Manitowoc 2250

Service/Maintenance Manual

Grove Manitowoc National Crane Potain

SERVICE/MAINTENANCE MANUAL

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

2250

Model Number

XXXXXREF

Serial Number

This manual is divided into the following Sections:

NOTICE

The serial number of the crane and applicable attachments (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 07-19-16, Control # 249-01

THE ORIGINAL LANGUAGE OF THIS PUBLICATION IS ENGLISH

See end of this manual for Alphabetical Index

SECTION 3 . . . . Electrical System

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SECTION 1
INTRODUCTION

TABLE OF CONTENTS

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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, all service/maintenance information is subject to change without notice. If there is doubt about any procedure, contact your Manitowoc Cranes dealer or the Manitowoc Crane Care Lattice Team.

SAFETY MESSAGES

General

The importance of safe operation and maintenance cannot be overemphasized. Carelessness or neglect on the part of operators, job supervisors and planners, rigging personnel, and jobsite 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 personnel of 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**

Safe Maintenance Required!

Importance of safe maintenance cannot be overemphasized. 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 is intended only as a guide to assist qualified maintenance personnel in safe maintenance. Manitowoc Cranes cannot foresee all hazards that will arise in the field. Therefore, safety remains the responsibility of the maintenance personnel and the crane's owner.

Maintenance Instructions

To ensure safe and proper operation of Manitowoc cranes, they must be maintained according to these maintenance instructions 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 Cranes dealer for assistance.

NOTE: Training/qualification of maintenance personnel is responsibility of crane's owner.

Safe Maintenance Practices

WARNING

Burn and Inhalation Hazards!

Temperature of exhaust and exhaust components for Tier 4F engines can be higher than other engines.

To prevent death or serious injury:

- Avoid physical contact with exhaust gases and exhaust system components.
- Keep all flammable materials away from the exhaust system to prevent fire.
- If it is necessary to service the crane while the engine is running, turn OFF the diesel particulate filter (DPF) regeneration using the switch in the cab to prevent higher exhaust temperatures.

Perform the following procedure (as applicable) before starting a maintenance procedure.

1. Park the crane where it will not interfere with other equipment or operations.
2. Lower all loads to the ground or otherwise secure them against movement.
3. Lower the boom onto blocking at ground level, if possible, or otherwise secure the boom against dropping.
4. Move all controls to the OFF position and secure all functions against movement by applying or engaging all brakes, pawls, or other locking devices.
5. Stop the engine and render starting means inoperative.
6. Place a warning sign at the start controls, alerting other personnel that the crane is being serviced and the engine must not be started. Do not remove the sign until it is safe to return the crane to service.

WARNING

Prevent Personal Injury!

Do not attempt to maintain or repair any part of the crane while the engine is operating, unless absolutely necessary. Wait for the engine and machinery to cool before servicing them.

If the engine is operating, follow these guidelines to prevent injury:

- Keep clothing and all body parts away from moving parts.
- Use extreme caution when working around machinery. It can be extremely hot.
- Maintain constant verbal communication between the person at the controls and the person performing the maintenance or repair procedure.

When performing maintenance or repair procedures on the crane, follow these guidelines to prevent personal injury or machine damage:

- Wear clothing that is relatively tight and belted.
- Wear appropriate eye protection and an approved hard hat.
- Never climb onto or off a moving crane. Climb onto and off the crane only when it is parked and only with the operator's permission.
- Use both hands and handrails, steps, and ladders provided to climb onto and off the crane.
- Lift tools and other equipment (which cannot be carried in pockets or tool belts) onto and off the crane with hand lines or hoists.
- The boom and gantry are not intended to be used as ladders. Do not attempt to climb the lattice work of the boom or gantry to get to the maintenance points. If the boom or gantry is not equipped with an approved ladder, lower them before performing maintenance or repair procedures.
- Do not remove the cylinders until the working unit has been securely restrained against movement.
- Pinch points are impossible to eliminate. Watch for them closely.

⚠ WARNING

High-Pressure Hazard!

Prevent personal injury. 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 body parts (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.

- Relieve pressures before disconnecting air, coolant, and hydraulic lines and fittings.
- Do not remove the radiator cap while the coolant is hot or under pressure. Stop the engine, wait until the pressure drops and the coolant cools, then slowly remove the cap.

⚠ DANGER

Battery Explosion Hazard!

Prevent serious injury. Avoid battery explosion:

- Do not smoke while performing battery maintenance.
- Do not short across battery terminals to check its charge.

- Read the safety information in the battery manufacturer's instructions before attempting to charge a battery.
- Avoid battery acid contact with skin and eyes. If contact occurs, flush the area with water and immediately consult a doctor.
- Stop the engine before refueling the crane.
- Do not smoke or allow open flames in refueling area.
- Use a safety-type can with an automatic closing cap and flame arrestor for refueling.
- Hydraulic oil can also be flammable. Do not smoke or allow open flames in the area when filling the hydraulic tanks.
- Never handle wire rope with bare hands. Always wear heavy-duty gloves to prevent being cut by broken wires.
- Use extreme care when handling coiled pendants. Stored energy can cause coiled pendants to uncoil quickly with considerable force.
- When inflating tires, use a tire cage, a clip-on inflater, and an extension hose that permits standing well away from the tire.
- Only use cleaning solvents that are non-volatile and non-flammable.
- Do not attempt to lift heavy components by hand. Use a hoist, jacks, or blocking to lift components.

CAUTION

Prevent Machine Damage!

To prevent damage to crane parts, such as bearings, cylinders, swivels, slewing ring, and computers, perform the following steps before welding on the crane:

- Disconnect all cables from the batteries.
- Disconnect output cables at the engine junction box.
- Attach the ground cable from the welder directly to the part being welded and as close to the weld as possible.

Do not weld on the engine or any engine-mounted parts (per engine manufacturer).

- Use care while welding or burning on the crane. Cover all hoses and components with non-flammable shields or blankets to prevent a fire or other damage.
- Disconnect and lock the power supply switch before attempting to service high-voltage electrical components and before entering tight areas (such as carbody openings) containing high-voltage components.

⚠ DANGER

Overhead Hazard!

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

Boom, jib, or mast sections may fall.

- When assembling and disassembling the booms, jibs, or masts on the ground (with or without support of the boom rigging pendants or straps), securely block each section to provide adequate support and alignment.
- Unless authorized in writing by Manitowoc Cranes, do not alter the crane in any way that affects the crane's performance (to include welding, cutting, or burning of structural members or changing pressures and flows of the air/hydraulic components). Doing so will invalidate all warranties and capacity charts and make the crane's owner/user liable for any resultant accidents.

- Keep the crane clean. Accumulations of dirt, grease, oil, rags, paper, and other waste will not only interfere with safe operation and maintenance but also create a fire hazard.
- Store tools, oil cans, spare parts, and other necessary equipment in tool boxes. Do not allow these items to lie around loose in the operator's cab or on walkways and stairs.
- Do not store flammable materials on the crane.

Perform the following procedure before returning the crane to service.

1. Do not return the crane to service at completion of maintenance or repair procedures until all guards and covers have been reinstalled, trapped air has been bled from the hydraulic systems, safety devices have been reactivated, and all maintenance equipment has been removed.
2. Perform a function check to ensure proper operation at completion of maintenance or repair.

ENVIRONMENTAL PROTECTION

CAUTION

Prevent Environmental Damage!

Dispose of waste properly.

Improperly disposing of waste can threaten the environment.

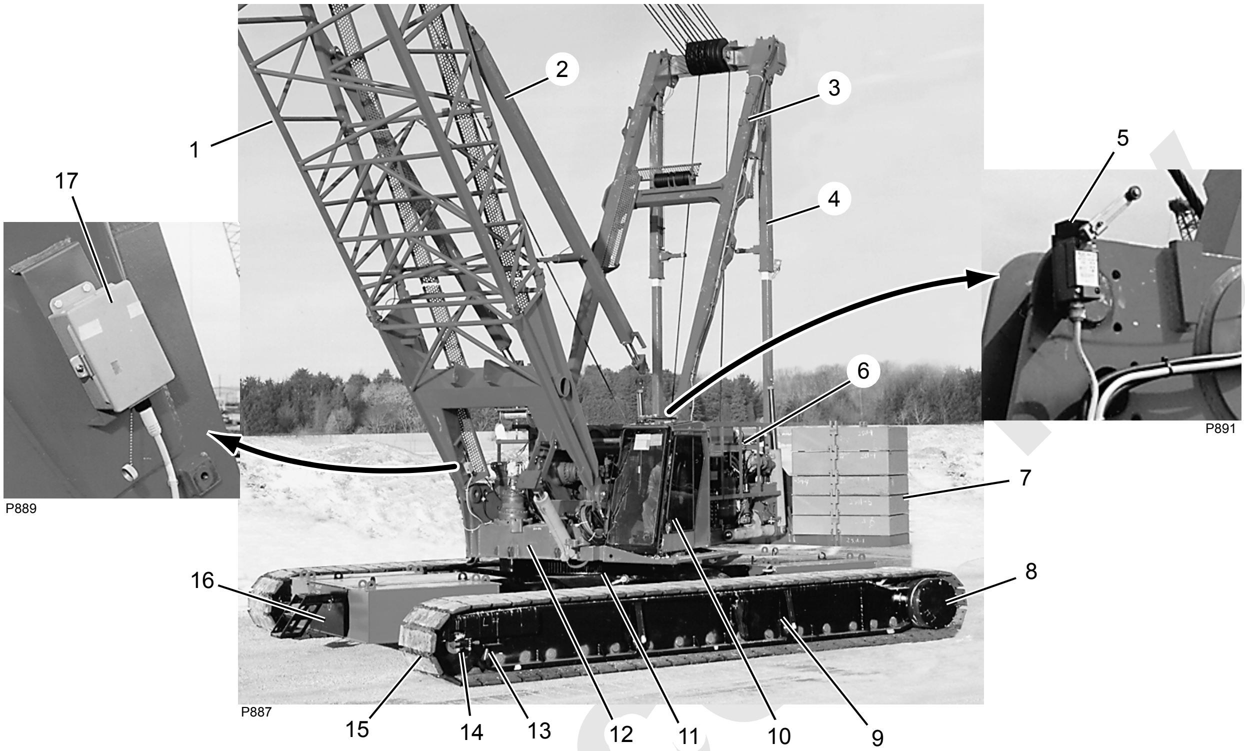
Potentially harmful waste used in Manitowoc cranes includes, but is not limited to, oil, fuel, grease, coolant, air conditioning refrigerant, filters, batteries, and soiled cloths.

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

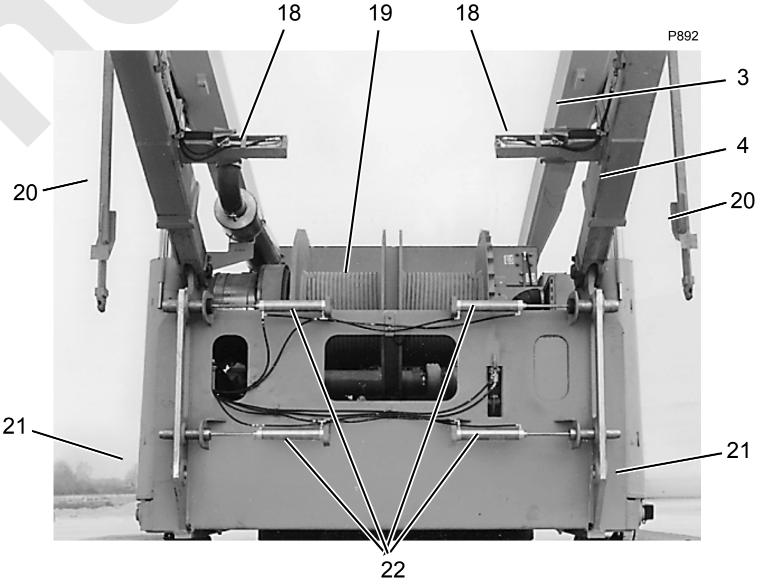
When filling and draining crane components, perform the following:

- 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

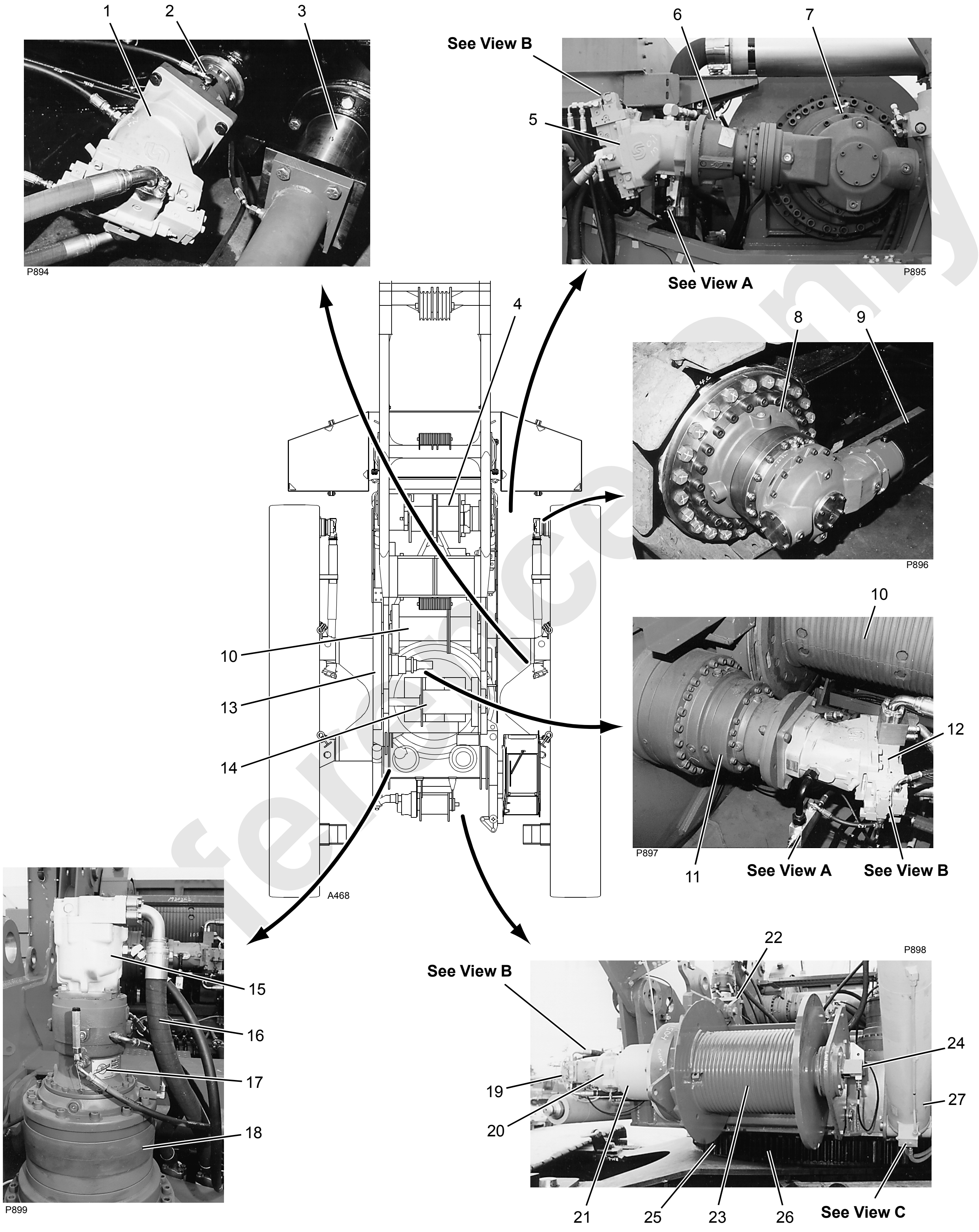


Item	Description
1	#44 Heavy Lift Boom
2	Physical Air Cushioned Boom Stop (qty 2)
3	Gantry
4	Gantry Backhitch (telescopic) (qty 2)
5	Boom Stop Limit Switch
6	Rotating Bed
7	Upper Counterweight
8	Crawler Output Planetary with Drive Tumbler (qty 2)
9	Crawler (qty 2)
10	Operator’s Cab
11	Carbody
12	Adapter Frame
13	Crawler Intermediate Roller (qty 2)
14	Crawler Front Roller (qty 2)
15	Crawler Tread (qty 2)
16	Carbody Counterweight
17	Boom Angle Indicator Junction Box
18	Gantry Backhitch Cylinder (air)
19	Boom Hoist Drum (qty 2)
20	Counterweight Handling Link (qty 2)
21	Gantry Lifting Cylinder (hydraulic) (qty 2)
22	Counterweight Connecting Pin Cylinder (qty 4)



Rear View with Upper Counterweight Removed
Upper Counterweight Attached to the Crane with Items 22

FIGURE 1-1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See View A
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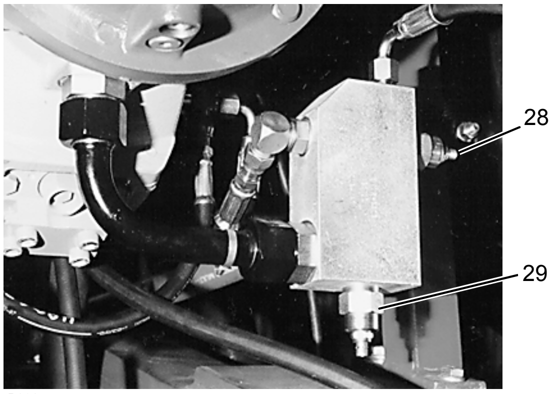
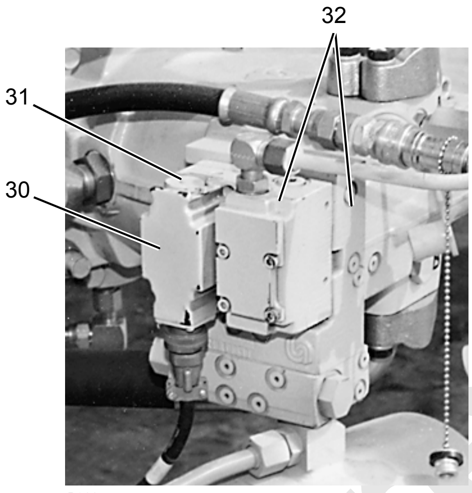
See View C

FIGURE 1-2



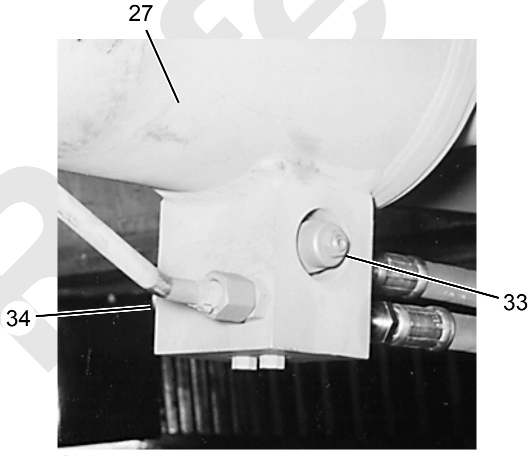
View A

Typical at Boom Hoist and
Drum Drive Motors



View B

Typical at Boom Hoist, Luffing
Hoist, and Drum Drive Motors



View C

Item	Description
1	Crawler Drive Motor
2	Travel Brake (disc)
3	Crawler Connecting Pin Cylinder (hydraulic)
4	Boom Hoist
5	Boom Hoist Motor
6	Boom Hoist Brake (disc)
7	Boom Hoist Planetary
8	Crawler Input Planetary
9	Crawler Drive Shaft
10	Rear Load Drum
11	Drum Drive Planetary
12	Drum Drive Motor
13	Drum Drive Gear Case
14	Front Load Drum
15	Swing Motor
16	Swing Motor Hydraulic Hose
17	Swing Brake (disc)
18	Swing Planetary
19	Luffing Hoist Motor
20	Luffing Hoist Brake (disc)
21	Luffing Hoist Planetary
22	Luffing Hoist Ratchet and Pawl
23	Luffing Hoist Drum
24	Luffing Hoist Drum Speed Sender
25	Swing Pinion
26	Swing Gear (with turntable bearing)
27	Boom Butt Handling Cylinder
28	Loop Flushing Sequence Valve
29	Loop Flushing Flow Control Valve
30	Pressure Control Pilot Valve
31	Manual Motor Control (speed)
32	Proportional Speed Control Valve
33	Boom Butt Handling Counterbalance Valve (piston end)
34	Boom Butt Handling Counterbalance Valve (rod end)

FIGURE 1-2 continued

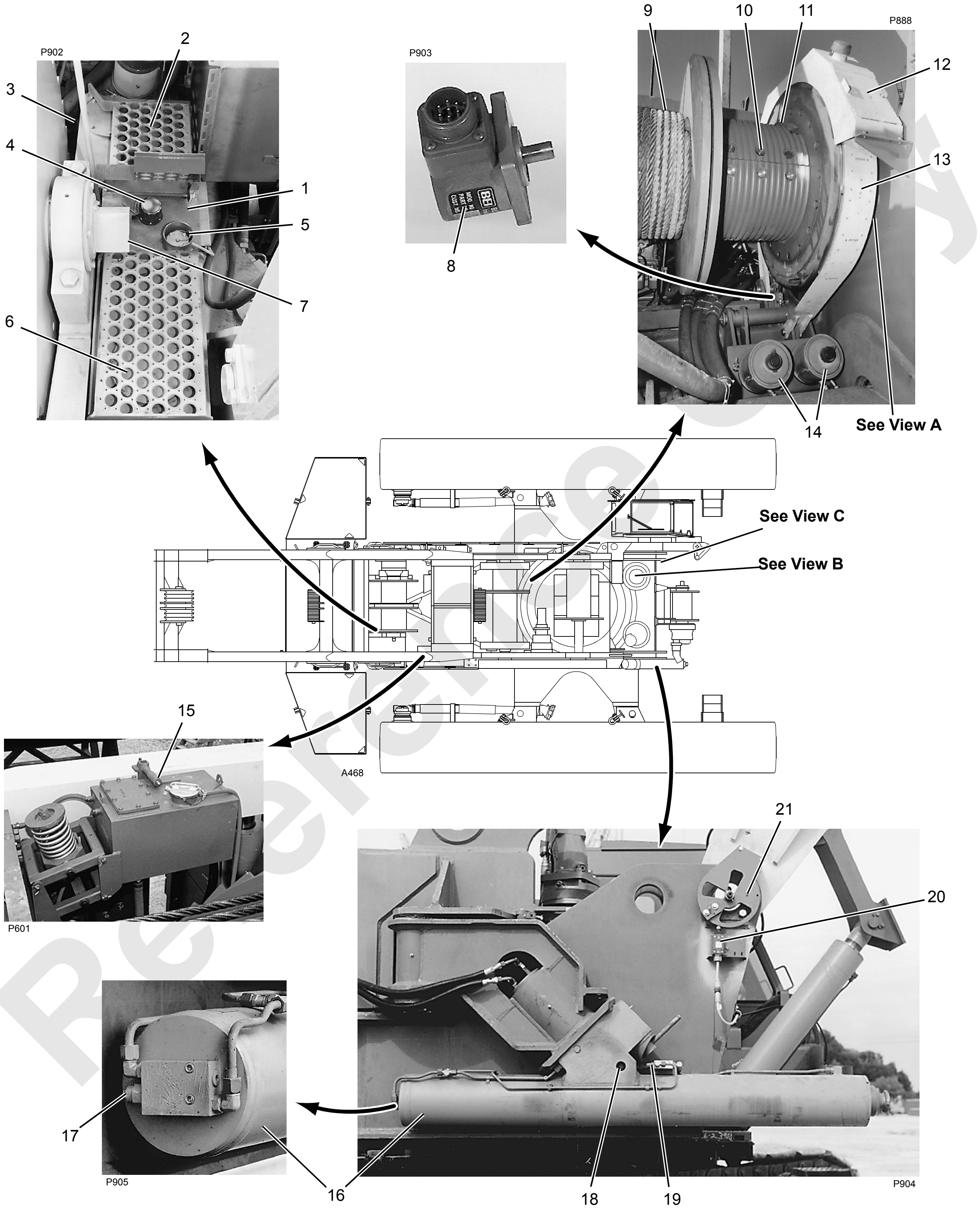

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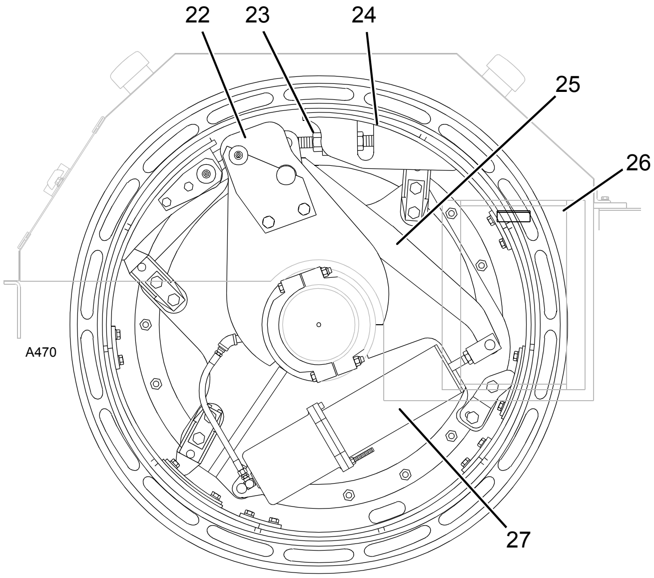
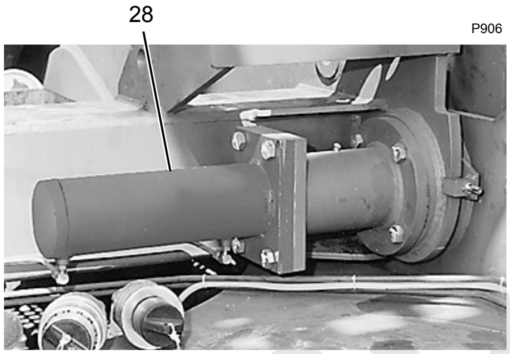
FIGURE 1-3



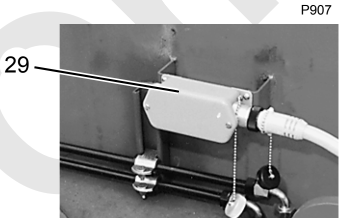
View A

Typical Outboard End of
Each Drum Shaft



View B

Typical Four Places



View C

Item	Description
1	Hydraulic Tank
2	Hydraulic Tank Filter (under grate in tank) (qty 2)
3	Hydraulic Tank Vacuum and Temperature Sender (inboard side) (qty 1 each)
4	Hydraulic Tank Fill Cap
5	Hydraulic Tank Level Sender
6	Hydraulic Tank Clean-Out Cover (under grate)
7	Boom Hoist Drum Speed Sender
8	Load Drum Speed Sender (each drum)
9	Right Rear Drum
10	Drum Lagging
11	Left Rear Drum
12	Drum Brake Adjustment Access Door
13	Drum Brake Band (external contracting)
14	Drum Brake Cylinder (air and spring applied) (qty 2)
15	Radiator Auxiliary Tank
16	Rotating Bed Jacking Cylinder (qty 4)
17	Rotating Bed Jacking Counterbalance Valve (retract)
18	Rotating Bed Jacking Counterbalance Valve (extend)
19	Rotating Bed Jacking Anti-Drift Valve
20	Automatic Boom Stop Limit Switch
21	Boom Stop Actuator
22	Drum Clutch Spider
23	Drum Clutch Adjusting Nut
24	Drum Clutch Band (internal expanding)
25	Drum Clutch Actuating Lever
26	Drum Clutch Adjustment Access Door
27	Drum Clutch Cylinder (spring applied, air released)
28	Adapter Frame Connecting Pin Cylinder (qty 4)
29	Block-Up Limit Shorting Plug Junction Box

FIGURE 1-3 continued

See the Operator Manual for complete list of operating controls

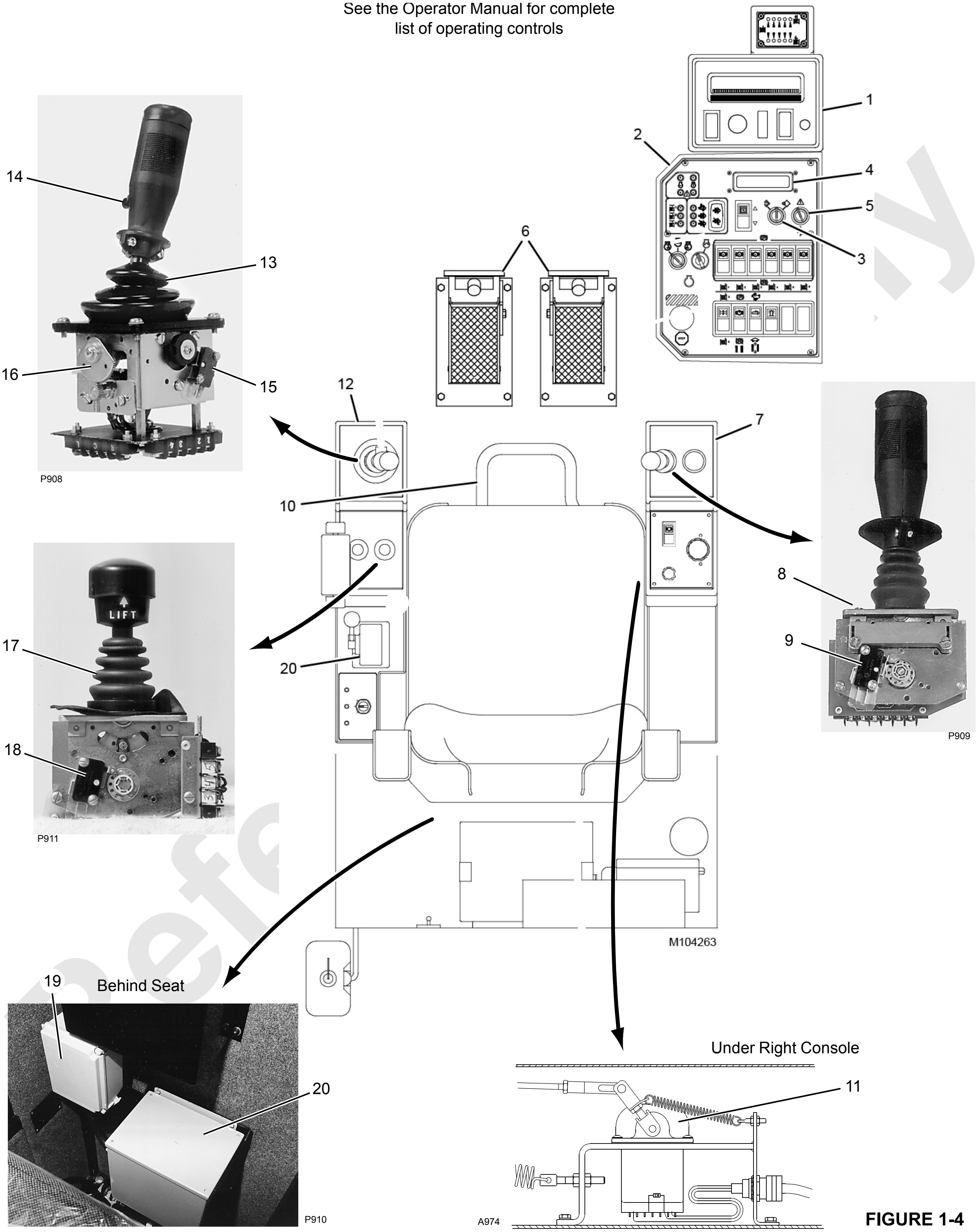
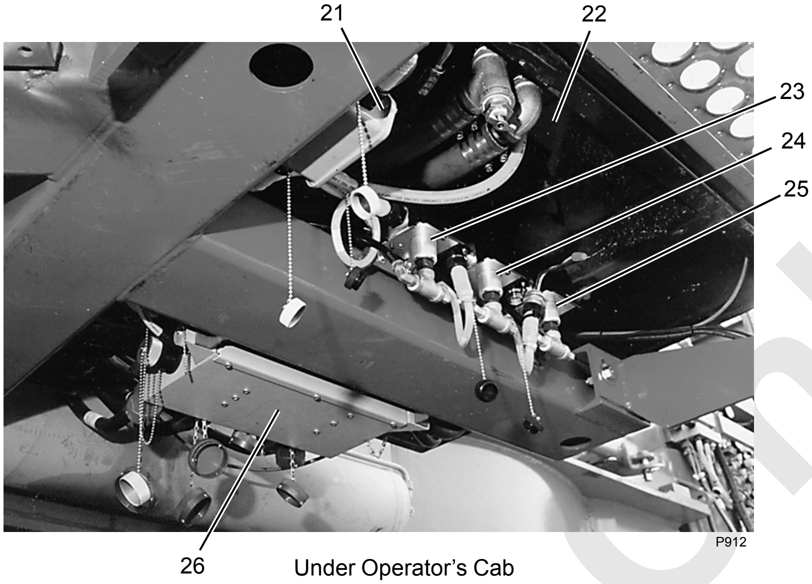


FIGURE 1-4



Under Operator’s Cab

Item‘	Description
1	Rated Capacity Indicator/Limiter Console
2	Front Console
3	Crane Mode (select and confirm)
4	Digital Display
5	Cab Power Switch
6	Brake Treadle Valve
7	Right Console
8	Load Drum Controller
9	Handle Center Switch
10	Foot Throttle Pedal
11	Foot Throttle Controller
12	Left Console
13	Boom Hoist and Swing Controller
14	Swing Holding Brake Switch
15	Handle Center Switch
16	Potentiometer Axis Gear
17	Crawler Controller
18	Handle Center Switch
19	Fuse Junction Box
20	Programmable Controller
21	Alarm Junction Box
22	Cab Heater
23	Has No Function
24	Has No Function
25	Low Air Pressure Switch
26	Main Junction Box

FIGURE 1-4 continued

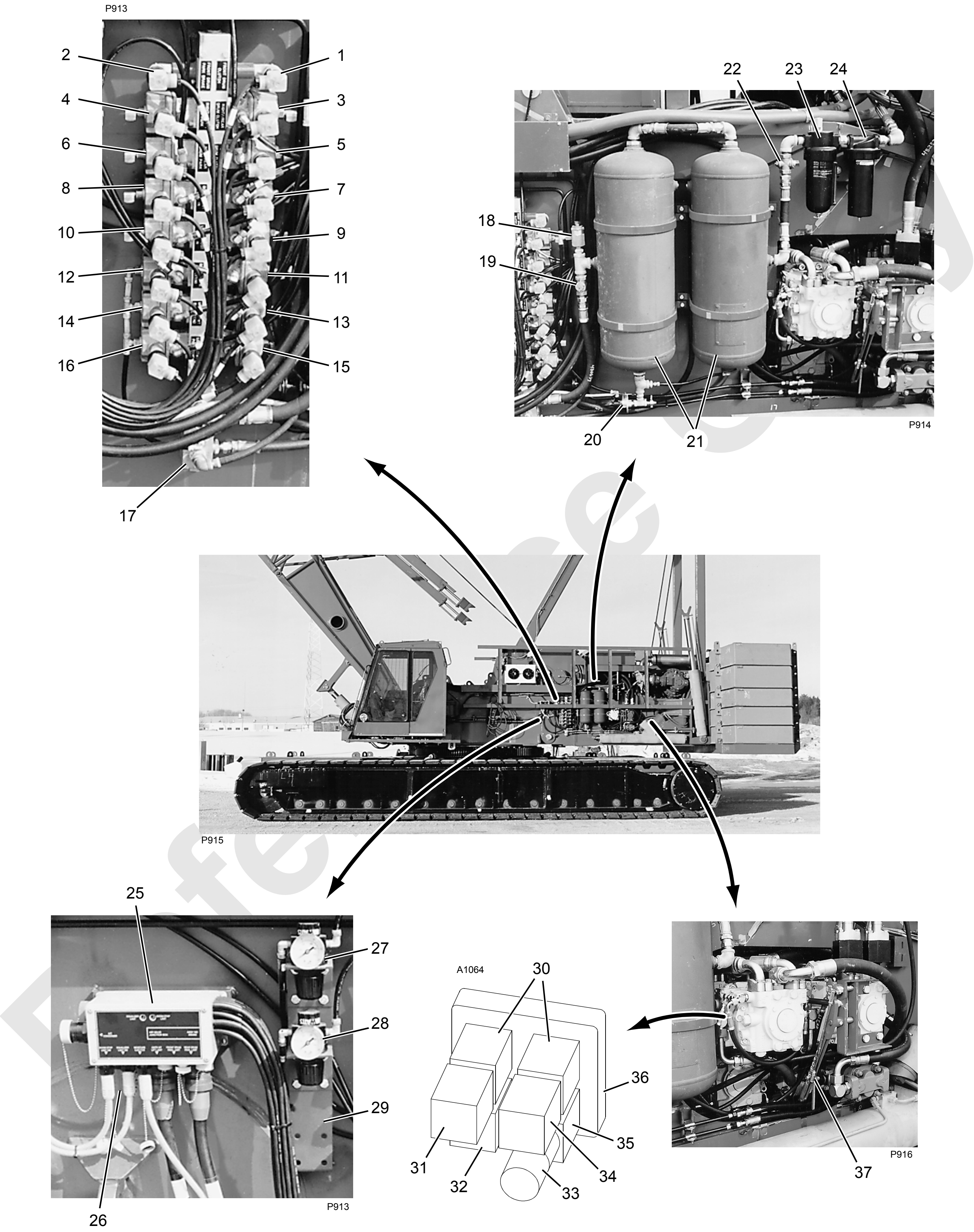

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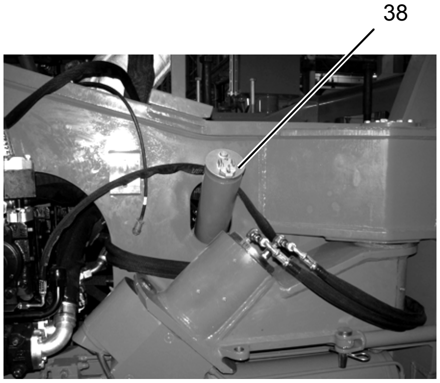
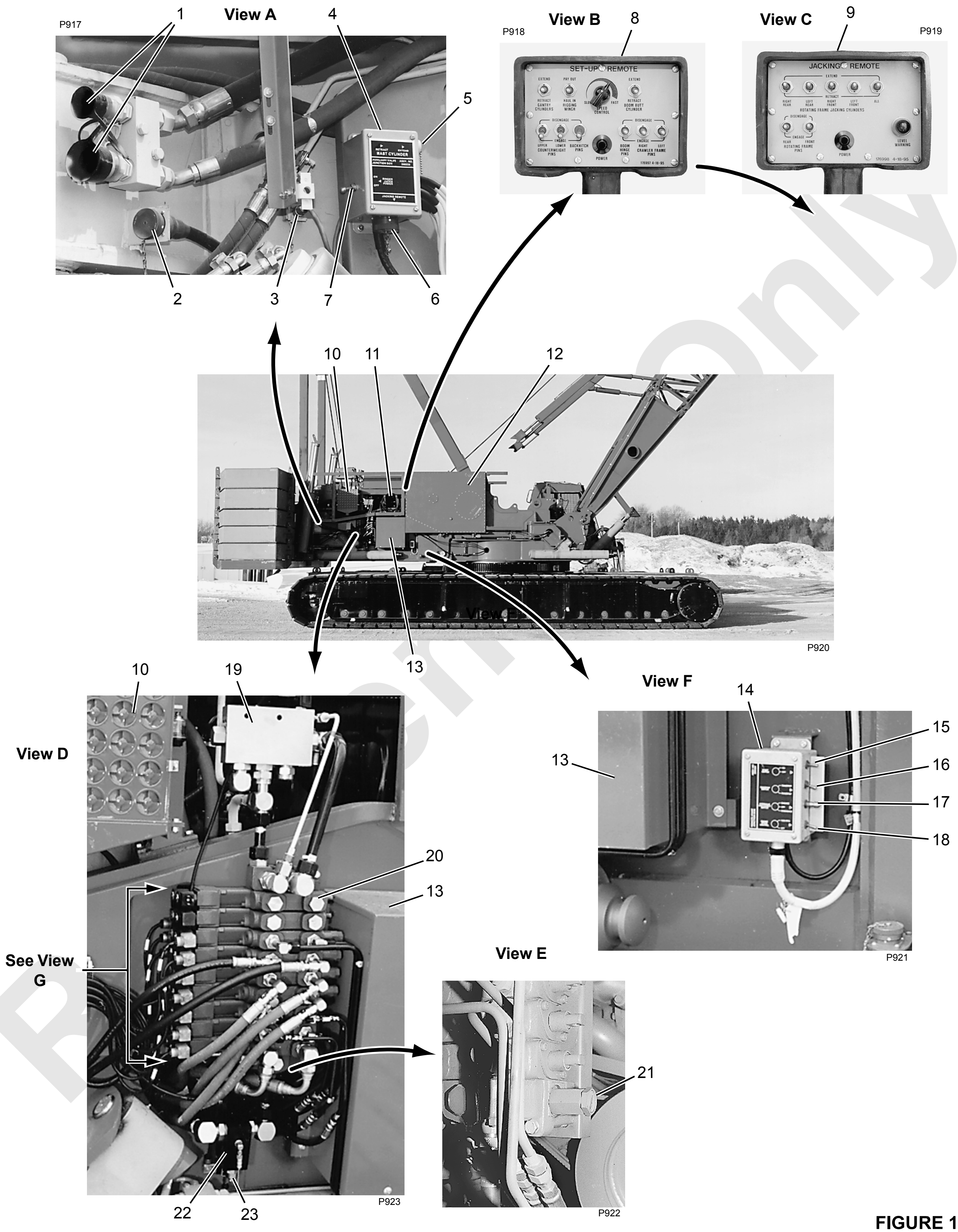
FIGURE 1-5



Item	Description
1	Front Drum Clutch Solenoid Valve
2	Front Drum Park Brake Solenoid Valve
3	Rear or Right Rear Drum Clutch Solenoid Valve
4	Rear or Right Rear Drum Park Brake Solenoid Valve
5	Left Rear Drum Clutch Solenoid Valve
6	Left Rear Drum Park Brake Solenoid Valve
7	Boom Hoist Pawl Out Solenoid Valve
8	Boom Hoist Pawl In Solenoid Valve
9	Luffing Hoist Pawl Out Solenoid Valve
10	Luffing Hoist Pawl In Solenoid Valve
11	Backhitch Pin Cylinders Retract Solenoid Valve
12	Backhitch Pin Cylinders Extend Solenoid Valve
13	Upper Counterweight Pin Cylinders Retract Solenoid Valve
14	Upper Counterweight Pin Cylinders Extend Solenoid Valve
15	Lower Counterweight Pin Cylinders Retract Solenoid Valve
16	Lower Counterweight Pin Cylinders Extend Solenoid Valve
17	Air Manifold
18	Air Compressor Unloader Valve
19	Air Shut-off Valve (from tanks)
20	Moisture Ejector Valve
21	Air Tank (qty 2)
22	Air Shut-off Valve (from compressor)
23	Air De-icer
24	Air Filter
25	Air Valve Junction Box
26	Setup Remote Control Receptacle
27	Left Rear Drum Brake Air Regulator
28	Right Rear Drum Brake Air Regulator
29	Front Drum Brake Air Regulator
30	Load Drums Pump
31	Swing Pump
32	Left Crawler Pump
33	Fan (outboard) and Accessory (inboard) Pump
34	Boom Hoist Pump
35	Right Crawler Pump
36	Pump Drive
37	Pump Drive Disconnect Lever
38	Fuel Tank Fill Cap

FIGURE 1-5 continued


View A
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View B
P918
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SET-UP REMOTE
View C
P919
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JACKING REMOTE
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P920
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View D
See View G
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View F
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View E
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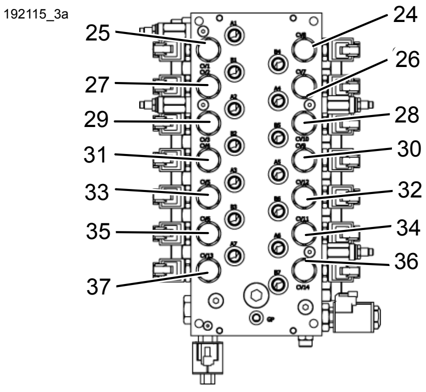
FIGURE 1-6

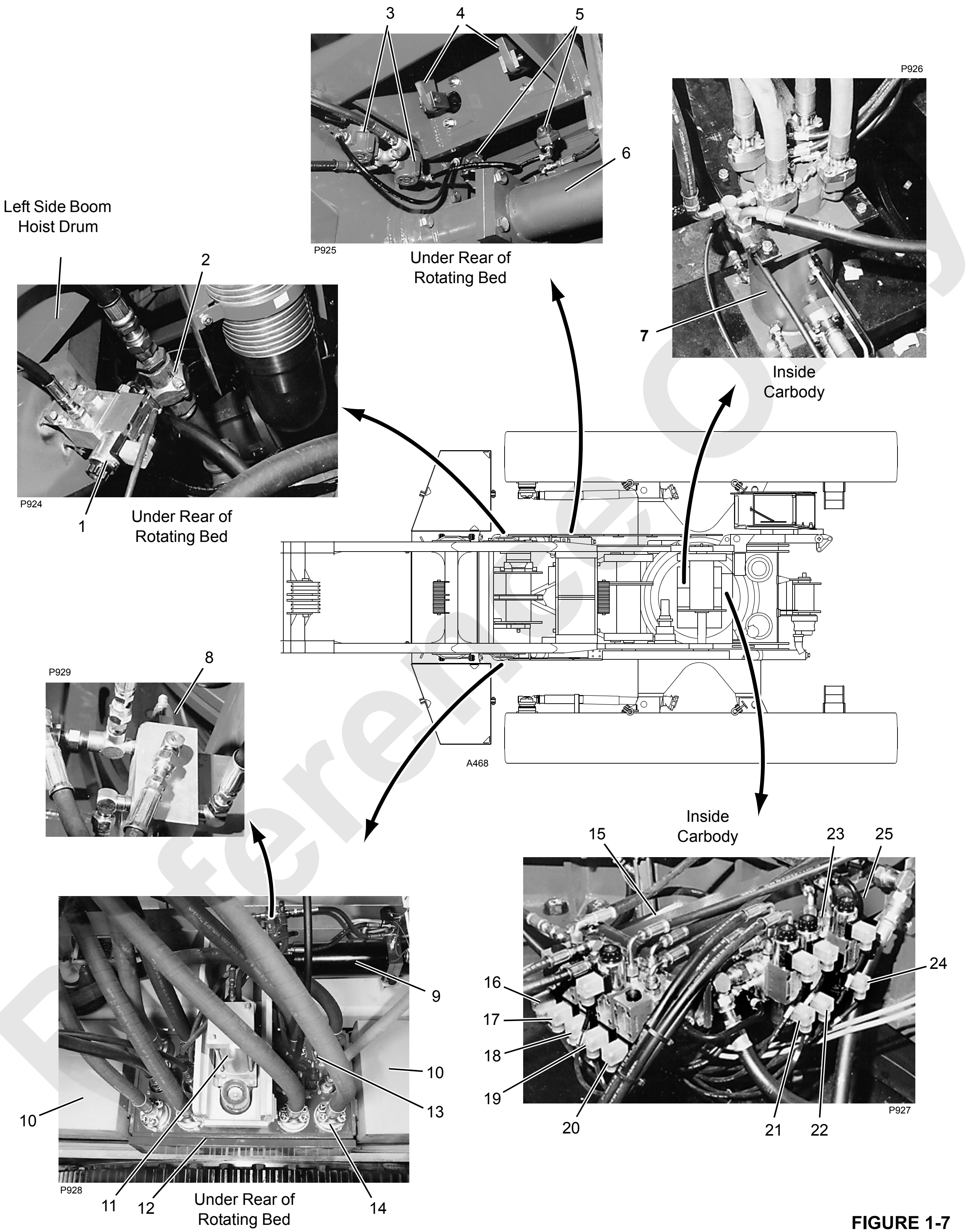
View G



End View

Item	Description
1	MAX-ER Hydraulic Quick-Couplers
2	MAX-ER Electric Receptacle
3	MAX-ER Load Sensing Storage Receptacle
4	Auxiliary Valves Junction Box
5	Switch (not used)
6	Jacking Remote Control Receptacle
7	Not Used
8	Setup Remote Control
9	Jacking Remote Control
10	Engine Air Cleaner
11	Remote Control Storage Compartment (under panel)
12	Drum Drive Gear Case
13	Battery Compartment
14	Remote Start Junction Box
15	Engine Start Switch
16	Engine Run-Stop Switch
17	Hydraulic Disconnect Switch
18	Engine Speed Switch
19	Flow Control Valve (to rotating bed auxiliary valves)
20	Rotating Bed Auxiliary Valves
21	Relief Valve (rotating bed valve assembly)
22	Auxiliary System Disable-Relief Valve
23	Auxiliary System Disable Manual Override
24	Right Front Jack Retract Solenoid Valve
25	Right Rear Jack Extend Solenoid Valve
26	Right Front Jack Retract Solenoid Valve
27	Right Rear Jack Retract Solenoid Valve
28	Front Frame Pins Retract Solenoid Valve
29	Left Rear Jack Extend Solenoid Valve
30	Front Frame Pins Extend Solenoid Valve
31	Left Rear Jack Retract Solenoid Valve
32	Left Front Jack Retract Solenoid Valve
33	Rear Frame Pins Extend Solenoid Valve
34	Left Front Jack Extend Solenoid Valve
35	Rear Frame Pins Retract Solenoid Valve
36	Gantry Cylinders Retract Solenoid Valve
37	Gantry Cylinders Extend Solenoid Valve

FIGURE 1-6 continued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P925
Under Rear of Rotating Bed
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Inside Carbody
Left Side Boom Hoist Drum
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P924
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Under Rear of Rotating Bed
A468
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P929
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P928
11
12
Under Rear of Rotating Bed
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Inside Carbody
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FIGURE 1-7

Item	Description
1	Boom Hoist Brake Solenoid Valve
2	Return Oil Check Valve (qty 3)
3	Drum Brake Relay Valve (qty 2)
4	Drum Brake Lever
5	Drum Brake Quick-Release Valve (qty 2)
6	Adapter Frame Connecting Pin Cylinder (qty 4)
7	Hydraulic Swivel
8	Hydraulic Disconnect Sequence Valve
9	Hydraulic Disconnect Pump (electric with integral oil tank)
10	Shipping Cover
11	Hydraulic Disconnect Travel Cylinder
12	Adapter Frame Coupling Plate (outboard side) Adapter Frame Coupling Plate (inboard side)
13	Hydraulic Disconnect Coupling Cylinder
14	Disconnect (typical)
15	Adapter Frame Junction Box
16	Luffing Hoist Brake Solenoid Valve
17	Travel 2-Speed Solenoid Valve
18	Travel Brake Solenoid Valve
19	Not Used
20	Swing Brake Solenoid Valve
21	Left Crawler Pins Solenoid Valve (top retract / bottom extend)
22	Right Crawler Pins Solenoid Valve (top retract / bottom extend)
23	Boom Hinge Pins Solenoid Valve (top retract / bottom extend)
24	Boom Butt Handling Solenoid Valve (top retract / bottom extend)
25	Rigging Winch Solenoid Valve (top pay out / bottom haul in)

FIGURE 1-7 continued

TIER 4 FINAL ENGINE COMPONENTS

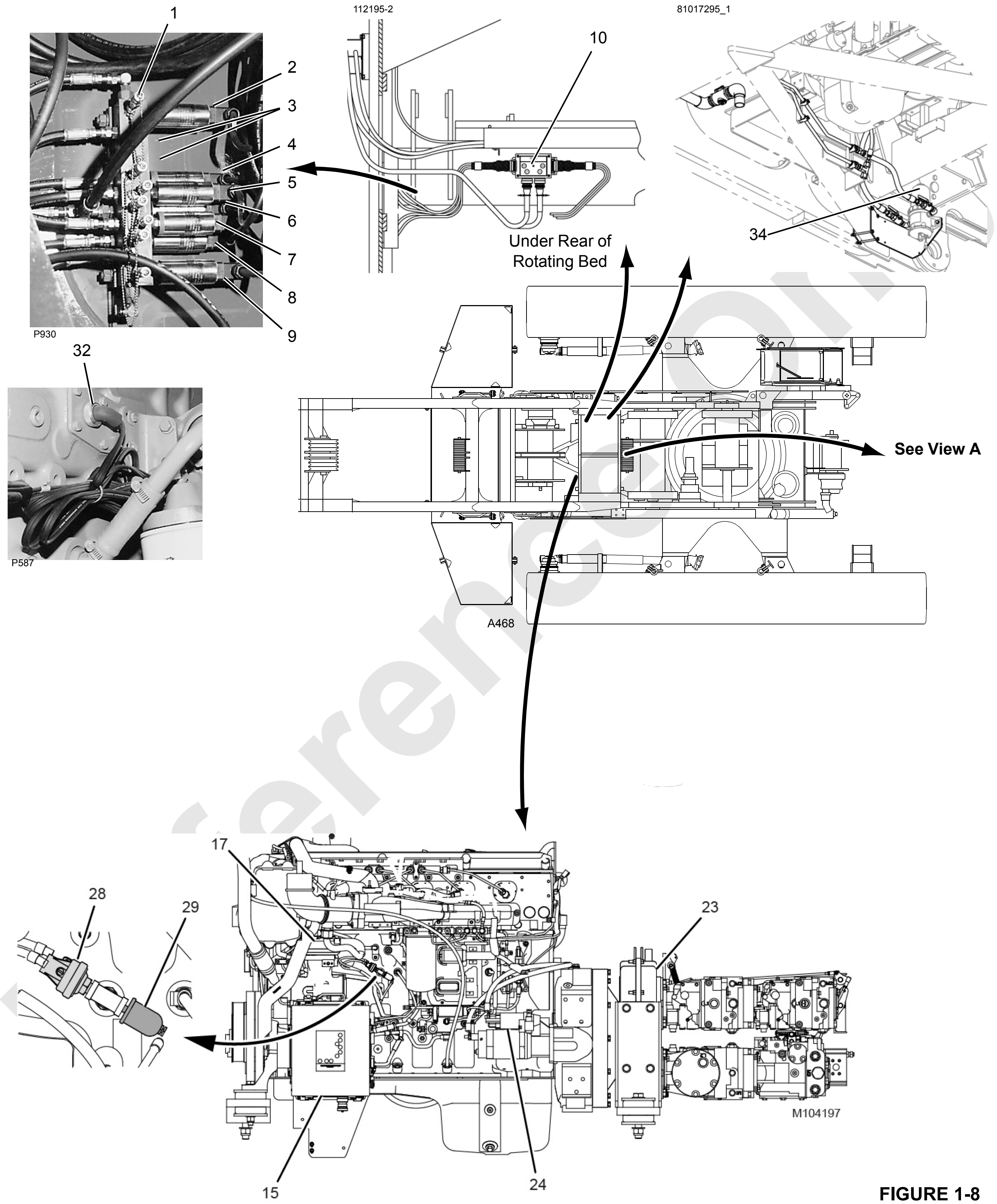


FIGURE 1-8

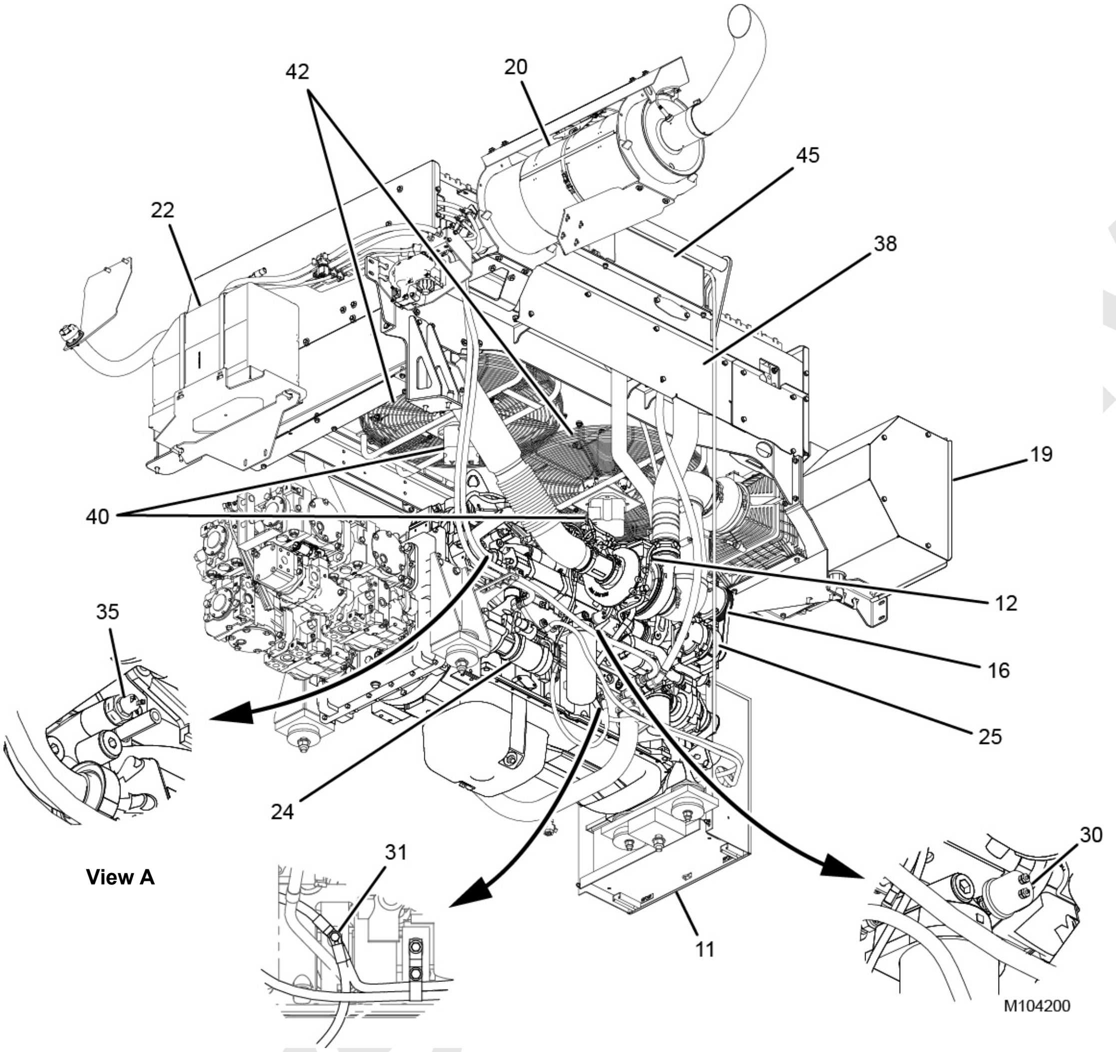
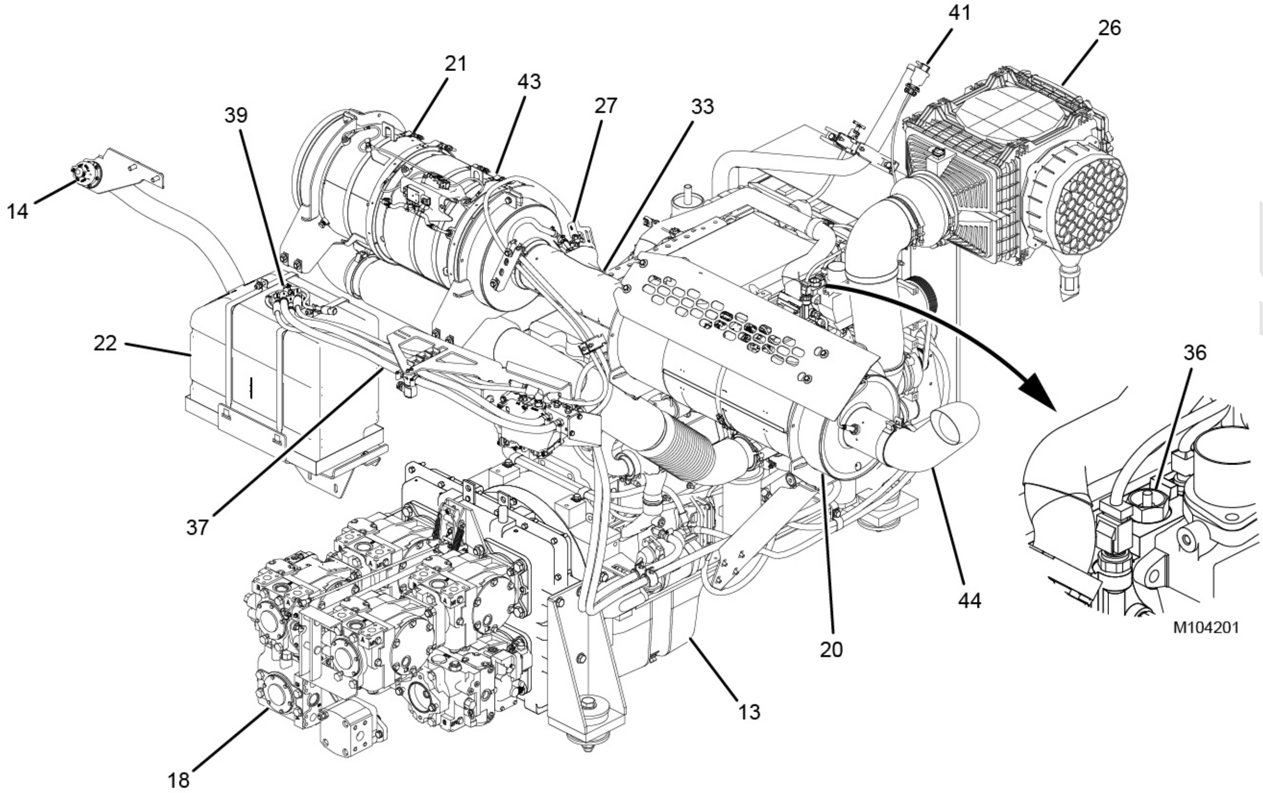


FIGURE 1-8 continued



Item	Description	Item	Description
1	Diagnostic Gauge Coupler (typical each sender)	24	Engine Starter (qty 2)
2	Right Travel Pressure Sender	25	Alternator
3	Spares	26	Air Cleaner
4	Boom Hoist Pressure Sender	27	Diesel Exhaust Fluid (DEF) Dosing Unit
5	Load Drum System Pressure Sender	28	Engine Oil Pressure Switch
6	Load Drum Charge Pressure Sender	29	Engine Oil Pressure Sender
7	Swing Right “B” Pressure Sender	30	Engine Oil Pressure Switch
8	Swing Left “A” Pressure Sender	31	Ground Point
9	Left Travel Pressure Sender	32	Engine Block Heater (1500 W 120 V with extension cord)
10	Pump Control Junction Box	33	Decomposition Tube
11	Battery Box	34	Fuel Filter
12	Variable Geometry Turbocharger (VGT)	35	Engine Coolant Temperature Switch
13	Engine Oil Pan	36	Engine Coolant Temperature Switch Sender
14	Diesel Exhaust Fluid (DEF) Tank Fill Cap	37	Diesel Exhaust Fluid (DEF) Fluid Lines
15	Engine Controller Node	38	Engine Cooler
16	Air Conditioner Compressor	39	Diesel Exhaust Fluid (DEF) Pump
17	Air System Compressor	40	Hydraulic Fan Motor (qty 2)
18	Drive Pump Assembly	41	Air Cleaner Service Indicator
19	Air Intake Shroud	42	Cooling System Hydraulic Variable-Speed Fan (qty 2)
20	Selective Catalyst Reduction (SCR) Catalyst	43	Diesel Particulate Filter (DPF)
21	Diesel Oxidation Catalyst (DOC)	44	Exhaust
22	Diesel Exhaust Fluid (DEF) Tank	45	Cooling System Surge Tank
23	Pump Drive		

FIGURE 1-8 continued

CRANE DESCRIPTION OF OPERATION

General Operation

See Figure 1-9 for the following.

The model 2250 is powered with the Cummins QSX15 engine. Standard and optional equipment available for the crane is included. Disregard any equipment the crane does not have. See the MAX-ER® 2000 Operator Manual for information on the MAX-ER 2000. See MAX-ER 2000 Description of Operation.

The Model 2250 operating system is an electronically-processed independent controls (EPIC) system. Through the programmable controller (PC) 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 displayed on a digital display screen in operator's cab.

A single diesel engine provides power to operate the system pumps through a pump drive transmission. In a closed-loop hydraulic system, high-pressure hydraulic fluid from the system pump drives a hydraulic motor. Pressure develops within the closed-loop system while resistance to movement of the load on the motor is overcome. When movement begins, the pump's volume displacement maintains motor speed. The spent hydraulic fluid from the motor outlet returns directly to the pump's input. The crane's closed-loop systems are swing, right travel, left travel, boom hoist, load drums, and luffing jib hoist.

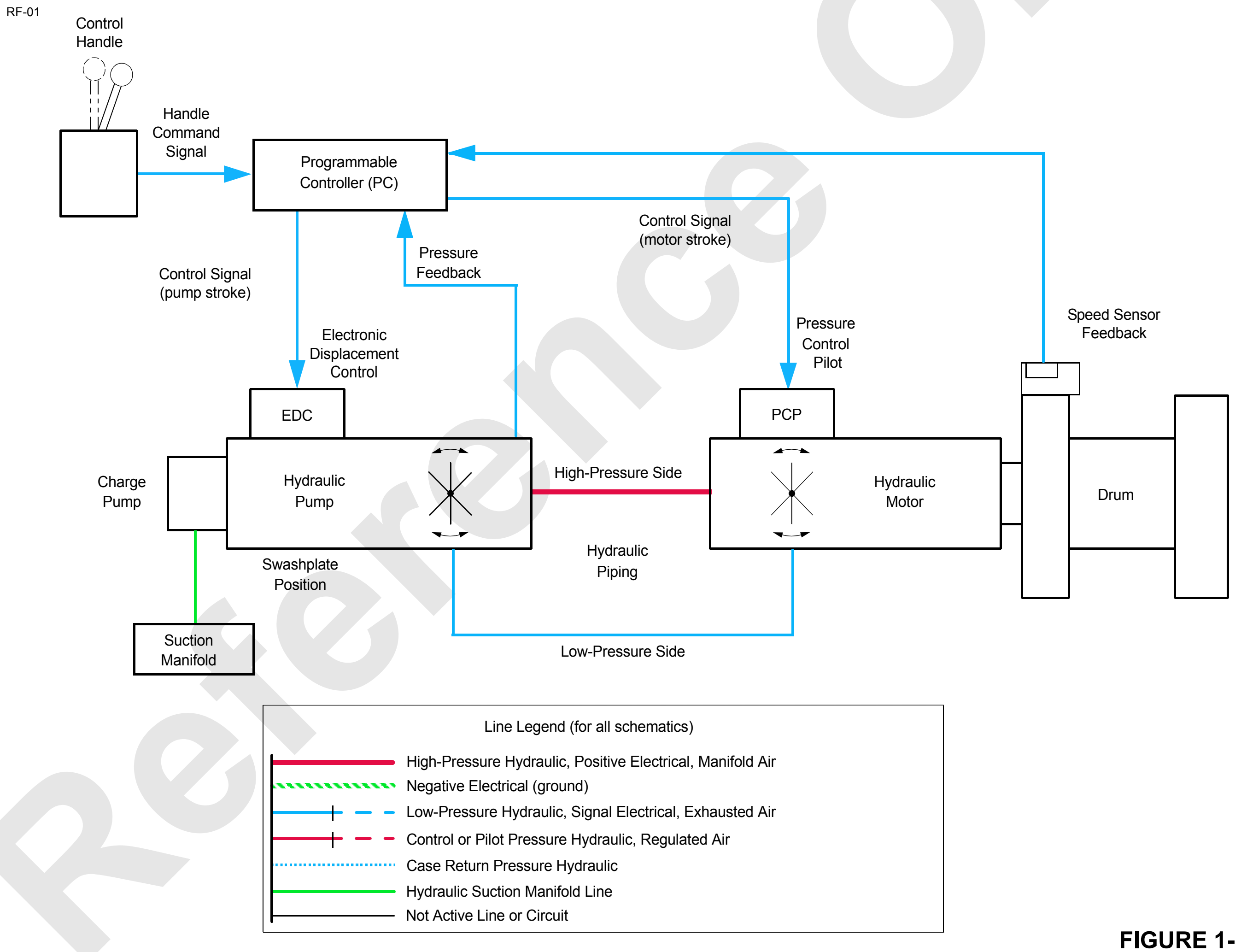


FIGURE 1-9

Hydraulic Components

See Hydraulic and Air Systems Section 2 for the hydraulic schematic.

High-pressure piston pumps driven by a multi-pump drive provides independent closed-loop hydraulic power for the crane's functions. Each system is equipped with relief valves to protect for overload or shock.

Each hydraulic solenoid valve is assigned an hydraulic solenoid (HS) number. The HS number identifies each hydraulic solenoid valve.

Table 1-1. Hydraulic Solenoid (HS) Valves

HS-1	Travel Brake
HS-2	Left Crawler Frame Pins Engage
HS-3	Left Crawler Frame Pins Disengage
HS-4	Gantry Cylinders Extend
HS-5	Gantry Cylinders Retract
HS-6	Boom Hoist (drum 4) Brake
HS-7	Swing Brake
HS-8	Not Used
HS-9	Not used
HS-10	Boom Hinge Pins Engage
HS-11	Boom Hinge Pins Disengage
HS-12	Auxiliary System Disable-Relief
HS-13	Right Crawler Frame Pins Engage
HS-14	Right Crawler Frame Pins Disengage
HS-15	Boom Butt Handling Cylinder Extend
HS-16	Boom Butt Handling Cylinder Retract
HS-17	Rigging Winch Haul In
HS-18	Rigging Winch Pay Out
HS-19	Luffing Jib Hoist Drum Brake
HS-20	Variable Output Control (proportional)
HS-21	Front Adapter Frame Pins Engage
HS-22	Front Adapter Frame Pins Disengage
HS-23	Rear Adapter Frame Pins Engage
HS-24	Rear Adapter Frame Pins Disengage
HS-25	Left Front Jack Extend
HS-26	Left Front Jack Retract
HS-27	Right Front Jack Extend
HS-28	Right Front Jack Retract
HS-29	Left Rear Jack Extend
HS-30	Left Rear Jack Retract
HS-31	Right Rear Jack Extend
HS-32	Right Rear Jack Retract
HS-33	Hydraulic Quick Disconnect Engage
HS-34	Hydraulic Quick Disconnect Disengage
HS-35	Travel 2-Speed

Hydraulic Tank

The hydraulic tank has a vented fill cap, high and low level sight gauge, vacuum sensor, temperature sensor, and fluid level sensor. The digital display indicates temperature and pressure (vacuum) of the fluid in the reservoir. Hydraulic fluid vacuum is displayed as a pressure between 0.5 and 1.2 bar absolute (7 and 18 psi) depending on engine speed, ambient temperature, and filter condition. The breather protects the tank from excessive pressures by opening at 0, 20 bar (3 psi), or the vacuum opens at 38 mm HG (1.5 in HG).

The hydraulic tank has two sections, a suction section and a return section. The suction section has a 100-micron mesh strainer that allows fluid to bypass the strainer at 0,31 bar (4.5 psi) if it becomes plugged. Two spin-on filters also filter the fluid. Replace the filter elements when a pressure of 0,5 bar absolute (7 psi) is shown on the digital display.

The return section inlets are routed through the check valves. A diffuser inside the tank's return line reduces turbulence created by the fluid returning to the tank. See Lubrication Section 9 for recommended replacement of the hydraulic fluid.

Shut-off Valve

A manual shut-off valve is located between the hydraulic tank and the suction manifold. Close the shut-off valve when performing maintenance on the hydraulic systems. Open the shut-off valve before starting the engine.

Suction Manifold

The suction manifold supplies fluid to the system pumps. A line between the suction side of the tank and the suction manifold has a shut-off valve. When the shut-off valve is open, fluid flows from the tank through the valve to the suction manifold. The suction manifold distributes fluid to the charge pumps of the six main system pumps, auxiliary pump, and fan pump.

Return Manifolds

Fluid from the closed-loop relief valves, brake valves, motor servos, cylinders, fan drive, pump case drain, and motor case drain is routed to the main return manifold or the cooler return manifolds before returning to the hydraulic tank.

Hydraulic Fluid Cooler

To control hydraulic fluid temperature, return fluid from some of the component systems returns to the tank through the cooler. A 1,4 bar (20 psi) bypass valve shifts to allow the fluid to flow around the cooler if it becomes plugged.

Hydraulic Pumps

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

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

The auxiliary pump provides hydraulic fluid pressure for the accessory valve’s operation. The fan pump provides fluid requirements for the fan motors and pilot fluid pressure for the accessory valve’s operation.

All the main pumps are variable-displacement, axial-piston pumps that operate in a bi-directional closed-loop system.

Each pump contains the following:

- Charge pump
- Electrical displacement control (EDC)
- 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 charge pump that is internally mounted on the end of each pump system’s driveshaft. The charge pump draws fluid directly from the suction manifold and delivers it to the closed-loop system at a charge pressure of approximately 24 bar (350 psi). Charge pressure depends on the engine’s load/speed, pressure-relief valve settings, and hydraulic system’s efficiency.

When a system control handle is moved, the programmable controller (PC) sends a variable plus or minus 0 to 2.8 V output to the pump’s EDC as required for the handle’s command direction. The EDC tilts the swashplate to stroke the pump in the command direction. The pump’s pistons move within the cylinder block as the block rotates. The longer stroke of each piston draws in return fluid from the system’s motor. As the stroke shortens, hydraulic fluid is pushed out of the pump piston cylinders into hydraulic piping to the motor.

Hydraulic fluid displaced by the motor returns through the piping to the inlet side of the system pump. The swashplate’s tilt angle determines the volume of fluid that can be pumped to the motor. Increasing the swashplate’s tilt angle increases the piston stroke length, allowing more fluid to be pumped to the motor.

Table 1-2. Malfunction Valve Pressure Limit Pressure

SYSTEM	FUNCTION	PRESSURE
Load Drums (1, 2, and 3)	Hoist	420 bar (6,090 psi)
	Lower	200 bar (2,900 psi)
Boom Hoist (drum 4)	Up	420 bar (6,090 psi)
	Down	420 bar (6,090 psi)
Luffing Jib (drum 5)	Up	420 bar (6,090 psi)
	Down	420 bar (6,090 psi)
Swing	Left	420 bar (6,090 psi)
	Right	420 bar (6,090 psi)
Travel	Forward	420 bar (6,090 psi)
	Reverse	420 bar (6,090 psi)

Each pump has two multifunction valves that consist of a system-relief valve and a charge flow make-up check valve. The pump’s system multifunction valves control the maximum system pressure and protect each pump’s system from damage by limiting pressure spikes in each operating direction. When preset loop system pressure is reached, the multifunction valves limit system pressure by de-stroking the pump or transferring fluid from the high-pressure side to the low-pressure side. The maximum pressure setting of the multifunction valves for each pump is listed in Table 1-2. Limits should not be reached unless there is a failure in the system.

Charge Pressure

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

If the boom/luffing jib charge pressure system drops, the brake begins to apply at approximately 20 bar (295 psi) for the boom hoist and 18 bar (260 psi) for the luffing jib. The brakes are fully applied at 15 bar (219 psi) for the boom hoist and 10 bar (140 psi) for the luffing jib.

Hydraulic Motors

See Sauer-Sundstrand Service Manual or Rexroth Service Manual for a description of a hydraulic motor.

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

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

Hydraulic fluid from the pump enters the inlet side of the motor and places a force against the pistons. The retained piston ends place a thrust against the output flange with a rotational torque that turns the output shaft.

This also rotates the cylinder block on a bent axis, while the tilt angle to the flange face moves the pistons as they rotate. Fluid displaced by the motor’s pistons exits on the outlet side of the motor and returns to the inlet side of the pump.

Monitoring the Main Pressure

Each system's digital display screen displays the monitored system pressure. The system pressure displayed on the system screen is charge pressure or greater. System pressure can also be checked at each pressure sender diagnostic coupler with a 689 bar (10,000 psi) high-pressure gauge when the pump is stroked.

Basic Operation

See Figure 1-10 and Figure 1-11 for the following.

When a control handle is moved from the neutral position, an input voltage in the handle command direction is sent to the programmable controller (PC). The PC sends a variable plus or minus 0 to 2.8 V output that is applied to the pump's external electrical displacement control (EDC). The output current magnetizes an armature and starts to block one of the orifice ports, depending on the command direction. Blockage of flow at the exhaust side of the right orifice port causes a pressure difference across the spool. This pressure difference overcomes the resistance of the spool spring and moves the spool proportionally to pressurize the top servo pistons. The fluid from the bottom servo pistons is routed to the tank. This tilts the swashplate, stroking the pump in the selected command direction. As the swashplate tilts, the chamber spring is pulled in the opposite direction of the spool with linkage. This centers and maintains the spool in a the neutral position until the 1 bar (16 psi) chamber spring pressure is reached.

In travel pumps, the pressure-relief and pressure-limiting sections of the multifunction valves respond when relief pressure is reached. If the travel pump pressure exceeds the preset pressure limit, the pump de-strokes to prevent overheating of the system fluid. The hydraulic fluid pressure overcomes spring resistance in the pressure-limiting relief valve (1), shifting the spool to open a line for fluid pressure. The servo check valve (2) is spring loaded with an opening pressure of 52 bar (750 psi). Hydraulic fluid from the pressure-limiting relief valve flows through the exhaust port of the displacement control valve (3). The exhaust port has a restricted orifice that develops pressure for the servo control cylinder (4) to pressurize and limit the system pressure to de-stroke the pump. When rapid loading produces pressure spikes, the system-relief valve (5) shifts. This allows high-pressure fluid to return to the tank through the charge pump's relief valve (6). Alternatively, fluid transfers to the low-pressure side of the closed-loop system through the charge flow make-up check valve (7).

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

The pressure limiting-relief valve (1) serves as a pilot valve to open the system-relief valve (5) when the desired relief pressure setting is reached. For example, if a pressure imbalance occurs on both sides of the flow restrictor (9), the pressure-limiting valve opens and the system-relief valve relieves system pressure.

Hydraulic fluid is directed to the tank through the relief valve (7), or the flow is transferred to the low-pressure side of the system through the make-up check valve (8).

Each variable-displacement motor, except the travel motor, begins operation at maximum displacement (high-torque, low-speed) and shifts to minimum displacement (low-torque, high-speed) if the torque requirement is low. The motor remains in maximum displacement until the servo PC valve (10) receives a command from the pressure-control pilot (PCP) valve (11) to direct system pressure and flow from the shuttle valve (12) to the minimum displacement side of the servo cylinder (13) that shifts the motor.

As the PCP valve opens in proportion to the output voltage received from the PC, pilot line pressure is directed to shift the servo PC valve. After overcoming the adjustable valve spring (14) and the valve spring (15), the servo PC valve shifts and directs fluid to stroke the motor to minimum displacement output. If the load at the motor shaft increases, force on the adjustable valve spring increases. This shifts the servo PC valve to de-stroke the motor to maximum displacement for safe load handling.

Optional drum 1 motor, boom hoist motor, and the single motor drive for split rear drum also have a pressure-compensating override (PCOR) valve (16) that is enabled when system pressure of 340 bar (4,930 psi) is reached. When system pressure exceeds the PCOR setting, the valve shifts to direct flow from the shuttle valve into the maximum displacement side of the servo cylinder.

The PCOR valve overrides the command from the servo PC valve, increasing motor displacement, output torque, and reducing output speed. When the PCOR valve closes, control of the motor returns to the servo PC valve.

The optional dual motor drive for the split rear drum shaft (Figure 1-28) has one bi-directional, variable-displacement motor with a 12 V proportional solenoid control along with one fixed-displacement motor mounted in tandem. Proportional motor displacement is set to override to maximum (high torque) at 310 bar (4,500 psi), preventing high-pressure motor failure.

The travel motor servo is opposite of the other system motors. The travel variable-displacement motors begin operation at minimum displacement (low-torque, high-speed). The motor shifts to maximum displacement (high torque, low speed) when starting torque is required and back to minimum displacement when in motion if load is below a preset pressure of 260 bar (3,770 psi). Depending on the motor system, the servo uses internally or externally supplied pressure to perform the shifting operation. Servo control fluid is supplied from the high-pressure line of motor port A or B and shifts the shuttle valve and the servo control valve before entering the servo cylinder.

Continuous changing of the closed-loop fluid occurs through leakage in the pumps, motors, and loop-flushing valves.

Motor case fluid drainage lubricates the motor and provides a recirculation of hydraulic fluid to control the heat in the closed-loop system.

The loop-flushing (purge) system consists of a control valve (17) and a relief valve (18). If the system pressure is above 14 bar (200 psi), the loop-flushing system removes 15 L/min (4 gpm) of hot fluid from the system for added cooling. If system pressure is under 14 bar (200 psi), the loop-flushing system is disabled.

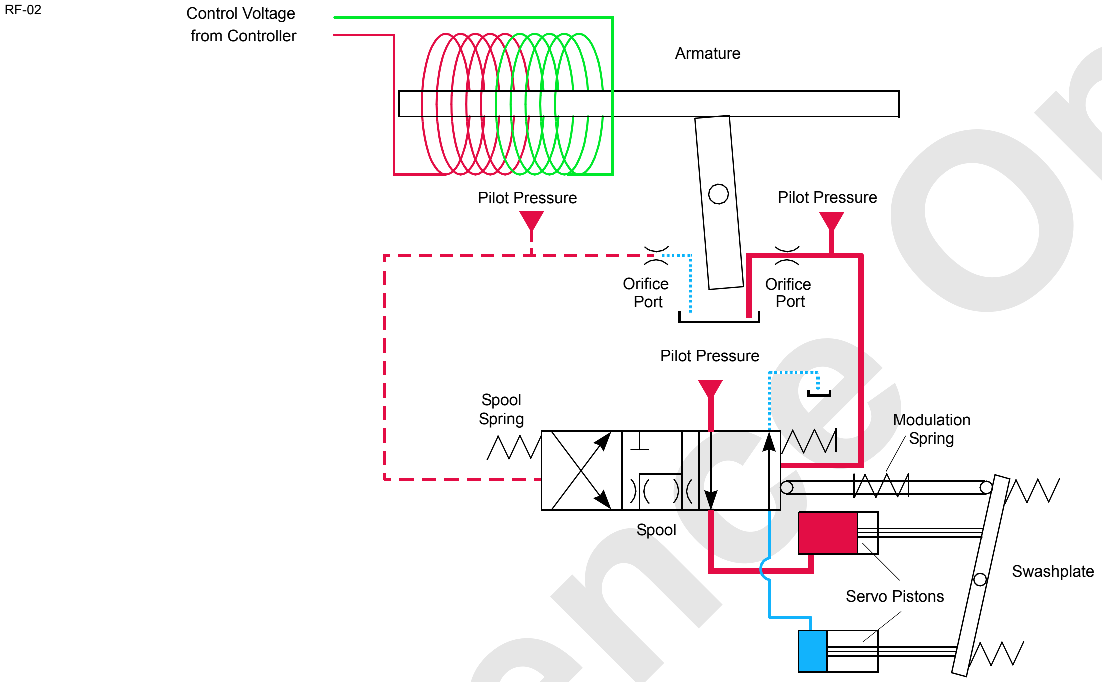
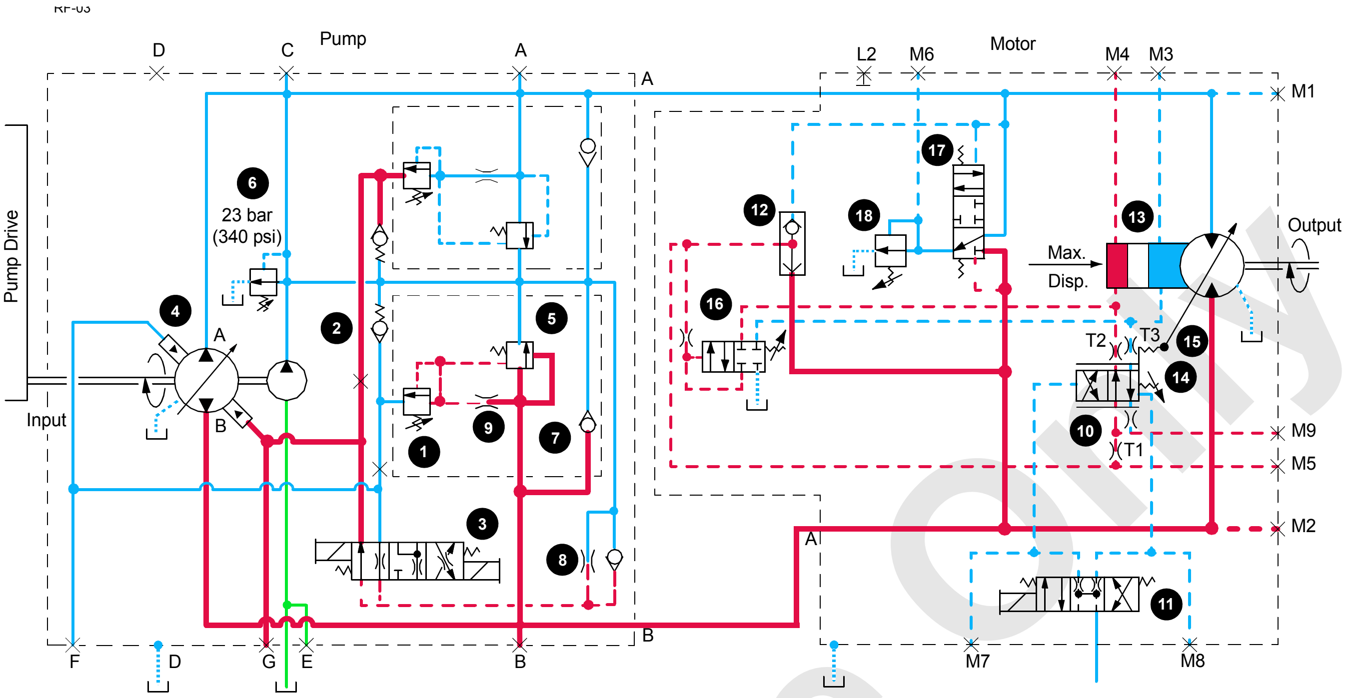


FIGURE 1-10



Item	Description
1	Pressure-Limiting Relief Valve
2	Servo Check Valve
3	Displacement Control Valve
4	Servo Control Cylinder
5	System-Relief Valve
6	Charge Pump Relief Valve
7	Charge Flow Make-up Check Valve
8	Flow Control Orifice
9	Flow Restrictor
10	Programmable Controller (PC) Servo Valve
11	Pressure-Control Pilot (PCP) Valve
12	Shuttle Valve
13	Servo Cylinder
14	Adjustable Valve Spring
15	Valve Spring
16	Pressure-Compensating Override (PCOR) valve
17	Control Valve
18	Relief Valve

FIGURE 1-11

Accessory Systems

See Figure 1-12 for the following.

The auxiliary pump obtains fluid from the hydraulic tank through the suction manifold. The auxiliary pump supplies fluid to all of the hydraulic cylinder systems. Fluid flow is from the accessory pump through the auxiliary system's disable-relief valve HS-12, upper accessory valve, proportional flow control valve, and to the lower accessory valve.

When the auxiliary system is disabled, the auxiliary system's disable-relief valve HS-12 is opened. Hydraulic fluid from the auxiliary pump then returns directly to the tank. The auxiliary-system disable-relief valve also protects the auxiliary pump, the down-stream components from excessive wear that higher pressures can cause, and reduces power demand on the engine.

When a component of the auxiliary system is enabled, the auxiliary system's disable-relief valve HS-12 shifts to block the flow to the tank. Accessory system pressure builds up to 276 bar (4,000 psi), allowing the fluid to flow through the auxiliary system disable-relief valve.

The suction manifold supplies hydraulic fluid to the fan pump. The fan pump supplies hydraulic fluid to drive the two fan motors. The fan's relief valve protects the fan pump and two fan motors from damage by limiting the fan's system pressure to 276 bar (4,000 psi). System pressure after the fans are limited by a relief valve to 21 bar (300 psi) for pilot pressure or fluid return to the tank.

The upper accessory function includes the following:

- Rotating bed jacking cylinders (qty 4)
- Front and rear adapter frame pin cylinders (qty 4)
- Gantry raising cylinders (qty 2)

The lower accessory function includes the following:

- Boom hinge pin cylinders (qty 2)
- Boom butt handling cylinder
- Rigging winch drum motor
- Crawler frame pins (qty 2)

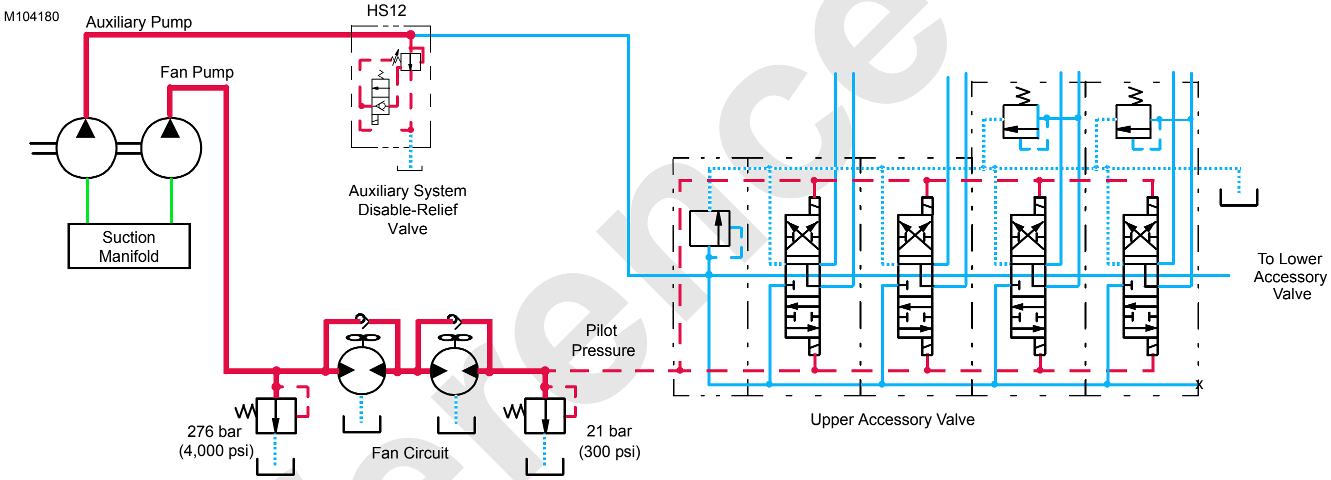


FIGURE 1-12

Pressurized Air Supply

See Figure 1-13 for the following.

Pressurized air is provided to the crane's air cylinder systems, such as the boom hoist pawl, luffing hoist pawl, load drum pawls, load drum brakes, load drum clutches, counterweight pin cylinders, backhitch pin cylinders, and optional boom stop cushion cylinders. See Hydraulic and Air Systems Section 2 for the Air Schematic drawing.

Airflow from the compressor passes through the air dryer before entering the air tanks. An optional alcohol injector provides de-icing, and condensation is eliminated through an electrical moisture ejector.

The unloader valve adjusts the compressor delivery rate by briefly opening the compressor's intake valve at 9 bar (32 psi). The safety-relief valve limits pressure in the system to 11,4 bar (165 psi). Another shut-off valve isolates air supply from the air system.

Air tanks, filter, injector, ejector, and a shut-off valve are mounted on the left side of the rotating bed. The unloader valve and relief valves are located on the right side, near the engine-mounted air compressor. The pressure sender monitors air pressure and sends the information to the programmable controller (PC). The digital display indicates supply pressure. If the supply pressure drops to 6 bar (90 psi), the PC enables an alert. The load drum brakes apply automatically at 5,2 bar (75 psi).

Each air solenoid valve is assigned an AS number. The AS number identifies each air solenoid valve.

Table 1-3. Air Solenoid (AS) Valves

AS-1	Backhitch Pins Extend
AS-2	Backhitch Pins Retract
AS-3	Lower Counterweight Pins Engage
AS-4	Lower Counterweight Pins Disengage
AS-5	Upper Counterweight Pins Engage
AS-6	Upper Counterweight Pins Disengage
AS-7	Front (drum 1) Brake
AS-8	Front (drum 1) Clutch
AS-9	Right Rear or Rear (drum 2) Brake
AS-10	Right Rear or Rear (drum 2) Clutch
AS-11	Right (drum 3) Brake
AS-12	Right (drum 3) Clutch
AS-13	Boom Hoist Pawl Out
AS-14	Boom Hoist Pawl In
AS-15	Luffing Jib Pawl Out
AS-16	Luffing Jib Pawl In
AS-17	Front (drum 1) Pawl Out
AS-18	Front (drum 1) Pawl In
AS-19	Rear (drum 2) Pawl Out
AS-20	Rear (drum 2) Pawl In

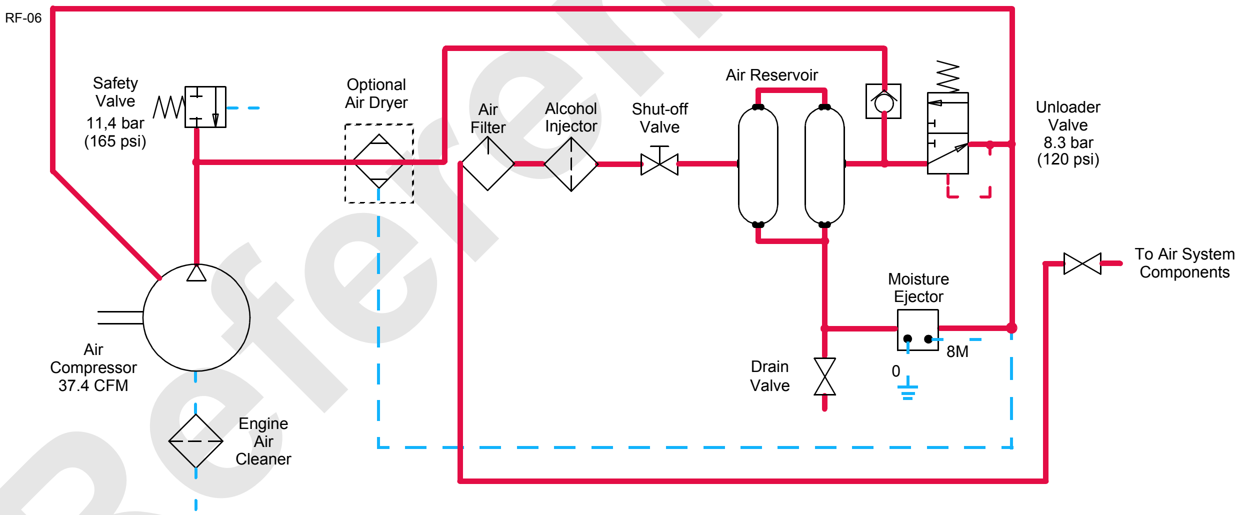


FIGURE 1-13

Engine Controls

See the engine manufacturer's manual for instructions.

The engine is started and stopped with the engine key switch.

Engine rpm is controlled with the hand throttle or foot throttle. The programmable controller (PC) and engine control module (ECM) monitor engine information and display the information on a digital screen.

The crane's system speed depends on the engine's speed and the control handle's movement in either direction from the neutral position. The engine's clutch lever for the pump drive must be manually engaged for operation.

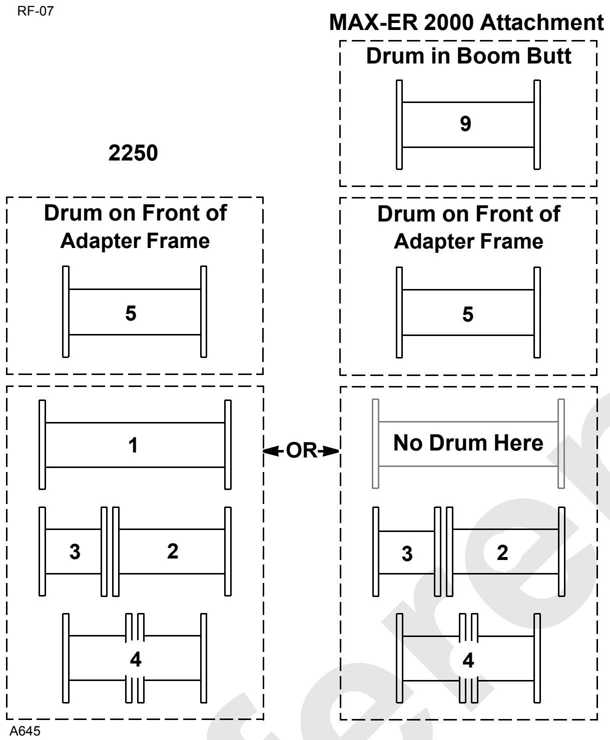
Use the engine stop push button only in an emergency as all of the brakes apply and any function stops abruptly.

Three engine diagnostic lights are mounted on the front console. See Power Train Section 7 for diagnostic light information.

Drum Identification

See Figure 1-14 for the following.

The handle-to-load drum selection turns on a corresponding numbered green light adjacent to the control handle on the right console. See Operating Controls in Section 3 of the Operator Manual for handle-to-drum identification and selection.



Drum Number	2250	MAX-ER 2000
1	Front Load Drum	No Drum Available
2	Rear or Right Rear Load Drum	Boom Hoist
3	Left Rear Load Drum or Mast Hoist (MAX-ER)	Rear Load Drum (with luffing hoist)
4	Boom Hoist	Mast Hoist
5	Luffing Hoist	Luffing Hoist or Rear Load Drum or Auxiliary Drum (without luffing hoist)
9	—	Front Load Drum

FIGURE 1-14

EPIC® Programmable Controller (PC)

See Figure 1-15 for the following.

The Model 2250 crane’s boom, load lines, swing, crawler tracks, and accessory components are controlled electronically with the electronically-processed independent controls (EPIC) system. This simplifies the crane's electrical control system by avoiding mechanical control switches and relays. Standard or custom programming allows the programmable controller (PC) to automatically adjust each operational mode's acceleration rate and speed, apply the brakes, and engage the clutches.

The PC 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 12 V nominal voltages that are either 0 = OFF or 1 = ON.

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

The controller processes the information by comparing it to programming requirement and data information. The PC then provides appropriate output commands to the crane’s control devices. See Troubleshooting Section 10.

Digital Display

The digital display screen on the front console shows operating conditions, operating limits, and system faults monitored by the PC. Access information by scrolling to the desired display screen with the scroll switch. System messages are shown in Tables in Digital Display Readings in Section 3 of the Operator Manual.

Rated Capacity Indicator/Limiter (RCI/RCL)

The rated capacity indicator/limiter (RCL) system has its own PC and is part of the EPIC system. Load charts are specific for each crane’s model. For complete information see the separate Rated Capacity Indicator/Limiter Operation Manual.

Crane Modes

- Standard mode is for all normal load-handling operations.
- In Setup mode, the program allows limited operation, but the boom-up limit is bypassed.
- In Luffing Jib mode, the program allows Standard mode load handling operations plus luffing jib operation.
- In Tandem Drum mode, the program allows operation of both load drums on a split drum shaft, or both front and rear load drums are operated at the same time in full power operation with a single control handle.

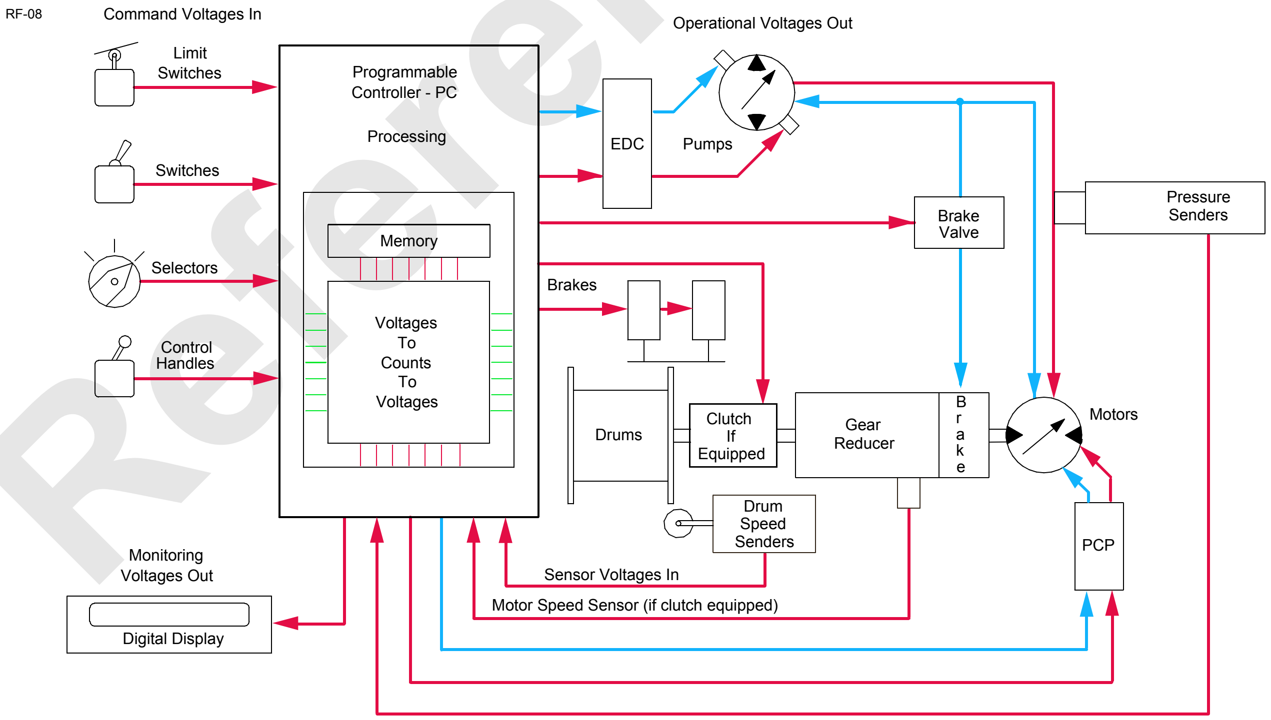


FIGURE 1-15

- In Clamshell mode, two load drums (holding and closing) are operated at the same time and are controlled with one load drum control handle. The power-down and closing features are turned ON. The PC controls the pump's electrical displacement controls (EDC) and engages the clutches in UP and DOWN operations. The PC also controls the load drum brake application. Contact the Manitowoc Crane Care Lattice Team for information on Clamshell modes.
- In MAX-ER mode, the program allows operation of the crane and MAX-ER attachment as one system.

Electrical Power to Operator's Cab

See Figure 1-16 for the following.

Battery power is available at all times to operate the dome light switch, horn switch, alternator, accessory outlet, and PC.

When the Engine RUN/STOP/RUN key switch is placed in the RUN position, voltage is available at the key-operated Engine Start switch and other cab controls.

Contacts of the start switch and remote RUN/STOP switches must be enabled to start the engine. When both switches are enabled, voltage is available to the following:

- Starter solenoid relays MS1 and MS2
- Engine hour meter
- Fan motor relay
- Ignition relay

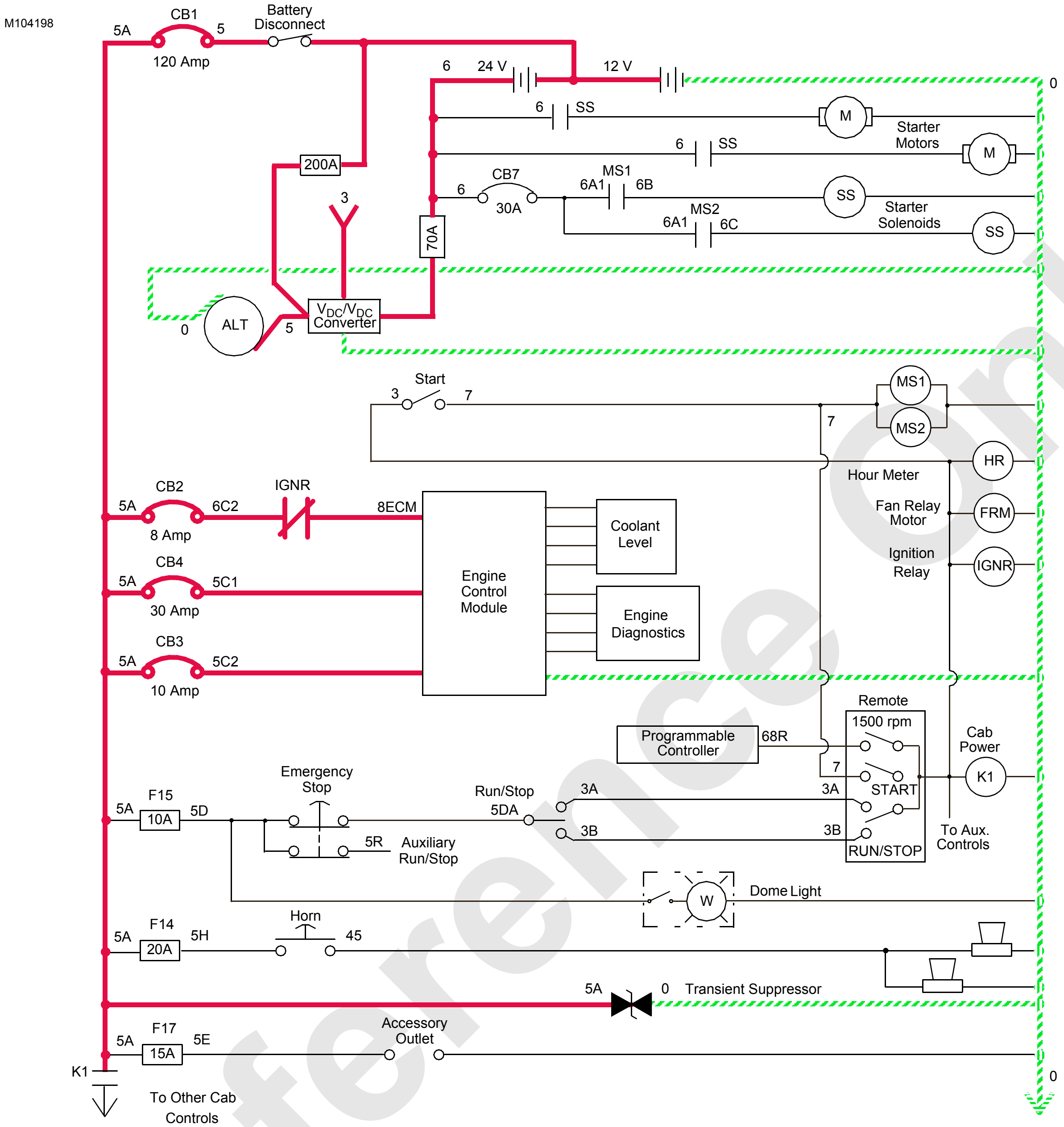

M104198
5A
CB1
120 Amp
5
Battery Disconnect
6
24 V
12 V
0
6
SS
M
Starter Motors
6
SS
M
200A
CB7
6
30A
MS1
6A1
6B
SS
Starter Solenoids
MS2
6A1
6C
SS
3
70A
VDC/VDC Converter
0
ALT
5
Start
3
7
MS1
MS2
7
HR
Hour Meter
Fan Relay Motor
FRM
Ignition Relay
IGNR
CB2
5A
6C2
8 Amp
IGNR
8ECM
Coolant Level
CB4
5A
5C1
30 Amp
Engine Control Module
Engine Diagnostics
CB3
5A
5C2
10 Amp
Remote
1500 rpm
Programmable Controller
68R
7
Cab Power
K1
Emergency Stop
F15
5A
10A
5D
Run/Stop
5DA
3A
3A
START
3B
3B
RUN/STOP
To Aux. Controls
5R
Auxiliary Run/Stop
W
Dome Light
Horn
F14
5A
20A
5H
45
5A
0
Transient Suppressor
F17
5A
15A
5E
Accessory Outlet
0
K1
To Other Cab Controls

FIGURE 1-16

Pressure Senders and Speed Sensors

See Figure 1-17 for the following.

The pressure senders monitor the drum system pressures, load drum charge pressure, right/left travel system pressure, and swing right/left system pressure. The PC receives input hydraulic pressure information from each of the system's pressure senders. The pressure senders provide information for the required load-holding pressures for the load drums, boom hoist drum, or luffing hoist drum.

The drum speed sensors on the drum shafts or flanges detect speed and direction of the drum's movement. The PC receives this information as two out-of-phase square wave voltages that are converted to "counts." The PC compares the control handle's voltage with the pump's output to determine when to vary the pump's stroke.

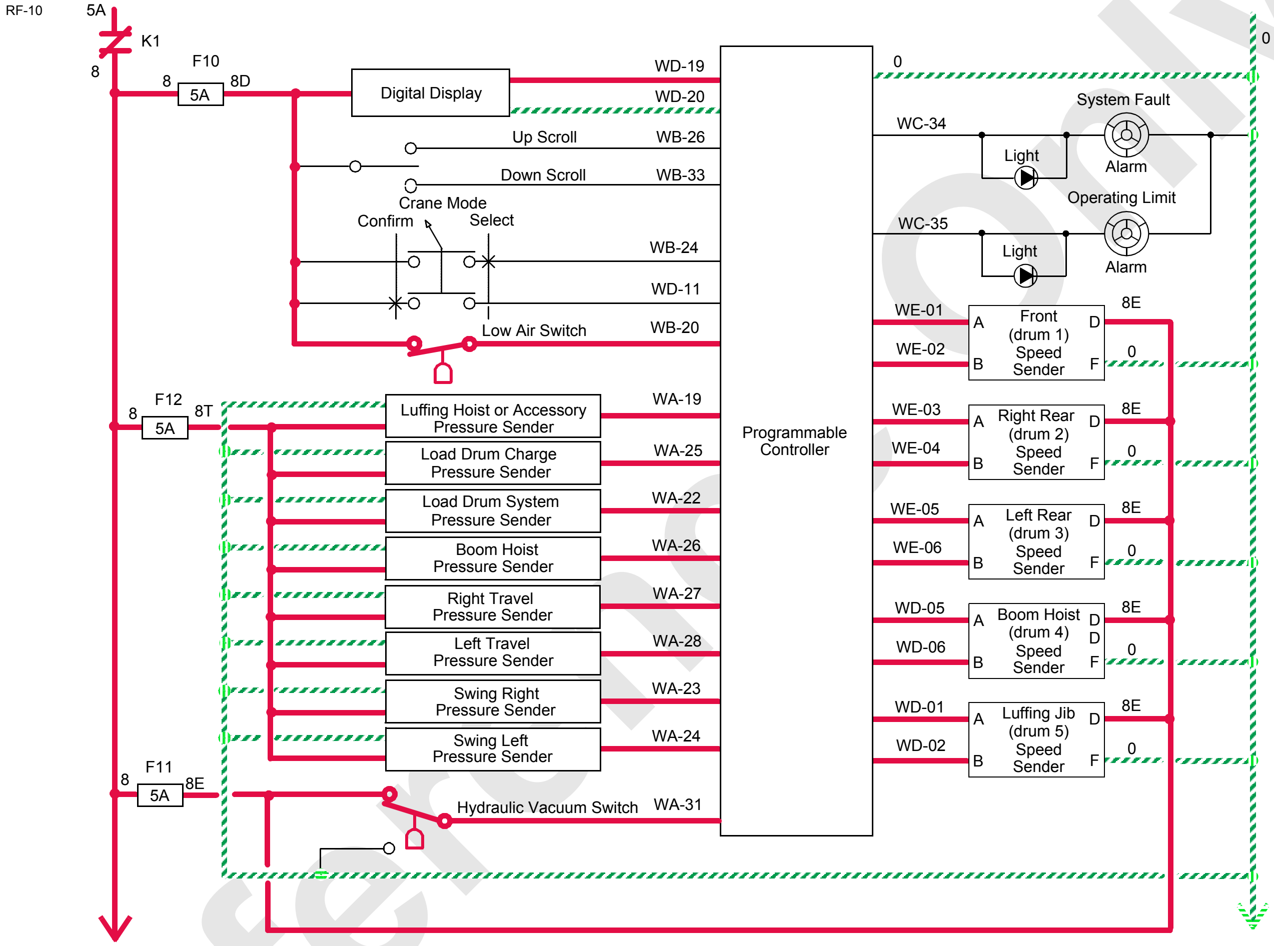


FIGURE 1-17

Limit Switches and Faults

See Figure 1-18 for the following.

When operating, all of the limit switches are closed, sending an input voltage to the PC. If a limit switch is tripped, the PC sends a 0 V output to the system pump's EDC and the brake solenoid. The system's pump de-strokes, and the system's brake solenoid valve shifts to apply the brake. Adjust the component that tripped the limit switch in the opposite direction from the limit switch to correct the problem.

The limit-bypass switch allows the crane to be operated beyond the limits for crane setup or maintenance only, such as adding or removing wire rope from the load drum after an operating limit is enabled. The jib up limit-bypass switch allows the jib maximum up limit to be bypassed when the boom or luffing jib is lowered to the ground.

Hydraulic Brake Systems

Travel, swing, boom hoist, and luffing jib hoist brakes are spring set and hydraulically released. The operator enables brake operation by placing the selected brake switch in the OFF position. The PC releases the swing brake immediately when the swing brake switch is placed in the OFF position. The PC controls the release of the other brakes with the control handle's movement.

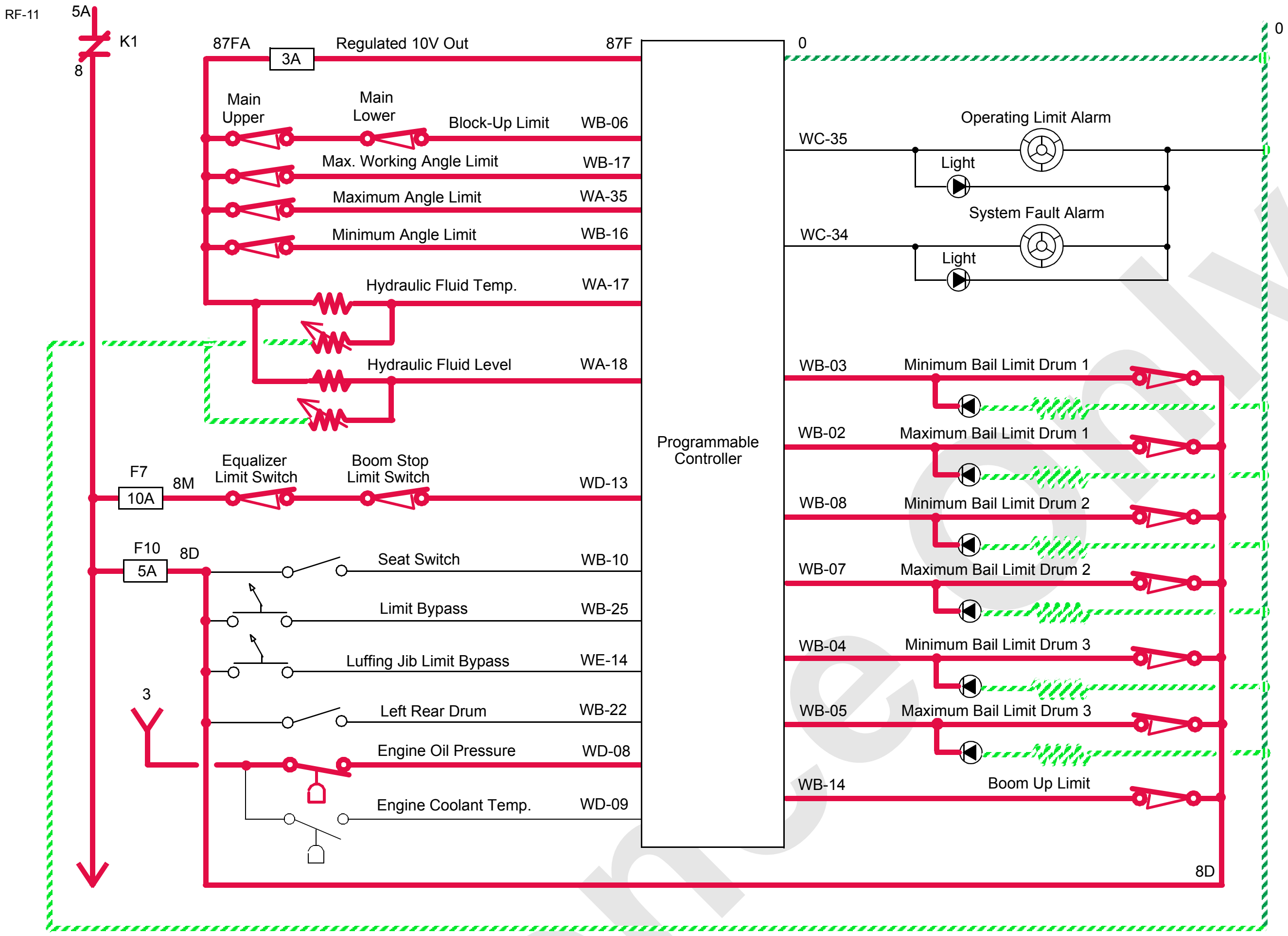


FIGURE 1-18

When a control handle is moved, an input voltage in the handle command direction is sent to the PC. The PC does not release the selected brake until the load pressure memory is reached to hold the load, as determined by the system pressure sender.

When the hydraulic brake solenoid is enabled, the selected brake valve shifts to block the tank port and supplies pilot pressure from the boom/luffing jib charge pump to release the selected brake.

When a brake solenoid is disabled, the solenoid valve closes to block the charge pump port and to vent the brake pressure to the tank, and the spring brake applies. If brake pressure or electrical power is lost when operating, the brakes apply.

Load Drum Air Brakes

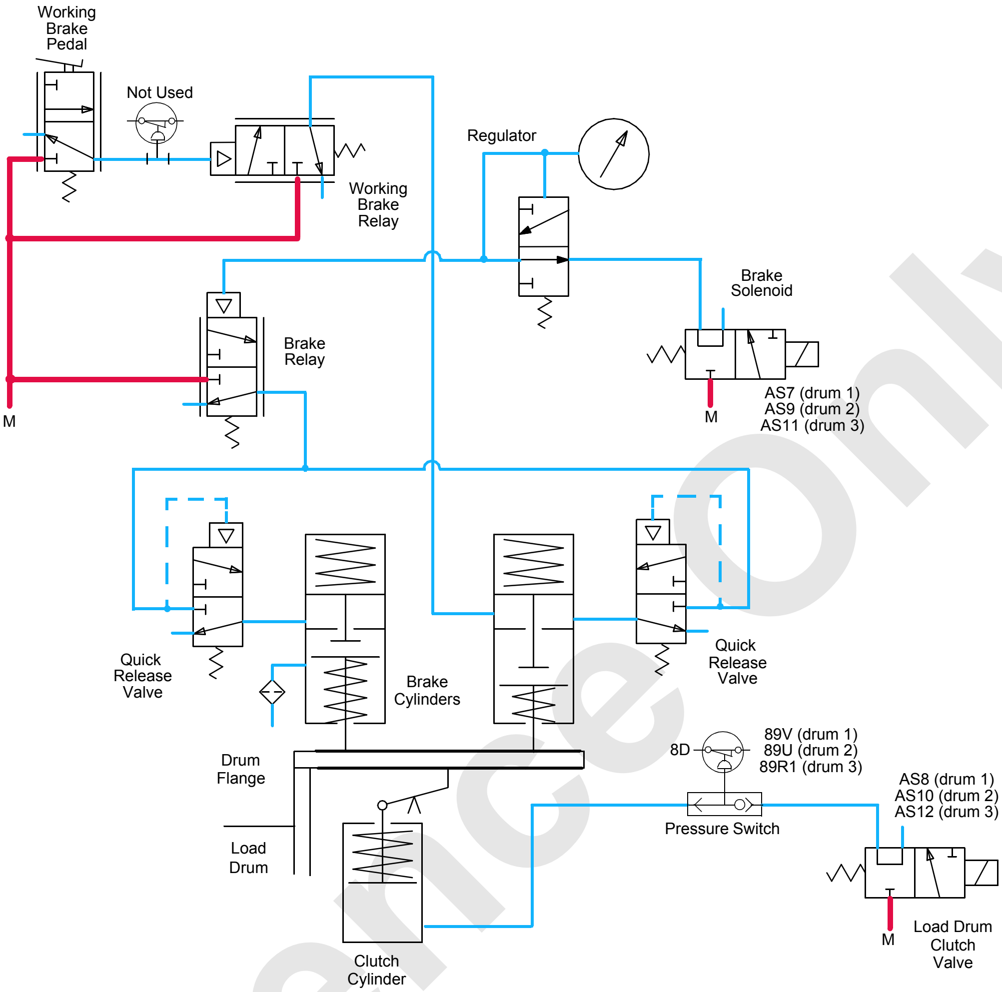
See Figure 1-19 for the following.

Each load drum brake has two air cylinders, and each cylinder has two chambers. The first brake cylinder chamber is a spring-applied/air-released brake controlled by the PC. The other chamber is a working brake for free fall that is air-applied/spring-released. The second brake cylinder chamber is a spring-applied/air-released brake controlled by the PC, and the other chamber is not used.

Release the load drum brakes by placing the selected load drum brake switch in the OFF position. The PC enables the brake solenoid when the load pressure memory is reached.

When the PC enables drum 1, 2, or 3 load drum brake solenoid (AS-7, AS-9, or AS-11), regulated air shifts the brake relay. This allows manifold air to close the quick-release valves. Air flows to the brake cylinder chambers, compressing the springs to release the brake. With the selected load drum brake released, the load drum motor can hold the load when operating in full-power operation.

In Standard mode, when either a selected load drum control handle or a selected load drum brake switch is in the OFF position, the brakes are spring-applied. Air in the brake cylinders is exhausted to ensure that the load drum brake spring applies. Exhausted air from the cylinders goes through the quick-release valves when the sealing pressure is exhausted off the valve diaphragms, opening the exhaust ports. This occurs when pilot pressure is removed from the brake relay valve.



=-12

FIGURE 1-19

When the drum 1, 2, or 3 load drum brake solenoid (AS-7, AS-9, or AS-11) is disabled, pilot pressure is exhausted from the brake relay. The brake relay valve closes, exhausting sealing air from the quick-release valve's diaphragms, to exhaust air from the brake cylinders. The brake cylinder springs apply the brakes.

Working (Service) Brakes

The working brake part of the cylinder chamber is controlled with a selected drum working brake pedal. The working brake relay shifts to allow manifold air flow to the working brake cylinder chamber, compressing the spring and applying the brake band against the drum.

Pressure applied by the brake is in proportion to the brake pedal's movement. Full brake application is obtained when the brake pedal is applied and latched. When the brake pedal is released, the working brake is released at the same rate as pedal movement until completely released.

