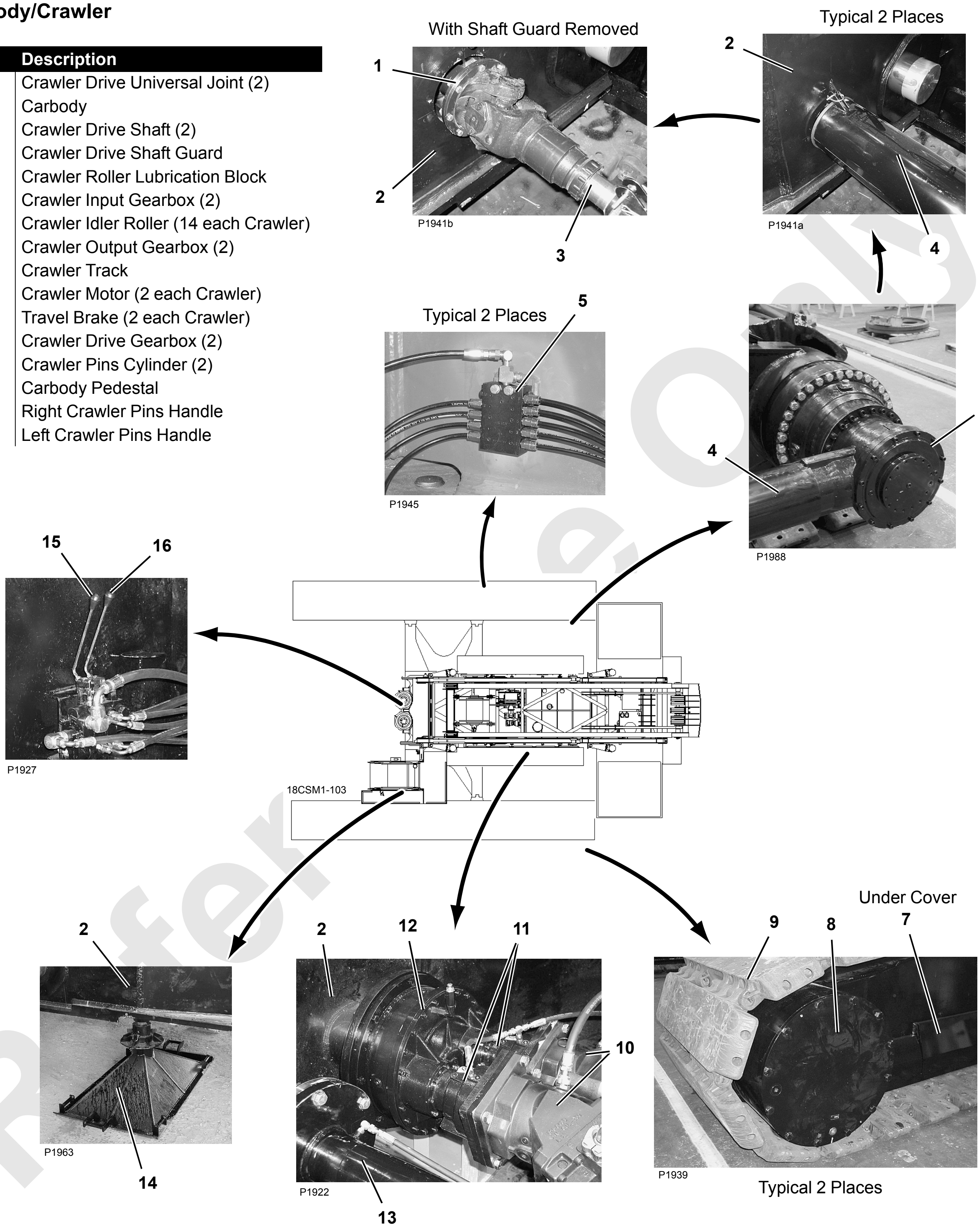



FIGURE 1-8

## Operator Cab/Controls

| Item | Description | Item | Description |
|---|---|---|---|
| 1 | Engine Foot Throttle | 13 | Test Point Receptacle |
| 2 | Node-1 Master Controller | 14 | Horn/Travel Cruise Panel |
| 3 | Node-2 Side Console Controller | 15 | Main Console |
| 4 | Front Console (with RCL) | 16 | Boom or Luffing Jib Hoist Handle |
| 5 | Drum Handles | 17 | Engine Hand Throttle |
| 6 | Engine Start/Travel Controls Console | 18 | Hand-Held Radio Remote |
| 7 | Crawler Left and Right Handles | 19 | Circuit Breaker A8CB1 (24/12 Volt Converter) |
| 8 | Windshield Wiper Switches | 20 | Circuit Breaker A8CB2 (A/C Heater Power) |
| 9 | Customer Panel (Optional) | 21 | Circuit Breaker A8CB3 (Windshield Wipers) |
| 10 | Radio (Optional) | 22 | Circuit A8CB4 (Panel Lights) |
| 11 | 12 Volt Power Receptacle (2) | 23 | 24/12 Volts Converter |
| 12 | Foot Activated Horn | | |

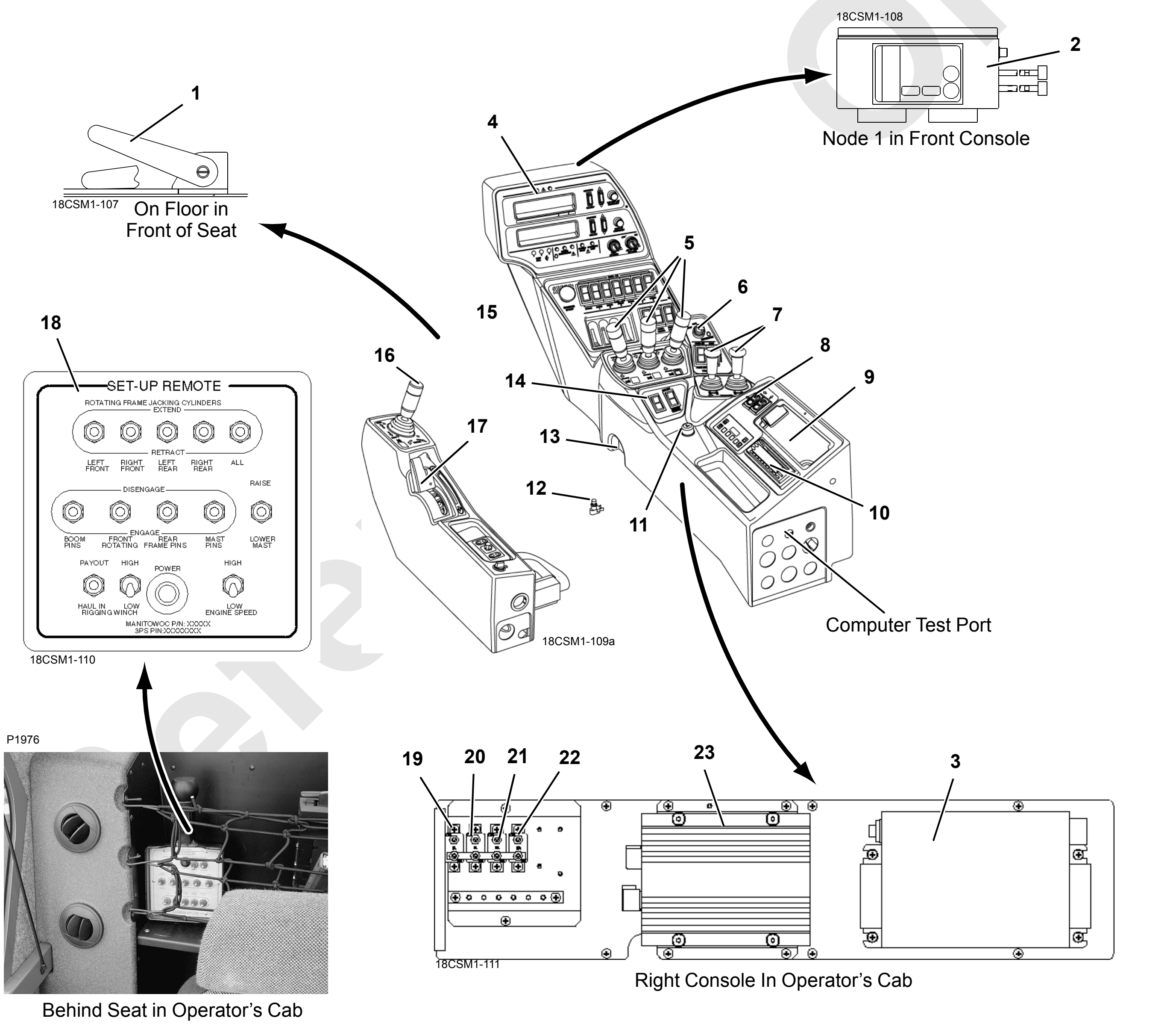
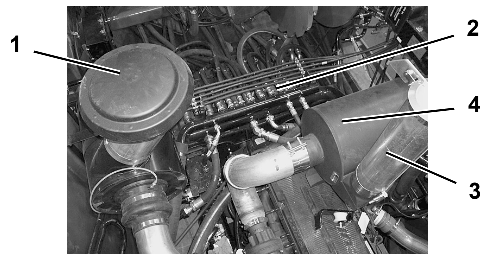


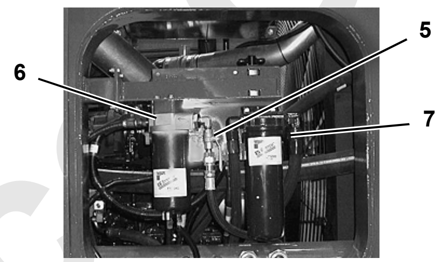

**FIGURE 1-9**

## Cummins Engine Tier 3

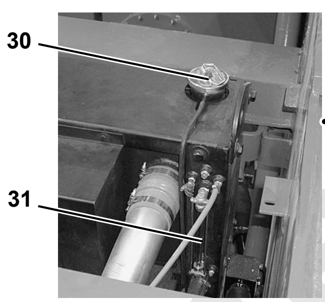
| Item | Description | Item | Description |
|---|---|---|---|
| 1 | Engine Air Cleaner | 17 | Engine Node-0 Controller |
| 2 | Pump Drive | 18 | Engine Water Filter |
| 3 | Engine Exhaust Stack | 19 | Engine Alternator |
| 4 | Engine Muffler | 20 | Engine Starter Motor (2) |
| 5 | Fuel Shut Off Valve | 21 | Engine Starter Solenoid (2) |
| 6 | Fuel Filter | 22 | Ether Starting Aid |
| 7 | Oil Filter | 23 | Coolant Level Sensor |
| 8 | Circuit Breaker CB1 (main system power) | 24 | Battery (2) |
| 9 | Circuit Breaker CB2 (Engine ECM) | 25 | Air Conditioning Low/High Pressure Switch |
| 10 | Circuit Breaker CB3 (Engine ECM) | 26 | Fuel Pump |
| 11 | Circuit Breaker CB4 (Engine Bus Run/Stop) | 27 | Fuel Shut Off |
| 12 | Circuit Breaker CB5 (Engine Ether Start) | 28 | ECM (Engine Control Module) |
| 13 | Circuit Breaker CB6 (Engine Start Solenoid) | 29 | Engine Oil Dipstick |
| 14 | Circuit Breaker CB7 (CAN System Power) | 30 | Radiator Fill |
| 15 | Circuit Breaker CB8 (Cab Power) | 31 | Radiator Coolant Sight Gauge |
| 16 | Battery Disconnect Switch | 32 | Radiator Drain |




P1987 Top of Engine




P1986 Left Side of Rotating Bed

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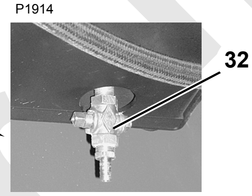
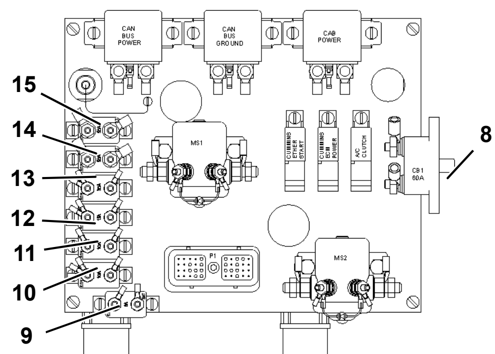



Under Engine

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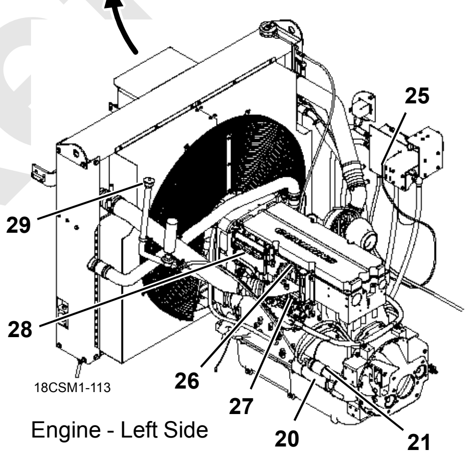


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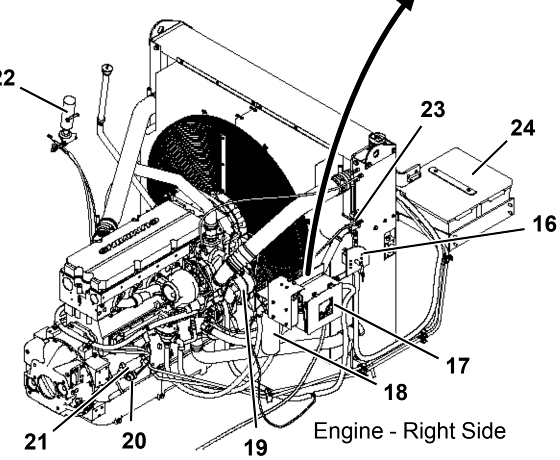
Engine - Left Side




Engine - Right Side

**FIGURE 1-10**

## Cummins Engine Tier 4

| Item | Description | Item | Description |
|---|---|---|---|
| 1 | Engine Air Cleaner | 7 | Engine Oil Fill Tube |
| 2 | Diesel Particulate Filter (DPF) | 8 | Diesel Particulate Filter (DPF) |
| 3 | Engine Exhaust Stack | 9 | Engine Oil Filter |
| 4 | PreCleaner | 10 | Cooler Surge Tank |
| 5 | Engine Node | 11 | Cooler Fill Cap |
| 6 | Battery Disconnect | 12 | Cooler Drain |

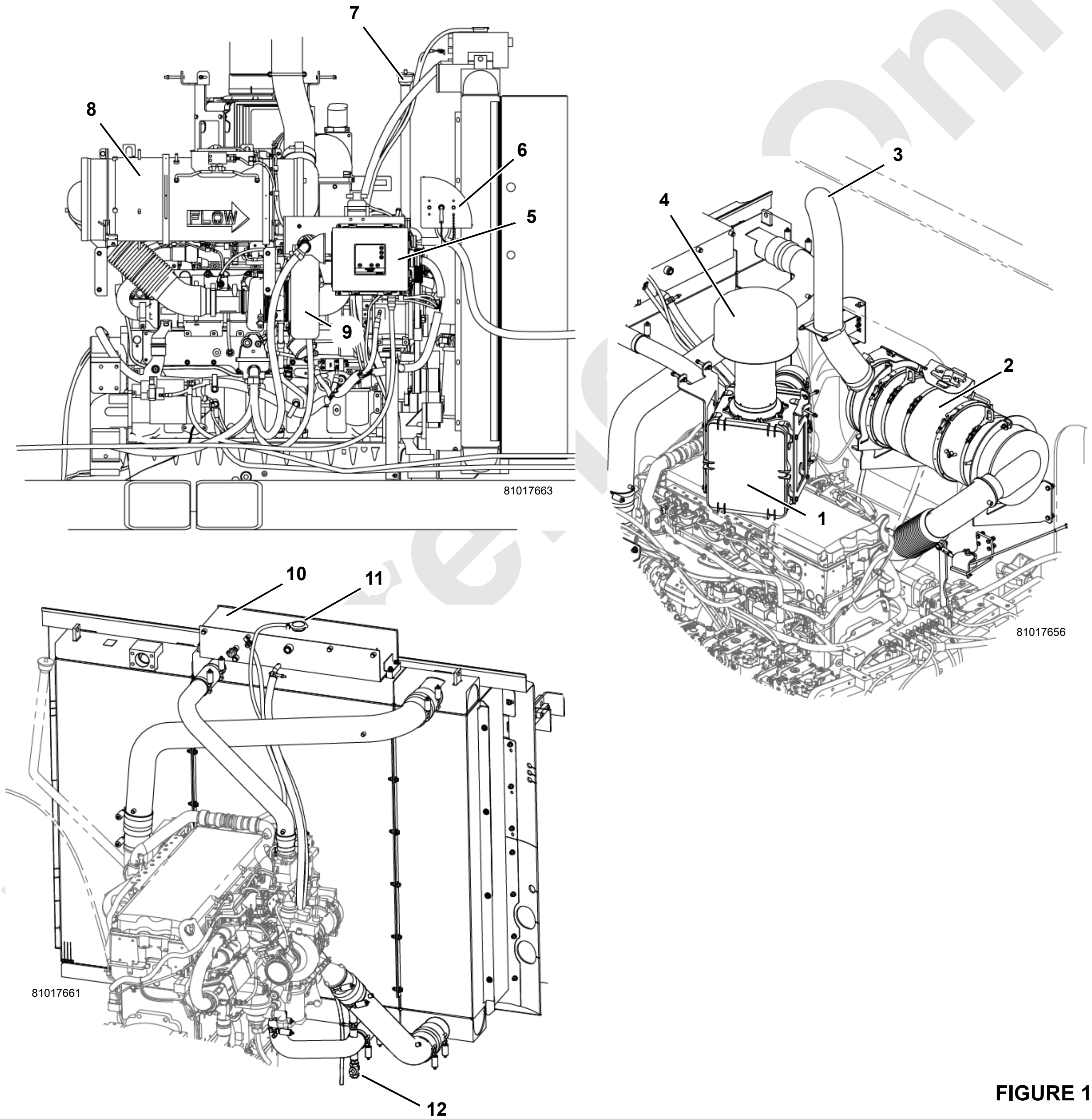
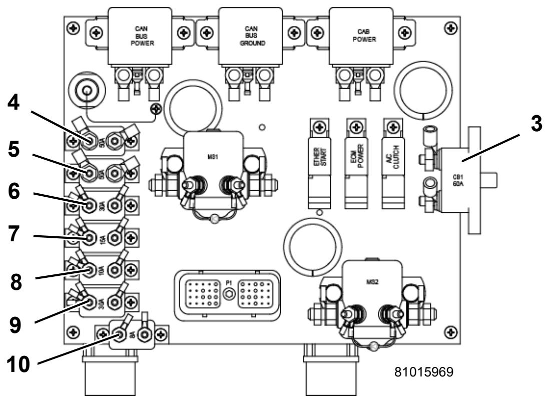
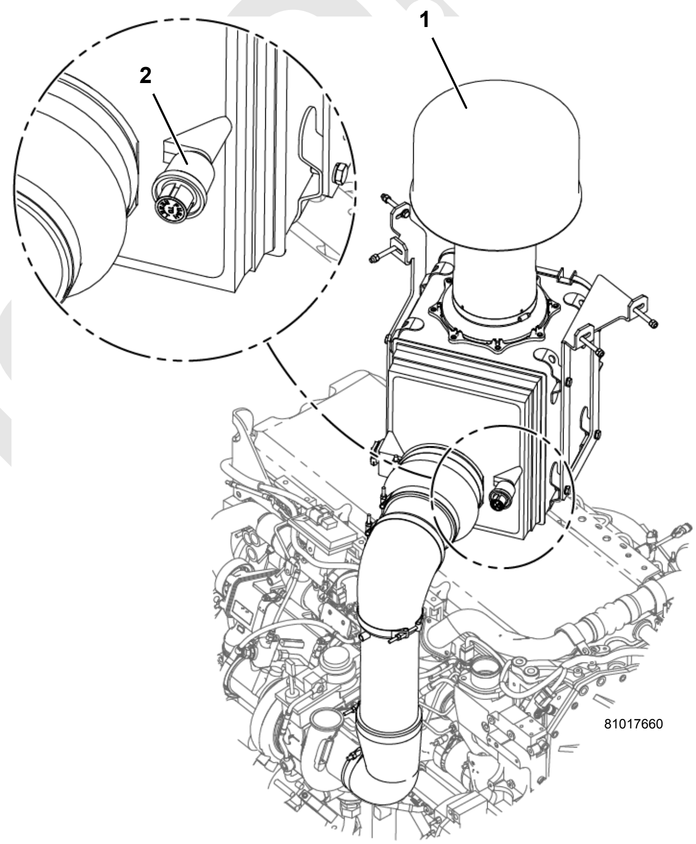



FIGURE 1-11

## Cummins Engine Tier 4 (Continued)

| Item | Description | Item | Description |
|---|---|---|---|
| 1 | Air Intake Pre-Cleaner | 8 | Circuit Breaker CB6 (Engine Start Solenoid) |
| 2 | Air Filter Indicator | 9 | Circuit Breaker CB7 (CAN System Power) |
| 3 | Circuit Breaker CB1 (main system power) | 10 | Circuit Breaker CB8 (Cab Power) |
| 4 | Circuit Breaker CB2 (Engine ECM) | 11 | Ether Bottle |
| 5 | Circuit Breaker CB3 (Engine ECM) | 12 | Fuel Filter, High Pressure |
| 6 | Circuit Breaker CB4 (Engine Bus Run/Stop) | 13 | Water In Fuel Filter, Low Pressure |
| 7 | Circuit Breaker CB5 (Engine Ether Start) | | |



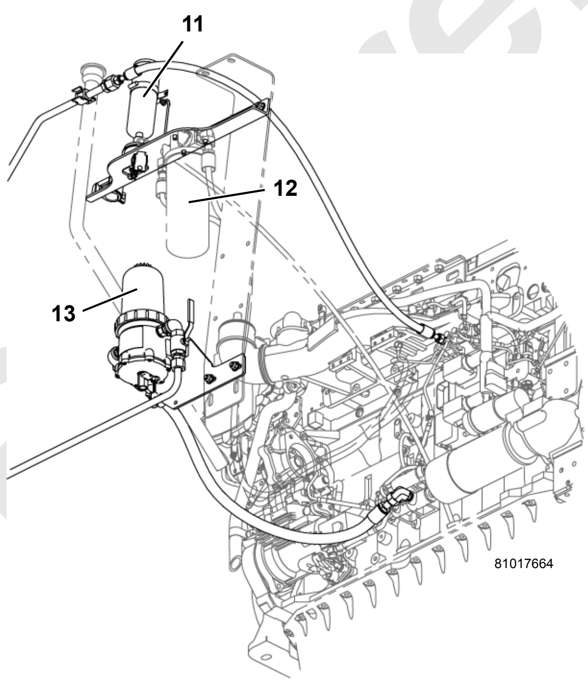




FIGURE 1-11 continued

### Boom Butt and Insert

| Item | Description | Item | Description |
|---|---|---|---|
| 1 | Node-8 Controller | 9 | Luffing Jib Hoist (Drum 6) |
| 2 | Main Hoist Motor (Drum 2) | 10 | Luffing Jib Hoist Motor (Drum 6) |
| 3 | Main Hoist (Drum 2) | 11 | Electrical Boom Cable |
| 4 | Wire Rope Sheave | 12 | Electrical Cable Reel |
| 5 | Boom Insert | 13 | Hydraulic Manifold Block |
| 6 | Boom Insert Accumulator | 14 | Boom Butt Accumulator |
| 7 | Main Hoist Motor (Drum 1) | 15 | Boom Angle Indicator |
| 8 | Main Hoist (Drum 1) | | |

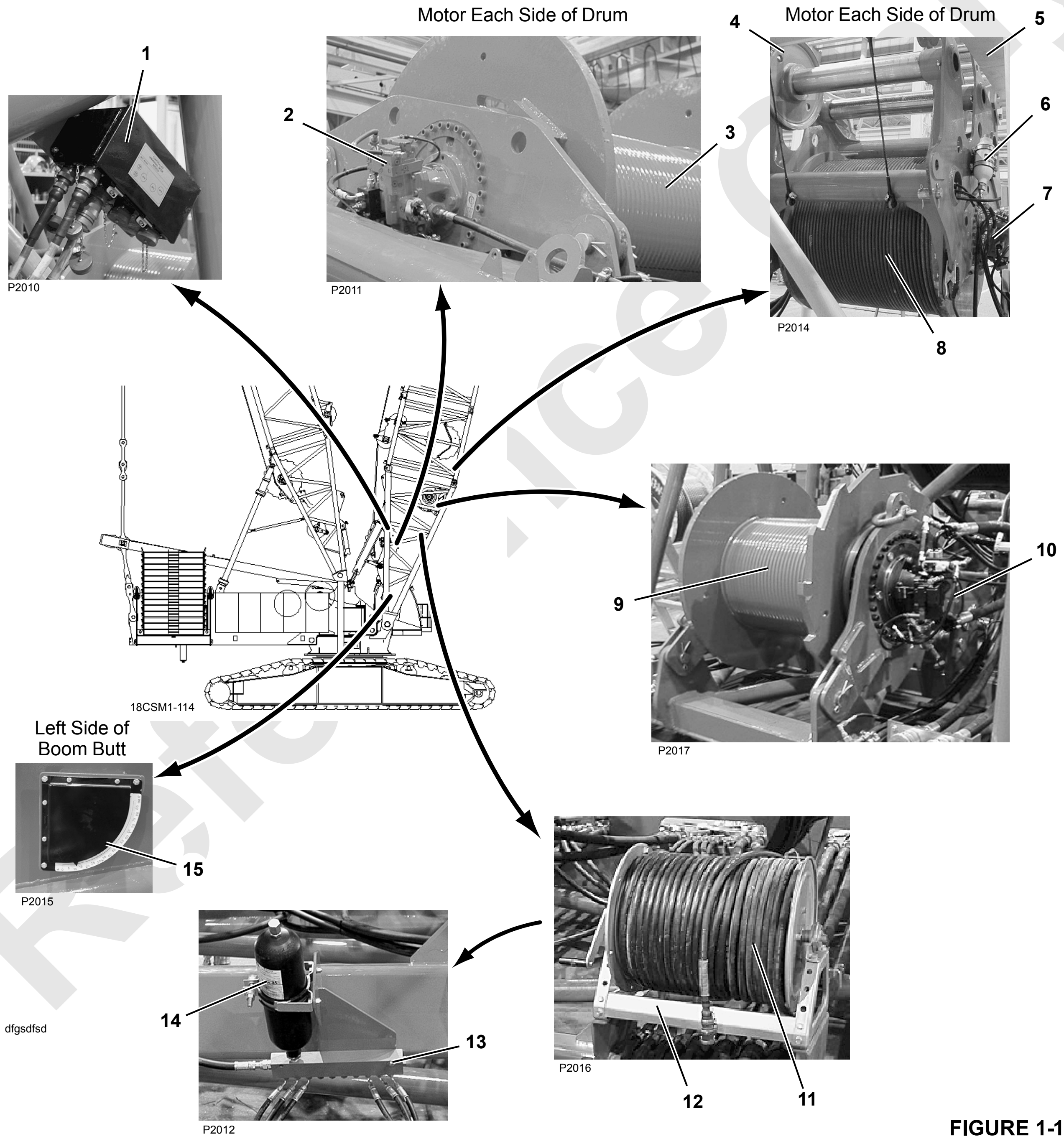



FIGURE 1-12

## Mast Butt

| Item | Description |
|---|---|
| 1 | Mast Butt Accumulator |
| 2 | Boom Hoist (Drum 4) |
| 3 | Motor Control |
| 4 | Boom Hoist Motor (Drum 4) |
| 5 | Boom Hoist Brake (Inside Gearbox) |
| 6 | Motor Speed Sensor |
| 7 | Loop Flushing Valve |
| 8 | Pawl Electrical Junction Box |
| 9 | Boom Hoist Pawl |

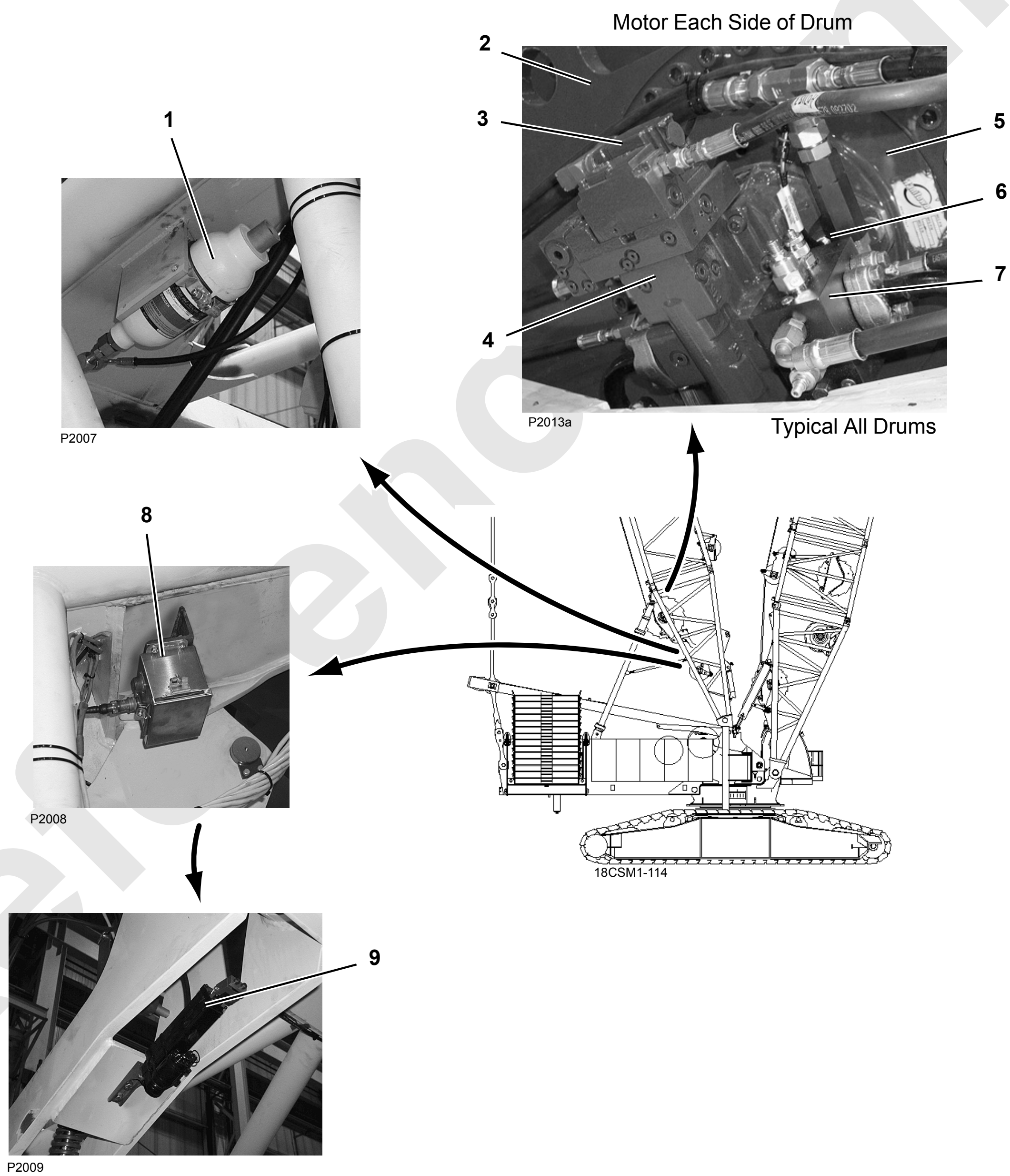



FIGURE 1-13

# DESCRIPTION OF OPERATION

## General Abbreviations

| | |
|---|---|
| A | Amber Light |
| ACR | Air Conditioning Relay |
| AH | Auxiliary Hoist |
| AL | Auto Lube Pump |
| ALT | Alternator |
| AUX | Auxiliary |
| BH | Boom Hoist |
| CAN | Controller Area Network |
| DPF | Diesel Particulate Filter |
| EDC | Electrical Displacement Control (Pump) |
| EFC | Electronic Fuel Control |
| EPIC | Electrical Processed Independent Control |
| ER | Ether Relay |
| ES | Ether Start |
| FS | Fuel Solenoid |
| FSR | Fuel Solenoid Relay |
| G | Green Light |
| GND | Ground (Electrical) |
| HDC | Hydraulic Displacement Control |
| HS | Hydraulic Solenoid |
| LD | Load Drum |
| LH | Luffing Hoist |
| LJ | Luffing Jib |
| LT | Left Travel |
| M/C | Motor Control |
| MS1 & 2 | Start Solenoid Relay |
| PC | Programmable Controller |
| P/C | Pump Control |
| PCOR | Pressure Compensated Over-Ride |
| PCP | Pressure Control Pilot (Motor) |
| PCR | Pressure Compensated Regulator |
| PCV | Pressure Control Valve |
| PM | Pawl Motor |
| PWR | Power (Electrical) |
| R | Red Light |
| RT | Right Travel |
| S | Swing |
| SOL | Solenoid |
| SS | Starter Solenoid |
| VDC | Volts Direct Current |
| W | White Light |

## Solenoid Valve Identification

| | |
|---|---|
| HS-1 | Swing Brake |
| HS-2 | Swing Lock In |
| HS-3 | Swing Lock Out |
| HS-4 | Travel Brake |
| HS-5 | Travel Two-speed |
| HS-6 | Boom Hoist (Drum 4) Brake |
| HS-7 | Main Hoist 1 (Drum 1) Brake |
| HS-8 | Whip Line Hoist (Drum 3) Brake |
| HS-9 | Whip Line Hoist (Drum 3) Diverting |
| HS-10 | Main Hoist 2 (Drum 2) Brake |
| HS-11 | Mast Hoist (Drum 5) Brake |
| HS-12 | Mast Hoist (Drum 5) Pawl Out |
| HS-13 | Mast Hoist (Drum 5) Pawl In |
| HS-14 | Mast Hoist (Drum 5) Diverting |
| HS-15 | Luffing Jib (Drum 6) Brake |
| HS-16 | Accessory System Proportional |
| HS-17 | Right Front Jack Extend |
| HS-18 | Right Front Jack Retract |
| HS-19 | Left Front Jack Extend |
| HS-20 | Left Front Jack Retract |
| HS-21 | Right Rear Jack Extend |
| HS-22 | Right Rear Jack Retract |
| HS-23 | Left Rear Jack Extend |
| HS-24 | Left Rear Jack Retract |
| HS-25 | Boom Pins Engage |
| HS-26 | Boom Pins Disengage |
| HS-27 | Rear Adapter Frame Pins Engage |
| HS-28 | Rear Adapter Frame Pins Disengage |
| HS-29 | Front Adapter Frame Pins Engage |
| HS-30 | Front Adapter Frame Pins Disengage |
| HS-31 | Mast Pins Engage |
| HS-32 | Mast Pins Disengage |
| HS-33 | Mast Cylinders Raise |
| HS-34 | Mast Cylinders Lower |
| HS-35 | Rigging Winch (Drum 7) Pay Out |
| HS-36 | Rigging Winch (Drum 7) Haul In |
| HS-37 | Cab Tilt Up |
| HS-38 | Cab Tilt Down |
| HS-39 | Hydraulic Pumps Warm-up |

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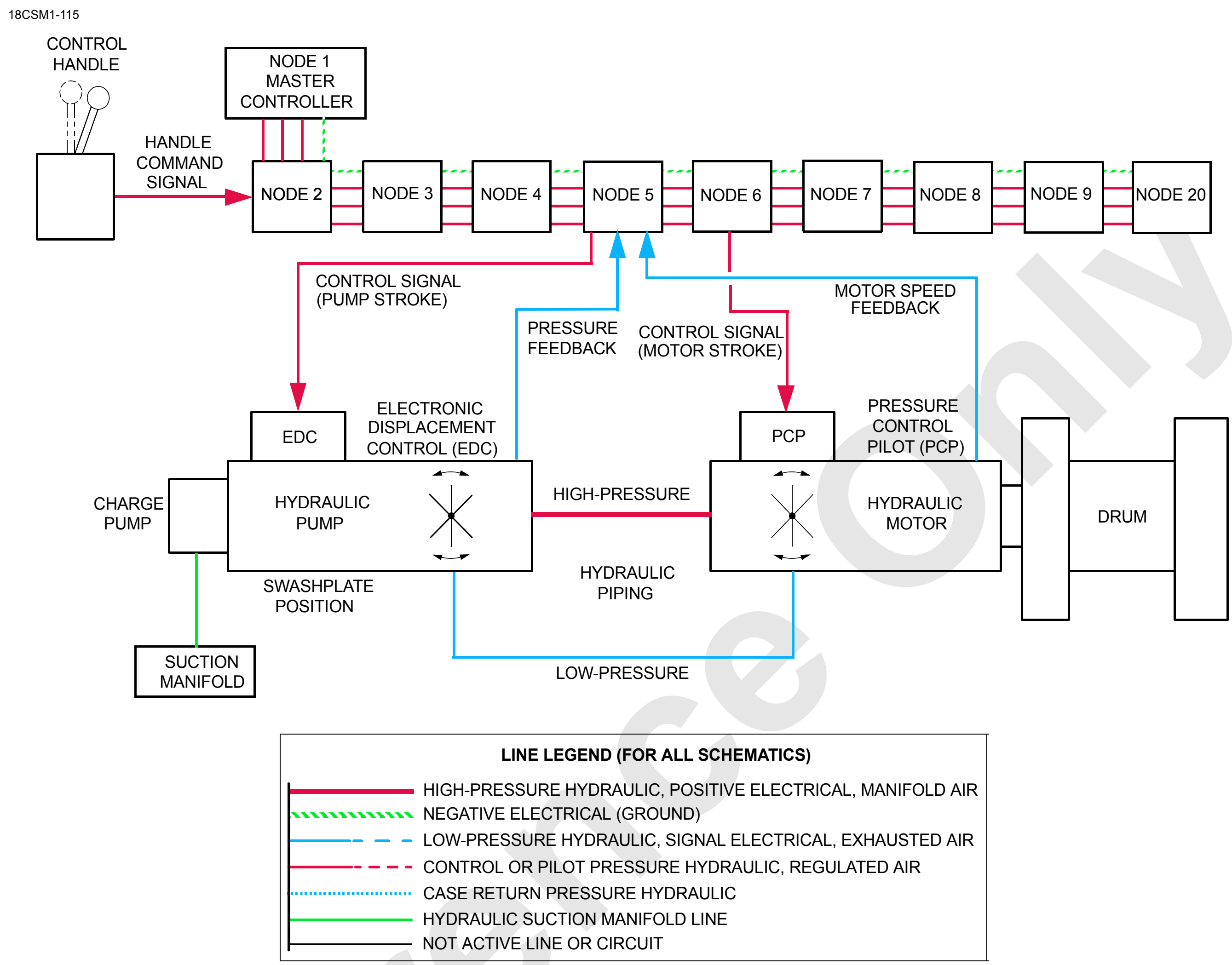



**FIGURE 1-14**

## GENERAL OPERATION

See Figure 1-14 for the following procedure.

This Service/Maintenance manual describes the standard and optional equipment available for the crane. Disregard any equipment your crane does not have. The 18000 MAX-ER™ attachment is not covered in this manual.

The Model 18000 operating system is an EPIC® (Electrical Processed Independent Control) with Can-Bus 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 digital display in operator's cab.

A single diesel engine provides power to operate system pumps through a pump drive transmission. In a closed-loop hydraulic system, high-pressure hydraulic fluid from the system pump drives a hydraulic motor. Pressure develops within the closed-loop system while resistance to movement of the load on motor is overcome. When movement begins, pump volume displacement maintains motor speed. The spent hydraulic fluid from motor outlet returns directly to pump input. The crane closed loop systems are swing, right travel, left travel, boom hoist, load drums 1 and 2, and luffing jib hoist. The whip line hoist (Drum 3) and mast hoist (Drum 5) can be operated through diversion valves from main hoist drums 1 or 2.

In this Service/Maintenance manual, "enabled" means hydraulic fluid can flow in the system. Each hydraulic solenoid valve is assigned an HS number for training identification only.

## Hydraulic Components

High-pressure piston pumps driven by a multi-pump drive transmission provide independent closed-loop hydraulic power for crane functions. Each system has relief valves to protect for overload or shock. Each hydraulic system operation is explained in different sections of this manual.

### *Hydraulic Tank*

Hydraulic tank has a breather, suction filter, return filter, sight gauge, temperature gauge, temperature sensor, and level sensor. Hydraulic tank has two sections: a suction section and a return section.

The suction section has two mesh strainers that allow fluid bypass around strainer at 3 psi (0,21 bar) if they become plugged. The breather protects the tank from excessive pressures (opens at 3 psi [0,21bar]) or vacuum (opens at 1.5 in HG [38 mm HG]).

The return section has three (current production), two (past production) media filters that allow fluid bypass around filter at 25 psi (1,7 bar) if they become plugged. A diffuser inside tank return line reduces turbulence created by fluid returning to tank.

Digital display 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.

**NOTE:** See Lubrication Guide in Section 9 of this manual, for recommended replacement of hydraulic fluid.

### *Shutoff Valves*

Two manual shutoff valves are located between the hydraulic tank and suction manifold. Close shutoff valves when performing maintenance on hydraulic systems. Open shutoff valves before starting engine.

### *Charge Filters (Past Production)*

Accessory pumps supply hydraulic fluid through charge filters to high pressure accessory manifold. Charge filter elements must be replaced when system fault alerts are enabled and digital display indicates that charge filters need to be serviced.

### *Suction Manifolds*

Suction manifolds supply hydraulic fluid to all system pumps. Each hydraulic system draws hydraulic fluid from a suction manifold as needed.

### *Return Manifolds*

Return fluid from closed-loop relief valves, brake valves, motor servos, cylinders, pump case drain, and motor case drain is routed to main return manifold or cooler return manifolds before returning to hydraulic tank. The final cooler return manifold has a 20 psi (1,4 bar) bypass that allows fluid to bypass cooler if it becomes plugged.

### *Hydraulic Fluid Cooler*

If hydraulic fluid temperature is above 140°F (60°C), a valve opens to cooler to allow return hydraulic fluid through cooler before returning to tank. If hydraulic fluid temperature is below 140°F (60°C), cooler valve closes to allow return hydraulic fluid flow directly to tank.

### *Supercharge Pumps (Past Production)*

*See Sauer-Sundstrand Series 90 Service Manual for a description of a hydraulic piston pump.*

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

The supercharge accessory pump is a fixed displacement gear pump that draws hydraulic fluid from tank suction manifold and supplies hydraulic fluid to accessory system and high pressure accessory system.

### *Accessory Pumps (Current Production)*

The two accessory pumps are fixed displacement gear pumps that draw hydraulic fluid from tank suction manifold and supply high pressure hydraulic fluid to the high pressure accessory manifold. One pump is mounted on the left forward side engine and one is mounted on the right forward side pump drive.

### *Hydraulic Pumps*

*See Sauer-Sundstrand Series 90 Service Manual for a description of a hydraulic piston pump.*

All main pumps are variable displacement, axial piston pumps that operate in a bi-directional closed-loop system. Main host 1 (Drum 1), main host 2 (Drum 2), boom hoist (Drum 4), and swing systems have two hydraulic pumps. Travel system has a separate pump for each crawler.

Each pump contains:

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

Each system pump has a gerotor type gear charge pump that is internally mounted on the end of each pump system driveshaft. System charge pump draws fluid directly from the tank suction 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 zero to 24 volt output to pump EDC as required for handle command direction. Pump EDC tilts swashplate to stroke pump in the command direction. Pump pistons move within cylinder block as the block rotates. The longer stroke of each piston draws in return fluid from system motor. As the stroke shortens, hydraulic fluid is pushed out of pump piston cylinders into hydraulic piping to the motor. Pressurized hydraulic fluid from the pump turns the motor in the command direction.

Hydraulic fluid displaced by motor returns through piping to inlet side of system pump. Swashplate tilt angle determines volume of fluid that can be pumped to the motor. Increasing swashplate tilt angle increases piston stroke length, allowing more fluid to be pumped to the motor. Motor servos in drum and travel systems allow low and high speed operation. Hoist and swing system that have two pumps driving two motors have a pressure equalizing lines between pump legs A and B.

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. Maximum pressure setting of multifunction valves for each pump is listed in Table 1-1. Limits should not be reached unless there is a failure in the system.

**Table 1-1 Multifunction Valve Pressure Limit Settings**

| SYSTEM | FUNCTION | PRESSURE (BAR) |
|---|---|---|
| Load Drums (1, 2, and 3) | Hoist | 6,090 (420) |
| | Lower | 3,770 (260) |
| Boom Hoist (Drum 4) | Up | 6,090 (420) |
| | Down | 3,770 (260) |
| Mast Hoist (Drum 5) | Up | 6,090 (420) |
| | Down | 3,770 (260) |
| Luffing Jib Hoist (Drum 6) | Up | 6,090 (420) |
| | Down | 3,770 (260) |
| Swing | Left | 6,090 (420) |
| | Right | 6,090 (420) |
| Travel | Forward | 6,090 (420) |
| | Reverse | 6,090 (420) |
| Cooler Fan (Tier 4) | Port A | 3,330 (230) |
| | Port B | 3,330 (230) |

### *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 digital 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 when charge pressure drops to minimum pressure.

### *Hydraulic Motors*

*See Sauer-Sundstrand Series 90 Service Manual for a description of a hydraulic motor.*

Main hoist 1 (Drum 1), main hoist 2 (Drum 2), boom hoist (Drum 4), left crawler, and right crawler systems have two hydraulic motors.

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

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

Hydraulic fluid from pump enters 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 outlet side of motor and returns to inlet side of system pump through piping.

## Main Pressure Monitoring

Load drums, boom hoist, luffing jib, swing, and track screens display and monitor system pressure. The system pressure displayed on system screen is charge pressure or greater. System pressure can also be checked at each pressure sender diagnostic coupler with a 10,000 psi (689 bar) high pressure gauge, when pump is stroked.

## Accessory Systems

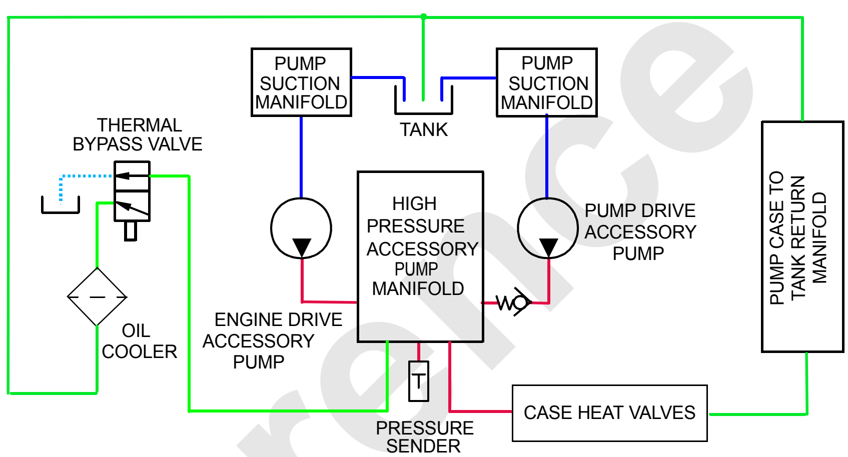
Crane Setup or Setup Remote mode must be selected and confirmed before the accessory system components can be enabled. The accessory pump (Current Production, Figure 1-15) supercharge pumps (Past Production, Figure 1-16) is the source of hydraulic pressure for the accessory system and high pressure accessory components.

The accessory system items that are electrically enabled with hand-held radio remote control include:

- Rotating bed jacking cylinders (four)
- Boom hinge pin cylinders
- Front and rear adapter frame pin cylinders
- Mast pins cylinders
- Mast raising cylinders
- Rigging winch (Drum 7)
- Engine speed

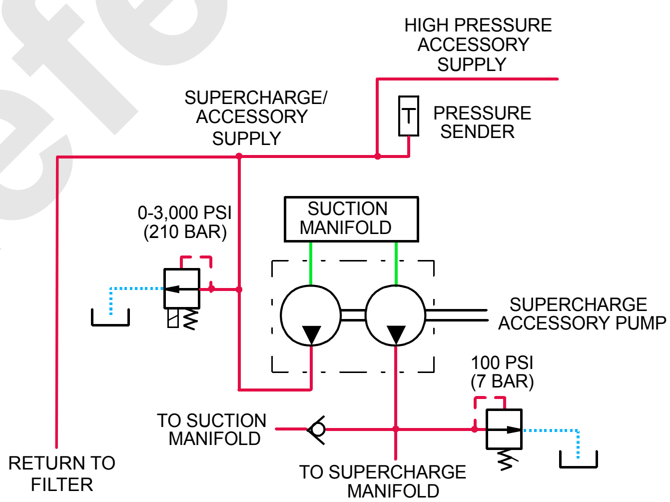
Each hydraulic solenoid valve of the accessory system is open circuit type where return fluid goes directly to tank. Accessory system and high pressure accessory pressure senders monitor each accessory system pressure.

Right and left crawler pin cylinders are enabled by spring centered hand levers at front of lowerworks.




**Current Production**

**FIGURE 1-15**




**Past Production**

**FIGURE 1-16**





Manitowoc

## Basic Operation

See Figure 1-17 or 1-18 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 component node controller sends a variable zero to 24 volt output that is divided by a resistor and applied to pump external EDC (Electrical Displacement Control). The output current magnetizes an armature (Figure 1-17) and starts to block one of the orifice ports, depending on command direction. Blockage of flow at exhaust side of right orifice port causes a pressure difference across spool. This pressure difference overcomes the resistance of spool spring and moves the spool proportionally to pressurize top servo pistons. The fluid from bottom servo pistons is routed to tank. This tilts the swashplate, stroking the pump in selected command direction. As swashplate tilts, chamber spring is pulled in the opposite direction of spool with linkage. This centers and maintains spool in a neutral position until the 16 psi (1 bar) chamber spring pressure is reached.

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

Hydraulic fluid pressure overcomes spring resistance in pressure limiting relief valve (1, Figure 1-18), 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-stroke pump to limit system pressure. When rapid loading produces pressure spikes, system relief valve (5) shifts. This allows high-pressure fluid to return to tank through charge pump relief valve (6). Alternatively, fluid transfers to low-pressure side of closed-loop system through charge flow make-up check valve (7).

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

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

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

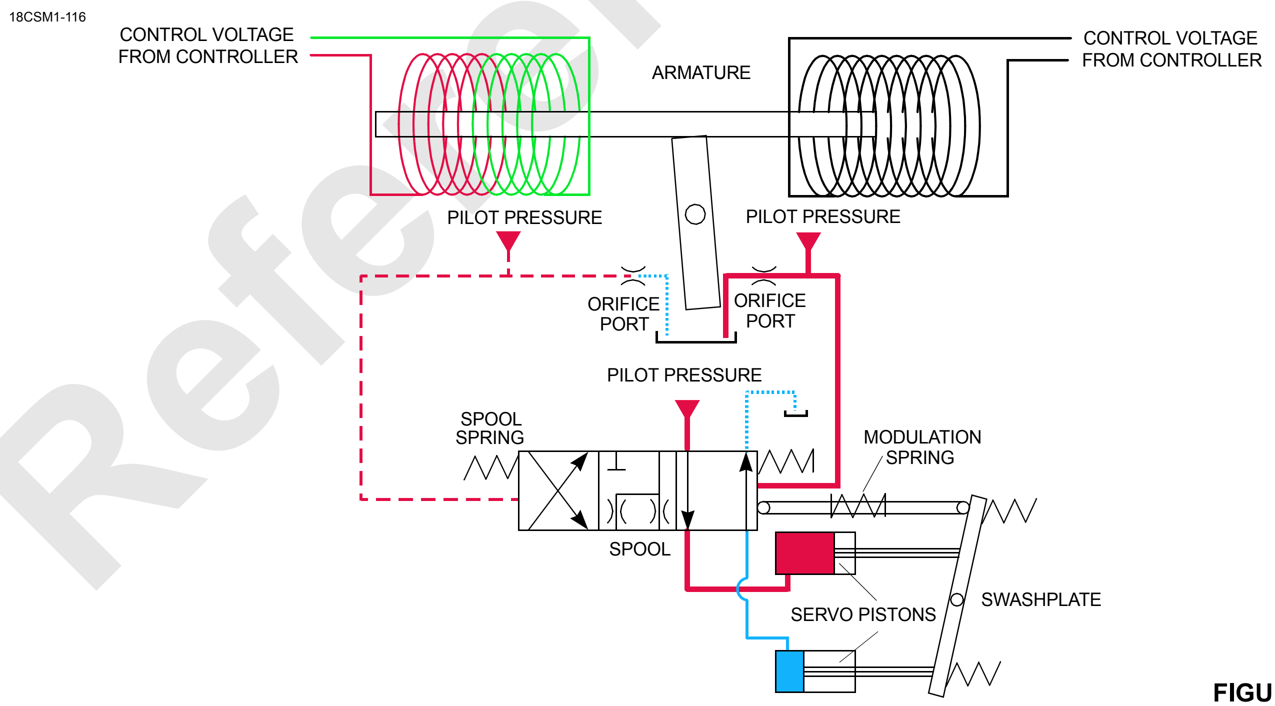



FIGURE 1-17

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

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

When PCOR valve closes, control of the motor returns to servo PC valve.

The travel motor servo is opposite of other system motors. The travel variable displacement motors begin operation at minimum displacement (low torque, high speed). The motor shifts to maximum displacement (high torque, low speed) when starting torque is required and back to minimum displacement when in motion if load is below a preset pressure of 3770 psi (270 bar). Depending on motor system, servo uses internally or externally supplied pressure to perform the shifting operation. Servo control fluid is supplied from high-pressure line of motor port “A” or “B” and 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 gallons per minute (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.

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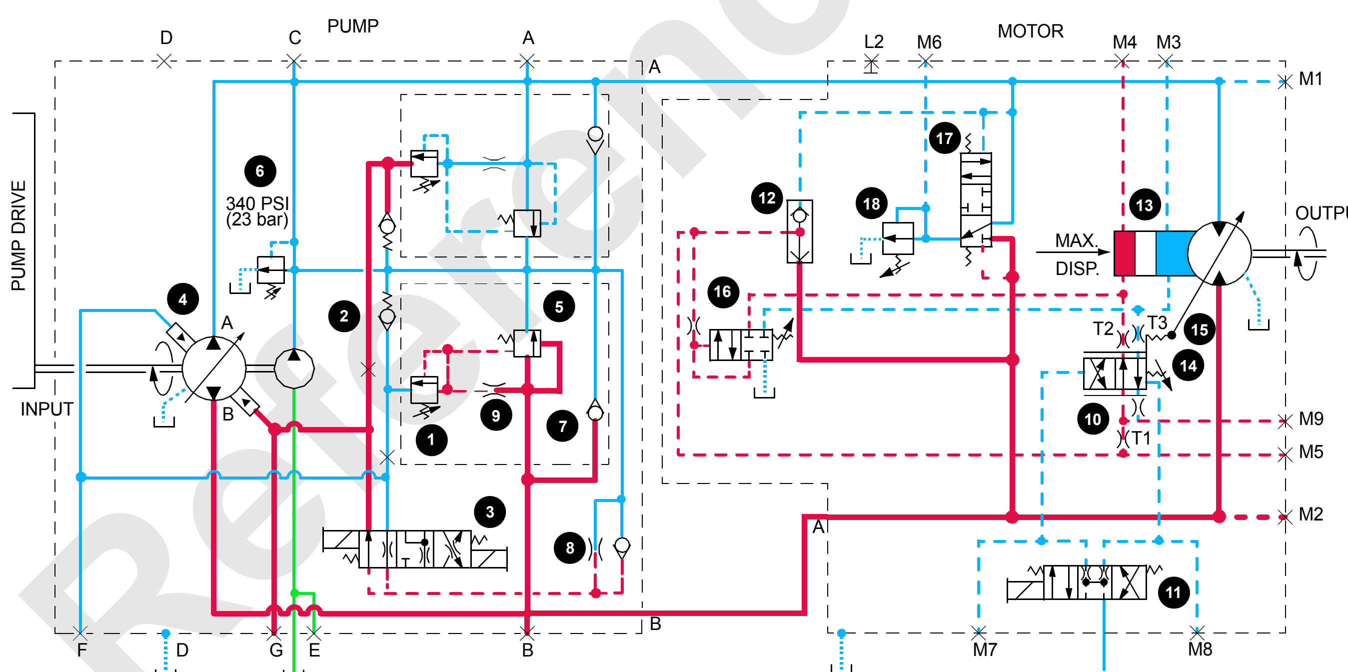



FIGURE 1-18

## Engine Controls

*See engine manufacturer’s manual for instructions.*

The engine is started and stopped with engine key switch.

Engine rpm is controlled with the hand throttle or foot throttle and is monitored with an AC magnetic sensor. Node-1 controller, engine node-0 controller, and engine control module controls and process engine information and display the information on digital display.

Crane systems speed depends on engine speed and control handle movement in either direction from neutral. Engine clutch lever for pump drive must be manually engaged for normal operation.

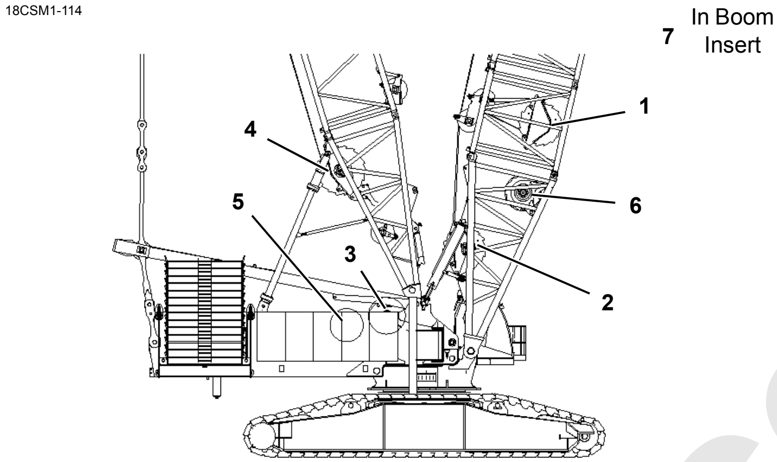
The engine stop push button stops the engine in an emergency only as all brakes apply and any functions stop abruptly.

Three engine diagnostic lights are mounted on front console, see Engine Diagnostics in Section 10 of the Service/ Maintenance Manual for diagnostic light information.

## Drum Identification

See Figure 1-19 for the following procedure.

Seven wire rope drum drives are on the Model 18000 crane. The location and nomenclature is shown in Figure 1-19.




| Item | Description |
|---|---|
| 1 | Main Hoist 1 |
| 2 | Main Hoist 2 |
| 3 | Whip Line Hoist |
| 4 | Boom Hoist |
| 5 | Mast Hoist |
| 6 | Luffing Jib Hoist |
| 7 | Rigging Winch |

FIGURE 1-19

# EPIC® CONTROL SYSTEM

## CAN-Bus

See Figure 1-20 for the following procedure.

The Model 18000 crane's boom, load lines, swing, crawler tracks, and accessory components are controlled electronically with the EPIC (Electrical Processed Independent Control) with Can-Bus technology. The 24 volt can-bus system uses remote 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. Node-1 controller compares these input data packet signals with programming directives and data information. Node-1 controller then provides appropriate output commands to other remote nodes.

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 that are in a pulse train. Digital input/output voltages are 24 volt nominal voltages that are either 0 = ***off*** or 1 = ***on***.

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. See Crane Diagnostics in Section 10 of the Service/Maintenance Manual.

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

The system nodes controllers are listed below:

Node-0 – Engine
Node-1 – Master (Front Console)
Node-2 – Handles and Controls
Node-3 – Drum 3, Travel, and Pressure Senders
Node-4 – Accessory Components and Mast
Node-5 – Alarms, Limits, Boom, and Pump Controls
Node-6 – Drums 2, 4, 5, and Adapter Frame Pins
Node-7 – Swing and Auto Lube
Node-8 – Drum 1 and Drum 6
Node-9 – MAX-ER (Optional)
Boom Node-20 – Boom

## Digital Display

See Figure 1-20 for the following procedure.

The digital display on front console shows operating conditions, operating limits, and system faults monitored by node controllers. Access information by scrolling to the desired screen with scroll switch. System messages are shown in Tables in Digital Display Readings in Section 10 of the Service/Maintenance Manual.

## Rated Capacity Indicator/Limiter (RCL)

The RCL system is part of the EPIC can bus system. Load charts are specific for each crane model. For complete information see Rated Capacity Indicator/Limiter manual.

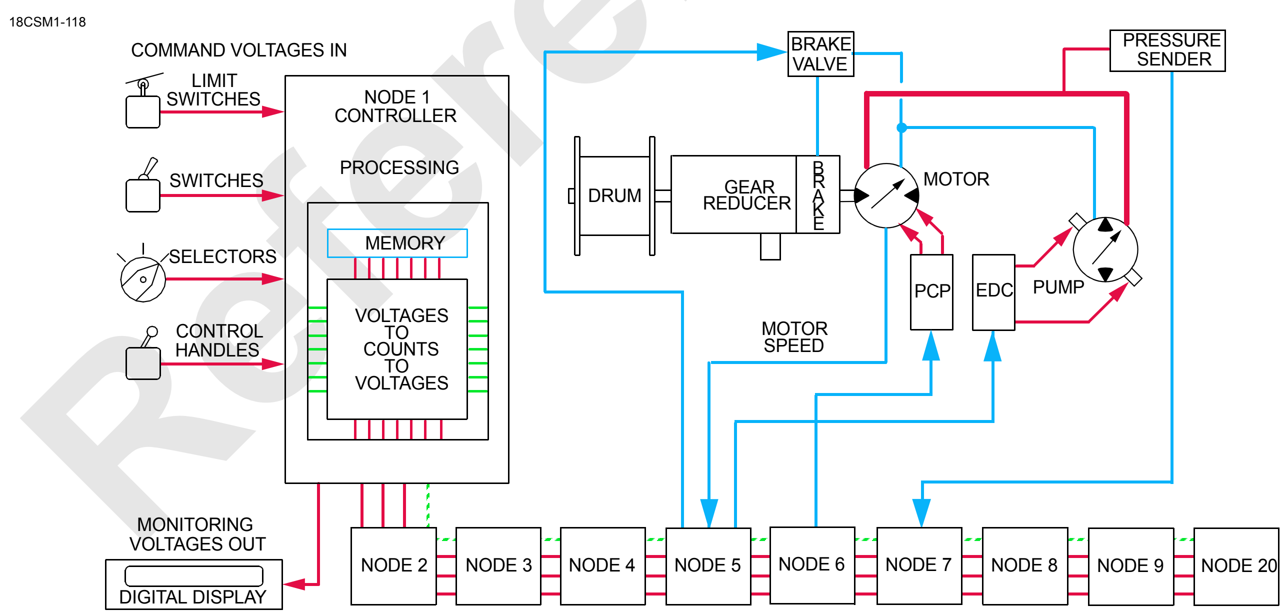



**FIGURE 1-20**

## Crane Modes

Standard mode is for all normal load-handling operations.

In Setup mode, the program allows limited operation of whip line hoist, boom hoist, mast hoist, swing and travel.

In Setup Remote mode, program allows operation of items on hand-held radio remote control.

In Luffing Jib mode, the program allows standard mode load handling operations plus luffing jib operation.

In Tandem Drum mode, the program allows operation main hoist 1 and 2 in tandem and other normal load-handling operations.

In MAX-ER mode, the program allows operation of crane and MAX-ER attachment as one system.

## Electrical Power to Operator's Cab

See Figure 1-21 for the following procedure.

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

- Engine control module relay (CU ECM)
- Engine ether start relay (CU ES)
- Cab power relay (CAB PWR)
- CAN system ground relay (CAN GND)
- Air conditioning system relay (A/C CLUTCH)
- Engine starter solenoid relays (MS1/MS2)
- CAN system power relay (CAN PWR)

When cab power relay is enabled, power is available to operate crane controls (see Electrical Schematics in this manual).

## Pressure Senders and Speed Sensors

Pressure senders monitor drum system pressures, right/left travel system pressure, swing right/left system pressure, swing brake pressure (cranes without swing lock), accessory system pressure, variable speed hydraulic cooler fan (tier 4 equipped), and high pressure accessory system pressure. Each node controller receives input hydraulic pressure information from each system pressure sender. Pressure senders provide information on the required load holding pressure for load drums, boom hoist drum, or luffing hoist drum.

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

## System Faults

See Figure 1-21 for the following procedure.

Node-1 controller monitors and enables a red system fault light and buzzer if any system fault is detected. Crane fault/ limits screen displays the faults and automatically scrolls through faults, stopping for three seconds at each fault. When fault is corrected, the display clears the fault from the screen after scrolling through fault screen twice. When a system fault is enabled, one or more message is displayed. See Digital Display Readings in Section 10 of this manual.

## Engine Faults (Tier 4)

See Section 7 for Tier 4 engine diagnostics and DPF related faults.

## Operating Faults and Limit Switches

See Figure 1-21 for the following procedure.

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

Node-1 controller monitors crane systems and enables a yellow operating limit light and alert if any limit switch is open or any programmed limit is reached. To identify and display operating limit, use scroll switch to access fault screen. When an operating limit is enabled, one or more messages are displayed. See Digital Display Readings in Section 10 of the Service/Maintenance Manual.

## Brake and Drum Pawl Operation

All load drums, boom hoist, travel, and swing park brakes are spring-applied and hydraulically released. Boom hoist (Drum 4), mast hoist (Drum 5), and luffing jib (Drum 6) 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.

The swing node-controller releases swing brake and swing lock when swing brake switch is placed in off - park position.

Travel node-controller releases brake with control handle movement.

With a drum up or down control handle command, an input voltage is sent to node-1 controller. Node-1 controller does not release drum brake until pressure memory holding pressure is reached to hold the load, as determined by pressure sender.

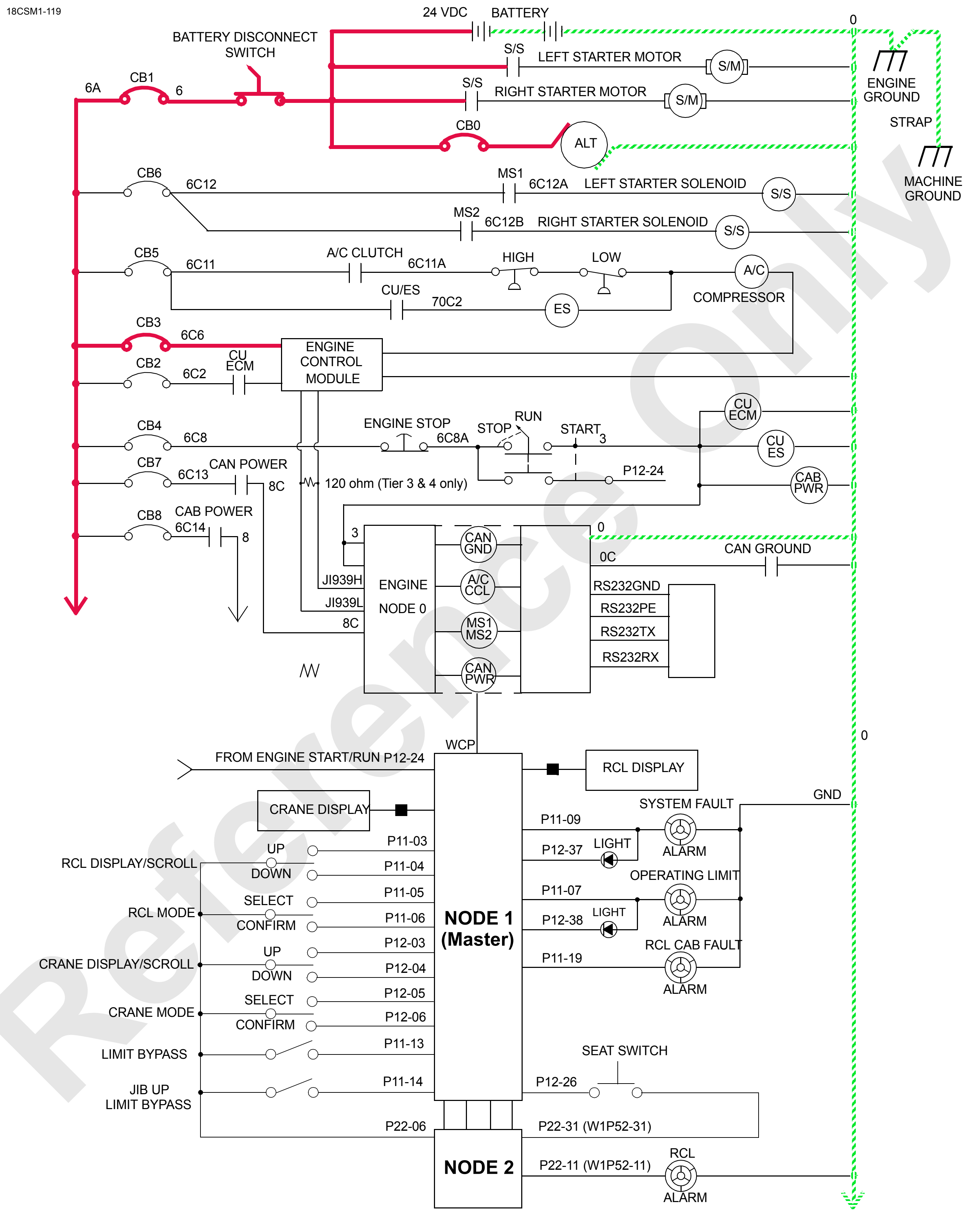

18CSM1-119
24 VDC
BATTERY
0
BATTERY DISCONNECT SWITCH
S/S
LEFT STARTER MOTOR
S/M
ENGINE GROUND
6A
CB1
6
S/S
RIGHT STARTER MOTOR
S/M
STRAP
CB0
ALT
MACHINE GROUND
CB6
6C12
MS1
6C12A
LEFT STARTER SOLENOID
S/S
MS2
6C12B
RIGHT STARTER SOLENOID
S/S
CB5
6C11
A/C CLUTCH
6C11A
HIGH
LOW
A/C
COMPRESSOR
CU/ES
70C2
ES
CB3
6C6
ENGINE CONTROL MODULE
CB2
6C2
CU ECM
CB4
6C8
ENGINE STOP
6C8A
STOP
RUN
START
3
CU ECM
CU ES
CB7
6C13
CAN POWER
8C
120 ohm (Tier 3 & 4 only)
P12-24
CAB PWR
CB8
CAB POWER
6C14
8
3
CAN GND
0
0C
CAN GROUND
JI939H
ENGINE NODE 0
A/C CCL
RS232GND
RS232PE
JI939L
MS1 MS2
RS232TX
8C
RS232RX
CAN PWR
0
WCP
FROM ENGINE START/RUN P12-24
RCL DISPLAY
CRANE DISPLAY
GND
SYSTEM FAULT
P11-09
ALARM
LIGHT
P12-37
P11-03
UP
RCL DISPLAY/SCROLL
P11-04
DOWN
OPERATING LIMIT
SELECT
P11-05
P11-07
RCL MODE
P11-06
NODE 1 (Master)
LIGHT
CONFIRM
P12-38
ALARM
UP
P12-03
RCL CAB FAULT
CRANE DISPLAY/SCROLL
P11-19
DOWN
P12-04
ALARM
SELECT
P12-05
CRANE MODE
P12-06
CONFIRM
P11-13
LIMIT BYPASS
SEAT SWITCH
JIB UP LIMIT BYPASS
P11-14
P12-26
P22-06
P22-31 (W1P52-31)
RCL
NODE 2
P22-11 (W1P52-11)
ALARM

FIGURE 1-21

# SWING SYSTEM OPERATION

**NOTE:** All reference to swing lock is past production. Current production cranes do not have a swing lock installed.

## Swing System Components

See Figures 1-22 and 1-23 for the following procedure.

One hydraulic swing pump drives two swing motors (optional swing drive has two swing pumps and four swing motors). There are equalizing lines between legs A and legs B when two pumps drive two motors. Both swing systems are controlled with swing control handle movement and node controllers. Swing control handle is inoperable when swing brake is applied or the swing lock is engaged. Each motor driven swing gearbox drives a tooth gear that is meshed with lowerworks turntable bearing to swing the upperworks.

Swing motors are controlled directly by the output fluid volume of the swing pump. Node controllers do not control the fixed displacement swing motors. Swing pressure senders monitor the pressure on swing left and swing right sides of swing closed loop system. Swing brake pressure is monitored by a pressure sender through Node-7 on current production cranes without swing lock. While in MAX-ER mode, travel will be disabled if the swing brake is applied.

The upperworks is free to coast if swing control handle is in neutral position, swing brake is released, and swing lock is disengaged.

Swing speed and swing torque can be selected for type of work being performed by referring to “Speeds” screen in Crane Diagnostics in Section 10 of the Service/Maintenance Manual.

Continuous changing of closed-loop fluid occurs through leakage in pumps and motors.

When swing control handle is moved from off, node-5 controller sends a 24 volt signal to enable swing/travel alarm. When swing control handle is moved to off, node-5 controller sends a 0 volt signal to disable swing/travel alarm.

## Swing Brake and Swing Lock

**NOTE:** To verify if the crane does not have a swing lock installed, scroll to the swing brake diagnostic screen on the crane display. The swing brake pressure bank will be present only on cranes without a swing lock.

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

The source hydraulic pressure for releasing the swing brakes and swing locks is from high pressure accessory pump system through a pressure reducing shuttle valve at 500 psi (34 bar). For swing brake and swing lock operation the system pressure must be above 200-psi (14 bar) for full release brake and lock. If system pressure is below 200-psi (14 bar), swing brake or swing lock could be partially applied and damage the swing system. If brake pressure or electrical power is lost when operating, the swing brake is applied.

After startup, place swing brake switch in off - park position. An input voltage is sent to node-1 controller. Node-7 controller sends a 24 volt output to enable swing brake solenoid valve HS-32 and swing lock out solenoid valve HS-33.

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

Before shutdown, place swing brake switch in on - park position. An input voltage is sent to node-1 controller. Node-7 controller sends a zero output voltage to disable swing brake solenoid valve HS-32 and enable swing lock in solenoid valve HS-34.

Swing brake solenoid valve shifts to block fluid to brake and swing brake is applied. Fluid from brake flows to tank. Swing lock in solenoid valve HS-34 shifts to block tank port and supplies hydraulic system pressure to piston end of cylinders to hydraulically engage mechanical locking pins into shaft locking flange. Fluid from rod end of cylinders 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-5 controllers send a variable zero to 24 volt output that is divided by a resistor and applied to swing pump(s) EDC. Pump EDC tilts swashplate relative to control handle movement. Fluid flows from pump ports to motor ports (see Figure 1-23), rotating upperworks to the left. An orifice, across swing motor ports A and B allow smoother fluid flow when shifting swing directions.

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-5 controllers send a variable zero to 24 volt output that is divided by a resistor and applied to swing pump(s) EDC. Pump EDC tilts swashplate relative to control handle movement. Fluid flows from pump ports to motor ports (see Figure 1-22), rotating upperworks 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-5 controllers send a zero output voltage to adjust swashplate to centered position.

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

## Swing Holding Brake Switch

Swing holding brake switch on side of swing control handle, holds upperworks 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-7 controller sends a zero output voltage to shift swing brake solenoid HS-32. Swing brake solenoid 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-7 controller sends a 24 volt output to shift swing brake solenoid HS-32. Swing brake solenoid valve shifts, allowing system pressure to hydraulically release park brake.

18CSM1-120

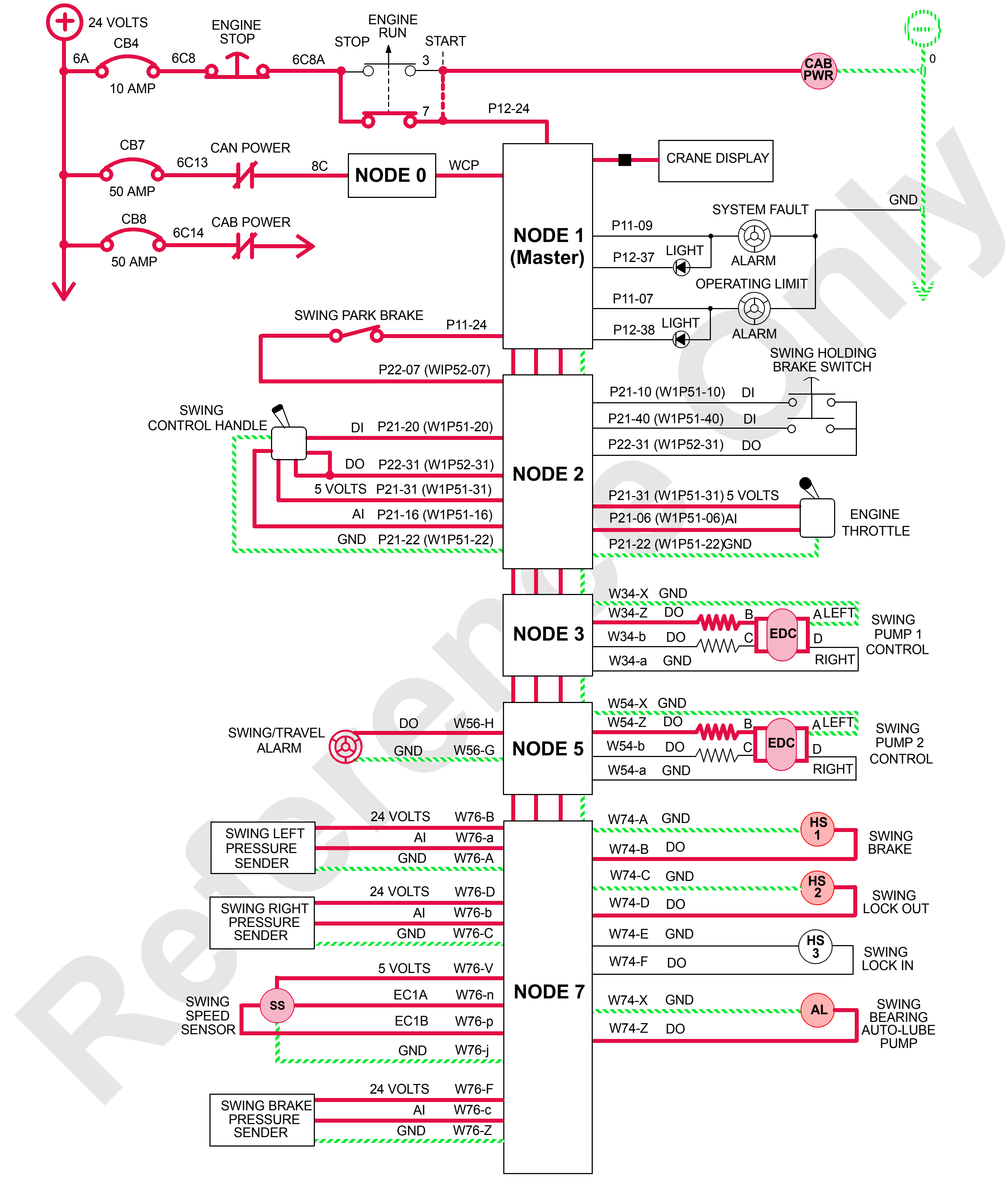



FIGURE 1-22

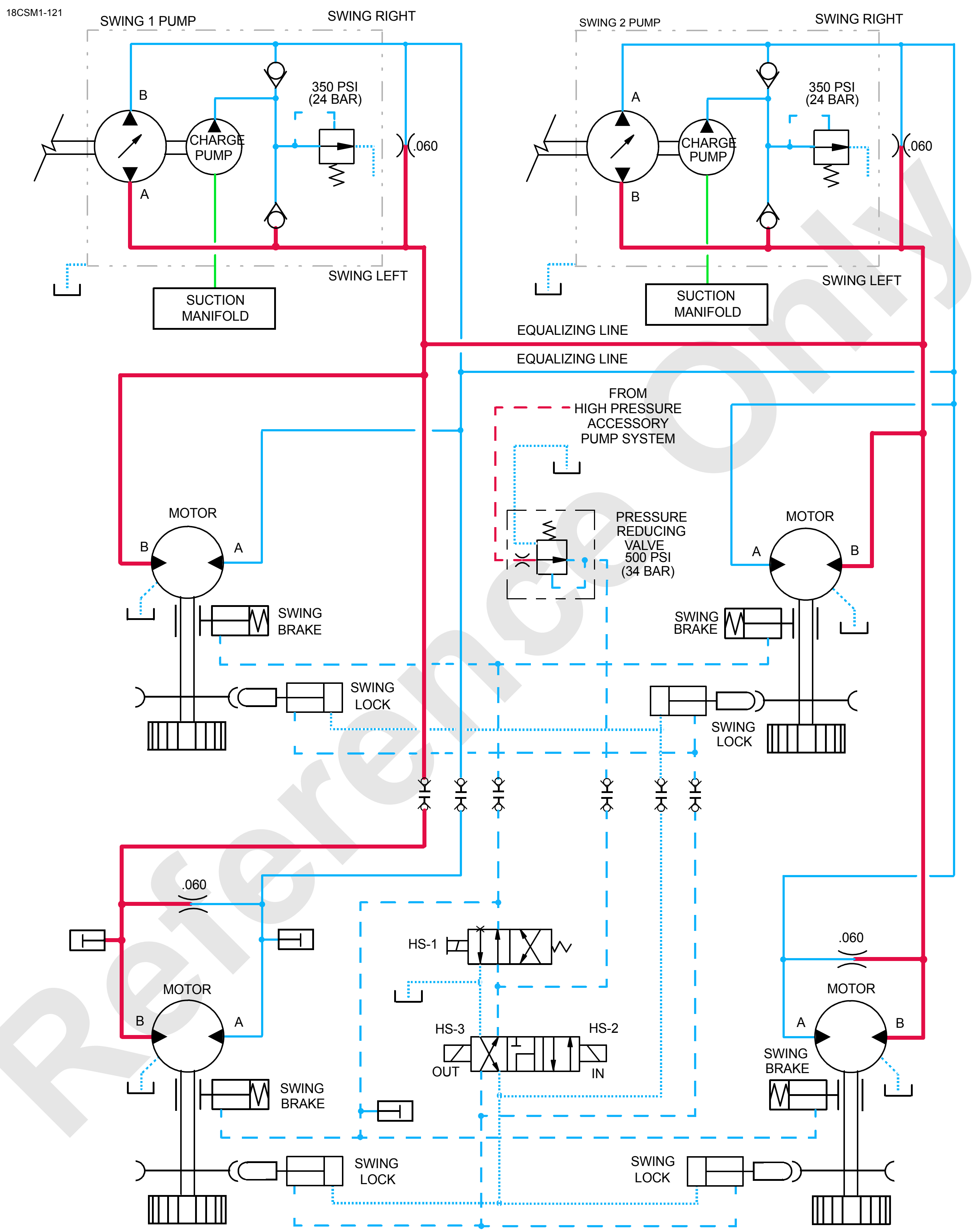

18CSM1-121
SWING 1 PUMP
SWING RIGHT
B
350 PSI
(24 BAR)
CHARGE
PUMP
A
.060
SWING LEFT
SUCTION
MANIFOLD
SWING 2 PUMP
SWING RIGHT
A
350 PSI
(24 BAR)
CHARGE
PUMP
B
.060
SWING LEFT
SUCTION
MANIFOLD
EQUALIZING LINE
EQUALIZING LINE
FROM
HIGH PRESSURE
ACCESSORY
PUMP SYSTEM
PRESSURE
REDUCING
VALVE
500 PSI
(34 BAR)
MOTOR
B
A
SWING
BRAKE
SWING
LOCK
MOTOR
A
B
SWING
BRAKE
SWING
LOCK
.060
HS-1
MOTOR
B
A
SWING
BRAKE
SWING
LOCK
HS-3
HS-2
OUT
IN
.060
MOTOR
A
B
SWING
BRAKE
SWING
LOCK

FIGURE 1-23

# TRAVEL SYSTEM OPERATION

## Travel System Components

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

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

To ensure that crane travels in a straight line forward or reverse direction, each travel drive system has shuttle valves and pressure senders that monitor hydraulic pressure to each closed-loop system. When traveling, node-3 controller monitors information from pressure senders and adjusts displacement of travel pumps to maintain equal pressure in each travel drive system. This allows crane to track in a controlled straight direction.

The source hydraulic pressure for releasing the travel brakes and enabling motor servo systems is from high pressure accessory pump system through a pressure reducing valve at 500 psi (34 bar). Continuous changing of closed-loop fluid occurs through leakage in pump, motor, and loop flushing valves that removes 4 gallons per minute (15 L/min) of fluid to when system pressure is above 200-psi (14 bar).

The travel pumps output can be programmed for 25% to 100% of rated volume. See “Speeds” screen in Crane Diagnostics in Section 10 of the Service/Maintenance Manual.

When either travel control handle is moved from off, an input signal is sent to node-1 controller. Node-5 controller sends a 24 volt signal to enable the swing/travel alarm. When travel control handle is moved to off, node-5 controller sends a 0 volt signal to disable the swing/travel alarm.

## Travel Brakes

Hydraulic pressure required for releasing the travel brakes is from high pressure accessory pump system through a pressure reducing valve at 500 psi (34 bar). For travel brake operation the system pressure must be above 200 psi (14 bar) for travel brakes to fully release from each travel motor shaft. If system pressure is below 200-psi (14 bar), travel brake could be partially applied and damage the brake. If brake pressure or electrical power is lost when operating, the travel brake is applied.

When travel brake switch is in on - park position, right and left travel brakes are applied to hold crane in position. Travel brake solenoid valve HS-35 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 active, waiting for a travel control handle command. When travel control handle is moved node-7 controller sends a 24 volt output to enable travel brake solenoid valve HS-35. Brake solenoid valve shifts to block tank port and supplies hydraulic charge pressure fluid from pump to hydraulically release all four crawler brakes. If brake pressure or electrical power is lost when operating, brakes apply.

## Travel Forward and Reverse

Both travel closed-loop systems operate the same, except fluid flow to motor ports is different to each track.

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/or node-5 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to selected travel pump EDC. Travel brake solenoid valve HS-35 is enabled to release both left and right crawler brakes, before selected travel pump(s) strokes.

Travel pump EDC tilts pump swashplate in the ***forward*** direction. Hydraulic fluid flow is from pump ports of selected travel pump through swivel to selected motor ports. Node-3 and/or node-5 controller input voltage to selected travel pump EDC is relative to selected 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/or node-5 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to selected travel pump EDC. Node-7 controller sends a 24 volt output to enable travel brake solenoid valve HS-35. Travel brake solenoid valve is enabled to release both left and right crawler brakes, before selected travel pump strokes.

The travel pump EDC tilts the motor swashplate in the reverse direction. Hydraulic fluid flow is from pump ports of selected travel pump through swivel to selected motor ports. Node-3 and/or node-5 controller input voltage to selected travel pump EDC is relative to selected control handle movement.

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

18CSM1-122

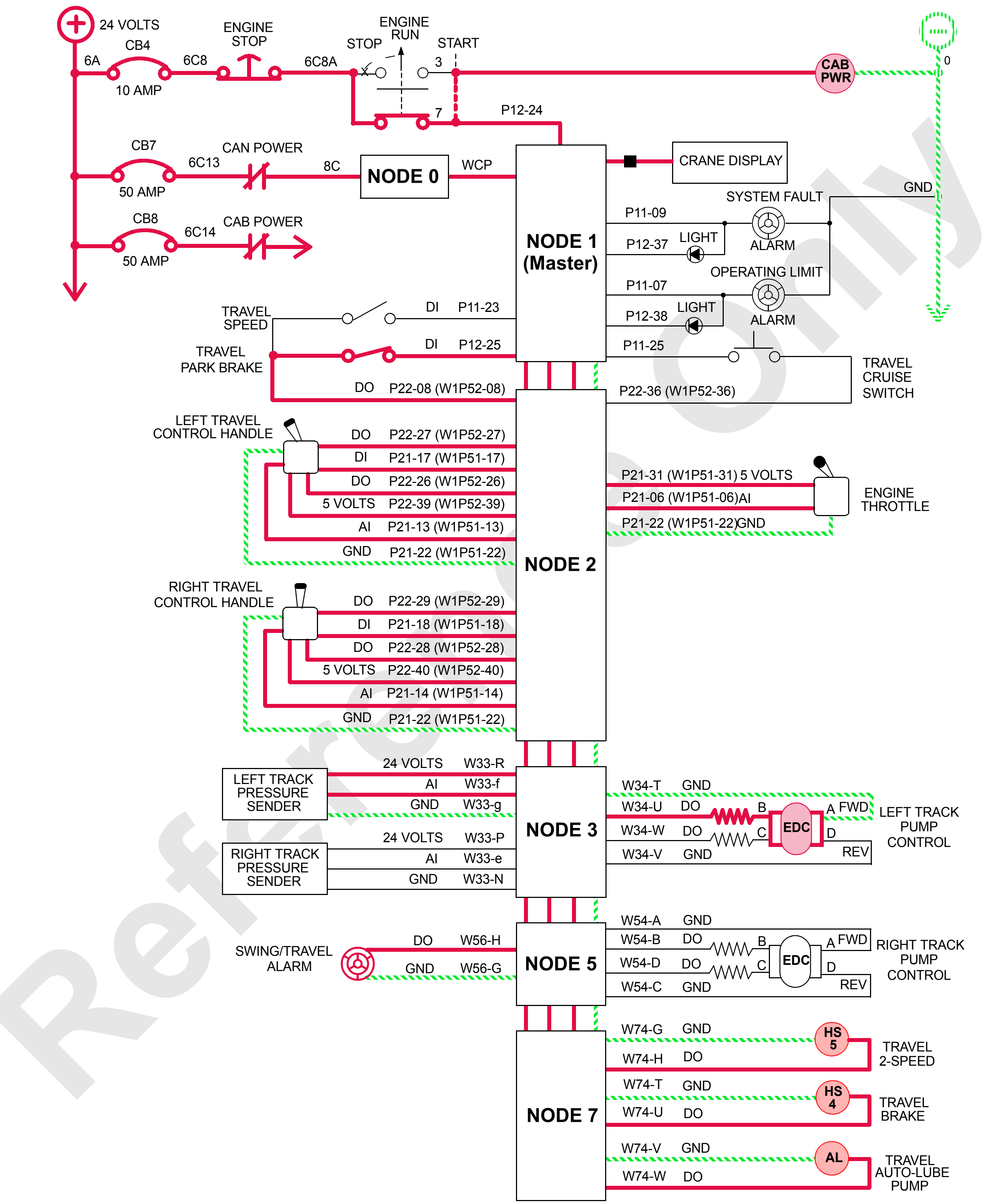



FIGURE 1-24

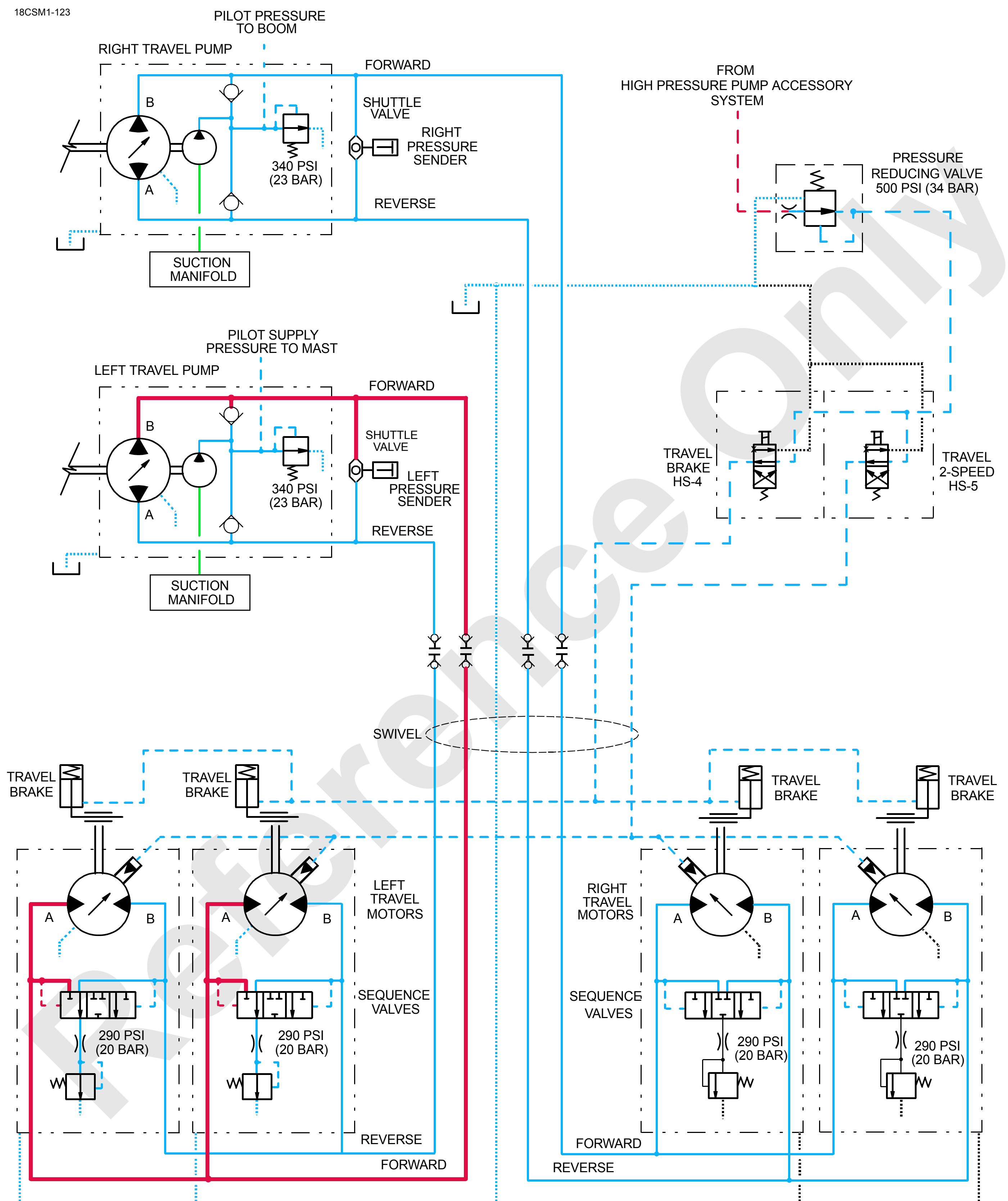

18CSM1-123
PILOT PRESSURE TO BOOM
RIGHT TRAVEL PUMP
FORWARD
B
A
SHUTTLE VALVE
RIGHT PRESSURE SENDER
340 PSI (23 BAR)
REVERSE
SUCTION MANIFOLD
FROM HIGH PRESSURE PUMP ACCESSORY SYSTEM
PRESSURE REDUCING VALVE 500 PSI (34 BAR)
PILOT SUPPLY PRESSURE TO MAST
LEFT TRAVEL PUMP
FORWARD
SHUTTLE VALVE
LEFT PRESSURE SENDER
340 PSI (23 BAR)
REVERSE
SUCTION MANIFOLD
TRAVEL BRAKE HS-4
TRAVEL 2-SPEED HS-5
SWIVEL
TRAVEL BRAKE
TRAVEL BRAKE
TRAVEL BRAKE
TRAVEL BRAKE
LEFT TRAVEL MOTORS
RIGHT TRAVEL MOTORS
SEQUENCE VALVES
SEQUENCE VALVES
290 PSI (20 BAR)
290 PSI (20 BAR)
290 PSI (20 BAR)
290 PSI (20 BAR)
REVERSE
FORWARD
FORWARD
REVERSE

**FIGURE 1-25**

As travel control handle nears neutral position, node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-3 and/or node-5 controller sends a zero output voltage to pump EDC to move swashplate to center position. After travel control handle command is off for a preset time, a zero output voltage is sent to disable travel brake solenoid valve HS-4. Travel brake solenoid valve shifts to block pilot pressure to brakes and opens a line to tank. Brakes apply.

## Two-Speed Travel Operation

Travel speed switch allows operator to select ***low*** speed when smoother starts and precise control over the load is required. Low speed places travel motor in maximum displacement (high torque, low speed) position and prevents motor from shifting to high speed.

Place travel speed switch in ***high*** speed when maximum available travel speed is required (normal operation). Hydraulic pressure required for releasing travel 2-speed solenoid valve is from high pressure accessory pump system through a pressure reducing valve at 500 psi (34 bar).

When travel speed switch is in ***low*** speed position, node-7 controller sends a 24 volt output to enable 2-speed travel solenoid valve HS-5, shifting valve and directing hydraulic pilot pressure to P/C (Pressure/ Compensated) valve. The P/ C valve shifts PCOR (Pressure Compensated Over-Ride) spool placing travel motor in maximum displacement (high torque, low speed) position. Travel motors remain in this position until travel speed switch is placed in ***high*** speed position and engine speed is more than 1500 RPM.

When travel speed switch is in ***high*** speed position, travel motors shift to minimum displacement (low torque, high speed) automatically if engine speed is above 1500 rpm and system pressure is below 3,915 psi (270 bar). If engine is below 1500 rpm, 2-speed travel solenoid valve HS-5 is enabled although travel speed switch is in the ***high*** position. Travel two-speed solenoid valve HS-5 is disabled, shifting valve and removing hydraulic pilot pressure to P/C valve, allowing motor to operate in PCOR mode.

## Travel Cruise

Travel cruise switch on right console locks-in any travel command. This allows crawler track to operate in either direction at a selected speed without manually moving travel handles. When moving at desired speed and direction, move travel switch to ***cruise*** position. The travel pump flow requirements and direction is locked-in. When a travel handle is moved to neutral position, the travel speed and direction is maintained.