Load Drum Clutch Release System

Front or rear load drum clutches are air controlled and are spring-applied/air-released. The PC controls the clutches with air pressure switches and selected load drum control handle movement, depending on mode and circuit requirements. The PC monitors the air pressure switches when the operator switches from one load drum to another. The clutch and brake air lines are connected through the shuttle valve to the pressure switch. The PC waits until the pressure switch closes before stroking the pump and releasing the selected drum brake.

When the circuit to the selected load drum clutch solenoid AS-8, AS-10, or AS-12 is open, manifold pressure is blocked and air is exhausted from the drum clutch cylinder. The clutch spring applies to connect the drum shaft to the motor.

When a selected load drum control handle is moved, an input signal is sent to the PC. The PC sends an output signal to the clutch solenoid AS-8, AS-10, or AS-12. The PC selects which clutches are released, depending on the control handle command and the mode selected.

Drum Pawls

A selected drum pawl must be disengaged before the drum can operate. Components for the engage/disengage operation for a selected drum pawl are specific to the drum pawl system being operated. A ratchet and pawl latch provides a positive way of locking the boom hoist, luffing hoist, front drum, rear drum, and auxiliary drum (if equipped).

Pawl operation is controlled with selected drum brake switch.

If a pawl is engaged during hoisting up, a hoist operating drive fault occurs when stopped because the PC cannot command down against the pawl to prove the brake is applied.

If a pawl switch is engaged accidentally when hoisting down, the PC sends an output signal to enable that drum brake. For the boom hoist pawl and luffing jib drum pawl, the spring applied brake on the motor end of the drum shaft enables and the pump de-strokes to stop the function. The PC delays the engage signal to the pawl engage air solenoid so the pawl does not engage for approximately 10 seconds after the hoist stops. The load drum pawls respond similarly, but the front and rear load drum brakes are spring applied and air released.

Swing System Operation

General

See Figure 1-20 and Figure 1-21 for the following.

One hydraulic swing pump drives one swing motor (optional swing drive has one swing pump driving two swing motors). The swing system is controlled with swing control handle movement and the programmable controller (PC). The swing control handle is inoperable when the swing brake is applied. The motor driven swing gearbox drives a tooth gear that is meshed with the undercarriage turntable bearing to swing the rotating bed.

The swing motor is controlled directly by the output fluid volume of the swing pump. The PC does not control the fixed displacement swing motor. Swing pressure senders monitor the pressure on the swing left and the swing right sides of the swing closed-loop system. If there is low swing pressure or if either pressure sender fails, swing movement may be erratic.

The rotating bed is free to coast if the swing control handle is in the neutral position and if the swing brake is released.

When the swing control handle is moved from the OFF position, an input signal is sent to the PC. The PC sends a 12 V output signal to enable the optional swing/travel alarm. When the swing control handle is moved to the OFF position, the PC sends a 0 V output signal to disable the swing/travel alarm.

An orifice across the swing pump and motor ports A and B allow smoother fluid flow when shifting the swing from one direction to the other.

Swing speed and swing torque can be selected for the type of work being performed by referring to Speeds screen in Troubleshooting Section 10.

Swing Brake and Swing Holding Brake

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

Pilot charge pressure from the boom hoist charge pump must be about 17 bar (250 psi) for full release of the swing brake. If system charge pressure is below 13 bar (190 psi), the swing brake could be partially applied and could damage the swing system. If brake pressure or electrical power is lost when operating, the swing brake is applied.

When the swing brake switch is in the OFF position, an input voltage is sent to enable the swing brake solenoid valve HS-7. The swing brake solenoid valve shifts to block the tank port and opens the port to supply hydraulic fluid to release the swing brake from the shaft.

When the swing brake switch is placed in the ON position, an input voltage is sent to disable the swing brake solenoid valve HS-7. The brake solenoid valve shifts to close the fluid flow to the brake and opens the tank port to apply the brake.

The swing holding brake switch is located on the side of the swing control handle. To prevent damage to the swing system, the swing holding brake switch must only be applied when the crane is at a standstill.

When the holding brake switch is pressed in and held, an input voltage is sent to disable the shift swing brake solenoid HS-7. The swing brake valve shifts to block the fluid to the brake, and the swing brake is applied.

When the swing holding brake switch is released, an input voltage is sent to enable the swing brake solenoid HS-7. The swing brake valve shifts, allowing system pressure to hydraulically release the brake.

Swing Right or Left

When the swing control handle is moved to the left, an input voltage of 5 V or more is sent to the PC. The PC sends a variable plus 0 to 2.8 V output that is applied to the swing pump's electronic displacement control (EDC). The pump's EDC tilts the swashplate relative to the control handle's movement. Fluid flows from the pump ports to the motor ports, turning the rotating bed to the left.

When the swing control handle is moved to the right, an input voltage of 5 V or less is sent to the PC. The PC sends a variable minus 0 to 2.8 V output that is applied to the swing pump's EDC. The pump's EDC tilts the swashplate relative to the control handle's movement. Fluid flows from the pump ports to the motor ports, turning the rotating bed to the right.

As the swing control handle is moved to the neutral position, the PC compensates for hydraulic system leakage or changing engine speed. The PC sends a 0 V output to adjust the swashplate to the centered position.

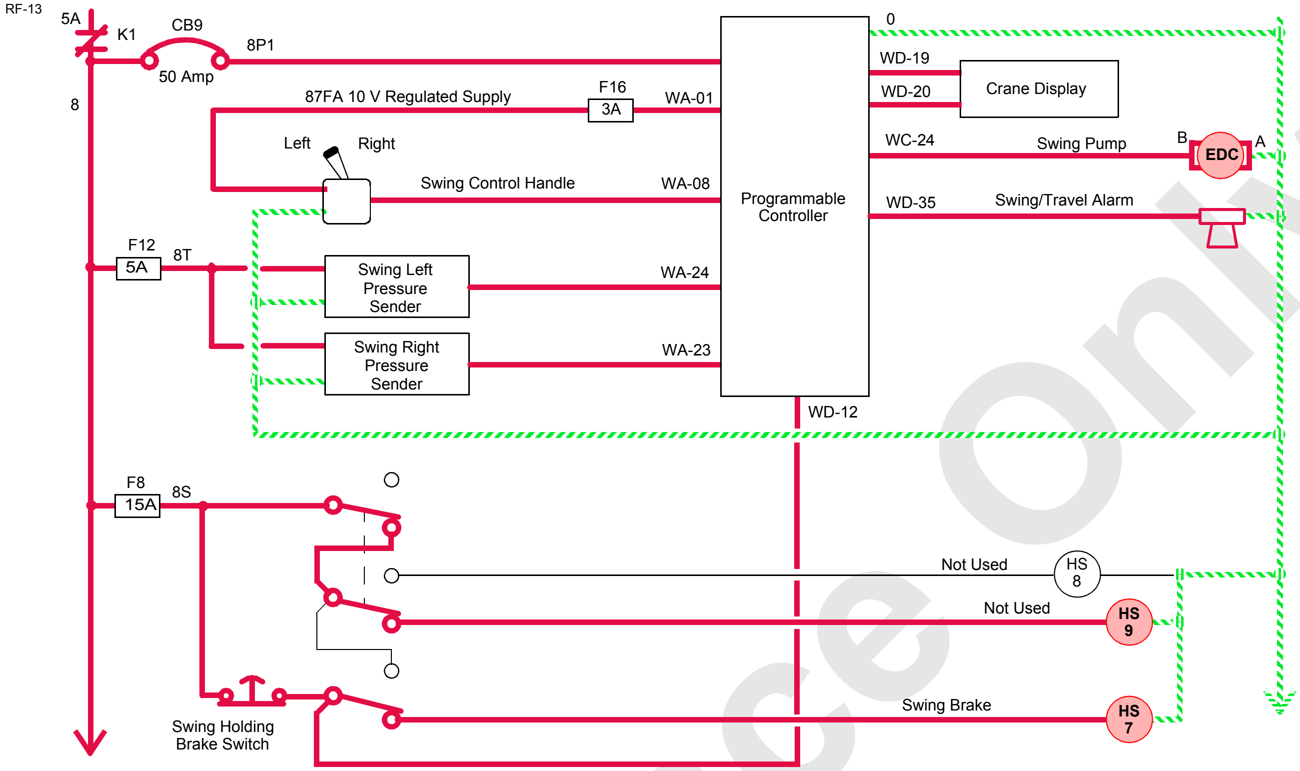


FIGURE 1-20

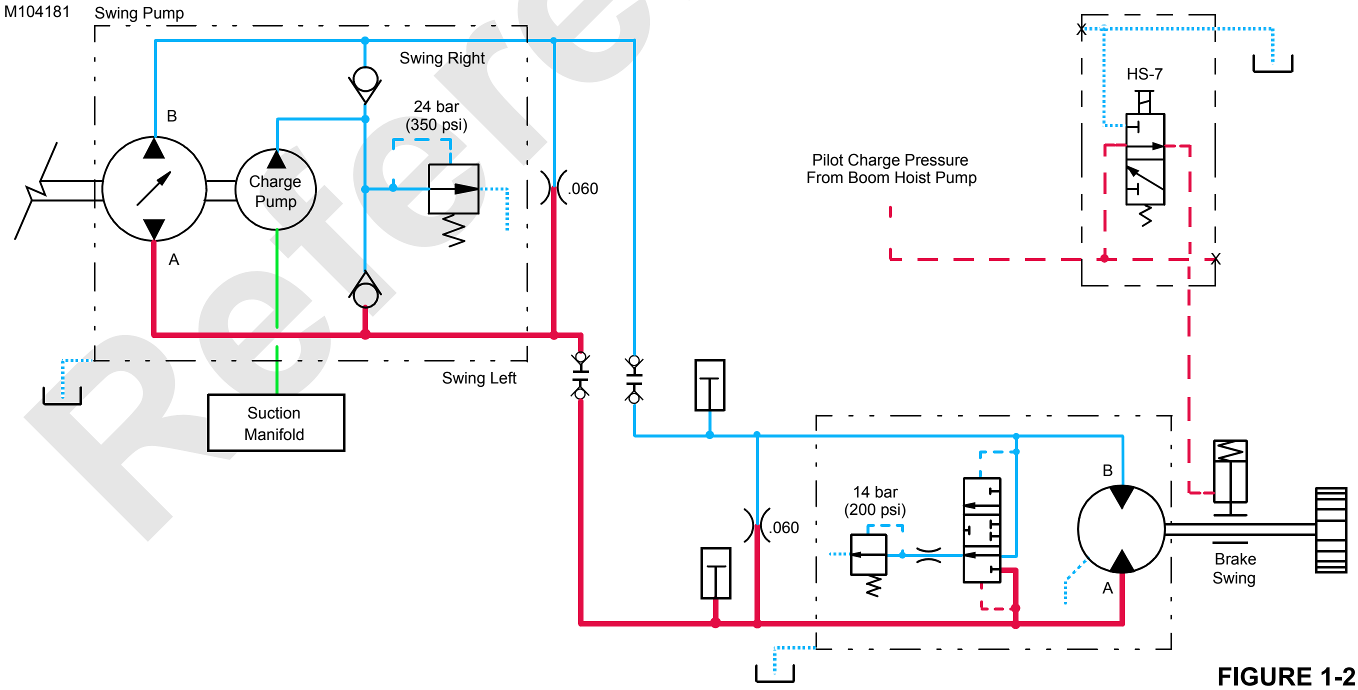


FIGURE 1-21

Travel System Operation

General

See Figure 1-22 and Figure 1-23 for the following.

Each travel hydraulic pump drives one crawler system motor and gearbox. Each pump and motor is controlled with the travel control handle's movement and the programmable controller (PC). The travel control handles are inoperable when the travel brake is applied. A gearbox for each crawler is driven with a flexible shaft connected between the motor output and the drive gearbox input.

To ensure that the 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, the PC monitors information from the pressure senders and adjusts the displacement of the travel pumps to maintain equal pressure in each travel drive system. This allows the crane to track in a controlled straight direction.

The source hydraulic pressure for releasing the travel brakes and enabling the motor servo systems is pilot pressure from the boom hoist charge pump at 24 bar (350 psi). Continuous changing of the closed-loop fluid occurs through leakage in the pump, motor, and loop flushing valves that removes 11 L/min (3 gpm) of fluid to when the system pressure is above 24 bar (350 psi).

When either travel control handle is moved from the OFF position, an input signal is sent to the PC. The PC sends a 12 V output signal to enable the optional swing/travel alarm. When the travel control handle is moved to the OFF position, the PC sends a 0 V output signal to disable the swing/travel alarm.

Travel Brakes

Hydraulic pressure required for releasing the travel brakes is pilot pressure from the boom hoist charge pump at 24 bar (350 psi). For travel brake operation, the system pressure must be above 14 bar (200 psi) for the travel brakes to fully release from each travel motor's shaft. If system pressure is below 14 bar (200 psi), the travel brake could be partially applied and damage the brake.

When the travel brake switch is in the ON position, right and left travel brakes are applied to hold the crane in position. The travel brake solenoid valve HS-1 is open to allow hydraulic flow from the brake to the tank.

When the travel brake switch is in the OFF position, an input signal is sent to the PC and the travel system circuit is active, waiting for a travel control handle command. When the travel control handle is moved, the PC sends a 12 V output to enable the travel brake solenoid valve HS-1. The brake solenoid valve shifts to block the tank port and supplies hydraulic charge pressure fluid from the boom hoist charge pump to hydraulically release both crawler brakes. If brake pressure or electrical power is lost when operating, the brakes apply.

Two-Speed Travel Operation

The travel 2-speed switch allows the operator to select LOW speed when a smoother start is required. LOW speed places the travel motor in the maximum displacement (high-torque, low-speed) position and prevents the motor from shifting to HIGH speed. Hydraulic pressure for releasing the travel 2-speed solenoid valve HS-35 is pilot pressure from the boom hoist charge pump at 24 bar (350 psi).

When the travel speed switch is in LOW speed, the PC sends a 12 V output to enable the 2-speed travel solenoid valve HS-35, shifting the valve to direct hydraulic pilot pressure to the end of the pressure compensator (P/C) valve. The P/C valve shifts the pressure-compensating override (PCOR) spool, placing the travel motor in the maximum displacement position. The travel motors remain in this position until the travel speed switch is placed in the HIGH speed position.

NOTE: Place the travel speed switch in HIGH speed when maximum available travel speed is required (normal operation).

In the HIGH speed position, the travel motors shift to minimum displacement (low-torque, high-speed) automatically if the system pressure is below 270 bar (3,915 psi). If the engine is below 1500 RPM, the 2-speed travel solenoid valve HS-35 is enabled, although the travel speed switch is in the HIGH speed position. The travel two-speed solenoid valve HS-35 is disabled, shifting the valve and removing hydraulic pilot pressure to the end of the P/C valve, allowing the motor to operate in PCOR mode.

Travel Detent Selector

The travel detent selector on the right travel control handle allows any travel command to be locked in. When moving at the desired speed and direction, lift the travel detent selector on the control handle. The PC locks in the information. Lifting the travel detent selector again or moving the travel control handle in the opposite direction opens the travel detent circuit and returns the control of the travel system back to the operator.

Travel Forward and Reverse

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

When a travel control handle is moved in a forward direction, an input voltage of 5 or more volts is sent to the PC. The PC sends a variable minus 0 to 2.8 V output that is applied to the selected travel pump's electrical displacement control (EDC). The travel brake solenoid valve HS-1 is enabled to release both the left and right crawler brakes, before the selected travel pump strokes.

The travel pump's EDC tilts the pump's swashplate in the forward direction. Hydraulic fluid flow is from the pump port of the selected travel pump through a quick disconnect and swivel to the travel motor. The PC input voltage to a selected travel pump's EDC is relative to the selected control handle's movement.

When a travel control handle is moved in a reverse direction, an input voltage of 5 V or less is sent to the PC. The PC sends a variable plus 0 to 2.8 V output that is applied to the selected travel pump's EDC. The PC sends a 12 V output to enable the travel brake solenoid valve HS-1. The travel brake solenoid valve is enabled to release both the left and right crawler brakes, before the selected travel pump strokes.

The travel pump's EDC tilts the motor's swashplate in the reverse direction. Hydraulic fluid flow is from the pump port of the selected travel pump through the swivel to the motor port. The PC sends an input voltage to the selected travel pump's EDC that is relative to the selected control handle's movement.

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

As the travel control handle nears the neutral position, the PC compensates for hydraulic system leakage or changing engine speed. The PC sends a 0 V output to the pump's EDC to move the swashplate to the center position. After the travel control handle command is in the OFF position for a preset time, a 0 V output is sent to disable the travel brake solenoid valve HS-1. The travel brake solenoid valve shifts to block pilot pressure to the brakes and opens a line to the tank, and the brakes apply.

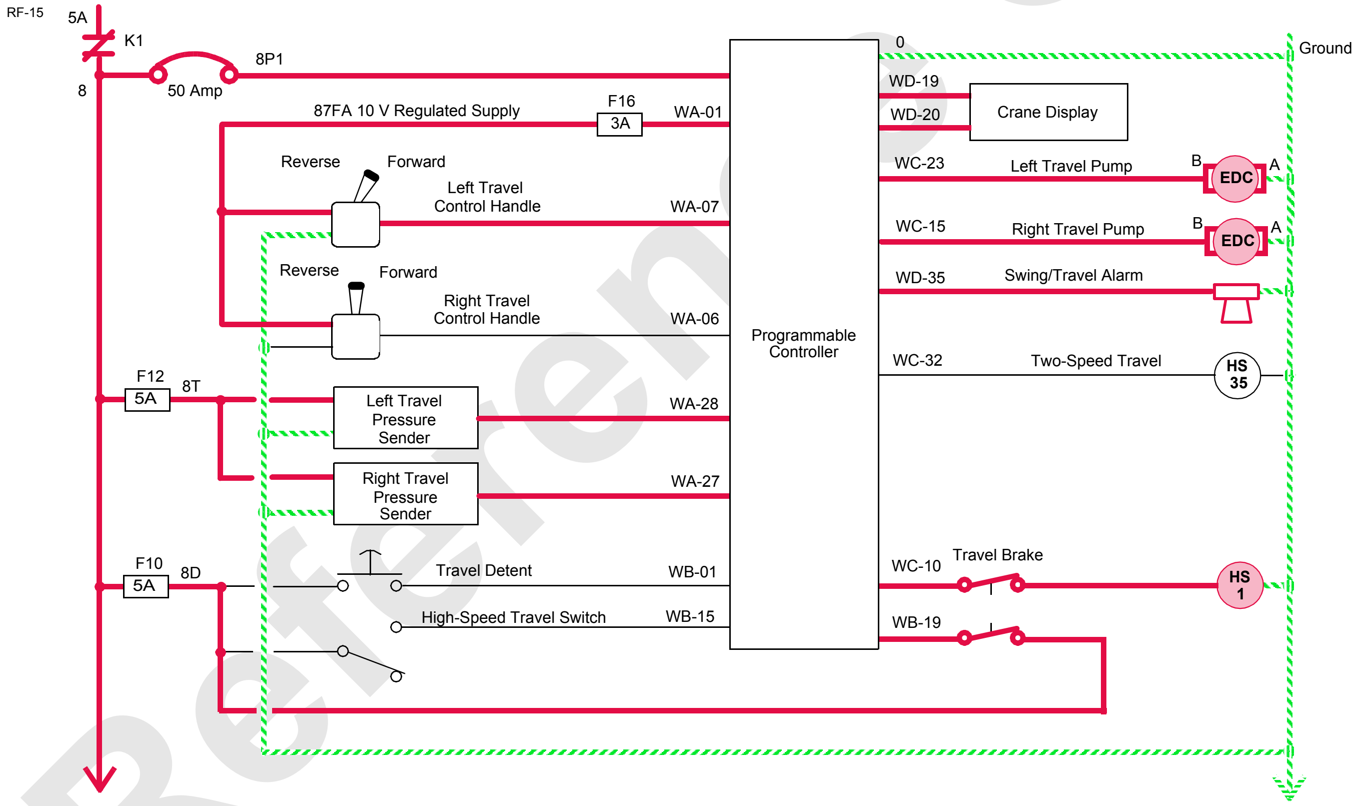


FIGURE 1-22

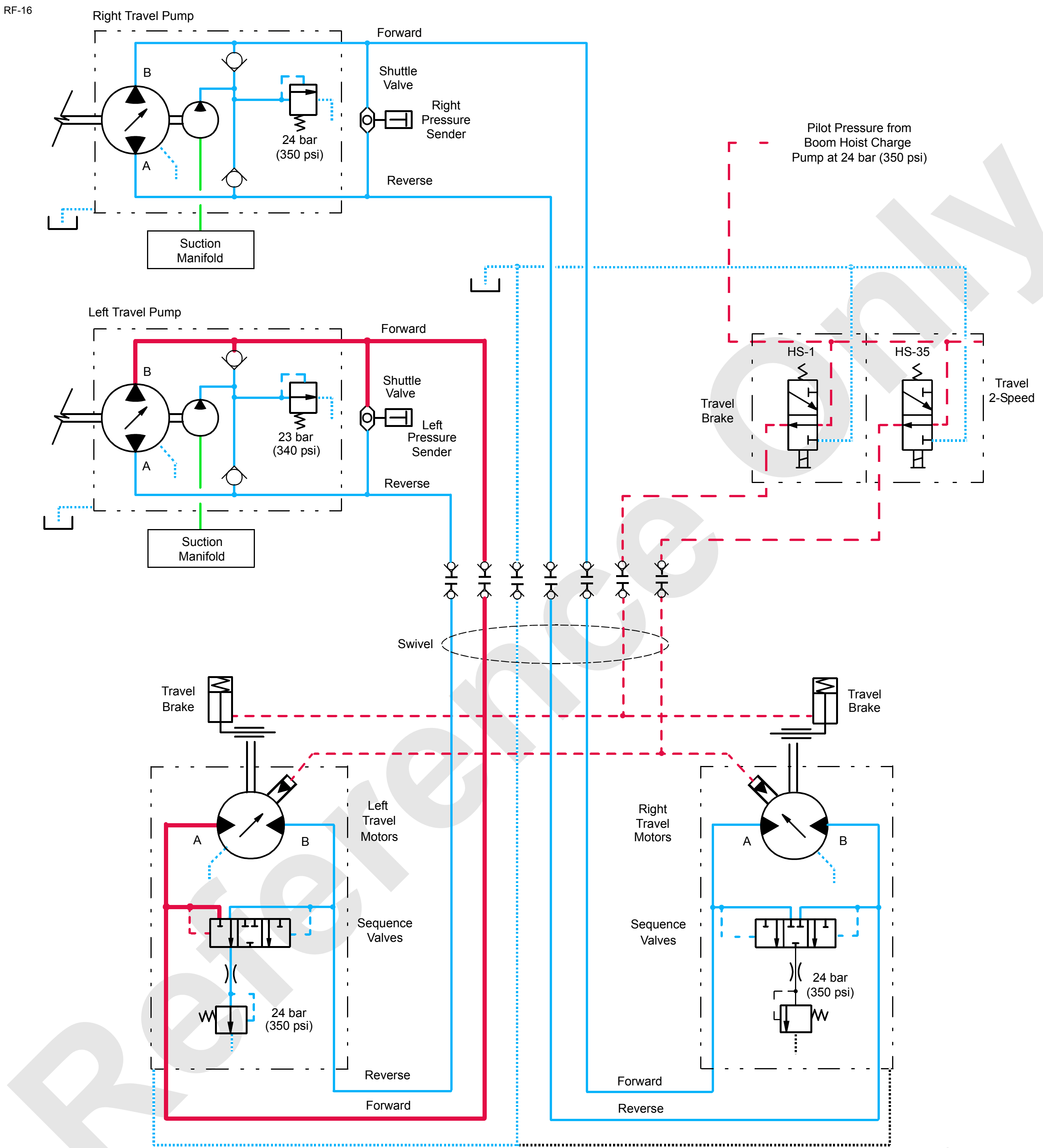

RF-16
Right Travel Pump
B
A
24 bar
(350 psi)
Forward
Shuttle
Valve
Right
Pressure
Sender
Reverse
Suction
Manifold
Pilot Pressure from
Boom Hoist Charge
Pump at 24 bar (350 psi)
Left Travel Pump
B
A
23 bar
(340 psi)
Forward
Shuttle
Valve
Left
Pressure
Sender
Reverse
Suction
Manifold
HS-1
HS-35
Travel
Brake
Travel
2-Speed
Swivel
Travel
Brake
Travel
Brake
Left
Travel
Motors
A
B
Sequence
Valves
24 bar
(350 psi)
Reverse
Forward
Right
Travel
Motors
A
B
Sequence
Valves
24 bar
(350 psi)
Forward
Reverse

FIGURE 1-23

Boom Hoist/Luffing Jib System Operation

General

See Figure 1-24, Figure 1-25, and Figure 1-26 for the following.

The boom hoist system and luffing jib system (optional) share the same pump. Only one system can be operated at a time. In Standard mode, the boom hoist (drum 4) is controlled with the control handle on the left side console and the luffing jib is inoperable. In Luffing Jib mode, the boom hoist is inoperable while the luffing jib hoist (drum 5) is controlled with the control handle on the left side console. Each motor drives a gearbox on the end of a drum shaft.

Hydraulic pilot pressure from the boom hoist charge pump operates the boom hoist and the luffing jib motor servos. A pressure sender in the high-pressure side of each system provides pressure information to the programmable controller (PC). A fixed orifice between motor ports A and B allows for smoother drum operation.

When the boom hoist or luffing jib drum rotates, a speed sensor on the end of the boom hoist drum shaft or luffing jib drum flange sends an input voltage to the PC. The PC sends a variable 0 to 12 V output to the rotation indicator in the control handle. As the drum rotates faster, the rotation indicator on the control handle pulsates to indicate the drum's rotational speed. The speed is shown on the display.

Continuous changing of system fluid occurs through leakage in the pump, motor, and external sequence/flow valve. The sequence/flow valve opens at 19 bar (275 psi) and removes 15 L/min (4 gpm) of hot fluid from the system by dumping it into the motor case where the fluid returns to the tank.

Brake and Pawl

Hydraulic pilot pressure from the boom hoist charge pump operates the boom hoist or luffing jib brake. Air pressure operates the boom hoist or luffing jib drum pawl.

When a brake switch is in the ON position, boom hoist brake solenoid valve HS-6 or luffing jib brake solenoid valve HS-19 is disabled to apply the brake to the drum. Boom hoist pawl-in air solenoid valve AS-14 or luffing jib pawl-in air solenoid valve AS-16 is enabled to keep the pawl applied to the drum flange. The boom hoist/luffing jib pump does not stroke in response to the control handle's movement.

When a brake switch is in the OFF position, the boom hoist or luffing jib brake remains applied, waiting for a control handle command. The PC sends a 0 V output to disable boom hoist pawl-in air solenoid AS-14 or luffing jib pawl-in air solenoid AS-16. The PC sends a 12 V output to enable boom hoist pawl-out air solenoid AS-13 or luffing jib pawl-out air solenoid AS-15. The solenoid valve shifts to exhaust the air pressure from the piston end of the pawl cylinder and to supply manifold air pressure to the rod end of the cylinder. The cylinder retracts the pawl out of the drum flange.

Raising the Boom Hoist/Luffing Jib

The following description is for the boom hoist system. The luffing jib system is similar.

When the left side console control handle is moved back for booming/luffing up, an input voltage of 5 V or more is sent to the PC. The PC sends a variable minus 0 to 2.8 V output that is applied to the pump's electrical displacement control (EDC). The PC sends a variable 0 to 2.19 V output that is applied to the boom hoist motor's pressure-control pilot (PCP). The PC checks that the system's limit switches are closed and that a system fault is not present.

The pump's EDC tilts the swashplate in the UP direction to satisfy pressure memory. The PC compares drum-holding pressure to pressure memory. When the system pressure is high enough, the PC sends a 12 V output to enable the brake solenoid valve HS-6. The brake solenoid shifts to block the drain port and opens the port to pilot pressure from the boom hoist charge pump to release the selected drum brake.

The pump's EDC continues to tilt the swashplate up as hydraulic fluid flows from the pump outlet port to the motor inlet port. Return fluid is from the motor outlet port to the pump inlet port.

The PC's output voltage to the pump's EDC and the motor's PCP is relative to the control handle's movement. As the boom hoist control handle moves back, the pump's swashplate angle increases. When system pressure exceeds the pressure-compensating override (PCOR) valve setting of 340 bar (4,930 psi), the valve shifts to direct the flow from the shuttle valve to the maximum displacement side of the servo cylinder. The PCOR valve overrides the command from the servo PC valve, increasing the motor's displacement, output torque, and reducing output speed. When the PCOR valve closes, the control of the motor returns to the servo PC valve.

The PC is continuously balancing the system's pressure and the motor's displacement angle so the motor displacement goes to minimum when the control handle is fully back, if the motor torque is not too high. The PC monitors the motor's displacement and controls the motor speed by regulating the hydraulic fluid flow through the pump.

When the boom hoist control handle is moved toward the neutral position, the PC compensates for hydraulic system leakage or changing engine speed. The PC sends a 0 V output to the boom hoist pump's EDC that moves the swashplate to the center position. This shifts the motor back to maximum displacement for slower output speed to slow the drum's rotation. The PC stores the load-holding pressure in pressure memory. After the control handle center switch opens, the PC sends a 0 V output to disable the boom hoist brake solenoid valve HS-6. The drum brake solenoid valve shifts to block pilot pressure to the brake and opens a line to the tank. The brake applies before the drum pump de-strokes.

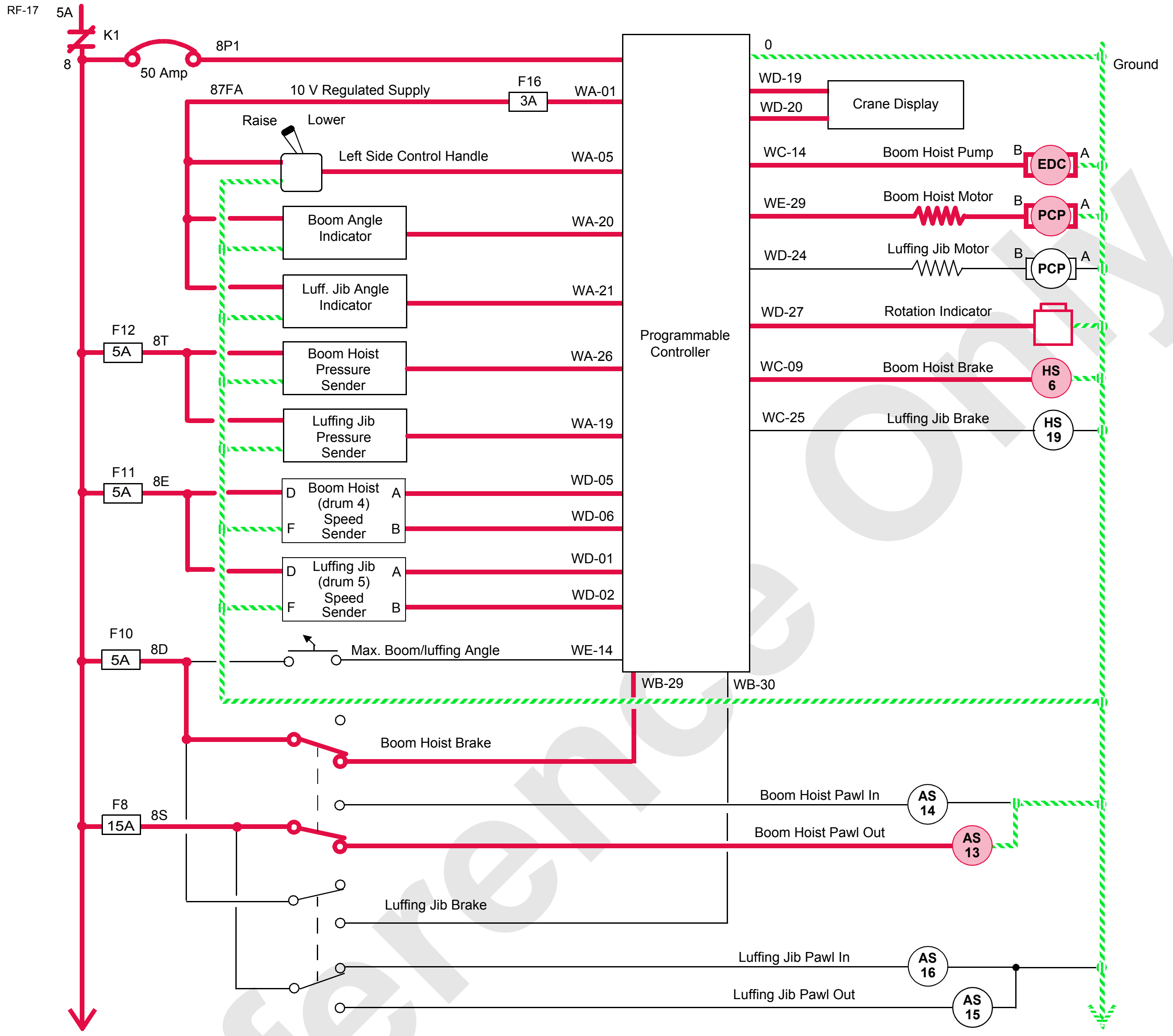


FIGURE 1-24

Lowering the Boom Hoist/Luffing Jib

The following description is for the boom hoist system. The luffing jib system is similar.

When the control handle is moved forward for booming down, an input voltage of 5 V or less is sent to the PC. The PC sends a variable plus 0 to 2.8 V output that is applied to the pump's EDC. The PC sends a variable 0 to 2.19 V output that is applied to the motor's PCP. The PC checks that all the block-up limit switches are closed and that a system fault is not present.

The pump's EDC tilts the swashplate up to satisfy pressure memory. The PC compares the boom hoist-holding pressure to the pressure memory. When the system pressure is high enough, the PC sends a 12 V output to the brake solenoid valve HS-6. The brake solenoid shifts to block the drain port and opens the port to pilot pressure from the boom hoist charge pump to release the drum brake. When the brake is released, the pump's EDC continues to tilt the swashplate down. Hydraulic fluid flows from the pump's outlet port to the motor's inlet port. Return fluid is from the motor's outlet port to the pump's inlet port.

The PC's output voltage to the pump's EDC and the PC's output voltage to the motor's PCP are relative to the control handle's movement. As the control handle is pushed forward, the pump's swashplate angle is increased. When system pressure exceeds the PCOR valve setting of 340 bar

(4,930 psi), the valve shifts to direct the flow from the shuttle valve into the maximum displacement side of the servo cylinder.

The PCOR valve overrides the command from servo PC valve, increasing motor displacement, output torque, and reducing output speed. When the PCOR valve closes, control of the motor returns to the servo PC valve.

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

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

When the boom hoist control handle is moved toward the neutral position, the PC compensates for hydraulic system leakage or changing engine speed. The PC sends a 0 V output to the pump's EDC that moves the swashplate to the center position. This shifts the motors back to maximum displacement for slower output speed to slow the drum's rotation.

The PC stores the boom-holding pressure in pressure memory. After the control handle center switch opens, the PC sends a 0 V output to disable the brake solenoid valve HS-6. The drum brake solenoid valve shifts to block the boom hoist charge pump pilot pressure to the brakes and opens a line to the tank. The brake applies before the drum pump de-strokes.

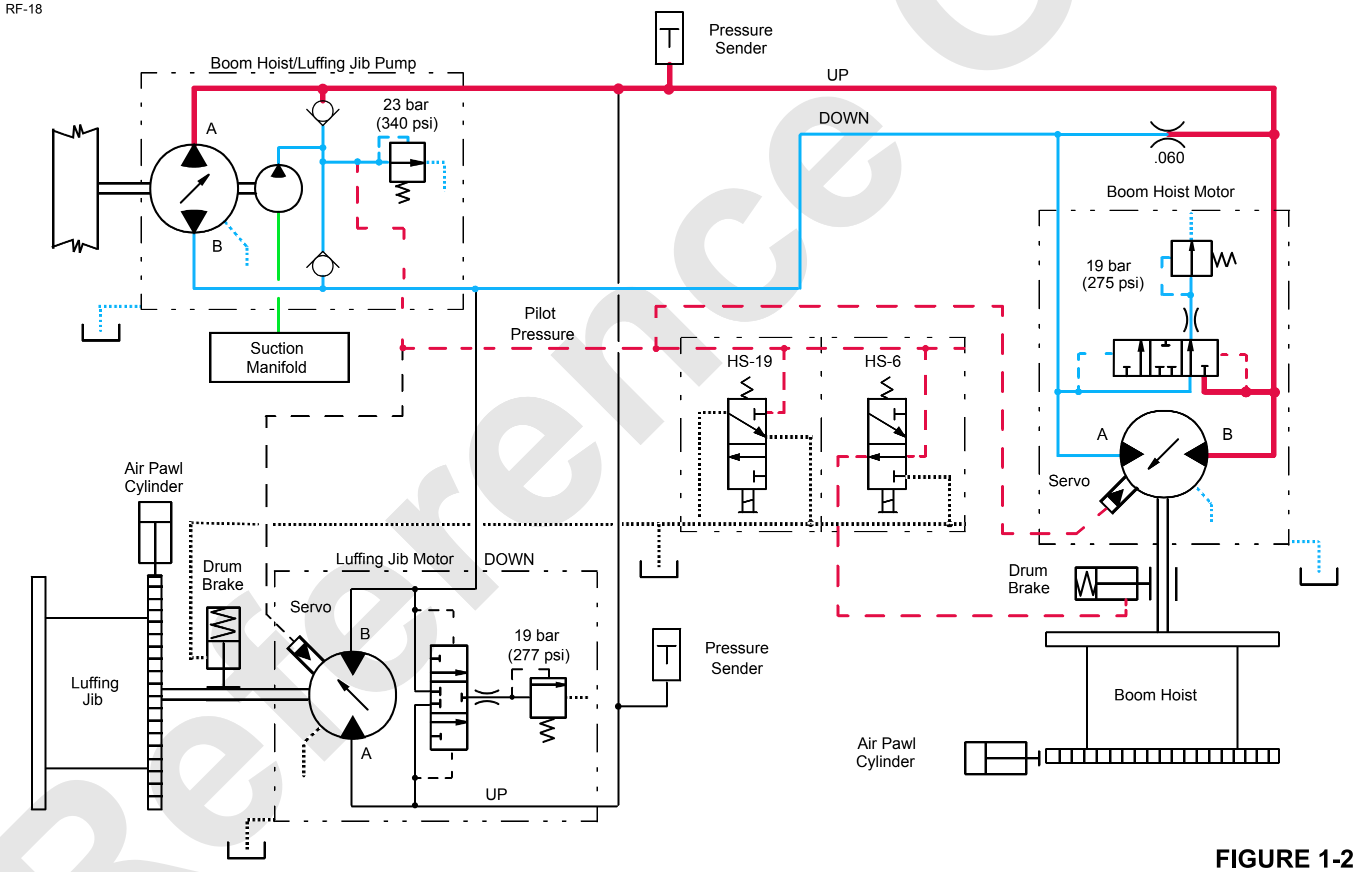


FIGURE 1-25

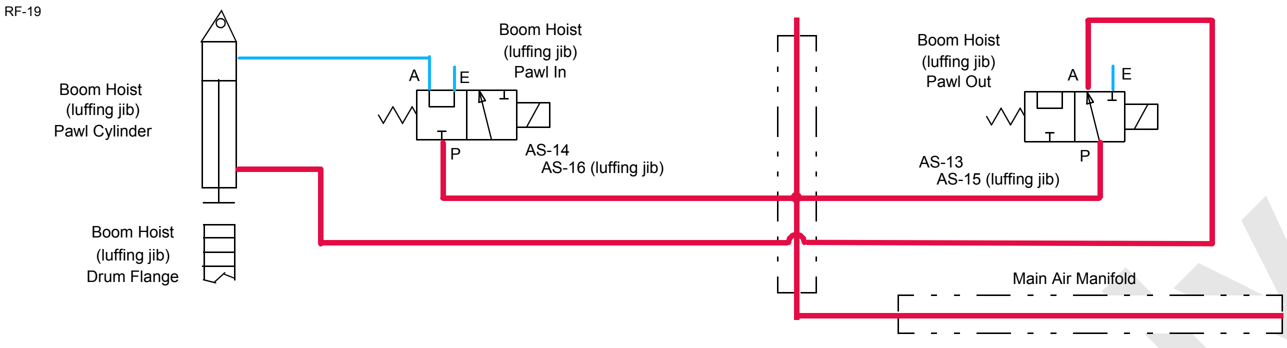


FIGURE 1-26

Load Drum System—Full Power

General

See Figure 1-27, Figure 1-28, and Figure 1-29 for the following.

The load drum system has two drive shafts where the three load drums connect and disconnect to the drive shaft with clutches. The front drum (drum 1) is on one drive shaft and the split drums right rear (drum 2) and left rear (drum 3) are on the second drive shaft. The two load drum pumps drive one motor (dual load drum motors are optional). The two pumps increase load drum speed and torque. In Standard mode only, one drum can be operated at a time.

The load drum that is connected to the drum shaft is determined either by the programmable controller (PC) or the operator. The PC engages the last selected drum clutch to the drum shaft and disengages the other clutches from the drive shaft. The operator selects the desired load drum with the load drum's handle movement.

Depending on the crane's load drum configuration, the left load drum control handle on the right console normally operates either the full front drum (drum 1) or right rear drum (drum 2), while the right load drum control handle on the right console normally operates either the full rear (drum 2) or left rear drum (drum 3). See Operating Controls in Section 3 of the Operator Manual for handle-to-drum identification.

When the crane is configured with two split rear drums, the operator shall select the desired operating rear drum. If a drum is not in use, the working brake pedal must be applied and latched.

Hydraulic charge pressure from the system charge pumps supplies hydraulic pilot pressure to operate the motor servo. A pressure sender in the motor servo pilot pressure line provides system pressure information to the PC.

A speed sensor at the load drum flange monitors rotational speed and sends an input voltage to the PC. The PC sends an output voltage to the rotation indicator in the control handle. As the drum rotates faster, the rotation indicator on top of the control handle pulsates to indicate the drum's rotational speed. The drum speed is also shown on the selected drum display screen.

Continuous changing of the closed-loop fluid occurs with leakage in the pump, motor, and external sequence/flow valve. The sequence/flow valve opens when system pressure exceeds 14 bar (200 psi) and removes 30 L/min (8 gpm) of hot fluid from the system by dumping the fluid in the motor case where the fluid returns to the tank through the tank cooler.

Drum Brake

When a selected main hoist drum brake switch is in the ON position, the drum brake solenoid valve to each drum is disabled and the brakes are applied to the drum shaft. The drum pump does not stroke in response to the control handle's movement.

When a selected load drum-brake switch is placed in the OFF position, the brake solenoid valve to the drum remains applied, waiting for a control handle command. The PC controls the selected drum brake with movement of the control handle when the drum is in the full power mode.

Hoisting the Load Drum

The following hoisting operation is for the right rear drum (drum 2) with a three drum configuration, while operating in full power mode. Operation of the other load drums is similar.

When the right load drum control handle is moved back for hoisting, an input voltage of 5 V or more is sent to the PC. The PC sends a variable minus 0 to 2.8 V output that is applied to both load drum pumps' electrical displacement control (EDC). The PC sends a variable 0 to 2.19 V output that is applied to the load drum motor's pressure-control pilot (PCP). The PC checks that the selected drum maximum bail and block-up limit switches are closed and that there are no faults in the air or hydraulic systems.

The PC sends a 12 V output signal to enable the front drum clutch solenoid AS-8 and left rear drum clutch solenoid AS-12. The valves shift to allow manifold air pressure to flow to the clutch cylinders and compress the springs to release the clutches from the drum shaft. The right rear drum clutch solenoid AS-10 air pressure is exhausted so the clutch remains spring-applied to the drum shaft.

The pump's EDC tilts the swashplates in the UP direction to satisfy pressure memory. The PC compares the load-holding pressure to pressure memory. When system pressure is high enough, the PC sends a 12 V output to the right rear brake solenoid AS-9. The valve is enabled and shifts to allow manifold air pressure to release the spring-applied brake.

The pump's EDC continues to tilt the swashplate in the UP direction as hydraulic fluid flow is from the pump's outlet port to the motor's inlet port. Fluid then flows from pump ports A to motor port A. Fluid from the motor port B returns to the load drum pump ports B.

The PC output voltage to the pump's EDC and the motor's PCP is relative to the control handle's movement. As the control handle is moved back, the pump's swashplate angle is increased. When system pressure exceeds the pressure-compensating override (PCOR) valve setting of 340 bar (4,930 psi), the valve shifts to direct the flow from the shuttle valve into the maximum displacement side of the servo cylinder. The PCOR valve overrides the command from the servo PC valve, increasing motor displacement, output torque, and reducing output speed. When the PCOR valve closes, control of the motor returns to the servo PC valve.

The PC is continuously balancing the system pressure and the motor displacement angle so the motor displacement goes to minimum when the control handle is fully back, if the motor torque is not too high. The PC monitors motor displacement and controls motor speed by regulating the hydraulic fluid flow through the pumps.

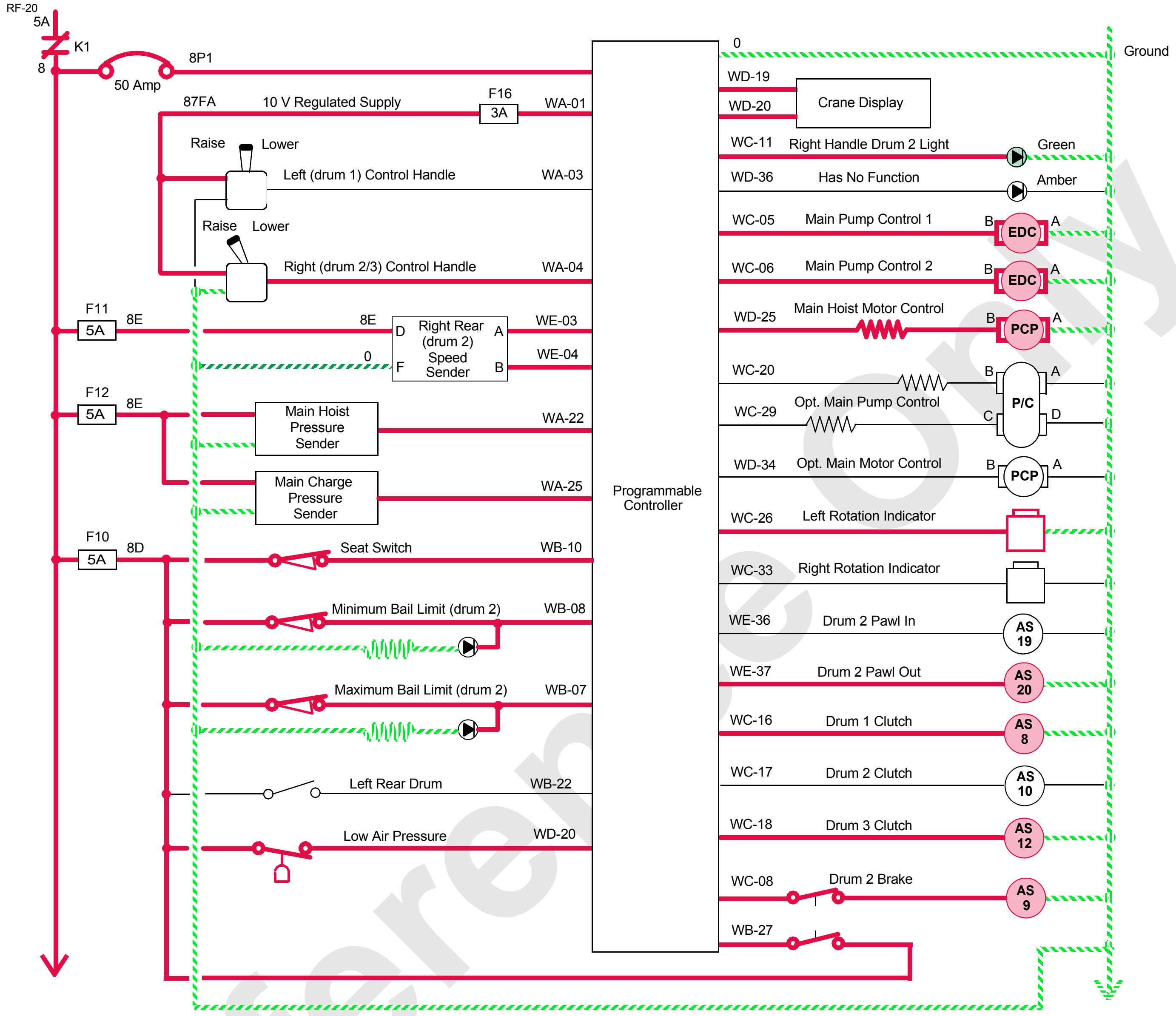


FIGURE 1-27

When the control handle moves toward the neutral position, the PC compensates for system leakage or changing engine speed. The PC sends a 0 V output to the pump's EDC that moves the swashplate to the center position. This shifts the motor back to maximum displacement for slower output speed to slow the drum's rotation.

The PC stores the load-holding pressure in pressure memory. After the control handle center switch opens, the PC sends a 0 V output signal to the right rear brake solenoid AS-9. The valve is disabled and shifts to block manifold air pressure to the brake cylinder and apply the brake. The brake applies before the drum pump de-strokes.

Lowering the Load Drum

When the right load drum control handle is moved forward for lowering, an input voltage of 5 V or less is sent to the PC. The PC sends a variable plus 0 to 2.8 V output that is applied to both load drum pump's EDC. The PC sends a variable 0 to 2.19 V output that is applied to the load drum motor's pressure-control pilot (PCP). The PC checks that the right rear maximum bail and block-up limit switches are closed and that there are no faults in the air or hydraulic system.

The PC sends a 12 V output signal to enable the front drum clutch solenoid AS-8 and left-rear drum clutch solenoid AS-12. The valves shift to allow manifold air pressure to flow to the clutch cylinders and compress the springs to release the clutches from the drum shaft. The right rear drum clutch solenoid AS-10 air pressure is exhausted so the clutch remains spring-applied to the drum shaft.

The pump's EDC tilts the swashplates in the UP direction to satisfy pressure memory. The PC compares load-holding pressure to pressure memory. When the system pressure is high enough, the PC sends a 12 V output to release the right rear brake solenoid AS-9. The valve is enabled and shifts to allow manifold air pressure to release the spring-applied brake.

The pump's EDC tilts the swashplate to stroke the pump in the DOWN direction. In the DOWN direction, fluid flow is from the low-pressure side from pump ports B to port B of the motor. Fluid from motor port A returns to pump ports A.

The PC output voltage to the pump's EDC and the PC output voltage to the motor's pressure-control pilot (PCP) is relative to the control handle's movement. As the control handle is moved forward, the pump's swashplate angle is increased. When pressure exceeds the PCOR valve setting of 340 bar (4,930 psi), the valve shifts to direct the flow from the shuttle valve into the maximum displacement side of the servo cylinder.

The PCOR valve overrides the command from the servo PC valve, increasing motor displacement, output torque, and reducing output speed. When the PCOR valve closes, control of the motor returns to the servo PC valve.

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

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

The PC controls the lowering speed by varying the voltage to the EDC's in relation to the control handle's movement to program requirements. Each pump's swashplate angle is increased as the control handle is moved forward. As more fluid is returned to the pumps, more fluid is pumped to the motor, and the drum lowers the load faster.

When a control handle is moved toward the neutral position, the PC compensates for hydraulic system leakage or changing engine speed. The PC sends a 0 V output to each pump's EDC that moves the swashplate to the center position. This shifts the motors back to maximum displacement for slower output speed to slow the drum's rotation.

The PC stores the load-holding pressure in pressure memory. After the control handle's center switch opens, the PC sends an output signal to the right rear brake solenoid AS-9. The valve is disabled and shifts to block manifold air pressure flow to the brake cylinder and applies the brake. The brake applies before the drum's pump de-strokes.

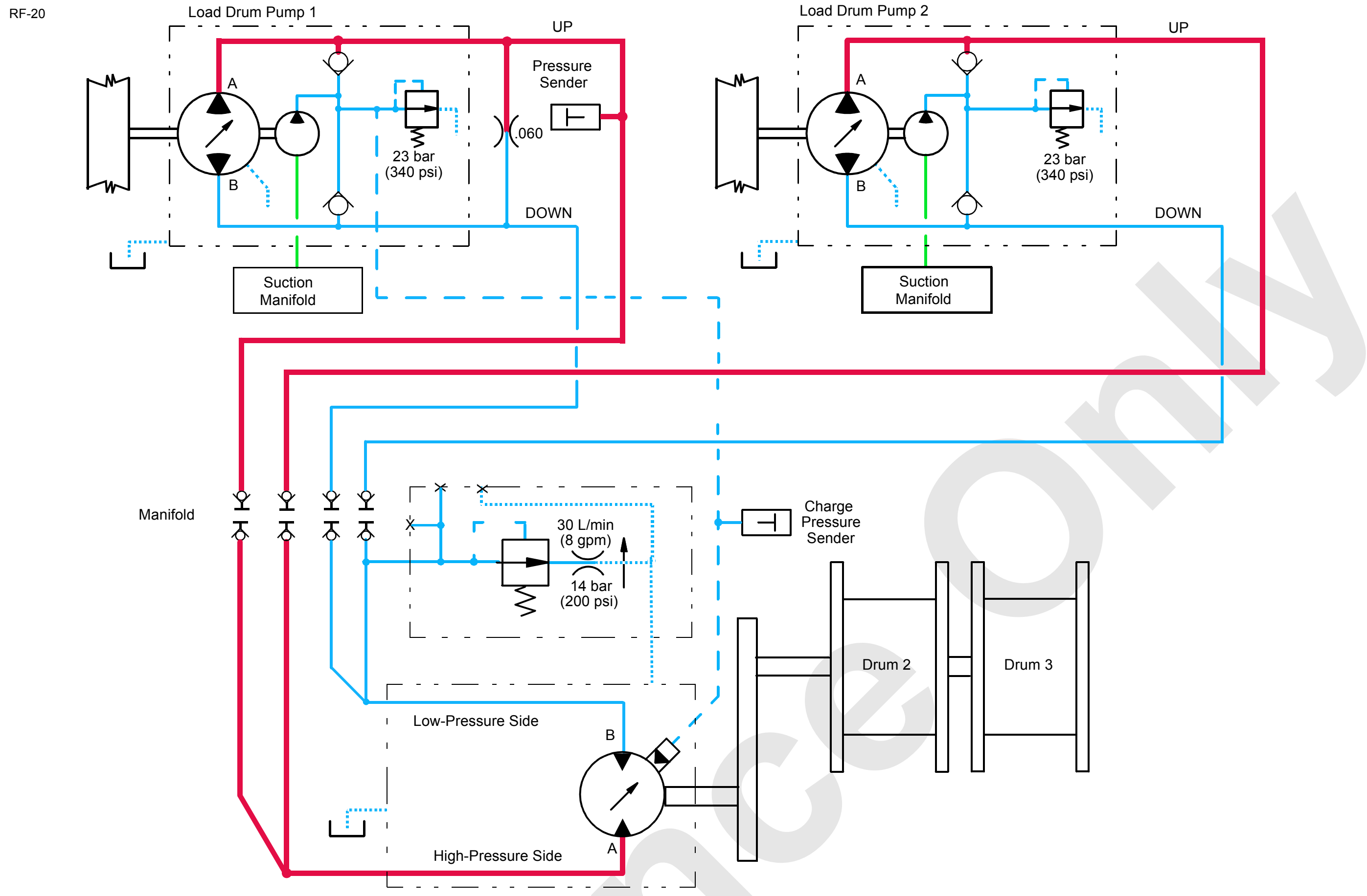
Dual Load Drum Motor Operation

See Figure 1-27, Figure 1-28, and Figure 1-29 for the following.

The optional dual load drum motors are usually equipped on cranes configured for duty cycle. The operation of the dual load drum motors is similar to what is described for Load Drum System—Full Power on page 1-44. Operation of the brakes and clutches is the same. The operation that is different includes the following:

- The sequence/flow valve for each motor opens when system pressure exceeds 25 bar (365 psi). The variable-speed motor removes 10 L/min (2.6 gpm), while the fixed speed motor removes 5 L/min (1.32 gpm) of hot fluid from the system by dumping the fluid in the motor case where fluid returns to the tank through the tank cooler.
- The motor electrical control is with a proportional solenoid that is proportional to the electrical control current applied (400 to 1200 mA).
- The motor PCP is replaced with the proportional solenoid.

There is no hydraulic servo system to the motors. The servo PC valve and the PCOR valve are replaced with the proportional solenoid.



Dual Load Drum Motors Hydraulic Circuit (optional)

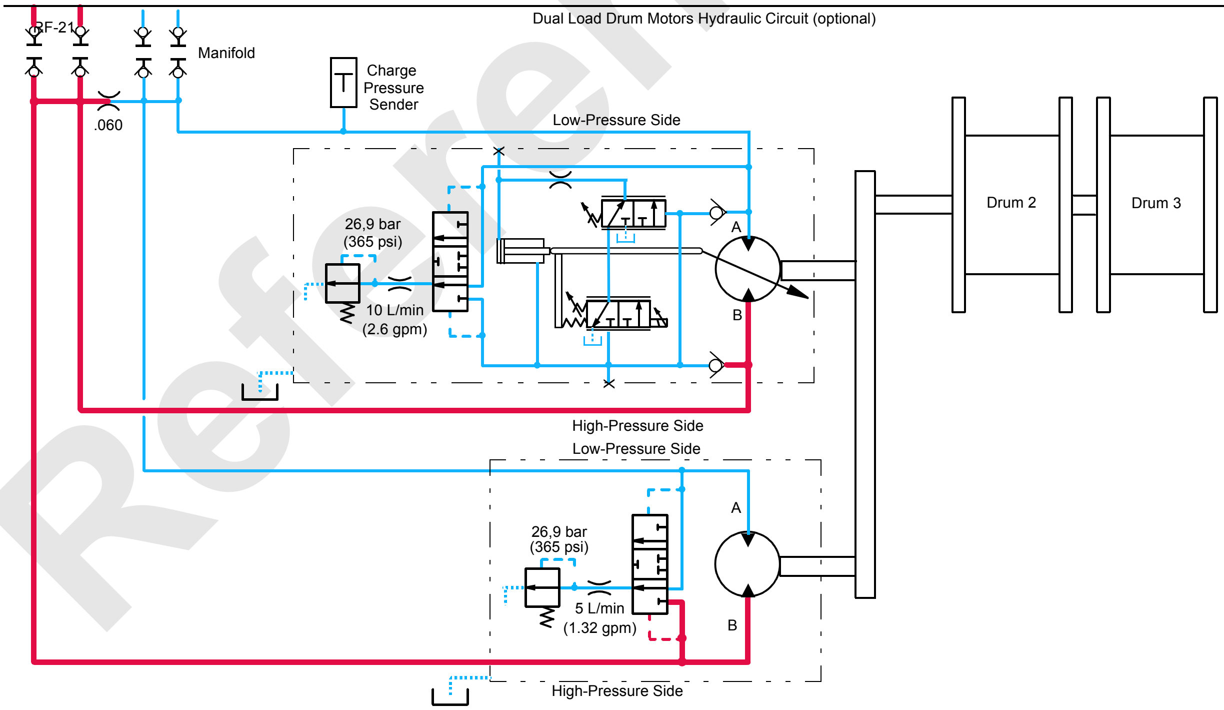


FIGURE 1-28

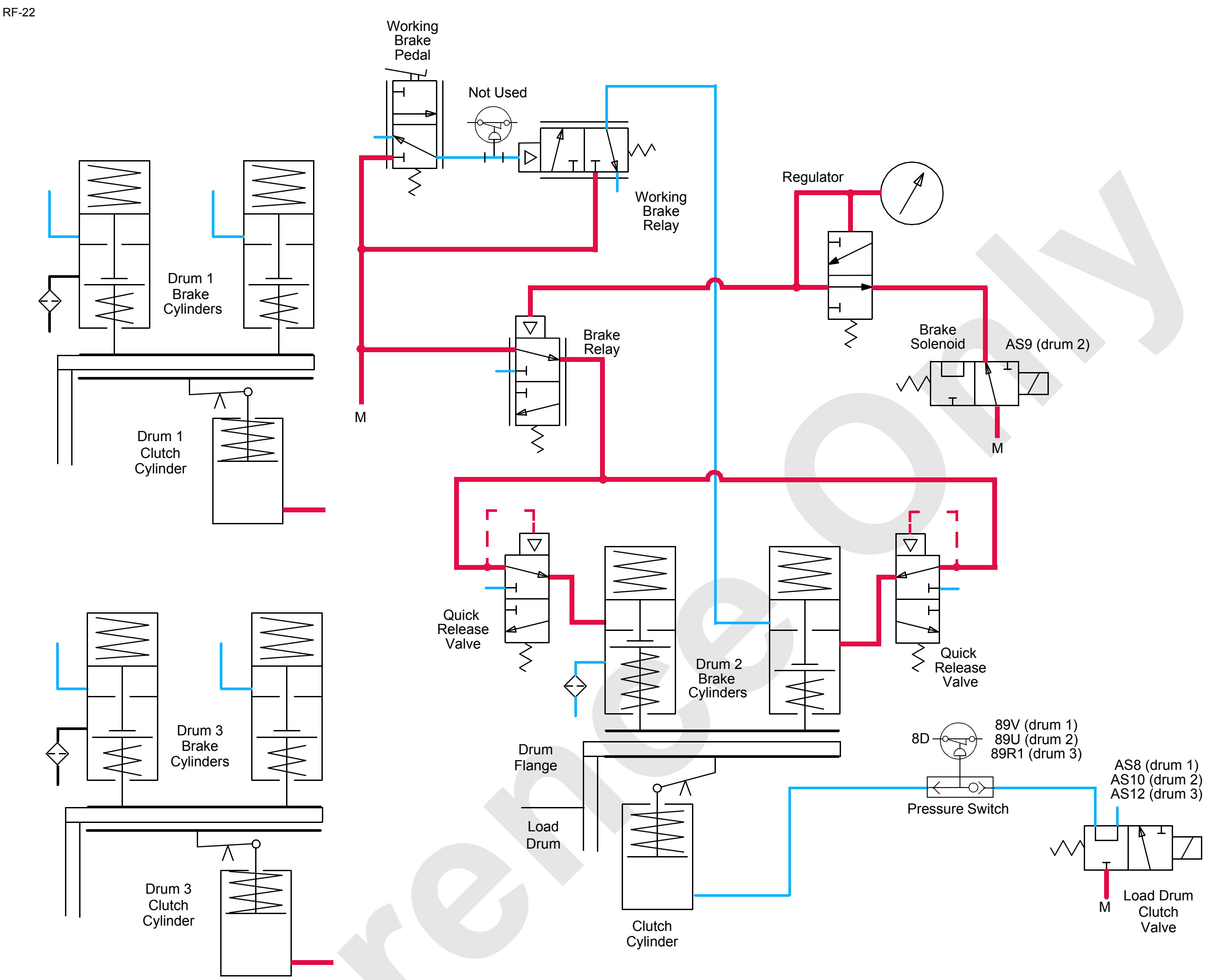

RF-22
Working Brake Pedal
Not Used
Working Brake Relay
Regulator
Drum 1 Brake Cylinders
Brake Relay
Brake Solenoid
AS9 (drum 2)
M
M
Drum 1 Clutch Cylinder
Quick Release Valve
Quick Release Valve
Drum 2 Brake Cylinders
Drum 3 Brake Cylinders
Drum Flange
8D
89V (drum 1)
89U (drum 2)
89R1 (drum 3)
AS8 (drum 1)
AS10 (drum 2)
AS12 (drum 3)
Pressure Switch
Load Drum
Drum 3 Clutch Cylinder
Clutch Cylinder
M
Load Drum Clutch Valve

FIGURE 1-29

Load Drum System—Free Fall

General

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

In Free Fall mode the load can be lowered with the control handle (Standard mode) or working brake pedal (Free Fall mode). Depending on the crane's load drum configuration, the left load drum working brake pedal on the cab floor normally operates either full front drum (drum 1) or right rear drum (drum 2), while the right load drum working brake pedal on the cab floor normally operates either full rear (drum 2) or left rear drum (drum 3).

The PC will not allow a drum to be switched to Free Fall mode until the following steps are performed.

1. Apply and latch the working brake pedal for the drum being used.
2. For right rear drum operation, place the load drum selector switch in the right rear (drum 2) position.
3. Select DRUM 2 FFALL on the crane's mode switch then turn the switch to confirm the position.
4. Turn the drum 2 park brake switch to the OFF position.

When the selected load drum control handle is in the OFF position, the load drum pumps do not stroke. If the selected load drum control handle is in the OFF position when charge pressure is lost, the programmable controller (PC) applies the selected drum brake, but the clutch remains released from the drum's shaft.

If a low-charge pressure fault occurs while hoisting or power lowering, the load drum pumps de-stroke. The PC sends an output signal that applies the clutch to the drum and applies the selected drum brake. Apply and latch the working brake pedal before moving the load drum control handle to the OFF position.

WARNING

Falling Load Hazard!

Avoid possible injury. When operating in Free Fall mode, the load will lower uncontrolled if the drum brake is not applied with the working brake pedal when the control handle is moved to the OFF position.

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

Hoisting the Load Drum—Free Fall

The following description is for hoisting the right rear load drum (drum 2) while operating in Free Fall mode. Free fall hoisting of the other load drums is the same, except for different drum, brake, clutch, and working brake pedal.

The procedure for hoisting in Free Fall mode is the same as in Standard mode. The selected free fall drum clutch is engaged, and the brake is released by the PC.

WARNING

Dropping Load Hazard!

Begin moving the selected load drum handle to the OFF position before releasing the working brake pedal to hold the load while the clutch releases from the drum shaft.

The hoisted load will drop momentarily if the working brake pedal is not applied.

When the control handle is moved to the OFF position, the selected load drum brake remains released from the drum. The PC sends a 12 V output signal to the right rear drum clutch solenoid AS-10 to release the drum clutch. This applies air pressure to the cylinder of the right rear drum clutch to release from the drum shaft, returning the drum to Free Fall mode.

Lowering the Load Drum —Free Fall

The following description is for lowering the right rear load drum (drum 2) while operating in Free Fall mode. Free fall lowering of the other load drums is the same, except for different drum, brake, clutch, and working brake pedal.

In Free Fall mode if a selected load drum control handle is moved in either direction from the OFF position, the PC sends an output signal to the right rear drum clutch solenoid AS-10. This exhausts air pressure from the selected drum clutch cylinder. The clutch spring applies to connect the drum shaft to the motor. The load is then controlled in full power in the direction the handle was moved.

CAUTION

Clutch/Motor Hazard!

Do not move a load drum control handle in either direction from the off position while a load is free falling. Damage to the clutch and/or motor drive system could occur. Stop the load with the working brake pedal before moving a load drum control handle in either direction.

Do not turn Free Fall mode off or turn the drum brake on while a load is free falling. Stop loads with the working brake pedal, then turn Free Fall mode off or turn on the drum brake.

When the working brake pedal is applied, full manifold air pressure closes the free fall safety pressure switch, sending an input signal to the PC that allows free fall operation.

WARNING

Falling Load Hazard!

Avoid possible injury. When the working brake pedal is released, the load on the drum free falls. The working brake pedal controls lowering speed. A hoisted load in Free Fall mode will fall unless stopped by the brake pedal.

Begin applying the load drum working brake pedal as the selected control handle is moved to the OFF position to hold the load when the PC releases the clutch from the drum shaft.

WARNING

Falling Load Hazard!

Avoid possible injury. The load will fall uncontrolled if working brake pedal is not applied before moving control handle to the OFF position.

As the working brake pedal is released, the load starts to free fall. Lowering speed must be controlled with the working brake pedal.

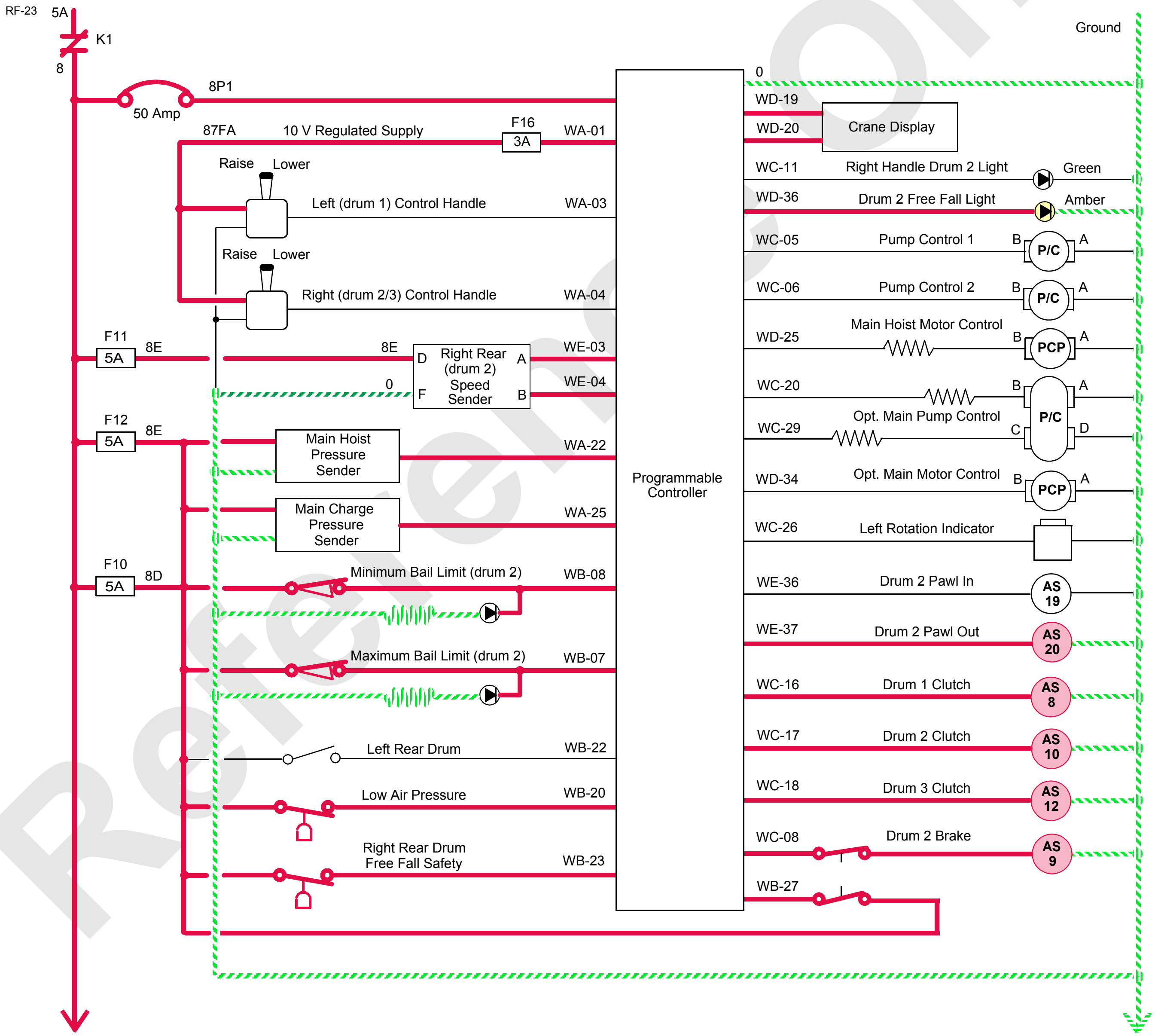


FIGURE 1-30

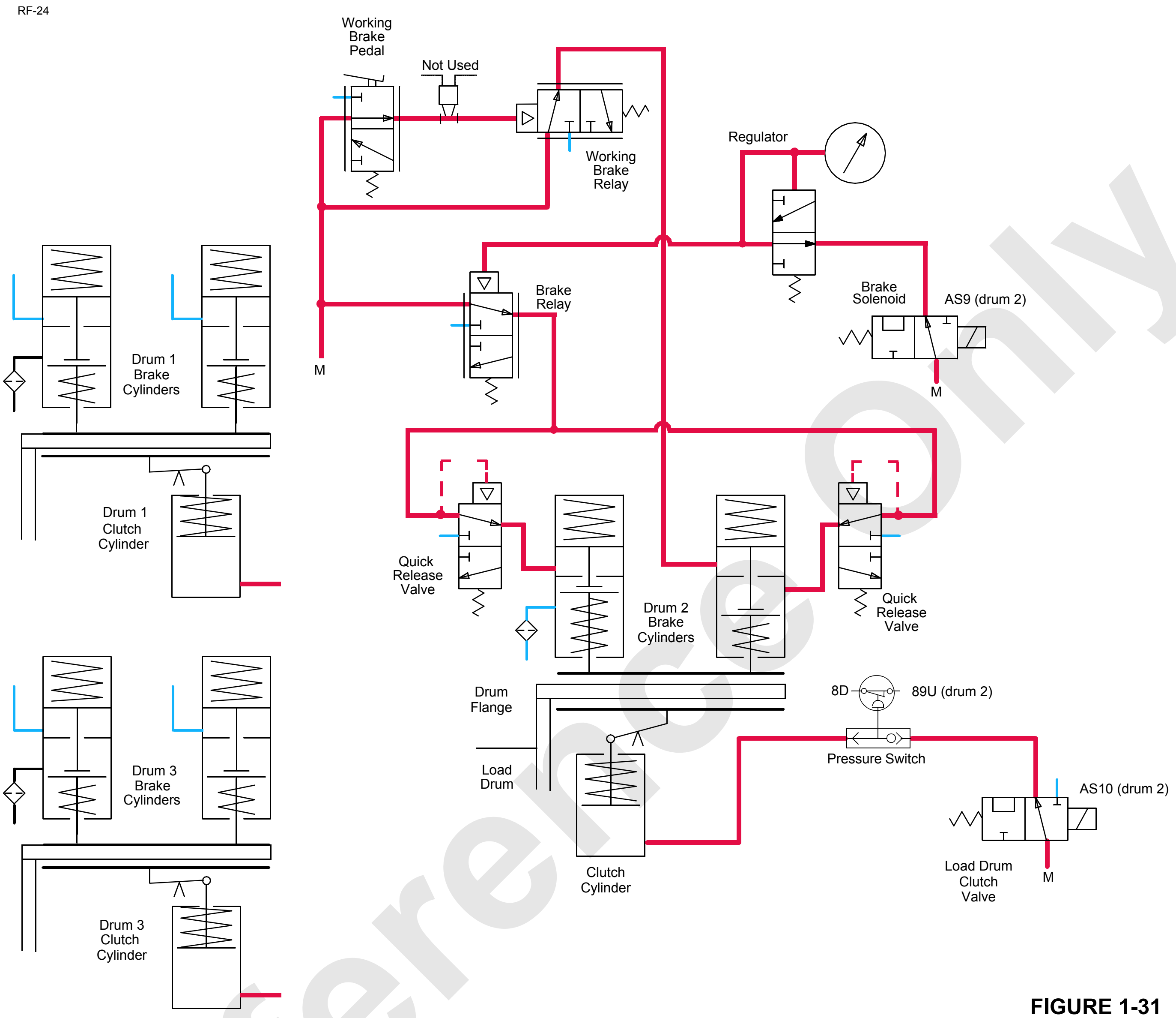

RF-24
Working Brake Pedal
Not Used
Working Brake Relay
Regulator
Brake Relay
Brake Solenoid
AS9 (drum 2)
M
M
Drum 1 Brake Cylinders
Drum 1 Clutch Cylinder
Quick Release Valve
Drum 2 Brake Cylinders
Quick Release Valve
Drum Flange
8D
89U (drum 2)
Pressure Switch
AS10 (drum 2)
Load Drum
Clutch Cylinder
Load Drum Clutch Valve
M
Drum 3 Brake Cylinders
Drum 3 Clutch Cylinder

FIGURE 1-31

Upper Accessory System Components

General

The upper accessory system components include four jacking cylinders, front and rear adapter frame pin cylinders, and gantry raising cylinders. During normal operation the upper accessory solenoid valves are “motor spooled” where both cylinder ports and the tank port of the valve spool section are connected in the center position and open to the tank.

Setup mode must be selected for operating the accessory system components. In Setup mode, the programmable controller (PC) supplies power to the equalizer limit switch, turns off boom hoist UP/DOWN limits, and prevents travel/swing from being operated faster than one-third speed.

The auxiliary pump is the hydraulic pressure source to operate the accessory system components. Hydraulic fluid from the auxiliary pump flows through the auxiliary system’s disable-relief valve HS-12. Hydraulic fluid enters the upper accessory valve and flows through to the lower accessory valve.

The auxiliary system’s disable-relief valve HS-12 is controlled by the PC. During normal operation the relief valve is open and excess supply flow from the auxiliary pump is dumped through the valve to the tank. When a component of either accessory system is enabled, an input signal is sent to the PC. The PC sends a 12 V output signal to the auxiliary system’s disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

Hydraulic pilot pressure to shift the upper accessory valves is from the boom hoist charge pump at 24 bar (350 psi).

Jacking Cylinders

See Figure 1-32 and Figure 1-33 for the following.

Jacking cylinders are mounted on each corner of the rotating bed. Jacking cylinder operation is controlled with the switches on the jacking remote control and PC programming. Operation of all four jacking cylinders is the same. All cylinders can be operated at the same time if the crane is level.

With the engine running, power is available to the jacking remote control when the cable is connected at the auxiliary valve junction box on the right side of the rotating bed. Pressing the power button and jacking remote switch(es) supplies power to operate the jacking cylinders.

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

⚠ WARNING

Collapsing Hazard!

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

When the rotating bed is 3° out of level, a red level warning light and beeper comes ON.

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

Jacking Cylinders Extend

The following operating description is for front jacks. Operation of the rear jacks is the same, except different switches are used.

When the power button is pressed and both left and right front jack switches are held in the UP (extend) position, an input voltage is sent through a diode to the PC. The PC sends a 12 V output signal to the auxiliary system’s disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

The PC also sends a 12 V output signal to enable the jacking solenoids HS-25 and HS-27 to extend the left and right front jacks. Hydraulic pilot pressure at 24 bar (350 psi) or 21 bar (300 psi) shifts the valve(s) in the selected direction.

Hydraulic fluid from the auxiliary pump flows through the auxiliary system’s disable-relief valve HS-12 and enters accessory valve. Fluid exits valve sections of the accessory valve and flows through free-flow check valve sections of the counterbalance valves. Fluid then enters the piston end of the front jacking cylinders, extending the cylinders to lift the front of the rotating bed.

Fluid returning to the tank from the rod end of the jacking cylinders is blocked by free-flow check valve sections of the counterbalance valves and goes through the flow-restraining relief valve set at 207 bar (3,000 psi). Counterbalance valves provide deceleration control with 3:1 pilot ratio of the relief pressure. This allows the valves to open when the pressure in the rod end of the cylinders is approximately 69 bar (1,000 psi).

The restraining section of the counterbalance valves open, controlling fluid flow out of the jacking cylinders. Fluid then exits the counterbalance valves and flows out of the upper accessory valve before returning to the tank through the return manifold. If more power is needed to extend the jacks, engine speed can be increased with the remote engine speed switch in the remote start junction box on the right side of the rotating bed.

When the power button or jacking switch is moved to the OFF position, the PC sends a 0 V output to shift the spool of solenoid valves HS-25 and HS-27 to the center position.

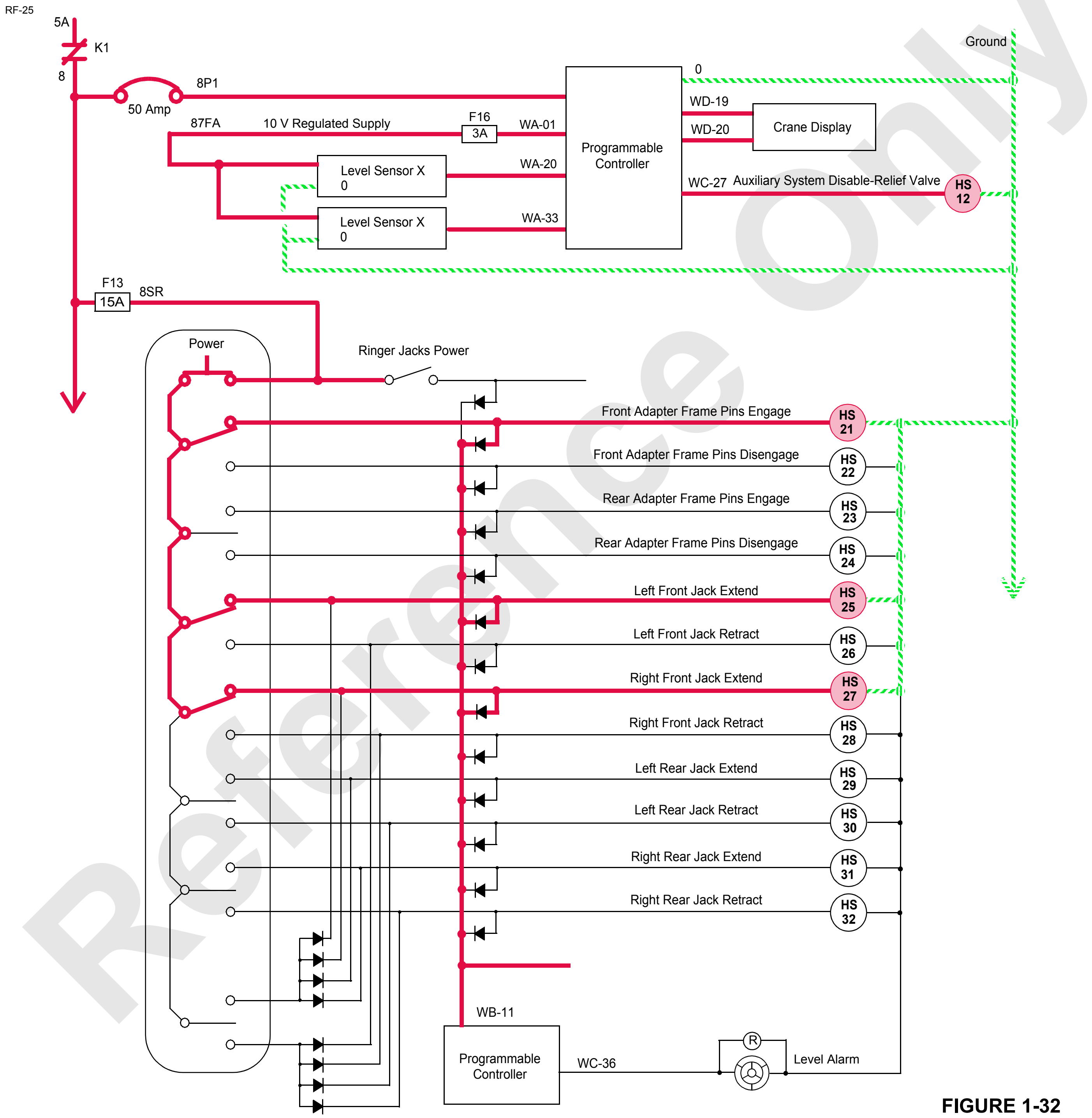


FIGURE 1-32

Jacking Cylinders Retract

The following operating description is for the front jacks. Operation of the rear jacks is the same, except different switches are used.

When the power button is pressed and both left and right front jack switches are held in the DOWN (retract) position, an input voltage is sent to the PC. The PC sends a 12 V output signal to the auxiliary system's disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

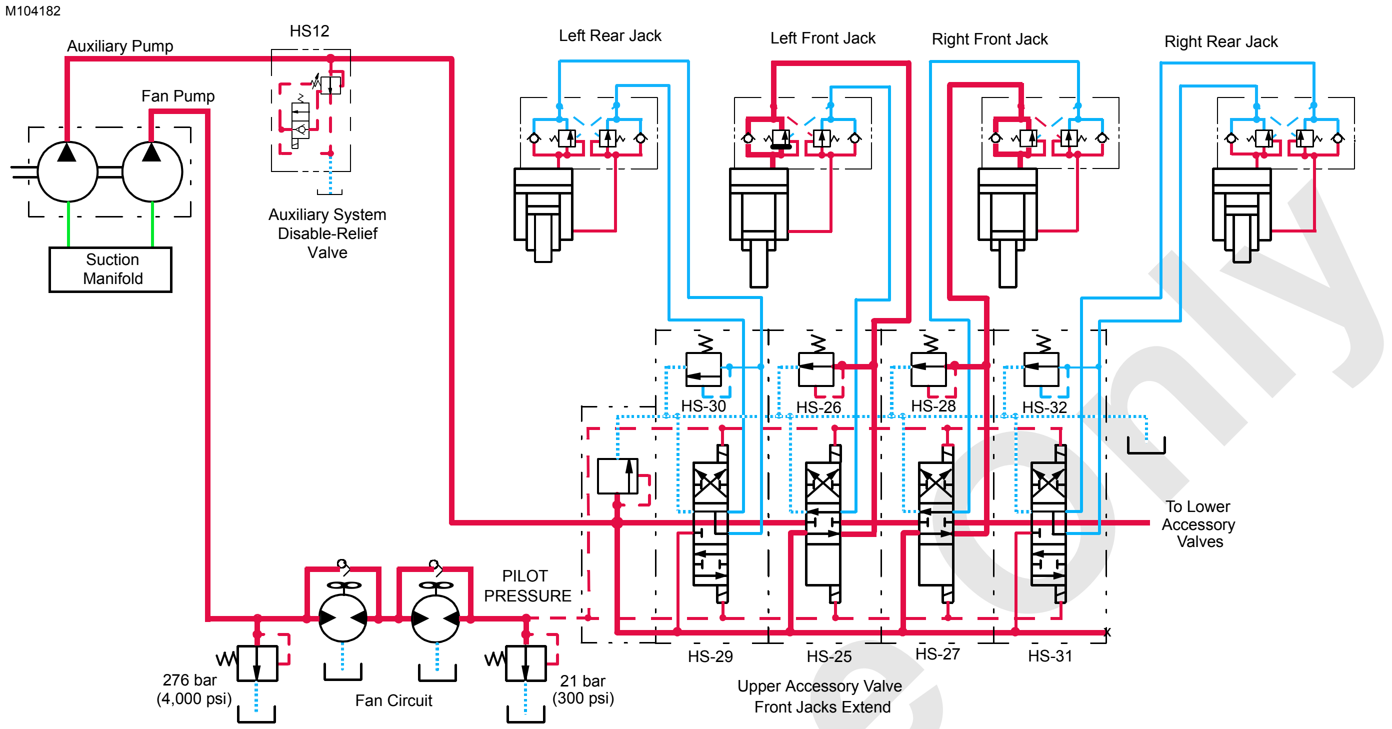
The PC also sends a 12 V output signal to enable the jacking solenoids HS-26 and HS-28 to extend the left and right front jacks. Hydraulic pilot pressure at 24 bar (350 psi) or 21 bar (300 psi) shifts the valve(s) in the selected direction.

Hydraulic fluid from the auxiliary pump flows through the auxiliary system's disable-relief valve HS-12 and enters the accessory valve. Fluid exits the valve sections of the accessory valve and flows through the free-flow check valve sections of the counterbalance valves. Fluid then enters the rod end of the front jacking cylinders, retracting the cylinders to lower the front of the rotating bed.

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

The restraining section of the counterbalance valves opens to control the fluid out of the jacking cylinders while maintaining back pressure on the piston end of the cylinders to prevent the rotating bed from falling or lowering. Hydraulic fluid then flows through the free-flow check valve section of the flow control valve before entering the upper accessory valve and returns to the tank.

When the power button or jacking switch is moved to the OFF position, the PC sends a 0 V output to shift the spool of solenoid valves HS-26 and HS-28 to the center position.


M104182
HS12
Auxiliary Pump
Fan Pump
Suction Manifold
Auxiliary System Disable-Relief Valve
Left Rear Jack
Left Front Jack
Right Front Jack
Right Rear Jack
HS-30
HS-26
HS-28
HS-32
To Lower Accessory Valves
PILOT PRESSURE
276 bar (4,000 psi)
Fan Circuit
21 bar (300 psi)
HS-29
HS-25
HS-27
HS-31
Upper Accessory Valve
Front Jacks Extend

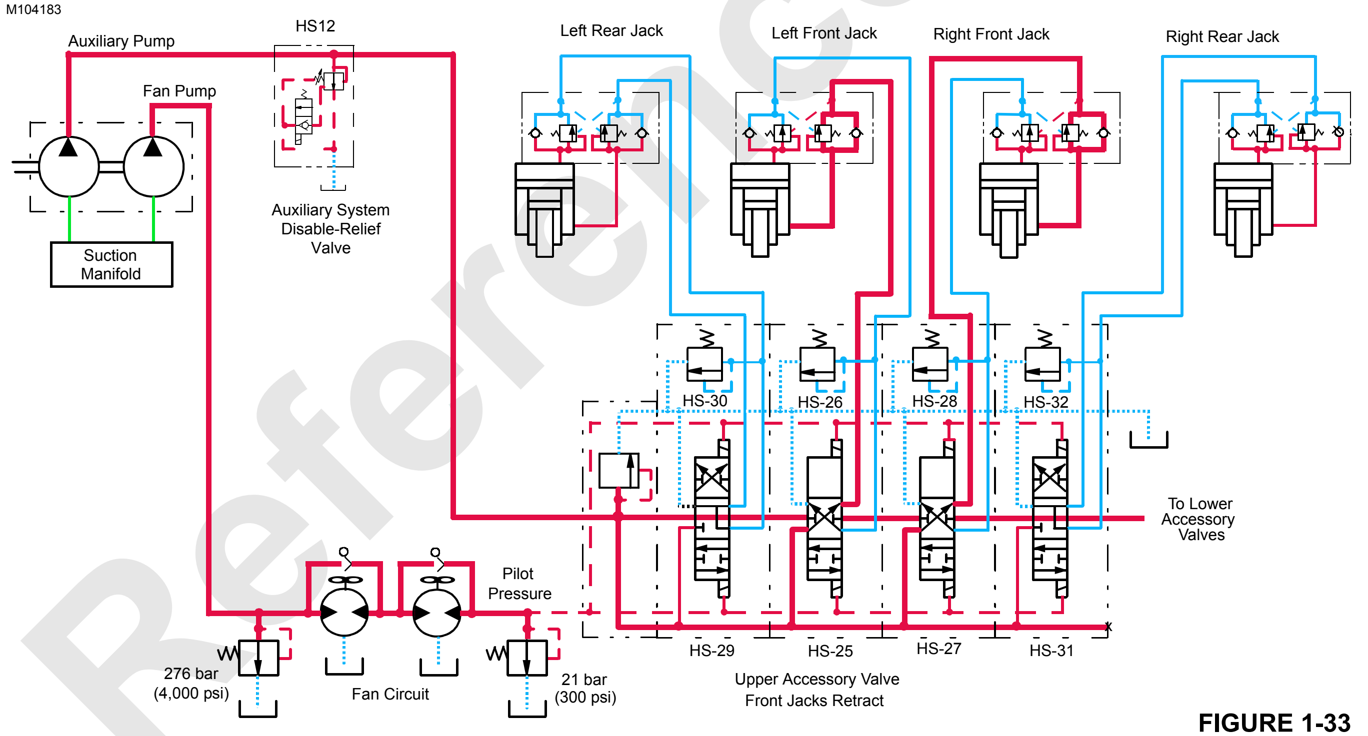

M104183
HS12
Auxiliary Pump
Fan Pump
Suction Manifold
Auxiliary System Disable-Relief Valve
Left Rear Jack
Left Front Jack
Right Front Jack
Right Rear Jack
HS-30
HS-26
HS-28
HS-32
To Lower Accessory Valves
Pilot Pressure
276 bar (4,000 psi)
Fan Circuit
21 bar (300 psi)
HS-29
HS-25
HS-27
HS-31
Upper Accessory Valve
Front Jacks Retract

FIGURE 1-33

Adapter Frame Pin Cylinders

See Figure 1-32 and Figure 1-34 for the following.

The operating description is for the front adapter frame connecting pins. Operation of the rear pins is the same, except different switches are used.

With the engine running, power is available to the jacking remote control when the cable is connected at the auxiliary valve junction box on the right side of the rotating bed.

Adapter Frame Pins Engage

When the power button is pressed and the front adapter frame pin switch is held in the UP (engage) position, an input voltage is sent through a diode to the PC. The PC sends a 12 V output signal to the auxiliary system's disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

The PC also sends a 12 V output signal to enable the front adapter frame pins engage solenoid HS-21. Hydraulic pilot pressure at 24 bar (350 psi) or 21 bar (300 psi) shifts the valve in the selected direction.

Hydraulic fluid exits the valve sections of the upper accessory valve and flows to the front left and right frame connecting pin cylinders piston end, extending the pins to connect the front of the rotating bed with the adapter frame. Fluid from the rod end of the pin cylinders flows back through the upper accessory valve to the tank.

When the power button or front adapter frame pins switch is moved to the OFF position, the PC sends a 0 V output to shift the spool of solenoid valve HS-21 to the center position.

Adapter Frame Pins Disengage

When the power button is pressed and the front adapter frame pin switch is held in the DOWN (disengage) position, an input voltage is sent through a diode to the PC. The PC sends a 12 V output signal to the auxiliary system's disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

The PC also sends a 12 V output signal to enable the front adapter frame pins disengage solenoid HS-22. Hydraulic pilot pressure at 24 bar (350 psi) or 21 bar (300 psi) shifts the valve in the selected direction.

Hydraulic fluid exits the valve sections of the upper accessory valve and flows to the front left and right frame pin cylinders' rod ends, retracting the pins to disconnect the front of the rotating bed with the adapter frame. Fluid from the piston end of the pin cylinders flows back through the upper accessory valve to the tank.

When the power button or front adapter frame pins switch is moved to the OFF position, the PC sends a 0 V output to shift the spool of solenoid valve HS-22 to the center position.

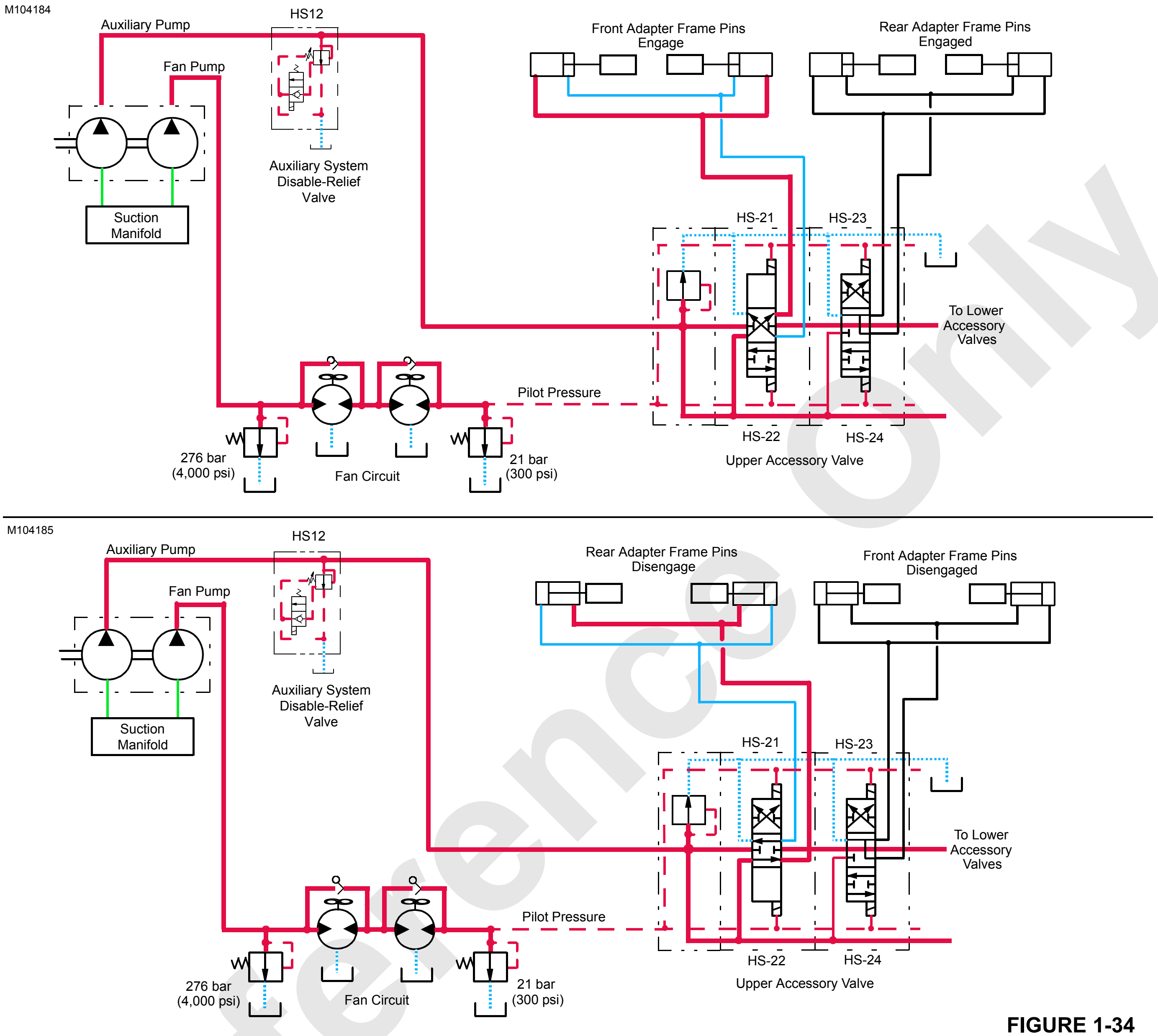

M104184
Auxiliary Pump
HS12
Fan Pump
Auxiliary System
Disable-Relief
Valve
Suction
Manifold
Front Adapter Frame Pins
Engage
Rear Adapter Frame Pins
Engaged
HS-21
HS-23
To Lower
Accessory
Valves
Pilot Pressure
276 bar
(4,000 psi)
Fan Circuit
21 bar
(300 psi)
HS-22
HS-24
Upper Accessory Valve
M104185
Auxiliary Pump
HS12
Fan Pump
Auxiliary System
Disable-Relief
Valve
Suction
Manifold
Rear Adapter Frame Pins
Disengage
Front Adapter Frame Pins
Disengaged
HS-21
HS-23
To Lower
Accessory
Valves
Pilot Pressure
276 bar
(4,000 psi)
Fan Circuit
21 bar
(300 psi)
HS-22
HS-24
Upper Accessory Valve

FIGURE 1-34

Gantry Cylinders

See Figure 1-35 and Figure 1-36 for the following.

The gantry cylinders partially raise and lower the gantry. Boom hoist rigging continues raising or lowering the gantry from or back to this position. See Crane Assembly and Rigging Guide in the Operator Manual for the gantry raising and lowering procedure.

With the engine running, power is available to the jacking remote control when the cable is connected at the auxiliary valve junction box on the right side of the rotating bed.

Gantry Cylinders Extend

When the power button is pressed and the gantry cylinders switch is held in the UP (extend) position, an input voltage is sent to the PC. The PC sends a 12 V output signal to the auxiliary system's disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

The PC also sends a 12 V output signal to enable the gantry cylinders extend solenoid HS-4. Hydraulic pilot pressure at 24 bar (350 psi) or 21 bar (300 psi) shifts the valve in the selected direction. Fluid from the auxiliary pump flows past the auxiliary system's disable-relief valve HS-12 and enters the upper accessory valve.

Hydraulic fluid leaves the upper accessory valve and flows through the free-flow check valve sections of the counterbalance valves, entering the piston end of the gantry cylinders, and extends the cylinders to raise the gantry.

Fluid from the rod end of the cylinders is blocked by the free-flow check valve sections of the counterbalance valves and flows through the flow-restraining section that has a relief setting of 241 bar (3,500 psi). The counterbalance valves serve as a deceleration control, with a 3:1 pilot ratio of the relief pressure. Hydraulic fluid then exits the counterbalance valves and passes through the upper accessory valve before returning to the tank.

If more power is needed to raise the gantry cylinders, engine speed can be increased with the remote engine speed switch in the remote start junction box on the right side of the rotating bed.

When the power button or the gantry cylinder switch is released, fluid to the gantry cylinders is stopped. The free-flow check valve sections trap the fluid in the rod and piston ends of the cylinders to lock the gantry in position.

When the power button or gantry switch is moved to the OFF position, the PC sends a 0 V output to shift the spool of solenoid HS-4 to the center position.

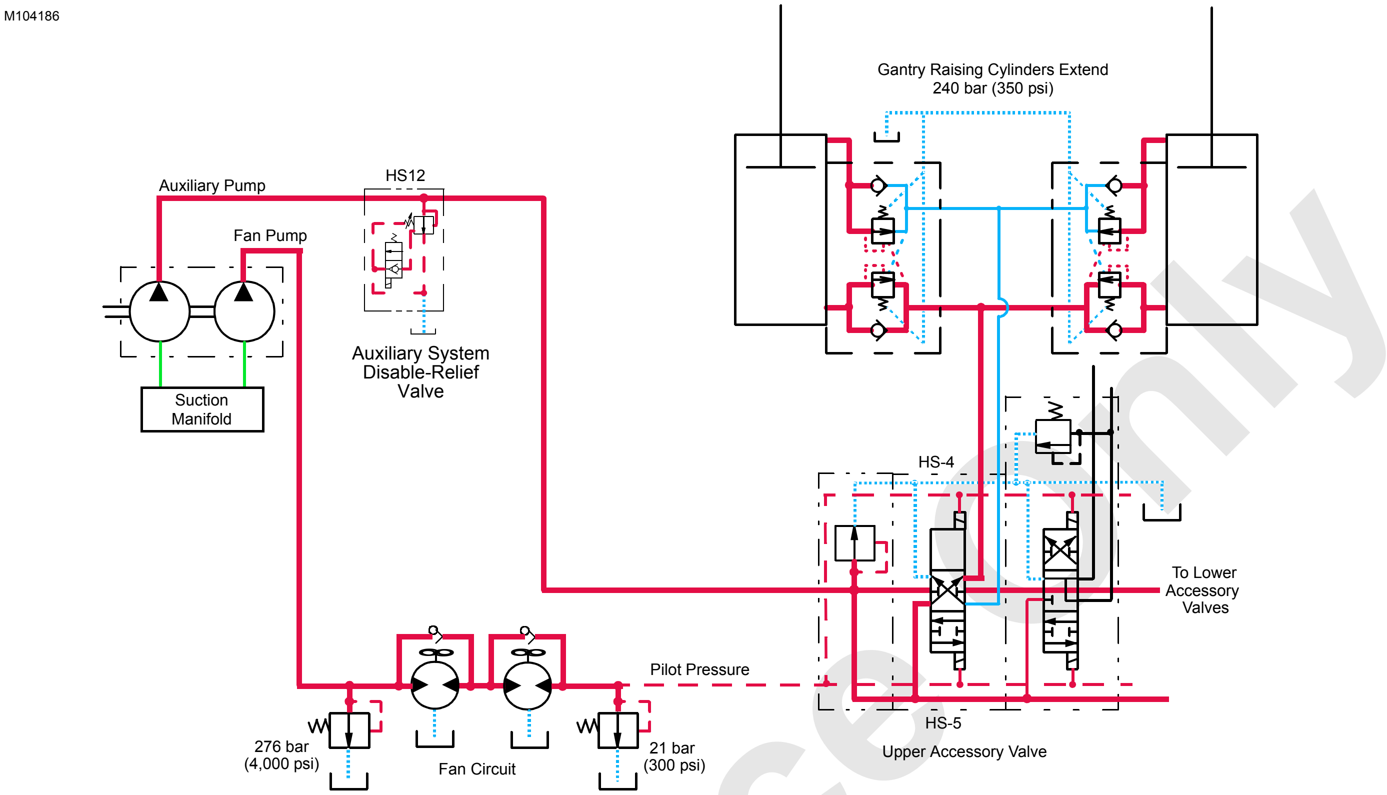
Gantry Cylinders Retract

When the power button is pressed and the gantry cylinders switch is held in the DOWN (retract) position, an input voltage is sent to the PC. The PC sends a 12 V output signal to the auxiliary system's disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

The PC also sends a 12 V output signal to enable the gantry cylinders retract solenoid HS-5. Hydraulic pilot pressure at 24 bar (350 psi) or 21 bar (300 psi) shifts the valve in the selected direction. Fluid from the auxiliary pump flows past the auxiliary system's disable-relief valve HS-12 and enters the upper accessory valve.

The gantry cylinder valve shifts to direct fluid through the free-flow check valve sections to the rod end of the gantry cylinder. The gantry lower weight increases the pressure in the piston end of the cylinders. The exit of the fluid out of the cylinders is blocked by the free-flow check valve sections and flows through the flow-restraining section that has a relief setting of 241 bar (3,500 psi), allowing the valves to open and controlling the flow out of the cylinders. Maintaining a back pressure on the piston end of the cylinders prevents the gantry from falling or lowering faster than the supply of fluid. Hydraulic fluid returns to the tank through the gantry cylinder solenoid valve as the gantry lowers.

When the power button or gantry cylinder switch is released, the PC sends a 0 V output to shift the spool of solenoid valve HS-5 to the center position. Fluid to the gantry cylinders is stopped. Free-flow check valve sections trap the fluid in the rod and piston ends of the cylinders to lock the gantry in position.


M104186
Gantry Raising Cylinders Extend
240 bar (350 psi)
Auxiliary Pump
HS12
Fan Pump
Auxiliary System
Disable-Relief
Valve
Suction
Manifold
HS-4
To Lower
Accessory
Valves
Pilot Pressure
276 bar
(4,000 psi)
Fan Circuit
21 bar
(300 psi)
HS-5
Upper Accessory Valve

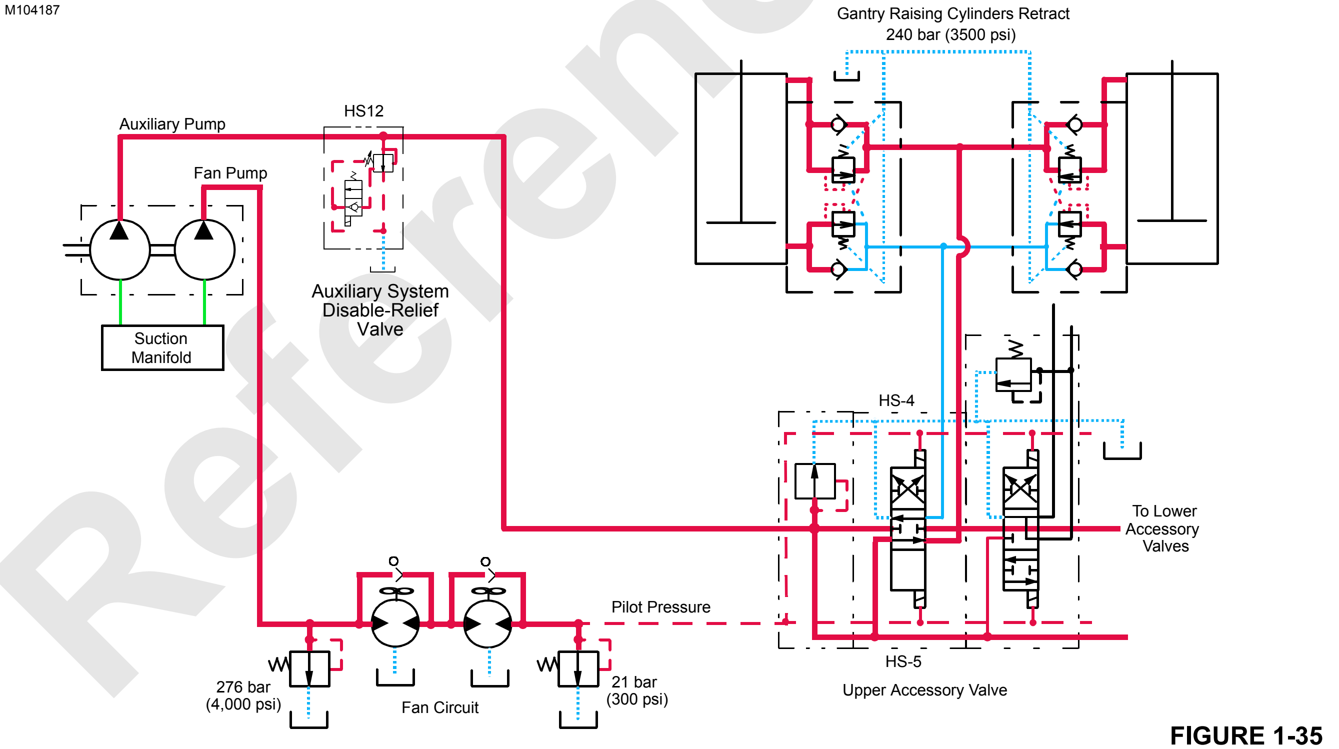

M104187
Gantry Raising Cylinders Retract
240 bar (3500 psi)
Auxiliary Pump
HS12
Fan Pump
Auxiliary System
Disable-Relief
Valve
Suction
Manifold
HS-4
To Lower
Accessory
Valves
Pilot Pressure
276 bar
(4,000 psi)
Fan Circuit
21 bar
(300 psi)
HS-5
Upper Accessory Valve

FIGURE 1-35

Lower Accessory System Components

General

The lower accessory system components include the boom hinge pin cylinders, boom handling cylinders, rigging winch motor, and crawler pin cylinders. During normal operation the lower accessory solenoid valves are “motor spooled,” where both cylinder ports and tank port of the valve spool section are connected in the center position and open to the tank.

The auxiliary pump is the hydraulic pressure source to operate the upper and lower accessory system components. Hydraulic fluid from the auxiliary pump flows through the auxiliary system’s disable-relief valve HS-12. Hydraulic fluid enters the upper accessory valve and flows through the variable output control valve HS-20 and hydraulic quick disconnect to the lower accessory valve.

The auxiliary system’s disable-relief valve HS-12 is controlled by the PC. During normal operation the relief valve is open and excess fluid from the auxiliary pump is dumped through the valve to the tank. When a component of either accessory system is enabled, an input signal is sent to the programmable controller (PC). The PC sends a 12 V output signal to the auxiliary system’s disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

When a lower accessory system switch is enabled, the PC sends a variable 0 to 12 V output signal to the variable output control valve HS-20. The variable-control valve output is adjustable from 0 to 57 L/min (0 to15 gpm) with the speed control rotary switch on the setup remote control.

Boom Hinge Pins

See Figure 1-36 and Figure 1-37 for the following.

Boom hinge pins cannot be disengaged until the cylinder lock cover on the front of the rotating bed is open.

With the engine running, power is available to the setup remote control when the cable is connected at the air valve junction box on the left side of the rotating bed.

Boom Hinge Pins Engage

When the power button is pressed and the boom hinge pins switch is held in the DOWN (engage) position, an input signal is sent to the PC. The PC sends a 12 V output signal to the auxiliary system’s disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

The boom hinge pins engage solenoid HS-10 and are enabled by the PC to shift the solenoid valve in the engage position. Hydraulic fluid enters the upper accessory valve and flows through the variable output control valve HS-20 and hydraulic quick disconnect assembly to the lower accessory valve.

Hydraulic fluid exits the valve assembly and flows to the piston end of the hinge pin cylinders, engaging the pins to connect the boom to the adapter frame. Fluid from the rod end of the cylinders flows through the valve assembly through the hydraulic quick disconnect and to the tank.

When the power button or boom hinge pins switch is released, the PC sends a 0 V output to shift the spool of solenoid HS-10 to the center position.

Boom Hinge Pins Disengage

When the power button is pressed and the boom hinge pins switch is held in the UP (disengage) position, an input signal is sent to the PC. The PC sends a 12 V output signal to the auxiliary system’s disable-relief valve HS-12 that adjusts the system pressure to 241 bar (3,500 psi).

The boom hinge pins engage solenoid HS-11 and are enabled by the PC to shift the boom hinge pin solenoid valve in the disengage position. Hydraulic fluid enters the upper accessory valve and flows through the variable output control valve HS-20 and hydraulic quick disconnect assembly to the lower accessory valve.

Hydraulic fluid exits the valve assembly and flows to the rod end of the hinge pin cylinders, disengaging the pins from the boom and adapter frame. Fluid from the piston end of the cylinders flows through the valve assembly through the hydraulic quick disconnect and to the tank.

When the power button or boom hinge pins switch is released, the PC sends a 0 V output to shift the spool of solenoid HS-10 to the center position.

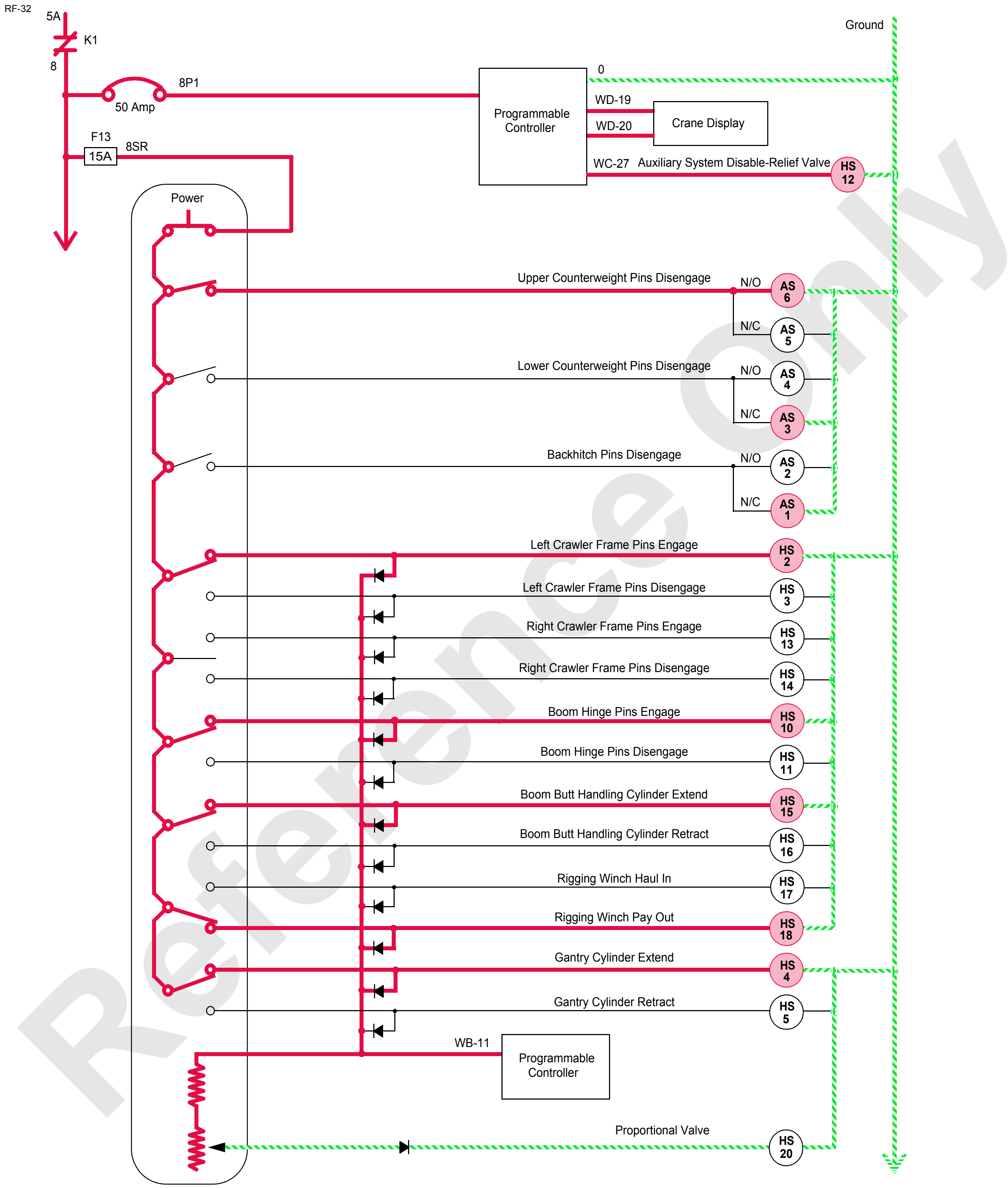

RF-32
5A
K1
8
50 Amp
8P1
F13
15A
8SR
Power
0
Ground
Programmable Controller
WD-19
WD-20
Crane Display
WC-27 Auxiliary System Disable-Relief Valve
HS 12
Upper Counterweight Pins Disengage
N/O
AS 6
N/C
AS 5
Lower Counterweight Pins Disengage
N/O
AS 4
N/C
AS 3
Backhitch Pins Disengage
N/O
AS 2
N/C
AS 1
Left Crawler Frame Pins Engage
HS 2
Left Crawler Frame Pins Disengage
HS 3
Right Crawler Frame Pins Engage
HS 13
Right Crawler Frame Pins Disengage
HS 14
Boom Hinge Pins Engage
HS 10
Boom Hinge Pins Disengage
HS 11
Boom Butt Handling Cylinder Extend
HS 15
Boom Butt Handling Cylinder Retract
HS 16
Rigging Winch Haul In
HS 17
Rigging Winch Pay Out
HS 18
Gantry Cylinder Extend
HS 4
Gantry Cylinder Retract
HS 5
WB-11
Programmable Controller
Proportional Valve
HS 20

FIGURE 1-36

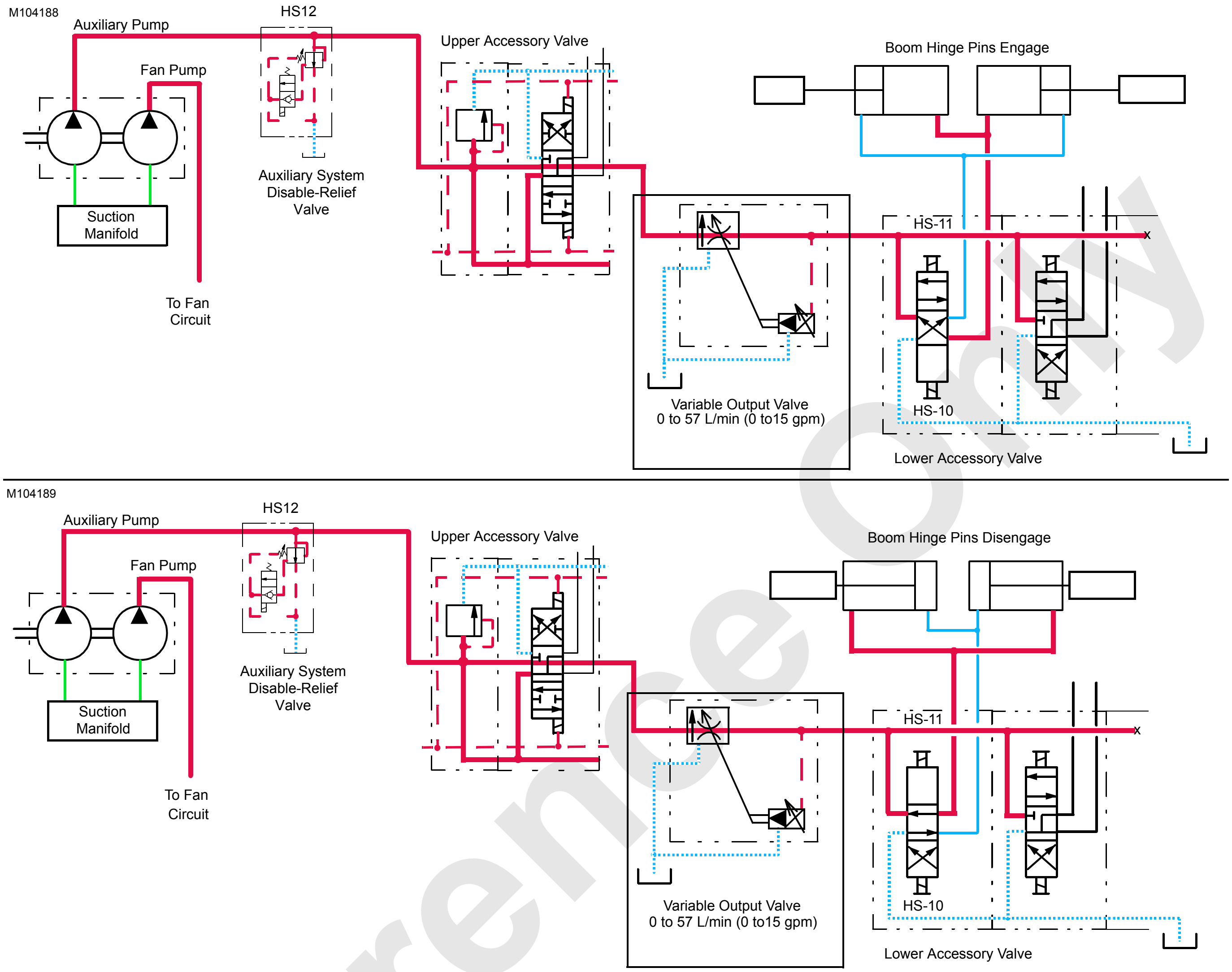


FIGURE 1-37

Boom Butt Handling Cylinder

See Figure 1-36 and Figure 1-38 for the following.

With the engine running, power is available to the setup remote control when the cable is connected at the air valve junction box on the left side of the rotating bed.

Boom Butt Handling Cylinder Extend

When the power button is pressed and the boom butt cylinder switch is held in the UP (extend) position, an input signal is sent to the PC. The PC sends a 12 V output signal to the auxiliary system's disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

The boom butt handling cylinder extend solenoid HS-15 is enabled by the PC to shift the solenoid valve in the extend position. Hydraulic fluid enters the upper accessory valve and flows through the variable output control valve HS-20 and hydraulic quick disconnect to the lower accessory valve.

Hydraulic fluid exits the valve assembly and flows through the free-flow check valve section of the counterbalance valve. Hydraulic fluid then enters the piston end of the boom butt handling cylinder, extending the cylinder to raise the boom butt.

Fluid from the rod end of the cylinder is blocked by the opposite side free-flow check valve section of the counterbalance valve and flows through the flow-restraining section with a relief setting of 207 bar (3,000 psi). The counterbalance valve acts as a deceleration control with a 3:1 pilot ratio. Hydraulic fluid flows through the boom butt handling cylinder valve to the tank through the hydraulic quick disconnect.

When the power button or boom butt cylinder switch is released, the PC sends a 0 V output to shift the spool of solenoid HS-15 to the center position.

Boom Butt Handling Cylinder Retract

When the power button is pressed and the boom butt cylinder switch is held in the DOWN (retract) position, an input signal is sent to the PC. The PC sends a 12 V output signal to the auxiliary system's disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

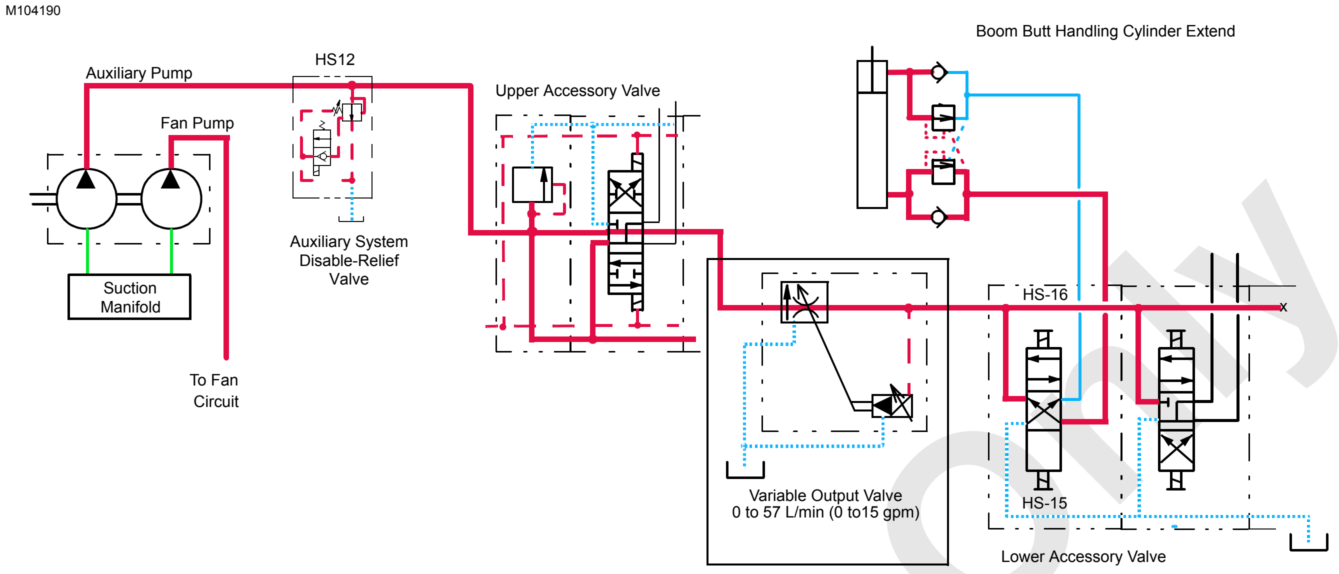
The boom butt handling cylinder retract solenoid HS-16 is enabled by the PC to shift the solenoid valve in the retract position. Hydraulic fluid enters the upper accessory valve and flows through the variable output control valve HS-20 and the hydraulic quick disconnect assembly to the lower accessory valve.

Hydraulic fluid exits the valve assembly and flows through the free-flow check valve section of the counterbalance valve. Hydraulic fluid then enters the rod end of the boom butt handling cylinder, retracting the cylinder to lower the boom butt.

Fluid from the piston end of the cylinder is blocked by the opposite side free-flow check valve section of the counterbalance valve and flows through the flow-restraining section with a relief setting of 207 bar (3,000 psi).

The counterbalance valve acts as a deceleration control with a 3:1 pilot ratio. Hydraulic fluid flows through the boom butt handling cylinder valve to the tank through the hydraulic quick disconnect.

When the power button or boom butt cylinder switch is released, the PC sends a 0 V output to shift the spool of solenoid HS-16 to the center position.



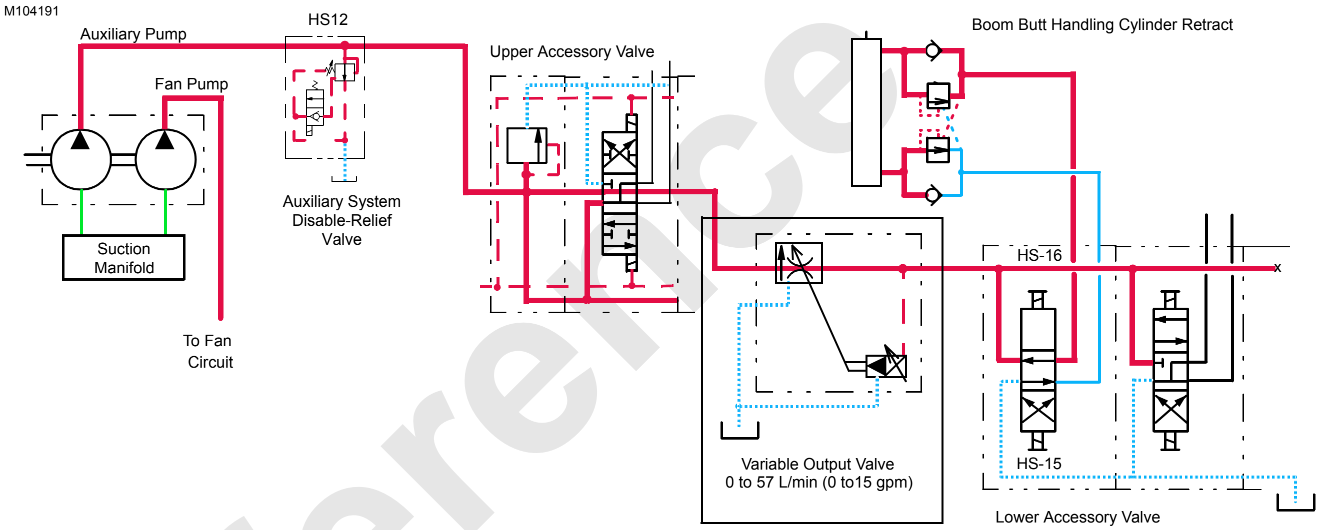


FIGURE 1-38

Rigging Winch

See Figure 1-36 and Figure 1-39 for the following.

The optional rigging winch is located in the boom butt.

With the engine running, power is available to the setup remote control when the cable is connected at the air valve junction box on the left side of the rotating bed.

Rigging Winch Pay Out

When the power button is pressed and the rigging winch switch is held in the UP (pay out) position, an input signal is sent to the PC. The PC sends a 12 V output signal to the auxiliary system's disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

Hydraulic fluid enters the upper accessory valve and flows through the variable output control valve HS-20 and hydraulic quick disconnect to the lower accessory valve.

The rigging winch payout solenoid valve HS-18 is enabled by the PC to shift the valve in the selected position. Hydraulic fluid leaves the accessory valve and enters the payout side of the winch motor to turn the drum to pay out wire rope at a fixed speed. Return hydraulic fluid from the motor leaves the accessory system valve and returns to the tank.

When the power button or rigging winch switch is released, the PC sends a 0 V output to shift the spool of solenoid HS-18 to the center position.

Rigging Winch Haul In

When the power button is pressed and rigging winch switch is held in the DOWN (haul in) position, an input signal is sent to the PC. The PC sends a 12 V output signal to the auxiliary system's disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

Hydraulic fluid enters the upper accessory valve and flows through the variable output control valve HS-20 and hydraulic quick disconnect to the lower accessory valve.

The rigging winch haul in solenoid valve HS-17 is enabled by the PC to shift the valve in the selected position. Hydraulic fluid leaves the accessory valve and enters the haul in side of the winch motor to turn the drum to haul in wire rope at a fixed speed. Return hydraulic fluid from the motor leaves the accessory system valve and returns to the tank.

When the power button or rigging winch switch is released, the PC sends a 0 V output to shift the spool of solenoid HS-17 to the center position.

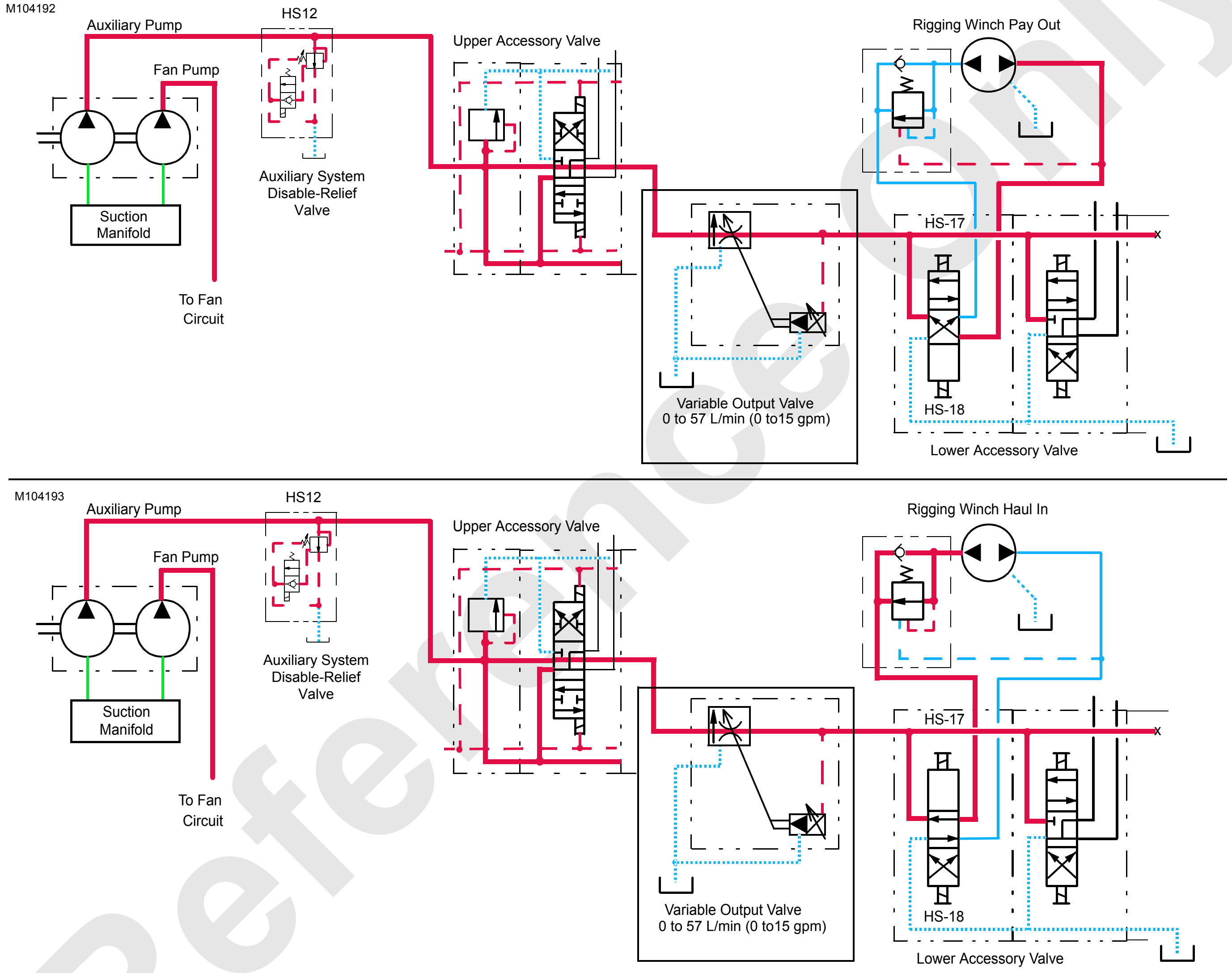


FIGURE 1-39

Crawler Frame Pins

See Figure 1-36 and Figure 1-40 for the following.

The following description is for engaging/disengaging the left crawler frame pins. Operation of the right crawler frame pins is the same as the left crawler frame pins.

With the engine running, power is available to the setup remote control when the cable is connected at the air valve junction box on the left side of the rotating bed.

Crawler Frame Pins Engage

When the power button is pressed and the left crawler frame pins switch is held in the DOWN (engage) position, an input signal is sent to the PC. The PC sends a 12 V output signal to the auxiliary system's disable-relief valve HS-12 that adjusts system pressure to 276 bar (4,000 psi).

The left crawler frame pins solenoid HS-2 is enabled by the PC to shift the solenoid valve in the engage position. Hydraulic fluid enters the upper accessory valve and flows through the variable output control valve HS-20 and hydraulic quick disconnect to the lower accessory valve.

Hydraulic fluid exits the valve assembly and flows to the piston end of the left crawler frame pin cylinders, engaging the cylinders, to connect the left crawler frame with the crawler frame. Fluid from the rod end of the cylinders flows back through the valve assembly through the hydraulic quick disconnect and to the tank.

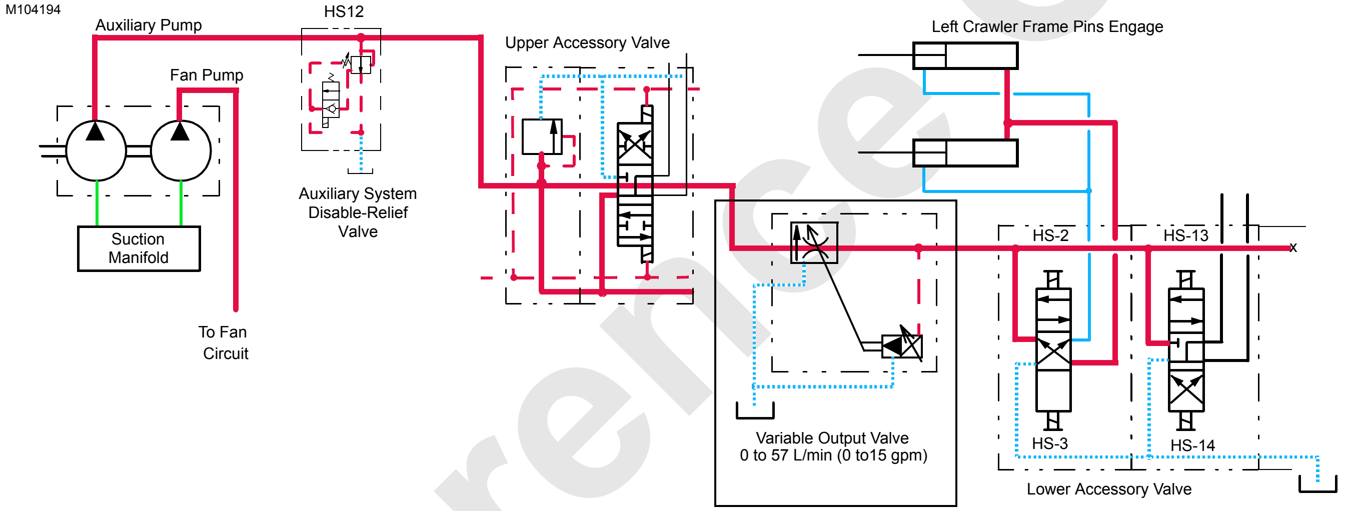
When the power button or left crawler frame pins switch is released, the PC sends a 0 V output to shift the spool of solenoid HS-2 to the center position.

Crawler Frame Pins Disengage

When the power button is pressed and the left crawler frame pins switch is held in the UP (disengage) position, an input signal is sent to the PC. The PC sends a 12 V output signal to the auxiliary system's disable-relief valve HS-12 that adjusts the system pressure to 276 bar (4,000 psi).

The left crawler frame pins solenoid HS-3 is enabled by the PC to shift the solenoid valve in the disengage position. Hydraulic fluid exits the valve assembly and flows to the rod end of the left crawler frame pin cylinders, disengaging the pins from the crawler frame. Fluid from the piston end of the cylinders flows through the valve assembly through the hydraulic quick disconnect and to the tank.

When the power button or left crawler frame pins switch is released, the PC sends a 0 V output to shift the spool of solenoid HS-3 to the center position.



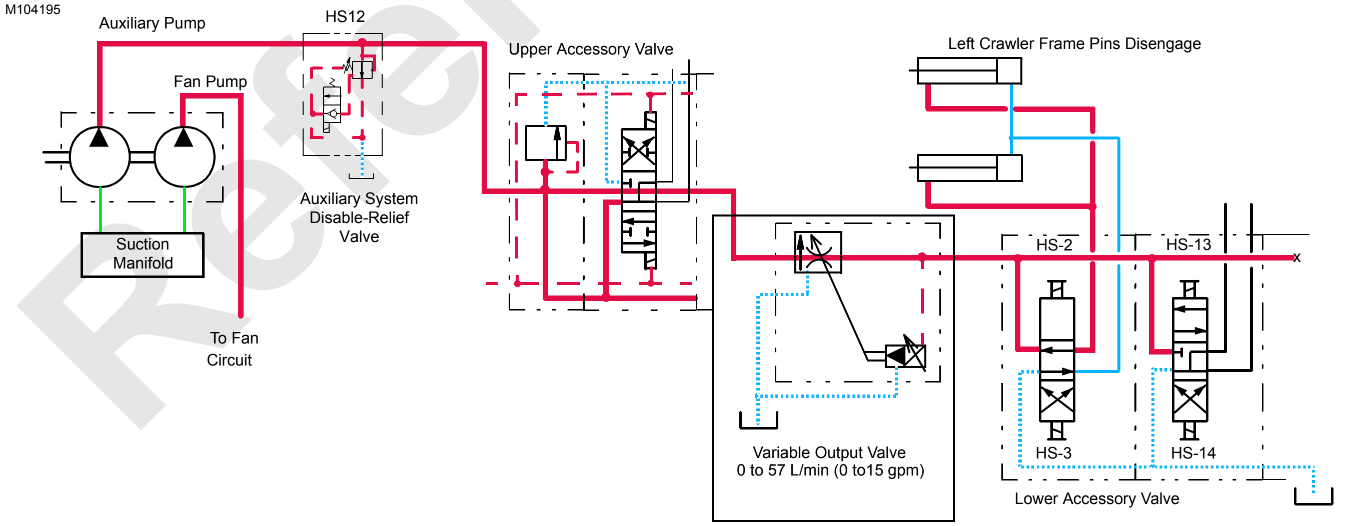


FIGURE 1-40

Air System Components

Counterweight/Backhitch Pins

See Figure 1-36 and Figure 1-41 for the following.

With the engine running, power is available to the setup remote control when the cable is connected at the air valve junction box on the left side of the rotating bed.

Counterweight/Backhitch Pins Extend

When the power button is pressed, power is enabled to operate the counterweight upper pins switch, counterweight lower pins switch, or backhitch pins switch.

Each pin switch is spring-returned to the (extend) position. In this position, the counterweight upper pins extend normally closed solenoid AS-5, the counterweight lower pins extend normally closed solenoid AS-3, or the backhitch pins extend normally closed solenoid AS-1 are enabled. Air flows through the normally closed solenoid to the piston end of the pin cylinders. The cylinders move the pins into engagement while air from the rod end of the cylinders exhausts to the atmosphere.

Counterweight/Backhitch Pins Retract

When the power button is pressed and the counterweight upper pins switch is held in the UP (retract) position, an input signal is sent to the programmable controller (PC). The PC sends a 0 V output signal to disable the counterweight upper pins normally closed solenoid AS-5 and a 12 V output signal to enable the counterweight upper pins normally open solenoid AS-6. Air then flows through the normally open solenoid to the rod end of the counterweight upper pin cylinders. The cylinders then retract to move the pins out of engagement while air from the piston end of the cylinders exhausts to the atmosphere.

When the power button or selected pin switch is released, the PC sends a 0 V output signal to disable the counterweight upper pins normally open solenoid AS-6 and a 12 V output signal to enable the counterweight upper pins normally closed solenoid AS-5.

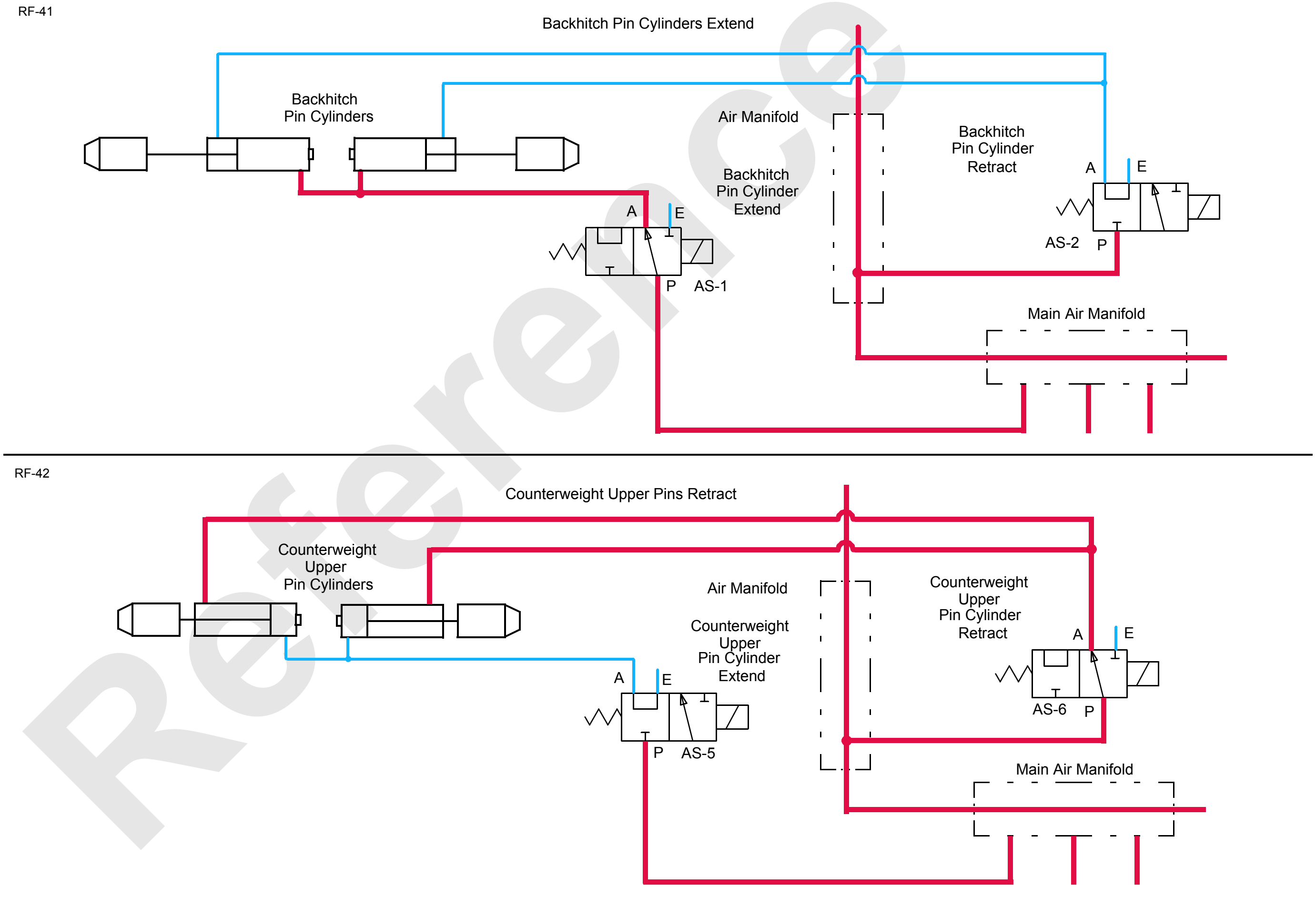


FIGURE 1-41

Hydraulic Quick Disconnect

General

A self-contained hydraulic system makes the mechanical connections between the adapter frame and the rotating bed hydraulic lines during assembly/disassembly.

When the cab power switch is ON and the engine fluid pressure switch is closed (engine not running), power is available to the hydraulic quick disconnect switch at the remote start junction box on the right side of the rotating bed. The hydraulic quick disconnect is operational after the following connections are made.

1. Connect the boom stop electrical cable from the rotating bed to the junction box plug and couplers on the right side of the adapter frame.
2. Connect the luffing jib pawl air lines from the rotating bed to the junction box plug and couplers on the right side of the adapter frame.

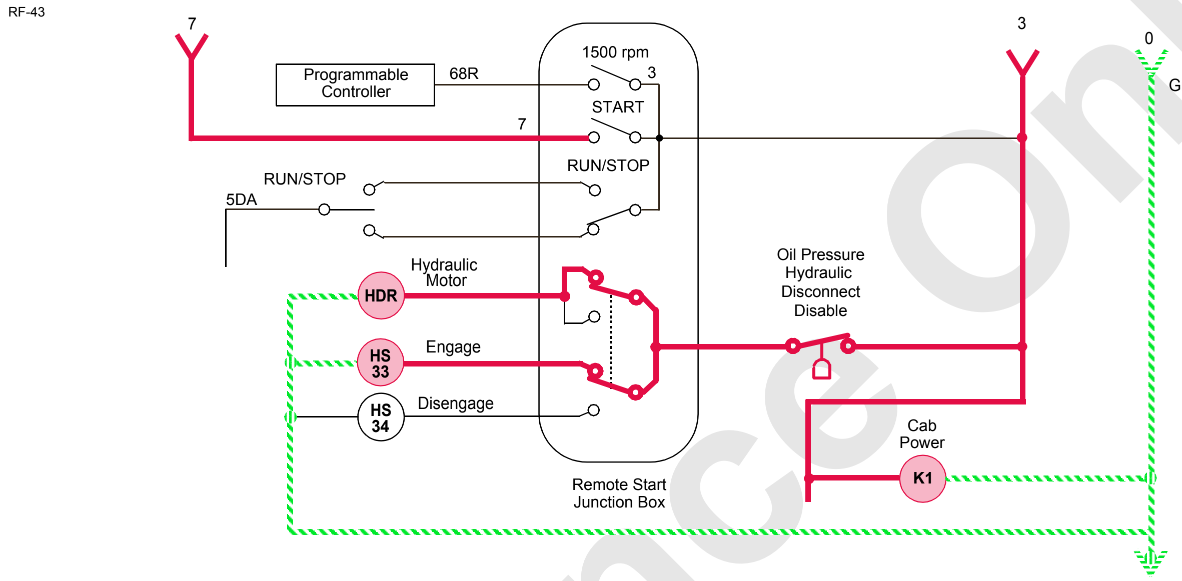


FIGURE 1-42

Hydraulic Quick Disconnect Engage

When the hydraulic quick disconnect switch is moved to the engage position, an output signal is sent to engage the hydraulic solenoid HS-33 and hydraulic disconnect relay (HDR). The relay sends an output signal to enable the hydraulic quick disconnect motor in the engage direction.

When the hydraulic solenoid HS-33 is enabled, the fluid from the motor flows past the relief valve that limits system pressure to 21 bar (300 psi), through the solenoid valve to the piston end of the frame cylinder.

The frame cylinder extends the rotating beds coupling plate and sleeve plates together toward the adapter frame coupling plate. The hydraulic quick disconnect closes as the fluid from the rod end returns to the tank through the sequence valve and then through solenoid HS-33.

Fluid also flows to the piston end of each coupling cylinder. Fluid from each coupling cylinder rod end flows back to the tank through solenoid HS-33. Coupling cylinders extend to close the quick disconnect, completing hydraulic line coupling between the rotating bed and the adapter frame.

Hydraulic Quick Disconnect Disengage

When the hydraulic quick disconnect switch is moved to the disengage position, an output signal is sent to disengage the hydraulic solenoid HS-34 and the hydraulic disconnect relay (HDR). The relay sends an output signal to enable the hydraulic quick disconnect motor in the disengage direction.

When the hydraulic solenoid HS-34 is enabled, the fluid from the motor flows past the relief valve that limits system pressure to 21 bar (300 psi).

Fluid from the solenoid valve flows to the rod end of the side of each coupling cylinder and through the sequence valve to the rod end of the main cylinder. A check valve blocks flow to the main cylinder. Then the coupling cylinders retract the sleeve plate first to unlock the couplings. Then at 14 bar (200 psi), the sequence valve opens to allow flow to the frame cylinder. The frame cylinder retracts, separating the rotating beds coupling plate from the adapter frames coupling plate.

Hydraulic quick disconnect opens, separating the coupling of hydraulic lines between the rotating bed and the adapter frame as the fluid from the piston end of the cylinders returns to the tank through solenoid HS-34.

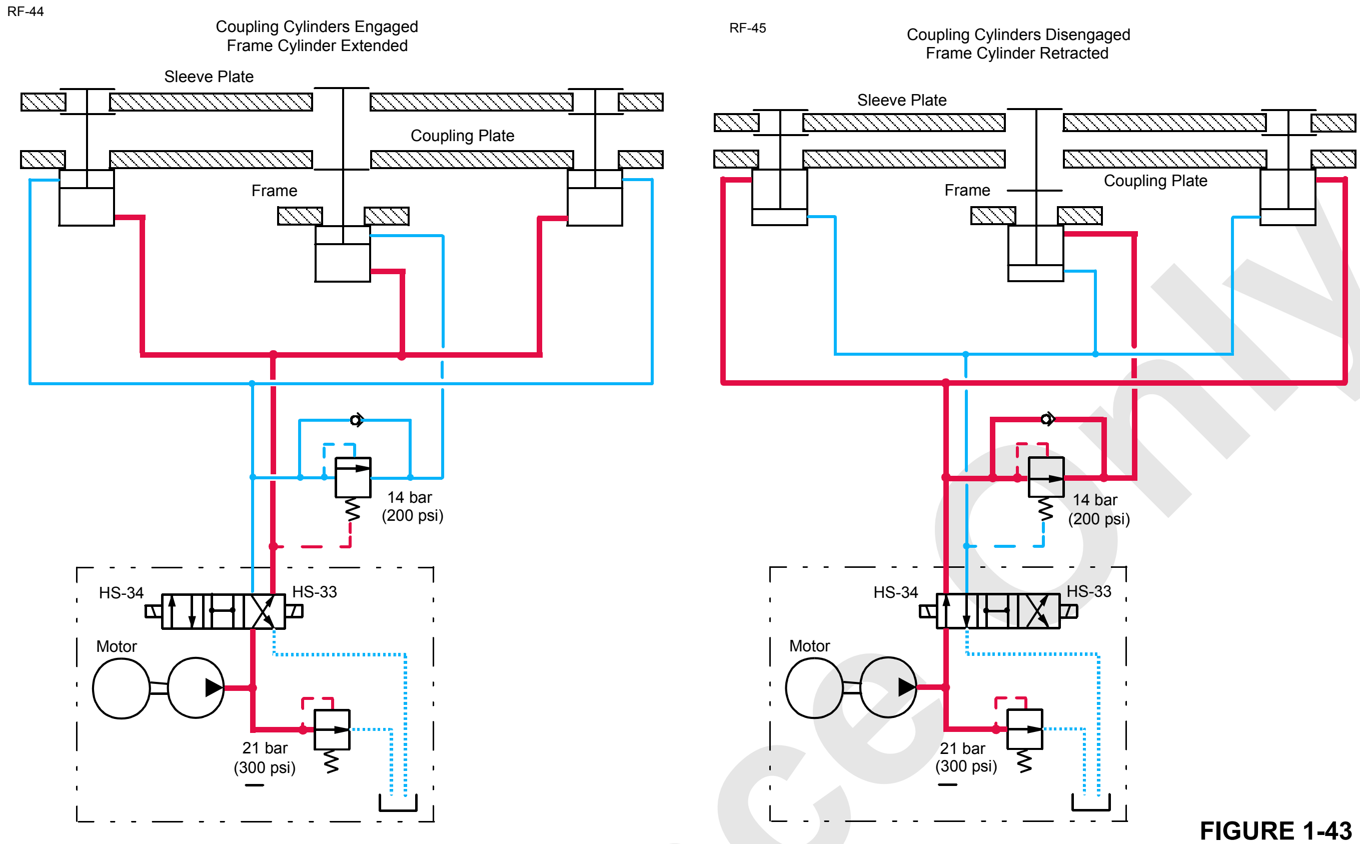

RF-44
Coupling Cylinders Engaged
Frame Cylinder Extended
Sleeve Plate
Coupling Plate
Frame
14 bar
(200 psi)
HS-34
HS-33
Motor
21 bar
(300 psi)
RF-45
Coupling Cylinders Disengaged
Frame Cylinder Retracted
Sleeve Plate
Frame
Coupling Plate
14 bar
(200 psi)
HS-34
HS-33
Motor
21 bar
(300 psi)

FIGURE 1-43

MAX-ER® 2000 DESCRIPTION OF OPERATION

MAX-ER Components

The line legend for all schematic is shown in Figure 1-44.

The MAX-ER 2000 combines a model 2250 crane with mast and boom-butt-mounted load drum with a wheeled counterweight assembly. The luffing jib attachment is also usually part of most MAX-ER 2000s. See Section 3 of MAX-ER 2000 Operator Manual for MAX-ER attachment operation instructions or luffing jib attachment operation instructions.

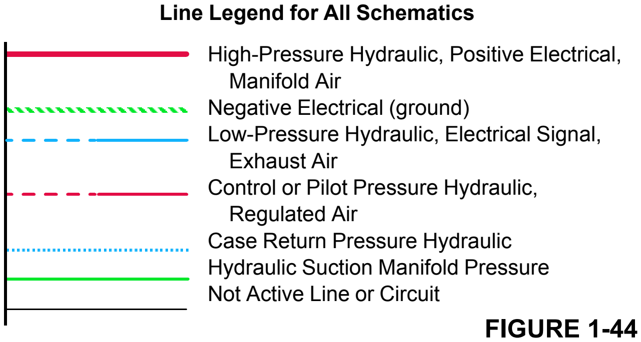


FIGURE 1-44

The MAX-ER 2000 wheeled counterweight assembly consists of the following components (see Figure 1-45):

- Wheeled Counterweight Assembly—This is suspended from the mast by straps and hydraulic cylinders. An arm connects the wheeled counterweight trailer to the rear of the crane. The trailer wheels can be turned to permit the crane to travel or swing when the trailer wheels are on the ground.
- Counterweight Straps and Cylinders—These suspend the wheeled counterweight assembly from the mast. The strap cylinders automatically raise and lower the counterweight in response to changes in the load (weight of lifted load and boom angle).
- Load-Sensing Pin—Located in the gantry left side backhitch, measures load tension created by the lifted load. The load-sensing pin sends a proportional 0.8 to 8.0 V signal to the crane's PC. The crane's PC enables the electrical and hydraulic systems to automatically extend and retract the counterweight strap cylinders to raise and lower the wheeled counterweight assembly in response to changes in the backhitch tension.
- Crane Programmable Controller (PC)—This controls the crane and MAX-ER systems.
- MAX-ER Programmable Controller (PC)—This operates the attachment's electrical and hydraulic systems to automatically raise and lower the wheeled counterweight assembly in response to electronic signals from the load-sensing pin, pressure senders, and cylinder limit switch.
- Strap Cylinder Limit Switch—This limits how high the wheeled counterweight assembly is raised.

MAX-ER Hydraulic Attachments

See Hydraulic and Air Systems Section 2 for the Hydraulic Schematic.

Hydraulic attachments include the wheeled counterweight trailer cylinders, mast stop cylinders, jib strut cylinders, and load drum 9 in the boom butt. Hydraulic fluid used to operate the attachments is from the auxiliary pump on the crane. In MAX-ER mode, hydraulic fluid used to operate the drum 9 system is from the travel system pumps, boom hoist charge pump, and fan auxiliary pump.

A hydraulic system that is open means fluid can flow in the circuit. Each hydraulic solenoid valve is assigned an HS number. The HS number identifies each hydraulic solenoid valve.

Table 1-4. Hydraulic Solenoid (HS) Valves

HS-40	Strap Cylinders Lower (extend)
HS-41	Strap Cylinders Raise (retract)
HS-42	Swing/Crab—Steering Cylinder Extend
HS-43	Straight—Steering Cylinder Retract
HS-44	Left Jack Extend
HS-45	Left Jack Retract
HS-46	Right Jack Extend
HS-47	Right Jack Retract
HS-48	Center Jack Extend
HS-49	Center Jack Retract
HS-50	Tongue Cylinder Extend
HS-51	Tongue Cylinder Retract
HS-52	Steering Pins Engage
HS-53	Steering Pins Disengage
HS-54	Crawler Travel/Drum 9 Diverting
HS-55	Boom Hoist/Drum 9 Diverting
HS-56	Drum 9 Brake

Auxiliary Pump

The main crane's hydraulic tank supplies hydraulic fluid for all attachments. The auxiliary pump draws fluid from the crane's hydraulic tank through a suction manifold. The auxiliary pump supplies pressurized hydraulic fluid between 152 bar (2,200 psi) and 200 bar (2,900 psi) to the mast accumulator system, MAX-ER accessory valve, and crane's accessory valve. The auxiliary pump's pressure is monitored and controlled by the mast accumulator pressure sender.

MAX-ER Accessory Valve

See Figure 1-45 for the following.

The MAX-ER's accessory valve manifold is mounted on the wheeled counterweight trailer. A relief valve limits the MAX-ER's accessory valve pressure to 207 bar (3,000 psi).

The auxiliary system's disable valve is set at 276 bar (4,000 psi) and protects the MAX-ER systems from excessive pressure by opening to the tank when the accessory items are disabled.

The MAX-ER's accessory valve manifold contains eight four-way, three-position spool valve sections. Six of these sections are open-centered and motor-spooled, and two sections are closed-centered. Each spool section is electrically enabled (12 V) with switches and/or the PC. Each valve is actuated by an internal 14 bar (200 psi) pilot supply, filtered with a 40-micron filter. The system pressure of each valve section is controlled independently by a relief valve, preset to 207 bar (3,000 psi), in the inlet section permitting more than one valve section to operate at the same time and at different operating pressures. When the operating pressure of a valve section is 207 bar (3,000 psi), the sequence valve closes the inlet port to pump flow. System pressure is limited by a pressure-relief valve in the inlet section through the section's shuttle valve. Both cylinder ports on each valve section have flow limiter valves that are preset for a predetermined flow rate.

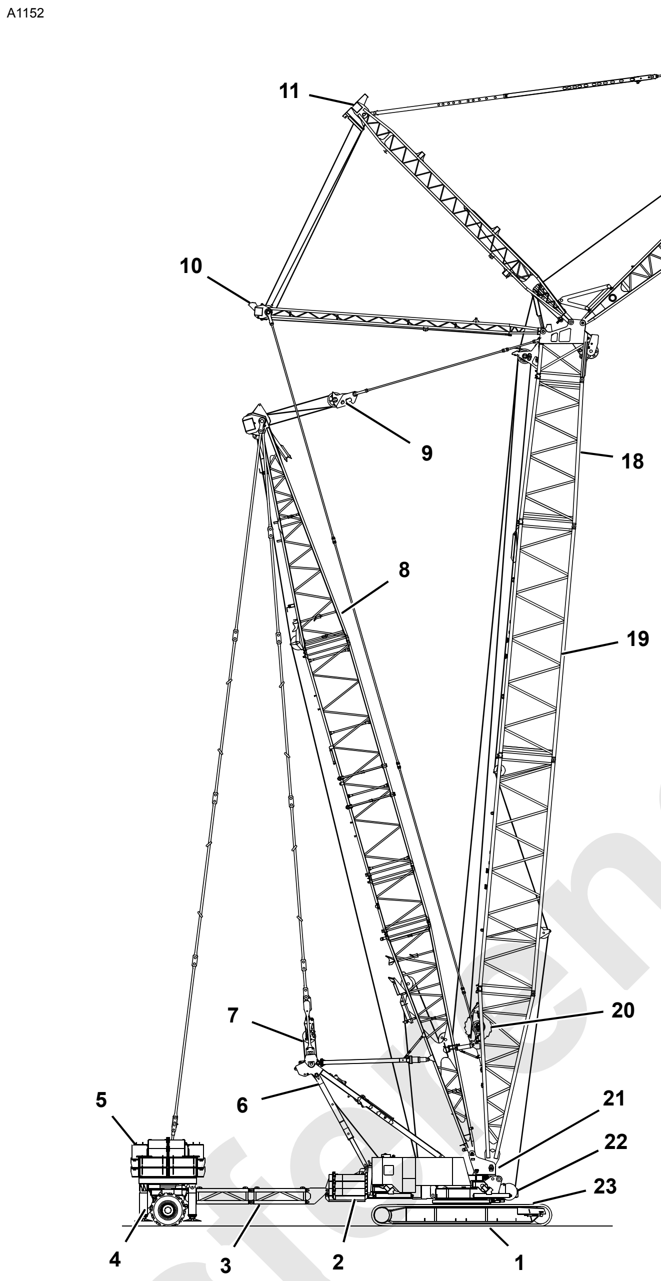
MAX-ER Pressurized Air Supply

Pressurized air from the crane's engine compressor provides air to operate the mast backhitch pin cylinders, drum 2 pawl, mast stop-raising cylinders, and boom stop-cushion cylinders.

Each air solenoid valve is assigned an AS number. The AS number identifies each air solenoid valve.

Table 1-5. Air Solenoid (AS) Valves

AS-1	Mast Backhitch Pins Cylinder Extend (N/C)
AS-2	Mast Backhitch Pins Cylinder Retract (N/O)
AS-21	Drum 9 Pawl In
AS-22	Drum 9 Pawl Out



Item	Description
1	2250 Crawler Crane
2	Crane Counterweight
3	Extender Frame
4	Wheeled Counterweight
5	MAX-ER Counterweight
6	Gantry
7	Mast Hoist Equalizer
8	#44 Mast
9	Boom Hoist Equalizer
10	Main Strut
11	Jib Strut
12	Wire Rope Guide
13	Upper Jib Point
14	Lower Jib Point
15	Weight Ball
16	Load Block
17	Luffing Jib
18	Insert
19	# 79 Boom
20	Load Drum (drum 9)
21	Boom and Mast Adapter Frame
22	Luffing Jib Hoist (drum 5)
23	Carbody Counterweight (both ends)

FIGURE 1-45

EPIC® Programmable Controller

See Figure 1-46 for the following.

The MAX-ER's solenoid valves, cylinders, and motors are monitored and controlled with electronic components of the electronically-processed independent controls (EPIC) system. The crane's programmable controller (PC) and MAX-ER PC are interfaced with serial wire RX3 (36) and TX3 (37). The abbreviation (PC) assumes MAX-ER programmable controller unless noted otherwise.

The PC receives and sends both analog and digital input/output signals. Analog input/output signals are AC or DC voltages or currents that are modulating. Digital input/output voltages are 12 V nominal voltages that are either 0 = OFF or 1 = ON.

The PC uses the binary system. The binary system is based on binary multiples of two and only recognizes 0 = OFF or 1 = ON. Basic counts of this system are exponents of the number two. These exponents are formed in words, called bytes, of eight numbers each. The eight numbers are 1, 2, 4, 8, 16, 32, 64, and 128 for an 8-bit controller or a combination of up to 255 bytes. These bytes represent electrical inputs/outputs to the controller. The controller processes this information by comparing it to the programming requirements and data information. The PC then provides appropriate output commands to the control devices.

Operating controls or control handles send input voltage command signals to the MAX-ER's or the crane's PC. The PC compares these input voltages with feedback voltages received from system monitoring sensors, memory information, and directives entered into programming. Monitoring sensors include limit switches, pressure senders, encoders, counterweight level sensor, and backhitch load pin sensor. The PC then sends a 12 V output signal to the solenoid valves to control the system cylinders, brakes, pawls, and other controls.

NOTE: The rated capacity indicator/limiter (RCL) system has its own programmable controller and is part of the EPIC system. For complete information see the Rated Capacity Indicator/Limiter Operation Manual.

The luffing jib (drum 5) operates the same as a load drum, whether used as a whip line or luffing jib. For drum 9 operation, load drum holding pressure memory is used. Before releasing the drum disc brake, the PC reverses the voltage polarity to the travel (or main hoist in MAX-ER mode) pump's EDCs, stroking the crawler's travel pumps in the UP direction until pressure memory is met. The PC then responds to the left control handle (drum 9) commands. See Section 3 of the MAX-ER Operator Manual for description of drum numbers and handle indicator lights.

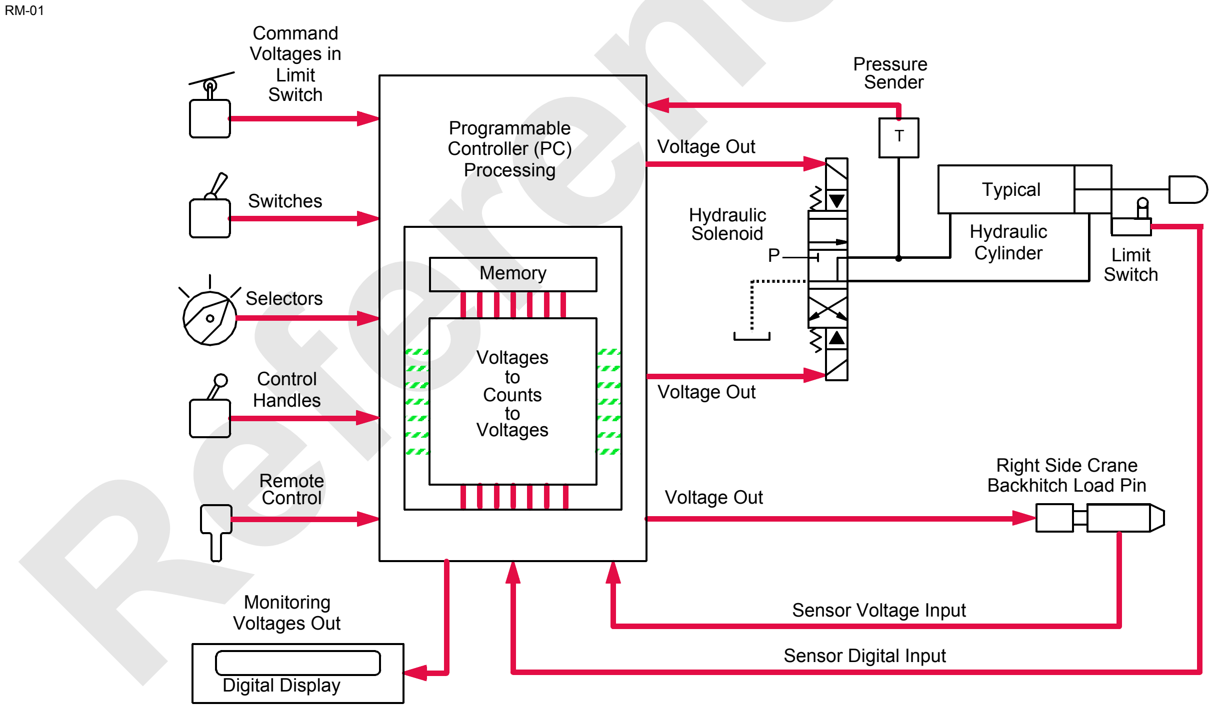


FIGURE 1-46

MAX-ER Modes

In Setup mode, the PC operates the same as in Standard mode, but the boom-up limit is bypassed.

In Luffing Jib mode, drum 5 cannot operate unless drum 4 is parked. In Standard mode, drum 4 cannot operate unless drum 5 is parked.

In MAX-ER mode, the PC responds to load changes by raising or lowering the wheeled counterweight assembly. The PC applies drum 9 brakes, controls crawler travel pump speed, and selects control handle operation depending on the crane's mode version. See Operating Controls in Section 3 of the MAX-ER Operator Manual for MAX-ER operation.

Electrical System

An electrical cable (W27) from the MAX-ER's programmable controller on the crane to the MAX-ER's junction box on the wheeled counterweight trailer provides electrical wiring to the MAX-ER's components.

MAX-ER electrical components include the following:

- Strap cylinders limit switch
- Strap cylinders pressure senders
- Counterweight tilt sensor
- MAX-ER accessory valve solenoids
- MAX-ER remote switch assembly

Other MAX-ER electrical components mounted on the crane include the following:

- Load pin sensor
- Mast backhitch pin cylinders
- Rear or right rear drum pawl
- Rear or right rear drum pawl limit switch
- Drum 9, crawler travel, and boom hoist diverting valves
- Mast angle limit
- Boom angle indicator
- Maximum boom angle limit switch
- Mast backhitch pins remote switch assembly

Other MAX-ER electrical components for drum 9 mounted on the boom butt include the following:

- Left/right motor controls
- Flange speed sender
- Minimum bail limit switch
- Drum pawl
- Drum brakes

MAX-ER Remote Switch Assembly

With the engine running, power is available to the MAX-ER's remote switch assembly when the power cable (W28) is plugged into the receptacle on the left side of the counterweight trailer. The counterweight raise/lower switch is only active in Setup mode. All other switches can be operated in any crane-operating mode. When the power button on the MAX-ER remote is pressed, power is enabled to operate the MAX-ER's cylinders.

When a MAX-ER remote switch is enabled, an input signal is sent to the PC. The crane's PC sends an output signal to shift the crane's auxiliary system disable-relief valve HS-12 to block the valve's bypass. This increases the MAX-ER's accessory pressure to 207 bar (3,000 psi) to operate the MAX-ER's cylinders.

The auxiliary system's disable-relief valve HS-12 is set at 276 bar (4,000 psi) and protects the MAX-ER systems from excessive pressure by opening to the tank when the accessory items are disabled.

Mast Backhitch Pins Remote Switch

With the engine running, power is available to the mast backhitch pins remote switch when the power cable (W29) is plugged into the receptacle at the bottom main junction box on the left side of the crane.

When the power and retract buttons are pressed, the backhitch cylinders retract the mast backhitch pins. When the power button and retract buttons are released, the backhitch cylinders, with spring assist, extend the mast backhitch pins.

Digital Display

Scroll to the CTWT BHITCH screen of the digital display to observe the counterweight position. The CTWT indicates UP or DOWN position of the wheeled counterweight assembly. BHITCH indicates backhitch loading in U.S. tons.

The MAX-ER (MXR) diagnostic screen displays the PC-monitored operating conditions. System messages are shown in Tables 1, 2, and 3 in Troubleshooting Section 10.

Pressure Senders and Speed Senders

See Figure 1-47 for the following.

A counterweight strap cylinder pressure sender is located at the rod end of each strap cylinder and the piston end of the right side strap cylinder. The counterweight strap cylinder pressure senders measure system pressures and send the information as input voltages to the PC.

The drum 9 flange-mounted speed sender (encoder) detects the speed and direction of the drum's movement. The PC receives this information as two out-of-phase square wave voltages that are converted to "counts."

The PC then determines when to apply the brake or adjust the pump's flow.

Limit Switches

See Figure 1-47 for the following.

When operating, all limit switches should be closed, sending input signals to the PC. If a limit switch opens, the PC sends an output signal to the affected system to stop and apply the system brake. Move the control in the opposite direction away from the limit switch to correct the problem.

The yellow operating limit light and alert in the operator's cab is enabled if one of the operating limits is activated. Use the display switch to scroll UP or DOWN to identify and display the operating limit.

When a MAX-ER operating limit is enabled, the PC displays the following messages:

- BOOM MAXIMUM UP:
  - Mast stops hoisting at 80°, operable only in Standard mode
- FUNCTION NOT PARKED:
  - Drum 2 (boom hoist) cannot operate until load drum (drum 3) is parked and vice versa.
  - Drum 9 (front load drum) cannot be operated until crawler travel is parked.
  - Drum 4 (mast hoist) cannot operate until drum 5 (luffing jib) is parked.

The red system fault light and alarm alert in the operator's cab is enabled if the crane's PC detects a load pin fault (output voltage from the pin that is greater than 9.8 V).

When a MAX-ER system fault is enabled, the PC displays the following message:

- LOAD PIN:
  - THE MAX-ER's counterweight assembly stops and remains in last position, and the boom hoist stops and is inoperable in UP direction. All other crane functions remain operable.

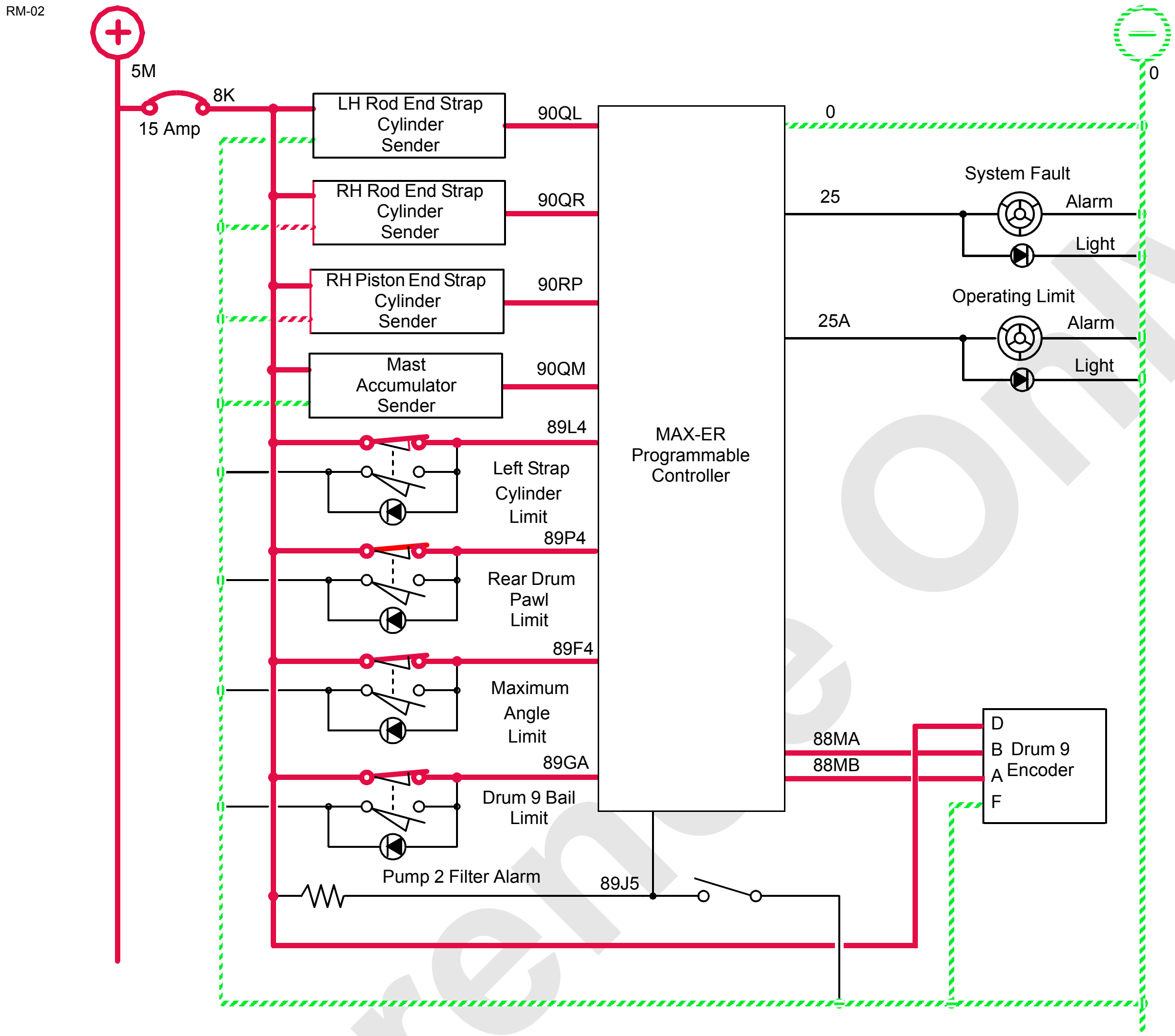

RM-02
5M
8K
15 Amp
LH Rod End Strap Cylinder Sender
90QL
RH Rod End Strap Cylinder Sender
90QR
RH Piston End Strap Cylinder Sender
90RP
Mast Accumulator Sender
90QM
89L4
Left Strap Cylinder Limit
89P4
Rear Drum Pawl Limit
89F4
Maximum Angle Limit
89GA
Drum 9 Bail Limit
Pump 2 Filter Alarm
89J5
MAX-ER Programmable Controller
0
25
System Fault
Alarm
Light
25A
Operating Limit
Alarm
Light
88MA
88MB
D
B
A
F
Drum 9 Encoder
0

FIGURE 1-47

Backhitch Pins

See Figure 1-48 for the following.

The backhitch pins are retracted from the telescopic backhitch strap during assembly or disassembly. With the engine running, power is available to the mast backhitch pins remote switch when the power cable (W29) is plugged into the receptacle at the bottom of the main junction box on the left side of the crane. The mast backhitch pins remote switch is operative only if the crane is in Standard or Setup mode.

Backhitch Pins Extend/Retract

Each backhitch pin cylinder is spring-returned to the extended position. In this position, the backhitch pins normally closed air solenoid AS-1 is disabled and normally opened air solenoid AS-2 is also disabled. This allows air flow from the manifold through AS-1 to the piston end of the pin cylinders. When the power ON button and retract OUT buttons are pressed and held, the backhitch pins air solenoids AS-2 and AS-1 are both enabled to retract the backhitch pins. Air then flows through solenoid AS-2 to the rod end of the backhitch pin cylinders. The backhitch pin cylinders then retract to move the pins out of engagement, while air from the piston end of the cylinders exhausts to the atmosphere through the air solenoid AS-1.

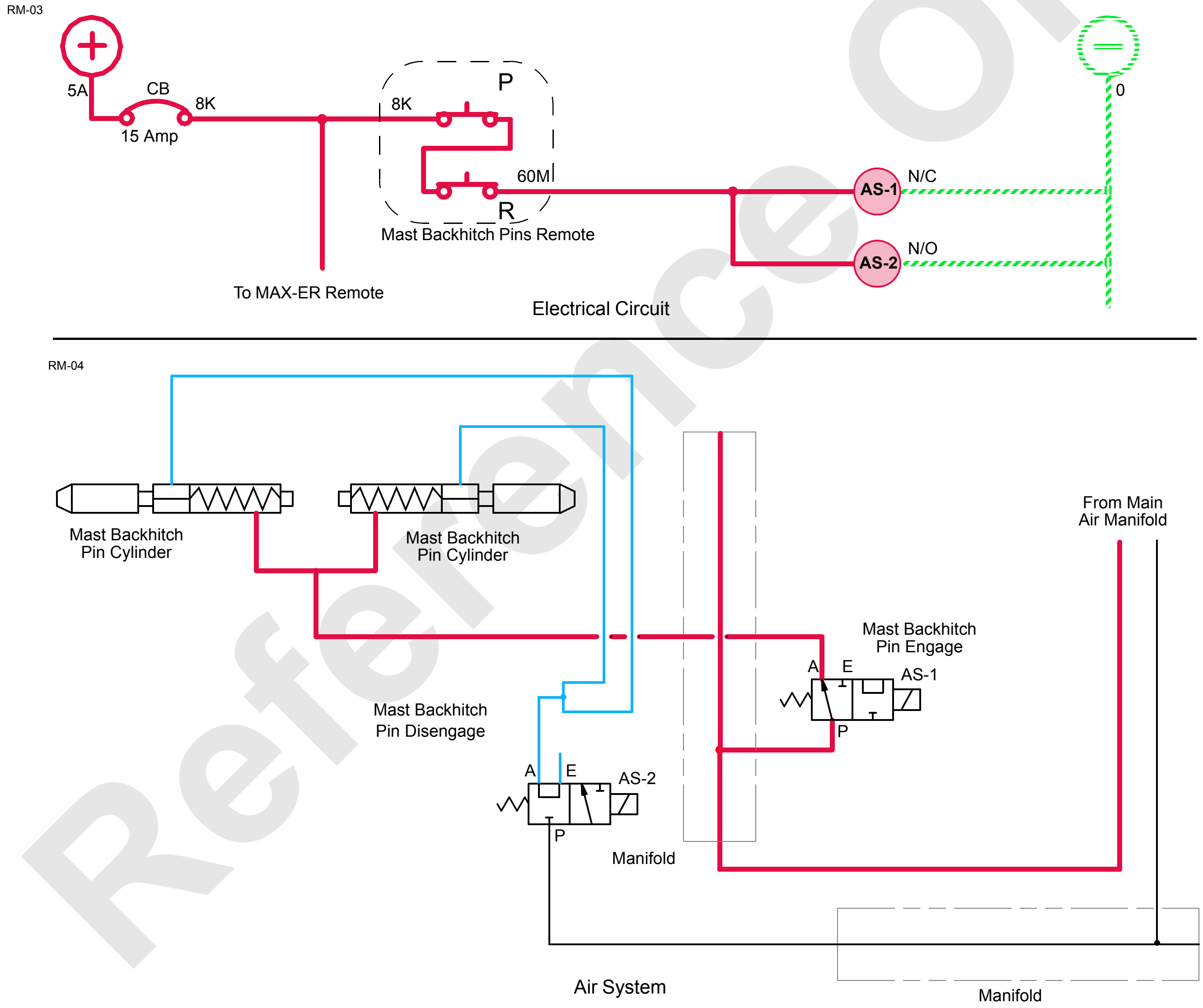


FIGURE 1-48

Tongue Cylinder

See Figure 1-49 and Figure 1-50 for the following.

The tongue cylinder aligns the wheeled counterweight trailer for attachment to the crane and levels the counterweight tray before positioning the steering wheels. The wheeled counterweight tray pins must be in the proper position for leveling. See Section 4 of Operator Manual for pin positions. After the wheeled counterweight trailer is leveled, return the tray pins to the operating position.

With the engine running, power is available to the MAX-ER's remote switch assembly when the power cable (W28) is plugged into the receptacle on the left side of the counterweight trailer. When the power button on MAX-ER's remote switch assembly is pressed, power is enabled to operate the tongue cylinder switch. The switch is spring-returned to the OFF position. In the OFF position, the tongue cylinder solenoid valve is "motor spooled" with both cylinder ports and the tank port connected when not enabled. This prevents premature opening of the counterbalance valves at the cylinder.

Tongue Cylinder Extend

When the power button is pressed and the tongue cylinder switch is enabled and held in the UP (extend) position, an input signal is sent to the programmable controller (PC). A 12 V output signal from the PC enables the tongue cylinder extend solenoid HS-50. Internal pilot supply pressure of 14 bar (200 psi) enables the selected spool to shift the tongue cylinder solenoid valve. The crane's PC sends an output signal to shift the crane's auxiliary system disable-relief valve HS-12 to block the valve's bypass. Accessory system pressure increases to operate the accessory items. Accessory system fluid enters the MAX-ER's accessory valve and flows to the free-flow check valve section of the counterbalance valve, entering the piston end of the tongue cylinder, and starts to extend the tongue cylinder. Fluid from the rod end of the cylinder is blocked by the free-flow check valve section of the counterbalance valve and flows through the flow-restraining section that has a relief setting of 193 bar (2,800 psi). Return hydraulic fluid then exits the counterbalance valve and passes through the MAX-ER's accessory valve before returning to the crane's hydraulic tank through the return line. Release the tongue cylinder switch to the OFF position to lock the tongue cylinder in position.

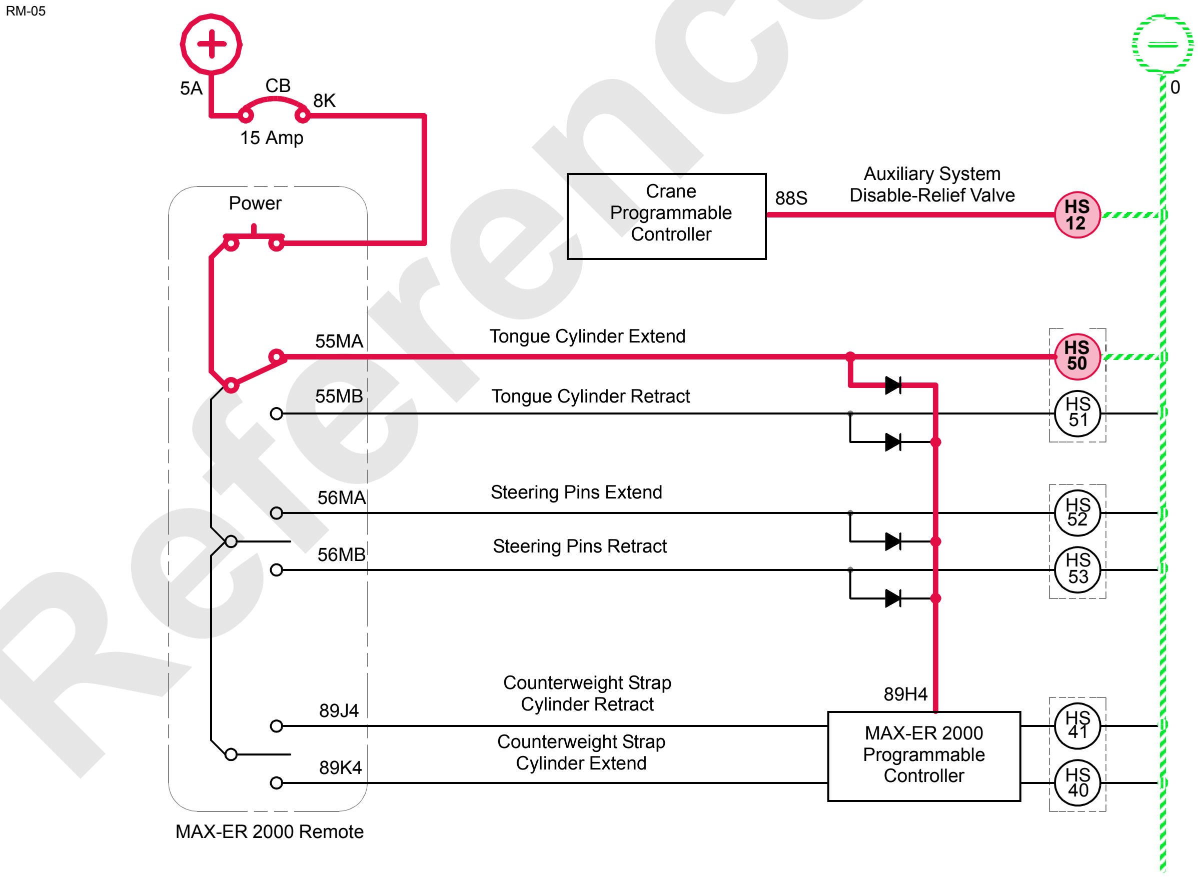


FIGURE 1-49

Tongue Cylinder Retract

When the tongue cylinder switch is held in the UP (retract) position, an input signal is sent to the PC. A 12 V output signal from the PC enables the tongue cylinder retract solenoid HS-51. Internal pilot supply pressure of 14 bar (200 psi) enables the selected spool to shift the tongue cylinder solenoid valve. The crane's PC sends an output signal to shift the crane's auxiliary system disable-relief valve HS-12 to block the valve's bypass. Accessory system pressure increases to operate the accessory items.

Accessory system fluid enters the MAX-ER's accessory valve and flows to the free-flow check valve section of the counterbalance valve, entering the rod end of the tongue cylinder to start retracting the tongue cylinder. Fluid from the piston end of the cylinder is blocked by the free-flow check valve section of the counterbalance valve and flows through the flow-restraining section that has a relief setting of 193 bar (2,800 psi). Return hydraulic fluid then exits the counterbalance valve and passes through the MAX-ER's accessory valve before returning to the crane's hydraulic tank through the return line. Release the tongue cylinder switch to the OFF position to lock the tongue in position.

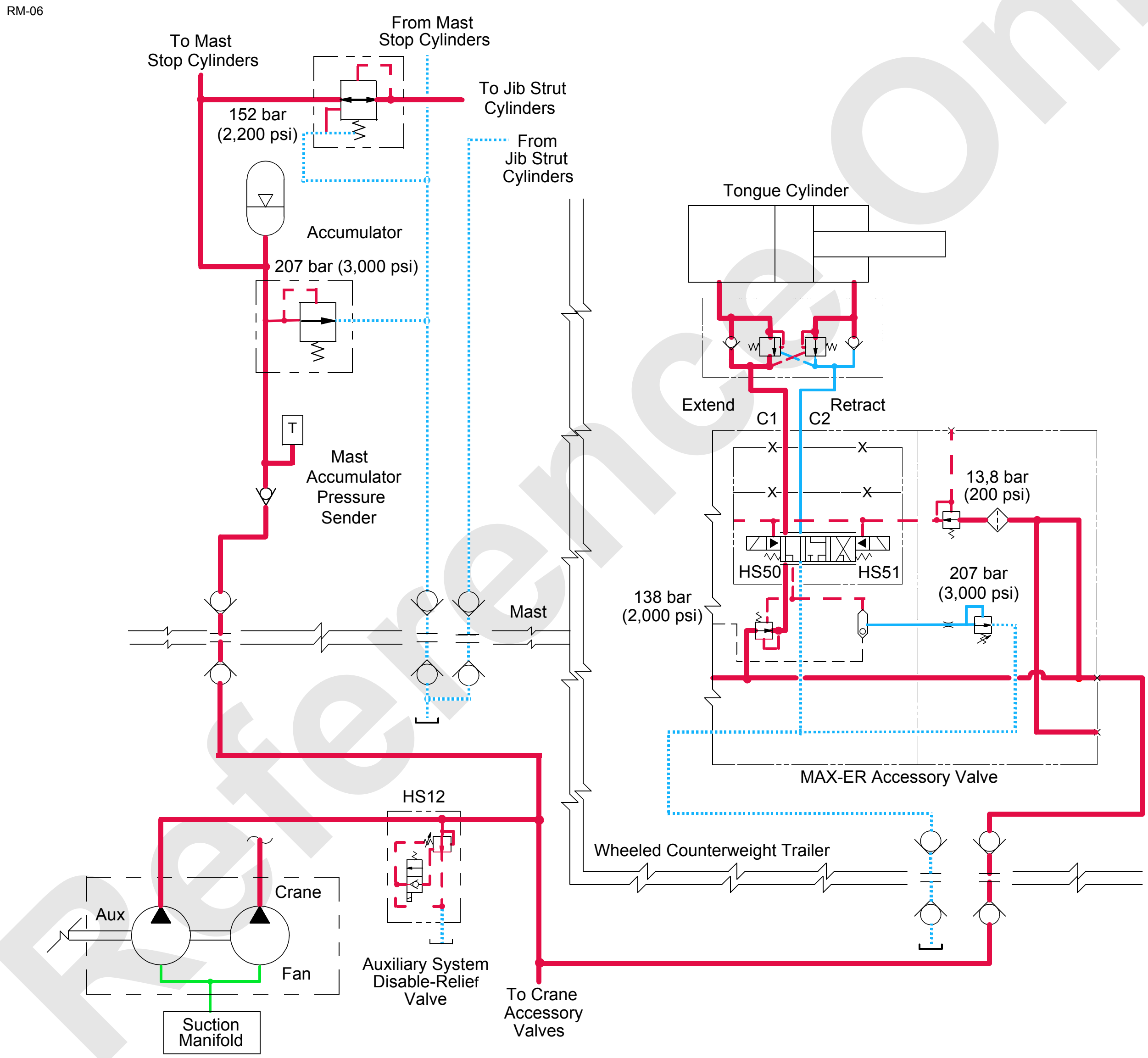


FIGURE 1-50

Counterweight Jack Cylinders

See Figure 1-51 and Figure 1-52 for the following procedure.

There are four counterweight jacks—one front left jack, one front right jack, and two rear center jacks. The counterweight trailer jack system is used to raise the wheels off the ground to move the steering arms to the desired steering position. The jacks allow the counterweight trailer to stand by itself when not attached to the crane and to aid in tire maintenance. Axle wedges help stabilize the counterweight trailer when it is not attached to the crane and when the jacks are retracted.

DANGER

Tipping Hazard!

The wheeled counterweight assembly can tip:

- Extend and retract the jack cylinders slowly to maintain the counterweight trailer as level as possible.
- Do not extend the jacks if the counterweight trailer is not attached to the crane and the wheels are not at a 90-degrees (stand-alone) position.
- Make sure the counterweight tray pins are in proper position when raising the counterweight trailer with the jacks.
- Read and understand the counterweight trailer jack procedure before operating the MAX-ER remote switch.

Each jack cylinder has a counterbalance valve at each cylinder port. These valves allow smooth operation when using the jack cylinders. The counterbalance valves lock the cylinders in position if there is a problem with the system. The counterbalance valves also provide relief protection for the cylinders.

With the engine running, power is available to the MAX-ER's remote switch assembly when the power cable (W28) is plugged into the receptacle on the left side of the counterweight trailer. When the power button on the MAX-ER's remote switch assembly is pressed, power is enabled to operate the counterweight jack switches. The four switches are spring-returned to the OFF position.

Jack Cylinder(s) Extend

When the selected left, right, center, or extend all switch is held in the UP (extend) position, an input signal is sent to the programmable controller (PC). A 12 V output signal from the PC enables the jack cylinder extend solenoid HS-44, HS-46, and/or HS-48. Internal pilot supply pressure of 14 bar (200 psi) enables the spool to shift the selected jack cylinder solenoid valve(s). An internal relief valve and shuttle valve for each spool valve allows pressure to be divided equally when more than one valve is operated at a time. The crane's PC sends an output signal to shift the crane's auxiliary system disable-relief valve HS-12 to block the valve's bypass. Accessory system pressure increases to operate the accessory items. Accessory system fluid enters the MAX-ER's accessory valve and flows to the free-flow check valve section of the counterbalance valve. Fluid pressure on the piston end of the selected jack cylinder extends the jack cylinder to raise the counterweight trailer.

Fluid from the rod end of the jack cylinder is blocked by the free-flow check valve section of the counterbalance valve and flow-restraining section of the relief valve preset for a relief setting of 276 bar (4,000 psi). The rod end cylinder pressure opens the restraining section of the counterbalance valve, allowing fluid to exit the valve. Return hydraulic fluid passes through the MAX-ER's accessory valve before returning to the crane's hydraulic tank through the return line.

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

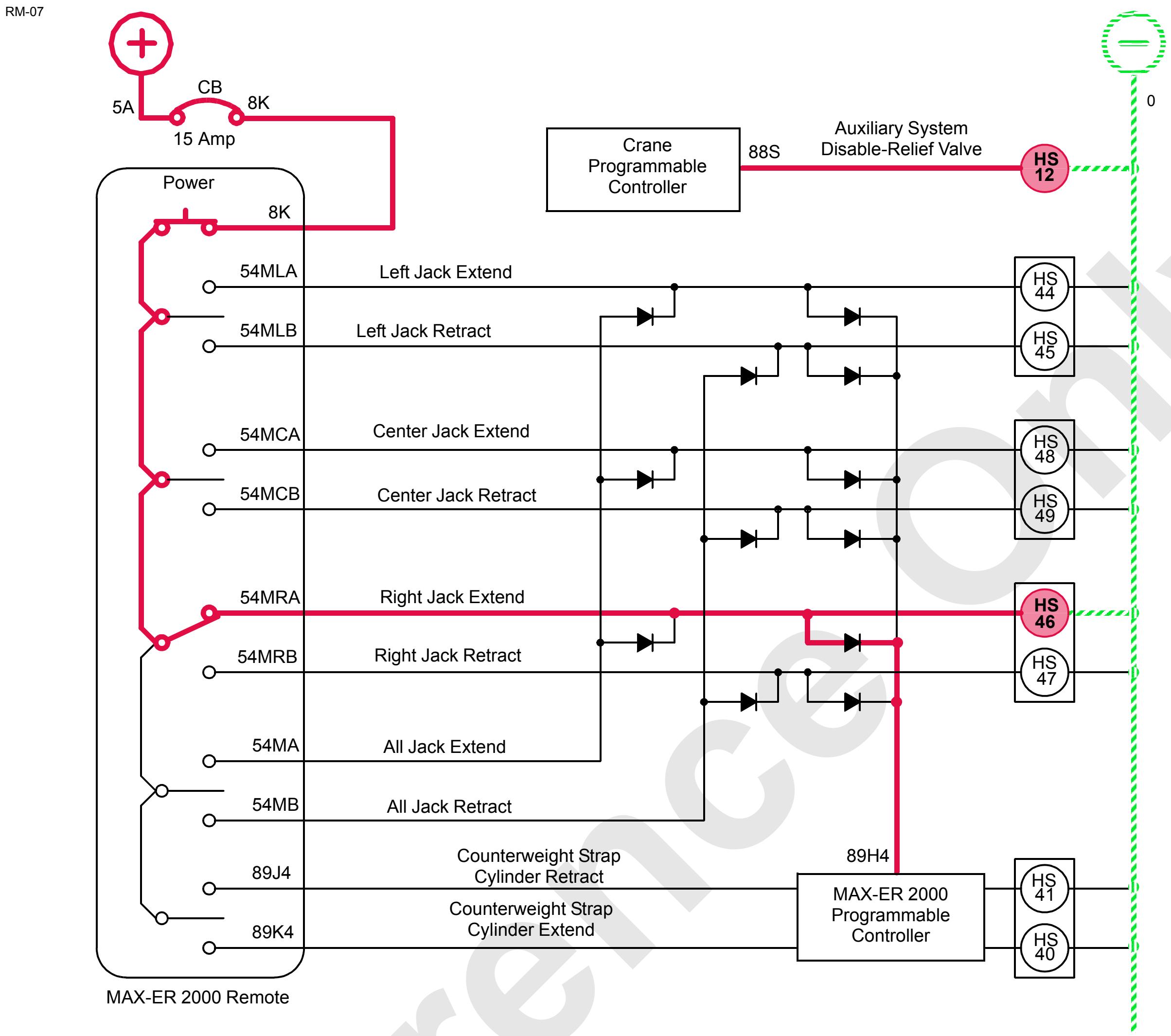


FIGURE 1-51

Jack Cylinder(s) Retract

When the selected left, right, center, or all switch is held in the DOWN (retract) position, an input signal is sent to the PC. A 12 V output signal from the PC enables the jack cylinder retract solenoid HS-45, HS-47, and/or HS-49. Internal pilot supply pressure of 14 bar (200 psi) enables the spool to shift the selected jack cylinder solenoid valve(s). Internal sequence valve and shuttle valve for each spool valve controls each system pressure when more than one valve is operated at a time. The crane's PC sends an output signal to shift the crane's auxiliary system disable-relief valve HS-12 to block the valve's bypass. Accessory system pressure increases to operate the accessory items. Accessory system fluid enters the MAX-ER's accessory valve and flows to the free-flow check valve section of the counterbalance valve. Fluid pressure on the rod end of the selected jack cylinder retracts the jack cylinder to lower the counterweight trailer.

Fluid from the piston end of the jack cylinder is blocked by the free-flow check valve section of the counterbalance valve and flow-restraining section of the relief valve preset for a relief setting of 138 bar (2,000 psi). Piston-end cylinder pressure opens the restraining section of the counterbalance valve, allowing fluid to exit the valve. Return hydraulic fluid then passes through the MAX-ER's accessory valve before returning to the crane's hydraulic tank through the return line.

When the jack cylinder is retracted the desired distance, release the selected jack switch to the OFF position to lock the jack cylinder(s) in position. Trapped hydraulic pressure at the piston end of the jack cylinder counterbalance valve supports the weight and gravity force of the counterweight trailer.

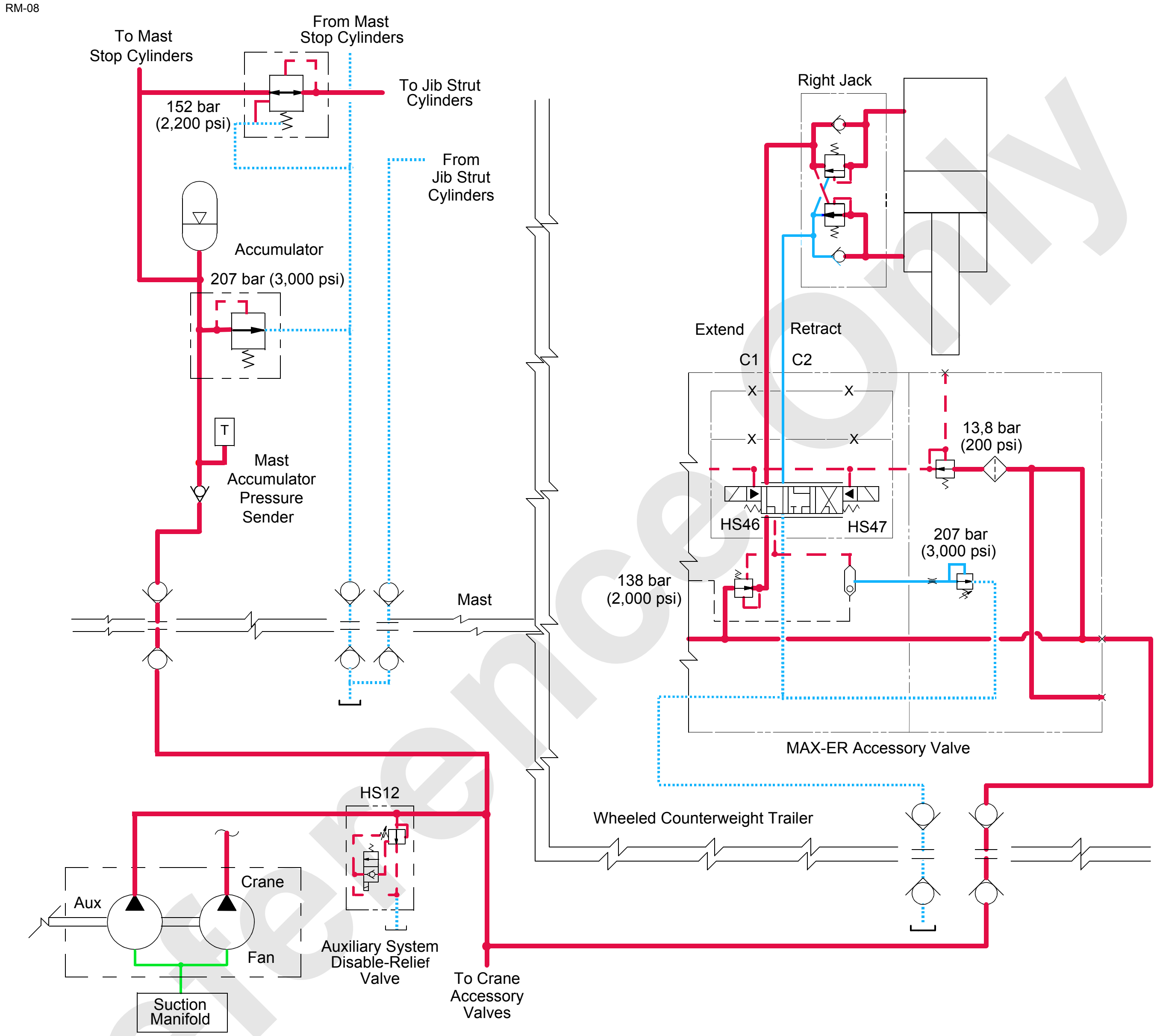

RM-08
To Mast
Stop Cylinders
From Mast
Stop Cylinders
To Jib Strut
Cylinders
152 bar
(2,200 psi)
From
Jib Strut
Cylinders
Accumulator
207 bar (3,000 psi)
T
Mast
Accumulator
Pressure
Sender
Mast
Right Jack
Extend
Retract
C1
C2
13,8 bar
(200 psi)
HS46
HS47
207 bar
(3,000 psi)
138 bar
(2,000 psi)
MAX-ER Accessory Valve
Wheeled Counterweight Trailer
HS12
Crane
Aux
Fan
Suction
Manifold
Auxiliary System
Disable-Relief
Valve
To Crane
Accessory
Valves

FIGURE 1-52

Steering Pin Cylinders

See Figure 1-53 and Figure 1-54 for the following.

Steering pin cylinders disconnect the MAX-ER's steering arms from the counterweight trailer to allow positioning of the steering wheels.

With the engine running, power is available to the MAX-ER's remote switch assembly when the power cable (W28) is plugged into the receptacle on the left side of the counterweight trailer. When the power button on the MAX-ER's remote switch assembly is pressed, power is enabled to operate the steering pins switch. The switch is spring-returned to the OFF position. In the OFF position, the steering pin cylinders solenoid valve has a closed center with both cylinder ports blocked.

Steering Pin Cylinders Disengage

When the steering pins switch is held in the UP (disengage) position, an input signal is sent to the PC. A 12 V output signal from the programmable controller (PC) enables the steering pins disengage solenoid HS-53. Internal pilot supply pressure of 14 bar (200 psi) enables the selected spool to shift the steering pins solenoid valve. The crane's PC sends an output signal to shift the crane's auxiliary system disable-relief valve HS-12 to block the valve's bypass. Accessory system pressure increases to operate the accessory items. Accessory system fluid enters the MAX-ER's accessory valve and flows to the rod end of the steering pin cylinders to disengage the pins from the right side and left side steering arms. Return fluid from the piston end of the cylinder passes through the MAX-ER's accessory valve before returning to the crane's hydraulic tank through the return line. Release the steering pins switch to lock the steering pins in position.

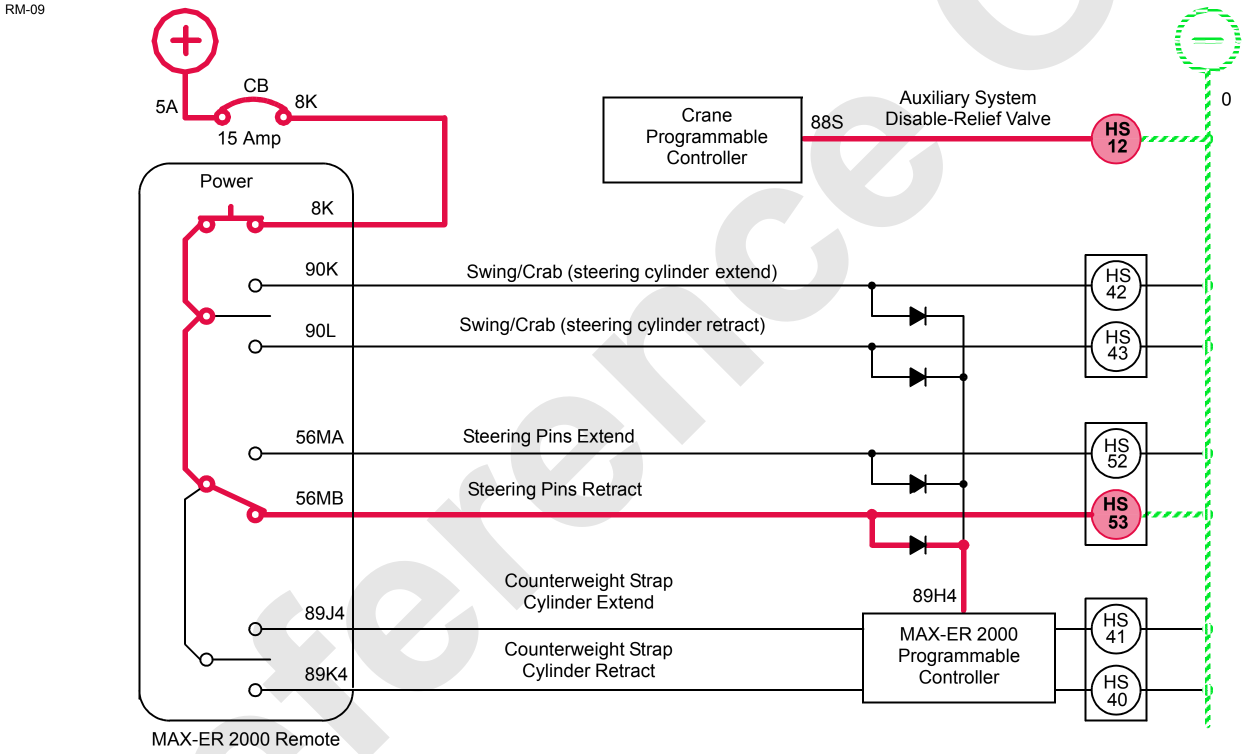


FIGURE 1-53

Steering Pin Cylinders Engage

When the steering pins switch is held in the DOWN (engage) position, an input signal is sent to the PC. A 12 V output signal from PC enables the steering pins engage solenoid HS-52. Internal pilot supply pressure of 14 bar (200 psi) enables the selected spool to shift the steering pins solenoid valve.

The crane's PC sends an output signal to shift the crane's auxiliary system disable-relief valve HS-12 to block the valve's bypass. Accessory system pressure increases to operate the accessory items. Accessory system fluid enters the MAX-ER's accessory valve and flows to the piston end of the steering pins to engage the pins at the right side and left side steering arms. Return fluid from the rod end of the cylinder passes through the MAX-ER's accessory valve before returning to the crane's hydraulic tank through the return line. Release the steering pins switch to lock the steering arms in position.

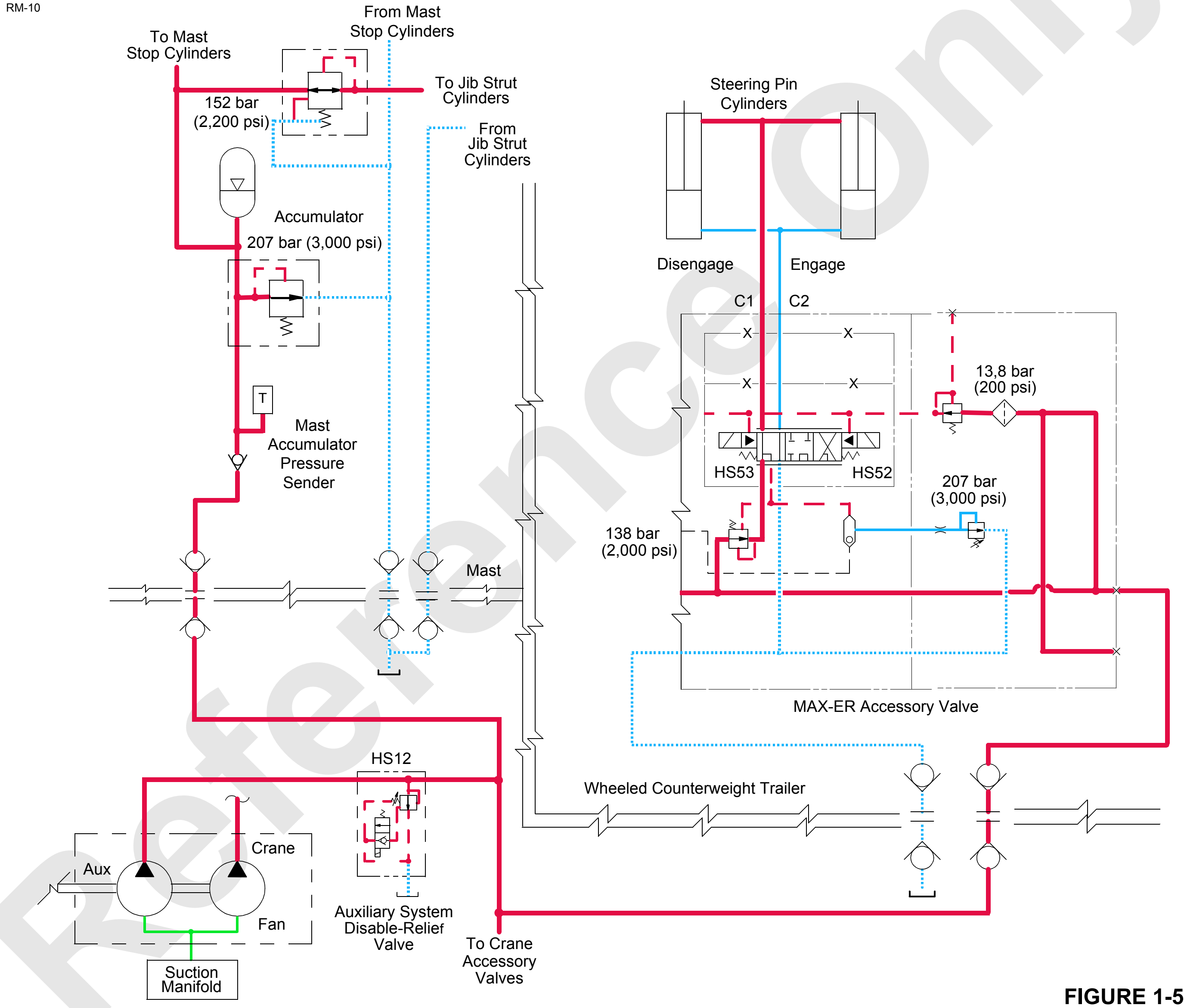


FIGURE 1-54

Steering Arm Cylinders

See Figure 1-55 and Figure 1-56 for the following.

Steering arms and stop pins must be properly positioned depending on the swing radius and type of crawler travel or swing. See Section 4 of Operator Manual for information on positioning the steering wheels.

With the engine running, power is available to the MAX-ER's remote switch assembly when the power cable (W28) is plugged into the receptacle on the left side of the counterweight trailer. When the power button on the MAX-ER's remote switch assembly is pressed, power is enabled to operate the steering switch. The switch is spring-returned to the OFF position.

CAUTION

Machinery Damage!

The wheeled counterweight assembly must be supported on jacks before changing the wheel position.

Make sure that the strut and draw bar pins are in the proper positions. Hydraulic cylinders and other wheeled counterweight trailer components may be damaged.

Extend the jacks to support most of the counterweight trailer's load until bulge is out of the tires. Failure to do so may cause the tires to separate from the rims as the wheels are positioned.

Steering Cylinders Extend (Swing/Crab)

The steering pins must be disengaged first, before the steering arms can be positioned. Move the stop pins to the desired steering position. When the steering switch is held in the UP (swing/crab) position, an input signal is sent to the programmable controller (PC). A 12 V output signal from the PC enables the steering solenoid valve HS-42 to extend the right side and left side steering arm cylinders. Internal pilot supply pressure of 14 bar (200 psi) enables the selected spool to shift the steering arm extend solenoid valve.

The crane's PC sends an output signal to shift the crane's auxiliary system disable-relief valve HS-12 to block the valve's bypass. Accessory system pressure increases to operate the accessory items. An inline relief valve set at 83 bar (1,200 psi) reduces the auxiliary system's pressure to the steering arm cylinders.

Accessory system fluid enters the MAX-ER's accessory valve and goes through the steering solenoid valve to the piston end of the steering arm cylinders to extend the cylinders and move the steering arms to the swing or crab position.

Return fluid from the rod end of the steering arm cylinders passes through the MAX-ER's accessory valve before returning to the crane's hydraulic tank through the return line. Release the steering switch to stop extending the steering arms when the stop is reached. When the steering arms are positioned, the steering pins must be engaged.

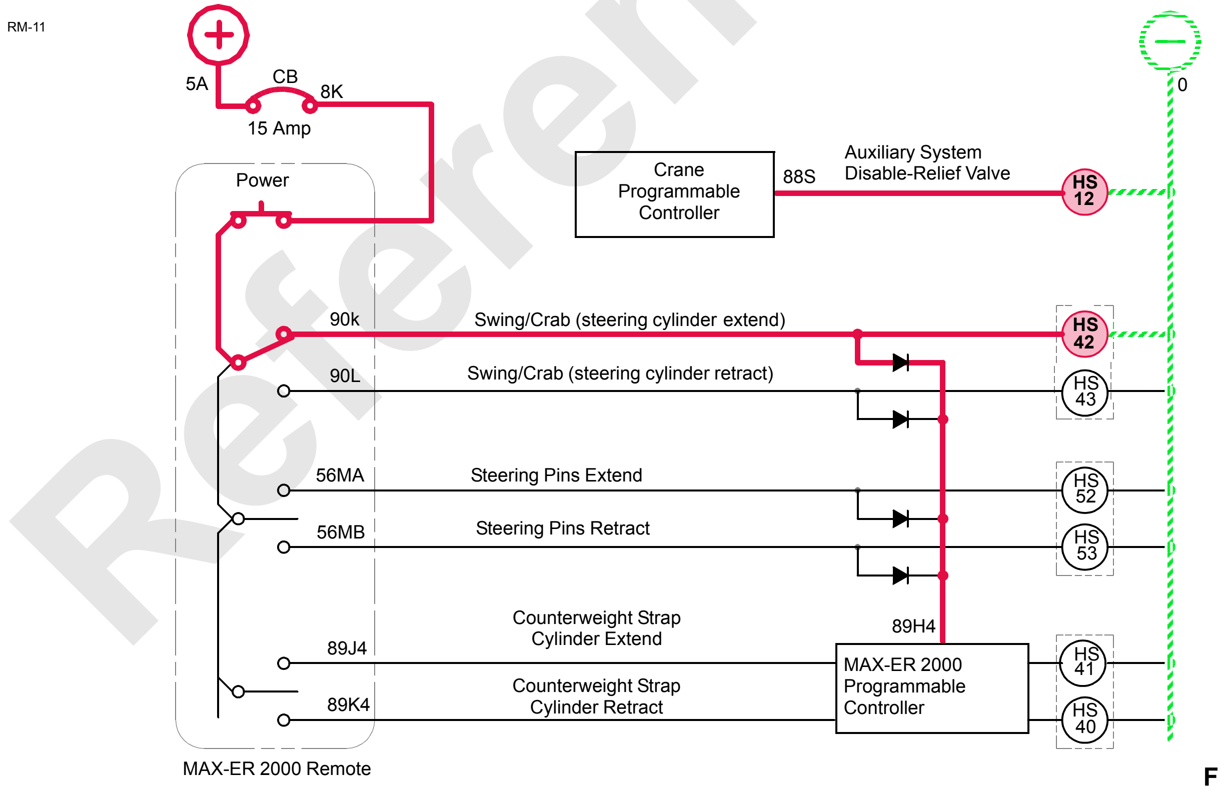


FIGURE 1-55

Steering Cylinders Retract (Straight)

The steering pins must be disengaged first, before the steering arms can be positioned. Move the stop pins to the desired steering position. When the steering switch is held in the DOWN (straight) position, an input signal is sent to the PC. A 12 V output signal from the PC enables the steering solenoid valve HS-43 to retract the right side and left side steering arm cylinders. Internal pilot supply pressure of 14 bar (200 psi) enables the selected spool to shift the steering arm retract solenoid valve.

The crane's PC sends an output signal to shift the crane's auxiliary system disable-relief valve HS-12 to block the valve's bypass. Accessory system pressure increases to operate the accessory items. An inline relief valve set at 183 bar (200 psi) reduces the auxiliary system's pressure to the steering arm cylinders.

Accessory system fluid enters the MAX-ER's accessory valve and goes through the steering solenoid valve to the rod end of the steering cylinders to retract the steering cylinders and move the steering arms to the straight position. Return fluid from the piston end of the cylinders passes through the MAX-ER's accessory valve before returning to the crane's hydraulic tank through the return line. Release the steering switch to stop retracting the steering arms when the stop is reached. When the steering arms are positioned, the steering pins must be engaged.

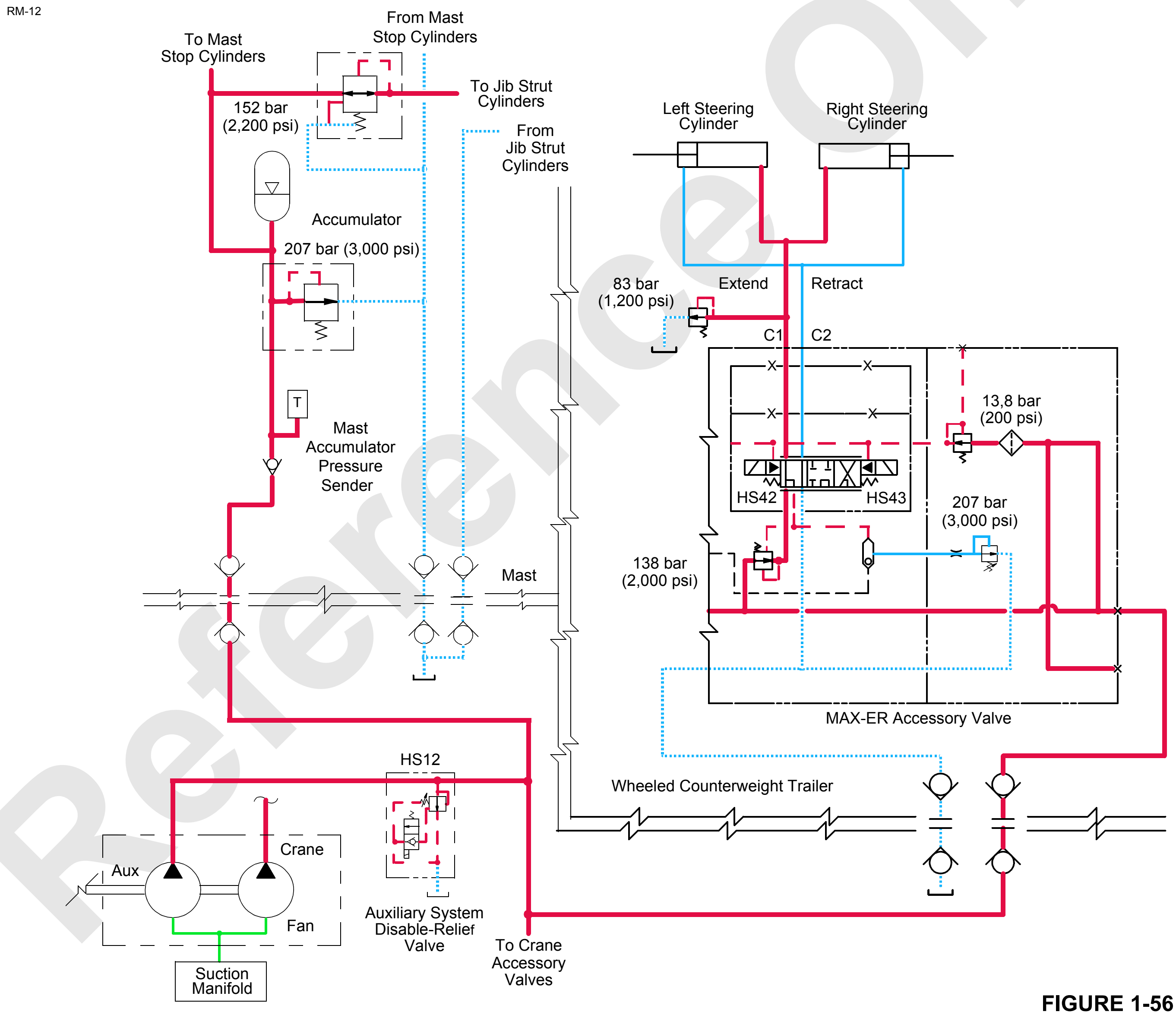


FIGURE 1-56

Counterweight Strap Cylinders

See Figure 1-57 and Figure 1-58 for the following.

When the MAX-ER mode is selected, the load-sensing pin in the gantry left side backhitch measures loading created by the lifted load. The load-sensing pin sends a proportional 0.8 to 8.0 V signal to the crane's programmable controller (PC). The crane's PC converts the load-sensing pin voltage signal to U.S tons that is displayed on the MAX-ER (MXR) screen.

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

DANGER

Collapsing Mast Hazard!

Avoid possible injury. After the straps are pinned to the strap cylinders, do not manually retract the cylinders. The mast can be pulled over backward. The strap cylinders automatically adjust when MAX-ER mode is selected.

Tipping Hazard!

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

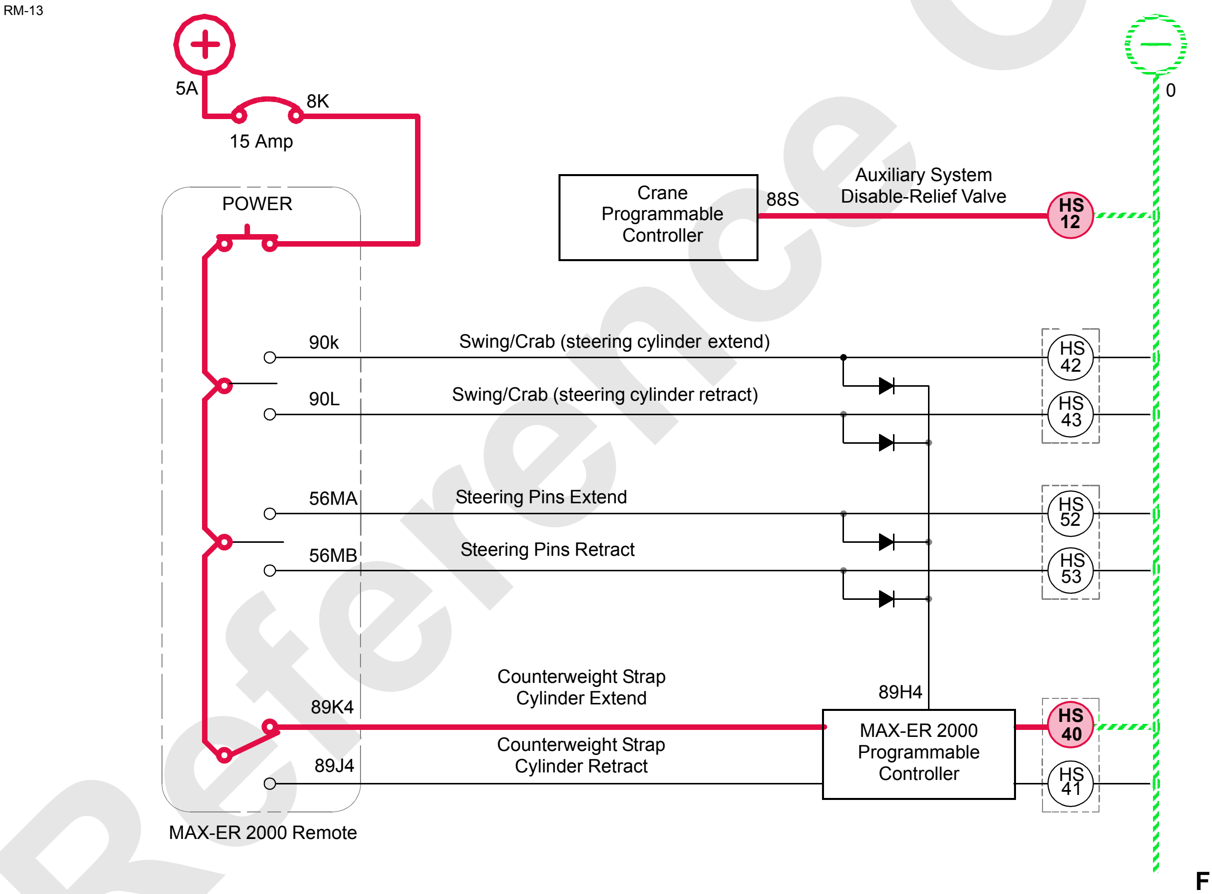


FIGURE 1-57

The PC enables the MAX-ER's electronic and hydraulic systems to automatically extend and retract the counterweight strap cylinders to raise and lower the wheeled counterweight assembly in response to changes in backhitch tension:

- At 30 U.S. tons of tension on the backhitch load-sensing pin, the strap cylinders begin to retract. At 28 tons of tension, the strap cylinders stop retracting.
- At less than 4 tons of tension on the backhitch load-sensing pin, the strap cylinders begin to extend. At 6 tons of tension, the strap cylinders stop extending.
- If the calculated strap cylinder load drops below 7.5 tons of tension, strap cylinders stop retracting, because the wheeled counterweight trailer should be on the ground.

If the left side strap cylinder limit switch is tripped, neither strap cylinder will retract.

The PC also monitors the pressure senders in both right side and left side rod end strap cylinders and right side piston end strap cylinder hydraulic circuit to control the raising or lowering of the counterweight assembly when operating. The operating pressure range is from 0 to 3,000 psi (0 to 207 bar).

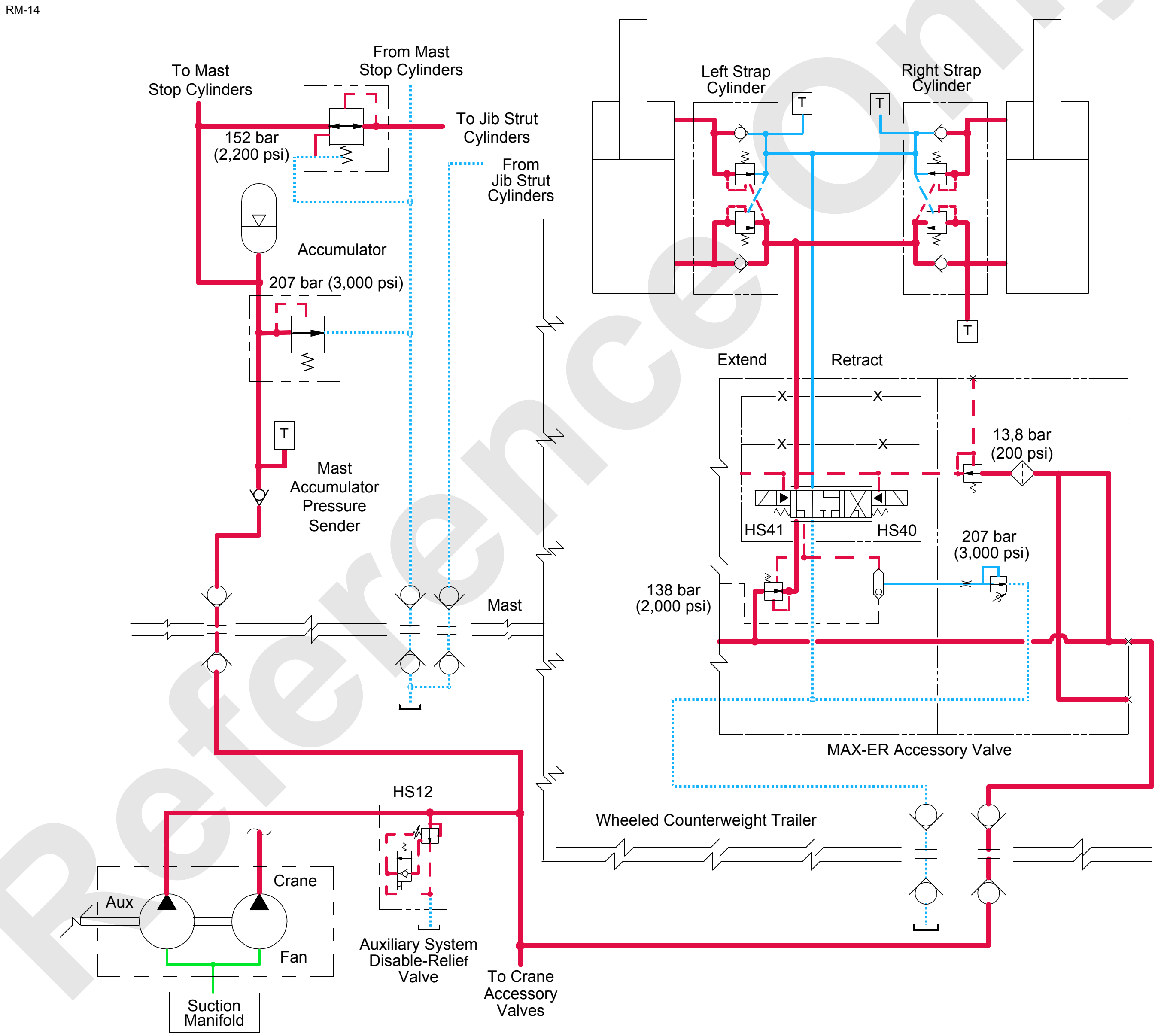


FIGURE 1-58

Counterweight Switch

The counterweight switch is operative only in Standard or Setup modes. It allows the counterweight strap cylinders to be disconnected from the counterweight straps during assembly and disassembly.

With the engine running, power is available to the MAX-ER's remote switch assembly when the power cable (W28) is plugged into the receptacle on the left side of the counterweight trailer. When the power button on MAX-ER's remote switch assembly is pressed, power is enabled to operate the counterweight switch. The switch is spring-returned to the OFF position. In the OFF position, the counterweight strap cylinders solenoid valve is "motor spooled" with both cylinder ports and the tank port connected to the spool center position. This prevents premature opening of the counterbalance valves.

Counterweight Strap Cylinders Lower

When the counterweight switch is held in the DOWN (lower) position (extend cylinder), an input signal is sent to the PC. A 12 V output signal from the PC enables the counterweight strap cylinder lower solenoid valve HS-41. Internal pilot supply pressure of 14 bar (200 psi) enables the selected spool to shift the counterweight strap cylinder solenoid valve. The crane's PC sends an output signal to shift the crane's auxiliary system disable-relief valve HS-12 to block the valve's bypass. Accessory system pressure increases to operate the accessory items. Accessory system fluid enters the MAX-ER's accessory valve and flows through the free-flow check valve section of the counterbalance strap cylinder valves, entering the piston end of the strap cylinders to start extending the cylinder rods.

Fluid from the rod end of the cylinders is blocked by the free-flow check valve section of the counterbalance valve and flows through the flow-restraining section that has a relief setting of 110 bar (1,600 psi). Return hydraulic fluid then exits the counterbalance valve and passes through the MAX-ER's accessory valve before returning to the crane's hydraulic tank through the return line. Move the release counterweight switch to the OFF position to lock the strap cylinders in position.

Counterweight Strap Cylinders Raise

When the counterweight switch is held in the UP (raise) position (retract cylinder), an input signal is sent to the PC. A 12 V output signal from the PC enables the counterweight strap cylinder raise solenoid valve HS-40. Internal pilot supply pressure of 14 bar (200 psi) enables the selected spool to shift the counterweight strap cylinder solenoid valve. The crane's PC sends an output signal to shift the crane's auxiliary system disable-relief valve HS-12 to block the valve's bypass. Accessory system pressure increases to operate the accessory items. Accessory system fluid enters the MAX-ER's accessory valve and flows through the free-flow check valve section of the counterbalance strap cylinder valves, entering the rod end of the strap cylinders to start retracting the cylinder rods. Fluid from the piston end of the cylinders is not blocked by the counterbalance valve and exits to the MAX-ER's accessory valve before returning to the crane's hydraulic tank through the return line. Move the release counterweight switch to the OFF position to lock the strap cylinders in position.

Mast Stop Raising And Boom Stop

Mast Stop Raising Cylinders

See Figure 1-59 for the following.

The mast stop raising cylinders pneumatically position the physical mast stops. Once the physical mast stops are raised at the assembly, the mast stop raising cylinders are pinned to the physical mast stops. See Section 4 of MAX-ER 2000 Operator Manual for instructions on mast assembly/ disassembly.

When the engine is started, pressurized air at 8,2 to 9,1 bar (120 to 132 psi) from the crane's engine compressor provides air to operate the mast stop raising cylinders. An air line from the crane's manifold goes to the quick disconnect at the mast base. After the quick disconnect there is a tee that splits, with one line going to the mast stop raising cylinders on mast and the other line going to the boom stop cushion cylinders on the boom butt. The mast stop raising cylinder rods extend and push the mast stops to the working position. The physical mast stop ends rest on the gantry pins. A fixed restriction at the piston end of each cylinder acts as a cylinder shock cushion.

Boom Stop Cushion Cylinders

See Figure 1-59 for the following.

The boom stop cushion cylinders pneumatically cushion the boom against the mast when at or near maximum boom angle.

When the engine is started, pressurized air at 8,2 to 9,1 bar (120 to 132 psi) from the crane's engine compressor provides air to the boom stop cushion cylinders. An air line from the crane's manifold goes to the quick disconnect at the mast base. After the quick disconnect there is a tee that splits, with one line going to the mast stop raising cylinders on mast and the other line going to the boom stop cushion cylinders on the boom butt.

If the boom is raised to 80 degrees, the boom-stop cylinders slow the boom's opposite movement. Check valves prevent compressed air from escaping the boom stop cylinders. Air pressure increases in the boom stop cylinders, slowing the boom before the boom stop struts contact the boom. At approximately 90 degrees the boom-stop cylinders bottom out and the boom physically stops. Orifices of the boom stop cylinders act as shock absorbers for the lowered boom struts when transporting the crane.

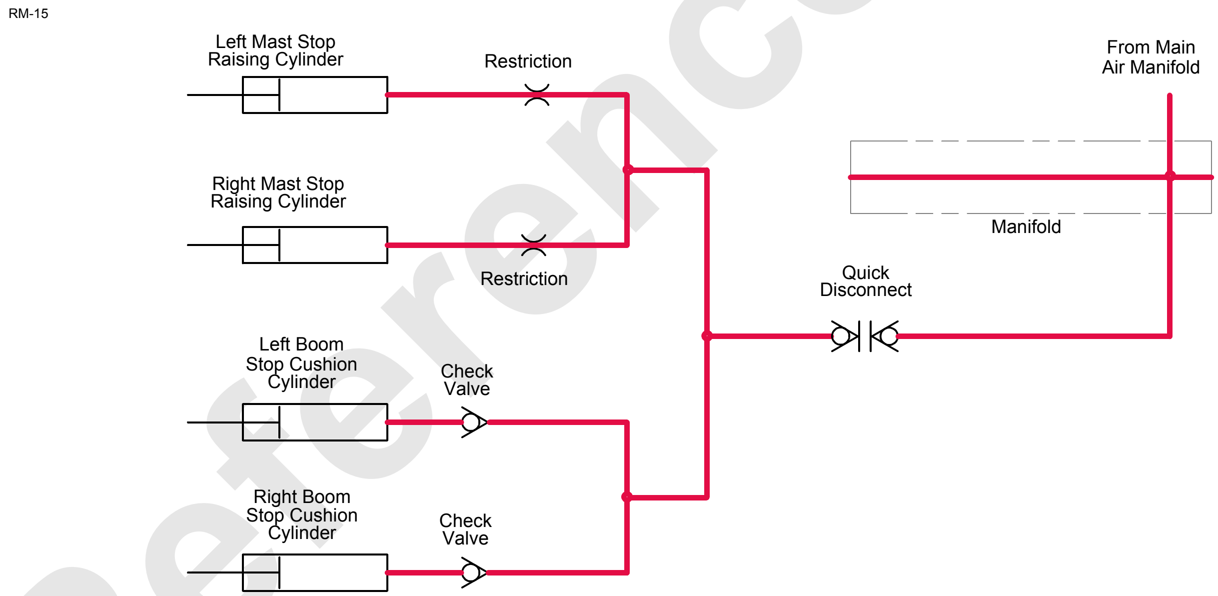


FIGURE 1-59

Mast Stop

Mast Stop Cylinders

See Figure 1-60 for the following.

The mast stop cylinders are connected to the mast and contact the gantry pins to stop the mast when at or near maximum mast angle. The hydraulically filled cylinders act as shock absorbers to cushion the mast as it contacts the gantry. After a certain distance, the mast stop cylinders bottom out to stop the mast's travel.

Mast Stop System Operation

See Figure 1-60 for the following.

The crane's auxiliary pump supplies pressurized hydraulic fluid to the mast stop cylinders and jib strut cylinders at 152 to 200 bar (2,200 to 2,900 psi). The system pressure is monitored and controlled by the mast accumulator pressure sensor. From the crane's auxiliary pump, pressurized hydraulic fluid goes through the quick disconnect at the mast butt, through an in-line check valve, and into an accumulator mounted on the mast butt.

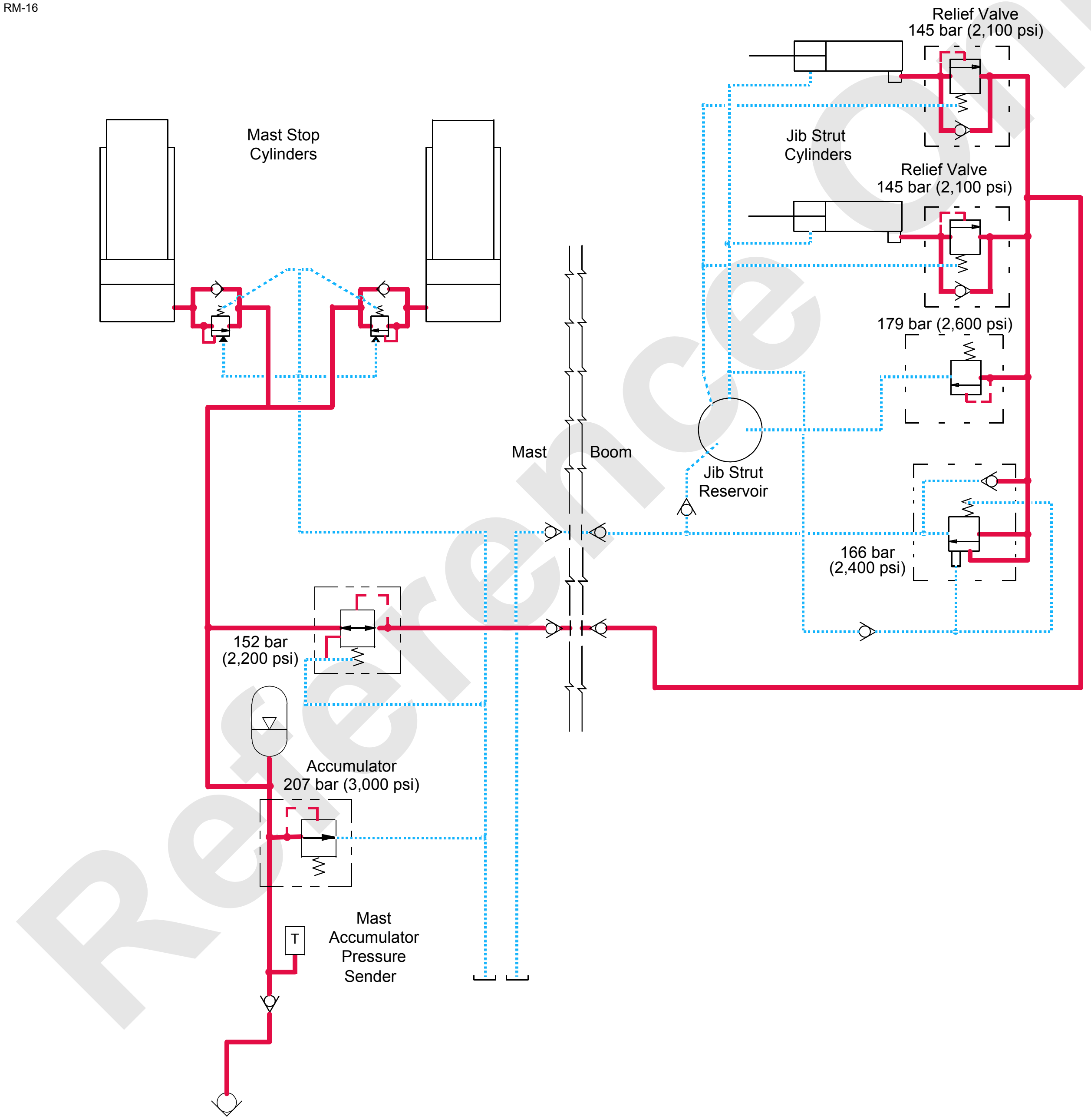


FIGURE 1-60

After the accumulator is filled, the mast stop cylinders and jib strut cylinders are filled with pressurized hydraulic fluid, monitored by the mast accumulator pressure sender. A pressure-relief valve opens at 207 bar (3,000 psi).

The auxiliary system's disable-relief valve HS-12 is set at 276 bar (4,000 psi) and protects the MAX-ER systems from excessive pressure by opening to the tank when the accessory items are disabled.

Each mast stop cylinder has a counterbalance valve at the cylinder piston end port. These valves hold hydraulic pressure at approximately 207 bar (3,000 psi) in the cylinders to cushion the mast.

Luffing Jib Stop Cylinders

See Figure 1-60 for the following.

Luffing jib stop cylinders on the jib strut act as hydraulic cushions for the jib struts. The jib stop cylinder ends contact the main jib base to prevent two-blocking between the main strut and jib strut. After a certain distance, the jib stop cylinders bottom out to stop the jib strut's travel. Pressure and return lines are routed from the accumulator at the mast butt to the jib strut cylinders mounted at the boom top.

Jib Stop System Operation

See Figure 1-60 for the following.

After the mast stop cylinders' system is filled, the jib strut cylinders' system is filled with hydraulic fluid until the pressure is 152 bar (2,200 psi), as controlled by a pressure-control pilot-reducing valve.