Moving the travel switch to ***off*** position or moving either travel handle in opposite direction from neutral, opens travel cruise circuit and returns control of travel system to the operator.

# BOOM HOIST SYSTEM OPERATION

## Boom Hoist System Components

See Figures 1-26 and 1-27 for the following procedure.

Two separate hydraulic pumps and motors drive a gearbox on each end of boom hoist drum (Drum 4). The boom hoist drum is controlled with the boom hoist control handle movement and node controllers. Boom hoist control handle is inoperable when boom hoist park brake is applied. Each boom hoist drum motor drives a shaft that is connected to a gearbox.

In Standard mode boom hoist (Drum 4) is controlled with control handle on left side console. In Luffing Jib mode boom hoist is controlled with control handle on far right of right side console, while the luffing jib hoist (Drum 6) is controlled by control handle on left side console.

Hydraulic charge pressure from left travel charge pump supplies hydraulic pilot pressure to operate both boom hoist motor servos. Hydraulic charge pressure from system charge pumps supplies hydraulic make-up fluid to low-pressure side of each boom hoist motor. A pressure sender in one high-pressure side of boom hoist system provides system pressure information to node-1 controller. There are equalizing lines between legs A and legs B when two pumps drive two motors. A fixed orifice between pump ports A and B allows for smoother drum operation.

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

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

## Boom Hoist Brake and Pawl

Hydraulic pressure to operate boom hoist brake is from low-pressure side of boom hoist system. A electrical motor operates the boom hoist drum pawl.

When boom hoist brake switch is in on - park position, boom hoist brake solenoid valve HS-6 is disabled to apply brake to drum. Boom hoist electric drum pawl in relay K1 is enabled to keep pawl applied to boom hoist drum. Boom hoist pump does not stroke in response to boom hoist control handle movement.

When boom hoist brake switch is placed in off - park position, boom hoist brake remains applied to boom hoist drum until node-6 controller sends a 24 volt output to brake solenoid valve HS-6 to release brake. Node-6 controller sends 24 volt output to enable boom hoist pawl electric motor K2 relay in the pawl out direction. Boom system circuit is active, waiting for a control handle command.

## Boom Hoist Raise

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-5 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to each boom pump EDC. Node-6 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to each boom hoist motor PCP. Node-1 controller checks that boom up limit switch is closed and no hydraulic system fault is present.

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

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

Node-5 controller output voltage to each pump EDC and node-6 controller output voltage to each motor PCP is relative to control handle movement. As boom hoist control handle is moved back, pump swashplate angle is increased. When system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

Node controllers are continuously balancing the system pressure and the motor displacement angle so the motor displacement goes to minimum when control handle is fully back, if the motor torque requirement is not too high. Node-6 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, node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-5 controller sends a zero output voltage to each boom hoist pump EDC that moves swashplate to center position. This shifts the motor back to maximum displacement for slower output speed to slow the drum rotation. The controller stores

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the load holding pressure in pressure memory. After control handle center switch opens, node-6 controller sends a zero output voltage to disable boom hoist brake solenoid valve HS-6. Drum brake solenoid valve shifts to block pilot pressure to brakes and opens a line to tank. Brakes apply before drum pump de-strokes.

18CSM1-124

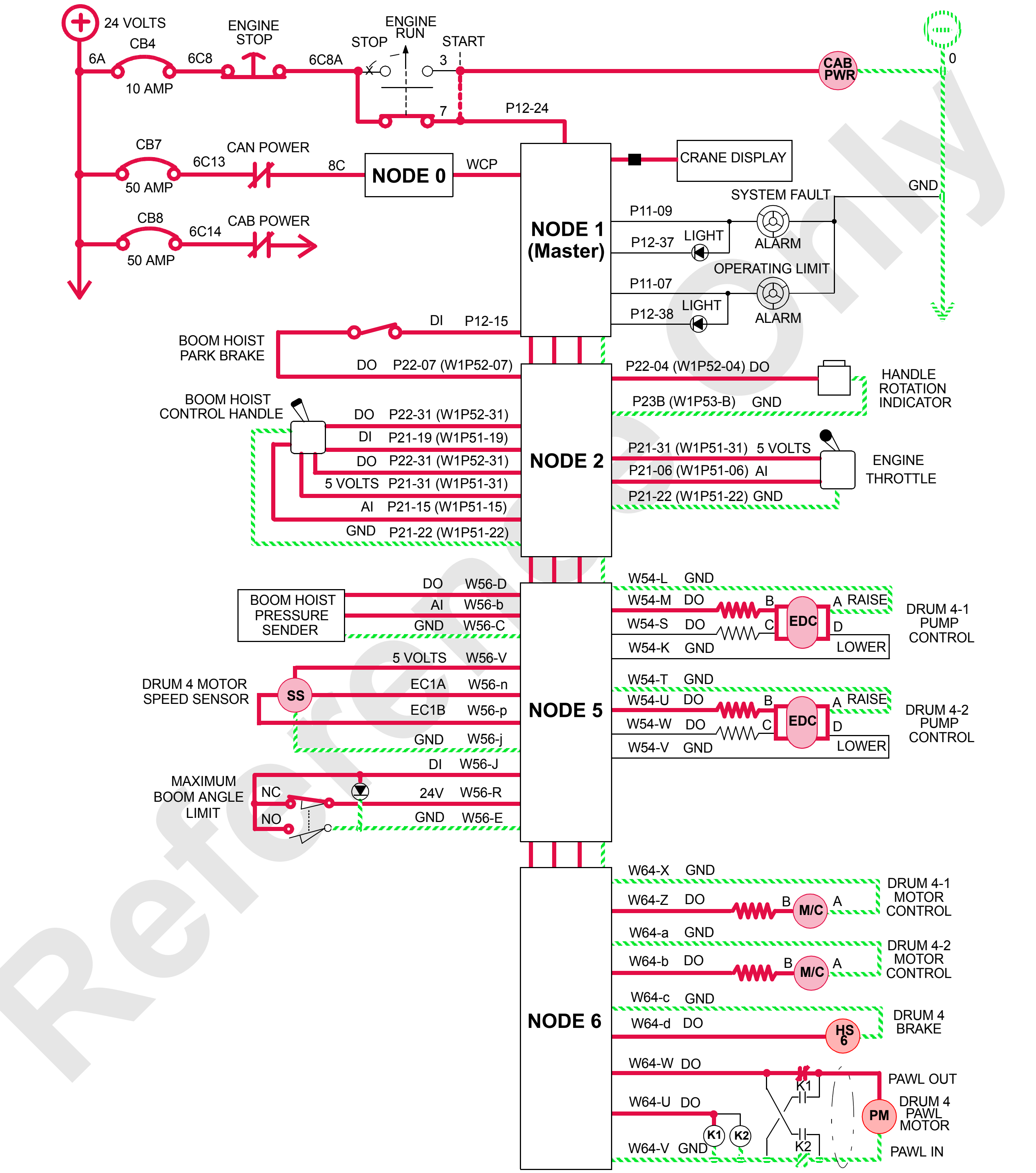



FIGURE 1-26

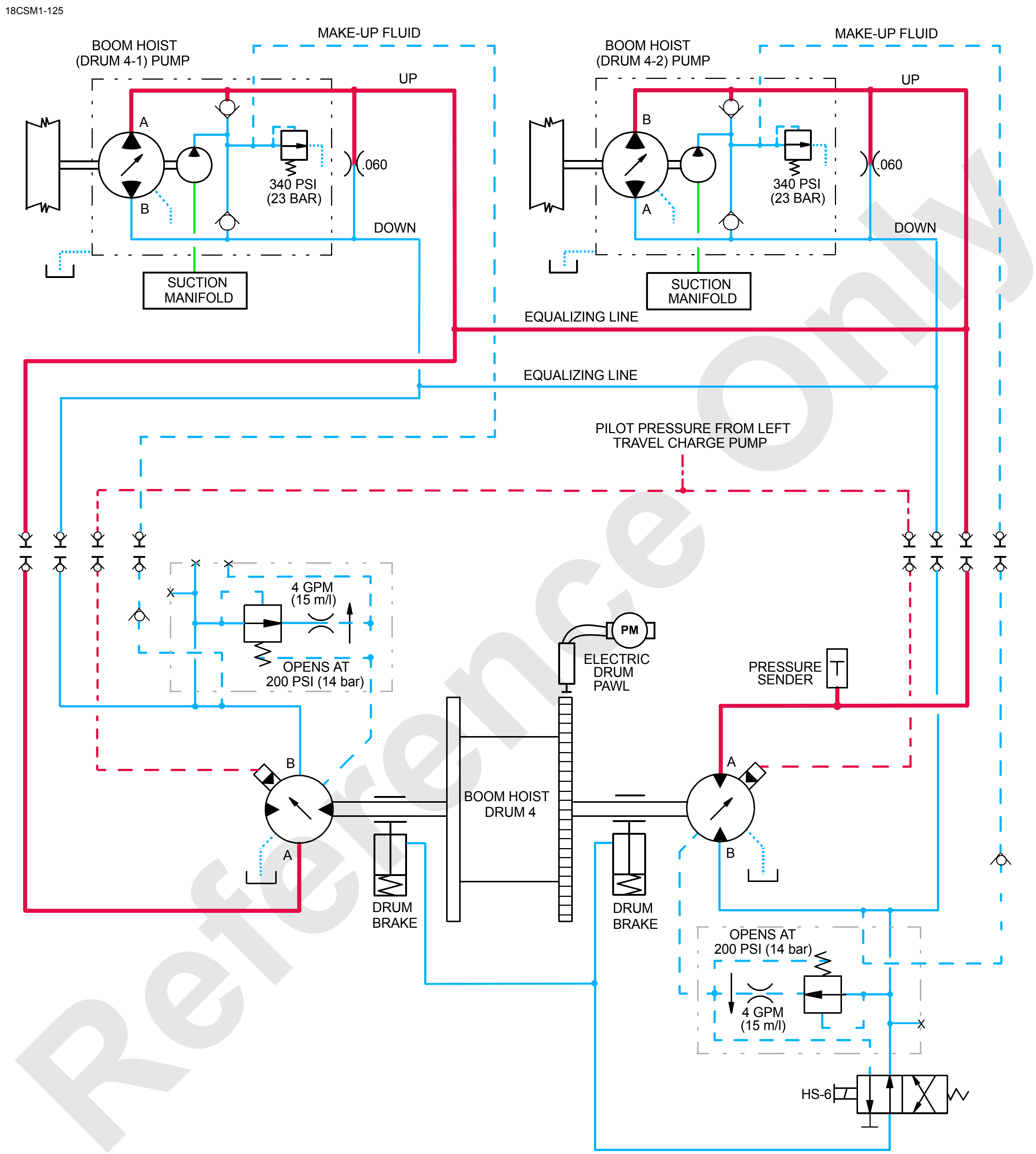

18CSM1-125
BOOM HOIST
(DRUM 4-1) PUMP
MAKE-UP FLUID
UP
A
B
340 PSI
(23 BAR)
.060
DOWN
SUCTION
MANIFOLD
BOOM HOIST
(DRUM 4-2) PUMP
MAKE-UP FLUID
UP
B
A
340 PSI
(23 BAR)
.060
DOWN
SUCTION
MANIFOLD
EQUALIZING LINE
EQUALIZING LINE
PILOT PRESSURE FROM LEFT
TRAVEL CHARGE PUMP
4 GPM
(15 m/l)
OPENS AT
200 PSI (14 bar)
PM
ELECTRIC
DRUM
PAWL
PRESSURE
SENDER
B
A
BOOM HOIST
DRUM 4
A
B
DRUM
BRAKE
DRUM
BRAKE
OPENS AT
200 PSI (14 bar)
4 GPM
(15 m/l)
HS-6

FIGURE 1-27

## Boom Hoist Lower

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 controller. Node-5 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to each boom pump EDC. Node-6 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to each boom motor PCP. Node-1 controller checks that boom up limit switch is closed and no hydraulic system fault is present.

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

When brake is released, each pump EDC continues to tilt swashplate 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-5 controller output voltage to each pump EDC and node-6 controller output voltage to each motor PCP is relative to control handle movement. As boom hoist control handle is pushed forward, pump swashplate angle is increased. When system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

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

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

When boom hoist control handle is moved to neutral position, node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-5 controller sends a zero output voltage to each boom hoist pump EDC that moves swashplate to center position. This shifts the motors back to maximum displacement for slower output speed to slow the drum rotation. Node-1 controller stores the load holding pressure in pressure memory. After control handle center switch opens, Node-6 controller sends a zero output to disable boom hoist brake solenoid valve HS-6. Drum brake solenoid valve shifts to block pilot pressure to brakes and opens a line to tank. Brakes apply before drum pump de-strokes.

# MAIN HOIST 1 SYSTEM

## Main Hoist 1 System Components

See Figures 1-28 and 1-29 for the following procedure.

Main hoist 1 drum is located in first boom insert. Two main hoist 1 pumps drive two drum motors on each end of load drum that is connected to a gearbox. Hydraulic connections between main hoist 1 pumps and motors form a closed-loop system that is controlled with control handle movement and node controllers. The left load drum control handle on the right side console operates the main hoist 1 in Standard, Luffing, or Tandem Drum mode. Main hoist 1 control handle is inoperable when drum 1 park brake is applied.

Main hoist pump 1/3 is dedicated to operate whip line hoist (Drum 3) motor. See Whip Line Hoist System in this manual for whip line hoist information.

Hydraulic charge pressure from left travel charge pump supplies hydraulic pilot pressure to operate both main hoist 1 motor servos. Hydraulic charge pressure from system charge pumps supplies hydraulic make-up fluid to low-pressure side of each main hoist 1 motor. A pressure sender in high-pressure side of one pump leg provides system pressure information to node-1 controller. There are equalizing lines between legs A and legs B when two pumps drive two motors. A fixed orifice between pump ports A and B allows for smoother drum operation.

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

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

## Main Hoist 1 Drum Brake

Hydraulic pressure to operate main hoist 1 drum brakes is from low-pressure side of drum1/3.

When selected main hoist drum brake switch is in on - park position, drum brake solenoid valve HS-7 is disabled so brakes are applied to each side of drum shaft. Drum pump does not stroke in response to control handle movement.

When selected main hoist drum brake switch is placed in off - park position, brake solenoid valve HS-7 remains applied. Brakes remain applied until node-8 controller sends a 24 volt output to release the brake. The drum circuit is active, waiting for a control handle command.

## Main Hoist 1 Raising

The following drum raising operation is for main hoist 1 (Drum 1) while operating in Standard mode.

When main hoist 1 control handle is moved back for ***raising***, an input voltage of 2.4 volts or less is sent to node-1 controller. Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to each pump EDC in the hoist direction. Node-8 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to both motor PCP's. Node-1 controller checks that drum block-up limit switches are closed and no system faults are present.

Pump EDC's tilt swashplate in the ***up*** direction to satisfy pressure memory. Node-1 controller compares drum holding pressure to value in pressure memory. When system pressure is high enough, node-8 controller sends a 24 volt output to enable drum brake solenoid valve HS-7. Drum brake solenoid shifts to block drain port and opens port to low-pressure side of drum system to release brakes from both sides of drum shaft.

Each pump EDC tilts swashplate in the up direction as hydraulic fluid flow is from port B of both pumps to port A of left side motor and port B of right side motor. Return fluid is from motor ports A and B to return ports A of each pump.

Node controller output voltages to each pump EDC and each motor PCP is relative to control handle movement. The system pumps operate a slave and master with one pump operating continuously and the other pump varying to keep drum at handle command setting. As control handle is moved back, an output voltage increases the pumps swashplate angles. When system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

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

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

After control handle center switch opens, node-6 controller sends a zero output voltage to disable drum brake solenoid valve HS-7. Drum brake solenoid valve shifts to block pilot pressure to brakes and opens a line to tank. Brakes apply before drum pump de-strokes.

The diverting valve lines to main hoist 1/3 drum motor remain open until whip line hoist control handle is selected for operating whip line hoist in any mode.

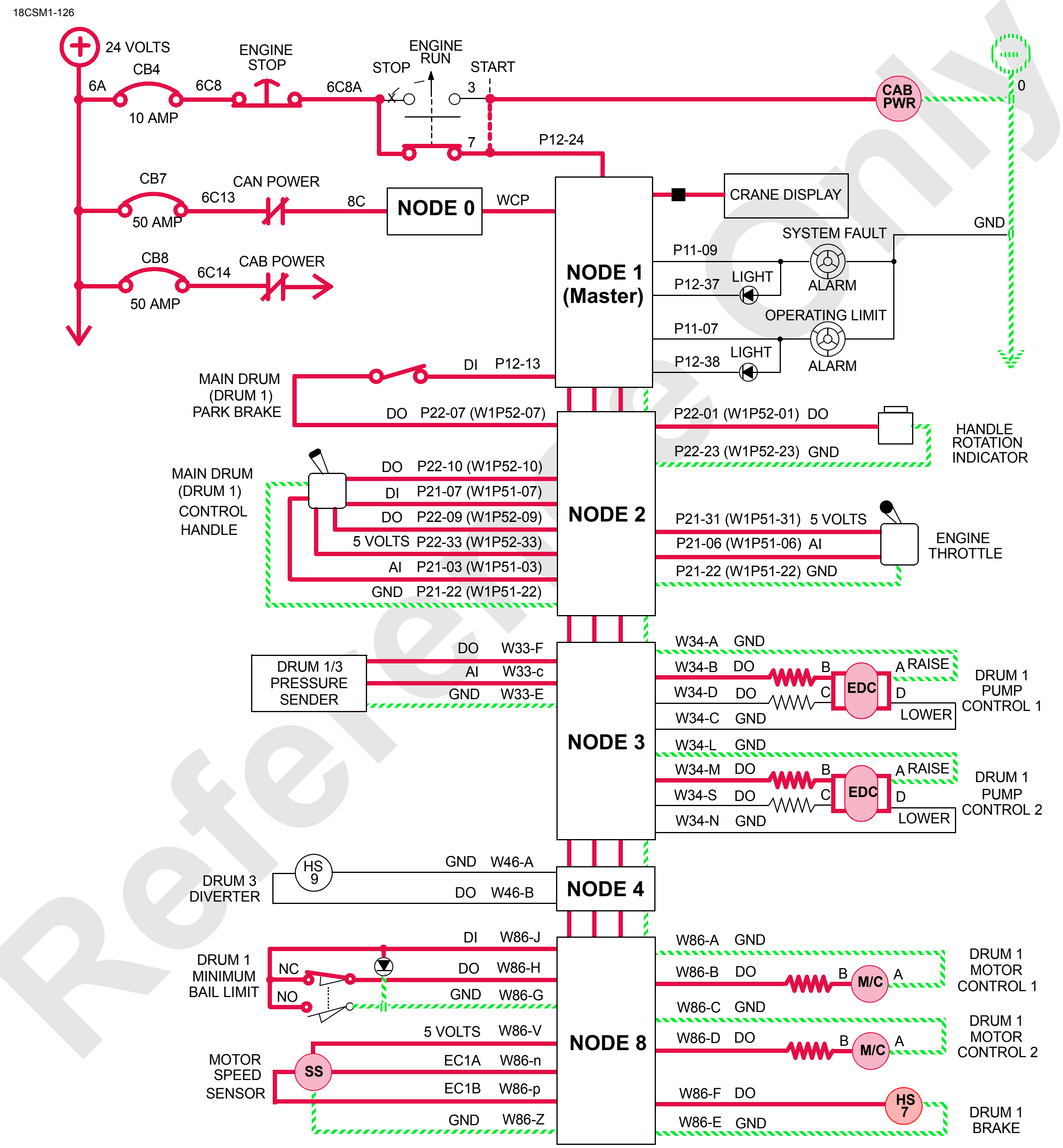



FIGURE 1-28

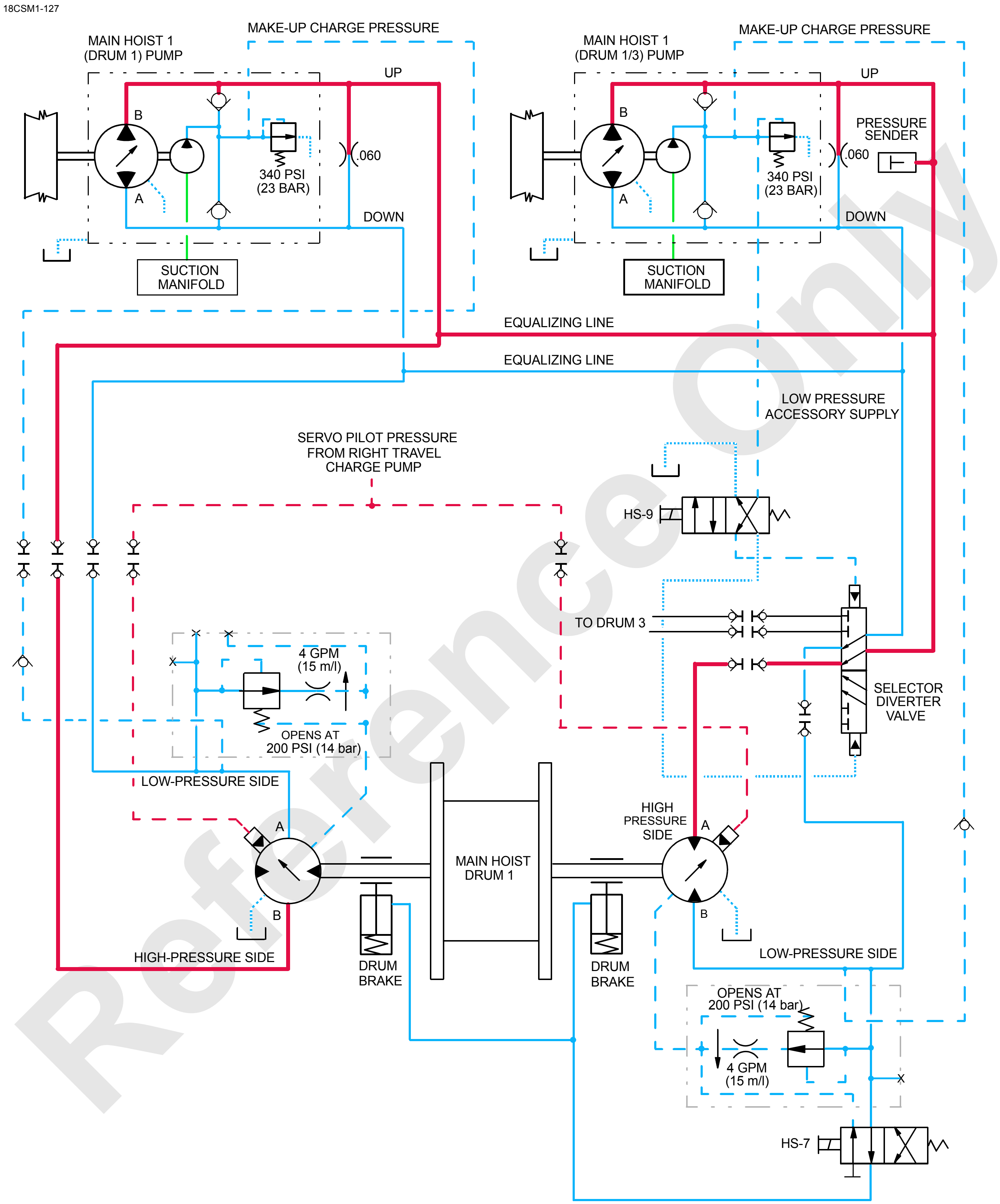

18CSM1-127
MAIN HOIST 1
(DRUM 1) PUMP
MAKE-UP CHARGE PRESSURE
UP
B
A
340 PSI
(23 BAR)
.060
DOWN
SUCTION
MANIFOLD
MAIN HOIST 1
(DRUM 1/3) PUMP
MAKE-UP CHARGE PRESSURE
UP
B
A
PRESSURE
SENDER
340 PSI
(23 BAR)
.060
DOWN
SUCTION
MANIFOLD
EQUALIZING LINE
EQUALIZING LINE
LOW PRESSURE
ACCESSORY SUPPLY
SERVO PILOT PRESSURE
FROM RIGHT TRAVEL
CHARGE PUMP
HS-9
TO DRUM 3
SELECTOR
DIVERTER
VALVE
4 GPM
(15 m/l)
OPENS AT
200 PSI (14 bar)
LOW-PRESSURE SIDE
A
B
HIGH-PRESSURE SIDE
DRUM
BRAKE
MAIN HOIST
DRUM 1
DRUM
BRAKE
HIGH
PRESSURE
SIDE
A
B
LOW-PRESSURE SIDE
OPENS AT
200 PSI (14 bar)
4 GPM
(15 m/l)
HS-7

FIGURE 1-29

## Main Hoist 1 Lowering

The following drum lowering operation is for main hoist 1 while operating in Standard mode.

When main hoist 1 control handle is moved forward for lowering load, an input voltage of 2.6 volts or more is sent to node-1 controller. Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to each pump EDC in the hoist direction. Node-8 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to each motor PCP. The controller checks that drum block-up limit switches are closed and no system faults are present.

Each pump EDC tilts swashplate in the up direction to satisfy pressure memory. Node-1 controller compares holding pressure to value in pressure memory. When system pressure is high enough, node-8 controller sends a 24 volt output to enable drum brake solenoid valve HS-7. The brake solenoid shifts to block drain port and opens port to low-pressure side of drum system to release drum brake.

When brake is released, node controllers output voltage to each pump EDC and to each motor PCP tilts pump swashplate to stroke pump in the lowering direction. Hydraulic fluid flow is from port A of each pump to port B of left side motor and port A of right side motor. Return fluid is from motor ports A and B to return ports B of each pump.

Controller output voltage to each pump EDC and each motor PCP is relative to control handle movement. As drum control handle is pushed forward, an output voltage increases the pump swashplate angle. When system pressure exceeds the PCOR valve setting of 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve overrides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

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

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

When drum control handle is moved to neutral position, node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-3 controller sends a zero output voltage to each pump EDC that moves swashplate to center position. This shifts the motor back to maximum displacement for slower output speed to slow the drum rotation. Node-1 controller stores the load holding pressure in pressure memory. After control handle center switch opens, node-8 controller sends a zero output voltage is sent to disable drum brake solenoid valve HS-7 and to apply brake before pump de-strokes.

The diverting valve lines to main hoist 1/3 drum motor remain open until whip line hoist control handle is selected for operating whip line hoist in any mode.

# WHIP LINE HOIST (DRUM 3) SYSTEM

## Whip Line Hoist System Components

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

The whip line hoist (Drum 3) is located on the rotating bed. Main hoist 1 and whip line hoist is a dedicated system where only one function can be operated at a time. In Standard mode main hoist 1/3 pump drives the whip line motor through a diverting valve that is controlled with control handle movement and node controllers. The motor drives a drum shaft that is connected to a gearbox.

The far right drum control handle on the right side console operates the whip line hoist in Standard and Tandem Drum mode. The first drum control handle on the right side console operates the whip line hoist in Setup and Luffing Jib mode. The whip line hoist control handle is inoperable when whip line hoist park brake is applied.

Hydraulic pilot pressure to operate motor servo is from left travel charge pump. A pressure sender in high-pressure side of system provides system pressure information to node-1 controller. A fixed orifice between pump ports A and B allows for smoother drum operation.

When whip line hoist drum motor rotates, 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 load drum rotates faster, the rotation indicator on top of control handle pulsates with a varying frequency that indicates drum rotational speed.

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

## Whip Line Drum Brake

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

When whip line hoist brake switch is in on - park position, brake solenoid valve HS-8 is disabled so brake is applied to drum. Drum pump does not stroke in response to control handle movement.

When whip line hoist brake switch is placed in off - park position, brake solenoid valve HS-8 remains disabled. Brake remains applied until node-3 controller sends a 24 volt output to release the brake. Whip line hoist circuit is active, waiting for a control handle command.

## Whip Line Hoist Raising

The following drum raising operation is for whip line hoist while operating in Standard mode.

When whip line hoist control handle is moved back for ***raising***, an input voltage of 2.6 volts or more is sent to node-1 controller. Node-4 controller sends a 24 volt output to drum 3 diverting solenoid valve HS-9 to shift valve and open lines to drum 3 motor and close lines to main hoist 1 left side drum motor. Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to main hoist 1/3 pump EDC in the hoist direction. Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to whip line motor PCP. Node-1 controller checks that drum block-up limit switches are closed and no system faults are present.

Main hoist 1/3 pump EDC tilts swashplate in the ***up*** direction to satisfy pressure memory. Node-1 controller compares drum holding pressure to value in pressure memory. When system pressure is high enough, node-3 controller sends a 24 volt output to enable drum brake solenoid valve HS-8. The drum brake solenoid shifts to block drain port and opens port to low-pressure side of drum system to release brake.

The pump EDC continues to tilt swashplate in the up direction as hydraulic fluid flow is from port B of pump to port A of motor. Return fluid is from port B of motor to return port A of pump.

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

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

18CSM1-128

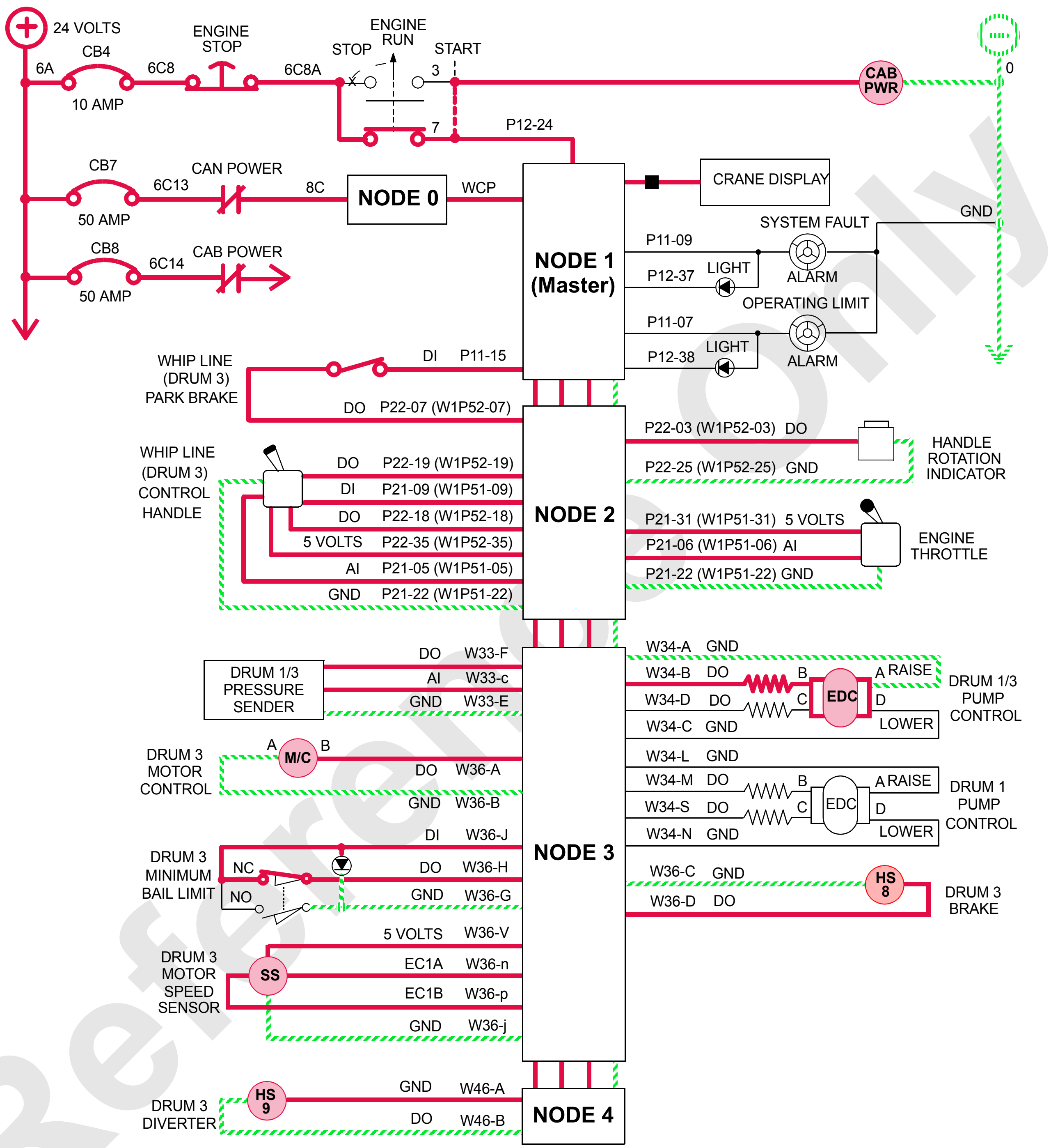



**FIGURE 1-30**

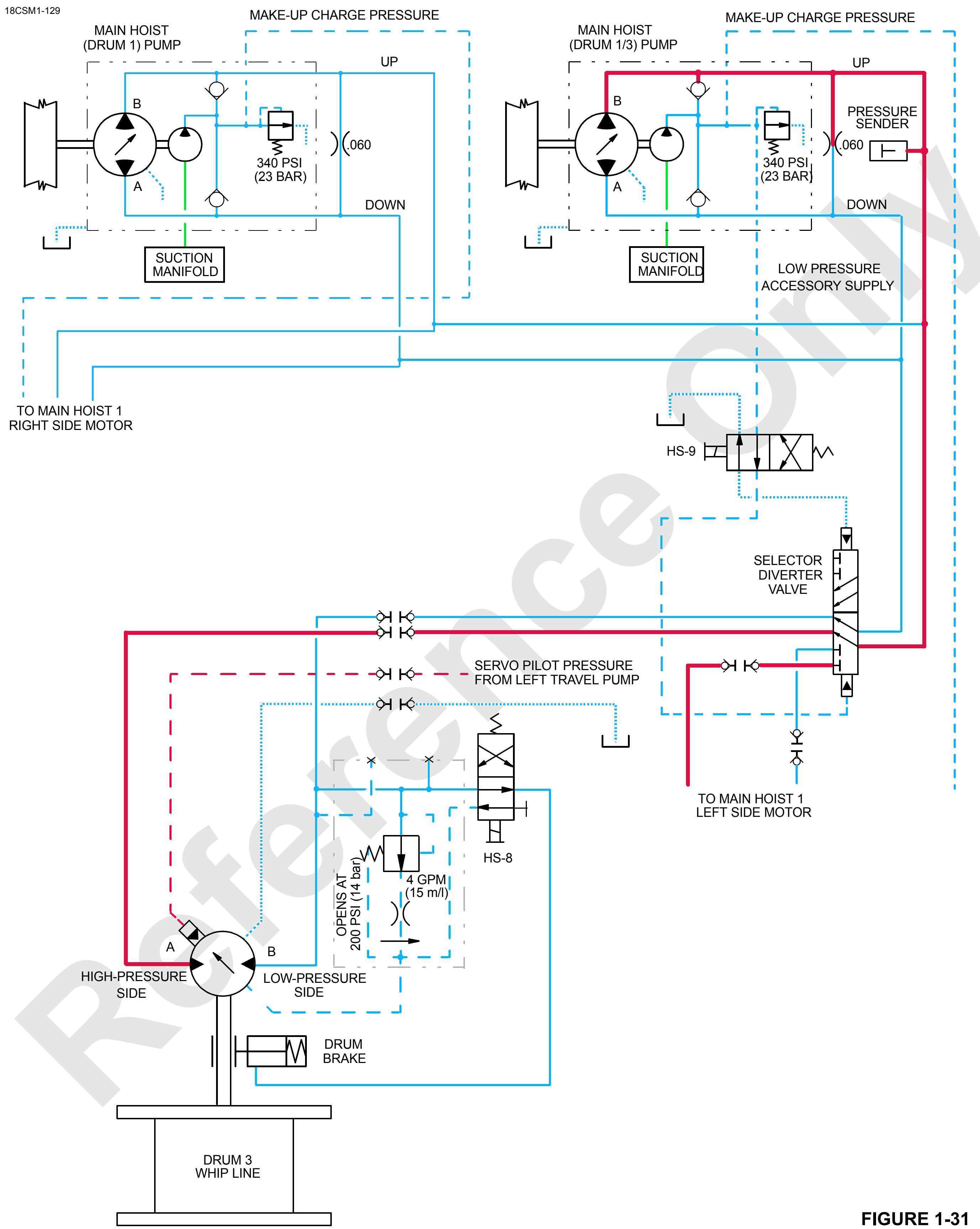

18CSM1-129
MAIN HOIST
(DRUM 1) PUMP
MAKE-UP CHARGE PRESSURE
UP
B
A
.060
340 PSI
(23 BAR)
DOWN
SUCTION
MANIFOLD
TO MAIN HOIST 1
RIGHT SIDE MOTOR
MAIN HOIST
(DRUM 1/3) PUMP
MAKE-UP CHARGE PRESSURE
UP
PRESSURE
SENDER
.060
340 PSI
(23 BAR)
DOWN
SUCTION
MANIFOLD
LOW PRESSURE
ACCESSORY SUPPLY
HS-9
SELECTOR
DIVERTER
VALVE
SERVO PILOT PRESSURE
FROM LEFT TRAVEL PUMP
TO MAIN HOIST 1
LEFT SIDE MOTOR
HS-8
4 GPM
(15 m/l)
OPENS AT
200 PSI (14 bar)
A
B
HIGH-PRESSURE
SIDE
LOW-PRESSURE
SIDE
DRUM
BRAKE
DRUM 3
WHIP LINE

FIGURE 1-31

When drum control handle is moved to neutral position, node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-3 controller sends a zero output voltage to pump EDC that moves swashplate to center position. This shifts the motor back to maximum displacement for slower output speed to slow the drum rotation. Node-1 controller stores the load holding pressure in pressure memory. After control handle center switch opens, node-3 controller sends a zero output voltage to disable drum brake solenoid valve HS-8 to apply brake before load drum pump de-strokes.

The diverting valve lines to whip line hoist motor remain open until main hoist 1 control handle is selected for operating main hoist 1.

## Whip Line Hoist Lowering

The following load drum lowering operation is for whip line hoist while operating in Standard mode.

When whip line hoist control handle is moved forward for ***lowering*** load, an input voltage of 2.4 volts or lower is sent to node-1 controller. Node-4 controller sends a 24 volt output to drum 3 diverting solenoid valve HS-9 to shift valve and open lines to drum 3 motor and close lines to main hoist 1 left side drum motor. Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to main hoist pump 1/3 EDC in the hoist direction. Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to whip line motor PCP. Node-1 controller checks that drum block-up limit switches are closed and no hydraulic system faults are present.

Main hoist 1/3 pump EDC tilts swashplate in the ***up*** direction to satisfy pressure memory. Node-1 controller compares drum holding pressure to value in pressure memory. When system pressure is high enough, node-3 controller sends a 24 volt output to enable drum brake solenoid valve HS-8. The drum brake solenoid shifts to block drain port and opens port to low-pressure side of drum system to release brake.

When brake is released, node-3 controller sends a 24 volt output voltage to pump EDC to tilt swashplate to stroke pump in the lower direction. In the lower direction, hydraulic fluid flow is from port B of pump to port A of motor. Return fluid is from port B of motor to port A of pump.

Controller output voltage to pump EDC and motor PCP is relative to control handle movement. As drum control handle is pushed forward, an output voltage increases the pump swashplate angle. When system pressure exceeds the PCOR valve setting of 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

Node controllers are continuously balancing the system pressure and the motor displacement angle so the motor displacement goes to minimum when control handle is all the way forward, if the motor torque requirement is not too high. Node-3 controller monitors motor displacement and controls motor speed by regulating the hydraulic fluid flow through the pump.

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

When drum control handle is moved to neutral position, node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-3 controller sends a zero output voltage to pump EDC that moves swashplate to center position. This shifts the motor back to maximum displacement for slower output speed to slow the drum rotation. Node-1 controller stores the load holding pressure in pressure memory. After control handle center switch opens, node-3 controller sends a zero output voltage is sent to disable drum brake solenoid valve HS-8 and to apply brake before pump de-strokes.

The diverting valve lines to whip line hoist motor remain open until main hoist 1 control handle is selected for operating main hoist 1.

# MAIN HOIST 2 SYSTEM

## Main Hoist 2 System Components

See Figures 1-32 and 1-33 for the following procedure.

The main hoist 2 system and the main hoist 1 system are similar and operate the same. See Main Hoist 1 System in this manual for main hoist 1 information.

Main hoist 2 drum is located in boom butt. Two main hoist 2 pumps drive two drum motors on each end of drive shaft that is connected to a gearbox. Hydraulic connections between main hoist 2 pumps and motors form a closed-loop system that is controlled with control handle movement and node controllers. The center load drum control handle on the right side console operates the main hoist 2 in all drum mode. Main hoist 2 control handle is inoperable when drum 2 park brake is applied.

Main hoist pump 2/5 is dedicated to operate mast hoist (Drum 5) motor. See Mast Hoist System in this manual for mast hoist information.

Hydraulic charge pressure from left travel charge pump supplies hydraulic pilot pressure to operate both main hoist 2 motor servos. Hydraulic charge pressure from system charge pumps supplies hydraulic make-up fluid to low-pressure side of each main hoist 2 motor. A pressure sender in high-pressure side of each pump leg provides system pressure information to node-1 controller. There are equalizing lines between legs A and legs B when two pumps drive two motors. A fixed orifice between pump ports A and B allows for smoother drum operation.

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

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

## Main Hoist 2 Drum Brake

Hydraulic pressure to operate main hoist 2 drum brakes is from low-pressure side of drum 2/5.

When selected main hoist drum brake switch is in on - park position, drum brake solenoid valve HS-10 (Drum 2) is disabled so brakes are applied to each side of drum shaft. Drum pump does not stroke in response to control handle movement.

When selected main hoist drum brake switch is placed in off - park position, brake solenoid valve HS-10 (Drum 2) remains applied. Brakes remain applied until node-6 controller sends a 24 volt output to release the brake. The drum circuit is active, waiting for a control handle command.

## Main Hoist 2 Raising

The following drum raising operation is for main hoist 2 (Drum 2) while operating in Standard mode.

When main hoist 2 control handle is moved back for ***raising,*** an input voltage of 2.4 volts or less is sent to node-1 controller. Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to each pump EDC in the hoist direction. Node-6 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to both motor PCP's. Node-1 controller checks that drum block-up limit switches are closed and no system faults are present.

Pump EDC's tilt swashplate in the ***up*** direction to satisfy pressure memory. Node-1 controller compares drum holding pressure to value in pressure memory. When system pressure is high enough, node-6 controller sends a 24 volt output to enable drum brake solenoid valve HS-10. Drum brake solenoid shifts to block drain port and opens port to low-pressure side of drum system to release brakes from both sides of drum shaft.

Each pump EDC tilts swashplate in the up direction as hydraulic fluid flow is from port A of pump 2 and port B of pump 2/5 to port A of left side motor and port B of right side motor. Return fluid is from motor ports A and B to return port B of pump 2 and port A of pump 2/5.

Node controller output voltages to each pump EDC and each motor PCP is relative to control handle movement. The system pumps operate a slave and master with one pump operating continuously and the other pump varying to keep drum at handle command setting. As control handle is moved back, an output voltage increases the pumps swashplate angles. When system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

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

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

After control handle center switch opens, node-6 controller sends a zero output voltage to disable drum brake solenoid valve HS-10. Drum brake solenoid valve shifts to block pilot pressure to brakes and opens a line to tank. Brakes apply before drum pump de-strokes.

The diverting valve lines to main hoist 2/5 drum motor remain open until mast hoist control handle is selected for operating mast hoist in Setup mode.

18CSM1-130

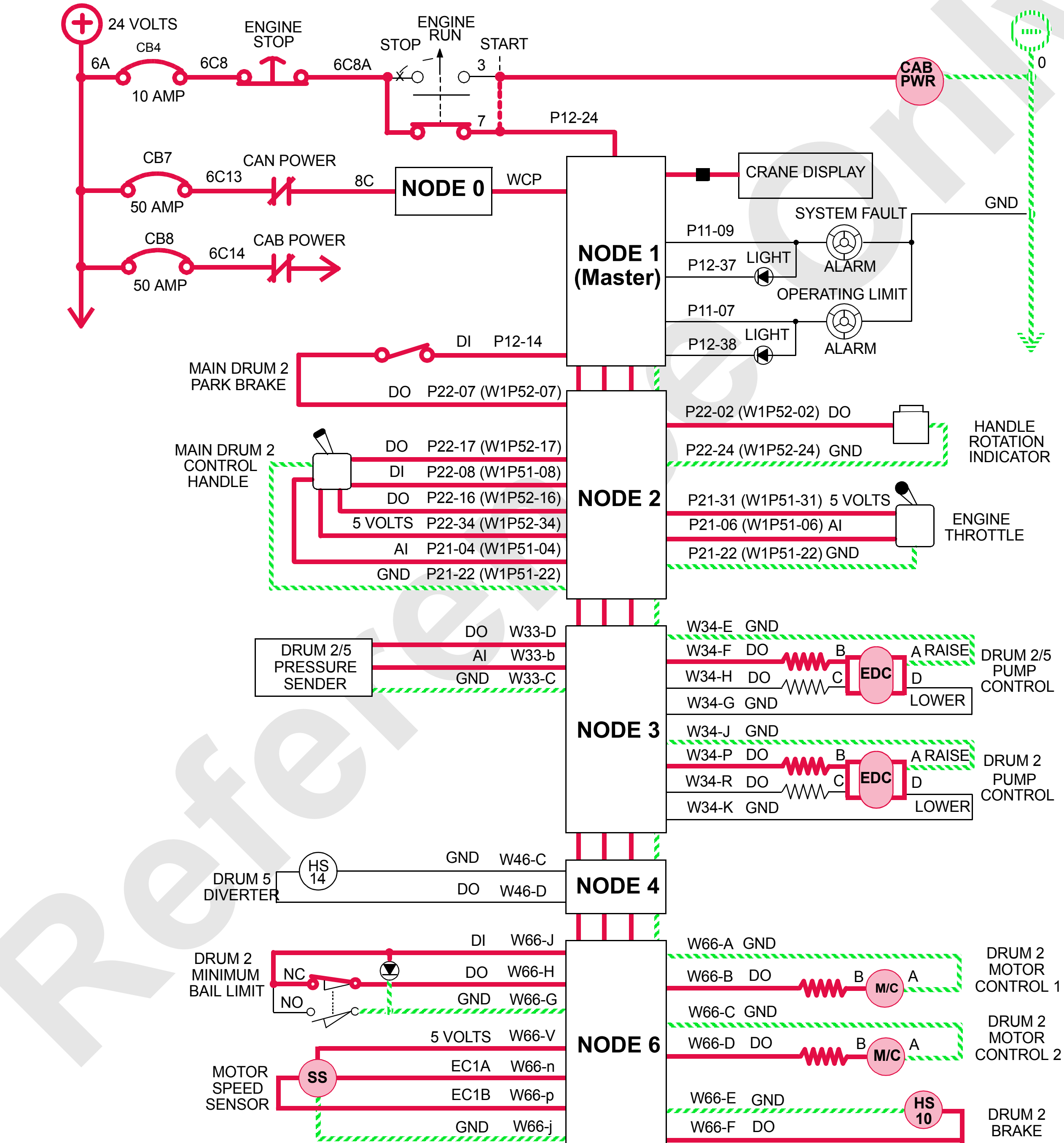



FIGURE 1-32

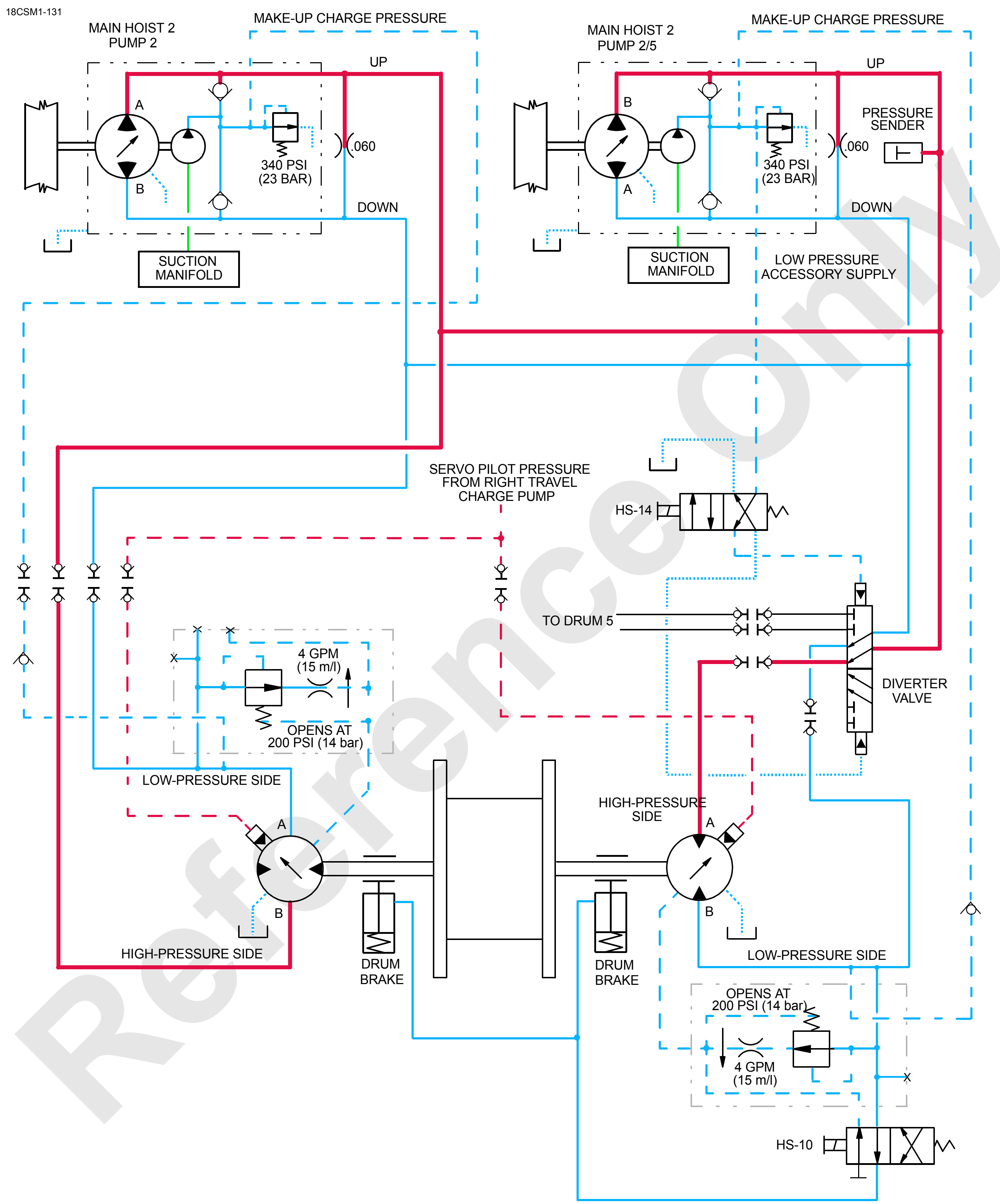

18CSM1-131
MAIN HOIST 2
PUMP 2
MAKE-UP CHARGE PRESSURE
UP
A
B
340 PSI
(23 BAR)
.060
DOWN
SUCTION
MANIFOLD
MAIN HOIST 2
PUMP 2/5
MAKE-UP CHARGE PRESSURE
UP
B
A
PRESSURE
SENDER
340 PSI
(23 BAR)
.060
DOWN
SUCTION
MANIFOLD
LOW PRESSURE
ACCESSORY SUPPLY
SERVO PILOT PRESSURE
FROM RIGHT TRAVEL
CHARGE PUMP
HS-14
TO DRUM 5
DIVERTER
VALVE
4 GPM
(15 m/l)
OPENS AT
200 PSI (14 bar)
LOW-PRESSURE SIDE
A
B
HIGH-PRESSURE SIDE
DRUM
BRAKE
DRUM
BRAKE
HIGH-PRESSURE
SIDE
A
B
LOW-PRESSURE SIDE
OPENS AT
200 PSI (14 bar)
4 GPM
(15 m/l)
HS-10

FIGURE 1-33

## Main Hoist 2 Lowering

The following drum lowering operation is for main hoist 2 while operating in Standard mode.

When main hoist 2 control handle is moved forward for ***lowering*** load, an input voltage of 2.6 volts or more is sent to node-1 controller. Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to each pump EDC in the hoist direction. Node-6 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to each motor PCP. The controller checks that drum block-up limit switches are closed and no system faults are present.

Each pump EDC tilts swashplate in the ***up*** direction to satisfy pressure memory. Node-1 controller compares holding pressure to value in pressure memory. When system pressure is high enough, node-6 controller sends a 24 volt output to enable drum brake solenoid valve HS-10. The brake solenoid shifts to block drain port and opens port to low-pressure side of drum system to release drum brake.

When brake is released, node controllers output voltage to each pump EDC and to each motor PCP tilts pump swashplate to stroke pump in the lowering direction. Hydraulic fluid flow is from port B of each pump to port B of left side motor and port A of right side motor. Return fluid is from motor ports A and B to return ports A of each pump.

Controller output voltage to each pump EDC and each motor PCP is relative to control handle movement. As drum control handle is pushed forward, an output voltage increases the pump swashplate angle. When system pressure exceeds the PCOR valve setting of 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve overrides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

Node controllers are continuously balancing the system pressure and the motor displacement angle so the motor displacement goes to minimum when control handle is all the way forward, if the motor torque requirement is not too high. Node-3 controller monitors motor displacement and controls motor speed by regulating the hydraulic fluid flow through the pump.

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

When drum control handle is moved to neutral position, node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-3 controller sends a zero output voltage to each pump EDC that moves swashplate to center position. This shifts the motor back to maximum displacement for slower output speed to slow the drum rotation. Node-1 controller stores the load holding pressure in pressure memory. After control handle center switch opens, node-6 controller sends a zero output voltage is sent to disable drum brake solenoid valve HS-10 and to apply brake before pump de-strokes.

The diverting valve lines to main hoist 2/5 drum motor remain open until mast hoist control handle is selected for operating mast hoist in Setup mode.

# MAST HOIST DRUM 5 SYSTEM

## Mast Hoist System Components

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

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

Mast raising cylinders are required to raise the live mast to a working position of 114° to 160°. In crane Setup mode, live mast-raising sequence is controlled automatically by the computer program and the mast hoist control handle. Mast raising and lowering rate is controlled by engine speed, as it regulates pay out and haul in of the cable reeving between mast hoist (Drum 5) and gantry sheaves.

Hydraulic connections between main hoist 2/5 pump and mast hoist motor forms a closed-loop system that is controlled with control handle movement and node controllers. The far right drum control handle on the right side console operates the mast hoist in Setup mode only. The mast hoist control handle is inoperable when mast hoist park brake is applied.

The mast hoist is located on the rotating bed. Main hoist 2 (Drum 2) and mast hoist form a dedicated system where only one function can be operated at a time.

In Setup mode, main hoist 2/5 pump drives the mast hoist motor through a diverting valve. The motor drives a drum shaft that is connected to a gearbox. Drum 5 diverting solenoid valve remains open to drum 5 motor until another mode is selected.

A pressure sender in high-pressure side of system provides system pressure information to node-1 controller. A fixed orifice between pump ports A and B allows for smoother drum operation.

Continuous changing of fluid occurs through leakage in pump and motor. Fluid from system is dumped into the motor case where the fluid returns to tank.

When mast hoist drum motor rotates, 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.

## Mast Hoist Brake and Pawl

Hydraulic charge pressure to operate mast hoist (Drum 5) brake and pawl is from main hoist 2/5 charge pump. Hydraulic charge pressure from pump must be above 200 psi (14 bar) for brake or pawl to retract from drum.

When mast hoist (Drum 5) brake switch is in on - park position, brake solenoid valve HS-11 is disabled and drum brake is applied. Mast hoist drum pawl in solenoid valve HS-12 is enabled to keep pawl applied to mast hoist drum flange. The pawl in solenoid is open to charge pressure from pump 2/5 to piston end of cylinder to extend pawl to drum flange. Mast hoist pump does not stroke in response to mast hoist control handle movement.

When mast hoist (Drum 5) brake switch is placed in off - park position, brake remains applied to drum until node-6 controller sends a 24 volt output to brake solenoid valve HS-11 to release brake. Node-6 controller sends 24 volt output to enable drum pawl out solenoid valve HS-13 in the out direction. The pawl out solenoid shifts to block drain port and opens charge pressure port from pump 2/5 to rod end of cylinder to retract pawl from drum flange. Mast system circuit is active, waiting for a control handle command.

## Mast Raising Cylinders

The mast raising cylinders can be manually operated with controls on the hand-held radio remote control for extending/retracting mast cylinders without rope rigging. Power is available to hand-held radio remote control when Setup Remote mode is selected, engine is running, and power button is pressed.

Hydraulic pressure to operate mast-raising cylinders is from accessory pump. Node-1 controller monitors system pressure to control accessory system proportional relief valve setting. Mast raising cylinders proportional directional control valve is “motor spooled” where both cylinder ports and tank port of the valve spool section are connected in center position. This type of spool prevents premature opening of load equalizing valves. Load equalizing valves ensures mast-raising cylinders operate in unison, protecting mast from structural damage caused by twisting. Load equalizing valves also provide support resistance against mast to ensure control of the unit while rotating it at assembly.

When mast cylinders switch is placed in the extend position and held, an input voltage from Setup Remote is sent to node-1 controller. Node-4 controller sends a 24 volt output to enable mast raise cylinders solenoid valve HS-33.

When mast cylinders switch is placed in the retract position and held, an input voltage is sent to node-1 controller. Node-4 controller sends a 24 volt output to enable to mast raise cylinders solenoid valve HS-34.

## Mast Hoist Raising from Transport Position

The following drum lowering operation is for mast hoist (Drum 5) while raising from transport position 0° (mast lowering) to 160°. Node-4 controller monitors the mast angle sensor in Setup mode.

When Setup mode is selected, Node-4 controller sends a 24 volt output to drum 5 diverting solenoid valve HS-14 to shift solenoid valve and apply hydraulic pressure to shift diverting valve to open lines to drum 5 motor and close lines to main hoist 2 motor.

When mast hoist (Drum 5) control handle is moved forward for ***lowering*** mast, an input voltage of 2.4 volts or less is sent to node-1 controller. Node-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to main hoist pump 2/5 EDC in the lower direction.

18CSM1-132

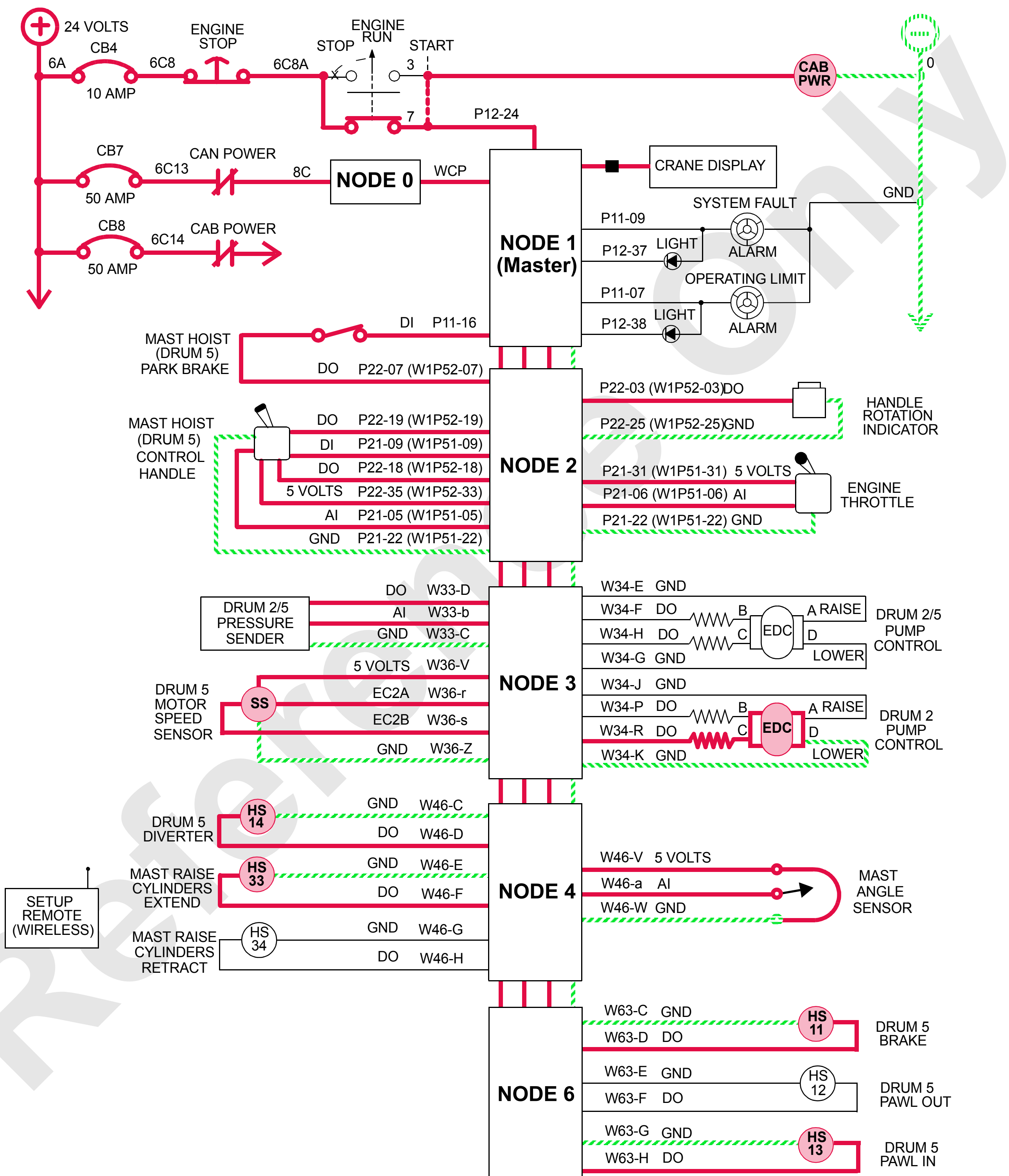



**FIGURE 1-34**

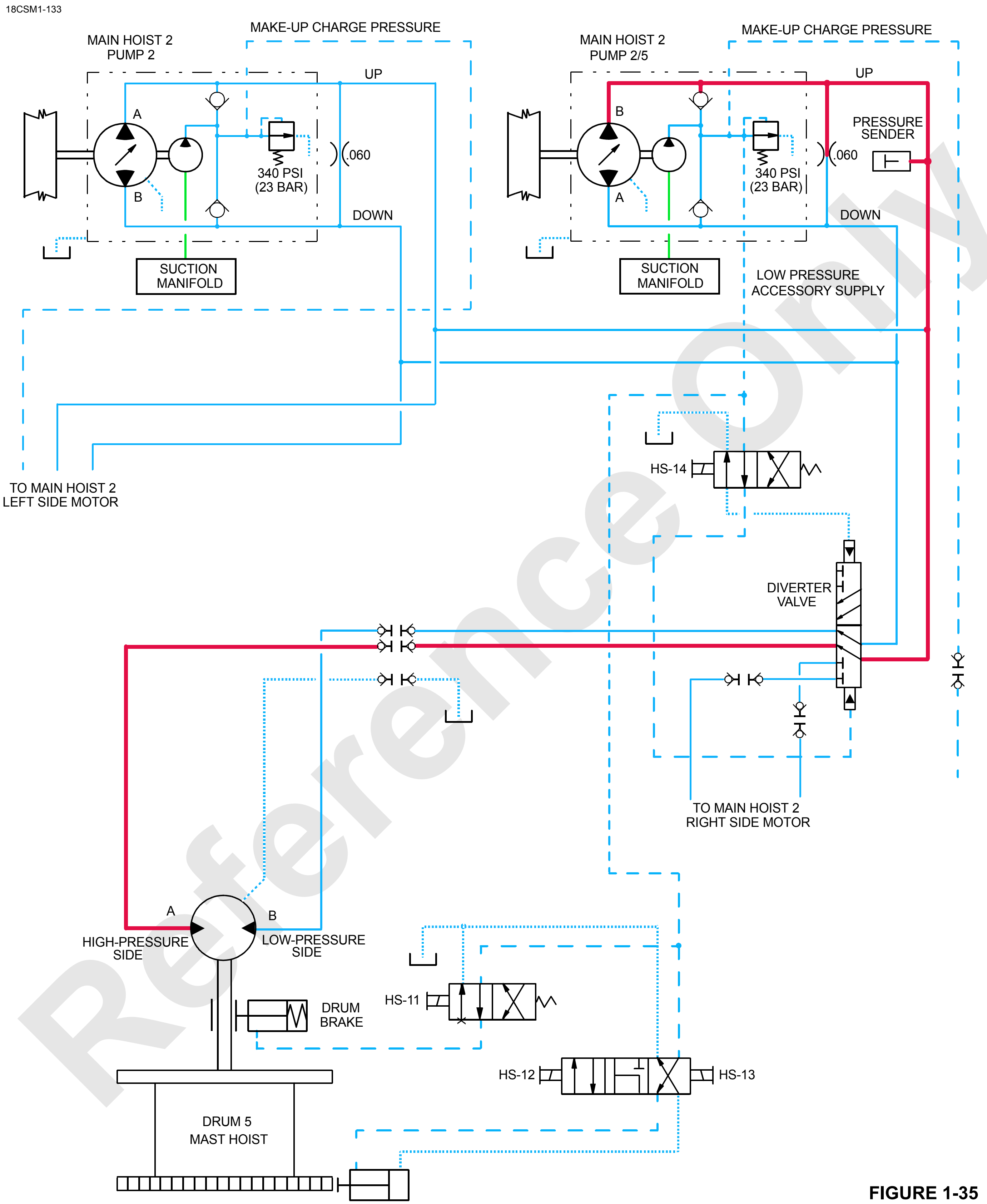

18CSM1-133
MAIN HOIST 2
PUMP 2
MAKE-UP CHARGE PRESSURE
UP
A
B
340 PSI
(23 BAR)
.060
DOWN
SUCTION
MANIFOLD
MAIN HOIST 2
PUMP 2/5
MAKE-UP CHARGE PRESSURE
UP
B
A
340 PSI
(23 BAR)
.060
PRESSURE
SENDER
DOWN
SUCTION
MANIFOLD
LOW PRESSURE
ACCESSORY SUPPLY
TO MAIN HOIST 2
LEFT SIDE MOTOR
HS-14
DIVERTER
VALVE
TO MAIN HOIST 2
RIGHT SIDE MOTOR
A
B
HIGH-PRESSURE
SIDE
LOW-PRESSURE
SIDE
DRUM
BRAKE
HS-11
HS-12
HS-13
DRUM 5
MAST HOIST

FIGURE 1-35

Main hoist 2/5 pump EDC tilts swashplate in the up direction to satisfy pressure memory. Node-1 controller compares drum holding pressure to value in pressure memory. When system pressure is high enough, node-6 controller sends a 24 volt output to drum brake solenoid valve HS-11. The drum brake solenoid shifts to block drain port and opens charge pressure port from pump 2/5 to release brake.

When brake is released, node-3 controller sends a 24 volt output voltage to pump EDC to tilt swashplate to stroke pump in the lower direction. In the lower direction, hydraulic fluid flow is from port B of pump to port A of motor. Return fluid is from port B of motor to port A of pump. As mast raises from transport position, mast hoist drum pays out wire rope between mast drum and gantry sheaves.

Node-4 controller sends a 24 volt output to enable mast raising cylinders solenoid valve HS-33 in extend (mast raising) direction. Solenoid valve shifts to block tank port and open port to system pressure controlled by node-1 controller.

The accessory system pressure builds with the actual pressure between a minimum of 500-psi (34 bar) at the beginning and 4,000 psi (276 bar) after the mast starts moving.

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

Fluid flow from rod end of mast raising cylinders is blocked by free-flow check valve sections on side “B” of counterbalance valves and flows through valve flow restrain sections preset for a relief pressure of 3,500 psi (240 bar). Counterbalance valves operate with a 5:1 pilot ratio of the relief valve pressure, permitting valve to open when pressure in rod end of the cylinders is approximately 700 psi (48 bar). Hydraulic fluid from side “B” sections of both counterbalance valves combines, and the free-flow check valve section on side “B” of load equalizing valve blocks the flow.

The fluid then passes through the valve flow restrain section that is preset at 4,000 psi (276 bar). Load equalizing valve operates with a 1.5:1 pilot ratio of the relief valve pressure, permitting valve to open when the hydraulic pressure on side “A” of the load-equalizing valve is approximately 2,670 psi (185 bar). Restraining section on side “B” of load equalizing valve opens, controlling flow of fluid out of the cylinders to ensure cylinder operation is balanced.

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

Node-4 controller monitors the mast angle sensor when mast is moving. When mast is raised to 115°, node-3 controller sends a zero output voltage to pump EDC. Node-4 controller sends a zero output voltage to shift spool of mast raising cylinder solenoid valve HS-33 to center position.

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

The live mast continues to lower until the mast hoist control handle is moved to neutral position. Node-3 controller sends a zero output voltage to main hoist pump 2/5 EDC that moves swashplate to center position.

After control handle center switch opens, node-6 controller sends a zero output voltage is sent to disable mast hoist brake solenoid valve HS-11 to apply brake before pump de-strokes.

## Mast Hoist Raising to Transport Position

The following drum raising operation is for mast hoist (Drum 5) while lowering from 160° to transport position 0° (mast raising). Node-4 controller monitors the mast angle sensor in Setup mode.

When Setup mode is selected, Node-4 controller sends a 24 volt output to drum 5 diverting solenoid valve HS-14 to shift solenoid valve and apply hydraulic pressure to shift diverting valve to open lines to drum 5 motor and close lines to main hoist 2 motor.

When mast hoist (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-3 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to main hoist pump 2/5 EDC in the raise direction.

Main hoist 2/5 pump EDC tilts the swashplate in the raise direction to satisfy pressure memory. Node-1 controller compares drum holding pressure to value in pressure memory. When system pressure is high enough, node-6 controller sends a 24 volt output to drum brake solenoid valve HS-11. The drum brake solenoid shifts to block drain port and opens charge pressure port from pump 2/5 to release brake.

When brake is released, node-3 controller sends a 24 volt output voltage to pump EDC to tilt swashplate to stroke pump in the raise direction. In the raise direction, hydraulic fluid flow is from port B of pump to port A of motor. Return fluid is from port B of motor to port A of pump. As mast raises to transport position, mast hoist drum hauls in wire rope between mast drum and gantry sheaves.

Before the mast is raised to 114°, mast angle sensor sends an input voltage to node-1 controller. Node-3 controller sends a 24 volt output to enable mast raising cylinders solenoid valve HS-33 in extend direction. The mast raising cylinders extend sequence is explained in “Mast Hoist Raising from Transport Position”.

When the mast is raised to 114°, the live mast is resting on the cylinder arms. The accessory system pressure builds with the actual pressure between a minimum of 3,000-psi (207 bar) at the beginning and 4,000 psi (276 bar) after the mast cylinders start moving down.

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

Fluid flow from piston end of mast raising cylinders is blocked by free-flow check valve sections on side “A” of counterbalance valves and flows through valve flow restrain sections preset for a relief pressure of 3,500 psi (240 bar). Counterbalance valves operate with a 5:1 pilot ratio of the relief valve pressure, permitting valve to open when pressure in piston end of the cylinders is approximately 700 psi (48 bar).

Hydraulic fluid from side “A” sections of both counterbalance valves combines, and the free-flow check valve section on side “A” of load equalizing valve blocks the flow. The fluid then passes through the valve flow restrain section that is preset at 4,000 psi (276 bar). Load equalizing valve operates with a 1.5:1 pilot ratio of the relief valve pressure, permitting valve to open when the hydraulic pressure on side “A” of the load-equalizing valve is approximately 2,670 psi (185 bar). Restraining section on side “B” of load equalizing valve opens, controlling flow of fluid out of the cylinders to ensuring cylinder operation is balanced.

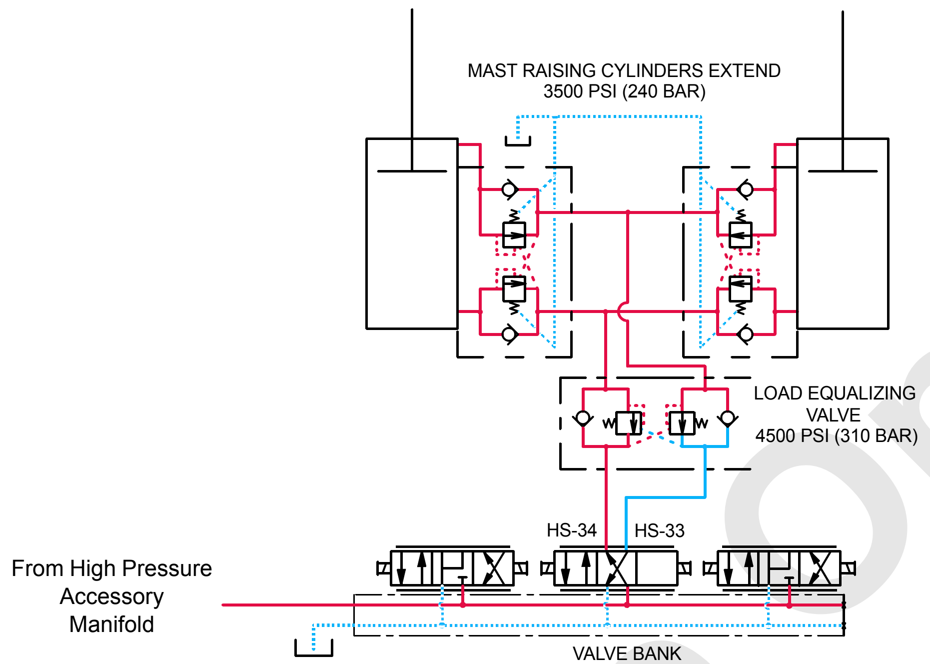
When the mast cylinders are retracting, node-3 controller monitors mast hoist drum speed sensor. Node-1 controller maintains a speed that is proportional to accessory system hydraulic pressure applied to the mast raising cylinders.

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

Node-4 controller monitors the mast angle sensor when mast is moving. When mast is at 0°, node-3 controller sends a zero output voltage to pump EDC that moves swashplate to center position. After control handle center switch opens, node-6 controller also sends a zero output voltage to disable mast hoist brake solenoid valve HS-11 to apply brake before mast hoist pump de-strokes.

Node-4 controller sends a zero output voltage to shift spool of mast raising cylinder solenoid valve HS-34 to center position.

18CSM1-134




18CSM1-135

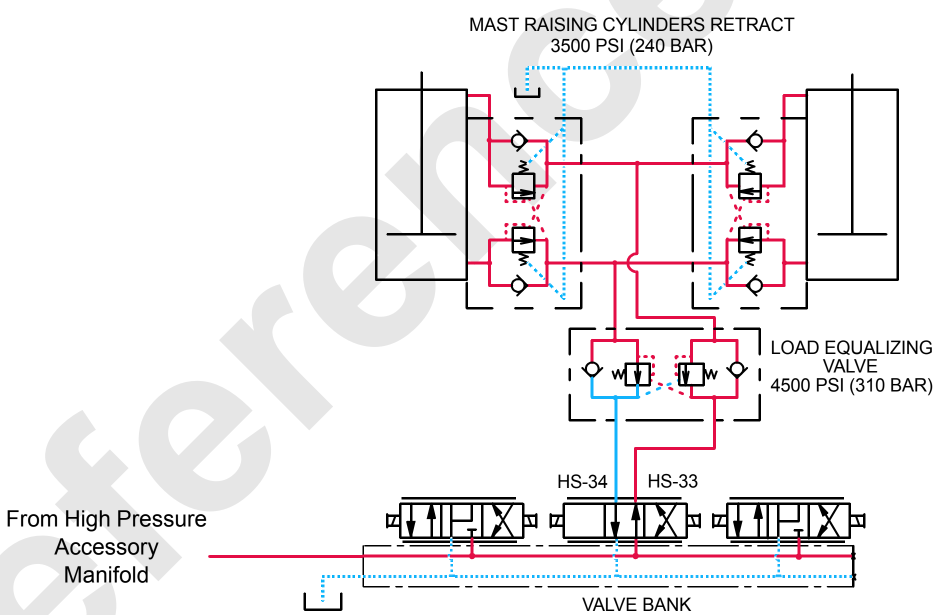



**FIGURE 1-36**

# LUFFING JIB DRUM 6 (OPTIONAL) SYSTEM

## Luffing Jib System Components

See Figures 1-37 and 1-38 for the following procedure.

One hydraulic pump drives one hydraulic motor and gearbox on luffing jib drum. In Luffing Jib mode luffing jib hoist (Drum 6) is controlled with control handle on left side console, while the boom hoist (Drum 4) is controlled by control handle on far right of right side console. Luffing jib control handle is inoperable when luffing jib park brake is applied.

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

When luffing jib motor rotates, a speed sensor monitors motor rotor movement and sends an input voltage to node-1 controller. Node-2 controller sends a 24 volt output to rotation indicator in control handle. As luffing jib drum rotates faster, the rotation indicator on top of control handle pulsates with a varying frequency that indicates drum rotational speed.

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

## Luffing Jib Brake and Pawl

Hydraulic pressure to operate luffing jib brake is from low-pressure side of luffing jib system. An electrical motor operates the boom hoist drum pawl.

When luffing jib (Drum 6) brake switch is in on - park position, luffing jib brake solenoid valve HS-15 is disabled to apply brake to drum. Luffing jib electric drum pawl in relay K1 is enabled to keep pawl applied to boom hoist drum. Boom hoist pump does not stroke in response to boom hoist control handle movement.

When luffing jib (Drum 6) brake switch is placed in off - park position, luffing jib brake remains applied to luffing jib drum until node-8 controller sends a 24 volt output to brake solenoid valve HS-15 to release brake. Node-8 controller sends 24 volt output to enable luffing jib pawl electric motor K2 relay in the pawl out direction. Luffing jib system circuit is active, waiting for a control handle command.

## Luffing Jib Raise

Node-1 controller checks that luffing jib up limit switch is closed and no hydraulic system fault is present. If a block up limit or RCL operating fault occurs while luffing, node-1 controller sends an output signal to stop luffing jib drum. Corrective action for these operating faults is to raise the jib.

When luffing jib control handle is moved back for luffing ***up***, an input voltage of 2.4 volts or less is sent to node-1 controller. Node-5 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to luffing pump EDC. Node-8 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to luffing motor PCP.

Pump EDC tilts swashplate in the ***up*** direction to satisfy pressure memory. Node-1 controller compares luffing holding pressure to value in pressure memory. When system pressure is high enough, node-8 controller sends a 24 volt output to luffing jib brake solenoid valve HS-15. The brake solenoid shifts to block drain port and opens port to low-pressure side of luffing jib system to release luffing jib drum brake.

Pump EDC continues to tilt swashplate in the up direction as hydraulic fluid flow is from port B of pump to port A of motor. Return fluid is from port B of motor to port A of pump.

Node-5 controller output voltage to pump EDC and node-8 controller output voltage to motor PCP is relative to control handle movement. As luffing jib control handle is moved back, pump swashplate angle is increased. When system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

Node controllers are continuously balancing system pressure and motor displacement angle so the motor displacement goes to minimum when control handle is all the way back, if the motor torque requirement is not too high. Node-6 controller monitors motor displacement and controls motor speed by regulating hydraulic fluid through the pump.

When luffing jib control handle is moved to neutral position, node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-5 controller sends a zero output voltage to luffing jib pump EDC that moves swashplate to center position. This shifts the motor back to maximum displacement for slower output speed to slow the drum rotation. The controller stores the load holding pressure in pressure memory. After control handle center switch opens, a zero output voltage is sent to disable luffing brake solenoid valve HS-15 to apply brake before pump de-strokes.

18CSM1-136

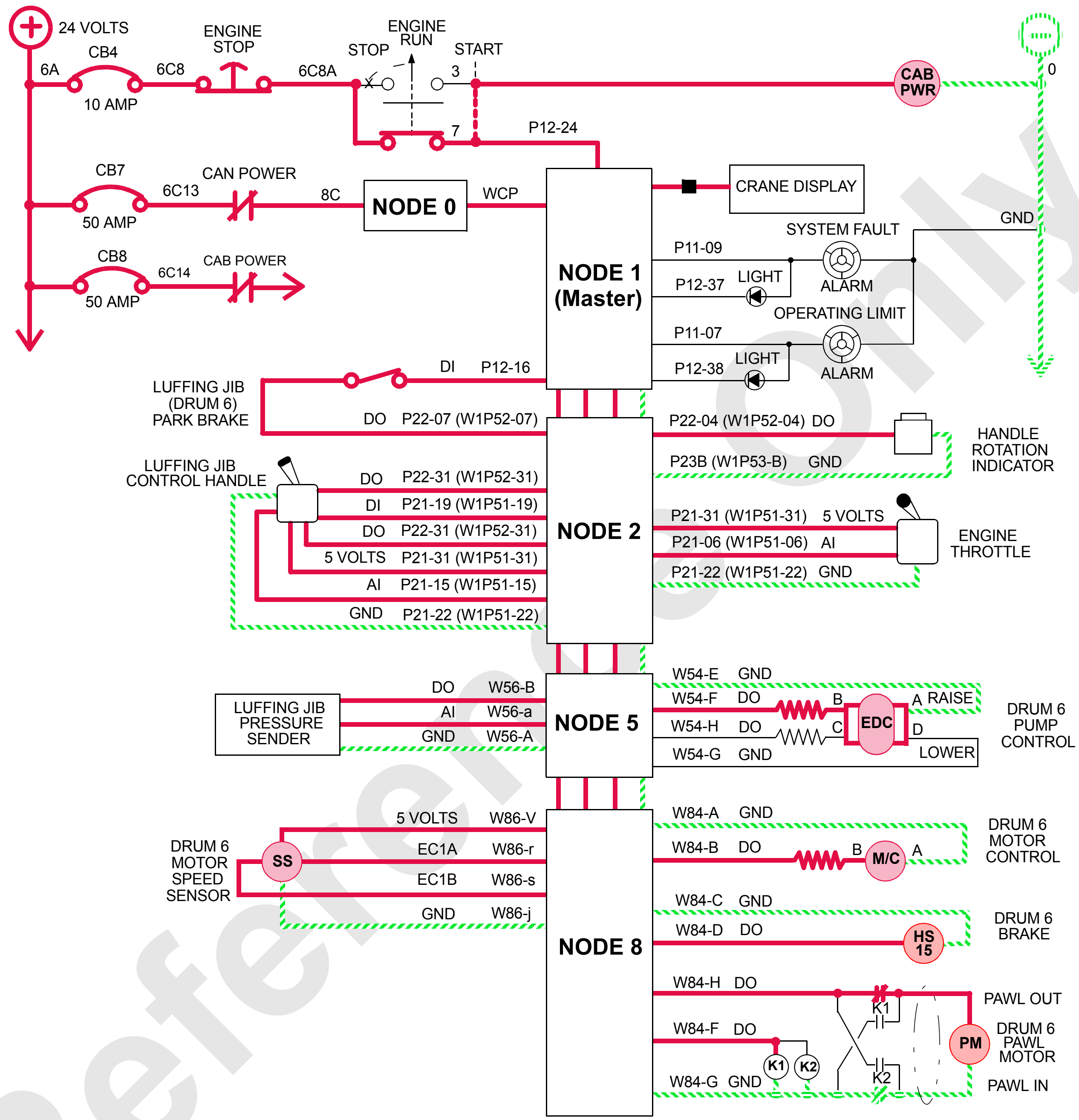



**FIGURE 1-37**

## Luffing Jib Lower

When luffing jib control handle is moved forward for luffing ***down***, an input voltage of 2.6 volts or more is sent to node-1 controller. Node-5 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to luffing pump EDC. Node-8 controller sends a variable zero to 24 volt output that is divided by a resistor and applied to motor PCP.

Pump EDC tilts swashplate in the ***up*** direction to satisfy pressure memory. Node-1 controller compares luffing holding pressure to value in pressure memory. When system pressure is high enough, node-8 controller sends a 24 volt output to luffing jib brake solenoid valve HS-15. The brake solenoid shifts to block drain port and opens port to low-pressure side of luffing jib system to release luffing jib drum brake.

When brake is released, pump EDC continues to tilt swashplate to stroke pump in the down direction. In the down direction, hydraulic fluid flow is from port A of pump to port B of motor. Return fluid is from port A of motor to port B of pump.

Node-5 controller output voltage to pump EDC and node-8 controller output voltage to motor PCP is relative to control handle movement. As luffing jib control handle is pushed forward, pump swashplate angle is increased. When system pressure exceeds the PCOR (Pressure Compensating Over-Ride) valve setting of 4,930 psi (340 bar), the valve shifts to direct flow from shuttle valve into maximum displacement side of servo cylinder. The PCOR valve over-rides the command from servo PC valve, increasing motor displacement and output torque and reducing output speed. When PCOR valve closes, control of the motor returns to servo PC valve.

Node controllers are continuously balancing the system pressure and the motor displacement angle so the motor displacement goes to minimum when control handle is all the way forward, if the motor torque requirement is not too high. Node-8 controller monitors motor displacement and controls motor speed by regulating the hydraulic fluid flow through the pump.

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

When luffing jib control handle is moved to neutral position, node-1 controller compensates for hydraulic system leakage or changing engine speed. Node-5 controller sends a zero output voltage to luffing jib pump EDC that moves swashplate to center position. This shifts the motor back to maximum displacement for slower output speed to slow the drum rotation. Node-1 controller stores the load holding pressure in pressure memory. After control handle center switch opens, Node-8 controller sends a zero output to disable luffing jib brake solenoid valve HS-15 to apply brake before luffing jib pump de-strokes.

18CSM1-137

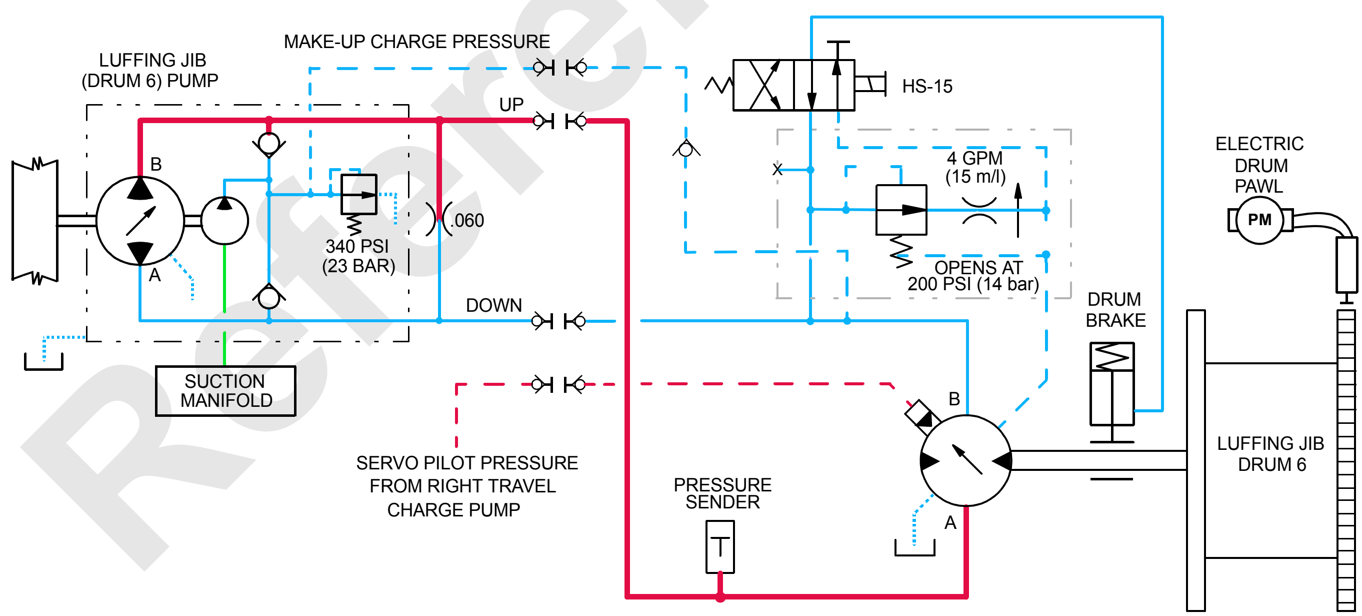



**FIGURE 1-38**

# ACCESSORY SYSTEM COMPONENTS

## Accessory Systems

Accessory system components include the rotating bed jacking cylinders, adapter frame pins, boom hinge pins, mast pins, mast raising cylinders, cab tilt, and rigging winch.

The accessory pumps are the hydraulic pressure source to operate accessory system components. The accessory system proportional relief valve is controlled by node-5 controller. The accessory system and the high pressure accessory system pressure are monitored by separate pressure senders. During normal operation the relief valve is set at approximately 150 psi (10 bar). Excess supply flow from fixed displacement accessory pump is dumped through valve to tank. When a component of either accessory system is enabled, an input signal is sent to node-1 controller. Node-5 controller sends a variable 0 to 24 volt signal to accessory system proportional relief valve solenoid to increase the relief valve setting up to 3,000 psi (207 bar), except for mast raising cylinders where the pressure is 4,000 psi (276 bar). The accessory systems pressure increases to operate selected component.

Power is available to hand-held radio remote control when Setup Remote mode is selected, engine is running, and power button is pressed.

## Jacking Cylinders

See Figures 1-39 and 1-40 for the following procedure.

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

**WARNING**

**Collapsing Hazard!**

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

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

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

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

### *Rotating bed Jacking - Raise*

Move desired jacking switch to extend position and hold. An input voltage is sent to node-1 controller. Node-6 controller sends a 24 volt output to enable selected jacking cylinder proportional control valve (HS-20) and shifts valve to the raise position. Node-5 controller sends a variable zero to 24 volt output voltage to enable accessory system proportional relief valve.

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to selected jacking cylinder(s) proportional control valve. Hydraulic fluid exits valve and enters free-flow check valve section of jacking cylinder counterbalance valve. Hydraulic fluid then enters piston end of jacking cylinder, extending cylinder to raise the rotating bed. Node-4 controller monitors accessory system pressure sender to control jacking cylinder raising speed rate.

Hydraulic fluid returning to tank from rod end of the jacking cylinder is blocked by the free-flow check valve section of counterbalance valve and flows through flow restraining section that has a relief setting of 2,500 psi (172 bar). The counterbalance valve acts as a deceleration control and functions with a 3:1 pilot ratio of the relief pressure. This permits the valve to open when the pressure in rod end of the cylinder is approximately 833 psi (57 bar). Restraining section of counterbalance valve opens, controlling the fluid out of the jacking cylinder. Hydraulic fluid then flows through free-flow check valve section of flow control valve before entering lower accessory valve. Hydraulic fluid leaving the lower accessory valve is returned to tank.

When rotating bed switch is moved back to center position, node-4 controller sends a zero output voltage to shift spool of rotating bed solenoid valve HS-20 to center position.

### *Rotating bed Jacking - Lower*

Move desired jacking switch to retract position and hold. An input voltage is sent to node-1 controller. Node-6 controller sends a 24 volt output to enable selected jacking cylinder proportional control valve HS-21 and shifts valve to the lower position. Node-5 controller sends a variable zero to 24 volt output voltage to enable accessory system proportional relief valve.

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to selected jacking cylinder(s) proportional control valve. Hydraulic fluid exits valve and enters the restraining section of flow control valve. The restraining section controls the rate of speed for the cylinder to retract by limiting the fluid velocity before passing through the free-flow check valve section of counterbalance valve. Hydraulic fluid then flows to rod end of jacking cylinder.

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

Hydraulic fluid returning to tank from piston end of the jacking cylinder is blocked by the free-flow check valve section of counterbalance valve. From counterbalance valve flow is through flow restraining section that has a relief setting of 2,500 psi (172 bar). The counterbalance valve acts as a deceleration control and functions with a 3:1 pilot ratio of the relief pressure. This permits the valve to open when the pressure in piston end of the cylinder is approximately 833 psi (57 bar).

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

When rotating bed switch is moved back to center position, node-4 controller sends a zero output voltage to shift spool of rotating bed solenoid valve HS-21 to center position.

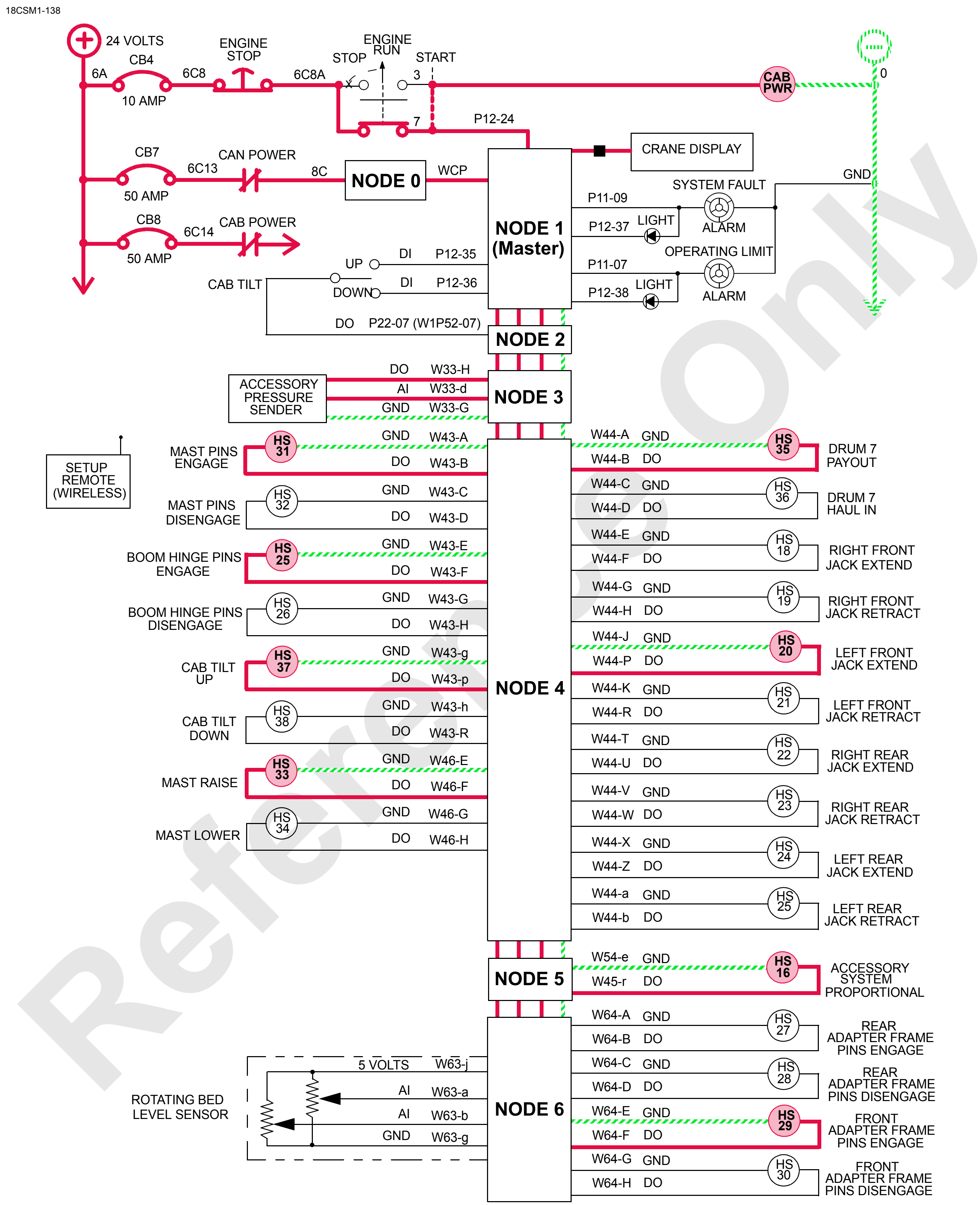

18CSM1-138
24 VOLTS
CB4
6A
10 AMP
6C8
ENGINE STOP
6C8A
STOP
ENGINE RUN
START
CAB PWR
P12-24
CB7
6C13
CAN POWER
8C
NODE 0
WCP
50 AMP
CB8
6C14
CAB POWER
CRANE DISPLAY
NODE 1 (Master)
SYSTEM FAULT
P11-09
P12-37
LIGHT
ALARM
OPERATING LIMIT
P11-07
P12-38
GND
UP
DOWN
DI
P12-35
P12-36
CAB TILT
DO
P22-07 (W1P52-07)
NODE 2
ACCESSORY PRESSURE SENDER
W33-H
AI
W33-d
W33-G
NODE 3
SETUP REMOTE (WIRELESS)
MAST PINS ENGAGE
HS 31
W43-A
W43-B
MAST PINS DISENGAGE
HS 32
W43-C
W43-D
BOOM HINGE PINS ENGAGE
HS 25
W43-E
W43-F
BOOM HINGE PINS DISENGAGE
HS 26
W43-G
W43-H
CAB TILT UP
HS 37
W43-g
W43-p
CAB TILT DOWN
HS 38
W43-h
W43-R
MAST RAISE
HS 33
W46-E
W46-F
MAST LOWER
HS 34
W46-G
W46-H
NODE 4
W44-A
W44-B
HS 35
DRUM 7 PAYOUT
W44-C
W44-D
HS 36
DRUM 7 HAUL IN
W44-E
W44-F
HS 18
RIGHT FRONT JACK EXTEND
W44-G
W44-H
HS 19
RIGHT FRONT JACK RETRACT
W44-J
W44-P
HS 20
LEFT FRONT JACK EXTEND
W44-K
W44-R
HS 21
LEFT FRONT JACK RETRACT
W44-T
W44-U
HS 22
RIGHT REAR JACK EXTEND
W44-V
W44-W
HS 23
RIGHT REAR JACK RETRACT
W44-X
W44-Z
HS 24
LEFT REAR JACK EXTEND
W44-a
W44-b
HS 25
LEFT REAR JACK RETRACT
NODE 5
W54-e
W45-r
HS 16
ACCESSORY SYSTEM PROPORTIONAL
NODE 6
W64-A
W64-B
HS 27
REAR ADAPTER FRAME PINS ENGAGE
W64-C
W64-D
HS 28
REAR ADAPTER FRAME PINS DISENGAGE
W64-E
W64-F
HS 29
FRONT ADAPTER FRAME PINS ENGAGE
W64-G
W64-H
HS 30
FRONT ADAPTER FRAME PINS DISENGAGE
ROTATING BED LEVEL SENSOR
5 VOLTS
W63-j
W63-a
W63-b
W63-g

**FIGURE 1-39**

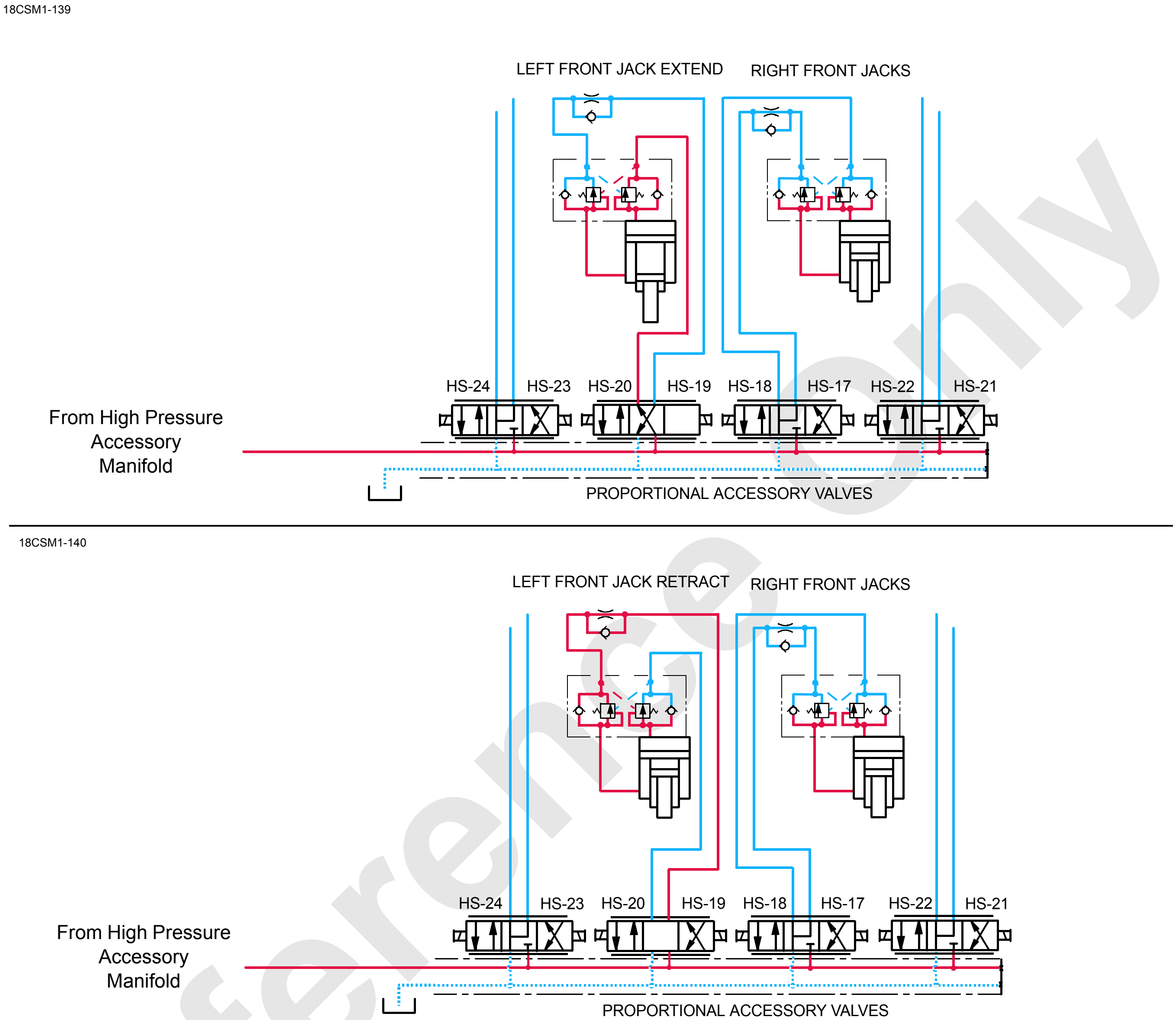

18CSM1-139
LEFT FRONT JACK EXTEND
RIGHT FRONT JACKS
HS-24
HS-23
HS-20
HS-19
HS-18
HS-17
HS-22
HS-21
From High Pressure Accessory Manifold
PROPORTIONAL ACCESSORY VALVES
18CSM1-140
LEFT FRONT JACK RETRACT
RIGHT FRONT JACKS
HS-24
HS-23
HS-20
HS-19
HS-18
HS-17
HS-22
HS-21
From High Pressure Accessory Manifold
PROPORTIONAL ACCESSORY VALVES

**FIGURE 1-40**

## Boom Hinge Pins

See Figures 1-39 and 1-41 for the following procedure.