The jib strut cylinder-relief valves limit pressure to each cylinder at 145 bar (2,100 psi). Pressurized hydraulic fluid flows through the check valve part of the relief valves to the piston end of the cylinders to extend the jib strut cylinders. Hydraulic fluid from the piston end of the cylinders goes to the vertical hydraulic tank on the jib.

The jib strut cylinders' counterbalance vent valve is pilot operated and opens if system pressure exceeds 165 bar (2,400 psi).

The secondary-relief valve opens if inlet pressure to the cylinders exceeds 179 bar (2,600 psi). Hydraulic fluid from the primary- and secondary-relief valve goes to the vertical hydraulic tank on the jib. Excess hydraulic fluid in the vertical hydraulic tank is directed down the boom and returns to the crane's hydraulic tank.

Drum 9 Operation

See Figure 1-61 through Figure 1-64 for the following.

For MAX-ER configurations, drum 9 is mounted in the boom butt. The source of pressurized hydraulic fluid to operate drum 9 is from the crane's crawler travel system or boom hoist system depending on the crane's program version.

The left control handle controls the drum 9 operation. The corresponding number 9 green light comes on behind the left control handle. The programmable controller (PC) applies the drum 9 brakes, controls the crawler travel pump's speed, and selects the control handle operation depending on the crane's mode version. See Section 3 of MAX-ER Operator Manual for MAX-ER operation.

The motor loop flushing valves open when system pressure exceeds 14 bar (200 psi). The sequence/flow control valve removes 15 L/min (4 gpm) of hot fluid from the system by dumping the fluid in the motor's case where it returns to the tank.

When drum 9 is operating, the PC monitors input signals from the crawler travel pressure senders and adjusts the motor's displacement to maintain equal pressure.

The drum-flange-mounted speed sender monitors drum speed and controls drum overspeed. The speed sender sends a signal to the crane's PC that enables the rotation indicator in the drum's control handle. This indicator pulsates with a varying frequency depending on the drum's rotational speed.

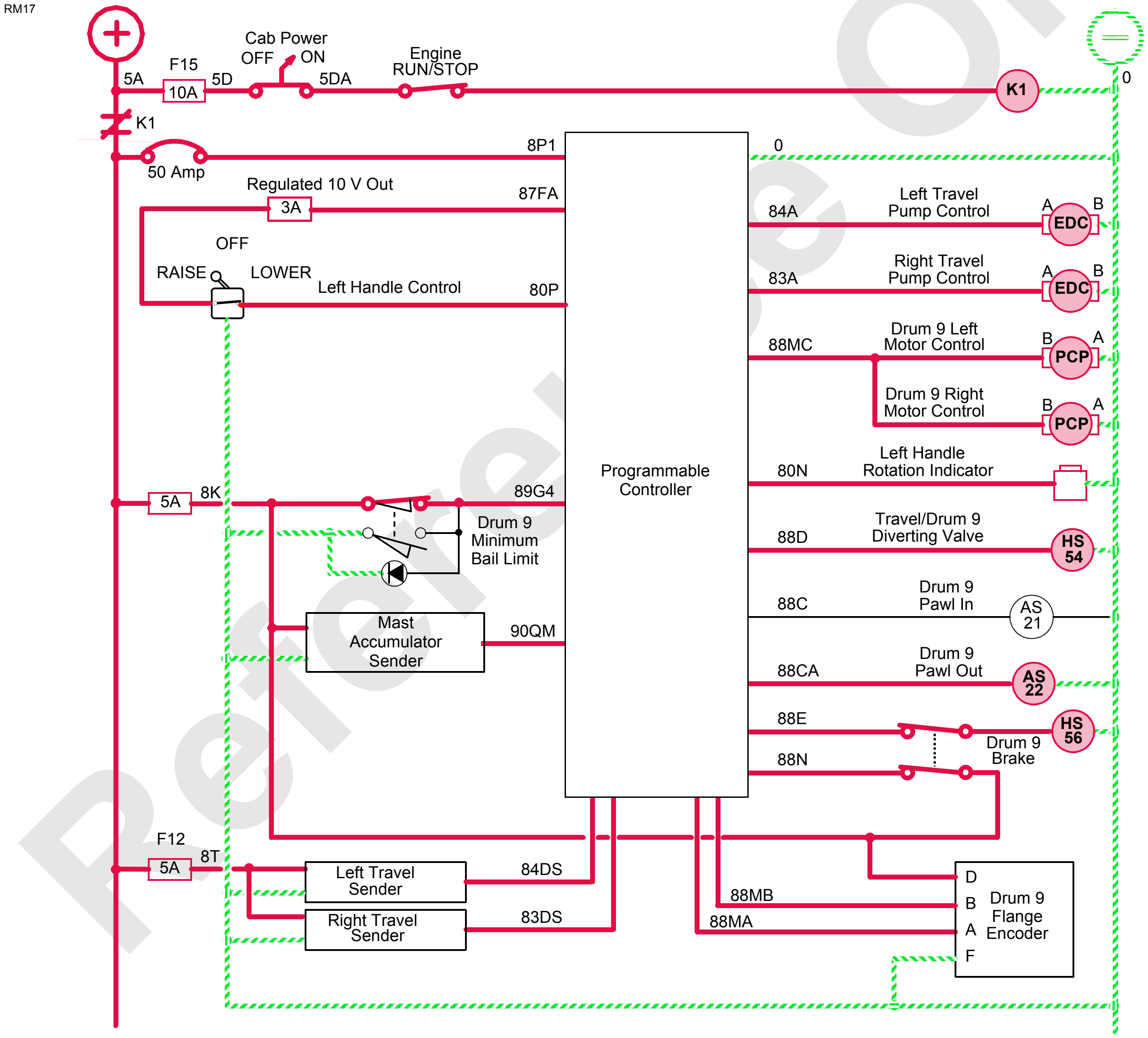


FIGURE 1-61

Drum 9 Brake

Drum 9 motors have hydraulic disc brakes that are spring-applied and hydraulically released. The brakes start to release at 13 bar (188 psi) and are fully released at 17 bar (246 psi). The PC controls the drum 9 disc brake release solenoid HS-56 with movement of the left control handle, when the drum 9 brake switch is in the OFF position. Drum 9 pawl is released and applied with the drum 9 brake switch.

Drum 9 Hoisting (MAX-ER Mode)

See Figure 1-61 and Figure 1-62 for the following.

When the left control handle (drum 9) is moved back to RAISE, the handle's neutral switch closes, sending an output voltage of 5 V or more to the crane's PC. The PC sends an output signal to shift the diversion solenoid valve HS-54 to allow fluid flow from the crawler's travel pumps through the diverting valve to the drum 9 motors.

The crane's PC also sends a negative output signal to stroke each of the crawler travel pump's EDC in the RAISE direction and a positive output signal to each motor's PCP. The crane's PC checks that the block-up limit switches are closed with no other systems' operating limits present.

The PC compares drum-holding pressure to the value stored in pressure memory. When system pressure is high enough, the PC sends a positive output signal to enable the brake solenoid HS-56. The brake solenoid shifts to block the tank port and opens the port to system charge pressure to release the brake.

The crane's PC sends a negative output voltage to each of the pumps' EDC that tilts the swashplate to stroke each pump in the RAISE direction. Hydraulic fluid at system pressure up to 407 bar (5,900 psi) flows from pump ports A to port A of the motors. Fluid from the motor ports B returns to the pump ports B.

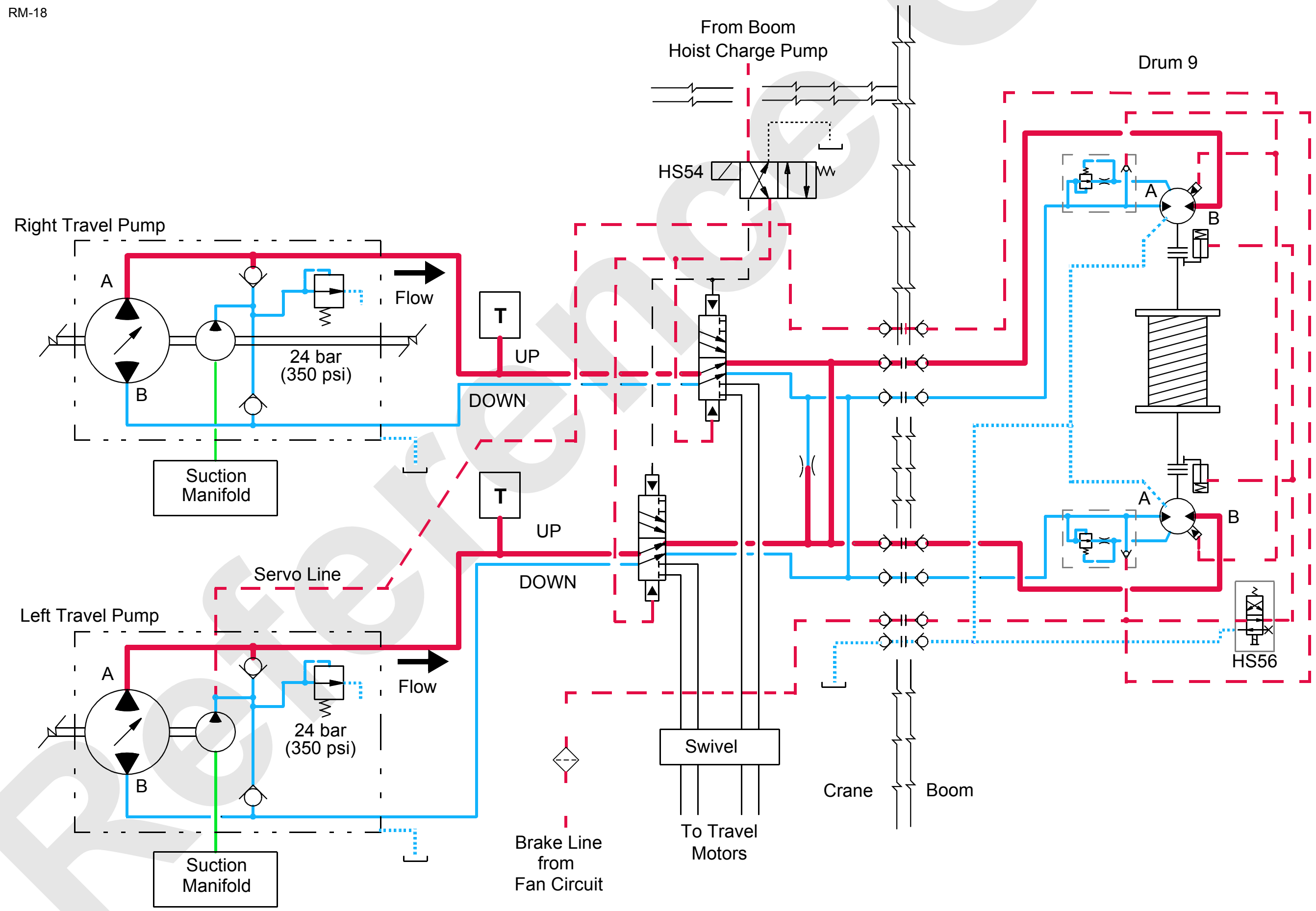


FIGURE 1-62

The crane's PC controls raising speed by varying the voltage to both pumps' EDC and motor's PCP in relation to the handle's movement. As the handle is moved back (RAISE), the crane's PC sends a signal to increase the pump's swashplate angle. The crane's PC also sends a signal to the motor's servo to reduce the motor's displacement. The crane's PC is continuously balancing the system pressure and the motor's displacement angle so the motor's displacement goes to minimum when the handle is all the way back, if torque requirement on the motors is not too high.

Knowing the displacement of the motors, the crane's PC may then control the speed that the motors turn by regulating the flow through the pumps.

When the left control handle is moved to the neutral position, the crane's PC sends an output signal to the travel pump's EDCs to decrease the swashplate angle, reducing oil flow output. This shifts the motor's servos back to maximum displacement for slower output speed to slow the drum's rotation. The crane's PC stores the load-holding pressure in pressure memory. After the control handle's neutral switch opens, the PC sends an output signal to disable the brake solenoid HS-56 to apply the brake before the travel pumps de-stroke.

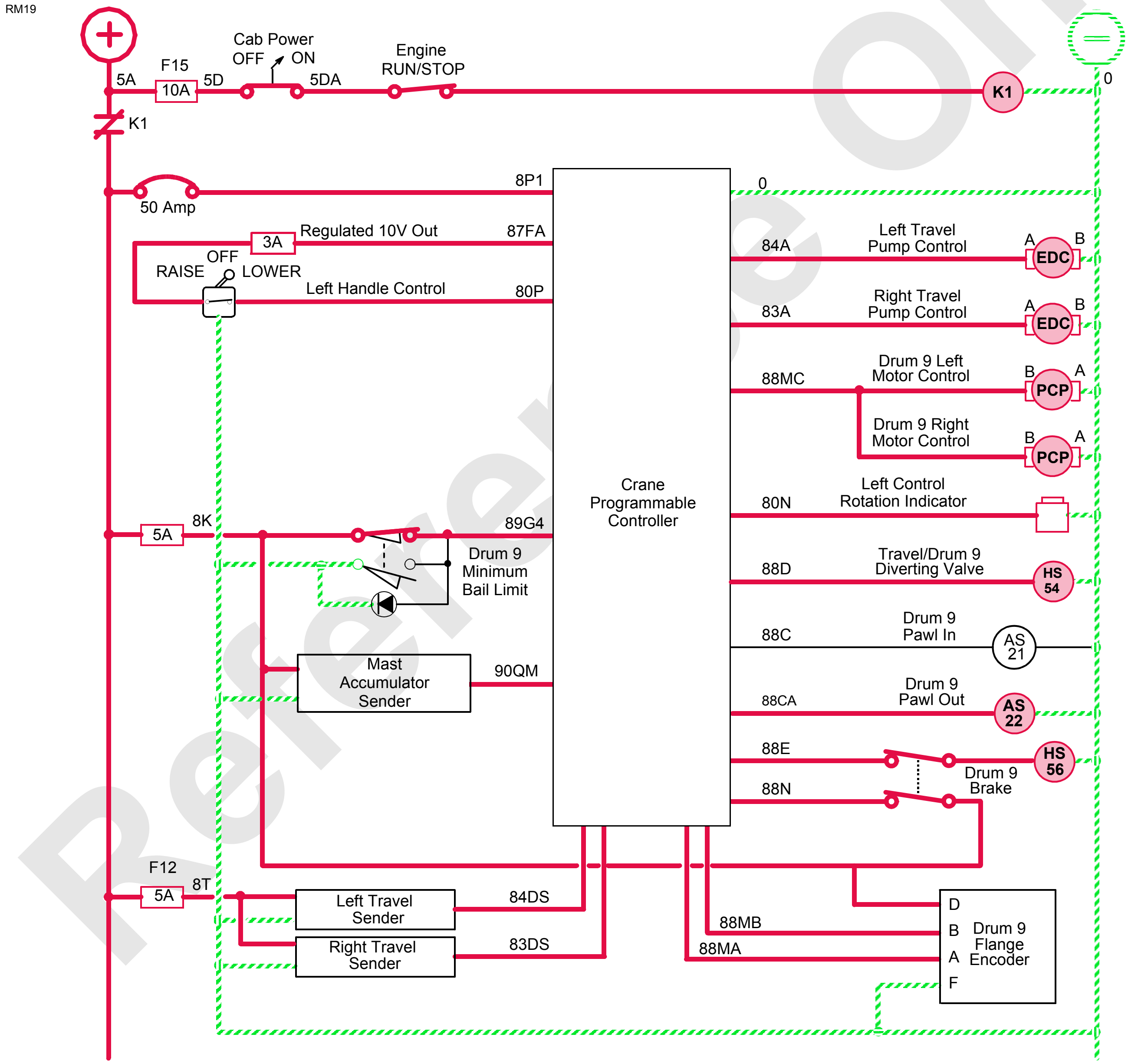


FIGURE 1-63

Drum 9 Lowering (MAX-ER Mode)

See Figure 1-63 and Figure 1-64 for the following.

When the left control handle (drum 9) is moved forward to (lower), the handle neutral switch closes, sending an output voltage of 5 V or less to the crane's PC. The PC sends an output signal to shift the diversion solenoid valve HS-54 to allow the fluid to flow from the crawler's travel pumps through the diverting valve to the drum 9 motors.

The crane's PC sends a negative output signal to stroke the crawler's travel pumps momentarily in the RAISE direction to satisfy pressure memory. The PC compares drum-holding pressure to the value stored in pressure memory. When system pressure is high enough, the PC sends a positive output signal to enable the brake solenoid HS-56. The brake solenoid shifts to block the tank port and opens the port to system charge pressure to release the brake.

The PC sends a positive output signal to stroke each crawler travel pump's EDC in the lower direction and a positive output signal to each motor's PCP. The crane's PC checks that the block-up limit switches are closed with no other system operating limits present.

The crane's PC sends a negative output voltage to each pump's EDC that tilts the pump's swashplate in the LOWER direction. Hydraulic fluid at system pressure up to 407 bar (5,900 psi) maximum flows from pump ports B to port B of the motors. Fluid from motor ports A returns to pump ports A.

The load weight attempts to drive the motors faster than return fluid is available to the pumps. The system charge pump maintains fluid supply at a positive pressure to the motors. The position of each pump's swashplate restricts the returning fluid flow. Pressure builds on the return fluid side of the closed-loop system, acting as a brake against the motors to control the lowering speed.

The crane's PC controls the lowering speed by varying the voltage sent to the EDCs in relation to the left control handle's movement to program requirements. Each pump's swashplate angle is increased as the handle is moved forward. As more fluid is returned to the pumps, more fluid is pumped to the motors, and the drum lowers the load faster.

When the left control handle is moved to the neutral position, the crane's PC sends an output signal to the travel pump's EDCs to decrease the swashplate angle, reducing oil flow output. The crane's PC stores the load-holding pressure in pressure memory. After the control handle's neutral switch opens, the PC sends an output signal to disable the brake solenoid HS-56 to apply the brake before the crawler travel pumps de-stroke.

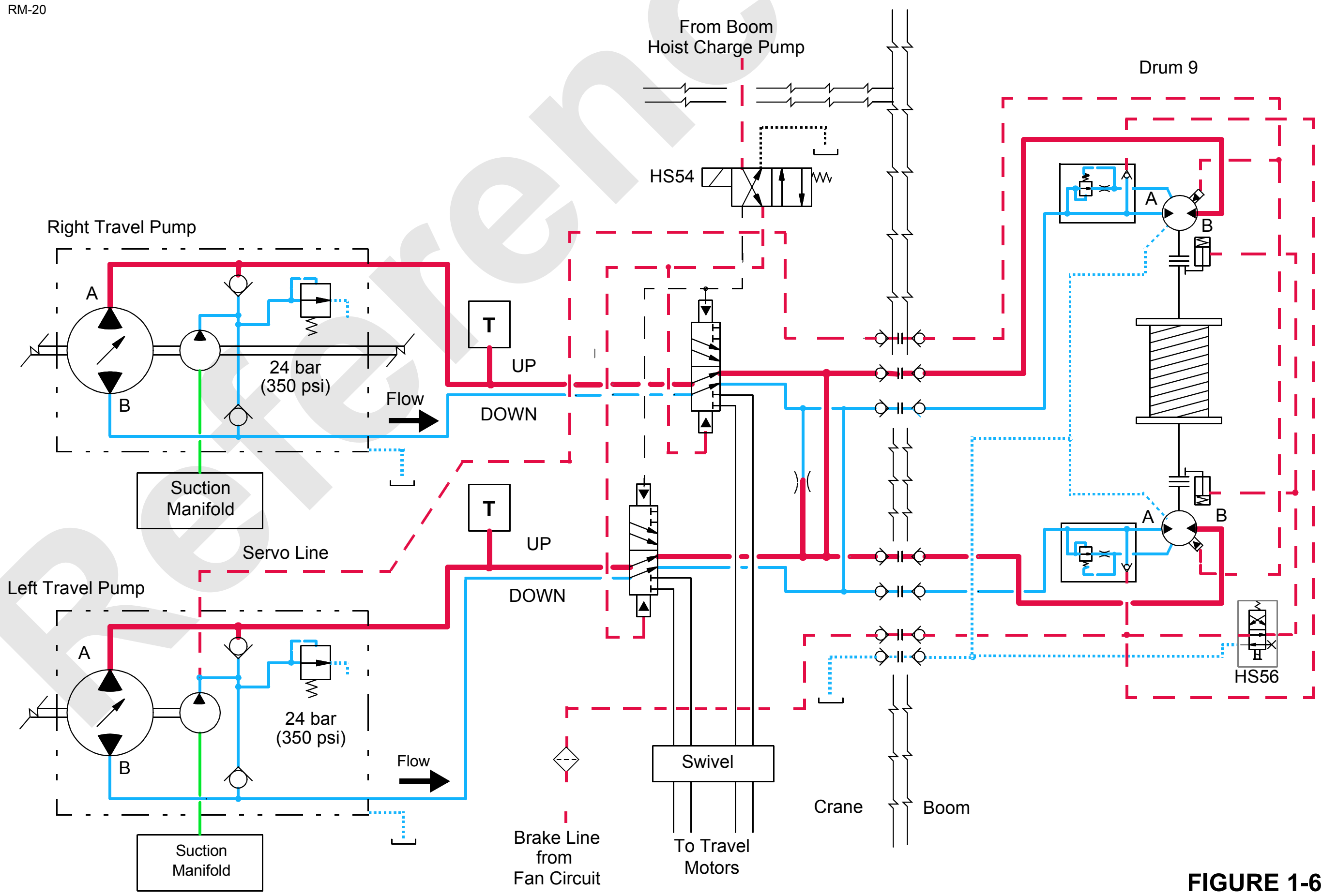


FIGURE 1-64

HYDRAULIC COOLER FAN DRIVE

See Figure 1-65 for the following.

Description

The cooler fan drive assembly includes two hydraulic-driven motor variable-speed fans. Each fan is 749 mm (29.5 in) in diameter and has seven blades. The accessory pump supplies the pressure to run the fan motors. As the engine load increases, fan speed will also increase to meet the engine's cooling needs.

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

A variable-speed fan provides several benefits over fans for which operating speed is determined by engine speed. These benefits include quieter operation, higher efficiency, and longer fan life. This type of fan also helps keep the engine running more consistently at its optimal temperature and results in increased available engine power when full fan speed is not required.

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

Maintenance

Fan speed is determined by the greatest demand of four inputs:

- Coolant temperature
- Air intake temperature
- Hydraulic oil temperature
- State of the air conditioning clutch

The system monitors these inputs every 10 seconds and adjusts the fan speed depending on the input readings.

A high-temperature fault may be triggered by a coolant, air intake, or hydraulic oil temperature that exceeds the normal temperatures. If such a fault occurs, the operator or service person should investigate the cause.

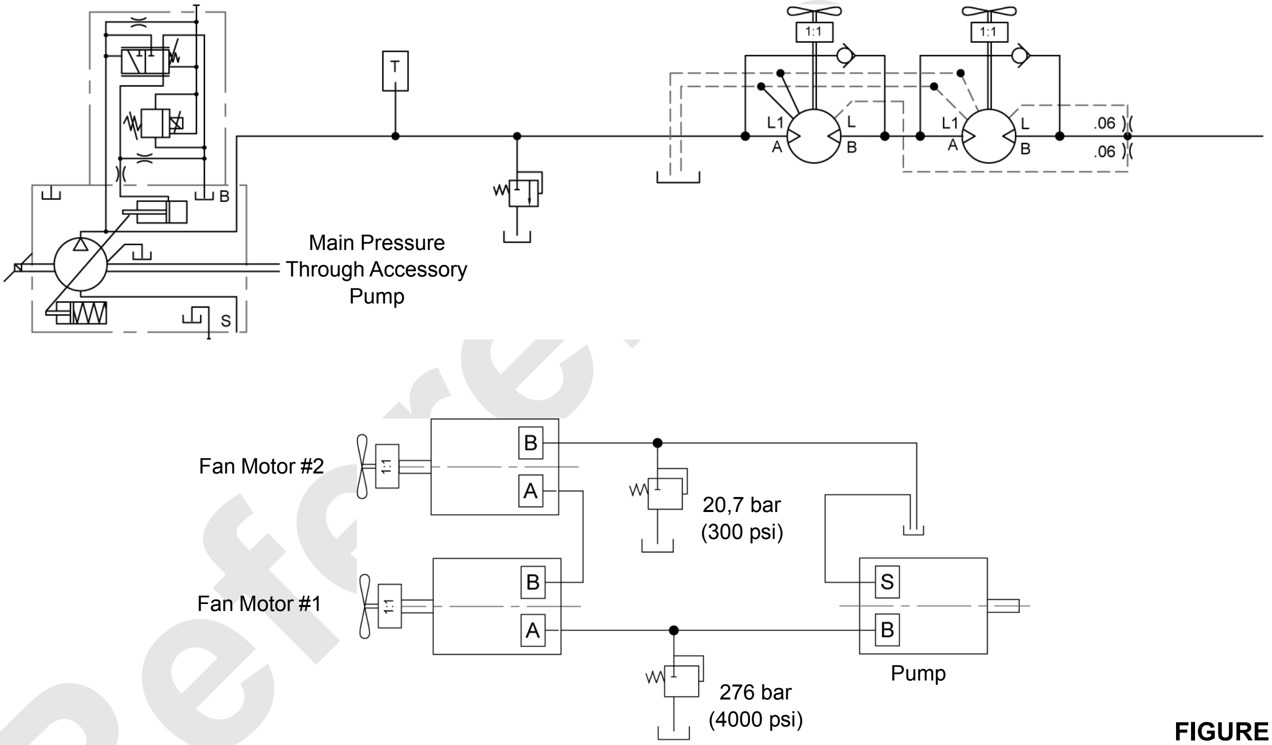


FIGURE 1-65

SECTION 2
HYDRAULIC AND AIR SYSTEMS

TABLE OF CONTENTS

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SECTION 2

HYDRAULIC AND AIR SYSTEMS

HYDRAULIC SCHEMATICS

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

HYDRAULIC SYSTEM—GENERAL

This section contains maintenance, adjustment, and test procedures for the hydraulic system and related components on the Model 2250.

Experienced technicians trained in the operation of this crane and its hydraulic system shall perform these procedures. The technicians shall read, understand, and comply with all instructions and with the display screen instructions in Section 3 of the Operator Manual. Contact your Manitowoc Cranes dealer for an explanation of any procedure not fully understood.

Adjustment, calibration, and test procedures were performed on 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 Cranes dealer.

CAUTION

Hydraulic System Damage!

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

Do not alter specifications without the approval of your Manitowoc Cranes dealer.

CHECKING AND REPLACING HYDRAULIC HOSES

⚠ CAUTION

Burn Hazard!

Personal injury may occur due to contact with oil in the hydraulic tank that is under pressure and extremely hot.

Ensure that the 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 the hose
   - **b.** Damaged, cut, or abraded cover
   - **c.** Exposed reinforcement
   - **d.** Kinked, crushed, flattened, or twisted hose
   - **e.** Hard, stiff, heat-cracked, or charred hose
   - **f.** Blistered, soft, degraded, or loose cover
   - **g.** Cracked, damaged, or badly corroded fittings
   - **h.** Fitting slippage on hose
   - **i.** Other signs of significant deterioration

   If any of these conditions exist, evaluate the hose assemblies for correction or replacement.
2. At the same service interval, visually inspect all other hydraulic components and valves for the following.
   - **a.** Leaking ports
   - **b.** Leaking valve sections or manifolds and valves installed into cylinders or onto motors
   - **c.** Damaged or missing hose clamps, 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 Zone B with high ambient temperatures and high-duty circuits could see hose service life reduced by 40% to 50%. High-duty circuits can include, but are not limited to, hoist(s), boom lift, swing, travel, pump suction and discharge to directional valves and directional valve return to reservoir. It is recommended to replace these hoses after 4,000 to 5,000 hours of service life.

Table 2-1. Climate Zone Classification

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

Hydraulic hose assemblies operating in Zone D and Zone E (cold climates) should expect a degradation of mechanical properties. Long-term exposure to these cold temperatures will negatively impact service life. It is recommended these hoses be inspected as indicated in step 1.

HYDRAULIC SYSTEM MAINTENANCE

Safety

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

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

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

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

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

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

Storing and Handling Oil

Adhere to the following when storing and handling oil:

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

Storing and Handling Parts

Adhere to the following when 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 the parts are needed.
- Once unpacked, carefully inspect each part for damage that may have occurred during shipping. Remove all shipping material from the ports of the parts before installing.
- Fittings, hoses, and tubes that are not equipped with shipping caps or plugs must be carefully cleaned before they are used. Flush these parts 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 the 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. Inspection frequency depends on operating conditions and experience with the system. The more often the system is inspected and deficiencies are corrected, the less likely it is that the system will malfunction.

A good inspection program includes the following checks:

- Keep accurate records so future maintenance needs can be projected.
- Only use approved hydraulic oil in the system. See Lubrication Section 9 for more information.
- Check the oil level in the tank daily. Carefully clean the area around the fill cap before removing it to add oil. When adding oil to the tank, filter the oil through a 10-micron filter.
- Clean the exterior of the system often. Do not let dirt accumulate on or around any part of the system.
- Check for external leaks. Leaks are not only unsafe, but they also attract dirt, and in some cases, allow air and water to enter the system. Do not return leakage oil back to the hydraulic tank.
- Look for oil leaking from fittings and from between parts that are bolted together. Tighten loose fittings and attaching bolts to the proper torque, and do not overtighten.

  If leaks continue, replace necessary seals or gaskets.
- Look for oil leaking from pump and motor shaft ends, from valve spool ends, and from cylinder shaft ends. Replace the necessary seals 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 the inlet fitting, hose, or tube with oil. If there is an air leak, the oil will cause a noticeable reduction in noise. Correct the cause of any air leak, or the pump/motor will be damaged.

  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:

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

NOTE: Do not return leakage oil back to the hydraulic tank.

- Inspect for signs of overheating, such as heat-peeled parts, a burned or scorched oil odor, and darkening and thickening of oil. The maximum temperature of the oil in the tank must not exceed 82°C (180°F).
- Have the hydraulic oil analyzed at regular intervals to determine the condition of oil and the extent of system contamination.

  By having the oil analyzed on a regular basis, an oil change interval that meets 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.

Servicing the Pumps

See Figure 2-1 for the following.

It is not necessary to drain the hydraulic tank when servicing the hydraulic pumps. To service the pumps, close the hydraulic tank shut-off valve in the pump suction line.

After servicing the pumps, open the valve prior to starting the engine. The valve can be locked open with a padlock.

CAUTION

Hydraulic Pump Damage!

Running the hydraulic pumps without an adequate oil supply will result in damage to the pumps from cavitation.

Open the hydraulic tank shut-off valve before starting the engine.

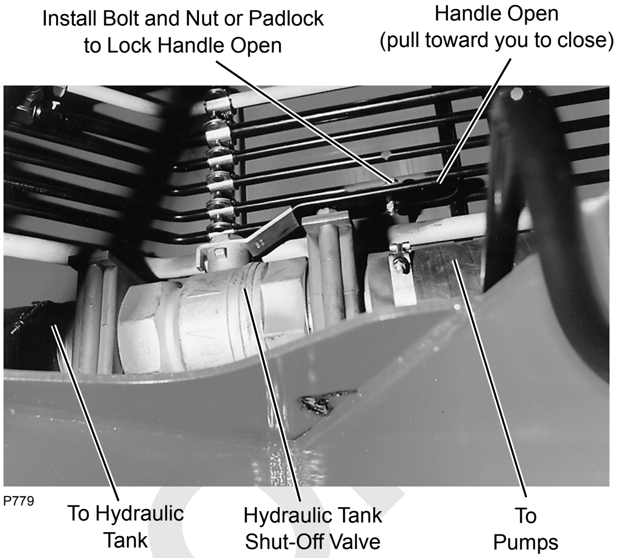


FIGURE 2-1

Cleaning the Fill Cap Assembly

See Figure 2-2 for the following procedure.

1. Clean the fill cap weekly to ensure that the ventilating ports in the fill cap remain open.
   a. Clean the area around the fill cap.
   b. Remove the fill cap from the flange.
   c. Thoroughly clean the fill cap with a clean, nonflammable solvent. Blow dry the fill cap with compressed air.
   d. Reattach the fill cap to the flange.

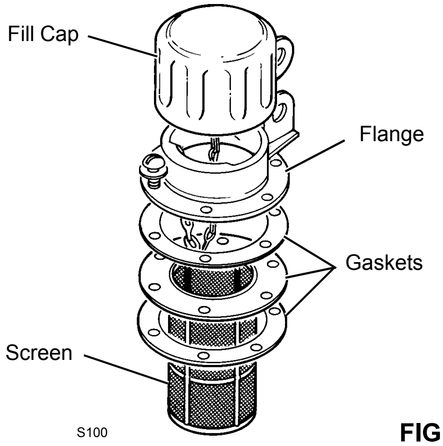


FIGURE 2-2

2. Clean the entire fill cap assembly whenever the hydraulic oil is changed.
   a. Clean the area around the fill cap.
   b. Disassemble the fill cap.

- **c.** Thoroughly clean the fill cap and screen in a clean, nonflammable solvent and blow dry the parts with compressed air.
- **d.** Replace the screen if it is damaged.
- **e.** Install new gaskets if necessary.
- **f.** Assemble the screen, gaskets, and flange to the tank. Tighten the screws evenly.
- **g.** Securely fasten the fill cap to the flange.

Replacing the Suction Filter Element

See Figure 2-3 for the following procedure.

The system faults alert will come on in the operator's cab when the filter elements are plugged with dirt. See Section 3 of the Operator Manual for more information.

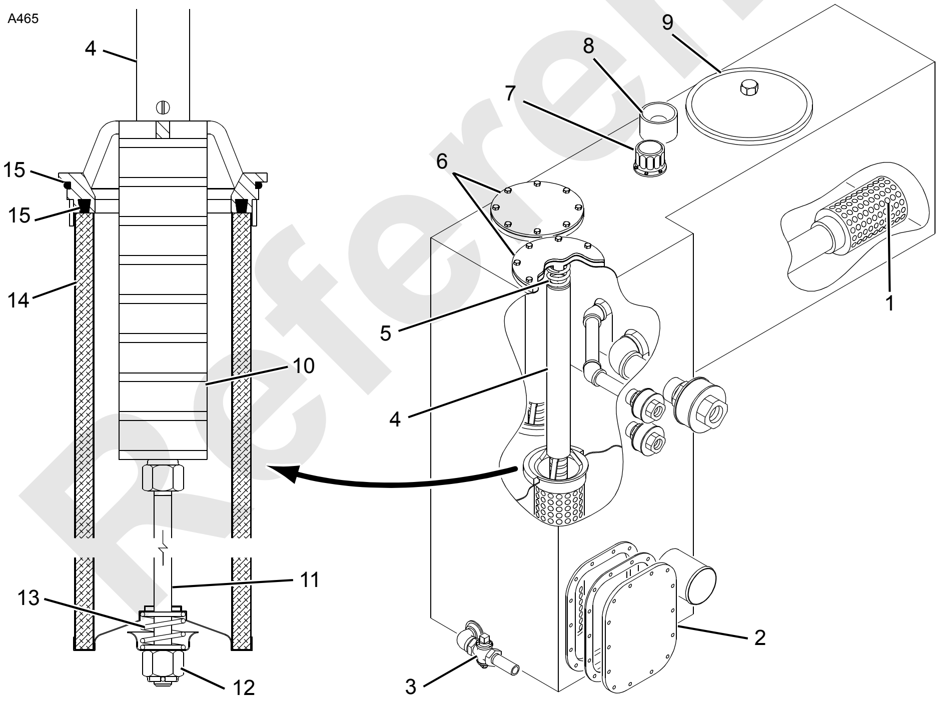
Replace both elements when the alert comes on and at each oil change.

NOTE: The hydraulic tank does not need to be drained to replace the filter elements (except when changing the oil).

1. Stop the engine.
2. Remove the filter access cover (6).
3. Remove the filter spring (5).
4. Lift the filter assembly out of the tank using the insert (4).
5. Remove the bypass spring (13).
6. Remove the filter element (14) by twisting it off and discard.
7. Clean the magnetic core (10) with a lint-free cloth.
8. Check all seals (15) for damage and replace them if necessary.
9. Lubricate the seals with clean hydraulic oil.
10. Install a new filter element.

NOTE: For ease of mounting, hold the element away from the magnetic core until the stud (11) is through the hole in the bottom of the element. Then slide the element up to securely seat it with the top of the filter housing.

11. Install the bypass spring assembly. Tighten the nut (12) until snug.
12. Reinstall the filter assembly in the tank housing.
13. Reinstall the filter spring (5), gasket, and filter access cover.
14. Evenly tighten the capscrews holding the cover in place.
15. Perform step 2 through step 14 for the other element.
16. Fill the hydraulic tank to the specified level with the proper hydraulic oil (see Lubrication Section 9). When adding oil to the tank, filter the oil through a 10-micron filter.



Suction Filter
(2 each)
View B

Hydraulic Tank
(right corner of rotating bed)
View A

Item	Description
1	Diffuser (qty 2)
2	Clean-Out Cover
3	Drain Valve
4	Insert (qty 2)
5	Filter Spring (qty 2)
6	Filter Access Cover (qty 2)
7	Fill Cap
8	Level Gauge
9	Clean-Out Cover
10	Magnetic Core (qty 2)
11	Stud (qty 2)
12	Nut (qty 2)
13	Bypass Spring (qty 2)
14	Filter Element (qty 2)
15	Seal (qty 4)

FIGURE 2-3

Changing the Oil

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

See Figure 2-3 for the following procedure.

1. Operate the crane until the hydraulic oil is at its normal operating temperature. This will help prevent impurities from settling in the system.
2. Stop the engine.
3. Open the drain valve (3) on the hydraulic tank to completely drain the tank.

CAUTION

Air System Contamination!

Dust, dirt, and other debris can contaminate and damage the air intake system.

Clean the outside of the air piping to prevent contaminates from entering the air intake system when the air piping connection is opened to access the hydraulic tank clean-out covers.

Hydraulic Oil Contamination!

Dust, dirt, and other debris can contaminate and damage the hydraulic system.

Take precautions to prevent contaminates from entering the tank while the covers are off.

4. Disconnect the air piping at the connections to fully access the clean-out cover (2).
5. Clean all dirt off the clean-out cover.
6. Remove the cover from the tank and proceed as follows.
    a. Clean out any sediment inside the tank.
    b. Remove the diffusers (1) from inside the tank.

       Soak the diffusers in diesel fuel and blow them clean and dry with compressed air. Replace any damaged parts.
    c. Reinstall the diffusers after cleaning.
7. Use new seals and fasten the clean-out covers to the tank.
8. Replace the suction filter elements.
9. Clean the fill cap assembly.
10. Fill the hydraulic tank to the specified level with the proper hydraulic oil (see Lubrication Section 9). When adding oil to the tank, filter the oil through a 10-micron filter.
11. Start and run the engine at low speed for 10 to 15 minutes to fill all the lines with oil and to bleed any air from the system.
12. Stop the engine and fill the hydraulic tank to the specified level.

NOTE: If the hydraulic system is extremely dirty (gum or lacquer formation on parts indicated by erratic, jerky, or sluggish operation), change the oil again after 48 hours of operation.

Table 2-2. Hydraulic System Specifications

Function	Direction	Pump-Motor Port Connections	System Pressure 1 [1] bar (psi)	System Pressure 2 [2] bar (psi)	Charge Pressure bar (psi)	Speed [3] rpm
Drum 1[9] Low Speed	Lower	Pump B to Motor B	200 (2,900) Lower 420 (6,090) Hoist	N/A	24 (350)	40 to 48
Drum 1[9] Low Speed	Hoist	Pump A to Motor A				45 to 50
Drum 1[9] High Speed	Lower	Pump B to Motor B				50 to 56
Drum 1[9] High Speed	Hoist	Pump A to Motor A				
Drum 2[4] Low Speed	Lower	Pump B to Motor B				40 to 48
Drum 2[4] Low Speed	Hoist	Pump A to Motor A				45 to 50
Drum 2[4] High Speed	Lower	Pump B to Motor B				50 to 56
Drum 2[4] High Speed	Hoist	Pump A to Motor A				
Drum 3[4] Low Speed	Lower	Pump B to Motor B				40 to 48
Drum 3[4] Low Speed	Hoist	Pump A to Motor A				45 to 50
Drum 3[4] High Speed	Lower	Pump B to Motor B				50 to 56
Drum 3[4] High Speed	Hoist	Pump A to Motor A				
Boom Hoist Drum 4[5]	Lower	Pump B to Motor A	200 (2,900) Lower 420 (6,090) Hoist	N/A	24 (350)	14 to 17
	Hoist	Pump A to Motor B				16 to 18
Luffing Jib Hoist Drum 5[5]	Lower	Pump B to Motor B				34 to 40
	Hoist	Pump A to Motor A				38 to 42
MAX-ER Main Hoist Drum 9[6]	Lower	Pump B to Motor A				38 to 46
	Hoist	Pump A to Motor B				43 to 48
Rigging Winch	Haul In	N/A	204 (3,000)	N/A	N/A	85 to 90
	Pay Out	N/A				
Swing Single Drive	Left	Pump A to Motor A	420 (6,090) Right or Left	N/A	24 (350)	1.1 to 1.5
	Right	Pump B to Motor B				
Swing Dual Drive[7]	Left	Pump A to Motors A				
	Right	Pump B to Motors B				
Swing Dual Drive High Speed[7]	Left	Pump A to Motors B				
	Right	Pump B to Motors A				
Left Side Travel[6]	Forward	Pump B to Motor A	420 (6,090) Forward or Reverse			8 to 9 at Tumbler
	Reverse	Pump A to Motor B				
Right Side Travel[6]	Forward	Pump B to Motor A				
	Reverse	Pump A to Motor B				
Accessory Pumps [8]	N/A	Open Loop to Tank	N/A	0 to 241 (0 to 3,500)	N/A	N/A
Fan Pump[10]	N/A	Open Loop to Tank	224 (3,250)			

Notes	
1	This is controlled by multi-function valves in each pump.
2	This is controlled by the crane's programmable controller.
3	Speeds are based on engine at high idle, no load (no rope on drums), and handles moved fully forward or back.
4	The same pump is used for split rear drum 2 or 3. The active drum is selected by the first handle moved.
5	This is the pump used for Boom Hoist 4 or Luffing Jib Hoist 5. The active drum will not hoist until the alternate drum is parked.
6	These are the pumps used for MAX-ER Main Hoist Drum 9 or travel left side and right side.
7	Dual swing standard with MAX-ER 2000 prep. High-speed swing motors optional for clamshell operation.
8	Accessory pumps are the source of hydraulic pressure for the 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, crawler pin cylinders, and MAX-ER 2000. The computer controls pump pressure depending on the accessory selected.
9	Optional Front Drum 1 is not present in MAX-ER configuration.
10	The fixed-displacement fan pump also supplies low pressure to MAX-ER Drum 9 accessory.

TIGHTENING THE HYDRAULIC CONNECTIONS

General

1. Make sure the fittings and O-rings being used are the proper size and style.
2. Flush the sealing surfaces with clean hydraulic oil to remove any dirt.
3. Carefully inspect the threads and sealing surfaces for nicks, gouges, and other damage. Do not use damaged parts. They will leak.
4. Carefully inspect O-rings for cuts and other damage. Do not use damaged O-rings. They will leak.
5. Lubricate O-rings when assembling them to fittings.
6. Be careful not to cut O-rings when assembling them to fittings. Use a thimble as shown in Figure 2-4 when assembling an O-ring over threads.

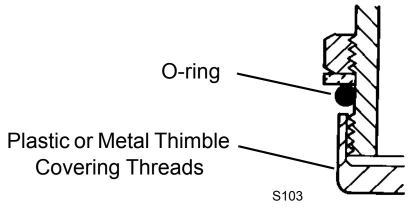


FIGURE 2-4

Pipe Thread Connection

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

CAUTION

Hydraulic System Damage!

Debris can contaminate and damage the hydraulic system.

Do not use FTE-fluorocarbon tape to seal threads. Pieces of tape will enter the hydraulic system and cause damage.

---

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

Table 2-3. Pipe Thread Leakage

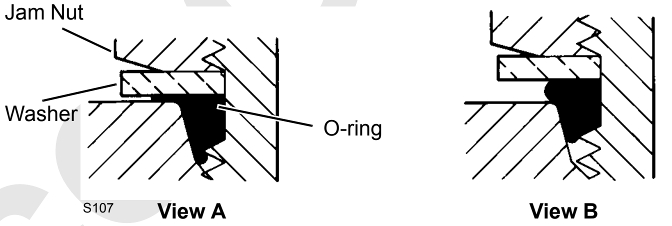
Cause	Cure
Fitting loose	Tighten
Fitting too tight causing thread distortion	Replace damaged parts
Fitting or port threads wrong size	Use proper size threads
Threads dirty, galled, or nicked	Clean or replace parts
Straight thread used instead of tapered thread	Use proper type and size thread
Female threads expanded from heat	Tighten when hot

SAE Straight Thread Connection

See Figure 2-5 for the following.

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

As shown in View A, 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 View B, the compressed rubber between the washer and the spot face will cold flow out of compression, causing the fitting to loosen and leak.



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

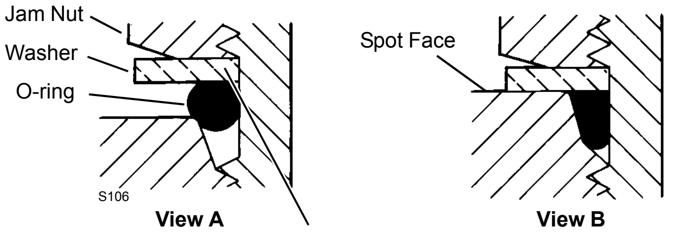
View B: The washer cannot seat properly on the spot face. Compressed rubber between the washer and spot face will cold flow out of compression, causing the fitting to loosen and leak.

FIGURE 2-5

See Figure 2-6 for the following procedure.

Tighten SAE straight thread connections, as follows.

1. Back up the jam nut and washer to the end of the smooth portion on the fitting (View A).



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

FIGURE 2-6

2. It is important to lubricate the O-ring with clean oil.
3. Thread the fitting into the port until the washer bottoms against the spot face (View B).

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

4. Tighten the jam nut. When the fitting is properly installed, the O-ring will completely fill the seal cavity and the washer will be tight against the spot face (View B).

Table 2-4. Straight Thread Leakage

Cause	Cure
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 are scratched or gouged	Repair if possible or replace damaged parts
Sealing surfaces dirty	Clean and lubricate

ORS® Connection

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

1. Lubricate and install the O-ring in the adapter groove (Figure 2-7).

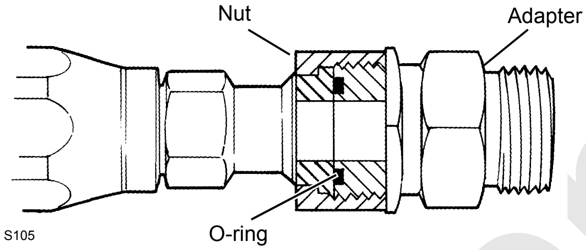


FIGURE 2-7

2. Lubricate the threads. Tighten the nut to the torque value given in Table 2-5.

Table 2-5. ORS® Assembly Torque

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

Table 2-6. ORS® Leakage

Cause	Cure
Nut loose	Tighten to proper torque
O-ring cut	Replace
O-ring wrong size	Replace with proper size
Sealing surfaces gouged or scratched	Repair/replace damaged parts
Sealing surfaces dirty	Clean and lubricate

Split Flange Connection

1. Lubricate and install the O-ring in the shoulder groove (Figure 2-8).

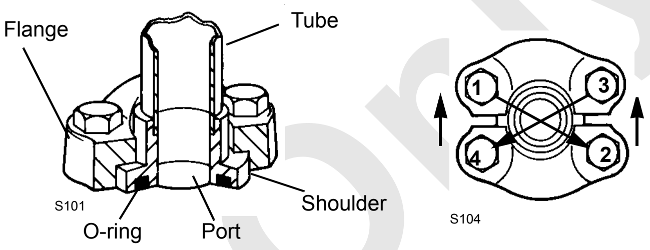


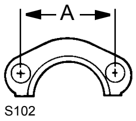
FIGURE 2-8

2. Align the shoulder with the port and assemble the flanges over the shoulder.

NOTE: The bolts used must be grade 5 or better. A grade 5 bolt has three dashes in its head.

3. Snug the bolts in a diagonal manner as shown in Figure 2-8 to 1/3 of the torque given in Table 2-7.
4. Repeat step 3 to 2/3 of the final torque.
5. Repeat step 3 to the final torque.

Table 2-7. Split Flange Assembly Torque

Dimension A inch 	Flange Size	Torque	
		Nm	in-lb
Standard Pressure Series			
1-1/2	-08	20 to 25	175 to 225
1-7/8	-12	25 to 40	225 to 350
2-1/16	-16	37 to 48	325 to 425
2-5/16	-20	48 to 62	425 to 550
2-3/4	-24	62 to 79	550 to 700
3-1/16	-32	73 to 90	650 to 800
High Pressure Series			
1-9/16	-08	20 to 25	175 to 225
2	-12	34 to 45	300 to 400
2-1/4	-16	57 to 68	500 to 600
2-5/8	-20	85 to 102	750 to 900

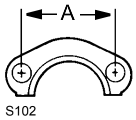
Dimension A inch 	**Flange Size**	**Torque**	
		Nm	in-lb
3-1/8	-24	158 to 181	1400 to 1600
3-13/16	-32	271 to 294	2400 to 2600

Table 2-8. Split Flange Leakage

Cause	Cure
Flanges not tight	Tighten bolts evenly to proper torque
Flanges tightened unevenly causing extrusion of O-ring	Replace O-rings and tighten bolts evenly to proper torque
O-ring cut	Replace
O-ring wrong size	Replace with proper size
Sealing surfaces are not smooth. They are 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 and retighten bolts after system is hot

SAE Flare Connection

See Figure 2-9 for the following procedure.

1. Tighten the nut finger tight until the sealing surfaces touch.
2. Using a felt pen or marker, mark a line on the adapter and extend it onto the connector nut (View A).
3. Using wrenches, tighten the connector nut the number of flats shown in Table 2-9.

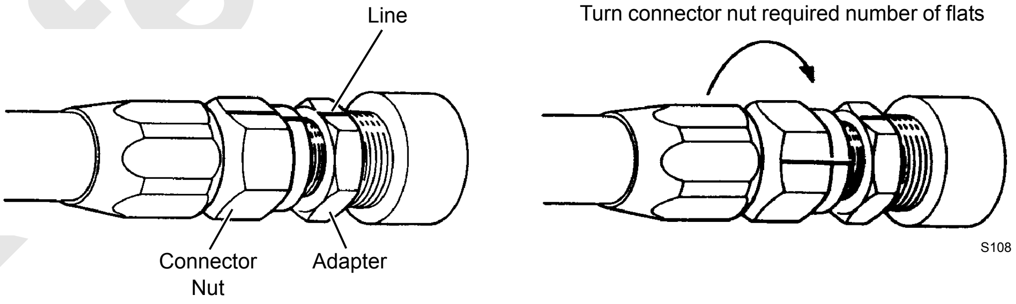
   Misalignment of the marks will show how much the nut has been tightened.

Table 2-9. 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 to 2
1-1/4	-12	1
1-1/2	-16	3/4 to 1
2	-20	3/4 to 1
2-1/4	-24	1/2 to 3/4

Table 2-10. SAE 37° Flare Leakage

Cause	Cure
Joint loose	Tighten properly
Sealing surfaces dirty	Clean
Sealing surfaces are 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



View A **View B**

FIGURE 2-9

PROGRAMMABLE CONTROLLER CALIBRATION PROCEDURES

General

To ensure proper operation of the crane functions, the pressure senders and controls must be properly calibrated as described below.

Calibrating the Pressure Sender

When the pressure sender calibration screen is accessed and calibration is started, the crane's programmable controller zeros the pressure senders to ensure accurate pressure signals.

The pressure transducers must be calibrated at the following instances and/or intervals:

- Installation of a new programmable controller
- Installation of a new CPU board
- Replacement of a pressure sender
- Every six months
- Incorrect displayed pressure

If there is any residual pressure in the system during the calibration process, the display pressure reading in the cab may not reflect the actual system pressure. See the note at the end of this procedure regarding replacing a pressure sender.

To calibrate pressure senders, proceed as follows.

1. Access the diagnostic screens by pressing the Limit Bypass switch while scrolling up with the scroll switch.
2. Scroll until the Control Calibration screen appears (Figure 2-10).

PRESS SENDER CAL
BYPASS TO START

FIGURE 2-10

3. Stop the engine (leave the ignition and cab power switches on), turn the Limit Bypass key clockwise, and hold the key. It is normal for the yellow Operating Limits light to come on during this procedure.

   Calibration will not start if the engine is running and the screen shown in Figure 2-11 appears. Likewise, the same screen appears and calibration stops if the engine is started during calibration.

PRESS SENDER CAL
ENGINE MUST BE OFF

FIGURE 2-11

4. Repeat step 3 if the engine is running or if the engine is started.

   When calibration starts, the screen shown in Figure 2-12 appears to indicate the percentage of completion. It takes approximately 1 minute to complete this process.

PRESS SENDER CAL
___% COMPLETE

FIGURE 2-12

   When calibration is complete, the Start screen shown in Figure 2-10 reappears.

5. Check the data bank in the upper right corner of the screen. If a pressure sender/pump failed the test, the fail item's binary number is displayed.

   See Table 2-11 for a list of the binary numbers and their corresponding descriptions.

Table 2-11. Pressure Sender Binary Numbers

Binary No.	Pump No.	Description
1	1	System Pressure (main hoist)
2	3	System Pressure (swing left)
4	3	System Pressure (swing right)
8	1	Charge Pressure (main hoist)
16	2	System Pressure (boom and luffing drums)
32	4	System Pressure (travel/drum 9 on MAX-ER)
64	5	System Pressure (left travel)
128	0	System Pressure (independent luffing)

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.

6. Before replacing a pressure sender, perform the following steps.
   a. Perform the pressure sender calibration steps.
   b. Attach an accurate hydraulic pressure gauge to the quick-coupler at the suspect pressure transducer.
   c. If pressure appears on the gauge, bleed the corresponding system so the gauge reads zero pressure.
   d. Repeat the calibration steps and check the pressure on the display in the cab with the engine running at idle. The display reading and the gauge reading should be the same.
   e. Before replacing a pressure sender, check the signal voltage at the sender. It should be 1.0 volt against ground at 0 psi.

Calibrating the Controls

The controls must be calibrated at the following instances and/or intervals:

- Replacement of a pump
- Replacement of a pump control (EDC or PCP)
- Installation of a new programmable controller
- Installation of a new CPU board
- When there is a noticeable increase in the time it takes a crane function to engage when the handle is pulled back from OFF
- Every six months

To calibrate the controls, proceed as follows.

1. Access the diagnostic screens by pressing the Limit Bypass switch while scrolling up with the scroll switch.
2. Scroll until the Control Calibration screen appears (Figure 2-13).

CONTROL CALIBRATION
BYPASS TO BEGIN

FIGURE 2-13

3. Increase engine speed to high idle and press the Limit Bypass switch.

NOTE: It is normal for the yellow Operating Limits light to come on during this procedure.

The calibration process does not start if the engine is not at high idle. The calibration process stops if engine speed is decreased during calibration. In either case, the screen shown in Figure 2-14 appears.

CONTROL CALIBRATION
HIGH IDLE REQUIRED

FIGURE 2-14

4. Repeat step 3 if engine speed is decreased during calibration.
5. When the calibration process starts, the Percentage of Completion screen appears (Figure 2-15). It takes approximately two minutes to complete this process.

CONTROL CALIBRATION 6
___% COMPLETE

FIGURE 2-15

6. When calibration is complete, the Start screen appears (Figure 2-13).
7. Check the data bank in the upper right corner of the screen. If a control/pump failed the test, the fail item's binary numbers are displayed.

Table 2-12. Controls Binary Numbers

Binary No.	Pump No.	Description
1	1	Main Hoist
2	2	Boom and Luffing Drums
4	3	Swing Right
8	3	Swing Left
16	4	Drum 9 on MAX-ER

REPLACING A PRESSURE SENDER

See Figure 2-16 for identification of the pressure senders.

General

These instructions must be followed to ensure safe removal of faulty pressure senders and to ensure proper operation after the installation of new pressure senders.

See Figure 2-16 for the following procedure.

NOTE: The replacement procedure is the same for all pressure senders.

CAUTION

High-Pressure Oil Hazard!

High-pressure oil can exhaust from the pressure sender ports and cause minor to moderate injury.

Do not attempt to remove a pressure sender unless the proper procedure is performed.

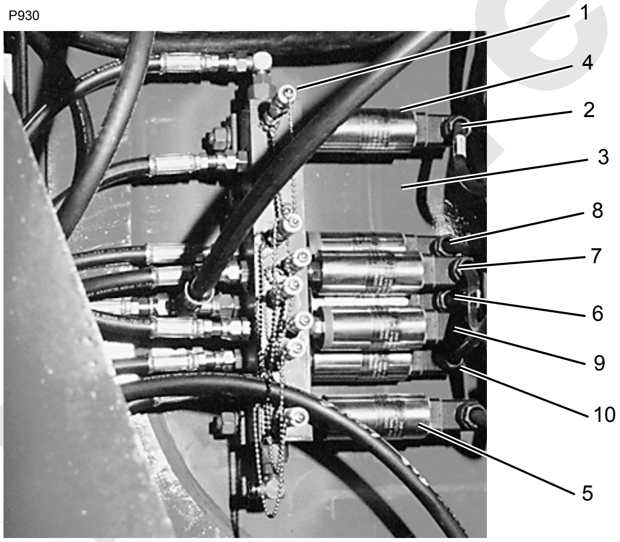
---

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

NOTE: Perform step 5 through step 9 only with faulty pressure senders.

5. Disconnect the electric plug (2) from the pressure sender.
6. Slowly loosen the pressure sender only enough to allow any remaining pressure to exhaust.
7. Remove the pressure sender.
8. Install the new pressure sender and connect the electric plug.

   Pressure senders have pipe threads. Be sure to install thread sealant.
9. Bleed the pressure sender as follows.
   - a. Connect a bleed line with a shut-off valve to the gauge coupler (1) on the pressure sender manifold.
   - b. Open the valve in the bleed line and use a suitable container to catch the oil flow.
   - c. With all control handles off, start the engine and allow it to idle at 950 to 1,000 rpm.
   - d. Observe oil flowing from the bleed line.
   - e. Close the valve in the bleed line when clear oil flows (no air bubbles in oil).
   - f. Stop the engine.
   - g. Remove the bleed line from the gauge coupler at the pressure sender.
10. Calibrate the pressure sender.



2250 Left Inboard Side of Rotating Bed
(forward of pumps)

Item	Description
1	Gauge Coupler (typical)
2	Electric Plug (typical)
3	Independent Luffing Hoist Pressure Sender[1]
4	Right Travel System Pressure Sender
5	Left Travel System Pressure Sender
6	Load Drum Charge Pressure Sender
7	Load Drum System Pressure Sender
8	Boom Hoist System Pressure Sender
9	Swing Right System Pressure Sender
10	Swing Left System Pressure Sender

[1] Optional

FIGURE 2-16

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DISC BRAKE OPERATIONAL TEST

General

There is no physical way to check the disc brakes for travel, boom hoist, luffing hoist, front/rear drums, and swing. An operational test of each brake must be performed weekly. See Figure 2-17 for brake and brake solenoid valve locations.

Operational Test

NOTE: For all pumps, the system pressure is preset at 379 to 448 bar (5,500 to 6,500 psi).

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

CAUTION

Overheating Hazard!

Avoid equipment damage due to overheating system components.

Do not hold any function on stall for more than 10 seconds.

---

1. Start the engine and allow it to idle at 1,500 rpm.
2. Select and confirm SETUP mode (faulty pressures will be recorded in any other mode).

NOTE: For load drums, make sure the crane is in Full Power mode.

3. Disconnect the electrical plug for the brake being checked.
4. Scroll to the corresponding diagnostics screen for the brake being checked. Monitor PUMP PRESSURE and PUMP COMMAND while moving the control handles.
5. For all functions, move the control handle in both directions, one at a time, to check brake operation in both directions.
6. Slowly move the handle for the function being checked. The specified system pressure must be reached before 50% pump command is reached, and the brake must not slip.

WARNING

Falling Load/Moving Crane Hazard!

Avoid death or serious injury. Loads could fall or the crane could move if the brakes are not operating properly.

If any disc brake slips when an operational test is performed, repair or replace the corresponding brake before placing the crane back into service. For load drums with a disc brake on both ends of the drum, repair or replace both disc brakes.

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

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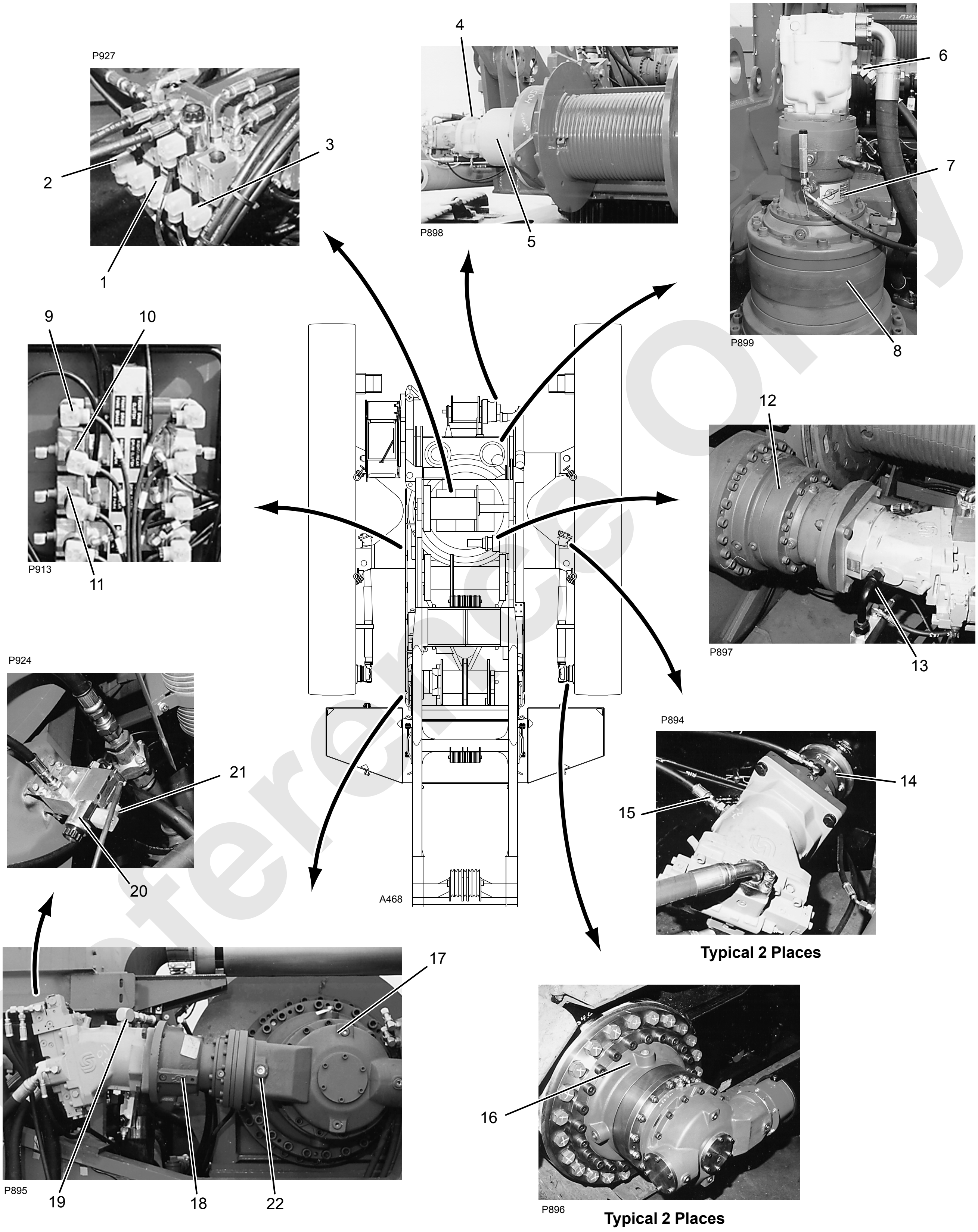
7. Reconnect the electrical plugs at all brake solenoid valves at the completion of operational tests.
8. If disc brakes were repaired or replaced, retest the brakes before operating with a load.

Legend for Figure 2-17

Item	Description
1	Travel Disc Brake Solenoid Valve (both brakes)
2	Luffing Hoist Disc Brake Solenoid Valve
3	Swing Disc Brake Solenoid Valve
4	Luffing Hoist Disc Brake
5	Luffing Hoist Planetary
6	Case Drain Port
7	Swing Brake (disc)
8	Swing Planetary
9	Front Drum Disc Brake Solenoid Valve
10	Right Rear Drum Disc Brake Solenoid Valve
11	Left Rear Drum Disc Brake Solenoid Valve
12	Load Drum Planetary
13	Case Drain Port
14	Travel Disc Brake (qty 2)
15	Case Drain Port (qty 2)
16	Crawler Input Planetary (qty 2)
17	Boom Hoist Planetary
18	Boom Hoist Disc Brake
19	Case Drain Port
20	Boom Hoist Brake Solenoid Valve
21	Electrical Plug (typical)
22	Boom Hoist Planetary Fill Sight Gauge



Typical 2 Places

Typical 2 Places

FIGURE 2-17

SHOP PROCEDURE

General

This section covers hydraulic adjustments for the hydraulic system and related components on this crane.

Experienced technicians, trained in the operation of this crane and its hydraulic system, shall perform these procedures. These technicians shall read, understand, and comply with all instructions.

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

Comply with the pressure and flow settings specified. Altering settings without the approval of the Manitowoc Crane Care Lattice Team can damage crane components or cause the crane to operate improperly. Procedures for connecting hydraulic fittings are provided in this section.

During many of these procedures, it will be necessary to monitor data on the diagnostic screens of the digital display. See Electrical System Section 3 for the description and operation of the diagnostic screens.

When a procedure states "determine cause and correct," proceed as follows:

- MCC Assembly Personnel—Contact the Engineering Department.
- Field Service Personnel—Contact the Manitowoc Crane Care Lattice Team.

Pump Identification

Item	Description
1	Boom Hoist Pump
2	Load Drum Pump (qty 2)
3	Swing Pump
4	Right Crawler Pump
5	Left Crawler Pump
6	Fan (outboard) and Accessory (inboard) Pump
7	Pump Drive

Pump Port Identification

Pump	Port A	Port B
1	Lower	Hoist
2	Hoist	Lower
3	Left	Right
4, 5	Reverse	Forward

Pump Port Identification

Item	Description
A	System Pressure Port A
B	System Pressure Port B
1	Mulitfunction Valve Port A
2	Charge Pressure Gauge Port
3	Multifunction Valve Port B
4	Charge Pressure Relief Valve
5	Neutral Adjusting Screw
6	Electronic Displacement Control (EDC)
7	Manual Override Knob

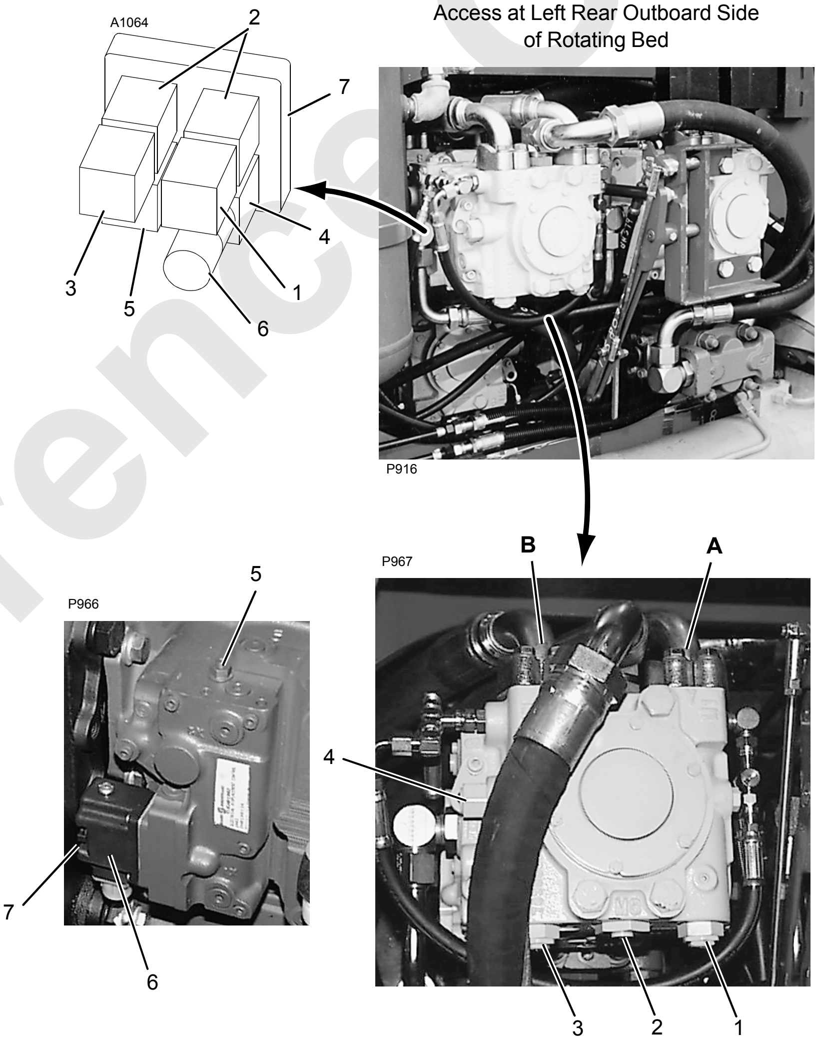


FIGURE 2-18

Initial Oil Fill

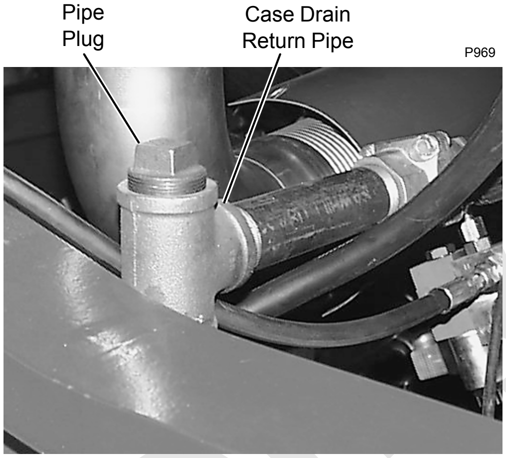
NOTE: Use new hydraulic oil of the proper viscosity filtered through at least a 10-micron filter.

1. Fill each motor case with clean oil to the level of the case drain port (Figure 2-17).
2. Fill the pump cases as follows.
   a. Remove the pipe plug from the case drain return pipe (Figure 2-19).
   b. Slowly fill the pipe with clean oil. Air will gurgle out of the pipe as oil is added.
   c. Stop filling the pipe when oil stops gurgling and the pipe is full.
   d. Securely install the pipe plug.
3. Fill the hydraulic tank with clean oil to the middle of the High Level sight gauge (Figure 2-20).

Pressure Sender Calibration

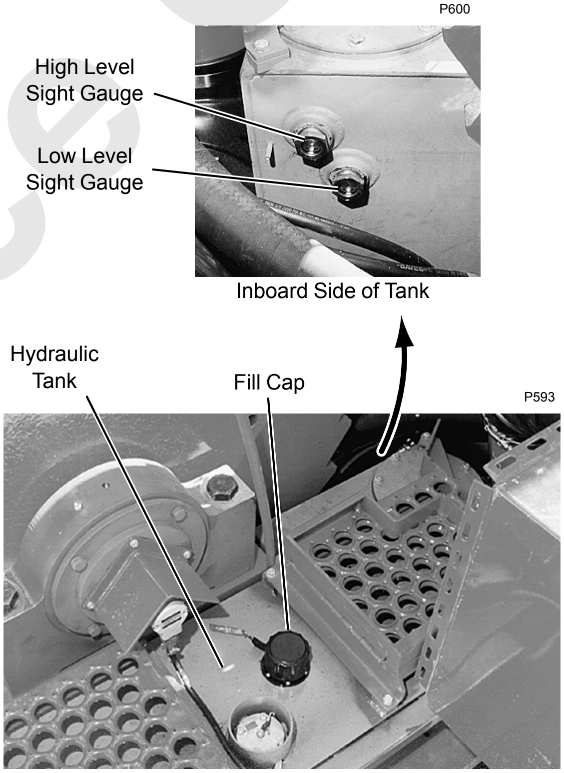
Perform this procedure before initial start-up.

1. Turn on the cab power switch.
2. Turn the Crane Mode Selector key counterclockwise to the CONFIRM position and hold.
3. Turn the Engine Run/Stop switch to the RUN position.
4. Continue to hold the Crane Mode Selector key in the CONFIRM position for one minute after performing step 3.
5. Confirm proper calibration. With the engine off (key in the RUN position), the charge pressure on the diagnostic screen for each crane function should be 3,4 bar (50 psi) or less.



Access at Left Rear Side of Rotating Bed (to rear of pumps)

FIGURE 2-19



Access at Right Outboard Side of Rotating Bed (next to boom hoist)

FIGURE 2-20

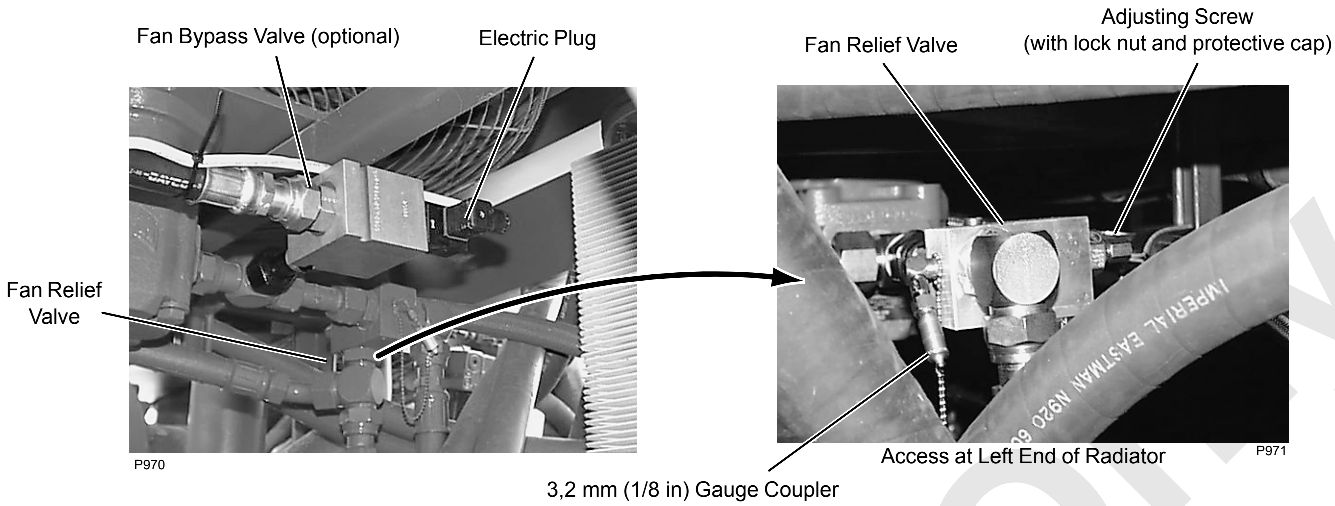


FIGURE 2-21

Initial Startup

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

1. Calibrate the pressure senders as described in Calibrating the Pressure Sender on page 2-10.
2. Open the shut-off valve in the pump suction line (Figure 2-22). Pumps can be damaged from cavitation if this step is not performed.

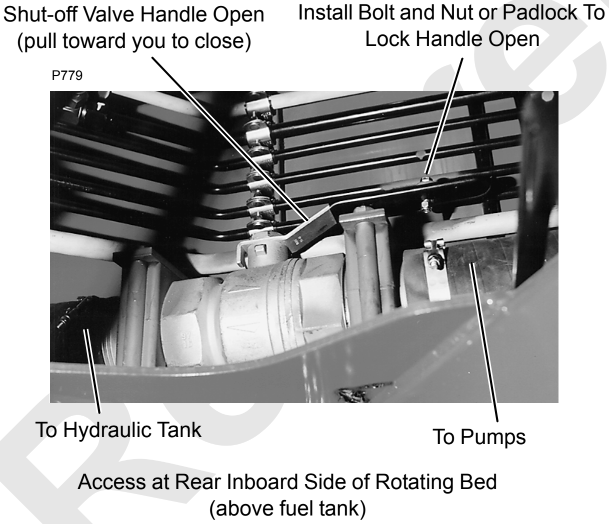


FIGURE 2-22

3. Connect the bleed lines equipped with shut-off valves to the gauge coupler at each pressure sender. The pressure senders can be seen in Figure 2-16.
4. Open the shut-off valve in each bleed line. Use a suitable container to catch oil.
5. Remove the adjusting screw from the fan and pilot pressure relief valves (Figure 2-21 and Figure 2-23). Then reinstall the screws approximately 6 mm (1/4 in) and securely tighten the lock nuts. Serious damage can occur to system components if this step is not performed before starting the engine for the first time.

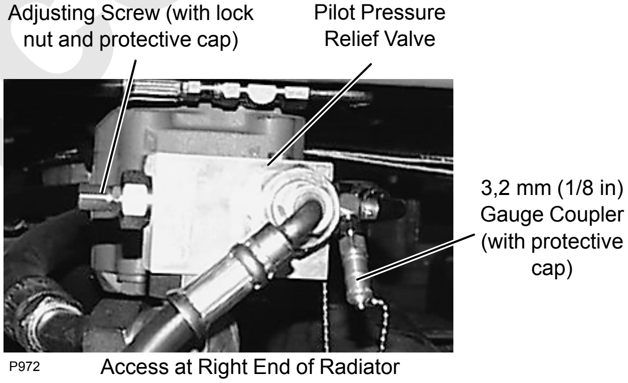


FIGURE 2-23

6. With all controls off, start and run the engine at its lowest possible speed.
7. Have one person bleed the pressure senders while a second person checks the pressures.
8. Bleed the pressure senders as follows:
   a. Observe oil flowing from the bleed line at each pressure sender. The pressure senders can be seen in Figure 2-16.
   b. Close each bleed valve when a clear, steady stream of oil appears (no air bubbles in the oil).
   c. If oil does not flow from any bleed line, determine the cause and correct it.

CAUTION

Equipment Damage!

Inadequate oil pressure can damage hydraulic pumps.

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

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9. On the diagnostic screens, check pump pressures for the load drums, boom hoist, swing, and travel pumps.
    a. Make sure the pressure reading for each pump is 13,8 to 34,5 bar (200 to 500 psi). Pump pressures will be adjusted to their final settings later in this procedure.
    b. If pump pressures are not within the specified range, stop the engine immediately. Determine the cause of the faulty pressure and correct it.
10. Stop the engine.
11. Remove the bleed lines from the gauge couplers at each pressure sender.
12. Perform the following procedures.
    a. Engine throttle adjustment (MCC Electrician)—Do not perform the remaining procedures until the engine throttle is adjusted to the following proper speeds:
        - 950 to 1,000 rpm low idle
        - 2,100 to 2,125 rpm high idle
    b. Fan and pilot pressure adjustment
    c. Charge pressure checks
13. With the engine at low idle, extend and retract all cylinders (jacking, boom butt handling, gantry) three times.
14. With the engine running at low idle, slowly cycle each crane function in both directions for at least five minutes to vent any remaining air from the hydraulic system.
15. Be sure all crane functions operate in the proper direction in relation to control handle movement.
16. Check for hydraulic leaks, and correct the cause if found.
17. Stop the engine and fill the hydraulic tank to the proper level.

NOTE: MCC Assembly Personnel—Pressures and speeds noted in the remaining procedures and any adjustments you make to correct them must be recorded in the appropriate Quality Verification Form for the crane you are working on.

Calibrating the Controls

1. Calibrate the pressure transducers, if not already done.
2. Start and run the engine at high idle.
3. Depress and hold the swing holding brake switch (on the swing handle) for one minute.
4. Repeat step 2 and step 3.

Adjusting the Fan and Pilot Pressure

See Figure 2-21 for the fan relief valve and components. See Figure 2-23 for the pilot pressure relief valve and components.

1. Stop the engine.
2. If the crane has the cold weather option, disconnect the electric plug from the fan bypass valve before starting.
3. Connect accurate hydraulic pressure gauges to the gauge couplers, as follows.
    a. 0 to 345 bar (0 to 5,000 psi) at the fan relief valve
    b. 0 to 69 bar (0 to 1,000 psi) at the pilot pressure relief valve
4. Remove the adjusting screws from both valves. Then reinstall them approximately 6 mm (1/4 in).
5. Start the engine.
6. With the engine running at low idle, turn the fan relief valve adjusting screw in until the gauge reads approximately 69 bar (1,000 psi).
7. With the engine running at high idle, turn the pilot pressure relief valve adjusting screw in until the gauge reads 22,4 to 25,8 bar (325 to 375 psi). Hold the adjusting screw in position and securely tighten the lock nut.
8. With the engine running at high idle, adjust the fan relief valve, as follows.
    a. Slowly turn the adjusting screw out to decrease the pressure until the fans start to slow down and the pressure starts to drop on the gauge.
    b. Slowly turn the adjusting screw in. The fan speed and pressure will increase.
    c. Continue to slowly turn the adjusting screw in until the pressure stops increasing. Then turn the adjusting screw in an additional 1/2 turn.

        The fan pressure should be 62 to 117 bar (900 to 1,700 psi).

        If the pressure is okay, hold the adjusting screw in position and securely tighten the lock nut.

        If the pressure is not okay, determine the cause and correct it.

9. Stop the engine.

10. Remove the gauges and install protective caps over the adjusting screws and gauge couplers.

11. If the crane has the cold weather option, connect the electric plug to the fan bypass valve.

Checking the Charge Pressure

Check the charge pressure for the load drums, boom hoist, luffing hoist, swing, and both travel pumps, one at a time, as follows.

1. Stop the engine.

2. Connect an accurate 0 to 69 bar (0 to 1,000 psi) hydraulic pressure gauge to the gauge coupler for the desired pump (Figure 2-16).

3. Start and run the engine at low idle.

4. Note and record the gauge reading. The gauge should read 22,4 to 25,8 bar (325 to 375 psi).

NOTE: Charge pressure can be monitored on the diagnostic screen for each function. The charge pressure shown on the diagnostic screens can vary ±6,9 bar (100 psi) from that shown on the pressure gauges.

5. If the proper pressure is not obtained, adjust the charge pressure relief valve for the corresponding pump. See the instructions in the pump manufacturer's manual.

6. Stop the engine and remove the gauge from the coupler (Figure 2-16). Install a protective cap over the coupler.

Checking the Operating Pressure

It will be necessary to monitor the pressure and pump command on the diagnostic screens of the digital display during the following procedures. Do not confuse PUMP COMMAND with HANDLE COMMAND on the display.

CAUTION

Overheating Damage!

Avoid equipment damage due to overheating system components.

Do not hold any function on stall for more than 10 seconds.

Boom Hoist Down

1. Stop the engine.

2. Loosen the lock nut on the adjusting screw at the down multifunction valve in the boom hoist pump.

3. Turn the adjusting screw out until it stops. Then turn the adjusting screw in 1-3/4 turns.

4. Start and run the engine at 1,500 rpm and operate the boom hoist in the down direction (no wire rope or load on the drums). The drum should turn freely. If not, proceed as follows.

  a. Stop the boom hoist drum.

  b. Turn the down adjusting screw in 1/4 turn.

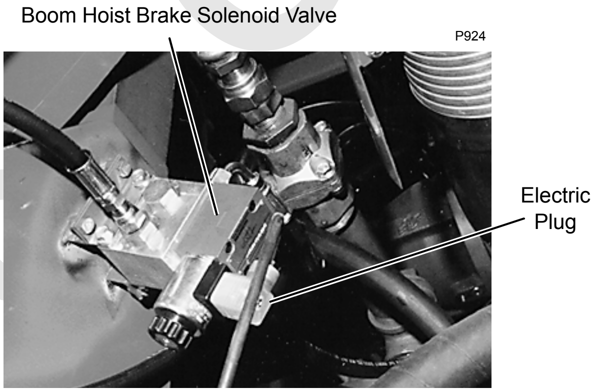
  c. Repeat step 4 through step 4b until the drum turns freely.

5. Hold the adjusting screw and securely tighten the lock nut.

Boom Hoist Up

1. Stop the engine.

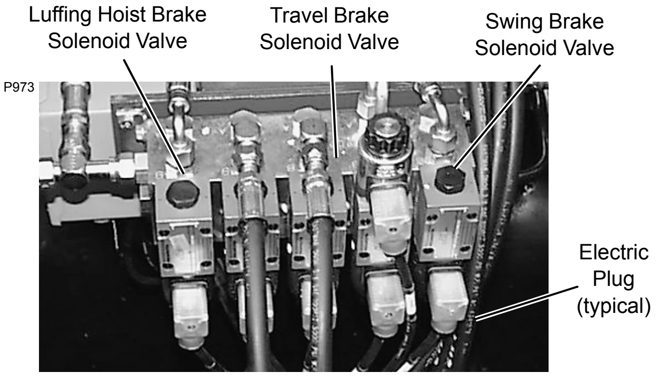
2. Disconnect the electric plug from the boom hoist brake solenoid valve (Figure 2-24). This will stall the boom hoist pump.



Access at Left Rear Inboard Side of Rotating Bed

FIGURE 2-24

NOTE: If equipped with a luffing hoist, disconnect the electric plug from the luffing hoist brake solenoid valve (Figure 2-25).



Access Through Center Hole in Rotating Bed

FIGURE 2-25

3. Start and run the engine at 1,500 rpm.

4. Scroll to the Drum 4 (boom hoist) Diagnostic screen. Monitor the pump pressure and pump command while moving the control handle.
5. Slowly pull the boom hoist control handle back. The diagnostic screen should indicate 379 to 448 bar (5,500 to 6,500 psi) of system pressure before 50% pump command is reached, and the boom hoist brake (luffing hoist, also, if equipped) must not slip.
6. If the specified pressure is not indicated or either of the brakes slips, determine the cause and correct.
7. Connect the electric plug to the boom hoist (and luffing hoist if equipped) brake solenoid valve (Figure 2-24 and Figure 2-25).

Swing

See Figure 2-25 for the following procedure.

1. Stop the engine.
2. Disconnect the electric plug from the swing brake solenoid valve. This will stall the swing pump.
3. Start and run the engine at 1,500 rpm.
4. Scroll to the Swing Diagnostic screen. Monitor PUMP PRESSURE and COMMAND while moving the control handle.
5. Slowly move the swing control handle in both directions, one at a time, to check swing pressure.
6. The swing pressure in both directions should be 379 to 448 bar (5,500 to 6,500 psi) before 50% pump command is reached, and the brake must not slip.
7. If the specified pressure is not indicated in either direction or the if brake slips, determine the cause and correct it.
8. Connect the electric plug to the swing brake solenoid valve.

Travel

See Figure 2-25 for the following procedure.

1. Stop the engine.
2. Disconnect the electric plug from the travel brake solenoid valve. This will stall the travel pumps.
3. Start and run the engine at 1,500 rpm.
4. Scroll to the Track Diagnostic screen. Monitor PUMP PRESSURE and COMMAND while moving the control handles.
5. Slowly move both travel control handles in both directions, one handle at a time.
6. The travel pressure for each crawler in both directions should be 379 to 448 bar (5,500 to 6,500 psi) before 50% pump command is reached, and the brake must not slip.
7. If the specified pressure is not indicated in either direction or if the brake slips, determine the cause and correct it.
8. Connect the electric plug to the travel brake solenoid valve.

Load Drums

The following procedure must be performed after the crane is fully assembled and rigged with the boom.

1. Select FULL POWER mode at any load drum.
2. Scroll to the corresponding drum (1, 2, or 3) diagnostic screen. Monitor PUMP PRESSURE and COMMAND while moving the appropriate control handle.
3. Working with a single-part line from the first layer of the selected drum, hook onto an 18 144 kg (40,000 lb) load.
4. Run the engine at 1,500 rpm.
5. Hoist the load just clear of the ground and fully apply the corresponding drum working brake.
6. Slowly pull the corresponding drum control handle back.

   The drum pressure should be 379 to 448 bar (5,500 to 6,500 psi) before 50% pump command is reached, and the brake must not slip.
7. If the specified pressure is not indicated or if the brake slips, determine the cause and correct it.

Checking the Auxiliary System Pressure

The setup and jacking remote controls must be operated for the following procedures. See Section 3 of the Operator Manual for operating instructions.

CAUTION

Overheating Damage!

Avoid equipment damage due to overheating system components.

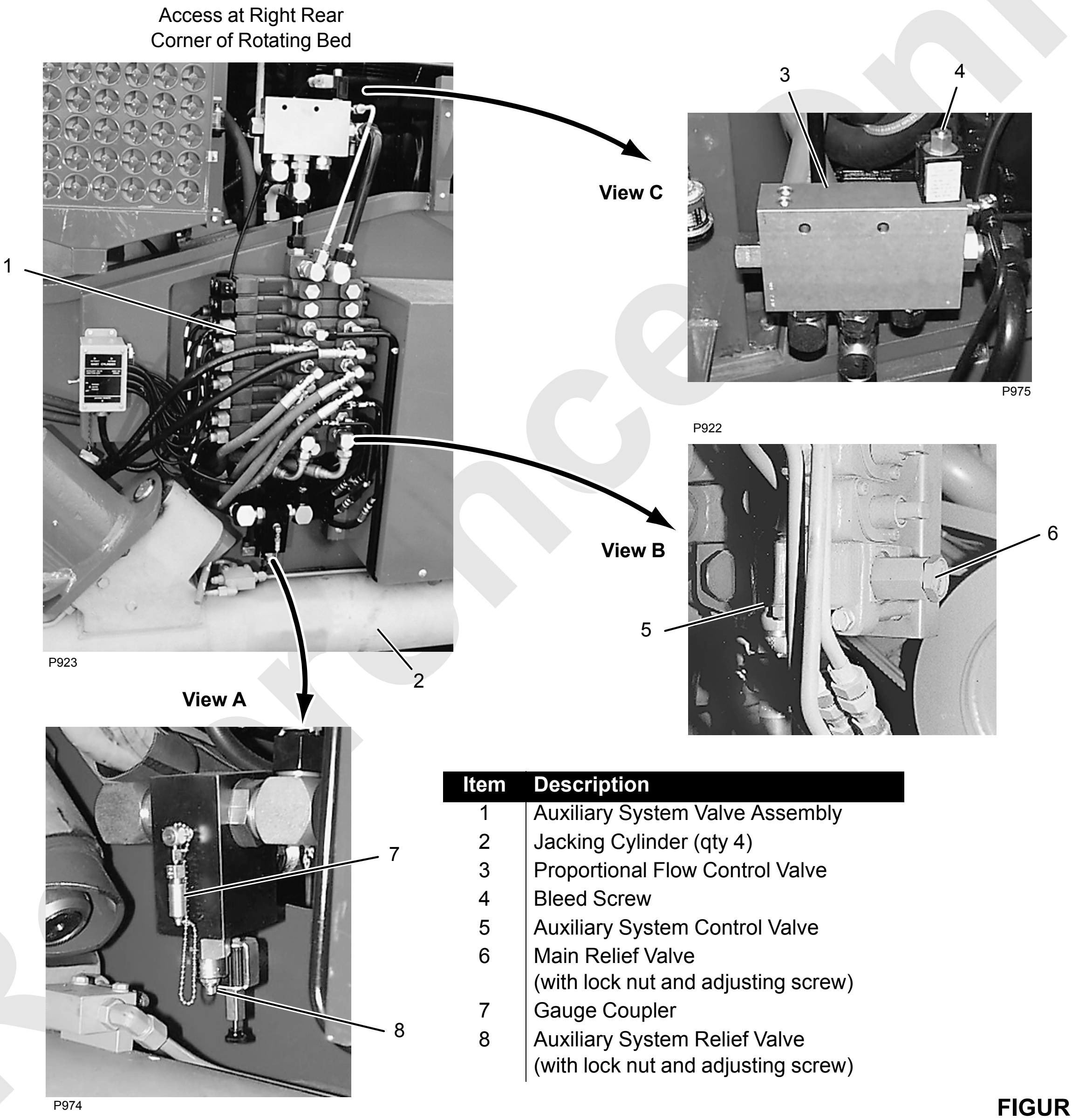
Do not hold any function on stall longer than necessary to read the pressures and make adjustments.

Auxiliary System Relief Valve

See Figure 2-26 for the following procedure.

1. Stop the engine.
2. Connect an accurate 0 to 413 bar (0 to 6,000 psi) hydraulic pressure gauge to the gauge coupler (7) at the auxiliary system relief valve (8).

3. At the main relief valve (6) on the auxiliary system control valve (5), loosen the lock nut and turn the adjusting screw in one full turn. Securely tighten the lock nut.
4. Start and run the engine at 1,500 rpm.
5. Fully retract both gantry cylinders until they bottom out (stall the hydraulic system). Gauge pressure should be 241 to 248 bar (3,500 to 3,600 psi).
6. If the specified pressure is not indicated, proceed as follows.
    - a. Loosen the lock nut on the adjusting screw for the auxiliary system relief valve.
    - b. Turn the adjusting screw in to increase or out to decrease the pressure.
    - c. Repeat step 5 through step 6b until the specified pressure is obtained, and securely tighten the lock nut.
7. Stop the engine and remove the gauge from the coupler on the auxiliary system relief valve. Install a protective cap over the coupler.



Item	Description
1	Auxiliary System Valve Assembly
2	Jacking Cylinder (qty 4)
3	Proportional Flow Control Valve
4	Bleed Screw
5	Auxiliary System Control Valve
6	Main Relief Valve (with lock nut and adjusting screw)
7	Gauge Coupler
8	Auxiliary System Relief Valve (with lock nut and adjusting screw)

FIGURE 2-26

Rotating Bed Jacking Cylinders

See Figure 2-26 for the following procedure.

1. Stop the engine.
2. The jacking cylinders (2) will be extended during this procedure.
    a. Rotate the jacking cylinders away from the rotating bed so they cannot contact anything.
    b. Warn all personnel to stand clear of the cylinders.
3. Connect an accurate 0 to 413 bar (0 to 6,000 psi) hydraulic pressure gauge to the gauge coupler (7) on the auxiliary system relief valve (8).
4. Start and run the engine at 1,500 rpm.
5. Fully extend one jacking cylinder until it bottoms out (stall the hydraulic system). The gauge pressure should be 152 to 158 bar (2,200 to 2,300 psi).
6. Repeat step 4 and step 5 for each jacking cylinder, one at a time.
7. If the specified pressure is not indicated for any cylinder, determine the cause and correct it.
8. Fully retract and store cylinders when done.
9. Stop the engine and remove the gauge from the coupler on the auxiliary system relief valve. Install a protective cap over the coupler.

Connecting Pin Cylinders (Crawler, Boom Hinge, and Adapter Frame)

1. Start and run the engine at 1,500 rpm.
2. Fully extend and retract all connecting pin cylinders. Make sure of the following:
    - The cylinders operate in the proper directions with relation to the controls.
    - All cylinders fully extend and retract smoothly without resistance.
3. If any cylinder does not operate properly, determine the cause and correct it.

Boom Butt Handling Cylinder

See Figure 2-26 for the following procedure.

Perform the following procedure with the boom butt connected to the crane and cylinder.

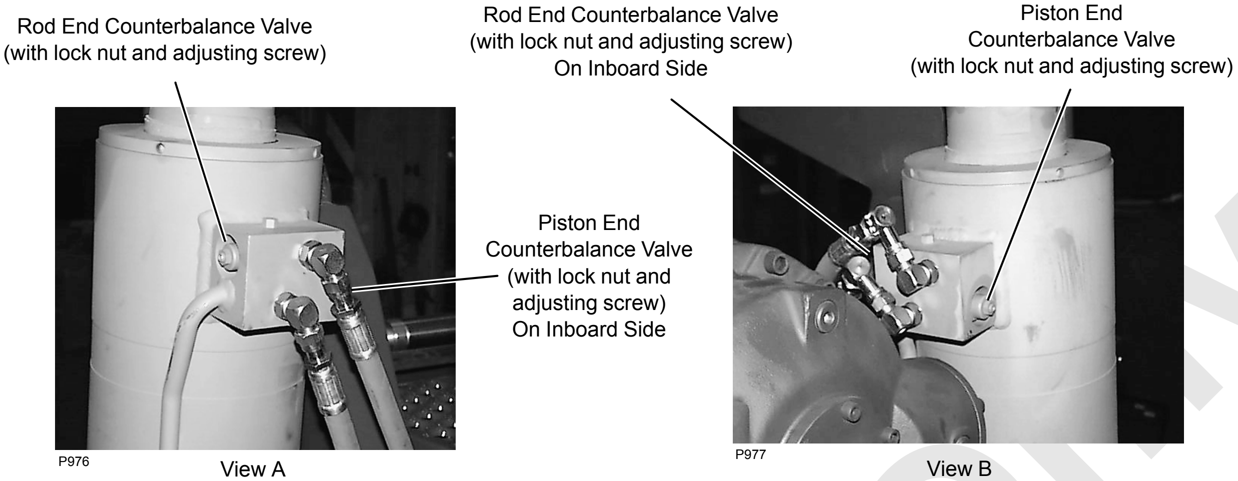
1. Start and run the engine at 1,500 rpm.
2. Fully retract the cylinder until it bottoms out, and proceed as follows.
    a. Crack open the bleed screw (4) on the proportional flow control valve (3).
    b. Securely close the bleed screw when a steady stream of clear oil appears.
3. Set the speed control on the setup remote control to FAST.
4. Fully retract and then fully extend the boom butt handling cylinder. The extension time should be approximately 60 seconds. If not, determine the cause and correct it.
5. Once fully extended, the cylinder must hold the boom butt in position without retracting.
6. If the cylinder does not hold, determine the cause and correct it.
7. The cylinder must extend and retract smoothly. If not, determine the cause and correct it.

Gantry Cylinders

See Figure 2-27 for the following procedure.

Perform step 1 and step 2 with the gantry removed.

1. Start and run the engine at 1,500 rpm.
2. Extend the gantry cylinders. Both cylinders should extend at the same speed. If they do, go to step 4. If they do not, proceed as follows.
    a. At the faster cylinder, loosen the lock nut and turn the rod end counterbalance valve adjusting screw out in small increments until both cylinders extend at the same speed.
    b. Securely tighten the lock nut.
3. Install the gantry and perform the remaining steps.
4. Fully retract the cylinders and attach the counterweights (Series 1 minimum).
5. Extend the cylinders to raise the counterweights approximately 0,3 m (1 ft) off the ground and stop.
6. The cylinders must hold the counterweights in position. If they do, go to step 7. If they do not, proceed as follows.
    a. Lower the counterweights to the ground (retract the cylinders).
    b. At the piston end counterbalance valve, in both cylinders, loosen the lock nut and turn the adjusting screw out 1/2 turn.
    c. Repeat step 5 through step 6b until the cylinders hold the counterweight in position.
    d. Securely tighten the lock nuts.



View A
Gantry Cylinder
Right Rear Corner of Rotating Bed

View B
Gantry Cylinder
Left Rear Corner of Rotating Bed

FIGURE 2-27

7. Extend the cylinders to raise the counterweights approximately 0,3 m (1 ft) off the ground and stop.

8. Retract the cylinders to lower the counterweights to the ground. Both cylinders should retract at the same speed. If they do, go to step 9. If they do not, proceed as follows.

   a. At the faster cylinder, loosen the lock nut and turn the piston end counterbalance valve adjusting screw out in small increments until both cylinders retract at the same speed.

   b. Securely tighten the lock nut.

9. Repeat step 5 through step 6b with the counterweights raised approximately 0,9 m (3 ft) off the ground.

Checking the System Speed

Check the minimum operating speed of each crane function with the engine running at high idle (Table 2-2).

Load drum speeds are shown on the Diagnostics screen for each pump.

Count the number of revolutions the rotating bed makes in one minute to determine the swing speed. Make sure the crane is in an area where nothing will interfere with the boom or rotating bed while swinging.

Mark both crawler tumblers and count the number of revolutions they make in one minute to determine the travel speed. Make sure the crane is in an area where it can travel without interference.

If proper speeds are not indicated, determine the cause and correct it.

Travel Straightness

1. Make sure the crane is in an area where it can travel without interference.

2. Start and run the engine at high idle.

3. Push both crawler handles fully forward to travel forward at full speed.

4. Travel approximately 30 m (100 ft). Check the track prints on the ground.

5. The track prints must be straight to within 0,3 m (1 ft) in 30 m (100 ft). If not, determine the cause and correct it.

UNLOADER PILOT VALVE MAINTENANCE

General

See Figure 2-28 for the following.

The unloader pilot valve automatically controls air system pressure by controlling when the compressor starts and stops compressing air.

Table 2-13. Unloader Pilot Valve Air System Pressure Settings

Model	Unloader Pilot Valve		Safety Valve
	Cut-In[1] bar (psi)	Cut-Out[2] bar (psi)	
2250	8,3 (120)	9,1 (132)	11,4 bar (165 psi)

[1] Cut-in is the pressure at which the air compressor starts compressing air.

[2] Cut-out is the pressure at which the air compressor stops compressing air.

Air pressure from the air tank acts against the unloader valve (8) during operation.

As air system pressure increases, the unloader valve moves up against the resistance of the unloader spring (6). When the air pressure reaches the cut-out setting, the unloader valve seats against the unloader cap (4). This action closes the exhaust port in the adjusting screw (2) and opens a flow path from the air tank to the compressor unloading mechanism. The air compressor then stops compressing air.

When air system pressure decreases to the cut-in setting, the unloader spring (6) forces the unloader valve (8) down, seating it against the unloader body (7). This action closes the flow path from the air tank and opens the exhaust port in the adjusting screw (2). The air at the compressor unloading mechanism then exhausts, and the compressor starts compressing air.

Adjustment

The unloader pilot valve has a 0,83 bar (12 psi) range between the cut-out and cut-in pressures. The range is fixed and can be changed only slightly by removing or installing shims (5). Remove one shim to increase the range or add one shim to decrease the range.

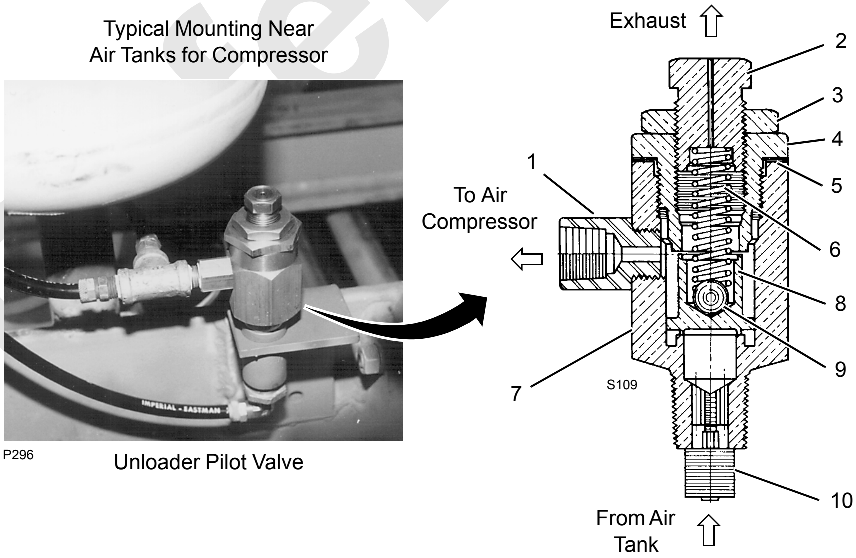
To adjust the cut-out setting, loosen the lock nut (3) and turn the adjusting screw (2) in to increase the pressure or out to decrease the pressure. Hold the adjusting screw and securely tighten the lock nut.

Maintenance

If the unloader pilot valve sticks or flutters, take it apart and clean it thoroughly in nonflammable solvent. Be sure to clean the filter (10) by removing it and washing it thoroughly in a nonflammable solvent. Be sure to reinstall the filter, since it is important that no foreign matter enters the valve chamber.

In case of unsatisfactory operation, perform the following services.

1. Check the compressor unloading mechanism for damage (see the air compressor manufacturer's manual).
2. Disconnect the air line from the air tank at the unloader pilot valve, and blow out all oil, sludge, and scale.
3. Disassemble the entire unloader pilot valve. Wash all parts in a nonflammable solvent and reassemble.
4. In case of major repair work, return the unloader pilot valve to the valve manufacturer. The manufacturer has the special tools and testing equipment required to lap and align the seating surfaces.



Item	Description
1	Unloader Outlet
2	Adjusting Screw
3	Lock Nut
4	Unloader Cap
5	Unloader Cap Shim
6	Unloader Spring
7	Unloader Body
8	Unloader Valve
9	Valve Ball
10	Filter

FIGURE 2-28

MOISTURE EJECTOR VALVE MAINTENANCE

General

See Figure 2-29 for the following.

The moisture ejector valve is fastened to the bottom of the air tank for the purpose of automatically ejecting moisture which settles in the bottom of the air tank. The valve has a heater controlled by its own thermostat.

On some crane models, a moisture ejector valve is fastened to the bottom of each air tank.

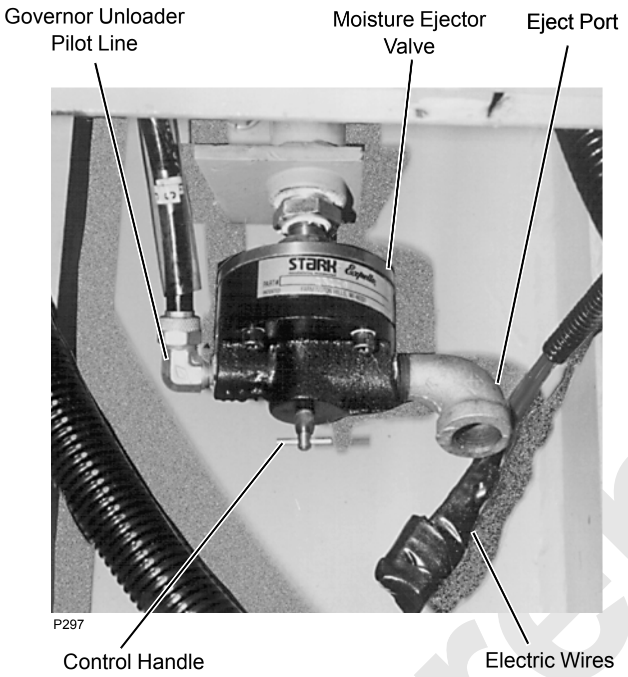


FIGURE 2-29

Control Handle Positions

See Figure 2-30 for the following procedures.

Automatic Operation

Turn the handle all the way out.

Shut-Off

Turn the handle all the way in.Turn the handle to this position if the valve malfunctions. The crane can then be operated until repairs or a replacement can be made at a convenient time.

Operational Checks

Make the following checks after the engine is started at the beginning of each work shift.

1. Check for air leaks. There must be no leaks in the pilot line to the valve or at any point on the valve.

2. Observe the valve for proper operation.

   The valve should eject air and moisture each time the compressor cuts in at the low pressure setting and each time the compressor cuts out at the high pressure setting. See Table 2-13 for air system pressure settings.

3. If the valve does not operate properly, verify that the handle is turned all the way out to the AUTOMATIC position. If the valve still does not operate properly, repair or replace the valve.

   The valve should feel warm to the touch within 60 seconds after starting the engine when the outside temperature is 2°C (35°F) or less.

   The heater should shut off when the valve temperature rises to 41°C (105°F).

   If the heater does not operate properly, check the electrical wires for continuity. One wire should be connected to ground. The other wire should be connected to the appropriate power supply (see the electrical schematic in Electrical System Section 3).

   If the heater still does not operate properly, replace the valve upper body, which houses the heater.

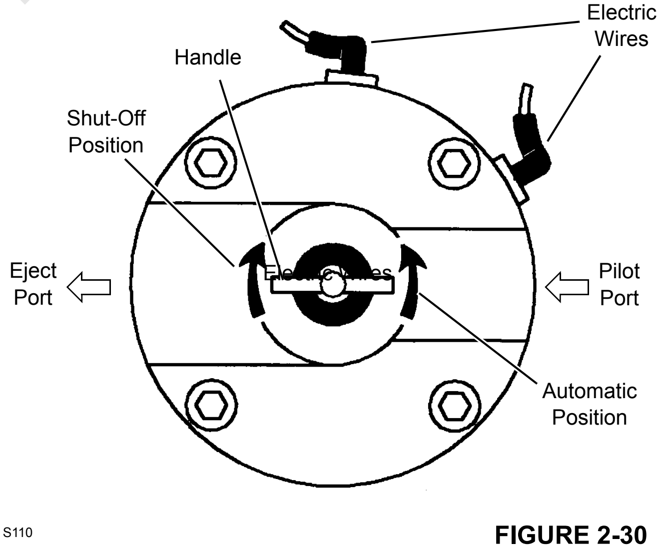


FIGURE 2-30

AIR SYSTEM FILTER MAINTENANCE

General

Two styles of air filters are used on cranes—Type A and Type B. This section describes maintenance of both filters.

Daily Maintenance

See Figure 2-31 for the following procedure.

1. Open the manual drain valve (3) at the end of each shift to drain water and dirt from the air filter (2).
2. If equipped, check the automatic drain valve (17) periodically during the day for proper operation.

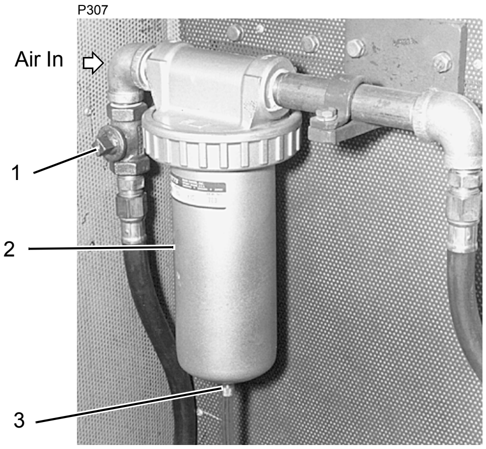
Monthly Maintenance

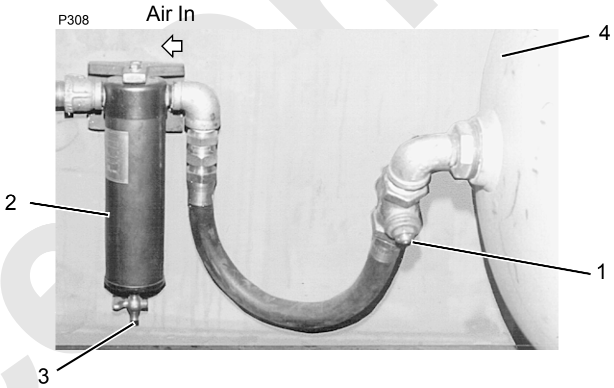
See Figure 2-31 for the following procedure.

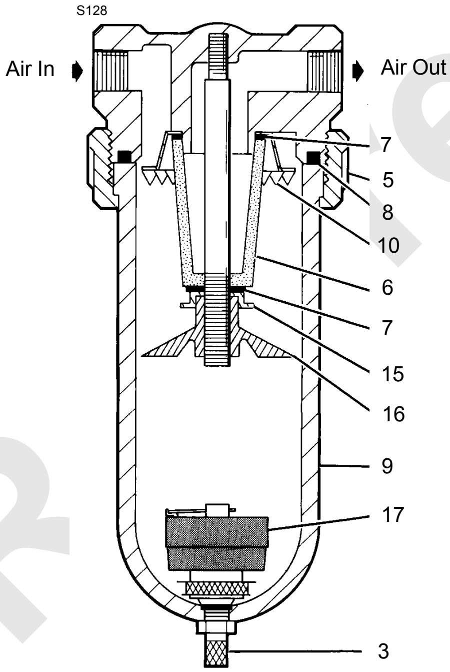
Replace the filter element as follows.

NOTE: It is not necessary to remove the filter head (5) from its mounting to replace the element (6).

1. Stop the engine and de-pressurize the filter. If a shut-off valve (1) is provided, close the shut-off valve and open the manual drain valve (3) on the filter to vent the filter.
2. If a shut-off valve is not provided, open the drain valve on the air tank(s) and on the filter to vent the air system.
3. Use the diagram to disassemble the filter.

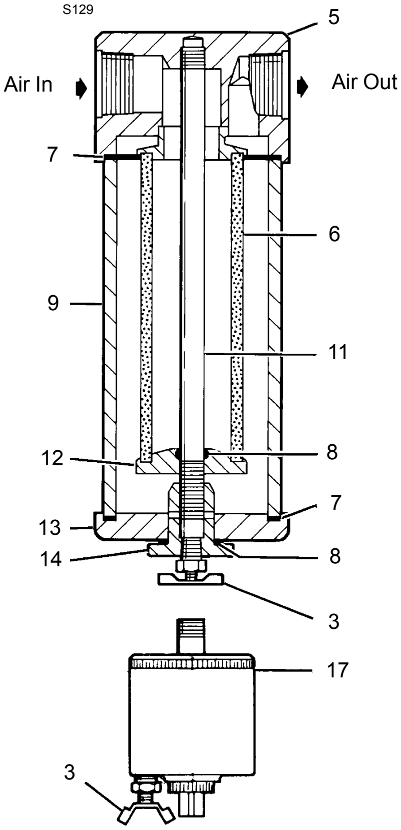






Type A Air Filter

Item	Description
1	Shut-Off Valve
2	Air Filter
3	Manual Drain Valve
4	Air Tank
5	Filter Head
6	Element
7	Gasket
8	O-ring
9	Bowl
10	Deflector
11	Stud
12	Element Retainer
13	Base
14	Nut
15	Secondary Baffle
16	Primary Baffle
17	Automatic Drain Valve



Type B Air Filter

FIGURE 2-31

4. Wash all parts in soap and water and dry.

5. For the Type A filter, wash the element in alcohol and blow it out from the inside with air. For the Type B filter, discard the element.

6. Inspect all parts for damage and replace as necessary.

7. Use the diagram to reassemble the filter. Tighten all threaded parts securely.

8. If disconnected, reconnect the air lines to the proper ports of the filter. Use pipe-thread sealant or tape sparingly and apply only to the male threads.

NOTE: The top of the Type A filter is marked IN and OUT to identify the ports. Connect the line from the tank to the IN port.

The top of the Type B filter has an arrow to identify direction of flow. The arrow must point away from the air tank.

9. Close all drain valves and open all shut-off valves.

10. Build air system pressure to the normal operating range and check the filter for leaks.

Automatic Drain Valve Operation

NOTE: The automatic drain valve is not used on all filter installations.

The automatic drain valve contains a float. When the liquid in the valve body rises to the level of the float, the float rises to open a needle valve. This action allows the liquid to drain. Air pressure then re-seats the float, and the cycle repeats.

AIR SYSTEM DE-ICER MAINTENANCE

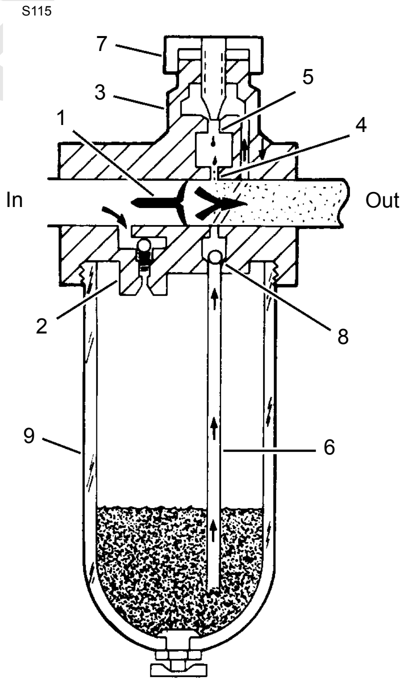
Operation

See Figure 2-32 for the following.

The air system de-icer meters antifreeze into the air line only when there is air flow through the de-icer. Air flowing through the de-icer passes around the flow sensor (1) to the downstream system. Inlet pressure is admitted to the reservoir (9) through the check (charge) valve (2). When air is flowing, a small pressure drop occurs across the flow sensor. The outlet (lower) pressure is sensed in the sight feed dome (3) through the nozzle passage (4). This establishes a pressure drop across the metering orifice (5), and antifreeze at inlet pressure flows upward through the siphon tube (6) into the sight feed dome, where it drips into the nozzle passage and then into the de-icer throat. The adjusting knob (7) controls the drip rate. antifreeze drops are atomized by the high velocity air flowing past the flow sensor and are carried downstream. The check ball (8) prevents backflow of antifreeze into the reservoir during periods of no flow.

The flow sensor functions as a variable restriction in the throat of the de-icer to produce a pressure drop of up to 0,3 bar (5 psi) that is proportional to the rate of air flow through the de-icer. These variations in outlet pressure, sensed in the sight-feed dome, cause a similar variation in the pressure drop across the metering orifice as a function of air flow. Thus, for a given drip rate setting at some average air flow, a lower air flow will cause a proportionally higher drip rate.

The check (charge) valve (2) controls the rate of reservoir pressurization and allows rapid de-pressurization for refilling without shutting off the air pressure. When the antifreeze plug is loosened, a bleed orifice is exposed, which immediately reduces the reservoir pressure. This pressure drop causes the charge valve to close and restrict air flow into the reservoir to eliminate blow-back when adding antifreeze. When the fill plug is replaced, the reservoir re-pressurizes through the charge valve at a nominal rate. The charge valve opens fully when the inlet pressure is reached.



Item	Description	Item	Description
1	Flow Sensor	6	Siphon Tube
2	Check (charge) Valve	7	Adjusting Knob
3	Sight Feed Dome	8	Check Ball
4	Nozzle Passage	9	Reservoir
5	Metering Orifice		

FIGURE 2-32

Adjusting

See Figure 2-32 for the following procedure.

Turn the adjusting knob (7) counterclockwise to increase the drip rate or clockwise to decrease the drip rate (1 to 3 drops per minute is usually sufficient). Drip rate adjustments should only be made under a steady flow condition. Once established, the de-icer will automatically adjust the drip rate proportionally to variations in the air flow. Push the green lock ring down to lock the setting after the final adjustment. To release, pull the lock ring up.

Maintenance

See Figure 2-33 for the following procedures.

Disassembly

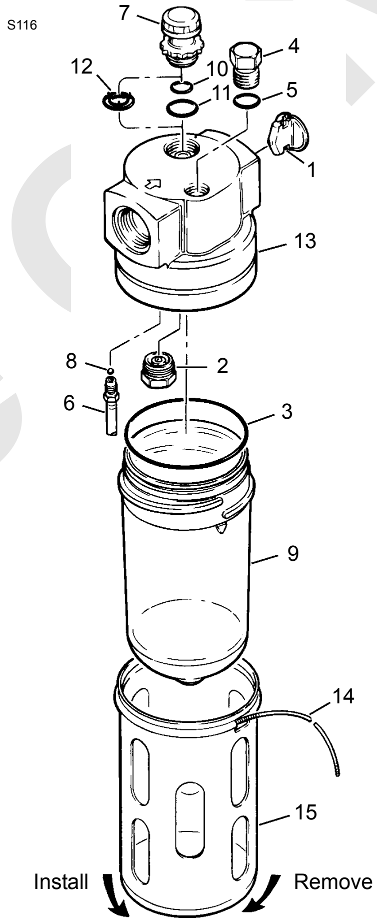
1. Shut off the air supply pressure. The de-icer may be disassembled without removal from the air line.
2. With a transparent reservoir, remove the side guard (15) by rotating the guard around the body (13) to wind out the retaining spring (14) through the cutout in the guard.
3. Slide the guard off the body.
4. Unscrew and remove the reservoir (9).
5. Remove the reservoir O-ring (3), fill plug (4), fill plug O-ring (5), sight feed dome (7), O-rings (10 and 11), seal (12), check (charge) valve (2) (if used), siphon tube (6), and check ball (8).
6. Do not remove the flow sensor (1) unless it is obviously damaged. If necessary, insert a needle-nose pliers into the inlet port in the body (13) and grasp the point of the flow sensor. Turn the sensor approximately 1/4 turn either direction and push it through the body outlet port.
7. Clean the transparent reservoir using clear, warm water only. Clean other parts using soap and water.
8. Dry the parts and blow out internal passages using clean, dry compressed air.

Inspection

Inspect each part carefully. Replace any parts that are damaged.

Reassembly

1. Reinstall the flow sensor (1), if removed, with the point in the direction opposite to the flow arrow on the body (13).
2. Apply a wipe coat of 44M grease (or equivalent) to the reservoir O-ring (3).
3. Tighten the sight feed dome (7) and charge valve (2), if used, to 3,4 to 4,4 Nm (30 to 35 in-lb).
4. Tighten the siphon tube (6) until snug only.
5. Tighten the reservoir (9) by hand until the arrowhead on the reservoir is in line with or to the right of the arrowhead on the body.
6. Slide the side guard (15) onto the body and align the retaining spring bead in the guard with the groove in the body.
7. Insert the retaining spring (14) in the groove through the cutout in the guard, and rotate the guard around the body to "wind in" the spring.



Item	Description	Item	Description
1	Flow Sensor	9	Reservoir
2	Check (charge) Valve	10	O-ring
3	Reservoir O-ring	11	O-ring
4	Fill Plug	12	Seal
5	Fill Plug O-ring	13	Body
6	Siphon Tube	14	Retaining Spring
7	Sight Feed Dome	15	Side Guard
8	Check Ball		

FIGURE 2-33

Filling

Fill the reservoir with a high-quality desiccant to the level indicated by the maximum fill line. Do not overfill the reservoir.

AIR DRYER MAINTENANCE

Description

The air dryer is a filtering unit that cleans and dries the air delivered to the air system by the air compressor.

The air dryer consists of a desiccant cartridge and a die cast aluminum end cover secured to a cylindrical steel outer shell. The end cover contains a check valve, a safety valve, three threaded air connections, and the purge valve. The desiccant cartridge and discharge check valve are the screw-in type. Servicing the screw-in desiccant cartridge requires removing the air dryer from the crane.

Replacing the Desiccant Cartridge

See Figure 2-35 for the following procedure.

NOTE: This procedure covers only the desiccant cartridge replacement. Refer to the vendor manual for replacement of any other air dryer components.

1. Stop the engine.
2. Relieve all pressure in the reservoirs.
3. Tag and disconnect all air lines from the end cover (1).
4. Note the position of end cover ports relative to the crane.
5. Disconnect the wiring harness from the purge valve assembly (2).
6. On a standard mounting bracket, loosen the capscrew (3) and sleeve nut (4) that secure the mounting strap (5) to the mounting saddle (6).

   On a non-standard mounting bracket, loosen the adjusting nut (7) and remove the mounting strap (8) and isolator (9) from the upper bracket (10).
7. Remove the two end cover capscrews (11), lock nuts (12), and special washers (13) that secure the end cover to the lower mounting bracket (14).

NOTE: For installation purposes, tag the capscrews and capscrew holes. These capscrews are longer than the others, and it is important that they be reinstalled in the correct places.

Retain the mounting hardware.

8. Remove the air dryer assembly (15) from the crane.
9. Remove the capscrews (16), lock nuts (17), and special washers (18) that secure the end cover to the air dryer housing (19).
10. Remove the air dryer housing from the end cover.
11. Remove the outer housing O-ring (20).
12. Remove the desiccant cartridge (21) from the end cover by turning the cartridge counterclockwise.

NOTE: It is acceptable to use a strap or chain around the cartridge to assist in removal. Make sure to place the strap or chain 50 to 76 mm (2 to 3 in) away from the end cover.

A significant amount of force may be required to remove the cartridge.

13. Remove the desiccant cartridge O-ring (22).

See Figure 2-34 for the following procedure.

Installation is the reverse of removal. When tightening the capscrews that secure the air dryer housing to the end cover, follow the pattern shown.

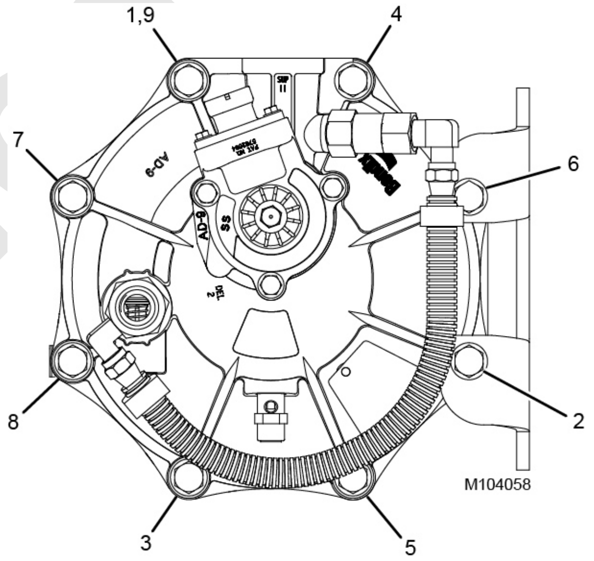
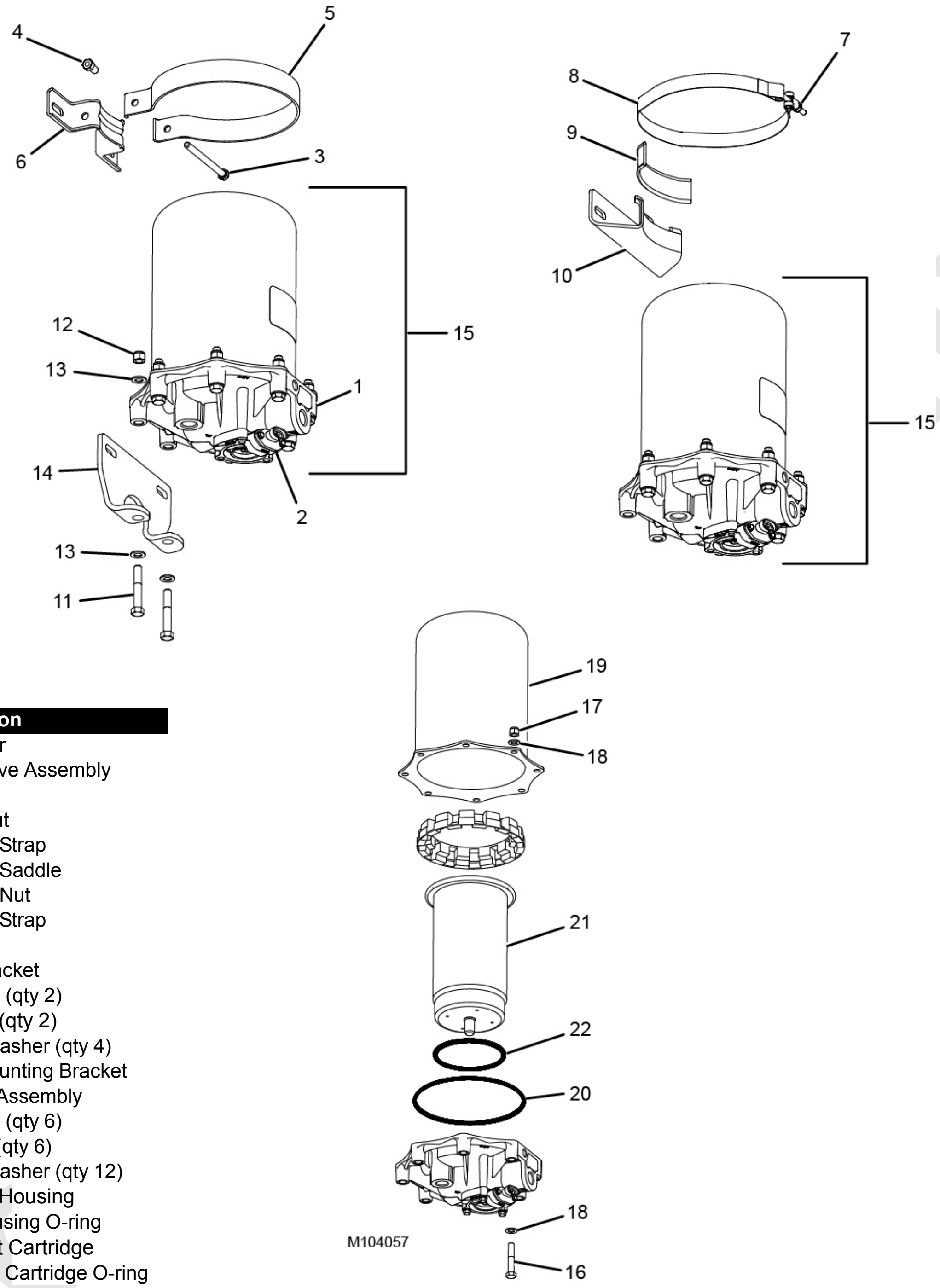


FIGURE 2-34

For operation, leak testing, disassembly and assembly, cleaning, inspection, and preventive maintenance, see the vendor manual and contact the Manitowoc Crane Care Lattice Team.



Item	Description
1	End Cover
2	Purge Valve Assembly
3	Capscrew
4	Sleeve Nut
5	Mounting Strap
6	Mounting Saddle
7	Adjusting Nut
8	Mounting Strap
9	Isolator
10	Upper Bracket
11	Capscrew (qty 2)
12	Lock Nut (qty 2)
13	Special Washer (qty 4)
14	Lower Mounting Bracket
15	Air Dryer Assembly
16	Capscrew (qty 6)
17	Lock Nut (qty 6)
18	Special Washer (qty 12)
19	Air Dryer Housing
20	Outer Housing O-ring
21	Desiccant Cartridge
22	Desiccant Cartridge O-ring

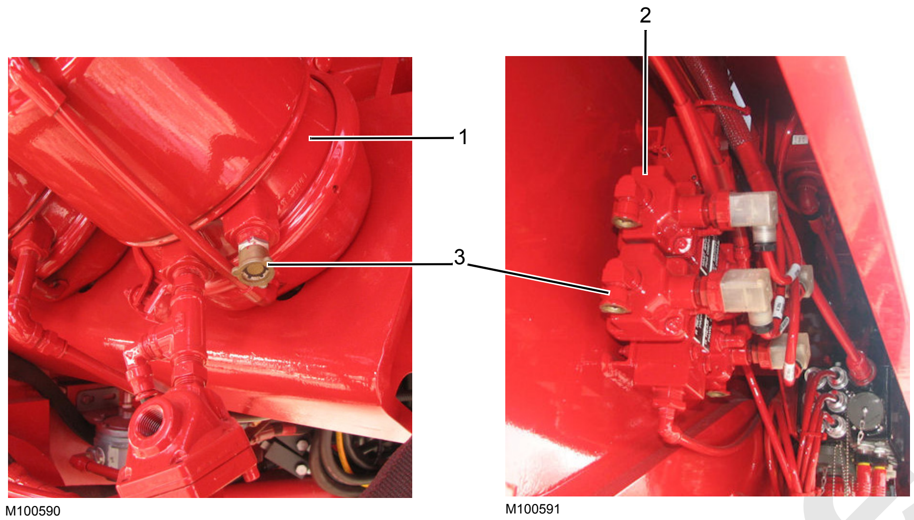
FIGURE 2-35

BREATHER VENT MAINTENANCE

See Figure 2-36 for the following procedure.

The solenoid valves (2) on the left side of the rotating bed and the brake chambers (1) at the drum brakes are equipped with breather vents (3).

Inspect the breather vents weekly to make sure they are not obstructed by any debris. If necessary, remove and clean (or replace) them as needed.



Item	Description
1	Brake Chamber (qty varies)
2	Solenoid Valve (qty varies)
3	Breather Vent (qty varies)

FIGURE 2-36

SOLENOID VALVE MAINTENANCE

Operation

Normally Closed

See Figure 2-37 for the following.

Pressure is applied to inlet port P. With the valve de-energized, air at port P is sealed off by the force of the plunger return spring and the seal in the plunger assembly. Cylinder port A is open to exhaust port E.

When current is applied to the coil, the plunger assembly moves to open inlet port P to cylinder port A. Exhaust port E is sealed off by the plunger assembly.

Normally open operation is the opposite of normally closed operation.

Air Line Connection

See Figure 2-37 for the following.

The solenoid valve has three ports identified as follows:

- P = Inlet from control valve
- A = Outlet to cylinder
- E = Exhaust

For normally closed operation, the air lines must be connected to the valve ports.

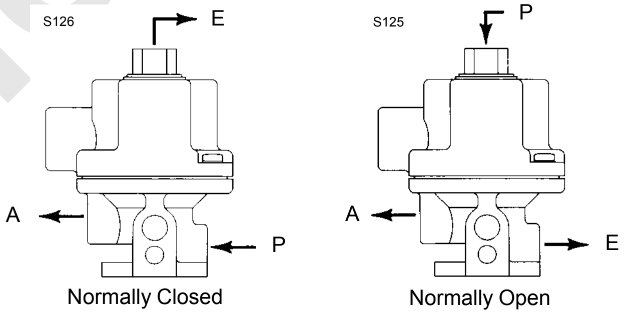


FIGURE 2-37

For normally open operation, the air lines must be connected to the valve ports.

NOTE: Improper connection of the air lines will cause improper system operation.

Electrical Connection

See Figure 2-38 for the following procedure.

If the coil housing is located in an inconvenient position, it may be oriented in 90-degree steps. For 90 degrees, remove the two housing screws and relocate the two housing plate screws. For 180 degrees, remove only the two housing screws. Reinstall the screws after orientation.

Maintenance

Troubleshooting

See Figure 2-38 for the following procedures.

If the valve fails to operate at all, check the coil (5) for shorted or open turns. Also check the supply current. See the following troubleshooting topics if the coil is not damaged.

Troubleshooting—External Leakage

If leakage occurs around the sleeve (9), the metering pins, or the manual override stem, the O-rings (10) should be removed and inspected for imperfections.

Troubleshooting—Sticking or Internal Leakage

If the valve leaks internally or the plunger (11) sticks in the energized position, examine the soft inserts in the plunger ends or inside the sleeve (9) for excessive dirt or wear. If the inserts show considerable wear, the plunger should be replaced.

Troubleshooting—Noise

If the valve develops a loud buzzing noise, check the voltage and pressure to determine if they correspond to the nameplate (2) rating. Examine the inside of the sleeve (9) and the upper portion of the plunger (11). Remove all foreign matter embedded in these parts. Do not damage the sleeve seat.

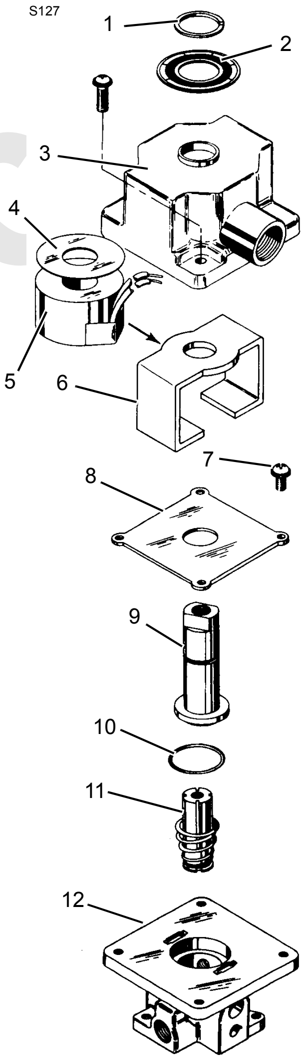
NOTE: Do not expose the plunger or O-rings (10) to any type of commercial cleaning fluid. Clean the plunger and O-rings with a mild soap-and-water solution.

Disassembly

1. Shut off pressure and electricity to the valve. The valve does not need to be removed from the line.
2. Remove the screws from the housing (3).
3. Remove the housing from the valve assembly.
4. Remove the yoke (6) and coil (5) with an upward twisting motion.
5. Remove the screws (7) that hold the housing plate (8) to the body (12).
6. Remove the housing plate, sleeve (9), and plunger (11).

Reassembly

1. Place the housing plate (8) over the sleeve (9).
2. Apply a light oil to the O-ring (10) flange seal. Always assemble the O-ring to the sleeve before inserting in valve bodies.
3. Make sure the plunger (11) and the return spring are in place and then push the sleeve, along with the housing plate, down in place on the body (12) with a slight twisting motion.
4. Hold the housing plate down and replace the screws (7). Tighten the screws to 2 ± 0,3 Nm (18 ± 3 in-lb). Place these screws so they give the desired orientation of the housing later in reassembly.
5. Apply pressure to the port that leads to the body chamber and check for leakage around the flange seal. If the valve has a sleeve port, cap the port at the top of the sleeve to perform this test.
6. Check for leakage by applying a soap-and-water solution to the joint and watch it for air bubbles.
7. Once the housing plate is secure, push the yoke (6) and coil (5) over the sleeve with a slight twisting motion.
8. Install the housing with two screws. Tighten the screws to 2 ± 0,3 Nm (18 ± 3 in-lb).
9. Repeat the internal leakage check.



Item	Description
1	Nameplate Retainer
2	Nameplate
3	Housing
4	Coil Washer
5	Coil
6	Yoke
7	Screw (qty 2)
8	Housing Plate
9	Sleeve
10	O-ring
11	Plunger
12	Body

FIGURE 2-38

QUICK RELEASE VALVE MAINTENANCE

General

See Figure 2-39 for the following.

The quick release valve shortens the time required to vent air pressure from a cylinder or other pneumatic device. This is made possible by exhausting the air pressure directly to atmosphere at the quick release valve instead of back through the control valve.

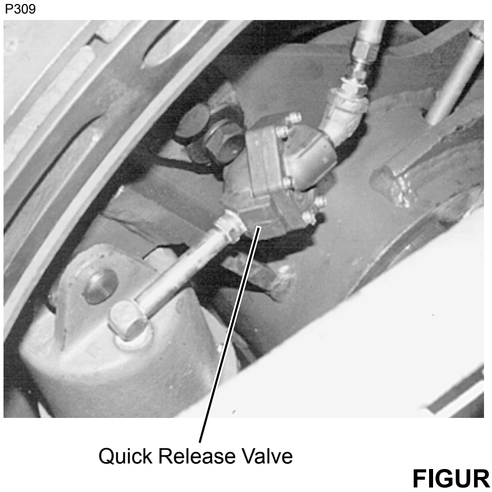


FIGURE 2-39

Adjustment

The quick release valve does not require adjustment.

Maintenance

By removing the screws and washers, the cover can be removed for easy replacement of the diaphragm without disturbing the piping connections.

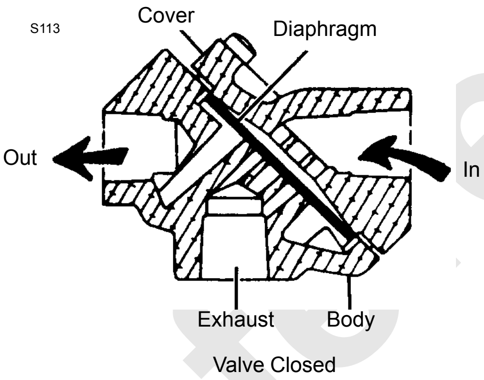
When complete disassembly is required, wash all metal parts with a nonflammable solvent. Wash all rubber parts with soap and water. Rinse all parts thoroughly and blow dry with a low-pressure air jet. Replace the diaphragm and the gasket if it is damaged or worn. Reassemble the valve and check for leaks during operation. No lubrication is required.

Operation

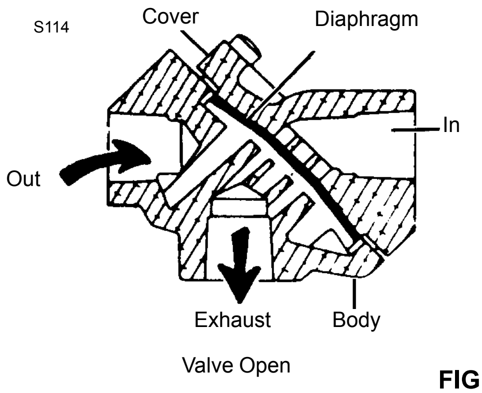
See Figure 2-40 for the following.

The quick release valve has three ports. Air pressure entering the IN port forces the diaphragm to seal the exhaust port and open a direct passage between the IN and OUT (cylinder) ports.

When air pressure at the IN port is reduced and pressure is slightly greater at the OUT port, the diaphragm is forced against the IN port. With the IN port sealed off, a direct passage is opened between the OUT and EXHAUST ports, allowing the operated device to vent quickly.



Valve Closed



Valve Open

FIGURE 2-40

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AIR PRESSURE SAFETY SWITCHES MAINTENANCE

General

See Figure 2-41 for the following.

The air pressure safety switch consists of an electric limit switch and a diaphragm-type valve. The pressure switch is used to control operation of auxiliary electrical devices or circuits in response to air pressure.

Air pressure safety switches are used for the following crane functions:

- To monitor the load drum clutch/brake maximum air pressure to ensure the appropriate clutch/brake is applied before allowing operation of load drums—This switch also alerts the programmable crane controller if the clutch/brake has not applied for a duration of 4 seconds or more. The AIR DRUM VALVES fault will appear on the crane display. Each drum clutch/brake safety switch is normally closed (N/C) with a trip point of 4,14 bar (60 psi).
- To monitor the free-fall interlock treadle valve minimum air pressure—When the selected drum's service brake treadle valve is locked down, the safety pressure switch sends a signal to the programmable crane controller allowing the operator to confirm the selected drum into Free-Fall mode. Each free-fall interlock safety switch is normally open (N/O) with a trip point of 4,14 bar (60 psi).
- To monitor system air pressure—The safety pressure switch sends a signal to the programmable crane controller to alert the operator with a LOW AIR PRESSURE system fault when activated. The air pressure safety switch is N/O with a trip point of 6,21 bar (90 psi).

NOTE: Always confirm by crane serial number the specific pressure at which the limit switch is set and the operation for which the limit switch is wired by referring to the corresponding assembly drawing and air/electrical schematics.

Operation

As pressure increases, the diaphragm moves up causing the adjusting screw to move up. When the pressure reaches the specified point, the adjusting screw pushes the limit switch plunger in, and the switch contacts either open or close.

If the limit switch is wired N/O, the contacts close to turn on the corresponding circuit when the specified pressure is reached. If the limit switch is wired N/C, the contacts open to turn off the corresponding circuit when the specified pressure is reached.

Adjustment Requirements

Adjustments can be performed when either installed on the crane or when removed from the crane. Adjustments will be easier and more accurate when done with the pressure switch removed from the crane. The following items will be required to perform the adjustment:

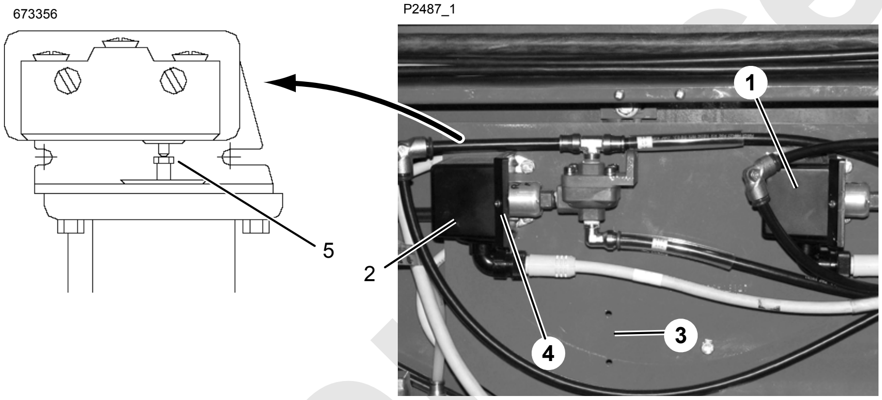
- Air supply capable of being regulated up to 8,27 bar (120 psi)
- Calibrated 0 to 10,34 bar (0 to 150 psi) air gauge
- DC voltage power supply
- Bulb-type continuity tester
- 1/4” open-end wrench

NOTE: Air pressure and electric current from the crane source can be used for this adjustment.

Adjustment

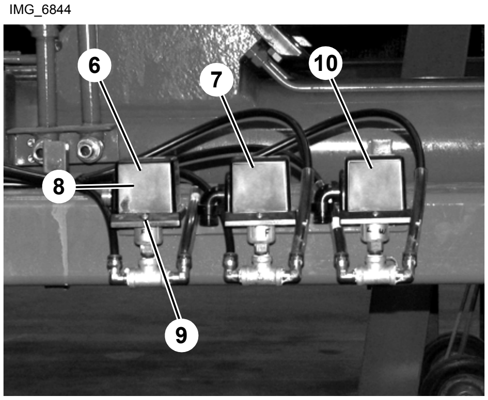
See Figure 2-41 for the following procedure.

1. Shut down the crane.
2. Discharge the system air pressure.
3. Disconnect the crane source air line piping at the pressure switch that needs adjustment.
4. Remove the cover screw (4 or 9) and pressure switch cover (8).
5. Connect a calibrated pressure source with a gauge to the 1/4” NPT fitting on the air sensor inlet, ensuring there are no air leaks.
6. Connect one lead of the tester to either the normally closed (N/C) terminal or the normally open (N/O) terminal of the limit switch, depending on the circuit application. Ground the other lead of the tester.
7. Connect the DC voltage power supply to the common (COM) terminal of the limit switch.
8. If the pressure switch is wired N/C, proceed as follows.
   - a. Turn the switch adjustment screw (5) all the way in and then out until it just touches the plunger.
   - b. Increase air pressure to the specified point. The tester light should go off.
   - c. Turn the switch adjustment screw in until the tester light comes on.
9. If the pressure switch is wired N/O, proceed as follows.
   - a. Turn the switch adjustment screw all the way in.
   - b. Increase air pressure to the specified point.
   - c. Turn the switch adjustment screw out until the tester light comes on.
10. Always recheck set points after adjustments are made.
11. Disconnect the DC voltage power supply, calibrated air supply, and tester.
12. Reinstall the air pressure switch.
13. Start the crane and allow the system to reach operating pressure. Activate the corresponding circuit to test and confirm the pressure switch trip point.



Left Side of Crane

Item	Description
1	Drum 3 (left rear) Pressure Switch
2	Drum 2 (rear/right rear) Pressure Switch
3	Drum 1 (front) Pressure Switch (not shown)
4	Cover Screw (typical)
5	Switch Adjustment Screw



Left Side of Crane Under Cab

Item	Description
6	Has No Function
7	Has No Function
8	Pressure Switch Cover
9	Cover Screw (typical)
10	Low System Air Pressure Safety Switch

FIGURE 2-41

SHUTTLE VALVE MAINTENANCE

General

See Figure 2-42 for the following.

The shuttle valve automatically selects the higher pressure from one or the other of two controlling devices and directs the flow of air to a common outlet. The valve serves to connect two segregated lines to a common line without destroying the segregation.

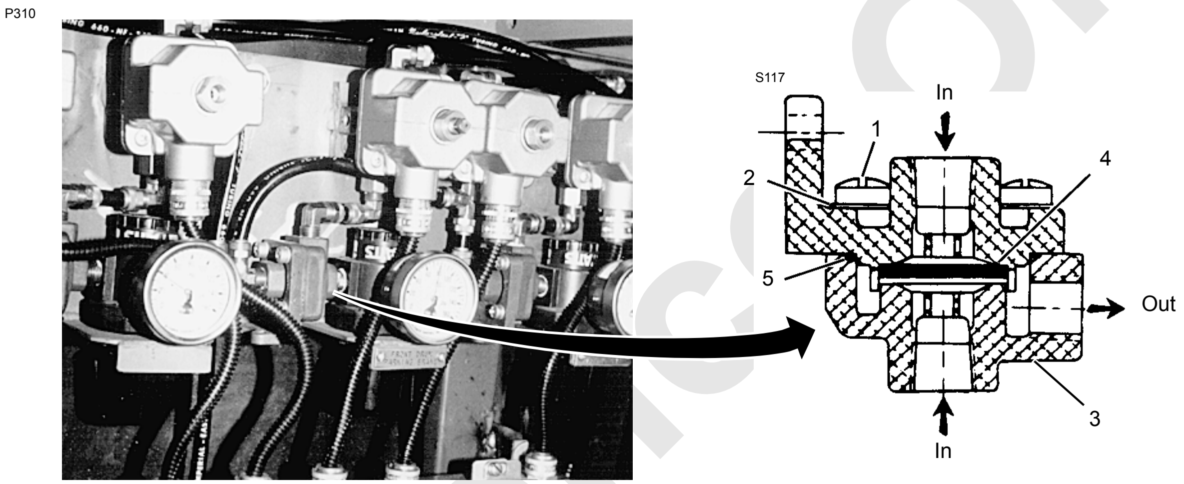
Operation

The shuttle valve has three ports. When a pressure differential of 0.07 bar (1 psi) or more exists between either IN port, the higher pressure forces the diaphragm to seal the opposite port of the valve and air flows out the common OUT port. The low pressure IN port is sealed from both the OUT port and the opposite side IN port.

Maintenance

By removing the screws (1) and washers (2), the body (3) can be removed for easy replacement of the diaphragm (4) without disturbing the piping connections.

When complete disassembly is required, wash all metal parts with a nonflammable solvent. Wash all rubber parts with soap and water. Rinse thoroughly and blow dry with a low-pressure air jet. Replace the diaphragm and gasket (5) if they are damaged or worn. Reassemble the valve and check for leaks during operation. No lubricant is required.



Item	Description
1	Screw (qty 4)
2	Washer (qty 4)
3	Body
4	Diaphragm
5	Gasket

FIGURE 2-42

TYPE A AIR REGULATOR MAINTENANCE

Installation

Before installing the regulator, blow out the air line to remove scale and other foreign matter. This unit has Dryseal pipe threads. Use pipe compound or tape sparingly on male threads only. Install the regulator in the air lines so that air will flow in the direction of the arrow stamped on the body.

Adjustment

See Figure 2-43 for the following procedure.

To unlock the adjustment, push the knob (4) all the way down. Turn the knob clockwise to increase regulated pressure or counterclockwise to decrease pressure. To lock the adjustment, pull the knob all the way up.

Maintenance

See Figure 2-43 for the following procedure.

CAUTION

Equipment Damage!

Certain chemicals can degrade non-metal components.

Never use carbon tetrachloride, trichloroethylene, thinner, acetone, or similar solvents when cleaning any part.

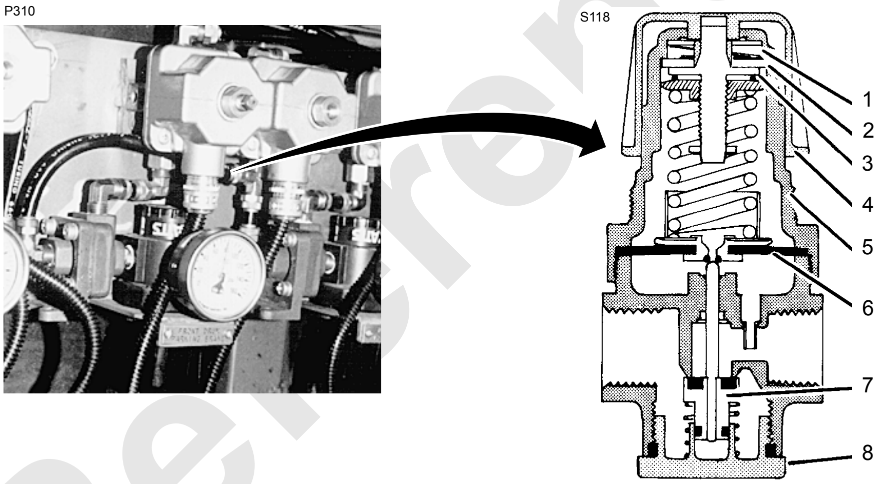
NOTE: To clean, it is not necessary to remove the regulator from the lines.

If the air supply is kept clean, the regulator should provide long periods of uninterrupted service.

Erratic operation or loss of regulation is usually due to dirt in the disc area.

To clean the regulator, perform the following procedure.

1. Shut off the air pressure and disassemble the regulator.
2. Clean all parts with denatured alcohol and blow out the body with compressed air.
3. When reassembling, make sure the disc stem fits into the center hole of the diaphragm assembly (6). If the diaphragm assembly is replaced, make sure the disc stem fits into its center hole.
4. Tighten the bonnet (8) slightly more than hand-tight 5,1 Nm (45 in-lb).



Item	Description
1	Lock Assembly
2	Adjustment Screw
3	Adjustment Knob
4	Knob
5	Spring Cage
6	Diaphragm Assembly
7	Disc Assembly
8	Bonnet

FIGURE 2-43

N-1 PRESSURE-REDUCING VALVE MAINTENANCE

Operation

See Figure 2-44 and Figure 2-45 for the following.

Air pressure from the main supply passes from the IN port to the OUT port through the unseated inlet valve of the exhaust valve unit (1). The inlet valve is held off its seat by a control spring (2) which forces the diaphragm (3) and exhaust valve seat (4) upward. While the seat is in the upward position, the exhaust valve is closed and the inlet valve is held open.

Air pressure at the OUT port also passes through a sensing port to the top of the diaphragm. When the pressure at the OUT port reaches the setting of the control spring, it is compressed, and the valve assembly moves down far enough to close the inlet valve and keep the exhaust valve closed. As long as air pressure at the OUT port and spring force are balanced, the inlet and exhaust valve remain closed.

The valve automatically compensates for downstream pressure changes, keeping the control circuit at the predetermined or set pressure. Pressure changes may be caused by line leakage, temperature changes, or load thrust. If air pressure at the OUT port increases over that called for by the spring setting, the diaphragm deflects downward, moving the exhaust valve seat away from the inlet and exhaust valve unit and vents the excess pressure. If the pressure drops below that called for by the spring setting, the control spring forces the diaphragm upward and the exhaust valve seat moves the inlet valve from its seat, opening the IN port to the OUT port to restore the pressure called for.

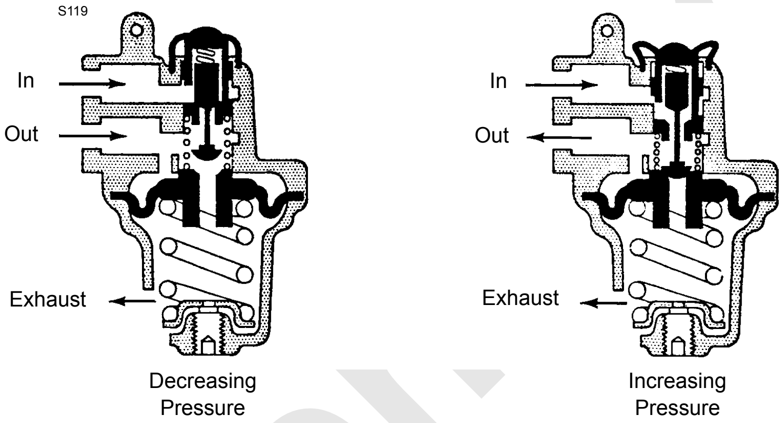


FIGURE 2-44

Maintenance

See Figure 2-45 for the following procedure.

Maintenance periods should be scheduled in accordance with the frequency of use and working conditions of the valve.

One complete valve should be kept in stock for each four valves in service. During the maintenance period, change out the complete valve with the standby unit. This will reduce production time loss and allow inspection and replacement of worn parts in a clean location at a more convenient time.

NOTE: The operating portion of the valve can be removed without disturbing the pipe connections.

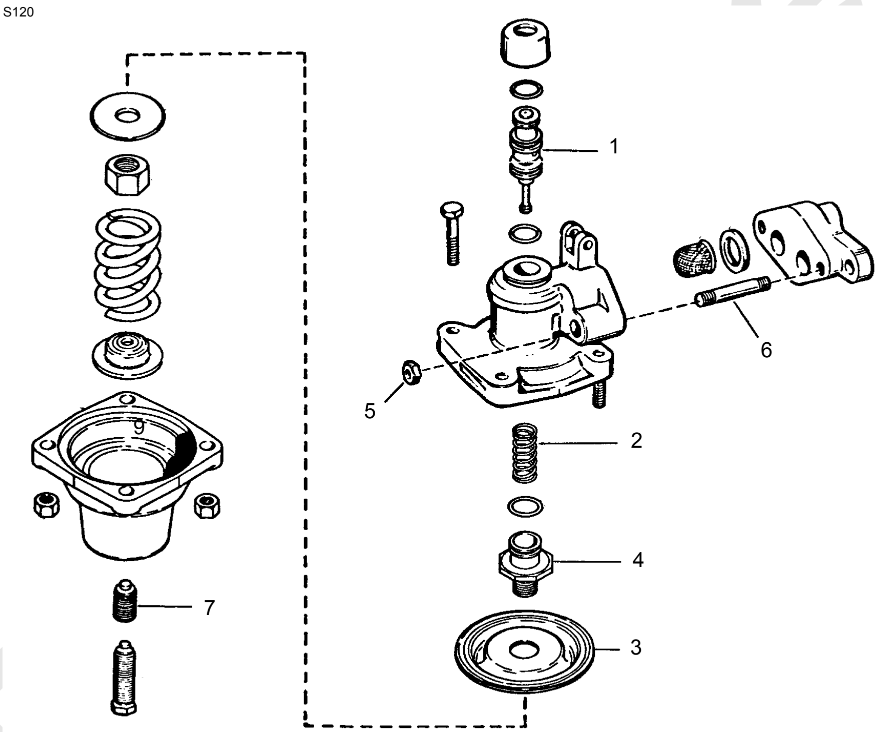
No special tools are required to maintain the valve.

1. Remove the valve portion by loosening the nut (5) and stud (6).
2. Completely disassemble the valve.
3. Wash all metal parts in a nonflammable solvent and all rubber parts in soap and water.
4. Rinse each part thoroughly and blow dry them with a low-pressure air jet.
5. Arrange the parts on a clean surface in the order of the exploded view.
6. Examine each part carefully. Flex the diaphragm and packing rings, and if cracked or worn, replace them. Replace all parts that may not provide satisfactory service until the next maintenance period.
7. Reassemble the valve using the exploded view as a guide. Lubricate each part before it is put into place. Use No. 107 Lubriplate on all metal-to-metal surfaces and No. 55 Pneumatic Grease on all rubber parts. Equivalent greases to those recommended can be used.
8. Store the reconditioned valve in a moisture-proof bag.

Adjustments

See Figure 2-45 for the following procedure.

Use the adjusting screw (7) to adjust the valve. Turn the adjusting screw in to raise the outlet pressure, and turn it out to lower the outlet pressure.



Item	Description
1	Exhaust Valve Unit
2	Control Spring
3	Diaphragm
4	Exhaust Valve Seat
5	Nut
6	Stud
7	Adjusting Screw

FIGURE 2-45

TYPE S RELAY VALVE MAINTENANCE

General

See Figure 2-46 for the following.

The Type S Relay Valve is a pilot-operated, air control valve which speeds drum brake response time on machines where there is a long distance between each drum brake treadle valve and each drum brake cylinder.

The relay valve receives an air pressure signal from the brake treadle valve and repeats the pressure with a faster rate of flow to the brake cylinder.

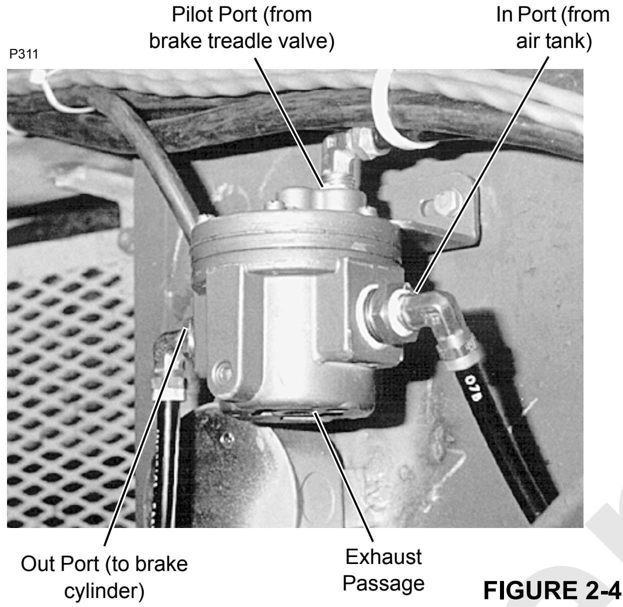


FIGURE 2-46

Operation

Increasing Pressure

See Figure 2-47 for the following.

As the brake pedal is pushed down to apply the drum brake, air flows to the pilot port. The diaphragm assembly then moves down to block the exhaust passage, to unseat the inlet valve plunger, and then to compress the inlet valve spring. Air from the tank then flows through the IN port to the OUT port. A controlled flow of air is also directed to the underside of the diaphragm assembly. Air continues to flow until the brake pedal is stopped or held at the desired brake-applied position. Pressure at the OUT port then becomes equal to pressure at the pilot port (see Balanced Position).

Balanced Position

See Figure 2-47 for the following.

Pressure at the OUT port (below diaphragm assembly) becomes equal to pressure at the pilot port (above diaphragm assembly). The balanced pressure allows the inlet valve spring to move the inlet valve plunger up. This seats the inlet valve plunger and exhaust passage, sealing the IN and OUT ports.

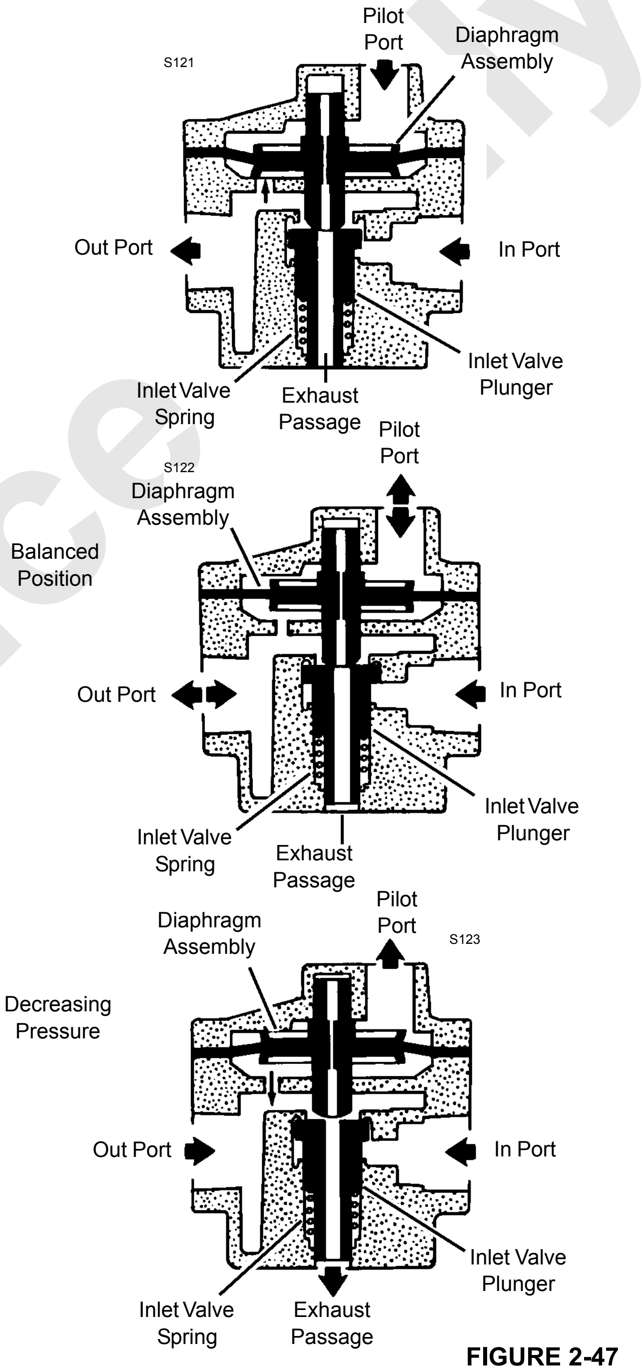


FIGURE 2-47

Decreasing Pressure

See Figure 2-47 for the following procedure.

As the brake pedal is eased up to release the drum brake, reduced pressure at the pilot port unbalances the pressure across the diaphragm assembly. This causes the diaphragm assembly to move away from the seated inlet-valve plunger, opening the OUT port to the exhaust passage. Air continues to exhaust until the brake pedal is stopped or held at the desired position. Pressure at the OUT port then becomes equal to pressure at the pilot port (see Balanced Position on page 2-42).

Maintenance

See Figure 2-48 for the following procedure.

The relay valve does not require periodic maintenance or adjustment.

Overhaul the relay valve as follows if it fails to operate properly.

NOTE: The relay valve can be overhauled without disconnecting the air lines. All parts are accessible by removing the cover.

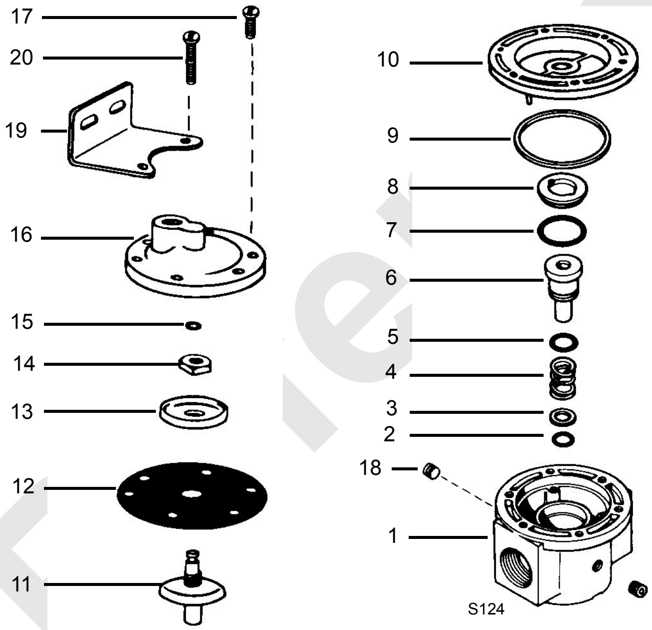
CAUTION

Flying Debris Hazard!

A sudden release of pressurized air can cause minor injury due to flying debris.

Drain the air system before removing the relay valve cover.

1. Completely disassemble the relay valve. No special tools are required.
2. Clean all metal parts with a nonflammable solvent. Wash all rubber parts with soap and water.
3. Rinse all parts in clean water and blow dry them with a low pressure air jet.
4. Lay all parts on a clean surface.
5. Examine each part for wear and cracks. Replace worn parts. Parts contained in the repair kit for the relay valve are identified in the exploded view.
6. Reassemble the relay valve.
7. During assembly, lubricate all metal-to-metal surfaces with No. 107 Lubriplate and all rubber parts with Cosmolube or their equivalent.



Relay Valve Assembly

Item	Description	Item	Description
1	Body	11	Diaphragm Follower
2	O-ring*	12	Diaphragm*
3	Washer	13	Diaphragm Retainer
4	Inlet-Valve Spring*	14	Hex Nut
5	O-ring*	15	O-ring*
6	Inlet-Valve Plunger*	16	Cover
7	O-ring*	17	Screw (short) (qty 4 each)
8	Inlet-Valve Seat*	18	1/8 in Pipe Plug (qty 2 each)
9	O-ring*	19	Mounting Bracket
10	Baffle*	20	Screw (long) (qty 2 each)

*Parts in Repair Kit

FIGURE 2-48

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SECTION 3
ELECTRICAL SYSTEM

TABLE OF CONTENTS

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SECTION 3
ELECTRICAL SYSTEM

ELECTRICAL DRAWINGS AND SCHEMATICS

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

INSPECTING OR REPLACING ELECTRICAL COMPONENTS

DANGER

Electrical Shock Hazard!

Prevent personal injury from electrical shock.

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

Electrical Harnesses and Cables—Monthly or 200 Hour Service Life Inspection

Visually inspect all of the electrical harnesses and cables for the following conditions:

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

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

Electrical Junction Boxes—Monthly or 200 Hour Service Life Inspection

Visually inspect all of the electrical junction boxes for the following conditions:

- 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.

Electrical Harnesses and Cables—Service Life

Electrical harnesses and cables potentially have different service lives based on the climate zones they are operating in. Take into consideration if the crane is moved and operated in different climate zones. The service life will be a combination of the recommended intervals. See Table 3-1 for the following items:

- Harness and battery cables operating in Zone C are recommended to be replaced after 10,000 hours of service life.
- Harness and cables operating in Zone A and Zone B with high ambient temperatures and high-duty circuits could see electrical service life reduced by 25% to 40%. It is recommended to replace these assemblies after 8,000 hours of service life.
- Harness and cable assemblies operating in climate Zone D and Zone E should expect a degrade of mechanical properties. Long-term exposure to these cold temperatures will negatively impact the service life. It is recommended for these electrical harnesses and cables to be inspected monthly or every 200 hours, since service life may be more than 10,000 hours.
- 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 cables to be inspected monthly or every 200 hours, since service life may be more than 8,000 hours.

Table 3-1. Climate Zone Classification

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

CIRCUIT BREAKER AND FUSE ID

General

This section identifies the fuses and circuit breakers.

The fuses are mounted in the fuse junction box located in the operator's cab (Figure 3-1) or the CraneSTAR TCU Harness at the batteries (Figure 3-5).

Circuit breakers are mounted in the following locations:

- Fuse junction box (Figure 3-1)
- Engine junction box (Figure 3-2 or Figure 3-4)
- Cold weather package junction boxes (Figure 3-3)
- MAX-ER junction box (Figure 3-4)
- Power plant (Figure 3-5)

Fuse	Amps	Wire No.	Description of Items Protected
Circuit Breaker and Fuse Junction Box Located in Operator's Cab			
F2	15	8H	Heater and A/C
F3	10	8W1	Front Wiper
F4	10	8W2	Overhead Wiper
F5	10	8F	Defogger
F6	10	8X	Container Handling
F7	10	8M	Moisture Ejector
F8	15	8S	Air/Hydraulic Solenoids
F9	5	8A	Overhead Panel and LMI
F10	5	8D	Computer Inputs
F11	5	8E	Encoders
F12	5	8T	Pressure Transducers
F13	15	8SR	Jacking and Setup Remote
F14	20	5H	Horn
F15	10	5D	Cab Power
F16	3	87FA	10 VDC Regulated Power Supply
F17	15	5E	Accessory Outlet
S1	50 CB-9	8P1	12 VDC to Programmable Controller
S2	30 CB-8	58	Air Conditioning and Accessory

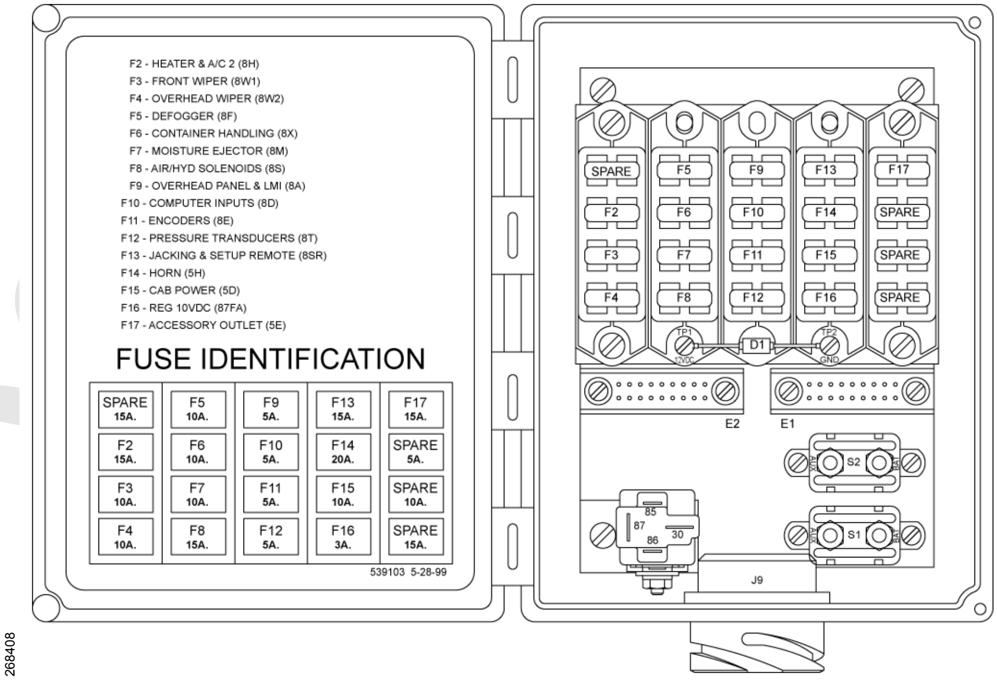


FIGURE 3-1

Circuit Breaker	Amps	Wire No.	Description of Items Protected
Engine Controller Module Breakers for Tier 4 Cummins QSX-15 Power Plant			
CB Numbers Are per the Electrical Schematic			
CB-2	8	6C2	Engine Control Module (ECM)
CB-3	10	5C2	Engine Diagnostics
CB-4	30	5C1	Engine Control Module (ECM)
CB-5	15	6A3	CAN Power
CB-6	15	6A4	Autolube
CB-7	30	6A1	Starter Solenoid
CB-8	30	58	A/C Clutch

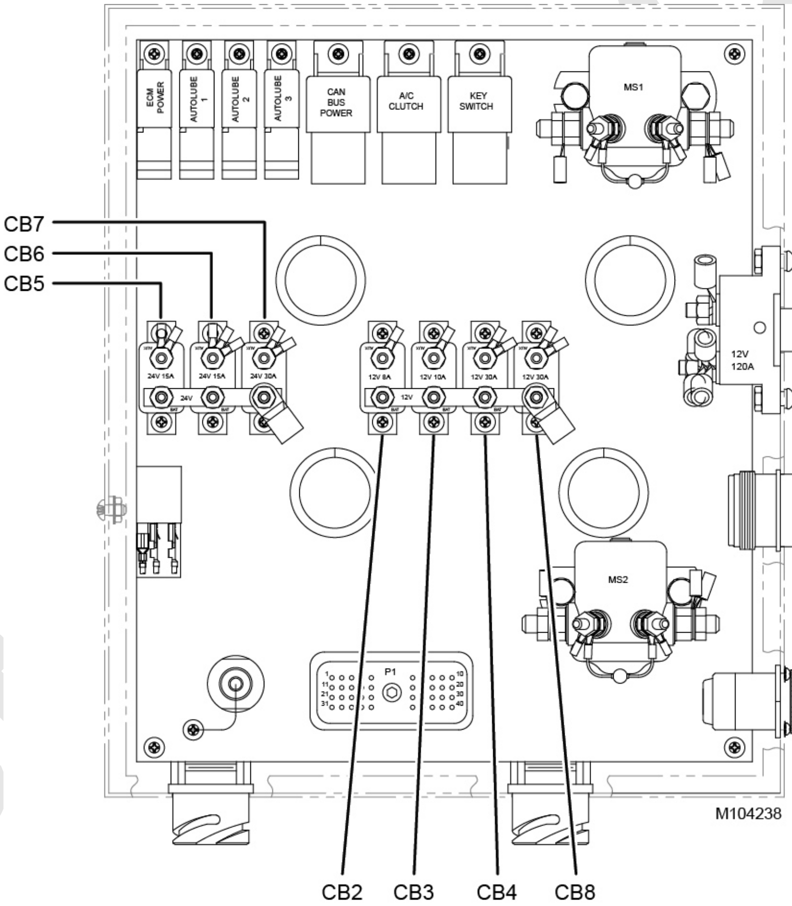
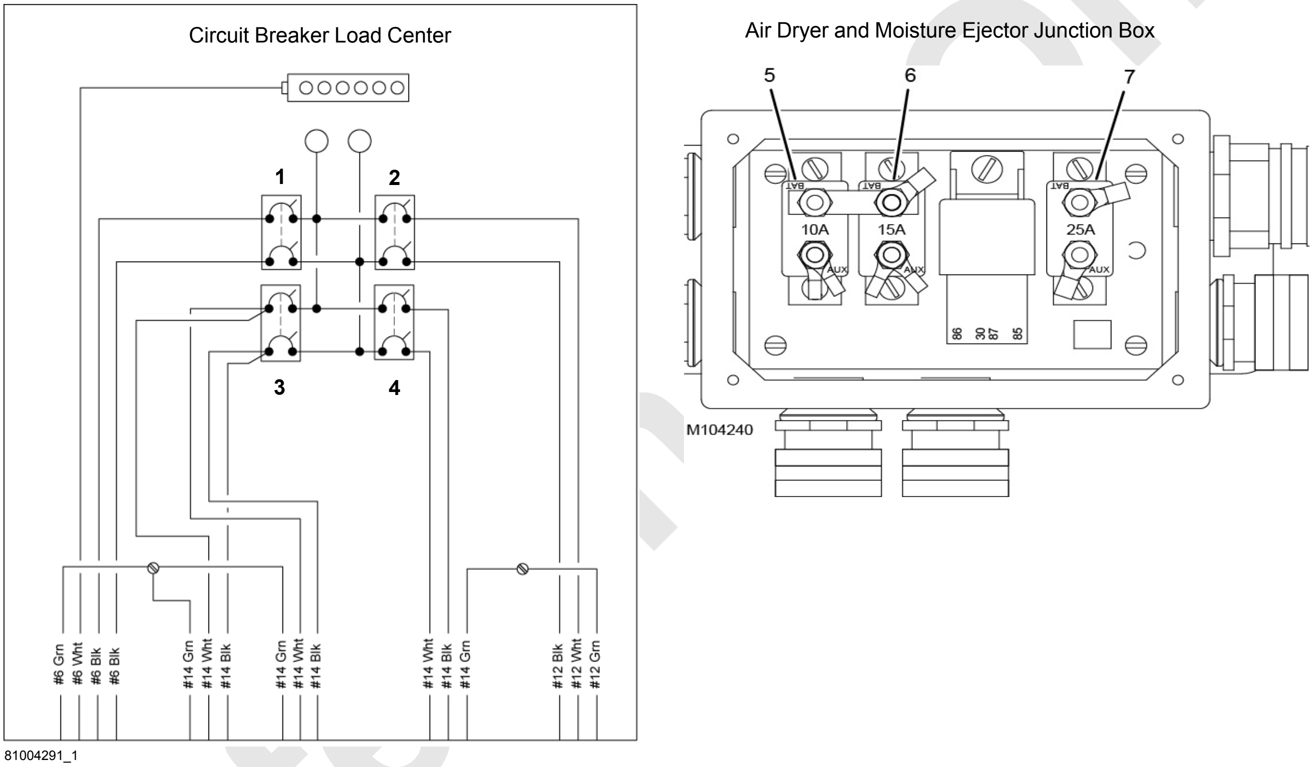


FIGURE 3-2

Circuit Breaker	Amps	Description of Items Protected
Cold Weather Package Circuit Breakers		
1	50	Cold Weather Package Main Load Center Circuit Breaker
2	20	Engine Coolant Heater
3	15	Control Console and Treadle Valve Heaters
4	15	Hydraulic Reservoir, Engine Oil, and Battery Pad Heaters
5	10	Air Dryer
6	15	Moisture Ejector
7	25	Air Dryer and Moisture Ejector Junction Box Main Breaker


Circuit Breaker Load Center

Air Dryer and Moisture Ejector Junction Box

FIGURE 3-3

Circuit Breaker	Amps	Wire No.	Description of Items Protected
MAX-ER 2000 Junction Box Enclosure			
1	15	8K	Main Junction Box
2	15	8L	Drum 9 Pawl Relays
3	25	8N	MAX-ER Programmable Controller

MAX-ER 2000 Junction Box Enclosure

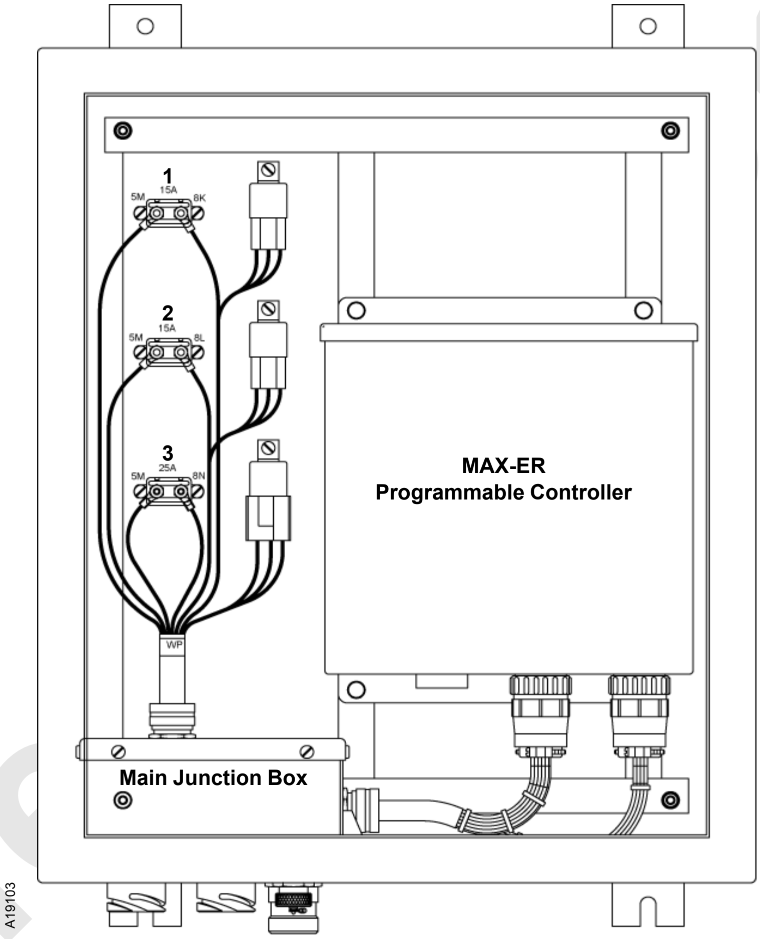
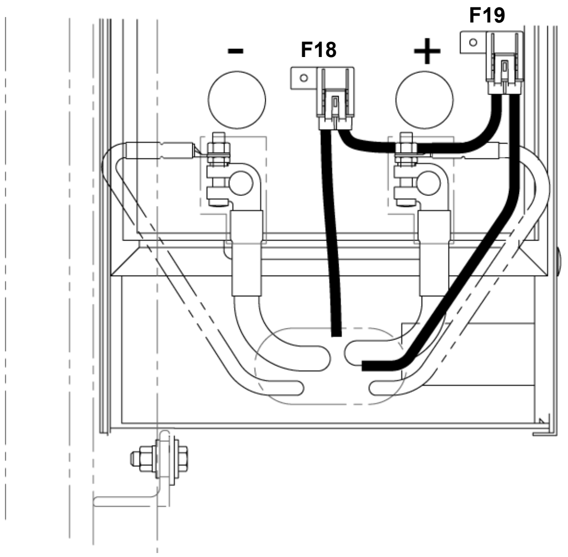


FIGURE 3-4

Fuse	Amps	Wire No.	Description of Items Protected
Inline Fuses for TCU Harness Located at Battery Terminals			
F18	10	6C	Master Node 24VDC Supply
F19	5	P15-24	TCU 24VDC Supply



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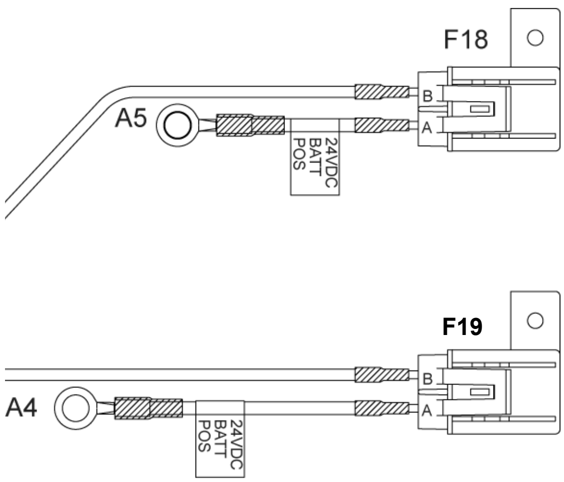

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Fuse	Amps	Description of Items Protected
Aftertreatment Junction Box Enclosure		
F5	15	Diesel Exhaust Fluid (DEF) Supply Module
F6	10	Aftertreatment Sensors
F7	15	Diesel Exhaust Fluid (DEF) Heaters
K1	10	Diesel Exhaust Fluid (DEF) Pressure Hose Heater
K2	10	Diesel Exhaust Fluid (DEF) Return Hose Heater
K3	10	Diesel Exhaust Fluid (DEF) Suction Hose Heater
K4	10	Diesel Exhaust Fluid (DEF) Supply Module
K5	10	Aftertreatment Sensors

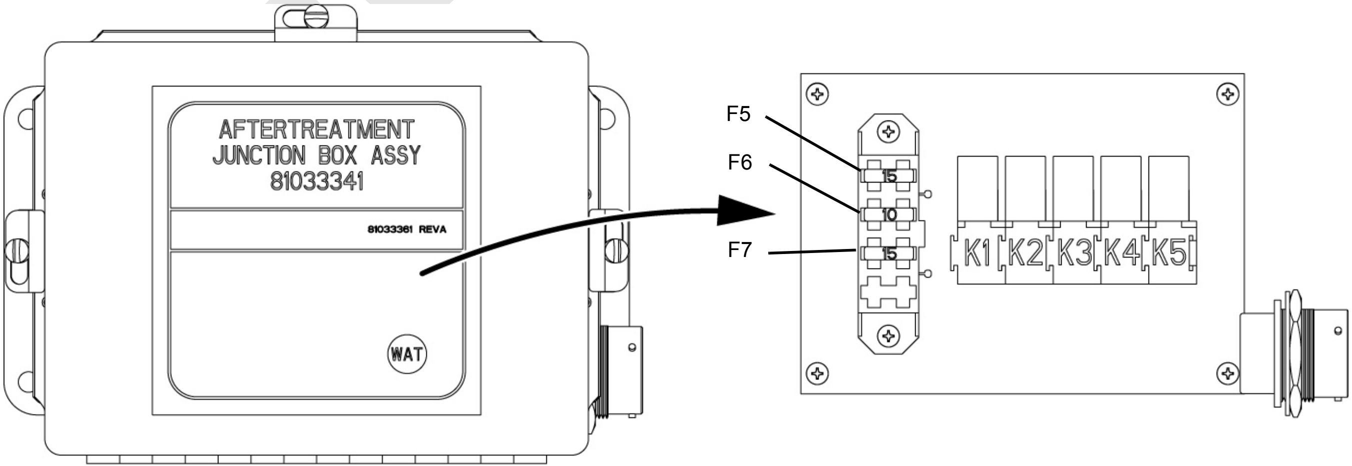

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FIGURE 3-5

TEST VOLTAGES FOR CRANE CONTROLLER

General

This section contains test voltages sorted into the following four categories:

- Pin identification
- Wire identification
- Description identification
- Master node pin identification

NOTE: The master node is only present on CraneSTAR-equipped machines.

Controller Board Layout

The board locations in the cab programmable controller are shown below. The MAX-ER programmable controller is located in an electrical junction box behind the operator’s cab (on the left side of the rotating bed).

Abbreviations

The following abbreviations are used in this section:

AI	=	Analog Input
AO	=	Analog Output
CHA or CHB	=	Channel A or B
Comm	=	Communication
CPU	=	Central Processing Unit
DI	=	Digital Input
DO	=	Digital Output
I/O	=	Input/Output
lb	=	Pounds
N/C	=	No Connection
Press	=	Pressure
psi	=	Pounds per Square Inch

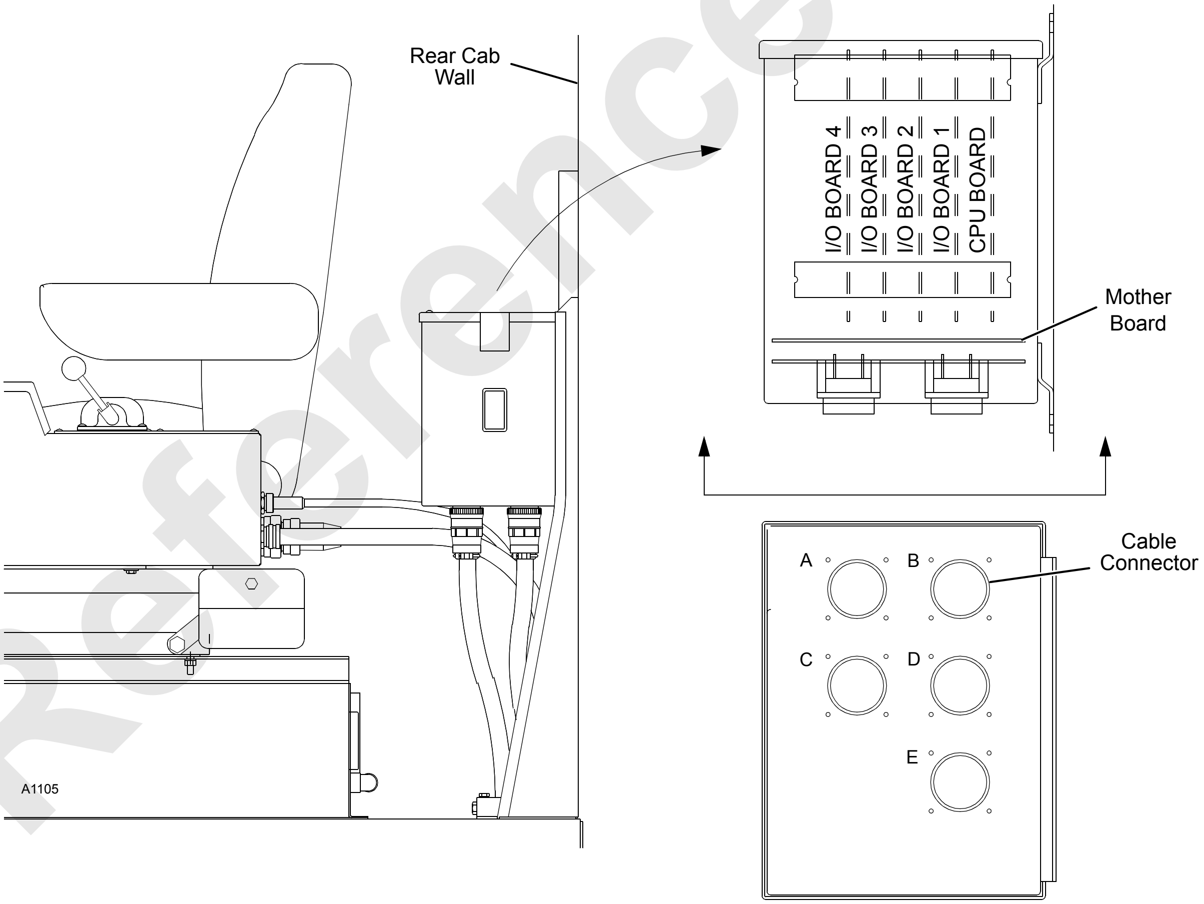

FIGURE 3-6

Crane Controller Pin, Wire, and Description Identification

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (signal type)
A-01	87F	10 VDC Regulated Supply Out	10 Volts	CPU (VDC)
A-02		Not Used		CPU (AI)
A-03	80P	Front or Right Rear Drum Handle	0 Volts Neutral, 1.4 to 5 Volts Lower, 5 to 8.6 Volts Raise	I/O 1 (AI)
A-04	81P	Rear or Left Rear Drum Handle	0 Volts Neutral, 1.4 to 5 Volts Lower, 5 to 8.6 Volts Raise	I/O 1(AI)
A-05	82P	Boom Hoist Handle	0 Volts Neutral, 1.4 to 5 Volts Reverse, 5 to 8.6 Volts Forward	I/O 1 (AI)
A-06	83P	Right Track Handle	0 Volts Neutral, 1.4 to 5 Volts Reverse, 5 to 8.6 Volts Forward	I/O 1 (AI)
A-07	84P	Left Track Handle	0 Volts Neutral, 1.4 to 5 Volts Reverse, 5 to 8.6 Volts Forward	I/O 1 (AI)
A-08	85P	Swing Handle	0 Volts Neutral, 1.7 to 5 Volts Right, 5 to 8.3 Volts Left	I/O 1 (AI)
A-09	68KA	Engine Throttle (foot)	2.9 to 3.0 Volts Low Idle, 0.9 to 1.0 Volts High Idle	I/O 1 (AI)
A-10	68K	Engine Throttle Input/Output (hand)	0.5 Volts Low Idle, 4.5 Volts High Idle	I/O 1 (AI)
A-11		Not Used		(SHIELD)
A-12		Not Used		I/O 2 (AI)
A-13		Not Used		I/O 2 (AI)
A-14		Not Used		I/O 2 (AI)
A-15		Not Used		I/O 2 (AI)
A-16	88QS	Cooling Fan Hydraulic System Press. Sender	1.2 Volts at 300 psi, 1 Volt at 0 psi	CPU (AI)
A-17	42	Hydraulic Fluid Temperature Sender	1.3 Volts at 155°F, 5.56 Volts at 95°F	I/O 2 (AI)
A-18	98F	Hydraulic Fluid Level Sender	5.2 Volts Low Idle, 1.2 Volts High Idle	I/O 2 (AI)
A-19	87QS	Ind. Luffing Hoist Hydraulic System Press. Sender	1.2 Volts at 300 psi, 1 Volt at 0 psi	I/O 2 (AI)
A-20	82BA	Boom Angle Indicator	1.9 Volts Boom at 0°, 6.9 Volts Boom at 60°, 8.7 Volts Boom at 82°	CPU (AI)
A-21	87BA	Luffing Jib Angle Indicator	4.7 Volts Boom at 0°, 8.0 Volts Boom at 60°, 9.2 Volts Boom at 82°	CPU (AI)
A-22	81QS	Main Hoist Hydraulic System Press. Sender	1.2 Volts at 300 psi, 1 Volt at 0 psi	CPU (AI)
A-23	85QR	Swing Right Hydraulic System Press. Sender	1.2 Volts at 300 psi, 1 Volt at 0 psi	CPU (AI)
A-24	85QL	Swing Left Hydraulic System Press. Sender	1.2 Volts at 300 psi, 1 Volt at 0 psi	CPU (AI)
A-25	81Q	Main Hoist Hydraulic Charge Press. Sender	2.6 Volts at 300 psi, 1 Volt at 0 psi	CPU (AI)
A-26	82QS	Boom Hoist Hydraulic System Press. Sender	1.2 Volts at 300 psi, 1 Volt at 0 psi	CPU (AI)
A-27	83QS	Right Track Hydraulic System Press. Sender	1.2 Volts at 300 psi, 1 Volt at 0 psi	CPU (AI)
A-28	84QS	Left Track Hydraulic System Press. Sender	1.2 Volts at 300 psi, 1 Volt at 0 psi	CPU (AI)
A-29	86P	Luffing Hoist Handle	0 Volts Neutral, 1.4 to 5 Volts Lower, 5 to 8.6 Volts Raise	CPU (AI)
A-30	90E	Backhitch Load Sensor	3.15 V at No Load, Compression 0.804 V at 180,000 lb, Tension 8.04 V at 375,000 lb	CPU (AI)

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (signal type)
A-31	98Q	Hydraulic Vacuum Switch	1 Volt at 762 mm (30 in) of Mercury (Hg), 2.3 Volts at 0 psi	I/O 3 (AI)
A-32	99	Level Sensor—X Dimension	5 Volts at 0°, 0.5 Volts Change per Degree	I/O 3 (AI)
A-33	99A	Level Sensor—Y Dimension	5 Volts at 0°, 0.5 Volts Change per Degree	I/O 3 (AI)
A-34	SIG1V	Lower Boom Point Load Pin	0.8 Volts 0 Load, 7 Volts 30,000 lb	CPU (AI)
A-35	SIG2V	Upper Boom Point Load Pin	0.8 Volts 0 Load, 7 Volts 30,000 lb	CPU (AI)
A-36	SIG3V	Lower Jib Load Pin	0.8 Volts 0 Load, 7 Volts 30,000 lb	CPU (AI)
A-37	SIG4V	Upper Jib Load Pin	0.8 Volts 0 Load, 7 Volts 30,000 lb	CPU (AI)
B-01	89X	Travel Detent Set & Cancel	12 Volts Nominal	I/O 1 (DI)
B-02	89V	Drum 1 Clutch/Brake Maximum Air Pressure	12 Volts Nominal	I/O 1 (DI)
B-03	89T	Minimum Bail Limit Switch Front Drum	12 Volts Nominal	I/O 1 (DI)
B-04	89Q1	Minimum Bail Limit Switch Left Rear Drum	12 Volts Nominal	I/O 1 (DI)
B-05	89R1	Drum 3 Clutch/Brake Maximum Air Pressure	12 Volts Nominal	I/O 1 (DI)
B-06	89W	Block-Up Limit Switches	10 Volts	I/O 1 (DI)
B-07	89U	Drum 2 Clutch/Brake Maximum Air Pressure	12 Volts Nominal	I/O 1 (DI)
B-08	89S	Min. Bail Limit Switch Rear/Right Rear Drum	12 Volts Nominal	I/O 1 (DI)
B-09	39	Jumper to Single Board Controller (Lights)	12 Volts Nominal	I/O 1 (DI)
B-10	89Q3	Seat Switch	12 Volts Nominal	I/O 1 (DI)
B-11	89D1	Jacking Remote/MAX-ER Steering System	12 Volts Nominal	I/O 1 (DI)
B-12	89D3	Jacking/Setup Remote	12 Volts Nominal	I/O 1 (DI)
B-13	89N	Boom Hoist Pawl-In Switch	12 Volts Nominal	I/O 1 (DI)
B-14	89R	Boom Up Limit Switch	12 Volts Nominal	I/O 1 (DI)
B-15	89L1	High Speed Travel Switch	12 Volts Nominal	I/O 2 (DI)
B-16	89S1	Luffing Jib Minimum Angle Limit Switch	10 Volts	I/O 2 (DI)
B-17	89W1	Luffing Jib Maximum Angle Limit Switch	10 Volts	I/O 2 (DI)
B-18	89Y3	Front Drum Park Switch	12 Volts Nominal	I/O 2 (DI)
B-19	89B4	Travel Park Switch	12 Volts Nominal	I/O 2 (DI)
B-20	89V3	Low Air Pressure Switch	3.2 Volts at 110 psi, 1 Volt at 0 psi	I/O 2 (DI)
B-21		Not Used		I/O 2 (DI)
B-22	89J1	Left Rear Drum Selector Switch	12 Volts Nominal	I/O 2 (DI)
B-23	89M	Drum 1 and Drum 2 Free-Fall Safety Switch	12 Volts Nominal	I/O 2 (DI)
B-24	89S2	Crane Mode Select Switch	12 Volts Nominal	I/O 2 (DI)
B-25	89L	Limit Bypass Switch	12 Volts Nominal	I/O 2 (DI)
B-26	89J	Display Scroll Up Switch	12 Volts Nominal	I/O 2 (DI)
B-27	89X3	Rear or Right Rear Drum Park Switch	12 Volts Nominal	I/O 2 (DI)
B-28	89Z3	Left Rear Drum Park Switch	12 Volts Nominal	I/O 2 (DI)
B-29	89A4	Boom Hoist Park Switch	12 Volts Nominal	I/O 3 (DI)
B-30	89C4	Luffing Hoist Park Switch	12 Volts Nominal	I/O 3 (DI)
B-31		Not Used		I/O 3 (DI)
B-32		Not Used		I/O 3 (DI)
B-33	89K	Display Scroll Down Switch	12 Volts Nominal	I/O 3 (DI)
B-34		Not Used		I/O 3 (DI)

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (signal type)
B-35		Not Used		I/O 3 (DI)
B-36		Not Used		I/O3 (DI)
B-37		Not Used		
C-01	8P1	Computer Input	12 Volts Nominal	
C-02	0	Computer Ground	0 Volts	
C-03	8P1	Computer Input	12 Volts Nominal	
C-04	0	Computer Ground	0 Volts	
C-05	80A	Main Hoist Pump Control 1	0 to 2.8 ± 10% (110 mA) Volts Down, 0 to -2.8 ± 10% (-110 mA) Volts Up	I/O 1 (AO)
C-06	81A	Main Hoist Pump Control 2	0 to 2.8 ± 10% (110 mA) Volts Down, 0 to -2.8 ± 10% (-110 mA) Volts Up	I/O 1 (AO)
C-07	80E	Front Drum Parking Brake Solenoid	12 Volts Nominal	I/O 1 (DO)
C-08	81E	Rear or Right Rear Drum Parking Brake Sol.	12 Volts Nominal	I/O 1 (DO)
C-09	82E	Boom Hoist Brake Solenoid	12 Volts Nominal	I/O 1 (DO)
C-10	84E	Travel Brake Solenoid	12 Volts Nominal	I/O 1 (DO)
C-11	38	Jumper to Signal Board Controller (Lights)	12 Volts Nominal	I/O 1 (DO)
C-12	8P1	Computer Input	12 Volts Nominal	
C-13	0	Computer Ground	0 Volts	
C-14	82A	Boom Hoist Pump Control	0 to 2.8 ±10% (110 mA) Volts Down, 0 to -2.8 ± 10% (-110 mA) Volts Up	I/O 2 (AO)
C-15	83A	Right Track Pump Control	0 to 2.8 ±10% (110 mA) Volts Reverse, 0 to -2.8 ± 10% (-110 mA) Volts Forward	I/O 2 (AO)
C-16	80F	Front Drum Clutch Solenoid	12 Volts Nominal	I/O 1 (DO)
C-17	81F	Rear or Right Rear Drum Clutch Solenoid	12 Volts Nominal	I/O 1 (DO)
C-18	81FL	Left Rear Drum Clutch Solenoid	12 Volts Nominal	I/O 1 (DO)
C-19	81EL	Left Rear Drum Parking Brake Solenoid	12 Volts Nominal	I/O 1 (DO)
C-20	87A	Independent Hoist Pump Control 1	0 to 2.8 Volts Engine Running, 0 to 2.4 Volts Engine Off	I/O 1 (DO)
C-21	8P1	Computer Input	12 Volts Nominal	
C-22	0	Computer Ground	0 Volts	
C-23	84A	Left Track Pump Control	0 to 2.8 ± 10% (110 mA) Volts Reverse, 0 to -2.8 ± 10% (-110 mA) Volts Forward	I/O 3 (AO)
C-24	85A	Swing Pump Control	0 to 2.8 ± 10% (110 mA) Volts Left, 0 to -2.8 ± 10% (-110 mA) Volts Right	I/O 3 (AO)
C-25	87E	Luffing Hoist Brake Solenoid	12 Volts Nominal	I/O 2 (DO)
C-26	80N	Front or Right Rear Drum Rotation Indicator	12 Volts Nominal	I/O 2 (DO)
C-27	88S	Auxiliary System Disable Solenoid	12 Volts Nominal	I/O 2 (DO)
C-28	86N	Auxiliary Drum Rotation Indicator	12 Volts Nominal	I/O 2 (DO)
C-29	87B	Independent Hoist Pump Control 2	0 to 2.8 Volts Engine Running, 0 to 2.4 Volts Engine Off	I/O 2 (DO)
C-30	8P1	Computer Input	12 Volts Nominal	
C-31	0	Computer Ground	0 Volts	
C-32	88R	Travel 2-Speed Solenoid	12 Volts Nominal	I/O 2 (DO)
C-33	81N	Rear or Left Rear Drum Rotation Indicator	12 Volts Nominal	I/O 2 (DO)
C-34	25	System Fault Beeper & Light	12 Volts Nominal	I/O 2 (DO)

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (signal type)
C-35	25A	Operating Limit Buzzer & Light	12 Volts Nominal	I/O 2 (DO)
C-36	25B	Jacking Remote Level Alarm & Light	12 Volts Nominal	I/O 2 (DO)
C-37		Not Used		
D-01	87MA	Luffing Hoist Drum Flange Encoder CHA	7.5 Volts or 0 Volts Not Moving, 3.5 Volts Moving	I/O 1 (DI)
D-02	87MB	Luffing Hoist Drum Flange Encoder CHB	7.5 Volts or 0 Volts Not Moving, 3.5 Volts Moving	I/O 1 (DI)
D-03		Not Used		I/O 1 (DI)
D-04		Not Used		I/O 1 (DI)
D-05	82MA	Boom Hoist Shaft Encoder CHA	7.5 Volts or 0 Volts Not Moving, 3.5 Volts Moving	I/O 2 (DI)
D-06	82MB	Boom Hoist Shaft Encoder CHB	7.5 Volts or 0 Volts Not Moving, 3.5 Volts Moving	I/O 2 (DI)
D-07	24	Engine RPM Sender	7.5 Volts or 0 Volts Not Moving, 3.5 Volts Moving	I/O 1 (DI)
D-08	89T3	Engine Oil Pressure Switch	12 Volts Nominal	I/O 3 (DI)
D-09	89U3	Engine Coolant Temperature Switch	12 Volts Nominal	I/O 3 (DI)
D-10	89P	Rated Capacity Indicator/Limiter Switch	12 Volts Nominal	I/O 3 (DI)
D-11	89T2	Crane Mode Confirm Switch	12 Volts Nominal	I/O 3 (DI)
D-12	89B2	Swing Holding Brake On	12 Volts Nominal	I/O 3 (DI)
D-13	89C2	Equalizer & Physical Boom Stop Limit Switch	12 Volts Nominal	I/O 3 (DI)
D-14	68R	Remote Start	12 Volts Nominal	I/O 4 (DI)
D-15	89X2	Drum 2 and Drum 3 Free-Fall Safety Switch	12 Volts Nominal	I/O 4 (DI)
D-16	35 RX1	RCL Display Receive (w/o master node) w/ Master Node, Receive to Controller	Variable 6 to 7 Volts Nominal	CPU (Comm)
D-17	34 TX1	RCL Display Transmit (w/o master node) w/ Master Node, Transmit from Controller	Variable 6 to 7 Volts Nominal	CPU (Comm)
D-18	30 RS-0	Main Display CPU Receive/Transmit	Variable 6 to 7 Volts Nominal	CPU (Comm)
D-19	31 TX2	Main Display Transmit	Variable 6 to 7 Volts Nominal	CPU (Comm)
D-20	30 RS-0	Main Display Receive/Transmit	Variable 6 to 7 Volts Nominal	CPU (Comm)
D-21	37 RX3	MAX-ER PC Receive	Variable 6 to 7 Volts Nominal	CPU (Comm)
D-22	36 TX3	MAX-ER PC Transmit	Variable 6 to 7 Volts Nominal	CPU (Comm)
D-23		Not Used		
D-24	87MD	Luffing Hoist Motor Control	0.98 Volts to 8.01 Volts: 0% to 100% Motor Command	I/O 1 (AO)
D-25	81MD	Main Hoist Motor Control (Sauer-Danfoss)	0.98 Volts to 8.01 Volts: 0% to 100% Motor Command	I/O 2 (AO)
D-26		Not Used		I/O 3 (DO)
D-27	82N	Boom or Luffing Hoist Rotation Indicator	12 Volts Nominal	I/O 3 (DO)
D-28	68KB	Engine Throttle	12 Volts Nominal	I/O 3 (DO)
D-29		Not Used		I/O 3 (DO)
D-30		Not Used		I/O 3 (DO)
D-31		Not Used		I/O 3 (DO)

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (signal type)
D-32		Not Used		I/O 3 (DO)
D-33	80C	Front Drum Pawl-In Solenoid	12 Volts Nominal	I/O 3 (DO)
D-34	81MC	Main Hoist Motor Control (Rexroth)	0 Volts to 12 Volts	I/O 3 (DO)
D-35		Not Used		I/O 3 (DO)
D-36		Not Used		I/O 4 (DO)
D-37		Not Used		I/O 4 (DO)
E-01	80MA	Front Drum Flange Encoder CHA	Above 7.5 Volts or 0 Volts Not Moving, 3.5 Volts Moving	I/O 2 (DI)
E-02	80MB	Front Drum Flange Encoder CHB	Above 7.5 Volts or 0 Volts Not Moving, 3.5 Volts Moving	I/O 2 (DI)
E-03	81MAR	Right Rear Drum Flange Encoder CHA	Above 7.5 Volts or 0 Volts Not Moving, 3.5 Volts Moving	I/O 3 (DI)
E-04	81MBR	Right Rear Drum Flange Encoder CHB	Above 7.5 Volts or 0 Volts Not Moving, 3.5 Volts Moving	I/O 3 (DI)
E-05	81MAL	Left Rear Drum Flange Encoder CHA	Above 7.5 Volts or 0 Volts Not Moving, 3.5 Volts Moving	I/O 3 (DI)
E-06	81MBL	Left Rear Drum Flange Encoder CHB	Above 7.5 Volts or 0 Volts Not Moving, 3.5 Volts Moving	I/O 3 (DI)
E-07		Not Used		I/O 2 (DI)
E-08		Not Used		
E-09		Not Used		I/O 2 (AI)
E-10		Not Used		
E-11		Not Used		
E-12	89E3	Swing Brake Hydraulic System Press. Sender	2.6 Volts at 300 psi, 1 Volt at 0 psi	CPU (AI)
E-13	89D3	Counterweight Up Limit Switch	12 Volts Nominal	I/O 4 (DI)
E-14		Not Used		
E-15		Not Used		
E-16	89W2	Maximum Angle Limit	12 Volts Nominal	I/O 4 (DI)
E-17		Not Used		
E-18		Not Used		I/O 4 (DI)
E-19		Not Used		
E-20		Not Used		I/O 4 (DI)
E-21		Not Used		
E-22		Not Used		
E-23		Not Used		
E-24		Not Used		
E-25		Not Used		I/O 4 (DI)
E-26		Not Used		I/O 4 (DI)
E-27		Not Used		I/O 4 (DI)
E-28		Not Used		I/O 4 (DI)
E-29	82MD	Boom Hoist Motor Control	0.98 Volts to 8.01 Volts: 0% to 100% Motor Command	I/O 3 (AO)
E-30		Not Used		I/O 4 (AO)
E-31		Not Used		

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (signal type)
E-32		Not Used		
E-33	85B	MAX-ER 2000 Power Relay	12 Volts Nominal	I/O 4 (DO)
E-34		Not Used		
E-35	80CA	Front Drum Pawl-Out Solenoid	12 Volts Nominal	I/O 4 (DO)
E-36	81C	Rear Drum Pawl-In Solenoid	12 Volts Nominal	I/O 4 (DO)
E-37	81CA	Rear Drum Pawl-Out Solenoid	12 Volts Nominal	I/O 4 (DO)

Master Node Pin Identification

CraneSTAR equipped machines are included.

Pin	Function Type	Description	Test Voltage (DC unless otherwise specified)
P11		**Receptacle—Front Console Master Node (unused terminals are omitted)**	
P11-01	24 Volts	24VDC Power Bus	24 Volts Nominal
P11-03	DI-12	Load Indicator Scroll Up Switch	0 Volts Off, 24 Volts On
P11-04	DI-14	Load Indicator Scroll Down Switch	0 Volts Off, 24 Volts On
P11-05	DI-31	Load Indicator Select Switch	0 Volts Off, 24 Volts On
P11-06	DI-9	Load Indicator Confirm Switch	0 Volts Off, 24 Volts On
P11-07	DO-1	Drum Directional Indicator	N/A
P11-08	DO-3	Load Indicator Warning LED	0 Volts Off, 24 Volts On
P11-09	DO-8	Beacon Alarm	0 Volts Off, 24 Volts On
P11-10	DO-6	Load Indicator Caution LED	0 Volts Off, 24 Volts On
P11-11	24 Volts	24VDC Power Bus	24 Volts Nominal
P11-18	DO-4	System Fault Beeper Alarm	0 Volts Off, 24 Volts On
P11-19	DO-7	Load Indicator Operator Cab Alarm	0 Volts Off, 24 Volts On
P11-20	DO-5	Operating Limit Buzzer	0 Volts Off, 24 Volts On
P11-27	DO-1Grd	CAN System Ground	Ground
P11-28	DO-2 Grd	CAN System Ground	Ground
P11-30	DO-4 Grd	CAN System Ground	Ground
P11-31	CANH	CAN-Hi Data Line	N/A
P11-32	CANL	CAN-Low Data Line	N/A
P11-37	DO-5 Grd	CAN System Ground	Ground
P11-38	DO-6 Grd	CAN System Ground	Ground
P12		**Receptacle—Front Console Master Node (unused terminals are omitted)**	
P12-01	24 Volts	24VDC Power Bus	24 Volts Nominal
P12-02	Display	Screen Contrast Positive	N/A
P12-06	DI-2	Data Logger Enable	0 Volts Off, 24 Volts On
P12-07	DO-9	High Exhaust System Temperature Amber LED	0 Volts Off, 24 Volts On
P12-08	DO-11	Rear Drum 2 Free Fall Amber LED	0 Volts Off, 24 Volts On
P12-09	DO-16	Operating Limit Amber LED	0 Volts Off, 24 Volts On
P12-10	DO-17	Diesel Particulate Filter (DPF) Amber LED	0 Volts Off, 24 Volts On
P12-11	24 Volts	24VDC Power Bus	24 Volts Nominal
P12-12	Display	Screen Contrast Wiper Adjust	N/A
P12-17	DO-10	Front Drum 1 Free Fall Amber LED	0 Volts Off, 24 Volts On
P12-18	DO-12	Left Rear Drum 3 Free Fall Amber LED	0 Volts Off, 24 Volts On
P12-19	DO-15	System Fault Red LED	0 Volts Off, 24 Volts On
P12-20	DO-13	Diesel Particulate Filter (DPF) Inhibit Amber LED	0 Volts Off, 24 Volts On
P12-21	Logic Grd	CAN System Ground	Ground
P12-22	Display	Screen Contrast Negative	N/A
P12-27	DO-9 Grd	CAN System Ground	Ground
P12-28	DO-10 Grd	CAN System Ground	Ground
P12-29	DO-11 Grd	CAN System Ground	Ground

Pin	Function Type	Description	Test Voltage (DC unless otherwise specified)
P12-30	DO-12 Grd	CAN System Ground	Ground
P12-31	CANH	CAN-Hi Data Line (CraneSTAR)	N/A
P12-32	CANL	CAN-Low Data Line (CraneSTAR)	N/A
P12-33	DI-19	Diesel Particulate Filter (DPF) Regeneration Disable	24 Volts Nominal
P12-34	DI-21	Diesel Particulate Filter (DPF) Regeneration Initiate	24 Volts Nominal
P12-37	DO-13 Grd	CAN System Ground	Ground
P12-38	DO-14 Grd	CAN System Ground	Ground
P2	**Data Download/Upload Receptacle—Front Console Master Node**		
P2-1	Data TX1	RX1-35 Receive data from Crane Controller	Variable 6 to 7 Volts Nominal
P2-2	Data RX1	TX1-34 Transmit data to Crane Controller	Variable 6 to 7 Volts Nominal
P2-3	Data X	Load Indicator Data Download	N/A
P2-4	Logic Grd	Ground	Ground

MODEL 2250 MAX-ER 2000® TEST VOLTAGES

General

This section contains MAX-ER 2000 test voltages sorted into the following three categories:

- Pin identification
- Wire identification
- Description identification

Controller Board Layout

The board locations in the MAX-ER 2000 programmable controller are shown below.

Abbreviations

The following abbreviations are used in this section:

AI	Analog Input
AO	Analog Output
CHA or CHB	Channel A or B
COMM	Communication
CPU	Central Processing Unit
DI	Digital Input
DO	Digital Output
I/O	Input/Output
lb	Pounds
N/C	No Connection
Press	Pressure
psi	Pounds per Square Inch

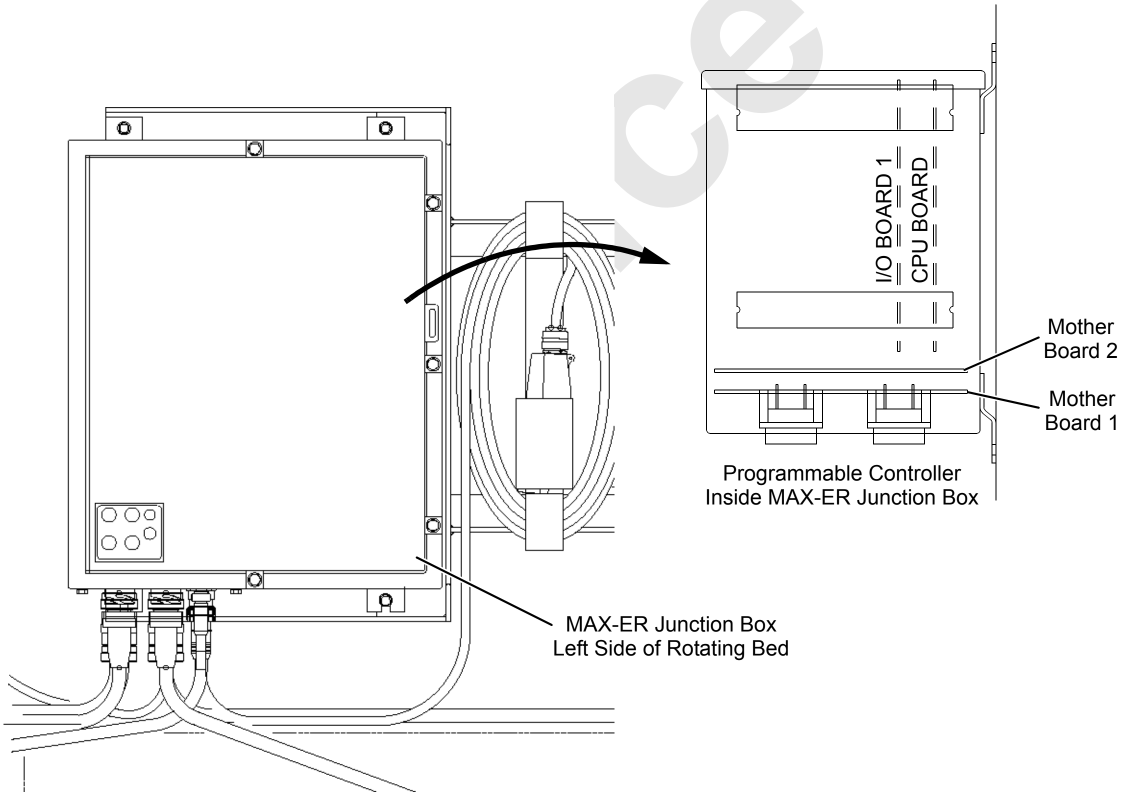

FIGURE 3-7

MAX-ER Controller Pin Identification

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (signal type)
A-01	87FM	10 Volt Regulated Supply	10 Volts	
A-03	89F4	Mast Angle Limit	12 Volts Nominal	(AI)
A-04	89G4	Drum 9 Minimum Bail Limit Switch	12 Volts Nominal	(AI)
A-05	89H4	Remote Switches	12 Volts Nominal	(AI)
A-06	89J4	Counterweight Raise Pendant Cylinder Retract	12 Volts Nominal	(AI)
A-07	89K4	Counterweight Lower Pendant Cylinder Extend	12 Volts Nominal	(AI)
A-08	89L4	Left Pendant Cylinder Limit Switch	12 Volts Nominal	(AI)
A-20	90QL	Left Pendant Cylinder Rod Pressure Sender	1.2 Volts at 300 psi, 1 Volt at 0 psi	(AI)
A-21	90QR	Right Pendant Cylinder Rod Pressure Sender	1.2 Volts at 300 psi, 1 Volt at 0 psi	(AI)
A-22	99B	Counterweight Level Sensor	5 Volts at 0°, 0.5 Volts Change Per 1°	(AI)
A-23	89P4	Rear Drum Pawl Limit Switch	12 Volts Nominal	(AI)
A-24	90RP	Right Pendant Cylinder Piston Pressure Sender	1.2 Volts at 300 psi, 1 Volt at 0 psi	(AI)
A-36	90QM	Mast Accumulator Pressure Sender	1.2 Volts at 300 psi, 1 Volt at 0 psi	(AI)
C-01	8N	MAX-ER PC Power	12 Volts	
C-02	0	MAX-ER PC Ground	Ground	
C-03	8N	MAX-ER PC Power	12 Volts	
C-04	0	MAX-ER PC Ground	Ground	
C-05	88MC	Drum 9 Left and Right Motor Control	-5 Volts to 5 Volts	(DO)
C-07	88D	Travel/Drum 9 Diverting Valve Solenoid	12 Volts Nominal	(DO)
C-08	90CR	Pendant Cylinder Extend Solenoid	12 Volts Nominal	(DO)
C-09	90DR	Pendant Cylinder Retract Solenoid	12 Volts Nominal	(DO)
C-10	25XM	Swing/Travel Alarm	12 Volts Nominal	(DO)
C-11	DO5	Spare		
C-12	8N	MAX-ER PC Power	12 Volts	
C-13	0	MAX-ER PC Ground	Ground	
C-16	88E	Drum 9 Brake	12 Volts Nominal	(DO)
C-17	88C	Drum 9 Pawl-In Relay	12 Volts Nominal	(DO)
C-18	88CA	Drum 9 Pawl-Out Relay	12 Volts Nominal	(DO)
C-19	81C	Rear or Right Rear Drum Pawl-In Air Solenoid	12 Volts Nominal	(DO)
C-20	81CA	Rear or Right Rear Drum Pawl-Out Air Solenoid	12 Volts Nominal	(DO)
C-21	8N	MAX-ER PC Power	12 Volts	

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (signal type)
C-22	0	MAX-ER PC Ground	Ground	
C-30	8N	MAX-ER PC Power	12 Volts Nominal	
C-31	0	MAX-ER PC Ground	Ground	
D-01	88MA	Drum 9 Flange Encoder CHA	7.5 or 0 Volts Not Moving, 3.5 Volts Moving	CH-A
D-02	88MB	Drum 9 Flange Encoder CHB	7.5 or 0 Volts Not Moving, 3.5 Volts Moving	CH-B
D-21	36 (RX3)	MAX-ER PC Receive	Variable	
D-22	37 (TX3)	MAX-ER PC Transmit	Variable	
D-37	88DP	Main Hoist Pump 2/Drum 9 Diverting Valve Solenoid	12 Volts Nominal	(DO)
E-20	89YY	RCL Override (CE Option Only)	12 Volts Nominal	(DI)

DIGITAL DISPLAY READINGS

General

The digital display and selector (see Operating Controls in Section 3 of the Operator Manual) allow the operator to monitor the following three groups of crane information:

- Operating conditions
- Operating limits
- System faults

Depress the top or bottom of the selector to scroll up and down through the display readings. Release the selector when the desired information is displayed.

To display the diagnostic operating conditions listed in Table 3-2, depress the limit bypass switch while scrolling up with the selector. To turn off the diagnostic operating conditions, depress the limit bypass switch while scrolling down with the selector or turn off the cab power.

See Table 3-5 for a list of abbreviations and notes used in the tables. See Drum Identification on page 3-27 for identification of the drums.

NOTE: This section identifies display readings for all modes and configurations in which the 2250 can be used (to include MAX-ER). Therefore, some of the display readings identified will not appear until the corresponding mode or configuration is selected.

Also, some display readings may appear even though the crane is not equipped with the corresponding attachment. In these cases, the display reading is meaningless.

Display readings for optional items are marked with an asterisk (*).

Operating Conditions

Table 3-2 lists operating conditions that can be displayed and the normal operating range of each.

When an operating condition is selected (such as ENGINE SPEED), the current status of the condition is displayed (see Figure 3-8).

ENGINE SPEED
900 RPM

FIGURE 3-8

Operating Limits

Table 3-3 lists operating limits that 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. At the same time, the operating limit display immediately appears (see Figure 3-9) and automatically scrolls through the names of the limits, stopping at each for approximately three seconds.

OPERATING LIMIT
BLOCK UP

FIGURE 3-9

The operating limit alert turns off when the cause of each limit is corrected. The name of each limit reached during operation is retained in memory, however, until two things happen.

1. The name of the limit appears on the display.
2. The cause of the limit is corrected.

For this reason, it is normal for the names of limits to appear when you scroll to the operating limit group, even when the operating limit alert is off.

To erase the names of inactive limits, scroll to the operating limit group. Wait until the display scrolls through the name of each limit. The names of 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 (see Figure 3-10) when there are no limits.

OPERATING LIMIT
NO FAULT

FIGURE 3-10

System Faults

Table 3-4 lists system faults that can be displayed.

When one or more system faults occur, the system fault alert (red light and beeper in cab) turns on to warn the operator. At the same time, the system fault display immediately appears (see Figure 3-11) and automatically scrolls through the names of the faults, stopping at each for approximately three seconds.


SYSTEM FAULT
LOAD PIN

FIGURE 3-11

The system fault alert turns off when the cause of each fault is corrected. The name of each fault that has occurred during operation is retained in memory, however, until two things happen.

1. The name of the fault appears on the display.
2. The cause of the fault is corrected.

For this reason, it is normal for the names of 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. The names of 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 (see Figure 3-12) when there are no faults.


SYSTEM FAULT
NO FAULT

FIGURE 3-12

Selecting Display Language

The display can be viewed in English or one of several foreign languages. Once the desired language is selected, it will remain in memory until another language is selected.

To select a different display language, perform both of the following steps at the same time.

1. Depress the limit bypass switch.
2. Turn the crane mode selector key to the CONFIRM position.

Repeat the steps until the screen displays the desired language.

Table 3-2. Operating Conditions

Listed below are the operating conditions that 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 OIL PRESSURE	PSI	See Engine Manual for specifications.
	ENGINE SPEED	RPM	900 rpm low idle, 2,300 rpm high idle, 2,100 rpm full load governed
	AIR PRESSURE	PSI	8 to 9 bar (120 to 132 psi)
	ENGINE TEMPERATURE	DEG F	See Engine Manual for specifications.
	MACHINE LEVEL FRONT	DEG IN	Each screen displays two numbers. The first number is the angle (+ or - degrees) that the crane is out of level in an indicated direction from horizontal. The second number is the approximate amount (inch) of blocking that is needed to level the crane in the required direction.
	MACHINE LEVEL RIGHT		
	BOOM ANGLE	DEG	Degrees the boom is positioned above horizontal
*	BOOM ANGLE LUFF ANGLE	DEG	Degrees the boom is positioned above horizontal Degrees the luffing jib is positioned above horizontal
*	BOOM TO LUFF JIB ANG	DEG	Degrees between centerline of the boom and centerline of the luffing jib
*	CTWT UP DOWN BHITCH XX.X	—	Indicates position of the counterweight (UP, DOWN) and backhitch loading during MAX-ER 2000 operation.
	CLAM CLOSING PRESS	PSI	See Clamshell Operation in Section 3 of the Operator Manual for instructions on the procedure to adjust the pressure.
	CRANE MODE (name of mode)	—	See Crane Mode Selector in Section 3 of the Operator Manual for instructions on the procedure to select and confirm the desired crane mode.
	Diagnostic Operating Conditions The operating conditions listed below are displayed only by first depressing the limit bypass switch and then scrolling up with the digital display selector. To turn off the diagnostic screens, depress the limit bypass switch and scroll down or stop and restart the engine.		
	HYDRAULIC TANK TEMP	DEG F	Oil temperature varies depending on the load and ambient temperature. These will not accurately read temperature less than approximately 32°C (90°F).
*	AUX HYD TANK TEMP		
	HYDRAULIC TANK PRESS	PSIA	0,5 to 1,2 bar absolute (7 to 18 psia) depending on filter condition and oil temperature.
	HYDRAULIC TANK LEVEL	%	75 to 100% of oil remaining in the tank.
	DRUM (10 screens)	2 Rows of Numbers in Multiple Display Screens	Numbers are used to monitor the operation of the programmable controller and system functions. See Diagnostic Display on page 3-28 for a detailed explanation of these screens. The Manitowoc Crane Care Lattice Team will request these numbers when troubleshooting the crane.
	SWING		
	AUX SWING		
	TRACKS		
	A1, A2, A3		
	D1, D2, D3		
	MXR	2 Rows of Numbers	Numbers are used to monitor the operation of the programmable controller and system functions for MAX-ER 2000 only. See Diagnostic Display on page 3-28 for detailed explanation of the screen.
	PROG M000000.0DP	—	Computer Program Version. The Manitowoc Crane Care Lattice Team will request these numbers when troubleshooting crane problems.
	CON 00000000000	—	Computer and Crane Configuration Code. The Manitowoc Crane Care Lattice Team will request these numbers when troubleshooting crane problems.

* = Optional

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Table 3-3. Operating Limits

Listed below are the limits that turn on the operating limit alert (yellow light and continuous buzzer) in the operator’s cab. When the alert comes on, scroll to the OPERATING LIMIT group of the digital display to determine which limit has been reached. Take corrective action.

Display Reading	Function Response	Corrective Action
FUNCTION PARKED	Function inoperable because it is parked.	Turn corresponding park switch off or sit down in the operator’s seat.
BLOCK UP	The load drum stops hoisting, and the boom hoist stops lowering.	Lower the load or raise the boom.
* MAXIMUM BAIL	The load on the corresponding drum stops hoisting.	Lower the load.
* MINIMUM BAIL	The load on the corresponding drum stops lowering.	Hoist the load.
FUNCTION NOT PARKED	For standard crane equipped with a luffing jib (Drum 5), boom hoist (Drum 4) cannot be operated until the luffing hoist is parked, and vice versa.	Park the corresponding drum.
FUNCTION NOT PARKED	For MAX-ER 2000: Drum 2 cannot be operated until Drum 3 is parked, and vice versa. Drum 9 cannot be operated until Travel is parked, and vice versa. Drum 4 cannot be operated until Drum 5 is parked, and vice versa.	Park the corresponding drum.
BOOM MAXIMUM UP [1]	The boom stops hoisting when the maximum limit is reached.	Lower the boom.
BOOM MAXIMUM DOWN	The boom stops lowering (limit usually set at 0°).	Raise the boom.
* MAST MAXIMUM UP	Mast stops hoisting 80°. Operable only in Standard mode (MAX-ER 2000 only).	Lower the boom. To raise the mast above limit, switch to Standard Setup mode to bypass the limit.
* LOAD MOMENT	If equipped with a shutdown option, the corresponding load drum stops hoisting and the boom hoist stops lowering. Other load drums are inoperable. If not equipped with a shutdown option, the operating limit light and buzzer will come on to alert the operator to an overload condition.	Land the load on the corresponding load drum or raise the boom.
CRANE OUT OF LEVEL	All functions operable. Crane 3° out of level.	Level the crane.
* LUFFING JIB MAX UP 1	The luffing jib stops rising when the boom-to-jib angle is 168°. This angle can be bypassed to allow jib raising to LUFFING JIB MAX UP 2 limit at 170° on #133 or 133A luffing jib (169.2° on #44 luffing jib).	Lower the luffing jib.
LUFFING JIB MAX UP 2	The luffing jib stops rising when the boom-to-luffing jib angle is 170° on #133 or 133A luffing jib (169.2° on #44 luffing jib). This limit can be bypassed only when the boom is below 50°.	Lower the luffing jib.

Display Reading	Function Response	Corrective Action
* LUFFING JIB MAX DOWN	The luffing jib stops lowering when the boom-to-jib angle is 60° (70° on #44 luffing jib).	Raise the luffing jib.
EQUALIZER BOOM STOP	The boom hoist stops hoisting when the equalizer is pulled back against the stops on the gantry and when the physical boom stops are within 25 mm (1 in) of bottoming out.	Pay out (lower) the boom hoist wire rope.
SETUP MODE ENGAGED	All functions are operable. For crane setup only, the travel operates at 1/2 speed and the automatic boom stop is disabled.	Turn off the setup selector. (Select and confirm the desired operating mode.)
* JIB BELOW HORIZONTAL	The luffing jib is operable. See Capacity Charts in Section 2 of the Operator Manual for luffing jib minimum operating angles.	Raise the luffing jib above horizontal.
* CTWT OFF RING	Alert only. Does not stop the boom hoist or load drum operation.	The crane's capacity has been exceeded. Stop lowering the boom or hoisting the load immediately. Land the load slowly and smoothly.
CONFIRM MODE	The load drums are inoperable until the mode in effect is confirmed or another mode is selected and confirmed.	Confirm the mode in effect or select and confirm a different mode.
DRUM AIR VALVES	The selected drum air pressure switch is open for more than 4 seconds.	The brakes and clutches of all the drums on the main shaft are applied. The fault cannot be cleared until the crane is shutdown and restarted.

* = Optional

Table 3-4. System Faults

Listed below are the faults that turn on the system fault alert (red light and beeper) in the operator’s cab. When the alert comes on, scroll to SYSTEM FAULT group of the digital display to determine which fault has been reached. Take corrective action.

Display Reading	Cause of Fault	Function Response
PUMP 1 CHARGE PRESS	Low charge pressure at the load drum pump.	The load drum brake applies, and the pump strokes to the neutral position to stop the load drum. If a drop in charge pressure is intermittent, operation may be resumed once the load drum control handle is returned to the OFF position. Verify that the cause of the fault is low pressure and correct the cause as soon as possible. If the pressure is correct, replace the pressure sender.
BOOM ANGLE SENDER	Sender output voltage 0.0 Volts or above 9.7 Volts.	All functions are operable. The machine level or boom and luffing jib angle displays will not be correct. Correct the cause of the sender fault as soon as possible. Neither fault is active when the crane is operated in Setup mode.
* LUFF JIB ANGLE SENDER		
LOW AIR PRESSURE	Manifold air pressure below 6,2 bar (90 psi).	If air pressure continues to drop, the load drum park brakes will apply.
HYD TANK LEVEL	Less than 75% level.	Stop and check the oil level—fill tank (reservoir).
LOAD PIN	Zero (0) output voltage from the pin.	The MAX-ER counterweight stops and remains in the last position, and the boom hoist stops and is inoperable in the up direction.
MOTION	A deselected drum turns.	If a deselected load drum moves, all drum brakes and clutches apply, and the pumps shift to the neutral position to stop all load drums. If a selected load drum rotates down when the handle is in the UP or NEUTRAL position, all drum brakes and clutches apply and the pumps shift to the NEUTRAL position to stop all load drums. If a deselected boom or luffing hoist drum moves, the brakes apply and the pumps shift to the NEUTRAL position to stop both hoists. Stop and restart the engine to the correct fault (reboot programmable controller).
* MAX-ER SYSTEM	One of the three MAX-ER transducers not in operating range of 0.6 to 9 Volts. The differential pressure between the left/ right side strap cylinders is 83 bar (1,200 psi). The counterweight tray level is over 3° in the right or left direction.	The MAX-ER counterweight stops and remains in the last position. Check and replace the faulty transducer(s). Check the hydraulic system and repair. Level the counterweight tray.

Display Reading	Cause of Fault	Function Response
MAST ACCUMULATOR	The mast stop cylinders, MAX-ER luffing jib stop cylinders, or accessory system pressure is not in range.	See ACCUM diagnostic screen to determine the cause of fault and correct the problem as soon as possible.
BATTERY VOLTAGE LOW	The system voltage is below 11 Volts.	Handle commands are disabled.
IO BOARD FAULT *n*	The CPU is not communicating with the I/O board *n,* where: 1 – first I/O board after the CPU 2 – second I/O board after the CPU 4 – third I/O board after the CPU 8 – fourth I/O board after the CPU Failure of more than one board is indicated by an *n* value that is the sum of the *n* values associated with each board (if *n*=6, the second and third I/O boards after the CPU may have failed).	Check for a loose or damaged I/O board. Reposition and reconnect the boards in the circuit to see if the problem moves with the location. If the indicated fault code *n* does not change, the problem is most likely in the mother board or the CPU board. See Programmable Controller (PC) I/O Board Fault Troubleshooting on page 3-35 for more information.

* = Optional

Table 3-5. Table Notes and Abbreviations

*	Optional item
[1]	The maximum angle at which the boom will stop varies with each attachment. See Boom Section 4 for the maximum angle at which the boom stops.

Abbreviation	Definition
+	Plus
-	Minus
%	Percent
A1	Handle Inputs
A2	Pump Control Outputs
A3	Programmer’s Screen
ANG	Angle
AUX	Auxiliary
BHITCH	Backhitch
CLAM	Clamshell
CTWT	Counterweight (MAX-ER)
D1	On-Off Inputs
D2	Digital Inputs
D3	Digital Inputs or Outputs
DEG F	Degrees Fahrenheit
HYD	Hydraulic
LUFF	Luffing
MIN	Minimum
MAX	Maximum
MXR	MAX-ER 2000
PRESS	Pressure
PSI	Pounds Per Square Inch
PSIA	Pounds Per Square Inch Absolute
RPM	Revolutions Per Minute
SYS	System
TEMP	Temperature

Drum Identification

Drum Number	2250	MAX-ER 2000	32,000 lb Clam
1	Front Load Drum	No Drum Available	Front Load Drum
2	Rear or Right Rear Load Drum	Boom Hoist	Full Width Rear Load Drum
3	Left Rear Load Drum or Mast Hoist (MAX-ER)	Rear Load Drum (with luffing hoist)	—
4	Boom Hoist	Mast Hoist	Boom Hoist
5	Luffing Hoist	Luffing Hoist or Rear Load Drum or Auxiliary Drum Without Luffing Hoist	Tagline
9	—	Front Load Drum	—

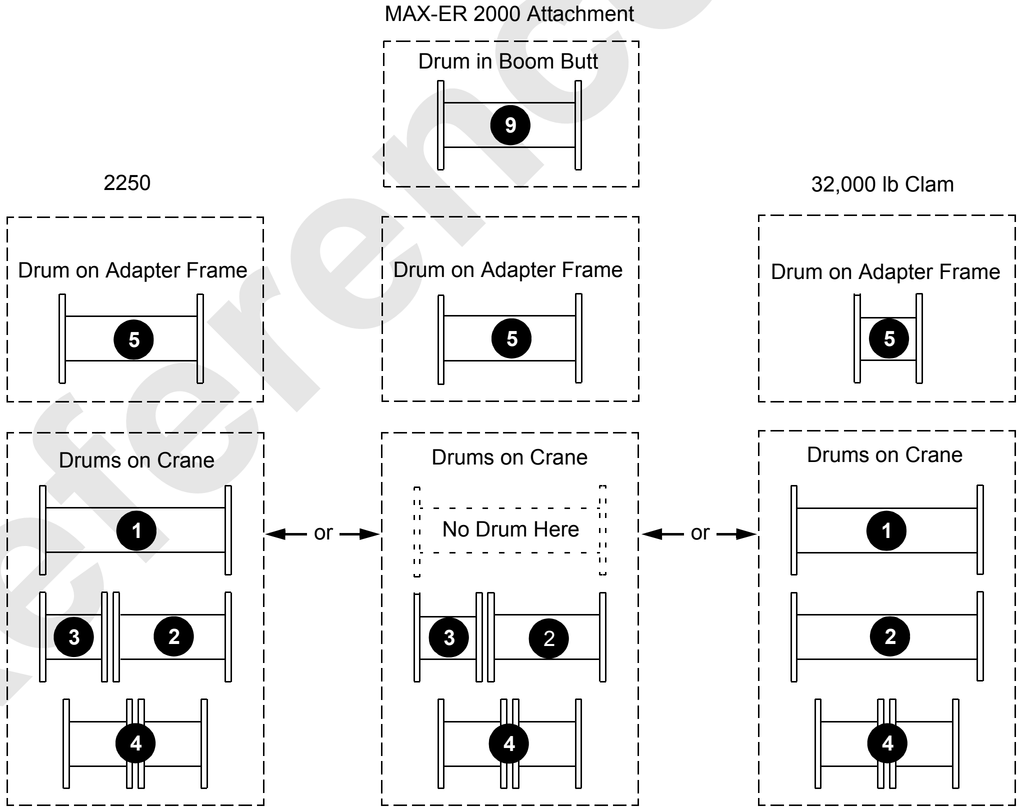


FIGURE 3-13

DIAGNOSTIC DISPLAY

General

The diagnostic display provides information about the status of all main crane components as well as the controller inputs and outputs during operation. Diagnostic screens contain the following:

- Information about a particular crane function (DRUMS 1 through 9, CRANE SWING, TRACK, ACCUMULATOR, and MAX-ER 2000)
- Digital outputs (D1) from the controller, digital inputs (D2) to the controller, control handle inputs (A1) to the controller, and programmer's screen (A2)

NOTE: See Figure 3-13 for drum identification.

Drums 1, 2, and 3 (crane load drums)

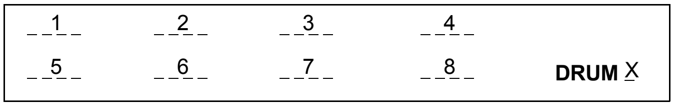


FIGURE 3-14

1. The handle command in percent from neutral (+ raise, – lower). For certain operating conditions the handle command is set to neutral by the controller even if the handle is not in neutral.
2. The pump command in percent from neutral (+ raise, – lower)
3. The motor command in percent (0% max displacement, 100% min displacement)
4. The measured drum speed in rpm (+ raise, – lower)
5. The command to park brake (1 release, 0 apply)
6. The command to clutch (1 disengage, 0 engage)
7. The measured pump system pressure (port A) in psi
8. The measured pump charge pressure in psi

NOTE: X = The corresponding drum number appears.

Drum 4 (boom hoist)

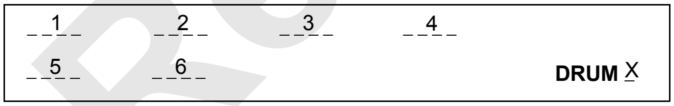


FIGURE 3-15

1. The handle command in percent from neutral (+ raise, – lower). For certain operating conditions the handle command is set to neutral by the controller even if the handle is not in neutral.
2. The pump command in percent from neutral (+ raise, – lower)
3. The motor command in percent (0% max displacement, 100% min displacement)
4. The measured drum speed in rpm (+ raise, – lower)
5. The command to park brake (1 release, 0 apply)
6. The measured pump system pressure (port B) is in psi

NOTE: X = The corresponding drum number appears.

Drum 5 (luffing or auxiliary hoist)

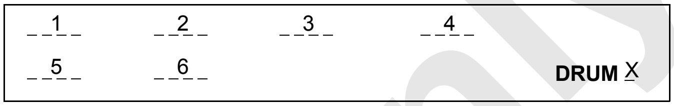


FIGURE 3-16

1. The handle command in percent from neutral (+ raise, – lower). For certain operating conditions the handle command is set to neutral by the controller even if the handle is not in neutral.
2. The pump command in percent from neutral (+ raise, – lower)
3. The motor command in percent (0% max displacement, 100% min displacement)
4. The measured drum speed in rpm (+ raise, – lower)
5. The command to park brake (1 release, 0 apply)
6. The measured pump system pressure (port B) in psi

NOTE: X = The corresponding drum number appears.

Drum 9 (MAX-ER 2000 load drum)

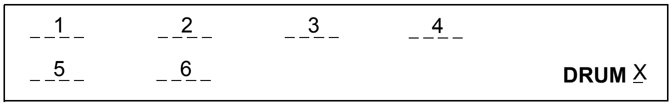


FIGURE 3-17

1. The handle command in percent from neutral (+ raise, – lower). For certain operating conditions the handle command is set to neutral by the controller even if the handle is not in neutral.
2. The pump command in percent from neutral (+ raise, – lower)
3. The motor command in percent (0% max displacement, 100% min displacement)
4. The measured drum speed in rpm (+ raise, – lower)
5. The command to park brake (1 release, 0 apply)
6. The measured pump system pressure (port B) in psi

NOTE: X = The corresponding drum number appears.

Swing (crane)

```
_ _1_ _     _ _2_ _     _ _3_ _     _ _4_ _     _ _5_ _
_ _6_ _     _ _7_ _     _ _8_ _                 SWING
```

FIGURE 3-18

1. The handle command in percent from neutral (+ right, – left). For certain operating conditions, the handle command is set to neutral by the controller even if the handle is not in neutral.
2. The crane swing pump command in percent from neutral (+ right, – left)
3. The measured pump pressure swing right (port B) in psi
4. The measured pump pressure swing left (port A) in psi
5. The measured swing brake pressure from 0 to 750 psi
6. MAX-ER 2000 shorting plug status:

   0 = MAX-ER 2000 enabled

   1 = MAX-ER 2000 shorting plug installed
7. MAX-ER 2000 travel status:

   0 = Travel disabled

   1 = Travel enabled

   The MAX-ER 2000 travel status is determined by the swing brake pressure and MAX-ER shorting plug status. If the swing pressure is less than 150 psi and the MAX-ER shorting plug is absent, travel is disabled.
8. Swing limiter sensor status (appears only if equipped with a swing limiter):

   + = Swing right

   - = Swing left

Track (crane crawlers)

```
_ _1_ _     _ _2_ _     _ _3_ _     _ _4_ _
_ _5_ _     _ _6_ _        7                TRACK
```

FIGURE 3-19

1. The right handle command in percent from neutral (+ forward, – backward). For certain operating conditions, the handle command is set to neutral by the controller even if the handle is not in neutral.
2. The right pump command in percent from neutral (+ forward, – backward)
3. The left handle command in percent from neutral (+ forward, – backward. For certain operating conditions, the handle command is set to neutral by the controller even if the handle is not in neutral.
4. The left pump command in percent from neutral (+ forward, – backward)
5. The measured system pressure right track in psi
6. The measured system pressure left track in psi
7. The command to park break (1 release, 0 engage)

Mast Accumulator

```
_ _1_ _     _ _2_ _
_ _3_ _     _ _4_ _                         ACCUM
```

FIGURE 3-20

1. The accessory disable valve stroke (0 to 100%)
2. Control requirement:

   0 = No demand

   1 = Accessory disable valve enable input

   2 = MAX-ER wagon controls

   3 = MAX-ER luffing jib stop cylinders

   4 = Mast stop cylinders
3. The accumulator pressure in psi
4. The accessory pump pressure (will display if equipped)

MXR (MAX-ER 2000)

```
_ _1_ _     _ _2_ _     _ _3_ _     _ _4_ _     _ _5_ _
_ _6_ _     _ _7_ _     _ _8_ _     _ _9_ _       MXR
```

FIGURE 3-21

1. Counterweight level indicator:

   + = Degrees high on right side

   - = Degrees low on left side
2. Backhitch load (US tons):

   + = Tension

   - = Compression
3. MAX-ER switches (see below)

Table 3-6. MAX-ER Switches

Switches	0	1	2	3	4	5	6	7
Left strap cylinder limit switch (normally closed)	□	■	□	■	□	■	□	■
Counterweight raise remote control switch (normally open)	□	□	■	■	□	□	■	■
Counterweight lower remote control switch (normally open)	□	□	□	□	■	■	■	■

Dark shaded boxes indicate ON, white boxes OFF.