During normal operation the boom hinge pins solenoid valve is “motor spooled” where both cylinder ports and tank port of valve spool section are connected in center position.

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

When boom hinge pins switch is placed in the engage position and held, an input voltage is sent to node-1 controller. Node-4 controller sends a 24 volt output to enable boom hinge pins solenoid valve HS-25 and shifts valve to the engage position. Node-5 controller sends a variable zero to 24 volt output voltage to enable accessory system proportional relief valve.

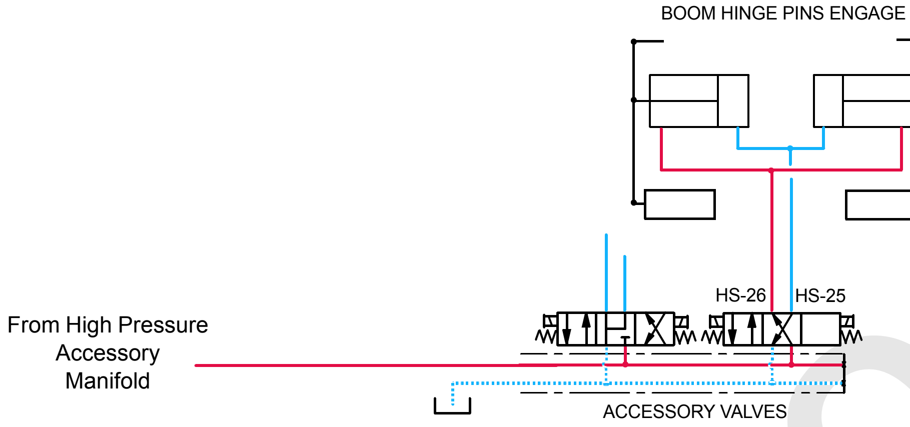
When an accessory valve spool shifts, supply flow to the other accessory valves is limited. The accessory system pressure sender monitors accessory system pressure.

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to boom hinge pins accessory valve. Hydraulic fluid leaves the accessory valve and enters rod end of boom pin cylinder, retracting cylinder rod to engage the boom hinge pins. Hydraulic fluid from piston end of boom pin cylinder leaves accessory system valve and returns to tank. When boom hinge pins switch is released, solenoid valve HS-25 returns to center position.

When boom hinge pins switch is placed in the disengage position and held an input voltage is sent to node-1 controller. Node-4 controller sends a 24 volt output to enable boom hinge pins solenoid valve HS-26 and shifts valve to the disengage position. Node-5 controller sends a variable zero to 24 volt output voltage to enable accessory system proportional relief valve.

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to boom hinge pins accessory valve. Hydraulic fluid leaves the accessory valve and enters piston end of boom pin cylinder, extending cylinder rod to disengage the boom hinge pins. Hydraulic fluid from rod end of boom pin cylinder leaves accessory system valve and returns to tank. When boom hinge pins switch is released, solenoid valve HS-26 returns to center position.

18CSM1-152




18CSM1-141

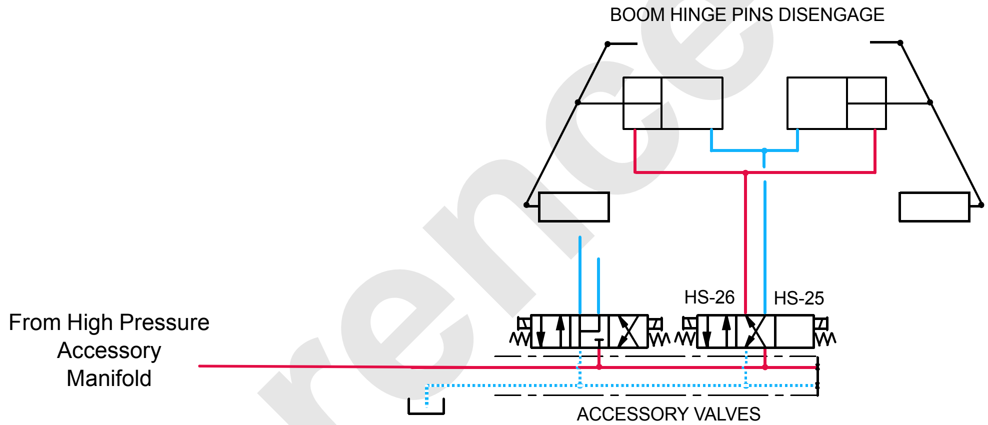



**FIGURE 1-41**

## Adapter Frame Pins

See Figures 1-39 and 1-42 for the following procedure.

During normal operation the adapter frame pins solenoid valve is “motor spooled” where both cylinder ports and tank port of valve spool section are connected in center position.

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

When front or rear adapter frame pins switch is placed in the engage position and held, an input voltage is sent to node-1 controller. Node-6 controller sends a 24 volt output to enable selected adapter frame pins solenoid valve HS-29 (front) or HS-27 (rear) and shifts valve to the engage position. Node-5 controller sends a variable zero to 24 volt output voltage to enable accessory system proportional relief valve.

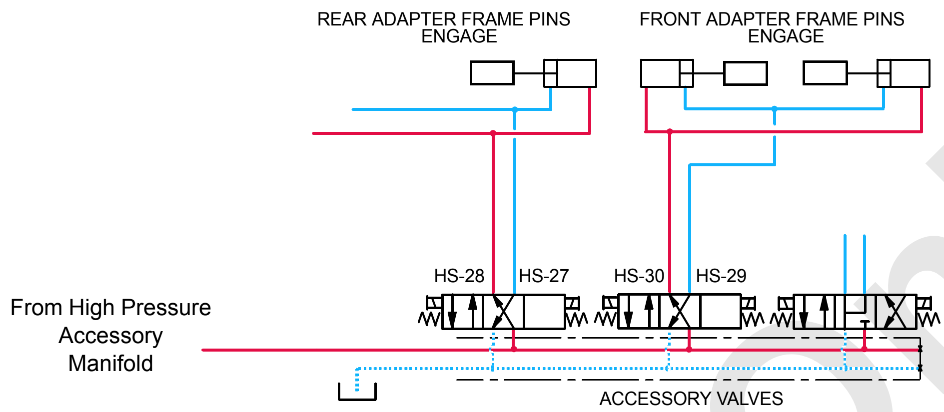
When an accessory valve spool shifts, supply flow to the other accessory valves is limited. The accessory system pressure sender monitors accessory system pressure.

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to adapter frame pins accessory valve. Hydraulic fluid leaves the accessory valve and enters piston end of selected pin cylinders, extending cylinder rod to engage the adapter frame pins. Hydraulic fluid from rod end of pin cylinders leaves accessory system valve and returns to tank. When adapter frame pins switch is released, solenoid valve HS-29 (front) or HS-27 (rear) returns to center position.

When adapter frame pins switch is placed in the disengage position and held, an input voltage is sent to node-1 controller. Node-6 controller sends a 24 volt output to enable selected adapter frame pins solenoid valve HS-30 (front) or HS-28 (rear) and shifts valve to the disengage position. Node-5 controller sends a variable zero to 24 volt output voltage to enable accessory system proportional relief valve.

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to adapter frame pins accessory valve. Hydraulic fluid leaves the accessory valve and enters rod end of pin cylinders, retracting cylinder rods to disengage the adapter frame pins. Hydraulic fluid from piston end of pin cylinders leaves accessory system valve and returns to tank. When adapter frame pins switch is released, solenoid valve HS-30 (front) or HS-28 (rear) returns to center position.

18CSM1-142




18CSM1-143

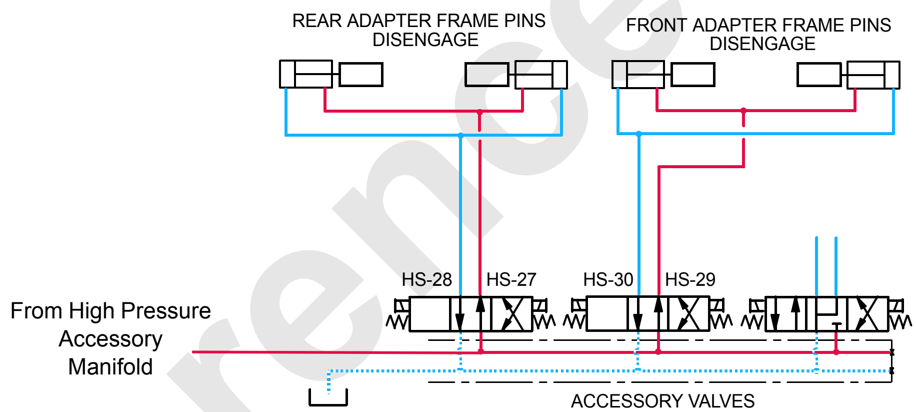



**FIGURE 1-42**

## Mast Pins

See Figures 1-39 and 1-43 for the following procedure.

During normal operation the mast pins solenoid valve is “motor spooled” where both cylinder ports and tank port of valve spool section are connected in center position.

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

When mast pins switch is placed in the engage position and held, an input voltage is sent to node-1 controller. Node-4 controller sends a 24 volt output to enable mast pins solenoid valve HS-31 and shifts valve to the engage position. Node-5 controller sends a variable zero to 24 volt output voltage to enable accessory system proportional relief valve.

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

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to mast pins accessory valve. Hydraulic fluid leaves the accessory valve and enters piston end of mast pin cylinders, extending cylinder rods to engage the mast pins. Hydraulic fluid from rod end of mast pin cylinders leaves accessory system valve and returns to tank. When mast pins switch is released, solenoid valve HS-31 returns to center.

When mast pins switch is placed in disengage position and held an input voltage is sent to node-1 controller. Node-4 controller sends a 24 volt output to enable mast pins solenoid valve HS-32 and shifts valve to disengage position. Node-5 controller sends a variable zero to 24 volt output voltage to enable accessory system proportional relief valve.

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to mast pins accessory valve. Hydraulic fluid exits accessory valve and enters rod end of mast pin cylinders, extending cylinder rods to disengage the mast pins. Hydraulic fluid from piston end of mast pin cylinders exits accessory system valve and returns to tank. When mast pins switch is released, solenoid valve HS-32 returns to center.

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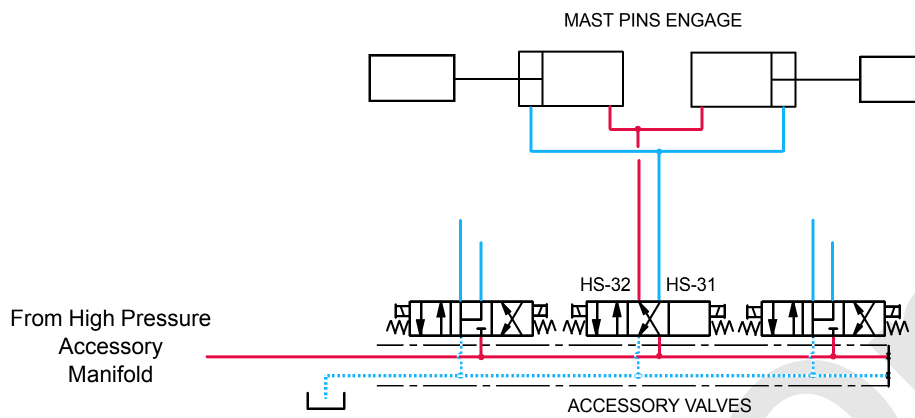


18CSM1-145

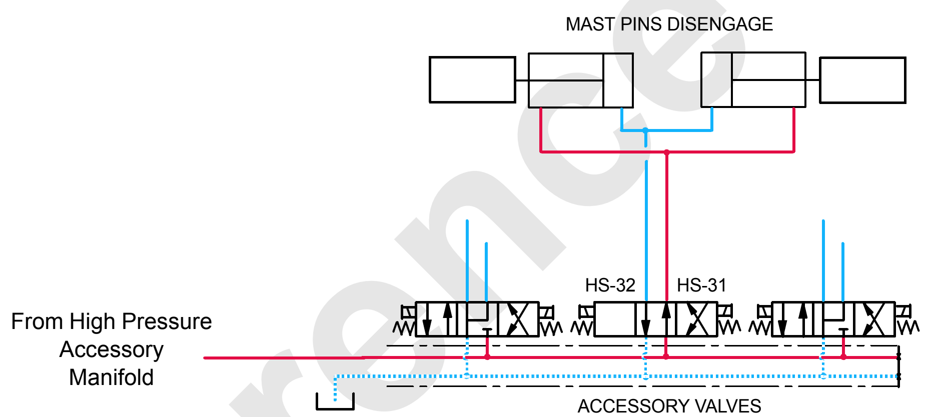


**FIGURE 1-43**

## Rigging Winch (Drum 7)

See Figures 1-39 and 1-44 for the following procedure.

The rigging winch (Drum 7) is located in the boom butt. During normal operation the rigging winch solenoid valve is “motor spooled” where both cylinder ports and tank port of valve spool section are connected in center position.

Power is available to hand-held radio remote control when setup remote mode is selected, engine is running, and power button is pressed.

When rigging winch switch is placed in pay out position and held, an input voltage is sent to node-1 controller. Node-4 controller sends a 24 volt output to enable rigging solenoid valve HS-35 and shifts valve to the pay out position. Node-5 controller sends a variable zero to 24 volt output voltage to enable accessory system proportional relief valve.

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

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to rigging winch accessory valve. Hydraulic fluid leaves the accessory valve and enters pay out side of winch motor to pay out wire rope at a fixed speed. Return hydraulic fluid from motor leaves accessory system valve and returns to tank. When rigging winch switch is released, solenoid valve HS-35 returns to center position.

When rigging winch switch is placed in the haul in position and held an input voltage is sent to node-1 controller. Node-4 controller sends a 24 volt output to enable rigging winch solenoid valve HS-36 and shifts valve to the haul in position. Node-5 controller sends a variable zero to 24 volt output voltage to enable accessory system proportional relief valve.

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to rigging winch accessory valve. Hydraulic fluid leaves the accessory valve and enters haul in side of winch motor to haul in wire rope at a fixed speed. Return hydraulic fluid from motor leaves accessory system valve and returns to tank. When rigging winch switch is released, solenoid valve HS-36 returns to center position.

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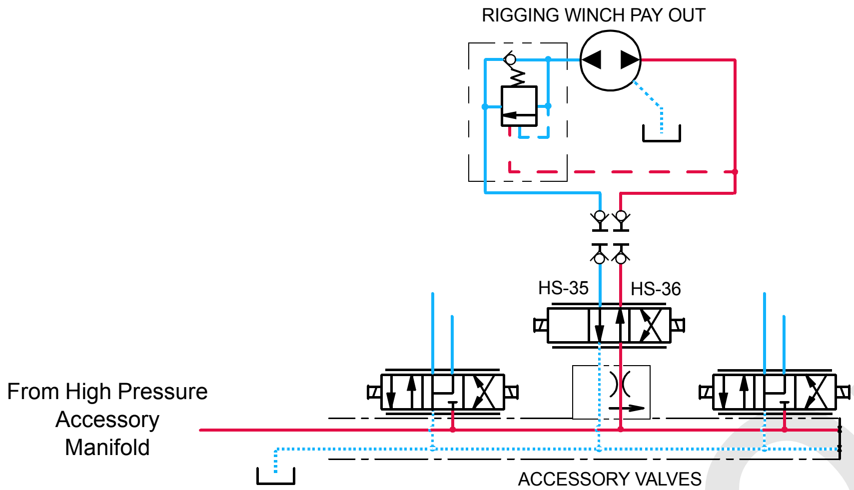


18CSM1-147

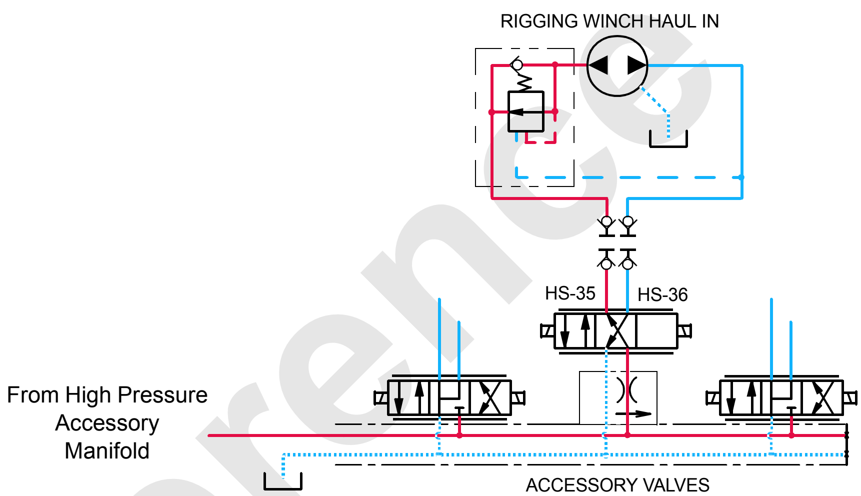


**FIGURE 1-44**

## Cab Tilt

See Figures 1-39 and 1-45 for the following procedure.

The cab tilt cylinder is attached to cab frame. During normal operation the cab tilt solenoid valve is “motor spooled” where both cylinder ports and tank port of valve spool section are connected in center position. The cab tilt switch is on the right side console in operator’s cab.

When top of cab tilt switch (raise front of cab) is pushed and held, an input voltage is sent to node-1 controller. Node-4 controller sends a 24 volt output to enable cab tilt up solenoid valve HS-37 and shifts valve to the up position. Node-5 controller sends a variable zero to 24 volt output voltage to enable accessory system proportional relief valve.

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to cab tilt accessory valve. Hydraulic fluid exits valve and enters free-flow check valve before entering piston end of cylinder, extending cylinder rod to raise the cab front.

Hydraulic fluid from rod end of cylinder enters free-flow check valve before entering accessory valve and returns to tank. When cab tilt switch is released, solenoid valve HS-37 returns to center position.

When bottom of cab tilt switch (lower front of cab) is pushed and held, an input voltage is sent to node-1 controller. Node-4 controller sends a 24 volt output to enable solenoid valve HS-38 and shifts valve to the lower position. Node-5 controller sends a variable zero to 24 volt output voltage to enable accessory system proportional relief valve.

Hydraulic fluid pressure at approximately 3,000 psi (204 bar) flows to cab tilt accessory valve. Hydraulic fluid exits valve and enters free-flow check valve before entering rod end of cylinder, retracting cylinder rod to lower the cab front.

Hydraulic fluid from piston end of cylinder enters free-flow check valve before entering accessory system valve and returns to tank. When cab tilt switch is released, solenoid valve HS-38 returns to center position.





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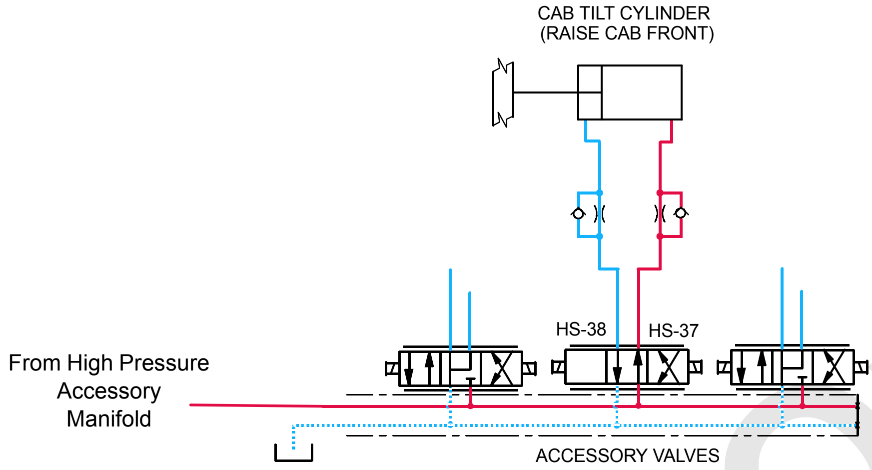


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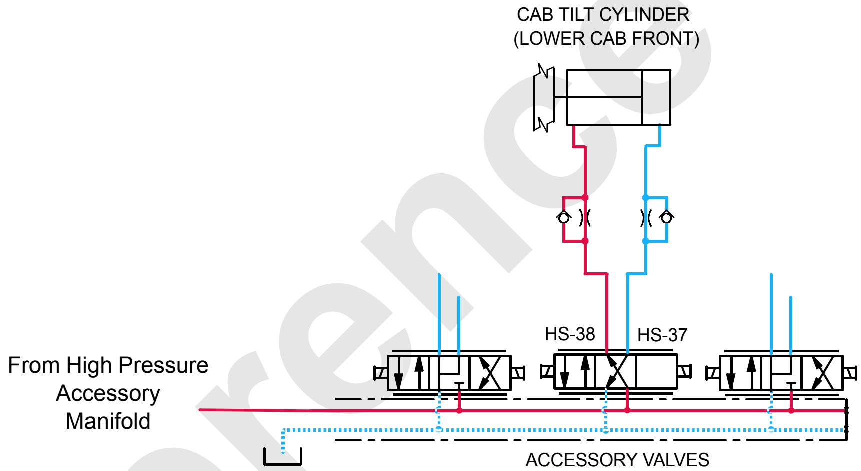



**FIGURE 1-45**

# CRAWLER PIN CYLINDERS

## Crawler Pin Cylinders

See Figure 1-46 for the following procedure.

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

The accessory pump is the hydraulic pressure source to operate crawler pin cylinders. The accessory system proportional relief valve is controlled by node-5 controller. The high pressure accessory system pressure is monitored by a pressure sender. During normal operation the proportional relief valve is set at approximately 150 psi (10 bar). Excess supply flow from fixed displacement accessory pump is dumped through valve to tank.

When a component of accessory system is enabled, an input signal is sent to node-1 controller. Node-5 controller sends a variable 0 to 24 volt signal to accessory system proportional relief valve solenoid to increase the relief valve setting to approximately 3,000 psi (207 bar). The high pressure accessory systems pressure increases to operate selected component. Node-1 controller monitors system pressure.

Pull crawler pin handle down to engage crawler pins into crawler track frame. This shifts selected crawler pins lower accessory valve to block supply through valve and opens supply port to cylinders.

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

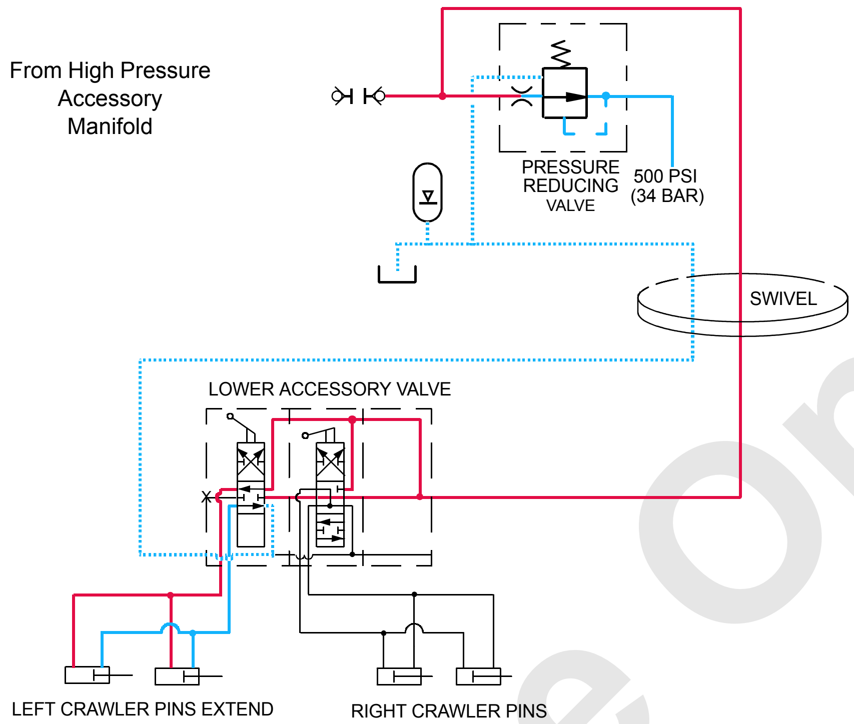
When crawler pin handle is moved back to center position, the selected crawler pin valve shifts to center position and opens line to cylinders.

Push selected crawler pin handle up to disengage crawler pins from crawler track frame. This shifts selected crawler pins lower accessory valve to block supply through valve and opens supply port to cylinders.

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

When crawler pin handle is moved back to center position, the selected crawler pin valve shifts to center position and opens line to cylinders.

18CSM1-150




18CSM1-151

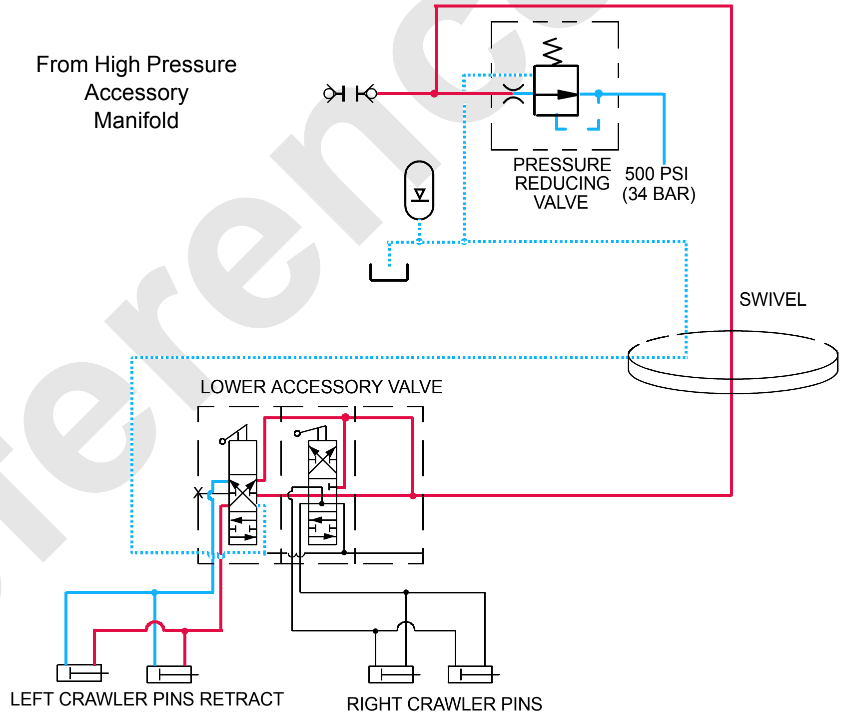



FIGURE 1-46

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# SECTION 2
# HYDRAULIC SYSTEM

## TABLE OF CONTENTS

# SECTION 2
# HYDRAULIC SYSTEM

## HYDRAULIC SCHEMATICS

Hydraulic schematics are attached at the end of this section.

## HYDRAULIC SYSTEM – GENERAL

This section contains hydraulic system maintenance, adjustment, calibration, and test procedures for the hydraulic system and related components on the Model 18000.

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

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

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

**CAUTION**

Do not alter hydraulic system specifications given in this section without approval of your Manitowoc dealer.

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

## CHECKING AND REPLACING HYDRAULIC HOSES

**CAUTION**

**Burn Hazard!**

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

Ensure that hydraulic hose is de-pressurized before loosening any connections.

1. Visually inspect all hydraulic hose assemblies every month or at 200 hours of service life for the following:
   - **a.** Leaks at hose fittings or in hose
   - **b.** Damaged, cut, or abraded cover
   - **c.** Exposed reinforcement
   - **d.** Kinked, crushed, flattened, or twisted hose
   - **e.** Hard, stiff, heat cracked, or charred hose
   - **f.** Blistered, soft, degraded, or loose cover
   - **g.** Cracked, damaged, or badly corroded fitting
   - **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, guards, 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. It is recommended that hydraulic hose assemblies operating in ***Zone C*** be replaced after 8,000 hours of service life.

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

**Table 2-1 Climate Zone Classification**:

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

**5.** Hydraulic hose 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 these hoses be inspected to step 1 above as service life may be more than 8,000 hours.

# HYDRAULIC SYSTEM MAINTENANCE

## Safety

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

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

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

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

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

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

## Storing and Handling Oil

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

## Storing and Handling Parts

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

## Inspecting System

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

A good inspection program will include the following checks:

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

**2.** Only use approved hydraulic oil in system (see Lubrication Guide).

**3.** Check oil level in tank daily at sight gauge (12, Figure 2-2).

**NOTE:** Fill tank by removing fill cap (8a, Figure 2-2) or by pumping oil through power fill coupler (8b) with owner supplied portable pump.

***Do not fill tank through breather port or through top of either filter (9, Figure 2-2). Hydraulic system could be contaminated from unfiltered oil.***

On crane Serial Number 18001082 and newer, hydraulic oil level can also be monitored on the digital display during operation (see Figure 2-1).

| | | |
|---|---|---|
| 0 % | = | Empty |
| 100 % | = | Full Cold |
| 110 % | = | Full Hot |

| | |
|---|---|
| **HYD TANK FLUID LEVEL** | **100 %** |
| CURRENT (MAX) WIND SPEED | 20 MPH |
| PUMP DRIVE TEMP | 160 DEG |
| PUMP DRIVE PRESSURE | 25 PSI |

**FIGURE 2-1**

4. Clean exterior of system often. Do not let dirt accumulate on or around any part of system.
5. Check for external leaks. Leaks are not only unsafe, but they also attract dirt and in some cases allow air and water to enter system. Do not return leaked oil back to hydraulic tank.

   ***Do not to use your hands to check for leaks.***

   - Look for oil leaking from fittings and from between parts that are bolted together. Tighten loose fittings and attaching bolts to proper torque. Do not over tighten.
   - If leakage persists at these points, replace seals or gaskets.
   - Look for oil leaking from pump and motor shaft ends, from valve spool ends, and from cylinder shaft ends. Replace seal if leakage is found at any of these points.
   - Replace tubes that are cracked, kinked, or bent.
   - Replace hoses that are cracked, split, or abraded.
   - Listen to pumps and motors for unusual noises. A high pitched whine or scream can indicate that air is being drawn in.

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

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

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

6. Look for signs of overheating: 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).
7. 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.

## Hydraulic Tank Heater

On hydraulic tanks with one tank heater, replacement hydraulic tank heaters must be set prior to installation.

1. Remove top cover from heater by unscrewing cover.
2. Turn adjusting knob fully clockwise. This position is 100°F (38°C).
3. Re-install cover.

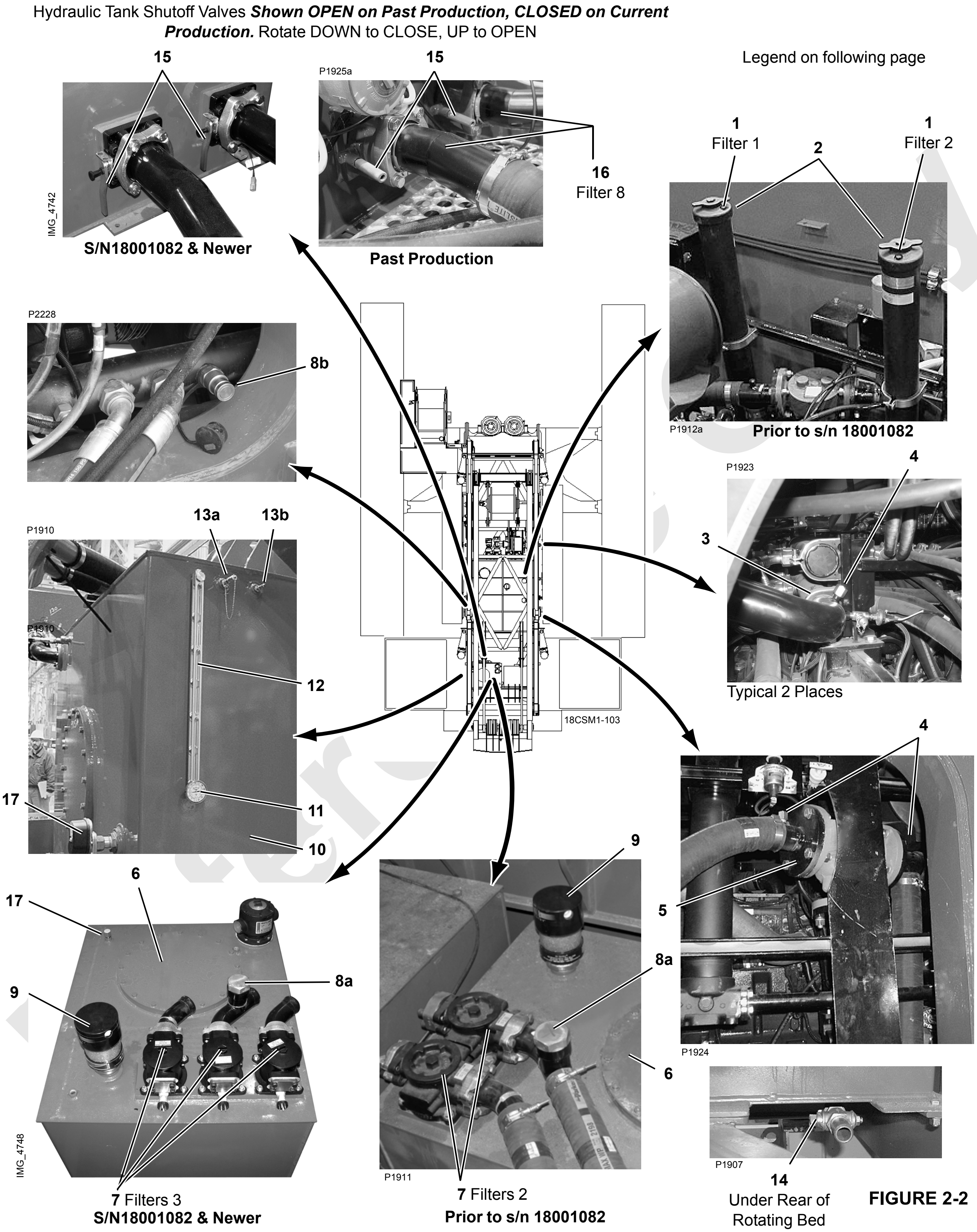

Hydraulic Tank Shutoff Valves **Shown OPEN on Past Production, CLOSED on Current Production.** Rotate DOWN to CLOSE, UP to OPEN
15
15
P1925a
Legend on following page
IMG_4742
16
Filter 8
1
Filter 1
2
1
Filter 2
S/N18001082 & Newer
Past Production
P2228
8b
P1912a
Prior to s/n 18001082
P1923
4
3
P1910
13a
13b
12
Typical 2 Places
18CSM1-103
4
17
11
10
9
6
17
5
8a
9
8a
6
P1924
P1907
IMG_4748
P1911
14
7 Filters 3
S/N18001082 & Newer
7 Filters 2
Prior to s/n 18001082
Under Rear of Rotating Bed

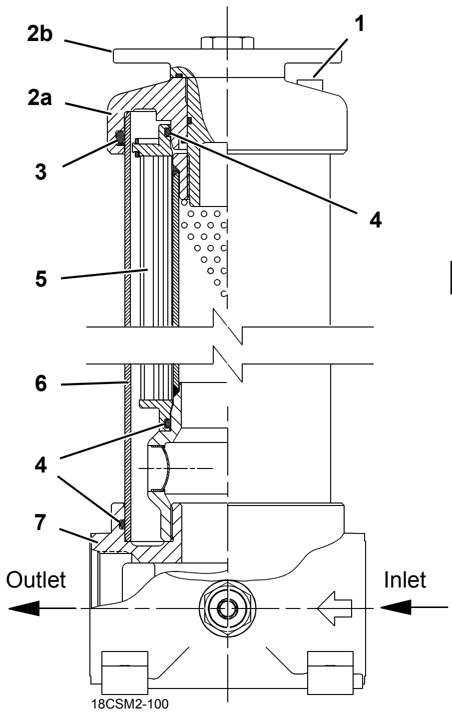
**FIGURE 2-2**

Legend for Figure 2-2

| Item | Description |
|---|---|
| 1 | Vent Plug (both charge filters) (NOTE 1) |
| 2 | Charge Filter (2 each) (NOTE 1 &2) |
| 3 | Charge Pressure Manifold |
| 4 | Vent Cap |
| 5 | Thermal Bypass Valve |
| 6 | Access Cover |
| 7 | Return Filter (2 or 3 each) |
| 8a | Fill Cap |
| 8b | Power Fill Coupler |
| 9 | Breather |
| 10 | Hydraulic Tank |
| 11 | Temperature Gauge (oil in tank) |
| 12 | Sight Gauge (oil level) |
| 13a | Coupler |
| 13b | Air Valve (depress valve stem to vent hydraulic tank before servicing) |
| 14 | Drain Valve |
| 15 | Tank Shutoff Valve (2 each) |
| 16 | Filter 8 (2 each, suction filter) |
| 17 | Oil Level Sensor |

**NOTE 1:** On S/N18001082 and newer - Supercharge pump and charge filters 1 and 2 replaced with accessory pump and additional return filter.

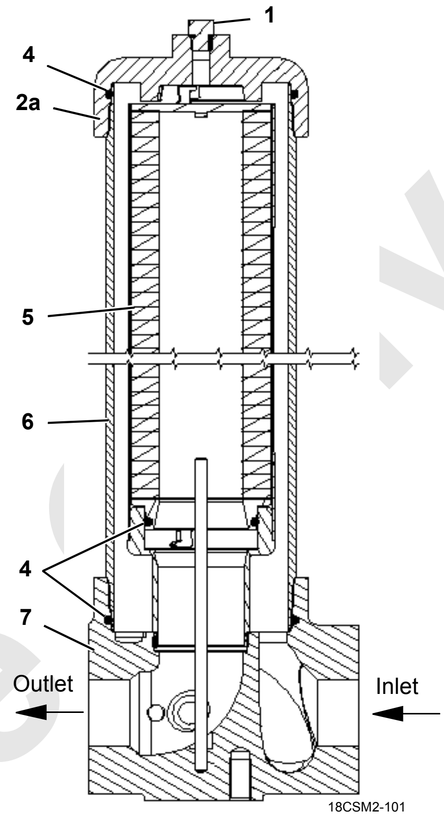
**NOTE 2:** Cranes prior to s/n 18001082.




**Past Production**
**Charge Filter**

| Item | Description |
|---|---|
| 1 | Vent Plug |
| 2a | Cover |
| 2b | Handle (part of cover) |
| 3 | O-Ring with Back-Up Ring |
| 4 | O-Ring |
| 5 | Element |
| 6 | Tube |
| 7 | Head |

**NOTE:** S/N18001082 and newer - Supercharge pump and charge filters 1 and 2 replaced with accessory pump and additional return filter.




**Current Production**
**Charge Filter prior**
**to S/N 18001082**

**FIGURE 2-3**

## REPLACING FILTERS

This crane has six or seven hydraulic filters, as shown in Figure 2-2:

- Filter 1 and 2 (Prior to s/n 18001082 Charge Filter): 12-micron absolute which filter oil to all charge pumps.
- Filter 1 and 2 (s/n 18001082 and newer Return Filters): 12-micron absolute which filter oil to all charge pumps.
- Filter 4 (2 or 3 each return): 12-micron absolute which filter all oil returning to tank.
- Filter 8 (2 each suction): 100-mesh which filter suction oil to the pumps.

The system fault alert will come on in the operator's cab when any filter plugs with dirt (see Digital Display in Section 3 of the Crane Operator Manual). The alert indicates which filter element needs replacing, as follows:

| Digital Display Reading |
|---|
| FILTER 1 or FILTER 2 (Prior to s/n 18001082 Charge Filter. S/N 18001082 and newer Return Filters)<br>***(replace both elements)***<br>**NOTE:** On S/N18001082 and newer - Supercharge pump and charge filters 1 and 2 replaced with accessory pump and additional return filter. |
| FILTER 4 (Return Filter)<br>***(replace all (2 or 3) elements)*** |
| FILTER 8 (Suction Filter)<br>***(clean both filters)***<br>Must drain hydraulic to service these filters.<br>See Changing Oil procedure in this section. |

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

**CAUTION**

**Avoid Hydraulic System Damage!**

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

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

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

## Charge Filters

**NOTE:** S/N18001082 and newer - Supercharge pump and charge filters 1 and 2 replaced with accessory pump and additional return filter.

See Figure 2-3 for the following procedure.

Replace BOTH charge filter elements when system fault alert comes on and display reads FILTER 1 or FILTER 2 prior to s/n 18001082.

On crane s/n 18001082 and newer, when system fault alert comes on and display reads FILTER 1 and FILTER 2 return filter 2 and return filter 3 elements will need replacing.

**1.** Stop engine.

**2.** Clean outside of filter tube (6) in area around cover (2a).

**WARNING**

**Burn Hazard!**

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

Hot oil can escape when you remove filter cover.

Relieve pressure through vent plug (1) in each filter before removing filter cover.

**3.** Slowly remove vent plug (1) to relieve pressure.

**4.** Remove cover (2a). ***Use care not to damage O-rings.***

For current production filter, cover (2a) will automatically lift element (5) out of tube (6).

**5.** For past production filter, lift element (5) out of tube (6).

**6.** Carefully inspect interior surface of element for visible contamination (flow through element is in-to-out). Normally, no dirt should show. Visible dirt or particles can be an early warning of system component failure.

**7.** Discard element.

***Do not attempt to clean or reuse element.***

***Do not operate crane without charge filter elements installed prior to crane s/n 18001082.***

**NOTE:** S/N18001082 and newer - Supercharge pump and charge filters 1 and 2 replaced with accessory pump and additional return filter.

**8.** Lubricate element O-ring(s) (4) with clean hydraulic oil and securely install element in tube (6).

**9.** If necessary, replace O-ring and back-up ring (3) or O-ring (4) in cover (2a) and lubricate with clean hydraulic oil.

**10.** Reinstall cover (2a) until threads bottom out. Securely ***hand tighten only***.

***Disregard steps step 11 through step 14 if you are also changing oil.***

**11.** Remove vent plug (1) from filter cover (2a).

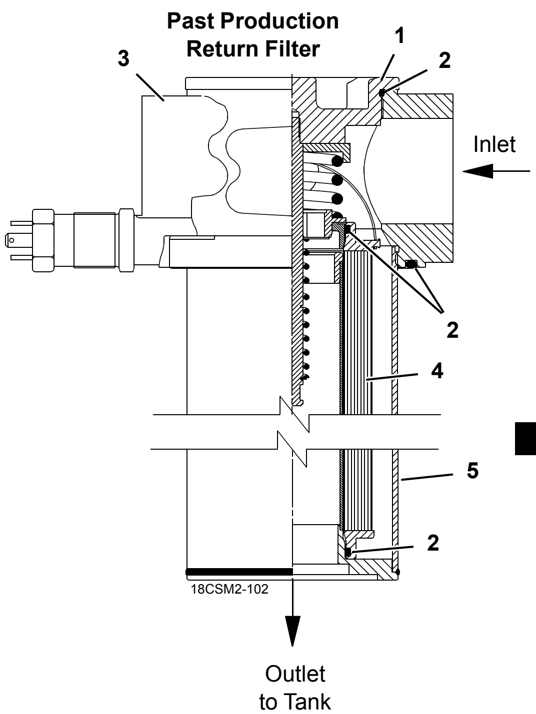
**12.** Apply 3 – 5 psi owner supplied air pressure to coupler (13a, Figure 2-2) or air valve (13b) on side of hydraulic tank. Some air will leak from breather.

**13.** Reinstall and securely tighten vent plug (1) when oil starts flowing from vent port.

**14.** Disconnect air supply.

**15.** Start engine and allow hydraulic system to return to normal operating pressure and temperature. Check filter cover (2a) and vent plug (1) for leaks. Tighten as required to stop leaks.

**16.** Stop engine, check tank level, and refill as required.




| Item | Description |
|---|---|
| 1 | Cover |
| 2 | O-Ring |
| 3 | Head |
| 4 | Element |
| 5 | Shell |

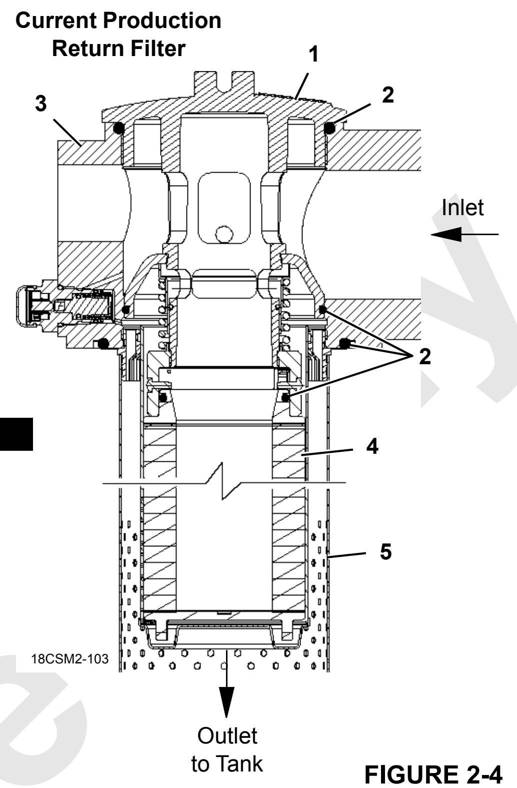



**FIGURE 2-4**

## Return Filters

See Figure 2-4 for the following procedure.

Replace elements (quantity of 2 or 3) when system fault alert comes on and display reads FILTER 4 prior to s/n 18001082.

Replace elements (quantity of 2 or 3) when system fault alert comes on and display reads FILTER 1, FILTER 2 or FILTER 4 on s/n 18001082 and newer.

**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 (13b, Figure 2-2) on side of tank before servicing filters. Internal hydraulic reservoir tank pressure must be equalized to atmosphere before starting oil filling or return filter replacement servicing.

---

**2.** Clean outside of filter head (3) in area around cover (1).

**3.** Remove cover (1). ***Use care not to damage O-rings.***

Cover has a hexagon stud for easy removal with a wrench.

**4.** Lift element (4) out of shell (5).

**5.** Carefully inspect interior surface of element for visible contamination (flow through element is in-to-out). Normally, no dirt should show. Visible dirt or particles can be an early warning of system component failure.

**6.** Discard element.

***Do not attempt to clean or reuse element.***

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

**7.** Lubricate element O-ring(s) (2) with clean hydraulic oil and securely install element in shell.

**8.** If necessary, replace O-ring in cover and lubricate with clean hydraulic oil.

**9.** Reinstall cover (1) until threads bottom out. Securely ***hand tighten only***.

**10.** Start engine and allow hydraulic system to return to normal operating pressure and temperature. Check for leaks. Tighten cover if required.

**11.** Stop engine, check tank level, and refill as required.

## REPLACING DESICCANT BREATHER

The following instructions apply only to current production cranes.

---

**WARNING**

**Burn Hazard!**

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

Hot oil can escape when you remove breather.

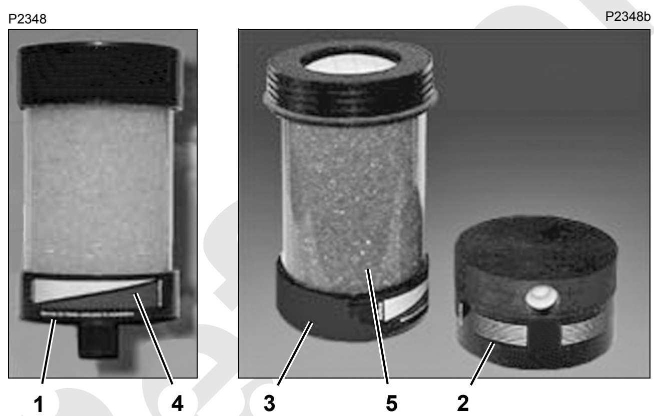
RELIEVE PRESSURE through air valve (13b, Figure 2-2) in side of tank before servicing desiccant breather.

---

See Figure 2-5 for the following procedure.

Replace cartridge (3) with a new one when desiccant beads (5) turn dark green. They are gold when new.

1. Unscrew breather assembly (1) from tank.
2. Unscrew cap (2) from cartridge (3) and discard cartridge.
3. Remove protective caps from top and bottom of new cartridge.
4. Securely attach cap (2) to cartridge (3) — ***hand tighten only***.
5. Securely attach breather assembly (1) to hydraulic tank — ***hand tighten only***.




| Item | Description |
|---|---|
| 1 | Breather Assembly |
| 2 | Cap (reusable) |
| 3 | Cartridge (disposable) |
| 4 | Service Indicator |
| 5 | Desiccant Beads |

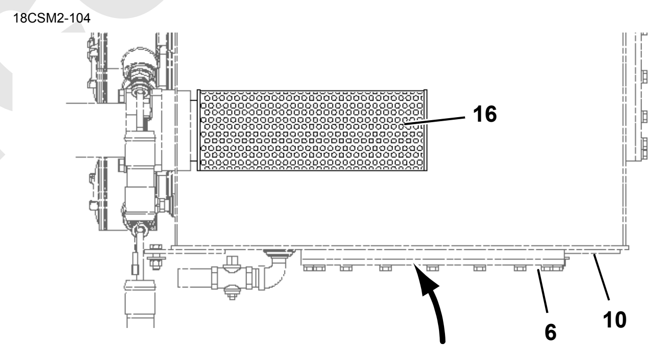
**FIGURE 2-5**

## CHANGING OIL

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

Drain and refill hydraulic system according to the recommended intervals of lubrication folio 2104, unless an alternate interval has been established through an oil analysis program.

1. Operate crane until hydraulic oil is at normal operating temperature. This will help prevent impurities from settling in system.
2. Stop engine.
3. Attach a rubber hose to pipe on drain valve (14) and insert end of hose into a suitable container to catch hydraulic oil. Tank capacity to FULL COLD mark on sight gauge is 270 gallons (1 022 liters).
4. Open drain valve (14) and drain tank completely.
5. Clean all dirt off access covers (6) in top and bottom of tank. Then remove covers. ***Take care to prevent dust and wind-blown dirt from entering tank while covers are off.***
6. Flush out any sediment inside tank.




| Item | Description |
|---|---|
| 6 | Access Cover (bottom) |
| 10 | Hydraulic Tank |
| 16 | Suction Filter 2 (2 each) |

**FIGURE 2-6**

7. Carefully inspect each suction filter (16, Figure 2-6) for damaged or clogged holes and for sludge, gum or lacquer formation. If necessary, clean as follows:
   a. Remove suction filter from inside tank. Use a wrench carefully if necessary.
   b. Soak in clean, nonflammable solvent. Brush off outer surface, and flush from inside out. Discard if damaged.
   c. Securely reinstall suction filter.
8. Use new seals and securely fasten access covers to tank.

9. If required on current production cranes, replace desiccant breather (1, Figure 2-5).

10. On past production cranes, either replace breather assembly (1, Figure 2-7) with a new one or replace breather element as follows, depending on which is more economical for you:

    a. Remove breather assembly (1) from tank.

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

    b. Remove three screws (4) securing cover (5) to base (3).

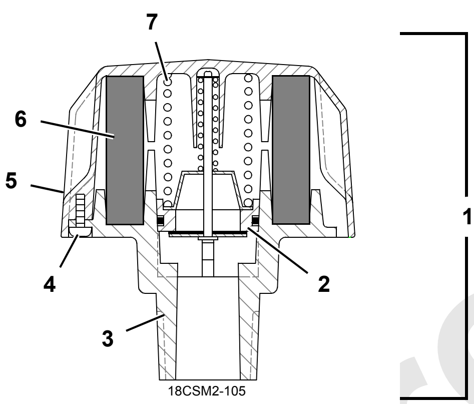
    c. Separate cover from base.

    d. Remove and discard old element (6).

    e. Install new element.

    f. Reassemble breather assembly (1) as shown in Figure 2-7.

    g. Fasten breather assembly to tank.




| Item | Description |
|---|---|
| 1 | Breather Assembly |
| 2 | Relief Valve |
| 3 | Base |
| 4 | Screw |
| 5 | Cover |
| 6 | Element |
| 7 | Spring |

**Past Production**

**FIGURE 2-7**

11. Replace all filter elements (2 and 7, Figure 2-2).

12. Fully close drain valve (14) and remove rubber hose.

13. Remove vent plug (1) from both charge filters (2) on cranes prior to s/n 18001082.

**NOTE:** S/N18001082 and newer - Supercharge pump and charge filters 1 and 2 replaced with accessory pump and additional return filter.

14. Remove vent cap (4) from end of both charge pressure manifolds (3).

**NOTE:** S/N18001082 and newer - Supercharge pump and charge filters 1 and 2 replaced with accessory pump and additional return filter.

15. Remove vent cap (4) from both sides of thermal bypass valve (5).

16. Fill hydraulic tank to FULL COLD level on sight gauge (12) with clean hydraulic oil (see F2104 at end of Section 9 in this manual for hydraulic oil specifications).

    Fill tank through fill port (8a) or through power fill coupler (8b).

17. Apply 3-5 psi owner supplied air pressure to coupler (13a) or air valve (13b) in side of hydraulic tank. Some air will leak from breather cap.

18. Observe vent ports:

    a. Securely install vent plug (1) when oil starts flowing from vent port in each charge filter (2) on cranes prior to s/n 18001082.

**NOTE:** S/N18001082 and newer - Supercharge pump and charge filters 1 and 2 replaced with accessory pump and additional return filter.

    b. Securely install vent caps (4) when oil starts flowing from vent port in each charge pressure manifold (3) and from cooler lines at thermal bypass valve (5).

19. Disconnect air supply.

20. Check tank level and refill as required.

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

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

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

## SERVICING PUMPS

It is not necessary to drain the hydraulic tank when servicing the hydraulic pumps. To service the pumps, close shut-off valves (15, Figure 2-2) in the pump suction lines.

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

### CAUTION

**Avoid Damage to Pumps!**

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

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## 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 2-8 when assembling O-ring over threads.

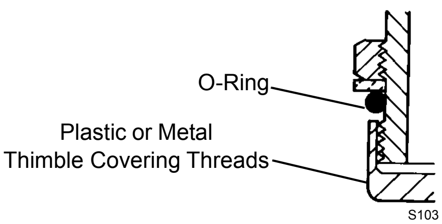



**FIGURE 2-8**

### 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 2-2 Pipe Thread Leakages**

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

### SAE Straight Thread Connection

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

When the jam nut and washer are not backed up, there is not enough room for the O-ring when the squeeze takes place and the washer cannot seat properly as shown in Figure 2-9, 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 2-9, View B.

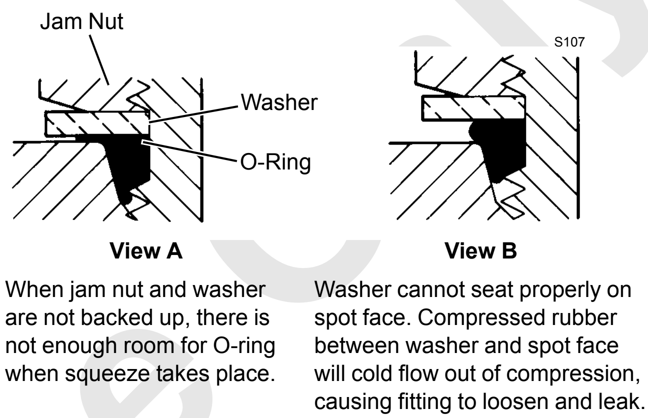



**FIGURE 2-9**

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 2-10, View A.

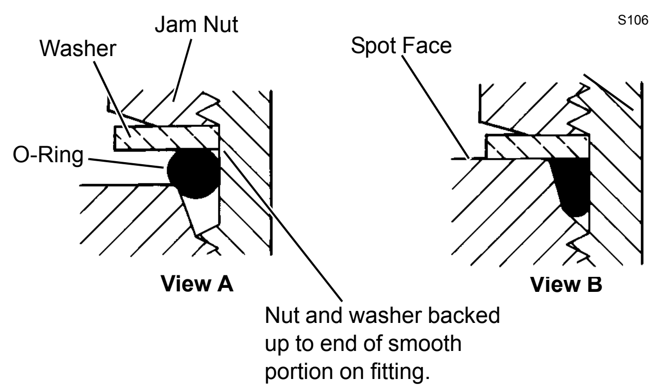



**FIGURE 2-10**

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 2-10, 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 2-10, View B.

**Table 2-3 Straight Thread Leakage**

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

## ORS Connection

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

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

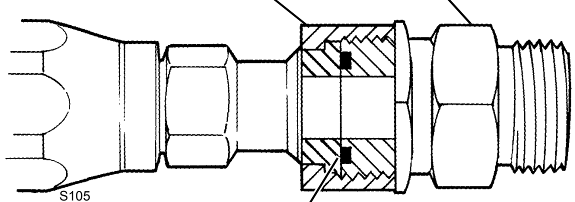



**FIGURE 2-11**

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

**Table 2-4 ORS Assembly Torque**

| Nut Size inch across flats | Fitting Size | Torque In-Lb | Torque N•m |
|---|---|---|---|
| 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 2-5 ORS Leakage**

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

2

## Split Flange Connection

1. Lubricate and install O-ring in shoulder groove (see Figure 2-12). 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 2-12) to 1/3 of torque given in Table 2-6.
3. Repeat step 2 to 2/3 of final torque. Repeat step 2 to final torque.

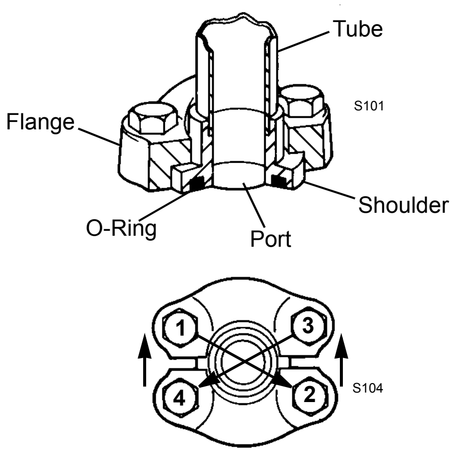
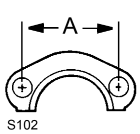



**FIGURE 2-12**

**Table 2-6 Split Flange Assembly Torque**

| "A" Dimension inch  | Flange Size | Torque | |
|---|---|---|---|
| | | in-lb | N•m |
| 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 |

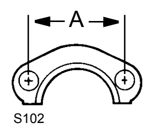
| "A" Dimension inch  | Flange Size | Torque | |
|---|---|---|---|
| | | in-lb | N•m |
| High Pressure Series | | | |
| 1-9/16 | -08 | 175 – 225 | 20 – 25 |
| 2 | -12 | 300 – 400 | 34 – 45 |
| 2-1/4 | -16 | 500 – 600 | 57 – 68 |
| 2-5/8 | -20 | 750 – 900 | 85 – 102 |
| 3-1/8 | -24 | 1400 – 1600 | 158 – 181 |
| 3-13/16 | -32 | 2400 – 2600 | 271 – 294 |

**Table 2-7 Split Flange Leakage**

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

## SAE Flare Connection

1. Tighten nut finger tight until sealing surfaces touch.
2. Mark a line (use felt pen or marker) on adapter and extend it onto connector nut (Figure 2-13, View A).
3. Using wrenches, tighten connector nut the number of flats shown in (Figure 2-13, View B).

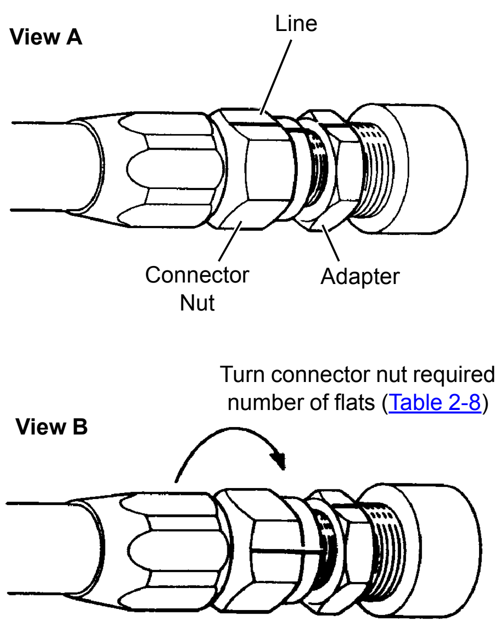



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**FIGURE 2-13**

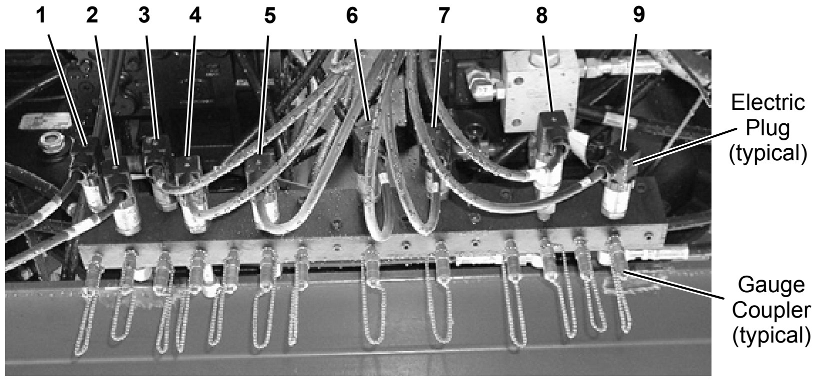
4. Misalignment of marks will show how much nut has been tightened, and best of all that it has been tightened.

**Table 2-8 SAE 37°Flare Tightening**

| **Connector Nut Size** 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 2-9 SAE 37° Flare Leakage**

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

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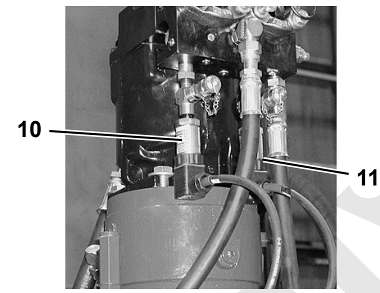
**Under Engine at Rear of Crane**

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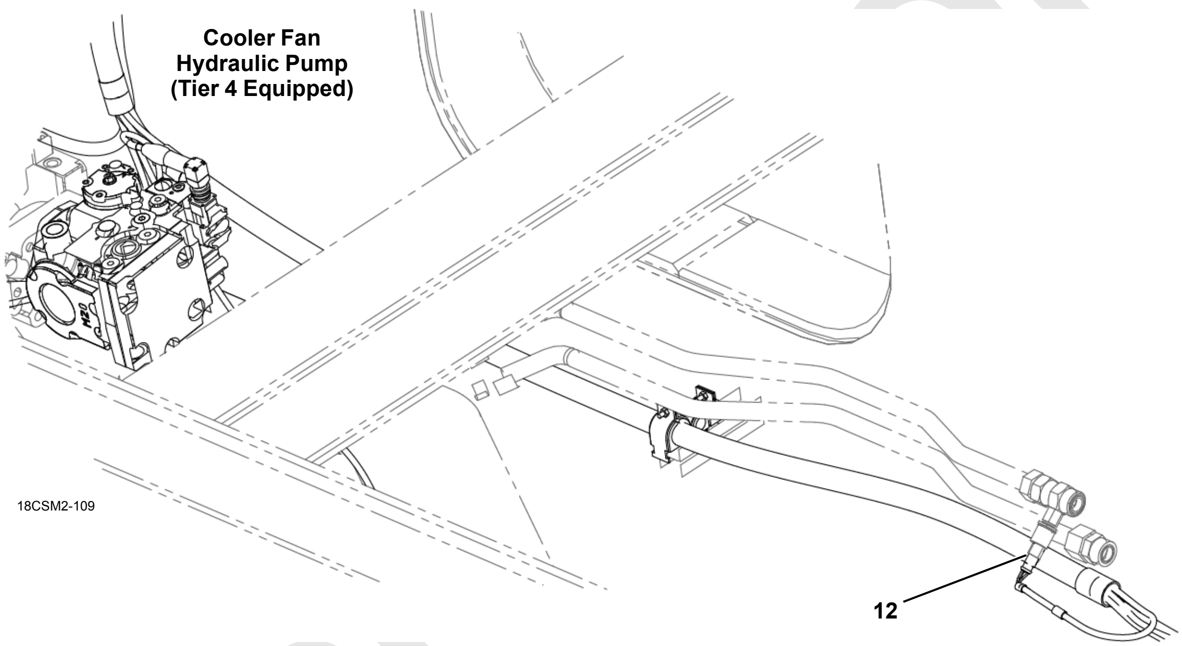
**Right Rear Swing Motor**




18CSM2-109

**Hydraulic Pressure Sender Identification**

| Item | Description | Item | Description |
|---|---|---|---|
| 1 | Drum 4 (Boom Hoist) | 8 | High Pressure Accessory Accumulator |
| 2 | Drum 6 (Luffing Hoist) | 9 | Accessory System |
| 3 | Load Drums 1 and 3 | 10 | Swing Right |
| 4 | Right Travel | 11 | Swing Left |
| 5 | Left Travel | 12 | Cooler Fan (Tier 4 Equipped) |
| 6 | Load Drums 2 and 5 | 13 | Swing Brake (Cranes Without Swing Lock) |
| 7 | Not Used | 14 | Pump Drive Cooler |

**FIGURE 2-14**

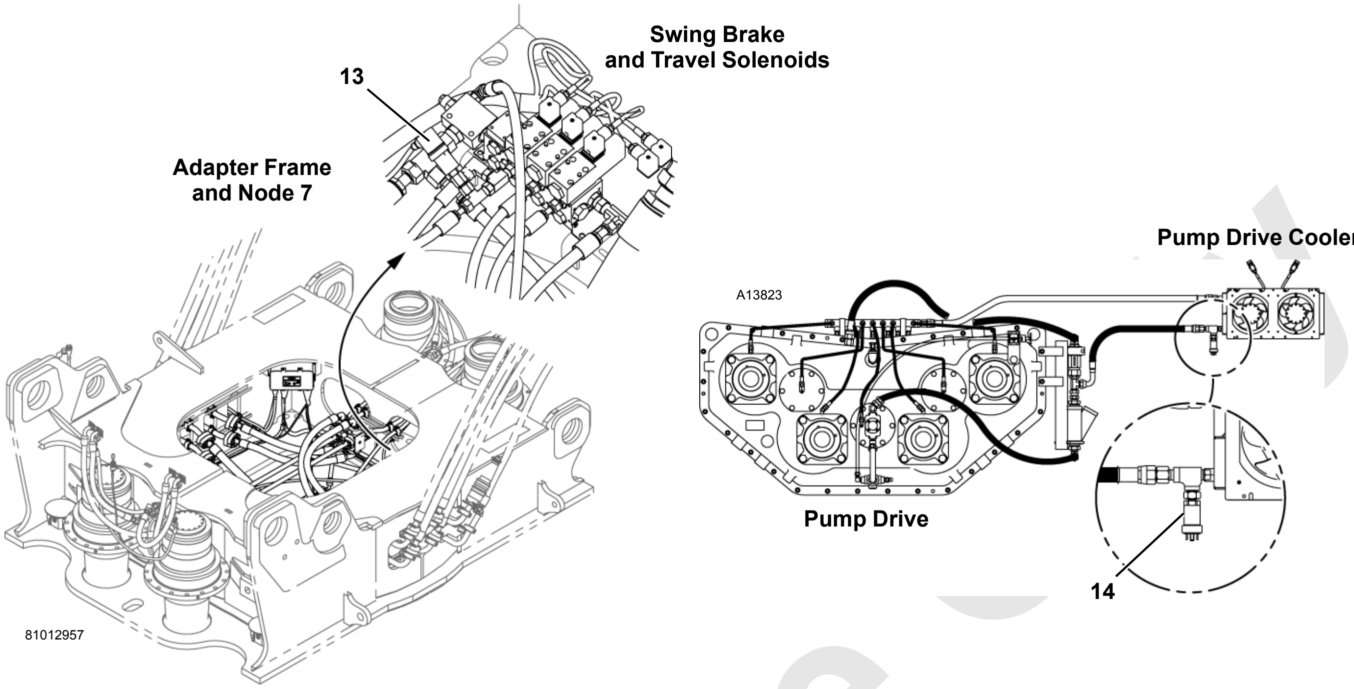



FIGURE 2-14 continued

## 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 2-14 for identification of the pressure senders.

**1.** Lower all loads to ground.

**2.** Move all control handles to off and park all crane functions.

**3.** ***Stop engine.***

**4.** Place a suitable container under pressure senders to catch oil leakage.

***Perform steps 5 – 9 only at faulty pressure senders.***

**5.** Disconnect electric plug from pressure senders.

**6.** ***Slowly loosen*** pressure senders only enough to allow any remaining pressure to exhaust.

**7.** Remove pressure senders.

**8.** Install new pressure senders and connect electric cords.

Pressure senders have pipe threads. ***Be sure to install thread sealant.***

**9.** Bleed pressure senders (all except swing) 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 engine and allow it to idle at 1,050-1,150 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.** Calibrate pressure senders (see procedure in this section).

## DISC BRAKE OPERATIONAL TEST

There is no physical way to check the disc brakes for travel, boom hoist, load drums, and swing. Therefore, an operational test of each brake must be performed weekly. Figure 2-16 shows the brake and brake solenoid valve locations.

**NOTE:** For all pumps except swing, system pressure is preset at 6,000 psi (413 bar). For swing pump, system pressure is preset at 5,000 psi (345 bar).

Electrical plugs at brake solenoid valves must be disconnected to stall crane functions during test.

1. Start engine and place throttle in low idle — 1,050 rpm.
2. Select and confirm STANDARD mode.

**NOTE:** For load drums, make sure crane is in full power mode (free-fall OFF) so disc brakes remain applied.

For swing, set swing torque for 100%.

3. Disconnect electrical plug for brake being checked (Figure 2-16).
4. Place park brake in off position for function being checked.
5. Access diagnostic screen (Figure 2-15) for function being checked – DRUM, BOOM HOIST, SWING, or TRAVEL.

   Monitor system PRESS (pressure) and PUMP command while moving control handles.

Pump Command

System Pressure

| | | | | | |
|---|---|---|---|---|---|
| HANDLE | 100% | V | PRESS | 6000 psi | |
| PUMP | 50% | | SPEED | rpm | |
| MOTOR | % | | BRAKE | 1 | |
| | | | DOS | 0 | DRUM 2 |

0 = Brake Applied

**FIGURE 2-15**

6. Slowly move 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 3 - 5 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.

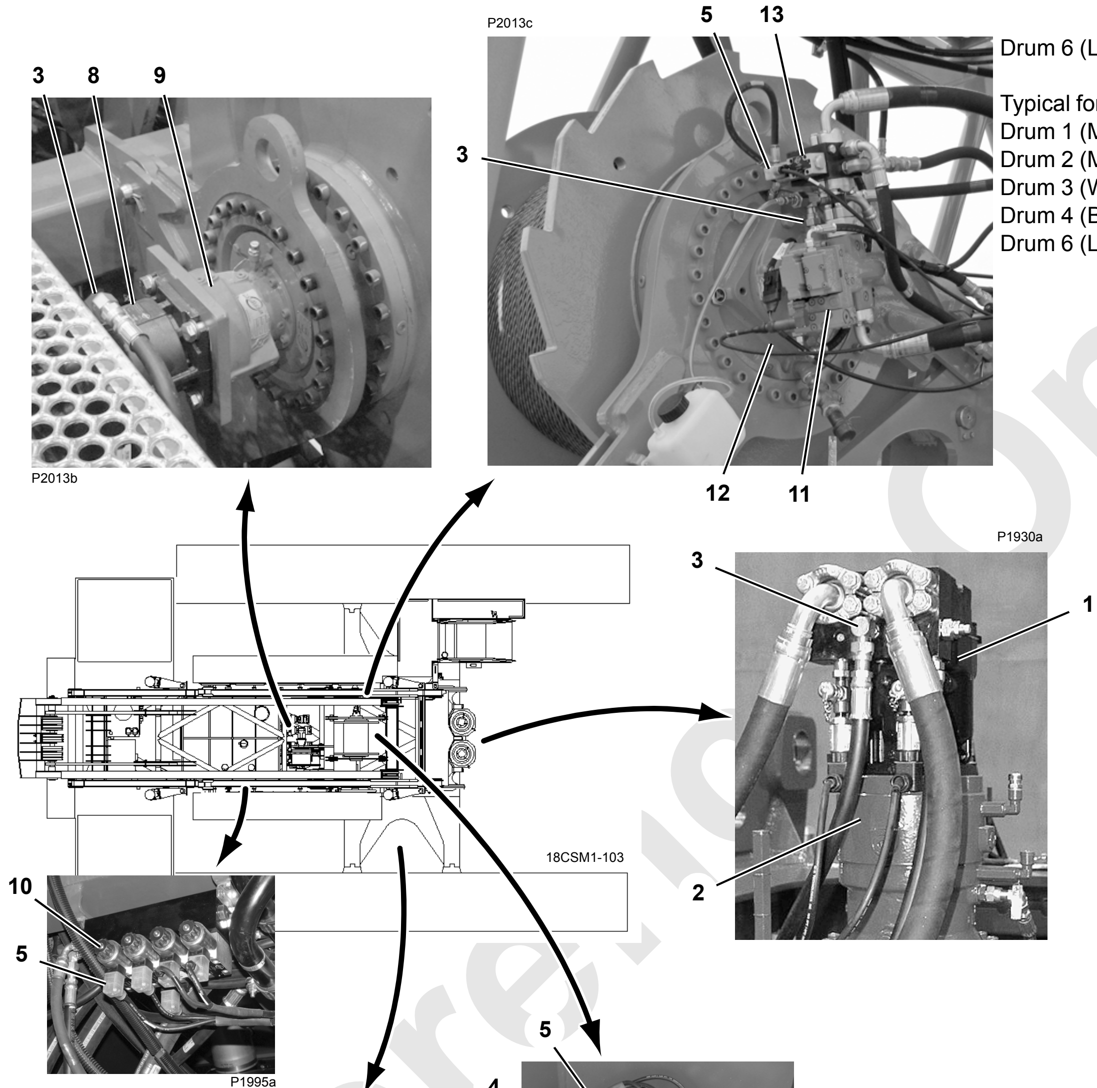
### WARNING

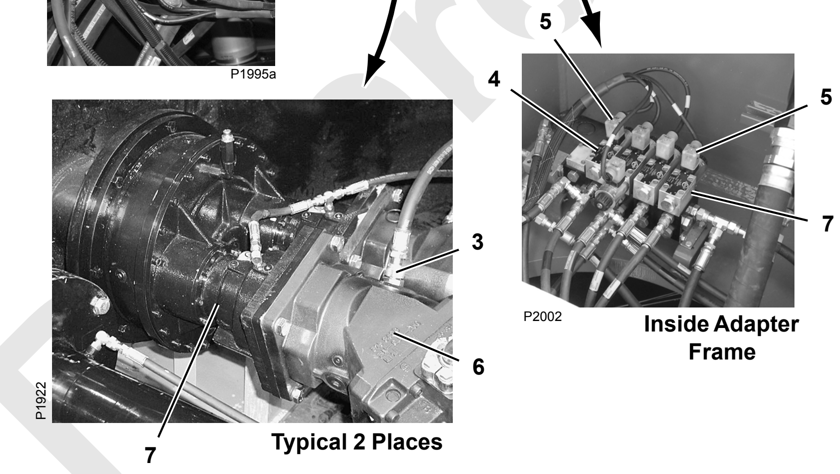
**Falling Load/Moving Crane Hazard!**

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.

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

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




| Item | Description |
|---|---|
| 1 | Swing Motor (4 places) |
| 2 | Swing Brake |
| 3 | Case Drain Port (typical) |
| 4 | Swing Brake Solenoid Valve |
| 5 | Electrical Plug (typical) |
| 6 | Travel Motor (4 places) |
| 7 | Travel Brake (4 places) |
| 8 | Drum 5 (Mast Hoist) Motor |
| 9 | Drum 5 Brake |
| 10 | Drum 5 Brake Solenoid Valve |
| Following items for Drums 1, 2, 3, 4, and 6 | |
| 11 | Drum Motor |
| 12 | Drum Brake (inside gear box) |
| 13 | Drum Brake Solenoid Valve |

**FIGURE 2-16**

## SHOP PROCEDURES

**CAUTION**

**Equipment Damage!**

Incorrectly installed filters and fittings will damage pumps and motors.

### Initial Oil Fill

1. Fill all motor cases (Figure 2-16) with oil:
   a. Disconnect fittings at highest case drain port (3) in each motor.
   b. Fill each motor case to level of case drain port. ***Use new hydraulic oil which has been filtered through a 10-micron filter.***
   c. Reconnect fittings.
2. Open vent ports:
   a. Remove vent plugs (1, Figure 2-2) from top of both charge filters (2) on cranes prior to s/n 18001082.

**NOTE: S/N18001082 and newer - Supercharge pump and charge filters 1 and 2 replaced with accessory pump and additional return filter.**

   b. Remove vent cap (4, Figure 2-2) from right end of charge pressure manifold (3).
   c. Remove vent caps (4, Figure 2-2) at thermal bypass valve (5).
3. Make sure both hydraulic tank shutoff valves (15, Figure 2-2) are fully opened.
4. At engine, engage engine clutch (Figure 2-17).

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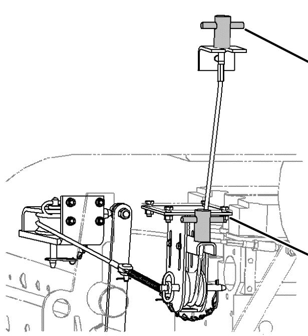



**FIGURE 2-17**

5. Fill hydraulic tank with clean hydraulic oil to FULL HOT level mark on sight gauge (12, Figure 2-2).

   Fill tank through fill port (8a, Figure 2-2) or through power fill coupler (8b).
6. If used, securely reinstall fill cap (8a).
7. Apply 3-5 psi owner supplied air pressure to coupler (13a, Figure 2-2) or to air valve (13b) in side of hydraulic tank.

   Breather allows 3 psi pressure to remain in tank to force oil into system.
8. Air pressure forces oil from tank to charge filters. As suction lines are filling, monitor vent port at top of charge filters on cranes prior to s/n 18001082. (2, Figure 2-2). When clear oil appears, install vent plugs (1).

**NOTE: S/N18001082 and newer - Supercharge pump and charge filters 1 and 2 replaced with accessory pump and additional return filter.**

9. Monitor vent ports in end of each charge pressure manifold (3, Figure 2-2). Install vent caps (4) when clear oil appears.
10. Monitor vent ports at thermal bypass valve (5, Figure 2-2). Install vent caps (4) when clear oil appears.

### Initial Engine Start-Up

Select and confirm SETUP mode.

**WARNING**

**Personal Injury Hazard!**

With engine running, crane components can operate unexpectedly while system pressures are checked. Disconnect power to brake valves before beginning adjustments.

Disconnect electrical connectors (DIN plugs) at all brake solenoid valves shown in Figure 2-16. Reconnect electrical connectors (DIN plugs) after all hydraulic system checks are completed.

#### *Pressure Sender Calibration*

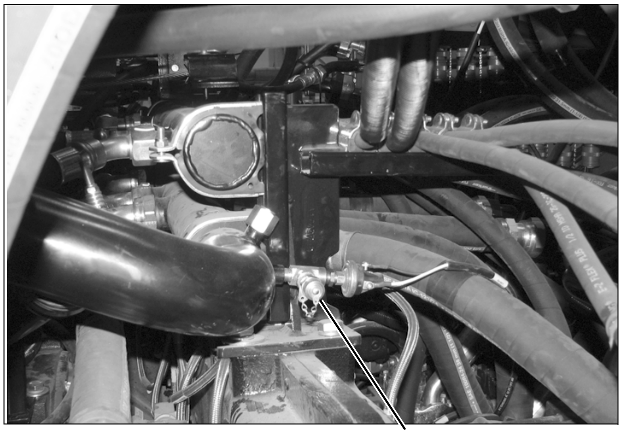
Calibrate the pressure senders as instructed in this section.

#### *Charge Pressure Check*

Perform charge pressure check as instructed in this section.

1. Attach a 0-600 psi (0-41 bar) gauge coupler on charge pressure manifold (Figure 2-18).
2. Start engine and run at low idle (1,050 rpm).
3. At diagnostic screens, scroll to each system in order:
   - Drum 1 (Main Hoist 1)
   - Drum 2 (Main Hoist 2)
   - Drum 3 (Whip Line Hoist)

- Drum 4 (Boom Hoist)
- Drum 5 (Mast Hoist)
- Drum 6 (Luffing Jib Hoist)
- Swing (left and right)
- Travel (left and right)



Opening in Right Side of Rotating Bed

Connect Charge Pressure Gauge Here

**FIGURE 2-18**

4. Each system must show ***some*** charge pressure within 30 seconds of starting engine.
5. Observe gauge pressure at test port (Figure 2-18). Pressure must be between 75-100 psi (5-7 bar).
6. Stop engine.
7. Contact Engineering Department if any pump fails test.
8. Remove gauge from test port (Figure 2-18).

### *Control Calibration*

Calibrate the pump controls as instructed in this section.

### *Hoist Pumps Pressure Test*

Test the pressure of the hoist pumps as instructed in this section.

### *Travel Pressure Check*

1. With brake on, move crawler handles in both directions to stroke travel motors.
2. Travel screen pressure should be 4,500 psi (303 bar).
3. Travel brakes must hold without slipping.

### *Swing Pressure Check*

1. With brake on, move swing handle in both directions to stroke swing motor.
2. Swing screen pressure should be 4,500 psi (303 bar).
3. Swing brake must hold without slipping.

## Accessory System Checks

### *High Pressure Accessory System*

The accessory pumps are the source for high pressure accessories. High pressure accessories include rotating bed jacking cylinders, front and rear adapter frame pins, cab tilt cylinder, mast pin cylinders, boom hinge pin cylinders, mast raising cylinders, and rigging winch. For operating these items, select and confirm SETUP REMOTE mode.

1. Rotating bed jacking cylinders:
   a. Access hand-held radio remote control.
   b. Use jack toggles to fully extend jacks.
   c. Scroll to accessory screen on diagnostic screen to verify that 3,000 psi (206 bar) is present when cylinders are extended and retracted.
   d. When retracting jacks, the rotating bed must lower slowly and smoothly.
2. Front and rear adapter frame pin cylinders:
   a. Remove locking plate to allow pin cylinders to operate.
   b. Access hand-held radio remote control.
   c. Use front or rear toggles to ENGAGE and DISENGAGE cylinders several times and remove air from system.
   d. Scroll to accessory screen to verify that 3,000 psi (206 bar) is present when cylinders are engaged and disengaged.
3. Cab tilt cylinder:
   a. Access cab tilt control on front console in operator's cab.
   b. Use rocker switch to ENGAGE and DISENGAGE cylinder several times and remove air from system.
   c. Scroll to accessory screen to verify that 3,000 psi (206 bar) is present when cylinder is engaged and disengaged.
4. Mast pin cylinders:
   a. Remove keeper plate to allow pin cylinders to operate.
   b. Access hand-held radio remote control.
   c. Use mast pins toggle to ENGAGE and DISENGAGE cylinders several times and remove air from system.
   d. Scroll to accessory screen to verify that 3,000 psi (206 bar) is present when cylinders are engaged and disengaged.

**5.** Boom hinge pin cylinders:

**NOTE:** Hydraulics must be connected to boom butt to operate boom hinge pin cylinders.

**a.** Remove lock plate to allow hinge pin cylinders to operate.

**b.** Access hand-held radio remote control.

**c.** Use boom hinge pins toggle to ENGAGE and DISENGAGE cylinders several times and remove air from system.

**d.** Scroll to accessory screen to verify that 3,000 psi (206 bar) is present when cylinders are engaged and disengaged.

**6.** Mast raising cylinders:

**a.** Access hand-held radio remote control.

**b.** Use mast toggle to RAISE and LOWER mast cylinders several times to remove air from system.

**c.** Scroll to accessory screen to verify that 3,000 psi (206 bar) is present when cylinders are retracted or extended.

## CAUTION

**Damage to Mast!**

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

**7.** Rigging winch motor (optional):

**NOTE:** Hydraulics must be connected to boom butt and boom inserts to operate rigging winch motor.

**a.** Access hand-held radio remote control.

**b.** Use payout and haul in toggle to PAYOUT and HAUL IN several times to remove air from system.

**c.** Scroll to accessory screen to verify that 3,000 psi (206 bar) is present when motor is operating.

### *Low-Pressure Accessory Components*

The swing system pressure reducing shuttle valve is the low-pressure source for the low-pressure accessories at a pressure of 350 psi (24 bar). The low-pressure accessories includes swing brake, swing lock, travel brake, and travel 2-speed.

**1.** Swing brake and swing lock:

**a.** Scroll to swing diagnostic screen.

**b.** With swing park brake and swing lock OFF, attempt to swing the crane by moving control handle in both directions.

**c.** Crane must respond and indicate on swing screen that swing park brake and swing lock are released.

**2.** Travel brakes:

**a.** Scroll to travel diagnostic screen.

**b.** With travel park brake OFF, attempt to travel the crane by moving control handles in both directions.

**c.** Crane must respond and indicate on travel screen that travel park brake is released.

**3.** Travel 2-speed is checked in test area when travel speed is checked.

### *Lower Accessory Valve*

The swing system pressure reducing valve is the low-pressure source for operating the crawler pin handles (Figure 2-19) at pressure of 350 psi (24 bar).

## CAUTION

**Machinery Damage!**

Do not perform this test if crawlers are attached to carbody.

**d.** With handles on front of carbody, fully extend the crawler pins if they are not already extended.

**e.** Scroll to accessory screen to verify that a pressure is present when pin cylinder are extended and retracted.

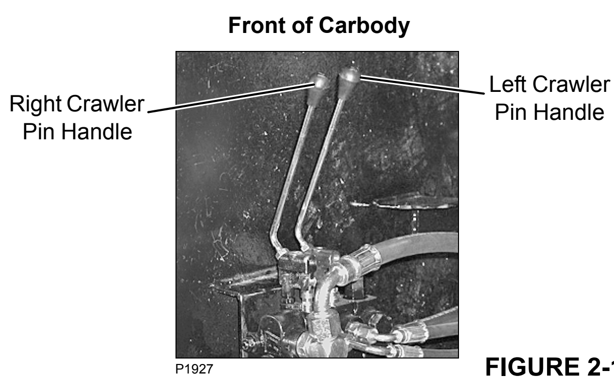



**FIGURE 2-19**

## Travel Handle and Speed Check

Verify that travel movement responds correctly to handle commands. Count the number of revolutions crawler roller rotates in one minute to determine travel speed.

**NOTE:** Final evaluation of travel system is completed in test area.

1. Put a timing mark on crawler roller at front of crane (Figure 2-20).


**FIGURE 2-20**

2. Start engine and set speed 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 mark makes.
5. Number should be 5.3 to 5.8 revolutions in one minute.
6. If count is not within this range, ***determine cause of problem and take corrective action.***

## Swing and Drum Speed Checks

Check operating speeds for functions listed in Table 2-10 with engine running at high idle (1,800 rpm), control handles moved fully forward and back, with no load, and no rope. Read speeds on digital display.

If proper speeds are not indicated, ***determine cause of problem and take corrective action.***

## HYDRAULIC SYSTEM SPECIFICATIONS - 18000

### Table 2-10 Hydraulic System Specifications

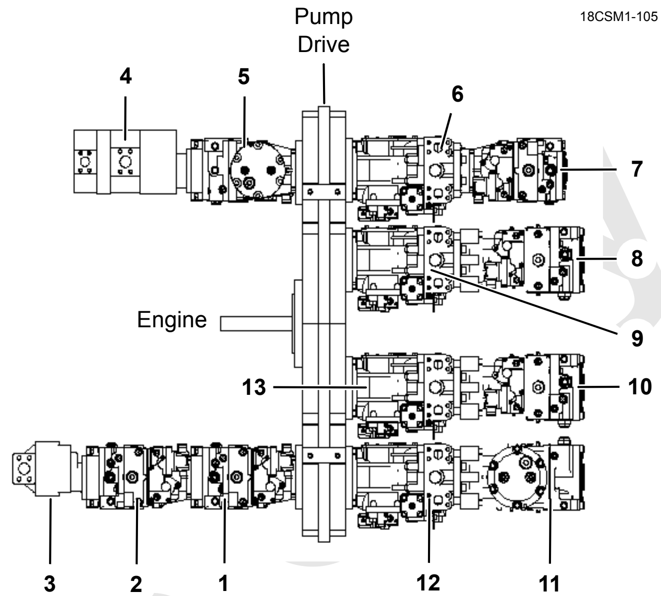
| Function | Direction | Pump-Motor Port Connections | System Pressure 1 [1] psi (bar) | System Pressure 2 [2] psi (bar) | Charge Pressure | Speed [3] rpm |
|---|---|---|---|---|---|---|
| Main Hoist 1 | Lower | Pump A to Motor A | 6,090 (420) Hoist or Lower | N/A | 350 (24) | 32 to 38 |
| | Hoist | Pump B to Motor B | | | | 36 to 40 |
| Main Hoist 1/3 [4] | Lower | Pump A to Motor B | | | | 32 to 38 |
| | Hoist | Pump B to Motor A | | | | 36 to 40 |
| Main Hoist 2 | Hoist | Pump A to Motor B | | | | 36 to 40 |
| | Lower | Pump B to Motor A | | | | 32 to 38 |
| Main Hoist 2/5 [5] | Hoist | Pump B to Motor A | | | | 36 to 40 |
| | Lower | Pump A to Motor B | | | | 32 to 38 |
| Whip Line Hoist 3 [4] | Hoist | Pump B to Motor A | | | | 36 to 40 |
| | Lower | Pump A to Motor B | | | | 32 to 38 |
| Boom Hoist 4A | Hoist | Pump A to Motor A | 6,090 (420) Hoist or Lower | N/A | 350 (24) | 41 to 45 |
| | Lower | Pump B to Motor B | | | | 36 to 43 |
| Boom Hoist 4B | Hoist | Pump B to Motor A | | | | 41 to 45 |
| | Lower | Pump A to Motor B | | | | 36 to 43 |
| Mast Hoist 5 [5] | Hoist | Pump B to Motor A | | | | 26 to 29 |
| | Lower | Pump A to Motor B | | | | 23 to 28 |
| Luffing Jib Hoist 6 | Lower | Pump A to Motor B | | | | 32 to 38 |
| | Hoist | Pump B to Motor A | | | | 36 to 40 |
| Rigging Winch | Haul In | Open Loop to Tank | 3,000 (204) | N/A | N/A | 85 to 90 |
| | Pay Out | Open Loop to Tank | | | | |
| Swing 1 | Left | Pump A to Motors B & B | 6,090 (420) Right or Left | N/A | 350 (24) | 1.1 to 1.2 |
| | Right | Pump B to Motors A & A | | | | |
| Swing 2 [6] | Left | Pump B to Motors B & B | | | | |
| | Right | Pump A to Motors A & A | | | | |
| Left Side Travel | Forward | Pump B to Motors A & A | 6,090 (420) Forward or Reverse | | | 5.3 to 5.8 at Tumbler |
| | Reverse | Pump A to Motors B & B | | | | |
| Right Side Travel | Forward | Pump B to Motors A & A | | | | |
| | Reverse | Pump A to Motors B & B | | | | |
| Accessory Pumps [7] | | Open Loop to Tank | N/A | 0 to 3,000 (0 to 204) | N/A | N/A |

| Notes | |
|---|---|
| 1 | Controlled by multi-function valves in each pump. |
| 2 | Controlled by crane's programmable controller. |
| 3 | Speeds based on engine at high idle, no load (no rope on drums), and handles moved fully forward or back. |
| 4 | Pump used for main hoist 1 right side **or** whip line hoist. Computer selects first handle moved. |
| 5 | Pump used for main hoist 2 right side **or** mast hoist. Computer selects first handle moved. |
| 6 | Swing 2 pump is optional |
| 7 | Accessory pumps are the source of hydraulic pressure for accessory system and high pressure accessory components. Items include swing and travel brakes, Boom hinge pin cylinders, rotating bed jacking cylinders, front and rear adapter frame pin cylinders, mast pins and raising cylinders, cab tilt cylinder, rigging winch, and crawler pin cylinders. Computer controls pump pressure depending on accessory selected. |

## Pumps

**Pump Identification (Prior to s/n 18001082)**

| Item | Description |
|---|---|
| 1 | Boom Hoist A (Drum 4) |
| 2 | Swing (Optional) |
| 3 | Supercharge |
| 4 | Supercharge/Accessory |
| 5 | Boom Hoist B (Drum 4) |
| 6 | Main Hoist (Drums 1 and 3) |
| 7 | Swing |
| 8 | Left Travel |
| 9 | Main Hoist (Drum 2) |
| 10 | Luffing Jib Hoist (Drum 6) |
| 11 | Right Travel |
| 12 | Main Hoist (Drum 1) |
| 13 | Main Hoist (Drums 2 and 5) |




**Pump Identification (S/N 18001082 & newer)**

| Item | Description |
|---|---|
| 1 | Accessory Pump |
| 2 | Boom Hoist B Pump (Drum 4) |
| 3 | Main Hoist Pump (Drums 1 and 3) |
| 4 | Swing Pump |
| 5 | Left Travel Pump |
| 6 | Main Hoist Pump (Drum 2) |
| 7 | Luffing Jib Hoist Pump (Drum 6) |
| 8 | Right Travel Pump |
| 9 | Main Hoist Pump (Drum 2 and 5) |
| 10 | Main Hoist Pump (Drum 1) |
| 11 | Boom Hoist A Pump (Drum 4) |
| 12 | Swing (Optional) |
| 13 | Cooler Fan Pump (Tier 4 Equipped) |
| 14 | Accessory Pump (Motor Drive) |

**NOTE:** S/N18001082 and newer - Supercharge pump and charge filters 1 and 2 replaced with accessory pump and additional return filter.