4. MAX-ER state/faults (total of number(s) listed):

1 = Tray high on left side (CWT level is more than 3.0 degrees)

2 = Tray high on right side (CWT level is less than -3.0 degrees)

4 = Each strap cylinder load is below 9 072 kg (20,000 lb). Value 4 does not trigger a MAX-ER fault.

8 = Not used

16 = Left rod side pressure transducer out of range (below 0.6 or above 9.0 volts)

32 = Right rod side pressure transducer out of range (below 0.6 or above 9.0 volts)

64 = Differential pressure (one side taking 145 bar [2100 psi] more than other side)

128 = Piston pressure transducer out of range (below 0.6 or above 9.0 volts)

5. MAX-ER controller communication status: 0 = Good. Any other number indicates a problem with MAX-ER controller communication to the crane controller. Contact the Manitowoc Crane Care Lattice Team.

6. Right strap cylinder rod side pressure (0 to 207 bar [0 to 3,000 psi])

7. Left strap cylinder rod side pressure (0 to 207 bar [0 to 3,000 psi])

8. Strap cylinder piston side pressure (0 to 207 bar [0 to 3,000 psi])

9. Strap cylinder command (0 = idle, 1 = raise tray, 2 = lower tray)

A1 (handles)

The variable control handle output voltage is represented in the controller by a number between 0 (0 volts) and 255 (10 volts). The diagnostic screen A1 displays this number for each of the control handles/pedals. The normal operating outputs of the handles range from:

- Approximately 38 (1.5 volts) to 120 (4.7 volts) for lower/reverse/right. Some dual-axis handles (joysticks) are internally limited and will not put out the full range stated.
- Approximately 136 (5.3 volts) to 215 (8.5 volts) for raise/forward/left. Some dual-axis handles (joysticks) are internally limited and will not put out the full range stated.
- A switch opens when the handle is in the neutral range (4.7—5.3 volts). In the neutral range, the screen reads 0.

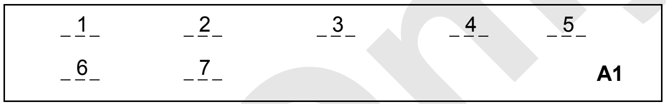
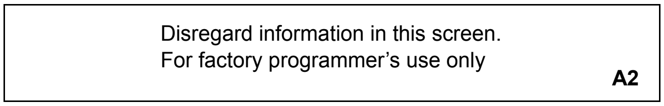


FIGURE 3-22

Banks:

- Handle 1—Right rear or front load drum
- Handle 2—Left rear or rear load drum
- Handle 3—Boom/luffing/mast hoist
- Handle 5—Right track
- Handle 6—Left track
- Handle 4—Swing
- Handle 7—Auxiliary load drum or luffing hoist with independent pump

A2 (programmer's screen)



Disregard information in this screen.
For factory programmer's use only

FIGURE 3-23

D1 and D2 (digital outputs and inputs)

The status of the digital outputs from the controller and the inputs to the controller is displayed in several banks in screens D1 and D2. Each bank can indicate the state of up to eight individual digital inputs or outputs.

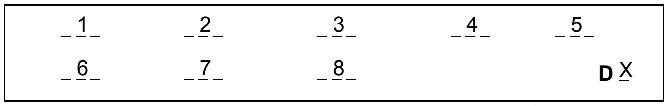


FIGURE 3-24

1. 1 through 8 = Bank number

NOTE: X = The corresponding digital screen number (1 or 2) appears.

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) are added to a total in each bank. Thus, the number displayed for each bank is the sum of all identifiers of the inputs/outputs that are on (0 through 255). With this system, each possible on/off combination per bank has a unique total.

For identification of the digital outputs and inputs (and the crane components connected to them), see Table 3-7 and Table 3-8.

To determine the state of the individual inputs/outputs in a bank, find the number displayed for the bank in the first column in Table 3-9. In the corresponding row the identifier numbers that are on (active) in the bank are shaded black.

Use Table 3-7 and Table 3-8 to identify the crane components associated with the identifiers for the corresponding bank.

Example 1: If the number displayed in Bank 3 of screen D2 is 41, go to row number 41 in Table 3-9. The boxes for identifiers 1, 8 and 32 are shaded black in this row, indicating that the corresponding inputs are active. Find the component description for the identifiers in Table 3-8, Bank 3. In this example, the inputs for High Speed Travel (identifier 1), Drum 1 Brake (identifier 8), and Low Air Pressure (identifier 32) are active.

Example 2: You want to know if the controller output for the Drum 2 Clutch is on. In Table 3-7 you will find Drum 2 Clutch in Bank 1 (identifier 64). Look up the current number for Bank 1 in screen D1 (for example 152). Then go to the corresponding row number (152) in Table 3-9. Identifier 64 box is not shaded black in this row, indicating that the controller output to the rear drum clutch is off.

All numbers in screen D1, and the pump/motor command values in screens Drum, Swing, and Track, represent controller commands to the corresponding output devices only. The state of a certain output port on the controller may not necessarily correspond to the actual state of the associated crane component since the connection between the controller and the component may be faulty due to loose connections, corroded terminals, broken wiring, or improperly operating components.

Table 3-7. D1 *(digital outputs)*

Binary Identifier*	Component
Bank 1	
1	Drum 1 Brake
2	Drum 2 Brake
4	Drum 4 Brake
8	Travel Brake
16	COMM Output to Right Side Console Control Board
32	Drum 1 Clutch/Drum 5 Diverting Valve
64	Drum 2 Clutch
128	Drum 3 Clutch
Bank 2	
1	Drum 3 Brake
2	Spare
Bank 3	
1	Drum 5 Brake
2	Handle 1 Drum Rotation Indicator
4	Auxiliary System Disable Valve
8	Handle 7 Drum Rotation Indicator
16	Independent Luffing Hoist Pump
32	Travel 2-Speed Valve
64	Handle 2 Drum Rotation Indicator
128	System Fault Alarm
Bank 4	
1	Operating Limit Alarm
2	Out of Level Alarm (crane remote control)
Bank 5	
1	Not Used
2	Handle 3 Drum Rotation Indicator
4	Pulse Width Modulation Engine RPM
8	Spare
16	Counterweight Down Valve (MAX-ER 2000)
32	Counterweight Up Valve (MAX-ER 2000)
64	Proportional Valve (MAX-ER and Setup modes)
128	Drum 1 Pawl In
Bank 6	Pulse Width Modulation to Split Drum 2/3 Hoist Motor
1	Swing/Travel Alarm
2	
Bank 7	
1	Not Used
2	Not Used
4	MAX-ER Programmable Controller Relay
8	Swing Bake
16	Drum 1 Pawl Out
32	Not Used
64	Not Used
128	Not Used
Bank 8	Not Used
Bank 9	
1	Drum 9 (MAX-ER 2000)/Drum 5 Diverting Valve
2	Counterweight Strap Cylinder Extend (MAX-ER 2000)
4	Counterweight Strap Cylinder Retract (MAX-ER 2000)
8	Spare
16	Spare
32	Drum 9 Brake (MAX-ER 2000)
64	Drum 9 Pawl In (MAX-ER 2000)
128	Drum 9 Pawl Out (MAX-ER 2000)
Bank 10	
1	Drum 2 Pawl In (MAX-ER 2000)
2	Drum 2 Pawl Out (MAX-ER 2000)

Table 3-8. D2 *(digital inputs)*

Binary Identifier*	Component
Bank 1	
1	Travel Detent
2	Drum 1 Max Air Pressure/Swing Right Limit Switch
4	Drum 1 Minimum Bail Limit/Swing Left Limit Switch
8	Drum 3 Minimum Bail Limit
16	Drum 3 Maximum Bail Limit/Max Air Pressure Switch
32	Block-Up Limit
64	Drum 2 Maximum Bail Limit/Max Air Pressure Switch
128	Drum 2 Minimum Bail Limit
Bank 2	
1	COMM Input from Right Side Console Control Board
2	Seat Switch
4	Auxiliary Valve Input (remote)
8	Remote Jacking Enable Input
16	Drum 9 Brake
32	Boom Maximum Up
Bank 3	
1	High Speed Travel
2	Luffing Maximum Down
4	Luffing Maximum Up
8	Drum 1 Brake
16	Travel Brake
32	Low Air Pressure
64	Spare
128	Drum Selector Switch (drum 2 and 3)
Bank 4	
1	Not Used
2	Crane Mode (select)
4	Limit Bypass Switch
8	Digital Display Selector (scroll up)
16	Drum 2 Brake
32	Drum 3 Brake
Bank 5	
1	Drum 4 Brake
2	Drum 5 Brake
4	Spare
8	Not Used
16	Digital Display Selector (scroll down)
32	Spare
64	Counterweight Lower
128	Not Used
Bank 6	
1	Engine Oil Pressure Low Limit
2	Engine Temperature High Limit
4	Rated Capacity Indicator/Limiter
8	Crane Mode (confirm)
16	Swing Park Brake On
32	Equalizer/Boom Stop Limit
Bank 7	
1	Remote Throttle Switch
2	Not Used
4	Counterweight Up Limit (Ringer)
8	Maximum Boom/Luffing Angle Bypass
16	Drum 1 Pawl Limit
32	Drum 2 Pawl Limit
64	Boom Up Limit (ringer)
128	Spare
Bank 8	
1	Spare
2	RCI External Bypass (CE option only)
4	Spare
8	Not Used
16	Mast Maximum Up Limit
32	Rigging Winch Enable Input

Table 3-9. 8-Bit Binary System

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

Dark shaded boxes indicate ON, white boxes OFF.

Table 3-10. 8-Bit Binary System (continued)

	1	2	4	8	16	32	64	128
130		■						■
131	■	■						■
132			■					■
133	■		■					■
134		■	■					■
135	■	■	■					■
136				■				■
137	■			■				■
138		■		■				■
139	■	■		■				■
140			■	■				■
141	■		■	■				■
142		■	■	■				■
143	■	■	■	■				■
144					■			■
145	■				■			■
146		■			■			■
147	■	■			■			■
148			■		■			■
149	■		■		■			■
150		■	■		■			■
151	■	■	■		■			■
152				■	■			■
153	■			■	■			■
154		■		■	■			■
155	■	■		■	■			■
156			■	■	■			■
157	■		■	■	■			■
158		■	■	■	■			■
159	■	■	■	■	■			■
160						■		■
161	■					■		■
162		■				■		■
163	■	■				■		■
164			■			■		■
165	■		■			■		■
166		■	■			■		■
167	■	■	■			■		■
168				■		■		■
169	■			■		■		■
170		■		■		■		■
171	■	■		■		■		■
172			■	■		■		■
173	■		■	■		■		■
174		■	■	■		■		■
175	■	■	■	■		■		■
176					■	■		■
177	■				■	■		■
178		■			■	■		■
179	■	■			■	■		■
180			■		■	■		■
181	■		■		■	■		■
182		■	■		■	■		■
183	■	■	■		■	■		■
184				■	■	■		■
185	■			■	■	■		■
186		■		■	■	■		■
187	■	■		■	■	■		■
188			■	■	■	■		■
189	■		■	■	■	■		■
190		■	■	■	■	■		■
191	■	■	■	■	■	■		■
192							■	■
193	■						■	■
194		■					■	■
195	■	■					■	■
196			■				■	■
197	■		■				■	■
198		■	■				■	■
199	■	■	■				■	■
200				■			■	■
201	■			■			■	■
202		■		■			■	■
203	■	■		■			■	■
204			■	■			■	■
205	■		■	■			■	■
206		■	■	■			■	■
207	■	■	■	■			■	■
208					■		■	■
209	■				■		■	■
210		■			■		■	■
211	■	■			■		■	■
212			■		■		■	■
213	■		■		■		■	■
214		■	■		■		■	■
215	■	■	■		■		■	■
216				■	■		■	■
217	■			■	■		■	■
218		■		■	■		■	■
219	■	■		■	■		■	■
220			■	■	■		■	■
221	■		■	■	■		■	■
222		■	■	■	■		■	■
223	■	■	■	■	■		■	■
224						■	■	■
225	■					■	■	■
226		■				■	■	■
227	■	■				■	■	■
228			■			■	■	■
229	■		■			■	■	■
230		■	■			■	■	■
231	■	■	■			■	■	■
232				■		■	■	■
233	■			■		■	■	■
234		■		■		■	■	■
235	■	■		■		■	■	■
236			■	■		■	■	■
237	■		■	■		■	■	■
238		■	■	■		■	■	■
239	■	■	■	■		■	■	■
240					■	■	■	■
241	■				■	■	■	■
242		■			■	■	■	■
243	■	■			■	■	■	■
244			■		■	■	■	■
245	■		■		■	■	■	■
246		■	■		■	■	■	■
247	■	■	■		■	■	■	■
248				■	■	■	■	■
249	■			■	■	■	■	■
250		■		■	■	■	■	■
251	■	■		■	■	■	■	■
252			■	■	■	■	■	■
253	■		■	■	■	■	■	■
254		■	■	■	■	■	■	■
255	■	■	■	■	■	■	■	■

Dark shaded boxes indicate ON, white boxes OFF.

PROGRAMMABLE CONTROLLER (PC) I/O BOARD FAULT TROUBLESHOOTING

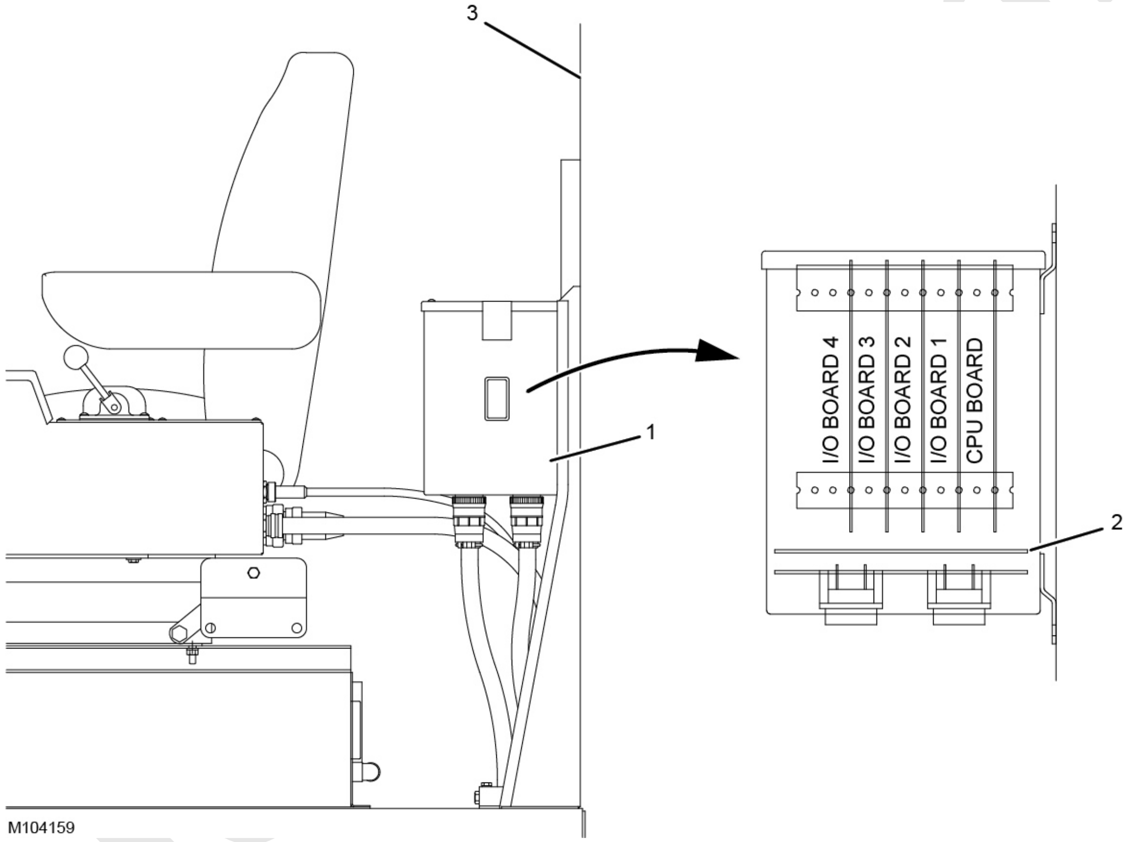
General

This section will assist in troubleshooting the model 2250 programmable controller (PC) for communication errors. The PC communication errors activate the system's fault IO BOARD FAULT *n*, where *n* identifies the input/output board(s) with which the PC is having difficulty communicating.

When an I/O board fault is on, all inputs to the PC are disabled. This prevents the crane's operator from being able to navigate through the display screens. The System Fault screen is the only active screen. The next power cycle of the PC resets and clears the fault if communication to the board has been restored.

To assist in troubleshooting, it is imperative the crane's operator or field service technician follows these steps before calling the Manitowoc Crane Care Lattice Team for technical support.

Prior to troubleshooting, read through the entire procedure for familiarization. When calling technical support, be prepared to supply all information noted below.



Item	Description
1	Crane Controller
2	Motherboard
3	Rear Cab Wall

FIGURE 3-25

Troubleshooting Procedure

CAUTION

Equipment Damage Hazard!

Prevent equipment damage from static electricity.

An electrostatic wrist band grounded to the programmable controller must be worn during any contact with the circuit boards to prevent a possible discharge of static electricity to the circuitry.

1. Note all crane functions that were in operation when I/O Board Fault came on.
2. Note any additional crane faults listed on the crane display to include any previous crane faults.
3. Power down the crane for a minimum of five minutes.
4. Restart the crane and note any faults listed on the crane display.
5. If I/O Board Fault is still on, remove the programmable controller cover located in the operator's cab behind the seat. Note the state of the LED on each board if equipped.
6. Power down the crane.
7. Note the locations of the I/O boards in relation to the CPU board in Figure 3-25. Each board has a lettered sticker between "C" and "F" that must be noted.
8. Reference Table 3-11 and verify that the corresponding I/O board is seated firmly in the controller motherboard.
9. If the corresponding I/O board is not seated firmly in the mother board of the controller, firmly seat the I/O board into the mother board. Restart the crane and check for faults listed on the crane display. If I/O Board Fault is still on, continue to step 10. If I/O Board Fault has cleared, communication has been restored and all inputs have been enabled. Replace the controller cover. The remaining troubleshooting steps are not necessary.
10. If the corresponding I/O board is seated firmly in the controller's mother board, shut down the crane and swap its location with one of the other three I/O boards in the programmable controller.
11. After the board is relocated and seated firmly in the controller's mother board, leave the cover open and power up the crane.
12. Note the active I/O Board Fault as it may have changed from the previous fault and call the Manitowoc Crane Care Lattice Team for technical support and additional troubleshooting procedures.

Table 3-11. I/O Board Fault Table Reference Guide

Fault	Controller Location	Fault	Controller Location
I/O Board Fault 1	I/O Board 1	I/O Board Fault 9	I/O Board 1 and 4
I/O Board Fault 2	I/O Board 2	I/O Board Fault 10	I/O Board 2 and 4
I/O Board Fault 3	I/O Board 1 and 2	I/O Board Fault 11	I/O Board 1, 2, and 4
I/O Board Fault 4	I/O Board 3	I/O Board Fault 12	I/O Board 3 and 4
I/O Board Fault 5	I/O Board 1 and 3	I/O Board Fault 13	I/O Board 1, 3, and 4
I/O Board Fault 6	I/O Board 2 and 3	I/O Board Fault 14	I/O Board 2, 3, and 4
I/O Board Fault 7	I/O Board 1, 2, and 3	I/O Board Fault 15	I/O Board ALL
I/O Board Fault 8	I/O Board 4	—	—

CPU EPROM REPLACEMENT

The central processing unit (CPU) in current production programmable controllers—to include cranes with Tier 4 Final engines—no longer has erasable programmable read-only memories (EPROMs) (computer chips).

For information on updating crane software, contact your Manitowoc dealer or the Manitowoc Crane Care Lattice Team.

DIELECTRIC GREASE

The following figures show the proper application of dielectric grease on J-tech type of connectors.

Dielectric grease is need when assembling J-tech type connectors. A bead of grease needs to be applied on the O-ring and face of a socket (female) connector and on only the O-ring of a pin (male) connector.

FIGURE 3-26

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

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

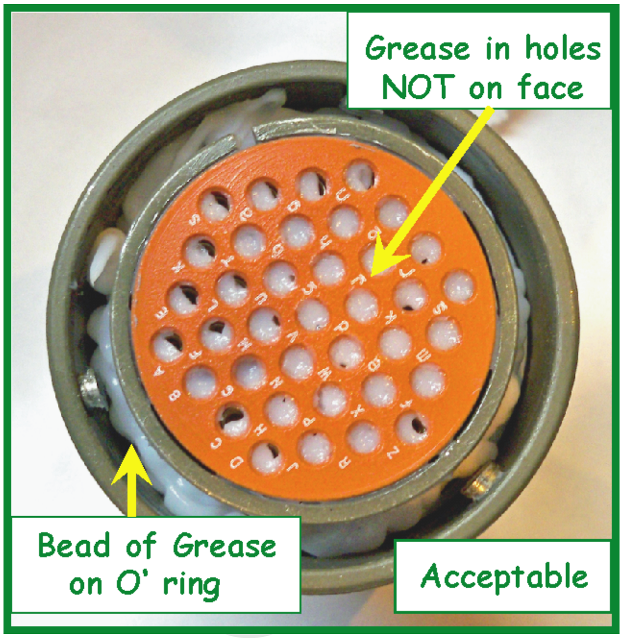


FIGURE 3-27

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 0,025 mm (0.001 in) on the connector's face. This helps ensure that water will be kept out of the connectors and keeps the pins from fretting.

FIGURE 3-28

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SECTION 4
BOOM

TABLE OF CONTENTS

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SECTION 4
BOOM

AUTOMATIC BOOM STOP

WARNING

Falling Attachment Hazard!

Death or serious injury may occur if attachments fall from the crane.

If the boom fails to stop for any reason, stop the engine immediately. Troubleshoot the system to determine the problem. Do not resume operation until the problem has been corrected.

General

This crane has limit switches which automatically stop the boom hoist and apply its brake when the boom is raised or lowered to a preset angle.

The limit switches are set at the following angles depending on boom use.

Operating Angle

See Figure 4-1 for the following:

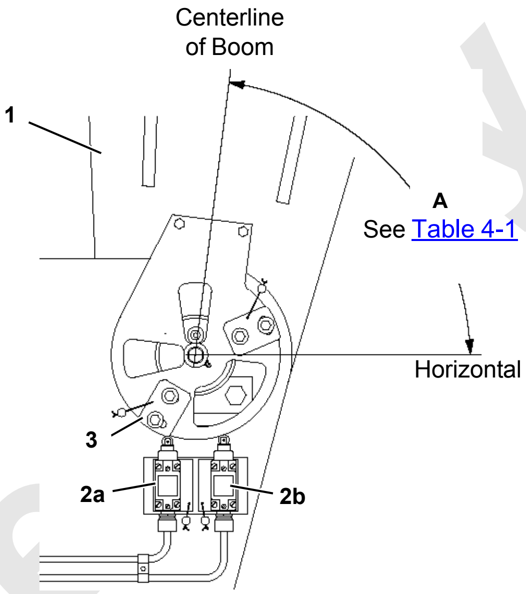
- 83° maximum (MAX) without the layout luffing jib
- 89° maximum (MAX) with the layout luffing jib
- 0° minimum (MIN)—The minimum boom stop is optional and can be adjusted to any angle between 4° above and 4° below horizontal.

NOTE: For the MAX-ER 2000 boom angles, refer to the Operator Manual supplied with the MAX-ER.

Setup Angle

- 89° with the boom butt in Crane Setup mode

NOTE: The operating angle is bypassed when the crane is in Crane Setup mode. The setup angle is bypassed when the setup selector is switched off.



Item	Description
1	Boom Butt
2a	Limit Switch (maximum angle)
2b	Limit Switch (minimum angle)
3	Actuator

FIGURE 4-1

Table 4-1. Automatic Boom Stop Maximum Angles

Maximum Angle A	Attachment
83°	#44 HL Boom and #44 LR Boom
89°	#44 HL Boom with #133 or #133A Luffing Jib

Operation

See Figure 4-2 for the following.

When the boom is below the maximum angle, the limit switch (2a) is closed. The boom hoist can now be operated. When the boom is raised to the maximum angle, the actuator (3a) opens the limit switch. Boom hoist operation stops automatically because the open limit switch turns off power to the electrical circuit. The boom hoist pump shifts to neutral, and the boom hoist brake applies to stop boom movement.

NOTE: An optional minimum boom stop is available. It operates the same as the maximum boom stop but in the Down direction.

Maintenance

Weekly—Verifying the Automatic Boom Stop Adjustment

Verify that the automatic boom stop actually stops the boom at the specified maximum angle. If it does not, replace any worn or damaged parts and/or adjust the automatic boom stop (see Adjusting the Maximum Automatic Boom Stop or Adjusting the Minimum Automatic Boom Stop on page 4-4).

Once the automatic boom stop is properly adjusted, it should not require periodic adjustment. However, adjustment is required when any of the following conditions exist:

- The luffing jib is installed or removed.
- Any automatic boom stop parts are replaced.

Adjustments

Adjusting the Maximum Automatic Boom Stop

See Figure 4-2 for the following procedure.

WARNING

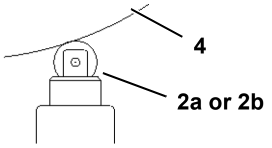
Falling Attachment Hazard!

The boom can be pulled over backwards or collapse, causing death or serious injury if the automatic boom stop does not function properly.

Do not operate the crane unless the automatic boom stop is properly adjusted and operational. Do not adjust the maximum operating angle higher than specified.

---

1. Travel the crane onto a firm level surface or level the crane by blocking under the crawlers.
2. If necessary, adjust the position of the limit switch (2a) with relation to the actuator bracket (4) as instructed in View B. Make sure the mounting hardware is tight after making the adjustment.
3. Loosen the capscrews (5, View D) retaining the actuator (3a) to the actuator bracket (4).
4. Cut and remove the lead and wire seal from the dowel pin (6). The dowel pin prevents the actuator from moving after the actuator position is set. Remove the dowel pin.
5. Rotate the actuator clockwise so it does not contact the limit switch roller when step 6 is performed.
6. Raise the boom to the specified maximum angle A (Figure 4-1) while monitoring the angle on the mechanical indicator or on the operating conditions screen of the front console display.
7. Verify that the boom is at the proper maximum angle as follows:
   a. Place an accurate digital level (7) on the centerline of the boom butt (1). The maximum angle should appear on the digital level.
   b. Raise or lower the boom as necessary to achieve the maximum angle.
8. Rotate the actuator against the limit switch roller until the limit switch clicks open. Hold the actuator in this position.
9. Check the position of the actuator with relation to the actuator bracket (4) as instructed in View C.
10. Securely tighten the capscrews to secure the actuator to the actuator bracket.
11. Verify the adjustment as follows:
    a. Lower the boom several degrees below the specified maximum angle.
    b. Slowly raise the boom.
    c. The boom must stop at the specified maximum angle. If the boom does not stop at the specified angle, perform the following:
       - Stop raising the boom (move the control handle to the OFF position).
       - Lower the boom several degrees below the specified maximum angle.
       - Repeat step 5 through step 11.
12. Use a new dowel pin, wire, and lead seal. Drill a new hole to seal the adjustment as instructed in View D.



View B

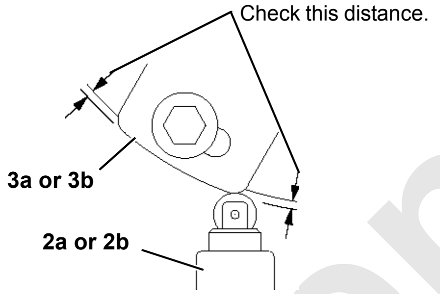
CAUTION

Equipment Damage!

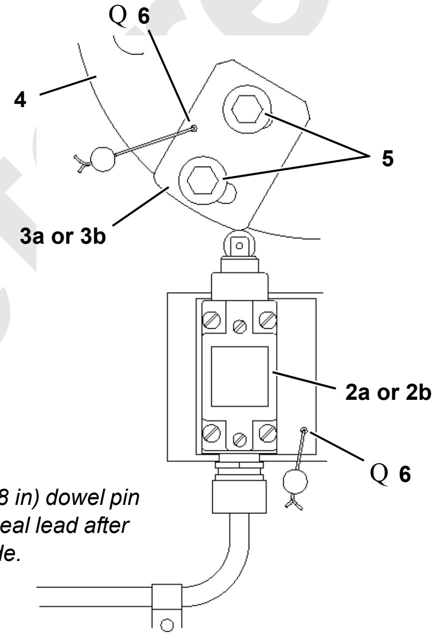
The limit switch could be damaged from over-travel if it is positioned too high in the slots or if either end of the actuator is cocked. The limit switch will also not trip open if it is positioned too low in the slots.

Before adjusting the limit switch (2a or 2b), loosen the limit switch mounting screws and move the limit switch up or down in the slots so the edge of the roller is even with the edge of the actuator bracket (4).

The distance from both ends of the actuator (3a or 3b) to the outside edge of the actuator bracket (4) must be equal.

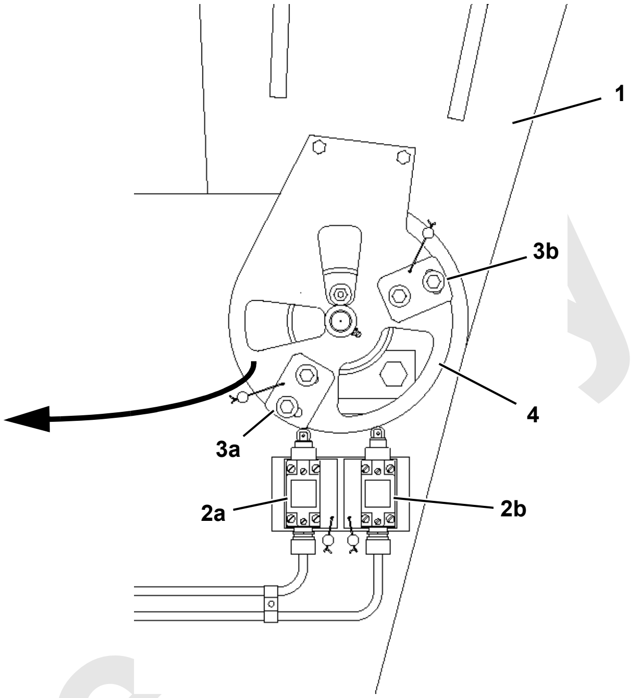


View C



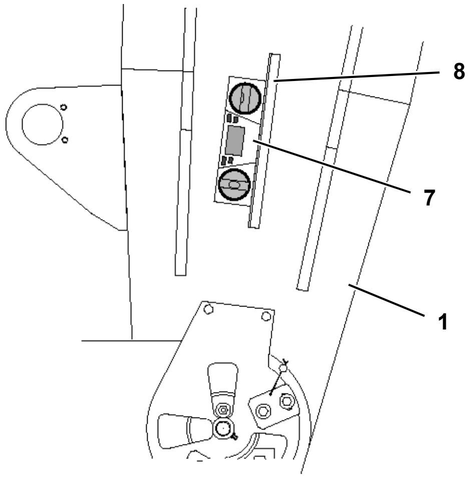
Q Drill for 3,2 mm (1/8 in) dowel pin (6). Install wire and seal lead after adjustments are made.

View D
(typical)



View A

Item	Description
1	Boom Butt
2a	Limit Switch (maximum)
2b	Limit Switch (minimum)
3a	Actuator (maximum)
3b	Actuator (minimum)
4	Actuator Bracket
5	Capscrew with Flat Washer and Lock Washer (qty 4)
6	Dowel Pin with Lead and Wire Seal (qty 4)
7	Digital Level
8	Level Support



View E

FIGURE 4-2

Adjusting the Minimum Automatic Boom Stop

See Figure 4-2 for the following procedure.

NOTE: The slots in the actuator (3b) allow the minimum boom angle to be adjusted to any angle between 4° above and 4° below horizontal.

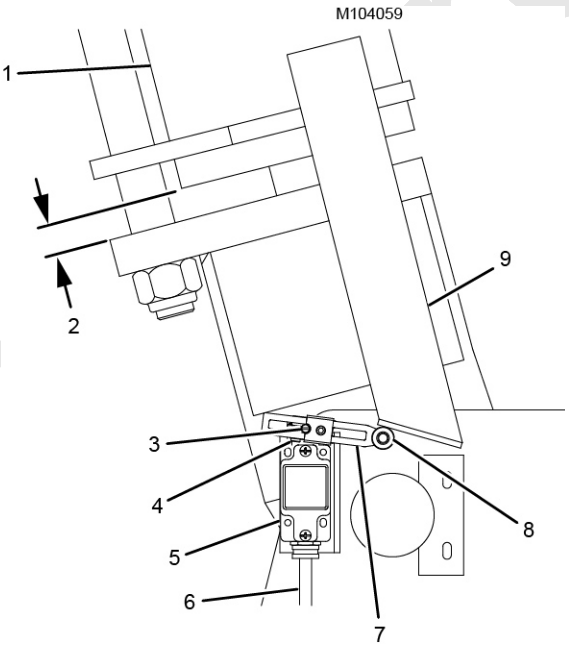
1. If necessary, adjust the limit switch (2b) in relation to the actuator bracket (4) as shown in View B. Make sure the mounting hardware is tight after making the adjustment.
2. Loosen the capscrews (5) that secure the actuator to the actuator bracket.
3. Cut and remove the wire and lead seal from the dowel pin (6). The dowel pin prevents the actuator from moving after the actuator position is set. Remove the dowel pin.
4. Rotate the actuator clockwise so it does not contact the limit switch roller when step 5 is performed.
5. Lower the boom to the desired minimum angle.
6. Rotate the actuator against the limit switch roller until the limit switch clicks open. Hold the actuator in this position (see View A).
7. Check the position of the actuator with relation to the actuator bracket as instructed (see View C).
8. Tighten the capscrews to secure the actuator to the actuator bracket.
9. Verify the adjustment as follows:
   - **a.** Raise the boom several degrees above the desired minimum angle.
   - **b.** Slowly lower the boom.
   - **c.** The boom should stop at the desired minimum angle. If it does not stop at the desired angle:
     - Stop lowering the boom.
     - Raise the boom several degrees above the desired minimum angle.
     - Repeat step 4 through step 9.
10. Use a new dowel pin, wire, and lead seal. Drill a new hole to seal the adjustment as shown in View D.

SETUP BOOM STOP ANGLE

See Figure 4-3 for the following procedure.

Perform the following steps when the crane is in Setup mode and rigged only with the boom butt.

1. Loosen the setscrew (4) in the limit switch lever (7), so the lever is free to rotate on the shaft (3).
2. Raise the boom butt until the physical boom stop (1) is 25 mm (1 in) (2) from bottoming out as shown. The boom angle will be at approximately 89°.
3. Hold the roller (8) on the lever against the actuator (9). Adjust the length of the lever, if necessary.
4. Turn the limit switch shaft clockwise (as viewed from the front of the switch) until the switch clicks open. Hold the switch in this position.
5. Securely tighten the setscrew in the lever.
6. Lower the boom butt several degrees.
7. Slowly raise the boom butt.
8. The boom butt must stop at the position specified in step 2. If not, repeat this procedure.



Item	Description
1	Physical Boom Stop (left side)
2	25 mm (1 in)
3	Shaft
4	Setscrew
5	Limit Switch
6	Cable to Air Valve Junction Box
7	Limit Switch Lever
8	Roller
9	Actuator

NOTE: Standard mounting shown. Mounting is raised approximately 0,61 m (2 ft) when equipped with the fold-under luffing jib.

FIGURE 4-3

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PHYSICAL BOOM STOP

WARNING

Boom Hazard!

The physical boom stop does not automatically stop the boom at the maximum operating angle. The automatic boom stop must be installed and properly adjusted to stop the boom (see Automatic Boom Stop on page 4-1). Otherwise, death or serious injury could occur.

Make sure the physical boom stop is installed for all crane operations.

General

See Figure 4-4 for the following information.

The physical boom stop assembly serves the following functions:

- Assists in stopping the boom smoothly at any angle above 80°.
- Assists in preventing the boom rigging from pulling the boom back when traveling or setting loads with the boom at any angle above 80°.
- Assists in moving the boom forward when lowering the boom from any angle above 80°.
- Provides a physical stop at 90°.

The strut cylinders between the boom stop tubes and the boom butt have two positions:

- Working position (struts fully extended)—The physical boom stop must be in this position for all crane operations.
- Shipping position (struts fully retracted)—This position provides maximum clearance for shipping the boom butt with the physical boom stop installed.

Operation

See Figure 4-4 for the following description.

1. Air system pressure of 8,6 to 9,4 bar (125 to 137 psi) is trapped in the boom stop cylinders by a check valve connected to each cylinder's inlet port as shown in View A.
2. When the boom is raised to 80°, the boom stop rod ends contact the boom stop pins in the adapter frame as shown in View B.
3. The cylinder rods then start to compress the air, which is trapped in the boom stop cylinders by the check valves.
4. As the boom is raised higher, the pressure of the trapped air increases to exert greater force against the boom.
5. If for any reason the boom is raised to 90°, the boom stop cylinders fully compress the air and bottom out to provide a physical stop.

Maintenance

Weekly

Inspect the air cylinders and piping for air leaks.

Quarterly—Adding Oil to the Boom Stop Cylinders

See Figure 4-4 for the following procedure.

1. Lower the boom stop to the shipping position (see Lowering the Boom Stop to the Shipping Position).

NOTE: It is necessary to exhaust the air from the boom stop cylinders before performing step 3.

2. Crack open the air line at each check valve to exhaust air from the boom stop cylinders.
3. Disconnect the hose from each check valve and squirt a few drops of light engine oil into the check valve.
4. Reconnect the hoses to the check valves.

Lowering the Boom Stop to the Shipping Position

See Figure 4-4 for the following procedure.

1. Lower the boom onto blocking at ground level.
2. Keep the engine running to ensure that there is sufficient air pressure to fully extend the strut cylinders.
3. Remove the quick-release pin from each strut support.
4. Rotate the supports to the shipping position as shown.
5. Reinstall the quick-release pins in the strut supports.
6. Stop the engine.

WARNING

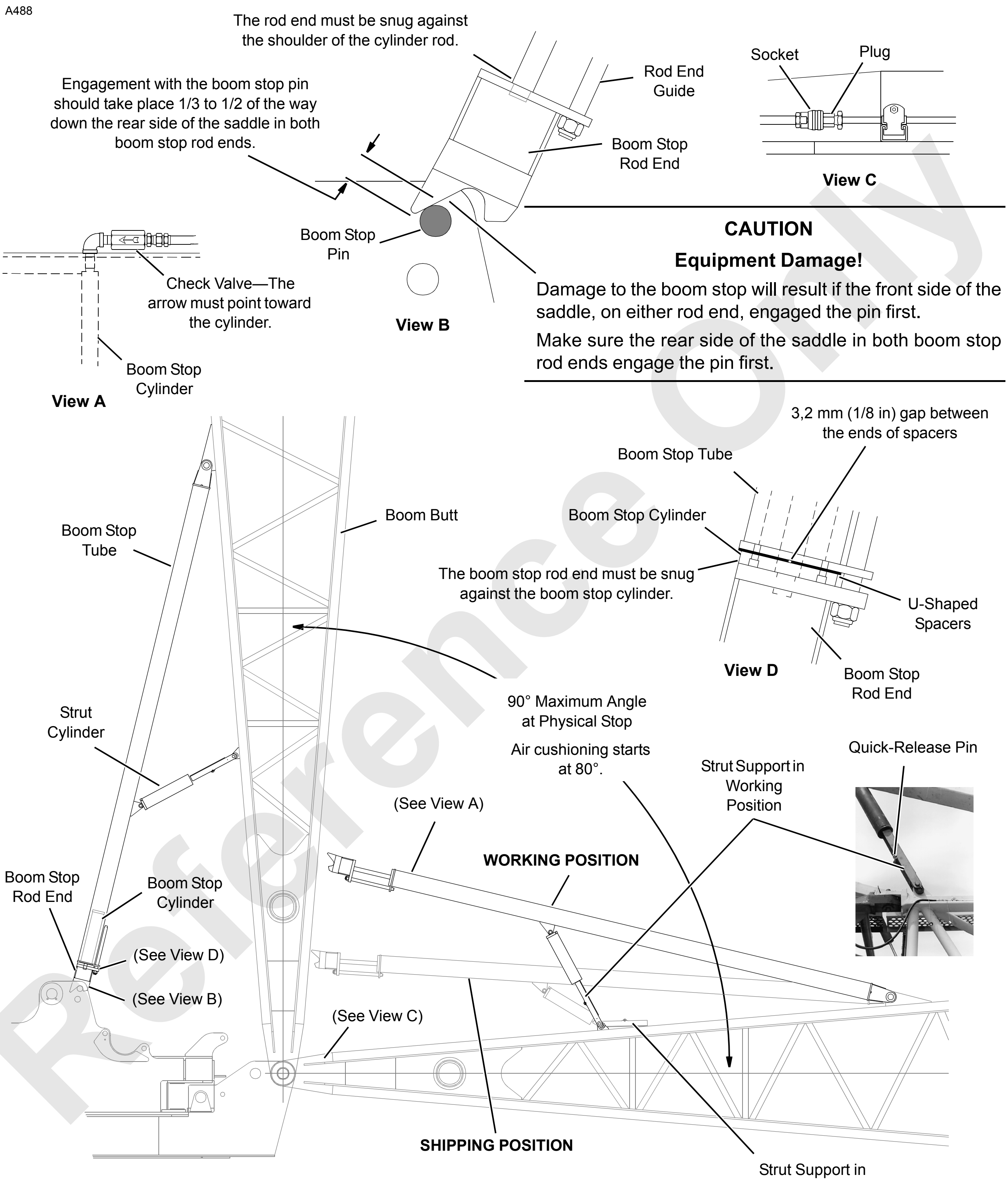
Crushing Injury Hazard!

The strut cylinders will retract as the air pressure exhausts, creating a hazardous situation in which death or serious injury may occur.

Stand clear of the boom stop tubes while performing step 7.

7. Disconnect the socket from the plug in the air supply line, near the right side boom hinge pin as shown in View C.

   The socket will block the supply air. Air pressure in the lines and cylinders will exhaust through the plug.



CAUTION

Equipment Damage!

Damage to the boom stop will result if the front side of the saddle, on either rod end, engaged the pin first.

Make sure the rear side of the saddle in both boom stop rod ends engage the pin first.

Physical Boom Stop Assembly

FIGURE 4-4

Raising the Boom Stop to the Working Position

See Figure 4-4 for the following procedure.

WARNING

Crushing Injury Hazard!

The strut cylinders will extend as air pressure is supplied, creating a hazardous situation in which death or serious injury may occur.

Stand clear of the boom stop tubes while performing step 1 and step 2.

1. Connect the socket to the plug in the air supply line near the right side boom hinge pin as shown in View C.
2. Start the engine. The strut cylinders will extend to raise the boom stop tubes as air pressure is supplied.
3. Remove the quick-release pin from both strut supports and rotate the supports to the working position as shown.
4. Reinstall the quick-release pins to lock the struts in position.

Adjustments

See Figure 4-4 for the following procedures.

The physical boom stop was adjusted at the factory and does not require periodic adjustment. The following items must be verified and adjusted at assembly, however, if the boom stop is disassembled for repair or parts replacement.

Boom Stop Rod Ends

Verify that each boom stop rod end is threaded all the way onto the cylinder rod so the rod end is snug against the shoulder on the cylinder rod as shown in View B. Also, make sure to install the rod end guides. The guides keep the boom stop rod ends in proper alignment.

Boom Stop Engagement

Watch the boom stop rod ends while slowly raising the boom butt. Both of the rod ends must engage the boom stop pins in the rotating bed at the same time and at the approximate point shown in View B. Adjust the boom stop rod end for each strut cylinder to provide the proper engagement.

Boom Stop Compression

Watch the boom stop rod ends while slowly raising the boom butt. With the boom butt at 90°, both boom stop rod ends should be bottomed out against the cylinders to within 3,2 mm (1/8 in) of each other as shown in View D.

Install the U-shaped spacers between the cylinder flanges and the boom stop tubes as shown in View D to limit the maximum angle to 90° and to bottom out the rod ends to within 3,2 mm (1/8 in) of each other.

ANGLE INDICATOR SENDING UNIT ASSEMBLY

General

See Figure 4-6 for the following.

An angle indicator sending unit (2) is mounted on the boom butt (6) and, if equipped, on the luffing jib butt (1).

Each sending unit houses an angle sensor that sends an electrical signal to the crane's programmable controller. The programmable controller converts the signal into an angle which can be monitored on the digital display in the operator's cab.

See Figure 4-5 for the following.

The following three angles can be monitored:

- Boom angle
- Luffing jib angle
- Boom-to-luffing jib angle

Boom and Jib Angle Identification

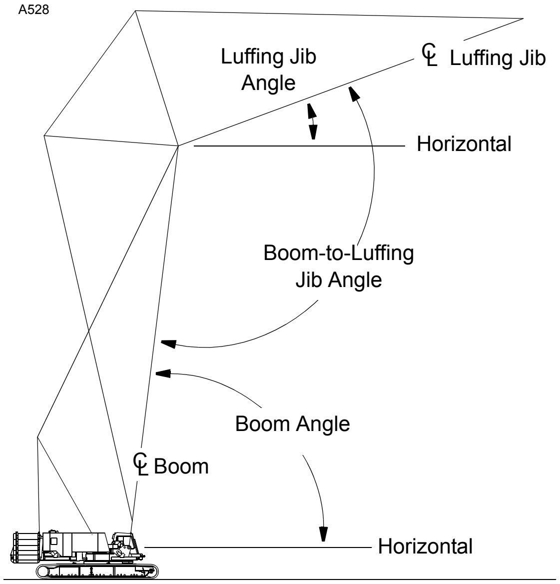
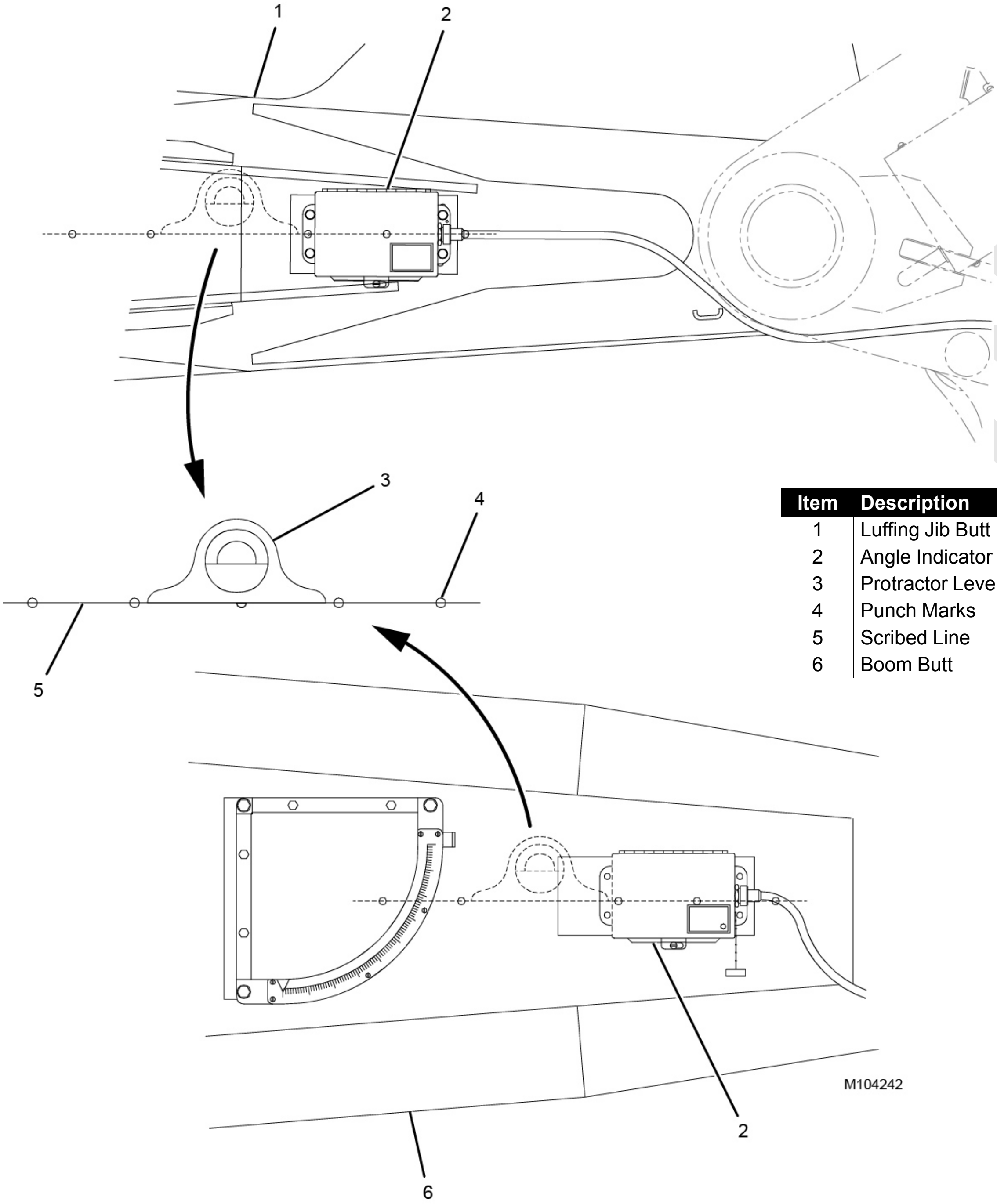


FIGURE 4-5



Item	Description
1	Luffing Jib Butt
2	Angle Indicator Sending Unit (qty 1 or 2)
3	Protractor Level
4	Punch Marks
5	Scribed Line
6	Boom Butt

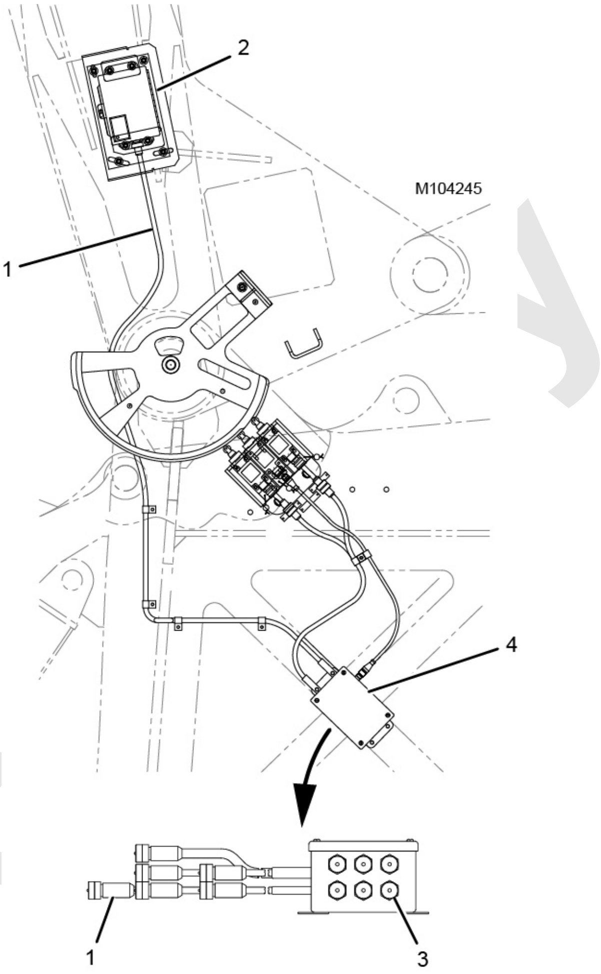
FIGURE 4-6

Disconnecting the Luffing Jib Angle Indicator Sending Unit Assembly

See Figure 4-7 for the following procedure.

1. Disconnect the electrical cord (1) from the receptacle on the sending unit (2).
2. Install the protective cap on the receptacle on the sending unit.
3. Connect the electrical cord to the shorting plug (3) on the boom point junction box (4).

NOTE: The procedure for disconnecting the boom angle indicator sending unit assembly is the same as the procedure for the luffing jib angle indicator sending unit assembly.



Item	Description
1	Electrical Cord
2	Sending Unit
3	Shorting Plug
4	Boom Point Junction Box

FIGURE 4-7

Angle Indicator Sending Unit

The angle indicator sending unit is a solid state sensor assembly. The sending units for the boom and the luffing jib are identical in appearance. However, the two units function differently and must not be interchanged.

The sending unit for the boom angle has a 120° sensor. This sensor is labeled 173010.

The sending unit for the luffing jib angle has a 180° sensor. This sensor is labeled 173732.

Replacing the Sensor

See Figure 4-8 for the following procedure.

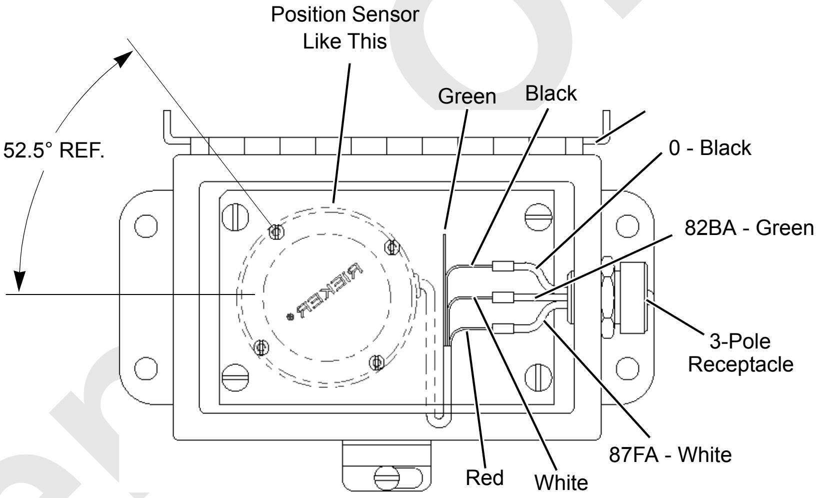
To replace a sensor, perform the following.

1. Identify all input wires to the existing sensor.
2. Cut the existing input wires near the terminal strip (if used) to allow for splicing.
3. Remove the existing sensor and the terminal strip (if used).
4. Mount the new sensor in the existing holes at the angle shown.
5. Refer to the wiring chart and parallel splice the sensor wires to the existing input wires with crimp, solder, and heat shrink tubing.
6. Seal the green wire on the sensor with heat shrink tubing and coil up.

A1294

Solid State Sensor (+/- 60°)
M.C.C. #81033730
Vendor #CS53

Input Wires Color	Sensor Wires Color	Operation Code
From	To	
Black	Black	Ground
Green	White	Signal
White	Red	10 Volts DC
	Green	N/C



A1294

Solid State Sensor (+/- 90°)
M.C.C. #81033734
Vendor #CS55

Input Wire Color	Sensor Wire Color	Operation Code
From	To	
Black	Black	Ground
Green	White	Signal
White	Red	10 Volts DC
	Green	N/C

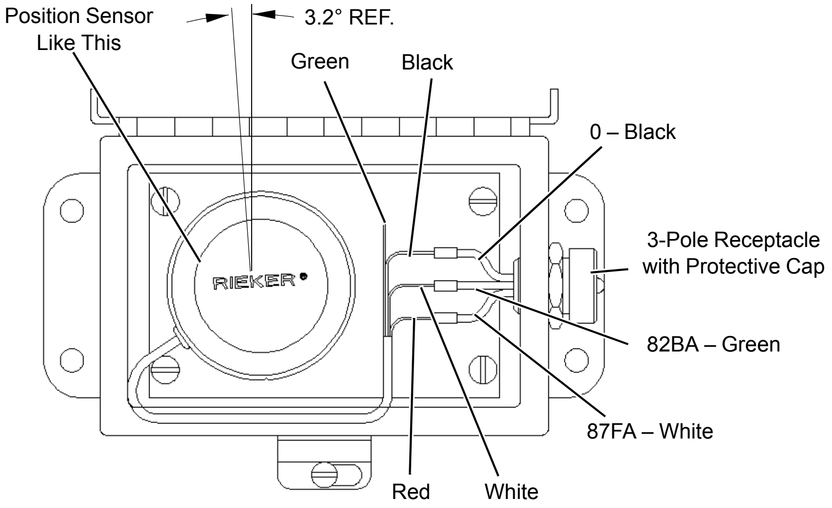


FIGURE 4-8

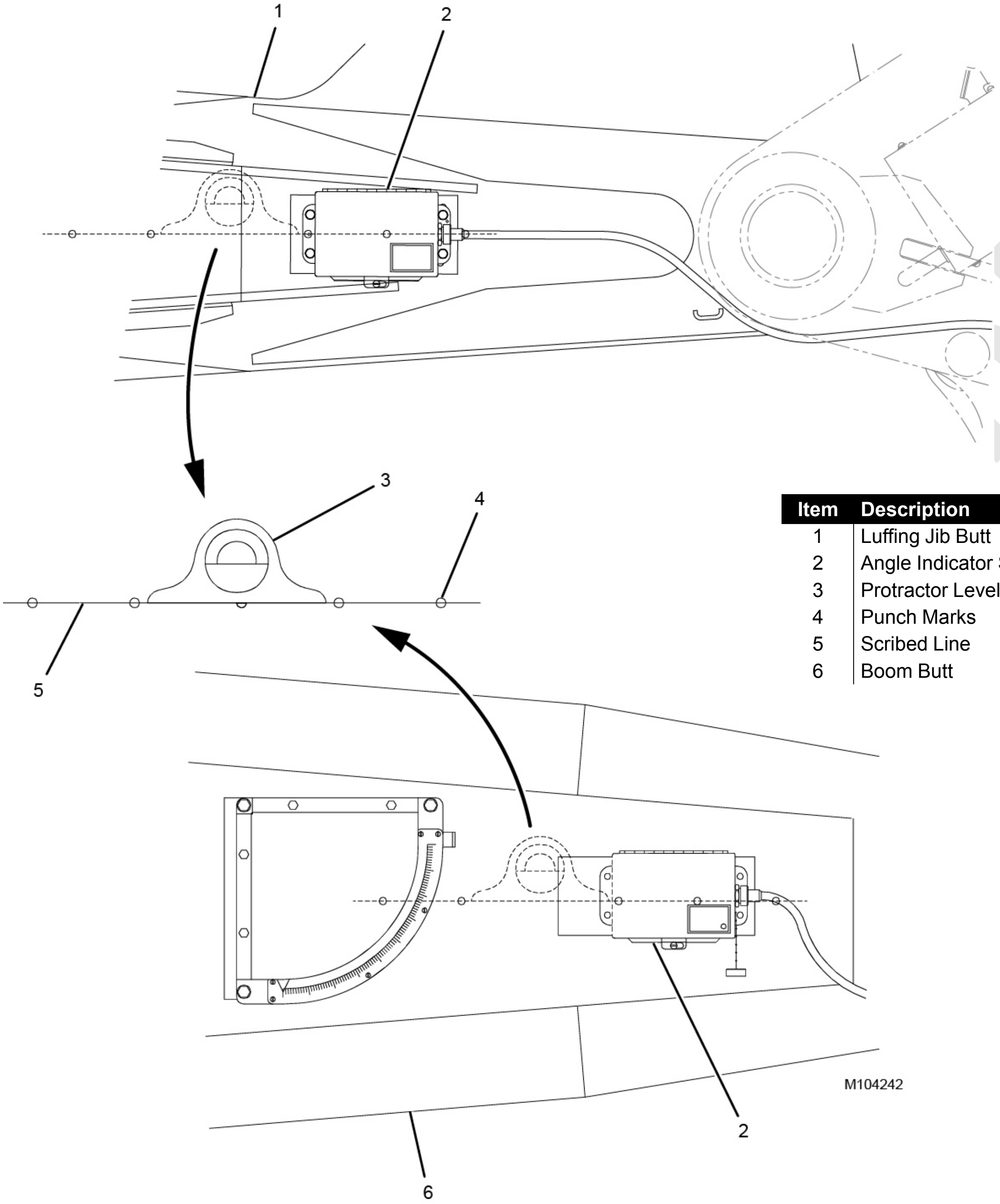
Adjusting the Angle Indicator Sender

See Figure 4-6 for the following procedure.

Perform the following adjustment procedure at the following times:

- At the initial installation
- After installing a new sending unit
- At least monthly when the boom, or the boom with the luffing jib, is lowered to ground

1. Lower the boom, or the boom and luffing jib assembly, onto blocking at ground level.
2. Scribe a line (5) through the centers of the punch marks (4) on the boom butt (6) or luffing jib butt (1) as shown.
3. Position a protractor level (3) along the scribed line.
4. Record the angle as shown on the protractor level.
5. Scroll to the desired angle (boom, luffing jib, or boom-to-luffing jib) on the digital display in the operator cab.
6. The angle shown on the digital display must match the angle recorded in step 4, plus or minus one degree.
7. If necessary, loosen the mounting screws and rotate the angle sending unit assembly in the mounting slots until the reading on the digital display matches the angle on the protractor level.
8. Securely tighten the mounting screws to lock the adjustment.



Item	Description
1	Luffing Jib Butt
2	Angle Indicator Sending Unit (qty 1 or 2)
3	Protractor Level
4	Punch Marks
5	Scribed Line
6	Boom Butt

FIGURE 4-9

BOOM HOIST RATCHET AND PAWL ADJUSTMENT

General

See Figure 4-10 for the following information.

These instructions apply only to the ratchet and pawl provided on the right, rear drum (drum 2 is used for the boom hoist when equipped with the MAX-ER 2000 attachment).

The pawl limit switch (6) must be properly adjusted to ensure proper operation of the boom hoist drum.

When the drum 2 park switch is on, the drum 2 park brake is applied, the boom hoist control handle is disabled, and the pawl (5) is engaged. When the pawl is engaged, the pawl limit switch closes the electric circuit to the crane's programmable controller. This action prevents drum 2 from being operated in either direction. However, drum 3 is operable when drum 2 is parked.

When the drum 2 park switch is off, the drum 2 park brake is released, the boom hoist control handle is enabled, and the pawl is disengaged. When the pawl is disengaged, the limit switch opens the electric circuit to the crane's programmable controller. This action allows operation of drum 2 in either direction, as long as drum 3 is parked.

If the operator attempts to operate either drum 2 or drum 3 when the other drum is not parked, the operating limit alert comes on and FUNCTON NOT PARKED appears on the digital display.

WARNING

Moving Parts Hazard!

Death or serious injury may occur from moving machinery. To make adjustments, the engine must be running, and the drums and the pawl must be operated.

Stay clear of the drums and the pawl while either is being operated. Maintain constant communication between the operator and the adjuster so the drums and pawl are not operated while the adjuster is in contact with the parts.

The pawl limit switch is factory set and does not require periodic adjustment. However, the limit switch must be adjusted if any parts are replaced or checked if the drum is not operating properly.

Adjusting the Pawl Limit Switch

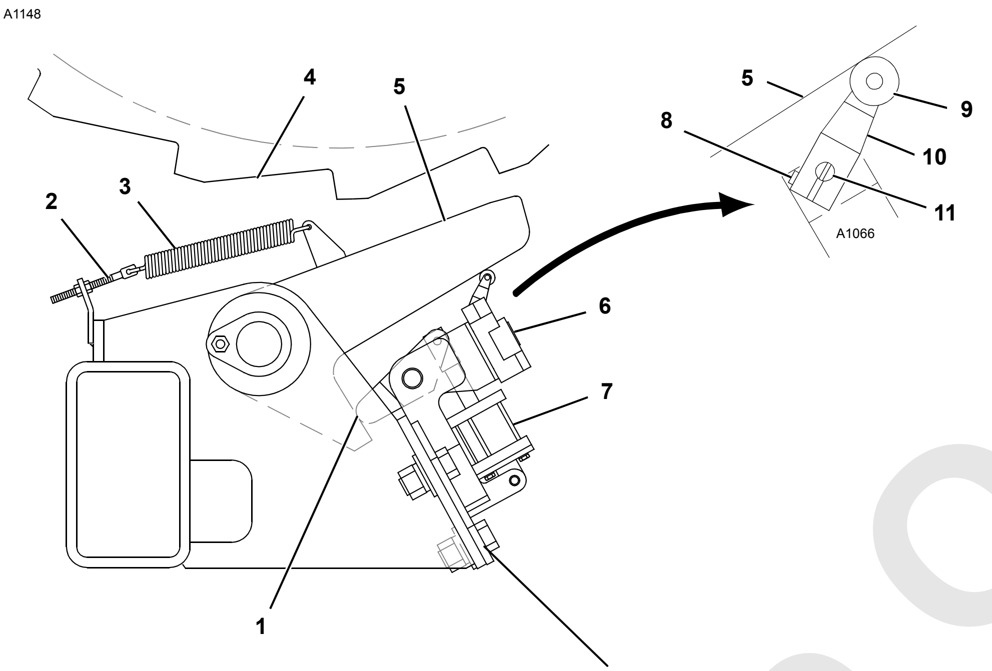
See Figure 4-10 for the following procedure.

1. Loosen the screw (8) so the limit switch lever (10) is free to rotate on the shaft (11).
2. Disengage the drum 2 pawl by toggling the drum 2 park switch to OFF. It may be necessary to jog the hoist control slightly before the pawl will disengage the ratchet (4).
3. Rotate the limit switch lever until the roller (9) is against the pawl. Hold the lever in this position.
4. Turn the shaft, not the lever, counterclockwise until the limit switch clicks open. Hold the shaft in this position.
5. Make sure the roller is against the pawl and securely tighten the screw in the lever to lock the adjustment.
6. Verify proper operation:
    - Engage the drum 2 pawl by toggling the drum 2 park switch to ON. Try to operate drum 2. Drum 2 should not operate in either direction. Drum 3 should be operable.
    - Disengage the Drum 2 pawl by toggling the drum 2 park switch to OFF. Toggle the drum 3 park switch to ON. Try to operate drum 2. Drum 2 should operate in either direction. Drum 3 should be inoperable.
7. Readjust the limit switch if required.

Adjusting the Tension on the Return Spring

See Figure 4-10 for the following procedure.

Adjust the eyebolt (2) so the return spring (3) has enough tension to fully engage and hold the pawl (5) against the ratchet (4).



Item	Description
1	Cam
2	Eyebolt
3	Return Spring
4	Ratchet
5	Pawl
6	Limit Switch
7	Cylinder
8	Screw
9	Roller
10	Limit Switch Lever
11	Shaft

FIGURE 4-10

STRAP INSPECTION AND MAINTENANCE

This is a guide for properly inspecting and maintaining straps in the field. It is impossible to predict whether or when a strap may fail. Frequent inspections can help reveal potential for failure. A qualified person should inspect straps regularly and keep dated records as part of the crane's preventive maintenance program.

Strap repairs are prohibited. Perform only the maintenance indicated. For inspection procedures not covered in this service manual, contact your dealer or the Manitowoc Crane Care Lattice Team.

WARNING

Falling Attachment Hazard!

Operating the crane with a damaged strap can cause structural failure or collapse of the boom, jib, mast, or other crane components, which can cause death or serious injury.

If damage to a strap was caused by an overload or a shock load, or if there is damage to other major structural components, Manitowoc Cranes 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 the straps. The word "strap" means the strap and its connecting links.

Inspection

A routine inspection of all straps is necessary to ensure that the crane can lift its rated load. If a strap fails, the boom or other attachment can collapse. A qualified, appointed inspector shall perform all inspections at the following intervals:

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

Frequent Inspection

Visually inspect all straps once each shift for obvious damage that poses an immediate hazard. Pay particular attention to areas where wear and other damage is likely to occur. Look for straps that are disconnected, loose, or sagging excessively and for distortion, such as kinking or twisting. If a strap looks like it is damaged, it must be checked to make sure it is within specification.

Periodic Inspection

Periodic inspection must be performed at least monthly. During this inspection, the entire length of strap must be inspected to ensure that it is within specifications.

NOTE: All straps must be within specification. Any damage found must be recorded and a determination made as to whether continued use of the strap is safe.

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

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

- The severity of the environment in which the crane is operated
- The size, nature, and frequency of lifts
- Any exposure to shock loading or other abuse

Inspecting the Straps on Idle Cranes

A qualified inspector should determine the type of inspection required for cranes that are not being used (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 strap identification, a part number is stamped into both ends of each strap (Figure 4-11).

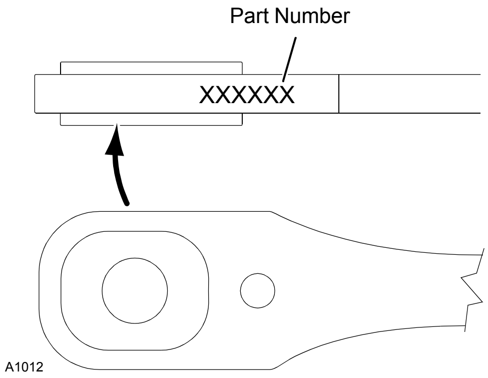


FIGURE 4-11

Strap Replacement Specifications

Any strap not within the specifications listed in Table 4-2 must be replaced.

WARNING

Falling Attachment Hazard!

Operating the crane with a damaged strap can cause structural failure or collapse of the boom, jib, mast, or other crane components, which can cause death or serious injury.

If the damage to the strap exceeds that allowed within the specifications, do not operate the crane until the strap has been replaced.

Table 4-2. Strap Specifications

Condition	Reference	Allowable Tolerance or Deviation	Corrective Action
Dent	Figure 4-12	< 3 mm (0.12 in)	Monitor the condition.
		≥ 3 mm (0.12 in)	Remove the strap from service.
Kink	Figure 4-13	None	Remove the strap from service.
Crack or Break	Figure 4-14	None	Remove the strap from service.
Corrosion or Abrasion	Figure 4-15	<6% of strap thickness	Sandblast and paint to maintain a continuous protective coating.
		≥6% of strap thickness	Remove the strap from service.
Straightness (gradual or sweeping bend)	Figure 4-16	Varies depending on strap length	Remove the strap from service if the deviation exceeds the maximum allowed.
Flatness (includes twisted straps)	Figure 4-17	Varies depending on strap length	Remove the strap from service if the deviation exceeds the maximum allowed.
Elongated Holes	Figure 4-18	None	Remove the strap from service.
Length	Figure 4-19	None	Remove the strap from service.

< = less than
≥ = equal to or greater than

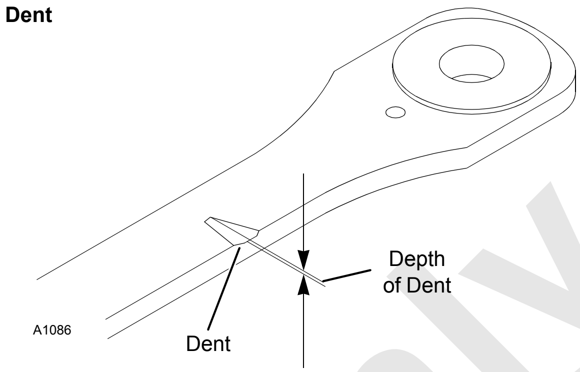
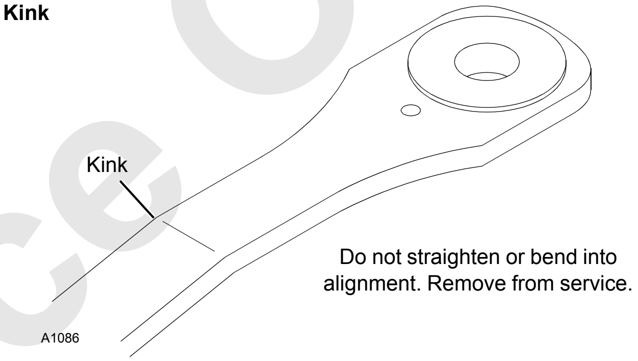
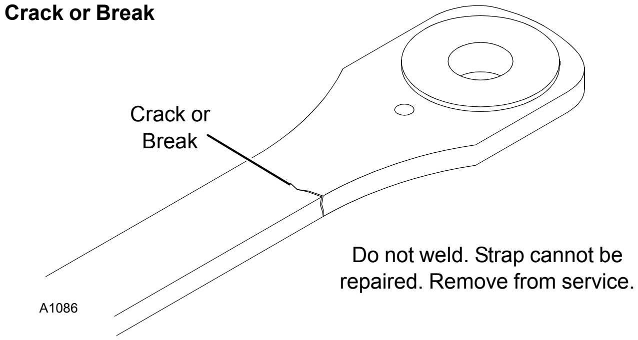


FIGURE 4-12



Do not straighten or bend into alignment. Remove from service.

FIGURE 4-13



Do not weld. Strap cannot be repaired. Remove from service.

FIGURE 4-14

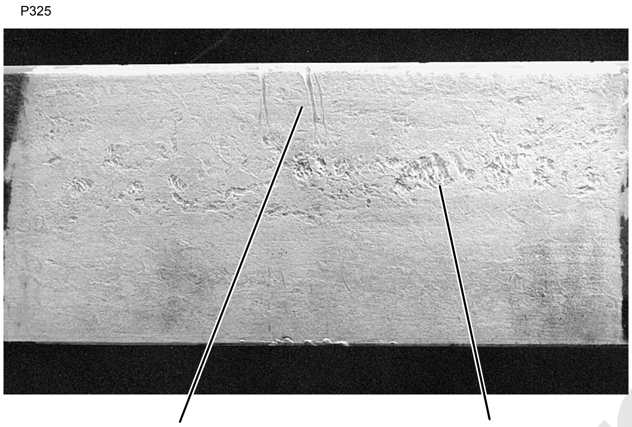
Corrosion or Abrasion

See Figure 4-15 for the following procedure.

1. Sandblast to remove the corrosion. Do not grind!
2. Determine the reduction in thickness.
3. If the reduction in thickness is less than 6% of strap thickness, clearly mark the damaged areas with brightly colored tape for quick identification by repair workers.

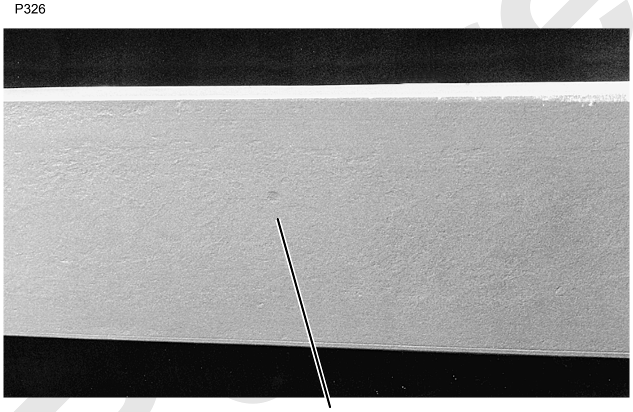
   Paint the strap to maintain a continuous protective coating.
4. If the reduction in thickness 6% or more of the strap thickness, remove the strap from service.

Corrosion or Abrasion



Not Acceptable
Abrasion from handling with a chain exceeds the allowable limit.

Not Acceptable
The surface is badly pitted, which exceeds the allowable limit.



Acceptable
The surface is relatively smooth and within the allowable limit.

FIGURE 4-15

Straightness

See Figure 4-16 and Table 4-3 for the following procedure.

1. Stretch a line (string or wire) from the pin storage hole at one end of the strap.
2. Stretch the line as tight as possible and tie it off at the other pin storage hole.
3. Mark the strap centerline, but do not use a center punch.
4. If the string does not align with the centerline, measure the distance from the centerline to stretched line.
5. If the deviation from being straight is greater than the maximum allowed, remove the strap from service.

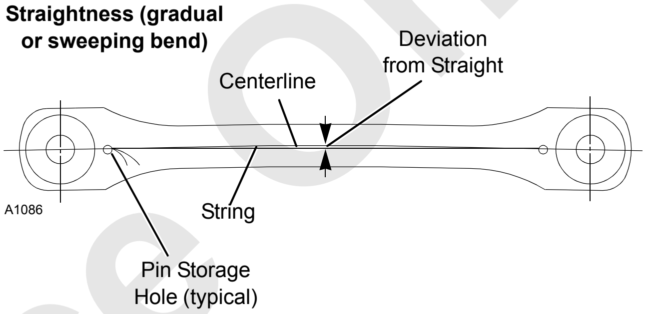


FIGURE 4-16

Table 4-3. Strap Straightness Deviations

Strap Length	Maximum Deviation Allowed
1,5 to <3,0 m (5 to <10 ft)	1,5 mm (0.060 in)
3,0 to <6,1 m (10 to <20 ft)	3,2 mm (0.125 in)
6,1 to <9,1 m (20 to <30 ft)	6,4 mm (0.250 in)
9,1 to <12,0 m (30 to <40 ft)	9,5 mm (0.375 in)
12,0 to <15,0 m (40 to <50 ft)	12,7 mm (0.50 in)
< = less than	

Flatness

See Figure 4-17 for the following procedure.

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

   If the deviation from straight is greater than the maximum allowed, remove the strap from service.
6. Remove the line and turn the strap over.
7. Repeat step 1 through step 5.

Flatness (includes twisted straps)

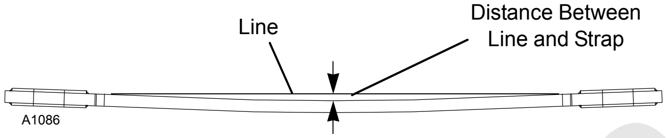


FIGURE 4-17

Elongated Holes

See Figure 4-18 for the following procedure.

1. Insert the pin into the hole on the strap.
2. Push the pin tight against the edge of the hole along the horizontal centerline. Measure the distance between the pin and the hole (A).
3. Push the pin tight against the edge of the hole along the vertical centerline. Measure the distance between the pin and the hole (B).

   If the dimensions are not identical, the hole is elongated. Remove the strap from service.

   If the dimensions are identical, but greater than 0,8 mm (0.03 in), contact the Manitowoc Crane Care Lattice Team.

Elongated Holes

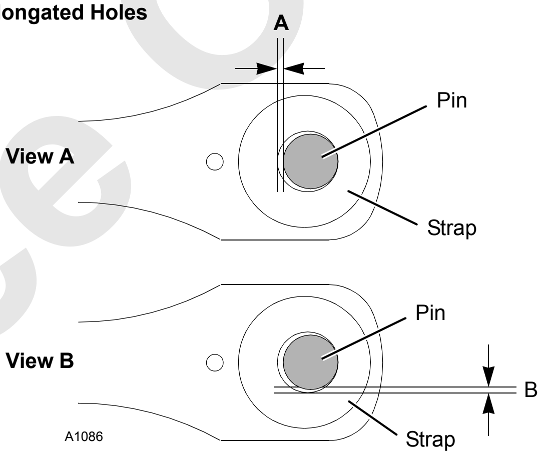


FIGURE 4-18

Length

See Figure 4-19 and Table 4-4 for the following procedure.

NOTE: See the appropriate Rigging Drawing in the Operator Manual for the original length.

1. Measure from one pin hole to the opposite pin hole to check the strap length. The strap length includes the connecting link.
2. If a deviation in length is detected and it is greater than the maximum allowed, remove the strap from service.

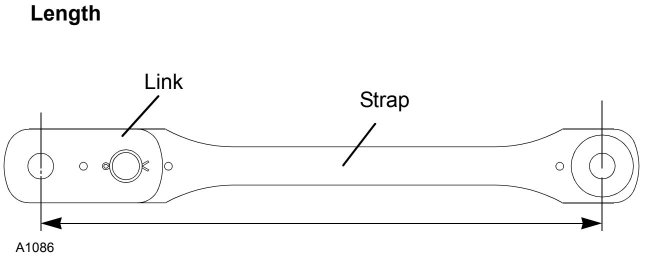


FIGURE 4-19

Table 4-4. Strap Length Deviations

Strap Length m (ft)	Maximum Deviation Allowed	
	25,4 to <50,8 mm (1 to <2 in) Thick	50,8 to <101,6 mm (2 to <4 in) Thick
<0,9 (<3)	4,3 (0.17)	12,7 (0.50)
0,9 to <1,2 (3 to <4)	15,9 (0.63)	14,3 (0.56)
1,2 to <1,5 (4 to <5)	19,1 (0.75)	17,5 (0.70)
1,5 to <1,8 (5 to <6)	20,6 (0.80)	19,1 (0.75)
1,8 to <2,1 (6 to <7)	22,2 (0.88)	19,1 (0.75)
2,1 to <2,4 (7 to <8)	23,8 (0.94)	19,1 (0.75)
2,4 to <2,7 (8 to <9)	25,4 (1.0)	19,1 (0.75)
2,7 to <3,0 (9 to <10)	25,4 (1.0)	22,2 (0.88)
3,0 to <3,7 (10 to <12)	25,4 (1.0)	25,4 (1.0)
≥3,7 (≥12)	Deviation not to exceed 25,4 mm (1 in) in any 3,7 m (12 ft) length of strap	

< = less than

≥ = equal to or greater than

Storing Straps

Straps should be stored in a protected area. If stored in the open, a protective covering is recommended, especially in a corrosive environment in which the straps are exposed to elements such as harsh chemicals or salt water spray.

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

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

Removing Straps from Service

Straps removed from service should be clearly marked to prevent accidental future use. Rendering the strap useless in some way, such as cutting off an end, is recommended.

Strap 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 because they may be required to verify warranty or product liability claims.

If no damage is found or damage is within specifications, check the box (☑) next to the item to indicate that its specific condition was evaluated and found acceptable. If damage is not within specifications, indicate so in the box next to the item (for example: “D” to indicate damage).

LATTICE SECTION INSPECTION AND LACING REPLACEMENT

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

STRAP INSPECTION CHECKLIST

Inspector's Name ______________ **Signature** ______________ **Date** __________

Length __________ m (ft) Part Number ______________

☐ Dents ☐ Kinks ☐ Cracks ☐ Breaks ☐ Corrosion

☐ Abrasion ☐ Length ☐ Straightness ☐ Flatness ☐ Elongated Holes

☐ Other ____

Length __________ m (ft) Part Number ______________

☐ Dents ☐ Kinks ☐ Cracks ☐ Breaks ☐ Corrosion

☐ Abrasion ☐ Length ☐ Straightness ☐ Flatness ☐ Elongated Holes

☐ Other ____

Length __________ m (ft) Part Number ______________

☐ Dents ☐ Kinks ☐ Cracks ☐ Breaks ☐ Corrosion

☐ Abrasion ☐ Length ☐ Straightness ☐ Flatness ☐ Elongated Holes

☐ Other ____

Length __________ m (ft) Part Number ______________

☐ Dents ☐ Kinks ☐ Cracks ☐ Breaks ☐ Corrosion

☐ Abrasion ☐ Length ☐ Straightness ☐ Flatness ☐ Elongated Holes

☐ Other ____

Length __________ m (ft) Part Number ______________

☐ Dents ☐ Kinks ☐ Cracks ☐ Breaks ☐ Corrosion

☐ Abrasion ☐ Length ☐ Straightness ☐ Flatness ☐ Elongated Holes

☐ Other ____

NOTES

DRAW SKETCHES OR ATTACH PHOTOGRAPHS HERE AND NEXT TWO PAGES

SECTION 5
HOISTS

TABLE OF CONTENTS

SECTION 5
HOISTS

ADJUSTING THE MINIMUM BAIL LIMIT

General

The minimum bail limit assembly is a protective device. It automatically stops the corresponding load drum from lowering when there are three to four wraps of wire rope remaining on the drum.

The load drum can be operated in the HOIST direction when the corresponding minimum bail limit is contacted.

WARNING

Falling Load Hazard!

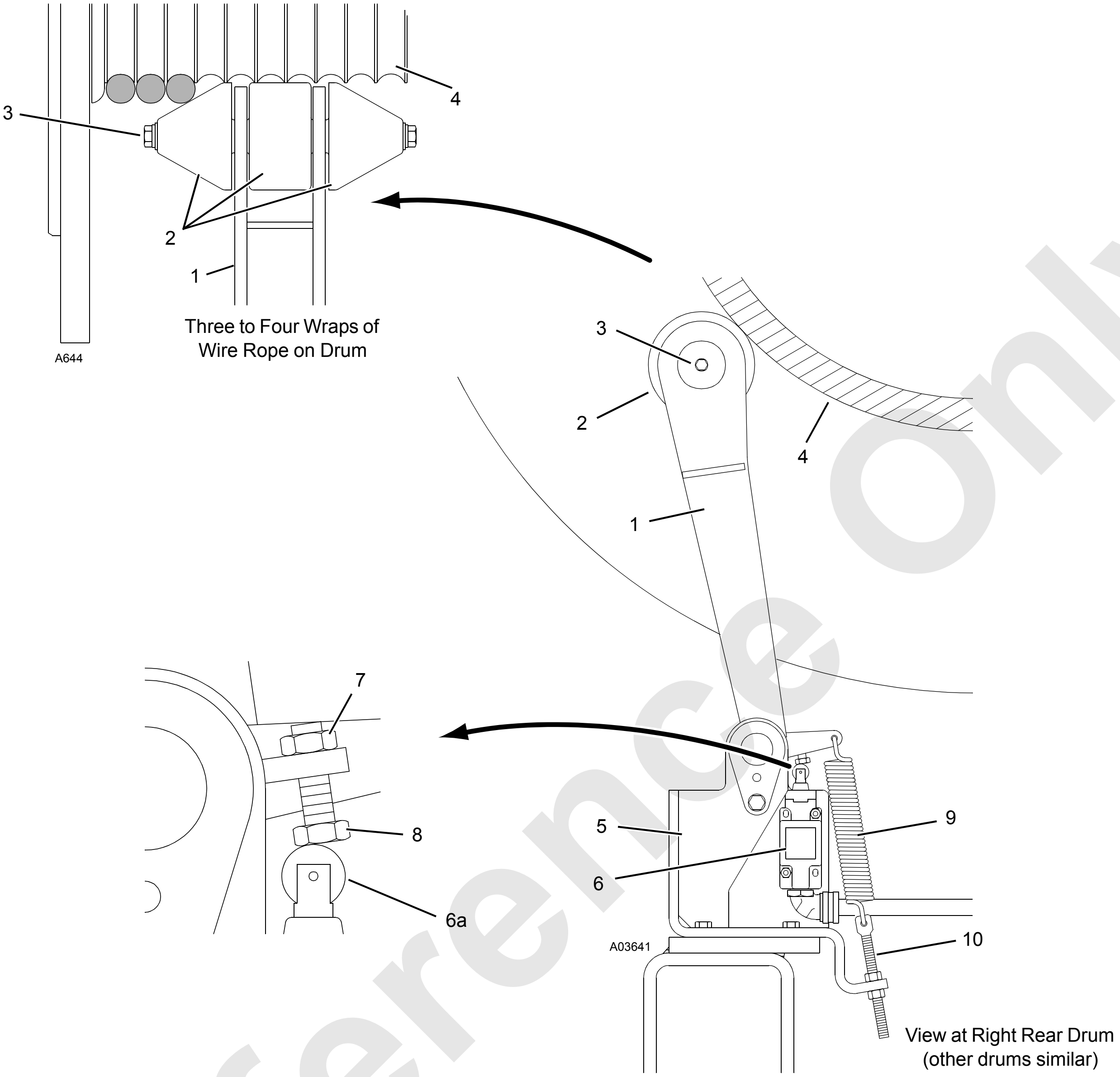
If the proper precautions are not followed, the wire rope can be pulled out of the drum, and the load will drop, which could result in death or serious injury.

Do not operate either load drum with less than three full wraps of wire rope on the drum.

Weekly Maintenance

See Figure 5-1 for the following procedure.

1. Check for proper operation of each minimum bail limit assembly, as follows.
   - a. Land the load.
   - b. Pay out the wire rope from the load drum.
   - c. The load drum must stop when there are three to four wraps of wire rope remaining on the drum.
2. Verify that the capscrews (3) holding the rollers (2) on the bail limit lever (1) are tight.
3. Check the tension of the return spring (9). If necessary, adjust the eyebolt (10) so the spring holds the rollers snugly against the drum (4).



Three to Four Wraps of Wire Rope on Drum

View at Right Rear Drum (other drums similar)

Item	Description	Item	Description
1	Bail Limit Lever	6a	Limit Switch Roller
2	Roller (qty 3)	7	Lock Nut
3	Capscrew (qty 2)	8	Adjusting Screw
4	Drum	9	Return Spring
5	Mounting Bracket	10	Eyebolt
6	Limit Switch		

FIGURE 5-1

Removing the Wire Rope

To remove the wire rope from a load drum, perform the following procedure.

1. Land the load and lower the boom onto blocking at ground level.
2. Pay out the wire rope from the load drum until the limit switch stops the drum from turning.
3. Move the Limit Bypass switch to the BYPASS position and hold it.
4. Operate the load drum in the LOWER direction to pay out the remaining wire rope from the drum.

Electrical Wiring

See the electrical schematics in Electrical System Section 3 for proper wiring of the limit switch.

Adjusting the Minimum Bail Limit

See Figure 5-1 for the following procedure.

1. Loosen the lock nut (7) and turn the adjusting screw (8) up as far as possible.
2. Pay out the wire rope from the drum (4) until the rollers (2) are against the drum lagging with three to four wraps of wire rope remaining on the drum.
3. Turn the adjusting screw down against the limit switch roller (6a) until the limit switch (6) "clicks open," then stop.
4. Spool six to seven wraps of wire rope onto the drum, and then pay out the wire rope.
5. The drum must stop when the rollers are against the drum lagging with three to four wraps of wire rope remaining on the drum.

   If necessary, turn the adjusting screw in or out slightly and recheck the adjustment.
6. Securely tighten the lock nut against the mounting bracket (5) to lock the adjustment.
7. Adjust the eyebolt (10) so the return spring (9) has sufficient tension to hold the rollers snugly against the bare drum.

ADJUSTING THE BLOCK-UP LIMIT CONTROL

General

WARNING

Two Blocking Hazard!

Two blocking can result in failure of sheaves and wire rope, possibly causing the load to fall resulting in death or serious injury.

The block-up limit control may not prevent two blocking when a load is hoisted at the maximum single line speed. The operator shall determine the fastest line speed that will allow the block-up limit control to function properly and, thereafter, not exceed that line speed.

The block-up limit control (also called an anti-two blocking device) is a two blocking prevention device that automatically stops the load drum from hoisting and the boom from lowering when a load is hoisted a predetermined distance. It is designed only to assist the operator in preventing a two blocking condition. Any other use is neither intended nor approved.

Two blocking is an unsafe condition in which the load block or the weight ball contacts the sheave assembly from which either is suspended.

The block-up limit controls must be installed according to the Boom Wiring, Limits, and Load Indicator Electrical Assembly drawing in the Operator Manual.

The block-up limit control consists of the following components (Figure 5-2):

- A normally closed limit switch assembly (2) fastened at any or all of the following locations (multiple limit switches are wired in series):
  - Lower boom point (3)
  - Upper boom point (standard or extended) (1)
  - Fixed jib point
  - Luffing jib point
- A weight (6) freely suspended by a chain (5) from each limit switch actuating lever (weight encircles load line)
- A lift block (7) clamped to the single-part load line or a lift plate (9) fastened to a multiple-part load block (10)

For detailed drawings of the limit switch locations, see the Boom Wiring and Limits Drawing in the Operator Manual.

Block-Up Limit Control Operation

During normal operation, the weight overcomes the 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/Luffing Jib Down electrical circuits. The load can be hoisted, and the boom/luffing jib can be lowered.

When the weight is lifted by the lift block or lift plates, spring force rotates the actuating lever against the limit switch lever. This action causes the corresponding limit switch to open the Load Drum Up and Boom/Luffing Jib Down electrical circuits.

The load drum and boom hoist pumps stroke to off. At the same time, the load drum and boom/luffing jib park brakes apply to stop the load drum from hoisting and to stop the boom/luffing jib from lowering.

Load Block Level Transmitter

See Figure 5-2 for the following procedure.

The optional load block level transmitter (12) is only used with tandem drum operation. See Troubleshooting Section 10 for more information. The wireless screen on the digital display indicates the load block level transmitter battery status.

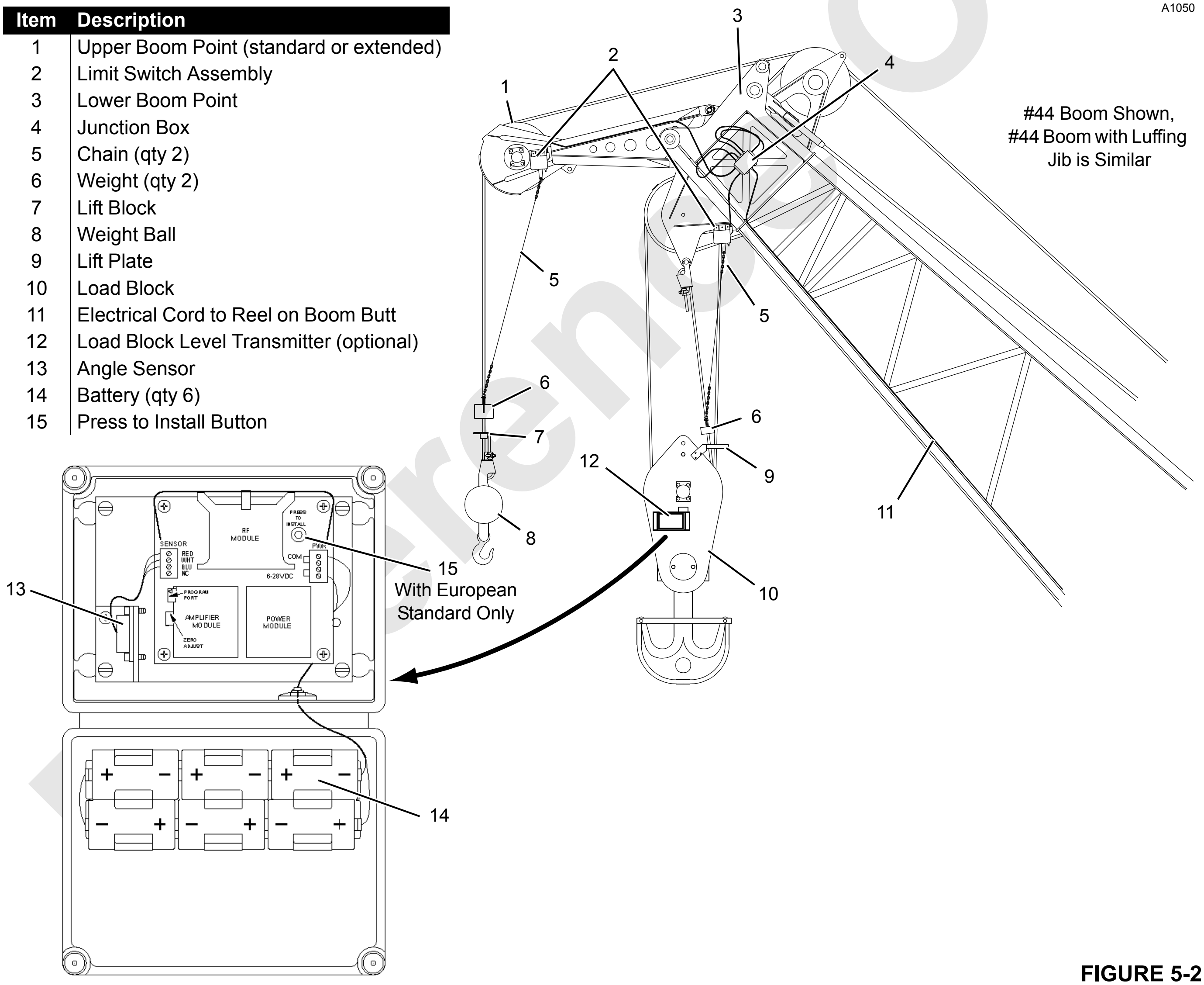
1. The load block level transmitter is mounted on the load block (10). There should be no obstructions between the transmitter (on the block) and the receiver (on the boom top).

NOTE: When reeved, the load block level transmitter must be on the left side of the load block when viewed from the operator's cab.

2. Use a smart level to check the level sensor zero. Follow the procedure below if a zero adjustment is required.
   - **a.** Open the enclosure.
   - **b.** If a European Standard transmitter is used, press the Press to Install button (15) to enable the transmitter.
   - **c.** Loosen the screw on each side of the angle sensor (13) and turn the sensor slightly either way until the sensor is zeroed.
   - **d.** Tighten the screws on each side of the sensor when the adjustment is complete.

The transmitter is shipped with six Alkaline-type size D batteries (14). It is recommend to replace the batteries with six Lithium-type size D batteries for longer battery life.

Item	Description
1	Upper Boom Point (standard or extended)
2	Limit Switch Assembly
3	Lower Boom Point
4	Junction Box
5	Chain (qty 2)
6	Weight (qty 2)
7	Lift Block
8	Weight Ball
9	Lift Plate
10	Load Block
11	Electrical Cord to Reel on Boom Butt
12	Load Block Level Transmitter (optional)
13	Angle Sensor
14	Battery (qty 6)
15	Press to Install Button



With European Standard Only

#44 Boom Shown, #44 Boom with Luffing Jib is Similar

FIGURE 5-2

Installation

See Figure 5-3 for installation of the weights.

The block-up limit control must be installed according to the assembly drawing.

Securely fasten the electrical cords to the boom and jib with the metal straps and nuts provided.

When equipped with more than one block-up limit switch, wire the limit switches in series.

Connect the electrical wires to the normally closed contacts inside each limit switch.

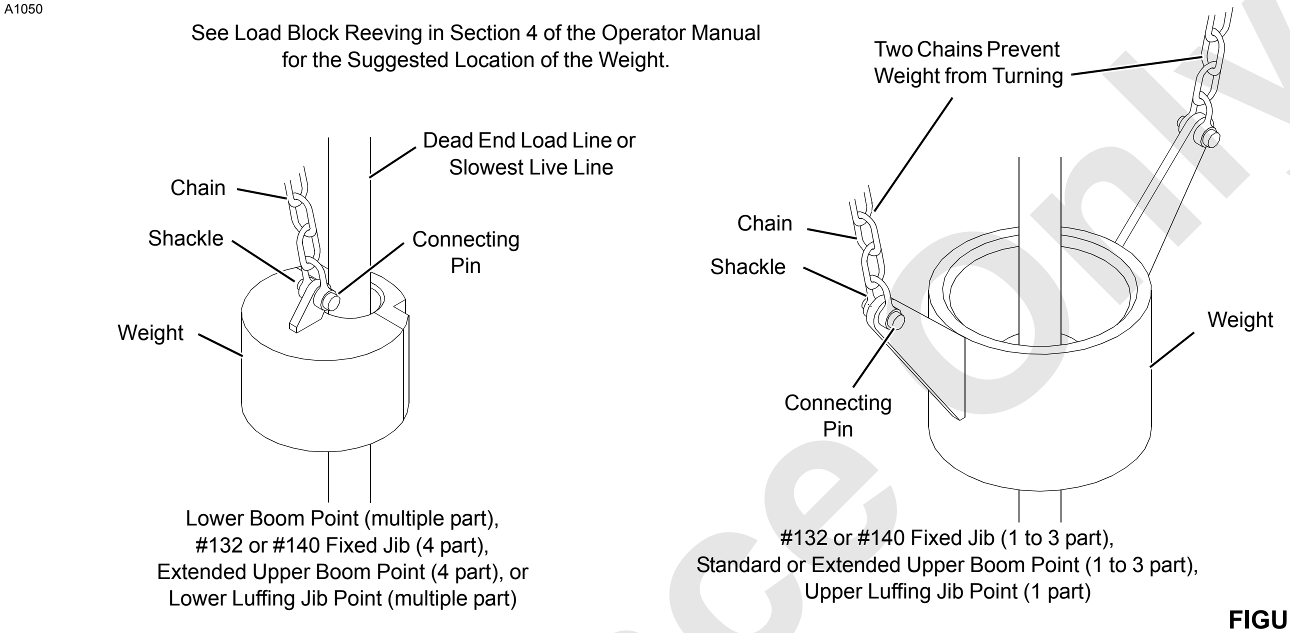


FIGURE 5-3

Storing the Electrical Cords

See Figure 5-4 for the following.

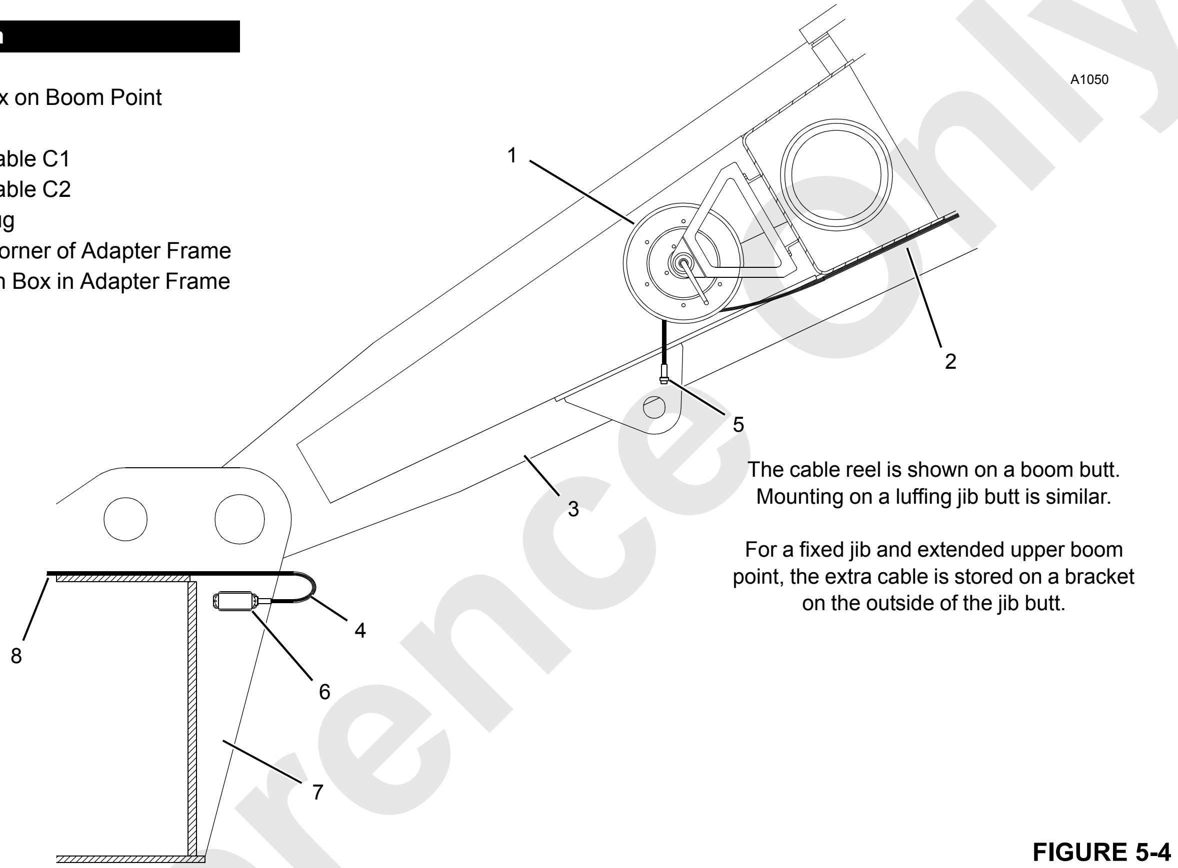
The electrical cords for the boom, fixed jib, and luffing jib are long enough to accommodate the maximum length of each attachment.

Store the excess cord for the boom and luffing jib on the cable reel (1) mounted on the boom butt (3) or luffing jib butt.

Disengage the cable reel locking pin to allow the reel to be wound. Engage the locking pin to lock the reel in position. The power supply cord to the reel must be disconnected before the reel can be wound.

Store the excess electrical cord for the #132 fixed jib, #140 fixed jib, or extended upper boom point by winding the cable around the brackets on the jib butt.

Item	Description
1	Cable Reel
2	Junction Box on Boom Point
3	Boom Butt
4	Electrical Cable C1
5	Electrical Cable C2
6	Shorting Plug
7	Left Front Corner of Adapter Frame
8	Top Junction Box in Adapter Frame



The cable reel is shown on a boom butt. Mounting on a luffing jib butt is similar.

For a fixed jib and extended upper boom point, the extra cable is stored on a bracket on the outside of the jib butt.

FIGURE 5-4

Disconnecting the Block-Up Limit Control

See Figure 5-4 for the following.

A shorting plug (6) is provided on the left front corner of the adapter frame (7) so the block-up limit system can be disconnected for the following reasons:

- Crane setup and rigging
- Maintenance
- Operations not requiring the use of a block-up limit control (clamshell and dragline)

To disconnect the block-up limit system, proceed as follows.

1. Disconnect electrical cable C1 (4) from the cable reel (1).
2. Remove the closure cap from the shorting plug.
3. Connect electrical cable C2 (5) to the shorting plug.
4. Reverse the steps to reconnect the block-up limit control.

Removing the Jib or Boom Point

For identification of junction boxes, electrical cords, and shorting plugs, see the Block-Up Limit Control Assembly drawing.

The junction boxes on the boom and jib points are equipped with shorting plugs.

If the fixed jib point, upper boom point, or luffing jib point has a block-up limit switch, the electrical cord from the limit switch must be connected to the proper shorting plug when the corresponding attachment is removed. Failing to perform this step prevents the load drum from hoisting and the boom from lowering. Also, the operating limit alert comes on.

Reconnect the electrical cord to the proper block-up limit switch when the corresponding attachment is reinstalled.

Maintenance

Inspect and test the block-up limit control weekly or every 40 hours of operation as follows.

NOTE: Do not operate the crane until cause for improper operation and all hazardous conditions have been found and corrected.

1. Lower the boom onto blocking at ground level and carefully inspect the following items:
   - Inspect each limit switch lever and actuating lever for freedom of movement. Apply a one-half shot of grease to the fitting on the actuating lever. Wipe away any excess grease.
   - Inspect each weight for freedom of movement on the load line.
   - Inspect each weight, chain, shackle and connecting pin for excessive or abnormal wear. Make sure the cotter pins for the shackles are installed and spread.
   - Inspect the entire length of the electrical cords for damage.
   - Make sure the electrical cords are clear of all moving parts and that the cords are securely fastened to the boom and jib with metal straps.
   - Verify that all plugs are securely fastened.
2. Test the block-up limit control for proper operation using either of the following methods:
   - Boom lowered—Manually lift each weight, one at a time, with the engine running. The load drum should not operate in the HOIST direction, and the boom hoist should not operate in the LOWER direction.
   - Boom raised—Slowly hoist each load block and weight ball, one at a time, against the weight. When the chain goes slack, the corresponding load drum should stop hoisting and the boom hoist should not operate in the LOWER direction.

WARNING

Two Blocking Hazard!

Two blocking can result in failure of sheaves and wire rope, possibly causing the load to fall, resulting in death or serious injury.

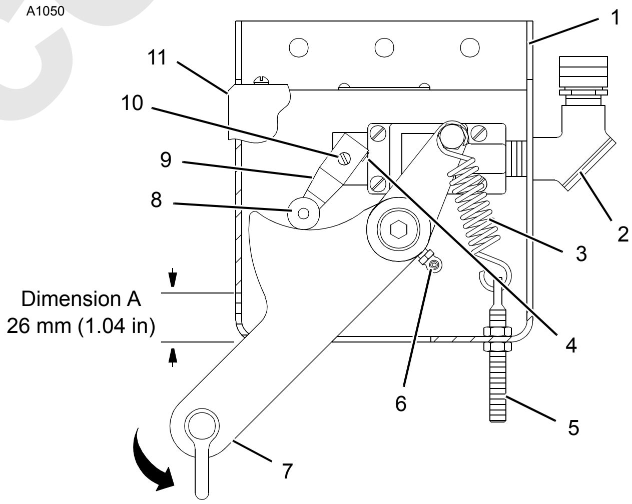
If the block-up limit control fails to stop the load, immediately stop the load by moving the drum control handle to the OFF position or by applying the drum working brake to prevent two blocking.

Adjustment

See Figure 5-5 for the following procedure.

Lower the boom onto blocking at ground level and adjust each limit switch as follows.

1. Adjust the spring (3) tension so there is enough force to lift the weight of the chain and rotate the actuating lever (7) when the weight is lifted.
2. Loosen the set screw (4) in the limit switch lever (9) so the lever is free to rotate.
3. Manually lift the weight to allow the actuating lever to rotate upward.
4. Hold the lever at Dimension A.
5. Hold the roller (8) on the limit switch lever against the actuating lever while performing step 6.
6. Turn the limit switch shaft (10) clockwise only enough for the limit switch to click open and hold it. Then securely tighten the set screw in the limit switch lever.
7. Test the limit switch for proper operation (see Maintenance). Repeat the adjustment steps until the limit switch operates properly.



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

FIGURE 5-5

INSPECTING AND ADJUSTING THE DRUM BRAKE

Description

Each drum brake consists of an external, contracting band-type brake and two actuators. On single drum shafts, the brake is mounted on the left end of the drum. On split drum shafts, a brake is mounted on the outboard end of both drums. An independent drum drive has two brakes, one mounted on the left end of the drum shaft and the other mounted on the right end.

Each actuator has two chambers that provide two separate braking systems for each load drum as follows:

- The spring chamber provides a spring-applied, air-released park brake. In the full power mode, the load drum control automatically applies and releases the park brake.
- Only one service chamber is used. It provides an air-applied, spring-released working brake. Braking control is variable, from fully applied to fully released, through the use of a treadle valve.

The operator must be seated and the engine must be running to operate the drum controls and park brakes during inspection, adjustment, and overhaul procedures. The drums are automatically parked and the handles are inoperable when the operator is out of the seat or the engine is off.

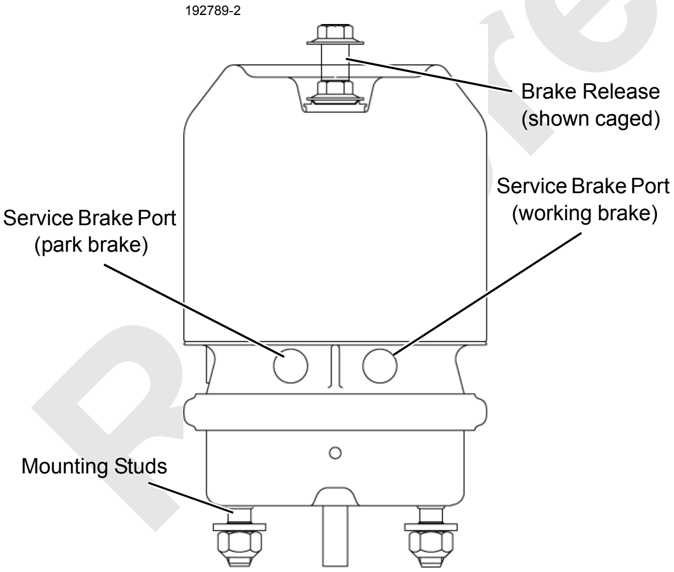


FIGURE 5-6

Inspecting and Adjusting the Brake

CAUTION

Moving Machinery Hazard!

It is necessary to rotate the load drum and apply and release the drum park brake during inspection, adjustment, and overhaul procedures. This creates a condition in which, if care is not exercised, minor injury or equipment damage may occur.

Drum brake inspection, adjustment, and overhaul requires two people—one to operate the drum and brake controls and one to perform the inspection, adjustment, and overhaul procedures. Maintain constant communication between the adjuster and operator so the drum and brake are not operated while the adjuster is in contact with moving parts.

Lower the load block or weight ball onto the ground so the wire rope is slack on the drum being serviced.

- The adjuster shall stay clear of all moving parts while the drum and brake are being operated.
- The operator shall not operate the drum or brake controls until the adjuster is clear of moving parts.

---

1. Inspect all pins and linkage for excessive wear. Replace parts as required. Worn pins and linkage make it difficult to obtain the proper drum-to-lining clearance.
2. Lubricate the pins in the linkage with a few drops of engine oil. Lubricate the grease fittings. See Lubrication Section 9 for more information.
3. Check the linings for excessive wear. Linings normally wear faster at the dead end of the brake band. Check this area first.

   The brake lining is 12 mm (1/2 in) thick when new. Replace the lining when the thinnest area has worn to 5 mm (7/32 in) thick.

WARNING

Falling Load Hazard!

Aftermarket brake linings may not provide the proper brake torque. The brake could slip, allowing the load to drop, resulting in death or serious injury.

Only use Manitowoc Cranes original equipment linings.

---

4. Thoroughly inspect the brake bands for cracks and corrosion when the bands are removed. This procedure also applies to band assemblies that are received in exchange for bands that were removed for relining.

The inspection method must include nondestructive testing—magnetic particle (MT) or ultrasound (UT).

The primary area to inspect is the dead-end attachment area on the band (Figure 5-7).

If there is evidence of cracks or a 10% reduction in the area due to corrosion, destroy and discard the band and replace it with a new band or a band that has passed nondestructive testing/inspection. Contact your Manitowoc Cranes dealer for brake band thickness. Have the band part number available at the time of the request.

5. Perform treadle valve checks and make necessary adjustments.

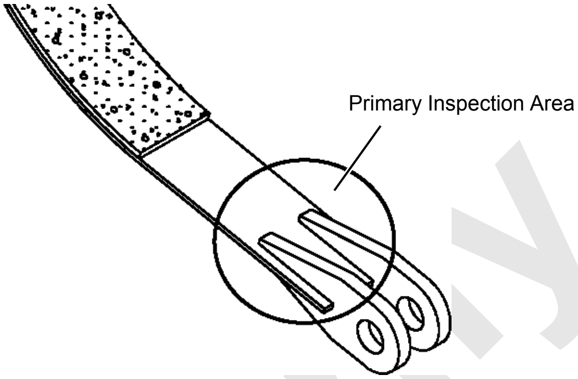


FIGURE 5-7

See Figure 5-8 for the remaining steps.

6. Check each brake band (6) for proper adjustment as follows.

NOTE: Check the band adjustment when the linings (7) are cold for lift-crane work or warm for duty-cycle work.

a. Lower the load block, weight ball, or bucket to the ground so the wire rope is slack on the drum being serviced.

b. If equipped with three drums, use the drum selector to select the desired rear drum, right or left.

c. Turn on Free Fall for the drum being serviced.

d. Release the drum working brake (brake pedal up fully).

e. Turn on the drum park for the drum being serviced. The drum park brake will spring apply.

f. Measure the distance from the bottom of the actuator (9) to the top of the rod end (17) as shown in View A.

Check for the following dimension:

- The dimension must be 51 to 63 mm (2 to 2-1/2 in).

g. Readjust the brake when 63 mm (2-1/2 in) is reached.

If the proper dimension is not obtained, turn off the drum park to release the brake for the drum being serviced.

h. Tighten the band adjusting nut (5) one to two flats at a time.

i. Repeat step 6f through step 6h until the proper dimension is obtained.

j. Turn off the drum park for the drum being serviced. The drum park brake will release.

k. Check for clearance between the brake lining and drum flange as follows:

- Grasp the brake band at the band adjusting nut. The band should move back and forth freely by hand.
- As a further check, the drum should turn freely when the load line is pulled by hand (clutch and park brake released). If the drum does not turn freely by hand and the band is loose, the clutch may not be releasing. See Inspecting and Adjusting the Drum Clutch—Standard on page 5-16.
- If necessary, loosen the jam nut (3) at the band supports (2). Turn the adjusting nuts (3) in the required direction to provide clearance between the lining and drum flange. Securely tighten the jam nuts to lock the adjustment.

l. For an independent drum drive, repeat step 6d through step 6k for the brake on the opposite side.

The dimension measured in step 6f must be identical for each brake on the drum to provide balanced braking.

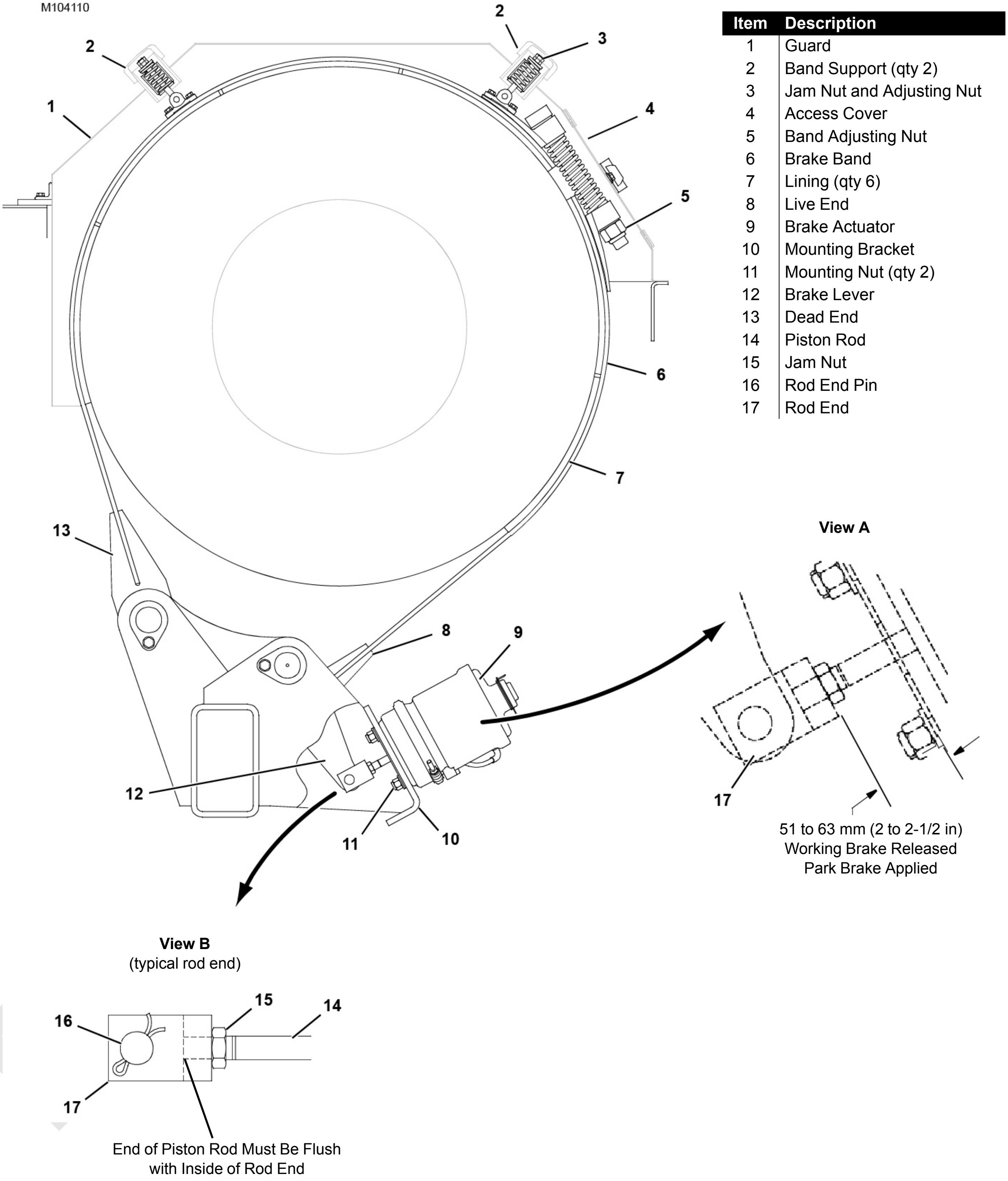
7. Band adjustment is now complete. Select and confirm the desired operating mode.

CAUTION

Drum Flange Damage!

If the brake lining rubs against the drum flange when the brake is release, the lining will overheat, possibly resulting in cracks in the drum flange.

After adjustment procedures, make sure the brake lining does not rub on the drum flange.



Item	Description
1	Guard
2	Band Support (qty 2)
3	Jam Nut and Adjusting Nut
4	Access Cover
5	Band Adjusting Nut
6	Brake Band
7	Lining (qty 6)
8	Live End
9	Brake Actuator
10	Mounting Bracket
11	Mounting Nut (qty 2)
12	Brake Lever
13	Dead End
14	Piston Rod
15	Jam Nut
16	Rod End Pin
17	Rod End

View A

51 to 63 mm (2 to 2-1/2 in)
Working Brake Released
Park Brake Applied

View B
(typical rod end)

End of Piston Rod Must Be Flush
with Inside of Rod End

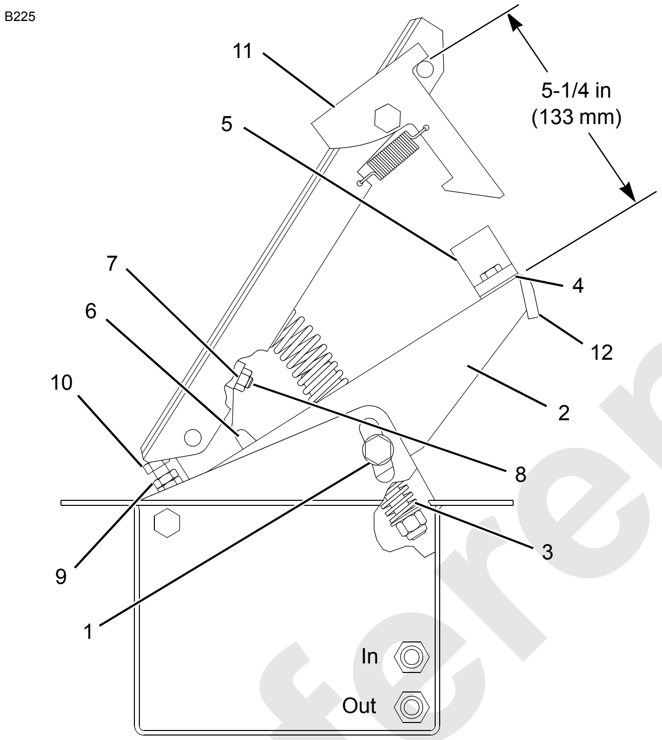
Left Rear Drum Brake
(all other drum brakes similar)

FIGURE 5-8

Checking the Treadle Valve

See Figure 5-9 for the following procedure.