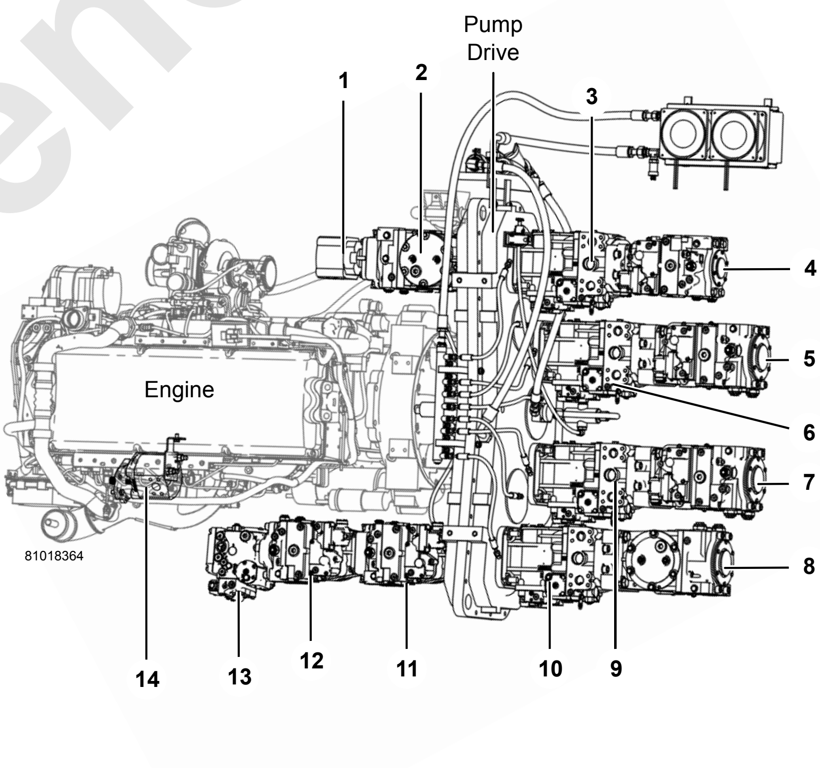



**FIGURE 2-21**

### Pump Components

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

**NOTE 1:** Both Sides of Pump.

**NOTE 2:** Valve is Directly Opposite Port it Protects.



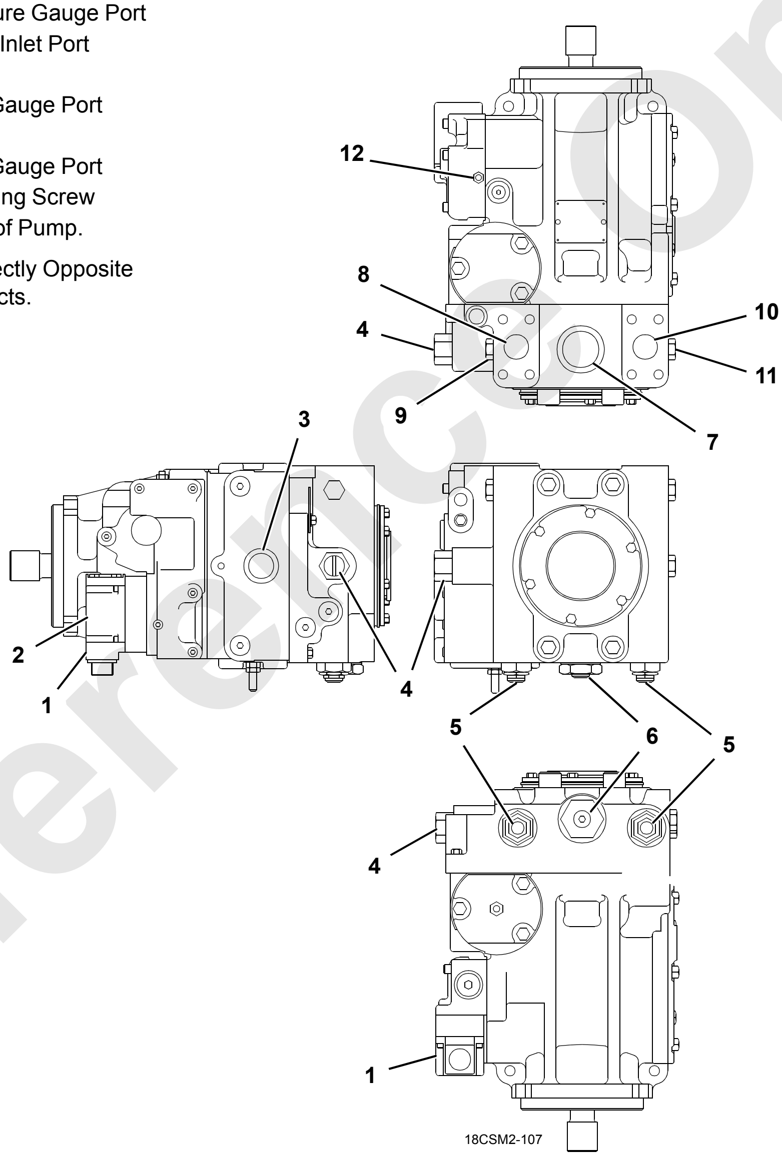
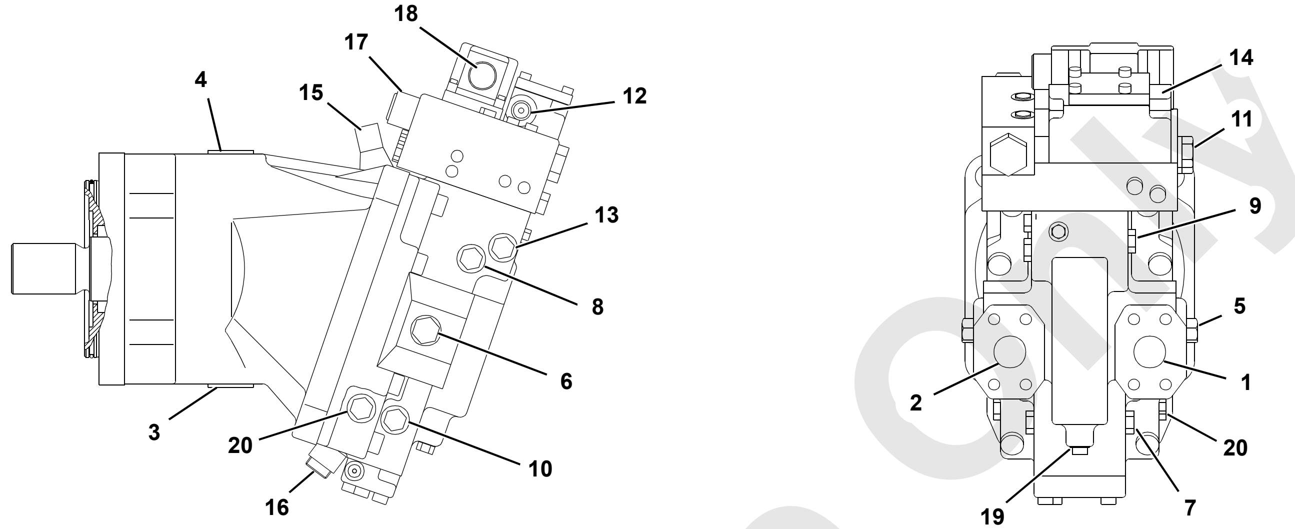



**FIGURE 2-21 continued**

## Motors

**Boom Hoist, Load Drums, and Travel Motor**




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

**FIGURE 2-22**

## HYDRAULIC SYSTEM CALIBRATION PROCEDURES

### Calibration Description

To ensure proper operation of the crane functions, the following items must be calibrated or tested at the intervals specified in this section:

- Pressure Senders
- Controls (pump centers)
- Pump Pressure
- Charge Pressure

See Figure 2-23 for identification of the controls used for calibration and testing.

**WARNING**

**Moving Load Hazard!**

With engine running, crane functions (drums, boom hoist, swing, travel) can operate unexpectedly while system components are being calibrated or tested.

To prevent crane functions from moving, turn PARK ON for all crane functions before you perform calibration or testing procedures.

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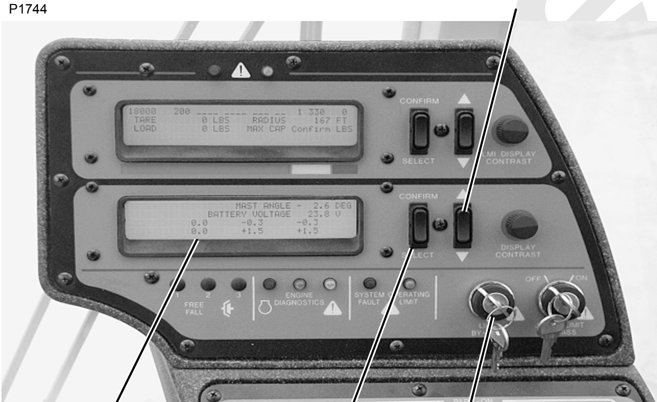



**FIGURE 2-23**

### Pressure Sender Calibration

Percent Complete | Bank 1 Binary Number | Bank 2 Binary Number

```
*  PRESSURE SENDER CAL        0%     16     0
   CONTROL CAL
   PUMP PRESSURE TEST
   CHARGE PRESSURE
```

| Binary No. | Pressure Sender (Bank 1) | Binary No. | Pressure Sender (Bank 2) |
|---|---|---|---|
| 1 | Drum 1/3 (Main Hoist) | 1 | Swing Left |
| 2 | Not Used | 2 | Swing Right |
| 4 | Drum 2/5 (Main Hoist) | 4 | High Pressure Accessory Accumulator |
| 8 | Accessory System | | |
| 16 | Drum 4 (Boom Hoist) | | |
| 32 | Drum 6 (Luffing Hoist) | | |
| 64 | Left Track | | |
| 128 | Right Track | | |

**FIGURE 2-24**

See Figure 2-23 and 2-24 for the following procedure.

Pressure sender line of calibration screen indicates if each system's pressure sender null (0) is within 0.65-1.35 volts.

Pressure senders must be calibrated at the following intervals:

- When a new controller node is installed
- When a pump is replaced
- When a pump control (EDC or PCP) is replaced
- When a pressure sender is replaced
- When displayed pressure is not correct

  Be aware that if there is any residual pressure in the system during the calibration process, the display pressure reading in the cab may not reflect actual system pressure. See Note on page 2-29.
- Every 6 months

To perform pressure sender calibration, proceed as follows:

1. Stop engine and turn ignition switch to RUN position.
2. Access calibration screen as follows:
   a. Select and confirm SETUP mode to activate calibration program.
   b. Turn LIMIT BYPASS switch clockwise and hold.
   c. SCROLL UP at least one screen.

d. Continue to scroll up or down until calibration screen appears.

e. Press bottom of CRANE MODE switch until (*) appears next to PRESSURE SENDER CAL.

f. Then press top end of CRANE MODE switch to CONFIRM. Calibration will start.

g. When calibration starts, percent (%) of completion is displayed on screen.

h. When calibration stops, check bank 1 and bank 2 binary numbers:

- If 0 appears, all pressure senders have passed calibration.
- If any number other than 0 appears in either bank, use Table 2-11 to determine which senders have failed calibration.
- Each pressure sender is assigned a number in the binary system (power of two). After running the calibration procedure, outputs that are ON (failed) for any sender are added together. To identify the failed senders, find the binary number displayed on the screen in the first column of Table 2-11. All shaded boxes to the right of the number indicate senders that failed calibration.
- Refer to Figure 2-24 to identify the pressure senders.

i. Troubleshoot the particular system to determine the cause of the fault.

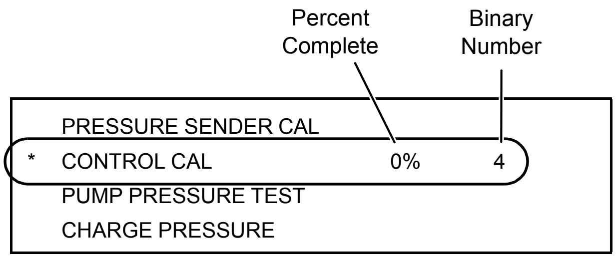
**NOTE:** The cause of a failed calibration or faulty display pressure reading in the cab may not be the pressure sender. The cause of the fault could be trapped air or hydraulic pressure in the system.

Before replacing a pressure sender, do the following:

- Perform pressure sender calibration steps.
- 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 calibration steps and check pressure on the display in the cab 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 1.0 volt against ground at 0 psi.

j. Proceed to next procedure, or exit calibration screen by pressing bottom of CRANE MODE switch. Cursor (*) will disappear from screen.

## Control Calibration




| Binary No. | Pressure Sender |
|---|---|
| 1 | Main Hoist 1 |
| 2 | Main Hoist 2 |
| 4 | Boom Hoist |
| 8 | Swing Left |
| 16 | Swing Right |
| 32 | Luffing Hoist |

**FIGURE 2-25**

See Figure 2-23 and 2-25 for the following procedure.

The control line of the calibration screen indicates whether the pump centers are within the allowable range of each pump's Electric Displacement Control (EDC). The allowable range is 5-25% pump command signal for the hoist pumps, and 2.5-20% in each direction for the swing pump.

The controls must be calibrated at the following intervals:

- When a new controller node is installed
- When a pump is replaced
- When a pump control (EDC or PCP) is replaced
- When there is a noticeable time increase to engage a crane function when handle is moved from off
- Every 6 months

To perform control system calibration, proceed as follows:

1. Turn PARK ON for all crane functions (drums, boom hoist, swing, travel).
2. Start engine. It is normal for yellow operating limits light to come on during this procedure.
3. Access calibration screen as follows:
   - **a.** Select and confirm SETUP mode to activate calibration program.
   - **b.** Turn LIMIT BYPASS switch clockwise and hold.
   - **c.** SCROLL UP at least one screen.
   - **d.** Continue to scroll up or down until calibration screen appears.
   - **e.** Press bottom of CRANE MODE switch until (*) appears next to CONTROL CAL.
   - **f.** Increase engine speed to HIGH IDLE.

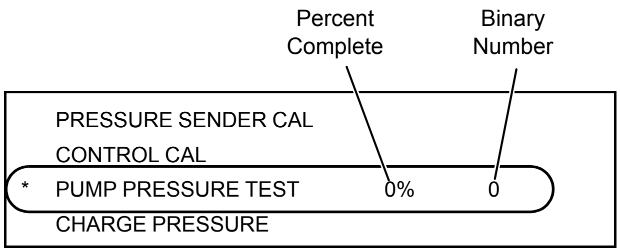
     Engine must be running at ***high idle*** before calibration will start.

     ***Calibration will stop if engine speed is decreased during calibration.***
   - **g.** Press top end of CRANE MODE switch to CONFIRM. Calibration will start.
   - **h.** When calibration starts, percent (%) of completion is displayed on screen.
   - **i.** When calibration stops, check binary number:
     - If 0 appears, all controls have passed calibration.
     - If any number other than 0 appears, use Table 2-11 to determine which controls have failed calibration.

       Each control is assigned a number in the binary system (power of two). After running the calibration procedure, outputs that are ON (failed) for any control are added together. To identify the failed controls, find the binary number displayed on the screen in the first column of Table 2-11. All shaded boxes to the right of the number indicate controls that failed calibration.

       Refer to Figure 2-25 to identify the controls.
   - **j.** Troubleshoot the particular system to determine the cause of the fault.
   - **k.** Proceed to next procedure, or exit calibration screen by pressing bottom of CRANE MODE switch. Cursor (*) will disappear from screen.

## Pump Pressure Test




| Binary No. | Pressure Sender |
|---|---|
| 1 | Main Hoist 1 |
| 2 | Main Hoist 2 |
| 4 | Boom Hoist |
| 8 | Luffing Hoist |

**FIGURE 2-26**

See Figure 2-23 and 2-26 for the following procedure.

The pump pressure line of the calibration screen cycles through the hoist pumps to make sure each pump is capable of producing 6,000 psi (414 bar).

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

**WARNING**

**High Pressure Hazard!**

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

Use a signal person to monitor functions operator cannot see.

Be prepared to stop engine if unintended motion occurs.

To perform pump pressure test, proceed as follows:

1. Turn PARK ON for all crane functions (drums, boom hoist, swing, travel).
2. Start engine. It is normal for yellow operating limits light to come on during this procedure.
3. Access calibration screen shown below as follows:
   - **a.** Select and confirm SETUP mode to activate calibration program.
   - **b.** Turn LIMIT BYPASS switch clockwise and hold.
   - **c.** SCROLL UP at least one screen.
   - **d.** Continue to scroll up or down until calibration screen appears.
   - **e.** Press bottom of CRANE MODE switch until (*) appears next to PRESSURE TEST.
   - **f.** Increase engine speed to:
     - HIGH IDLE, ***field personnel***
     - 1,350 rpm, ***MCC assembly personnel*** when checking out a new crane

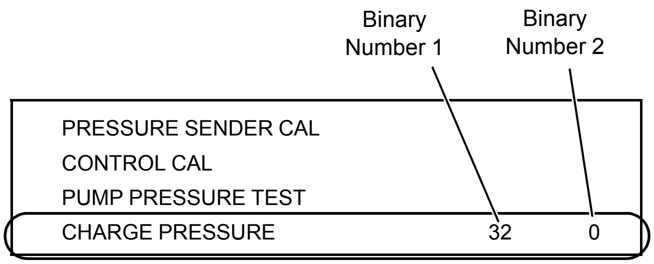
     Engine must be running faster than ***750 rpm*** before calibration will start.

     Calibration will stop if engine speed is decreased during calibration.
   - **g.** Press top end of CRANE MODE switch to CONFIRM. Testing will start.
   - **h.** When testing starts, percent (%) of completion is displayed on screen.
   - **i.** When testing stops, check binary number:
     - If 0 appears, all pumps have passed the test.
     - If any number other than 0 appears, use Table 2-11 to determine which pumps have failed the test.

       Each pump is assigned a number in the binary system (power of two). After running the pressure test, outputs that are ON (failed) for any pump are added together. To identify the failed pumps, find the binary number displayed on the screen in the first column of Table 2-11. All shaded boxes to the right of the number indicate pumps that failed testing.

       Refer to Figure 2-26 to identify the pumps.
   - **j.** Troubleshoot the particular system to determine the cause of the fault.
   - **k.** Proceed to next procedure, or exit calibration screen by pressing bottom of CRANE MODE switch. Cursor (*) will disappear from screen.

## Charge Pressure Check




| Binary No. | Pressure Sender (Bank 1) | Binary No. | Pressure Sender (Bank 2) |
|---|---|---|---|
| 1 | Drum 1/3 (Main Hoist) | 1 | Swing Left |
| 2 | Not Used | 2 | Swing Right |
| 4 | Drum 2/5 (Main Hoist) | 4 | High Pressure Accessory Accumulator |
| 8 | Accessory System | | |
| 16 | Drum 4 (Boom Hoist) | | |
| 32 | Drum 6 (Luffing Hoist) | | |
| 64 | Left Track | | |
| 128 | Right Track | | |

**FIGURE 2-27**

See Figure 2-23 and 2-27 for the following procedure.

The charge pressure line of the calibration screen indicates if any charge pump is not within 275-400 psi (19-27 bar).

Charge pressure should be checked at the following intervals:

- When a new controller node is installed
- When a pump is replaced
- When a pump control (EDC or PCP) is replaced
- Every 6 months

To check charge pressure, proceed as follows:

1. Start and run engine at low idle
2. Access calibration screen shown below as follows:
   a. Turn LIMIT BYPASS switch clockwise and hold.
   b. SCROLL UP at least one screen.
   c. Continue to scroll up or down until calibration screen appears.
   d. The fourth line of the screen indicates charge pressure:
      - If 0 appears, all charge pumps are okay.
      - If any number other than 0 appears, use Table 2-11 to determine which pumps have failed the test.

      Each pump is assigned a number in the binary system. Outputs that are ON (failed) for any pump, are added together. To identify the failed pumps, find the binary number displayed on the screen in the first column of Table 2-11. All shaded boxes to the right of the number indicate pumps that have failed. Troubleshoot the particular system to determine the cause of the fault.
   e. Proceed to next procedure, or exit calibration screen by pressing bottom of CRANE MODE switch. Cursor (*) will disappear from screen.

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**Table 2-11 Binary System**

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**Table 2-11 (continued) Binary System**

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# HYDRAULIC SYSTEM ADJUSTMENT PROCEDURES

## High Pressure Adjustment

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

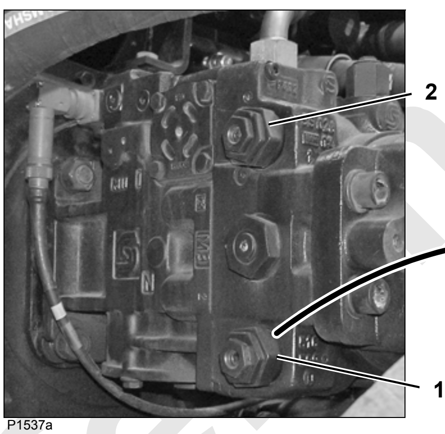
Unless otherwise specified, see Figure 2-28 for the following procedure.

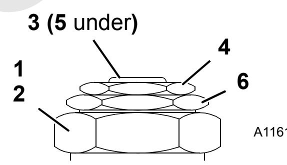
1. Scroll to system component screen for corresponding function.
2. Disconnect electrical (DIN) connector from corresponding brake solenoid valve (see Figure 2-16).
3. With engine running at low idle, slowly move desired control handle in either direction.
4. Do not demand any more than 20% handle command.
5. Pressure on screen should indicate pressure specified in Table 2-10.
6. If proper pressure is not indicated, adjust the corresponding multi-function valve:
   a. Remove protective cap (3) from multi-function valve (1 or 2). See Table 2-10 and Figure 2-21 for pump port identification.
   b. Loosen lock nut (4).

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

   c. Using an internal hex wrench, adjust multi-function valve adjusting screw (5).
      - Turn IN to INCREASE pressure.
      - Turn OUT to DECREASE pressure.
7. Repeat steps until specified pressure is indicated.
8. Hold adjusting screw (5) in position and securely tighten lock nut (4).
9. Install protective cap (3).
10. Reconnect electrical (DIN) connector to corresponding brake solenoid valve (see Figure 2-16).

**Typical Pump Installation**




**Multi-Function Valve**

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

**Wrench Size**

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

**FIGURE 2-28**

## Charge Pressure Adjustment

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

1. Scroll to system display screen for corresponding function.
2. Start and run engine at high idle. With function in neutral, system pressure on diagnostic screen should read 320 to 370 psi (22 to 25,5 bar).
3. If specified pressure is not indicated, stop engine and connect an accurate 0 to 1,000 psi (0 to 69 bar) hydraulic pressure gauge to coupler at corresponding pressure sender.
4. Repeat step 2, if specified pressure is still not indicated:
   - Do a Pressure Sender Test as instructed in this section. Replace faulty pressure sender if needed.
   - Do a Control Calibration as instructed in this section.

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

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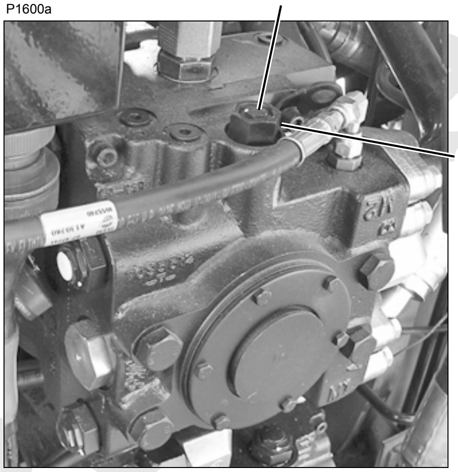

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Typical Pump Installation

| Item | Description | Hex Wrench Size |
|---|---|---|
| 1 | Lock Nut | 1/2 in (12,7 mm) |
| 2 | Adjusting Plug Series 030-100 | 1-1/16 in (27,0 mm) |
| | Adjusting Plug Series 030-100 | 1-5/8 in (41,28 mm) |

**FIGURE 2-29**

5. To adjust charge pressure:

See Figure 2-29 for the following procedure.

   a. Loosen lock nut (1).
   b. Adjust adjusting plug (2).
      - Turn *in* to *increase* pressure.
      - Turn *out* to *decrease* pressure.
   c. Once specified pressure is indicated, hold adjusting plug (2) in position and securely tighten lock nut (1).

6. Stop engine and remove gauge from gauge port.

## Pump Neutral Adjustment

See Figure 2-30 for the following procedure.

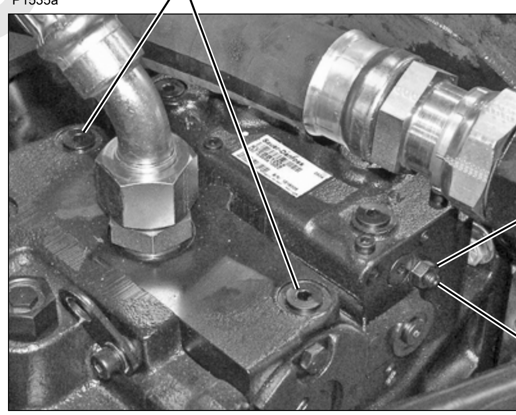
To adjust pump neutral:

1. Park all crane functions and stop engine.
2. Disconnect electrical (DIN) connector from pump EDC (see Figure 2-32).
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.

1

P1535a

Typical Pump Installation



2

3

| 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 2-30**

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

## Motor Leakage Test

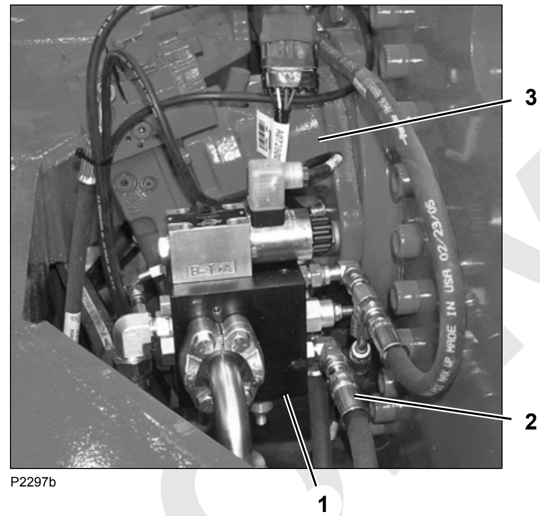
Perform the following test if troubleshooting indicates the need:

- Low Charge Pressure
- Sluggish Operation
- Excessive Heat

See Figure 2-31 for the following procedure.

1. Stop engine.
2. Install an accurate flow meter in highest case drain port (see Figure 2-16) at desired motor.
   - A 3,000 psi (207 bar) in-line meter with a flow rate of 30 gpm (114 L/m) is required.
   - All motors except swing require 16 ORS fittings. Swing requires 12 ORS fittings.
3. For hoist motors only, disable loop flushing as follows:
   - **a.** Disconnect loop flushing hose (2) from elbow in loop flushing valve (1).
   - **b.** Install an 08 ORS cap on end of elbow and an 08 ORS plug in end of hose.
4. Start and run engine at high idle.
5. Monitor flow meter. Under all operating conditions, leakage should not be more than 1-1/2 to 2-1/2 gpm (5,7 to 9,5 L/m.
6. Stop engine and enable loop flushing by reconnecting hose to elbow in loop flushing valve.
7. Start and run engine at high idle.

**Typical Motor Installation**




P2297b

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

**FIGURE 2-31**

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.

## Loop Flushing Valve Adjustment

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

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

## Manual Override Tests

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

**DANGER**

**Falling or Moving Load Hazard!**

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

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

### *Pump or Motor Override*

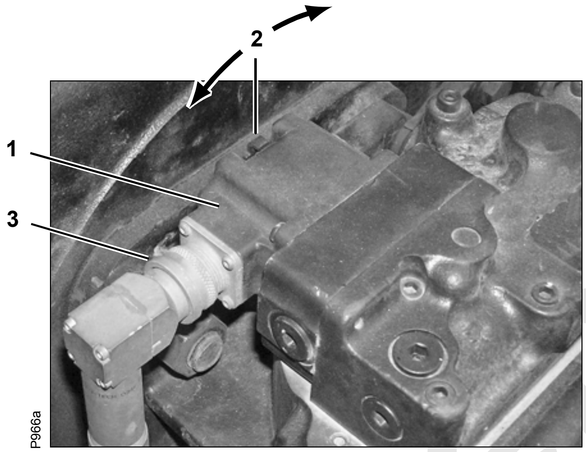
See Figure 2-32 for the following procedure.

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.

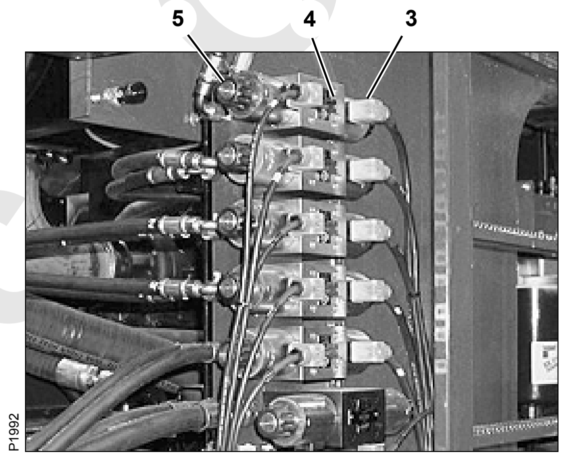
### *Solenoid Valve Override*

See Figure 2-32 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 Installation**

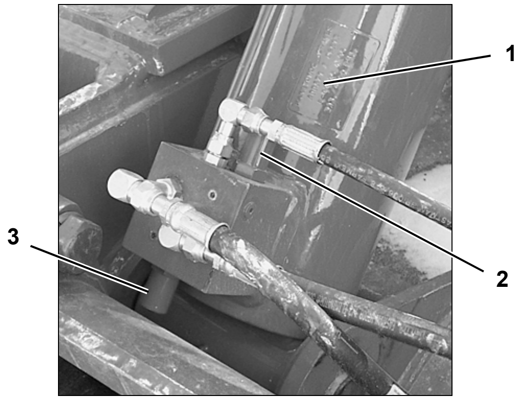



**Typical Solenoid Valve Installation**

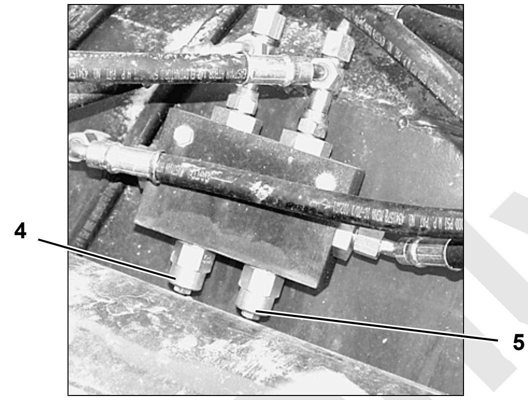
| Item | Description | Item | Description |
|---|---|---|---|
| 1 | Pump EDC/Motor PCP | 4 | Solenoid Valve |
| 2 | Manual Override | 5 | Manual Override (though end cap) |
| 3 | Electrical (DIN) Connector | | |

**FIGURE 2-32**

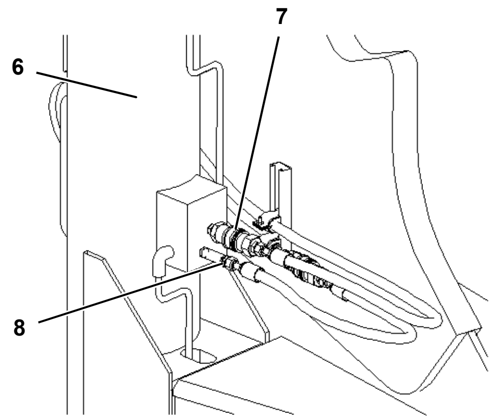
## Counterbalance Valves Adjustment




P1693a




P1693b




18CSM10-104

| Item | Description | Item | Description |
|---|---|---|---|
| 1 | Right Mast Cylinder | 5 | Mast Cylinder Extend Valve |
| 2 | Mast Cylinder Counterbalance Extend Valve | 6 | Rotating Bed Jack |
| 3 | Mast Cylinder Counterbalance Retract Valve | 7 | Rotating Bed Jack Extend Counterbalance Valve |
| 4 | Mast Cylinder Retract Valve | 8 | Rotating Bed Jack Retract Counterbalance Valve |

Each jacking cylinder has a single counterbalance valve at the piston end of the cylinder. The retract adjusting screw at the valve provides adjustment for each jacking cylinder load support. The extend adjusting screw allows cylinders to be adjusted for uniform operation on level ground.

Counterbalance valves are pre-adjusted at the factory, but are not calibrated. Adjust counterbalance valves with a closed end wrench and hex wrench. To avoid over-adjusting the cylinders, use a hex wrench as a guide and never turn a counterbalance valve more than 1/2 turn in either direction.

To adjust a counterbalance valve:

- Loosen the adjusting lock nut.
- Rotate counterbalance adjusting screw 1/2 turn clockwise (in) to lower holding pressure.
- Rotate counterbalance adjusting screw 1/2 turn counter-clockwise (out) to raise holding pressure.
- While holding counterbalance-adjusting screw with hex wrench, tighten lock nut.
- Recheck cylinder(s) for correct load support and uniform operation.

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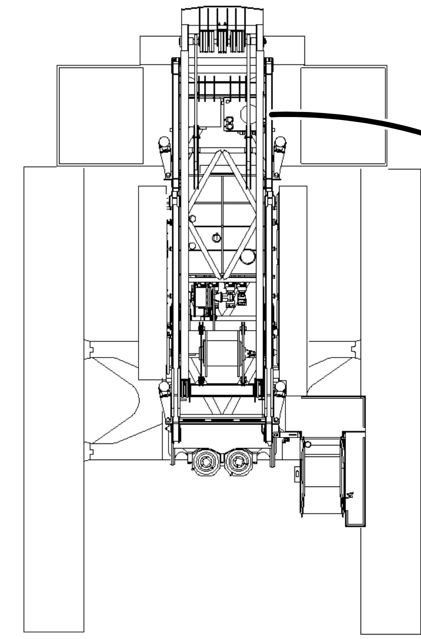
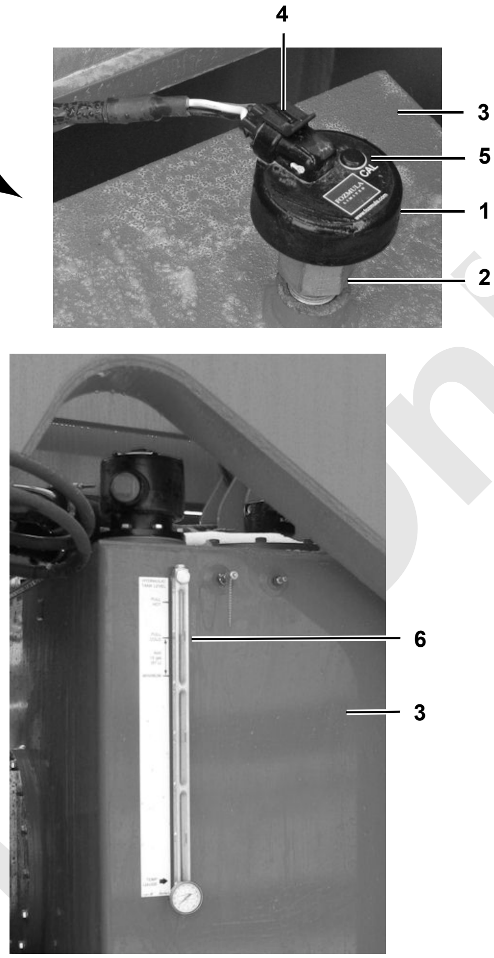

18CSM1-103




| Item | Description |
|---|---|
| 1 | Level Sensor |
| 2 | Adapter |
| 3 | Hydraulic Tank |
| 4 | Electric Cable W2 |
| 5 | CAL Button |
| 6 | Sight Gauge |

**FIGURE 2-33**

## HYDRAULIC TANK LEVEL SENSOR CALIBRATION

See Figure 2-33 for the following procedures.

The following calibration procedures apply only to crane Serial Number 18001082 and newer.

Perform the calibration procedures:

- If you are installing a new level sensor (1)
- If you see faulty level readings in the digital display

### Empty Calibration

1. In the operator cab, turn the engine stop/run/start switch to the STOP position.
2. Disconnect electric cable (4) from level sensor (1).
3. Remove level sensor (1) from hydraulic tank (3).
4. Wipe the level sensor rod dry with a clean rag.
5. Depress CAL button (5) hold.
6. Turn the engine stop/run/start switch to the RUN position.
7. Connect electric cable (4) to level sensor (1) while continuing to hold the CALL button down for 5 more seconds.
8. Release the CAL button.
9. Empty calibration is now set. The hydraulic oil level in the digital display should read **0%.**

| | |
|---|---|
| **HYD TANK FLUID LEVEL** | **0 %** |
| CURRENT (MAX) WIND SPEED | 20 MPH |
| PUMP DRIVE TEMP | 160 DEG |
| PUMP DRIVE PRESSURE | 25 PSI |

**FIGURE 2-34**

10. Turn the engine stop/run/start switch to the STOP position.
11. Disconnect electric cable (4) from level sensor (1).
12. Securely install adapter (2) and level sensor (1).

    Apply Loctite® 569 to the threads of the adapter and the level sensor.
13. Connect electric cable (4) to level sensor (1).
14. Perform the Full Cold Calibration procedure.

### Full Cold Calibration

Perform the following calibration procedure when the hydraulic oil is cold.

1. In the operator cab, turn the engine stop/run/start switch to the STOP position.
2. If not already done:
   a. Securely install adapter (2) and level sensor (1).

      Apply Loctite® 569 to the threads of the adapter and the level sensor.
   b. Connect electric cable (4) to level sensor (1).
3. Fill the hydraulic tank with approved hydraulic oil to the FULL COLD mark on sight gauge (5).
4. Turn the engine stop/run/start switch to the RUN position.
5. Depress the CAL button on the top of the sensor and hold for 5 seconds to set full cold calibration.
6. Full cold calibration is now set. The hydraulic oil level in the digital display should read **100%.**

| | |
|---|---|
| **HYD TANK FLUID LEVEL** | **100 %** |
| CURRENT (MAX) WIND SPEED | 20 MPH |
| PUMP DRIVE TEMP | 160 DEG |
| PUMP DRIVE PRESSURE | 25 PSI |

**FIGURE 2-35**

**NOTE:** As the hydraulic oil warms up, the level in the digital display will rise to a maximum of 110% when the oil is at FULL HOT mark on the sight gauge.

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# SECTION 3
# ELECTRIC SYSTEM

## TABLE OF CONTENTS

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# SECTION 3
# ELECTRIC SYSTEM



## ELECTRICAL SCHEMATICS

Electrical schematics are located at the end of this section.

## CHECKING AND REPLACING ELECTRICAL COMPONENTS

**DANGER**

**Electrical Shock Hazard!**

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

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

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

   If any of these conditions exist, address them appropriately.

   **See Table 3-1 below for the following items.**
3. Harness and battery cables operating in Z***one C*** are recommended to be replaced after 10,000 hours of service life.
4. Harness and cables operating in Z***one 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 Z***one 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.<br>Latitude: 15° - 25° N & S |
| B | Dry or Arid: Deficient precipitation most of the year.<br>Latitude: 20° - 35° N & S |
| C | Moist Mid-Latitude: Temperate with mild winters.<br>Latitude: 30° - 50° N & S |
| D | Moist Mid-Latitude: Cold winters.<br>Latitude 50° - 70° N & S |
| E | Polar: Extremely cold winters and summers.<br>Latitude: 60° - 75° N & S |

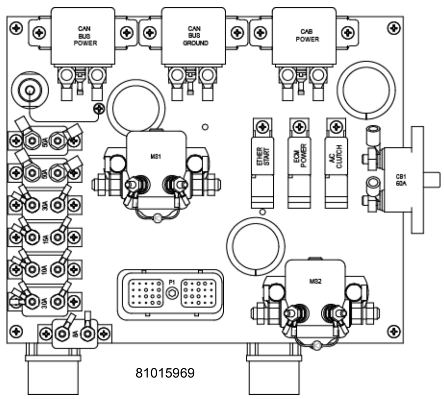
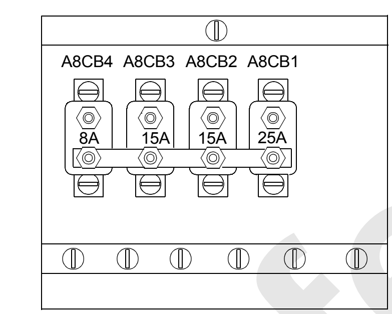
## CIRCUIT BREAKER IDENTIFICATION

This section contains circuit breaker identification. There are no individual in-line fuses.

Circuit breakers CB-1 through CB-8 are mounted in the engine node-0 controller box in left side enclosure.

Circuit breakers ABCB1 through ABCB4 are mounted in load center of right hand console in operator’s cab.

**Table 3-2 Circuit Breaker Identification**

| Circuit Breaker Location | Circuit Breaker | Amps | Wire No. | Description of Items Protected |
|---|---|---|---|---|
|   Left Side Enclosure Near Engine | CB-1 | 60 | 6A | Main System 24 Volt Power |
| | CB-2 | 8 | 6C2 | Electronic Control Module (Cummins) |
| | CB-3* | 10 | 6C6 | Electronic Control Module (Cummins Tier 3) |
| | CB-3* | 30 | 6C6 | Electronic Control Module (Cummins Tier 4) |
| | CB-4 | 10 | 6C8 | Engine Stop |
| | CB-4 | 10 | 6C8 | Engine Stop-Run-Start |
| | CB-4 | 10 | 6C8 | Dome Light |
| | CB-4 | 10 | 6C8 | Horn |
| | CB-4 | 10 | 6C8 | Radio |
| | CB-5 | 15 | 6C11 | Ether Start |
| | CB-5 | 15 | 6C11 | Air Conditioner Clutch |
| | CB-5 | 15 | 6C11 | Heater/Air Conditioner Compressor |
| | CB-6 | 30 | 6C12 | Start Solenoid |
| | CB-7 | 50 | 6C13 | Can Buss Power |
| | CB-7 | 50 | 6C13 | Master Node 1 Power |
| | CB-7 | 50 | 6C13 | Operating Controls |
| | CB-8 | 50 | 6C14 | Cap Power |
| | * 10 amps Tier 3 or 30 amps Tier 4 (reference crane electrical schematic) | | | |
|   In Load Center (Bottom of Right Console) | A8CB1 | 25 | 8PW | 24/12 Volt Converter |
| | A8CB2 | 15 | 8HP | Air Conditioning/Heater Power |
| | A8CB3 | 15 | 8WF<br>8WO | Front Wiper<br>Overhead Wiper |
| | A8CB4 | 8 | 8P | Panel Lights |

# TEST VOLTAGES

## CAN Bus Nodes

The Model 18000 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 wireless hand-held radio remote is used for operating setup items.

Test voltages are sorted by nodes (reference Electrical Schematic A06374). The nodes are listed and identified in Figure 3-1.

| Node Number | Node |
|---|---|
| 1 | Master (Front Console) |
| 2 | Handles and Cab Controls |
| 3 | Drum 3 and Pressure Senders |
| 4 | Jacking, Connecting Pins, and Mast |
| 5 | Alarms, Limits, and Pump Controls |
| 6 | Drums 2, 4, 5, and Adapter Frame Pins |
| 7 | Swing, Travel and Auto Lube |
| 8 | Drum 1 and Drum 6 |
| 9 | MAX-ER |
| 0 | Power, Engine Controls, and Diagnostics |
| 20 | Boom Block Up, Block Sensor, & Limits |
| 21 | Luffing Jib Block Up, Block Sensor, & Limits |

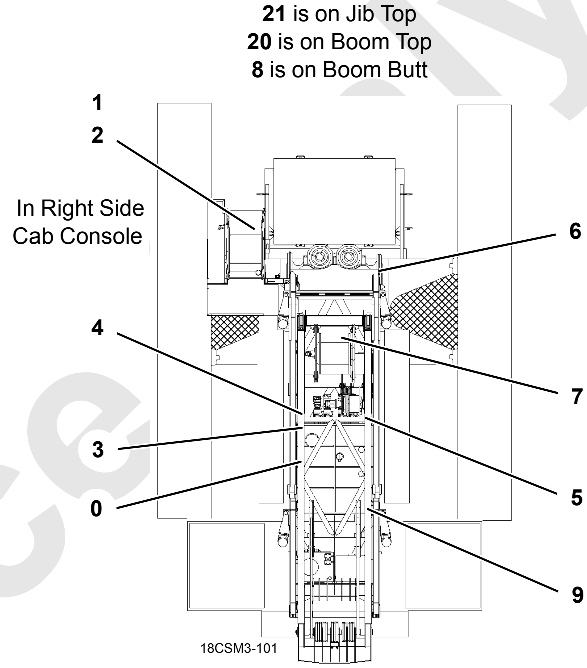



FIGURE 3-1

## Pumps and Motors

The node output voltage and input voltage values at the pumps and motors are shown in Table 3-3 and Table 3-4.

**Table 3-3. Pump Values**

| | At Node | At Pump |
|---|---|---|
| **All** | 0 to 24 Volts | 0 to 2 Volts (0 - 95 mA)[1] |

**Table 3-4 Motor Values**

| | At Node | At Motor |
|---|---|---|
| **Boom Hoist (Drum 4)** | 2.5 to 22 Volts | .2 to 2.2 Volts (10 to 90 mA)[1] |
| **Travel** | 0 or 24 Volts | 0 or 24 Volts (0 or 1500 mA)[1,2] |
| **Hoist Drum 3 and 6** | 2.5 to 16 Volts | .2 to 1.6 Volts (10 to 65 mA)[1] |
| **Hoist Drum 1 and 2** | 2.5 to 19 volts | .2 to 1.9 volts (10 to 75 mA)[1] |

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

[2] Travel motor control is two speed. When the 2-speed 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.

## Alphabetical Index of Components

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

| Component | Location |
|---|---|
| Accessory System Components | Node 4 |
| Adapter frame Pins | Node 6 |
| Alarms | Node 5 |
| Air Conditioning Clutch | Nodes 0 & 1 |
| Auto Lube | Node 7 |
| Block Up Limit (Boom) | Node 20 |
| Block Up Limit (Luffing Jib) | Node 21 |
| Cab Switches and Controls | Nodes 1 & 2 |
| Cab Power | Node 0 |
| Cab Tilt | Node 4 |
| Control Handles | Nodes 1 & 2 |
| Drum 1(Main Hoist 1) Components | Nodes 3 & 8 |
| Drum 2 (Main Hoist 2) Components | Nodes 3 & 6 |
| Drum 3 (Whip Line Hoist) Components | Nodes 3 & 4 |
| Drum 4 (Boom Hoist) Components | Nodes 5 & 6 |
| Drum 5 (Mast Hoist) Components | Nodes 4 & 6 |
| Drum 6 (Luffing Hoist) Components | Nodes 5 & 8 |
| Drum 7 (Rigging Winch) Components | Nodes 4 & 6 |
| Engine Control Module | Node 0 |
| Filters | Node 5 |
| Jacking Components | Node 4 |
| Limits | Node 5 |
| Mast | Node 4 |
| MAX-ER | Node 9 |
| Pressure Senders | Nodes 3, 5 & 6 |
| Swing Components | Nodes 3 & 7 |
| Throttle (Hand and Foot) | Node 2 |
| Travel Components | Nodes 3, 6 & 7 |

## Node Heading Descriptions

CAN ID. NO. indicates the can bus system node number, cable, receptacle number, and pin number code (***43-D***) is as follows:

- The letter and number ***43*** is the ***cable number.***
- The number ***4*** is the ***node number***.
- The number ***3*** is the ***receptacle number*** where the item is located on the node.
- The last number ***D*** is the ***pin number*** of the receptacle.

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

RECPT/PIN NO. (Engine Node 0 only) indicates input to receptacle number and pin number code (P1-7 or J2-E).

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

DESCRIPTION indicates the component item.

PACKET NO. indicates location of items for master node 1, node 2, universal nodes (3 though 9), boom node 20, and luffing jib node 21. Engine node 0 does not have packet numbers.

Master (front console node) node 1:

- ***FCN-2-4*** (Limit Bypass Switch) indicates where the inputs/output are located on the master node 1.
- ***FCN*** is the ***packet*** location number.
- Number ***2*** is the ***bank*** where information is stored.
- Number ***4*** is the ***identifier*** for that item.

Node 2, universal nodes (3 though 9), boom node 20, and luffing jib node 21:

- ***CAN38-1-32*** (Return Filter Alarm Switch) indicates where the inputs/output are located on the node.
- ***CAN38*** is the ***packet*** location number.
- Number ***1*** is the ***bank*** where information is stored.
- Number ***32*** is the ***identifier*** for that item.

3

***NODE 1 - Master Node (Front Console)***

Reference Electrical Schematic A06374 - Sheets 4, 5, and 17.

| Can ID. # /Connector # | Function Type | Description | Test Voltages | Packet No. |
|---|---|---|---|---|
| **J11** | **Receptacle – Front Console** | | | |
| 1101/P11-1 | 24 Volts | Backlight Power | 24 Volts | |
| 1102/P11-2 | 24 Volts | Crane Display Contrast Control – High | 24 Volts | |
| 1103/P11-3 | DI-12 | RCL Display Scroll Up Switch | 0 Volts Off; 24 Volts On | FCN-2-8 |
| 1104/P11-4 | DI-14 | RCL Display Scroll Down Switch | 0 Volts Off; 24 Volts On | FCN-2-32 |
| 1105/P11-5 | DI-31 | RCL Mode Select Switch | 0 Volts Off; 24 Volts On | FCN-4-64 |
| 1106/P11-6 | DI-9 | RCL Mode Confirm Switch | 0 Volts Off; 24 Volts On | FCN-2-1 |
| 1107 /P11-7 | DO-1 | Operating Limit Alarm (Beeper) & L.E.D. | 0 Volts Off; 24 Volts On | FCN-5-1 |
| 1108/P11-8 | DO-3 | RCL Warning L.E.D. | 0 Volts Off; 24 Volts On | FCN-5-4 |
| 1109 /P11-9 | DO-8 | System Fault Alarm (Buzzer) & L.E.D. | 0 Volts Off; 24 Volts On | FCN-5-128 |
| 1110/P11-10 | DO-6 | RCL Caution L.E.D. | 0 Volts Off; 24 Volts On | FCN-5-32 |
| 1111/P11-11 | 24 Volts | Backlight Power | 24 Volts | |
| 1112/P11-12 | Signal | Crane Display Contrast Control – Wiper | Between 0 to 24 Volts | |
| 1113/P11-13 | DI-11 | Limit Bypass Switch | 0 Volts Off; 24 Volts On | FCN-2-4 |
| 1114/P11-14 | DI-13 | Not Used | 0 Volts Off; 24 Volts On | FCN-2-16 |
| 1115/P11-15 | DI-32 | Drum 3 (Whip Line) Park Switch – On | 0 Volts Off; 24 Volts On | FCN-4-128 |
| 1116/P11-16 | DI-10 | Drum 5 (Mast Hoist) Park Switch – On | 0 Volts Off; 24 Volts On | FCN-2-2 |
| 1119/P11-19 | DO-7 | RCL Fault Alarm in Cab | 0 Volts Off; 24 Volts On | FCN-5-64 |
| 1121/P11-21 | Ground | Backlight Ground | Ground | |
| 1122/P11-22 | Ground | Crane Display Contrast Control – Low | Ground | |
| 1123/P11-23 | DI-28 | Travel 2-Speed Switch | 0 Volts Off; 24 Volts On | FCN-4-8 |
| 1124/P11-24 | DI-30 | Swing Park Switch – On | 0 Volts Off; 24 Volts On | FCN-4-32 |
| 1125/P11-25 | DI-15 | Travel Cruise Switch - On | 0 Volts Off; 24 Volts On | FCN-2-64 |
| 1129/P11-29 | Ground | RCL Caution L.E.D. | Ground | |
| 1130/P11-30 | Ground | RCL Warning L.E.D. | Ground | |
| 1131/P11-31 | CANH | Can High Data Line | N/A | |
| 1132/P11-32 | CANL | Can Low Data Line | N/A | |
| **J12** | **Receptacle – Front Console** | | | |
| 1201/P12-1 | 24 Volts | Backlight Power | 24 Volts | |
| 1202/P12-2 | 24 Volts | RCL Display Contrast Control - High | 24 Volts | |
| 1203/P12-3 | DI-4 | Crane Display Scroll Up Switch | 0 Volts Off; 24 Volts On | FCN-1-8 |
| 1204/P12-4 | DI-6 | Crane Display Scroll Down Switch | 0 Volts Off; 24 Volts On | FCN-1-32 |
| 1205/P12-5 | DI-23 | Crane Mode Select Switch | 0 Volts Off; 24 Volts On | FCN-3-64 |
| 1206/P12-6 | DI-2 | Crane Mode Confirm Switch | 0 Volts Off; 24 Volts On | FCN-1-2 |
| 1208/P12-8 | DO-11 | Engine Diagnostics (Red L.E.D.) | 0 Volts Off; 24 Volts On | FCN-6-4 |
| 1209/P12-9 | DO-16 | Engine Diagnostics (Amber L.E.D.) | 0 Volts Off; 24 Volts On | FCN-6-128 |
| 1210/P12-10 | DO-14 | Engine Diagnostics (White L.E.D.) | 0 Volts Off; 24 Volts On | FCN-6-32 |
| 1211/P12-11 | 24 Volts | Backlight Power | 24 Volts | |





Published 12-05-17, Control # 035-23

| Can ID. # /Connector # | Function Type | Description | Test Voltages | Packet No. |
|---|---|---|---|---|
| 1212/P12-12 | Signal | RCL Display Contrast Control - Wiper | Between 0 to 24 Volts | |
| 1213/P12-13 | DI-3 | Drum 1 (Main Drum 1) Park Switch – On | 0 Volts Off; 24 Volts On | FCN-1-4 |
| 1214/P12-14 | DI-5 | Drum 2 (Main Drum 2) Park Switch – On | 0 Volts Off; 24 Volts On | FCN-1-16 |
| 1215/P12-15 | DI-24 | Drum 4 (Boom Hoist) Park Switch – On | 0 Volts Off; 24 Volts On | FCN-3-128 |
| 1216/P12-16 | DI-1 | Drum 6 (Luffing Jib) Park Switch – On | 0 Volts Off; 24 Volts On | FCN-1-1 |
| 1217/P12-17 | DO-10 | Handle B Display | 24 Volts Nominal | FCN-6-2 |
| 1218/P12-18 | DO-12 | Handle D Display | 24 Volts Nominal | FCN-6-8 |
| 1219/P12-19 | DO-15 | Handle C Display | 24 Volts Nominal | FCN-6-64 |
| 1220/P12-20 | DO-13 | Handle A Display | 24 Volts Nominal | FCN-6-16 |
| 1221/P12-21 | Ground | Backlight Ground | Ground | |
| 1222/P12-22 | Ground | RCL Display Contrast Control - Low | Ground | |
| 1223/P12-23 | DI-20 | Air Conditioning Compressor Clutch - On | 0 Volts Off; 24 Volts On | FCN-3-8 |
| 1224/P12-24 | DI-22 | Engine Start | 0 Volts Off; 24 Volts On | FCN-3-32 |
| 1225/P12-25 | DI-7 | Travel Park Switch – On | 0 Volts Off; 24 Volts On | FCN-1-64 |
| 1226/P12-26 | DI-17 | Seat Switch | 0 Volts Off; 24 Volts On | FCN-3-1 |
| 1228/P12-28 | Ground | Engine Diagnostics (Red L.E.D.) | Ground | |
| 1229/P12-29 | Ground | Engine Diagnostics (Amber L.E.D.) | Ground | |
| 1230/P12-30 | Ground | Engine Diagnostics (White L.E.D.) | Ground | |
| 1231/P12-31 | CANH | Can High Wire Termination | N/A | |
| 1232/P12-32 | CANL | Can Low Wire Termination | N/A | |
| 1233/P12-33 | DI-19 | DPF Regen Initiate | 0 Volts Off; 24 Volts On | |
| 1234/P12-34 | DI-21 | DPF Regen Inhibit | 0 Volts Off; 24 Volts On | |
| 1235/P12-35 | DI-8 | Cab Tilt Up Switch | 0 Volts Off; 24 Volts On | FCN-1-128 |
| 1236/P12-36 | DI-18 | Cab Tilt Down Switch | 0 Volts Off; 24 Volts On | FCN-3-2 |
| 1237/P12-37 | Ground | System Fault Alarm | Ground | |
| 1238/P12-38 | Ground | Operating Limit Alarm | Ground | |

***NODE 2 - Handles and Cab Controls***

Reference Electrical Schematic A06374 - Sheets 4, 5, 6 and 18.

| Can ID. # /Connector # | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| **J1** | **Receptacle - Alarms** | | | |
| 2101/P51-1 | CAN-H | Can High Data Line | N/A | |
| 2102/P51-2 | CAN-L | Can Low Data Line | N/A | |
| 2103/P51-3 | AI-2 | Handle B Output Signal | Raise 2.4 - 0.5 Volts; Lower 2.6 - 4.5 Volts | CAN0-4 [1] |
| 2104/P51-4 | AI-5 | Handle C Output Signal | Raise 2.4 - 0.5 Volts; Lower 2.6 - 4.5 Volts | CAN1-2 [1] |
| 2105/P51-5 | AI-10 | Handle D Output Signal | Lower 2.6 - 4.5 Volts; Raise 2.4 - 0.5 Volts | CAN2-4 [1] |
| 2106/P51-6 | AI-14 | Hand Throttle Input Signal | Low Idle 2.9 – 3.0 Volts; High Idle 0.9 – 1.0 Volts | CAN3-4 [1] |
| 2107/P51-7 | DI-10 | Handle B Direction Signal | 0 to 24 Volts | CAN57-2-2 |
| 2108/P51-8 | DI-11 | Handle C Direction Signal | 0 to 24 Volts | CAN57-2-4 |
| 2109/P51-9 | DI-2 | Handle D Direction Signal | 0 to 24 Volts | CAN57-1-2 |
| 2110/P51-10 | DI-3 | Swing Holding Brake Switch | 0 Volts Off; 24 Volts On | CAN57-1-4 |
| 2111/P51-11 | CAN-H | Can High Data Line to Node 1 | N/A | |
| 2112/P51-12 | CAN-L | Can Low Data Line to Node 1 | N/A | |
| 2113/P51-13 | AI-4 | Left Travel Handle Output Signal | Forward 2.6 - 4.5 Volts; Reverse 2.4 - 0.5 Volts | CAN0-8 [1] |
| 2114/P51-14 | AI-6 | Right Travel Handle Output Signal | Forward 2.6 - 4.5 Volts; Reverse 2.4 - 0.5 Volts | CAN1-4 [1] |
| 2115/P51-15 | AI-9 | Handle A Output Signal | Raise 2.4 - 0.5 Volts; Lower 2.6 - 4.5 Volts | CAN2-2 [1] |
| 2116/P51-16 | AI-13 | Swing Handle Output Signal | Left 2.4 - 0.5 Volts; Right 2.6 - 4.5 Volts | CAN3-2 [1] |
| 2117/P51-17 | DI-9 | Left Track Direction Signal | 0 to 24 Volts | CAN57-2-1 |
| 2118/P51-18 | DI-12 | Right Track Direction Signal | 0 to 24 Volts | CAN57-2-8 |
| 2119/P51-19 | DI-1 | Handle A Direction Signal | 0 to 24 Volts | CAN57-1-1 |
| 2120/P51-20 | DI-4 | Swing Handle Direction Signal | 0 to 24 Volts | CAN57-1-8 |
| 2121/P51-21 | Ground | Foot Throttle | Ground | |
| 2122/P51-22 | Ground | Handle and Node Select Ground | Analog Ground | |
| 2123/P51-23 | AI-1 | Foot Throttle Input Signal | Low Idle 2.9 – 3.0 Volts; High Idle 0.9 – 1.0 Volts | CAN0-2 [1] |
| 2124/P51-24 | AI-8 | Left Travel Pedal | Forward 2.6 - 4.5 Volts; Reverse 2.4 - 0.5 Volts | CAN1-8 [1] |
| 2125/P51-25 | AI-12 | Right Travel Pedal | Forward 2.6 - 4.5 Volts; Reverse 2.4 - 0.5 Volts | CAN2-8 [1] |
| 2128/P51-28 | DI-7 | RCL Override (CE Option) | 0 Volts Off; 24 Volts On | CAN 57-1-64 |
| 2131/P51-31 | 5 Volts DC | Handle A and Hand Throttle Power | 5 Volts | |
| 2132/P51-32 | Node 1 | Node Select Jumper 1 to Ground | 0 Volts (With Jumper) | |
| 2140/P51-40 | DI-5 | Swing Handle Dead Man Option | 0 Volts Off; 24 Volts On | CAN57-1-16 |

| Can ID. # /Connector # | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| **J2** | **Receptacle - Handles** | | | |
| 2201/P52-1 | DO-7 | Handle B Rotation Indicator | 24 Volts Nominal | CAN32-1-64 |
| 2202/P52-2 | DO-3 | Handle C Rotation Indicator | 24 Volts Nominal | CAN32-1-4 |
| 2203/P52-3 | DO-6 | Handle D Rotation Indicator | 24 Volts Nominal | CAN32-1-32 |
| 2204/P52-4 | DO-2 | Handle A Rotation Indicator | 24 Volts Nominal | CAN32-1-2 |
| 2205/P52-5 | DO-5 | Overhead Wiper Switch | 24 Volts Nominal | CAN32-1-16 |
| 2206/P52-6 | DO-13 | Power to Switches 1 | 24 Volts Nominal | CAN32-2-16 |
| 2207/P52-7 | DO-16 | Power to Switches 2 | 24 Volts Nominal | CAN32-2-128 |
| 2208/P52-8 | DO-9 | Power to Switches 3 | 24 Volts Nominal | CAN32-2-1 |
| 2209/P52-9 | DO-19 | Handle B Raise Direction | 24 Volts Nominal | CAN32-3-4 |
| 2210/P52-10 | DO-12 | Handle B Lower Direction | 24 Volts Nominal | CAN32-2-8 |
| 2211/P52-11 | DO-4 | Front Wiper Switch | 24 Volts Nominal | CAN32-1-8 |
| 2213/P52-13 | DO-8-2 | Handle B Display | 24 Volts Nominal | CAN32-1-128 |
| 2214/P52-14 | Ground | Handle B Display | Ground | |
| 2215/P52-15 | DO-1 | Cab Base RCL Beacon/Alarm | 24 Volts Nominal | CAN32-1-1 |
| 2216/P52-16 | DO-22 | Handle C Raise Direction | 24 Volts Nominal | CAN32-3-32 |
| 2217/P52-17 | DO-24 | Handle C Lower Direction | 24 Volts Nominal | CAN32-3-128 |
| 2218/P52-18 | DO-10 | Handle D Lower Direction | 24 Volts Nominal | CAN32-2-2 |
| 2219/P52-19 | DO-18 | Handle D Raise Direction | 24 Volts Nominal | CAN32-3-2 |
| 2220/P52-20 | Ground | Handle D Display | Ground | |
| 2221/P52-21 | DO-8-3 | Handle D Display | 24 Volts Nominal | CAN32-1-128 |
| 2222/P52-22 | DO-8-4 | Handle C Display | 24 Volts Nominal | CAN32-1-128 |
| 2223/P52-23 | Ground | Handle B Rotation Indicator | Ground | |
| 2224/P52-24 | Ground | Handle C Rotation Indicator | Ground | |
| 2225/P52-25 | Ground | Handle D Rotation Indicator | Ground | |
| 2226/P52-26 | DO-15 | Left Travel Handle Reverse Direction | 24 Volts Nominal | CAN32-2-64 |
| 2227/P52-27 | DO-14 | Left Travel Handle Forward Direction | 24 Volts Nominal | CAN32-2-32 |
| 2228/P52-28 | DO-11 | Right Travel Handle Reverse Direction | 24 Volts Nominal | CAN32-2-4 |
| 2229/P52-29 | DO-17 | Right Travel Handle Forward Direction | 24 Volts Nominal | CAN32-3-1 |
| 2230/P52-30 | Ground | Handle C Display | Ground | |
| 2231/P52-31 | DO-8-5 | Handle A Display/Seat Switch | 24 Volts Nominal | CAN32-2-128 |
| 2233/P52-33 | 5 Volts DC | Handle B Power | 5 Volts DC Nominal | |
| 2234/P52-34 | 5 Volts DC | Handle C Power | 5 Volts DC Nominal | |
| 2235/P52-35 | 5 Volts DC | Handle D Power | 5 Volts DC Nominal | |
| 2236/P52-36 | DO-21 | Travel Cruise Switch | 0 Volts Off; 24 Volts On | CAN-32-3-16 |
| 2237/P52-37 | DO-23 | Foot Throttle Output | Low Idle 2.9 – 3.0 Volts; High Idle 0.9 – 1.0 Volts | CAN-32-3-64 |
| 2239/P52-39 | 5 Volts DC | Left Travel Handle Power | 5 Volts DC Nominal | |
| 2240/P52-40 | 5 Volts DC | Right Travel Handle Power | 5 Volts DC Nominal | |
| **J3** | **Receptacle - Power** | | | |

| Can ID. # /Connector # | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| P53-A | Ground | Setup Receiver | Ground | |
| P53-B | Ground | Left Console | Ground | |
| P53-C | Ground | Cab Ground | Ground | |
| P53-E | 28 Volts | Setup Receiver | 28 Volts Nominal | |
| P53-F | 28 Volts | Bar Graph Display | 28 Volts Nominal | |

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

### *NODE 3 - Drum 3 and Pressure Senders*

Reference Electrical Schematic A06374 - Sheets 7, 19 and 20.

| Can ID. No. | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| WN10-A/WN04-A | 24 Volts | From Node 0 to Node 4 | 24 Volts | |
| WN10-C/WN04-C | CANH | Can High Wire Transmission | N/A | |
| WN10-D/WN04-D | Ground | From Node 0 to Node 4 | Ground | |
| WN10-F/WN04-F | CANL | Can Low Wire Transmission | N/A | |
| **J3** | **Receptacle – Pressure Senders** | | | |
| 33-B | DO-1 | Super Charge Hydraulic Pressure (Prior to S/N 18001082) | 0 Volts Off; 24 Volts On | CAN33-1-1 |
| 33-C | Ground | Drum 2/5 Pressure Sender | Ground | |
| 33-D | DO-2 | Drum 2/5 Pressure Sender | 0 Volts Off; 24 Volts On | CAN33-1-2 |
| 33-E | Ground | Drum 1/3 Pressure Sender | Ground | |
| 33-F | DO-3 | Drum 1/3 Pressure Sender | 0 Volts Off; 24 Volts On | CAN33-1-4 |
| 33-G | Ground | Accessory System Pressure Sender | Ground | |
| 33-H | DO-4 | Accessory System Pressure Sender | 0 Volts Off; 24 Volts On | CAN33-1-8 |
| 33-J | Ground | Jumper to Node Select | Ground | |
| 33-L | NS-2 | Node Select Jumper to Ground | 0 Volts (With Jumper) | |
| 33-N | Ground | Right Track Pressure Sender | Ground | |
| 33-P | DO-6 | Right Track Pressure Sender | 0 Volts Off; 24 Volts On | CAN33-1-32 |
| 33-R | DO-5 | Left Track Pressure Sender | 0 Volts Off; 24 Volts On | CAN33-1-16 |
| 33-T | DI-3 | Super Charge Hydraulic Pressure (Prior to S/N 18001082) | 0 Volts Off; 24 Volts On | CAN59-1-4 |
| 33-b | AI-2 | Drum 2/5 Pressure Sender | 1 Volt at 0 psi;<br>5 Volts at 7,500 psi | CAN4-4 [1] |
| 33-c | AI-3 | Drum 1/3 Pressure Sender | 1 Volt at 0 psi;<br>5 Volts at 7,500 psi | CAN4-6 [1] |
| 33-d | AI-4 | Accessory System Pressure Sender | 1 Volt at 0 psi;<br>5 Volts at 7,500 psi | CAN4-8 [1] |
| 33-e | AI-5 | Right Track Pressure Sender | 1 Volt at 0 psi;<br>5 Volts at 7,500 psi | CAN5-2 [1] |
| 33-f | AI-6 | Left Track Pressure Sender | 1 Volt at 0 psi;<br>5 Volts at 7,500 psi | CAN5-4 [1] |
| 33-g | Ground | Left Track Pressure Sender | Ground | |
| **J4** | **Receptacle – Drum Pump Control** | | | |
| 34-A | Ground | Drum 1/3 Pump Control – Raise | Ground | |
| 34-B | DO-11 | Drum 1/3 Pump Control – Raise | See Table 3-3 for Values | CAN33-2-4 |
| 34-C | Ground | Drum 1/3 Pump Control – Lower | Ground | |
| 34-D | DO-12 | Drum 1/3 Pump Control – Lower | See Table 3-3 for Values | CAN33-2-8 |
| 34-E | Ground | Drum 2/5 Pump Control – Raise | Ground | |
| 34-F | DO-13 | Drum 2/5 Pump Control – Raise | See Table 3-3for Values | CAN33-2-16 |
| 34-G | Ground | Drum 2/5 Pump Control – Lower | Ground | |
| 34-H | DO-14 | Drum 2/5 Pump Control – Lower | See Table 3-3 for Values | CAN33-2-32 |
| 34-J | Ground | Drum 2 Pump Control – Raise | Ground | |
| 34-K | Ground | Drum 2 Pump Control – Lower | Ground | |
| 34-L | Ground | Drum 1/3 (opt.) Pump Control – Raise | Ground | |
| 34-M | DO-17 | Drum 1/3 (opt.) Pump Control – Raise | See Table 3-3 for Values | CAN33-3-1 |
| 34-N | Ground | Drum 1/3 (opt.) Pump Control – Lower | Ground | |

| Can ID. No. | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| 34-P | DO-16 | Drum 2 Pump Control – Raise | See Table 3-3 for Values | CAN33-2-128 |
| 34-R | DO-15 | Drum 2 Pump Control – Lower | See Table 3-3 for Values | CAN33-2-64 |
| 34-S | DO-18 | Drum 1/3 (opt.) Pump Control – Lower | See Table 3-3 for Values | CAN33-3-2 |
| 34-T | Ground | Left Track Pump Control – Forward | Ground | |
| 34-U | DO-19 | Left Track Pump Control – Forward | See Table 3-3 for Values | CAN33-3-4 |
| 34-V | Ground | Left Track Pump Control – Reverse | Ground | |
| 34-W | DO-20 | Left Track Pump Control – Reverse | See Table 3-3 for Values | CAN33-3-8 |
| 34-X | Ground | Swing 1 Pump Control – Left | Ground | |
| 34-Z | DO-21 | Swing 1 Pump Control – Left | See Table 3-3 for Values | CAN33-3-16 |
| 34-a | Ground | Swing 1 Pump Control – Right | Ground | |
| 34-b | DO-22 | Swing 1 Pump Control – Right | See Table 3-3 for Values | CAN33-3-32 |
| 34-g | Ground | Jumper to Node Select 2 | 0 Volts (With Jumper) | |
| 34-j | NS-2 | Node Select Jumper to Ground | 0 Volts (With Jumper) | |
| **J6** | **Receptacle – Drum 3 Controls** | | | |
| 36-A | Ground | Drum 3 Motor Control | Ground | |
| 36-B | DO-7 | Drum 3 Motor Control | See Table 3-3 for Values | CAN33-1-64 |
| 36-C | Ground | Drum 3 Brake Solenoid | Ground | |
| 36-D | DO-8 | Drum 3 Brake Solenoid | See Table 3-3 for Values | CAN33-1-128 |
| 36-E | Ground | Pump Drive Cooler Pressure | Ground | |
| 36-F | DO-9 | Pump Drive Cooler Pressure | 0 Volts Off; 24 Volts On | CAN33-2-1 |
| 36-G | Ground | Drum 3 Minimum Bail Limit Switch | Ground | |
| 36-H | DO-10 | Drum 3 Minimum Bail Limit Switch | 0 Volts Off; 24 Volts On | CAN33-2-2 |
| 36-J | DI-8 | Drum 3 Minimum Bail Limit Switch | 0 Volts Off; 24 Volts On | CAN59-1-128 |
| 36-L | NS-2 | Node Select 2 Jumper to Ground | 0 Volts (With Jumper) | |
| 36-U | Ground | Jumper to Node Select | Ground | |
| 36-V | 5 Volts | Drum 3 and 5 Motor Speed Sensor | 0 to 5 Volts | |
| 36-W | Ground | Pump Drive Temperature Sender | Ground | |
| 36-X | 28 Volts | Pump Drive Temperature Sender | 28 Volts Nominal | |
| 36-Z | Ground | Drum 5 Motor Speed Sensor | Ground | |
| 36-a | AI-9 | Pump Drive Cooler Pressure | 1 Volt at 0 psi; 5 Volts at 200 psi | CAN6-2 [1] |
| 36-b | AI-10 | Pump Drive Temperature Sender | 32.5K ohms at $0^{o}$ C; 680 ohms at $90^{o}$ C | CAN6-4 [1] |
| 36-j | Ground | Drum 3 Motor Speed Sensor | Ground | |
| 36-n | ENC-1A | Drum 3 Motor Speed Sensor | 1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving | CAN58-2 [2] |
| 36-p | ENC-1B | Drum 3 Motor Speed Sensor | 1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving | CAN58-2 [2] |
| 36-r | ENC-2A | Drum 5 Motor Speed Sensor | 1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving | CAN58-4 [2] |
| 36-s | ENC-2B | Drum 5 Motor Speed Sensor | 1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving | CAN58-4 [2] |

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

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

### *NODE 4 - Connecting Pins, Jacking, and Mast*

Reference Electrical Schematic A06374 - Sheets 8, 19 and 20.

| Can ID. No. | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| WN04-A/WN30-A | 24 Volts | From Node 3 to Node 2 | 24 Volts Nominal | |
| WN04-C/WN30-C | CANH | Can High Wire Transmission | N/A | |
| WN04-D/WN30-D | Ground | From Node 3 to Node 2 | Ground | |
| WN04-F/WN30-F | CANL | Can Low Wire Transmission | N/A | |
| **J3** | **Receptacle – Connecting Pins** | | | |
| 43-A | Ground | Mast Pins Engage Solenoid | Ground | |
| 43-B | DO-1 | Mast Pins Engage Solenoid | 0 Volts Off; 24 Volts On | CAN35-1-1 |
| 43-C | Ground | Mast Pins Disengage Solenoid | Ground | |
| 43-D | DO-2 | Mast Pins Disengage Solenoid | 0 Volts Off; 24 Volts On | CAN35-1-2 |
| 43-E | Ground | Boom Pins Engage Solenoid | Ground | |
| 43-F | DO-3 | Boom Pins Engage Solenoid | 0 Volts Off; 24 Volts On | CAN35-1-4 |
| 43-G | Ground | Boom Pins Disengage Solenoid | Ground | |
| 43-H | DO-4 | Boom Pins Disengage Solenoid | 0 Volts Off; 24 Volts On | CAN35-1-8 |
| 43-J | Ground | Jumper to Node Select 3 | Ground | |
| 43-M | NS-3 | Node Select 3 Jumper to Ground | 0 Volts (With Jumper) | |
| 43-P | DO-6 | Cab Tilt – Up Solenoid | 0 Volts Off; 24 Volts On | CAN35-1-32 |
| 43-R | DO-5 | Cab Tilt – Down Solenoid | 0 Volts Off; 24 Volts On | CAN35-1-16 |
| 43-g | Ground | Cab Tilt – Up Solenoid | Ground | |
| 43-h | Ground | Cab Tilt – Down Solenoid | Ground | |
| **J4** | **Receptacle – Jacking Solenoids** | | | |
| 44-A | Ground | Drum 7 Payout Solenoid | Ground | |
| 44-B | DO-11 | Drum 7 Payout Solenoid | 0 Volts Off; 24 Volts On | CAN35-2-4 |
| 44-C | Ground | Drum 7 Haul In Solenoid | Ground | |
| 44-D | DO-12 | Drum 7 Haul In Solenoid | 0 Volts Off; 24 Volts On | CAN35-2-8 |
| 44-E | Ground | Right Front Jack Extend Solenoid | Ground | |
| 44-F | DO-13 | Right Front Jack Extend Solenoid | 0 Volts Off; 24 Volts On | CAN35-2-16 |
| 44-G | Ground | Right Front Jack Retract Solenoid | Ground | |
| 44-H | DO-14 | Right Front Jack Retract Solenoid | 0 Volts Off; 24 Volts On | CAN35-2-32 |
| 44-J | Ground | Left Front Jack Extend Solenoid | Ground | |
| 44-K | Ground | Left Front Jack Retract Solenoid | Ground | |
| 44-P | DO-16 | Left Front Jack Extend Solenoid | 0 Volts Off; 24 Volts On | CAN35-2-128 |
| 44-R | DO-15 | Left Front Jack Retract Solenoid | 0 Volts Off; 24 Volts On | CAN35-2-64 |
| 44-T | Ground | Right Rear Jack Extend Solenoid | Ground | |
| 44-U | DO-19 | Right Rear Jack Extend Solenoid | 0 Volts Off; 24 Volts On | CAN35-3-4 |
| 44-V | Ground | Right Rear Jack Retract Solenoid | Ground | |
| 44-W | DO-20 | Right Rear Jack Retract Solenoid | 0 Volts Off; 24 Volts On | CAN35-3-8 |
| 44-X | Ground | Left Rear Jack Extend Solenoid | Ground | |
| 44-Z | DO-21 | Left Rear Jack Extend Solenoid | 0 Volts Off; 24 Volts On | CAN35-3-16 |

| Can ID. No. | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| 44-a | Ground | Left Rear Jack Retract Solenoid | Ground | |
| 44-b | DO-22 | Left Rear Jack Retract Solenoid | 0 Volts Off; 24 Volts On | CAN35-3-32 |
| 44-g | Ground | Jumper to Node Select 3 | Ground | |
| 44-k | NS-3 | Node Select 3 Jumper to Ground | 0 Volts (With Jumper) | |
| **J6** | **Receptacle – Mast** | | | |
| 46-A | Ground | Drum 3 Diverter Solenoid | Ground | |
| 46-B | DO-7 | Drum 3 Diverter Solenoid | 0 Volts Off; 24 Volts On | CAN35-1-64 |
| 46-C | Ground | Drum 5 Diverter Solenoid | Ground | |
| 46-D | DO-8 | Drum 5 Diverter Solenoid | 0 Volts Off; 24 Volts On | CAN35-1-128 |
| 46-E | Ground | Mast Raise Solenoid | Ground | |
| 46-F | DO-9 | Mast Raise Solenoid | 0 Volts Off; 24 Volts On | CAN35-2-1 |
| 46-G | Ground | Mast Lower Solenoid | Ground | |
| 46-H | DO-10 | Mast Lower Solenoid | 0 Volts Off; 24 Volts On | CAN35-2-2 |
| 46-M | NS-3 | Node Select 4 Jumper to Ground | 0 Volts (With Jumper) | |
| 46-U | Ground | Jumper to Node Select 4 | Ground | |
| 46-V | 5 Volts | Mast Angle Sensor | 5 Volts | |
| 46-W | Ground | Mast Angle Sensor | Ground | |
| 46-a | AI-9 | Mast Angle Sensor | 5 Volts DC Mast at Vertical | CAN14-2 [1] |

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

***NODE 5 - Alarms, Pump Controls, and Limits***

Reference Electrical Schematic A06374 - Sheets 9, 19, 20 and 21.

| Can ID. No. | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| WN16-A/WN14-A | 24 Volts | From Node 0 to Node 9 | 24 Volts Nominal | |
| WN16-C/WN14-C | CANH | Can High Wire Transmission | N/A | |
| WN16-D/WN14-D | Ground | From Node 0 to Node 9 | Ground | |
| WN16-F/WN14-F | CANL | Can Low Wire Transmission | N/A | |
| **J3** | **Receptacle – Alarms** | | | |
| 53-B | DO-1 | Hydraulic Vacuum Switch | 0 Volts Off; 24 Volts On | CAN38-1-1 |
| 53-C | Ground | Cooler Fan Pump Control (Tier 4) | Ground | |
| 53-D | DO-2 | Return Line Filter 2 Alarm Switch | 0 Volts Off; 24 Volts On | CAN38-1-2 |
| 53-E | Ground | Cooler Fan Pump Control (Tier 4) | Ground | |
| 53-F | DO-3 | Hydraulic Fluid Low Temperature Switch (Tier 2 and Tier 3) | 0 Volts Off; 24 Volts On | CAN38-1-4 |
| 53-F | DO-3 | Cooler Fan Pump Control - Primary Coil (Tier 4) | See Table 3-3 for Values | CAN38-1-4 |
| 53-H | DO-4 | Return Line Filter 3 Alarm Switch | 0 Volts Off; 24 Volts On | CAN38-1-8 |
| 53-J | Ground | Jumper to Node Select 4 | Ground | |
| 53-P | DO-6 | Return Line Filter 1 Alarm Switch | 0 Volts Off; 24 Volts On | CAN38-1-32 |

| Can ID. No. | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| 53-R | DO-5 | Hydraulic Fluid High Temperature Switch (Tier 2 and Tier 3) | 0 Volts Off; 24 Volts On | CAN38-1-16 |
| 53-R | DO-5 | Cooler Fan Pump Control - Back-Up Coil (Tier 4) | See Table 3-3 for Values | CAN38-1-16 |
| 53-S | NS-4 | Node Select Jumper to Ground | 0 Volts (With Jumper) | |
| 53-T | DI-3 | Hydraulic Fluid Level Switch (Prior to S/N 18001082) | 0 Volts Off; 24 Volts On | CAN69-1-4 |
| 53-W | DI-4 | Return Line Filter 2 Alarm Switch (S/N 18001082 and newer) Charge Filter 1 Alarm Switch (Prior to S/N 18001082) | 0 Volts Off; 24 Volts On | CAN69-1-8 |
| 53-X | 24 Volts | Hydraulic Fluid Temperature Sensor (Tier 4) | 24 Volts | |
| 53-Z | 24 Volts | Cooler Fan Pressure Transducer (Tier 4) | 24 Volts | |
| 53-a | AI-1 | Hydraulic Fluid Low Temperature Switch $60^{o}$ (Tier 2 and Tier 3 only) | 0 Volts Off; 24 Volts On | CAN24-3-16 |
| 53-a | AI-1 | Hydraulic Fluid Temperature Sensor (Tier 4) | 32.5K ohms at $0^{o}$ C; 680 ohms at $90^{o}$ C | CAN24-3 [1] |
| 53-b | AI-2 | Return Line Filter 3 Alarm Switch | 0 Volts Off; 24 Volts On | CAN24-2-32 |
| 53-c | AI-3 | Fuel Level Sensor | 0 Volts Off; 24 Volts On | CAN24-6 [1] |
| 53-d | AI-4 | Return Line Filter 1 Alarm Switch | 0 Volts Off; 24 Volts On | CAN24-2-128 |
| 53-e | AI-5 | Hydraulic Vacuum Switch | 0 Volts Off; 24 Volts On | CAN25-2-16 |
| 53-f | AI-6 | Hydraulic Fluid High Temperature Switch $185^{o}$ (Tier 2 and Tier 3 only) | 0 Volts Off; 24 Volts On | CAN25-2-32 |
| 53-f | AI-6 | Cooler Fan Pressure Transducer (Tier 4) | 1 Volt at 0 psi; 5 Volts at 7,500 psi | CAN25-2 [1] |
| 53-g | Ground | Hydraulic Fluid Level Sensor | Ground | |
| 53-h | Ground | Fuel Level Sensor | Ground | |
| 53-j | 5 Volts | Fuel Level Sensor | 5 Volts DC | |
| 53-k | Ground | Hydraulic Fluid Temperature Sensor (Tier 4) | Ground | |
| 53-m | Ground | Cooler Fan Pressure Transducer (Tier 4) | Ground | |
| 53-n | 24 Volts | Hydraulic Fluid Level Sensor (S/N 18001082 and newer) | 24 Volts | |
| 53-p | AI-7 | Hydraulic Fluid Level Sensor (S/N 18001082 and newer) | 0 Volts Off; 24 Volts On | |
| **J4** | **Receptacle – Pump Controls** | | | |
| 54-A | Ground | Right Track Pump Control – Forward | Ground | |
| 54-B | DO-11 | Right Track Pump Control – Forward | See Table 3-3 for Values | CAN38-2-4 |
| 54-C | Ground | Right Track Pump Control – Reverse | Ground | |
| 54-D | DO-12 | Right Track Pump Control – Reverse | See Table 3-3 for Values | CAN38-2-8 |
| 54-E | Ground | Drum 6 Pump Control – Raise | Ground | |
| 54-F | DO-13 | Drum 6 Pump Control – Raise | See Table 3-3 for Values | CAN38-2-16 |
| 54-G | Ground | Drum 6 Pump Control – Lower | Ground | |

| Can ID. No. | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| 54-H | DO-14 | Drum 6 Pump Control – Lower | See Table 3-3 for Values | CAN38-2-32 |
| 54-K | Ground | Drum 4A Pump Control – Lower | Ground | |
| 54-L | Ground | Drum 4A Pump Control – Raise | Ground | |
| 54-M | DO-17 | Drum 4A Pump Control –Raise | See Table 3-3 for Values | CAN38-3-1 |
| 54-N | Ground | Pump Drive Cooler 1 | Ground | |
| 54-P | DO-16 | Pump Drive Cooler 1 | 0 Volts Off; 24 Volts On | CAN38-2-128 |
| 54-S | DO-18 | Drum 4A Pump Control – Lower | See Table 3-3 for Values | CAN38-3-2 |
| 54-T | Ground | Drum 4B Pump Control – Raise | Ground | |
| 54-U | DO-19 | Drum 4B Pump Control – Raise | See Table 3-3 for Values | CAN38-3-4 |
| 54-V | Ground | Drum 4B Pump Control – Lower | Ground | |
| 54-W | DO-20 | Drum 4B Pump Control – Lower | See Table 3-3for Values | CAN38-3-8 |
| 54-X | Ground | Swing 2 (optional) Pump Control – Left | Ground | |
| 54-Z | DO-21 | Swing 2 (optional) Pump Control – Left | See Table 3-3 for Values | CAN38-3-16 |
| 54-a | Ground | Swing 2 (optional) Pump Control – Right | Ground | |
| 54-b | DO-22 | Swing 2 (optional) Pump Control – Right | SeeTable 3-3 for Values | CAN38-3-32 |
| 54-c | Ground | Pump Drive Cooler 2 | Ground | |
| 54-d | DO-23 | Pump Drive Cooler 2 | 0 Volts Off; 24 Volts On | CAN38-3-64 |
| 54-e | Ground | Accessory System Proportional Solenoid | Ground | |
| 54-f | DO-24 | Accessory System Proportional Solenoid | 0 Volts Off; 24 Volts On | CAN38-3-128 |
| 54-g | Ground | Jumper to Node Select 4 | Ground | |
| 54-m | NS-4 | Node Select Jumper to Ground | 0 Volts (With Jumper) | |
| **J6** | **Receptacle – Limits** | | | |
| 56-A | Ground | Drum 6 Pressure Sender | Ground | |
| 56-B | DO-7 | Drum 6 Pressure Sender | 0 Volts Off; 24 Volts On | CAN38-1-64 |
| 56-C | Ground | Drum 4 Pressure Sender | Ground | |
| 56-D | DO-8 | Drum 4 Pressure Sender | 0 Volts Off; 24 Volts On | CAN38-1-128 |
| 56-E | Ground | Maximum Boom Angle Limit Switch | Ground | |
| 56-F | DO-9 | Pump Case Heat Control | 0 Volts Off; 24 Volts On | CAN38-2-1 |
| 56-G | Ground | Swing/Travel Alarm | Ground | |
| 56-H | DO-10 | Swing/Travel Alarm | 0 Volts Off; 24 Volts On | CAN38-2-2 |
| 56-J | DI-8 | Maximum Boom Angle Limit Switch | 0 Volts Off; 24 Volts On | CAN69-1-128 |
| 56-N | NS-4 | Node Select 4 Jumper to Ground | 0 Volts (With Jumper) | |
| 56-R | 24 Volts | Maximum Boom Angle Limit Switch | 24 Volts | |
| 56-U | Ground | Jumper to Node Select 4 | 0 Volts (With Jumper) | |
| 56-V | 5 Volts | Drum 4 Motor Speed Sensor | 5 Volts DC | |
| 56-W | Ground | Pump Case Heat Control | Ground | |
| 56-a | AI-9 | Drum 6 Pressure Sender | 1 Volt at 0 psi;<br>5 Volts at 7,500 psi | CAN26-2 [1] |
| 56-b | AI-10 | Drum 4 Pressure Sender | 1 Volt at 0 psi;<br>5 Volts at 7,500 psi | CAN26-4 [1] |
| 56-j | Ground | Drum 4 Motor Speed Sensor | Ground | |

| Can ID. No. | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| 56-n | ENC1A | Drum 4 Motor Speed Sensor | 1.2 or 3.2 Volt Not Moving; 2.2 Volts Moving | CAN68-2 [1] |
| 56-p | ENC1B | Drum 4 Motor Speed Sensor | 1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving | CAN68-2 [2] |

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

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

### *NODE 6 - Drums 2, 4, & 5, and Adapter Frame*

Reference Electrical Schematic A06374 - Sheets 10, 19, 20 and 21.

| Can ID. No. | Function Type | Description | Test Voltages | Packet No. |
|---|---|---|---|---|
| WN20-A/WNE06-A | 24 Volts | From Remote Receiver to Node 7 | 24 Volts Nominal | |
| WN20-C/WNE06-C | CANH | Can High Wire Transmission | N/A | |
| WN20-D/WNE06-D | Ground | From Remote Receiver to Node 7 | Ground | |
| WN20-F/WNE06-F | CANL | Can Low Wire Transmission | N/A | |
| WN20 formerly WN18 | | | | |
| **J3** | **Receptacle – Drum 5 Controls** | | | |
| 63-C | Ground | Drum 5 Brake Solenoid | Ground | |
| 63-D | DO-2 | Drum 5 Brake Solenoid | 0 Volts Off, 24 Volts On | CAN34-1-2 |
| 63-E | Ground | Drum 5 Pawl Out Solenoid | Ground | |
| 63-F | DO-3 | Drum 5 Pawl Out Solenoid | 0 Volts Off, 24 Volts On | CAN34-1-4 |
| 63-G | Ground | Drum 5 Pawl In Solenoid | Ground | |
| 63-H | DO-4 | Drum 5 Pawl In Solenoid | 0 Volts Off, 24 Volts On | CAN34-1-8 |
| 63-J | Ground | Jumper to Node Select 1 | Ground | |
| 63-K | NS-1 | Node Select 1 Jumper to Ground | 0 Volts (With Jumper) | |
| 63-L | NS-2 | Node Select 2 Jumper to Ground | 0 Volts (With Jumper) | |
| 63-N | Ground | Jumper to Node Select 2 | Ground | |
| 63-a | AI-1 | Rotating Frame Level Sensor (Pitch) | 0 to 10 Volts | CAN8-2 [1] |
| 63-b | AI-2 | Rotating Frame Level Sensor (Roll) | 0 to 10 Volts | CAN8-4 [1] |
| 63-g | Ground | Rotating Frame Level Sensor | Ground | |
| 63-j | 5 Volts | Rotating Frame Level Sensor | 5 Volts DC | |
| **J4** | **Receptacle – Adapter Frame & Drum 4 Controls** | | | |
| 64-A | Ground | Rear Adapter Frame Pins Engage Sol. | Ground | |
| 64-B | DO-11 | Rear Adapter Frame Pins Engage Sol. | 0 Volts Off; 24 Volts On | CAN34-2-4 |
| 64-C | Ground | Rear Adapter Frame Pins Disengage Sol. | Ground | |
| 64-D | DO-12 | Rear Adapter Frame Pins Disengage Sol. | 0 Volts Off; 24 Volts On | CAN34-2-8 |
| 64-E | Ground | Front Adapter Frame Pins Engage Sol. | Ground | |
| 64-F | DO-13 | Front Adapter Frame Pins Engage Sol. | 0 Volts Off; 24 Volts On | CAN34-2-16 |
| 64-G | Ground | Front Adapter Frame Pins Disengage Sol. | Ground | |
| 64-H | DO-14 | Front Adapter Frame Pins Disengage Sol. | 0 Volts Off; 24 Volts On | CAN34-2-32 |
| 64-U | DO-19 | Drum 4 Pawl In Motor | 0 Volts Off; 24 Volts On | CAN34-3-4 |
| 64-V | Ground | Drum 4 Pawl Motor | Ground | |
| 64-W | DO-20 | Drum 4 Pawl Out Motor | 0 Volts Off; 24 Volts On | CAN34-3-8 |
| 64-X | Ground | Drum 4 Motor Control 1 | Ground | |
| 64-Z | DO-21 | Drum 4 Motor Control 1 | See Table 3-3 for Values | CAN34-3-16 |
| 64-a | Ground | Drum 4 Motor Control 2 | Ground | |
| 64-b | DO-22 | Drum 4 Motor Control 2 | See Table 3-3 for Values | CAN34-3-32 |
| 64-c | Ground | Drum 4 Brake Solenoid | Ground | |
| 64-d | DO-23 | Drum 4 Brake Solenoid | 0 Volts Off; 24 Volts On | CAN34-3-64 |

| Can ID. No. | Function Type | Description | Test Voltages | Packet No. |
|---|---|---|---|---|
| 64-g | Ground | Jumper to Node Select 1 | Ground | |
| 64-h | NS-1 | Node Select 1 Jumper to Ground | 0 Volts (With Jumper) | |
| 64-j | NS-2 | Node Select 2 Jumper to Ground | 0 Volts (With Jumper) | |
| 64-r | Ground | Jumper to Node Select 2 | Ground | |
| **J6** | **Receptacle – Drum 2 Controls** | | | |
| 66-A | Ground | Drum 2 Motor Control 1 | Ground | |
| 66-B | DO-7 | Drum 2 Motor Control 1 | See Table 3-3 for Values | CAN34-1-64 |
| 66-C | Ground | Drum 2 Motor Control 2 | Ground | |
| 66-D | DO-8 | Drum 2 Motor Control 2 | See Table 3-3 for Values | CAN34-1-128 |
| 66-E | Ground | Drum 2 Brake Solenoid | Ground | |
| 66-F | DO-9 | Drum 2 Brake Solenoid | 0 Volts Off; 24 Volts On | CAN34-2-1 |
| 66-G | Ground | Drum 2 Minimum Bail Limit Switch | Ground | |
| 66-H | DO-10 | Drum 2 Minimum Bail Limit Switch | 0 Volts Off, 24 Volts On | CAN34-2-2 |
| 66-J | DI-8 | Drum 2 Minimum Bail Limit Switch | 0 Volts Off, 24 Volts On | CAN61-1-128 |
| 66-K | NS-1 | Node Select 1 Jumper to Ground | 0 Volts (With Jumper) | |
| 66-L | NS-2 | Node Select 2 Jumper to Ground | 0 Volts (With Jumper) | |
| 66-U | Ground | Jumper to Node Select 2 | Ground | |
| 66-V | 5 Volts | Drum 2 and Drum 7 Motor Speed Sensor | 5 Volts DC | |
| 66-W | Ground | Jumper to Node Select 1 | Ground | |
| 66-Z | Ground | Drum 2 Motor Speed Sensor | Ground | |
| 66-j | Ground | Drum 7 Motor Speed Sensor | Ground | |
| 66-n | ENC-1A | Drum 7 Motor Speed Sensor | 1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving | CAN62-2 [2] |
| 66-p | ENC-1B | Drum 7 Motor Speed Sensor | 1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving | CAN62-2 [2] |
| 66-r | ENC-2A | Drum 2 Motor Speed Sensor | 1.2 or 3.2 Volts Not Moving; .2 Volts Moving | CAN62-4 [2] |
| 66-s | ENC-2B | Drum 2 Motor Speed Sensor | 1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving | CAN62-4 [2] |

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

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

### *NODE 7 - Swing, Travel and Auto Lube*

Reference Electrical Schematic A06374 - Sheets 11, 19 and 21.