1. Check the pedal latch (11) and latch bar (12) for wear. The pedal latch must hold the pedal down in the fully applied position.
2. Connect a 0 to 10,3 bar (0 to150 psi) air pressure gauge to the In and Out ports of the valve (6) and observe the following:
   - Air pressure at the In port should be 8,3 to 9,1 bar (120 to 132 psi).
   - Air pressure at the Out port should modulate from 0 to 5,2 bar (0 to 75 psi) as the pedal is slowly depressed and then go to 8,3 to 9,1 bar (120 to 132 psi).



Item	Description	Item	Description
1	Capscrew (qty 4)	7	Jam Nut
2	Valve Support	8	Set Screw
3	Spring	9	Jam Nut
4	Shim (qty varies)	10	Screw
5	Bumper	11	Pedal Latch
6	Valve	12	Latch Bar

FIGURE 5-9

Adjusting the Treadle Valve

See Figure 5-9 for the following procedure.

1. Lower the load for the treadle valve being adjusted to the ground so the load line is slack.
2. Adjust the pedal to the desired height as follows.
   a. Latch the pedal down.
   b. Loosen the four capscrews (1).
   c. Move the valve support (2) to the desired height.
   d. Securely tighten the capscrews.
3. Adjust the spring (3) for a 73 mm (2-7/8 in) preload.
4. Install shims (4) under the bumper (5) so the pedal compresses the bumper 0,8 mm (1/32 in) when the pedal is latched.
5. Adjust the valve (6) as follows.
   a. Release the brake pedal to the fully raised position.
   b. Connect a 0 to 10,3 bar (0 to 150 psi) air pressure gauge to the Out port between the valve and the actuator.
   c. Depress the pedal so it is approximately 0,8 mm (1/32 in) from touching the bumper. The gauge should read 7,9 to 8,6 bar (115 to 125 psi).

      Do not set the pressure higher than 8,6 bar (125 psi).
   d. If required, loosen the jam nut (7) and tighten the set screw (8) to increase the pressure. Loosen the set screw to decrease the pressure. Securely tighten the jam nut to lock the adjustment.
   e. Release the brake pedal to the fully raised position. The gauge should read 0 bar (0 psi). If required, loosen the jam nut (9) and turn the screw (10) in until the pressure is 0 bar (0 psi). Securely tighten the jam nut to lock the adjustment.
   f. Remove the gauge.
   g. Repair or replace the valve if the correct pressures cannot be obtained.

Overhauling the Brake Actuator

⚠ WARNING

Personal Injury Hazard!

The actuator is spring-loaded and will fly apart with dangerous force if not disassembled correctly.

Do not attempt to disassemble the actuator while it is on the crane. See the instructions in the manufacturer's service manual for proper disassembly of the actuator.

Removal

See Figure 5-8 for the following procedure.

1. Lower the load block, weight ball, or bucket to the ground so the wire rope is slack on the drum being serviced.
2. If equipped with three drums, use the drum selector to select the desired rear drum, right or left.
3. Fully release the drum working brake (brake pedal up fully).
4. Turn on Free Fall and turn off the drum park for the drum being serviced. The drum park brake will release.
5. Using an appropriate wrench, turn the release bolt counterclockwise 22 to 23 turns to cage the power spring in the brake actuator (9).
6. Stand clear of the actuator. Turn on the drum park for the drum being serviced. The park brake will spring apply. The piston rod (14) may extend slightly when this step is performed.
7. Tag the air lines for proper identification when reinstalling the actuator.
8. Disconnect the air lines from the actuator.
9. Remove the rod end pin (16) to disconnect the rod end (17) from the brake lever (12).
10. Remove the mounting nuts (11) and remove the actuator from the mounting bracket (10). The actuator weighs approximately 14 kg (30 lb).

Repair

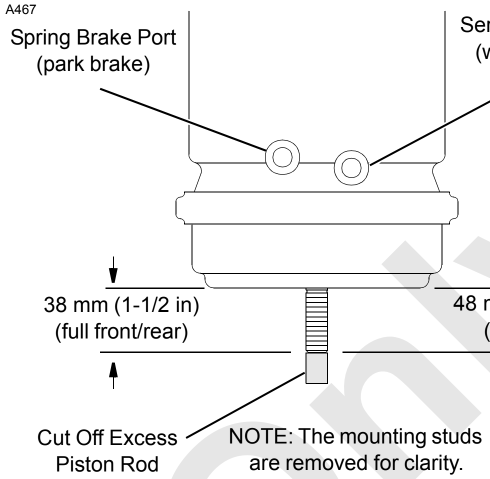
Follow the instructions in the manufacturer's service manual to properly repair the actuator.

Rework

See Figure 5-10 for the following procedure.

Before installing a new or rebuilt actuator, rework it according to the following steps.

1. Remove the jam nut from the piston rod end.
2. Turn the spring brake release bolt clockwise until tight and tighten it to 100 Nm (74 lb-ft).
3. Apply at least 6,2 bar (90 psi) of air pressure to the spring brake port of the actuator.
4. As shown, cut off the piston rod at 48 mm (1-7/8 in) for standard actuators and 38 mm (1-1/2 in) for clamshell drum actuators.
5. With air still applied to the actuator, perform step 5 under Removal to cage the power spring in the actuator.
6. Exhaust the air from the actuator.



NOTE: The mounting studs are removed for clarity.

FIGURE 5-10

Installation

See Figure 5-8 for the following procedure.

1. Rework the actuator. See Rework.
2. Install the jam nut (15) and rod end (17) on the piston rod (14) (see View B). The end of the piston rod must be flush with the inside of the rod end. Tighten the jam nut against the rod end.
3. Connect a quick-release valve to the spring brake port of the brake actuator (9).
4. Attach the actuator to the mounting bracket (10) with the two flat washers and two mounting nuts (11). Tighten the nuts to 180 to 210 Nm (133 to 155 lb-ft).

See Figure 5-10 for the remaining steps.

5. Connect the air lines to the proper ports of the actuator as follows.
    - **a.** Connect the air line from the working brake treadle valve to the service brake port.

      The inboard actuator has a nut bushing and breather installed in place of the air line.
    - **b.** Connect the air line from the park brake control valve to the spring brake port.
6. Pin the rod end to the brake lever.
7. Stand clear of the actuator and turn off the drum park to release the park brake for the drum being serviced.
8. Using an appropriate wrench, turn the release bolt clockwise until tight to uncage the power spring in the actuator. Tighten the release bolt to 100 Nm (74 lb-ft).
9. Turn on the drum park to apply the park brake for the drum being serviced.
10. Check the brake for proper operation and adjustment.

Adjusting the Brake Release

Perform the following adjustment only if a new or rebuilt actuator or regulator has been installed or if a new lining or band has been installed.

NOTE: The corresponding drum brake must be properly adjusted before performing this adjustment.

1. Lower the load block, weight ball, or bucket to the ground so the wire rope is slack on the drum being serviced.
2. If equipped with three drums, use the drum selector to select the desired rear drum, right or left.
3. Fully release the drum working brake (brake pedal up fully).
4. Turn on Free Fall and turn off the drum park for the drum being serviced. The drum park brake will release.
5. Push in the regulator adjusting knob (Figure 5-12) for the brake being adjusted.
6. Turn the knob clockwise to increase pressure or counterclockwise to decrease pressure until the gauge reads 4,8 bar (70 psi) as viewed from the knob end. This is the initial setting only.
7. Adjust the regulator until the distance from the bottom of the actuator to the top of the rod end is 25,4 mm (1.0 in) (Figure 5-11).
8. If the proper dimension is not obtained, turn the regulator knob clockwise to decrease the dimension or counterclockwise to increase the dimension (directions viewed from knob end).
9. Pull out the knob to lock the regulator setting when the proper dimension is obtained.

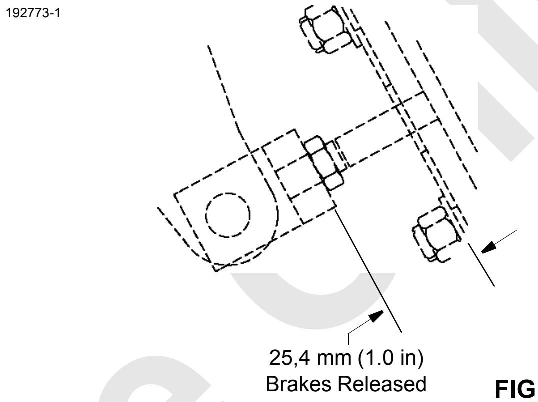
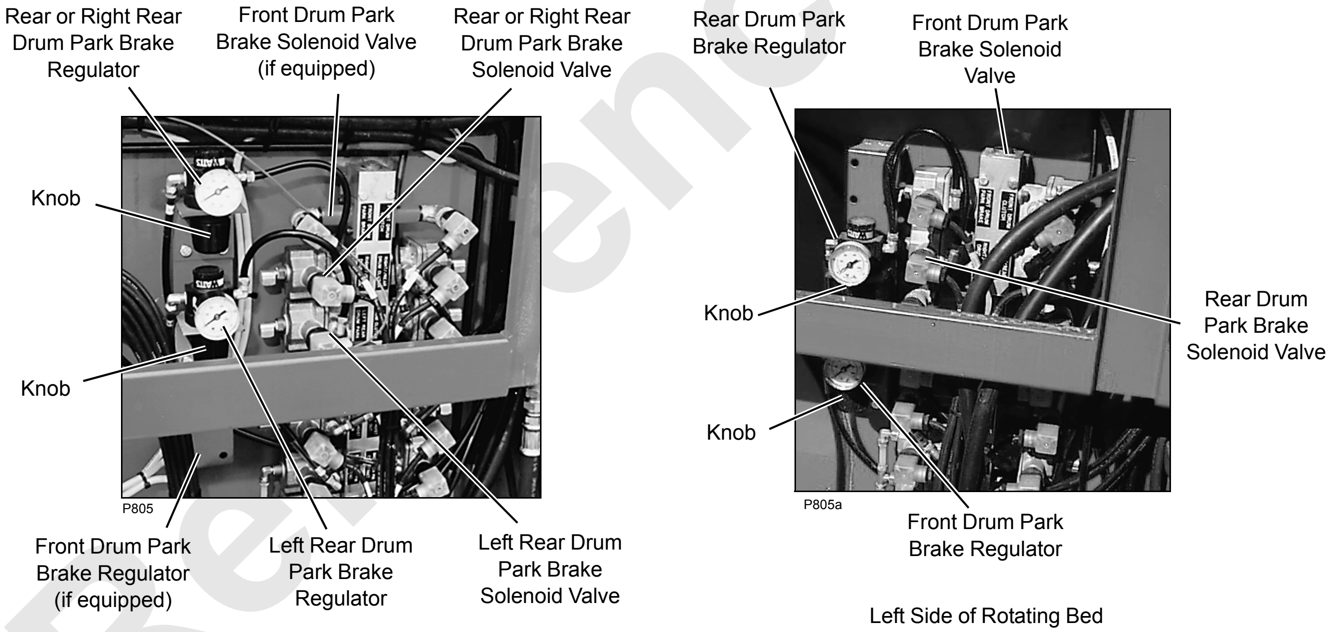


FIGURE 5-11



Left Side of Rotating Bed

Left Side of Rotating Bed (with independent drum drive)

FIGURE 5-12

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INSPECTING AND ADJUSTING THE DRUM CLUTCH—STANDARD

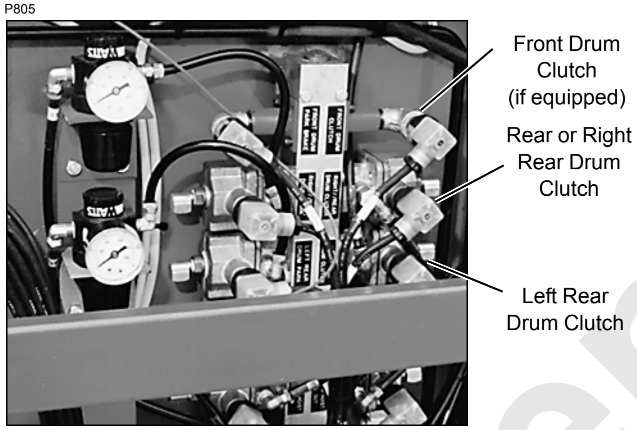
Description

See Figure 5-13 for the following.

The drum clutch is an internal, expanding band-type clutch that is spring-applied and air-released.

On a single drum shaft, the clutch is mounted on the left end of the drum. On a split drum shaft, a clutch is mounted on the outboard end of both drums. Each drum clutch is controlled by a two-position (on/off) normally closed solenoid valve located on the left side of the rotating bed.

A clutch access hole with a removable cover is provided in the guard over each drum brake and clutch. Make all inspections and adjustments when the clutch linings are cold.



Solenoid Valves on Left Side of Rotating Bed

FIGURE 5-13

Inspection and Adjustment

CAUTION

Moving Machinery Hazard!

It is necessary to rotate the load drum and apply/release the drum clutch during inspection, adjustment, and overhaul procedures. This creates a condition in which, if care is not exercised, minor injury or equipment damage may occur.

Drum clutch inspection, adjustment, and overhaul requires two people—one to operate the drum and brake controls and one to perform the inspection, adjustment, and overhaul procedures. Maintain constant communication between the adjuster and operator so the drum and brake are not operated while the adjuster is in contact with moving parts.

Lower the load block or weight ball onto the ground so the wire rope is slack on the drum being serviced.

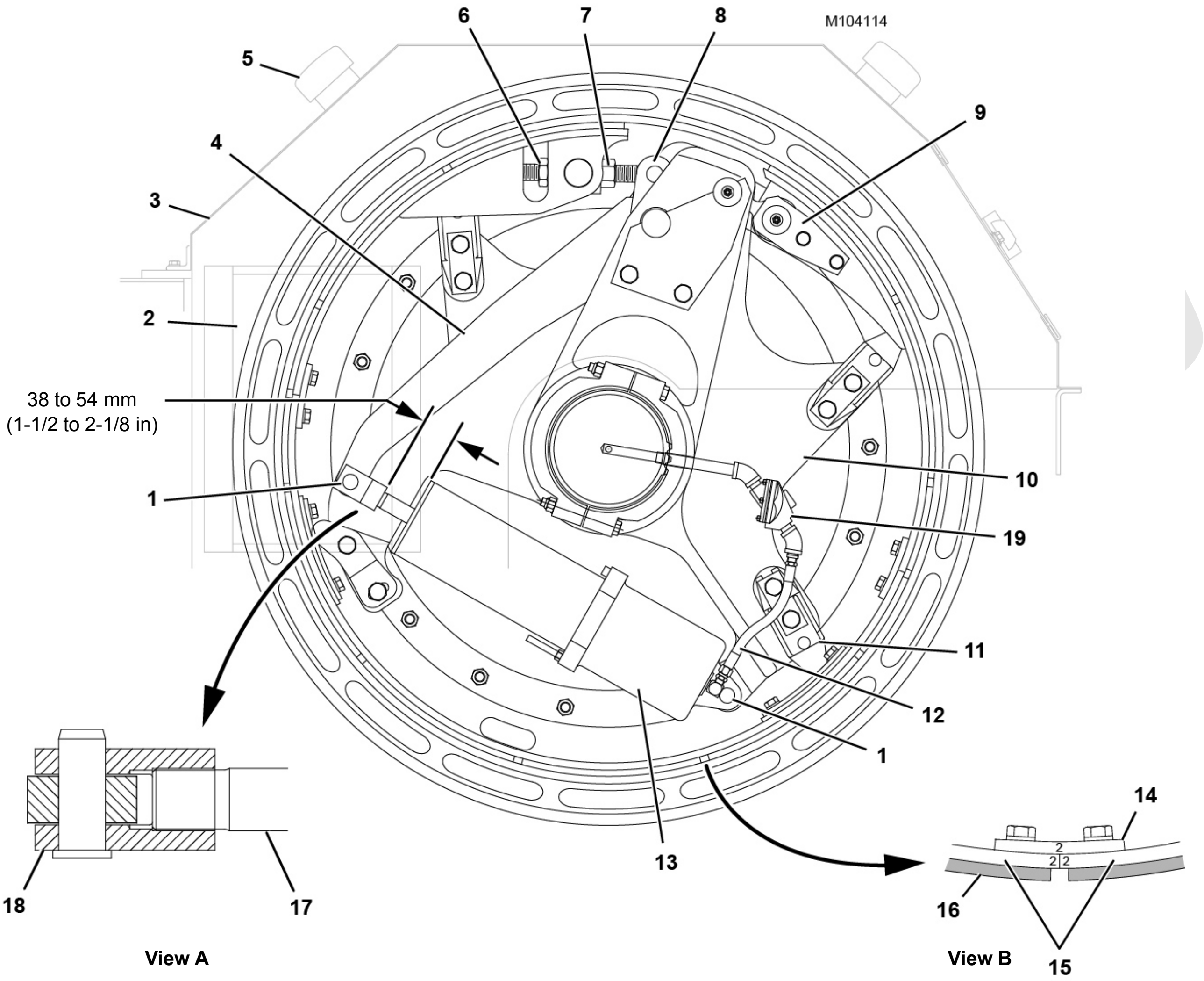
- The adjuster shall stay clear of all moving parts while the load drum and clutch are being operated.
- The operator shall not operate the drum controls until the adjuster is clear of moving parts.

See Figure 5-14 for the following procedure.

Make sure the air system pressure is 8,3 to 9,1 bar (120 to 132 psi) at all times during the inspection and adjustment procedure.

1. Lower the load block or weight ball to the ground so the wire rope is slack on the drum being serviced.
2. Select Standard mode and confirm.
3. To position the clutch parts in the access hole during the inspection and adjustment steps, proceed as follows.
   a. Remove the cover from over the access hole (2).
   b. Stand clear of the clutch while the drum is turning.
   c. Move the drum handle for the clutch being serviced in either direction from the OFF position to turn the clutch and drum.
   d. When the desired part is accessible through the access hole, have the adjuster signal the operator to release the drum handle to the OFF position to stop the clutch and drum.
4. Position the live end of the clutch band in the access hole and inspect the lining (16) wear.

   The clutch lining is 10 mm (3/8 in) thick when new. Replace the lining before its thickness is less than 6 mm (1/4 in), or the lining rivets will score the drum.



WARNING

Falling Load Hazard!

The cylinder rod can back out of the rod end during operation, and the load could drop, resulting in death or serious injury.

Apply Loctite #243 to the threads of the rod end before assembly.

Item	Description	Item	Description
1	Rod End Pin (qty 2)	11	Band Guide (qty 4)
2	Access Hole	12	Air Line
3	Guard	13	Air Cylinder
4	Clutch Lever	14	Connecting Plate
5	Brake Band Support (qty 2)	15	Band Section (qty 2)
6	Jam Nut	16	Lining
7	Adjusting Nut	17	Cylinder Rod
8	Live End	18	Rod End
9	Dead End	19	Quick-Release Valve
10	Clutch Spider		

FIGURE 5-14

WARNING

Falling Load Hazard!

Aftermarket clutch linings may not provide the proper clutch torque. The clutch could slip, allowing the load to drop, resulting in death or serious injury.

Only use Manitowoc Cranes original equipment linings.

5. Inspect all pins and linkage for excessive wear and replace parts as required. Excessively worn pins and linkage make it difficult to properly adjust the clutches.
6. Lubricate the clutch linkage. See Lubrication Section 9 for more information.
7. Position the rod end (18) of the air cylinder (13) in the access hole.

   The dimension between the end of the cylinder and the rod end must be 38 to 54 mm (1-1/2 to 2-1/4 in). Proceed as follows:

   - If the dimension is within the specified range, no further adjustment is required. Go to step 10.
   - Perform step 8 through step 10 when the minimum dimension is reached.
8. When the dimension reaches 38 mm (1-1/2 in), proceed as follows.
   a. Position the adjusting nut (7) in the access hole.
   b. Loosen the jam nut (6) several turns.
   c. Release the clutch. See the procedure in Table 5-1.
   d. Tighten the adjusting nut as required. Turning the adjusting nut one flat moves the cylinder rod (17) out approximately 14 mm (9/16 in).
   e. Apply the clutch. See the procedure in Table 5-1.
   f. Repeat step 7 and step 8a through step 8e until the dimension is 54 mm (2-1/8 in).
   g. Repeat step 8a and securely tighten the jam nut to lock the adjustment.
9. Adjust each band guide (11) as follows.
   a. Position the band guide in the access hole.
   b. With the clutch applied, check the clearance between the band guide and clutch band with a feeler gauge. Clearance should be 1 mm (1/32 in).
   c. If necessary, loosen the mounting screws and reposition the band guide to obtain the specified clearance. Then securely tighten the mounting screws.
10. Reinstall the cover over the access hole.

Table 5-1. Clutch Inspection

Clutch Being Adjusted	To Release Clutch	To Apply Clutch
Three Drum Configuration		
Left Rear Select Left with Rear Drum Selector Switch	Pull back the front drum handle.	Pull back the rear drum handle.
Right Rear Select Right with Rear Drum Selector Switch	Pull back the front drum handle.	Pull back the rear drum handle.
Front	Pull back the rear drum handle.	Pull back the front drum handle.
Two Drum Split Rear Configuration		
Left Rear	Pull back the right drum handle.	Pull back the left drum handle.
Right Rear	Pull back the left drum handle.	Pull back the right drum handle.
Two Drum Independent Configuration		
Front	Pull back the rear drum handle.	Pull back the front drum handle.
Rear	Pull back the front drum handle.	Pull back the rear drum handle.

NOTE: Pull back the specified handle only enough to release and apply the clutch without turning the drum. Listen for exhausting air from the air cylinder. Air exhausts from the cylinder on the clutch being serviced when the clutch applies. Air exhausts from the cylinder on the opposite clutch when the clutch being serviced releases.

Band Disassembly and Assembly Notes

See Figure 5-14 for the following.

Each clutch band consists of two segments fastened together with a connecting plate and capscrews (see View B). This arrangement makes the band easier to disassemble.

When reassembling a clutch band, match the numbers stamped on each end of the band segments with the number stamped on the connecting plate for proper assembly.

NOTE: Using band segments from different drums may make assembly difficult.

Do not mix band segments from one drum with those from another drum. Always keep band segments in a matched set.

Overhauling the Clutch Cylinder

WARNING

Personal Injury Hazard!

The clutch cylinder is spring-loaded and will fly apart with dangerous force if not disassembled correctly.

Disassemble the cylinder according to the following instructions.

Removing the Cylinder

See Figure 5-14 for the following procedure.

1. Read the precautionary steps given in Inspection and Adjustment on page 5-16.
2. Remove the guard (3) covering the brake flange and clutch assembly.

   To remove the guard, it is necessary to remove the nuts retaining the brake band supports (5).
3. Rotate the air cylinder (13) to its most accessible position.
4. Release the clutch. See the procedure in .
5. Support the rod end (18) of the cylinder and remove the rod end pin (1).
6. Stand clear of the cylinder and apply the clutch (cylinder rod (17) will retract). See the procedure in .
7. Disconnect the air line (12) from the end of the cylinder.
8. Remove the head end pin and remove the cylinder from the crane. The cylinder weighs approximately 32 kg (70 lb).

Disassembling the Cylinder

See Figure 5-15 for the following procedure.

1. Remove the four socket head capscrews (1).
2. Working in a crisscross manner, alternately loosen the nuts (2) on the threaded rods (3) until the bonnet (4) is removed from the cylinder (5). Make sure the threaded rods do not back out when loosening the nuts.
3. Disassemble the cylinder using the illustration as a guide.

Assembling the Cylinder

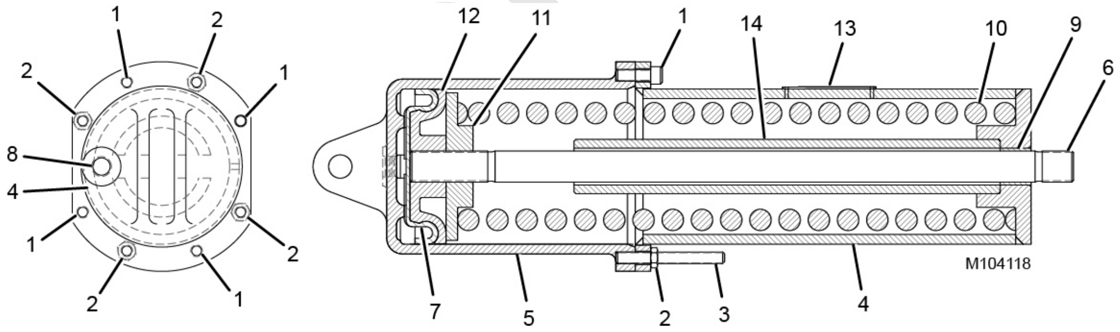
See Figure 5-15 for the following procedure.

1. Apply Loctite #263 to the exposed threads of the threaded rods (3) and apply Loctite #243 to the threads of the socket head capscrews (1).
2. Lubricate all parts with a light coat of air cylinder grease.
3. Assemble the cylinder (5) and observe the following precautions:
   - The piston rod (6) must be flush with the back edge of the piston (12).
   - The packing cup (7) must be snug against the back side of the piston.
   - The vent hole in the bonnet (4) must be positioned 180° from the air inlet hole (8) in the cylinder.
4. Align the holes in the bonnet with the threaded rods and install the nuts (2).
5. Working in a crisscross manner, alternately tighten the nuts on the threaded rods until the bonnet flange is tight against the cylinder flange.
6. Securely install the four socket head capscrews.

Installing the Cylinder

See Figure 5-14 for the following procedure.

1. Pin the air cylinder (13) to the clutch spider (10) so the air inlet port is toward the outside. Make sure to install the cotter pin.
2. Connect the air line (12) to the cylinder.
3. Block the cylinder in position.
4. Stand clear of the clutch and release the clutch. The cylinder rod (17) will extend. See the procedure in Table 5-1.
5. Pin the cylinder rod to the clutch lever (4). Make sure to install the cotter pin.
6. Apply the clutch. See the procedure in Table 5-1.
7. Adjust the clutch.
8. Install the guard (3) over the drum flange and clutch assembly.
9. Adjust the brake band supports (5) to provide the proper drum-to-lining clearance.



Item	Description	Item	Description
1	Socket Head Capscrew (qty 4)	8	Air Inlet Hole
2	Nut (qty 4)	9	Bushing
3	Threaded Rod (qty 4)	10	Spring
4	Bonnet	11	Spring Guide
5	Cylinder	12	Piston
6	Piston Rod	13	Warning Plate
7	Packing Cup	14	Spacer

FIGURE 5-15

INSPECTING AND ADJUSTING THE DRUM CLUTCH— RIGHT REAR DRUM CLUTCH (421339)

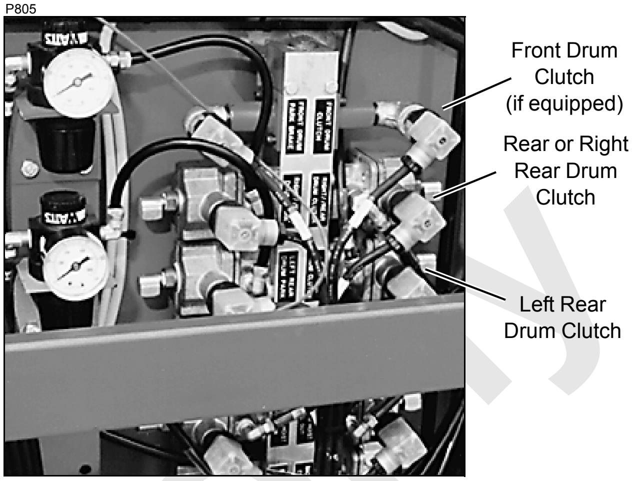
General

See Figure 5-16 for the following procedure.

The right rear drum clutch used for operation in Clamshell mode is an internal, expanding band-type clutch that is air-applied and spring-released. The clutch is mounted on the right end of the drum shaft.

The drum clutch is controlled by a two-position (on/off) normally-open solenoid valve located on the left side of the rotating bed.

A clutch access hole with a removable cover is provided in the guard over the drum brake and clutch. Make all inspections and adjustments when the clutch lining is warm from operation.



Solenoid Valves on
Left Side of Rotating Bed

FIGURE 5-16

Inspection and Adjustment

CAUTION

Moving Machinery Hazard!

It is necessary to rotate the load drum and apply/release the drum clutch during inspection, adjustment, and overhaul steps. This creates a condition in which, if care is not exercised, minor injury or equipment damage may occur.

Drum clutch inspection, adjustment, and overhaul require two people—one to operate the drum controls and one to perform inspection, adjustment, and overhaul steps. Maintain constant communication between the adjuster and operator so the drum is not operated while the adjuster is in contact with parts.

- The adjuster shall stay clear of all moving parts while the load drum and clutch are being operated.
- The operator shall not operate drum controls until the adjuster is clear of moving parts.

Lower the load block or weight ball onto the ground so the wire rope is slack on the drum being serviced.

See Figure 5-17 for the following procedure.

NOTE: Make sure the air system pressure is 8,3 to 9,1 bar (120 to 132 psi) at all times during the inspection and adjustment procedure.

1. Lower the load block or weight ball to the ground. Pay out enough wire rope so the drums can be operated without hoisting the load block or weight ball.
2. Select the right rear drum if not already done.
3. Note the air pressure indicated on the pressure gauge in the right rear console and turn off the pressure regulator.
4. Select Standard mode and confirm.
5. Remove the cover over the access hole (5) at the clutch.
6. Position the right rear drum clutch parts in the access hole for inspection and adjust as follows.
   a. Stand clear of the clutch while the right rear drum is turning.
   b. Move the rear drum handle in either direction from the OFF position to turn the clutch and drum.
   c. When the desired part is accessible through the access hole, signal the operator to release the drum handle to the OFF position to stop the clutch and drum.
7. Position the live end (2) of the clutch band (11) in the access hole and inspect the lining (10) wear.

   The clutch lining is 10 mm (3/8 in) thick when new. Replace the lining before its thickness is less than 6 mm (1/4 in), or the drum will be scored by the lining rivets.

WARNING

Falling Load Hazard!

Aftermarket clutch linings may not provide the proper clutch torque. The clutch could slip, allowing the load to drop, resulting in death or serious injury.

Only use Manitowoc Cranes original equipment linings.

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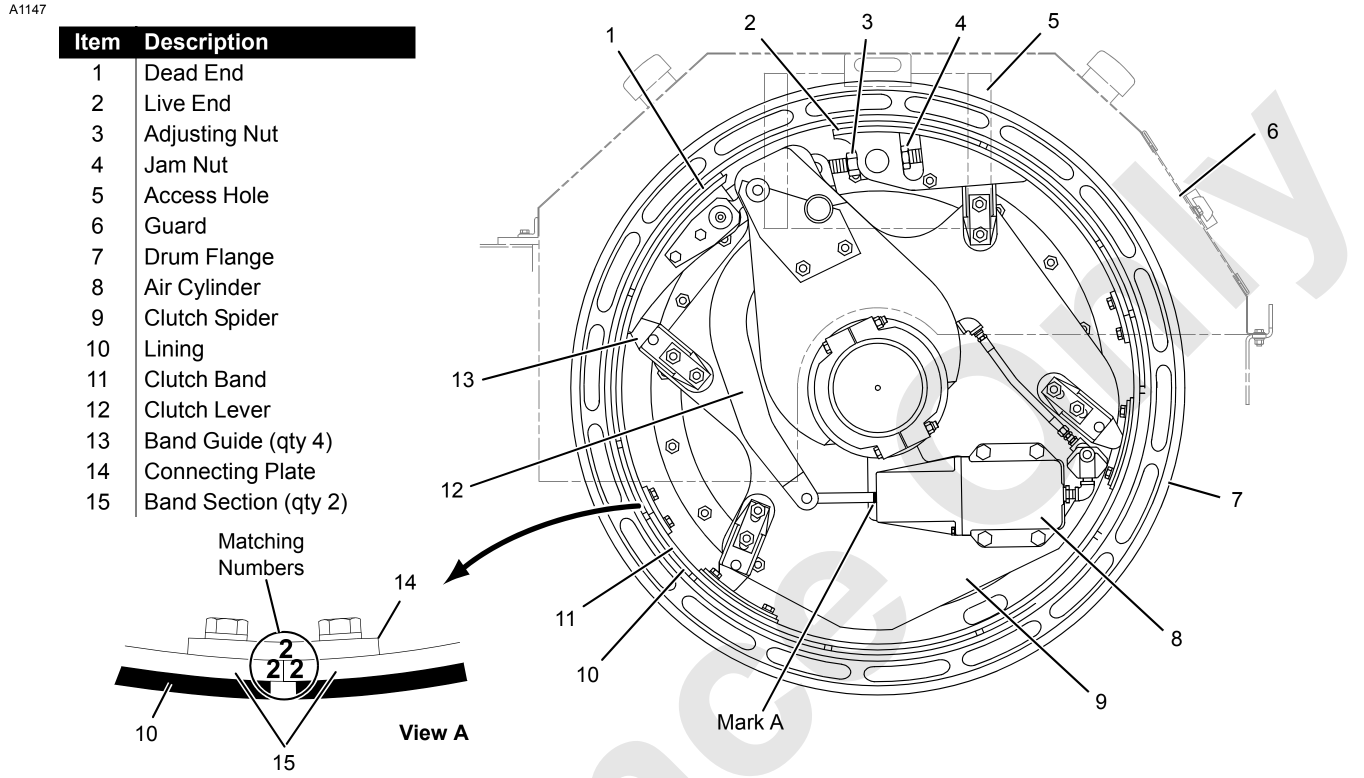
8. Inspect all pins and linkage for excessive wear and replace parts as required. Excessively worn pins and linkage make it difficult to properly adjust the clutches.
9. Lubricate the clutch linkage. See Lubrication Section 9 for more information.
10. Rotate the rear drum clutch so the cylinder rod is in the access hole.

    If Mark A is flush with the end of the air cylinder (8), no further adjustment is required. Proceed to step 12.
11. If Mark A is not flush with the end of the cylinder, continue with the procedure at step 11a.
    a. Rotate the rear drum clutch so the adjusting nut (3) and jam nut (4) are in the access hole.
    b. Loosen the jam nut several turns.
    c. Release the rear drum clutch—pull the front drum handle back until the front drum just starts to turn and stop (this releases the rear drum clutch).
    d. Tighten the adjusting nut as required. Turning the adjusting nut one flat moves the cylinder rod and Mark A approximately 14 mm (9/16 in).
    e. Repeat step 10 and step 11a through step 11d until Mark A is flush with the end of the cylinder.
    f. Repeat step 11a and securely tighten the jam nut to lock the adjustment.
12. Adjust each band guide (13) as follows.
    a. Rotate the rear drum clutch so the band guide is in the access hole.
    b. With the rear drum clutch applied, check the clearance between the band guide and clutch band with a feeler gauge. Clearance should be 1 mm (1/32 in).

c. If necessary, loosen the mounting screws and reposition the band guide to obtain the specified clearance. Securely tighten the mounting screws.

13. Reinstall the cover over the access hole.



Item	Description
1	Dead End
2	Live End
3	Adjusting Nut
4	Jam Nut
5	Access Hole
6	Guard
7	Drum Flange
8	Air Cylinder
9	Clutch Spider
10	Lining
11	Clutch Band
12	Clutch Lever
13	Band Guide (qty 4)
14	Connecting Plate
15	Band Section (qty 2)

FIGURE 5-17

Band Disassembly and Assembly Notes

See Figure 5-17 for the following.

Each clutch band consists of three segments fastened together with a connecting plate (14) and capscrews (see View A).

When reassembling a clutch band, match the numbers stamped on each end of the band sections (15) with the number stamped on the connecting plates.

CAUTION

Component Assembly!

Band segments from different drums may make assembly difficult and cause equipment damage.

Do not mix band segments from one drum with those from another drum. Always keep band segments in a matched set.

Marking the Cylinder Rod

See Figure 5-18 for the following procedure.

If a new cylinder is installed, it must be marked before installation to ensure proper clutch adjustment. A 6,9 bar (100 psi) shop air supply is required.

1. With the cylinder fully retracted, place a temporary mark on the cylinder rod flush with the cylinder body. Use a marker. Do not use a file or hacksaw blade.

   When the rod retracts, the distance from the cylinder end to the cylinder rod hole center is 27 mm (1-1/16 in).

2. Apply air to extend the cylinder so the temporary mark is 10 mm (3/8 in) from the end of the cylinder.
3. Mark the cylinder rod 6 mm (1/4 in) from the end of the cylinder with a file or hacksaw blade (see Mark B).
4. Apply air to fully extend the cylinder rod. Make a second mark on the cylinder rod 76 mm (3 in) down from Mark B (see Mark A).
5. Remove the temporary mark.

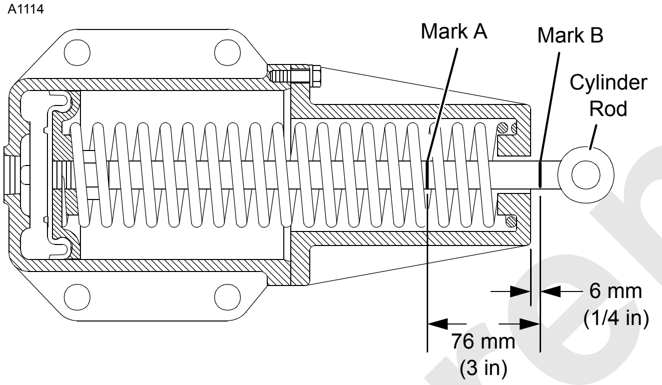
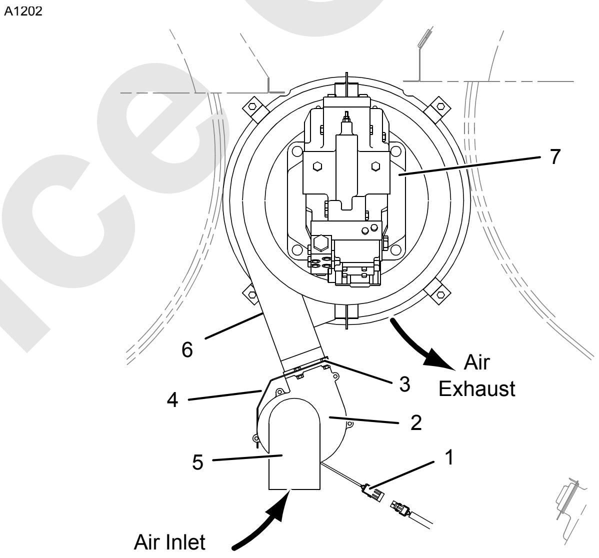


FIGURE 5-18

GEARBOX COOLING BLOWER

See Figure 5-19 for the following procedure.

1. Remove the blower assemblies and thoroughly clean them at the following intervals:
   - Every 200 hours of operation in a humid climate when operating in extremely dusty conditions
   - Every 500 hours of operation under normal operating conditions
2. Disconnect the electrical plug (1) from the plug on the crane.
3. Support the blower (2) so it cannot fall and remove the bolts with nuts and lock washers (3).
4. Remove the blower, guard (4), and inlet elbow (5).
5. Thoroughly clean the inside of the blower using a compressed air jet. Use a putty knife to loosen material as required.
6. Make sure the squirrel cage turns freely.
7. Thoroughly clean the inlet elbow.
8. Make sure the exhaust hole in the shroud (6) is open.
9. Reassemble the guard and blower to the shroud.
10. Clamp the inlet elbow to the blower so the elbow points down.
11. Connect the electrical plug to the plug on the crane.
12. Start the engine and test the blower for proper operation. Air should flow freely from the exhaust hole.



Item	Description
1	Electrical Plug
2	Blower
3	Bolts with Nut and Lock Washer (qty 4)
4	Guard
5	Inlet Elbow
6	Shroud
7	Drum Motor

FIGURE 5-19

ADJUSTING THE SLACK LINE SENSOR

General

See Figure 5-23 for the following procedure.

A laser light sensor mounted on the boom butt wire rope guide (1) detects a slack load line condition at either front or rear drum. The rated capacity limiter (RCL) detects a slack line condition at boom angles of 70 degrees and above if a line pull of one half the calibrated weight ball is reached. In either case, the operator is alerted as follows:

- The operating limit alert comes on (yellow light and buzzer in the operator's cab).
- The SLACK LINE INDICATOR message appears on the display screen.
- The drum is inoperable in the DOWN direction.

To correct a slack line condition, haul in the load line on the affected load drum. The operating limit alert goes off.

At least weekly, check the slack line sensor for correct operation and clean the optical lens of the transmitter (3) and receiver (4). The operating limit alert could be accidentally activated if either lens is dirty.

Adjusting the Light Sensor

See Figure 5-23 for the following procedure.

Lower the boom onto blocking to service the slack line sensor. The transmitter (3) mounted at the sensor junction box (2) is fixed. Make all adjustments at the receiver (4).

1. Stop the crane engine and place the Run/Stop switch in the RUN position.
2. Verify that the transmitter is emitting a light beam.
3. Loosen the adjusting screws and brackets (5) at the receiver.
4. Position the receiver in line with the transmitter light beam by moving the brackets in the slots.

NOTE: The yellow LED on the receiver turns on when the light beam is received by the transmitter.

5. Tighten the screws when the light beam is correct.
6. If the above procedure does not correct the problem, calibrate the slack line indicator.

Calibrating the Slack Line Indicator

To calibrate the slack line indicator, lower all load blocks/weight balls to the ground. Leave a little slack line at the first fall and proceed as follows:

1. Scroll through the diagnostics to the Slack Line Calibration screen.
2. Confirm the screen to begin the calibration process.

SLACK LINE INDICATOR
CONFIRM TO BEGIN

FIGURE 5-20

The screen asks what load sheave is being used, 1 through 4.

SLACK LINE INDICATOR
SHEAVE 1 IN USE? YES

FIGURE 5-21

3. To change an answer, use the Select switch.
4. To verify an answer is correct, press the Confirm switch and move on to the next sheave.

After all four sheaves have been verified (YES or NO), the controller starts to calibrate the load cells.

SLACK LINE INDICATOR
0% COMPLETE

FIGURE 5-22

After the screen counts to 100%, calibration is complete.

Item	Description
1	Boom Butt Wire Rope Guide
2	Sensor Junction Box
3	Transmitter
4	Receiver
5	Adjusting Screw (qty 2) and Bracket

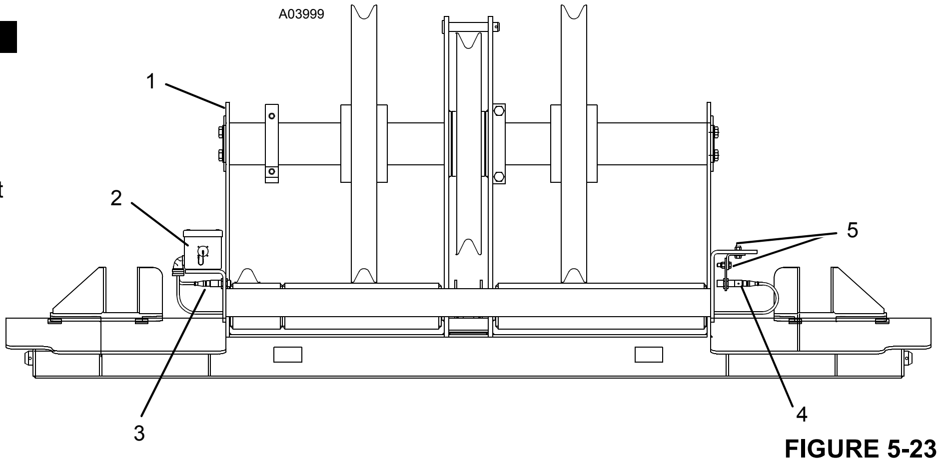


FIGURE 5-23

ADJUSTING THE DRUM PAWL

General

This section applies only to the ratchet and pawl provided on the 1,9 m (73 in) wide front and rear drums.

The pawl limit switches must be properly adjusted to ensure proper operation of the drums.

When either pawl is engaged, the corresponding limit switch closes the electrical circuit to the crane's programmable controller. This action prevents the corresponding drum from being operated in the LOWER direction.

When either pawl is disengaged, the corresponding limit switch opens the electrical circuit to the programmable controller. This action allows the corresponding drum to be operated in the LOWER direction.

If the operator attempts to operate either drum in the LOWER direction with the corresponding pawl engaged, the operating limit alert comes on and PAWL IN appears on the digital display.

⚠ CAUTION

Moving Machinery Hazard!

To make adjustments, the engine must be running and the drum and pawl must be operated. This creates a condition in which, if care is not exercised, minor injury or equipment damage may occur.

Stay clear of the drum and pawl while either is being operated. Maintain constant communication between the operator and the adjuster so the drum and pawl are not operated while the adjuster is in contact with parts.

The pawl limit switches are factory set and do not require periodic adjustment. Either limit switch must be adjusted if parts are replaced and checked if the corresponding drum is not operating properly.

Adjusting the Limit Switch

See Figure 5-24 for the following procedure.

1. Loosen the screw (4) so the lever (3) is free to rotate on the shaft (5).
2. Disengage the corresponding pawl (1). It may be necessary to hoist slightly before the pawl disengages the ratchet (6).
3. Rotate the lever and hold it so the roller (2) is against the pawl.
4. Turn the shaft, not the lever, counterclockwise until the limit switch (7) clicks open, and hold the shaft.
5. Make sure the roller is against the pawl and securely tighten the screw in the lever to lock the adjustment.
6. Check for proper operation as follows.
    a. Engage the pawl and try to operate the drum. The drum should not operate in the LOWER direction.
    b. Disengage the pawl and try to operate the drum. The drum should operate in the LOWER direction.
7. Readjust the limit switch if required.

Return Spring

See Figure 5-24 for the following procedure.

Adjust the eyebolt (12) so the return spring (13) has enough tension to fully engage and hold the pawl (1) against the ratchet (6).

Item	Description
1	Pawl
2	Roller
3	Lever
4	Screw
5	Shaft
6	Ratchet
7	Limit Switch
8	Cylinder
9	Air In Disengage Pawl
10	Air In Engage Pawl
11	Cam
12	Eyebolt
13	Return Spring

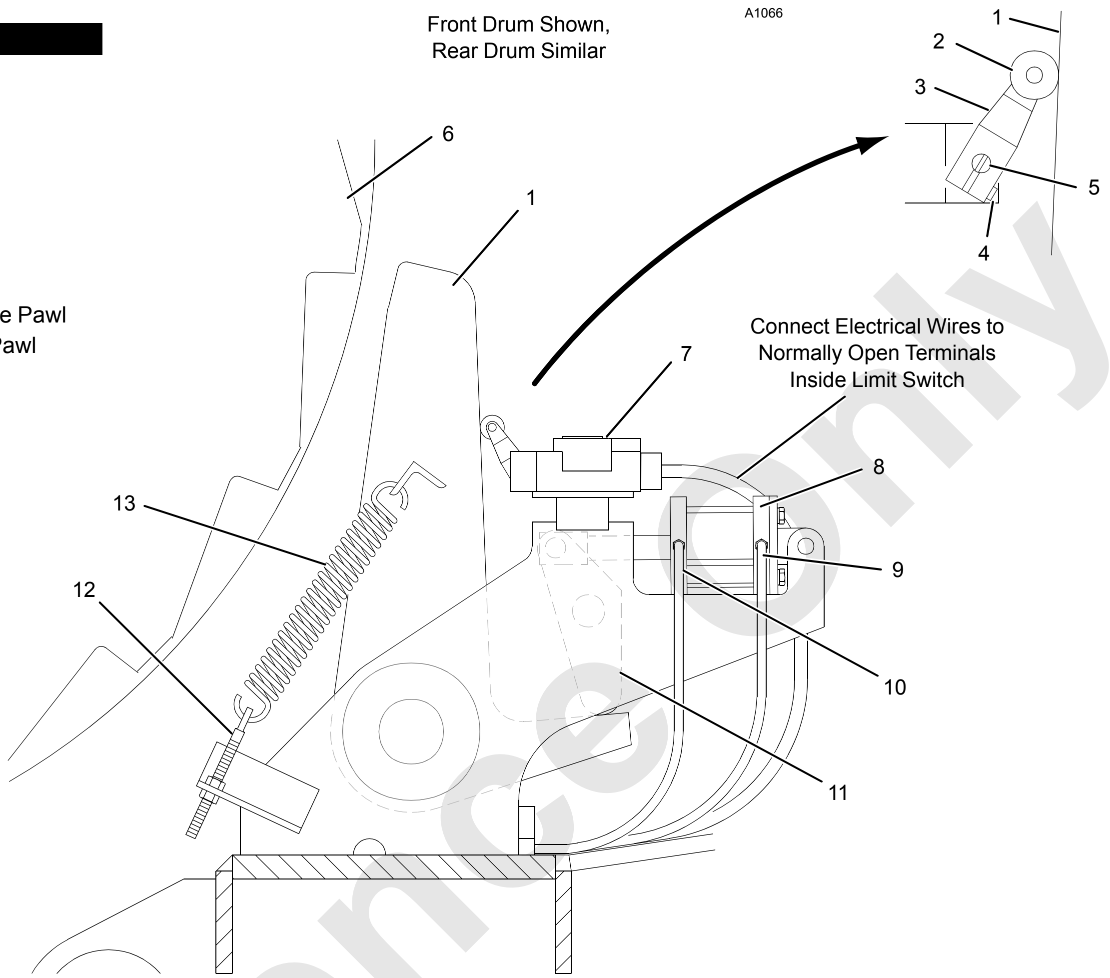


FIGURE 5-24

WIRE ROPE LUBRICATION

See Wire Rope Lubrication in Lubrication Section 9.

INSPECTING AND REPLACING WIRE ROPE

General

The inspection and replacement guidelines that follow comply with United States regulations.

It is impossible to predict when a wire rope will fail. However, frequent and periodic careful inspection by a qualified inspector will indicate when the potential for failure exists.

Keeping Records

A signed and dated report of the wire rope's condition at each periodic inspection must be kept on file at all times. The report must cover all inspection points listed in Inspecting Wire Rope on page 5-28. The information in the records can then be used to establish data that can be used to determine when a wire rope should be replaced.

It is recommended that the wire rope inspection program include reports on the examination of wire rope removed from service. This information can be used to establish a relationship between the visual inspection and the rope's actual internal condition at the time of removal from service.

Inspecting Wire Rope

Frequent Inspection

Visually inspect all running ropes in service once each work shift and observe the rope during operation. Pay particular attention to the following areas of the rope where wear and other damage are likely to occur:

- Pick-up points—Sections of wire rope that are repeatedly stressed during each lift, such as those sections in contact with sheaves
- End attachments—The point where a fitting is attached to the wire rope or the point where the wire rope is attached to the drum
- Abuse points—The point where the wire rope is subjected to abnormal scuffing and scraping

Inspect all rope that can be reasonably expected to be in use during operation for obvious damage that poses an immediate hazard, such as the following:

- Rope distortion such as kinking, crushing, unstranding, bird caging, main strand displacement, and core protrusion

  Loss of rope diameter and unevenness of the outer strands indicate that the rope should be replaced.
- Corrosion (clean and lubricate)
- Broken or cut strands
- Broken wires (see Periodic Inspection)
- Core failure in rotation resistant rope (indicated by lay lengthening and reduction in diameter)

Periodic Inspection

The periodic inspection interval must be determined by a qualified inspector and be based on the following factors:

- Expected rope life as indicated by the rope manufacturer or past experience as determined by a qualified inspector
- Severity of environment in which the rope is operated
- Size, nature, and frequency of lifts
- The rope's exposure to shock loading and other abuse
- Rope maintenance practices

The periodic inspection must be performed at least annually.

During the periodic inspection, the entire length of wire rope must be inspected. Any damage found, including the following, must be recorded and a determination made as to whether continued use of the rope is safe:

- All points listed under Frequent Inspection
- Reduction in rope diameter below the nominal diameter caused by loss of core support, internal or external corrosion, or wear of the outside wires
- Severely corroded or broken wires at the end attachments
- Severely corroded, cracked, bent, worn, or improperly applied end attachments

Inspecting Rope not in Regular Use

Wire rope must be given a complete inspection if it has been idle for a month or more due to shutdown or storage of the crane on which the rope is installed. The inspection must be performed by a qualified inspector looking for the damage identified under both frequent and periodic inspection.

Replacing Wire Rope

The final decision as to when a wire rope should be replaced is the responsibility of the qualified inspector. Discovery of any of the following conditions is sufficient reason for questioning a wire rope's safety and for replacing it:

- A reduction in rope diameter
- Broken wires
- Abnormal wear

Wire Rope Diameter

Measure and record the diameter of a new wire rope after initial loading for comparison with future inspections. A reduction in rope diameter is often the first outward sign that the wire rope core is damaged. When a reduction in diameter is noted, the rope must be removed from service.

Measure the rope's diameter across the crowns of the strands so the true diameter is measured (Figure 5-25).

Wire rope must be taken out of service when the reduction from its nominal diameter is more than five percent.

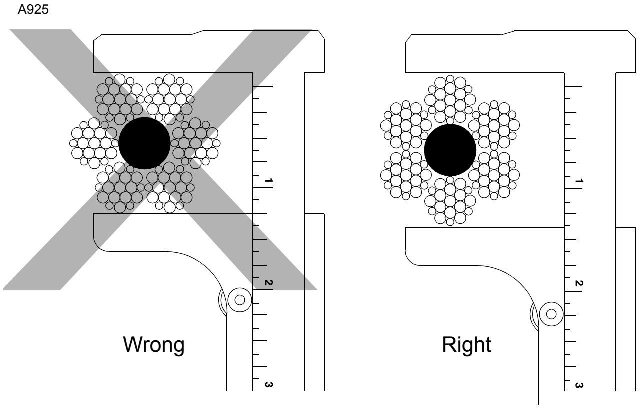


FIGURE 5-25

Broken Wires

Thoroughly clean the wire rope so breaks can be seen. Relax the rope, move it off pick-up points, and flex it as much as possible. Use a sharp awl to pick and probe between wires and strands, lifting any wire that appears loose or moves excessively.

See Figure 5-26 for an explanation of lay length.

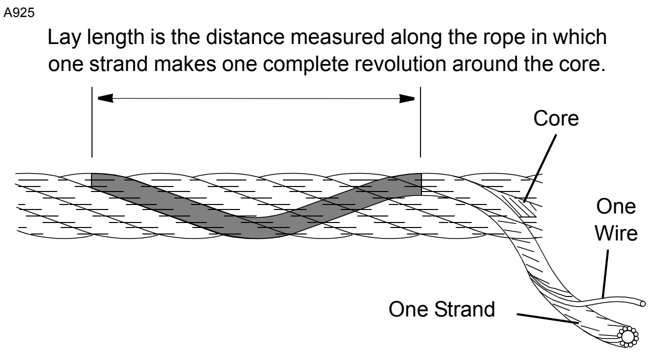


FIGURE 5-26

Wire rope must be taken out of service when it has the following number of broken wires:

- Running ropes (working lines)—Six randomly distributed broken wires in one lay length, or three broken wires in one strand of one lay length
- Rotation resistant rope—Two randomly distributed broken wires in a length equal to six rope diameters or four randomly distributed broken wires in a length equal to thirty rope diameters
- Standing ropes (pendants)—More than two broken wires in one lay length in sections beyond the end attachment, or more than one broken wire at the end attachment (Figure 5-27)
- All ropes—One broken wire at the point of contact with the core that protrudes or loops out of the rope structure

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!

If wire rope is damaged, it can break, causing the load to drop, thereby resulting in death or serious injury.

Replace the wire rope when more than one broken wire appears at the points marked by the arrows.

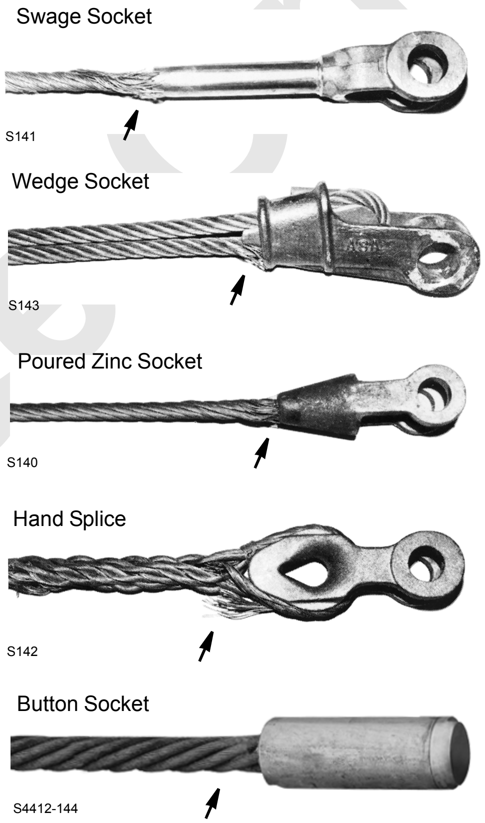


FIGURE 5-27

Wear and Other Damage

See Figure 5-28 for examples of wire rope damage.

It is normal for the outer wires of the rope to wear first because of friction.

Wire rope must be taken out of service if any of the following apply:

- The rope core protrudes from between the outer strands.
- Severed corrosion—indicated by pitting—exists.
- Obvious damage exists from any heat source including, but not limited to, welding, power line strike, or lightning.
- Kinking, crushing, bird caging, or any other damage resulting in distortion of wire rope structure exists.

⚠ WARNING

Falling Load Hazard!

Replacement wire rope can break if it does not meet Manitowoc Cranes' specifications given in the following publications supplied with the crane:

- Wire Rope Specifications Chart located in the Capacity Chart Manual (for load lines)
- Boom or Jib Assembly Drawings located in the crane Operator Manual (for boom or luffing hoist)
- Mast Assembly Drawing located in the Parts Manual

Make sure that replacement wire rope meets all specifications given by Manitowoc Cranes.

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 that different sections of rope are subjected to the wear points. This practice can also help correct spooling problems and rope vibration.

To move the wire rope, cut off a piece of wire rope at the drum and refasten it. The piece cut off should be long enough to move the wire rope at least one full drum wrap.

If the wire rope is too short to allow cutting off a piece of it, reverse the rope end for end and refasten it.

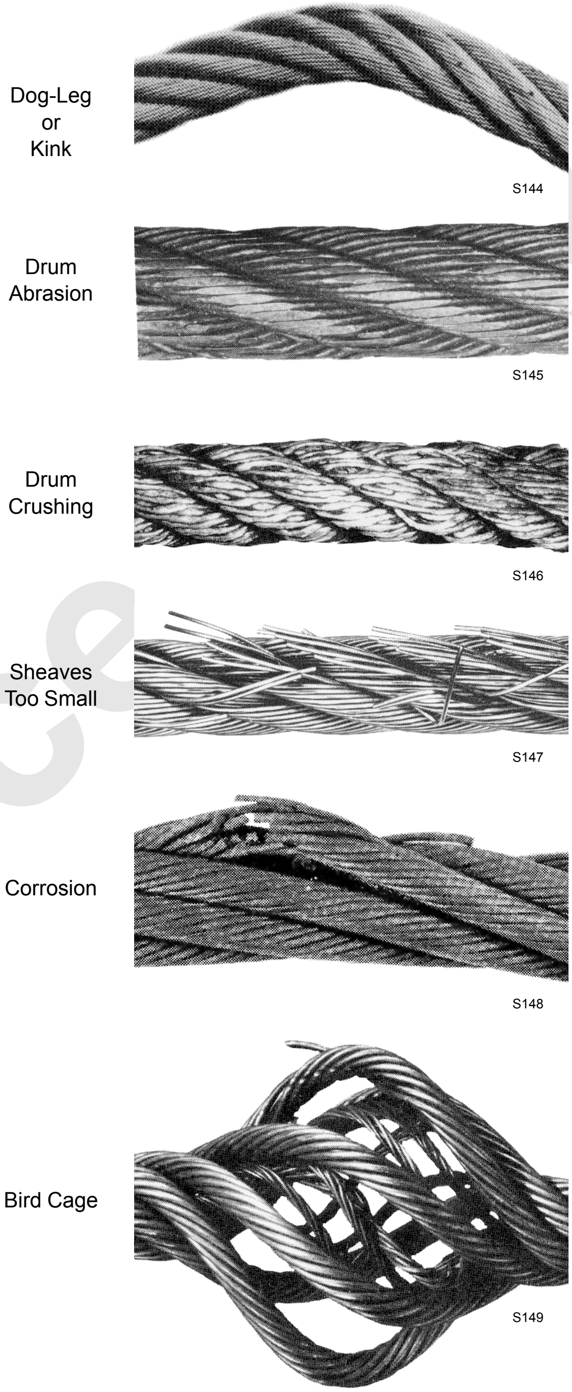


FIGURE 5-28

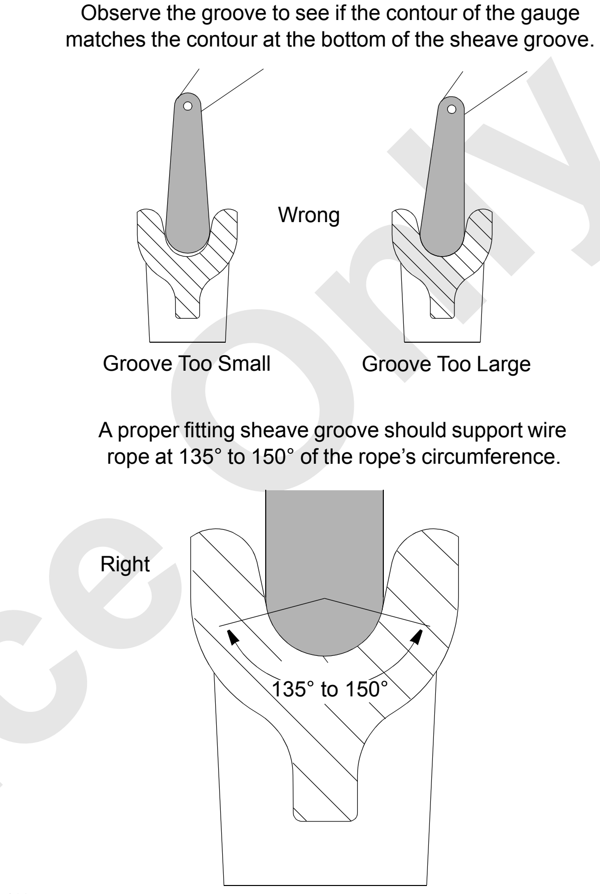
INSPECTING SHEAVES, ROLLERS, AND DRUMS

Perform the following inspections weekly.

1. Check the drum clutches and brakes for proper adjustment.
2. Check all sheaves, rollers, and drums for the following conditions:
    - Unusual noises
    - Freedom of movement—Sheaves, rollers, and drums must turn freely by hand. The wire rope may need to be loosened to perform this inspection.
    - Wobble—Sheaves, rollers, and drums must turn true with very little side-to-side or up-and-down play.
    - Signs of rust (indicating that water may have entered the bearing)
    - Grease leaks (indicating a faulty seal or water in the grease)

    The above problems indicate bearing damage. If found, the corresponding sheave, roller, or drum should be disassembled for further inspection. New bearings should be installed.

    For sheaves not equipped with grease fittings, make sure to pack new bearings with grease at assembly.
3. For steel sheaves, check the depth, width, and contour of each sheave using a groove gauge (Figure 5-29). Replace sheaves that have over- or undersized grooves.
4. Replace grooved drums that allow one wrap of 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.



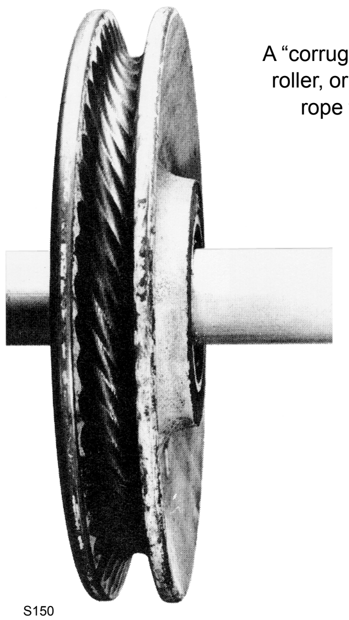
Observe the groove to see if the contour of the gauge matches the contour at the bottom of the sheave groove.

A proper fitting sheave groove should support wire rope at 135° to 150° of the rope's circumference.

FIGURE 5-29

6. Re-machine or replace steel sheaves, drums, or rollers that have been “corrugated” by the wire rope’s print as shown in (Figure 5-30).

NOTE: Depending on the type of wire rope used, it is normal for nylon sheaves to show the wire rope print. Do not re-machine nylon sheaves.



A “corrugated” steel sheave, roller, or drum causes wire rope to wear rapidly.

FIGURE 5-30

7. Inspect nylon sheaves for excessive tread diameter wear at location E in Figure 5-32. Measure at three positions to check for uneven wear.

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

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

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

Nylon sheave properties degrade in temperatures above 60ºC (140°F).

8. Inspect nylon sheaves to verify they have not separated and “walked off” the steel inserts or bearings (Figure 5-31). The maximum sideways displacement is 3 mm (1/8 in). Replace worn or damaged sheaves.

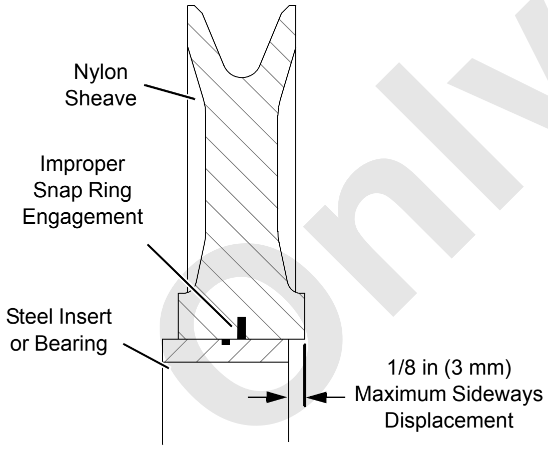


FIGURE 5-31

9. Make sure the sheaves, drums, and rollers are properly lubricated. Refer to Lubrication Section 9.

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

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

NOTE: For some sheaves, the seals are an integral part of the bearing. Therefore, if a seal is damaged during repacking, the complete bearing may need to be replaced.

Plastic Sheave Data

Sheave Part No.	A Outside Diameter		B Tread Diameter		C Width		D Rope Diameter	
	mm	inch	mm	inch	mm	inch	mm	inch
912738	335,0	13.19	290,1	11.42	45,0	1.77	16	5/8
631056								
631054	335,0	13.19	290,1	11.42	45,0	1.77	22	7/8
631065	406,4	16.00	339,6	13.37	55,1	2.17	14	9/16
631071	406,4	16.00	352,6	13.88	55,1	2.17	16	5/8
631526	489,0	19.25	422,4	16.63	50,8	1.94	22	7/8
631527	489,0	19.25	422,4	16.63	50,8	1.94	16	5/8
631055	500,1	19.69	447,0	17.60	47,0	1.85	22	7/8
631067	500,1	19.69	450,9	17.75	50,0	1.97	19	3/4
631529	508,0	20.00	431,8	17.00	76,2	3.00	25	1
631519	584,2	23.00	511,0	20.13	57,2	2.25	22	7/8
631520								
631084	584,2	23.00	511,0	20.13	63,5	2.50	22	7/8
A00083								
631102	584,2	23.00	511,0	20.13	63,5	2.50	25	1
631082	685,8	27.00	23,00	584.2	76,2	3.00	25	1
631103								
A00051								
631096	685,8	27.00	23,00	584.2	76,2	3.00	28	1.18
A00050								
631100	762,0	30.00	27,00	685.8	76,2	3	29	1-1/8

B = Tread diameter, new sheave
E = Tread diameter, used sheave
B minus E = Total wear
If the 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.

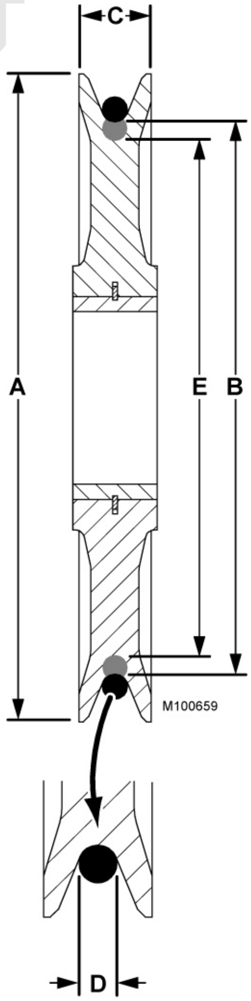


FIGURE 5-32

INSPECTING THE LOAD BLOCK AND HOOK-AND-WEIGHT BALL

WARNING

Falling Load Hazard!

Structural failure of the load block or hook-and-weight ball will allow the load to drop, which can result in death or serious injury.

To prevent the load from dropping due to failure of the load block or hook-and-weight ball, observe the following:

- Only use a load block or a hook-and-weight ball that has a capacity equal to or greater than the load to be handled.
- Do not remove or deface the nameplate (Figure 5-33) attached to the load blocks and hook-and-weight balls.
- See Section 4 of the Operator Manual for the recommended sling angles and capacity restrictions when the load block has a duplex or quadruplex hook.

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

FIGURE 5-33

The operating condition of the load block and the hook-and-weight ball can change daily with use. Therefore, they must be inspected daily (at the start of each shift) and observed during operation for any defects that could affect their safe operation. Correct all defects before using the load block or the hook-and-weight ball.

Daily inspection and maintenance include the following points (Figure 5-34 and Figure 5-35).

1. Clean the load block or the hook-and-weight ball.
2. Lubricate the sheaves (4, Figure 5-35) (if fittings are provided), trunnion (9, Figure 5-35), swivel (4, Figure 5-34), and any other part with a grease fitting at the intervals specified in Lubrication Section 9.
3. Tighten loose tie-bolts (3, Figure 5-35), capscrews, and set screws.
4. Verify that all cotter keys are installed and opened.
5. 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.
6. Check the fit of the wire rope in the groove of each sheave. An oversized 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 must be free of rough edges and burrs.
7. Verify that the hook (8, Figure 5-34 and 12, Figure 5-35), trunnion, and swivel rotate freely without excessive play. Faulty operation indicates faulty bushings, faulty bearings, or inadequate lubrication.
8. Check the swivel of the hook-and-weight ball for the following conditions:
    - Overloading—Spin the swivel by hand. If the motion is rough or has a ratchet-like effect, the swivel bearings are damaged.
    - Side loading—The swivel turns freely in one spot and locks up in another. This condition can also be checked by looking at the gap (4c, Figure 5-34) between the swivel barrel (4b, Figure 5-34) and the swivel shank (4a, Figure 5-34) (swivel must be removed from the weight ball to check). If the gap is wide on the side and closed on the other, damage is present.

NOTE: The gap between the barrel and the shank is normally 0.51 to 1.27 mm (0.020 to 0.050 in). If the gap increases, swivel bearing failure is indicated.

9. Check the load block for signs of overloading such as spread side plates, elongated holes, bent or elongated tie-bolts, and cracks.
10. Check all welds for defects and cracks.
11. Check the wire rope for wear and broken wires at the point the wire rope enters the dead-end socket. Check the socket for cracks. Tighten the wire rope clips at the dead end of the wire rope.

12. Verify that each hook has a hook latch and that the hook latch operates properly. The latch must not be wired open or removed.

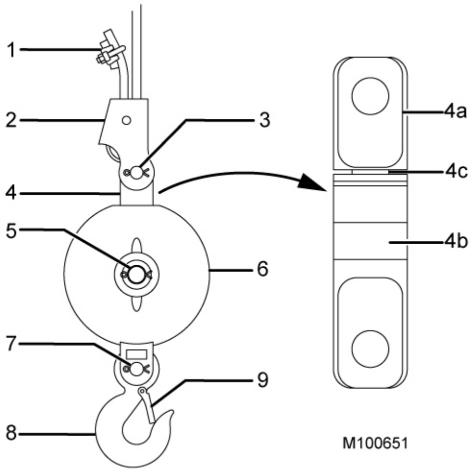
WARNING

Falling Load Hazard!

To prevent the load from dropping, the hook latch must retain the slings or other rigging in the hook under slack conditions.

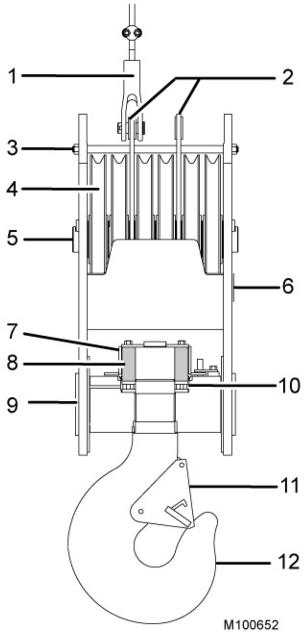
The hook latch is not intended as an anti-fouling device, and caution must be taken to prevent the hook latch from supporting any part of the load.

Slings or other rigging must be seated in the hook when handling a load. They must never be in position to foul the hook latch.



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 5-34



Item	Description
1	Socket and Wedge
2	Center Plate (qty 2)
3	Tie-Bolt
4	Sheave (qty varies)
5	Sheave Shaft
6	Name Plate
7	Locking Cap
8	Hook Nut
9	Trunnion
10	Thrust Bearing
11	Latch
12	Hook

FIGURE 5-35

13. Inspect each hook (5) and shackle (1) for damage (Figure 5-36).

14. See 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
    - Phone, US and Canada: 800-843-2763
    - Phone, Mexico: 95-800-843-2763
    - Phone, Universal: 973-882-1167
    - Fax: 973-882-1717 or 973-882-5155
    - E-mail: infocentral@asme.org

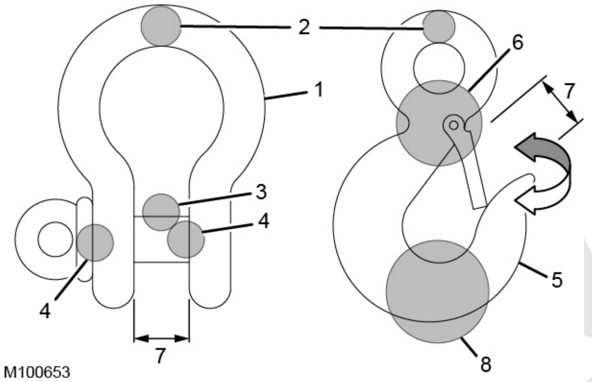
15. Contact the supplier of the hooks, shackles, blocks, and other rigging for repair instructions.

16. Check each hook and shackle at least yearly for cracks using a dye penetrant test, MAG particle test, ultrasonic test, or X-ray.

WARNING

Falling Load Hazard!

To prevent the load from dropping due to hook or shackle failure, do not attempt to repair cracks in hooks and shackles by welding. Furthermore, do not weld on any load-bearing component unless proper welding methods are used (contact the Manitowoc Crane Care Lattice Team for material and welding specifications).



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

FIGURE 5-36

SECTION 6
SWING

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SECTION 6
SWING

MANUAL RELEASE OF SWING BRAKE

This procedure is for servicing purposes only. The swing brake must be fully operational when operating the crane.

When removing or installing the swing planetary, the hydraulic swing brake must be released to allow alignment of the swing shaft gear teeth and the ring gear teeth.

Figure 6-1 shows the swing planetary and brake release port.

WARNING

Unexpected Crane Movement!

Avoid personal injury and equipment damage. The crane can swing suddenly when the swing brake is released.

Before releasing the swing brake, secure the crane by lowering the boom onto blocking at ground level to prevent sudden uncontrolled swinging.

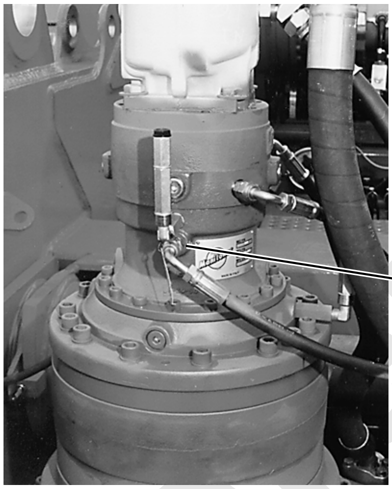

FIGURE 6-1

Manual Release Procedure

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

1. Disconnect the hose from the fitting at the brake release port.
2. Attach a hand pump to the brake release port.
3. Pressurize the brake to 24 bar (350 psi).
4. Remove or install the swing planetary as necessary.
5. Relieve the pressure and remove the hand pump.

CAUTION

Damage to Parts!

Excessive hydraulic pressure can damage hoses, fittings, and/or other components.

Do not exceed 24 bar (350 psi) of pressure when releasing the swing brake.

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SECTION 7
POWER TRAIN

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SECTION 7
POWER TRAIN

BATTERY MAINTENANCE

Safety Information

WARNING

Explosion Hazard!

Prevent personal injury. Batteries can explode and spray acid with great violence.

Avoid sparks or flames while charging the batteries.

Do not smoke while performing battery maintenance.

Do not short across the battery terminals to check for charge.

Store batteries in a ventilated area away from flames or sparks.

Batteries produce a byproduct of highly flammable hydrogen gas when producing electricity and elevated levels while being charged. Do not disturb the connection between the batteries until the charger is off.

Do not reverse the connection between the batteries and the charging equipment or an explosion may occur. 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. Connect both jumper cables to the battery on the crane to be started. Do not allow the opposite ends of the cables to touch.
2. Connect the positive cable to the positive terminal of the booster battery.
3. Connect the negative cable to the frame or engine block of the starting vehicle. Never connect it to the grounded terminal of the starting vehicle.

If the electrolyte comes in contact with eyes, skin, or clothing, flush the area immediately 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 resultant 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 results in plate buckling. Buckled plates can pinch the separators and cause a short circuit. An undercharged battery not only is unable to deliver power, but also may freeze. See Table 7-1 for the following.

Table 7-1. Battery Freeze Points

State of Charge	Specific Gravity	Freeze Point °C	Freeze Point °F
100%	1.26	-57	-70
75%	1.23	-38	-39
50%	1.20	-26	-16
25%	1.17	-19	-2
Discharged	1.11	-8	+17

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 resultant 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 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 the terminals and cables, resulting in high-resistance battery connections. This weakens the power of the battery. Overtightened hold-downs can distort or crack the container and cause the same problem.

Overloads

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

Multiple-Battery System

In a multiple-battery system, the batteries are connected either in series or in parallel. Always refer to your wiring diagram for the correct connection.

NOTE: Installing the batteries with reversed electrical connections will damage the batteries and also the crane's electrical system, the voltage regulator, and/or the alternator.

Maintenance

Weekly—Checking the Electrolyte Level

1. Clean the top of the battery before removing the vent caps. Take care to not allow dirt to enter the cells.
2. Use distilled water for replenishing the battery. Drinking water is satisfactory, but do not use water with a high mineral content (such as well, creek, or pond water).
3. Never overfill the cells. Overfilling will cause the electrolyte to pump out, and corrosion damage will result.

   Immediately clean and neutralize any acid spills on painted or metal surfaces with sodium bicarbonate (baking soda) or ammonia.
4. Look for heavy deposits of a black, lead-like mineral on the bottom of the vent caps. This indicates that an active material is being shed (a result 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—Testing the Batteries

NOTE: 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.
2. Readings should not be taken immediately after water is added. The solution must be thoroughly mixed by charging.
3. Readings should not be taken after a battery has been discharged at a high rate, such as from 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 the curvature of the liquid.
7. Readings must be temperature-corrected. Subtract 0.004 from the reading for each 10° below 80°F. Add 0.004 for each 10° above 80°F.

NOTE: It is the electrolyte temperature that is important, not the air temperature.

8. See Table 7-2 for the following.

Table 7-2. Hydrometer Readings

Temperature-corrected hydrometer readings may be interpreted as follows:

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 50 points (0.050 specific gravity) variation, try to recharge the battery. If the variation persists, the battery should be replaced.

For more specific hydrometer test information, see the instructions provided with your hydrometer.

Open Circuit Voltage Test

A voltmeter can be used to determine a battery's state of charge. See Table 7-3 for the following.

The open circuit test is not as reliable in determining a battery's condition as the hydrometer test. This test is acceptable for stored batteries, but not ones in use.

This test must not be performed on batteries being charged or delivering power. Charging causes an increase in voltage, which may persist for an extended period.

Table 7-3. Open Circuit Cell Voltage

% Charge	Specific Gravity	Approximate Open Circuit Cell Voltage
100	1.260	2.10
75	1.230	2.07
50	1.200	2.04
25	1.170	2.01
Discharged	1.110	1.95

NOTE: Detailed test information is provided by the meter manufacturer.

High Resistance Test

A voltage drop (while cranking) of more than 0.2 V between the starting motor cable and ground can result in 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 battery posts and terminals. The posts can be lightly coated with grease to prevent corrosion.
4. Make sure the hold-downs are in good condition and replace any faulty parts.
5. Replace frayed, broken, or corroded cables.
6. Replace the batteries if their containers are cracked or worn to the point at which they leak.
7. Ensure a good contact (tight) exists between the clamp terminals and battery posts.

Make sure the hold-downs are tight enough to prevent battery movement but not so tight as to cause distortion.

Charging

If at all possible, the battery should be at room temperature when recharging. Before a battery is recharged, it must be thoroughly cleaned. Do not 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 A 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 A.

If a battery was discharged rapidly (cranking until dead), it can be recharged on a fast charger with an output of up to 40 A for a maximum of two hours. If the electrolyte temperature reaches 52°C (125°F) or if it gasses violently, the charging current must be reduced or halted to prevent battery damage.

For optimum charging results, adhere to the charger manufacturer's instructions.

Storage

When a machine 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 7-1 for the following.

A battery disconnect switch is provided on the right side of the upperworks, next to the batteries. Use the switch to disconnect the batteries when servicing the electrical control system.

See Section 3 of the Operator Manual for operation of the battery disconnect switch.

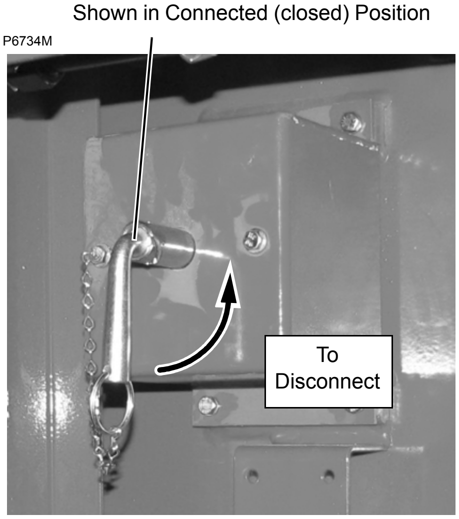
CAUTION

Electronic Damage!

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

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

Make sure the engine ignition switch has been off for five minutes before disconnecting the batteries.



Right Side of Rotating Bed

FIGURE 7-1

ENGINE DIAGNOSTICS

General

The Cummins QSX15 engine has the following two types of fault codes:

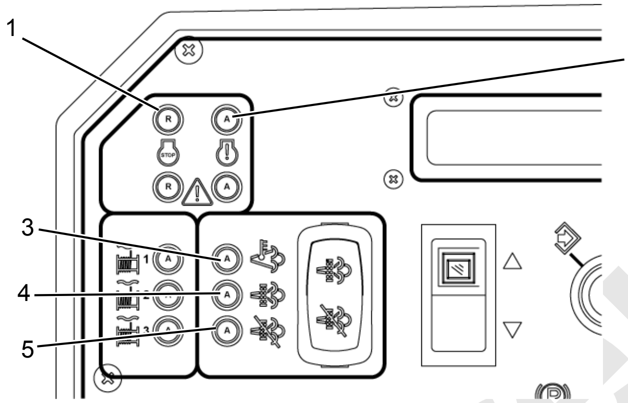
- Engine electronic fuel system fault codes
- Engine protection system fault codes

All fault codes are either active or inactive. Active fault codes can be read with the red Engine Stop light and the yellow Engine Warning light on the front console. Inactive faults can only be read with the electronic service tool supplied by the engine manufacturer.

Diagnostic Lights

See Figure 7-2 for the following.

The engine diagnostic lights are mounted on the front console in the operator's cab.



Item	Description
1	Engine Stop Light
2	Engine Warning Light
3	High Exhaust System Temperature Light
4	Selective Catalytic Reduction (SCR) Regeneration Light
5	Selective Catalytic Reduction (SCR) Regeneration Inhibited Light

FIGURE 7-2

Engine Stop Light

CAUTION

Engine Damage!

Permanent damage can occur if the engine is run while the red Engine Stop light is illuminated.

If possible, lower a lifted load and then stop the engine as soon as possible when the red Engine Stop light illuminates. Do not run the engine until the fault is corrected.

When illuminated, the red Engine Stop light (1) indicates the need to stop the engine as soon and safely as possible and correct the fault.

Engine Warning Light

When illuminated, the yellow Engine Warning light (2) indicates that the engine can be run, but the fault should be corrected as soon as possible.

High Exhaust System Temperature Light

See the Operator Manual for details on the high exhaust system temperature light (3).

Selective Catalytic Reduction (SCR) Regeneration Light

See the Operator Manual for details on the selective catalytic reduction (SCR) regeneration light (4).

Selective Catalytic Reduction (SCR) Regeneration Inhibited Light

See the Operator Manual for details on the selective catalytic reduction (SCR) regeneration inhibited light (5).

Engine Off Diagnostics

See Figure 7-3 for the following.

A laminated list of fault codes is located in the operator's cab. To identify active faults, proceed as follows.

1. Stop the engine.
2. Move the Run/Stop/Run key switch to either RUN position to turn on the display screen.
3. Move the hand throttle from LOW to HIGH and back to LOW three times within five seconds.
4. If no active faults exist, the red Engine Stop and yellow Engine Warning lights illuminate but do not flash.
5. If active faults exist, the following occurs.
    - **a.** The yellow Engine Warning light flashes, indicating that a fault code is about to be flashed.
    - **b.** There is a 1- to 2-second pause.
    - **c.** The red Engine Stop light flashes a three-digit code to show which active fault has been detected. There is a 1- to 2-second pause between each number.
    - **d.** When the code is finished flashing in red, there is a 1- to 2-second pause, and the yellow Engine Warning light flashes again.
    - **e.** The same fault code flashes a second time before advancing to the next code.

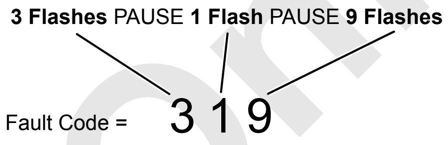


FIGURE 7-3

ENGINE AIR CLEANER MAINTENANCE

See Figure 7-4 for the following.

The air cleaner (1) is connected to the engine air intake (17) with a rubber elbow reducer (3), clamps (4), steel tubes (5), a rubber elbow (6), and a rubber reducer (7). Servicing the air cleaner is important because either of the following conditions can cause engine damage:

- Clogged air cleaner filters can 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.

Inspection

To maintain engine protection and filter service life, inspect the following areas at regular intervals.

Daily

Check the service indicator (8) with the engine running. The indicator gives a visual indication when it is time to replace the filters:

- A yellow flag in the indicator window (9) extends as the filters become plugged. Replace the 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 the reset button (10) in to reset the indicator.

Weekly

1. Inspect the reducers (3 and 7) between the air cleaner and the engine for cracks or other damage that might allow unfiltered air to enter the engine. Replace worn or damaged parts.
2. Check the housing (11) for dents or other damage that may allow unfiltered air to enter the engine. Replace the housing if it is damaged.
3. Check for loose clamps (4). Tighten them if necessary.
4. Inspect the intake/pre-cleaner (2) for obstructions. Clean the intake as required.
5. Inspect the dust ejector (16) for damage. Replace the ejector if necessary.

CAUTION

Engine Damage!

Drawing contaminants into the engine while it is running will damage the engine.

Never operate the engine without the air cleaner. Stop the engine before servicing the air cleaner.

Clean the fittings, the mounting hardware, and the area around the component(s) to be removed.

Replace the secondary filter as quickly as possible to prevent engine ingestion of contaminants. Do not reuse old filters. Discard old filters and install new ones. Using compressed air to clean an old filter elements voids the warranty and can degrade or damage the filter media, leading to a malfunction.

Service

1. Unlatch and remove the service cover (12). The primary (13) and secondary (14) filters should be removed gently to prevent dislodging dust. There will be some initial resistance, similar to breaking the seal on a jar. Using the tabs on the filters, move the end of the primary filter back and forth to break the seal.
2. Using the tabs, pull each primary filter out of the housing (9). Avoid knocking the filter against the housing.
3. Using the tabs, pull each secondary filter out of the housing. Avoid knocking the filter against the housing.

NOTE: The secondary element should be replaced every third time the primary element is replaced. Inspect the secondary element and replace it if necessary.

4. Use a clean cloth to wipe clean the sealing surfaces and inside of the housing. Dust on the sealing surfaces could render the seal ineffective and cause leakage. Remove all contamination before installing the new filters.

CAUTION

Engine Damage!

Dirt transferred to the inside of the outlet tube will reach the engine and cause damage.

Clean the inside of the outlet tube to prevent dirt from entering the engine.

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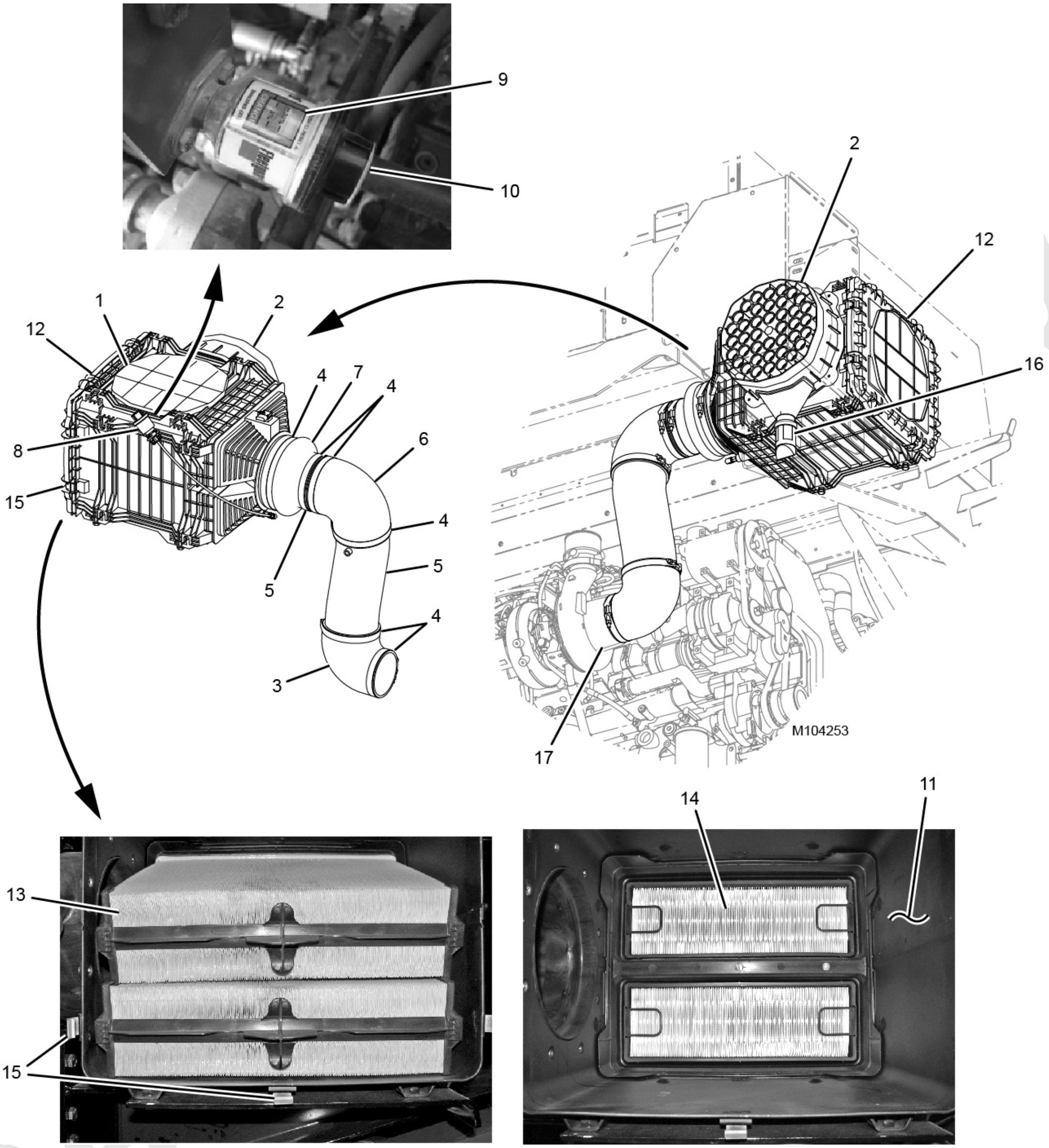
5. Wipe the inside of the outlet tube with a clean cloth. Be careful not to damage the sealing area of the tube.
6. Visually inspect the old filters for any sign of leaks. A streak of dust on the clean side of the filter is a sign. Remove any cause of leaks before installing a new filter.



Item	Description	Item	Description
1	Air Cleaner	10	Reset Button
2	Intake/Pre-Cleaner	11	Housing
3	Rubber Elbow Reducer (qty 2)	12	Service Cover
4	Clamp (qty 6)	13	Primary Filter (qty 2)
5	Steel Tube (qty 2)	14	Secondary Filter (qty 2)
6	Rubber Elbow	15	Latch (qty 6)
7	Rubber Reducer	16	Dust Ejector
8	Service Indicator	17	Engine Air Intake
9	Indicator Window		

FIGURE 7-4

ENGINE COOLING SYSTEM FILL

WARNING

Poison Hazard!

Prevent personal injury. Coolant is toxic to humans, animals, and the environment. Ingestion of coolant could cause serious injury or death.

If not reused, dispose of coolant in accordance with all local and other applicable environmental regulations.

General

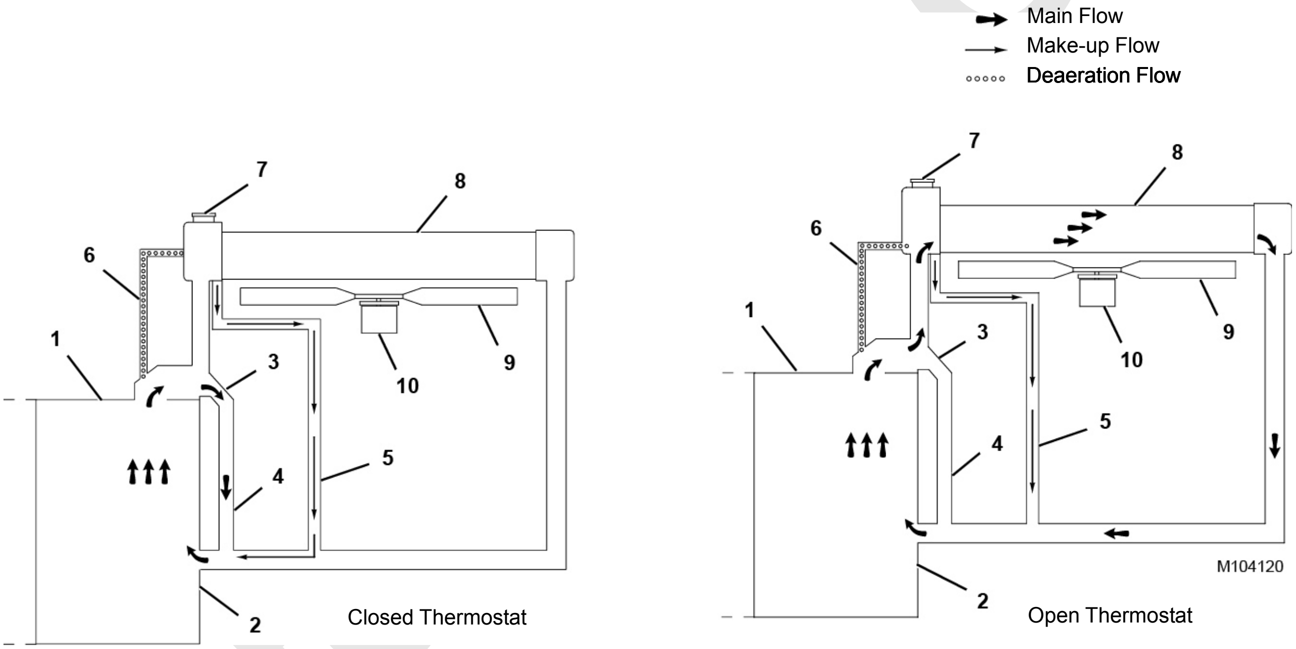
The cooling system consists of a horizontal radiator (mounted above the engine) and two variable-speed, hydraulically driven, blower-type fans.

Cooling System Operation

Cooling system flow is illustrated in Figure 7-5.

The cooling system is of the deaeration type, which continually removes air from the system, as follows:

- A small percentage of total coolant flow is circulated through a vent line to the radiator.
- Since coolant circulation is very slow in the radiator, air separates from the coolant.
- Air collects at the top of the radiator. When the pressure rises to 1 bar (16 psi), a relief in the fill cap opens to exhaust air through the overflow line.
- Deaerated coolant returns to the system through a make-up line.



Closed Thermostat

Open Thermostat

Item	Description
1	Engine
2	Water Pump Housing
3	Thermostat Housing
4	Bypass Line
5	Make-up Line
6	Vent Line
7	Fill Cap
8	Cooler Assembly
9	Fan (qty 2)
10	Motor (qty 2)

FIGURE 7-5

Maintenance

WARNING

Burn Hazard!

Prevent personal injury. Hot coolant, coolant spray, and coolant steam can cause serious injury.

Do not remove the radiator cap from a hot engine. Stop the engine and wait until the coolant temperature is below 50°C (120°F).

Removal of the Radiator Cap

See Figure 7-6 for the following procedure.

1. Place a protective covering over the fill cap (4).
2. Slowly turn the fill cap counterclockwise until it stops at the safety detent.
3. Wait until the pressure (indicated by hissing sound) is completely relieved.
4. Depress the fill cap and turn it counterclockwise to remove.

CAUTION

Engine Damage!

Inadequate coolant level will cause the engine to overheat.

Do not allow the coolant level to go below the low level on the gauge.

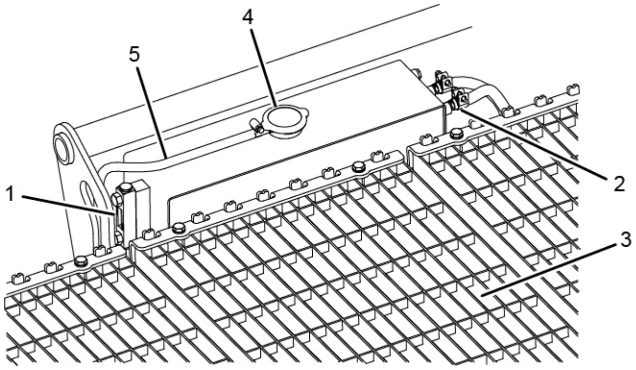
Daily Maintenance (start of each shift)

See Figure 7-6 for the following procedure.

Before the start of each shift, perform the following.

1. Check the coolant level when the coolant is cold. The coolant should be at the Full Cold mark on the level gauge (1).
2. Fill the cooling system as required with coolant. To ensure an adequate fill, do not add coolant at a rate greater than 19 L/min (5 gpm).

   See the engine manufacturer's manual for antifreeze and coolant additive recommendations.
3. Look for coolant leaks while the engine is running and correct causes of leaks if any are found.



Item	Description
1	Level Gauge
2	Vent Line
3	Radiator
4	Fill Cap
5	Overflow Line

FIGURE 7-6

Semiannual Checks

See Figure 7-6 for the following procedure.

1. Inspect the fill cap (4) and thermostat for proper operation and replace any worn parts. Verify the following:
   - The fill cap relieves at 1 bar (16 psi).
   - The thermostat closes at 82°C (180°F) and opens fully at 94°C (202°F).
2. Inspect the water pump belts for wear and proper adjustment (see the engine manufacturer's manual).
3. Inspect the cooling system hoses for deterioration and other defects. Replace as necessary.
4. Tighten the hose clamps.
5. Clean all dirt and other debris from the outside of the radiator.
6. Make sure the overflow line (5) on the tank is open.

Draining the Radiator

See Figure 7-7, Figure 7-8, and Figure 7-9 for the following.

Drain the radiator system as follows.

1. Stop the engine.
2. Remove the covers over the three bleed valves—two at the front of the radiator and one at the rear of the radiator.
3. Open the three bleed valves.
4. Remove the radiator surge tank fill cap.

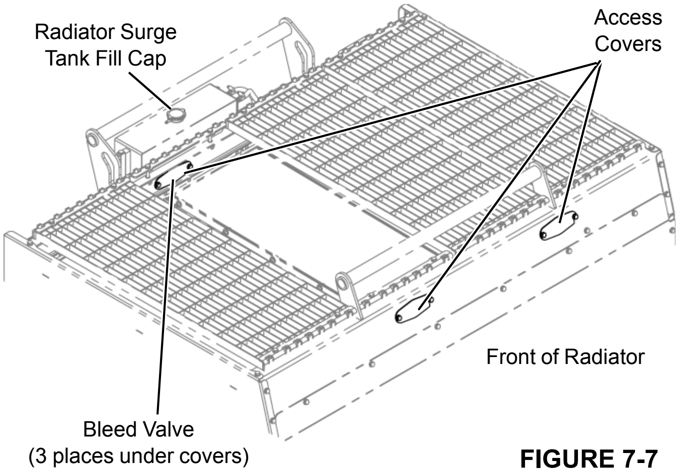


FIGURE 7-7

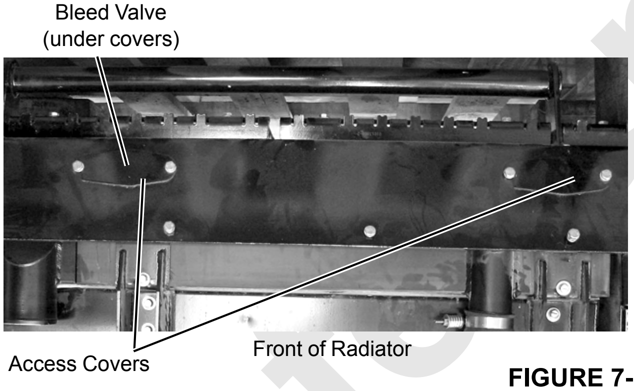
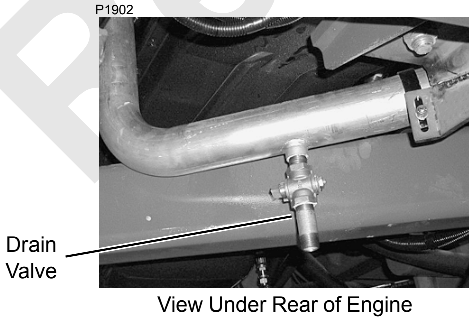


FIGURE 7-8

5. Open the drain valve and drain the coolant into a suitable container.



View Under Rear of Engine

FIGURE 7-9

6. Close the drain valve once the system is completely drained.

Filling the Radiator

CAUTION

Engine Damage!

The required supplemental coolant additive (SCA) concentration must be maintained to prevent engine damage.

An SCA must be added to the cooling system to prevent liner pitting and for scaling protection.

Check the SCA concentration according to the schedule in the engine manufacturer's operator manual and to the warnings, cautions, and instructions in the engine manufacturer's service manual.

CAUTION

Engine Damage!

Engine castings can be damaged if cold coolant is added to a hot engine.

Allow the engine to cool below 50°C (120°F) before adding coolant.

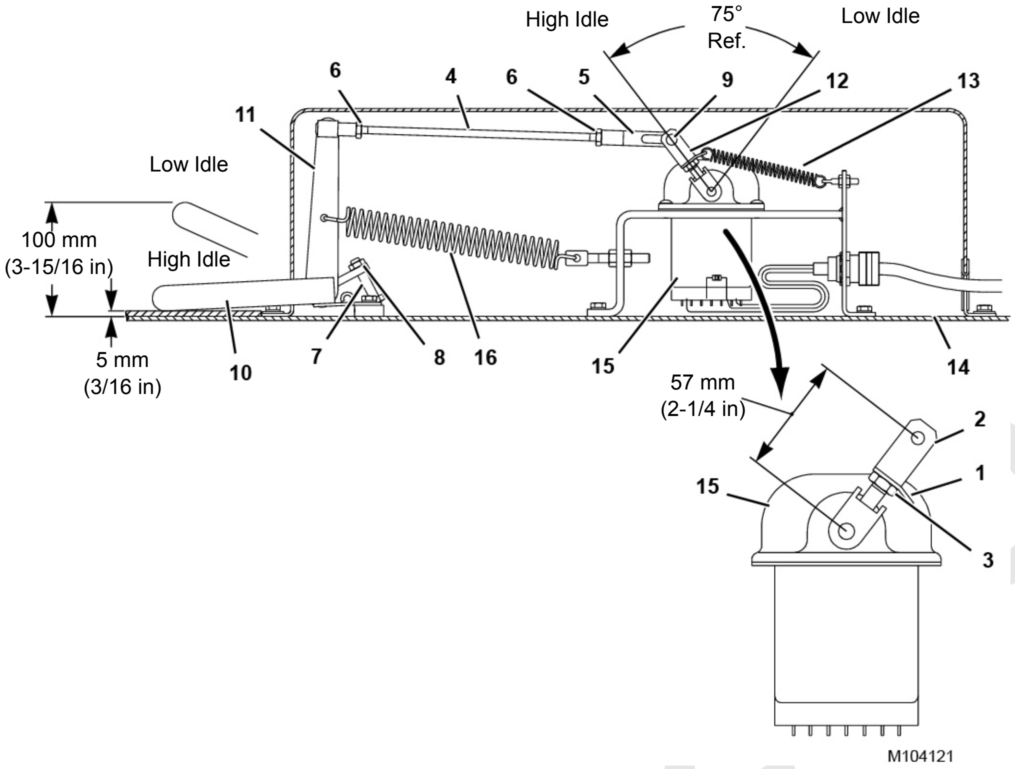
Add coolant to the Full Cold mark as determined on checks per the schedule in the engine owner's manual.

1. Fully open all three air bleed valves.
2. Fill the cooling system through the radiator fill cap to the Full Cold mark on the sight gauge. The coolant system capacity is approximately 80 L (21 gal).
3. Observe and close the bleed valves once clear coolant appears at the bleed valves.
4. Continue adding coolant until the level is at the Full Cold mark.

NOTE: The maximum fill rate is 19 L/min (5 gpm).

5. Install the fill cap and run the engine until it is at normal operating temperature.
6. Look for coolant leaks while the engine is running and correct causes of leaks if any are found.
7. Stop the engine, wait until the engine is cool, and refill the radiator to the Full Cold mark.

ENGINE THROTTLE ADJUSTMENT



Item	Description
1	Spring Clip
2	Rod End
3	Jam Nut
4	Reach Rod
5	Rod End
6	Jam Nut (qty 2)
7	Pedal Stop Screw
8	Jam Nut
9	Pin
10	Foot Pedal
11	Foot Pedal Lever
12	Lever Assembly
13	Spring
14	Cab Floor
15	Foot Throttle Controller
16	Return Spring

FIGURE 7-10

The throttle assembly consists of an electronic control module (ECM) on the engine, a hand throttle controller in the left console, a foot pedal (10) and a foot throttle controller (15) on the cab floor (14), associated linkage, and electrical connections.

A reach rod (4) connects the foot pedal to the lever assembly (12) on the foot throttle controller. An electric cable connects the hand throttle controller in the left control console to the foot throttle controller.

Engine high idle and low idle speed is calibrated automatically by the crane's programmable controller.

Foot Throttle Linkage Adjustment

See Figure 7-10 for the following procedure.

1. Install the spring clip (1) and rod end (2) on the controller lever assembly at the dimension shown in View A, and securely tighten the jam nut (3).
2. Insert a 5 mm (3/16 in) thick shim or piece of floor mat between the foot pedal and cab floor.
3. Press the foot pedal down fully to the high idle position against the shim or floor mat.
4. Loosen the jam nuts (6). Adjust the reach rod and rod end (5) so the controller lever is rotated fully to the high idle position. Securely tighten the jam nuts (6) to lock the adjustment.

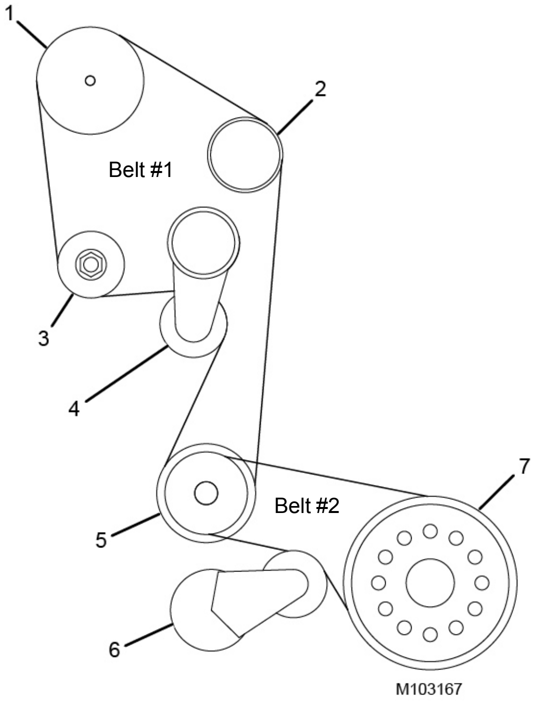
NOTE: The controller has internal stops at the high and low idle positions.

5. Release the foot pedal to the low idle position.
6. Adjust the return spring (16) so there is sufficient force to raise the foot pedal and rotate the controller lever to the low idle position.
7. Loosen the jam nut (8). Adjust the pedal stop screw (7). The screw must be tight against the cab floor, and there must be a 31 mm (1/8 in) gap between the pin (9) and the rear end of the slot in the rod end. Securely tighten the jam nut (8).
8. With the foot pedal in the low idle position, the distance from the top of the foot pedal to the cab floor should be 100 mm (3-15/16 in).

ENGINE BELT ROUTING

See Figure 7-11 for the following.

Follow the engine belt routing when installing a new belt.



Item	Description
1	A/C Compressor
2	Idler
3	Alternator
4	Tensioner
5	Water Pump
6	Tensioner
7	Harmonic Balancer

FIGURE 7-11

DIESEL PARTICULATE FILTER (DPF) REGENERATION

General

The diesel particulate filter (DPF), located at the rear of the upperworks, captures soot and ash from the engine exhaust.

- Soot is partially burned fuel particles that occur during normal operation (black smoke).
- Ash is partially burned engine oil particles that occur during normal operation.

Over time, both soot and ash are collected in the DPF and must be removed as follows:

- Soot is removed by a process called regeneration.
- Ash is removed by manually cleaning the DPF at specified intervals (see the engine manufacturer's manual for detailed instructions).

Regeneration

General

Regeneration is the process of converting the soot collected in the diesel particulate filter (DPF) into carbon dioxide. Heat is required for regeneration 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 diesel particulate filter (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 diesel particulate filter (DPF). If this happens, the engine's controller initiates the process (see the engine manufacturer's manual for detailed instructions).

The process occurs more frequently in cranes operated at low speed, light or no load, and stop-and-go cycles.

During active regeneration, the operator may notice an increase in turbocharger noise and an increase in exhaust temperature (High Exhaust System Temperature light illuminates).

NOTE: Inhibit regeneration by using the Selective Catalytic Reduction (SCR) switch only in circumstances in which it is desirable to disable active regeneration. Prolonged engine operation with regeneration inhibited causes 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 Selective Catalytic Reduction (SCR) light illuminates to alert the operator if regeneration is required (see Section 3 of the 2250 Operator Manual and the engine manufacturer's manual for detailed instructions).

EXHAUST AFTERTREATMENT SYSTEM

⚠ WARNING

Hot Exhaust Surfaces and Inhalation Hazards!

Extremely hot surfaces and exhaust gases can cause death or serious injury.

Allow the engine and exhaust system to cool before performing service procedures.

⚠ WARNING

Personal Injury or Equipment Damage Hazard!

Personal injury and/or equipment damage may occur if a technician is inexperienced in servicing diesel exhaust fluid (DEF) equipment.

Do not remove hoses from or attempt to service the DEF supply module without first consulting the engine manufacturer's instructions.

CAUTION

Equipment Damage!

Use of non-approved replacement parts may result in system damage.

The diesel exhaust fluid (DEF) system components are designed to withstand freezing and to be compatible with DEF fluid and the other unique characteristics of the system. Use only approved replacement parts when servicing the system.

The engine exhaust is treated to significantly reduce the amount of harmful by-products of combustion from contaminating breathable air.

Diesel Exhaust Fluid (DEF) Tank

⚠ WARNING

Chemical Hazard!

Diesel exhaust fluid (DEF) contains urea, and exposure to certain body parts or ingestion can cause death or serious injury.

Observe the following:

- Do not get DEF in your eyes. In case of contact, immediately flush eyes with large amounts of water for a minimum of 15 minutes.
- Do not swallow DEF. If DEF is ingested, contact a physician immediately.

See Figure 7-12 for the following.

The DEF tank (1) can hold 57 L (15 gal) of DEF. DEF consists of 32% urea and 68% de-ionized water. A varying, metered mist of DEF, equal to 2 to 3% of the fuel used, is injected into the decomposition reactor tube (DRT) (2). This is about 59 L (15.6 gal) of DEF for two tanks of fuel.

There is a 40-micron filter in the DEF supply line. For filter maintenance intervals and procedures, refer to the engine manufacturer's manual.

A drain valve (9) is provided in case the tank needs to be emptied of poor-quality DEF.

CAUTION

Loss of Power or Engine Shutdown Hazard!

If the diesel exhaust fluid (DEF) is not maintained, an error code is activated. Poor-quality or low DEF can lead to engine power being reduced (de-rated) by the engine control module (ECM). If the condition persists, engine shutdown may occur.

Do not use a poor-quality DEF or allow the DEF to run low. Refer to Section 3 of the Operator Manual for identification and location of the engine and exhaust aftertreatment warning lights.

NOTE: Do not store DEF for long periods of time. DEF deteriorates relative to time, temperature, and sunlight (UV). Poor-quality DEF may require the tank to be drained and the system purged. Store DEF in a cool, dark location.

Coolant Solenoid Valve

See Figure 7-12 for the following.

When needed, the diesel exhaust fluid (DEF) is heated by engine coolant which is circulated through a heat exchanger in the tank. If the tank temperature drops below –4°C (25°F), the engine control module (ECM) opens the coolant control valve (3) to allow coolant to flow through the heat exchanger.

Coolant Manifold

See Figure 7-12 for the following.

The coolant manifold (4) routes coolant flow to the system.

Diesel Exhaust Fluid (DEF) Supply Pump

See Figure 7-12 for the following.

The DEF supply pump (5) is an electronically operated pump and metering system controlled by the engine control module (ECM). The pump sends DEF to the DEF dosing module (6), which is mounted on the decomposition reactor tube (DRT) (2).

At engine shutdown, the DEF supply pump enters a purge cycle to prevent DEF from being left in the system, and in cold climates, from potentially freezing. When it is in the purge cycle, an audible click and pumping sound is heard from the pump, and the pump pulls out all of the DEF in the system and returns the DEF to the tank.

The DEF supply pump is heated electrically and has a 10-micron filter that requires periodic cleaning and inspection. For filter maintenance intervals, refer to the engine manufacturer's manual.

Selective Catalytic Reduction (SCR) Module

See Figure 7-12 for the following.

The SCR module (7) incorporates a catalyst, two temperature sensors, and an NO_X sensor. The SCR module utilizes a liquid mixture of urea and deionized water (called DEF) to reduce NO_X content in the exhaust gas to nitrogen. The SCR module does not require maintenance.

Excessive NO_X Warning System

CAUTION

Loss of Power or Engine Shutdown Hazard!

If NO_X emissions exceed legislated limits, the operator is alerted with warning lights and audible warnings. If the condition is not corrected in a set amount of time, an engine de-rate and shutdown sequence begins.

Refer to Section 3 of the Operator Manual for the following:

- Identification and location of the engine and exhaust aftertreatment warning lights
- How to correct an excessive emissions condition

If an excessive NO_X warning is issued, check anything that might cause an elevated NO_X level, such as the following:

- Disconnected DEF tank level or quality sensor
- Blocked DEF hose or dosing module
- Disconnected dosing module
- Disconnected supply module
- Disconnected SCR wiring harness
- Disconnected NO_X sensor
- EGR valve malfunction

Aftertreatment Protection System (APS)

The APS continually monitors exhaust gas temperatures. If excessive exhaust temperatures are detected, the APS illuminates the high exhaust system temperature (HEST) lamp in the cab.

Decomposition Reactor Tube (DRT)

See Figure 7-12 for the following.

The DRT (2) is a tube mounted between the diesel oxidation catalyst (DOC)/diesel particulate filter (DPF) module (8) and the selective catalyst reduction (SCR) module (7).

The DRT module does not require maintenance.

Diesel Exhaust Fluid (DEF) Dosing Module

See Figure 7-12 for the following.

The DEF dosing module (6) injects a liquid mixture of urea and deionized water (called DEF) into the exhaust stream ahead of the inlet to the selective catalyst reduction (SCR) module (7). Coolant lines run through the dosing module to keep it cool and operable.

Diesel Oxidation Catalyst (DOC)/Diesel Particulate Filter (DPF) Module

See Figure 7-12 for the following.

The primary function of the DOC/DPF module (8) is to oxidize the remaining hydrocarbons in the exhaust to carbon dioxide. It incorporates a dual pressure (dP) sensor and two temperature sensors.

The DOC module does not require maintenance.

Diesel Exhaust Fluid (DEF) Heating and Cooling System

See Figure 7-12 for the following.

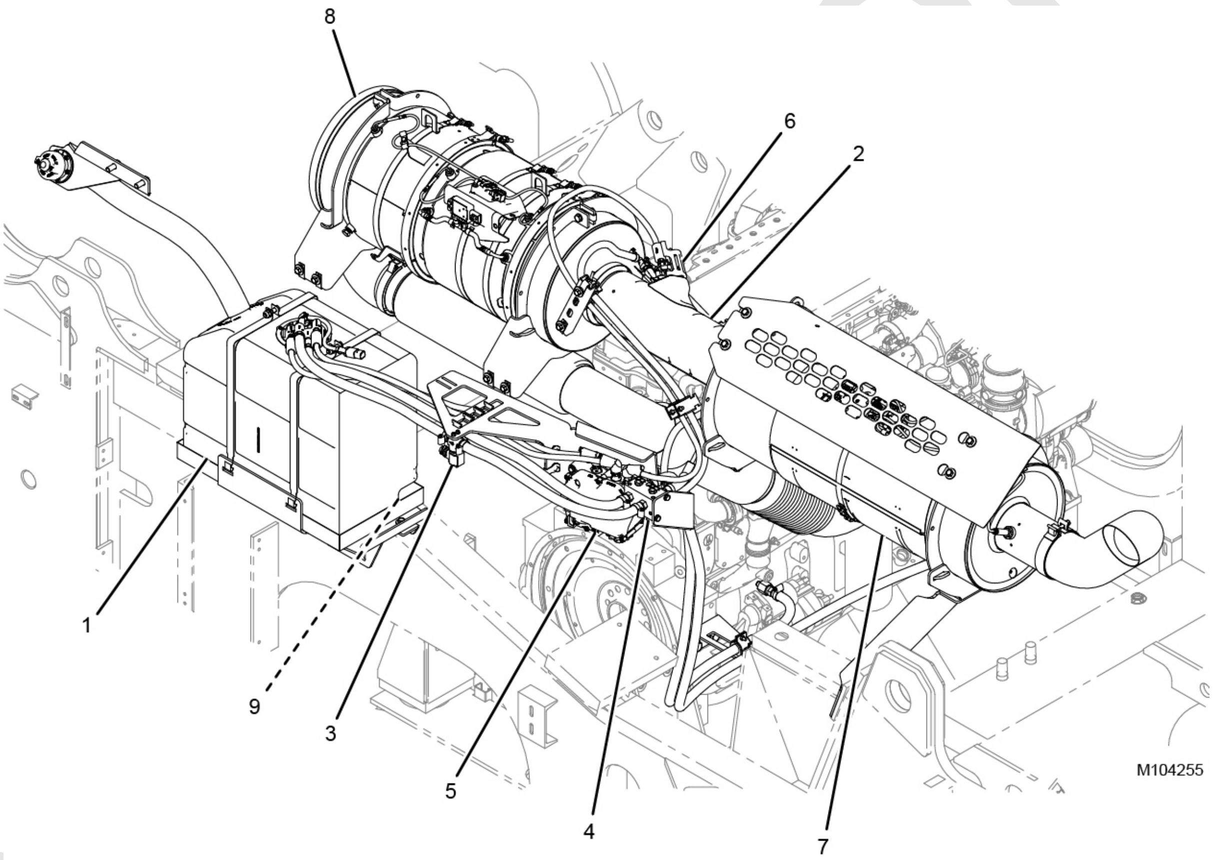
Warm coolant from the engine is routed to the coolant manifold (4) where it splits into two paths—one path delivers coolant to the heat exchanger in the DEF tank (1) to keep the DEF warm, and the other path delivers coolant to the DEF dosing module (6) to keep it from overheating.

The coolant control valve (3) adjusts coolant flow according to the temperature of the DEF in the DEF tank. If the tank temperature drops below –4°C (25°F), the ECM opens the solenoid valve, and engine coolant flows through the heat exchanger in the DEF tank.

To keep the DEF flowing during cold temperatures, two heating elements are provided—one in the DEF supply pump and one in DEF line. The heating elements turn on if the ambient air temperature sensor reads a temperature below -4°C (25°F).

The DEF dosing module does not prime the system until every component is completely defrosted. If ambient conditions continue to be cold after the system has primed, the ECM commands a maintenance heating cycle to prevent the DEF system from refreezing. This feature cycles the heating on and off to the DEF lines, DEF tank, and dosing module.

NOTE: DEF freezes at –11°C (12°F) and, when frozen, expands by 7%. There are no approved additives to improve the freezing point.



Item	Description
1	Diesel Exhaust Fluid (DEF) Tank
2	Decomposition Reactor Tube (DRT)
3	Coolant Control Valve
4	Coolant Manifold
5	Diesel Exhaust Fluid (DEF) Supply Pump
6	Diesel Exhaust Fluid (DEF) Dosing Module
7	Selective Catalyst Reduction (SCR) Module
8	Diesel Oxidation Catalyst (DOC)/Diesel Particulate Filter (DPF) Module
9	Drain Valve

FIGURE 7-12

PUMP DRIVE DISCONNECT

General

CAUTION

Pump Damage!