| Can ID. No. | Function Type | Description | Test Voltages | Packet No. |
|---|---|---|---|---|
| WN12-A/WNE08-A | 24 Volts | From Node 6 to Node 8 | 24 Volts Nominal | |
| WN12-C/WNE08C | CANH | Can High Wire Transmission | N/A | |
| WN12-D/WNE08-D | Ground | From Node 6 to Node 8 | Ground | |
| WN12-F/WNE08-F | CANL | Can Low Wire Transmission | N/A | |
| **J4** | **Receptacle – Swing System and Auto Lube** | | | |
| 74-A | Ground | Swing Brake Solenoid | Ground | |
| 74-B | DO-11 | Swing Brake Solenoid | 0 Volts Off; 24 Volts On | CAN36-2-4 |
| 74-C | Ground | Swing Lock Out Solenoid | Ground | |
| 74-D | DO-12 | Swing Lock Out Solenoid | 0 Volts Off; 24 Volts On | CAN36-2-8 |
| 74-E | Ground | Swing Lock In Solenoid | Ground | |
| 74-F | DO-13 | Swing Lock In Solenoid | 0 Volts Off, 24 Volts On | CAN36-2-16 |
| 74-G | Ground | Travel Two Speed Solenoid | Ground | |
| 74-H | DO-14 | Travel Two Speed Solenoid | 0 Volts Off, 24 Volts On | CAN36-2-32 |
| 74-T | Ground | Travel Brake Solenoid | Ground | |
| 74-U | DO-19 | Travel Brake Solenoid | 0 Volts Off; 24 Volts On | CAN36-3-4 |
| 74-V | Ground | Track Auto Lube Pump | Ground | |
| 74-W | DO-20 | Track Auto Lube Pump | 0 Volts Off; 24 Volts On | CAN36-3-8 |
| 74-X | Ground | Swing Bearing Auto Lube Pump | Ground | |
| 74-Z | DO-21 | Swing Bearing Auto Lube Pump | 0 Volts Off; 24 Volts On | CAN36-3-16 |
| 74-g | Ground | Jumper to Node Select 1 | Ground | |
| 74-h | NS-1 | Node Select 1 Jumper to Ground | 0 Volts (With Jumper) | |
| 74-k | NS-3 | Node Select 3 Jumper to Ground | 0 Volts (With Jumper) | |
| 74-r | Ground | Jumper to Node Select 3 | Ground | |
| **J6** | **Receptacle – Swing System** | | | |
| 76-A | Ground | Swing Left Pressure Sender | Ground | |
| 76-B | DO-7 | Swing Left Pressure Sender | 24 Volts | CAN36-1-64 |
| 76-C | Ground | Swing Right Pressure Sender | Ground | |
| 76-D | DO-8 | Swing Right Pressure Sender | 24 Volts | CAN36-1-128 |
| 76-F | DO-9 | Swing Brake Pressure Sender | 24 Volts | |
| 76-H | DO-10 | Accessory System Hydraulic Pressure Switch | 0 Volts Off; 24 Volts On | CAN36-2-2 |
| 76-J | DI-8 | Accessory System Hydraulic Pressure Switch | 0 Volts Off; 24 Volts On | CAN65-1-128 |
| 76-K | NS-1 | Node Select 1 Jumper to Ground | 0 Volts (With Jumper) | |
| 76-M | NS-3 | Node Select 3 Jumper to Ground | 0 Volts (With Jumper) | |
| 76-U | Ground | Jumper to Node Select 3 | Ground | |
| 76-V | 5 Volts | Swing Motor Speed Sensor | 5 Volts DC | |
| 76-W | Ground | Jumper to Node Select 1 | Ground | |
| 76-Z | Ground | Swing Brake Pressure Sender | Ground | |
| 76-a | AI-9 | Swing Left Pressure Sender | 1 Volt at 0 psi;<br>5 Volts at 7,500 psi | CAN18-2 [1] |

| Can ID. No. | Function Type | Description | Test Voltages | Packet No. |
|---|---|---|---|---|
| 76-b | AI-10 | Swing Right Pressure Sender | 1 Volt at 0 psi;<br>5 Volts at 7,500 psi | CAN18-4 [1] |
| 76-c | AI-11 | Swing Brake Pressure Sender | 1 Volt at 0 psi;<br>5 Volts at 750 psi | CAN18-6 [1] |
| 76-j | Ground | Swing Motor Speed Sensor | Ground | |
| 76-n | ENC-1A | Swing Motor Speed Sensor CH A | 1.2 or 3.2 Volts Not Moving;<br>2.2 Volts Moving | CAN64-2 [2] |
| 76-p | ENC-1B | Swing Motor Speed Sensor CH B | 1.2 or 3.2 Volts Not Moving;<br>2.2 Volts Moving | CAN64-2 [2] |

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

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

### *NODE 8 - Drum 1 and Drum 6*

Reference Electrical Schematic A06374 - Sheets 12, 19 and 21.

| Can ID. No. | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| WN18-A/WN12-A | 24 Volts | From Node 7 to Bin Node | 24 Volts Nominal | |
| WN18-C/WN12-C | CANH | Can High Wire Transmission | N/A | |
| WN18-D/WN12-D | Ground | From Node 7 to Bin Node | Ground | |
| WN18-F/WN12-F | CANL | Can Low Wire Transmission | N/A | |
| **J4** | **Receptacle – Drum 6 Controls** | | | |
| 84-A | Ground | Drum 6 Motor Control | Ground | |
| 84-B | DO-11 | Drum 6 Motor Control | See Table 3-3 for Values | CAN39-2-4 |
| 84-C | Ground | Drum 6 Brake Solenoid | Ground | |
| 84-D | DO-12 | Drum 6 Brake Solenoid | 0 Volts Off; 24 Volts On | CAN39-2-8 |
| 84-F | DO-13 | Drum 6 Pawl In Motor | 0 Volts Off, 24 Volts On | CAN39-2-16 |
| 84-G | Ground | Drum 6 Pawl Motor | Ground | |
| 84-H | DO-14 | Drum 6 Pawl Out Motor | 0 Volts Off; 24 Volts On | CAN39-2-32 |
| 84-g | Ground | Jumper to Node Select 1 | Ground | |
| 84-h | NS-1 | Node Select 1 Jumper to Ground | 0 Volts (With Jumper) | |
| 84-m | NS-4 | Node Select 4 Jumper to Ground | 0 Volts (With Jumper) | |
| 84-r | Ground | Juniper to Node Select 4 | Ground | |
| **J6** | **Receptacle – Drum 1 Controls** | | | |
| 86-A | Ground | Drum 1 Motor Control 1 | Ground | |
| 86-B | DO-7 | Drum 1 Motor Control 1 | See Table 3-3 for Values | CAN39-1-64 |
| 86-C | Ground | Drum 1 Motor Control 2 | Ground | |
| 86-D | DO-8 | Drum 1 Motor Control 2 | See Table 3-3 for Values | CAN39-1-128 |
| 86-E | Ground | Drum 1 Brake Solenoid | Ground | |
| 86-F | DO-9 | Drum 1 Brake Solenoid | 0 Volts Off; 24 Volts On | CAN39-2-1 |
| 86-G | Ground | Drum 1 Minimum Bail Limit Switch | Ground | |
| 86-H | DO-10 | Drum 1 Minimum Bail Limit Switch | 0 Volts Off; 24 Volts On | CAN39-2-2 |
| 86-J | DI-8 | Drum 1 Minimum Bail Limit Switch | 0 Volts Off; 24 Volts On | CAN71-1-128 |
| 86-K | NS-1 | Node Select 1 Jumper to Ground | 0 Volts (With Jumper) | |
| 86-N | NS-4 | Node Select 4 Jumper to Ground | 0 Volts (With Jumper) | |
| 86-U | Ground | Jumper to Node Select 4 | Ground | |
| 86-V | 5 Volts | Drum 1 and Drum 6 Motor Speed Sensor | 5 Volts DC | |
| 86-W | Ground | Jumper to Node Select 1 | Ground | |
| 86-Z | Ground | Drum 1 Motor Speed Sensor | Ground | |
| 86-j | Ground | Drum 6 Motor Speed Sensor | Ground | |
| 86-n | ENC-1A | Drum 1 Motor Speed Sensor CH A | 1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving | CAN70-2 [2] |
| 86-p | ENC-1B | Drum 1 Motor Speed Sensor CH B | 1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving | CAN70-2 [2] |
| 86-r | ENC-2A | Drum 6 Motor Speed Sensor CH A | 1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving | CAN70-4 [2] |
| 86-s | ENC-2B | Drum 6 Motor Speed Sensor CH B | 1.2 or 3.2 Volts Not Moving; 2.2 Volts Moving | CAN70-4 [2] |

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

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### *NODE 9 - MAX-ER*

Reference Electrical Schematic A06374 - Sheets 13, 19 and 21.

| Can ID. # /Connector # | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| WN14-A/WN14-A | 24 Volts | From Node 5 to Remote Receiver | 24 Volts Nominal | |
| WN14-C/WN14-C | CANH | Can High Wire Transmission | N/A | |
| WN14-D/WN14-D | Ground | From Node 5 to Remote Receiver | Ground | |
| WN14-F/WN14-F | CANL | Can Low Wire Transmission | N/A | |
| **J3** | **Receptacle – MAX-ER Controls** | | | |
| 93-A | Ground | MAX-ER Right Side CWT Carrier Load PIn | Ground | |
| 93-B | 24 Volts | W48 Shorting Plug (MAX-ER not used) | 24 Volts Nominal | |
| 93-D | DO-2 | CWT Left Cylinder - Retract Solenoid | 0 Volts Off, 24 Volts On | CAN37-1-2 |
| 93-F | DO-3 | Counterweight Limit Switch | 0 Volts Off, 24 Volts On | CAN37-1-4 |
| 93-H | DO-4 | CWT Right Cylinder - Retract Solenoid | 0 Volts Off, 24 Volts On | CAN37-1-8 |
| 93-J | Ground | Jumper to Node Select 2 | Ground | |
| 93-L | NS-2 | Node Select 2 Jumper to Ground | 0 Volts (With Jumper) | |
| 93-M | NS-3 | Node Select 3 Jumper to Ground | 0 Volts (With Jumper) | |
| 93-N | Ground | Jumper to Node Select 3 | Ground | |
| 93-P | DO-6 | CWT Right Cylinder - Extend Solenoid | 0 Volts Off, 24 Volts On | CAN37-1-32 |
| 93-R | DO-5 | CWT Left Cylinder - Extend Solenoid | 0 Volts Off, 24 Volts On | CAN37-1-16 |
| 93-T | DI-3 | Counterweight Limit Switch - Right Side | 0 Volts Off, 24 Volts On | CAN67-1-4 |
| 93-W | DI-4 | Counterweight Limit Switch - Left Side | 0 Volts Off, 24 Volts On | CAN67-1-8 |
| 93-X | 24 Volts | MAX-ER Right Side CWT Carrier Load PIn | 24 Volts | |
| 93-Z | 24 Volts | MAX-ER Left Side CWT Carrier Load PIn | 24 Volts | |
| 93-a | AI-1 | Remote Active | 24 Volts Nominal | CAN20-2-16 |
| 93-b | AI-2 | CWT Pendant Cylinder Remote-Lower | 0 Volts Off, 24 Volts On | CAN20-2-32 |
| 93-c | AI-3 | CWT Pendant Cylinder Remote-Raise | 0 Volts Off, 24 Volts On | CAN20-6 [1] |
| 93-d | AI-4 | MAX-ER Right Side CWT Carrier Load PIn | 0.8 Volts Min.; 8.0 Volts Max. | CAN20-8 [1] |
| 93-e | AI-5 | MAX-ER Left Side CWT Carrier Load PIn | 0.8 Volts Min.;8.0 Volts Max. | CAN21-2 [1] |
| 93-g | Ground | MAX-ER Left Side CWT Carrier Load PIn | Ground | |
| 93-h | Ground | Counterweight Limit Switch Ground | Ground | |
| 93-k | Ground | Counterweight Limit Switch Ground | Ground | |
| 93-m | Ground | MAX-ER Backhitch Load Pin | Ground | |
| 93-p | AI-7 | W48 Shorting Plug (MAX-ER not used) | 0 Volts Off, 24 Volts On | CAN21-2-64 |
| 93-r | AI-8 | MAX-ER Backhitch Load Pin | No Load 1.5 Volts | CAN21-8 [1] |
| 93-s | 24 Volts | MAX-ER Backhitch Load PIn | 24 Volts | |
| **J6** | **Receptacle – MAX-ER Controls** | | | |
| 96B | DO-7 | Power to MAX-ER Remote Control | 0 Volts Off, 24 Volts On | CAN37-1-64 |
| 96D | DO-8 | Power to MAX-ER Remote Control | 0 Volts Off, 24 Volts On | CAN37-1-128 |
| 96F | DO-9 | Power to MAX-ER Remote Control | 0 Volts Off, 24 Volts On | CAN37-2-1 |
| 96H | DO-10 | Power to MAX-ER Remote Control | 0 Volts Off, 24 Volts On | CAN37-2-2 |

| Can ID. # /Connector # | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| 96L | NS-2 | Node Select 2 Jumper to Ground | 0 Volts (With Jumper) | |
| 96M | NS-3 | Node Select 3 Jumper to Ground | 0 Volts (With Jumper) | |
| 96U | Ground | Jumper to Node Select 2 | Ground | |
| 96W | Ground | Jumper to Node Select 3 | Ground | |
| | **MAX-ER Remote Controls** | | | |
| 8SR/W51-A | | Power | | |
| 8SR/W51-V | | Power | | |
| 54LA/W51-B | | Left Front Jack - Extend | | |
| 54LB/W51-C | | Left Front Jack - Retract | | |
| 54RA/W51-D | | Right Front Jack - Extend | | |
| 54RB/W51-E | | Right Front Jack - Retract | | |
| 54LC/W51-F | | Left Rear Jack - Extend | | |
| 54LD/W51-G | | Left Rear Jack - Retract | | |
| 54RC/W51-H | | Right Rear Jack - Extend | | |
| 54RD/W51-J | | Right Rear Jack - Retract | | |
| 54AC/W51-KW | | All Jacks - Extend | | |
| 54BD/W51-LX | | All Jacks - Retract | | |
| 58RD/W51-M | | Right Steering Pins - Disengage | | |
| 58RE/W51-N | | Right Steering Pins - Engage | | |
| 58LD/W51-P | | Left Steering Pins - Disengage | | |
| 58LE/W51-Q | | Left Steering Pins - Engage | | |
| 59CC/W51-R | | Steering Position - Counterclockwise | | |
| 59CW/W51-S | | Steering Position - Clockwise | | |
| 89N3/W51-T | | Counterweight - Raise | | |
| 89K3/W51-U | | Counterweight - Lower | | |

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



3

### *NODE 20 - Boom Block Up, Block Sensor, & Limits*

Reference Electrical Schematic A06374 - Sheets 14 and 22.

| Can ID. No. | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| **J1** | | **Receptacle – Can In** | | |
| 201-A | 24 Volts | Can Bus System (From RCL Receiver) | 24 Volts Nominal | |
| 201-B | AI-NS | Node Select AI-NS | Node Select Jumper to Ground | |
| 201-C | CANH | Can High Wire Transmission (From RCL Receiver) | N/A | |
| 201-D | Ground | Can System Bus (From RCL Receiver) | Ground | |
| 201-E | Ground | Node Select Ground | Jumper to AI-NS | |
| 201-F | CANL | Can Low Wire Transmission (From RCL Receiver) | N/A | |
| **J2** | | **Receptacle – Upper Block Up** | | |
| 202-A | 24 Volts | Block Up Limit Boom Upper Point | 24 Volts Nominal | |
| 202-B | DI-2 | Block Up Limit Boom Upper Point | 0 Volts Off; 24 Volts On | CAN136-6-128 |
| **J3** | | **Receptacle – Lower Block Up** | | |
| 203-A | 24 Volts | Block Up Limit Boom Lower Point | 24 Volts Nominal | |
| 203-B | DI-1 | Block Up Limit Boom Lower Point | 0 Volts Off; 24 Volts On | CAN136-6-64 |
| **J4** | | **Receptacle – Can Out** | | |
| 204-A | 24 Volts | Can Bus System | 24 Volts Nominal | |
| 204-C | CANH | Can High Wire Transmission | N/A | |
| 204-D | Ground | Can System Bus | Ground | |
| 204-E | DI-ID | To Jib Butt Cable Reel | 24 Volts Nominal | CAN 136-6-4 |
| 204-F | CANL | Can Low Wire Transmission | N/A | |
| **J5** | | **Receptacle – Block Level Sensor** | | |
| 205-A | 24 Volts | Load Pin 1 - Lower Boom Point | 24 Volts Nominal | |
| 205-B | AI-1 | Load Pin 1 - Lower Boom Point | 0.47 V No Load; 5.7 V Full Load | |
| 205-D | Ground | Load Pin 1 - Lower Boom Point | Ground | |
| **J6** | | **Receptacle – Block Level Sensor** | | |
| 206-A | 24 Volts | Load Pin 2 - Lower Boom Point W/Tandem Drum | 24 Volts Nominal | |
| 206-B | AI-2 | Load Pin 2 - Lower Boom Point W/Tandem Drum | 0.47 V No Load; 5.7 V Full Load | |
| 206-D | Ground | Load Pin 2 - Lower Boom Point W/Tandem Drum | Ground | |
| **J8** | | **Wind Speed Indicator** | | |
| 208-A | AI-3 | Wind Speed Sensor | 0.05 to 16 Volts DC | |
| 208-B | Ground | Wind Speed Sensor | Ground | |
| **J9** | | **Receptacle – Maximum Jib Angle Limit** | | |
| 209-A | 24 Volts | Maximum Jib Angle Limit | 24 Volts Nominal | |
| 209-B | DI-6 | Maximum Jib Angle Limit | 0 Volts Off; 24 Volts On | CAN136-6-32 |
| **J10** | | **Receptacle – Maximum Jib Angle Working Limit** | | |
| 2010-A | 24 Volts | Maximum Jib Angle Working Limit | 24 Volts Nominal | |
| 2010-B | DI-5 | Maximum Jib Angle Working Limit | 0 Volts Off; 24 Volts On | CAN136-6-16 |
| **J11** | | **Receptacle – Minimum Jib Angle Limit** | | |
| 2011-A | 24 Volts | Minimum Jib Angle Limit | 24 Volts Nominal | |
| 2011-B | DI-4 | Minimum Jib Angle Limit | 0 Volts Off; 24 Volts On | CAN136-6-8 |
| | | **Boom Angle Indicator** | | |
| Wire 1 | 5 Volts | Boom Angle Indicator | 5 Volts Nominal | |
| Wire 2 | Signal | Boom Angle Indicator | Between 0 and 5 Volts | |
| Wire 3 | Ground | Boom Angle Indicator | Ground | |

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

Reference Electrical Schematic A06374 - Sheets 14 and 23.

| Can ID. No. | Function Type | Description | Test Voltage | Packet No. |
|---|---|---|---|---|
| **J1** | | **Receptacle – Can In** | | |
| 211-A | 24 Volts | Can Bus System (From Jib Butt) | 24 Volts Nominal | |
| 211-B | AI-NS | Node Select AI | Node Select Jumper to Ground | |
| 211-C | CANH | Can High Wire Transmission (From Jib Butt) | N/A | |
| 211-D | Ground | Can System Bus (From Jib Butt) | Ground | |
| 211-E | Ground | Node Select Ground | Jumper to AI-NS | |
| 211-F | CANL | Can Low Wire Transmission (From Jib Butt) | N/A | |
| **J2** | | **Receptacle – Upper Block Up** | | |
| 212-A | 24 Volts | Block Up Limit Luffing (#44 or #79A) or Fixed Jib Upper Point | 24 Volts Nominal | |
| 212-B | DI-2 | Block Up Limit Luffing (#44) or Fixed Jib Upper Point | 0 Volts Off; 24 Volts On | CAN132-6-128* |
| 212-B | DI-2 | Block Up Limit Luffing (#79A) or Fixed Jib Upper Point | 0 Volts Off; 24 Volts On | CAN135-6-128* |
| **J3** | | **Receptacle – Lower Block Up** | | |
| 213-A | 24 Volts | Block Up Limit Luffing (#44 or #79A) or Fixed Jib Lower Point | 24 Volts Nominal | |
| 213-B | DI-1 | Block Up Limit Luffing (#44) or Fixed Jib Lower Point | 0 Volts Off; 24 Volts On | CAN132-6-64* |
| 213-B | DI-1 | Block Up Limit Luffing (#79A) or Fixed Jib Lower Point | 0 Volts Off; 24 Volts On | CAN135-6-64* |
| **J4** | | **Receptacle – Can Out** | | |
| 214-A | 24 Volts | Can Bus System | 24 Volts Nominal | |
| 214-C | CANH | Can High Wire Transmission | N/A | |
| 214-D | Ground | Can System Bus | Ground | |
| 214-E | DI-ID | Last Node Terminating Plug | 24 Volts Nominal | |
| 214-F | CANL | Can Low Wire Transmission | N/A | |
| **J5** | | **Receptacle – Lower Jib** | | |
| 215-A | 24 Volts | Jib Lower Point | 24 Volts Nominal | |
| 215-B | AI-1 | Jib Lower Point | 0 Volts Off; 24 Volts On | |
| 215-D | Ground | Jib Lower Point | Ground | |
| **J8** | | **Wind Speed Indicator** | | |
| 218-A | AI-6 | Wind Speed Sensor | .05 to 16 Volts DC | |
| 218-B | Ground | Wind Speed Sensor | Ground | |
| | | **Jib Angle Indicator** | | |
| Wire 1 | 5 Volts | Jib Angle Indicator | 5 Volts Nominal | |
| Wire 2 | Signal | Jib Angle Indicator | Between 0 and 5 Volts | |
| Wire 3 | Ground | Jib Angle Indicator | Ground | |

* Packet number depends on specific attachment used.



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### *NODE 0 - Power, Engine Controls, and Diagnostics*

Reference Electrical Schematic A06374 - Sheet 15

| Receptacle/ CAN/ID | Wire No. | Function Type | Description | Test Voltage |
|---|---|---|---|---|
| **J1** | | | **Connector – 40 Pin** | |
| P11 | 3 | 24 Volts | Ignition Signal | 24 Volts Nominal |
| P12 | 0102 | Ground | Can System Bus | Ground |
| P13 | 0103 | DO-1 | Ether Relay Coil - Positive | 24 Volts |
| P14 | 0104 | 24 Volts | ECM Power Relay Coil - Positive | 24 Volts |
| P17 | 0107 | 24 Volts | Air Conditioning Clutch Relay Coil - Positive | 24 Volts Nominal |
| P110 | 0110 | 24 Volts | MS1/MS2 Start Relay Coil - Positive | 24 Volts Nominal |
| P111 | 0 | Ground | Battery | Ground |
| P112 | 0112 | Ground | Can System Bus | Ground |
| P114 | 0114 | Ground | ECM Power Relay Coil - Negative | Ground |
| P117 | 0117 | Ground | Air Conditioning Clutch Relay Coil - Negative | Ground |
| P119 | 0119 | Ground | Ether Relay Coil - Negative | Ground |
| P120 | 0120 | Ground | MS1/MS2 Start Relay Coil - Negative | Ground |
| P121 | OC | Ground | Can System Bus Output Wire | Ground |
| P122 | 0122 | Ground | Can Power Relay Coil - Negative | Ground |
| P129 | RS232GND | Ground | Common | Ground |
| P130 | RS232PE | Signal | Program Enable | N/A |
| P131 | 8C | 24 Volts | Can Power Relay Output | 24 Volts Nominal |
| P132 | 0132 | 24 Volts | Can Power Relay Coil - Positive | 24 Volts Nominal |
| P133 | 3 | 24 Volts | Ignition Signal | 24 Volts Nominal |
| P136 | J1939H | Signal | Communication – High | N/A |
| P137 | J1939L | Signal | Communication – Low | N/A |
| P139 | RS232TX | Signal | Program Transmit | N/A |
| P140 | RS232RX | Signal | Program Receive | N/A |

## Abbreviations

The following abbreviations are used in this section:

| | | | | | |
|---|---|---|---|---|---|
| AC | = | Alternating Current | I/O | = | Input/Output |
| A/C | = | Air Conditioning | L.E.D. | = | Light Emitting Diode |
| AI | = | Analog Input | Max. | = | Maximum |
| AO | = | Analog Output | Min. | = | Minimum |
| CAN | = | Controller Area Network | MS | = | Motor Starter |
| CANH | = | Controller Area Network - High | N/A | = | Not Applicable |
| CANL | = | Controller Area Network - Low | N/C | = | No Connection |
| CHA or CHB | = | Channel A or B | NO | = | Number |
| DC | = | Direct Current | NS | = | Node Select |
| DI | = | Digital Input | Opt. | = | Optional |
| DO | = | Digital Output | psi | = | Pressure |
| EC | = | Encoder Control | RCL | = | Rated Capacity Indicator/Limiter |
| ENC | = | Encoder Number Count | V | = | Volt or Volts |
| FCN | = | Front Console Node | VDC | = | Volts Direct Current |
| GND | = | Ground | W | = | Wire |
| ID | = | Identification | | | |

## CHECKING ELECTRICAL INPUTS/OUTPUTS

See Figure 3-2 for the following procedure

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. To test for a voltage:
   - Close knife switch across test terminal on board.
   - Select voltage 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.

7. To test for amperes:
   - Open knife switch across test terminal.
   - Select amperes on meter.
   - Connect meter leads across test board problem component terminal.
   - Enable test component and check ampere reading on meter.

Test a for a communication problem on a universal node with communication in-line test board:

1. Engine must be off and engine key switch in ***run*** position, with all brakes and locks engaged.
2. Access desired node to install communication in-line test board.
3. Remove cable from node at W1 or W7 connector.
4. Connect the communication in-line test board between cable and universal node connector.
5. Check between terminals C (CAN high) to D (ground) ***or*** F (CAN low) to D (ground).
6. A reading of 1 to 3 volts indicates normal communication between nodes.
7. A reading of a steady 0 or 2.5 volts can indicate no communication on CAN-Bus.

### Control Handle Voltages

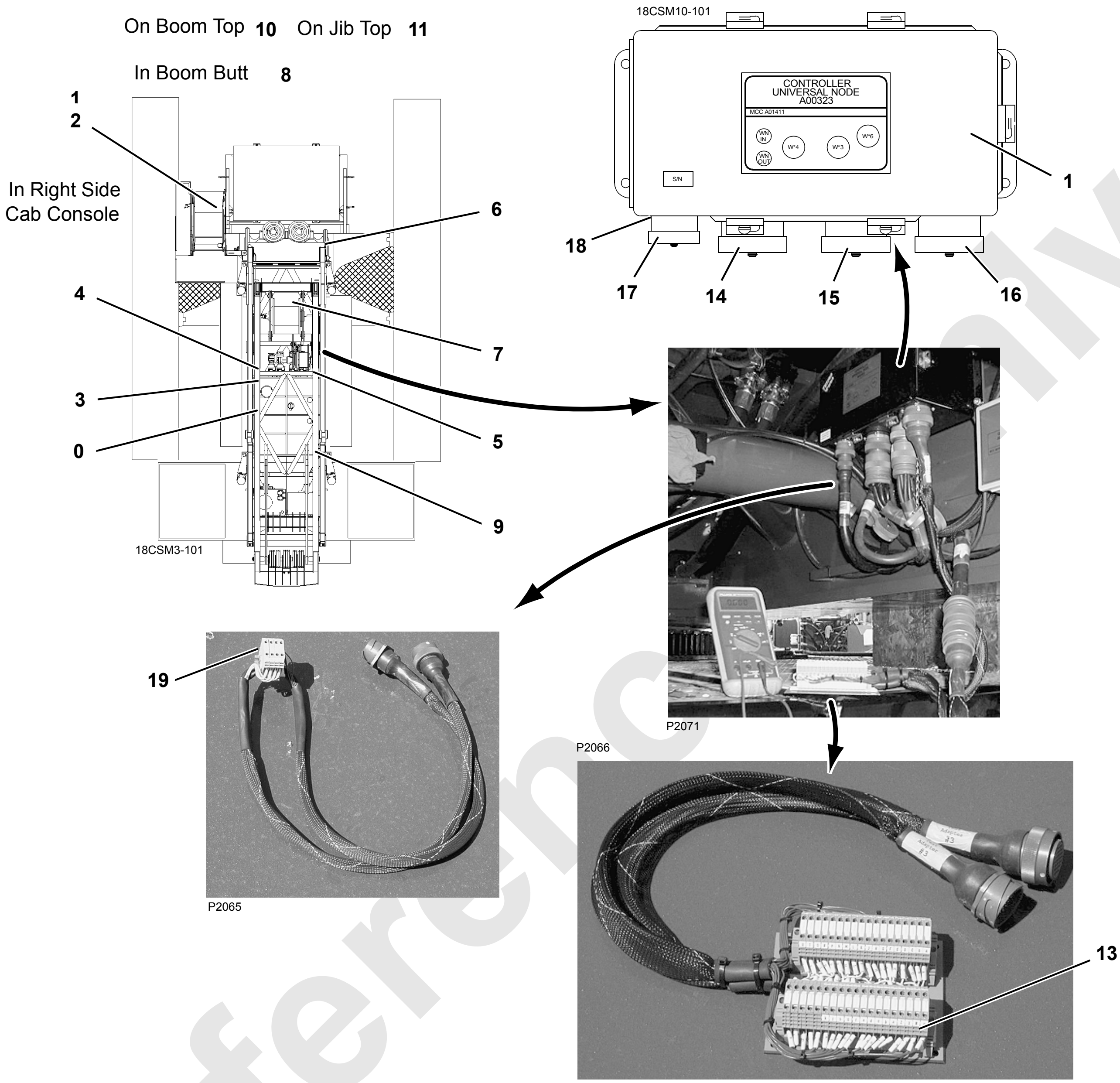
Troubleshooting control handles can be performed ***only*** on digital display screen. See individual component screens and CAN-bus screen in Crane Diagnostics topic in this section.

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.

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




| Item | Description | Item | Description |
|---|---|---|---|
| 0 | Node-0 Engine Node | 10 | Node-20 At Boom Top |
| 1 | Node-1 Master Node in Front Console | 11 | Node-21 At Jib Top |
| 2 | Node-2 In Right Side Console | 12 | Universal Node Controller (3 through 9) |
| 3 | Node-3 Left Side of Crane in Machinery Enclosure | 13 | Node In-line Test Board (3 Separate Boards) |
| 4 | Node-4 Left Side of Crane in Machinery Enclosure | 14 | W4 Connector - 110 Degree Key |
| 5 | Node-5 Right Side of Crane in Machinery Enclosure | 15 | W3 Connector - Zero Degree Key |
| 6 | Node-6 Right Front Side of Rotating Bed | 16 | W6 Connector - 80 Degree Key |
| 7 | Node-7 In Swivel Area | 17 | J1 Connector - Communication In |
| 8 | Node-8 In Boom Butt | 18 | J7 Connector - Communication Out |
| 9 | Node-9 MAX-ER At Rear of Rotating Bed | 19 | Communication In-line Test Board (1 Board) |

**FIGURE 3-2**

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## DIELECTRIC GREASE

The following figures show the proper application of dielectric grease on J - tech type connectors.

Dielectric grease is need when assembling J - tech type connectors. A bead of grease needs to be applied on O-ring and face of the socket (female) connector ***and only on the O-ring for a pin (male) connector.***


FIGURE 3-3

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.

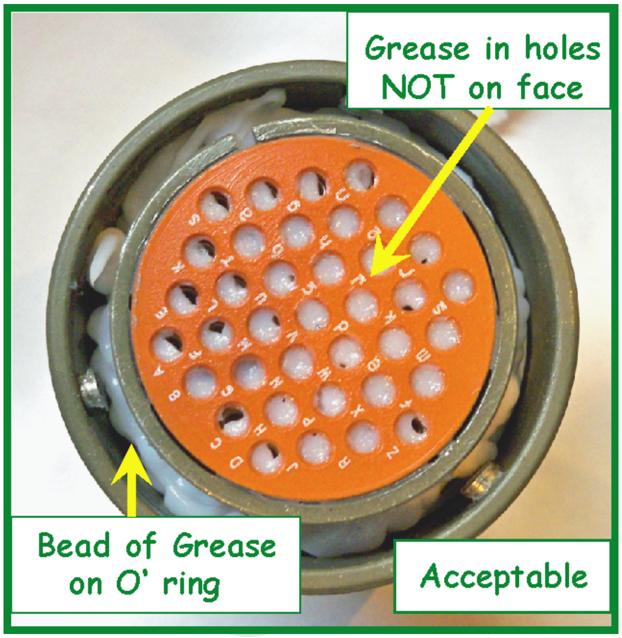


FIGURE 3-4

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 3-5

## DIGITAL DISPLAY

The digital display and scroll up/down rocker (see Special Controls in this section) allow the operator to monitor operating conditions screen, operating limits screen, or system faults screen.

To display one of the above screens, depress the top or bottom of the digital display screen selector to scroll up or down through the display readings. Continue to scroll up or down until desired screen is displayed.

### Crane Operating Conditions

Table 3-5 lists operating conditions that are displayed and the normal operating range of each item. The current status of operating conditions are displayed in the screen shown in Figure 3-6.

| | |
|---|---|
| ENGINE SPEED | 2,200 RPM |
| BOOM ANGLE | 66. 0 DEG |
| LUFFING JIB ANGLE | 00. 0 DEG |
| BOOM TO LUFF ANGLE | 000.0 DEG |

**FIGURE 3-6**

The engine screen (Figure 3-7) displays the following information.

| | |
|---|---|
| FUEL LEVEL | 100% |
| OIL PRESSURE | 50 PSI |
| COOLANT TEMP | 150 DEG |
| ENGINE HOURS | 1800 |

**FIGURE 3-7**

The engine diagnostics screen (Figure 3-8) displays engine faults. See Engine Diagnostics in section 7 of this manual for information on fault codes.

ENGINE DIAGNOSTICS

FLASH CODE - SPN- FMI-

**FIGURE 3-8**

The mast angle, battery voltage, and crane level screen (Figure 3-9) displays the following information.

| | |
|---|---|
| MAST ANGLE | DEG 000 |
| BATTERY VOLTAGE | V |
| TILT RIGHT | DEG 000IN 00 |
| TILT FRONT | DEG 000 IN 00 |

**FIGURE 3-9**

On crane Serial Numbers 18001081 and older, the wind speed and pump drive screen (Figure 3-10) displays the current steady wind speed, maximum gust wind speed, and pump drive operating conditions.

- MAX WIND SPEED resets when crane power is off.

Pump drive operating conditions are provided only on current production cranes (pump drives with a circulating oil system).

| | |
|---|---|
| CURRENT WIND SPEED | 10 MPH |
| MAX WIND SPEED | 20 MPH |
| PUMP DRIVE TEMP | 160 DEG |
| PUMP DRIVE PRESSURE | 25 PSI |

**FIGURE 3-10**

On crane Serial Number 18001082 and newer, the hydraulic tank fluid level, wind speed, and pump drive screen (Figure 3-11) displays the hydraulic tank fluid level, the current steady wind speed or maximum gust wind speed (in parenthesis, and pump drive operating conditions.

- For hydraulic tank level: 0% = empty; 100% = full cold; 110% is full hot
- MAX WIND SPEED resets when crane power is off

| | |
|---|---|
| HYD TANK FLUID LEVEL | 100 % |
| CURRENT (MAX) WIND SPEED | 20 MPH |
| PUMP DRIVE TEMP | 160 DEG |
| PUMP DRIVE PRESSURE | 25 PSI |

**FIGURE 3-11**

### Operating Limits

Table 3-6 lists operating limits which can be displayed.

When one or more operating limit is reached, the operating limit alert (yellow light and buzzer in cab) turns on to warn the operator. Scroll to the crane faults/limits display screen. The crane faults/limits screen (Figure 3-12) automatically scrolls through the active faults/limits, stopping at each for approximately three seconds.

CRANE FAULTS/LIMITS

OPERATING LIMIT- BLOCK UP

**FIGURE 3-12**

The operating limit alert turns off when the cause of limit is corrected. Each active limit reached during operation is retained in memory, until two things happen:

1. Name of limit appears on display at least once
2. Cause of limit is corrected

For this reason, it is normal for the inactive limits to appear when you scroll to the operating limit group, even when the operating limit alert is off.

To erase the inactive limits, scroll to the operating limit group. Wait until the display scrolls through the name of each limit. Inactive limits will be erased automatically. If the alert is on, only the names of active limits will remain.

NO FAULT appears on the display (Figure 3-13) when no limits have been reached.

| |
|---|
| CRANE FAULTS/LIMITS<br>OPERATING LIMIT- NO FAULT |

**FIGURE 3-13**

## System Faults

Table 3-7 lists system faults which can be displayed.

When one or more system fault occurs, the system fault alert (red light and beeper in cab) turns on to warn the operator. Scroll to the crane faults/limits screen. The screen (Figure 3-14) automatically scrolls through the active faults/limit, stopping at each for approximately three seconds.

| |
|---|
| CRANE FAULTS/LIMITS<br>SYSTEM FAULT- BOOM ANGLE SEND |

**FIGURE 3-14**

The system fault alert turns off when the cause of each fault is corrected. Each active fault that has occurred during operation is retained in memory, until two things happen:

1. Name of fault appears on display at least once
2. Cause of fault is corrected

For this reason, it is normal for the names of inactive faults to appear when you scroll to the system fault group, even when the system fault alert is off.

To erase the names of inactive faults, scroll to the system fault group. Wait until the display scrolls through the name of each fault. Inactive faults will be erased automatically. If the alert is on, only the names of active faults will remain.

NO FAULT appears on the display (Figure 3-15) when there are no faults.

| |
|---|
| CRANE FAULTS/LIMITS<br>SYSTEM FAULTS- NO FAULT |

**FIGURE 3-15**

**Table 3-5 Operating Conditions**

Listed below are the operating conditions which can be viewed on the digital display.

| Display Reading | Unit of Measure | Operating Range |
|---|---|---|
| **Normal Operating Conditions** The operating conditions listed below are displayed by scrolling up or down with the digital display selector. | | |
| ENGINE SPEED | RPM | 1,050 rpm low idle; 1,800 rpm high idle. |
| BOOM ANGLE | DEG | Degrees boom is positioned above horizontal. |
| LUFFING JIB ANGLE [1] | DEG | Degrees luffing jib is positioned above horizontal. |
| BOOM TO LUFF ANGLE [1] | DEG | Degrees between centerline of boom and centerline of luffing jib. |
| FUEL LEVEL | % | Indicates 0-100% of fuel remaining in tank. |
| OIL PRESSURE | PSI | Indicates engine oil pressure when operating. |
| COOLANT TEMP | DEG F | Indicates temperature of coolant in engine. |
| ENGINE HOURS | HOURS | Indicates total number of hours the engine has been run. |
| ENGINE DIAGNOSTICS | — | Indicates engine fault codes and engine troubleshooting. |
| MAST ANGLE | DEG | Degrees live mast is positioned above transport position, which is 0° |
| BATTERY VOLTAGE | V | Indicates crane battery voltage. |
| TILT RIGHT (Crane Level)<br>TILT FRONT (Crane Level) | DEG/IN | First number is angle (+ or - degrees) that crane is out of level in indicated direction from horizontal. Second number is (inches) of blocking to level crane in required direction. |
| HYD TANK FLUID LEVEL | % | Indicates hydraulic tank fluid level in % full. |
| CURRENT WIND SPEED | MPH | Indicates current steady wind speed. |
| (MAX) WIND SPEED | MPH | Indicates maximum gust wind speed. |
| PUMP DRIVE TEMP | DEG F | indicates temperature of oil in pump drive. |
| PUMP DRIVE PRESSURE | PSI | Indicates pump drive oil pressure when operating. |
| **Diagnostic Screens** Operating conditions listed below are displayed only by turning limit by-pass switch and scrolling up with digital display selector. To turn off diagnostic screens, turn limit bypass switch and scroll down or stop and restart engine. | | |
| DRUM [2] | 4 Rows of Text and Numbers in Display Screen | Text and numbers are used to monitor and troubleshoot controls and hydraulic systems. See Crane Diagnostics in this section for explanation of these screens. |
| SWING | | |
| TRK (Travel) | | |
| FCN (Front Console Node) | | |
| CAN (CAN-Bus) | | |
| ACC (Accessory System) | | |
| WIRELESS | | |
| LEVEL | | |
| SPEEDS AND TORQUE | | |
| HYD SYSTEM CHECK | | |
| CRANE MODE<br>(name of mode) | — | See Crane Mode Selector instructions in this section for procedure to select and confirm desired crane mode. |
| PROGRAM M000001.0JP | — | Computer Program Version. *Factory service personnel will request these numbers when troubleshooting crane problems.* |
| CON 00000000000 | — | Computer and Crane Configuration Code. *Factory service personnel will request these numbers when troubleshooting crane problems.* |

[1] Optional Item.

[2] Appropriate Drum Number.

**Table 3-6 Operating Limits**

Listed below are limits which turn on the operating limit alert (yellow light and continuous buzzer). When the alert comes on, the OPERATING LIMIT group of the digital display indicates which limit has been reached; take corrective action.

| Display Reading | Function Response | Corrective Action |
|---|---|---|
| BLOCK LEVEL | Block level sensing fault. | Block angle exceeded for parts of line. See Block Level screen in Crane Diagnostic section. |
| BLOCK UP | Stops load drums from hoisting and boom/ luffing jib from lowering. | Lower corresponding load or raise boom or jib. |
| CONFIRM MODE | All drums inoperable until an operating mode is selected and confirmed. | Select and confirm the desired operating mode (see Operating Controls in this section for procedure). |
| CRANE LEVEL | Crane is 3 degrees out of level when jacking. | Level crane with individual jacking switches. |
| FUNCTION PARKED | Function inoperable because it is parked. | Turn corresponding park switch off and sit down in operator's seat. |
| JIB BELOW HORIZONTAL [1] | Luffing jib operable. See capacity chart for luffing jib minimum operating angles. | Raise luffing jib above horizontal. |
| LOAD MOMENT | Stops all load drums from hoisting and boom/luffing jib from lowering. | Land load on load drum or raise boom or jib. |
| MAST BELOW 2 DEGREES | Stops down movement of live mast when lowering mast to transport position. | Pin live mast in place before retracting mast arms cylinders fully. |
| MAST TOO FAR FORWARD | Boom hoist (live mast) inoperable in lowering direction (occurs if mast is below 160°). | Raise live mast. Further lowering is not intended—**mast will fall.** |
| MAX DOWN [1] | Stops boom from lowering (limit set at 0°).<br>Stops luffing jib from lowering when boom to luffing jib MINIMUM angle is reached. | Raise boom or luffing jib. |
| MAX UP 1 | Stops boom from rising when maximum up limit is reached. [2]<br>Stops luffing jib from rising when boom to jib MAXIMUM WORKING angle is reached. This angle can be bypassed to raise jib to MAXIMUM angle. | Lower boom/luffing jib. |
| MAX UP 2 [1] | Stops luffing jib from rising when boom to jib MAXIMUM angle is reached. This limit can be bypassed only when boom is below 50°. | Lower luffing jib. |
| MAX BAIL | Drum stops hoisting. | Operate drum in lowering direction. |
| MIN BAIL | Drum stops lowering. | Operate drum in hoisting direction. |
| RANGE LIMITER | Stops swing movement of rotating bed when either swing limit is reached. | Swing rotating bed in opposite direction away from limit. |
| SWING PARKED (cranes with swing lock) | Stops travel function with MAX-ER. | Place swing park in off position to travel. |
| SWING PARKED (cranes without swing lock ) | Stops travel function without MAX-ER. | 1) Place swing park in off position to travel. 2) Install W48 Shorting Plug in MAX-ER Junction Box **IF** configured without MAX-ER attachment. 3) Confirm swing brake release pressure on Swing (Crane) diagnostic screen; if below 200 psi (13,8 Bar), troubleshoot swing brake hydraulic circuit. |

[1] Optional item.

[2] Angle at which boom stops varies with attachment. See Section 4 of this manual for maximum operating angles.

**Table 3-7 System Faults**

Listed below are faults which turn on the system fault alert (red light and beeper). When the alert comes on, the SYSTEM FAULT group of the digital display indicates which fault has occurred; take corrective action. The beeper sounds intermittently.

| Display Reading | Function Response | Cause of Fault |
|---|---|---|
| BATTERY VOLTAGE LOW | Correct cause for low voltage to prevent faulty crane operation. | Battery voltage below 18 volts. |
| BOOM ANGLE SENDER | All functions operable, BOOM ANGLE and BOOM TO LUFF JIB ANG display will be faulty; correct cause of angle sender fault as soon as possible. | Sender output voltage 0 volts or above 9.7 volts. Fault not active when crane is in SETUP mode. |
| CRANE LEVEL SENSOR | Jacking ALL switch inoperable. Crane is 4.7 degrees out of level | Use individual jacking switches to level crane. |
| DISABLED DIG OUTPUT | Affected system not operating properly. Correct cause of fault as soon as possible. | Electric signal interrupted between computer node and output device (i.e.: faulty brake solenoid or broken wire). |
| ENGINE OIL PRESSURE LOW | Does not affect operation. Correct cause of low oil pressure as soon as possible to prevent engine damage. | Oil pressure below 15 psi (1,0 bar). |
| ENGINE TEMP HIGH | Does not affect operation. Correct cause of overheating as soon as possible to prevent engine damage. | Engine coolant temperature above 205°F (96°C). |
| FILTER FAULT 1 or 2 | All functions operable. Replace charge filter 1 or 2 as soon as possible. Cranes prior to S/N 18001082. | Filter is dirty. |
| FILTER FAULT 4 | All functions operable. Replace return filters as soon as possible. Cranes prior to S/N 18001082. | Filter is dirty. |
| FILTER FAULT 1 | All functions operable. Replace return filter 2 as soon as possible. Crane S/N 18001082 and newer. See Table 3-8. | Filter is dirty. |
| FILTER FAULT 2 | All functions operable. Replace return filter 3 as soon as possible. Crane S/N 18001082 and newer. See Table 3-8. | Filter is dirty. |
| FILTER FAULT 4 | All functions operable. Replace return filter 1 as soon as possible. Crane S/N 18001082 and newer. See Table 3-8. | Filter is dirty. |
| FILTER FAULT 8 | Oil flow through suction filter inside hydraulic tank blocked. | Remove blockage or hydraulic pumps will be damaged from cavitation. |
| FUEL LEVEL SENSOR | Five percent fuel remaining in tank. Does not affect operation. | Fill tank as soon as possible to prevent engine stoppage. |
| HYDRAULIC FAN | Tier 4 engine. Does not affect operation. Correct cause of fault as soon as possible to prevent engine or hydraulic system from overheating. | Fan system pressure below 500 psi (34 bar). |
| HYDRAULIC FLUID LEVEL LOW | Does not affect operation. Fill tank as soon as possible. | Hydraulic oil at CAUTION LOW LEVEL indicated on tank gauge. |
| HYDRAULIC FLUID TEMP LOW | Reduce loads and/or speeds to allow oil to warm. | Oil temperature in hydraulic tank is below 40°F (4°C). |
| HYDRAULIC FLUID TEMP HIGH | Does not affect operation. Reduce loads and/or speeds to allow oil to cool. | Oil temperature in hydraulic tank above 180°F (82°C). |

| Display Reading | Function Response | Cause of Fault |
|---|---|---|
| LOAD PIN | Load drum operation will stop. | Load pin voltage not within 0.5 - 9 volts. |
| LUFFING JIB ANGLE SENDER [1] | All functions operable, but JIB ANGLE and BOOM TO LUFF JIB ANG display will be faulty; correct cause of angle sender fault as soon as possible. | Sender output voltage 0 volts or above 9.7 volts. Fault not active when crane is in SETUP mode. |
| MAST SYSTEM | Mast operation with boom hoist will stop. | Boom or accessory transducer voltage less than 0.6 volts. |
| PUMP DRIVE PRESSURE LOW [2] | Does not affect operation. Shut down and correct cause as soon as possible to prevent gear or bearing damage. | Gear oil pressure below 5 psi (0,34 bar). Check pump for proper operation. Check pump drive oil level. |
| PUMP DRIVE TEMP HIGH [2] | Does not affect operation. Shut down and correct cause as soon as possible to prevent gear or bearing damage. | Gear oil temperature above 250°F (121°C). Check oil cooler for proper operation. Check pump drive oil level. |
| SUPERCHARGE PRESSURE (Prior to S/N 18001082) | Does not affect operation. Shut down and correct cause as soon as possible to prevent pump cavitation. | Accessory pressure at pressure switch (suction manifold) is less than 15 psi (1 bar). Check hydraulic accessory system. |
| WIRELESS SYSTEM | Wireless load link sensing fault. | See wireless link information in Rated Capacity Indicator/Limiter manual. |
| EXTERNAL VAC | Does not affect operation. Disconnect external power supply cable. | External power supply cable connected to crane when attempting to swing. |

[1] Optional item.

[2] Pump drive faults apply only to current production cranes (pump drives with a circulating oil system).

**Table 3-8**
Filter Fault Indication

| FILTER FAULT INDICATION | RETURN FILTER 1 AFFECTED | RETURN FILTER 2 AFFECTED | RETURN FILTER 3 AFFECTED |
|---|---|---|---|
| FILTER FAULT 1 | | X | |
| FILTER FAULT 2 | | | X |
| FILTER FAULT 3 | | X | X |
| FILTER FAULT 4 | X | | |
| FILTER FAULT 5 | X | X | |
| FILTER FAULT 6 | X | | X |

## FUNCTION SPEED/TORQUE ADJUSTMENT

The speed of each crane function (all drums, travel, swing) and swing torque can be adjusted to suit operator needs.

### Adjustment

To adjust the desired function's speed or swing torque, proceed as follows:

1. Stop operating the desired function and park it.
2. Access diagnostic screens (Figure 3-16):
   a. Turn limit bypass key clockwise and scroll up at least one screen (with selector next to display screen).
   b. Once step 2a is performed, release key and scroll up or down through diagnostic screens until speed and torque screen appears.
3. Press BOTTOM of CONFIRM/SELECT switch until cursor ( * ) appears next to desired function.
4. Scroll up or down to change speed or torque of selected function to desired percentage between 25% and 100%.
5. Repeat steps 1, 3 and 4 for other functions, as desired.
6. Press BOTTOM of CONFIRM/SELECT switch until cursor ( * ) disappears.
7. Adjustment is complete. The selected speeds and torque will remain in computer memory, even after engine is stopped.
8. If desired, turn off diagnostic screens:
   a. Turn limit bypass key clockwise.
   b. Once step 8a is performed, scroll down at least one screen and release key.

   Stopping engine will also turn off diagnostic screens.

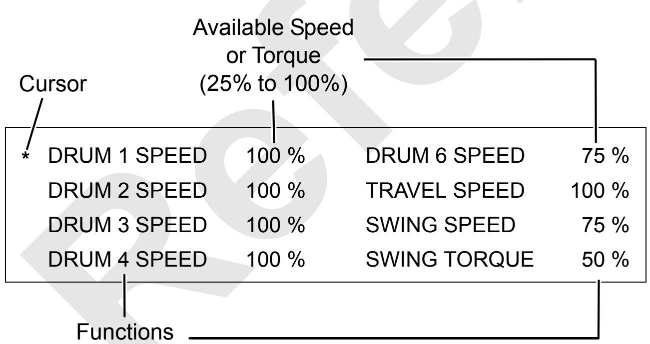


FIGURE 3-16

## CRANE DIAGNOSTICS

### General

To enable the diagnostic screens, turn limit bypass key switch clockwise and scroll up at least one screen. Once this step is performed, you can scroll up or down through the diagnostic screens in addition to the operating screens. To disable the diagnostic screens, turn limit bypass key switch clockwise and scroll down. The operating screens remain active.

The diagnostic screens provide information about the status of all main crane components as well as the controller inputs and outputs during operation. The diagnostic screens display the following information:

- Particular crane functions — DRUMS, SWING, and TRACK. See Figure 1-1 in Section 1 of this Service/Maintenance Manual for drum location and identification.
- FCN (front console node) and CAN (can bus) screens display digital input and digital output information — Table 3-11 (digital inputs to master node controller), and Table 3-12 (digital outputs from crane master node controller). See Figure 3-17 for location of node controllers.
- Controller programming information —These screens are for factory use only, and are not shown in this folio.
- Hydraulic system calibration information — Check includes pressure sender calibration, control calibration, pump pressure test, and charge pressure test.
- Speed adjustment screen — Allows for setting each drum, travel, and swing system maximum operating speed and swing torque.
- Accessory (ACC) system — Provides accessory system component status information.
- Wireless screen — Provides load link and hand-held radio remote information.
- Crane mode screen — Allows for selecting crane mode of operation.
- Table 3-13 contains bank identifier numbers.

### Drum 1

| | | | | | |
|---|---|---|---|---|---|
| HANDLE | +/-0 % | 0.0 V | PRESS | 0 psi | |
| PUMP A | +/-0 % | 0 CS | SPEED | +/-0 rpm | |
| PUMP B | +/-0 % | | BRAKE | 0 | |
| MOTOR | 0 % | | DOS | 0 | DRUM 1 |

DRUM 1 screen displays the following information:

- Control HANDLE command in percent from neutral with + raise and - lower.
- The normal operating voltage (V) outputs of the control handle range is 2.4 to 0.5 volts to raise a load and 2.6 to 4.5 volts to lower a load.

**NOTE:** With drum control handle D function, raise and lower voltage is reversed.

- Control handle Center Switch (CS) command with 0 neutral and 1 active.
- PUMP A and B command in percent from neutral with + raise and - lower for each pump.
- MOTOR command in percent with 0% maximum displacement and 100% minimum displacement.
- Measured hoist PRESSURE (psi) at high side pressure port.
- Measured drum SPEED in rpm with + raise and - lower.
- Park BRAKE command with 0 engaged and 1 released.
- DOS (digital output status) displays a binary number (or total) if digital output signal is disabled to: pump A - drum 1 (1), pump B - drum 1 and 3 (2), motor 1 (4), motor 2 (8) or drum brake (16).

## Drum 2

| | | | | | |
|---|---|---|---|---|---|
| HANDLE | +/-0 % | 0.0 V | PRESS | 0 psi | |
| PUMP A | +/-0 % | 0 CS | SPEED | +/-0 rpm | |
| PUMP B | +/-0 % | | BRAKE | 0 | |
| MOTOR | 0 % | | DOS | 0 | DRUM 2 |

DRUM 2 screen displays the following information:

- Control HANDLE command in percent from neutral with + raise and - lower.
- The normal operating voltage (V) outputs of the control handle range is 2.4 to 0.5 volts to raise a load and 2.6 to 4.5 volts to lower a load.

**NOTE:** With drum control handle D function, raise and lower voltage is reversed.

- Control handle Center Switch (CS) command with 0 neutral and 1 active.
- PUMP A and B command in percent from neutral with + raise and - lower for each pump.
- MOTOR command in percent with 0% maximum displacement and 100% minimum displacement.
- Measured hoist PRESSURE (psi) at high side pressure port.
- Measured drum SPEED in rpm with + raise and - lower.
- Park BRAKE command with 0 engaged and 1 released.
- DOS (digital output status) displays a binary number (or total) if digital output signal is disabled to: pump A - drum 2 (1), pump B - drum 2 and 5 (2), motor 1 (4), motor 2 (8), or drum brake (16).

## Drum 3

| | | | | | |
|---|---|---|---|---|---|
| HANDLE | +/-0 % | 0.0 V | PRESS | 0 psi | |
| PUMP A | +/-0 % | 0 CS | SPEED | +/-0 rpm | |
| | | | BRAKE | 0 | |
| MOTOR | 0 % | | DOS | 0 | DRUM 3 |

DRUM 3 screen displays the following information:

- Control HANDLE command in percent from neutral with + raise and - lower.
- The normal operating voltage (V) outputs of the control handle range is 2.4 to 0.5 volts to lower a load and 2.6 to 4.5 volts to raise a load.

**NOTE:** With drum control handle D function, raise and lower voltage is reversed.

- Control handle Center Switch (CS) command with 0 neutral and 1 active.
- PUMP A command in percent from neutral with + raise and - lower.
- MOTOR command in percent with 0% maximum displacement and 100% minimum displacement.
- Measured hoist PRESSURE (psi) at high side pressure port.
- Measured drum SPEED in rpm with + raise and - lower.
- Park BRAKE command with 0 engaged and 1 released.
- DOS (digital output status) displays a binary number (or total) if digital output signal is disabled to: pump A - drum 1 and 3 (1), motor (2), brake (4) or diverter - drum 1 and 3 (8).

## Drum 4

| | | | | | |
|---|---|---|---|---|---|
| HANDLE | +/-0 % | 0.0 V | PRESS | 0 psi | |
| PUMP A | +/-0 % | 0 CS | SPEED | +/-0 rpm | |
| PUMP B | +/-0 % | | BRAKE | 0 | |
| MOTOR | 0 % | | DOS | 0 | DRUM 4 |

DRUM 4 screen displays the following information:

- Control HANDLE command in percent from neutral with + raise and - lower.

- The normal operating voltage (V) outputs of the control handle range is 2.4 to 0.5 volts to raise a load and 2.6 to 4.5 volts to lower a load.

**NOTE:** With drum control handle D function, raise and lower voltage is reversed.

- Control handle Center Switch (CS) command with 0 neutral and 1 active.
- PUMP A and B command in percent from neutral with + raise and - lower for each pump.
- MOTOR command in percent with 0% maximum displacement and 100% minimum displacement.
- Measured hoist PRESSURE (psi) at high side pressure port.
- Measured drum SPEED in rpm with + raise and - lower.
- Park BRAKE command with 0 engaged and 1 released.
- DOS (digital output status) displays a binary number (or total) if digital output signal is disabled to: pump A - pump 1 (1), pump B - pump 2 (2), motor 1 (4), motor 2 (8), drum brake (16) or drum pawl (32).

## Drum 5

| | | | | | |
|---|---|---|---|---|---|
| HANDLE | +/-0 % | 0.0 V | PRESS | 0 psi | |
| PUMP A | +/-0 % | 0 CS | SPEED | +/-0 rpm | |
| | | | BRAKE | 0 | |
| MOTOR | 0 % | | DOS | 0 | DRUM 5 |

DRUM 5 screen displays the following information:

- Control HANDLE command in percent from neutral with + raise and - lower.
- The normal operating voltage (V) outputs of the control handle range is 2.4 to 0.5 volts to raise a load and 2.6 to 4.5 volts to lower a load.

**NOTE:** With drum control handle D function, raise and lower voltage is reversed.

- Control handle Center Switch (CS) command with 0 neutral and 1 active.
- PUMP A command in percent from neutral with + raise and - lower.
- MOTOR command in percent with 0% maximum displacement and 100% minimum displacement.
- Measured hoist PRESSURE (psi) at high side pressure port.
- Measured drum SPEED in rpm with + raise and - lower.
- Park BRAKE command with 0 engaged and 1 released.
- DOS (digital output status) displays a binary number (or total) if digital output signal is disabled to: pump A - drum 5 (1), not used (2), drum brake (4), drum pawl (8) or diverter (16).

## Drum 6

| | | | | | |
|---|---|---|---|---|---|
| HANDLE | +/-0 % | 0.0 V | PRESS | 0 psi | |
| PUMP A | +/-0 % | 0 CS | SPEED | +/-0 rpm | |
| | | | BRAKE | 0 | |
| MOTOR | 0 % | | DOS | 0 | DRUM 6 |

DRUM 6 screen displays the following information:

- Control HANDLE command in percent from neutral with + raise and - lower.
- The normal operating voltage (V) outputs of the control handle range is 2.4 to 0.5 volts to raise a load and 2.6 to 4.5 volts to lower a load.

**NOTE:** With drum control handle D function, raise and lower voltage is reversed.

- Control handle Center Switch (CS) command with 0 neutral and 1 active.
- PUMP A command in percent from neutral with + raise and - lower.
- MOTOR command in percent with 0% maximum displacement and 100% minimum displacement.
- Measured hoist PRESSURE (psi) at high side pressure port.
- Measured drum SPEED in rpm with + raise and - lower.
- Park BRAKE command with 0 engaged and 1 released.
- DOS (digital output status) displays a binary number (or total) if digital output signal is disabled to: pump A (1), motor (2), drum brake (4) or drum pawl (8).

## Swing (Crane)

| | | | | | |
|---|---|---|---|---|---|
| HANDLE | +/-0 % | 0.0 V | RT PRES | 0 psi | |
| PUMP | +/-0 % | 0 CS | LT PRES | 0 psi | |
| BRAKE | 0 % | 0 psi | DOS | 0 | |
| LOCK | 0 | | | | SWING |

The SWING screen displays the following information:

- Control HANDLE command in percent from neutral with + right and - left.
- The normal operating voltage (V) outputs of the control handle range is 2.4 to 0.5 volts for left swing and 2.6 to 4.5 volts for right swing.

- Control handle Center Switch (CS) command with 0 neutral and 1 active.
- PUMP command in percent from neutral with + right and - left.
- Park BRAKE command with 0 engaged and 1 released.
- Swing Brake Pressure (cranes without swing lock).
- Swing LOCK command with 0 engaged and 1 released (cranes with swing lock).
- Measured pump RT PRES (psi) when swinging right.
- Measured pump LT PRES (psi) when swinging left.
- DOS (digital output status) displays a binary number (or total) if the digital output signal is disabled to: pump 1 (1), pump 2 (2), swing brake (4), swing lock in (8) or swing lock out (16).

## **Trk** (Travel)

| | LEFT | | RIGHT | | BRAKE | 0 |
|---|---|---|---|---|---|---|
| HANDLE | +/-0 % | 0.0 V | +/-0 % | 0.0 V | MOTOR | 0 |
| PUMP | +/-0 % | 0 CS | +/-0 % | 0 CS | CRUISE | 0 |
| PRES | | 0 psi | 0 psi | DOS | 0 | TRK |

The right and left TRK (Travel) screen displays the following information:

- Control HANDLE command in percent from neutral with + forward and - reverse.
- The normal operating voltage (V) outputs of the control handle range 2.6 to 4.5 volts for forward and 0.5 to 2.4 volts for reverse.
- Control handle Center Switch (CS) command with 0 neutral and 1 active.
- Left or right PUMP command in percent from neutral with + forward and - reverse.
- Measured track PRESS (psi) at right or left crawler track.
- Park BRAKE command with 0 engaged and 1 released.
- MOTOR command with 0 high speed/minimum displacement and 1 low speed/maximum displacement.
- CRUISE indicates status of travel cruise with 1 engaged and 0 disengaged.
- DOS (digital output status) displays a binary number (or total) if the digital output signal is disabled to: right pump (1), left pump (2), travel brake (4), or motor (8).

## **FCN** (Front Console Node)

| | | | | |
|---|---|---|---|---|
| DI BANKS: | 72 | 8 | 33 | 15 |
| DO BANKS: | 223 | 0 | | |
| TF BANKS: | 000 | 000 | 000 | 000 |
| | | | | FCN |

The status of the digital inputs and outputs of the front console controller is displayed in the FCN screen. Each bank can indicate the state of up to 255 individual digital inputs or outputs. The FCN screen displays the following information:

- Front console digital input DI BANKS 1, 2, 3, and 4.
- Front console digital output DO BANKS 5 and 6.
- Only programmers use TF BANKS 1, 2, 3, and 4.

Each individual input/output is assigned a number (identifier) in the binary system (powers of two). The identifiers of all inputs/outputs that are ON (active) for each bank are added for a total of 0 – 255. The number displayed for each bank is the ***sum*** of all identifiers that are ON in that bank. Each possible ON/OFF combination per bank has a unique total.

To determine the state of an individual digital input or output (crane component), find the individual crane component in Table 3-11 or Table 3-12, for example: Seat Switch ***FCN-3-1***.

- The first part of the Code Number ***FCN*** indicates that the individual input or output is located in the FCN computer.

  **NOTE:** If the Code Number starts with CAN, see CAN screen for input/output.

- The second part of the Code Number ***3*** is the ***bank*** where the individual information is shown on the FCN screen.
- The third part of the Code Number ***1*** is the item ***identifier***.

To determine the state of the individual input/output in a bank, find the number displayed for the bank in the numbered column of Table 3-13. In the corresponding row the identifier numbers that are ON (active) in the bank are shaded. In the above example if 1 is shaded the Seat Switch is ON (active).

| Node Number | Node |
|---|---|
| 1 | Master (Front Console) |
| 2 | Handles and Cab Controls |
| 3 | Drum 3 and Pressure Senders |
| 4 | Jacking, Connecting Pins, and Mast |
| 5 | Alarms, Limits and Pump Controls |
| 6 | Drums 2, 4, 5 & Adapter Frame Pins |
| 7 | Swing and Auto Lube |
| 8 | Drum 1 and Drum 6 |
| 9 | MAX-ER (optional) |
| 0 | Engine |
| 20 | Boom Top (not shown) |
| 21 | Luffing or Fixed Jib Top (not shown) |

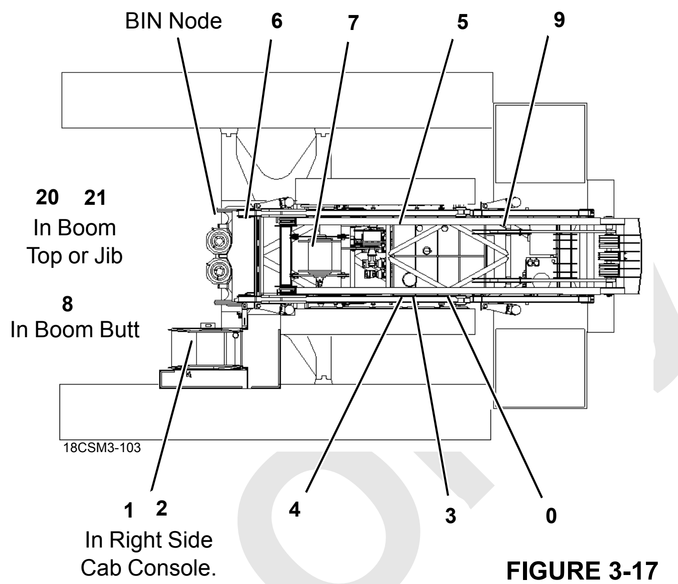


FIGURE 3-17

## **CAN** (Can Bus)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| STATUS 033 | 000 | HIST | 000 000 | | ENG | 12 |
| *PACKET ID # | 38 | | BOOM | 16 | W/L | 1 |
| BANKS 1 - 4: | 55 | 0 | 178 | 0 | | |
| BANKS 5 - 8: | 4 | 35 | 0 | 16 | | CAN |

The CAN screen displays digital inputs and outputs of the master node controller. The location of crane nodes are shown in Figure 3-17. The CAN screen displays the following information:

- STATUS indicates possible active communication errors between nodes on two banks that should read 000. The binary system status numbers are shown in Table 3-9.

  If a communication error occurs (033 in bank one) see Table 3-9 for bank identifier numbers (node-2 and node-7)

**Table 3-9**

| | | |
|---|---|---|
| **Bank 1** | 1 = Node 2 | 16 = Node 6 |
| | 2 = Node 3 | 32 = Node 7 |
| | 4 = Node 4 | 64 = Node 8 |
| | 8 = Node 5 | 128 = Node 0 |

| | | |
|---|---|---|
| **Bank 2** | 1 = Node 9 | 2= BIN Node |

- HISTORY indicates errors since power was cycled. Communication errors correspond to above table.
- BOOM indicates what boom nodes may be available on the bus. Boom status should always display a number or an error exists (see Table 3-10).

**Table 3-10**

| Boom Status | Node Number | Description |
|---|---|---|
| 1 | 21 | Luffing Jib node with #44 |
| 8 | 21 | Luffing jib node 79A **or** Fixed jib node 79A |
| 16 | 20 | Boom top node 55A or 79A |
| 128 | 20 **or** 21 | Indicates a node is present that is not currently identified. |

- ENGINE displays engine ECM bus status that is for factory use only.
- W/L indicates what wireless receiver nodes can be available.
  - Number 1 is boom to load link.
  - Number 2 is remote.
- PACKET ID number — Move select/confirm switch to SELECT. Cursor appears next to Packet ID #. Scroll up or down to desired packet number to display packet item status.
- Digital input or digital output BANKS 1, 2, 3, and 4.
- Digital input or digital output BANKS 5, 6, 7, and 8.

Each individual input/output is assigned a number (identifier) in the binary system (powers of two). The identifiers of all inputs/outputs that are ON (active) for each bank are added for a total of 0 – 255. The number displayed for each bank is the ***sum*** of all identifiers that are ON in that bank. Each possible ON/OFF combination per bank has a unique total.

To determine a state of an individual digital input or output, find the individual crane component in Table 3-11 or Table 3-12, for example: Return Filter Alarm ***CAN38-1-32***.

- The first part of the Code Number ***CAN38*** indicates that the individual input or output is located in packet ***38*** of the master CAN computer.

**NOTE 1:** If the Code Number starts with FCN, see FCN screen for the input/output.

- Select PACKET ID# ***38*** by moving select/confirm switch to SELECT and a cursor appears next to Packet ID #. Scroll up or down to desired packet number to display packet item status.
- The second part of Code Number ***1*** is ***bank*** were the individual information is shown on the CAN screen.
- The third part of the Code Number ***32*** is the item ***identifier***.

To determine the state of the individual input/output in a bank, find the number displayed for the bank in the numbered column of Table 3-13. In the corresponding row the identifier numbers that are ON (active) in the bank are shaded. In the above example if ***32*** is shaded the Return Filter Alarm is ON (active).

To exit CAN screen move select/confirm switch to SELECT and cursor disappears. Continue scrolling up or down to access next screen.

## Hydraulic System Calibration

See Hydraulic System Calibration Procedures in this section.

| | | | |
|---|---|---|---|
| PRESSURE SENDER CAL | 0% | 0 | 0 |
| CONTROL CAL | 0% | 0 | |
| PUMP PRESSURE TEST | 0% | 0 | |
| CHARGE PRESSURE | | 0 | 0 |

## Speed/Torque

See Function Speed/Torque Adjustment in this section.

| | | | |
|---|---|---|---|
| DRUM 1 SPEED | 25 % | DRUM 6 SPEED | 25 % |
| DRUM 2 SPEED | 50 % | TRAVEL SPEED | 75 % |
| DRUM 3 SPEED | 25 % | SWING SPEED | 25 % |
| DRUM 4 SPEED | 25 % | SWING TORQUE | 60 % |

## Accessory System

| | | | | |
|---|---|---|---|---|
| HANDLE | +/-0 % | ACC PRES | psi | |
| ACC VLV | -0 % | DM 5 PRES | psi | |
| DM 5 PMP | +/-0 % | DM 5 SPD | rpm | |
| VALVES | 256 | ACCUM P | psi | ACC |

The ACC system screen displays the following information:

- Drum 5 (mast hoist) control HANDLE command in percent from neutral with + raise and - lower.
- Accessory valve (ACC VLV) command in percent.
- Drum 5 (mast hoist) pump (DM 5 PMP) command in percent from neutral with + raise and - lower.
- Accessory system pressure (ACC PRES) in psi.
- Drum 5 (mast hoist) pump pressure (DM 5 PRES) in psi.
- Drum 5 (mast hoist) drum speed (DM 5 SPD) in rpm.
- Accumulator system pressure (ACCUM PRES) in psi.
- VALVES - displays binary number of system components that are active in bank:

**Bank 1:**

1 = Jacking command.

2 = Rotating fame command.

4 = Mast raise switch and mast hoist control handle command is OFF.

8 = Mast lower switch and mast hoist control handle command is OFF

16 = Boom hinge pins in switch.

32 = Boom hinge pins out switch.

64 = Mast pins in switch.

128 = Mast pins out switch.

256 = Cab tilt up.

512 = Cab tilt down.

1028 = Raise mast arms from stored position.

2056 = Lower mast arms to stored position.

4096 = MAX-ER cylinder.

8192 = Rigging winch command.

## Wireless

| | | | | | |
|---|---|---|---|---|---|
| *REMOTE TxID | 0000 | | | | |
| SENSOR BANKS: | 0 | 64 | 0 | 128 | 160 |
| LOAD LINK TRAFFIC | 0 | 0 | | | |
| REMOTE TRAFFIC | 0 | 0 | | | WIRELESS |

The WIRELESS screen displays the following information:

- REMOTE TxID - where the link identification code is entered and displayed. To enter a link identification code, press select. The cursor (*) appears next to remote TxID. Press select again to enter identification code area. Scroll up or down to enter 0 to 9 and/or A to F, press select to move through each four positions.
- SENSOR BANKS - where the four banks listed below display information shown in table.

  1. Link 1 information.
  2. Link 2 information.
  3. Link 3 information.
  4. Hand-held radio remote control information.
  5. Block Level control information.

| Binary Number | Information |
|---|---|
| 1, 2, or 4 | Disregard information displayed. |
| 8 | RF link suspect. |
| 16 | Configuration data corrupt. |
| 32 | Internal CPU error. |
| 64 | Sensor voltage out of range. (Not used with block level sensor) |
| 128 | Sensor battery low. |

- LOAD LINK TRAFFIC where bank one is transmitter identification and bank two property code (weight code of link). The two banks work together and continuously display information for each load link in immediate area.
- REMOTE TRAFFIC where bank one is transmitter identification and bank two property code of hand-held radio remote. The two banks work together and continuously display information for each radio remote in immediate area.

**NOTE:** Cranes with 2.4 Ghz wireless systems will not display traffic information.

## Block Level Sensor

| | | |
|---|---|---|
| *BLOCK LEVEL SENSOR | 01B2 | |
| BLOCK ANGLE | + 3.43 DEG | |
| DRUM 1 PUMP | 30% | |
| DRUM 2 PUMP | 31% | LEVEL |

The LEVEL screen displays the following information when:

BLOCK LEVEL SENSOR - where the block identification code is entered and displayed. To enter a block identification code, press select. The cursor (*) appears next to Block Level Sensor. Press select again to enter identification code area. Scroll up or down to enter 0 to 9, press select to move through each four positions.

BLOCK ANGLE - where the block angle is displayed. A block level fault occurs if the maximum block angle for parts of line is exceeded:

| Angle in Degree | Parts of Line |
|---|---|
| 10 | 16 or less |
| 8.8 | 20 |
| 7.6 | 24 |
| 6.4 | 28 |
| 5.2 | 32 |
| 4.0 | 36 |

DRUM 1 and 2 PUMP - displays pump command in percent.

## Crane Mode

| | |
|---|---|
| Crane Mode - STANDARD | |
| PROG M0000000.ONP | CON 000000 |

The crane mode screen displays the selected crane mode:

- Crane mode.
- PROG is computer program version.
- CON is computer and crane configuration code.

## Hydraulic Fan (Tier 4 only)

| | | |
|---|---|---|
| PRESS | 000 | PSI |
| PUMP | 0 | % |
| STATUS | 0 | |
| HYRAULIC FAN | | |

The hydraulic fan screen displays the following information for the Tier 4 hydraulic fan system:

- PRESS – Fan system pressure. Increased cooling demand and increased engine speed will increase this pressure.
- PUMP – Displays the current pump command. This will range from 5 to 100% and change in response to cooling demand and engine speed.
- STATUS – Displays the error status of the fan system:

  0 = okay.

  Bit 1 = fan pressure transducer out of range.

  Bit 2 = fan control valve digital output fault.

  Bit 3 = fault is set if fan pressure is below 500 psi (34,5 bar) after the system is initialized. Will cause the backup coil to energize and try to fully stroke the pump.

## DIGITAL INPUT AND OUTPUT ITEM TABLES

Table 3-11 and Table 3-12 identify selected component digital Inputs and digital outputs used on the crane. The Code Number indicates the computer packet number (CAN) or front console computer location (FCN).

See CAN screen if the item Code Number has a CAN prefix or to FCN screen if item Code Number has a FCN prefix. Table 3-13 lists the identifier numbers that are ON (active) for each bank.



**Table 3-11 Digital Inputs**

| CAN Packet Number | Item Description (Node Number) | CAN Packet Number | Item Description (Node Number) |
|---|---|---|---|
| CAN57-1-1 | Handle A Direction Signal (2) | FCN-1-1 | Drum 6 Park Switch - On (1) |
| CAN57-1-2 | Handle D Direction Signal (2) | FCN-1-2 | Crane Mode Confirm Switch (1) |
| CAN57-1-4 | Swing Holding Brake Switch (2) | FCN-1-4 | Drum 1 Park Switch - On (1) |
| CAN57-1-8 | Swing Handle Direction Signal (2) | FCN-1-8 | Crane Display Scroll Up Switch (1) |
| CAN57-1-16 | Swing Handle Dead Man Option (2) | FCN-1-16 | Drum 2 Park Switch - On (1) |
| CAN57-2-1 | Left Track Direction Signal (2) | FCN-1-32 | Crane Display Scroll Down Switch (1) |
| CAN57-2-2 | Handle B Direction Signal (2) | FCN-1-64 | Travel Park Switch - On (1) |
| CAN57-2-4 | Handle C Direction Signal (2) | FCN-1-128 | Cab Tilt Up Switch (1) |
| CAN57-2-8 | Right Track Direction Signal (2) | FCN-2-1 | RCL Mode Confirm Switch (1) |
| CAN59-1-4 | Super Charge Hydraulic Pressure (3) (Prior to S/N 18001082) | FCN-2-2 | Drum 5 Park Switch - On (1) |
| CAN59-1-128 | Drum 3 Minimum Bail Limit Switch (3) | FCN-2-4 | Limit Bypass Switch (1) |
| CAN61-1-128 | Drum 2 Minimum Bail Limit Switch (6) | FCN-2-8 | RCL Display Scroll Up Switch (1) |
| CAN65-1-128 | Accessory System Hydraulic Pressure Sw. (7) | FCN-2-32 | RCL Display Scroll Down Switch (1) |
| CAN67-1-4 | Counterweight Limit Switch - Right Side (9) | FCN-2-64 | Travel Cruise Switch - On (1) |
| CAN67-1-8 | Counterweight Limit Switch - Left Side (9) | FCN-3-1 | Seat Switch (1) |
| CAN69-1-4 | Hydraulic Fluid Level (5) | FCN-3-2 | Cab Tilt Down Switch (1) |
| CAN69-1-8 | Charge Filter 1 Alarm (5)<br>(Prior to S/N 18001082)<br>Return Filter 2 Alarm<br>(S/N 18001082 and Newer) | FCN-3-8 | A/C Compressor Switch - On (1) |
| CAN69-1-128 | Maximum Boom Angle Limit Switch (5 | FCN-3-32 | Engine Start (1) |
| CAN71-1-128 | Drum 1 Minimum Bail Limit Switch (8) | FCN-3-64 | Crane Mode Select Switch (1) |
| CAN132-6-64 | Block Up Limit Luffing/Jib Lower Pt. (#44) (21) | FCN-3-128 | Drum 4 Park Switch - On (1) |
| CAN132-6-128 | Block Up Limit Luffing/Jib Upper Pt. (#44) (21) | FCN-4-8 | Travel 2-Speed Switch (1) |
| CAN135-6-64 | Block Up Limit Luffing/Jib Lower Pt. (#79A) (21) | FCN-4-32 | Swing Park Brake - On (1) |
| CAN135-6-128 | Block Up Limit Luffing/Jib Upper Pt. (#79A) (21) | FCN-4-64 | RCL Mode Select Switch (1) |
| CAN136-6-64 | Block Up Limit Boom Lower Point (20) | FCN-4-128 | Drum 3 Park Switch - On (1) |
| CAN136-6-128 | Block Up Limit Boom Upper Point (20) | | |

**Table 3-12 Digital Outputs**

| CAN Packet Number | Item Description (Node Number) |
|---|---|
| CAN32-1-1 | Cab Base RCL Beacon/Alarm (2) |
| CAN32-1-2 | Handle A Rotation Indicator (2) |
| CAN32-1-4 | Handle C Rotation Indicator (2) |
| CAN32-1-8 | Front Wiper Switch (2) |
| CAN32-1-16 | Overhead Wiper Switch (2) |
| CAN32-1-32 | Handle D Rotation Indicator (2) |
| CAN32-1-64 | Handle B Rotation Indicator (2) |
| CAN32-1-128 | Handle Displays (2) |
| CAN32-2-1 | Power to Switches 3 (2) |
| CAN32-2-2 | Handle D Lower Direction (2) |
| CAN32-2-4 | Right Travel Handle Reverse Direction (2) |
| CAN32-2-16 | Power to Switches 1 (2) |
| CAN32-2-32 | Left Travel Handle Forward Direction (2) |
| CAN32-2-64 | Left Travel Handle Reverse Direction (2) |
| CAN32-2-128 | Power to Switches 2/Seat Switch (2) |
| CAN32-3-1 | Right Travel Handle Forward Direction (2) |
| CAN32-3-2 | Handle D Raise Direction (2) |
| CAN32-3-4 | Handle B Raise Direction (2) |
| CAN32-3-8 | Handle B Lower Direction (2) |
| CAN32-3-16 | Travel Cruise Switch (2) |
| CAN32-3-32 | Handle C Raise Direction (2) |
| CAN32-3-64 | Foot Throttle Output (2) |
| CAN33-3-32 | Swing 1 Pump Control - Right (3) |
| CAN34-1-2 | Drum 5 Brake Solenoid (6) |
| CAN34-1-4 | Drum 5 Pawl Out Solenoid (6) |
| CAN34-1-8 | Drum 5 Pawl In Solenoid (6) |
| CAN34-1-64 | Drum 2 Motor Control 1 (6) |
| CAN34-1-128 | Drum 2 Motor Control 2 (6) |
| CAN34-2-1 | Drum 2 Brake Solenoid (6) |
| CAN34-2-4 | Rear Adapter Frame Pins Engage (6) |
| CAN34-2-8 | Rear Adapter Frame Pins Disengage (6) |
| CAN34-2-16 | Front Adapter Frame Pins Engage (6) |
| CAN34-2-32 | Front Adapter Frame Pins disengage (6) |
| CAN34-3-4 | Drum 4 Pawl In Motor (6) |
| CAN34-3-8 | Drum 4 Pawl Out Motor (6) |
| CAN34-3-16 | Drum 4 Motor Control 1 (6) |
| CAN34-3-32 | Drum 4 Motor Control 2 (6) |
| CAN34-3-64 | Drum 4 Brake Solenoid (6) |
| CAN35-1-1 | Mast Pins Engage Solenoid (4) |
| CAN35-1-2 | Mast Pins Disengage Solenoid (4) |
| CAN35-1-4 | Boom Pins Engage Solenoid (4) |
| CAN35-1-8 | Boom Pins Disengage Solenoid (4) |
| CAN35-1-16 | Cab Tilt - Down Solenoid (4) |
| CAN35-1-32 | Cab Tilt - Up Solenoid (4) |
| CAN35-1-64 | Drum 3 Diverter Solenoid (4) |
| CAN32-3-128 | Handle C Lower Direction (2) |
| CAN33-1-1 | Accessory Hydraulic Pressure (3) |
| CAN33-1-2 | Drum 2/5 Pressure Sender (3) |
| CAN33-1-4 | Drum 1/3 Pressure Sender (3) |
| CAN33-1-8 | Accessory System Pressure Sender (3) |
| CAN33-1-16 | Left Track Pressure Sender (3) |
| CAN33-1-32 | Right Track Pressure Sender (3) |
| CAN33-1-64 | Drum 3 Motor Control (3) |
| CAN33-1-128 | Drum 3 Brake Solenoid (3) |
| CAN33-2-1 | Pump Drive Cooler Pressure (3) |
| CAN33-2-2 | Drum 3 Minimum Bail Limit Switch (3) |
| CAN33-2-4 | Drum 1/3 Pump Control - Raise (3) |
| CAN33-2-8 | Drum 1/3 Pump Control - Lower (3) |
| CAN33-2-16 | Drum 2/5 Pump Control - Raise (3) |
| CAN33-2-32 | Drum 2/5 Pump Control - Lower (3) |
| CAN33-2-64 | Drum 2 Pump Control - Lower (3) |
| CAN33-2-128 | Drum 2 Pump Control - Raise (3) |
| CAN33-3-1 | Drum 1/3 (opt.) Pump Control - Raise (3) |
| CAN33-3-2 | Drum 1/3 (opt.) Pump Control - Lower (3) |
| CAN33-3-4 | Left Track Pump Control - Forward (3) |
| CAN33-3-8 | Left Track Pump Control - Reverse (3) |
| CAN33-3-16 | Swing 1 Pump Control - Left (3) |
| CAN37-1-32 | CWT Right Cylinder - Extend Solenoid (9) |
| CAN37-1-64 | Power to MAX-ER Remote Control (9) |
| CAN37-1-128 | Power to MAX-ER Remote Control (9) |
| CAN37-2-1 | Power to MAX-ER Remote Control (9) |
| CAN37-2-2 | Power to MAX-ER Remote Control (9) |
| CAN38-1-1 | Hydraulic Vacuum Switch (5) |
| CAN38-1-2 | Hydraulic Fluid Level/Charge Filter 1 Alarm (5) (Prior to S/N 18001082).<br>Hydraulic Fluid Level/Return Filter 2 Alarm (S/N 18001082 and newer). |
| CAN38-1-4 | Hydraulic Fluid Low Temperature Switch (5) |
| CAN38-1-8 | Charge Filter 2 Alarm (5) (Pr or to S/N 18001082).<br>Return Filter 3 Alarm (S/N 18001082 and newer). |
| CAN38-1-16 | Hydraulic Fluid High Temperature Switch (5) |
| CAN38-1-32 | Return Filter Alarm Switch (5) |
| CAN38-1-64 | Drum 6 Pressure Sender (5) |
| CAN38-1-128 | Drum 4 Pressure Sender (5) |
| CAN38-2-1 | Hydraulic Pumps Case Heat(5) |
| CAN38-2-2 | Swing/Travel Alarm (5) |
| CAN38-2-4 | Right Track Pump Control - Forward (5) |
| CAN38-2-8 | Right Track Pump Control - Reverse (5) |
| CAN38-2-16 | Drum 6 Pump Control -Raise (5) |
| CAN38-2-32 | Drum 6 Pump Control - Lower (5) |
| CAN38-2-128 | Pump Drive Cooler 1 (5) |
| CAN38-3-1 | Drum 4A Pump Control -Raise (5) |
| CAN38-3-2 | Drum 4A Pump Control -Lower (5) |
| CAN38-3-4 | Drum 4B Pump Control -Raise (5) |

| CAN Packet Number | Item Description (Node Number) | CAN Packet Number | Item Description (Node Number) |
|---|---|---|---|
| CAN35-1-128 | Drum 5 Diverter Solenoid (4) | CAN38-3-8 | Drum 4B Pump Control -Lower (5) |
| CAN35-2-1 | Mast Raise Solenoid (4) | CAN38-3-16 | Swing 2 (optional) Pump Control - Left (5) |
| CAN35-2-2 | Mast Lower Solenoid (4) | CAN38-3-32 | Swing 2 (optional) Pump Control - Right (5) |
| CAN35-2-4 | Drum 7 Payout Solenoid (4) | CAN38-3-64 | Pump Drive Cooler 2 (5) |
| CAN35-2-8 | Drum 7 Haul In Solenoid (4) | CAN38-3-128 | Accessory System Proportional Solenoid (5) |
| CAN35-2-16 | Right Front Jack Extend Solenoid (4) | CAN39-1-64 | Drum 1 Motor Control 1 (8) |
| CAN35-2-32 | Right Front Jack Retract Solenoid (4) | CAN39-1-128 | Drum 1 Motor Control 2 (8) |
| CAN35-2-64 | Left Front Jack Retract Solenoid (4) | CAN39-2-1 | Drum 1 Brake Solenoid (8) |
| CAN35-2-128 | Left Front Jack Extend Solenoid (4) | CAN39-2-2 | Drum 1 Minimum Bail Limit Switch (8) |
| CAN35-3-4 | Right Rear Jack Extend Solenoid (4) | CAN39-2-4 | Drum 6 Pawl Motor Control (8) |
| CAN35-3-8 | Right Rear Jack Retract Solenoid (4) | CAN39-2-8 | Drum 6 Brake Solenoid (8) |
| CAN35-3-16 | Left Rear Jack Extend Solenoid (4) | CAN39-2-16 | Drum 6 Pawl In Motor (8) |
| CAN35-3-32 | Right Rear Jack Retract Solenoid (4) | CAN39-2-32 | Drum 6 Pawl Out Motor (8) |
| CAN36-1-64 | Swing Left Pressure Sender (7) | | |
| CAN36-1-128 | Swing Right Pressure Sender (7) | FCN-5-1 | Operating Limit Alarm (Beeper) and L.E.D. (1) |
| CAN36-2-2 | Accessory System Hydraulic Pressure Sw. (7) | FCN-5-4 | RCL Warning L.E.D. (1) |
| CAN36-2-4 | Swing Brake Solenoid (7) | FCN-5-32 | RCL Caution L.E.D. (1) |
| CAN36-2-8 | Swing Lock Out Solenoid (7) | FCN-5-64 | RCL Fault Alarm in Cab (1) |
| CAN36-2-16 | Swing Lock In Solenoid (7) | FCN-5-128 | System Fault Alarm (Buzzer) and L.E.D. (1) |
| CAN36-2-32 | Travel 2-Speed Solenoid (7) | FCN-6-2 | Handle B Display (1) |
| CAN36-3-4 | Travel Brake Solenoid (7) | FCN-6-4 | Engine Diagnostics (Red L.E.D.) (1) |
| CAN36-3-8 | Track Auto Lube Solenoid (7) | FCN-6-8 | Handle D Display (1) |
| CAN36-3-16 | Swing Bearing Auto Lube Solenoid (7) | FCN-6-16 | Handle A Display (1) |
| CAN37-1-2 | CWT Left Cylinder - Retract Solenoid (9) | FCN-6-32 | Engine Diagnostics (White L.E.D.) (1) |
| CAN37-1-4 | Counterweight Limit Switch (9) | FCN-6-64 | Handle C Display (1) |
| CAN37-1-8 | CWT Right Cylinder - Retract Solenoid (9) | FCN-6-128 | Engine Diagnostics (Amber L.E.D.) (1) |
| CAN37-1-16 | CWT Left Cylinder - Extend Solenoid (9) | | |

**Table 3-13 Bank Identifier Numbers**

| | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
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Dark shaded boxes indicate ON; white boxes OFF.

**Table 3-13** **Bank Identifier Numbers** (continued)

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Dark shaded boxes indicate ON; white boxes OFF.

**Table 3-13 Bank Identifier Numbers** (continued)

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**Table 3-13 Bank Identifier Numbers** (continued)

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# SECTION 4
# BOOM

## TABLE OF CONTENTS

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# SECTION 4
# BOOM

## AUTOMATIC BOOM STOP ADJUSTMENT

### Maximum Operating Angles

Boom stop limit switch (5, Figure 4-2) automatically stops the boom and applies the boom hoist brake when the boom is raised to ***Angle A*** (see Figure 4-1 and Table 4-1).

### Operation

See Figure 4-2 for the following description.

**NOTE:** All reference to LED is past production only.

When the boom is below the maximum angle, limit switch (5) is closed and its LED (light-emitting diode) is ON (View B). The boom hoist can be operated.

When the boom is raised to the maximum angle, boom butt (1) pushes adjusting rod (2a or 2b) in and actuator rod (11, View A) opens limit switch (5). The LED then goes OFF. Boom hoist operation stops automatically because the open limit switch turns off power to the boom hoist electric circuit. The boom hoist pump shifts to neutral and the brake applies to stop boom movement.

**WARNING**

**Falling Attachment Hazard!**

If boom fails to stop for any reason, stop engine immediately. Troubleshoot system to determine problem.

Do not resume operation until problem has been corrected.

### Maintenance

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

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

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

**WARNING**

**Falling Attachment Hazard!**

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

**Table 4-1 —** Automatic Boom Stop Angles

| Angle A (see Figure 4-1) | Attachment |
|---|---|
| 83° [1] | #55-79A, #55, or 55A Boom without Luffing Jib |
| OR | |
| 84° [2] | #55-79A, #55, or 55A Boom without Luffing Jib |
| **When Boom Up Limit *Can be Bypassed* *** | |
| 85° | #44 or 79A Luffing Jib on 140 – 180 ft (42,7 – 54,9 m) of Boom |
| 87° | #44 or 79A Luffing Jib on 200 – 340 ft (61,0 – 103,6) of Boom |
| **When Boom Up Limit *Cannot be Bypassed* *** | |
| 86° | #44 or 79A Luffing Jib on 140 – 180 ft (42,7 – 54,9 m) of Boom |
| 88° | #44 or 79A Luffing Jib on 200 – 340 ft (61,0 – 103,6) of Boom |

***** To determine if the boom up limit on you crane can be bypassed or not, perform Bypass Limit Test given below.

[1]: Past production with 4-3/4 in (121 mm) long adjusting rod.

[2]: Current production with 4-1/2 in (114 mm) long adjusting rod.

## Bypass Limit Test

Perform the following test to determine if the boom up limit on your crane can be bypassed or not.

**WARNING**

**Crush Hazard!**

Maintain constant communication between operator and assistant during the following steps.

Stay clear of moving parts.

1. Lower the boom onto blocking at ground level.
2. Have an assistant push adjusting rod (2a or 2b Figure 4-2) in to trip the boom stop limit switch open.
3. Rotate the limit bypass key (in crane cab) to the bypass position and hold.
4. Try to boom up — do not raise the boom any higher than necessary to perform the test:
   - **a.** If the boom rises, your boom up limit ***can be bypassed***.
   - **b.** If the boom does not rise, your boom up limit ***cannot be bypassed***.
5. The test is complete. Release the limit bypass key and the adjusting rod to the normal operating positions.





Manitowoc

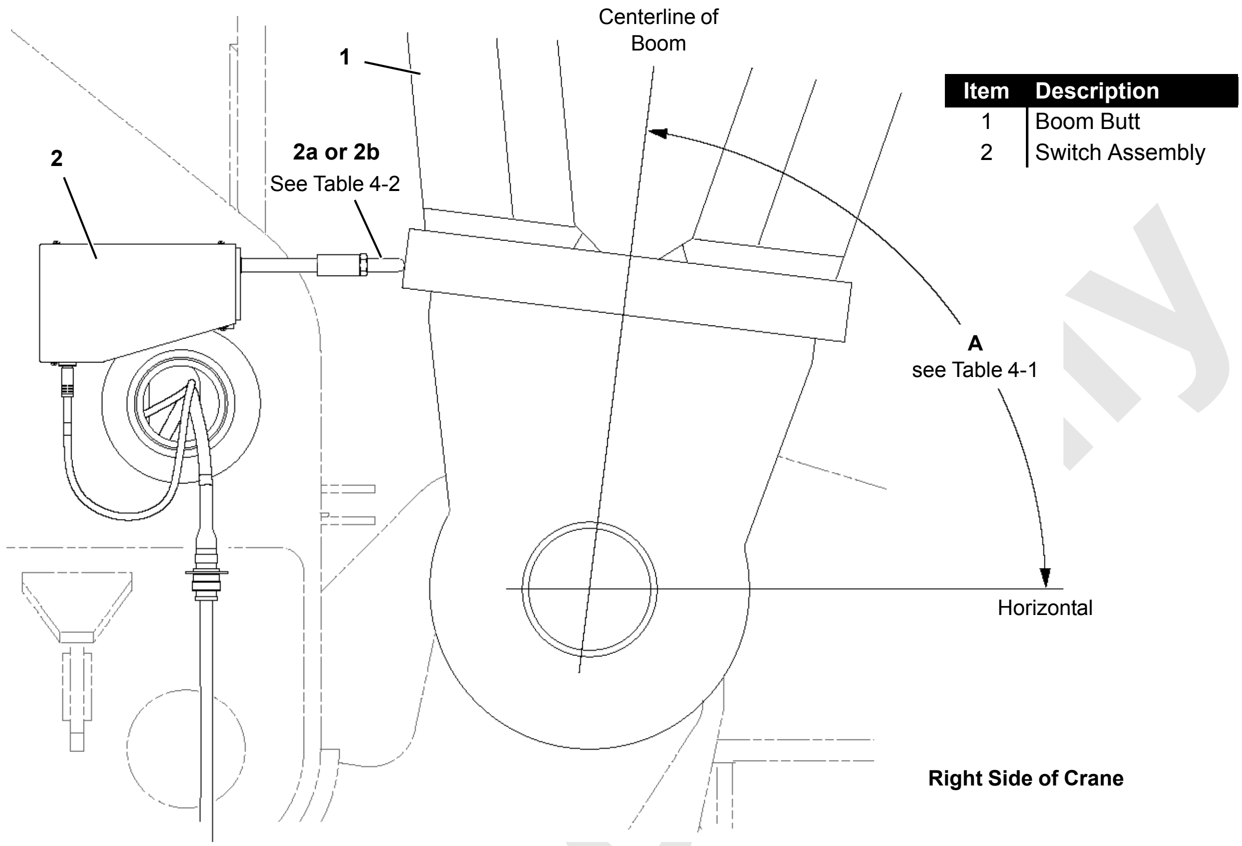
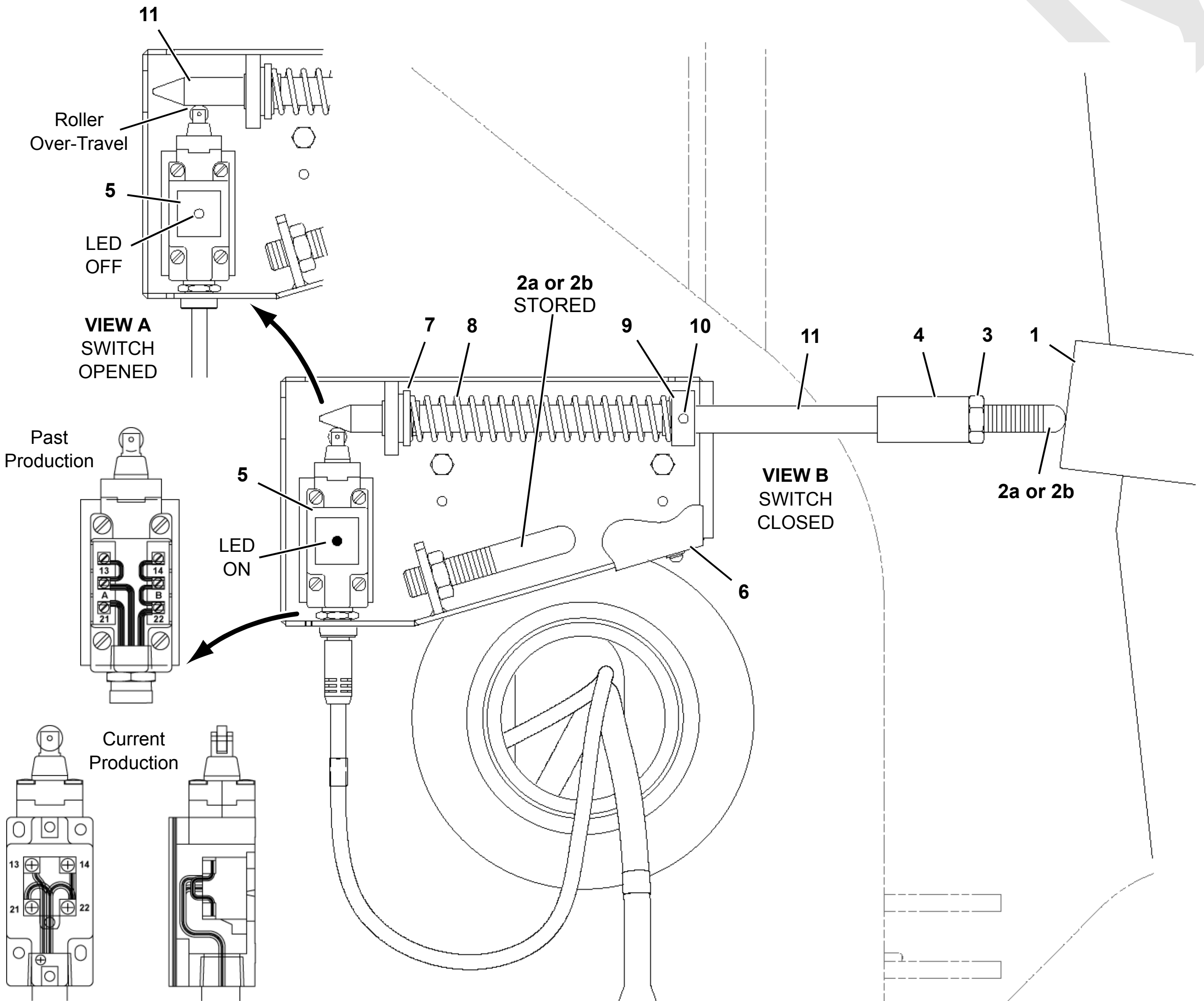



FIGURE 4-1

**Table 4-2 —** Adjusting Rods

| Adjusting Rod Length | |
|---|---|
| **2a**<br>Boom Only | **2b**<br>With Luffing Jib |
| **When Boom Up Limit *Can be Bypassed*** | |
| 4-3/4 in (121 mm) for 83°<br>4-1/2 in (114 mm) for 84° | 3-3/4 in (83 mm) |
| **When Boom Up Limit *Cannot be Bypassed*** | |
| 4-3/4 in (121 mm) for 83°<br>4-1/2 in (114 mm) for 84° | 3-1/4 in (83 mm) |

| Item | Description | Item | Description |
|---|---|---|---|
| 1 | Boom Butt | 7 | Spring Washer |
| 2a | Adjusting Rod – Boom only | 8 | Spring |
| 2b | Adjusting Rod – Boom with Luffing Jib (see Table 4-2) | 9 | Spring Washer |
| 3 | Jam Nut | 10 | Dowel Pin 1/4 in (6,35 mm) Diameter |
| 4 | Coupling | 11 | Actuator Rod |
| 5 | Limit Switch | 12 | Digital Level (see Figure 4-5) |
| 6 | Cover | | |




**Limit Switch Wiring Past Production**

| Receptacle | Switch Terminals | | | Function |
|---|---|---|---|---|
| 1 (green) | 22 | B | 14 | Max Angle |
| 2 (black) | A | 13 | | LED |
| 3 (white) | 21 | | | 12 VDC Supply |

**Limit Switch Wiring Current Production**

| Receptacle | Switch Terminals | | | Function |
|---|---|---|---|---|
| 1 (green) | 22 | | 14 | Max Angle |
| 2 (black) | | 13 | | LED |
| 3 (white) | 21 | | | 12 VDC Supply |

**FIGURE 4-2**

| Boom Stop Angle | Digital Level Angle |
|---|---|
| 83° | 70.7° |
| 84° | 71.7° |
| 85° | 72.7° |
| 86° | 73.7° |
| 87° | 74.7° |
| 88° | 75.7° |

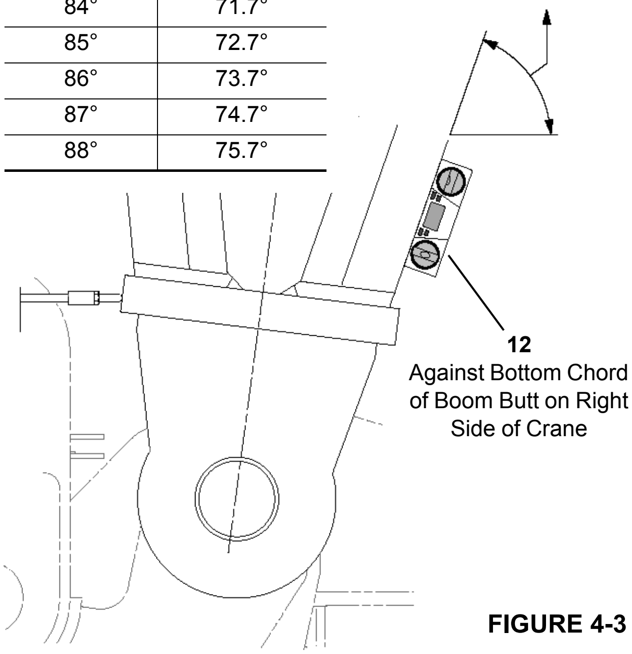



FIGURE 4-3

## Adjustment

**NOTE:** All reference to LED is past production only.

1. Park the crane on a firm level surface or level the crane by blocking under the crawlers.
2. Make sure the proper adjusting rod is installed (see Table 4-2):
   - Rod (2a) for BOOM ONLY
   - Rod (2b) for boom WITH LUFFING JIB
3. Raise the boom to specified **Angle A** (Figure 4-1) while monitoring the angle on the mechanical indicator or on the operating conditions screen of the front-console display.
4. Verify that the boom is at the proper Angle A:
   a. Place an accurate digital level (12) on the boom butt as shown in Figure 4-3. The corresponding **Digital Level Angle** should appear on the digital level.
   b. Raise or lower the boom as necessary.
5. If the boom stops at the specified angle, further adjustment is not needed.
   - 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 4-2 for the remaining steps.

6. If the boom stops before reaching the specified angle:
   a. Loosen jam nut (3, View B).
   b. Turn adjusting rod (2a or 2b) all the way into coupling (4).
   c. Boom up slowly until the boom the reaches specified angle.
   d. Turn adjusting rod (2a or 2b) out against boom butt (1) until limit switch (5) “clicks” open and the LED is OFF (View A).
   e. Tighten jam nut (3).
7. If the boom reaches the specified angle before it stops:
   a. Loosen jam nut (3, View B).
   b. Turn adjusting rod (2a or 2b) out against boom butt (1) until limit switch (5) “clicks” open and the LED is OFF (View A).
   c. Tighten jam nut (3).
8. Check that actuator rod (11) over-travels the limit switch as shown in View A.
9. Test the adjustment as follows:
   a. Lower the boom several degrees below 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:
      - Stop raising the boom (move control handle to off).
      - Lower the boom several degrees below the specified angle.
   d. Repeat adjustment steps 2 through 9.

## Actuator Rod Replacement

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

1. Remove damaged actuator rod (11).
2. Slide spring washers (7 and 9) and spring (8) over new actuator rod (11) while sliding the actuator rod into the bracket assembly.
3. Position actuator rod (11) so the tapered end just touches 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 (11).
5. Install dowel pin (10).
6. Install proper adjusting rod (2a or 2b).

7. Adjust the boom stop.

## PHYSICAL BOOM STOP

**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.

### *General*

The physical boom stops (Figure 4-4):

- Assist in stopping the boom smoothly at any angle above 77°
- Assist in preventing the boom rigging from pulling the boom back when traveling or setting loads with the boom at any angle above 77°
- Assist in moving the boom forward when lowering the boom from any angle above 77°
- Provide a physical stop at 89 °

### *Operation*

See Figure 4-4 for the following procedure.

1. When boom is raised to 77°, springs in boom stop tubes begin to compress.
2. As boom is raised higher, spring compression increases to exert greater force against boom.
3. If for any reason boom is raised to 89°, boom stop springs fully compress to provide a physical stop.

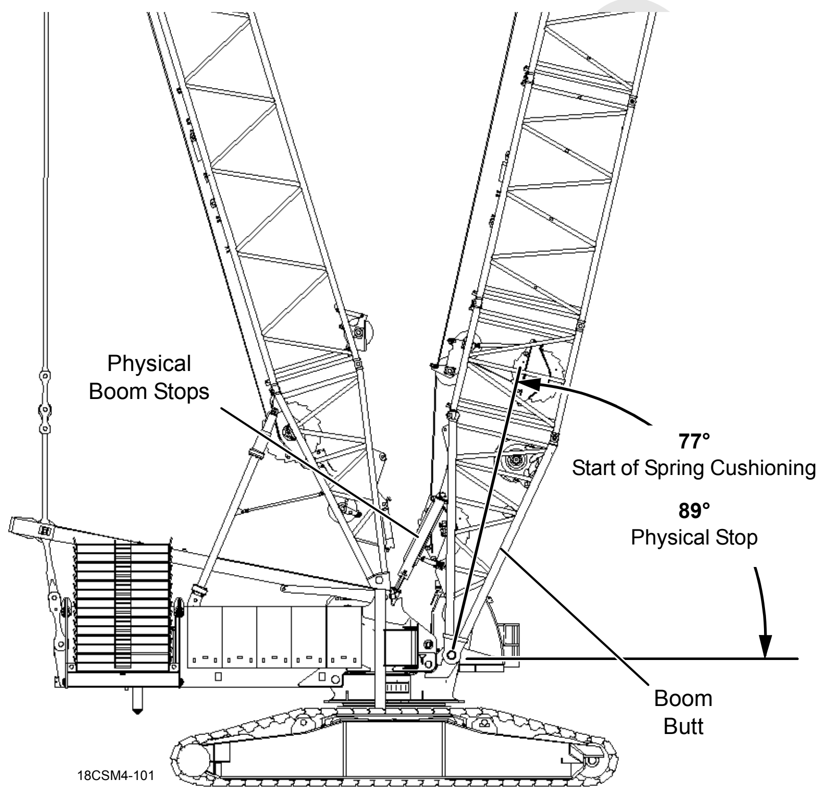


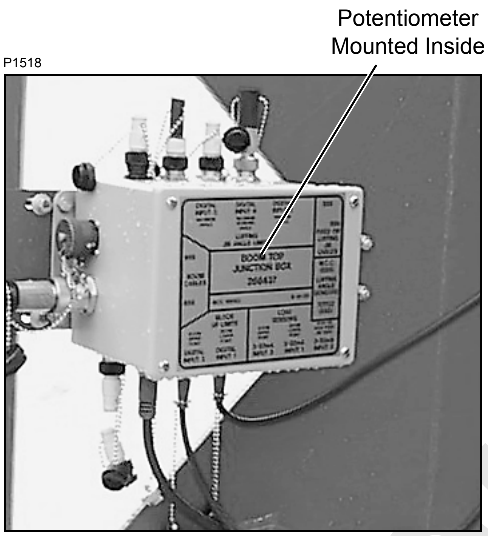

**FIGURE 4-4**

# BOOM AND LUFFING JIB ANGLE INDICATOR CALIBRATION

The subject cranes do not have an angle indicator junction box mounted on the boom butt or on the luffing jib butt like other cranes manufactured by Manitowoc.

The angle indicator potentiometers are located inside the node controllers mounted on the boom top and on the luffing jib top.

The boom and luffing jib angles are calibrated automatically by the crane's programmable controller as part of the load indicator calibration procedure (see separate Rated Capacity Indicator/Limiter Manual for instructions).




**Typical Node Controller Installation on Boom or Luffing Jib Top**

**FIGURE 4-5**

# MAST ANGLE INDICATOR ADJUSTMENT

## Mast Angle Indicator

The mast angle sending unit (Figure 4-6) houses a pendulum-type 120° potentiometer (Figure 4-7) which provides a digital electronic input to the crane's programmable controller. The programmable controller uses the signal for the following purposes:

- Automatically control the position of the mast raising cylinder and levers during crane setup
- Allow the operator to monitor the mast angle on the digital display during crane setup

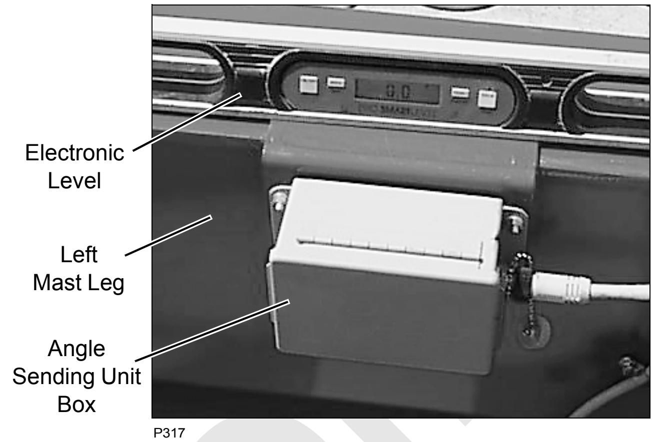



**FIGURE 4-6**

### *Adjusting Angle*

Perform the following adjustment steps at initial installation, after installing a new sending unit or potentiometer, and during assembly. Mast angle should be 0° when mast is fully lowered to the rear (transport position).

**NOTE:** Mast must be in transport position when checking or adjusting angle indicator.

1. Park crane on a solid, level surface
2. Lower mast to transport position
3. Place an electronic level on mast (Figure 4-6)
4. Record angle indicated on level
5. Scroll to angle on digital display in operator's cab
6. Angle shown on digital display must match angle recorded in step 4 plus or minus one degree
7. If necessary, loosen mounting screws and rotate sending unit box in mounting slots until reading on digital display matches angle on level.
8. Securely tighten mounting screws to lock adjustment

### *Sending Unit Assembly*

Replacement sending units can be either the pendulum-type 120° potentiometer (past production) or solid state sensor (current production).

#### Pendulum-type 120° Potentiometer

When replacing parts in the pendulum-type potentiometer sending unit, take the following precautions (see Figure 4-7, View A):

1. Mount potentiometer at angle shown.
2. Connect black, green, and white wires from receptacle to proper terminals on terminal strip.

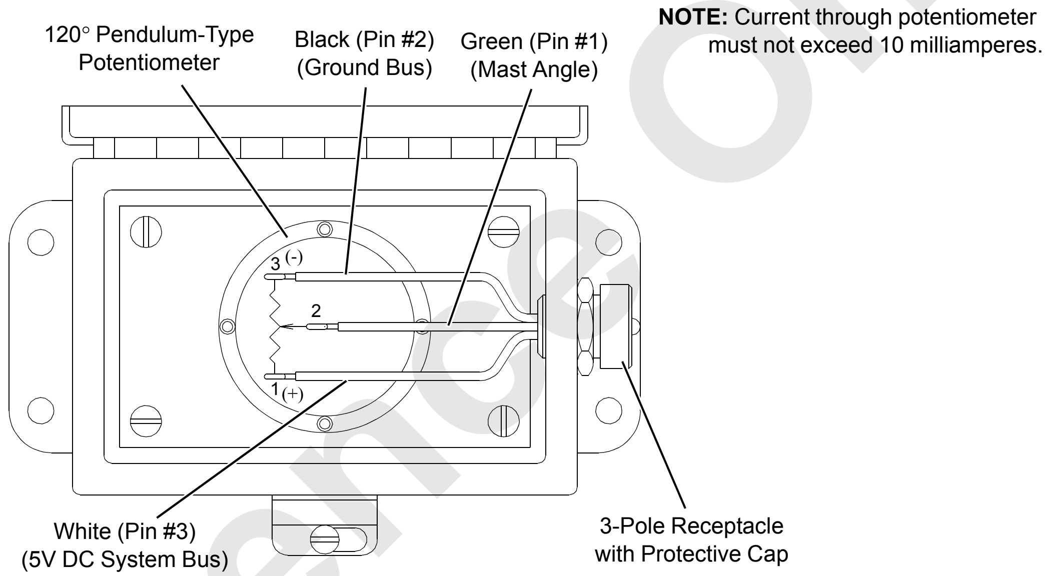
3. Connect wires from potentiometer to proper terminals on terminal strip.
4. Make sure all parts are securely fastened to their mounting position.

### Solid State Sensor

When replacing existing pendulum-type potentiometer with current production solid state sensor, take the following precautions (see Figure 4-7, View B):

1. Identify all input wires to existing potentiometer.
2. Cut existing input wires near terminal strip (if used) to allow for splicing.
3. Remove existing potentiometer and terminal strip (if used).
4. Mount new sensor in existing holes as shown in View B.
5. Refer to wiring chart in View B and parallel splice sensor wires to existing input wires with crimp, solder, and heat shrink tubing.
6. Seal green wire on sensor with heat shrink tubing and coil up.

18CSM4-105

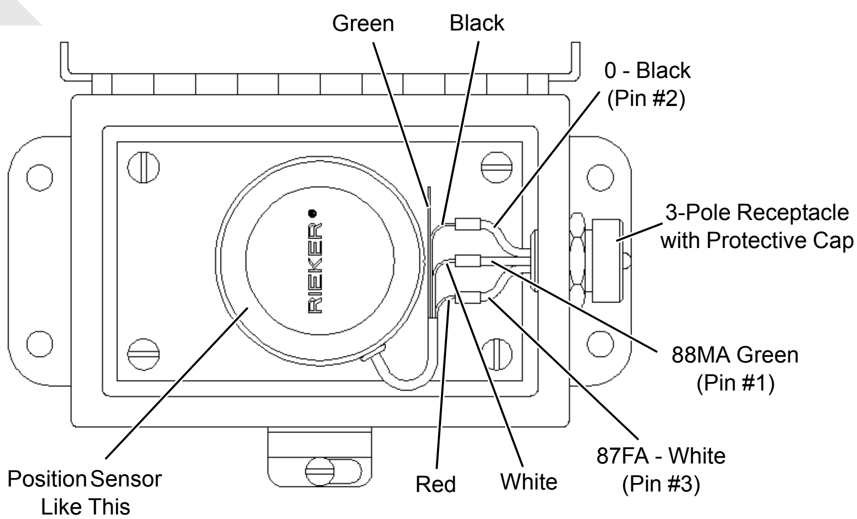



**VIEW A**

18CSM4-106

Solid State Sensor (+/-100°)
M.C.C. #A13335
Vendor #CS17

| Input Wires From | Sensor Wires To | Operation Code |
|---|---|---|
| Black | Black | Ground |
| Green | Green | Signal |
| White | Red | 10 Volts DC |
| | White | N/C |




**VIEW B**

**FIGURE 4-7**

## STRAP INSPECTION AND MAINTENANCE

This section is a guide to crane owners for properly inspecting and maintaining straps in the field. It is impossible to predict whether or when a strap may fail. Frequent and periodic inspections can help reveal potential for failure. Straps are to be inspected regularly by a ***qualified person*** as part of crane's preventive maintenance program. Dated records should also be kept.

***Strap repairs are prohibited***. Perform only the maintenance indicated in this section. For inspection procedures not covered in this Service/Maintenance Manual, contact your dealer or the Manitowoc Crane Care Lattice Team.

**WARNING**

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

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

### Inspection

Regular inspection of all straps is necessary to assure that crane can lift its rated load. If a strap fails, boom or other attachment can collapse. All inspections must be performed by a qualified appointed inspector at 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 boom and/or jib has come into contact with another object (for example, power lines, building, another crane)
- If boom or jib has been struck by lightning

#### *Frequent Inspection*

Visually inspect all straps once each work shift for obvious damage which poses an immediate hazard. Pay particular attention to areas where wear and other damage is likely to occur. Look for straps that are disconnected, loose or sagging excessively and for distortion such as kinking or twisting. If any strap looks like it is damaged, strap must be checked to make sure it is within specifications given in this section.

#### *Periodic Inspection*

Periodic inspection must be performed at least monthly. During this inspection, entire length of strap must be inspected to assure that it is within specifications. ***Strap must be within all specifications identified in this section***. Any damage found must be recorded and a determination made as to whether continued use of strap is safe.

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

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

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

#### *Cranes Not In Regular Use*

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

### Identifying Straps

To aid in identification, part number is stamped into both ends of each strap as shown in Figure 4-8.

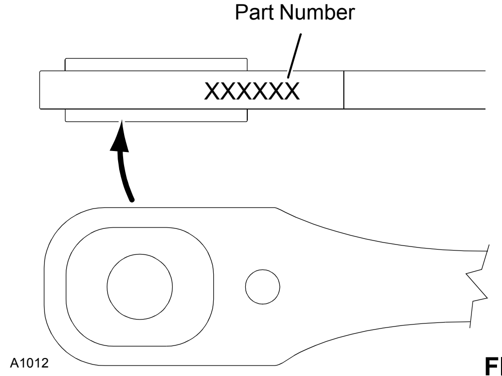



**FIGURE 4-8**

## Replacement Specifications

Any strap not within specifications listed in Table 4-3 must be replaced.

### WARNING

If damage to strap exceeds that allowed within specification, do not operate crane until strap has been replaced.

Operating crane with a damaged strap can cause structural failure or collapse of boom, jib, mast, or other crane components.

**Table 4-3**
**Strap Specifications**

| Condition | Reference | Allowable Tolerance or Deviation | Corrective Action |
|---|---|---|---|
| Dent | Figure 4-9 | < 0.12 in (3,175 mm) | Monitor condition. |
| | | ≥ 0.12 in (3,175 mm) | Remove strap from service. |
| Kink | Figure 4-10 | None | Remove strap from service. |
| Crack or Break | Figure 4-11 | None | Remove strap from service. |
| Corrosion or Abrasion | Figure 4-12 | <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 4-13 | Varies depending on strap length | Remove strap from service if deviation exceeds maximum allowed. |
| Flatness (includes twisted straps) | Figure 4-14 | Varies depending on strap length. | Remove strap from service if deviation exceeds maximum allowed. |
| Elongated Holes | Figure 4-15 | None | Remove strap from service. |
| Length | Figure 4-16 | None | Remove strap from service. |

< = less than
≥ = equal to or greater than

**Dent**

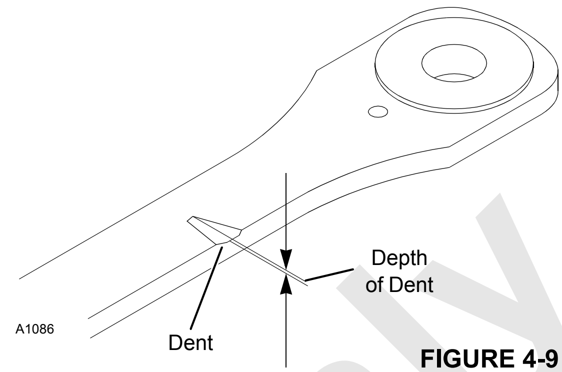



**FIGURE 4-9**

**Kink**

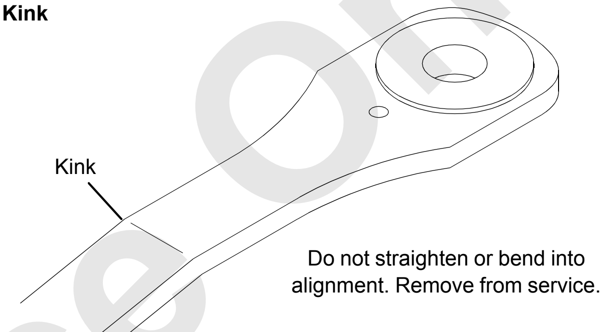



**FIGURE 4-10**

**Crack Or Break**

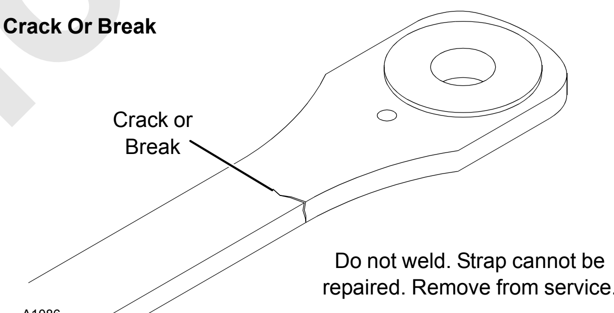



**FIGURE 4-11**

### *Corrosion Or Abrasion*

See Figure 4-12 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.

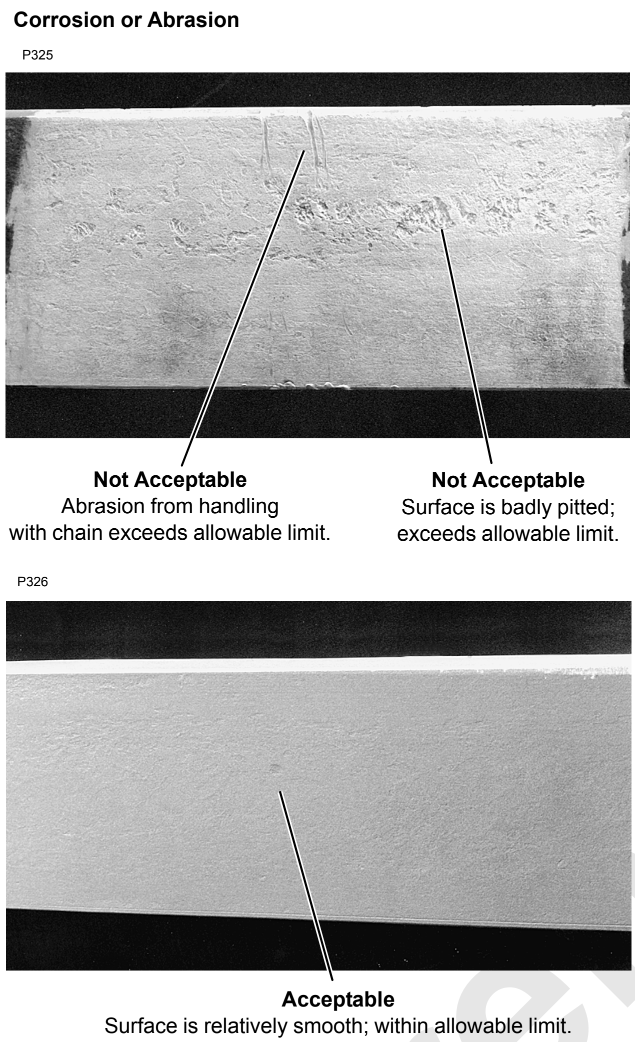



FIGURE 4-12

### *Straightness*

See Figure 4-13 for the following procedure.

1. Stretch a line (string or wire) from pin storage hole at one end of strap.
2. Stretch line as tight as possible and tie it off at other end.
3. Mark strap center line. ***Do not use center punch!***
4. If string does not align with center line, measure distance from center line to line.

If deviation from straight is greater than maximum allowed, remove strap from service.

| Strap Length (L) | Maximum Deviation Allowed |
|---|---|
| 5 to <10 ft (1.5 to <3,0 m) | 0.060 in (1,5 mm) |
| 10 to <20 ft (3.0 to <6,1 m) | 0.125 in (3,2 mm) |
| 20 to <30 ft (6,1 to <9,1 m) | 0.250 in (6,4 mm) |
| 30 to <40 ft (9,1 to <12,2 m) | 0.375 in (9,5 mm) |
| 40 to <50 ft (12,2 to <15,2 m) | 0.50 in (12,7 mm) |
| < = less than | |

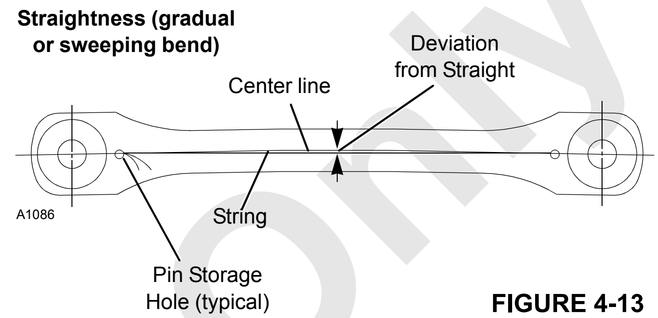



FIGURE 4-13

### *Flatness*

See Figure 4-14 for the following procedure.

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

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

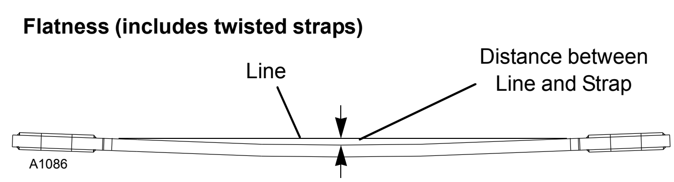



FIGURE 4-14

### *Elongated Hole*

See Figure 4-15 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).





4

3. Push pin tight against edge of hole along vertical center line. Measure dimension between pin and hole (View B).

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

   If two dimensions are identical, but greater than 0.030 in (0,8 mm), contact factory Service Department.

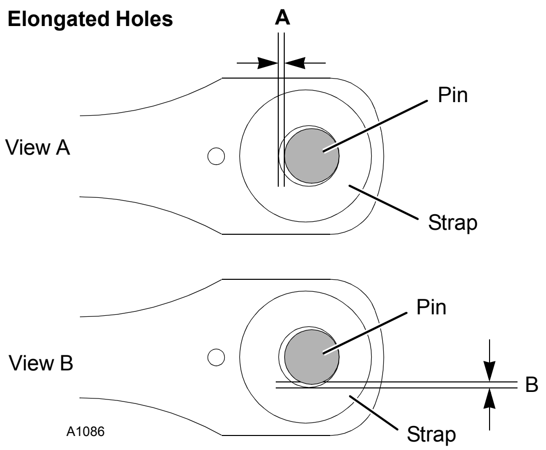
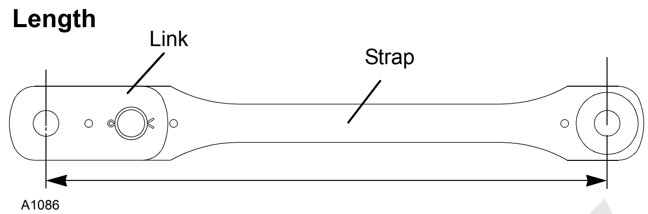



FIGURE 4-15

| Strap Length (L) ft (m) | Maximum Deviation Allowed | |
|---|---|---|
| | 1 to <2 in (25.4 to <50.8 mm) Thick | 2 to <4 in (50.8 to <101.6 mm) Thick |
| <3 (<0,9) | 0.17 (4,3) | 0.50 (12,7) |
| 3 to <4 (0,9 to <1,2) | 0.63 (15,9) | 0.56 (14,3) |
| 4 to <5 (1,2 to <1,5) | 0.75 (19,1) | 0.70 (17,5) |
| 5 to <6 (1,5 to <1,8) | 0.80 (20,6) | 0.75 (19,1) |
| 6 to <7 (1,8 to <2,1) | 0.88 (22,2) | 0.75 (19,1) |
| 7 to <8 (2,1 to <2,4) | 0.94 (23,8) | 0.75 (19,1) |
| 8 to <9 (2,4 to <2,7) | 1.0 (25,4) | 0.75 (19,1) |
| 9 to <10 (2,7 to <3,0) | 1.0 (25,4) | 0.88 (22,2) |
| 10 to <12 (3,0 to <3,7) | 1.0 (25,4) | 1.0 (25,4) |
| ≥12 (≥3,7) | Deviation not to exceed 1 in (25,4 mm) in any 12 ft (3,7 m) length of strap | |

< = less than

≥ = equal to or greater than




Measure to check length. See appropriate Rigging Drawing in Operator Manual for original length. Strap length includes connecting link. If change in length is detected, remove strap from service.

FIGURE 4-16

## Storing Straps

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

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

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

## Removing Straps from Service

Straps removed from service should be clearly marked to prevent accidental future use. Rendering the strap useless in some way, such as cutting off an end, is recommended.

## Inspection Checklist

A Strap Inspection Checklist is provided at the end of this section. The checklist can be reproduced as needed.

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

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



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## STRAP INSPECTION CHECKLIST

**Inspector's Name** ________________ **Signature** ________________ **Date** __________

Length __________ mm (ft) Part Number ________________

| | | | | |
|---|---|---|---|---|
| ☐ Dents | ☐ Kinks | ☐ Cracks | ☐ Breaks | ☐ Corrosion |
| ☐ Abrasion | ☐ Length | ☐ Straightness | ☐ Flatness | ☐ Elongated Holes |
| ☐ Other ________________ | | | | |

Length __________ mm (ft) Part Number ________________

| | | | | |
|---|---|---|---|---|
| ☐ Dents | ☐ Kinks | ☐ Cracks | ☐ Breaks | ☐ Corrosion |
| ☐ Abrasion | ☐ Length | ☐ Straightness | ☐ Flatness | ☐ Elongated Holes |
| ☐ Other ________________ | | | | |

Length __________ mm (ft) Part Number ________________

| | | | | |
|---|---|---|---|---|
| ☐ Dents | ☐ Kinks | ☐ Cracks | ☐ Breaks | ☐ Corrosion |
| ☐ Abrasion | ☐ Length | ☐ Straightness | ☐ Flatness | ☐ Elongated Holes |
| ☐ Other ________________ | | | | |

Length __________ mm (ft) Part Number ________________

| | | | | |
|---|---|---|---|---|
| ☐ Dents | ☐ Kinks | ☐ Cracks | ☐ Breaks | ☐ Corrosion |
| ☐ Abrasion | ☐ Length | ☐ Straightness | ☐ Flatness | ☐ Elongated Holes |
| ☐ Other ________________ | | | | |

Length __________ mm (ft) Part Number ________________

| | | | | |
|---|---|---|---|---|
| ☐ Dents | ☐ Kinks | ☐ Cracks | ☐ Breaks | ☐ Corrosion |
| ☐ Abrasion | ☐ Length | ☐ Straightness | ☐ Flatness | ☐ Elongated Holes |
| ☐ Other ________________ | | | | |

## NOTES

## SKETCHES AND PHOTOGRAPHS

## LATTICE SECTION INSPECTION AND LACING REPLACEMENT

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

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# SECTION 5
# HOISTS

## TABLE OF CONTENTS



5

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# SECTION 5
# HOISTS

## HOIST DRAWINGS

Applicable hoist and load block drawings are attached at the end of this section.

## BOOM HOIST PAWL ADJUSTMENT

### General

The boom hoist (Drum 4) has a drum pawl which is a positive locking device. When engaged, the pawl prevents the boom hoist drum from turning in the down direction.

The pawl is engaged and disengaged electrically by a motor driven screw-type actuator controlled by the boom hoist park switch in the operator's cab. A limit switch inside both ends of the actuator turns off the motor when the actuator is fully extended or retracted.

The pawl was adjusted at the factory and should not need adjustment during the service life of the actuator. Adjustment is required when a new actuator is installed.

**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.

## ACTUATOR REMOVAL

See Figure 5-1 for the following procedure.

1. Turn off Drum 4 park to disengage pawl (1) and ***stop engine***. Actuator (3) will retract.

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

2. Disconnect electrical cord (4) from actuator (3).
3. Loosen jam nut (5) and back out adjusting screw (6) until leaf spring (7) is fully relaxed.

**DANGER**

**Flying Part Hazard!**

Leaf springs are preloaded. Do not proceed to step 4 until step 3 is performed. Parts will fly apart with sudden and dangerous force if spring preload is not relieved.

4. Carefully remove pins (8) securing actuator (3) to lug (9) and bracket (10).
5. If necessary, loosen bracket nuts (11) to loosen actuator pins (8).
6. Remove actuator (3).

### Actuator Installation and Adjustment

See Figure 5-1 for the following procedure.

1. Turn ignition key to RUN position. ***Do not start engine***.
2. If necessary, turn on Drum 4 park switch.

**DANGER**

**Pinch Point Hazard!**

Actuator rod will retract when step 3 is performed. To prevent crushing injury to hands, keep actuator clear of all other parts while performing step 3.

3. Connect electrical cord (4) to actuator (3). Actuator will retract.
4. Pin actuator (3) to bracket (10) and lug (9).
5. Set Dimension A (View B):
   a. Loosen bracket nuts (11).
   b. Adjust position of bracket (10) until Dimension A is obtained between pawl (1) and ratchet tooth (2).
   c. Securely tighten nuts (11) to hold bracket (10) in position.

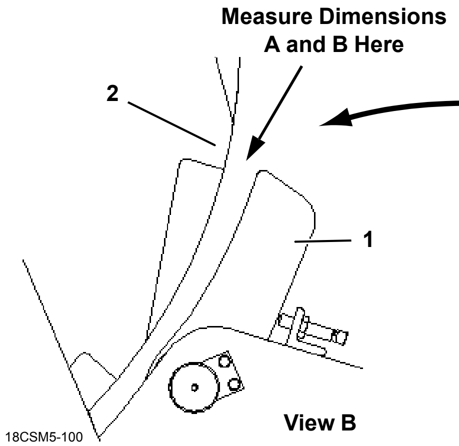
5

6. Set Dimension B (View B):
   a. Loosen jam nut (5).
   b. Turn adjusting screw (6) IN until Dimension B is obtained between pawl (1) and ratchet tooth (2).
   c. Securely tighten jam nut (5) to lock adjusting screw.
7. Operate pawl (1) to make sure that internal limit switches stop actuator motor when actuator (3) is fully extended and fully retracted and that pawl (1) fully engages and disengages ratchet tooth (2).

## CAUTION

**Flying Part Hazard!**

Actuator must be free to fully extend and retract. Motor will overheat and be ruined if actuator stroke is restricted in either direction.




| Dimension A | | Dimension B | |
|---|---|---|---|
| 1-9/16 in | 40 mm | 21/32 in | 17 mm |

| Item | Description |
|---|---|
| 1 | Pawl |
| 2 | Ratchet Tooth |
| 3 | Actuator |
| 4 | Electrical Cord |
| 5 | Jam Nut |
| 6 | Adjusting Screw |
| 7 | Leaf Spring |
| 8 | Actuator Pin |
| 9 | Lug |
| 10 | Bracket |
| 11 | Bracket Nuts |

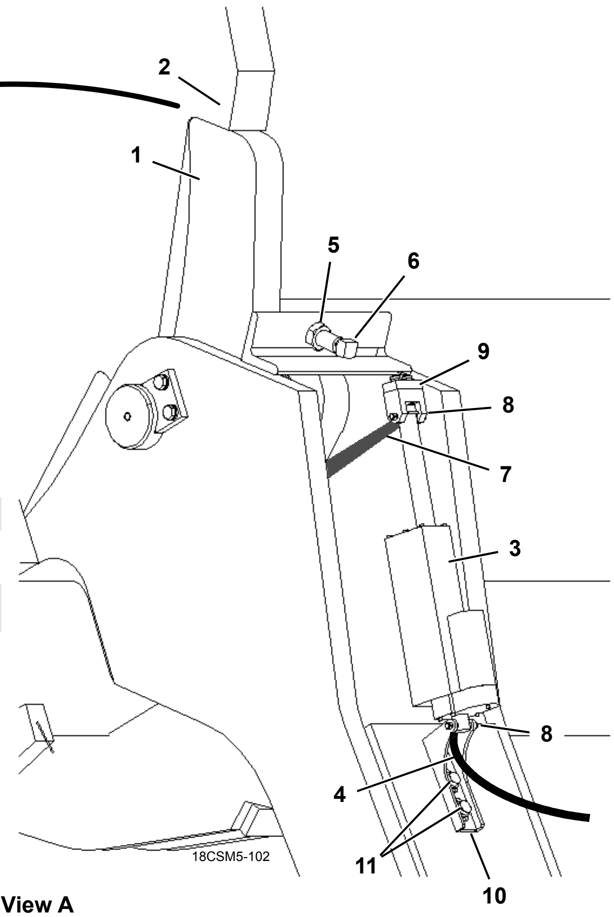



**FIGURE 5-1**

## MAST HOIST PAWL MAINTENANCE

### General

The mast hoist (Drum 5) has a drum pawl which is a positive locking device. When engaged, the pawl prevents the mast hoist drum from turning in the down direction.

The pawl is controlled by Drum 5 (mast hoist) park switch in the operator's cab:

- When park is turned ON, the pawl engages. The hydraulic cylinder extends and spring force rotates the pawl into engagement with the ratchet.
- When park is turned OFF, the pawl disengages. The hydraulic cylinder retracts, and the cam rotates to disengage the pawl from the ratchet.

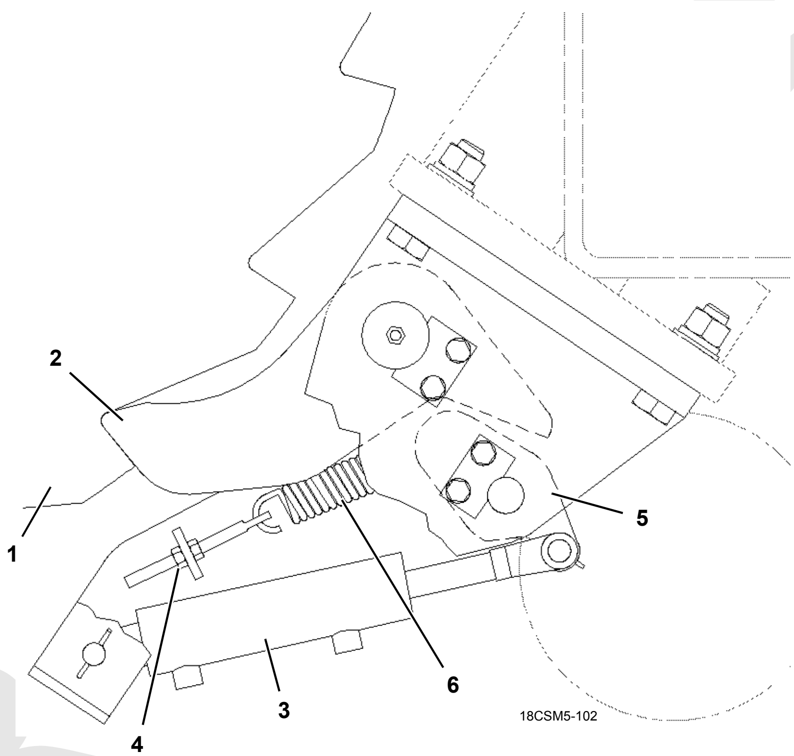
  It may be necessary to hoist slightly to fully disengage the pawl from the ratchet.

### Maintenance

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

If necessary, adjust the eye bolts so the spring has sufficient tension to fully engage the pawl with the ratchet.

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




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

**View from Right Side of Crane**

**FIGURE 5-2**

# SPEED SENSOR ADJUSTMENT

## Hydraulic Motors with Speed Sensors

The hydraulic motors for the hoists (boom, mast, load) 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 the signal to a remote node controller that transmits the information to the crane's master controller. The master controller uses the information to control the crane function.

## Speed Sensor Replacement

**WARNING**

**Hot Oil!**

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

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

## Speed Sensor Adjustment

The speed sensors are set at the factory and should not need adjustment, unless replaced.

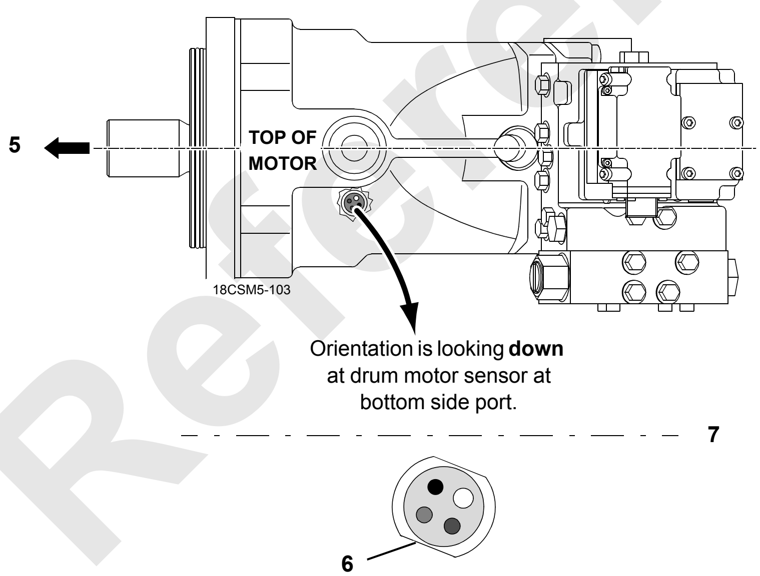
### *Version 1 – Sensor with Flats*

See Figure 5-3 for the following procedure.

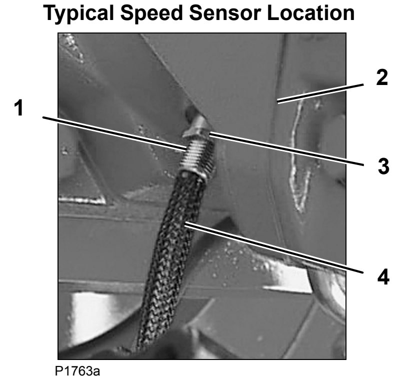
1. Bring corresponding function to a complete stop, land suspended load if load drum is being serviced, and PARK function.
2. Remove faulty sensor. Do not connect sensor cable to crane wire harness until initial adjustment is made.
3. Loosen lock nut and carefully turn sensor in (clockwise) by hand until it gently contacts speed ring inside motor.
4. Back sensor out (counterclockwise) 1/4 turn or more until flat on sensor is positioned as shown in Figure 5-3.
5. Connect sensor cable to crane wire harness.
6. Operate drum motor and check for a steady drum speed (rpm) signal on drum screen in cab.

   If necessary, turn sensor out slightly until drum speed (rpm) is steady at low and high rpm.
7. Check for proper drum direction (+/-) on corresponding drum screen.
   - + (plus) = RAISE
   - - (minus) = LOWER

   ***If proper direction is not indicated, turn sensor out 180°.***
8. Repeat step 6.
9. Hold sensor in position and securely tighten lock nut.




**Typical Speed Sensor Location**




| Item | Description |
|---|---|
| 1 | Flat on Sensor |
| 2 | Motor |
| 3 | Lock Nut |
| 4 | Cable |
| 5 | Gearbox |
| 6 | Flat |
| 7 | Centerline of Motor |

**FIGURE 5-3**

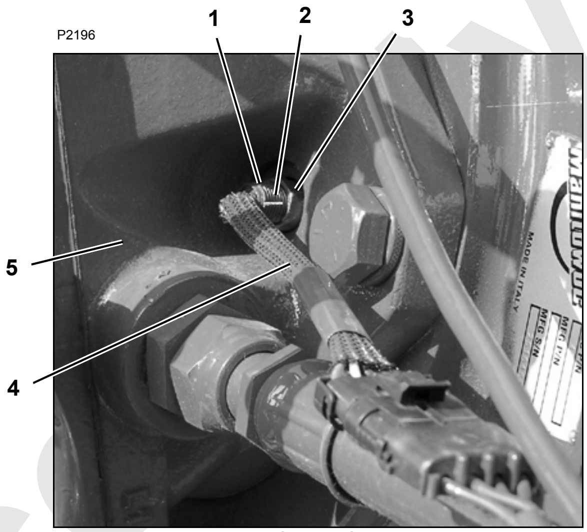
### *Version 2 – Sensor with Notch in Threads*

See Figure 5-4 for the following procedure.

1. Bring corresponding function to a complete stop, land suspended load if load drum is being serviced, and PARK function.
2. Remove faulty sensor. Do not connect sensor cable to crane wire harness until initial adjustment is made.
3. Loosen lock nut and carefully turn sensor in (clockwise) by hand until it gently contacts speed ring inside motor.
4. Back sensor out 1 turn or more until notch is positioned 180° from motor shaft (facing outboard side of motor).
5. Connect sensor cable to crane wire harness.
6. Operate drum motor and check for a steady drum speed (rpm) signal on drum screen in cab.

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

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




Typical Speed Sensor Location

**FIGURE 5-4**

## BAIL LIMIT ADJUSTMENT

**NOTE:** Reference to LED is past production.

The optional minimum bail limit assembly on Drum 1 (main hoist in insert), Drum 2 (main hoist in boom butt), and Drum 3 (whip hoist on crane) is a protective device which limits how much wire rope can be spooled off the corresponding drum.

The minimum bail limit automatically stops the corresponding drum when there are 3 to 4 wraps of wire rope remaining on the first layer. The drum can be operated in the hoist direction when the minimum bail limit switch is contacted.

Adjusting the minimum bail limit switch requires operating the drum to spool wire rope off the drum.

**WARNING**

**Falling Load Hazard!**

Do not operate drum with less than 3 to 4 full wraps of wire rope remaining on drum. Doing so can cause wire rope to be pulled out of drum and load to fall.

### Weekly Maintenance

1. Check minimum bail limit switch for proper operation.
   a. LED (light emitting diode) should be on for normal operation.
   b. Pay out wire rope from drum. Drum should stop with approximately 3 to 4 wraps of wire rope remaining on first layer (LED off). Adjust limit switch if necessary.
2. Check that cap screws holding rollers on lever shaft are tight.
3. Check tension of return springs. If necessary, adjust eyebolts so springs hold rollers snug against bare drum.

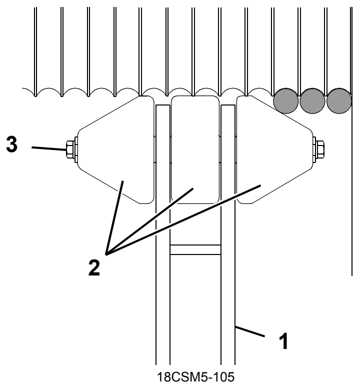
### Adjustment

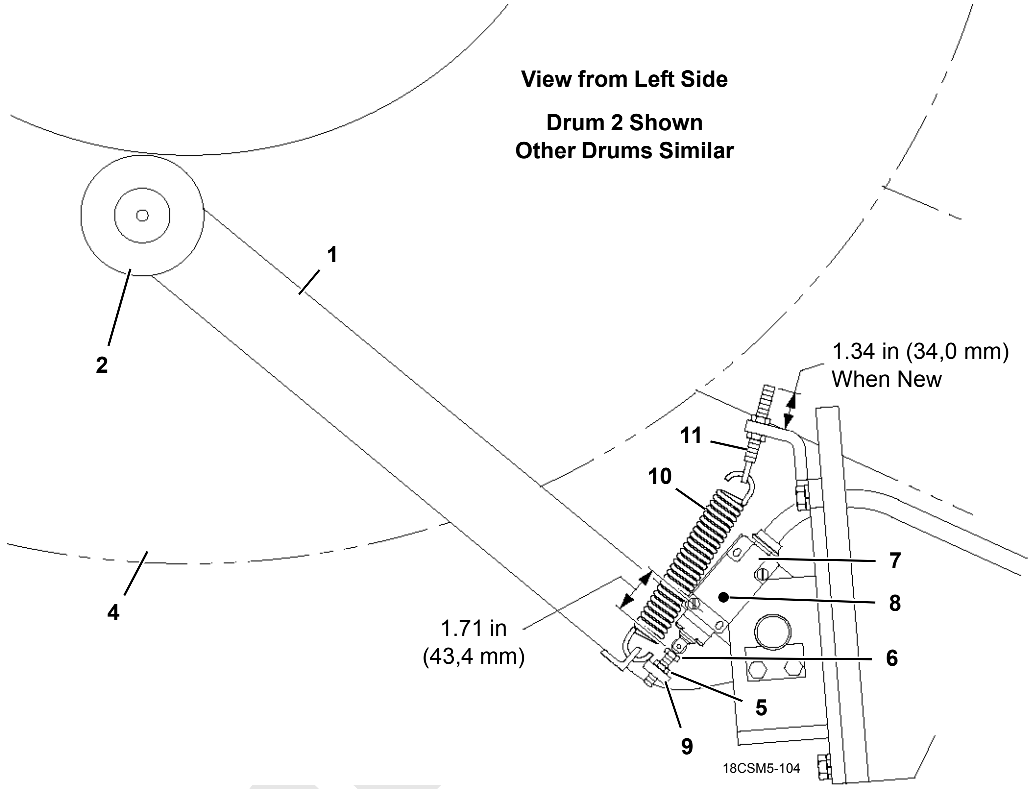
1. Pay out wire rope until rollers are against bare drum with 3 to 4 wraps of wire rope remaining on first layer.
2. Turn adjusting screw in (toward mounting plate) until LED is on.
3. Turn adjusting screw out against limit switch roller until limit switch clicks open (LED off) and stop — should be at approximate dimension given in Figure 5-5.
4. Spool several wraps of wire rope onto drum. Then pay out wire rope. Drum must stop with 3 to 4 wraps of wire rope remaining first layer.

   Repeat adjustment steps if necessary.
5. Tighten jam nut against mounting plate to lock adjustment.
6. Check that return springs have sufficient tension to hold rollers snugly against bare drum. Adjust eyebolts if necessary.

### Electrical Wiring

See Figure 5-5 for limit switch electrical wiring diagram.




| Item | Description |
|---|---|
| 1 | Lever |
| 2 | Rollers |
| 3 | Cap Screw |
| 4 | Drum |
| 5 | Jam Nut |
| 6 | Adjusting Screw |
| 7 | Limit Switch |
| 8 | LED |
| 9 | Mounting Plate |
| 10 | Return Spring |
| 11 | Eyebolt |

**NOTE:** Dimensions given above apply to all drums.



**Limit Switch Wiring**

| Receptacle | Switch Terminals | | | Function |
|---|---|---|---|---|
| 1 (green) | 22 | B | 14 | Max Angle |
| 2 (black) | A | 13 | | LED |
| 3 (white) | 21 | | | 12 VDC Supply |

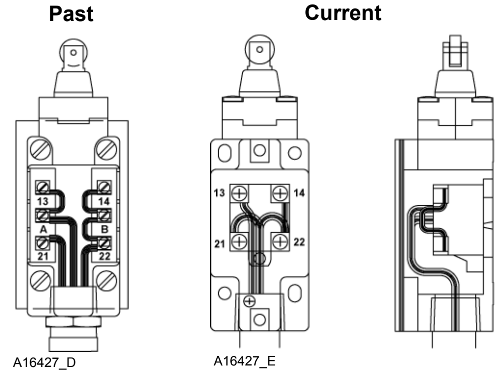



**FIGURE 5-5**

# BLOCK-UP LIMIT ADJUSTMENT

## General

A block-up limit (also called anti two-block device) is a ***two-blocking prevention device*** which automatically stops the load drum from hoisting and the boom from lowering when a load is hoisted a predetermined distance.

DEFINITION: Two-blocking is the unsafe condition in which the load block or the weight ball contacts the sheave assembly from which either is suspended.

***Two-blocking can result in failure of sheaves and wire rope, possibly causing load to fall.***

**WARNING**

**Two-Blocking Hazard!**

Block-up limit is a protective device designed only to assist operator in preventing a two-blocking condition. Any other use is neither intended nor approved.

Block-up limit may not prevent two-blocking when load is hoisted at maximum single line speed. Operator shall determine fastest line speed that allows block-up limit to function properly and, thereafter, not exceed that line speed.

The block-up limit system consists of the following components (see Figure 5-6):

1. Normally closed limit switch assembly fastened at any or all of the following locations:
   a. Lower boom point
   b. Upper boom point
   c. Lower luffing jib point
   d. Upper luffing jib point
   e. Fixed jib point
2. Weight freely suspended by chain from each limit switch actuating lever (weight encircles load line as shown in Figure 5-8).
3. Lift block fastened to load line or lift plates fastened to load block (see Figure 5-8).

## Operation

See Figure 5-6 through 5-10 for component identification.

See the wiring diagram in the Boom Wiring and Limits Electrical Control Assembly drawing in this manual.

### *Block-Up Limit Control Deactivated*

During normal operation, the weight overcomes spring force and rotates the actuating lever away from the limit switch lever. This action allows the limit switch to close the load drum UP and boom DOWN electric circuits. Therefore, the load can be hoisted and the boom can be lowered.

### *Block-Up Limit Control Activated*

When the weight is lifted by the lift block or the lift plates, spring force rotates the actuating lever against the limit switch lever. This action causes the corresponding limit switch to open the load drum UP and boom DOWN electric circuits.

The load drum and boom hoist pumps stroke to off. At the same time, the load drum and boom parking brakes apply to stop load drum from hoisting and boom from lowering.

## Installation

See Figure 5-8 for installation of the weights.

The block-up limit controls must be installed according to the Boom Wiring and Limits Electrical Control Assembly drawing in this manual.

## Load Block Level Transmitter

See Figure 5-6 for the following procedure.

The optional load block level transmitter is only used with tandem drum operation. See load block level screen topic in Section 3 of this manual. The wireless screen on digital display indicates load block level battery status.

1. The load block level transmitter is mounted on block as shown in Figure 5-6, Item 14. Locate on block where there are no obstructions between transmitter and receiver on boom top.
2. When reeved, load block level transmitter must be on left side of load block when viewed from operator’s cab.
3. Use a smart level to check level sensor zero and compare to block angle on Level screen. If a zero adjustment is required, follow adjustment procedure.
4. Past Production adjustment procedure.
   a. Open enclosure
   b. If European Standard transmitter is used, ***press to install button*** must be pressed to enable.
   c. Loosen screw on each side of sensor (Figure 5-6, Item 15) and turn sensor slightly either way until sensor is zeroed.
   d. Tighten screws on each side of sensor when adjustment is complete.
   e. Close enclosure

**5.** Current Production adjustment procedure:

**NOTE:** The angle sensor and printed circuit board are a matched set. The zero adjustment potentiometer on the printed circuit board must not be re-adjusted.
It is recommended two people perform this adjustment procedure.

**a.** When replacing the angle sensor and printed circuit board, remove batteries and install the new angle sensor and printed circuit board with the angle sensor loosely mounted for adjustment rotation. Mount angle sensor in position shown.

**b.** Install batteries.

**c.** Adjust the block level controller assembly box as needed such that box mounting surface (backside) is 90 degrees to the horizontal mounting surface of the load block assembly.

**d.** Turn cab power on and scroll to the Level screen for the block level sensor and block level angle diagnostic display readings (see Section 3, Crane Diagnostics, Block Level Sensor topic).

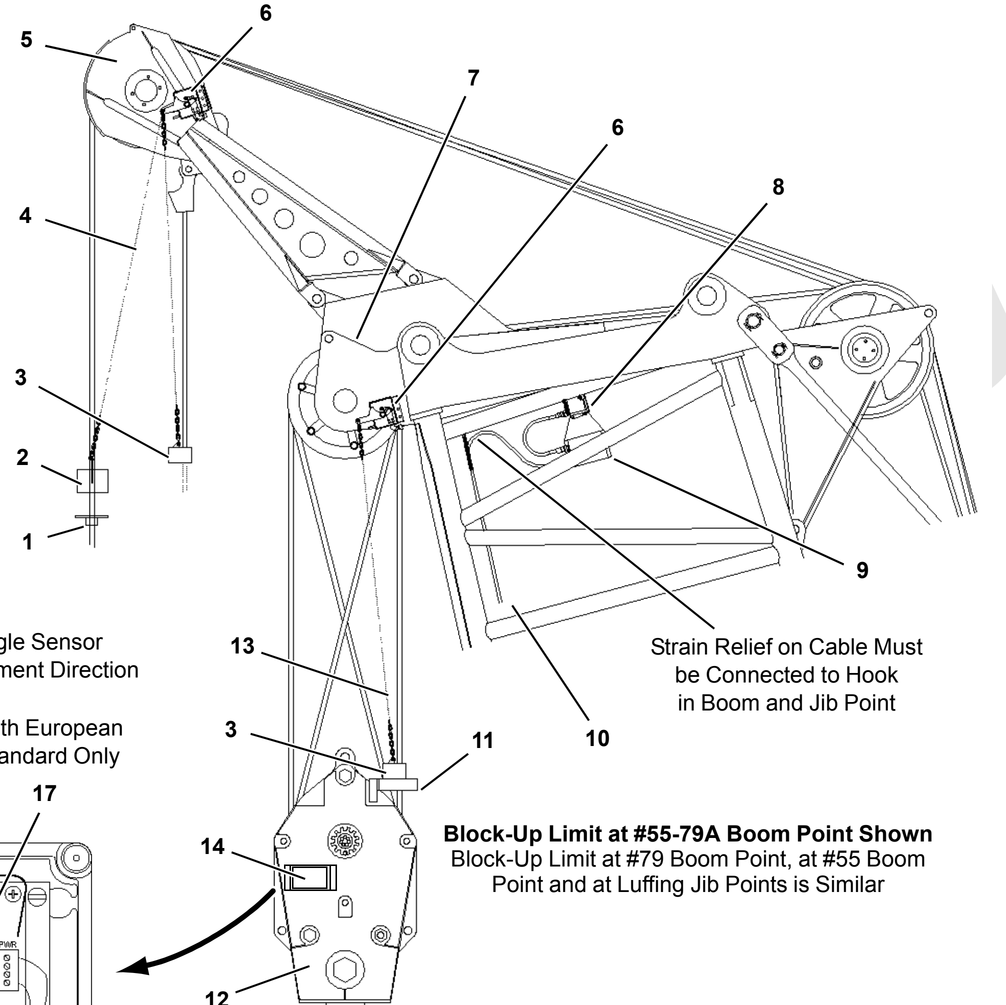
**e.** While one person is monitoring the block level diagnostic display in the operator cab, the second person rotates the angle sensor in the block level controller assembly until 0 degrees is achieved on display screen.

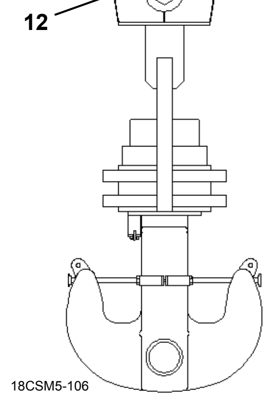
**f.** Carefully tighten angle sensor mounting hardware.

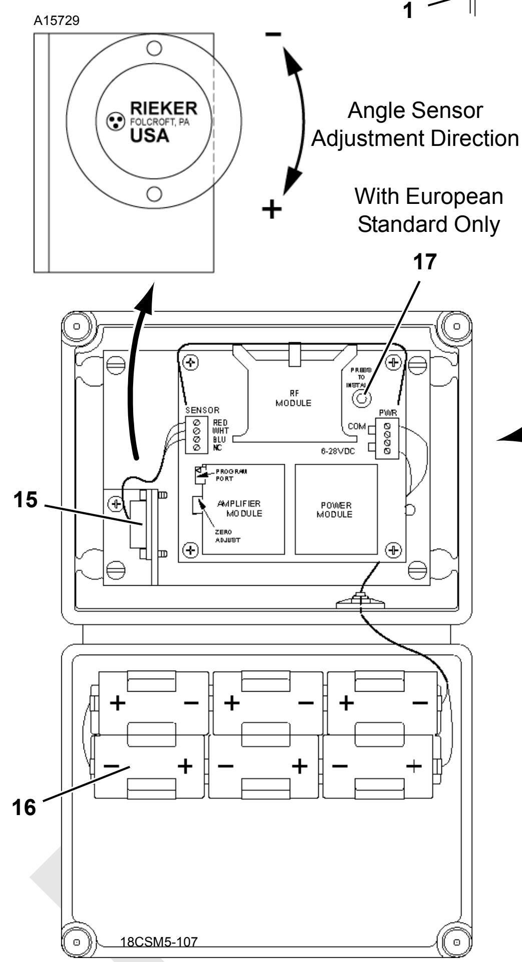
**g.** Confirm angle sensor reading on diagnostic display remains 0 degrees.

**h.** Close block level controller assembly cover ensuring proper seal and fasten screws (2 each).

Six ***Lithium*** type size D batteries are recommended for longer battery life.



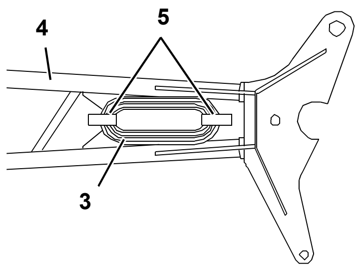




| Item | Description |
|---|---|
| 1 | Lift Block |
| 2 | 1-Part Weight |
| 3 | Multiple Part Weight |
| 4 | Chain 8 ft (2,4 m) (1 or 2 each) |
| 5 | Upper Boom or Jib Point |
| 6 | Limit Switch Assembly |
| 7 | Lower Boom Point |
| 8 | Boom Node |
| 9 | Load Cell Receiver |
| 10 | Electric Cable From Reel |
| 11 | Lift Plate |
| 12 | Load Block |
| 13 | Chain 12 ft (3,7 m) |
| 14 | Block Angle Transmitter (optional) |
| 15 | Angle Sensor |
| 16 | Batteries |
| 17 | Press to Install Button |

**FIGURE 5-6**

18CSM5-108

| Item | Description |
|---|---|
| 1 | Electric Cable |
| 2 | Cable Reel |
| 3 | Cable |
| 4 | Fixed Jib Butt |
| 5 | Brackets |



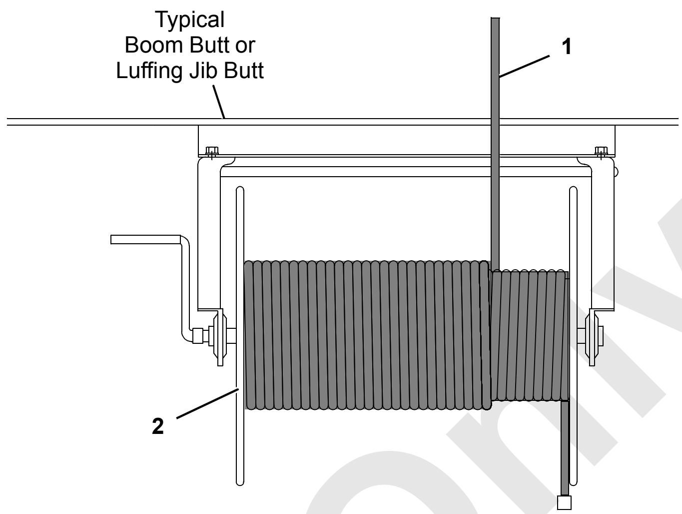
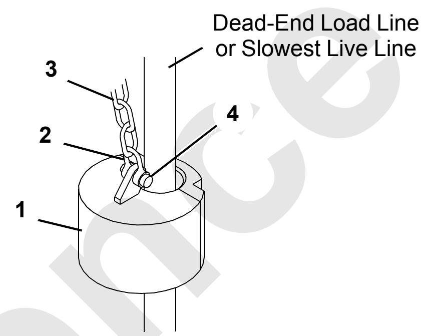



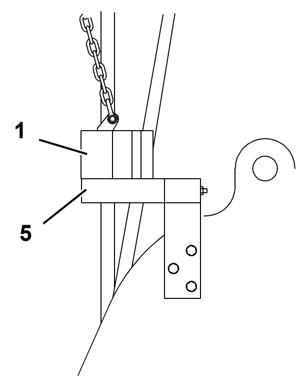

FIGURE 5-7

18CSM5-109

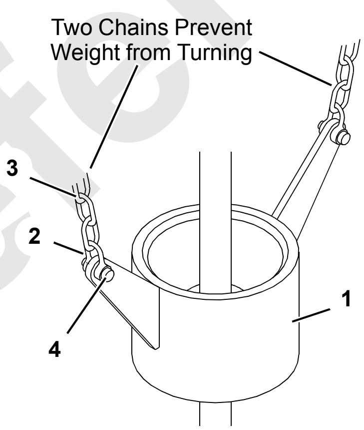
| Item | Description |
|---|---|
| 1 | Weight |
| 2 | Shackle |
| 3 | Chain |
| 4 | Connecting Pin |
| 5 | Lift Plate |
| 6 | Lift Block |



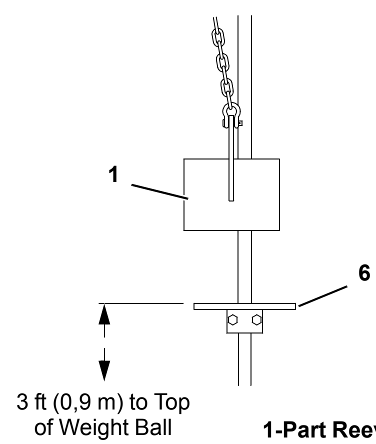

Lower or Upper Boom Point
(multiple part)




See Load Block Reeving for
Suggested Location of Weight



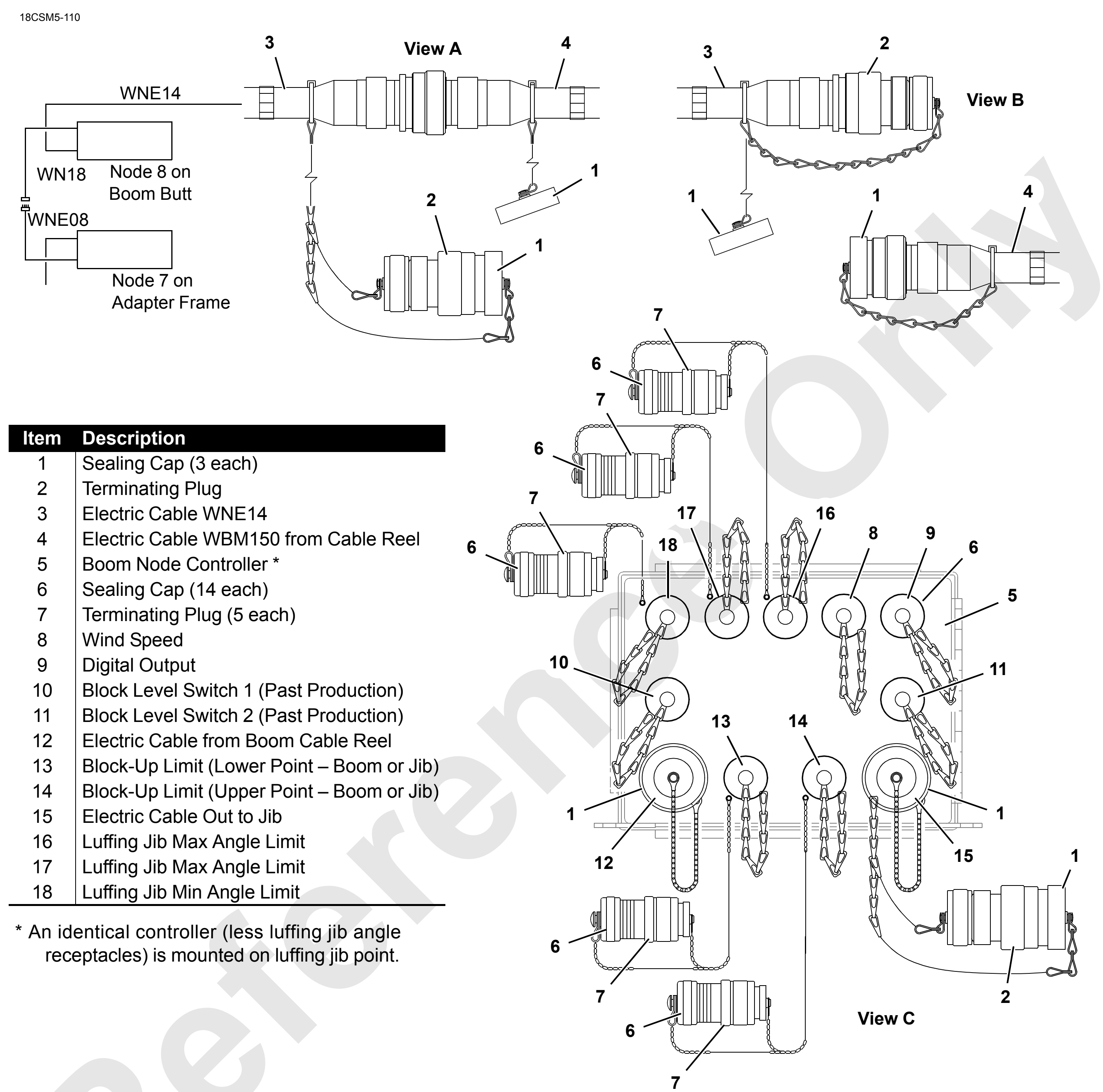

Upper Boom Point (1-part)
Upper Jib Point (1-part)
Lower Jib Point (1-part)




1-Part Reeving

FIGURE 5-8

5




| Item | Description |
|---|---|
| 1 | Sealing Cap (3 each) |
| 2 | Terminating Plug |
| 3 | Electric Cable WNE14 |
| 4 | Electric Cable WBM150 from Cable Reel |
| 5 | Boom Node Controller * |
| 6 | Sealing Cap (14 each) |
| 7 | Terminating Plug (5 each) |
| 8 | Wind Speed |
| 9 | Digital Output |
| 10 | Block Level Switch 1 (Past Production) |
| 11 | Block Level Switch 2 (Past Production) |
| 12 | Electric Cable from Boom Cable Reel |
| 13 | Block-Up Limit (Lower Point – Boom or Jib) |
| 14 | Block-Up Limit (Upper Point – Boom or Jib) |
| 15 | Electric Cable Out to Jib |
| 16 | Luffing Jib Max Angle Limit |
| 17 | Luffing Jib Max Angle Limit |
| 18 | Luffing Jib Min Angle Limit |

* An identical controller (less luffing jib angle receptacles) is mounted on luffing jib point.

FIGURE 5-9



## Disconnecting Block-Up Limit Control

See Figure 5-9 for the following procedure.

Terminating plug (2, Views A and B) is provided so the block-up limit control can be disconnected for the following reasons:

- Crane setup and rigging
- Maintenance

If electric cable (3) is terminated, all of the block-up limits (on boom and jib), the RCL, and the wind speed indicator will be inactive.

1. Unscrew sealing cap (1, View A) from terminating plug (2).
2. Disconnect electric cable (3, View B) from cable (4).
3. Connect sealing cap (1, View A) to electric cable (4).
4. Connect terminating plug (2, View B) to electric cable (2).

   Failing to perform this step will prevent load drums from hoisting and boom from lowering. Operating limits alert will come on.
5. Reverse above steps to reconnect the block-up limits, the RCL, and the wind speed indicator.

## Removing Upper Boom Point or Jib Point

See Figure 5-9 for the following procedures.

Failing to perform the following steps will prevent load drums from hoisting and boom (or luffing jib) from lowering. Also operating limits alert will come on.

Remove terminating plugs and reconnect electric cables to proper receptacles when corresponding attachment is reinstalled.

If upper boom point, upper luffing jib point, or fixed jib is removed:

1. Disconnect cable from receptacle (14, View C).
2. Unscrew sealing cap (6, View C) from terminating plug (7) and attach to receptacle (14).
3. Connect sealing cap to end of cable and store on upper boom point or upper jib point.

If the luffing jib is removed:

1. Unscrew sealing cap (1, View C) from terminating plug (2).
2. Disconnect cable from receptacle (15, View C).
3. Connect terminating plug (2, View C) to receptacle (15).
4. Connect sealing cap to end of cable and coil cable onto cable reel (luffing jib butt).
5. Remove sealing caps (7, View C) from terminating plugs (6) and connect terminating plugs to jib stop receptacles (16, 17, and 18).

## Storing Electric Cable

See Figure 5-2 for the following procedure.

The electric cables for the boom and jib are long enough to accommodate the maximum length of each attachment.

Store excess electric cable for the boom and luffing jib by winding it onto the reel mounted on the respective butt. The reel has a locking pin. Disengage the locking pin to allow the reel to be wound. Engage the locking pin to lock the reel in position. The electric cable from the crane to the reel must be disconnected before the reel can be wound.

Store excess electric cable for the fixed jib by winding it around the brackets on the fixed jib.

## Maintenance

Inspect and test the block-up limits ***weekly or every 40 hours of operation***, as follows:

---

### CAUTION

**Avoid Machinery Damage!**

To prevent two-blocking from occurring, do not operate crane until cause for improper operation and all hazardous conditions have been found and corrected.

---

1. Lower the boom and jib onto blocking at ground level and carefully inspect the following items:
   a. Inspect each limit switch lever and actuating lever for freedom of movement. Apply one-half shot of grease to fitting on the actuating lever; wipe away any excess grease.
   b. Inspect each weight for freedom of movement on the load line.
   c. Inspect each weight, chain, shackle and connecting pin for excessive or abnormal wear. Make sure cotter pins for shackles are installed and spread.
   d. Inspect entire length of each electric cable for damage.
   e. Check that electric cables are clear of all moving parts on boom and jib and that cables are securely fastened to boom and jib with nylon straps.
   f. Check that all plugs are securely fastened.
2. Test block-up limits for proper operation using either of the following methods:
   a. BOOM LOWERED: Manually lift each weight — ***one at a time*** — while engine is running. Load drum should not operate in HOIST direction and boom 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.

5

## CAUTION

**Avoid Sheave Damage!**

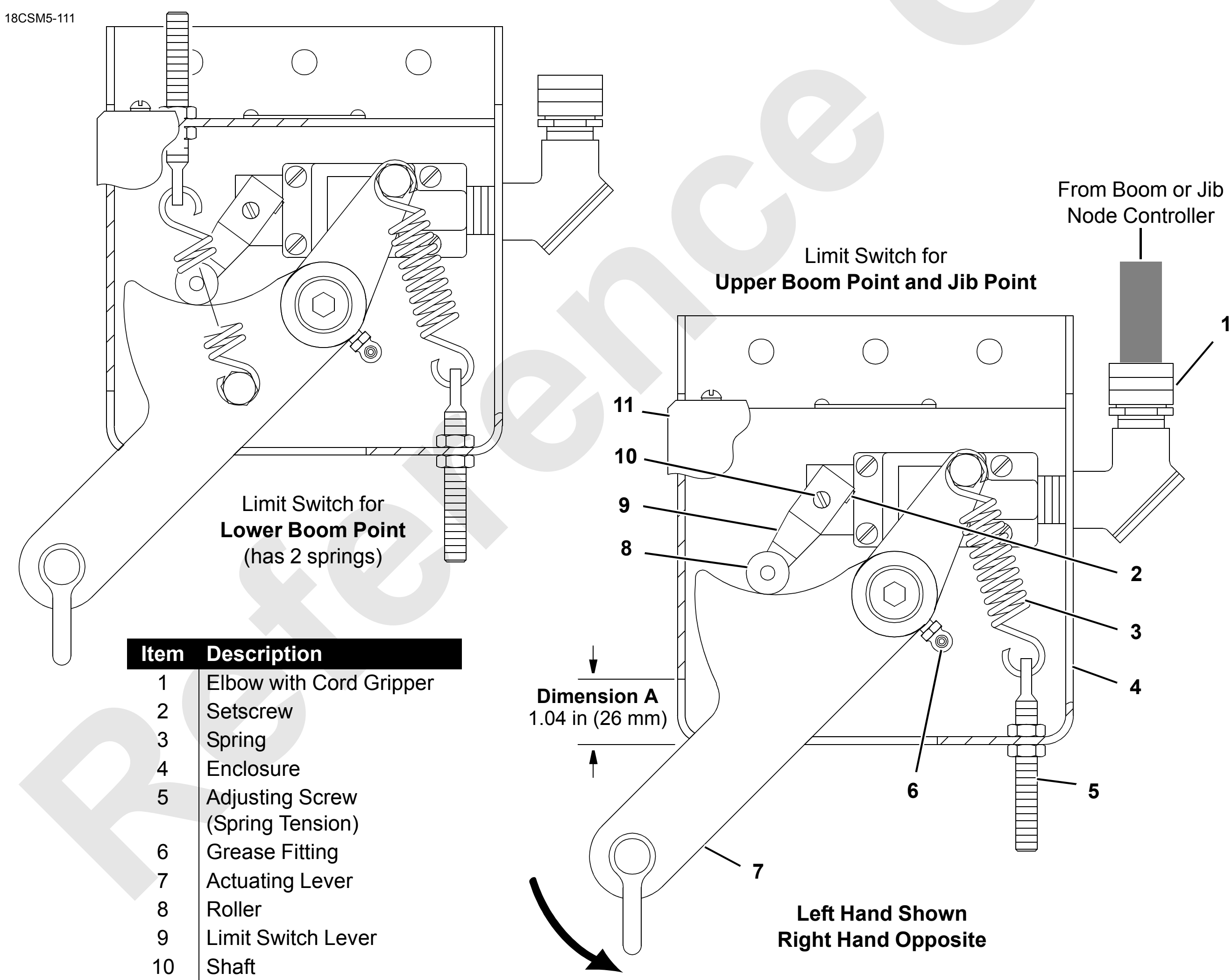
Use extreme care when testing block-up limits when boom is raised. If a block-up limit fails to stop load, immediately stop load by moving drum control handle to off. Otherwise, two-blocking may occur.

## Adjustment

See Figure 5-10 for the following procedure.

Lower boom onto blocking at ground level and adjust each limit switch as follows:

1. Adjust spring tension so there is enough force to lift weight of chain and rotate actuating lever when weight is lifted.
2. Loosen setscrew in limit switch lever so lever is free to rotate.
3. Manually lift weight to allow actuating lever to rotate upward.
4. Hold lever at Dimension A.
5. Hold roller on limit switch lever against actuating lever while performing step 6.
6. Turn limit switch shaft CLOCKWISE ***only enough to "click" limit switch open and hold.*** Then securely tighten setscrew in limit switch lever.
7. Test limit switch for proper operation (see Maintenance topic). Repeat adjustment steps until limit switch operates properly.




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

**FIGURE 5-10**

## WIRE ROPE INSPECTION AND REPLACEMENT

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

### Wire Rope Lubrication

Refer to the lube folio for lubrication techniques.

Do not use grease to lubricate wire rope. Grease will not penetrate the rope properly and will build up in the valleys between the wires and strands. This buildup will inhibit rope inspection and could trap moisture in the rope's interior.

A high-quality wire rope lubricant is available from the Manitowoc Crane Care Lattice Team. Otherwise, consult your wire rope supplier.

### Maintain a Wire Rope Condition Report

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

After initial loading of a new rope, measure and record its diameter for comparison with future inspections. Measure the rope's diameter across the crowns of the strands so the true diameter is measured as shown in Figure 5-12.

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

#### *Required Inspection Intervals*

The frequency of wire rope inspection must be:

- Daily (see Daily Inspection)

and, **at minimum:**

- Yearly (see Periodic Comprehensive Inspection)

#### *Wire Rope Care and Replacement Guidelines*

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

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

#### *Daily Inspection*

Wire rope should be inspected in accordance with ANSI/ASME B30.5 and OSHA 29 CFR 1926.1413. A running record of the condition of each wire rope should be noted in the equipment inspection log.

---

**WARNING**

**Personal Injury Hazard**

Prior to conducting an inspection of wire rope:

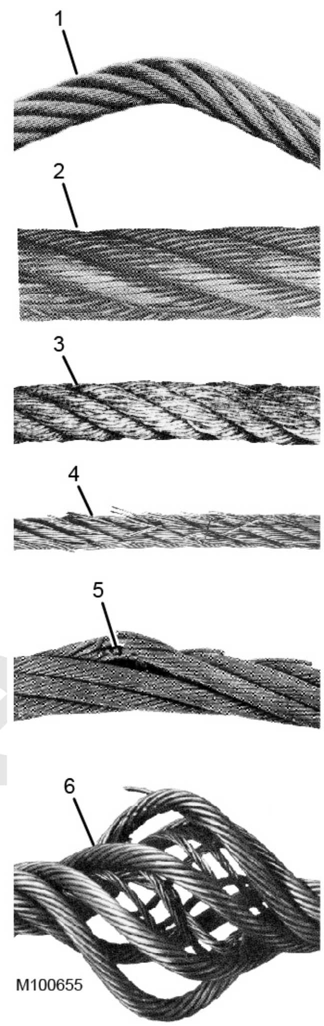
- Lock out the equipment power when removing or installing the wire rope assemblies.
- Use safety glasses for eye protection.
- Wear protective clothing, gloves, and safety shoes as appropriate.
- Use supports and clamps to prevent uncontrolled movement of the wire rope, parts, and equipment.

---

1. Each work day, prior to crane work, visually inspect all rope that can reasonably be expected to be used that day. Check for obvious damage, including:
   - Rope defects such as shown in Figure 5-11
   - Loss of rope diameter (see Reduction in the Rope Diameter)
   - Broken wires—Record the number, distribution and type of broken wires (see Broken Rope Wires).
   - Internal wear or broken wires for ropes operating on synthetic sheaves. Common indicators of internal deterioration include localized reduction in rope diameter, corrosion between the strands, localized lengthening of lay, wire displacement, or wire distortion.

- End fitting wear/abrasion
- Minor or general corrosion
- Areas that deteriorate more rapidly, such as the flange points, the crossover points, and the repetitive pickup points on drums
- Take special care to observe the boom hoist ropes and rotation-resistant ropes for evidence of core failure or other deterioration (remove from service)
- Internal deterioration of rotation-resistant ropes may not be readily observable

2. Throughout the day, observe the wire rope during operation, particularly:
   - Pick-up Points—Sections of the wire rope that are repeatedly stressed during each lift, such as the sections that are in contact with the sheaves
   - End Attachments—The point where a fitting is attached to the wire rope or the point where the wire rope is attached to the drum.
   - Abuse Points—The point where the wire rope is subjected to abnormal scuffing and scraping.




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

FIGURE 5-11

## Periodic Comprehensive Inspection

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

The inspection must include:

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

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

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

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

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

**WARNING**

**Falling Load Hazard**

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

### *Determining the Frequency of Inspection*

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

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

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

## Replacement Criteria

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

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

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

### *Reduction in the Rope Diameter*

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



5

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

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

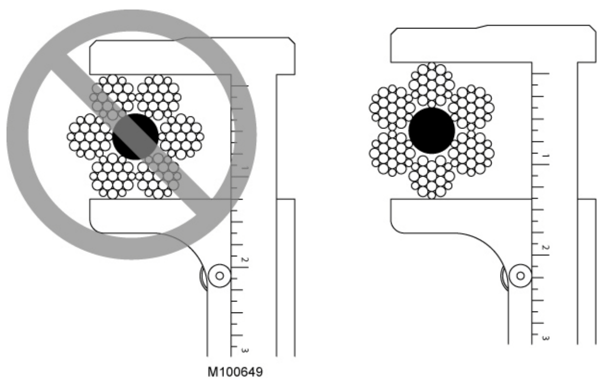



FIGURE 5-12

### *Broken Rope Wires*

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

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

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

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

See Figure 5-14 for an explanation of lay length.

- Running Ropes—six randomly broken wires in one lay length or three broken wires in one strand in one lay length.
- Standing Ropes (Pendants)—more than two broken wires in one lay length in sections beyond the end attachment, or more than one broken wire at the end attachment (see Figure 5-13).
- Rotation-resistant Rope—two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters.
- All Ropes—one outer wire broken at the point of contact with the core and protrudes or loops out of the rope structure—additional inspection is required.
- End Attachments (Figure 5-13)—when more than one broken wire appears at the attachment, replace the rope or cut off the affected area and reattach the fitting.

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

**WARNING**

**Falling Load Hazard**

Replace wire rope when more than one broken wire appears at point marked by arrow.

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

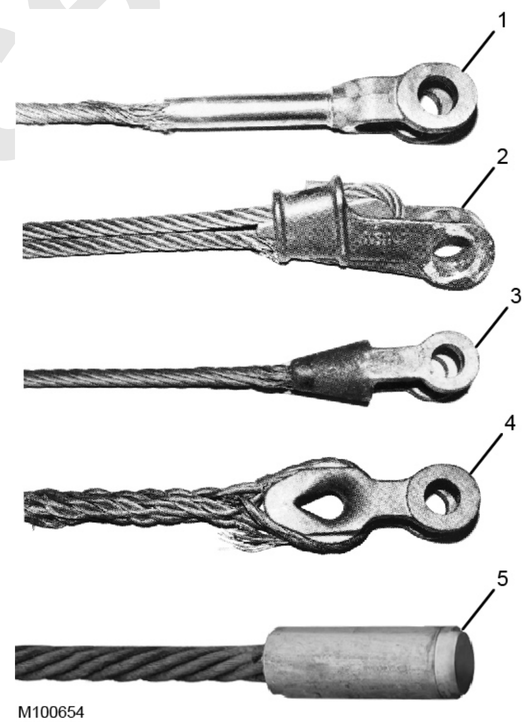
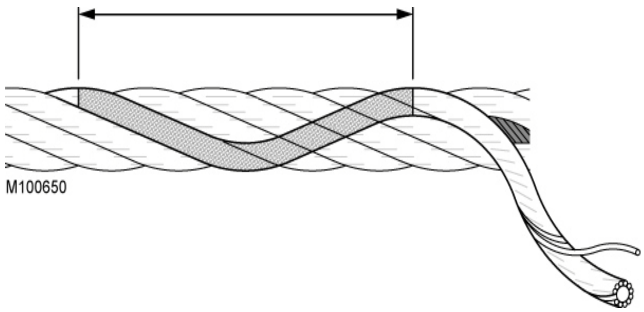



FIGURE 5-13




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

**FIGURE 5-14**

### *Rope That Has Been Idle a Month or More*

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

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

**WARNING**

**Falling Load Hazard**

Replacement wire rope can break if it does not meet Manitowoc specifications given in the following publications supplied with your crane:

- Wire Rope Specifications Chart located in the Capacity Chart Manual (for load lines)
- Boom or Jib Assembly drawings located in the Operator Manual (for boom or luffing hoist)
- Mast Assembly drawing located in the Parts Manual

## Distributing Wire Rope Wear

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

To move the wire rope, cut off a piece of the rope at the worn end and refasten. The piece should be long enough to move the wire rope at least one full drum wrap.

If the wire rope is too short to allow cutting off a piece, reverse the rope end for end and refasten it.

## SHEAVE, ROLLER, AND DRUM INSPECTION

Perform the following inspections weekly:

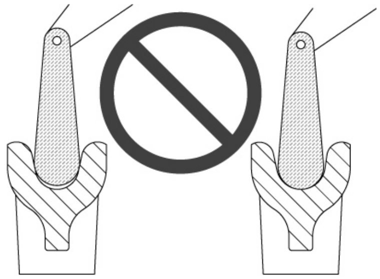
1. Check the drum clutches and the brakes for proper adjustment.
2. Check all sheaves, rollers, and drums for the following conditions:
   - Unusual noises
   - Freedom of movement—must turn freely by hand. Wire rope may have to be loosened to perform this inspection.
   - Wobble—must turn true with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

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

   For sheaves not equipped with grease fittings, be sure to pack the new bearings with grease at assembly.
3. For steel sheaves, check the depth, width, and contour of each sheave using a groove gauge as shown in Figure 5-15. Replace the sheaves that have over or under size grooves.
4. Replace any grooved drums that allow one wrap of the wire rope to contact the next wrap as the rope spools onto the drum.
5. Inspect the sheaves to verify they **do not** contact another sheave or structural plate work. There should be uniform clearance between sheaves in a cluster. Repair or replace worn or damaged sheaves.
6. Remachine or replace steel sheaves, drums, or rollers that have been corrugated by the wire rope’s print Figure 5-16.
7. Measure the nylon sheaves for excessive tread wear. See Figure 5-18. To check for uneven wear, measure at three places.

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

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




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

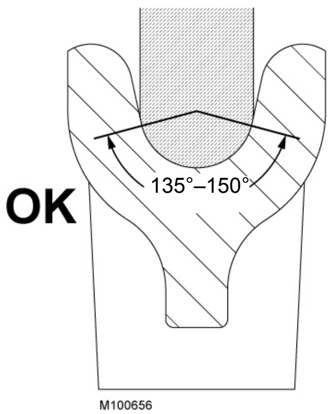
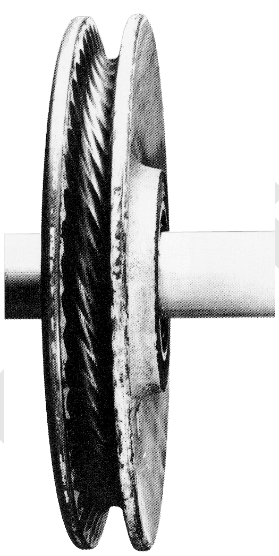



**FIGURE 5-15**



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

**FIGURE 5-16**

8. Inspect the nylon sheaves to verify they have not separated and "walked off" the steel inserts or the bearings as shown in Figure 5-17. Maximum sideways displacement is 3 mm (1/8 in.). **Replace worn or damaged sheaves**.

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

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

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

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

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

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

9. Make sure the sheaves, drums, and rollers are properly lubricated according to the instructions in the lubrication guide provided with this manual.

**NOTE:** For some sheaves, the seals are an integral part of the bearing. Therefore, if a seal is damaged during repacking, the complete bearing may have to be replaced.

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

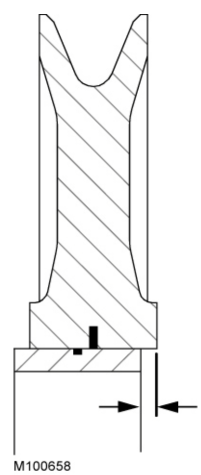
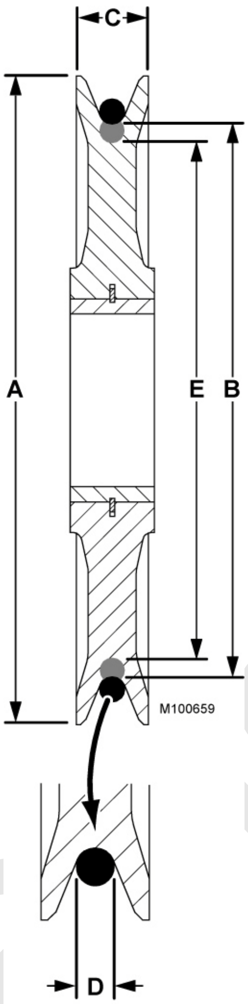



**FIGURE 5-17**

**B** = tread diameter, new sheave
**E** = tread diameter, used sheave
**B minus E = total wear**
**If total wear is 5 mm (3/16 in) or more, the sheave should be replaced.**
If a tread print exists in the root of the sheave groove, measure to the maximum tread diameter.




**PLASTIC SHEAVE DATA**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | mm | inch | mm | inch | mm | inch | mm | inch |
| 912738<br>631056 | 335 | 13.19 | 290,1 | 11.42 | 45 | 1.77 | 16 | 5/8 |
| | | | | | | | | |
| 631054 | 335 | 13.19 | 290,1 | 11.42 | 45 | 1.77 | 22 | 7/8 |
| | | | | | | | | |
| 631065 | 406,4 | 16 | 339,6 | 13.37 | 55,1 | 2.17 | 14 | 9/16 |
| | | | | | | | | |
| 631071 | 406,4 | 16 | 352,6 | 13.88 | 55,1 | 2.17 | 16 | 5/8 |
| | | | | | | | | |
| 631526 | 489 | 19.25 | 422,4 | 16.63 | 50,8 | 1.94 | 22 | 7/8 |
| | | | | | | | | |
| 631527 | 489 | 19.25 | 422,4 | 16.63 | 50,8 | 1.94 | 16 | 5/8 |
| | | | | | | | | |
| 631055 | 500,1 | 19.69 | 447 | 17.60 | 47 | 1.85 | 22 | 7/8 |
| | | | | | | | | |
| 631067 | 500,1 | 19.69 | 450,9 | 17.75 | 50 | 1.97 | 19 | 3/4 |
| | | | | | | | | |
| 631529 | 508 | 20 | 431,8 | 17.00 | 76,2 | 3 | 25 | 1 |
| | | | | | | | | |
| 631519<br>631520 | 584,2 | 23 | 511 | 20.13 | 57,2 | 2.25 | 22 | 7/8 |
| | | | | | | | | |
| 631084<br>A00083 | 584,2 | 23 | 511 | 20.13 | 63,5 | 2.50 | 22 | 7/8 |
| | | | | | | | | |
| 631102 | 584,2 | 23 | 511 | 20.13 | 63,5 | 2.50 | 25 | 1 |
| | | | | | | | | |

**FIGURE 5-18**

5

## LOAD BLOCK AND HOOK-AND-WEIGHT BALL INSPECTION

**WARNING**

**Falling Load Hazard**

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

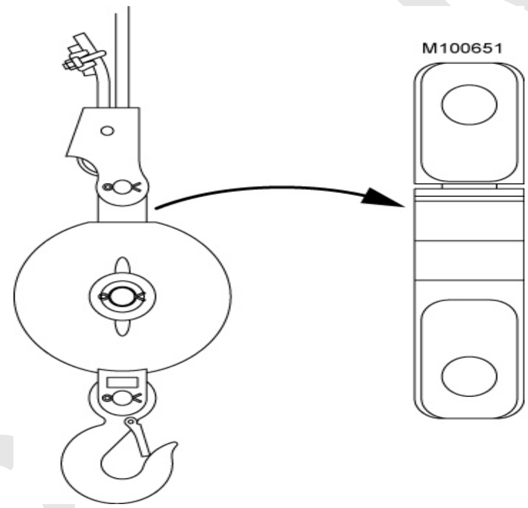
- Only use a load block or a hook-and-weight ball which has a capacity equal to or greater than the load to be handled.
- Do not remove or deface the nameplate (Figure 5-19) that is attached to the load blocks and hook-and-weight balls.
- See Section 4 of the Operator Manual for recommended sling angles and capacity restrictions when the load block has a duplex or a quadruplex hook.


FIGURE 5-19

### Daily Inspection

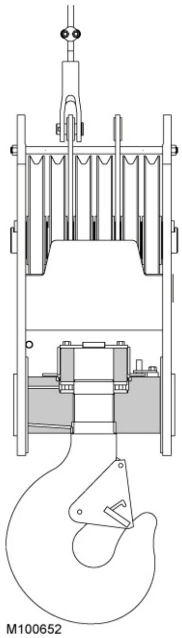
The operating condition of the load block and the hook-and-weight ball can change daily with use, and so they must be inspected daily (at start of each shift). During operation, observe for any defects which could affect their safe operation. Correct all defects before using the load block or the hook-and-weight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

Daily inspection and maintenance will include the following points (see Figure 5-20 and Figure 5-21):




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

**FIGURE 5-20**




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

**FIGURE 5-21**

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 any loose tie-bolts, cap screws, and set screws. Check that all the cotter pins are installed with the legs opened and trimmed.
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: This can cause the swivel to turn freely in one spot and lock-up in another.

     This condition can also be checked by checking the gap (4c, Figure 5-20) between the barrel and shank (To check, the swivel must be removed from the weight ball).

     If the gap is wide on one side and closed on the other side, damage is present.

**NOTE:** The gap between the barrel and the shank is normally 0,5 mm (0.02 in) to 1,3 mm (0.05 in). If the gap increases, swivel-bearing failure is indicated.

8. Check the load block for signs of overloading:
   - Spread side plates
   - Elongated holes
   - Bent or elongated tie-bolts
   - Cracks
9. Check all of the welds for defects and cracks.
10. Check the wire rope for wear and broken wires at the point where the wire rope enters the dead-end socket. Check the socket for cracks. Tighten the wire-rope clips located at the dead end of the wire rope.
11. Check that each hook has a latch and that the hook latch operates properly.

## WARNING
**Falling Load Hazard**

To prevent the load from dropping due to a hook or shackle failure, do not attempt to repair any cracks in hooks and shackles by welding.

Do not weld on any load-bearing component unless proper welding methods are used (contact the Manitowoc Crane Care Lattice Team for material and welding specifications).



5

## ⚠ WARNING

**Falling Load Hazard**

To prevent the load from dropping, make sure that, under slack conditions, the hook latch retains the slings or other rigging in the hook.

The hook latch is not intended as an anti-fouling device. Make sure that the hook latch does not support any part of load.

Make sure that any slings or other rigging are seated in the hook. Rigging must never be in a position to foul the hook latch.

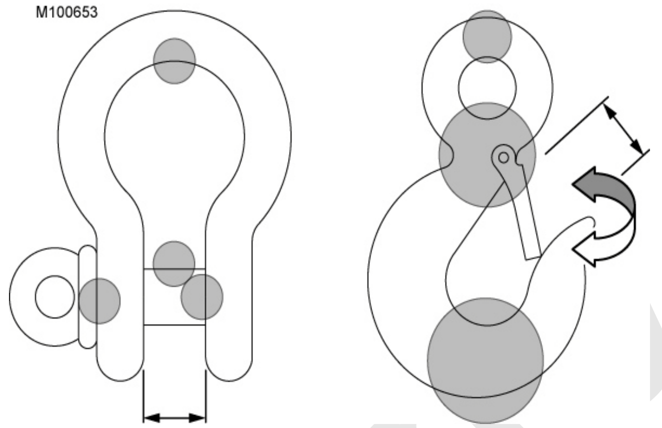
Never attempt to defeat the purpose of the hook latch.

**12.** Inspect each hook and shackle for damage as shown in Figure 5-22.

**13.** See the ASME B30-10 Standard for specific hook replacement guidelines. The standards are available as follows:

- **Mail**—ASME, 22 Law Drive, Fairfield, New Jersey, 07004-2900
- **Toll free phone**—US & Canada 800-843-2763, Mexico 95-800-843-2763, Universal 973-882-1167
- **Fax**—973-882-1717 or 973-882-515
- **E-mail**— *infocentral*@asme.org

**14.** Contact the supplier of your hooks, shackles, blocks, and other rigging for repair instructions.




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

**FIGURE 5-22**

## Yearly Inspection

Check each hook and shackle at least yearly for cracks using a dye penetrant test, MAG particle test, ultrasonic test, or by X-ray.

# SECTION 6
# SWING

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6

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# SECTION 6
# SWING

## MANUAL RELEASE OF SWING BRAKE AND LOCK

**NOTE:** The swing lock is installed on past production cranes only. Current production cranes will have the swing lock removed.

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

**WARNING**

**Unexpected Crane Movement!**

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

Procedure given in this section is for servicing purposes only. Swing brake and swing lock must be fully operational when operating crane.

### Manual Release Procedure

See Figure 6-1 for the following procedure.

Hydraulic hand pumps with pressure gauge are needed to manually release the swing brake and swing lock.

1. Disconnect hoses from fitting at brake release port and, if equipped, at swing lock OUT port.
2. Attach hand pump to each port — brake release and swing lock OUT.
3. Pressurize brake and swing lock to 350 psi (24 bar).
4. Remove or install swing planetary.
5. Relieve pressure and remove hand pumps.

**CAUTION**

**Avoid damage to parts!**

Do not exceed 350 psi (24 bar) pressure when releasing swing brake or swing lock.

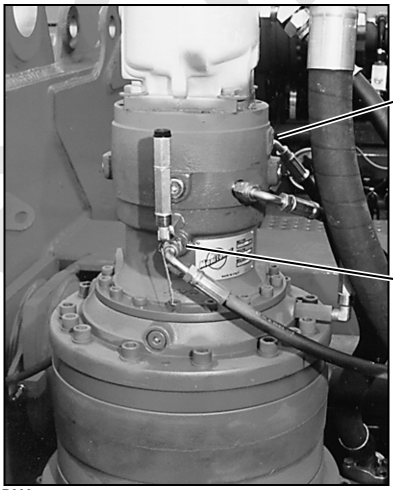


**FIGURE 6-1**

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# SECTION 7
# POWER TRAIN

## TABLE OF CONTENTS





7

# SECTION 7
# POWER TRAIN

## BATTERY MAINTENANCE

### Safety Information

**WARNING**

**Battery gases are explosive!**

Batteries can explode with great violence and spraying of acid if a spark or flame is brought too near them. The room or compartment in which batteries are stored must be ventilated and away from flames or sparks.

Avoid sparks while charging batteries. Do not disturb connection between batteries until charger is OFF.

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

Improper use of a “booster” battery to start a crane when the normal battery is inadequate presents a definite explosion hazard. To minimize this hazard, the following procedure is suggested:

1. First connect both jumper cables to the battery on the crane to be started. Do not allow ends of cables to touch.
2. Then connect the positive cable to the positive terminal of the booster battery.
3. Finally, connect the remaining cable to the frame or block of the starting vehicle. ***Never*** connect it to the grounded terminal of the starting vehicle.

If electrolyte comes in contact with eyes, skin, or clothing, the area must be immediately flushed with large amounts of water. Seek first aid if discomfort continues.

### Causes Of Battery Failure

#### *Overcharging*

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

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

#### *Undercharging*

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

**Table 7-1 Battery Freeze Points**

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

The sulfate condition can eventually be converted to metallic lead which can short the positive and negative plates. These small shorts can cause low cell voltage when the battery is charged.

#### *Lack of Water*

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

#### *Hold-Downs*

Loose hold-downs will allow the battery to vibrate in the holder. This can cause cracks or wear in the container and cause acid to leak. Leaking acid corrodes terminals and cables causing high resistance battery connections. This weakens the power of the battery. Overtightened hold-downs can also distort or crack the container.

#### *Overloads*

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

### Multiple Battery System

Multiple battery systems are connected either in series or in parallel. ***Always refer to wiring diagram for correct connection.***

**NOTE:** Installing batteries with reversed electrical connections will not only damage batteries but also crane’s electrical system, voltage regulator, and/or alternator.

## Maintenance

### *Weekly – Check Electrolyte Level*

1. Clean the top of the battery before removing the vent caps. Keep foreign material out. Confirm that the plates in each cell are completely covered with electrolyte.
2. Distilled water should be used. Drinking water is, however, satisfactory. Water with a high mineral content (well, creek, pond) must not be used.
3. Never overfill the cells. Overfilling will cause electrolyte to pump out, and corrosion damage will result.

   Any spills on painted or metal surfaces must be immediately cleaned and acid neutralized with baking soda or ammonia.
4. Look for heavy deposits of black lead like mineral on the bottom of the vent caps. This indicates that active material is being shed (an 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 (80°F). Add 0.004 for each 6° above 27°C (80°F).

**NOTE:** It is the electrolyte temperature which is important, not air temperature.

8. Temperature corrected hydrometer readings may be explained as shown in Table 7-2.

**Table 7-2 Hydrometer Readings**

| Hydrometer Reading — Specific Gravity. | % Charge |
|---|---|
| 1.260 – 1.280 = | 100% |
| 1.230 – 1.250 = | 75% |
| 1.200 – 1.220 = | 50% |
| 1.170 – 1.190 = | 25% |
| 1.140 – 1.160 = | Very little useful capacity |
| 1.110 – 1.130 = | Discharged |
| If any two cells show more than 0.050 specific gravity variation, try to recharge the battery. If the variation persists, the battery should be replaced. | |

**NOTE:** For more specific hydrometer test information, see the instructions provided with your hydrometer.

## Open-Circuit Voltage Test

A sensitive voltmeter (Figure 7-1) can be used to determine a battery's state-of-charge as shown in Table 7-3.

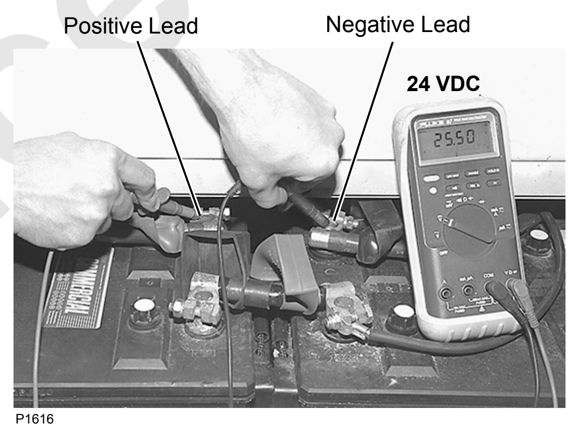



**FIGURE 7-1**

The open circuit test is not as reliable in determining a battery's condition as the hydrometer test. This test is acceptable for stored batteries, but not ones in use.

This test must not be performed on batteries being charged or delivering power; charging causes an increase in voltage which may persist for an extended period.

**Table 7-3 Open Circuit Cell Voltage**

| % Charge | Specific Gravity | Approximate Open Circuit Cell Voltage |
|---|---|---|
| 100 | 1.260 | 2.10 |
| 75 | 1.230 | 2.07 |
| 50 | 1.200 | 2.04 |

| % Charge | Specific Gravity | Approximate Open Circuit Cell Voltage |
|---|---|---|
| 25 | 1.170 | 2.01 |
| Discharged | 1.110 | 1.95 |

**NOTE:** Detailed test information is provided by the meter manufacturer.

## High Resistance Test

When cranking, a voltage drop of more than 0.2 volts between the starting motor cable and ground can cause hard starting regardless of a battery's condition. The voltage drop can be caused by a poor contact between the cable terminal and ground or between the clamp terminal and the battery post. Poor start-switch contacts and frayed, broken, or corroded cables can also be the cause.

## Quarterly

1. Thoroughly clean the batteries and the holder with baking soda.
2. If provided, make sure the drain holes are open in the holder. If water collects in the holder, drill drain holes.
3. Clean the posts and terminals. The posts can be tightly coated with grease to prevent corrosion.
4. Make sure the hold-downs are in good condition; replace faulty parts.
5. Replace frayed, broken, or corroded cables.
6. Replace the batteries if their containers are cracked or worn to the point they leak.
7. Ensure a good tight contact between the clamp terminals and battery posts.
8. Make sure the hold-downs are tight enough to prevent battery movement but not so tight to cause distortion.

## Charging

The battery should be at room temperature when recharging. Before a battery is recharged, it must be thoroughly cleaned. Take care not to allow dirt to enter the cells.

A battery should be recharged in the way it was discharged. If it was discharged over a long period of time, it should be recharged slowly at 6 to 10 amperes for up to 10 hours. A rule-of-thumb value for a slow rate is a current equal to about one-half the number of plates per cell in the battery. A battery with 13 plates per cell, should, therefore be charged at 7 amperes.

If a battery was discharged rapidly (cranking until dead), it can be recharged on a fast charger with an output of up to 40 amperes for a maximum of 2 hours. If the electrolyte temperature reaches 52°C (126°F) or if it gases violently, the charging current must be reduced or halted to avoid battery damage.

***For optimum charging results, adhere to the charger manufacturer's instructions.***

## Storage

When the crane is left idle for prolonged periods, it should be run periodically to charge the batteries.

When storing a battery, make sure it is at least 75% charged to prevent the possibility of freezing.

***Follow your battery dealer's recommendations.***

## Battery Disconnect Switch

See Figure 7-2 for the following procedure.

A battery disconnect switch is provided on the left side of rotating bed, near the engine node. Use the switch to disconnect the batteries when servicing the electrical control system. Turn switch handle counter-clockwise to disconnect the batteries for crane maintenance. In the disconnect position the handle can be removed from the switch.

**See Section 3 of Crane Operator Manual for operation of the battery disconnect switch.**

**CAUTION**

**Engine Damage!**

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

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

Make sure engine ignition switch has been off five minutes before disconnecting batteries.

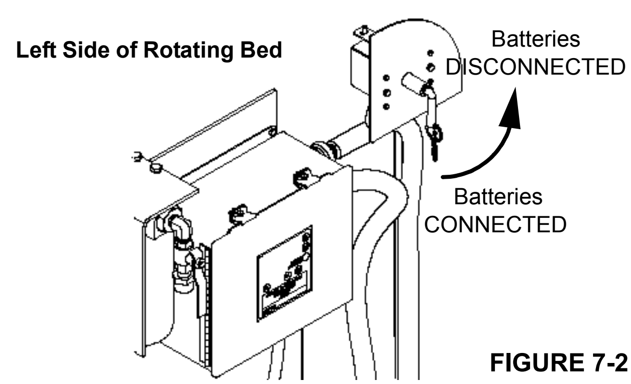



**FIGURE 7-2**

# ENGINE DIAGNOSTICS

## General

The Cummins QSX15 Engine has two types of fault codes:

- Engine electronic fuel system fault codes
- Engine protection system fault codes

All fault codes are either active or inactive. Active engine faults can be viewed on the crane's digital display either with the engine running or with the engine off (run/stop/run switch in RUN position). Inactive faults can only be read with electronic service tool supplied by the engine manufacturer.

The engine diagnostic lights are mounted on the front console in the operator's cab as shown in Figure 7-3.

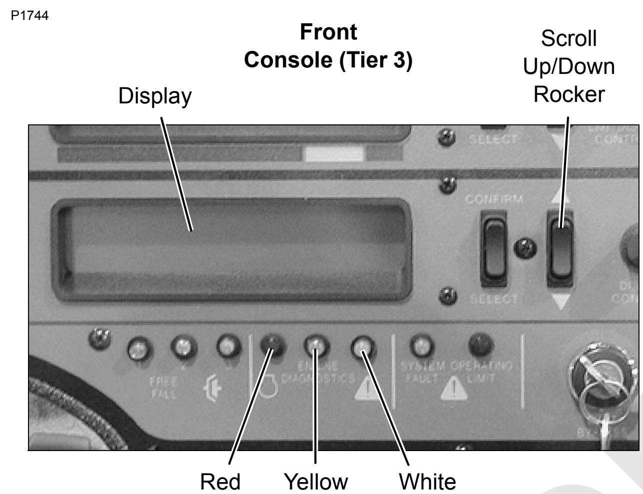



**FIGURE 7-3**

RED STOP LIGHT

When on, the red stop light indicates the need to ***stop engine as soon as safely possible*** and correct the fault.

### CAUTION

If possible, lower lifted loads to ground and then stop engine as soon as possible when red stop light comes on. Permanent damage can occur if engine is run while red stop light is on. Do not run engine until fault is corrected.

YELLOW WARNING LIGHT

When on, the yellow warning light indicates that engine can be run, but the fault should be corrected as soon as possible.

WHITE MAINTAIN LIGHT

When on, the white maintain light indicates that engine maintenance is required. See engine manufacturer's manual for maintenance instructions.

## On-Board Engine Diagnostics

### *Engine Diagnostics — Cummins*

Active engine faults can be viewed on the crane's digital display either with the engine running or with the engine off (run/stop/run switch in RUN position). A laminated list of fault codes is located in the operator's cab.

- Scroll up or down with rocker on right side of digital display until Engine Diagnostics screen appears.
- Corresponding flash code for each active fault will appear next to FLASH CODE as shown in Figure 7-4.

  The screen will automatically scroll through each fault at two-second intervals if more than one fault exists.

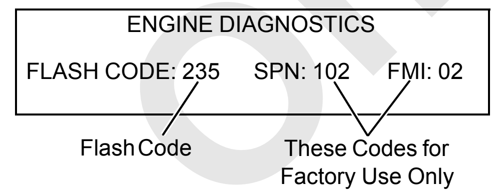



**FIGURE 7-4**

### *DPF Diagnostics — Tier 4*

See Figure 7-5 for the following procedure.

**DPF High Temperature**

GLOWS YELLOW to alert crane operator that the exhaust system temperature is higher than normal due to DPF regeneration.

### WARNING

**High Exhaust Temperatures!**

Active DPF Regeneration can occur at low engine idle as well as during crane operation. This may result in high exhaust temperature. Always keep personnel well away from the exhaust to prevent injury and possible death.

**DPF Condition**

Displays one of three conditions if the Regeneration Inhibit switch is on (reference the Engine Manufacturer's Manual for additional information):

- GLOWS YELLOW when DPF is active and starting to fill. **Turn off regeneration inhibit switch**. No immediate action is required.
- FLASHING when DPF is nearly full. The operator may sense a reduction in power. **Turn off regeneration inhibit switch.** Perform a manual stationary regeneration of the DPF at earliest convenience.

- OFF when DPF is full and Red Engine Stop Light is ON. The soot level is critically high and past the point of a manual stationary regeneration. The operator will notice a significant reduction in engine power. **Turn off regeneration inhibit switch and shut down crane. Do NOT** perform a manual stationary regeneration. The DPF must be removed from the crane and physically cleaned and the Red Engine Warning Light can only be cleared by a Cummins Service Technician, see Engine Manufacturer's Manual for details.

### DPF Regeneration Inhibit On

GLOWS YELLOW when active regeneration has been stopped by pressing the Inhibit function (bottom) of the regeneration switch. Excessive use of regeneration inhibit will result in the need to service or replace the DPF.

### DPF Regeneration/Inhibit Switch

The DPF switch is a three position switch. Top position is momentary. Center and bottom position are maintained.

CENTER position is for NORMAL engine operation. Regeneration of the DPF will occur automatically.

Press TOP of rocker to START manual stationary regeneration. Release switch back to center position. Cummins ECM will control a DPF regeneration if necessary. It is normal for the DPF High Temperature lamp to illuminate.

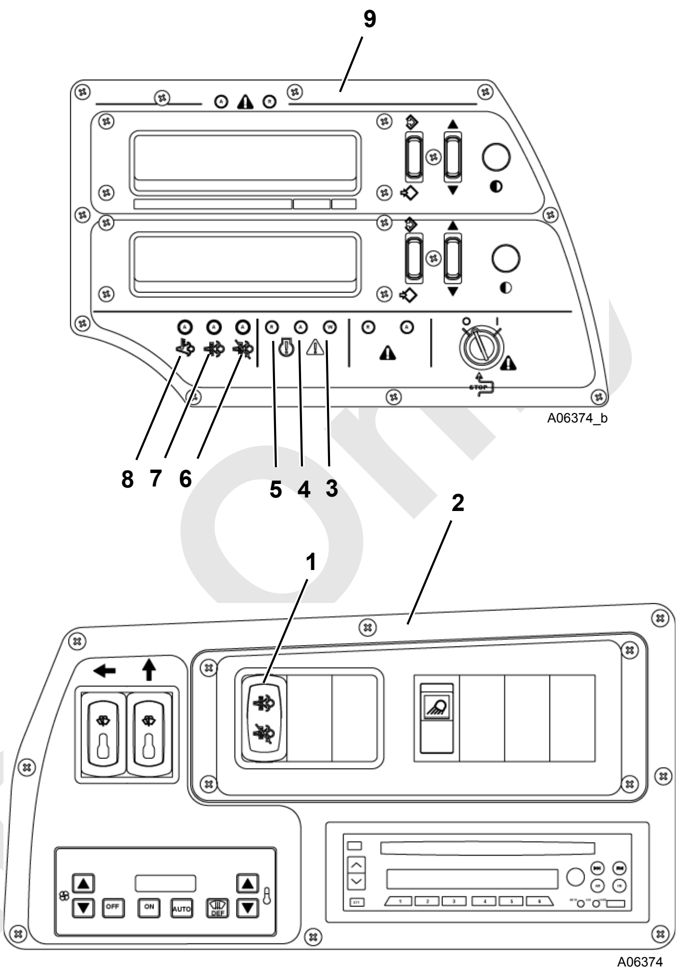
Perform a manual stationary regeneration **only** if indicated by the DPF diagnostic in the Tier 4 Engine Diagnostics — Cummins QSX15 Tier 4, (see DPF Condition for details).

**NOTE:** A guard over the top of the rocker prevents accidental manual regeneration of the DPF.

Press BOTTOM of rocker to INHIBIT active regeneration. The amber LED in the rocker will glow.

Use INHIBIT only for special circumstances where it is desirable to disable active regeneration. Prolonged engine operation with INHIBIT on will cause the DPF to fill with soot. Too much soot could cause the engine to stop. If that occurs it will be necessary to clean the DPF before the engine can be restarted.

See Engine Manufacturer's Manual for additional information regarding stationary regeneration and DPF inhibit operating instructions.




**DPF Diagnostics**

| Item | Description |
|---|---|
| 1 | DPF Regeneration/Inhibit Switch |
| 2 | Right Hand Console Accessory Panel |
| 3 | Engine Maintenance Light — White |
| 4 | Engine Warning Light — Amber |
| 5 | Engine Stop Light — Red |
| 6 | DPF Inhibit On — Amber |
| 7 | DPF Regeneration On — Amber |
| 8 | DPF High Temperature — Amber |
| 9 | Front Console (Tier 4) |

**FIGURE 7-5**

7

# ENGINE AIR CLEANER MAINTENANCE

## Tier 3 and Past Production

See Figure 7-6 for the following procedure.

The air cleaner is mounted horizontally and fastened to the engine air intake manifold with rubber elbows and metal tubes. Servicing the engine air cleaner is an important maintenance function:

- A clogged air cleaner filter 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:

**1.** Check service indicator ***daily*** with engine running.

The indicator gives a visual signal when it is time to replace the air cleaner.

The red flag in the indicator window rises as the air cleaner fills with dirt. ***Replace air cleaner when red flag locks in place at top of indicator.***

The red flag remains up after the engine is stopped. After the air cleaner is replaced, push the button ***in*** on the indicator to reset it.

**2.** Inspect elbows and tubes between air cleaner and engine for cracks or other damage which might allow unfiltered air to enter engine. Replace defective parts.

**3.** Check air cleaner housing for dents or other damage that may allow unfiltered air to enter engine. Replace air cleaner if damaged.

**4.** Check for loose clamps and tighten if required.

**5.** Check that inlet cap is free of obstructions.

**6.** Check that Evacuator™ Valve is open.

## Service

See Figure 7-6 for the following procedure.

---

### 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 air cleaner. Discard old air cleaner and install a new one.

---

**1.** Release seal carefully:

Unlatch and remove service cover. Make certain latches are folded back against cover so that they don't hinder filter removal/installation. Most latches are spring loaded to fold back when open. The air cleaner has two filters: a primary and a safety. 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 off outlet tube and out of housing. Avoid knocking filter against housing.

Repeat steps 1 and 2 for safety filter.

**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 that all contaminant 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 carefully and seal it by hand, making certain filter is completely seated in housing.

Repeat this step for primary filter.

**8.** Install service cover:

Once filter is in place, put service cover back on, making sure the Evacuator™ Valve points down. Re-fasten latches. 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 filter in could cause damage to housing and will void warranty.

Donaldson RadialSeal™ filters are self-aligning, self-centering, and self-sealing. New filters have a dry lubricant to aid installation. The critical sealing areas will stretch slightly, adjust themselves, and distribute the sealing pressure evenly. To complete a tight seal, apply pressure by hand at outer rim of filters, not the flexible center. Avoid pushing center of urethane end cap. No cover pressure is required to hold the seal. Again, ***do not*** use service cover to push filter into place.

**9.** Check connections for tight fit:

Make sure that all clamps, bolts, and connections in entire air intake system are tight. Check for holes in piping, and repair if needed.

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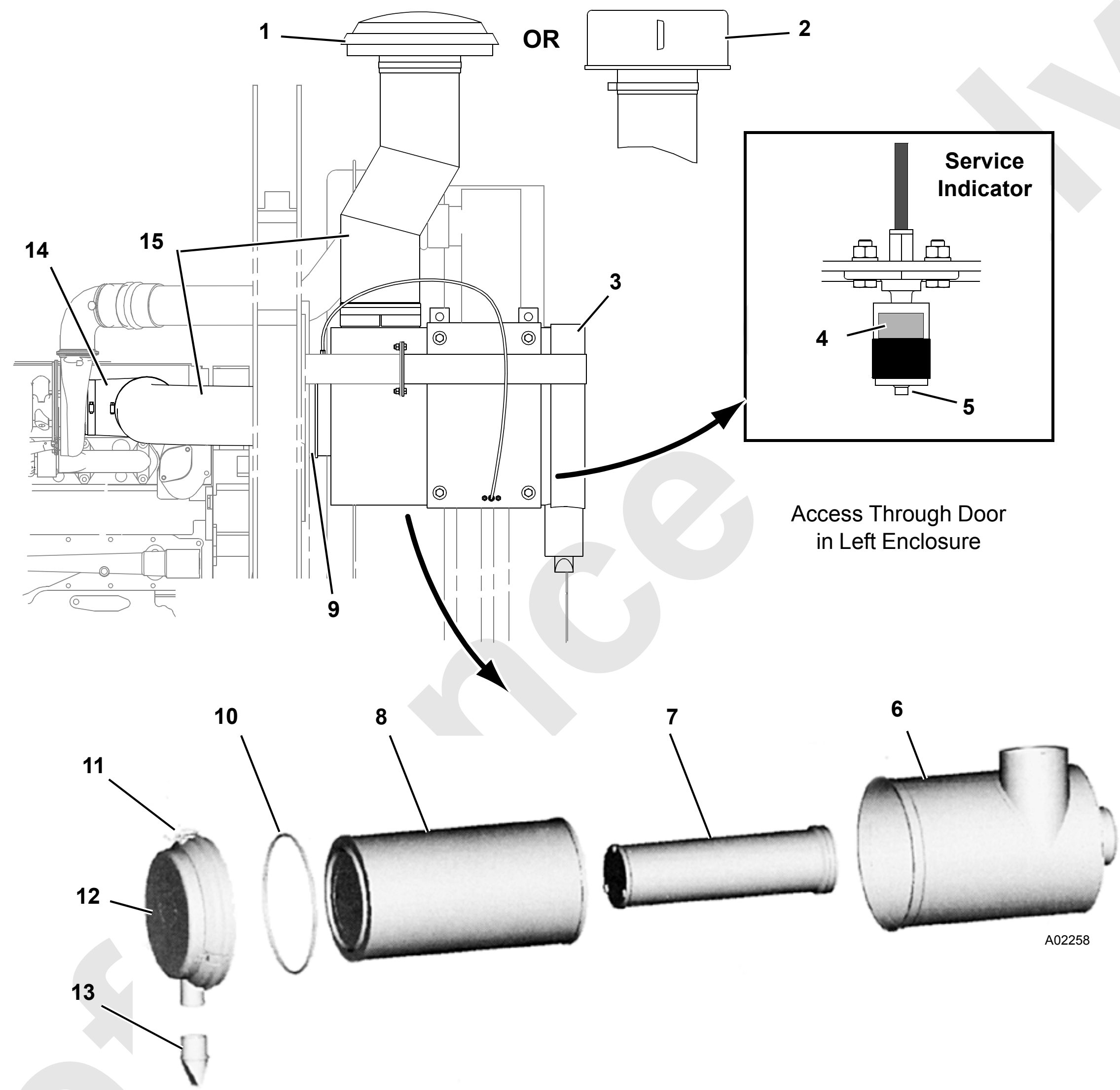



| Item | Description | Item | Description |
|---|---|---|---|
| 1 | Standard Inlet Cap | 9 | Rubber Reducer with Clamps |
| 2 | Pre-Cleaner Inlet Cap | 10 | Cover Seal |
| 3 | Housing | 11 | Clamp |
| 4 | Window | 12 | Service Cover |
| 5 | Reset Button | 13 | Evacuator™ Valve |
| 6 | Housing | 14 | Rubber Elbow with Clamps |
| 7 | Safety Filter | 15 | Tube |
| 8 | Primary Filter | | |

**FIGURE 7-6**

## Tier 4 Current Production

See Figure 7-7 for the following procedure.

The Tier 4 intake assembly has mounting brackets (4) that are fastened to the engine air cleaner assembly (3) with three rubber elbow reducers (1), clamps (2), and straight adapter tubes connecting it to the eng[ine. Servicing the air cleaner is an important function because:

- Clogged air cleaner filters will prevent adequate air flow to the engine, causing poor starting and increased exhaust emissions.
- An improperly installed or damaged air cleaner can allow dirty air to be drawn directly into the engine.

Either condition can cause engine damage.

## Inspection

To maintain engine protection and filter service life, inspect the following areas at regular intervals:

### *Daily*

Check service indicator (6) with engine running. The indicator gives a visual indication when it is time to replace the filters.

- A yellow flag in the indicator window extends as the filters become plugged. ***Replace filters when the yellow indicator reaches the red zone at the end of the indicator.***
- The yellow flag remains locked in place after the engine is stopped. When the filters are replaced, push button (7) ***in*** to reset the indicator.

### *Monthly*

1. Inspect rubber reducers (1) between air cleaner and engine for cracks or other damage which might allow unfiltered air to enter the engine. Replace worn or damaged parts.
2. Check air cleaner assembly housing (3) for dents or other damage that may allow unfiltered air to enter engine. Replace housing if damaged.
3. Check for loose clamps (2). Tighten if necessary.
4. Inspect engine intake pre cleaner (5) for obstructions or damage. Clean as required.

**CAUTION**

**Engine Damage!**

STOP ENGINE before servicing air cleaner or unfiltered air will be drawn directly into engine.

Before servicing clean fittings, mounting hardware and area around component(s) to be removed.

Never operate engine without air cleaner.

Replace secondary filter as quickly as possible to avoid engine ingestion of contaminants.

Do not attempt to clean and re use old filters. Discard old filters and install new filters. Cleaning filter elements by impact or compressed air voids the warranty and can degrade or damage the filter media, leading to malfunction.

## Service

Service the air cleaner and its primary and secondary filter elements per the intervals specified by the engine manufacturer and per the engine manufacturer's instructions. An illustration of these instructions is located on the air filter cover (see Figure 7-7).

Replacement of the primary filter is indicated only when the red flag locks in place at the top of the service indicator.

**NOTE:** The recommended service interval for replacing the secondary element is every **3rd** time the primary element is replaced

**CAUTION**

**Engine Damage!**

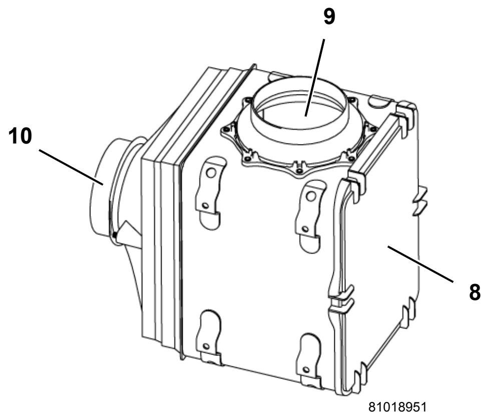
STOP ENGINE before servicing air cleaner, or unfiltered air will be drawn directly into engine.

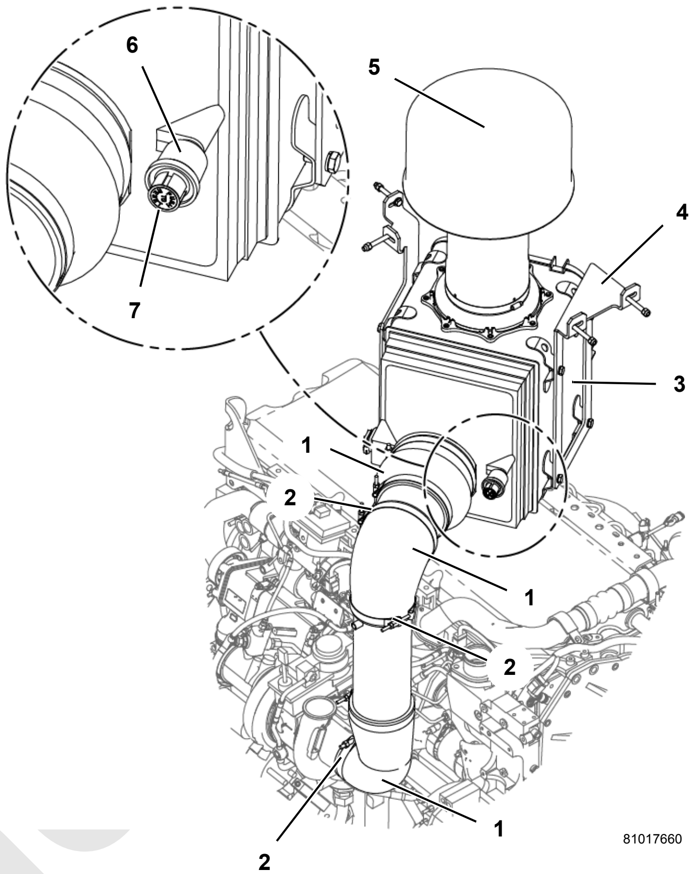
Do not attempt to clean and reuse old filter. Discard old filter and install a new one.

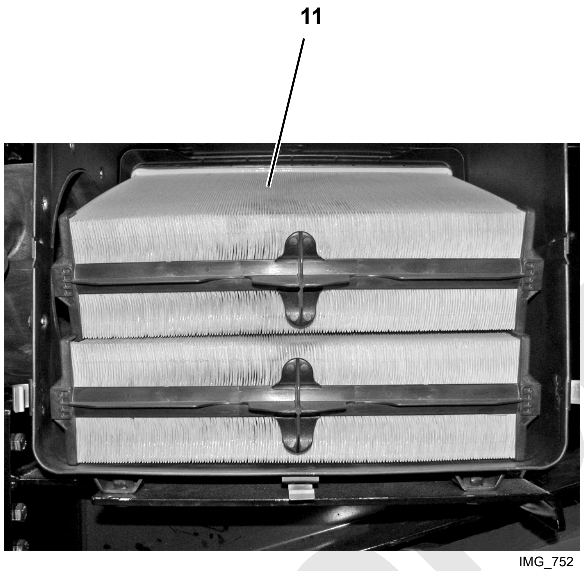
1. Wipe any accumulated dirt, grease, or other foreign material from the outside surface of the air cleaner assembly to prevent contamination when opening the air cleaner or integral pre-cleaner assemblies.

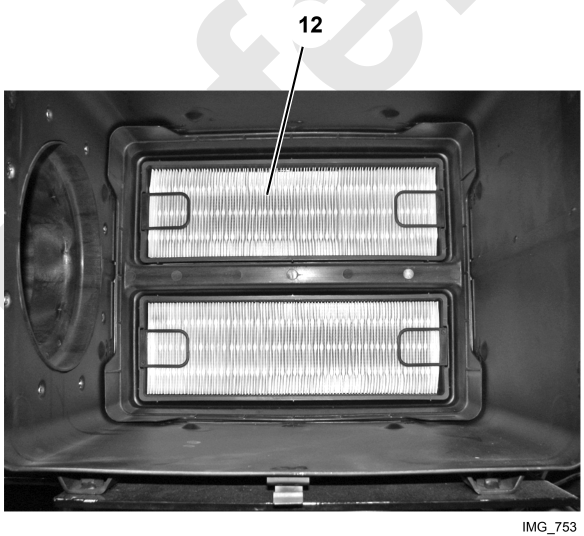
   ***Do not allow foreign matter to enter housing, tubing or air inlet hole to the engine.***

2. Refer to the engine manufacturer's instructions to open, service and close the air cleaner or integral pre-cleaner assemblies.




| Item | Description |
|---|---|
| 1 | Rubber Reducer |
| 2 | Clamp (6) |
| 3 | Air Cleaner Assembly |
| 4 | Mounting Bracket |
| 5 | Pre Cleaner |
| 6 | Service Indicator |
| 7 | Reset Button |
| 8 | Filter Access Cover |
| 9 | Air Cleaner Assembly Inlet |
| 10 | Air Cleaner Assembly Outlet |
| 11 | Primary Filter |
| 12 | Secondary Filter |

7

**FIGURE 7-7**

## ENGINE CLUTCH ADJUSTMENT

See Figure 7-8 for the following procedure.

A disc-type manually operated clutch is mounted between the engine and the pump drive on this crane. The clutch allows the pump drive to be disconnected from the engine, thereby reducing engine load and making start-up easier in cold weather. The clutch can be engaged or disengaged while the engine is running or off.

### CAUTION

**Avoid Clutch Damage!**

Observe the following precautions for the engine clutch:

- ***Decrease engine speed to idle*** before engaging or disengaging clutch.
- Do not run engine longer than twenty minutes with clutch disengaged.
- Disengage and engage clutch several times monthly with engine running.

## Operation

1. Grease clutch monthly. See Lubrication Guide in Section 9 of this manual.
2. At least once each month, disengage and engage the clutch several times with engine running. This practice will clean disc surfaces and prevent discs from seizing.
3. When disengaging clutch, check free travel at lower bracket. Free travel should be 2-3/8 – 2-1/2 in (60 – 64 mm). Readjust the clutch when free travel decreases to 1-3/8 in (35 mm).

### DANGER

**Moving Machinery Hazard!**

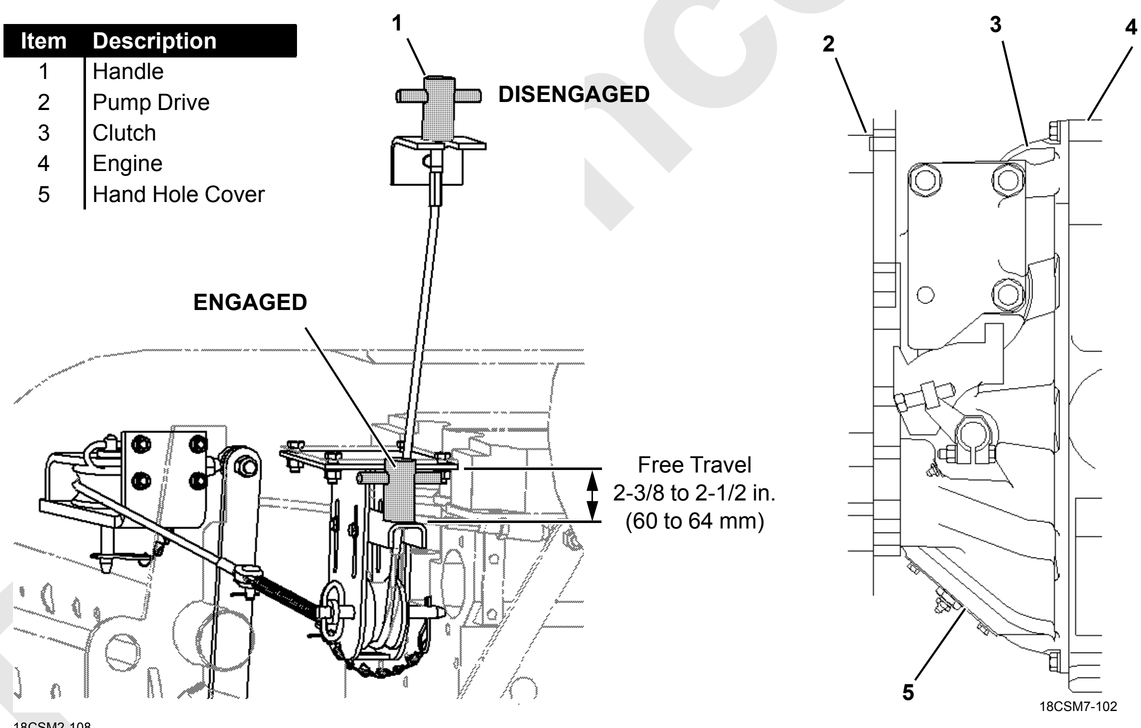
Parts inside clutch rotate when engine is running.

STOP ENGINE before adjusting clutch.

## Adjustment

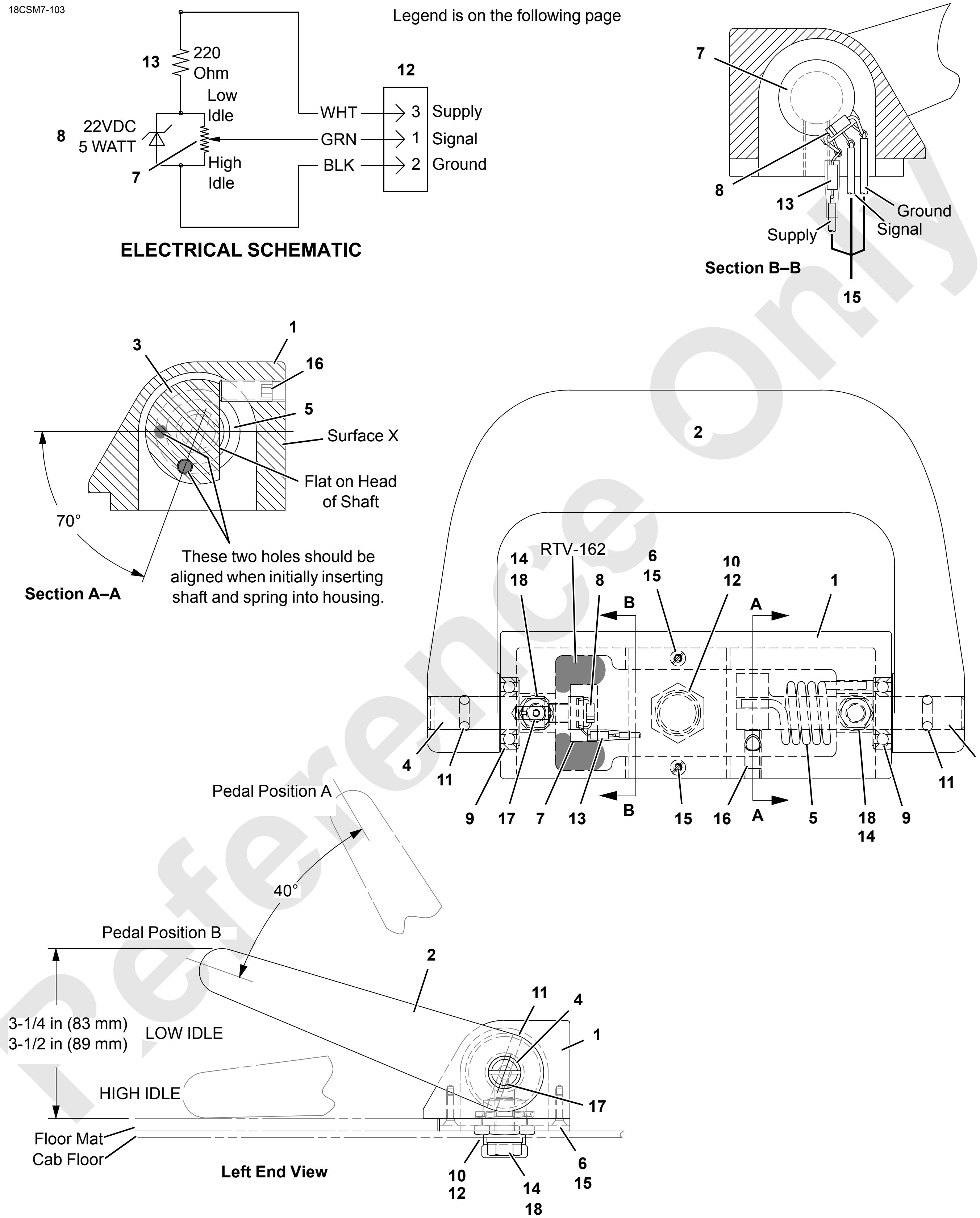
The clutch is adjusted internally through the hand hole on top of clutch housing. See the manufacturer's manual for adjustment instructions.

| Item | Description |
|---|---|
| 1 | Handle |
| 2 | Pump Drive |
| 3 | Clutch |
| 4 | Engine |
| 5 | Hand Hole Cover |




Left Side of Rotating Bed

FIGURE 7-8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Legend is on the following page
13
220
Ohm
Low
Idle
8
22VDC
5 WATT
7
High
Idle
12
WHT
GRN
BLK
3 Supply
1 Signal
2 Ground
ELECTRICAL SCHEMATIC
7
8
13
Ground
Signal
Supply
Section B–B
15
1
3
16
5
Surface X
Flat on Head
of Shaft
70°
These two holes should be
aligned when initially inserting
shaft and spring into housing.
Section A–A
2
RTV-162
14
18
8
6
15
10
12
1
B
A
4
11
9
17
7
13
B
15
16
A
5
18
14
9
11
3
Pedal Position A
40°
Pedal Position B
2
11
4
1
3-1/4 in (83 mm)
3-1/2 in (89 mm)
LOW IDLE
HIGH IDLE
17
Floor Mat
Cab Floor
Left End View
10
12
14
18
6
15

FIGURE 7-9

## ENGINE THROTTLE ADJUSTMENT

The engine throttle assembly consist 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.

## FOOT THROTTLE CONTROLLER

See Figure 7-9 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.

### Assembly

1. To assemble shaft (3) and torsion spring (5) into housing (1), first assemble spring onto shaft by inserting lug on one end of spring into hole in head of shaft.
2. Insert shaft (3) into cavity in bottom of housing (1), through bearing (9), and into pedal (2).

   Lug on outboard end of spring (5) must engage hole in housing (1) (Section A-A).
3. Insert shaft (4) into cavity in bottom of housing (1), through bearing (9), and into pedal (2).
4. Rotate pedal (2) as needed and install roll pins (14) through holes in pedal and shafts (Pedal Position "A").
5. Install setscrew (16). Do not insert deep enough to contact head on shaft (3).
6. Rotate pedal approximately 40° to position "B" (low idle). At this time flat on head of shaft (3) should be parallel with surface X on housing. Finish turning in setscrew (14) until it contacts flat on head of shaft (Section A-A).

### Calibration

Supply voltage to be 25.0 to 26.0 VDC.

1. Turn potentiometer (7) shaft fully CCW as viewed from shaft end (zero volts out).
2. With pedal (3) in Position B, insert potentiometer (7) into cavity in bottom of housing (1) as shown in View B-B. Insert potentiometer shaft into end of shaft (4) and tighten setscrew (22).
3. Rotate pedal to high idle position, hold in place using setscrew (16), and rotate potentiometer housing to obtain an output of 0.90 to 1.00 VDC.
4. Apply silicone sealant RTV-162 (MCC #622201) between housing (1) and potentiometer (7). Do not get sealant on shaft (4). Allow sealant to cure one to two hours before proceeding to next step.
5. After sealant has cured, check output for 0.90 to 1.00 VDC in high idle position.
6. Remove setscrew (16), apply LOCTITE #242 (MCC #622293) to threads, and adjust setscrew to obtain a low idle position output reading of 2.90 to 3.00 VDC.

## ENGINE SPEED CALIBRATION

Engine speed is calibrated automatically by the crane's programmable controller:

- HIGH IDLE = 1,800 rpm
- LOW IDLE = 1,050 rpm

**Component Identification for Figure 7-9**

| Item | Qty. | Description | Item | Qty. | Description |
|---|---|---|---|---|---|
| 1 | 1 | Foot Pedal Housing | 10 | 1 | Conduit Nut (1/2 in.) |
| 2 | 1 | Foot Pedal | 11 | 2 | Roll Pin (3/16 in. Diameter x 1-1/2 in. Long) |
| 3 | 1 | Foot Pedal Shaft (right) | 12 | 1 | 3-Pole Male Receptacle |
| 4 | 1 | Foot Pedal Shaft (left) | 13 | 1 | Resistor (220 Ohm, 1Watt) |
| 5 | 1 | Torsion Spring | 14 | 2 | Hex Head Cap Screw (3/8 in.-16UNC x 3/4 in. Long) |
| 6 | 1 | Receptacle Mounting Bracket | 15 | 2 | Flat Head Brass Screw (#6-32UNC x 1/2 in. Long) |
| 7 | 1 | Potentiometer | 16 | 1 | Allen Head Cup Set Screw (5/6 in.-18UNC x 3/4 in. Long) |
| 8 | 1 | Zener Diode (22 VDC, 5 Watt) | 17 | 1 | Allen Head Cup Set Screw (#6-32UNC x 3/16 in. Long) |
| 9 | 2 | Roller Bearing | 18 | 2 | Lockwasher (3/8 in.) |

# ENGINE COOLING SYSTEM

## General

The cooling system consists of a vertically mounted radiator in front of the engine with a hydraulically driven blower-type fan.

## Operation

### *Coolant Flow*

The cooling system is of the de-aerated type, which continually removes air from the system, as follows:

- A small percentage of total coolant flow is circulated through a vent line to the radiator.
- Since coolant circulation is very slow in the radiator, air separates from the coolant.
- Air collects at the top of the radiator. When pressure rises to 15 psi (1,03 bar), the relief in the fill cap opens to exhaust air through overflow line.
- De-aerated coolant returns to the system through a make-up line.

| Item | Description | Item | Description |
|---|---|---|---|
| 1 | Engine | 6 | Vent Line |
| 2 | Water Pump Housing | 7 | Fill Cap |
| 3 | Thermostat Housing | 8 | Cooler Assembly |
| 4 | Bypass Line | 9 | Fan |
| 5 | Make up Line | 10 | Motor |

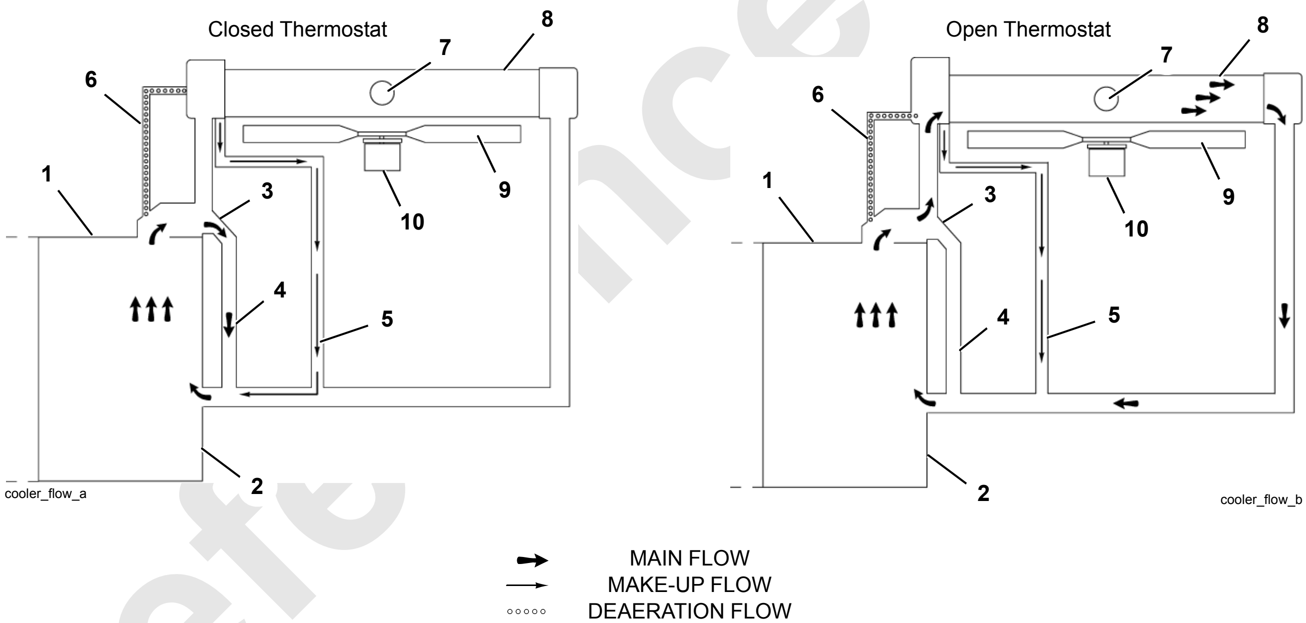



FIGURE 7-10



7

## Maintenance

See Figure 7-11 for the following procedure.

**WARNING**

**Burn Hazard!**

Avoid personal injury from heated coolant spray or steam — do not remove radiator cap from hot engine. Stop engine and wait until coolant temperature is below 120°F (50°C). Then:

- Place a protective covering over fill cap.
- Slowly turn fill cap counterclockwise until it stops at safety detent.
- Wait until pressure (indicated by hissing sound) is completely relieved.
- Depress fill cap and turn counterclockwise to remove.

**CAUTION!**

**Overheating Hazard!**

Avoid engine damage from overheating — do not allow coolant level to go below low level on gauge.

### *Daily Maintenance (Start of Each Shift)*

**NOTE:** Check coolant level when cold.

1. Coolant should be at full level of cold gauge.
2. Fill cooling system as required with coolant.

   See engine manufacturer's manual for antifreeze and coolant additive recommendations.
3. Look for coolant leaks while engine is running. Correct if found.

### *Semiannual Checks*

1. Inspect fill cap and thermostat for proper operation and replace worn parts:
   - Fill cap relieves at 15 psi (1,03 bar).
   - *Thermostat closes at 180°F (82°C) and opens fully at 200°F (93°C).*
2. Inspect water pump belts for wear and proper adjustment (see engine manufacturer's manual).
3. Inspect cooling system hoses for deterioration and other defects. Replace as necessary.
4. Tighten hose clamps.
5. Clean all dirt and other debris from outside of radiator.
6. Check that overflow line on tank is open.

### *Draining Cooling System*

Drain radiator system, as follows:

1. Stop engine.
2. Remove the cooler assembly fill cap.
3. Open drain valve and drain coolant into a suitable container.
4. Close the drain valve once the system is completely drained.

### *Filling Cooling System*

See the engine manufacturer's manual for antifreeze and coolant additive recommendations. Add coolant to FULL (COLD) LEVEL as determined on checks per the schedule in the engine owner's manual.

1. Fill cooling system through cooler assembly fill cap to FULL (COLD) LEVEL mark on sight gauge. Coolant system capacity is approximately 21 gallons (79,5 liters).

**CAUTION!**

**Engine Damage!**

The required coolant level must be maintained to prevent engine damage.

Do not remove the deaeration tank fill cap from a hot engine. Allow the engine to cool below 50°C (120°F) before adding coolant.

Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool below 50°C (120°F) before adding coolant.

Coolant is toxic. Do not ingest. If not reused, dispose of in accordance with all local and other applicable environmental regulations.

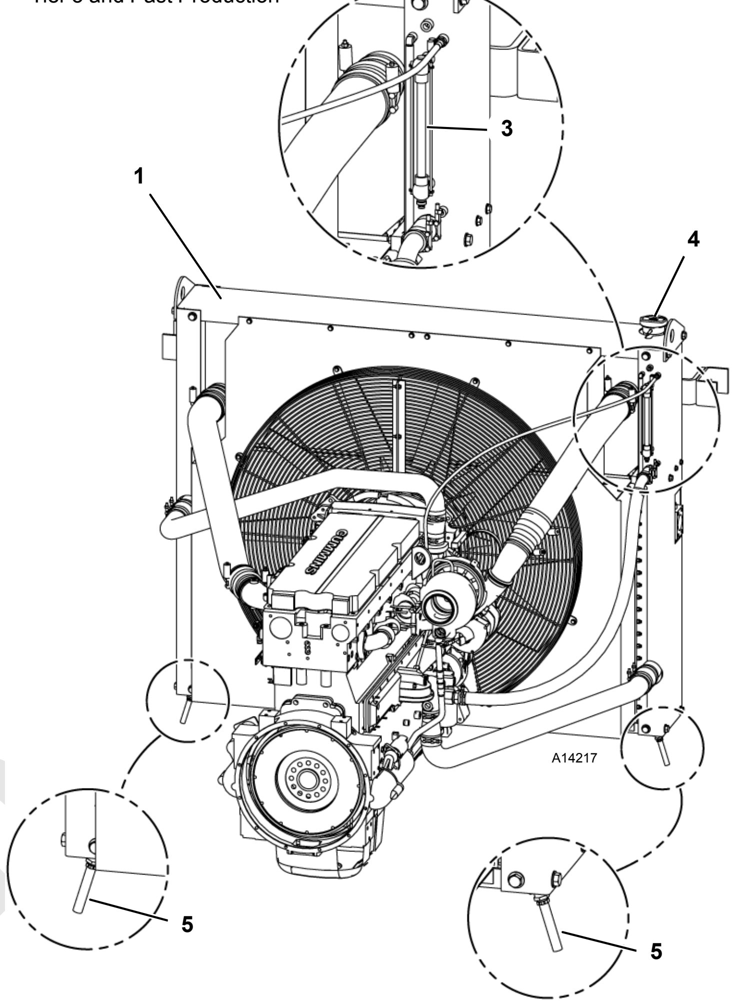
2. Look for coolant leaks while engine is running. Correct if found.
3. Stop engine, wait until engine is cool, and refill cooling system to FULL (COLD) level mark.

### *Supplemental Coolant Additive*

Supplemental Coolant Additive must be added to the cooling system to prevent liner pitting and for scaling protection. Check SCA concentration according to the schedule in the engine manufacturer's operator manual and per warnings, cautions and instructions in the engine manufacturer's service manual.

| Item | Description |
|---|---|
| 1 | Cooler Assembly Tier 3 and Past Production |
| 2 | Cooler Assembly Tier 4 |
| 3 | Coolant Level Sight Gauge |
| 4 | Cooler Assembly Fill Cap |
| 5 | Cooler Assembly Drain |

Tier 3 and Past Production




Tier 4 Current Production

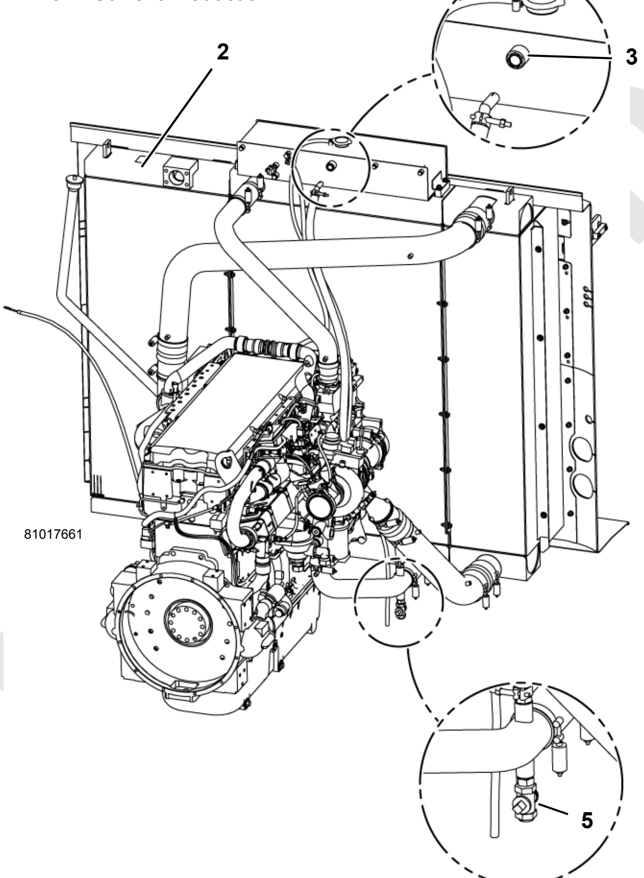
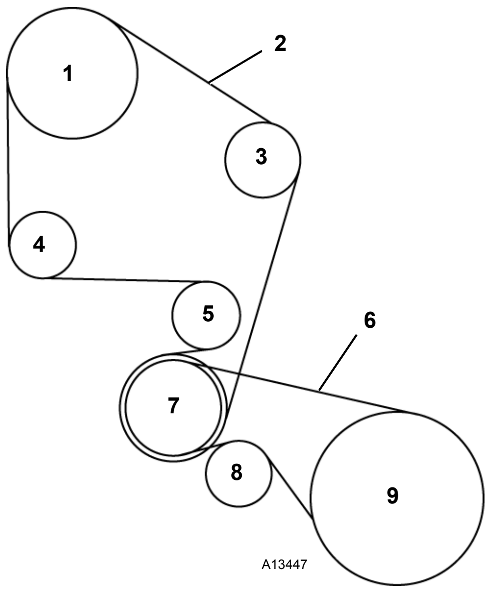



**FIGURE 7-11**

# ENGINE BELT ROUTING

## Tier 3 Engine

Engine belt routing for the Tier 3 engine is shown in Figure 7-12 to help service personnel when installing a new fan belt.

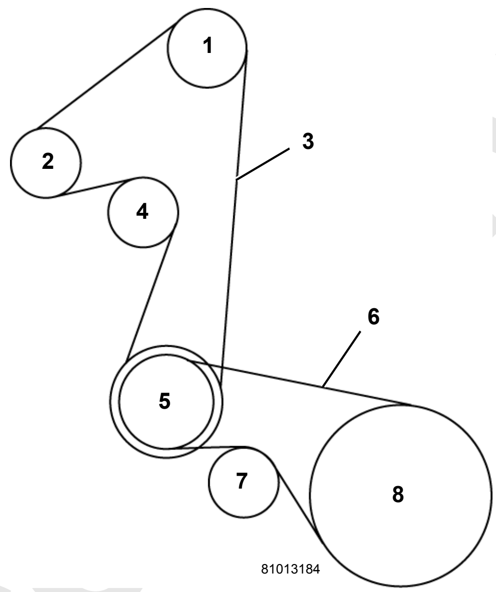



| Item | Description |
|---|---|
| 1 | Water Pump |
| 2 | Belt #1 |
| 3 | Tension Pulley |
| 4 | Alternator |
| 5 | Tension Pulley |
| 6 | Belt #2 |
| 7 | Pulley |
| 8 | Tension Pulley |
| 9 | Crankshaft Flywheel |

FIGURE 7-12

## Tier 4 Engine

Engine belt routing for the Tier 4 engine is shown in Figure 7-13 to help service personnel with installing a new fan belt.




| Item | Description |
|---|---|
| 1 | Water Pump |
| 2 | Alternator |
| 3 | Belt #1 |
| 4 | Tension Pulley |
| 5 | Pulley |
| 6 | Belt #2 |
| 7 | Tension Pulley |
| 8 | Crankshaft Flywheel |

FIGURE 7-13

# DIESEL PARTICULATE FILTER — TIER 4

## General

The Diesel Particulate Filter (DPF) — located in the engine enclosure — captures soot and ash from the engine exhaust.

- Soot is partially burned fuel particles that occur during normal operation (black smoke).
- Ash is partially burned engine oil particles that occur during normal operation.

Over time, both soot and ash are collected in the DPF and must be removed.

- Soot is removed by a process called **regeneration**.
- Ash is removed by manually cleaning the DPF at specified intervals (see Engine Manufacturer's Manual for detailed instructions).

## Regeneration

### *General*

Regeneration is the process of converting the soot collected in the DPF into carbon dioxide. Regeneration requires heat to occur. Two types of regeneration are used: passive and active.

### *Passive Regeneration*

Passive regeneration occurs when exhaust temperatures are naturally high enough to oxidize the soot faster than it is collected in the DPF.

The process typically occurs when the crane is operated at high speeds and/or under heavy loads.

The operator will not know when passive regeneration is occurring.

### *Active Regeneration*

Active regeneration occurs when exhaust temperatures are NOT naturally high enough to oxidize the soot faster than it is collected in the DPF. If this happens, the engine's controller will initiate the process (see Engine Manufacturer's Manual for detailed instructions).

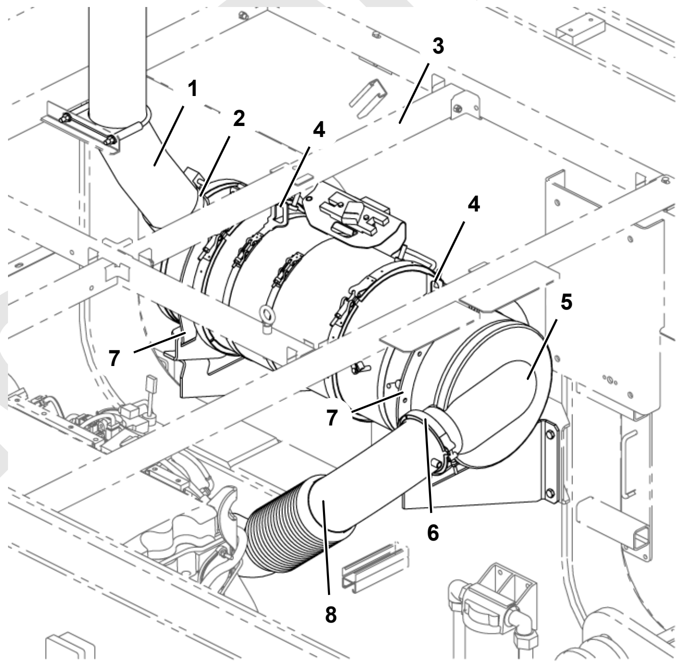
The process occurs more frequently in cranes operated at low speed, light or no load, or stop and go cycles.

Active regeneration will be transparent to the operator, except that he/she may notice an increase in turbocharger noise and an increase in exhaust temperature (high exhaust temperature condition light comes on).

**NOTE:** Use the INHIBIT switch in the operator's cab only for special circumstances where it is desirable to disable active regeneration. Prolonged engine operation with INHIBIT on will cause the DPF to fill with soot. Too much soot could cause the engine to stop. If that occurs it will be necessary to clean the DPF before the engine can be restarted.

### *Stationary Regeneration*

Stationary regeneration is a form of active regeneration that is initiated by the operator when the crane is parked. The DPF ON light will flash to alert the operator if stationary regeneration is required (see Section 3 of the Crane Operator Manual and the Engine Manufacturer's Manual for detailed instructions).




| Item | Description |
|---|---|
| 1 | Exhaust Outlet Tube |
| 2 | Outlet Tube V-Band Clamp and Gasket |
| 3 | Engine Enclosure Mounting Bracket |
| 4 | DPF Lifting Bracket |
| 5 | DPF Exhaust Inlet |
| 6 | Inlet Tube V-Band Clamp and Gasket |
| 7 | DPF Mounting Strap |
| 8 | Inlet Tube |

**FIGURE 7-14**

## Maintenance

Accumulated ash must be periodically cleaned from the DPF center section. A build-up of ash can result in cold spots and compact the ash within the DPF. This reduces the life of the filter, can damage it, and may increase the time required for regeneration.

In the United States, the Environmental Protection Agency requires that cleaning of the DPF be done at a minimum service interval of 4,500 operating hours, (roughly every two years of one-shift operation). This cleaning requires special tools using equipment specifically made for this purpose. The DPF cannot be cleaned using conventional methods. For this reason, it is recommended that the DPF be sent to the manufacturer for cleaning, or exchanged for a clean DPF if operation of the crane is critical. The DPF must be removed, sent for cleaning, then the cleaned DPF or a replacement installed.

### *DPF Removal*

See Figure 7-14 for the following procedure:

For inspection and/or cleaning, the DPF must be removed. It may be re-usable.

**NOTE:** The DPF must be removed *and replaced* if engine Fault Code 1981 or 1922 has been noted and the DPF is contaminated with coolant.

**DANGER**

**Electrical Shock Hazard!**

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

**WARNING!**

**Explosion Hazard!**

Batteries can explode and emit explosive gas. To reduce the chance of injury, always ventilate the area before servicing the batteries. Always remove the negative battery cable first and attach the negative cable last.

**WARNING**

**Burn and Inhalation Hazards!**

Temperature of exhaust and exhaust components for Tier 4 engines can be higher than other engines.

To prevent death or serious injury:

- Allow engine and diesel particulate filter to cool before performing maintenance.

**CAUTION**

**Engine Damage!**

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

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

1. Disconnect the crane's batteries by disconnecting the negative battery cable first and the positive battery cable last or turn the battery disconnect to the "Disconnect" position and remove the key.
2. Removed engine enclosure panels and bracing (3) as needed for clearance to DPF.
3. Disconnect the electrical wiring to the DPF. Remove wiring harness and P-clamp mounts on the DPF and lay to the side.
4. Loosen (but do not remove) V-band clamp and gasket (6) from the inlet side of the DPF. Slide clamp and gasket onto inlet tube.
5. Loosen screws, locknuts, and washers securing inlet tube support bracket or remove U-bolt guillotine clamp to free inlet tube assembly.
6. Disconnect inlet tube assembly (8) from DPF.
7. Loosen (but do not remove) V-band clamp and gasket (2) from the outlet side and slide onto outlet tube.
8. Loosen screws, locknuts, and washers securing outlet tube support bracket or remove U-bolt guillotine clamp to free outlet tube assembly.
9. Disconnect outlet tube assembly (1) from DPF.

10. Mark the direction of exhaust flow, from inlet to outlet, on the outside of the DPF. This will help if the DPF will be cleaned and re-installed.

**WARNING!**

**Personal Injury Hazard!**

The Diesel Particulate Filter assembly weighs more than 50 lb (23 kg). To prevent serious personal injury, use assistance or appropriate lifting equipment when lifting or removing.

**CAUTION!**

**Equipment Damage!**

The oxidation catalyst elements of the diesel particulate filter are made of brittle material. Do not drop or strike the side of the DPF as damage to these elements can result.

11. Attach hoist chains to lifting hooks (4) on the DPF and lift just enough to remove slack in the chain.
12. Remove hex cap screws and locknuts on each DPF mounting strap (7) and remove straps from DPF mounting bracket.
13. Using hoist, lift the DPF out of the mounting brackets (View A, Figure 7-15).

### *DPF Installation*

1. Using hoist, lift the DPF into the mounting brackets (View A, Figure 7-15).
2. Perform DPF re-orientation procedure if required following cleaning or replacement of the center section.
3. Reverse DPF removal procedure for installation.

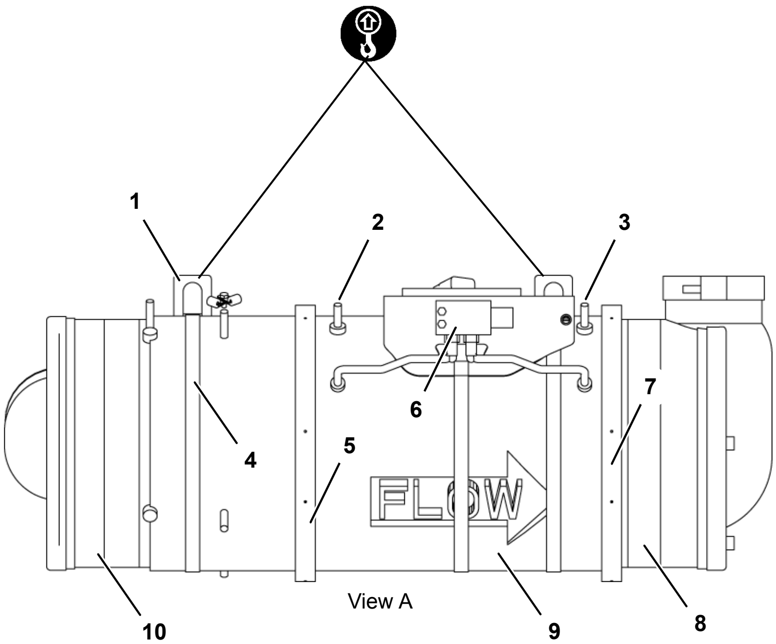
### *DPF Re-Orientation*

See Figure 7-15 for the following procedure.

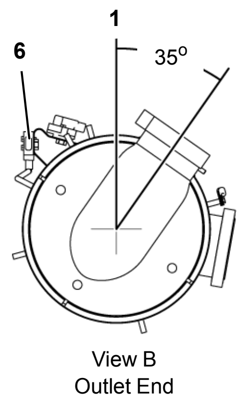
**NOTE:** It will only be necessary to re-orientate the DPF prior to installation after the center section has been removed for cleaning.

1. Prep DPF center section by removing any electrical wiring and P-clamp mounts as necessary and noting location of P-clamp mounts for re-installation. Store electrical wiring clear of DPF.
2. Loosen each V-Band clamp connecting the inlet section and the outlet section to the filter center section until each section can be freely rotated. Do not fully remove the clamp or gasket.
3. Rotate the inlet and outlet section to orientation shown in View B and C, Figure 7-15.
4. Tighten each V-Band clamp to 20 Nm (14.48 ft-lb).
5. Gently tap the circumference of each clamp with a rubber mallet to ensure proper seating of the V-Band. Re-torque to 20 Nm (14.48 ft-lb).
6. Loosen both band clamps retaining the lifting hooks on the inlet and outlet sections until the lifting hooks can be freely rotated.
7. Rotate each lifting hook back to vertical position. Ensure band clamp hardware is rotated 35° from the hook. Adjust hook orientation to ensure sensor harness will not be damaged while lifting.
8. Tighten the band clamp for each lifting hook to 7,3 Nm (64.6 in-lb).
9. Re-install DPF electrical wiring and P-clamps as necessary. Tighten P-clamps to 7,3 Nm (64.6 in-lb). Wires installed in P-clamps must not be within 25 mm of the DPF body. Avoid sharp bends and excessive tension in sensor wires.

7




| Item | Description |
|---|---|
| 1 | Lifting Hook |
| 2 | Temperature Sensor 1 |
| 3 | Temperature Sensor 2 |
| 4 | Lifting Hook Band |
| 5 | Inlet V-Band Clamp |
| 6 | Pressure Sensor |
| 7 | Outlet V-Band Clamp |
| 8 | DPF Outlet Section |
| 9 | DPF Center Section |
| 10 | DPF Inlet Section |



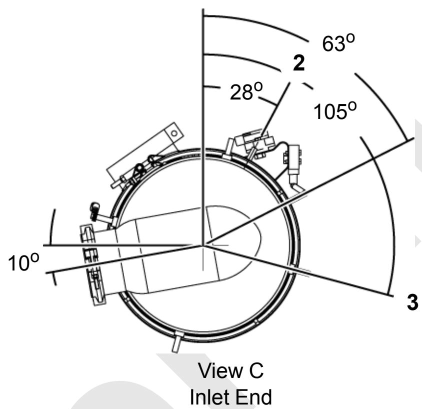




**FIGURE 7-15**

# SECTION 8
# UNDER CARRIAGE

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8

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# SECTION 8
# UNDER CARRIAGE

## TURNTABLE BEARING BOLT TORQUE

### Torque Requirements

**DANGER**

**Crushing Injury Hazard!**

Two people are required to torque turntable bearing bolts: an operator to operate swing control and a mechanic to torque bolts.

Mechanic must go inside carbody to torque inner turntable bearing bolts.

- Maintain constant communication between operator and mechanic while mechanic is inside carbody.
- Operator, do not swing upperworks until instructed to do so by mechanic.

Mechanic, stay well clear of moving parts while upper is being swung to position bolts.

**WARNING**

**Bolt Failure!**

Loose or improperly torqued bolts can cause bolts or turntable bearing to fail, possibly allowing upperworks to break away from carbody.

#### *Lubrication*

Before installing the turntable bearing bolts, lubricate the threads of each bolt and both sides of each washer with "Never-Seez" (MCC No. 361010) or an equivalent antiseizing lubricant.

#### *Torque Values*

Torque each turntable bearing bolt to 6,600 ft-lb (8 948 Nm).

When new bolts are installed, torque the bolts in two steps: first to 2,200 ft-lb (2 983 Nm) and then to 6,600 ft-lb (8 948 Nm).

#### *Torque Sequence*

Torque the bolts (two at a time in most cases) in the numbered sequence given in Figure 8-1 (one ring at a time).

#### *Torque Intervals*

Initial operation: torque all bolts to the specified value after the first 50 hours of operation.

Yearly or every 2,000 hours of operation (whichever comes first): torque all bolts to the specified value.

#### *Bolt Replacement*

**NOTE:** Always replace the washer when replacing a bolt.

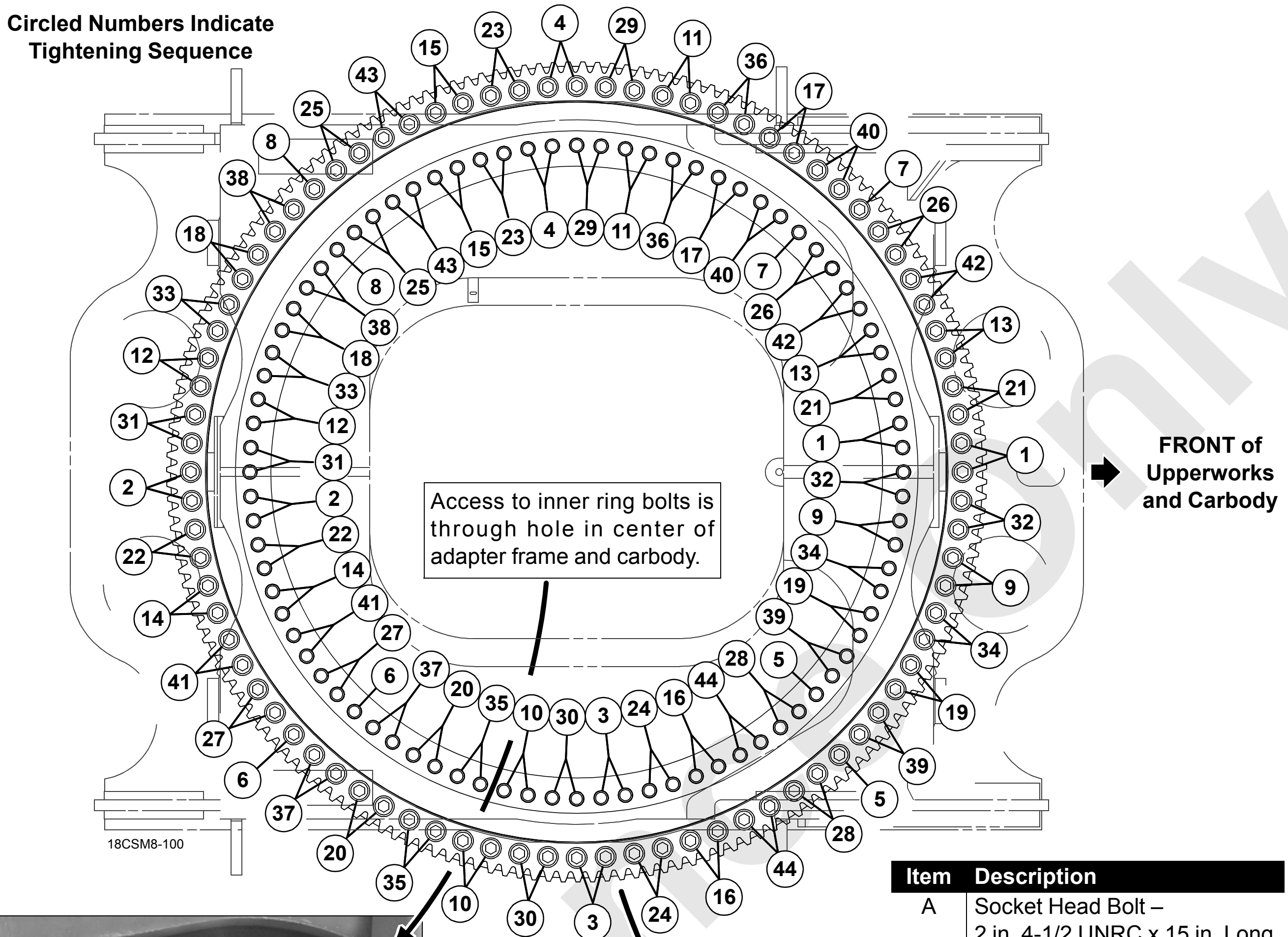
If at the yearly inspection interval, one or more bolts are found to be torqued to less than 5,280 ft-lb (7 159 Nm), replace each loose bolt. Also replace the bolt and washer on each side of each loose bolt.

If at the yearly inspection interval 17 or more bolts in either ring are found to be torqued to less than 5,280 ft-lb (7 159 Nm), replace all of the bolts and washers for the corresponding ring.

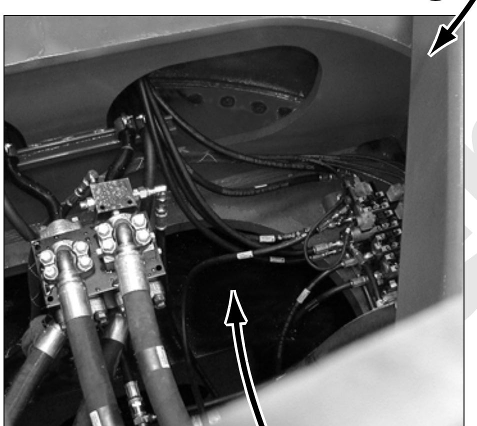
Replace all bolts and washers each time a new turntable bearing is installed.



8




| Item | Description |
|---|---|
| A | Socket Head Bolt –<br>2 in. 4-1/2 UNRC x 15 in. Long<br>84 in Each Ring |
| B | Flat Steel Washer –<br>3-1/4 in. OD x 2-1/8 in. ID<br>84 in Each Ring with<br>**Chamfer Toward Bolt** |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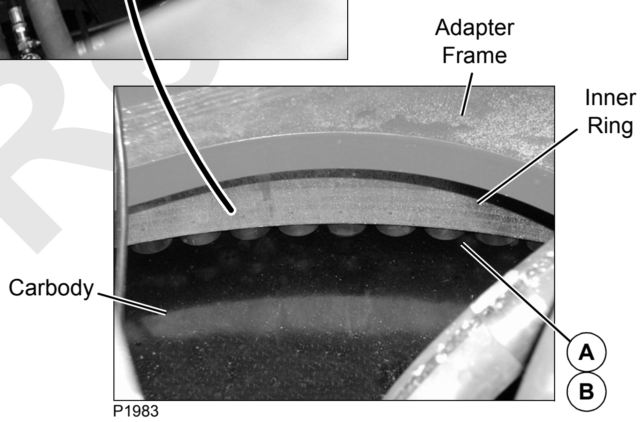

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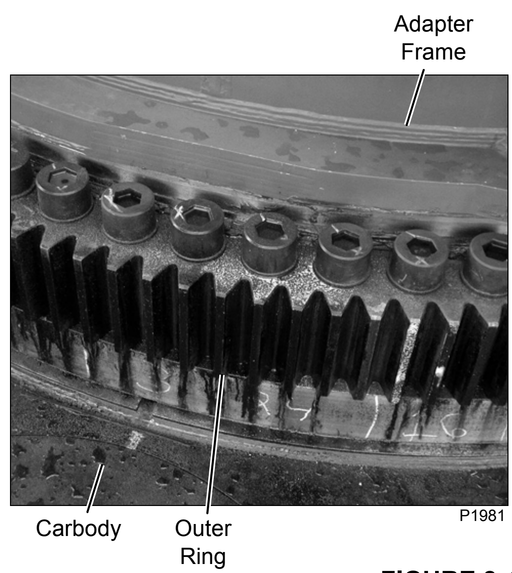

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**FIGURE 8-1**

# CRAWLER ADJUSTMENT

## Maintenance

Crawler wear cannot be eliminated, but the rate of wear can be reduced through regular preventive maintenance, as follows:

- Lubricate crawlers as instructed in Lubrication Guide.
- Keep crawlers clean and avoid dirt build-up when cutting.
- Keep all mounting bolts tight (see Parts Manual for applicable torque values).
- Keep treads properly adjusted.
- Inspect crawler gear cases, crawler frames, rollers, and treads on a regular basis.

  Look for oil leaks, excessive wear, cracks, and other damage. Broken or cracked parts can indicate that the treads are adjusted too tight.

  Repair or replace damaged parts immediately to prevent further damage.

## Tread Slack Adjustment

### *Adjustment Guideline*

Check tread slack at the tumbler end of each crawler. Maintain equal tread slack at both crawlers.

1. Travel forward or reverse on a firm level surface so all tread slack is in top of treads at tumbler end of crawlers as shown in Figure 8-2.
2. Place straight edge on tread as shown in Figure 8-2. Gap between straight edge and top of tread at lowest point should be 1-1/2 in (38 mm) (tight limit) to 3 in (76 mm) (loose limit).
3. Adjust tread slack if gap exceeds either limit.
4. Adjust treads tighter when operating on firm ground and looser when operating on soft ground (mud or sand).

**CAUTION**

**Pin Damage!**

Do not adjust treads too tight. Tread pins will wear rapidly and may break. Dirt build-up will tighten treads even more, increasing possibility of damage.

More torque is required to drive tight treads, which results in faster wear and more fuel consumption.

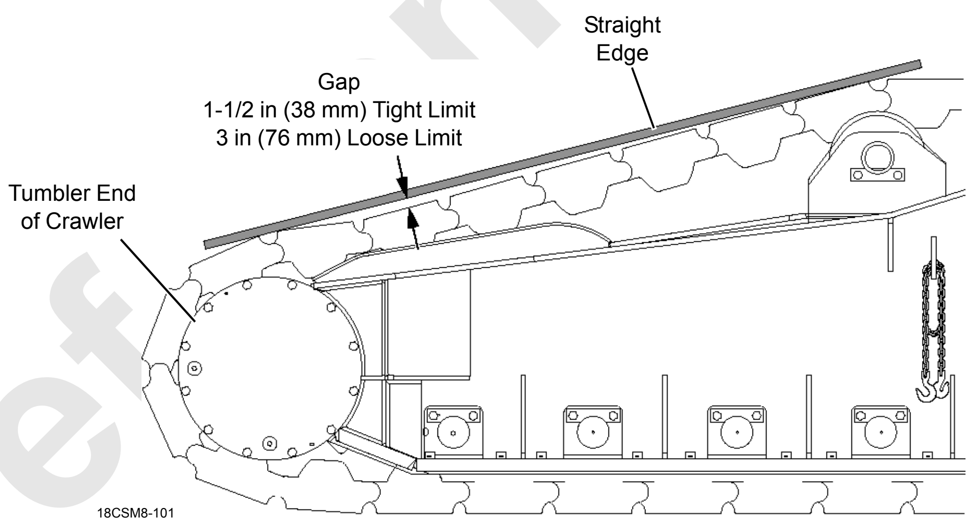



**FIGURE 8-2**

### *Adjustment Procedure*

Adjust tread slack at roller end of each crawler (Figure 8-3).

1. Thoroughly clean crawler to be adjusted.
2. Loosen bolt on each side of crawler roller.
3. Remove cover from both sides of crawler frame.

**CAUTION**

**Cylinder Damage!**

Two jacking cylinders (one on each side of crawler frame) are required to prevent damage to single jacking cylinder.

4. Place jacking cylinders on supports on both sides of crawler frame.
5. Jack against rod an equal amount on both sides of crawler frame.
6. Add or remove an equal thickness of shims on both sides of crawler frame.
7. Remove jacking cylinders.
8. Travel crane forward or reverse to tighten shims.
9. Check that dimension from center punch (A) in shaft to center punch line (B) in crawler frame is same on both sides of crawler to within 1/8 in (3 mm).

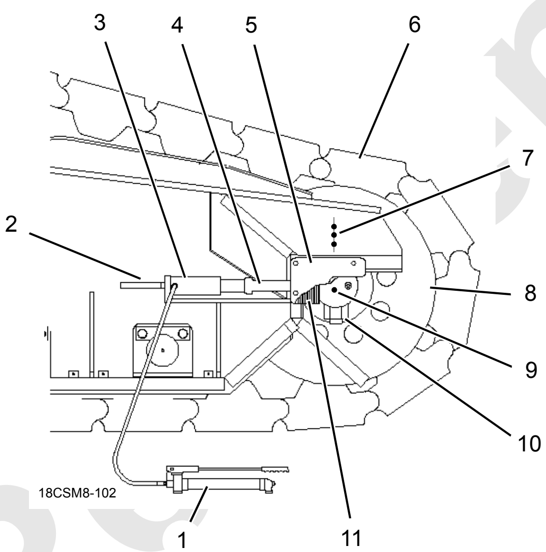
**CAUTION**

**Part Wear!**

Crawler roller and tumbler must be square with crawler frame within 1/8 in (3 mm). Otherwise, parts will wear rapidly.

10. Check for proper adjustment (see Adjustment Guideline) and readjust as required (steps 4 through 9).
11. Tighten nuts on bolts at crawler roller to 2,000 ft-lb (2 710 Nm) lubricated with Never-Seez or an equivalent oil and graphite mixture.
12. Install cover on both sides of crawler frame.

**NOTE:** The extreme limit of tread adjustment occurs when the bolts are tight against the front end of the slots in the crawler frame. One crawler tread can be removed when this limit is reached.




| Item | Description |
|---|---|
| 1 | Hand Pump |
| 2 | Support |
| 3 | Jacking Cylinder |
| 4 | Rod |
| 5 | Cover |
| 6 | Tread |
| 7 | Center Punch Line B |
| 8 | Crawler Roller |
| 9 | Center Punch A |
| 10 | Bolts |
| 11 | Shims<br>0.134 in (3 mm) and<br>0.250 in (6 mm) Thick |

**FIGURE 8-3**

# HYDRAULIC HAND PUMP

See Figure 8-4 for the following procedures.

**WARNING**

**Prevent Possible Death or Serious Injury to Maintenance Personnel**

Manitowoc has provided hand pump and cylinder for crawler adjustment only. Any other use is neither intended nor approved.

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

Do not exceed maximum pressure rating of components (pump, cylinder, hose) – 10,000 psi (700 bar). Higher pressure can cause components to explode.

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

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

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

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

## Assembly

1. Connect hose from pump outlet port to cylinder inlet.
2. Use 1-1/2 wraps of a high-grade thread sealant on fittings (for example, Teflon tape).

   ***Do not apply sealant to first complete thread to ensure tape does not shed into hydraulic system and cause malfunctioning or damage.***
3. Do not over tighten connections. Connections only need to be snug and leak free. Over-tightening can cause premature thread failure and may cause fittings or castings to split at lower than their rated pressures.

## Maintenance

1. Keep unit clean and stored in a safe place where it cannot be damaged.
2. Keep oil in pump at proper level. Check level as follows:
   a. Open valve and fully retract cylinder rod to return all oil to pump. ***Cylinder must be fully retracted or system will contain too much oil.***
   b. For Simplex pump:
      - Place pump in horizontal position on a flat surface.
      - Using a screw driver, remove vent/fill cap.
      - Add hydraulic oil until reservoir is 2/3 full. ***Do not overfill.***
      - Securely reinstall vent/fill cap.
   c. For Enerpac pump:
      - Place pump in vertical position with hose end down.
      - Using a screw driver, remove vent/fill cap.
      - Add hydraulic oil until it is at mark on dipstick. ***Do not overfill.***
      - Securely reinstall vent/fill cap.
   d. Test operation and remove air from system, if required. Recheck level after removing air.

## Air Removal

1. Close valve finger tight only.
2. Position pump higher than cylinder and position cylinder so rod is down.
3. Operate pump to fully extend cylinder rod.
4. Open valve and retract cylinder rod to force oil and trapped air back into pump.
5. Repeat steps until cylinder operates smoothly. *Erratic operation indicates air in system.*

## Operation

1. Before using pump:
   a. Check that all fittings are tight and leak free.
   b. Check oil level.
2. To pressurize cylinder and extend rod, close valve by turning clockwise until finger tight only. Then pump handle up and down.

   Pressure will be maintained until valve is opened.

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

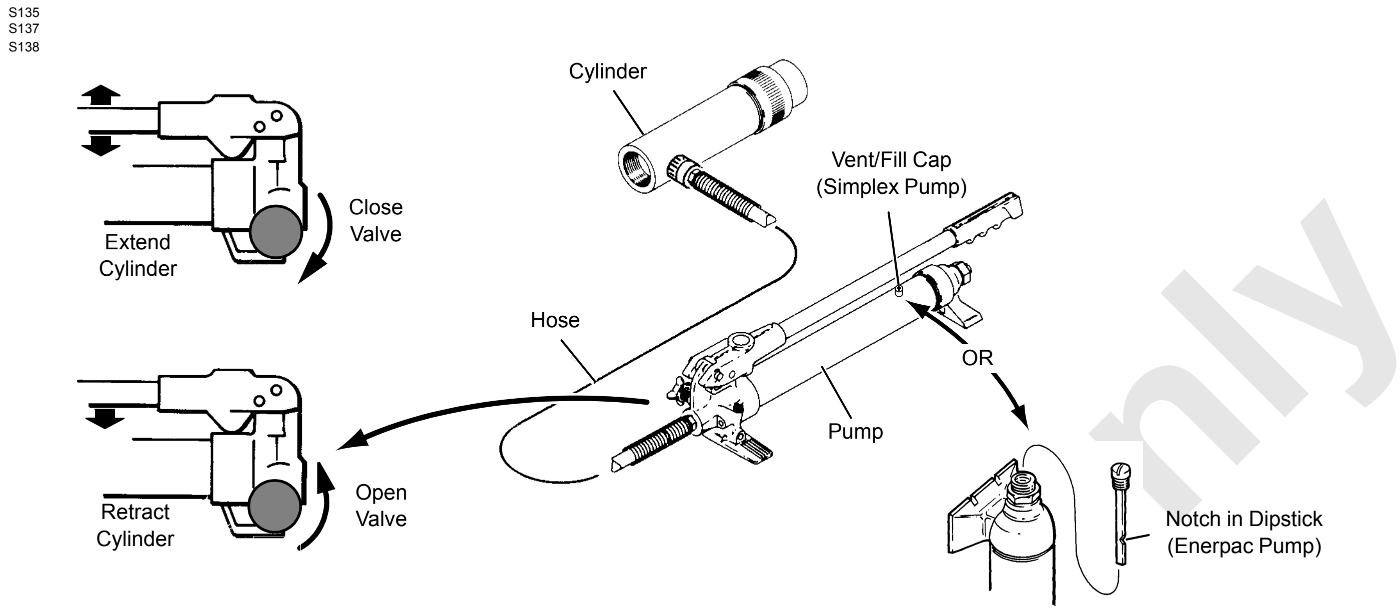

S135
S137
S138
Cylinder
Vent/Fill Cap
(Simplex Pump)
Close
Valve
Extend
Cylinder
Hose
OR
Pump
Open
Valve
Retract
Cylinder
Notch in Dipstick
(Enerpac Pump)

FIGURE 8-4

# SECTION 9
# LUBRICATION

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# SECTION 9
# LUBRICATION

## LUBRICATION

See F2104 at the end of this section.

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# SECTION 10
# TROUBLESHOOTING

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# SECTION 10
# TROUBLESHOOTING

## GENERAL TROUBLESHOOTING

This troubleshooting section is designed for qualified service technicians familiar with the operation and repair of electrical and hydraulic equipment. It is not possible to predict all problems that might occur or the correct procedure for troubleshooting each problem. ***If a problem is encountered that is not covered in this manual, first consult your Manitowoc dealer. The Manitowoc Crane Care Lattice Team can also provide assistance.***

## SAFETY SUMMARY

Hazards are always a possibility when performing trouble-shooting operations on heavy equipment. To minimize the risk of potential hazards and to prevent serious injury or death, comply with the following:

- Read the Operator Manual and Service/Maintenance Manual before beginning troubleshooting operations.
- Troubleshooting operations must be performed by a qualified service technician, competent in the repair and testing of electrical and hydraulic equipment. Manitowoc is not responsible for training personnel who might use this manual to perform troubleshooting operations.
- Whenever possible, turn off crane engine for your protection and keep unauthorized personnel away from the crane when troubleshooting.
- Never troubleshoot the crane alone. Always perform troubleshooting procedures with a qualified operator in crane cab. Maintain constant communication with this operator when performing operations that require crane engine to be running.
- Do not return crane to service after completion of maintenance or repair procedures until all guards and covers are re-installed, trapped air is bled from hydraulic systems, safety devices are enabled and maintenance equipment is removed.
- Perform a function check to ensure correct operation at completion of maintenance or repair operations.

The following warnings apply to all troubleshooting operations.

Manitowoc cannot foresee all hazards that may occur. Technicians shall be familiar with the equipment, trained in testing methods, and use common sense while troubleshooting to avoid other hazards.

**WARNING**

**Eye, Skin, And Respiratory Hazards!**

Wear proper eye and skin protection and avoid direct contact with battery acid, oil, or ether spray when searching for leaks, opening connections, or installing a pressure gauge.

Pressurized hydraulic oil can cause serious injury. Turn ***off*** engine, remove key, and relieve pressure on system before disconnecting, adjusting, or repairing any component.

Ensure that connections are made correctly, O-rings or gaskets are in place, and connectors are tight before pressurizing system.

Use necessary precautions to prevent electrical burns when checking battery charging and starter circuits.

Death or serious injury can occur if these warnings are ignored.

**Unexpected Moving Part Hazard!**

Keep personnel away from crane while manually actuating a valve or pump to avoid unexpected equipment movement that can cause death or serious injury.

## GENERAL TROUBLESHOOTING

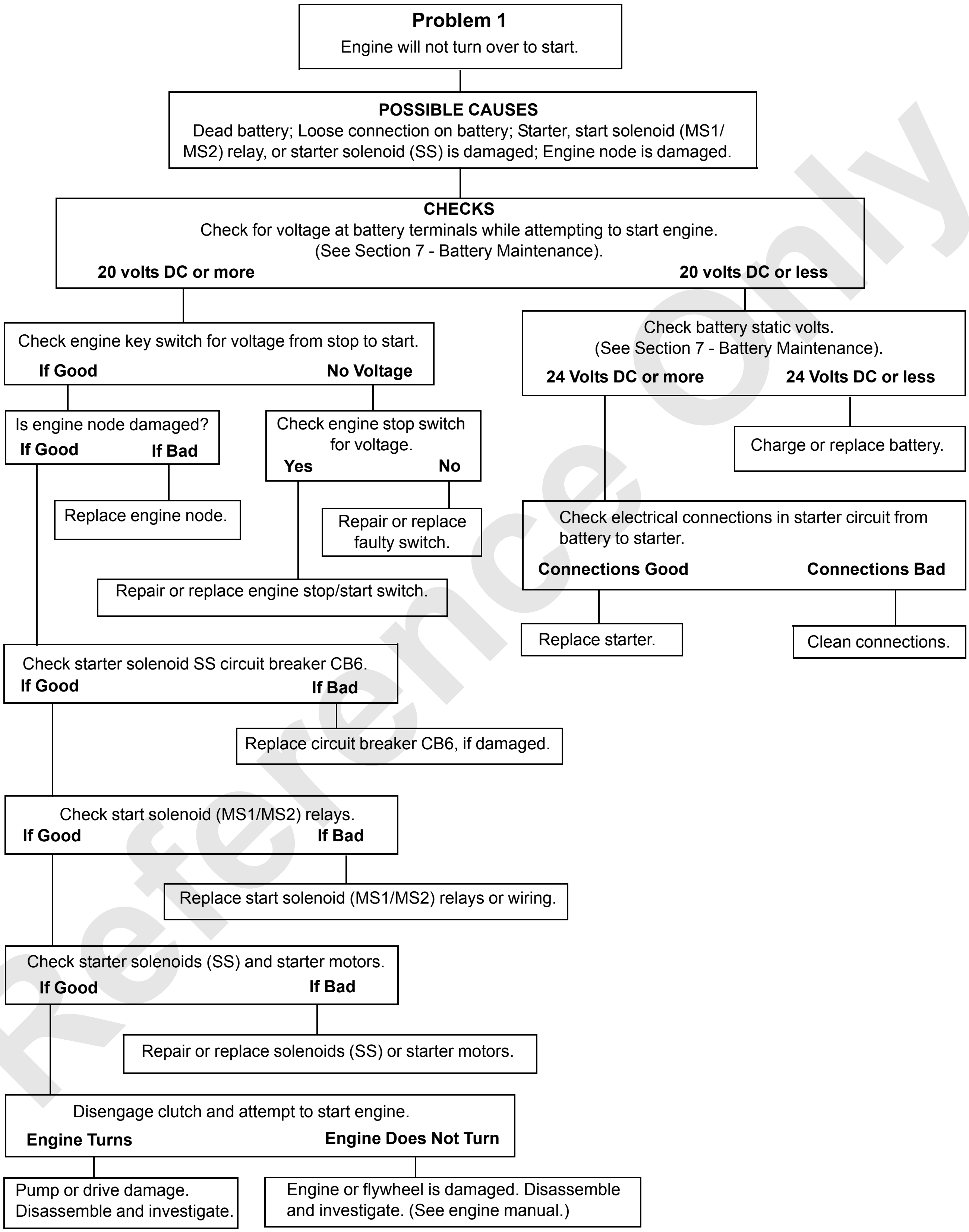
The following guidelines apply to all troubleshooting operations:

- Do not remove cylinders or counterbalance valve(s) from a cylinder until its working unit is restrained against movement.
- Do not use your hands to check for hydraulic oil leaks. Use a piece of cardboard to check for hydraulic oil leaks.
- Use a gauge of correct pressure range when checking hydraulic circuits.
- Check pressures at specified hydraulic component ports.
- Use the Rated Capacity Indicator/Limiter display and Main display for checking pump, motor, handle, brake, etc. components.
- Use in-line test boards or Manitowoc Universal Tester/ CAN Node Adapter (available from your Manitowoc dealer) for further testing of computer nodes and electrical circuits.

## TROUBLESHOOTING CHARTS

Troubleshooting Charts provide a series of flow charts that identify problems that could be encountered during normal operation. These charts contain instructions to assist in identifying and correcting problems. Follow the procedural steps in the order indicated. Some steps direct you to other charts in this manual or reference a specific test that should be performed to move through the complete troubleshooting procedure. If directed, consult your Manitowoc dealer or the Manitowoc Crane Care Lattice Team before proceeding.

## TROUBLESHOOTING CHARTS



**Problem 2**
Engine turns over, but will not start.

**POSSIBLE**
No fuel to or from injector pump; Water or algae in fuel; Air intake restricted or blocked;
Engine load is too high; Low battery amperage to gain starting RPM; Fuel shut-off is not working correctly.

**CHECKS**
Disengage drive clutch. (Cold weather hydraulic load is to high for engine to start.) Check engine faults on engine screen. Try starting engine again.

**Start** / **No Start**

Check that all system pumps are centered.
(See Section 2 - Control Calibration).

Remove injector pump inlet line. Check for fuel flowing out of line while turning over engine.

**Good Stream of Clear Fuel** / **No Fuel**

Make sure injector pump fuel shut-off valve is fully open.

**Fully Open** / **Not Open**

Check for fuel in tank or line obstruction. A fuel additive is recommended in cold weather. Algae can occur in warm climates.

Make adjustments to solenoid shut-off valve or check valve for correct operation.

Remove injector pump inlet line. Turn over engine. Look for momentary burst of fuel.

**Fuel** / **No Fuel**

Loosen fittings at filters. Turn engine over while holding throttle open to bleed air. Re-tighten lines and start engine.

**No Start**

Check all fuel lines for air down-stream of transfer pump.

**No Operation**

Check intake for obstruction.
**No Obstruction**

Repair or replace injector pump.

Check engine for adequate cranking RPM.
**400 RPM or Less**

Check each battery. (See Section 7 - Battery Maintenance). Replace battery if voltage drop exceeds 8 volts while starting engine.

See engine manual.

**Problem 3**

Engine runs, but no hydraulic operation.

**POSSIBLE CAUSES**

Clutch not engaged; No hydraulic fluid in tank; Blocked charge inlet to pumps; Clogged tank vent; Drive train damaged from flywheel to pump mount.

**CHECKS**

Check hydraulic filter service shut-off valve.

**Ok**

**Not Ok**

Check clutch engagement.

**Clutch Engaged**

**Clutch not Engaged**

Open filter service shut-off valve or replace filter if necessary.

Engage clutch.

Remove tank cap and check vent, fluid level, and viscosity. In extreme cold conditions, oil may not flow freely to pump inlets causing pump cavitation.

**Tank Vent, Oil Level, Viscosity Ok**

**Not Ok**

Service hydraulic system.

Check manual override on two or more pumps. Does engine load when manual override is applied? (See Section 2 - Manual Override Tests). Make sure all brakes are applied and swing lock is in place.

**Pump Loads**

**Pump does not Load**

Check electrical input from controller to pump. (See Section 3 - Checking Electrical Inputs/Outputs).

Consult dealer/factory.



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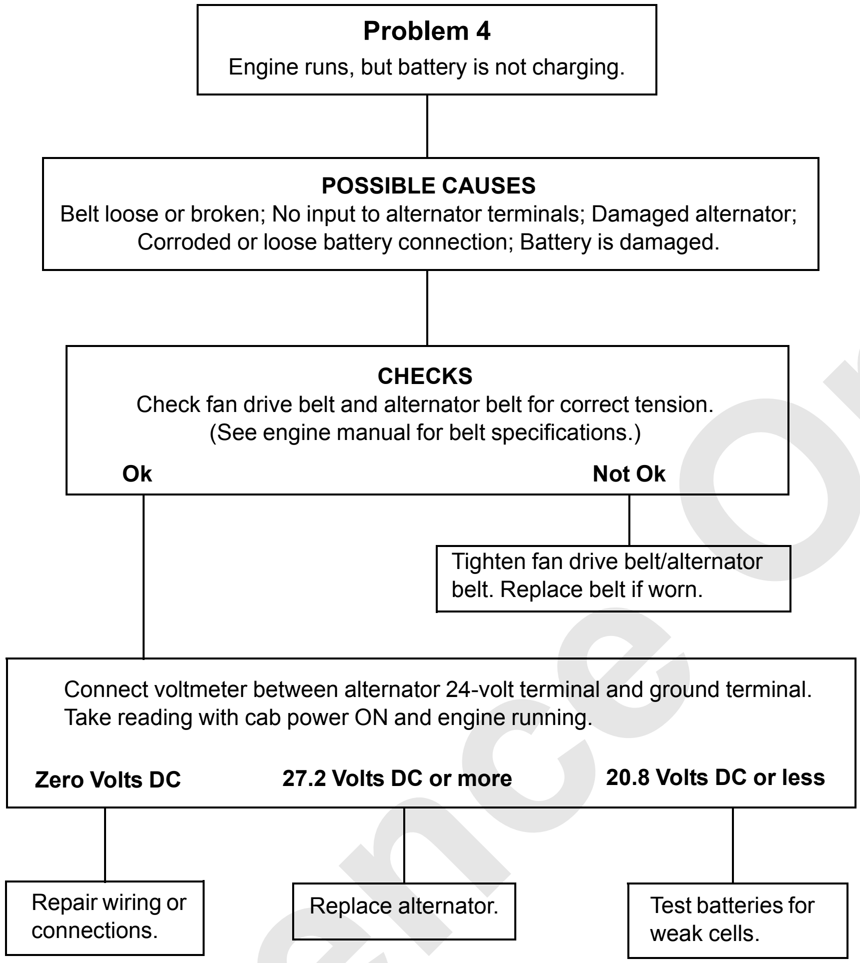
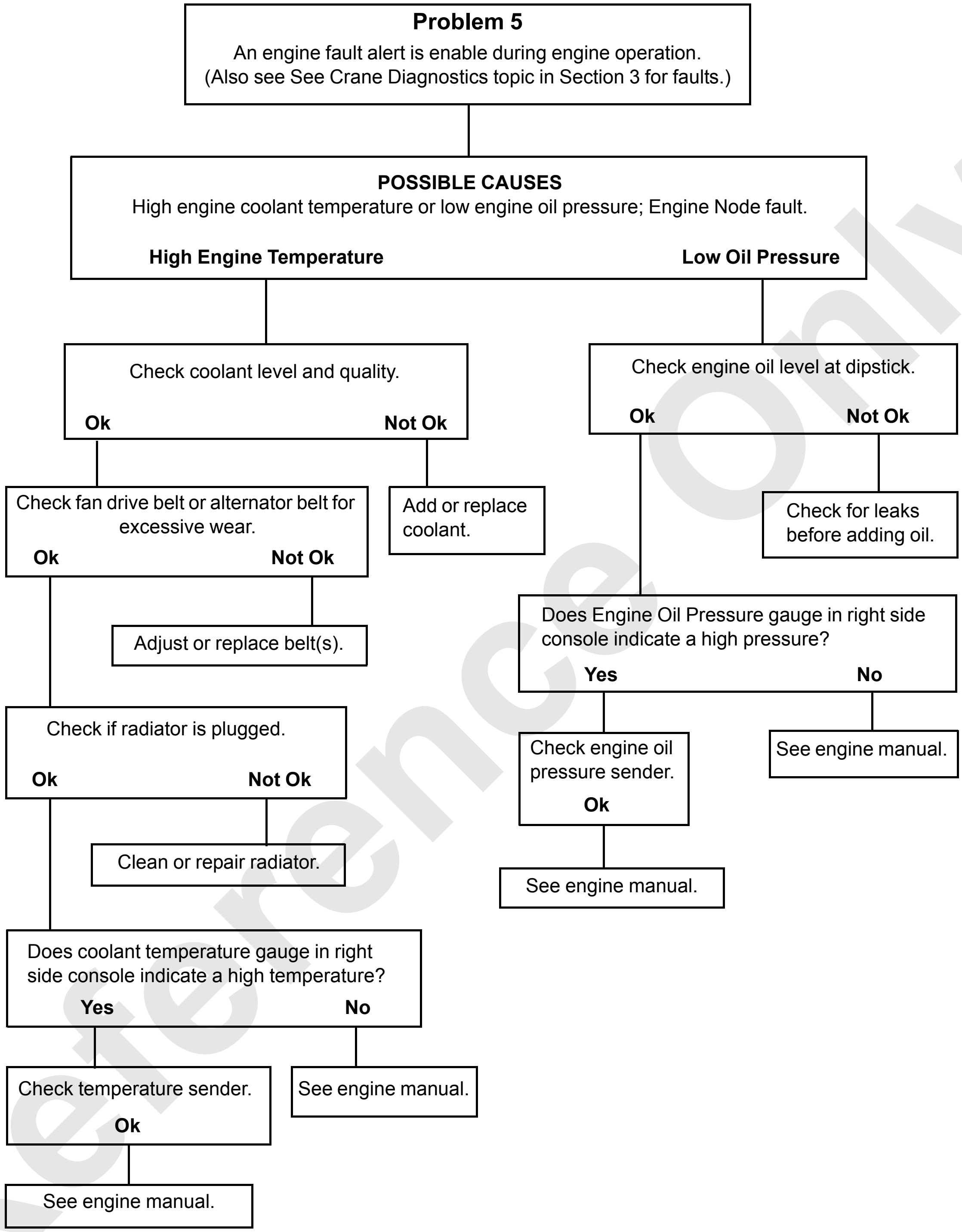

Problem 4
Engine runs, but battery is not charging.
POSSIBLE CAUSES
Belt loose or broken; No input to alternator terminals; Damaged alternator; Corroded or loose battery connection; Battery is damaged.
CHECKS
Check fan drive belt and alternator belt for correct tension. (See engine manual for belt specifications.)
Ok
Not Ok
Tighten fan drive belt/alternator belt. Replace belt if worn.
Connect voltmeter between alternator 24-volt terminal and ground terminal. Take reading with cab power ON and engine running.
Zero Volts DC
27.2 Volts DC or more
20.8 Volts DC or less
Repair wiring or connections.
Replace alternator.
Test batteries for weak cells.


Problem 5
An engine fault alert is enable during engine operation.
(Also see See Crane Diagnostics topic in Section 3 for faults.)
POSSIBLE CAUSES
High engine coolant temperature or low engine oil pressure; Engine Node fault.
High Engine Temperature
Low Oil Pressure
Check coolant level and quality.
Ok
Not Ok
Add or replace coolant.
Check fan drive belt or alternator belt for excessive wear.
Ok
Not Ok
Adjust or replace belt(s).
Check if radiator is plugged.
Ok
Not Ok
Clean or repair radiator.
Does coolant temperature gauge in right side console indicate a high temperature?
Yes
No
Check temperature sender.
Ok
See engine manual.
See engine manual.
Check engine oil level at dipstick.
Ok
Not Ok
Check for leaks before adding oil.
Does Engine Oil Pressure gauge in right side console indicate a high pressure?
Yes
No
Check engine oil pressure sender.
Ok
See engine manual.
See engine manual.



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**Problem 6**

Crawler travels at slow speed.

**POSSIBLE CAUSES**

Partial control voltage from handle to PC; Partial control voltage from PC to pump EDC; Pump or motor is damaged.

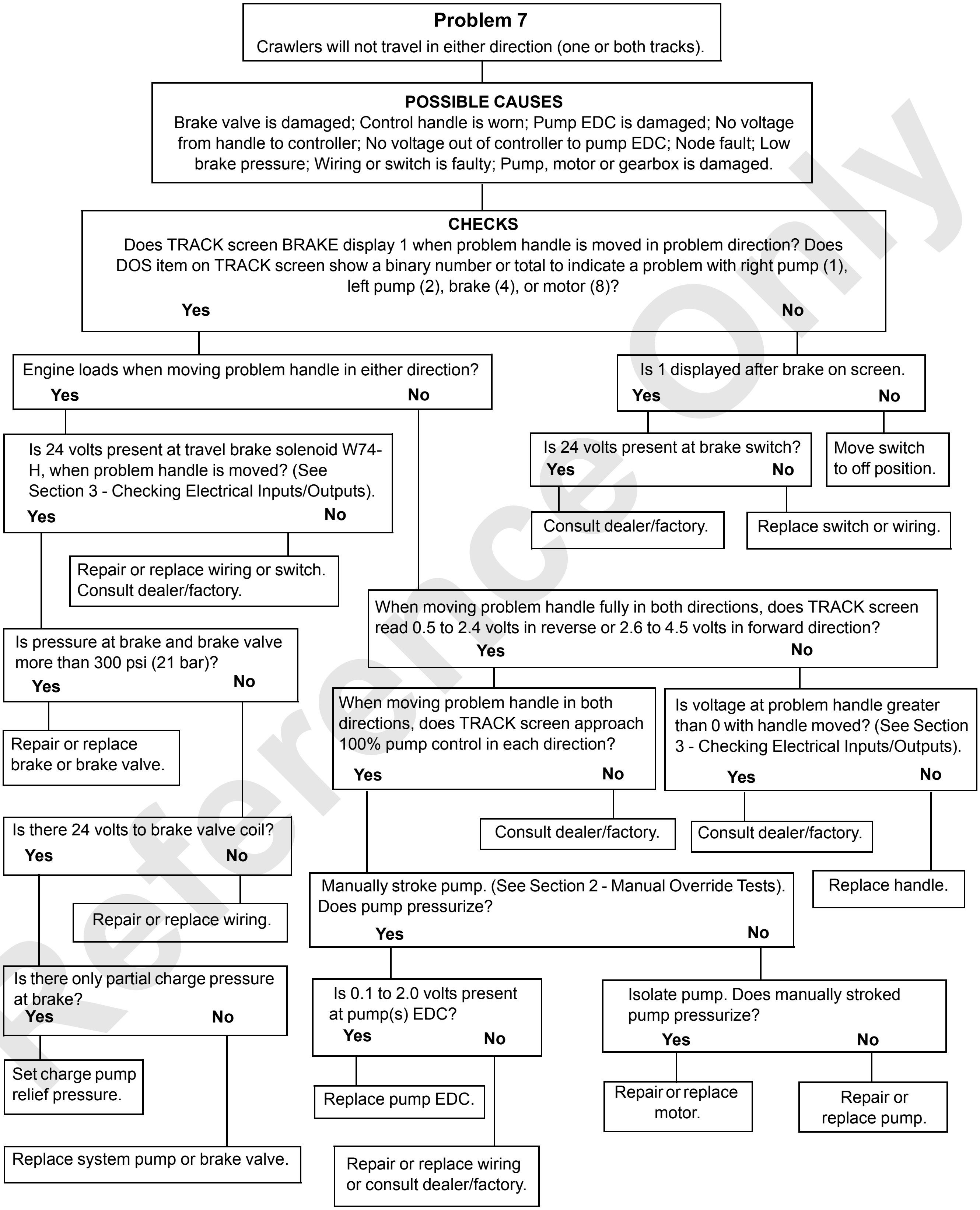
**CHECKS**

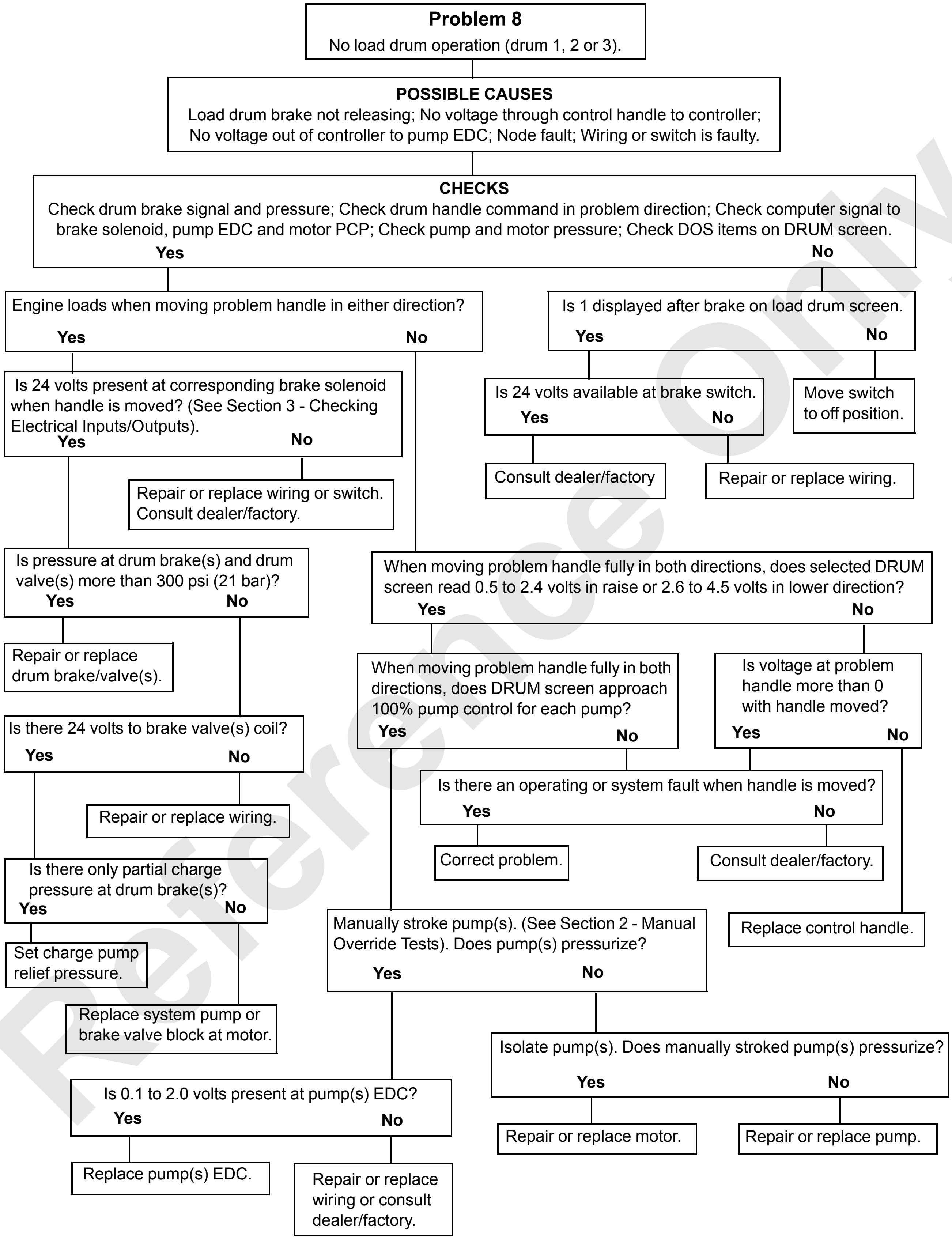
Check travel speed switch for high-speed selection. Check that 100% travel speed is selected on speeds screen.

- **Selected** → Is 2-speed travel valve receiving a voltage signal from controller?
  - **No** → Check 2-speed travel valve for mechanical problems by manually enabling spool.
    - **Problem** → Repair or replace valve.
    - **No Problem** → Remove plug at motor port M5 and check orifice for obstruction. (See Section 2 - Motor Components).
      - **Obstruction** → Clean or replace orifice.
      - **No Obstruction** → When moving travel handle fully in both directions, does TRACK screen read 0.5 to 2.4 volts in reverse or 2.6 to 4.5 volts in forward direction?
  - **Yes** → Engine RPM is more than 1,500 on screen?
    - **Yes** → When moving travel handle fully in both directions, does TRACK screen read 0.5 to 2.4 volts in reverse or 2.6 to 4.5 volts in forward direction?
    - **No** → Is throttle in maximum RPM position?
      - **Yes** → Check RPM transducer for correct operation on digital display.
      - **No** → Increase engine speed.
- **Not Selected** → Select high speed with switch and 100% travel speed on speeds screen.

When moving travel handle fully in both directions, does TRACK screen read 0.5 to 2.4 volts in reverse or 2.6 to 4.5 volts in forward direction?

- **No** → Replace control handle, node 2, or repair wiring.
- **Yes** → When moving travel handle fully in both directions, does TRACK screen approach 100% pump control in each direction?
  - **No** → Consult dealer/factory.
  - **Yes** → Check for control voltage of zero volts at rest and 24 at full speed at both sides of EDC coil, and a resistance of around 19 ohms at pump. (See Section 3 - Checking Electrical Inputs/Outputs).
    - **Voltage and/or Coil not Ok** → Repair or replace coil or wiring.
    - **Voltage and Coil Ok** → Is system pressure above 3,900 psi (270 bar) at motor port M4? (See Section 2 - Motor Components).
      - **Yes** → Slow speed is at desired speed.
      - **No** → Brake partially applied. Check accessory accumulator system pressure for 500 psi (35 bar).
        - **Above 300 psi (21 bar)** → Check brake pressure and repair.
        - **Below 200 psi (14 bar)** → Check for pump and motor leakage. (See Section 2 - Motor Leakage Test).


Problem 7
Crawlers will not travel in either direction (one or both tracks).
POSSIBLE CAUSES
Brake valve is damaged; Control handle is worn; Pump EDC is damaged; No voltage from handle to controller; No voltage out of controller to pump EDC; Node fault; Low brake pressure; Wiring or switch is faulty; Pump, motor or gearbox is damaged.
CHECKS
Does TRACK screen BRAKE display 1 when problem handle is moved in problem direction? Does DOS item on TRACK screen show a binary number or total to indicate a problem with right pump (1), left pump (2), brake (4), or motor (8)?
Yes
No
Engine loads when moving problem handle in either direction?
Yes
No
Is 1 displayed after brake on screen.
Yes
No
Is 24 volts present at travel brake solenoid W74-H, when problem handle is moved? (See Section 3 - Checking Electrical Inputs/Outputs).
Yes
No
Is 24 volts present at brake switch?
Yes
No
Move switch to off position.
Consult dealer/factory.
Replace switch or wiring.
Repair or replace wiring or switch. Consult dealer/factory.
When moving problem handle fully in both directions, does TRACK screen read 0.5 to 2.4 volts in reverse or 2.6 to 4.5 volts in forward direction?
Yes
No
Is pressure at brake and brake valve more than 300 psi (21 bar)?
Yes
No
When moving problem handle in both directions, does TRACK screen approach 100% pump control in each direction?
Yes
No
Is voltage at problem handle greater than 0 with handle moved? (See Section 3 - Checking Electrical Inputs/Outputs).
Yes
No
Repair or replace brake or brake valve.
Is there 24 volts to brake valve coil?
Yes
No
Consult dealer/factory.
Consult dealer/factory.
Repair or replace wiring.
Manually stroke pump. (See Section 2 - Manual Override Tests). Does pump pressurize?
Yes
No
Replace handle.
Is there only partial charge pressure at brake?
Yes
No
Is 0.1 to 2.0 volts present at pump(s) EDC?
Yes
No
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Set charge pump relief pressure.
Replace pump EDC.
Repair or replace motor.
Repair or replace pump.
Replace system pump or brake valve.
Repair or replace wiring or consult dealer/factory.







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**Problem 9**

Load drum (1, 2 or 3) will not raise load, but will lower load.

**POSSIBLE CAUSES**

Block up limit is opened; Pump is damaged; Control handle is worn; Maximum bail limit is opened; Node fault; Speed sender is damaged.

**CHECKS**

See Crane Diagnostics topic in Section 3 to find CAN bus packet numbers.
When applicable switch is enabled…

Boom Block-up . . . . . . . . . . . . . . . . . . . . . Packet #136, Bank 6 changed by 64 or 128
Fixed Jib Block Up . . . . . . . . . . . . . . . . . . Packet #132, Bank 6 changed by 64 or 128
Drum 1 Pump Control - Raise . . . . . . . . . . Packet #33, Bank 2 changed by 4
Drum 2 Pump Control - Raise . . . . . . . . . . Packet #33, Bank 2 changed by 16
Drum 3 Pump Control - Raise . . . . . . . . . . Packet #33, Bank 3 changed by 1

**All bank numbers increased by number shown.**

**Any bank number not increased by number shown.**

Does selected DRUM screen approach 100% handle control with handle moved back?

**Yes** **No**

Check for problem and repair limit switch operation, wiring, or circuit breaker.

Repair or replace control handle/wiring.

Does DRUM screen approach 100% pump control for each pump, with handle moved back?

**Yes** **No**

Zero volts at rest and 24 volts present at full speed at pump EDC with handle moved back?
(See Section 3 - Checking Electrical Inputs/Outputs).

**Yes** **No**

Consult dealer/factory.

Replace pump(s) EDC

Repair or replace wiring or consult dealer/factory.

**Problem 10**

Selected load drum will not lower load, but will raise load.

**POSSIBLE CAUSES**

Control handle is worn; Minimum bail limit opened; Pump is damaged; Node fault; Speed sender is damaged.

**CHECKS**

See Crane Diagnostics topic in Section 3 to find CAN bus packet numbers.

When applicable switch is enabled…

Drum 1 Minimum Bail Limit . . . . . . . . . . . . Packet #39, Bank 2 changed by 2
Drum 2 Minimum Bail Limit . . . . . . . . . . . . Packet #34, Bank 2 changed by 2
Drum 3 Minimum Bail Limit . . . . . . . . . . . . Packet #33, Bank 2 changed by 2
Drum 1 Pump Control - Lower . . . . . . . . . . Packet #33, Bank 2 changed by 8
Drum 2 Pump Control - Lower . . . . . . . . . . Packet #33, Bank 2 changed by 32
Drum 3 Pump Control - Lower . . . . . . . . . . Packet #33, Bank 3 changed by 2

**Bank number increased by number shown.** **Bank number not increased by number shown.**

Does selected DRUM screen approach 100% handle control with handle moved forward?
**Yes** **No**

Check for problem. Repair limit switch, wiring, or circuit breaker.

Replace control handle or repair wiring.

Does selected DRUM screen approach 100% pump control for each pump, with handle moved forward?
**Yes** **No**

Consult dealer/factory.

Zero volts at rest and 24 volts at full speed present at pump EDC with handle moved back? (See Section 2 - Checking Electrical Inputs/Outputs).
**Yes** **No**

Replace pump EDC.

Repair or replace wiring or consult dealer/factory.

**Problem 11**

Load drum (1, 2, or 3) will not reach maximum speed.

**POSSIBLE CAUSES**

Partial control from handle to controller; Partial control voltage from controller to pump EDC or motor PCP; Pump or motor is damaged; Node fault.

**CHECKS**

Check selected drum speed calibration screen for 100% reading.

**Yes** **No**

No: Make proper adjustment.

Yes: When moving selected load drum control handle fully in both directions, does DRUM screen approach 100% pump control for each pump?

**Yes** **No**

No: Replace control handle.

Yes: When moving problem handle fully in both directions, does selected DRUM screen read 0.5 to 2.4 volts in raise or 2.6 to 4.5 volts in lower direction?

**Yes** **No**

No: Replace control handle or repair wiring.

Yes: When moving load drum handle fully in both directions, does DRUM screen approach 100% pump and motor command for each pump and motor?

**Yes** **No**

No: Consult dealer/factory.

Yes: Check for zero volt at rest and 24 volt at full speed and coil resistance of around 19 ohms at pump EDC or 24 to 26 ohms at motor PCP.
(See Section 3 - Checking Electrical Inputs/Outputs).

**Voltage and Coil Ok** **Voltage and/or Coil not Ok**

Voltage and/or Coil not Ok: Repair or replace coil or wiring.

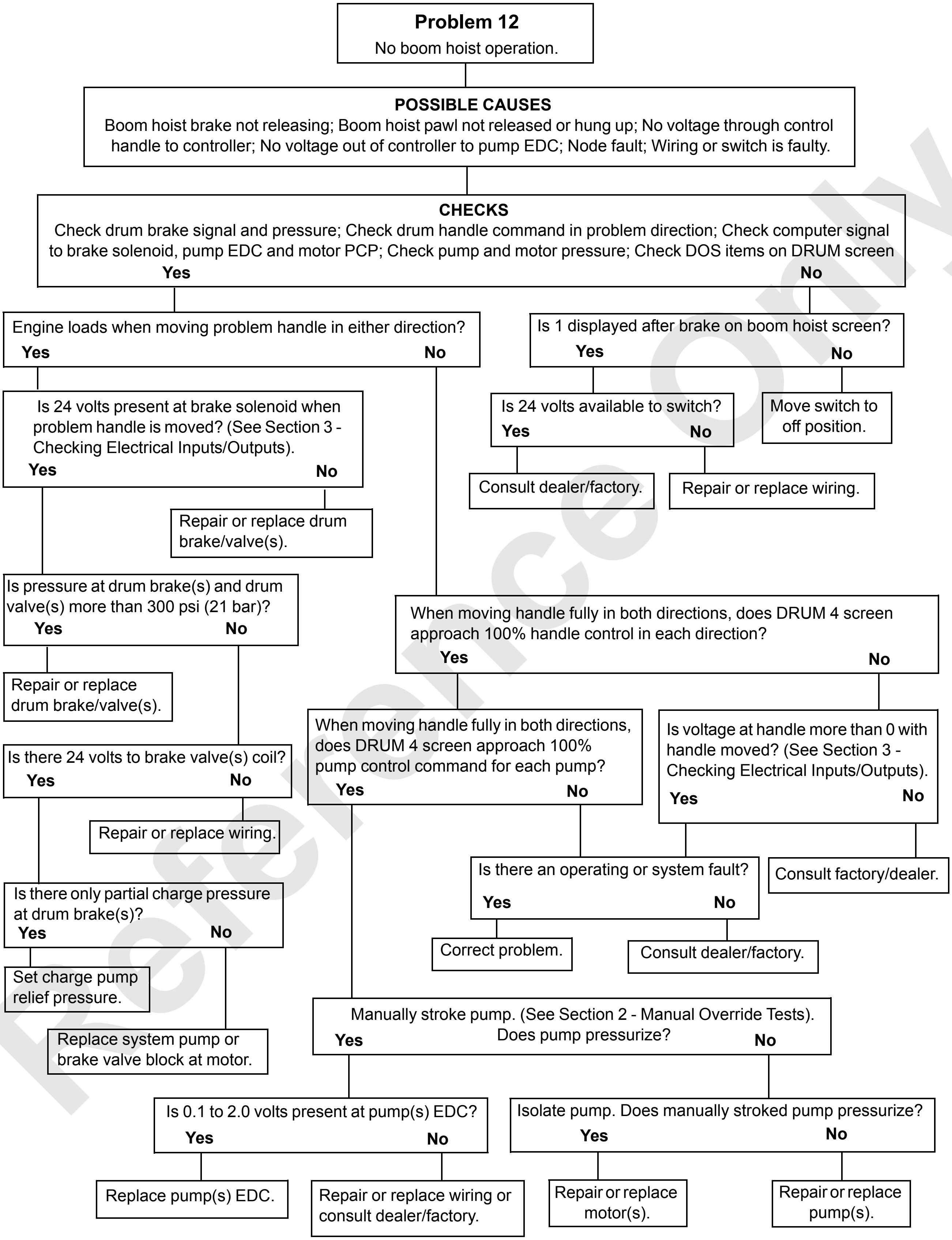
Voltage and Coil Ok: Remove plug at motor port M5 and check orifice for obstruction.
(See Section 2 - Motor Components).

**Obstruction** **No Obstruction**

Obstruction: Clean or replace orifice.

No Obstruction: Check pump and motor for leakage.
(See Section 2 - Motor Leakage Test).

Repair or replace pump(s) or motor(s).


Problem 12
No boom hoist operation.
POSSIBLE CAUSES
Boom hoist brake not releasing; Boom hoist pawl not released or hung up; No voltage through control handle to controller; No voltage out of controller to pump EDC; Node fault; Wiring or switch is faulty.
CHECKS
Check drum brake signal and pressure; Check drum handle command in problem direction; Check computer signal to brake solenoid, pump EDC and motor PCP; Check pump and motor pressure; Check DOS items on DRUM screen
Yes
No
Engine loads when moving problem handle in either direction?
Yes
No
Is 1 displayed after brake on boom hoist screen?
Yes
No
Is 24 volts present at brake solenoid when problem handle is moved? (See Section 3 - Checking Electrical Inputs/Outputs).
Yes
No
Is 24 volts available to switch?
Yes
No
Move switch to off position.
Consult dealer/factory.
Repair or replace wiring.
Repair or replace drum brake/valve(s).
Is pressure at drum brake(s) and drum valve(s) more than 300 psi (21 bar)?
Yes
No
When moving handle fully in both directions, does DRUM 4 screen approach 100% handle control in each direction?
Yes
No
Repair or replace drum brake/valve(s).
When moving handle fully in both directions, does DRUM 4 screen approach 100% pump control command for each pump?
Yes
No
Is voltage at handle more than 0 with handle moved? (See Section 3 - Checking Electrical Inputs/Outputs).
Yes
No
Is there 24 volts to brake valve(s) coil?
Yes
No
Repair or replace wiring.
Is there an operating or system fault?
Yes
No
Consult factory/dealer.
Is there only partial charge pressure at drum brake(s)?
Yes
No
Correct problem.
Consult dealer/factory.
Set charge pump relief pressure.
Replace system pump or brake valve block at motor.
Manually stroke pump. (See Section 2 - Manual Override Tests). Does pump pressurize?
Yes
No
Is 0.1 to 2.0 volts present at pump(s) EDC?
Yes
No
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Replace pump(s) EDC.
Repair or replace wiring or consult dealer/factory.
Repair or replace motor(s).
Repair or replace pump(s).

**Problem 13**

Boom hoist will not reach maximum speed.

**POSSIBLE CAUSES**

Partial control voltage from handle to controller; Partial control voltage from controller to pump EDC; Motor controller in low; Pump or motor is damaged; Node fault.

**CHECKS**

Check boom hoist drum speed calibration screen for 100% reading.

**Yes** / **No**

No: Make proper adjustment.

Yes: When moving boom hoist control handle fully in both directions, does DRUM 4 screen read 0.5 to 2.4 volts in raise or 2.6 to 4.5 volts in lower direction?

**Yes** / **No**

No: Repair wiring/consult dealer.

Yes: When moving boom hoist control handle fully in both directions, does DRUM 4 screen approach 100% pump control for each pump?

**Yes** / **No**

No: Consult dealer/factory.

Yes: When moving boom hoist control handle fully in both directions, does DRUM 4 screen approach 100% motor command for motor?

**Yes** / **No**

No: Consult dealer/factory.

Yes: Check for control voltage and coil resistance at pump EDC and motor PCP. (See Section 3 - Checking Electrical Inputs/Outputs).

**Voltage and Coil Ok** / **Voltage and/or Coil not Ok**

Voltage and/or Coil not Ok: Repair or replace coil or wiring.

Voltage and Coil Ok: Remove plug at motor port M5 and check orifice for obstructions. (See Section 2 - Motor Components).

**Obstruction** / **No Obstruction**

Obstruction: Clean or replace orifice.

No Obstruction: Check for pump and motor leakage. (See Section 2 - Motor Leakage Test).

**Problem 14**

Boom will not boom up, but will boom down.

**POSSIBLE CAUSES**

Pump is damaged; Boom maximum up limit opened; Equalizer/boom stop limit opened; Node fault; Control handle is worn.

**CHECKS**

See Crane Diagnostics topic in Section 3 to find CAN bus packet numbers.

When applicable switch is enabled…

Drum 1 Minimum Bail Limit. . . . . . . . . . . . Packet #39, Bank 2 changed by 2
Drum 2 Minimum Bail Limit. . . . . . . . . . . . Packet #34, Bank 2 changed by 2
Drum 3 Minimum Bail Limit. . . . . . . . . . . . Packet #33, Bank 2 changed by 2
Maximum Boom Angle Limit . . . . . . . . . . . Packet #69, Bank 1 changed by 128
Boom Hoist Pump Pressure . . . . . . . . . . . Packet #38, Bank 3 changed by 1 or 4

**Bank number increased by number shown.**

When moving boom hoist handle fully back directions, does DRUM 4 screen read 100% handle command and 0.5 to 2.4 volts in raise direction?

**Yes**

Does DRUM 4 screen approach 100% pump control command for both pumps, with handle moved back?

**Yes**

Are zero volts at rest and 24 volts at full speed present at pump EDC when control handle is moved back? (See Section 3 - Checking Electrical Inputs/Outputs).

**Yes**

Does pump charge pressure at charge pressure port drop to 250 psi (17 bar) or less when booming up?

**Yes**

Repair or replace pump(s).

**No**

Replace pump(s) EDC.

**No**

Repair or replace wiring or consult dealer/factory.

**No**

Consult dealer/factory.

**No**

Replace control handle.

**Bank number not increased by number shown.**

Check for problem. Repair limit switch, wiring, or circuit breaker.

**Problem 15**

Boom will not boom down, but will boom up.

**POSSIBLE CAUSES**

Boom maximum down limit opened; Pawl engaged; Pump is damaged;
Block-up limit open; Control handle is worn; Node fault; Speed encoder is damaged.

**CHECKS**

See Crane Diagnostics topic in Section 3 to find CAN bus packet numbers.
When applicable switch is enabled…

Maximum Boom Up Limit . . . . . . . . . . . . . Packet #69, Bank 1 changed by 128
Boom Hoist (Drum 4) Pump Pressure. . . . Packet #38, Bank 3 changed by 1 or 4

**Bank number increased by number shown.** **Bank number not increased by number shown.**

Does Packet #34, bank 3 (boom hoist pawl) change by 4 when moving brake switch?
**Yes** **No**

Check for problem. Repair limit switch, wiring, or circuit breaker.

Visually check pawl.
**Out** **In**

Repair or replace switch or wiring to controller.

Check pawl operation.

When moving boom hoist handle fully in forward directions, does DRUM 4 screen read 100% handle command and 2.6 to 4.5 volts in lower direction?
**Yes** **No**

Does DRUM 4 screen approach 100% pump control with handle moved fully forward?
**Yes** **No**

Replace control handle or repair wiring.

Are zero volts at rest and 24 volts at full speed present at pump EDC when control handle is moved forward? (See Section 3 - Checking Electrical Inputs/Outputs).
**Yes** **No**

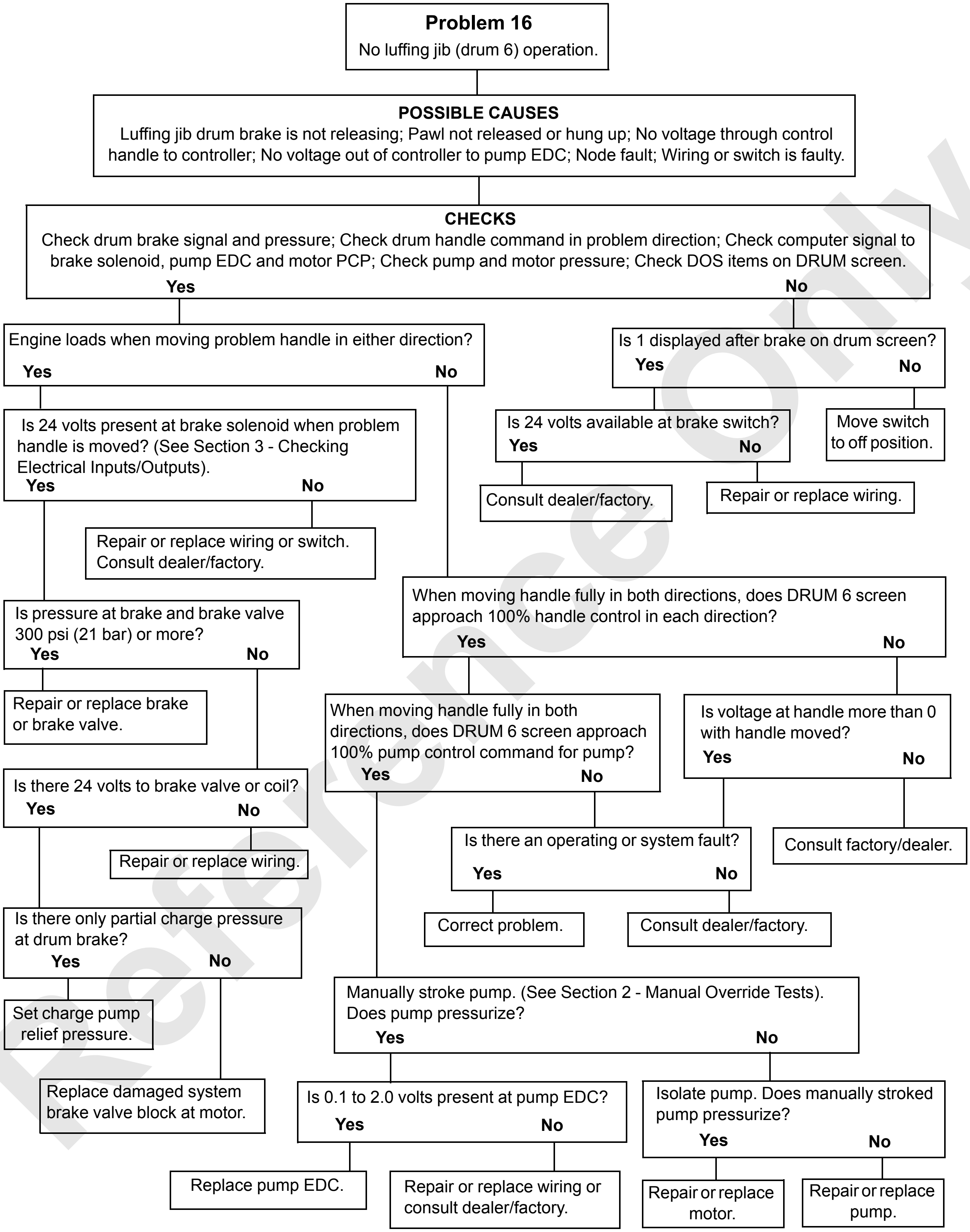
Consult dealer/factory.

Repair or replace wiring or consult dealer/factory.

Can boom pump(s) be manually stroked down? (See Section 2 - Manual Override Tests).
**Yes** **No**

Replace pump(s) EDC.

Repair or replace pump(s).


Problem 16
No luffing jib (drum 6) operation.
POSSIBLE CAUSES
Luffing jib drum brake is not releasing; Pawl not released or hung up; No voltage through control handle to controller; No voltage out of controller to pump EDC; Node fault; Wiring or switch is faulty.
CHECKS
Check drum brake signal and pressure; Check drum handle command in problem direction; Check computer signal to brake solenoid, pump EDC and motor PCP; Check pump and motor pressure; Check DOS items on DRUM screen.
Yes
No
Engine loads when moving problem handle in either direction?
Yes
No
Is 1 displayed after brake on drum screen?
Yes
No
Is 24 volts present at brake solenoid when problem handle is moved? (See Section 3 - Checking Electrical Inputs/Outputs).
Yes
No
Is 24 volts available at brake switch?
Yes
No
Move switch to off position.
Consult dealer/factory.
Repair or replace wiring.
Repair or replace wiring or switch. Consult dealer/factory.
When moving handle fully in both directions, does DRUM 6 screen approach 100% handle control in each direction?
Yes
No
Is pressure at brake and brake valve 300 psi (21 bar) or more?
Yes
No
Repair or replace brake or brake valve.
When moving handle fully in both directions, does DRUM 6 screen approach 100% pump control command for pump?
Yes
No
Is voltage at handle more than 0 with handle moved?
Yes
No
Is there 24 volts to brake valve or coil?
Yes
No
Repair or replace wiring.
Is there an operating or system fault?
Yes
No
Consult factory/dealer.
Is there only partial charge pressure at drum brake?
Yes
No
Correct problem.
Consult dealer/factory.
Set charge pump relief pressure.
Manually stroke pump. (See Section 2 - Manual Override Tests). Does pump pressurize?
Yes
No
Replace damaged system brake valve block at motor.
Is 0.1 to 2.0 volts present at pump EDC?
Yes
No
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Replace pump EDC.
Repair or replace wiring or consult dealer/factory.
Repair or replace motor.
Repair or replace pump.

**Problem 17**
Luffing jib will not reach maximum speed.

**POSSIBLE CAUSES**
Partial control voltage from handle to controller; Partial control voltage from controller to pump EDC; Motor controller in low; Pump or motor is damaged; Node fault.

**CHECKS**
Check boom hoist drum speed calibration screen for 100% reading.

- **Yes**: When moving hoist control handle fully in both directions, does DRUM 6 screen read 0.5 to 2.4 volts in raise or 2.6 to 4.5 volts in lower direction?
  - **Yes**: When moving boom hoist control handle fully in both directions, does DRUM 6 screen approach 100% pump control?
    - **Yes**: When moving boom hoist control handle fully in both directions, does DRUM 6 screen approach 100% motor command for motor?
      - **Yes**: Check for control voltage and coil resistance at pump EDC and motor PCP. (See Section 3 - Checking Electrical Inputs/Outputs).
        - **Voltage and Coil Ok**: Remove plug at motor port M5 and check orifice for obstructions. (See Section 2 - Motor Components).
          - **Obstruction**: Clean or replace orifice.
          - **No Obstruction**: Check for pump and motor leakage. (See Section 2 - Motor Leakage Test).
        - **Voltage and/or Coil not Ok**: Repair or replace coil or wiring.
      - **No**: Consult dealer/factory.
    - **No**: Consult dealer/factory.
  - **No**: Repair wiring/consult dealer.
- **No**: Make proper adjustment.

**Problem 18**

Luffing jib will not boom up, but will boom down.

**POSSIBLE CAUSES**

Maximum up limit 1 or 2 is tripped; Pawl engaged; Pump is damaged; Control handle is worn; Node fault; Speed encoder is damaged.

**CHECKS**

See Crane Diagnostics topic in Section 3 to find CAN bus packet numbers.

When applicable switch is enabled…

Maximum Jib Working Up Limit . . . . . . . . . Packet #136, Bank 6 changed by 16

Maximum Jib Maximum Up Limit . . . . . . . . Packet #136, Bank 6 changed by 32

Luffing jib (Drum 6) Pump Pressure . . . . . . Packet #38, Bank 2 changed by 16

**Bank number increased by number shown.**

Does Packet #39, bank 2 (luffing jib pawl) change by 32 when moving brake switch?

**Yes** — Visually check pawl.

- **Out** — go to next check.
- **In** — Check pawl operation.

**No** — Repair or replace switch or wiring to controller.

**Bank number not increased by number shown.**

Check for problem. Repair limit switch, wiring, or circuit breaker.

When moving luffing jib handle fully back, does DRUM 6 screen read 100% handle command and 0.5 to 2.4 volts in raise direction?

**Yes** — Does DRUM 6 screen approach 100% pump control with handle moved fully back?

**No** — Replace control handle or repair wiring.

Does DRUM 6 screen approach 100% pump control with handle moved fully back?

**Yes** — Are zero volts at rest and 24 volts at full speed present at pump EDC when control handle is moved back? (See Section 3 - Checking Electrical Inputs/Outputs).

**No** — Consult dealer/factory.

Are zero volts at rest and 24 volts at full speed present at pump EDC when control handle is moved back? (See Section 3 - Checking Electrical Inputs/Outputs).

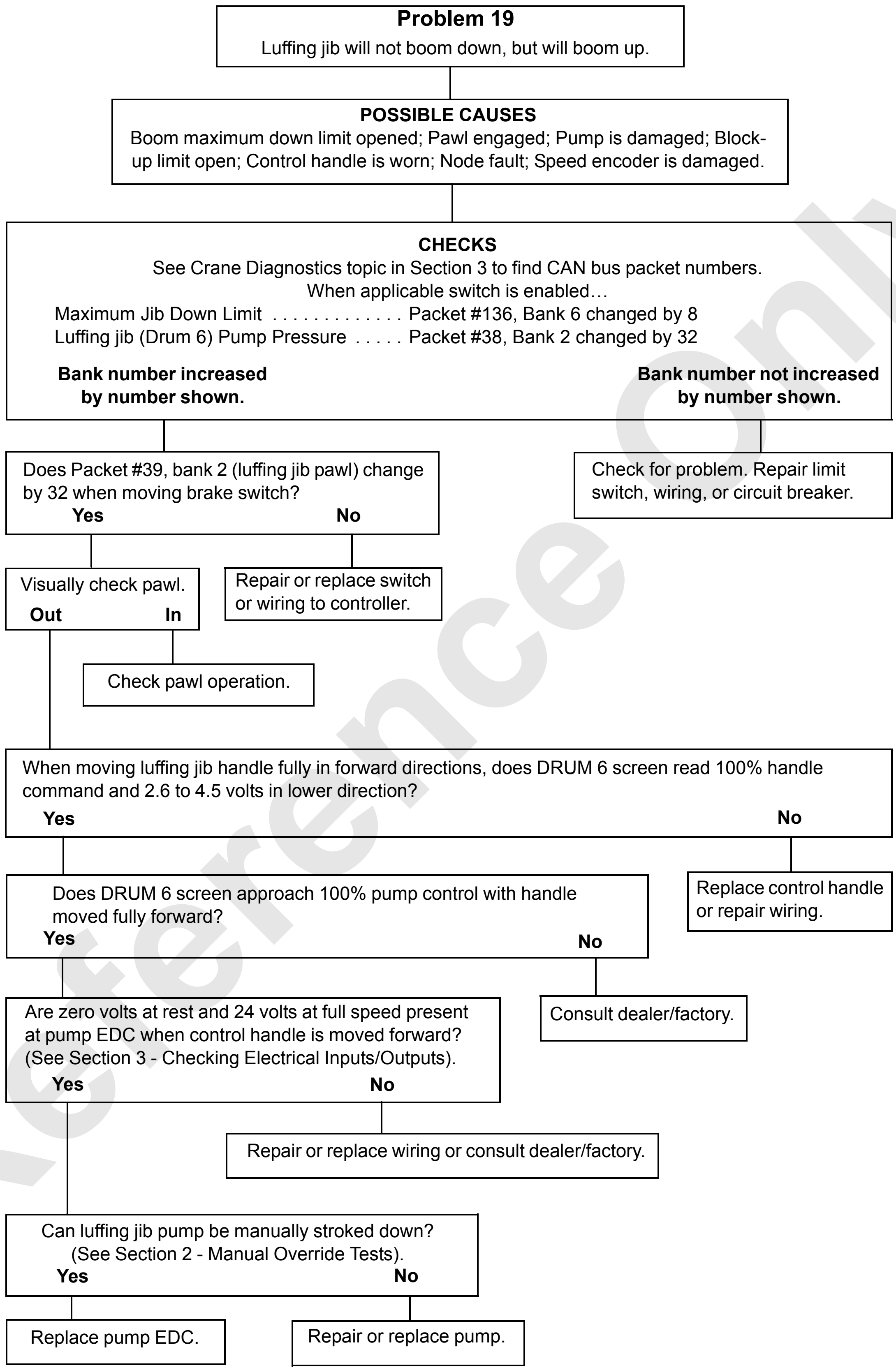
**Yes** — Can luffing jib pump be manually stroked down? (See Section 2 - Manual Override Tests).

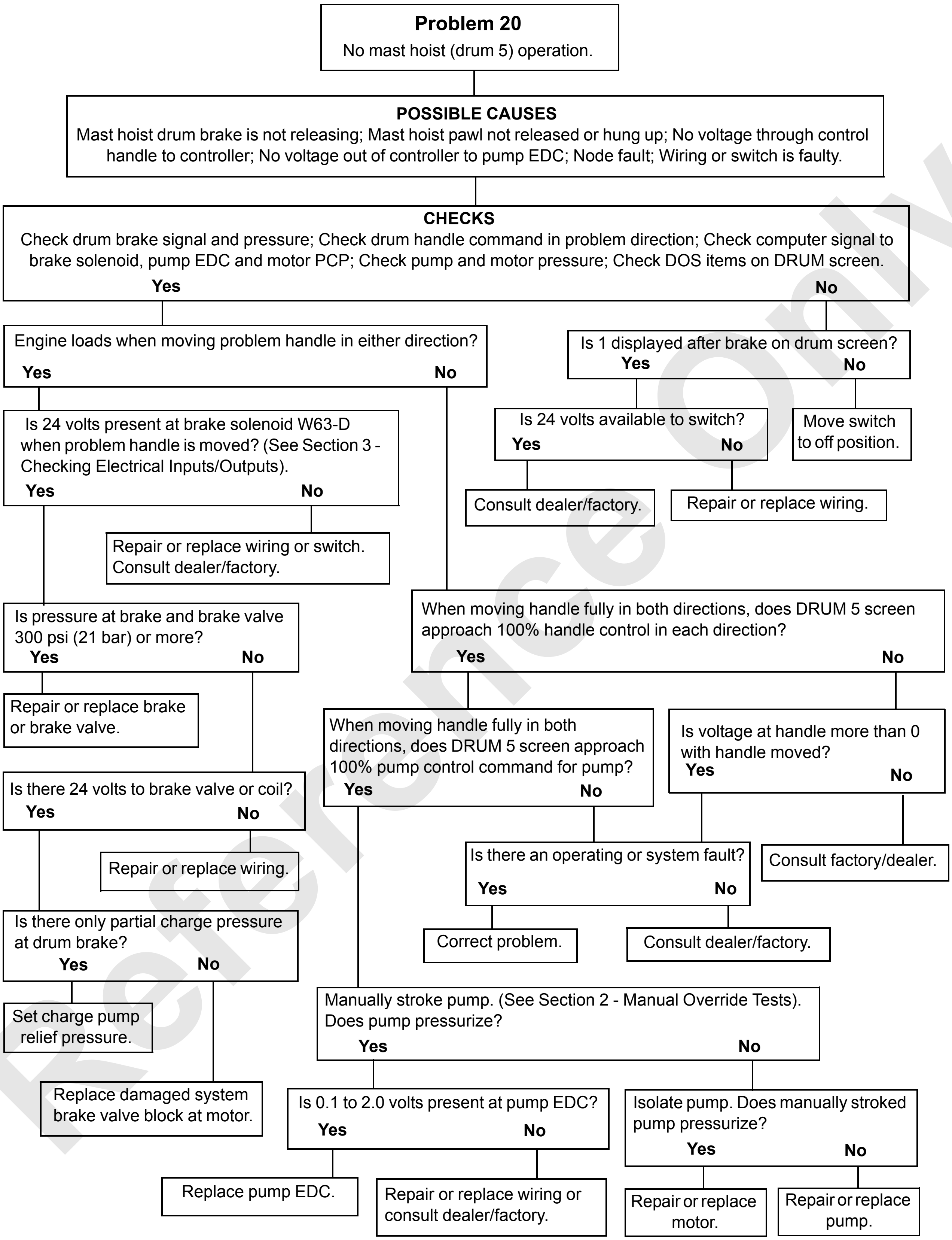
**No** — Repair or replace wiring or consult dealer/factory.

Can luffing jib pump be manually stroked down? (See Section 2 - Manual Override Tests).

**Yes** — Replace pump EDC.

**No** — Repair or replace pump.


Problem 19
Luffing jib will not boom down, but will boom up.
POSSIBLE CAUSES
Boom maximum down limit opened; Pawl engaged; Pump is damaged; Block-up limit open; Control handle is worn; Node fault; Speed encoder is damaged.
CHECKS
See Crane Diagnostics topic in Section 3 to find CAN bus packet numbers.
When applicable switch is enabled…
Maximum Jib Down Limit . . . . . . . . . . . . . Packet #136, Bank 6 changed by 8
Luffing jib (Drum 6) Pump Pressure . . . . . Packet #38, Bank 2 changed by 32
Bank number increased by number shown.
Bank number not increased by number shown.
Does Packet #39, bank 2 (luffing jib pawl) change by 32 when moving brake switch?
Yes
No
Check for problem. Repair limit switch, wiring, or circuit breaker.
Visually check pawl.
Out
In
Repair or replace switch or wiring to controller.
Check pawl operation.
When moving luffing jib handle fully in forward directions, does DRUM 6 screen read 100% handle command and 2.6 to 4.5 volts in lower direction?
Yes
No
Does DRUM 6 screen approach 100% pump control with handle moved fully forward?
Yes
No
Replace control handle or repair wiring.
Are zero volts at rest and 24 volts at full speed present at pump EDC when control handle is moved forward? (See Section 3 - Checking Electrical Inputs/Outputs).
Yes
No
Consult dealer/factory.
Repair or replace wiring or consult dealer/factory.
Can luffing jib pump be manually stroked down? (See Section 2 - Manual Override Tests).
Yes
No
Replace pump EDC.
Repair or replace pump.



Problem 20
No mast hoist (drum 5) operation.
POSSIBLE CAUSES
Mast hoist drum brake is not releasing; Mast hoist pawl not released or hung up; No voltage through control handle to controller; No voltage out of controller to pump EDC; Node fault; Wiring or switch is faulty.
CHECKS
Check drum brake signal and pressure; Check drum handle command in problem direction; Check computer signal to brake solenoid, pump EDC and motor PCP; Check pump and motor pressure; Check DOS items on DRUM screen.
Yes
No
Engine loads when moving problem handle in either direction?
Yes
No
Is 1 displayed after brake on drum screen?
Yes
No
Is 24 volts present at brake solenoid W63-D when problem handle is moved? (See Section 3 - Checking Electrical Inputs/Outputs).
Yes
No
Is 24 volts available to switch?
Yes
No
Move switch to off position.
Consult dealer/factory.
Repair or replace wiring.
Repair or replace wiring or switch. Consult dealer/factory.
Is pressure at brake and brake valve 300 psi (21 bar) or more?
Yes
No
When moving handle fully in both directions, does DRUM 5 screen approach 100% handle control in each direction?
Yes
No
Repair or replace brake or brake valve.
When moving handle fully in both directions, does DRUM 5 screen approach 100% pump control command for pump?
Yes
No
Is voltage at handle more than 0 with handle moved?
Yes
No
Is there 24 volts to brake valve or coil?
Yes
No
Repair or replace wiring.
Is there an operating or system fault?
Yes
No
Consult factory/dealer.
Is there only partial charge pressure at drum brake?
Yes
No
Correct problem.
Consult dealer/factory.
Set charge pump relief pressure.
Manually stroke pump. (See Section 2 - Manual Override Tests). Does pump pressurize?
Yes
No
Replace damaged system brake valve block at motor.
Is 0.1 to 2.0 volts present at pump EDC?
Yes
No
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Replace pump EDC.
Repair or replace wiring or consult dealer/factory.
Repair or replace motor.
Repair or replace pump.

**Problem 21**

No swing operation, but engine loads.

**POSSIBLE CAUSES**

Mechanical hang-up; Solenoid failure; Node fault; Wiring fault.

**CHECKS**

Check swing operation on digital display, swing screen.

When applicable switch is enabled…

Swing Lock - Out . . . . . . . . . . . . . . . . . . . . . Packet #36, Bank 2 changed by 8

Swing Brake. . . . . . . . . . . . . . . . . . . . . . . . Packet #36, Bank 2 changed by 4

**Yes** **No**

**Yes:** Is 24 volts present at swing brake solenoid W74-B or swing lock solenoid W74-F. (See Section 3 - Checking Electrical Inputs/Outputs).

**Voltage** **No Voltage**

**No:** Contact factory service department.

**No Voltage:** Repair or replace switch or wiring. Contact factory service department.

**Voltage:** Check accessory accumulator pressure at swing lock or brake valve with a 0 – 1000 psi (70 bar) gauge.

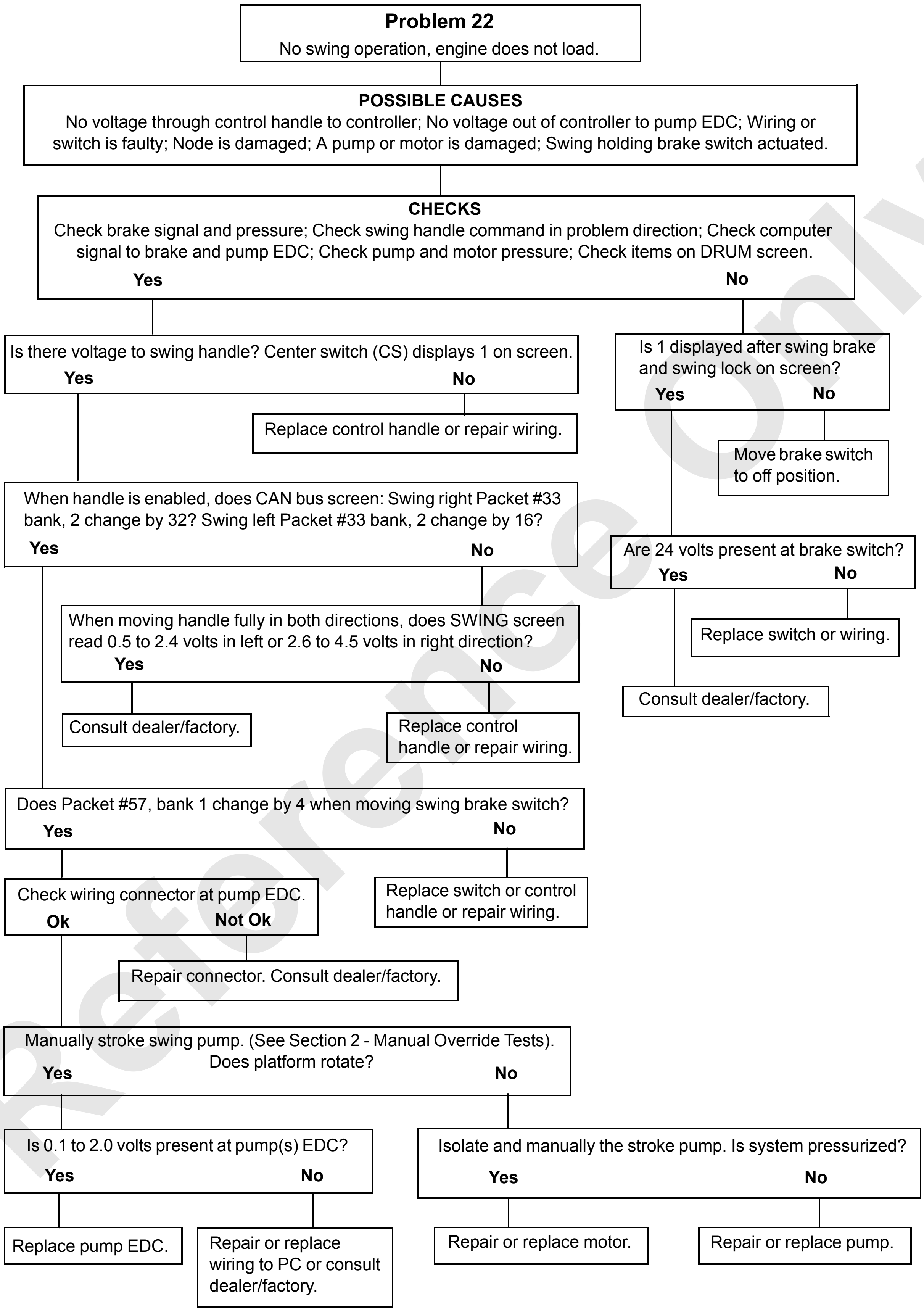
**250 psi (17 bar) or more** **250 psi (17 bar) or less**

**250 psi (17 bar) or more:** Repair or replace swing lock, brake or gearbox.

**250 psi (17 bar) or less:** Set high-pressure accumulator system to 500 psi (35 bar). Is 500 psi obtained?

**No**

**No:** Replace damaged relief valve or pump.







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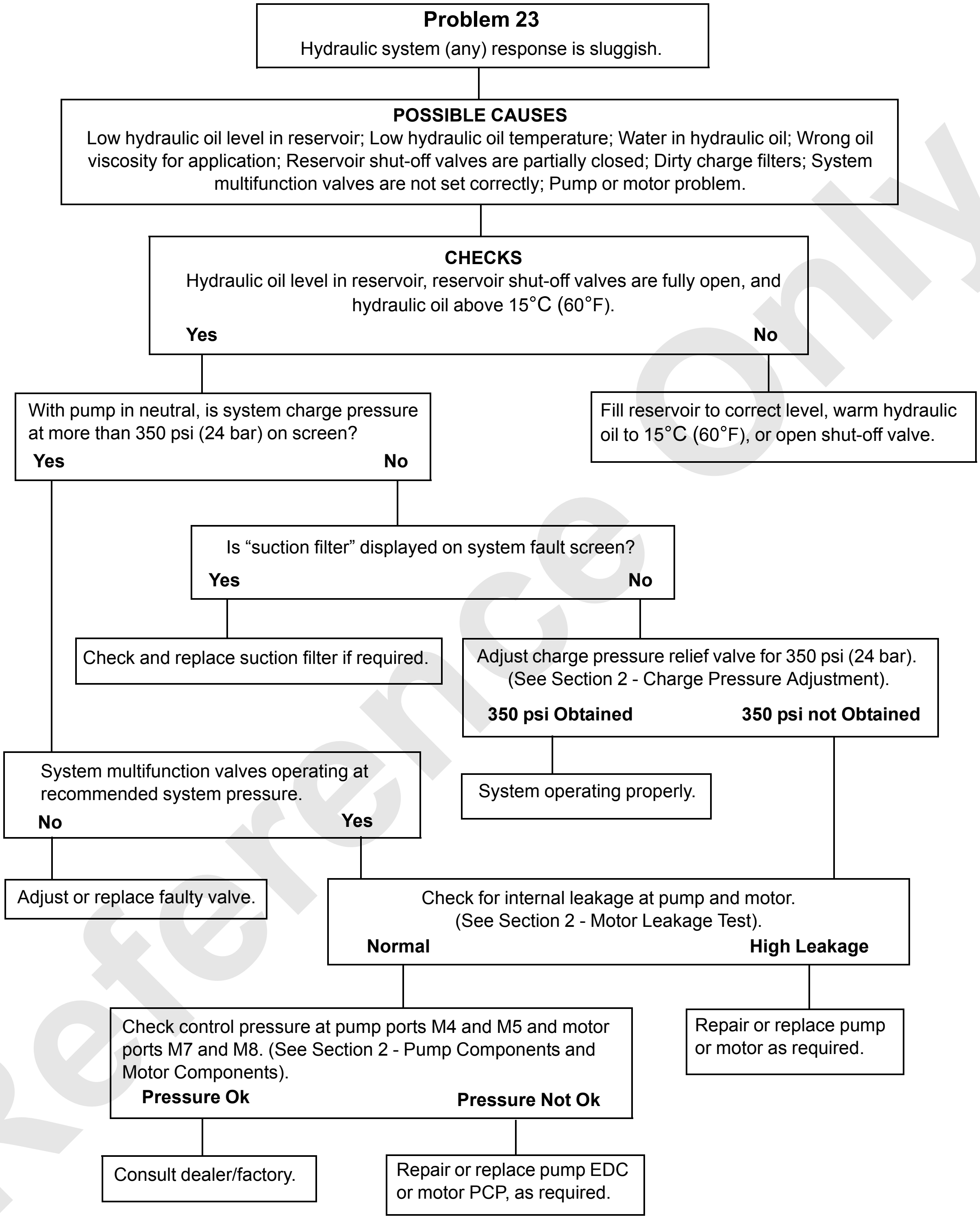
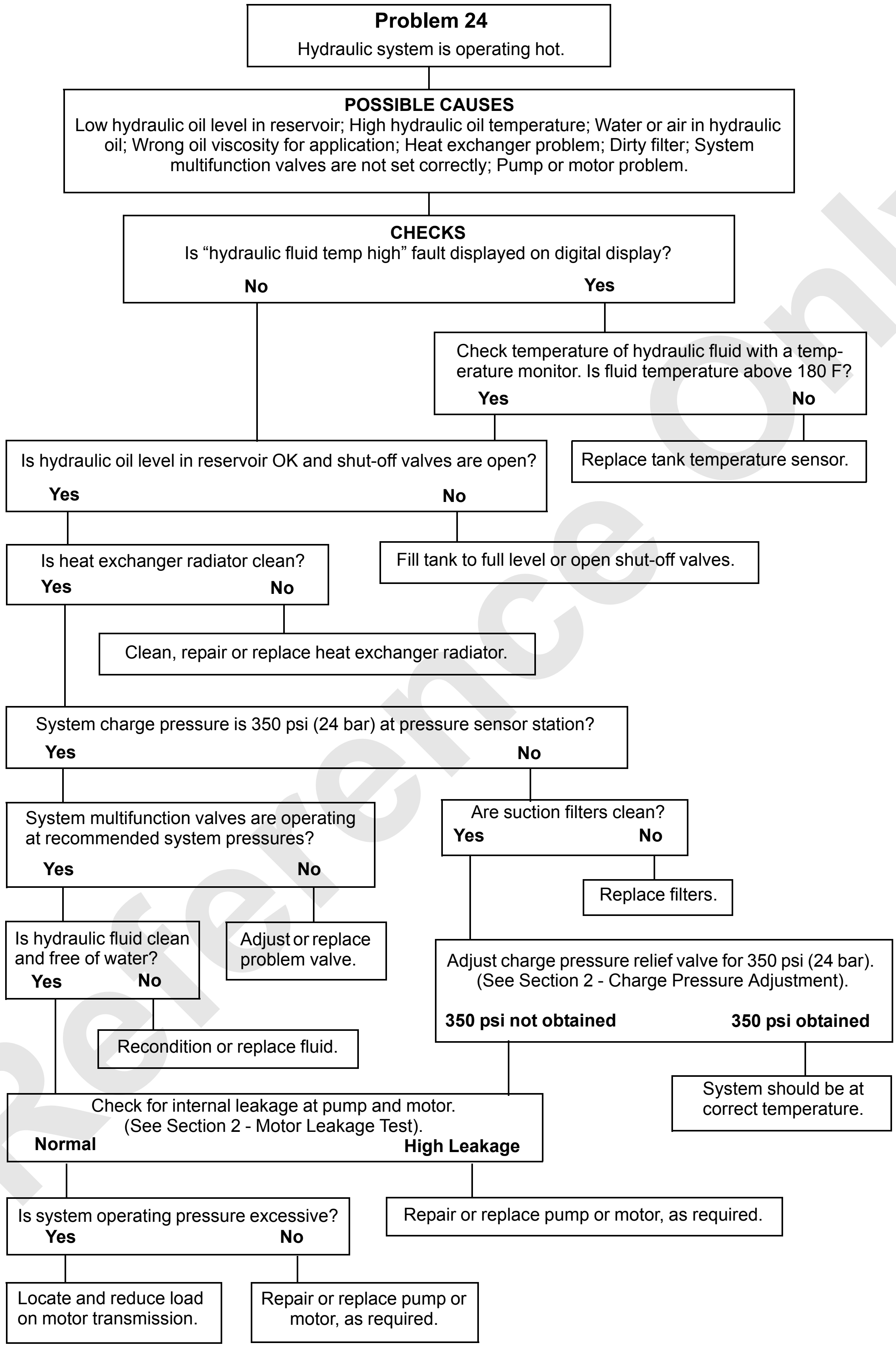

Problem 23
Hydraulic system (any) response is sluggish.
POSSIBLE CAUSES
Low hydraulic oil level in reservoir; Low hydraulic oil temperature; Water in hydraulic oil; Wrong oil viscosity for application; Reservoir shut-off valves are partially closed; Dirty charge filters; System multifunction valves are not set correctly; Pump or motor problem.
CHECKS
Hydraulic oil level in reservoir, reservoir shut-off valves are fully open, and hydraulic oil above 15°C (60°F).
Yes
No
With pump in neutral, is system charge pressure at more than 350 psi (24 bar) on screen?
Yes
No
Fill reservoir to correct level, warm hydraulic oil to 15°C (60°F), or open shut-off valve.
Is “suction filter” displayed on system fault screen?
Yes
No
Check and replace suction filter if required.
Adjust charge pressure relief valve for 350 psi (24 bar). (See Section 2 - Charge Pressure Adjustment).
350 psi Obtained
350 psi not Obtained
System multifunction valves operating at recommended system pressure.
No
Yes
System operating properly.
Adjust or replace faulty valve.
Check for internal leakage at pump and motor. (See Section 2 - Motor Leakage Test).
Normal
High Leakage
Check control pressure at pump ports M4 and M5 and motor ports M7 and M8. (See Section 2 - Pump Components and Motor Components).
Pressure Ok
Pressure Not Ok
Repair or replace pump or motor as required.
Consult dealer/factory.
Repair or replace pump EDC or motor PCP, as required.





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**Problem 25**

System pump will not return to neutral.

**POSSIBLE CAUSES**

Control handle is worn; System pump EDC is damaged or out of adjustment; System pump is damaged; Pump is not centered.

**CHECKS**

Does problem system screen CS (center switch) indicate a voltage when system handle is in neutral position?

**Yes** — Replace system control handle or repair wiring.

**No** — With system handle in neutral does screen display command activity for pump?

- **Yes** — Consult dealer/factory.
- **No** — Does system pump EDC manually return to neutral? (See Section 2 - Pump Neutral Adjustment).
  - **Yes** — Adjust pump neutral.
  - **No** — Repair or replace system pump or pump EDC.

**Problem 26**

Pawl on boom, luffing jib, or mast hoist is not operating correctly.

**POSSIBLE CAUSES**

Mechanical hang-up; No hydraulic pressure; No voltage to pawl solenoid; Bad wiring connection; Actuator/cylinder failure.

**CHECKS**

Check for damage to pawl linkage. Check pawl or pawl actuator/cylinder for freedom of movement.

**No Damage** **Damage**

Repair damage. Test and adjust.

Move brake switch to apply and release positions. See Crane Diagnostics topic in Section 3 to find CAN bus packet numbers. When applicable function was enabled...

Drum 1 Brake Enable . . . . . . . . . . . . . . . . Packet 39, Bank 2 changed by 1
Drum 2 Brake Enable . . . . . . . . . . . . . . . . Packet 34, Bank 2 changed by 1
Drum 3 Brake Enable . . . . . . . . . . . . . . . . Packet 33, Bank 1 changed by 128
Drum 4 Brake Enable . . . . . . . . . . . . . . . . Packet 34, Bank 3 changed by 64
Drum 5 Brake Enable . . . . . . . . . . . . . . . . Packet 34, Bank 1 changed by 2
Drum 6 Brake Enable . . . . . . . . . . . . . . . . Packet 39, Bank 2 changed by 8
Drum 4 Pawl Out. . . . . . . . . . . . . . . . . . . . Packet 34, Bank 3 changed by 8
Drum 4 Pawl In . . . . . . . . . . . . . . . . . . . . Packet 34, Bank 3 changed by 4
Drum 5 Pawl Out. . . . . . . . . . . . . . . . . . . . Packet 34, Bank 1 changed by 8
Drum 5 Pawl In . . . . . . . . . . . . . . . . . . . . . Packet 34, Bank 1 changed by 4
Drum 6 Pawl Out. . . . . . . . . . . . . . . . . . . . Packet 39, Bank 2 changed by 32
Drum 6 Pawl In . . . . . . . . . . . . . . . . . . . . . Packet 39, Bank 2 changed by 16

**Yes** **No**

Is there voltage from controller to applied brake valve?

**Yes** **No**

Check wiring. Consult dealer/factory.

Check node 1 for correct brake input.

Contact dealer/factory.

When enabling problem pawl (brake) switch, check ***hydraulic*** pawl cylinder for 350 psi (24 bar) at valve cylinder ports. (Luffing jib and boom hoist have pawls are electrically enabled.)

**Pressure** **No Pressure**

Check for binding or faulty cylinder.

Is hydraulic pressure at 350 psi (24 bar) present pawl valve or shuttle valve manifold?

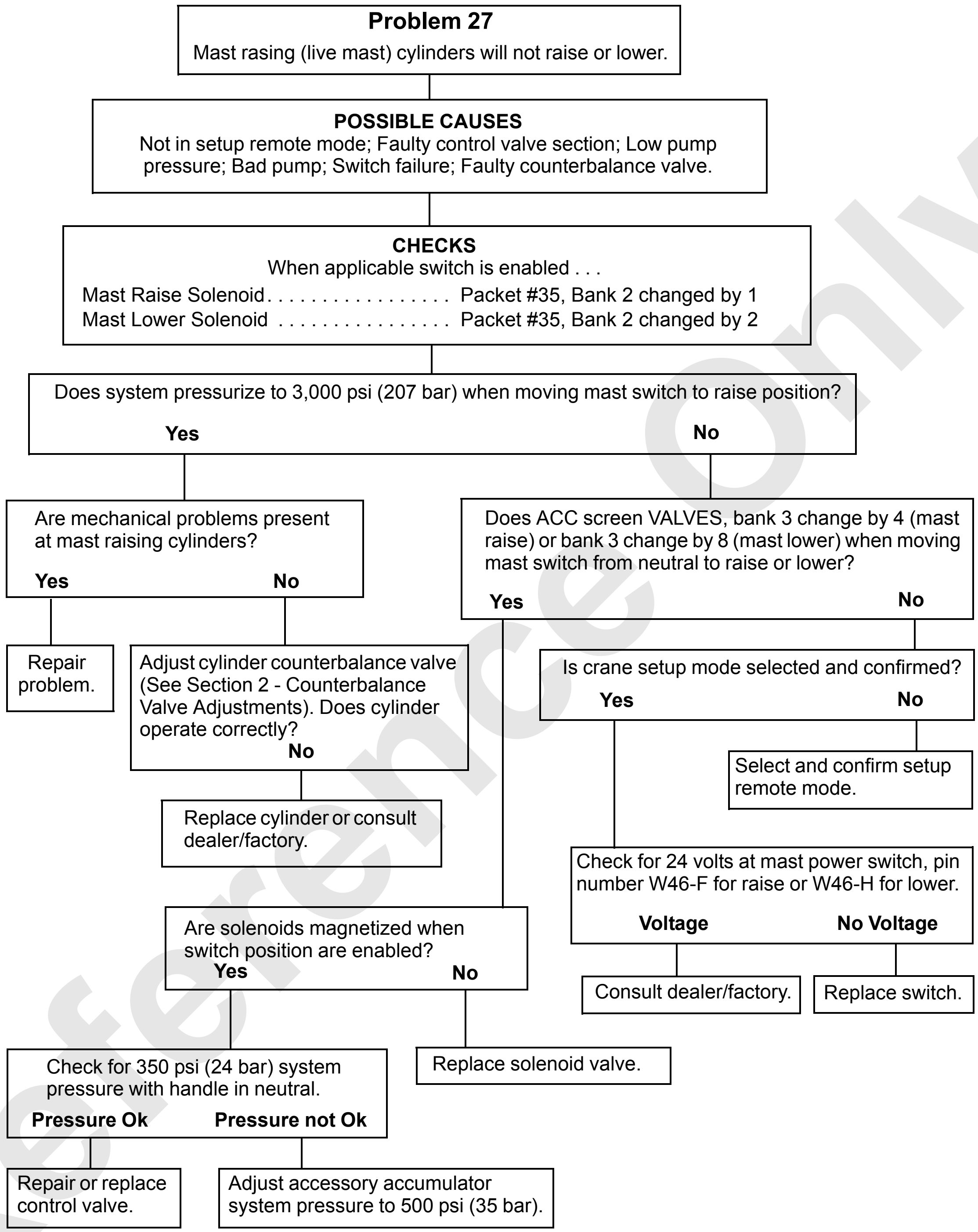
**Yes** **No**

Repair or replace control valve.

Readjust function charge pressure relief valve. Does this solve problem?

**No**

Repair or replace pump.Consult factory.


Problem 27
Mast rasing (live mast) cylinders will not raise or lower.
POSSIBLE CAUSES
Not in setup remote mode; Faulty control valve section; Low pump pressure; Bad pump; Switch failure; Faulty counterbalance valve.
CHECKS
When applicable switch is enabled . . .
Mast Raise Solenoid . . . . . . . . . . . . . . . . . Packet #35, Bank 2 changed by 1
Mast Lower Solenoid . . . . . . . . . . . . . . . . Packet #35, Bank 2 changed by 2
Does system pressurize to 3,000 psi (207 bar) when moving mast switch to raise position?
Yes
No
Are mechanical problems present at mast raising cylinders?
Yes
No
Repair problem.
Adjust cylinder counterbalance valve (See Section 2 - Counterbalance Valve Adjustments). Does cylinder operate correctly?
No
Replace cylinder or consult dealer/factory.
Does ACC screen VALVES, bank 3 change by 4 (mast raise) or bank 3 change by 8 (mast lower) when moving mast switch from neutral to raise or lower?
Yes
No
Is crane setup mode selected and confirmed?
Yes
No
Select and confirm setup remote mode.
Check for 24 volts at mast power switch, pin number W46-F for raise or W46-H for lower.
Voltage
No Voltage
Consult dealer/factory.
Replace switch.
Are solenoids magnetized when switch position are enabled?
Yes
No
Replace solenoid valve.
Check for 350 psi (24 bar) system pressure with handle in neutral.
Pressure Ok
Pressure not Ok
Repair or replace control valve.
Adjust accessory accumulator system pressure to 500 psi (35 bar).

**Problem 28**

Jacking cylinder(s) will not extend or retract.

**POSSIBLE CAUSES**

Not in setup mode; Faulty control valve section; Low pump pressure; Supercharge accessory supply pump is damaged; Faulty counterbalance valve.

**CHECKS**

Check supercharge accessory supply system for 3,000 psi (207 bar) while enabling selected jacking cylinder switch on remote control.

**3,000 psi (207 bar)** **Low/no pressure**

Exchange both counterbalance valve cartridges on problem jacking cylinder. Is cylinder enabled with switch movement?

**Yes** **No**

Repair or replace jacking cylinder.

Replace counterbalance valve. (See Section 2 - Counterbalance Valve Adjustments).

Is crane setup remote mode selected and confirmed?

**Yes** **No**

Select and confirm setup remote mode.

Does system develop any working pressure?

**Yes** **No**

Adjust supercharge accessory supply pressure to 3,000 psi (207 bar) when enabling jacking switch.

Check supercharge accessory supply pump operation.

**Ok** **Not Ok**

Repair or replace supercharge pump.

Consult dealer/factory.

**Problem 29**

Crawler pin cylinder(s) will not extend or retract (left or right set).

**POSSIBLE CAUSES**

Not in setup mode; Faulty control valve section; Supercharge accessory supply pump is damaged; Mechanical problem.

**CHECKS**

Check supercharge accessory supply system for 3,000 psi (207 bar) while enabling selected crawler pin cylinder handle.

**3,000 psi (207 bar)** **Low/No pressure**

Repair or replace problem crawler pin cylinder.

Is crane setup mode select and confirmed?

**Yes** **No**

Select and confirm setup mode.

Does system develop any working pressure?

**Yes** **No**

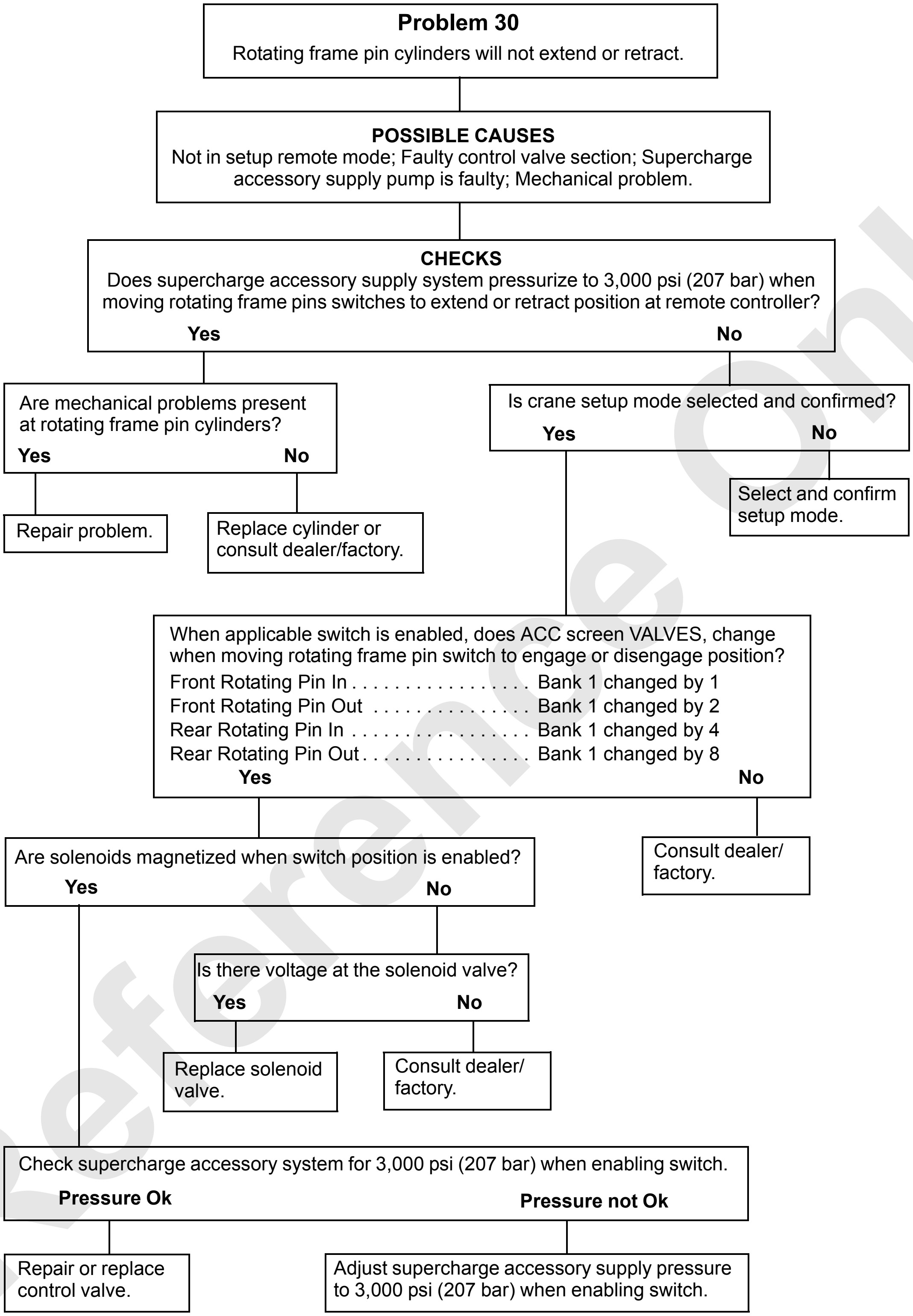
Adjust supercharge accessory supply system for 3,000 psi (207 bar) when pin handle is moved.

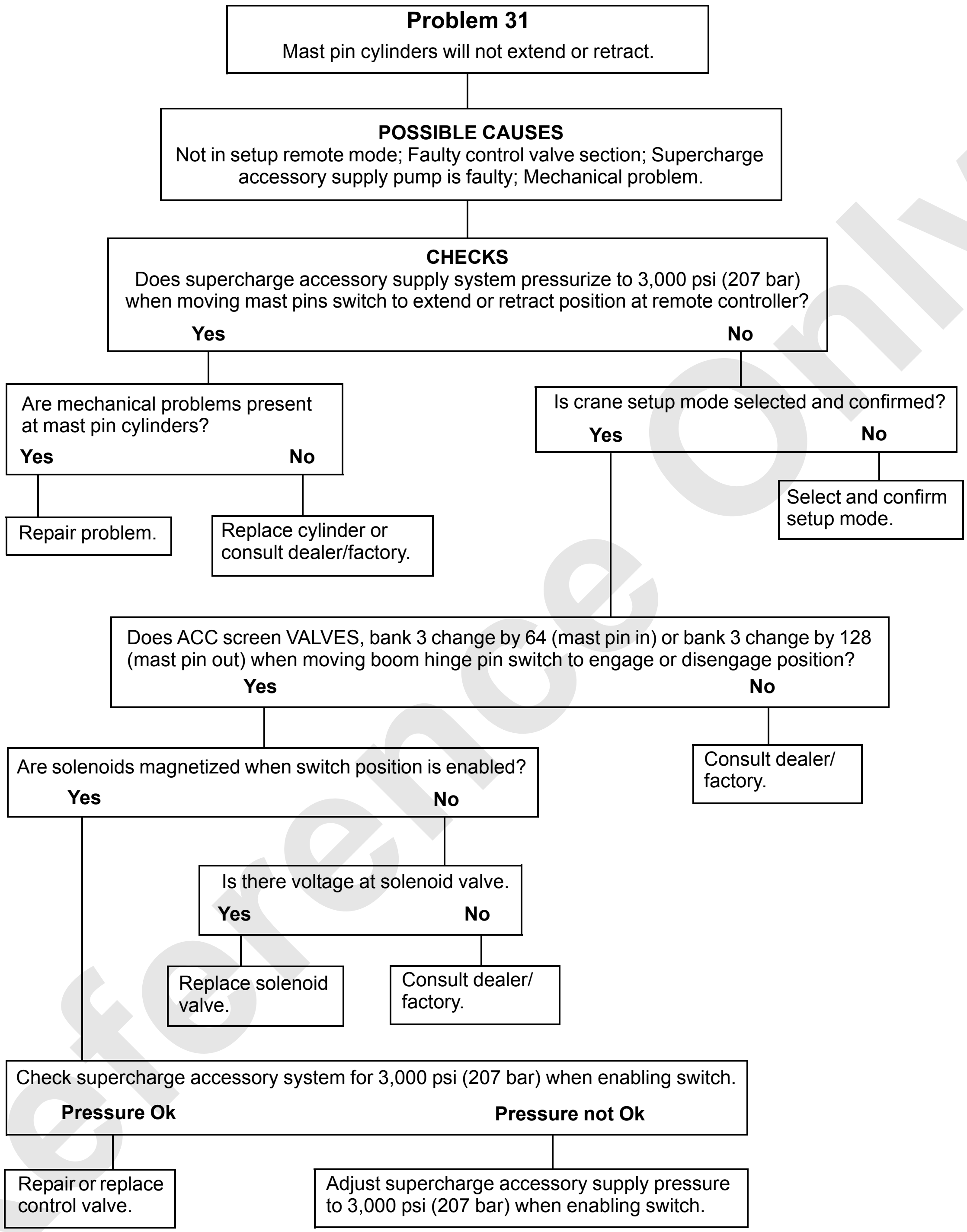
Check supercharge accessory supply pump operation.

**Ok** **Not Ok**

Repair or replace supercharge pump.

Consult dealer/factory.


Problem 30
Rotating frame pin cylinders will not extend or retract.
POSSIBLE CAUSES
Not in setup remote mode; Faulty control valve section; Supercharge accessory supply pump is faulty; Mechanical problem.
CHECKS
Does supercharge accessory supply system pressurize to 3,000 psi (207 bar) when moving rotating frame pins switches to extend or retract position at remote controller?
Yes
No
Are mechanical problems present at rotating frame pin cylinders?
Yes
No
Repair problem.
Replace cylinder or consult dealer/factory.
Is crane setup mode selected and confirmed?
Yes
No
Select and confirm setup mode.
When applicable switch is enabled, does ACC screen VALVES, change when moving rotating frame pin switch to engage or disengage position?
Front Rotating Pin In . . . . . . . . . . . . . . . . . Bank 1 changed by 1
Front Rotating Pin Out . . . . . . . . . . . . . . . Bank 1 changed by 2
Rear Rotating Pin In . . . . . . . . . . . . . . . . . . Bank 1 changed by 4
Rear Rotating Pin Out . . . . . . . . . . . . . . . . Bank 1 changed by 8
Yes
No
Are solenoids magnetized when switch position is enabled?
Yes
No
Consult dealer/ factory.
Is there voltage at the solenoid valve?
Yes
No
Replace solenoid valve.
Consult dealer/ factory.
Check supercharge accessory system for 3,000 psi (207 bar) when enabling switch.
Pressure Ok
Pressure not Ok
Repair or replace control valve.
Adjust supercharge accessory supply pressure to 3,000 psi (207 bar) when enabling switch.


Problem 31
Mast pin cylinders will not extend or retract.
POSSIBLE CAUSES
Not in setup remote mode; Faulty control valve section; Supercharge accessory supply pump is faulty; Mechanical problem.
CHECKS
Does supercharge accessory supply system pressurize to 3,000 psi (207 bar) when moving mast pins switch to extend or retract position at remote controller?
Yes
No
Are mechanical problems present at mast pin cylinders?
Yes
No
Repair problem.
Replace cylinder or consult dealer/factory.
Is crane setup mode selected and confirmed?
Yes
No
Select and confirm setup mode.
Does ACC screen VALVES, bank 3 change by 64 (mast pin in) or bank 3 change by 128 (mast pin out) when moving boom hinge pin switch to engage or disengage position?
Yes
No
Consult dealer/ factory.
Are solenoids magnetized when switch position is enabled?
Yes
No
Is there voltage at solenoid valve.
Yes
No
Replace solenoid valve.
Consult dealer/ factory.
Check supercharge accessory system for 3,000 psi (207 bar) when enabling switch.
Pressure Ok
Pressure not Ok
Repair or replace control valve.
Adjust supercharge accessory supply pressure to 3,000 psi (207 bar) when enabling switch.



10

**Problem 32**

Boom hinge pin cylinders will not extend or retract.

**POSSIBLE CAUSES**

Not in setup remote mode; Faulty control valve section; Supercharge accessory supply pump is faulty; Mechanical problem.

**CHECKS**

Does supercharge accessory supply system pressurize to 3,000 psi (207 bar) when moving boom hinge pins switch to extend or retract position at remote controller?

**Yes** **No**

Are mechanical problems present at boom hinge pin cylinders?

**Yes** **No**

Repair problem.

Replace cylinder or consult dealer/factory.

Is crane setup mode selected and confirmed?

**Yes** **No**

Select and confirm setup mode.

Does ACC screen VALVES, bank 3 change by 16 (hinge pin in) or bank 3 change by 32 (hinge pin out) when moving boom hinge pin switch to engage or disengage position?

**Yes** **No**

Consult dealer/ factory.

Are solenoids magnetized when switch position is enabled?

**Yes** **No**

Is there voltage at solenoid valve.

**Yes** **No**

Replace solenoid valve.

Consult dealer/ factory.

Check supercharge accessory system for 3,000 psi (207 bar) when enabling switch.

**Pressure Ok** **Pressure not Ok**

Repair or replace control valve.

Adjust supercharge accessory supply pressure to 3,000 psi (207 bar) when enabling switch.





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# ALPHABETICAL INDEX

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