The pump drive bearings can be damaged if the engine runs for more than two minutes with the pump drive disengaged.

Do not engage or disengage the pump drive with the engine running because gear damage could result.

A gear-type, manually operated disconnect is mounted inside the pump drive. The disconnect allows the pump drive to be disconnected from the engine, thereby reducing engine load and making startup easier in cold weather. The disconnect can be engaged or disengaged only while the engine is off.

Disconnect the pump drive for the following reasons:

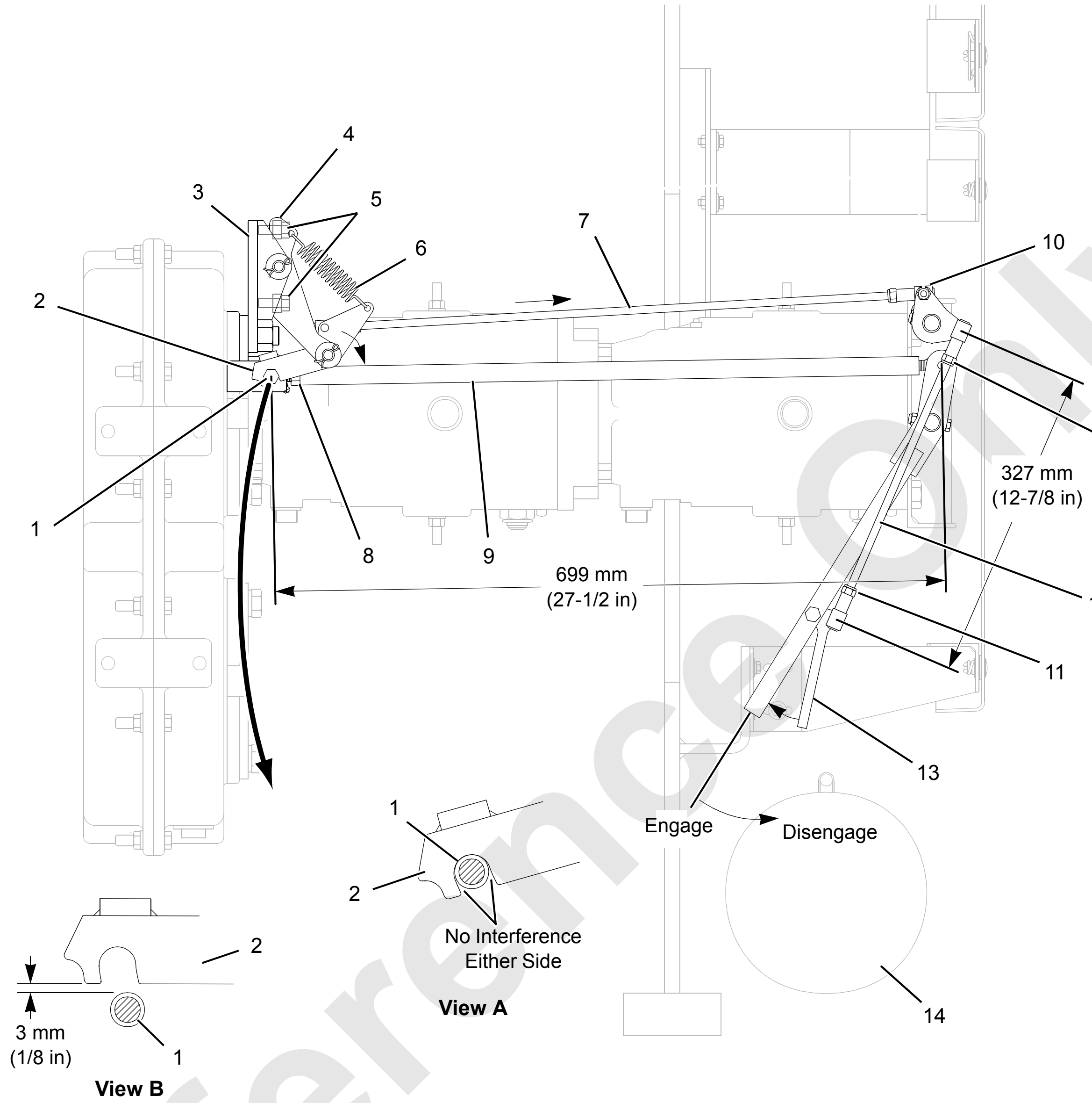
- To make the engine start easier during cold weather
- When the hydraulic pumps are being serviced

Adjustment

See Figure 7-13 for the following procedure.

Adjust the pump drive disconnect as follows.

1. Set the length of the shift rod (9) to 699 mm (27-1/2 in), lock it in place with the hex nut (8), and install the rod.
2. Set the length of the pull rod (12) to 327 mm (12-7/8 in), lock it in place with the elastic stop nuts (11), and install the rod.
3. Position the rocker arm (4) as follows.
    a. Loosen the set screws with lock nuts (5) and adjust the set screws against the base plate (3) until the hook (2) can fully engage the latch assembly (1) without interference (see View A).
    b. Lock the set screws in place with the lock nuts.
4. Install the spring (6) so the hook is held in the fully engaged position.
5. Install the control rod (7) as follows.
    a. The approximate assembly length from centerline to centerline of the ball joints (10) on the control rod is 624 mm (24-9/16 in).
    b. Adjust the length of the control rod to retain a minimum clearance of 3 mm (1/8 in) (see View B) between the hook and the latch assembly when the squeeze trigger (13) is compressed against the pump drive disconnect handle and the shift rod is shifted through the engaged and disengaged positions.



Item	Description	Item	Description
1	Latch Assembly	8	Hex Nut
2	Hook	9	Shift Rod
3	Base Plate	10	Ball Joint (qty 2)
4	Rocker Arm	11	Elastic Stop Nut (qty 2)
5	Set Screw with Lock Nut (qty 2)	12	Pull Rod
6	Spring	13	Squeeze Trigger
7	Control Rod	14	Left Rear Jacking Cylinder

FIGURE 7-13

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SECTION 8
UNDER CARRIAGE

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SECTION 8
UNDERCARRIAGE

TURNTABLE BEARING BOLT TORQUE

Installing the Turntable Bearing

See Figure 8-1 for the following.

The outer ring of the turntable bearing must be properly mounted to allow the rotating bed to be parked in line with the crawlers or the carrier.

The gear tooth valley marked XX in the outer ring must be mounted on the longitudinal centerline at the front or rear of the carbody or carrier as shown.

Four dowel pins are installed in the inner ring as shown in View A-A. Use the pins to align the upper adapter with the inner ring.

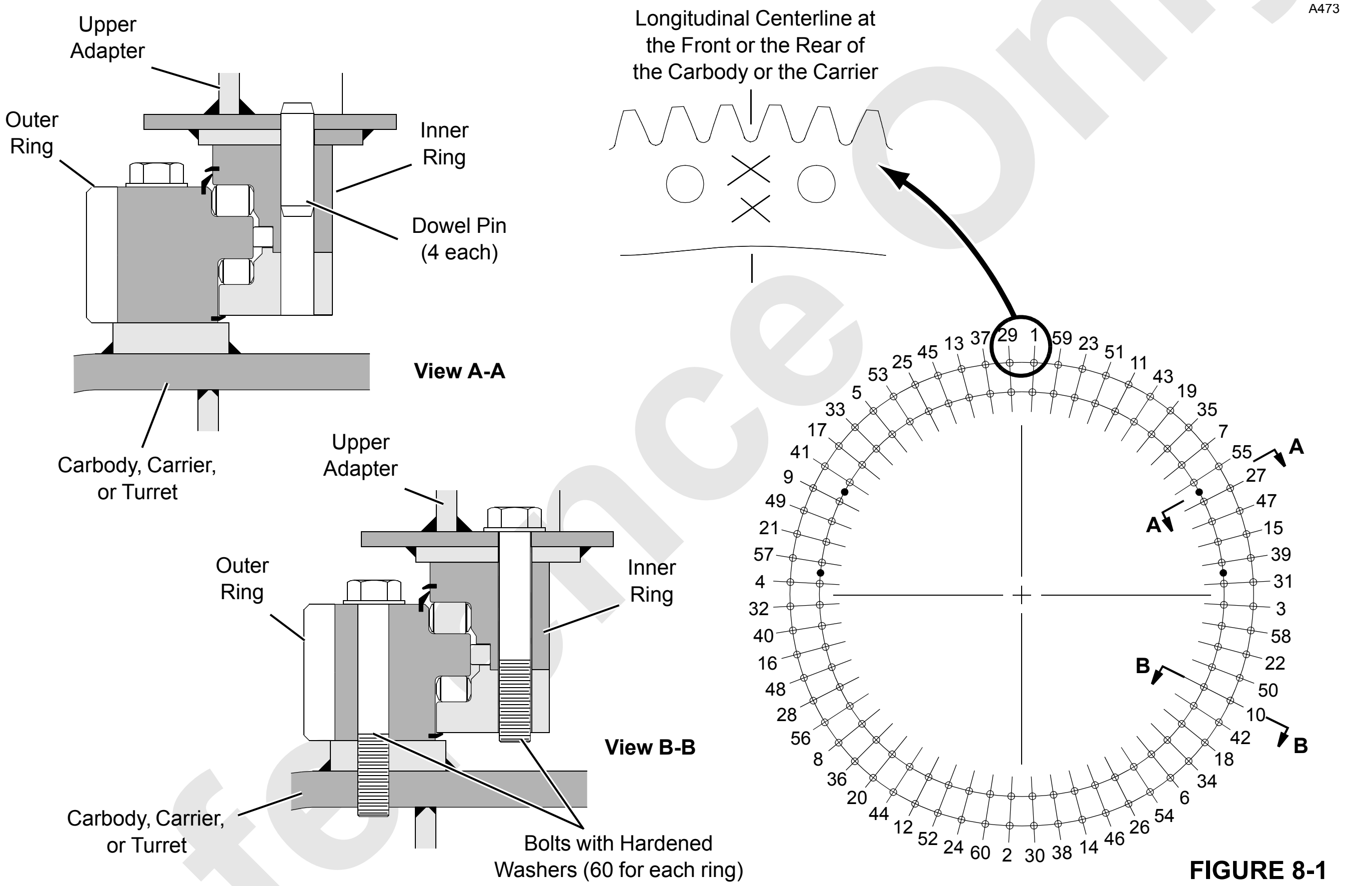

FIGURE 8-1

Torque Requirements

⚠ WARNING

Turntable Bearing Hazard!

Death or serious injury may occur due to loose or improperly tightened bolts. The bolts and/or the turntable bearing can fail, possibly allowing the rotating bed to break away from the carbody, carrier, or turret.

Make sure that all bolts are tightened to the proper torque specification.

Lubrication

Before installing the turntable bearing bolts, lubricate the threads of each bolt with Never-Seez (MCC 361010) or an equivalent antiseizing lubricant.

Torque Sequence

Tighten the bolts in the numbered sequence given in Figure 8-1.

Torque Values

When used turntable bearing bolts are installed, tighten each bolt to 2 848 Nm (2,100 lb-ft).

When new bolts are installed, tighten the bolts in two steps, as follows:

1. Tighten all bolts to 814 Nm (600 lb-ft).
2. Tighten all bolts to 2 848 Nm (2,100 lb-ft).

Torque Intervals

Tighten all bolts to the specified torque value at the following intervals:

- After the first 50 hours of operation
- Yearly or every 2,000 hours of operation (whichever comes first

Replacing the Turntable Bearing Bolts

If, at the yearly inspection interval, one or more bolts are found to be tightened to less than 2 278 Nm (1,680 lb-ft), replace the loose bolt(s). Also replace the bolts and washers on each side of each loose bolt.

If, at the yearly inspection interval, twelve or more bolts for either ring are found to be tightened to less than 2 278 Nm (1,680 lb-ft), replace all of the bolts and washers for the corresponding ring.

Replace all of the bolts and washers each time a new turntable bearing is installed.

CRAWLER ADJUSTMENT

Maintenance

Crawler wear cannot be eliminated, but the rate of wear can be reduced through regular preventive maintenance, as follows:

- Lubricate the crawlers as instructed in Lubrication Section 9.
- Keep the crawlers clean and avoid dirt buildup when cutting.
- Keep all mounting bolts tight (see the parts manual for applicable torque values).
- Keep the treads properly adjusted.
- Inspect the crawler gear cases, crawler frames, rollers, treads, and drive shafts 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 any damaged parts immediately to prevent further damage.

Adjusting the Tread Slack

Crawler Adjustment Guideline

See Figure 8-2 for the following procedure.

Check for tread slack at the tumbler end of each crawler. Maintain equal tread slack at both crawlers.

1. Travel forward on a firm, level surface so that all of the tread slack is in the top of the treads at the tumbler end of the crawlers.
2. Place a straightedge on the treads as shown. The gap between the straightedge and the top of the tread at the lowest point should be as follows:
   - Tight limit—25 mm (1 in)
   - Loose limit—63 mm (2.5 in)
3. Adjust the tread slack if the gap is less than the tight limit or greater than the loose limit.

CAUTION

Equipment Damage!

More torque is required to drive tight treads, which results in faster wear, possible pin breakage, and more fuel consumption. Dirt buildup will tighten the treads even more, increasing the possibility of damage.

Adjust the treads exactly as specified.

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4. Adjust the treads tighter when operating on firm ground or looser when operating on soft ground (mud or sand).

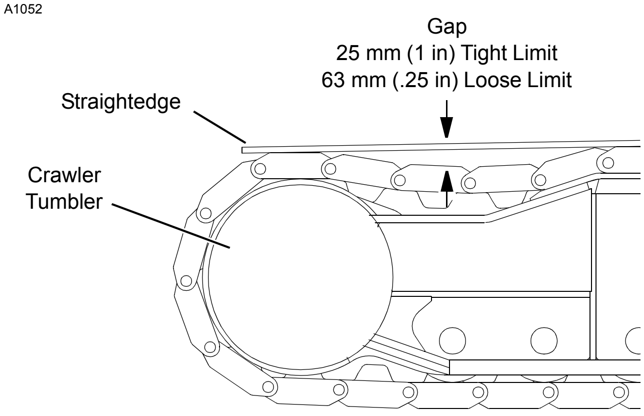


FIGURE 8-2

Adjusting the Tread Slack

See Figure 8-3 for the following procedure.

Adjust the tread slack at the front roller end of each crawler.

1. Thoroughly clean the crawler to be adjusted.
2. Loosen the two bolts (1) at the front roller end of the crawler (1 bolt, each side).
3. Remove the cover (2) from each side of the crawler frame.
4. Place the jack cylinder (3) on the support (4).
5. Using the hand pump (11), jack against the rod (5) an equal amount on both sides of the crawler frame.
6. Add or remove an equal thickness of shims (6) on both sides of the crawler frame.
7. Remove the jack cylinder.
8. Travel the crane forward to tighten the shims.

CAUTION

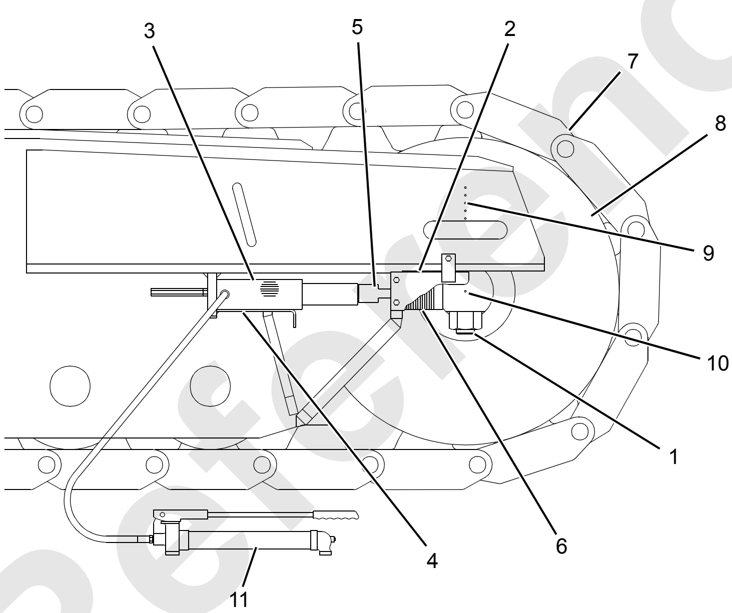
Excessive Part Wear!

Crawler parts will wear rapidly if they are not adjusted properly.

Make sure the front roller (8) and the rear tumbler are square with the crawler frame to within 3 mm (1/8 in).

9. Verify that the dimension from center punch mark A (10) in the shaft to center punch line B (9) in the crawler frame is within 3 mm (1/8 in) of each other on both sides of the crawler.
10. Check for proper adjustment (see Crawler Adjustment Guideline on page 8-2) and readjust as required (step 4 through step 9).
11. Tighten the nuts on the bolts at the front roller to 2 712 Nm (2,000 lb-ft).
12. Install the cover on each side of the crawler frame.

NOTE: The extreme limit of crawler tread (7) adjustment is 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	Bolt (qty 2)
2	Cover (qty 2)
3	Jack Cylinder
4	Support (qty 2)
5	Rod (qty 2)
6	Shims—3 mm (0.12 in) and 6 mm (0.25 in) Thick (qty varies)
7	Crawler Tread
8	Front Roller
9	Center Punch Line B
10	Center Punch Mark A
11	Hand Pump

FIGURE 8-3

HYDRAULIC HAND PUMP

Manitowoc provides a hand pump and cylinder to be used for performing the crawler adjustment procedure only. Any other use of this tool is neither intended nor approved.

WARNING

Personal Injury Hazard!

Serious personal injury may occur due to contact with hydraulic oil that is under pressure. The following may occur:

- Because the pump is not vented, the pump, cylinder, or hose can explode if the maximum pressure rating is exceeded.
- The pump handle can kick back.
- Handle extensions can cause unstable operation.

To avoid injury, observe the following:

- Wear safety glasses and other personal protective gear when operating the hand pump.
- Do not exceed the maximum pressure rating of 700 bar (10,000 psi).
- Do not set the pump relief valve higher than 700 bar (10,000 psi).
- Do not attempt to return more oil to the pump than it is capable of holding.
- Do not overfill the pump.
- Always keep your body to the side of the pump, away from a direct line of handle force.
- Do not add any extensions to the handle.

Assembly

See Figure 8-4 for the following procedure.

1. Apply 1-1/2 wraps of a high-grade thread sealant on the hose fitting threads.

   Do not apply sealant to the first complete thread to ensure that the tape does not enter into the hydraulic system, which could cause a malfunction or damage.

2. Connect the hose from the pump outlet port to the cylinder inlet port.
3. Do not overtighten the connections. The connections only need to be snug and leak free. Overtightening can cause premature thread failure and may cause the fittings or the castings to split at pressures lower than their rated capacity.

Maintenance

See Figure 8-4 for the following procedure.

1. Keep the unit clean and store it in a safe place where it cannot be damaged.
2. Keep the oil in the pump at the proper level. Check the oil level by opening the valve and fully retracting the cylinder rod to return all oil to the pump. The cylinder rod must be fully retracted or the reservoir will contain too much oil.

   For the Simplex pump, proceed as follows.

   a. Place the pump in a horizontal position on a flat surface.
   b. Using a screwdriver, remove the air release screw.
   c. Add hydraulic oil until the reservoir is 2/3 full. Do not overfill the pump.
   d. Securely reinstall the air release screw.

   For the Enerpac pump, proceed as follows.

   a. Place the pump in a vertical position with the hose end down.
   b. Using a screwdriver, remove the filler plug.
   c. Add hydraulic oil until it is at the oil level mark on the dipstick. Do not overfill the pump.
   d. Securely reinstall the filler plug.

3. Test the operation of the system. Erratic operation indicates that there is air in the system. Recheck the oil level after removing the air (see Removing Air from the Cylinder).

Removing Air from the Cylinder

See Figure 8-4 for the following procedure.

1. Close the valve finger tight only.
2. Position the pump higher than the cylinder and position the cylinder so the cylinder rod is pointing down.
3. Operate the pump to fully extend the cylinder rod.
4. Open the valve and retract the cylinder rod to force oil and trapped air back into the pump.
5. Repeat the steps until the cylinder operates smoothly. Erratic operation indicates that there is air in system.

Operating the Pump

See Figure 8-4 for the following procedure.

1. Before using the pump, perform the following.
   a. Verify that all fittings are tight and leak free.
   b. Verify that the oil is at the proper level.
2. To pressurize the cylinder and extend the cylinder rod, close the valve by turning it clockwise until finger tight only. Then pump the handle up and down to build pressure in the cylinder. The pressure will be maintained until the valve is opened.

   Make short strokes to reduce the amount of force required to pump the handle at high pressure. Maximum leverage is obtained in the last five degrees of the stroke.
3. To depressurize the cylinder, push the handle down fully and open the valve by turning it counterclockwise.

NOTE: The pump can be operated in any position from horizontal to vertical as long as the hose end of the pump is pointing down.

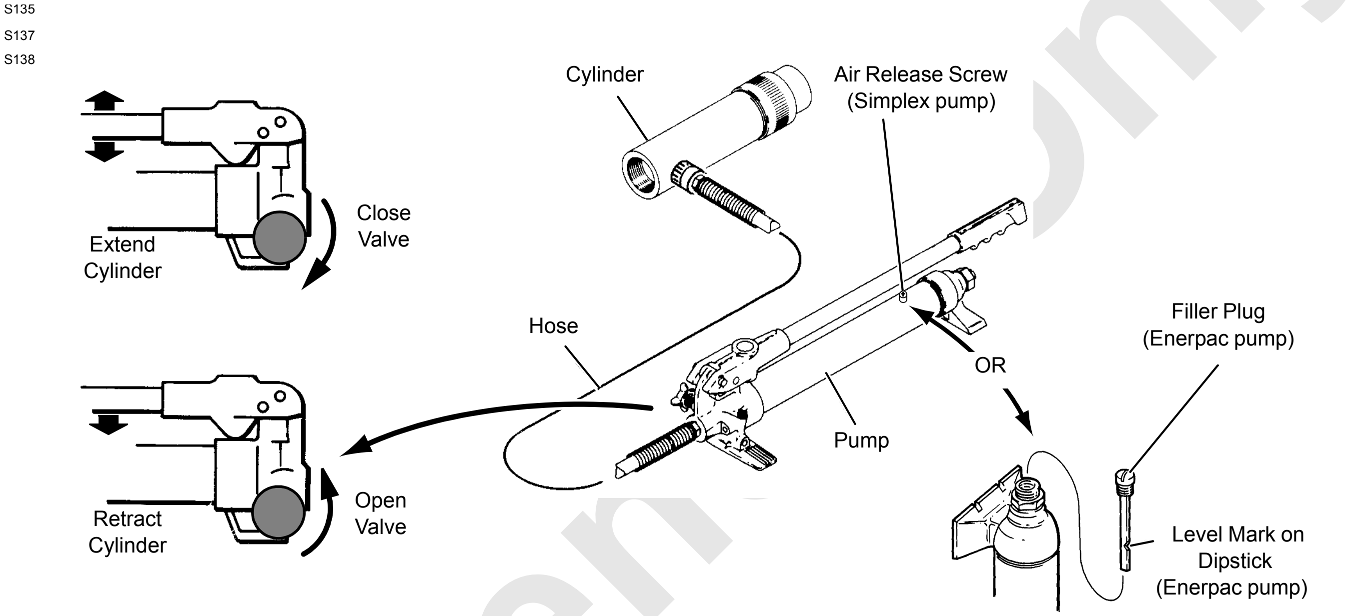


FIGURE 8-4

ROTATING BED LEVEL SENSOR

The rotating bed level sensor senses the crane's pitch and yaw. It is calibrated at the factory but can be reset if necessary.

Resetting the Level Sensor to Zero

See Figure 8-5 for the following procedure.

To reset the level sensor to zero, proceed as follows.

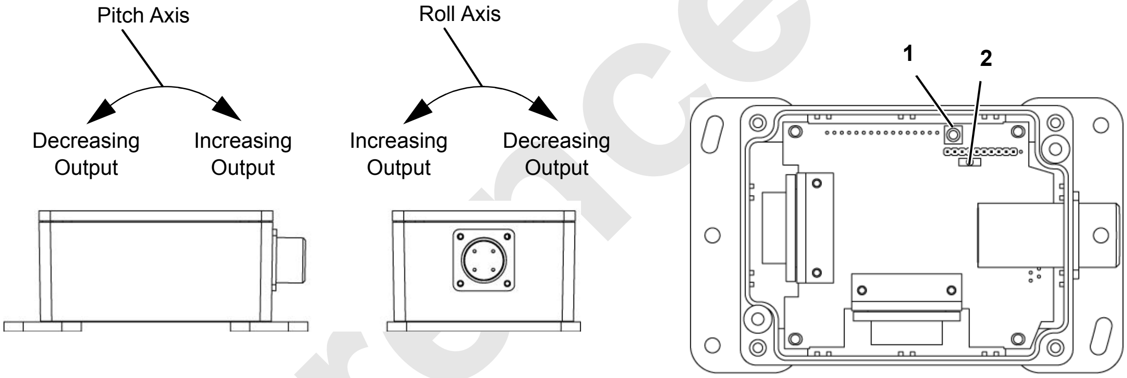
1. Mount the sensor to a horizontal mounting surface.
2. Remove the cover and apply 5 volts DC power to the sensor.
3. LED 023 (2) will be lit whenever the level is within ±5° of true level. Ensure that both axes are within ±5° of true level.
4. Press and hold switch SW1 (1) for one second and release.
5. The new "permanent zero" is now set and stored in non-volatile memory.
6. Repeat step 2 through step 5 to reset to a different setting if necessary.
7. Disconnect the power and install the cover.

Recalibrating the Level Sensor

See Figure 8-5 for the following procedure.

To recalibrate the level sensor, proceed as follows.

1. Disconnect power to the level sensor.
2. Remove the cover.
3. Press and hold down switch SW1 (1) while reapplying power to the unit.
4. Continue to hold down switch SW1 for one second and release.
5. The new "permanent zero" now is set and stored in non-volatile memory.
6. Install the cover.



Item	Description
1	Switch SW1
2	LED 023

FIGURE 8-5

SECTION 9
LUBRICATION

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SECTION 9

LUBRICATION

LUBRICATION GUIDE

See F2298 at the end of this section.

LUBE AND COOLANT PRODUCT GUIDE

See the publication at the end of this section.

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SECTION 10
TROUBLESHOOTING

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SECTION 10

TROUBLESHOOTING

BASIC 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 dealer. The Manitowoc Crane Care Lattice Team can also provide assistance if necessary.

The first part of this section provides a series of flow charts that identify problems that could be encountered during normal operation of the crane. 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 must be performed to move through the complete troubleshooting procedure. If directed, consult your dealer or the Manitowoc Crane Care Lattice Team before proceeding.

The second part of this section contains specific instructions for testing and servicing the various systems and components described in the troubleshooting charts.

SAFETY SUMMARY

Hazards are always a possibility when performing troubleshooting operations on heavy equipment. To minimize the risk of potential hazards and to prevent serious injury or death, you must comply with the following:

- Carefully read Crane Description of Operation in Section 1 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 Cranes shall not be responsible for the training of personnel who might use this manual to perform the troubleshooting operations.
- Whenever possible, turn off the engine and keep unauthorized personnel away from the crane when troubleshooting.
- Never troubleshoot the crane alone. Always perform troubleshooting procedures with a qualified operator in the crane cab. Maintain constant communication with the operator when performing operations that require the crane to be running.
- Do not return the crane to service after completion of maintenance or repair procedures until all guards and covers have been installed, trapped air is bled from the hydraulic systems, safety devices are activated, and maintenance equipment is removed.
- Perform a function check to ensure correct operation at the completion of maintenance or repair operations.

The following warnings apply to all troubleshooting operations. Manitowoc Cranes cannot foresee all hazards that may occur.

You shall be familiar with the equipment, trained in testing methods, and use common sense while troubleshooting to avoid other hazards.

⚠ WARNING

Eye, Skin, and Respiratory Hazards!

Death or serious injury may occur from contact with hydraulic oil that is under pressure.

Observe the following to prevent death or serious injury:

- Turn off the engine, remove the key, and relieve the pressure on the system before disconnecting, adjusting, or repairing any component.
- Wear proper eye and skin protection and avoid direct contact with battery acid, oil, or ether spray when searching for leaks, opening connections, or installing pressure gauges.
- Ensure that connections are made correctly, O-rings or gaskets are in place, and connectors are tight before pressurizing the system.
- Use necessary precautions to prevent electrical burns when checking the battery charging and starter circuits.

⚠ WARNING

Unexpected Moving Part Hazard!

There is sometimes unintended operation of the machine when manually activating valves or pumps. This unexpected movement can cause death or serious injury.

Keep personnel away from the crane while manually actuating a valve or pump.

GENERAL GUIDELINES

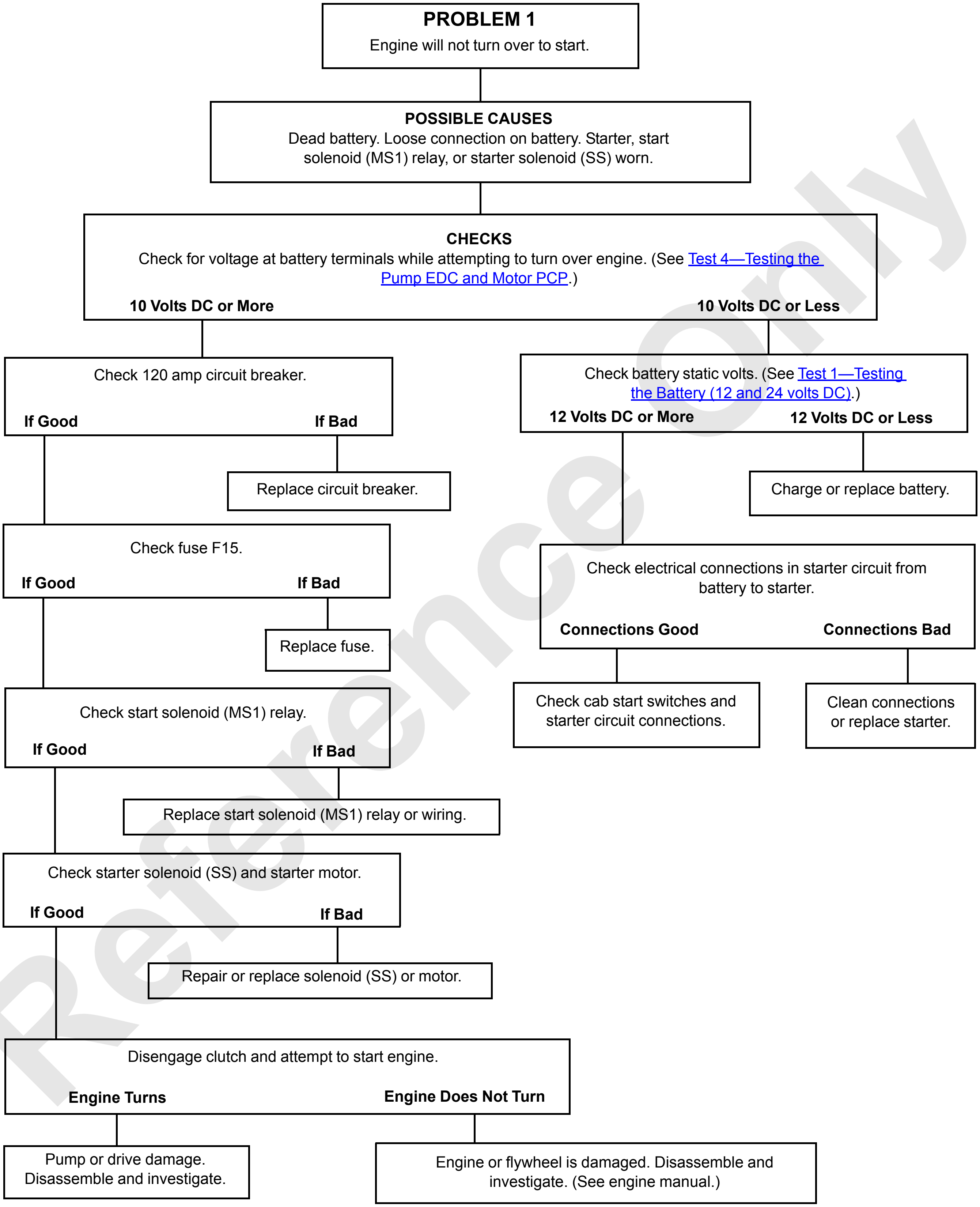
The following guidelines apply to all troubleshooting operations:

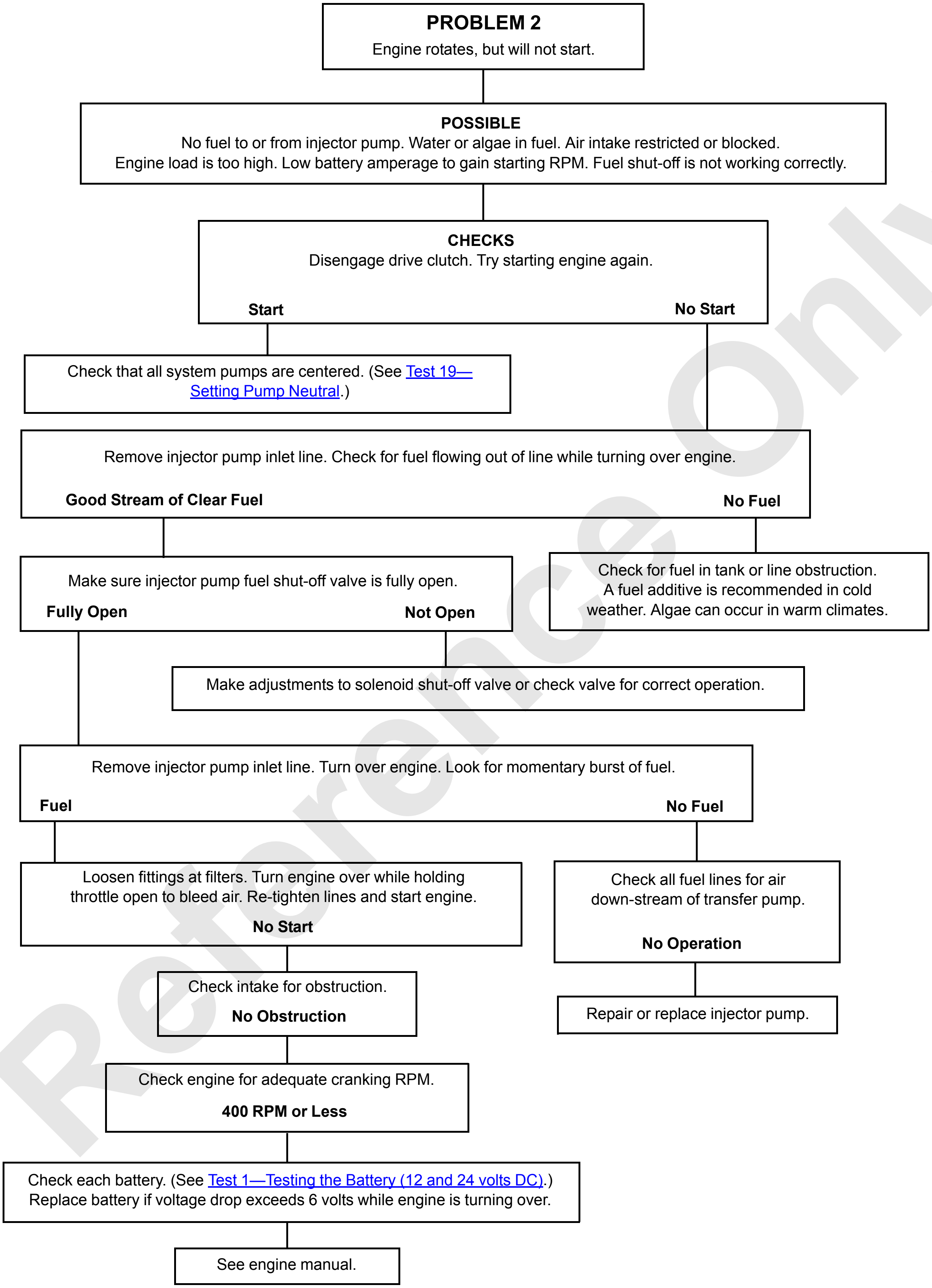
- Do not remove cylinders or counterbalance valve(s) from a cylinder until its working unit is restrained against movement.
- Do not use your hands to check for hydraulic oil leaks. Use a piece of cardboard to check for such leaks.
- Use gauges of the correct pressure range when checking hydraulic circuits.
- Use the standard test plug adapters (available from the Manitowoc Crane Care Lattice Team) for electrical testing.
- Check ground potentials when testing electric circuits for continuity, voltage, or resistance. When checking voltages, use the ground point for the circuit being checked. If voltage does not register on the multimeter, use a known ground. If a value is read, the ground of the circuit being tested is probably faulty.
- Check all terminal points for cleanliness and tighten connections.
- Check pressures at the specified hydraulic component ports.
- Check the motor pressure control pilot (PCP) valve on the motor being tested. Test the pump electric displacement controls (EDC) on the pump being tested.
- Check each pressure sender electric supply at the system sender.
- Check the encoder electric supply at the test plug adapter of the encoder being tested.
- Check the correct operating limit electric supply by viewing the diagnostic display in the operator's cab.
- Check the control handle electrical input and output voltages at the control handle being tested.
- Check the basic system electric supplies and cab power relay at the fuse box mounted above the main electrical junction box in the operator’s cab.
- Check the programmable controller (PC) input and output cables at the connector pins.

TEST EQUIPMENT

Test equipment shown or described is available for testing the crane’s hydraulic or electrical systems. The test equipment can be purchased in kit form (with or without carrying case) or separately by contacting the Manitowoc Crane Care Lattice Team.

TROUBLESHOOTING CHARTS





PROBLEM 2
Engine rotates, but will not start.

POSSIBLE
No fuel to or from injector pump. Water or algae in fuel. Air intake restricted or blocked.
Engine load is too high. Low battery amperage to gain starting RPM. Fuel shut-off is not working correctly.

CHECKS
Disengage drive clutch. Try starting engine again.

Start

Check that all system pumps are centered. (See Test 19—Setting Pump Neutral.)

No Start

Remove injector pump inlet line. Check for fuel flowing out of line while turning over engine.

Good Stream of Clear Fuel

Make sure injector pump fuel shut-off valve is fully open.

Fully Open

Remove injector pump inlet line. Turn over engine. Look for momentary burst of fuel.

Fuel

Loosen fittings at filters. Turn engine over while holding throttle open to bleed air. Re-tighten lines and start engine.

No Start

Check intake for obstruction.

No Obstruction

Check engine for adequate cranking RPM.

400 RPM or Less

Check each battery. (See Test 1—Testing the Battery (12 and 24 volts DC).)
Replace battery if voltage drop exceeds 6 volts while engine is turning over.

See engine manual.

No Fuel

Check all fuel lines for air down-stream of transfer pump.

No Operation

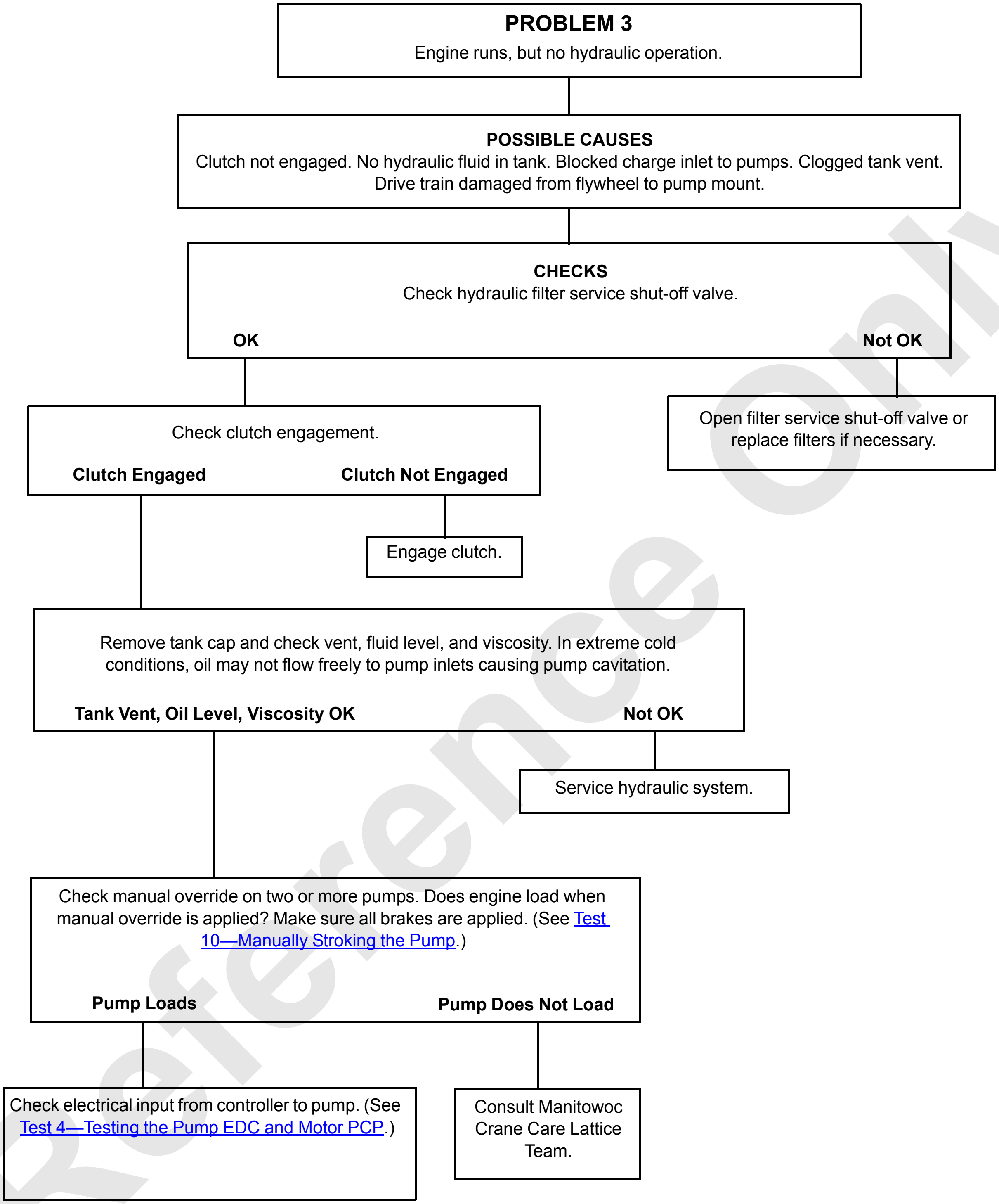
Repair or replace injector pump.

Not Open

Make adjustments to solenoid shut-off valve or check valve for correct operation.

No Fuel

Check for fuel in tank or line obstruction.
A fuel additive is recommended in cold weather. Algae can occur in warm climates.



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

Open filter service shut-off valve or replace filters if necessary.

Check clutch engagement.

Clutch Engaged

Clutch Not Engaged

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.

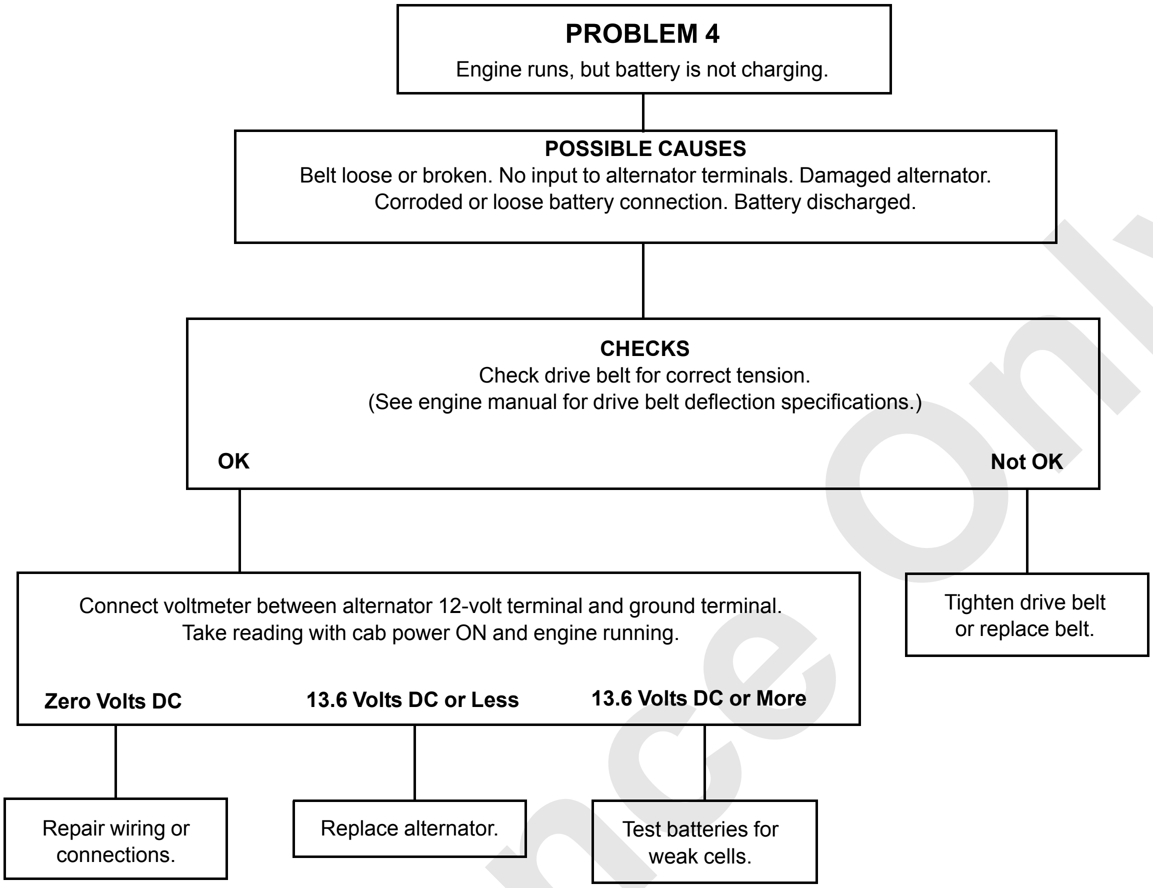
Check manual override on two or more pumps. Does engine load when manual override is applied? Make sure all brakes are applied. (See Test 10—Manually Stroking the Pump.)

Pump Loads

Pump Does Not Load

Check electrical input from controller to pump. (See Test 4—Testing the Pump EDC and Motor PCP.)

Consult Manitowoc Crane Care Lattice Team.



PROBLEM 4

Engine runs, but battery is not charging.

POSSIBLE CAUSES

Belt loose or broken. No input to alternator terminals. Damaged alternator. Corroded or loose battery connection. Battery discharged.

CHECKS

Check drive belt for correct tension.
(See engine manual for drive belt deflection specifications.)

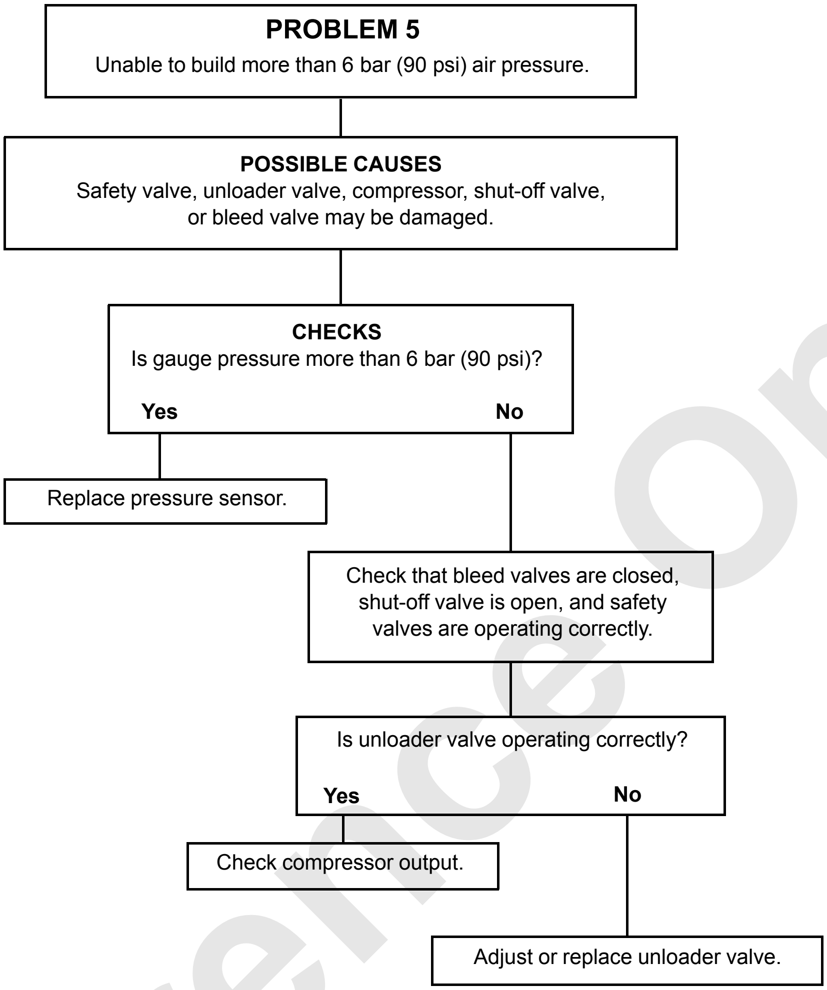
Connect voltmeter between alternator 12-volt terminal and ground terminal. Take reading with cab power ON and engine running.

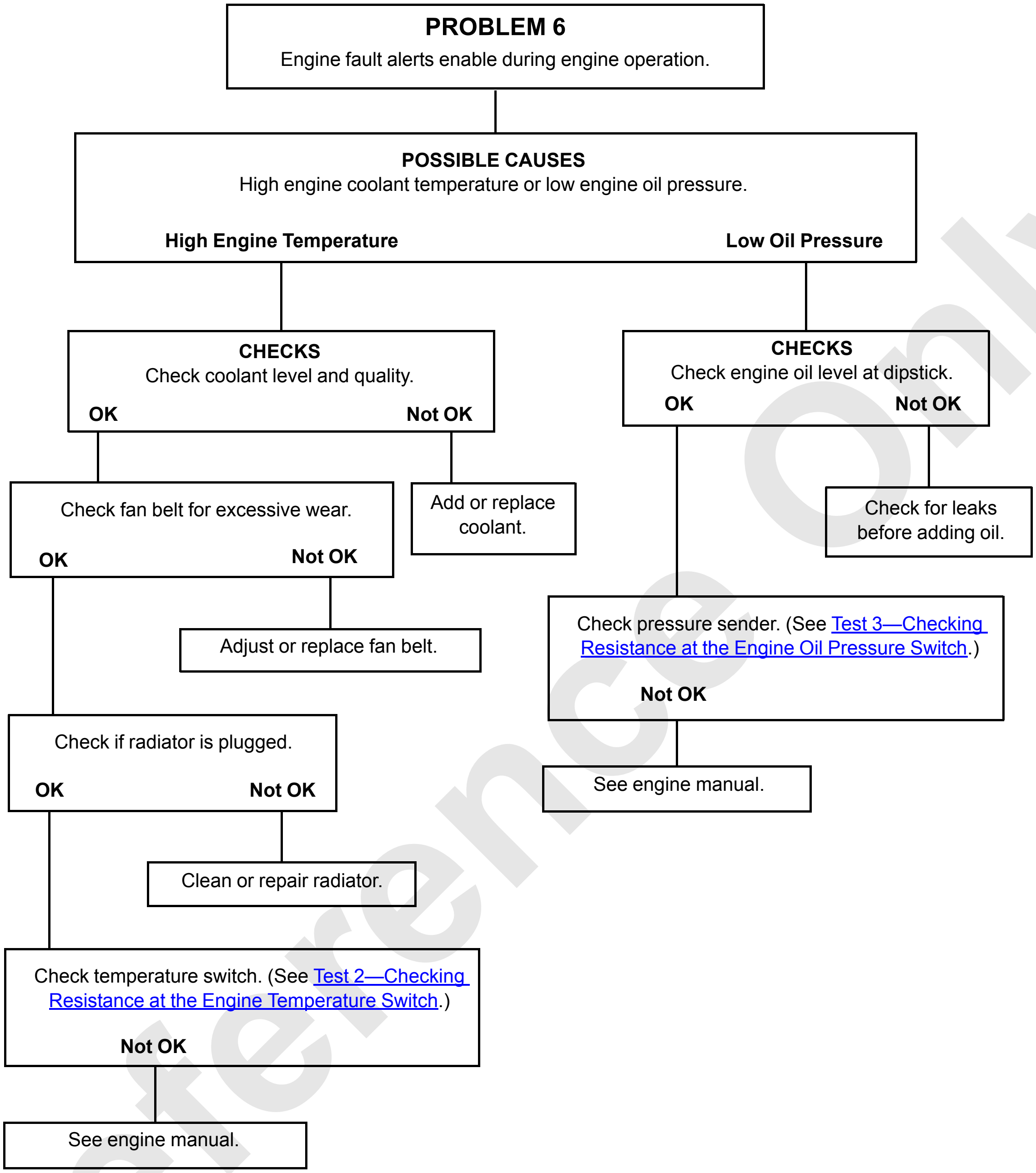
Repair wiring or connections.

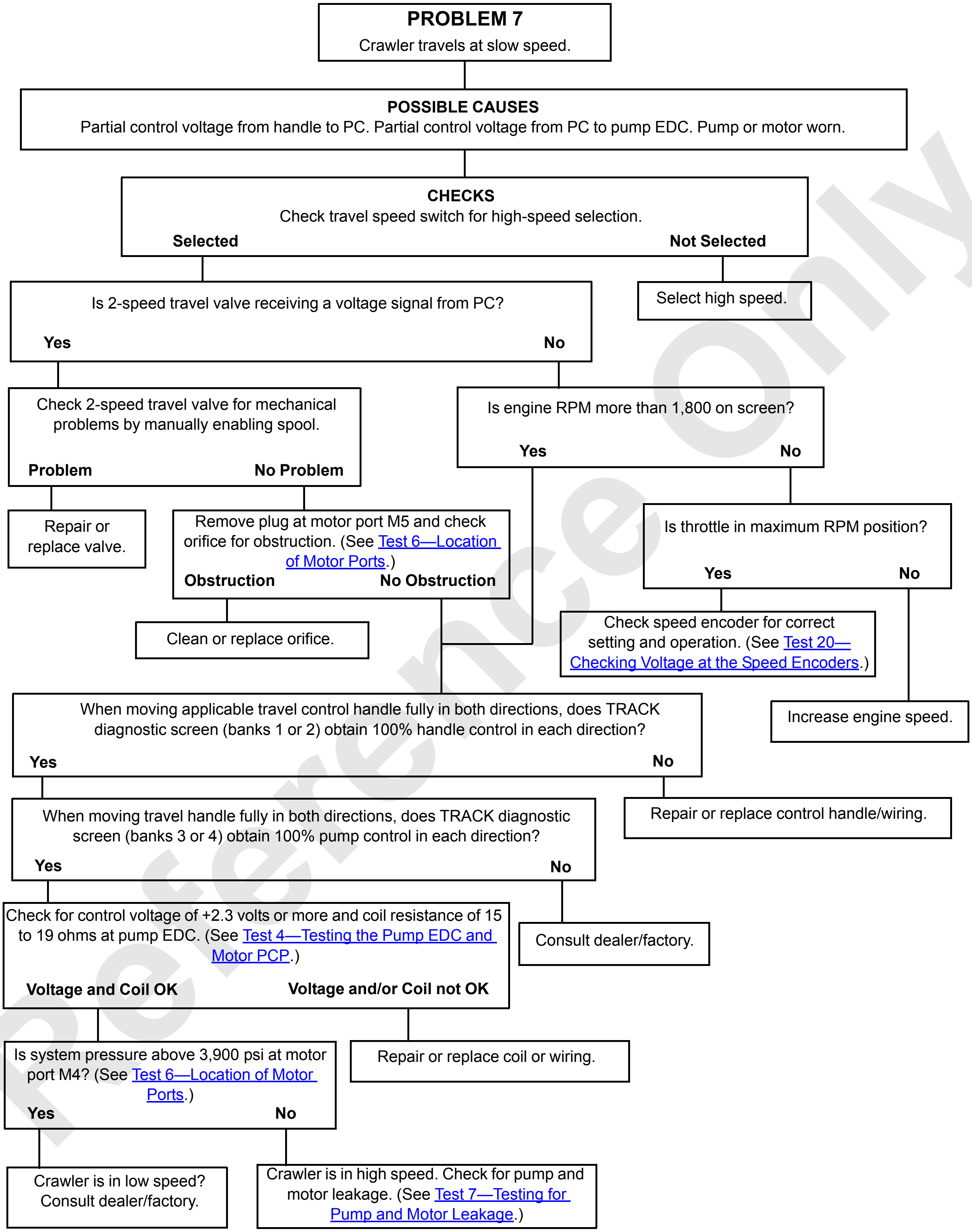
Replace alternator.

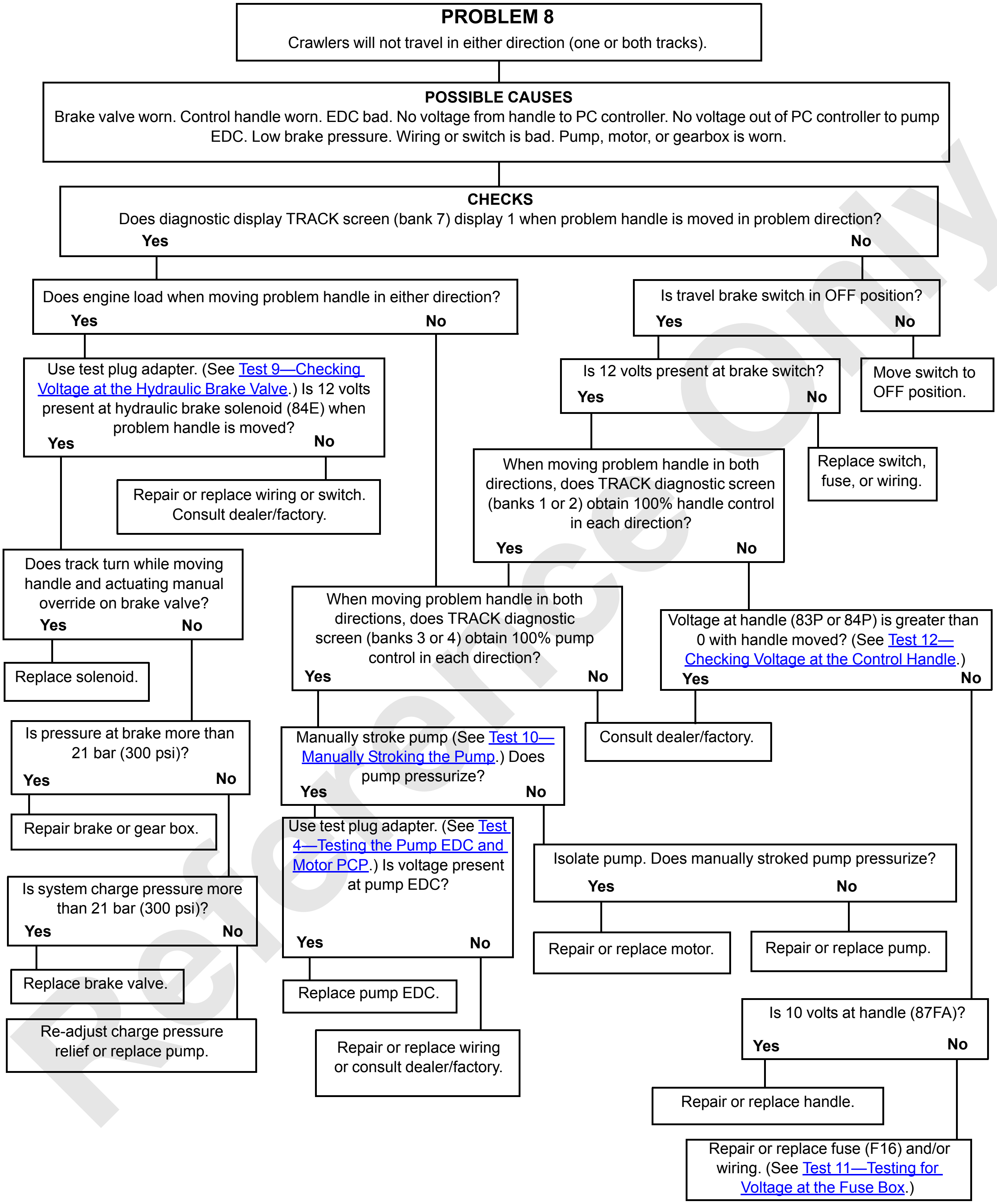
Test batteries for weak cells.

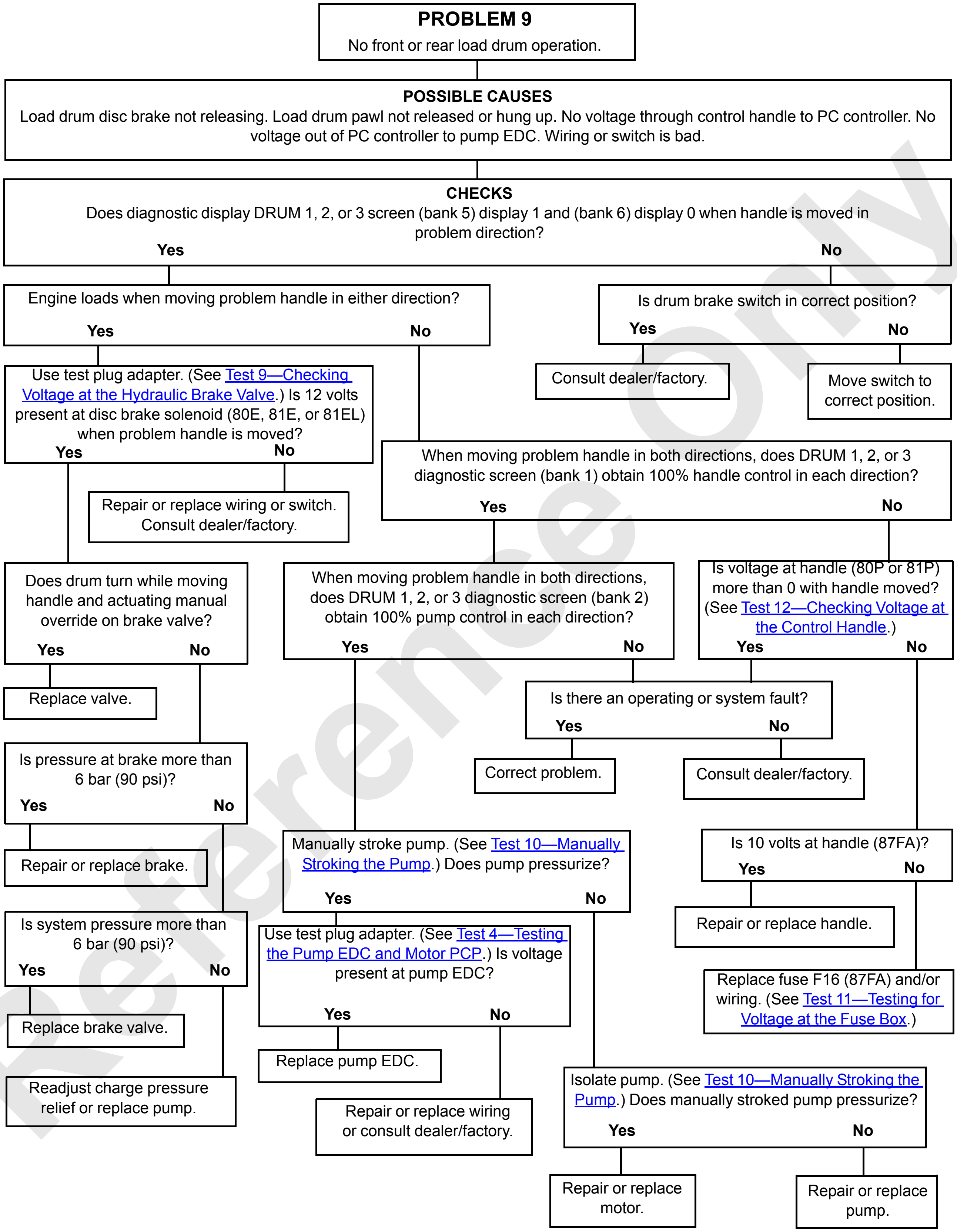
Tighten drive belt or replace belt.

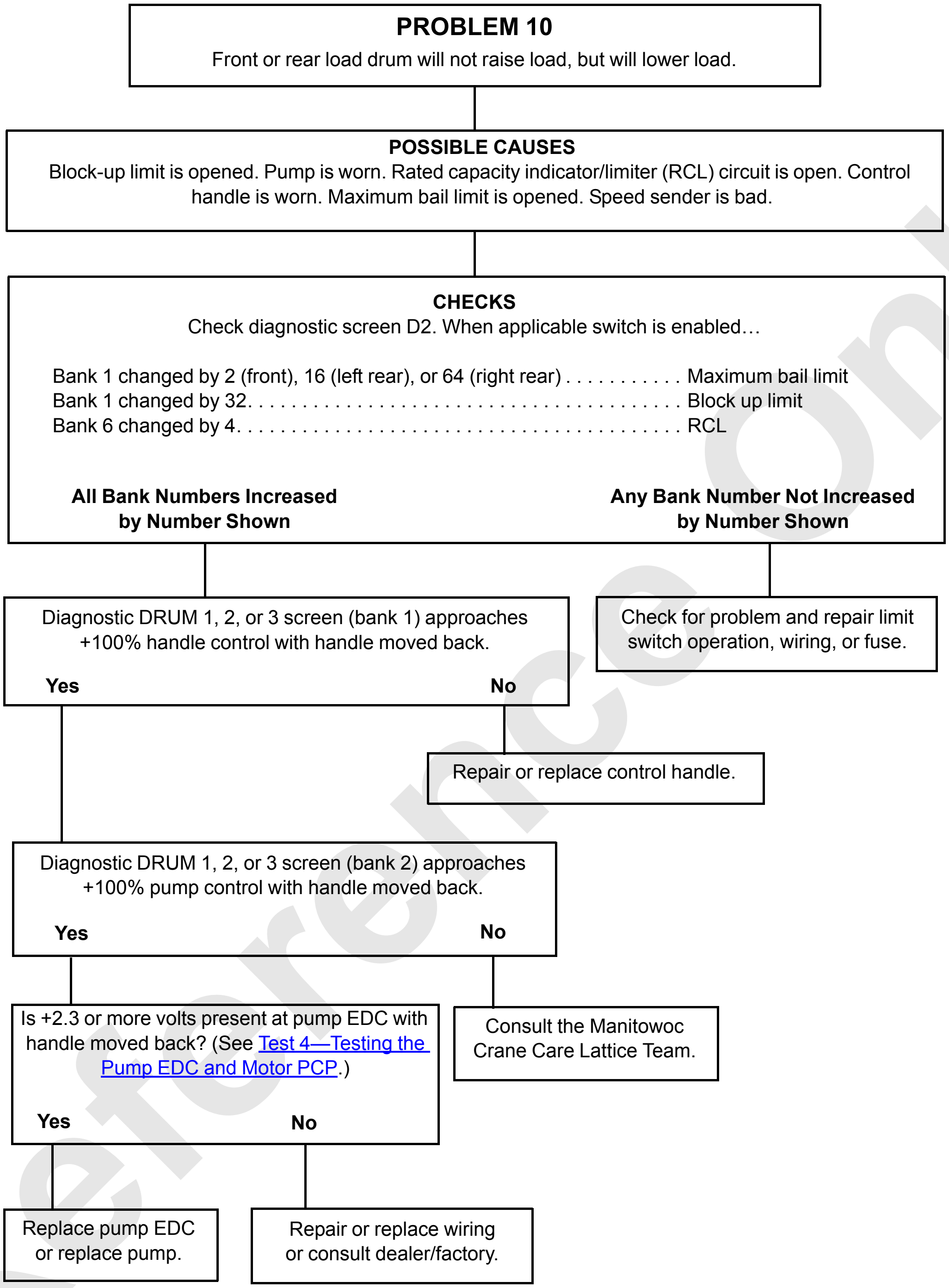

PROBLEM 5
Unable to build more than 6 bar (90 psi) air pressure.
POSSIBLE CAUSES
Safety valve, unloader valve, compressor, shut-off valve, or bleed valve may be damaged.
CHECKS
Is gauge pressure more than 6 bar (90 psi)?
Yes
No
Replace pressure sensor.
Check that bleed valves are closed, shut-off valve is open, and safety valves are operating correctly.
Is unloader valve operating correctly?
Yes
No
Check compressor output.
Adjust or replace unloader valve.


PROBLEM 6
Engine fault alerts enable during engine operation.
POSSIBLE CAUSES
High engine coolant temperature or low engine oil pressure.
High Engine Temperature
Low Oil Pressure
CHECKS
Check coolant level and quality.
OK
Not OK
Check fan belt for excessive wear.
OK
Not OK
Add or replace coolant.
Adjust or replace fan belt.
Check if radiator is plugged.
OK
Not OK
Clean or repair radiator.
Check temperature switch. (See Test 2—Checking Resistance at the Engine Temperature Switch.)
Not OK
See engine manual.
CHECKS
Check engine oil level at dipstick.
OK
Not OK
Check for leaks before adding oil.
Check pressure sender. (See Test 3—Checking Resistance at the Engine Oil Pressure Switch.)
Not OK
See engine manual.


PROBLEM 7
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 worn.
CHECKS
Check travel speed switch for high-speed selection.
Selected
Not Selected
Is 2-speed travel valve receiving a voltage signal from PC?
Yes
No
Select high speed.
Check 2-speed travel valve for mechanical problems by manually enabling spool.
Problem
No Problem
Is engine RPM more than 1,800 on screen?
Yes
No
Repair or replace valve.
Remove plug at motor port M5 and check orifice for obstruction. (See Test 6—Location of Motor Ports.)
Obstruction
No Obstruction
Is throttle in maximum RPM position?
Yes
No
Clean or replace orifice.
Check speed encoder for correct setting and operation. (See Test 20—Checking Voltage at the Speed Encoders.)
When moving applicable travel control handle fully in both directions, does TRACK diagnostic screen (banks 1 or 2) obtain 100% handle control in each direction?
Yes
No
Increase engine speed.
When moving travel handle fully in both directions, does TRACK diagnostic screen (banks 3 or 4) obtain 100% pump control in each direction?
Yes
No
Repair or replace control handle/wiring.
Check for control voltage of +2.3 volts or more and coil resistance of 15 to 19 ohms at pump EDC. (See Test 4—Testing the Pump EDC and Motor PCP.)
Voltage and Coil OK
Voltage and/or Coil not OK
Consult dealer/factory.
Is system pressure above 3,900 psi at motor port M4? (See Test 6—Location of Motor Ports.)
Yes
No
Repair or replace coil or wiring.
Crawler is in low speed? Consult dealer/factory.
Crawler is in high speed. Check for pump and motor leakage. (See Test 7—Testing for Pump and Motor Leakage.)


PROBLEM 8
Crawlers will not travel in either direction (one or both tracks).
POSSIBLE CAUSES
Brake valve worn. Control handle worn. EDC bad. No voltage from handle to PC controller. No voltage out of PC controller to pump EDC. Low brake pressure. Wiring or switch is bad. Pump, motor, or gearbox is worn.
CHECKS
Does diagnostic display TRACK screen (bank 7) display 1 when problem handle is moved in problem direction?
Yes
No
Does engine load when moving problem handle in either direction?
Yes
No
Use test plug adapter. (See Test 9—Checking Voltage at the Hydraulic Brake Valve.) Is 12 volts present at hydraulic brake solenoid (84E) when problem handle is moved?
Yes
No
Repair or replace wiring or switch. Consult dealer/factory.
Does track turn while moving handle and actuating manual override on brake valve?
Yes
No
Replace solenoid.
Is pressure at brake more than 21 bar (300 psi)?
Yes
No
Repair brake or gear box.
Is system charge pressure more than 21 bar (300 psi)?
Yes
No
Replace brake valve.
Re-adjust charge pressure relief or replace pump.
When moving problem handle in both directions, does TRACK diagnostic screen (banks 3 or 4) obtain 100% pump control in each direction?
Yes
No
Consult dealer/factory.
Manually stroke pump (See Test 10—Manually Stroking the Pump.) Does pump pressurize?
Yes
No
Use test plug adapter. (See Test 4—Testing the Pump EDC and Motor PCP.) Is voltage present at pump EDC?
Yes
No
Replace pump EDC.
Repair or replace wiring or consult dealer/factory.
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Repair or replace motor.
Repair or replace pump.
Is travel brake switch in OFF position?
Yes
No
Move switch to OFF position.
Is 12 volts present at brake switch?
Yes
No
Replace switch, fuse, or wiring.
When moving problem handle in both directions, does TRACK diagnostic screen (banks 1 or 2) obtain 100% handle control in each direction?
Yes
No
Voltage at handle (83P or 84P) is greater than 0 with handle moved? (See Test 12—Checking Voltage at the Control Handle.)
Yes
No
Is 10 volts at handle (87FA)?
Yes
No
Repair or replace handle.
Repair or replace fuse (F16) and/or wiring. (See Test 11—Testing for Voltage at the Fuse Box.)


PROBLEM 9
No front or rear load drum operation.
POSSIBLE CAUSES
Load drum disc brake not releasing. Load drum pawl not released or hung up. No voltage through control handle to PC controller. No voltage out of PC controller to pump EDC. Wiring or switch is bad.
CHECKS
Does diagnostic display DRUM 1, 2, or 3 screen (bank 5) display 1 and (bank 6) display 0 when handle is moved in problem direction?
Yes
No
Engine loads when moving problem handle in either direction?
Yes
No
Is drum brake switch in correct position?
Yes
No
Consult dealer/factory.
Move switch to correct position.
Use test plug adapter. (See Test 9—Checking Voltage at the Hydraulic Brake Valve.) Is 12 volts present at disc brake solenoid (80E, 81E, or 81EL) when problem handle is moved?
Yes
No
Repair or replace wiring or switch. Consult dealer/factory.
When moving problem handle in both directions, does DRUM 1, 2, or 3 diagnostic screen (bank 1) obtain 100% handle control in each direction?
Yes
No
Does drum turn while moving handle and actuating manual override on brake valve?
Yes
No
Replace valve.
When moving problem handle in both directions, does DRUM 1, 2, or 3 diagnostic screen (bank 2) obtain 100% pump control in each direction?
Yes
No
Is voltage at handle (80P or 81P) more than 0 with handle moved? (See Test 12—Checking Voltage at the Control Handle.)
Yes
No
Is there an operating or system fault?
Yes
No
Correct problem.
Consult dealer/factory.
Is pressure at brake more than 6 bar (90 psi)?
Yes
No
Repair or replace brake.
Is system pressure more than 6 bar (90 psi)?
Yes
No
Replace brake valve.
Readjust charge pressure relief or replace pump.
Manually stroke pump. (See Test 10—Manually Stroking the Pump.) Does pump pressurize?
Yes
No
Use test plug adapter. (See Test 4—Testing the Pump EDC and Motor PCP.) Is voltage present at pump EDC?
Yes
No
Replace pump EDC.
Repair or replace wiring or consult dealer/factory.
Is 10 volts at handle (87FA)?
Yes
No
Repair or replace handle.
Replace fuse F16 (87FA) and/or wiring. (See Test 11—Testing for Voltage at the Fuse Box.)
Isolate pump. (See Test 10—Manually Stroking the Pump.) Does manually stroked pump pressurize?
Yes
No
Repair or replace motor.
Repair or replace pump.



PROBLEM 10

Front or rear load drum will not raise load, but will lower load.

POSSIBLE CAUSES

Block-up limit is opened. Pump is worn. Rated capacity indicator/limiter (RCL) circuit is open. Control handle is worn. Maximum bail limit is opened. Speed sender is bad.

CHECKS

Check diagnostic screen D2. When applicable switch is enabled…

Bank 1 changed by 2 (front), 16 (left rear), or 64 (right rear) . . . . Maximum bail limit
Bank 1 changed by 32. . . . . Block up limit
Bank 6 changed by 4. . . . . RCL

All Bank Numbers Increased by Number Shown

Any Bank Number Not Increased by Number Shown

Diagnostic DRUM 1, 2, or 3 screen (bank 1) approaches +100% handle control with handle moved back.

Check for problem and repair limit switch operation, wiring, or fuse.

Repair or replace control handle.

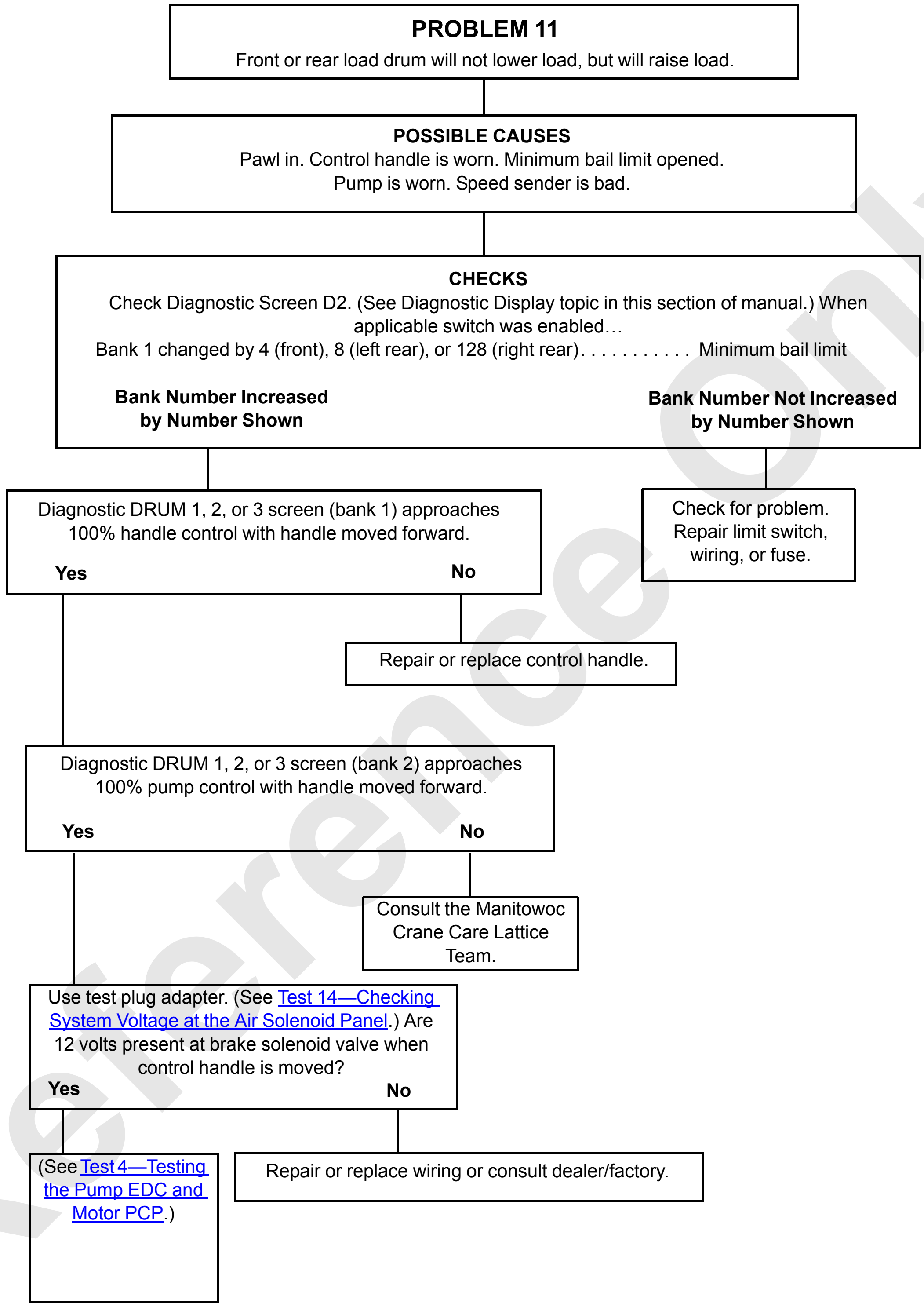
Diagnostic DRUM 1, 2, or 3 screen (bank 2) approaches +100% pump control with handle moved back.

Is +2.3 or more volts present at pump EDC with handle moved back? (See Test 4—Testing the Pump EDC and Motor PCP.)

Consult the Manitowoc Crane Care Lattice Team.

Replace pump EDC or replace pump.

Repair or replace wiring or consult dealer/factory.



PROBLEM 11

Front or rear load drum will not lower load, but will raise load.

POSSIBLE CAUSES

Pawl in. Control handle is worn. Minimum bail limit opened. Pump is worn. Speed sender is bad.

CHECKS

Check Diagnostic Screen D2. (See Diagnostic Display topic in this section of manual.) When applicable switch was enabled…

Bank 1 changed by 4 (front), 8 (left rear), or 128 (right rear). . . . . Minimum bail limit

Bank Number Increased by Number Shown

Bank Number Not Increased by Number Shown

Check for problem. Repair limit switch, wiring, or fuse.

Diagnostic DRUM 1, 2, or 3 screen (bank 1) approaches 100% handle control with handle moved forward.

Yes **No**

Repair or replace control handle.

Diagnostic DRUM 1, 2, or 3 screen (bank 2) approaches 100% pump control with handle moved forward.

Yes **No**

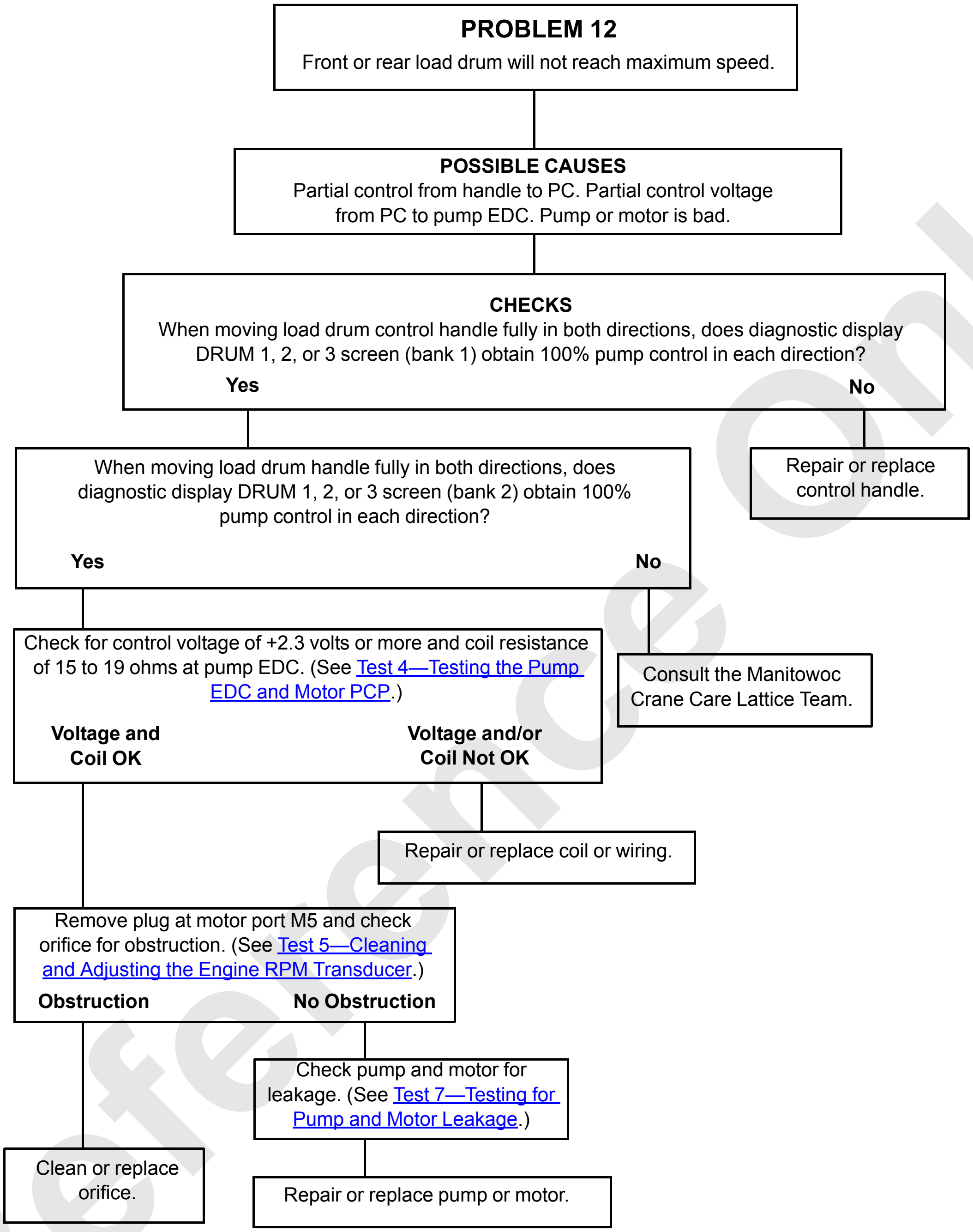
Consult the Manitowoc Crane Care Lattice Team.

Use test plug adapter. (See Test 14—Checking System Voltage at the Air Solenoid Panel.) Are 12 volts present at brake solenoid valve when control handle is moved?

Yes **No**

(See Test 4—Testing the Pump EDC and Motor PCP.)

Repair or replace wiring or consult dealer/factory.



PROBLEM 12

Front or rear load drum will not reach maximum speed.

POSSIBLE CAUSES

Partial control from handle to PC. Partial control voltage from PC to pump EDC. Pump or motor is bad.

CHECKS

When moving load drum control handle fully in both directions, does diagnostic display DRUM 1, 2, or 3 screen (bank 1) obtain 100% pump control in each direction?

Repair or replace control handle.

When moving load drum handle fully in both directions, does diagnostic display DRUM 1, 2, or 3 screen (bank 2) obtain 100% pump control in each direction?

Consult the Manitowoc Crane Care Lattice Team.

Check for control voltage of +2.3 volts or more and coil resistance of 15 to 19 ohms at pump EDC. (See Test 4—Testing the Pump EDC and Motor PCP.)

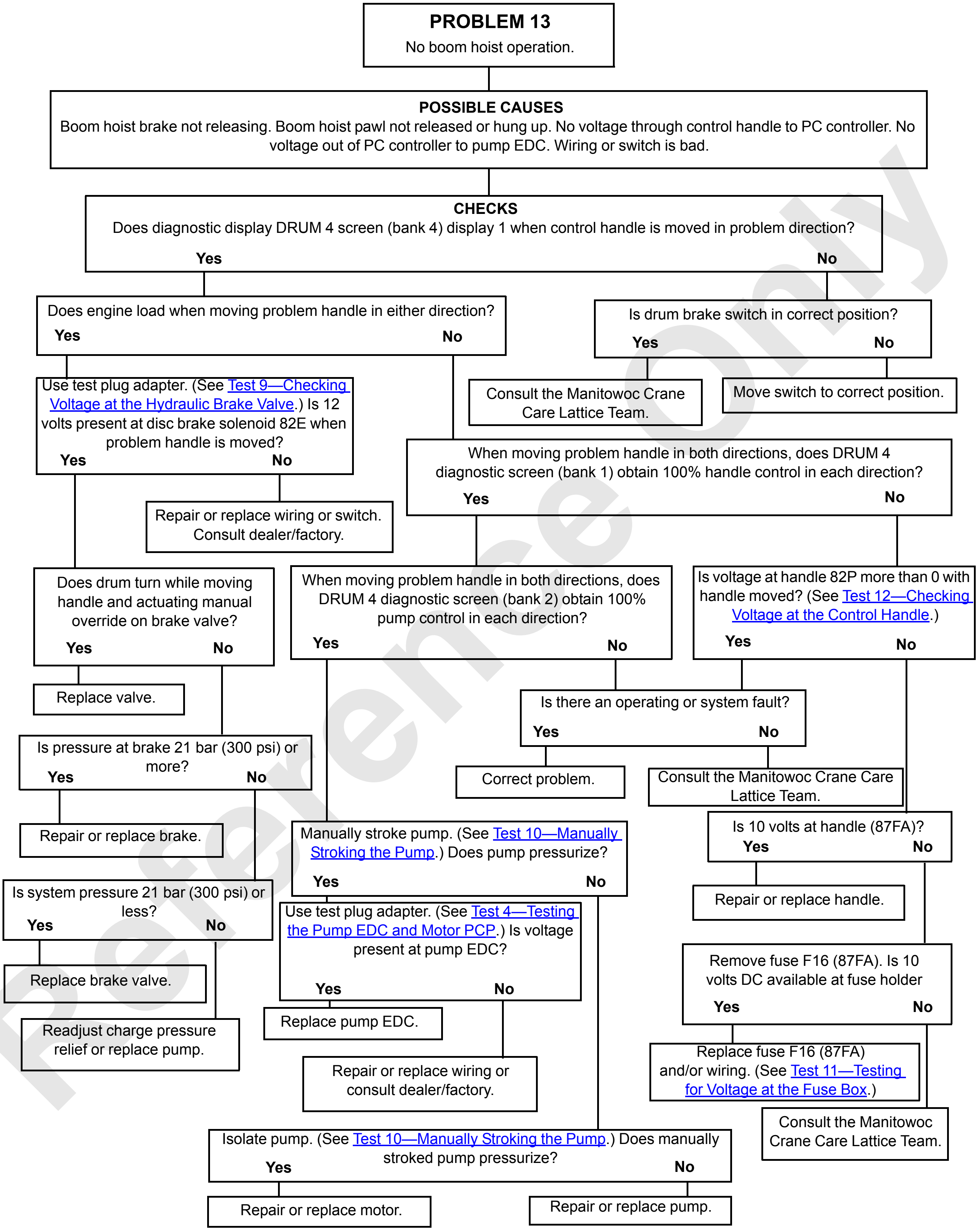
Repair or replace coil or wiring.

Remove plug at motor port M5 and check orifice for obstruction. (See Test 5—Cleaning and Adjusting the Engine RPM Transducer.)

Check pump and motor for leakage. (See Test 7—Testing for Pump and Motor Leakage.)

Clean or replace orifice.

Repair or replace pump or motor.



PROBLEM 13

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 PC controller. No voltage out of PC controller to pump EDC. Wiring or switch is bad.

CHECKS

Does diagnostic display DRUM 4 screen (bank 4) display 1 when control handle is moved in problem direction?

Yes **No**

Does engine load when moving problem handle in either direction?

Yes **No**

Is drum brake switch in correct position?

Yes **No**

Use test plug adapter. (See Test 9—Checking Voltage at the Hydraulic Brake Valve.) Is 12 volts present at disc brake solenoid 82E when problem handle is moved?

Yes **No**

Consult the Manitowoc Crane Care Lattice Team.

Move switch to correct position.

When moving problem handle in both directions, does DRUM 4 diagnostic screen (bank 1) obtain 100% handle control in each direction?

Yes **No**

Repair or replace wiring or switch. Consult dealer/factory.

Does drum turn while moving handle and actuating manual override on brake valve?

Yes **No**

When moving problem handle in both directions, does DRUM 4 diagnostic screen (bank 2) obtain 100% pump control in each direction?

Yes **No**

Is voltage at handle 82P more than 0 with handle moved? (See Test 12—Checking Voltage at the Control Handle.)

Yes **No**

Replace valve.

Is there an operating or system fault?

Yes **No**

Is pressure at brake 21 bar (300 psi) or more?

Yes **No**

Correct problem.

Consult the Manitowoc Crane Care Lattice Team.

Repair or replace brake.

Manually stroke pump. (See Test 10—Manually Stroking the Pump.) Does pump pressurize?

Yes **No**

Is 10 volts at handle (87FA)?

Yes **No**

Repair or replace handle.

Is system pressure 21 bar (300 psi) or less?

Yes **No**

Use test plug adapter. (See Test 4—Testing the Pump EDC and Motor PCP.) Is voltage present at pump EDC?

Yes **No**

Replace brake valve.

Remove fuse F16 (87FA). Is 10 volts DC available at fuse holder

Yes **No**

Replace pump EDC.

Readjust charge pressure relief or replace pump.

Repair or replace wiring or consult dealer/factory.

Replace fuse F16 (87FA) and/or wiring. (See Test 11—Testing for Voltage at the Fuse Box.)

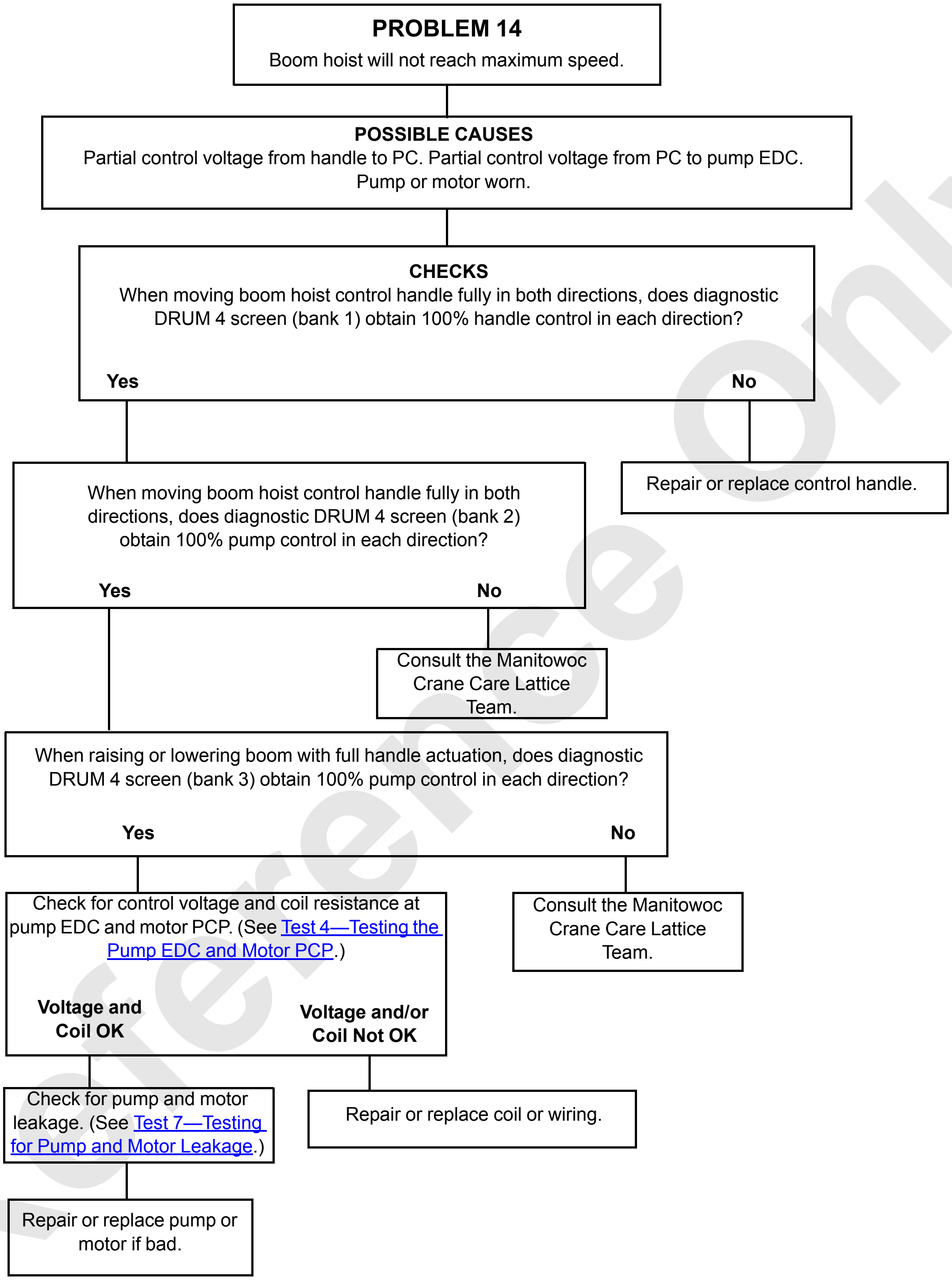
Consult the Manitowoc Crane Care Lattice Team.

Isolate pump. (See Test 10—Manually Stroking the Pump.) Does manually stroked pump pressurize?

Yes **No**

Repair or replace motor.

Repair or replace pump.



PROBLEM 14

Boom hoist will not reach maximum speed.

POSSIBLE CAUSES

Partial control voltage from handle to PC. Partial control voltage from PC to pump EDC. Pump or motor worn.

CHECKS

When moving boom hoist control handle fully in both directions, does diagnostic DRUM 4 screen (bank 1) obtain 100% handle control in each direction?

Yes **No**

Repair or replace control handle.

When moving boom hoist control handle fully in both directions, does diagnostic DRUM 4 screen (bank 2) obtain 100% pump control in each direction?

Yes **No**

Consult the Manitowoc Crane Care Lattice Team.

When raising or lowering boom with full handle actuation, does diagnostic DRUM 4 screen (bank 3) obtain 100% pump control in each direction?

Yes **No**

Consult the Manitowoc Crane Care Lattice Team.

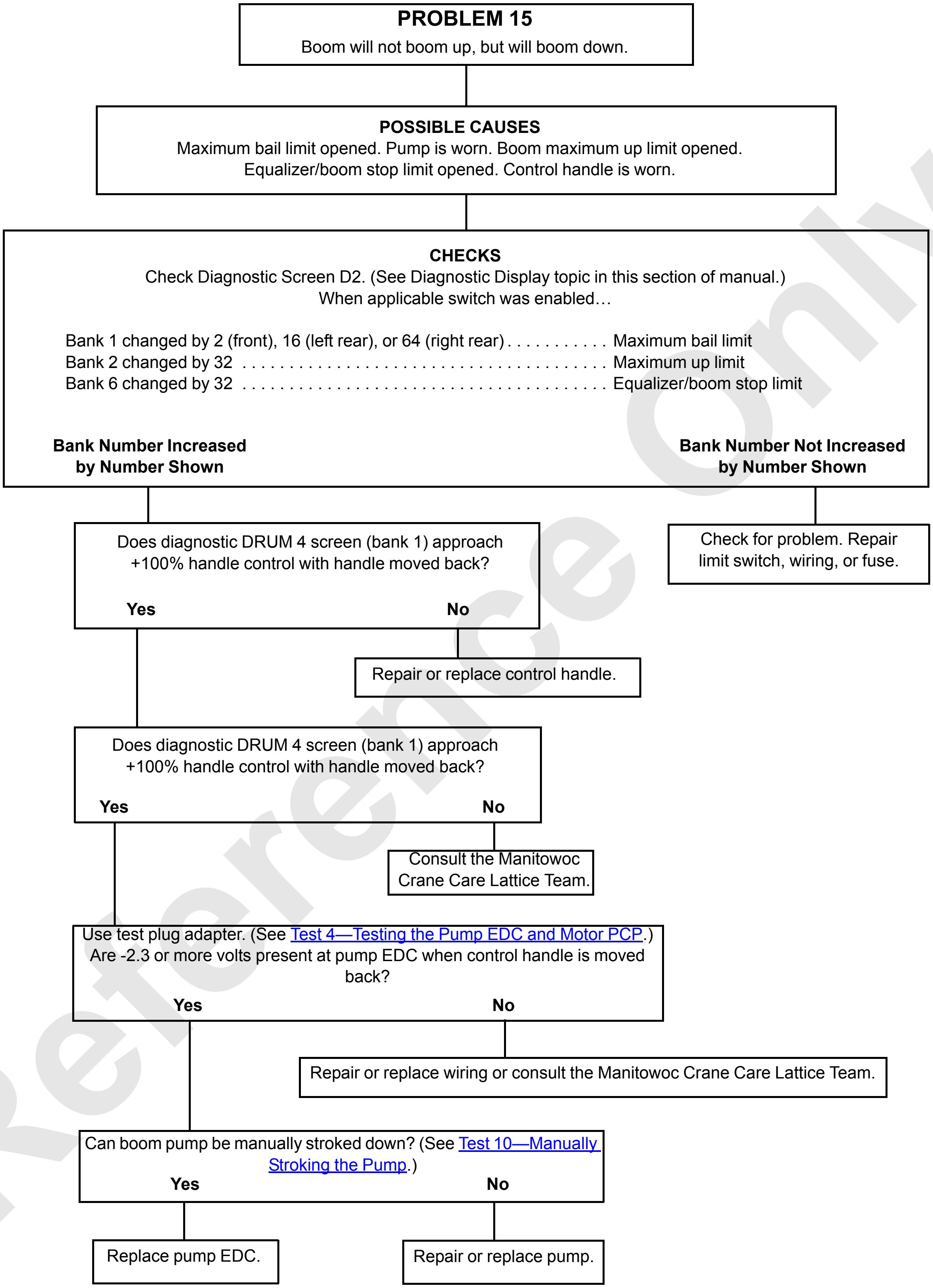
Check for control voltage and coil resistance at pump EDC and motor PCP. (See Test 4—Testing the Pump EDC and Motor PCP.)

Voltage and Coil OK **Voltage and/or Coil Not OK**

Repair or replace coil or wiring.

Check for pump and motor leakage. (See Test 7—Testing for Pump and Motor Leakage.)

Repair or replace pump or motor if bad.



PROBLEM 15

Boom will not boom up, but will boom down.

POSSIBLE CAUSES

Maximum bail limit opened. Pump is worn. Boom maximum up limit opened. Equalizer/boom stop limit opened. Control handle is worn.

CHECKS

Check Diagnostic Screen D2. (See Diagnostic Display topic in this section of manual.)
When applicable switch was enabled…

Bank 1 changed by 2 (front), 16 (left rear), or 64 (right rear) . . . . Maximum bail limit
Bank 2 changed by 32 . . . . Maximum up limit
Bank 6 changed by 32 . . . . Equalizer/boom stop limit

Bank Number Increased by Number Shown

Bank Number Not Increased by Number Shown

Check for problem. Repair limit switch, wiring, or fuse.

Does diagnostic DRUM 4 screen (bank 1) approach +100% handle control with handle moved back?

Yes **No**

Repair or replace control handle.

Does diagnostic DRUM 4 screen (bank 1) approach +100% handle control with handle moved back?

Yes **No**

Consult the Manitowoc Crane Care Lattice Team.

Use test plug adapter. (See Test 4—Testing the Pump EDC and Motor PCP.) Are -2.3 or more volts present at pump EDC when control handle is moved back?

Yes **No**

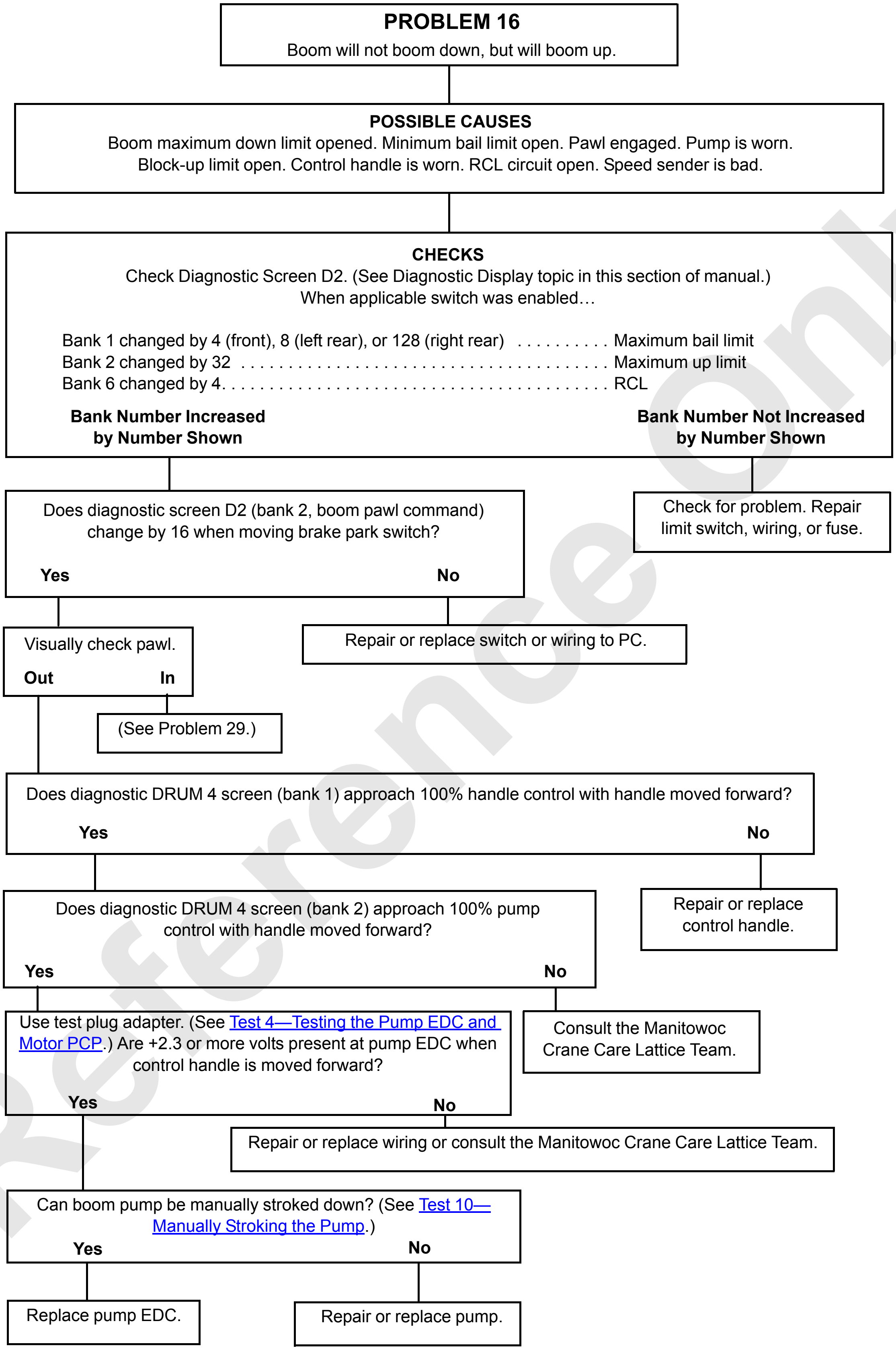
Repair or replace wiring or consult the Manitowoc Crane Care Lattice Team.

Can boom pump be manually stroked down? (See Test 10—Manually Stroking the Pump.)

Yes **No**

Replace pump EDC.

Repair or replace pump.



PROBLEM 16

Boom will not boom down, but will boom up.

POSSIBLE CAUSES

Boom maximum down limit opened. Minimum bail limit open. Pawl engaged. Pump is worn. Block-up limit open. Control handle is worn. RCL circuit open. Speed sender is bad.

CHECKS

Check Diagnostic Screen D2. (See Diagnostic Display topic in this section of manual.) When applicable switch was enabled…

Bank 1 changed by 4 (front), 8 (left rear), or 128 (right rear) . . . . Maximum bail limit
Bank 2 changed by 32 . . . . Maximum up limit
Bank 6 changed by 4. . . . . RCL

Bank Number Increased by Number Shown

Bank Number Not Increased by Number Shown

Check for problem. Repair limit switch, wiring, or fuse.

Does diagnostic screen D2 (bank 2, boom pawl command) change by 16 when moving brake park switch?

Yes **No**

Repair or replace switch or wiring to PC.

Visually check pawl.

Out **In**

(See Problem 29.)

Does diagnostic DRUM 4 screen (bank 1) approach 100% handle control with handle moved forward?

Yes **No**

Repair or replace control handle.

Does diagnostic DRUM 4 screen (bank 2) approach 100% pump control with handle moved forward?

Yes **No**

Consult the Manitowoc Crane Care Lattice Team.

Use test plug adapter. (See Test 4—Testing the Pump EDC and Motor PCP.) Are +2.3 or more volts present at pump EDC when control handle is moved forward?

Yes **No**

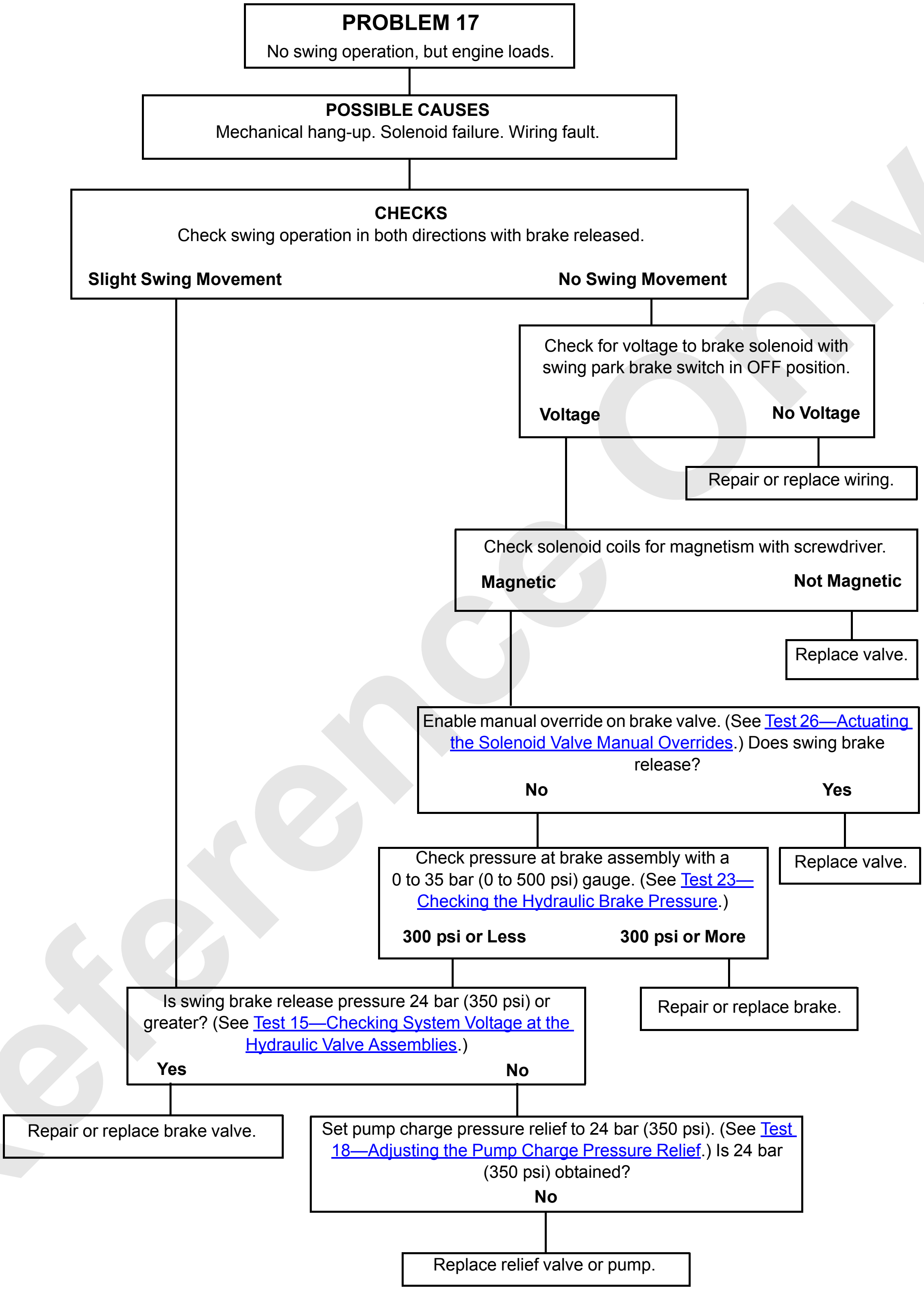
Repair or replace wiring or consult the Manitowoc Crane Care Lattice Team.

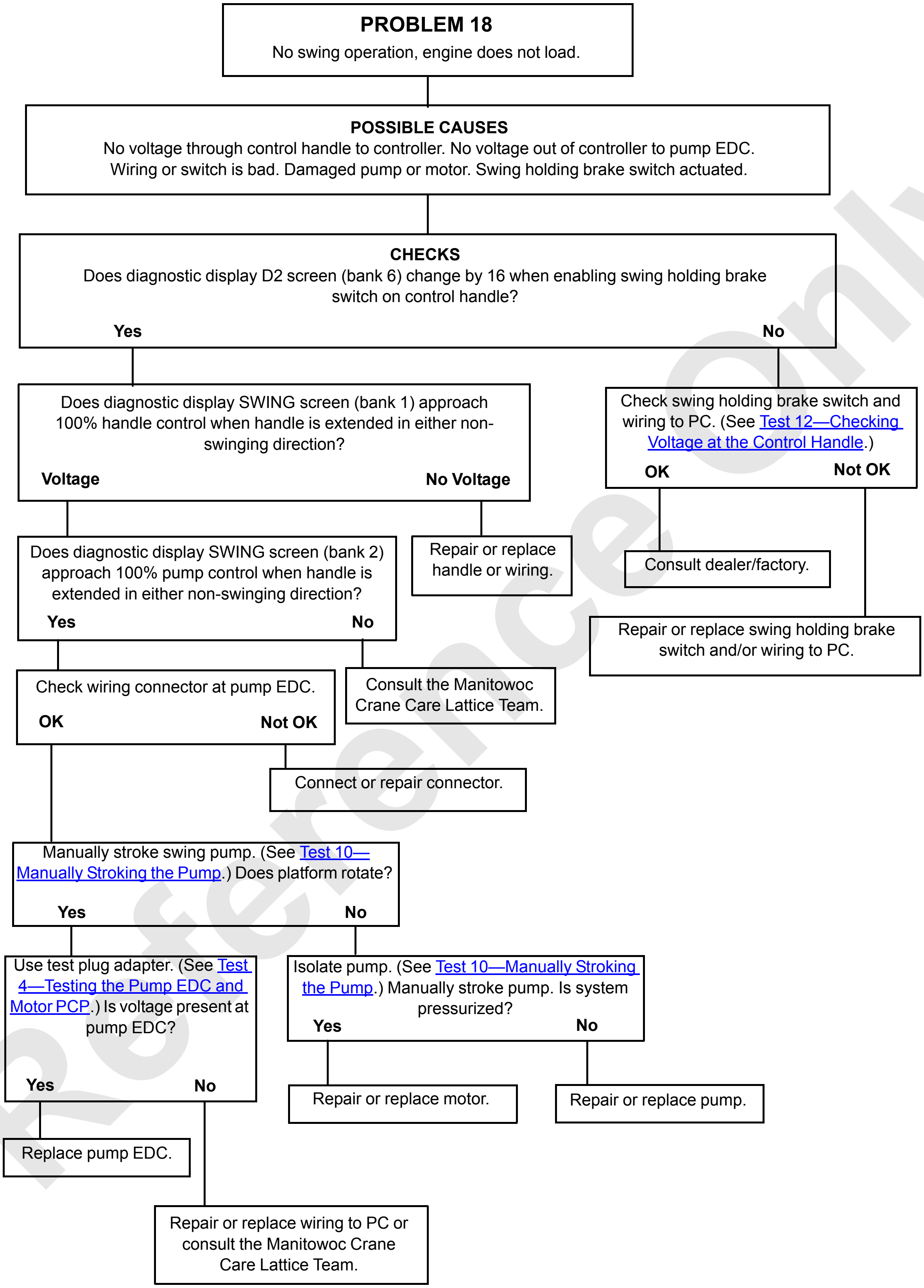
Can boom pump be manually stroked down? (See Test 10—Manually Stroking the Pump.)

Yes **No**

Replace pump EDC.

Repair or replace pump.


PROBLEM 17
No swing operation, but engine loads.
POSSIBLE CAUSES
Mechanical hang-up. Solenoid failure. Wiring fault.
CHECKS
Check swing operation in both directions with brake released.
Slight Swing Movement
No Swing Movement
Check for voltage to brake solenoid with swing park brake switch in OFF position.
Voltage
No Voltage
Repair or replace wiring.
Check solenoid coils for magnetism with screwdriver.
Magnetic
Not Magnetic
Replace valve.
Enable manual override on brake valve. (See Test 26—Actuating the Solenoid Valve Manual Overrides.) Does swing brake release?
No
Yes
Check pressure at brake assembly with a 0 to 35 bar (0 to 500 psi) gauge. (See Test 23—Checking the Hydraulic Brake Pressure.)
300 psi or Less
300 psi or More
Replace valve.
Repair or replace brake.
Is swing brake release pressure 24 bar (350 psi) or greater? (See Test 15—Checking System Voltage at the Hydraulic Valve Assemblies.)
Yes
No
Repair or replace brake valve.
Set pump charge pressure relief to 24 bar (350 psi). (See Test 18—Adjusting the Pump Charge Pressure Relief.) Is 24 bar (350 psi) obtained?
No
Replace relief valve or pump.



PROBLEM 18

No swing operation, engine does not load.

POSSIBLE CAUSES

No voltage through control handle to controller. No voltage out of controller to pump EDC. Wiring or switch is bad. Damaged pump or motor. Swing holding brake switch actuated.

CHECKS

Does diagnostic display D2 screen (bank 6) change by 16 when enabling swing holding brake switch on control handle?

Yes **No**

Does diagnostic display SWING screen (bank 1) approach 100% handle control when handle is extended in either non-swinging direction?

Voltage **No Voltage**

Check swing holding brake switch and wiring to PC. (See Test 12—Checking Voltage at the Control Handle.)

OK **Not OK**

Does diagnostic display SWING screen (bank 2) approach 100% pump control when handle is extended in either non-swinging direction?

Yes **No**

Repair or replace handle or wiring.

Consult dealer/factory.

Repair or replace swing holding brake switch and/or wiring to PC.

Check wiring connector at pump EDC.

OK **Not OK**

Consult the Manitowoc Crane Care Lattice Team.

Connect or repair connector.

Manually stroke swing pump. (See Test 10—Manually Stroking the Pump.) Does platform rotate?

Yes **No**

Use test plug adapter. (See Test 4—Testing the Pump EDC and Motor PCP.) Is voltage present at pump EDC?

Yes **No**

Isolate pump. (See Test 10—Manually Stroking the Pump.) Manually stroke pump. Is system pressurized?

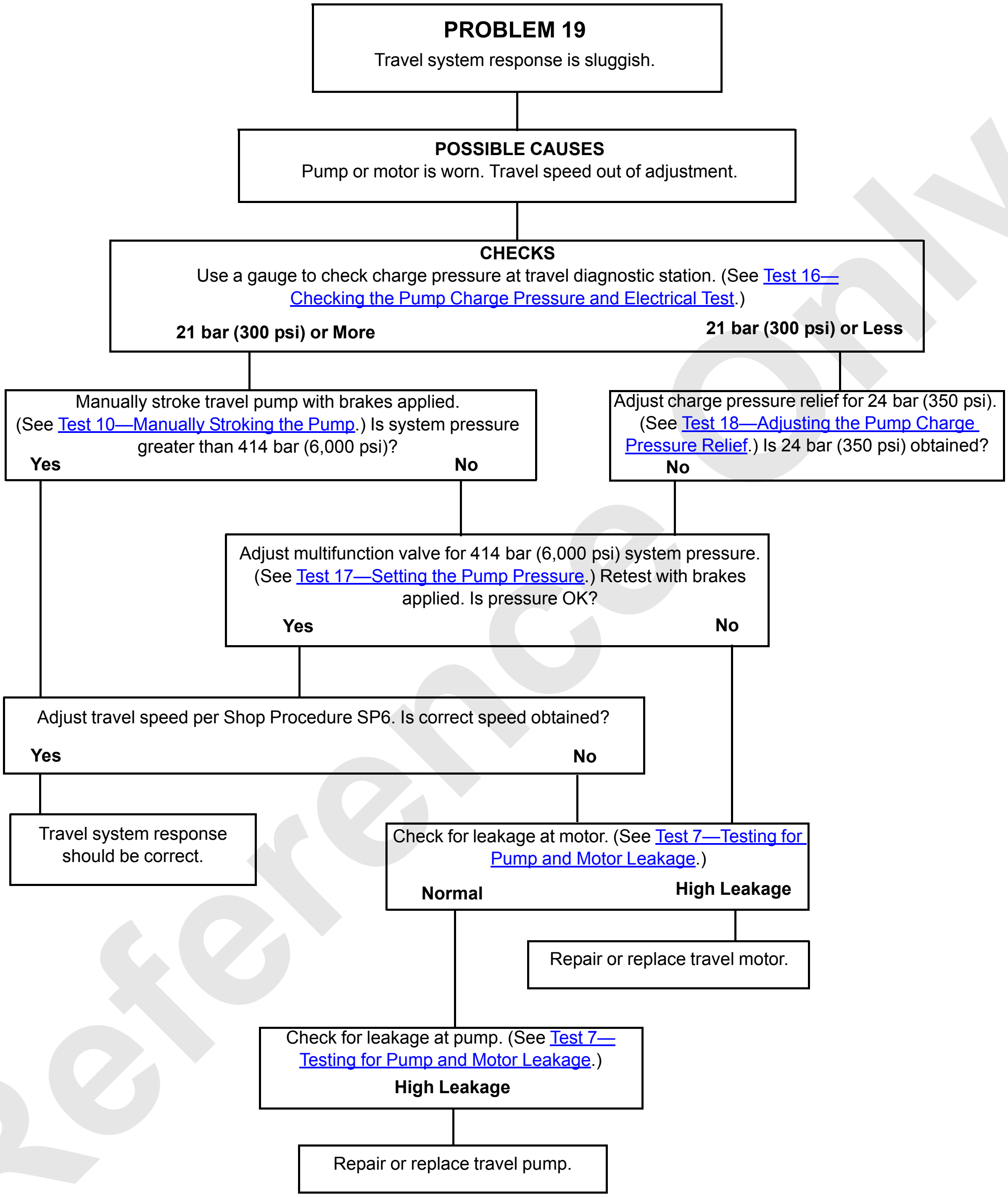
Yes **No**

Repair or replace motor.

Repair or replace pump.

Replace pump EDC.

Repair or replace wiring to PC or consult the Manitowoc Crane Care Lattice Team.



PROBLEM 19

Travel system response is sluggish.

POSSIBLE CAUSES

Pump or motor is worn. Travel speed out of adjustment.

CHECKS

Use a gauge to check charge pressure at travel diagnostic station. (See Test 16—Checking the Pump Charge Pressure and Electrical Test.)

Manually stroke travel pump with brakes applied. (See Test 10—Manually Stroking the Pump.) Is system pressure greater than 414 bar (6,000 psi)?

Adjust charge pressure relief for 24 bar (350 psi). (See Test 18—Adjusting the Pump Charge Pressure Relief.) Is 24 bar (350 psi) obtained?

Adjust multifunction valve for 414 bar (6,000 psi) system pressure. (See Test 17—Setting the Pump Pressure.) Retest with brakes applied. Is pressure OK?

Adjust travel speed per Shop Procedure SP6. Is correct speed obtained?

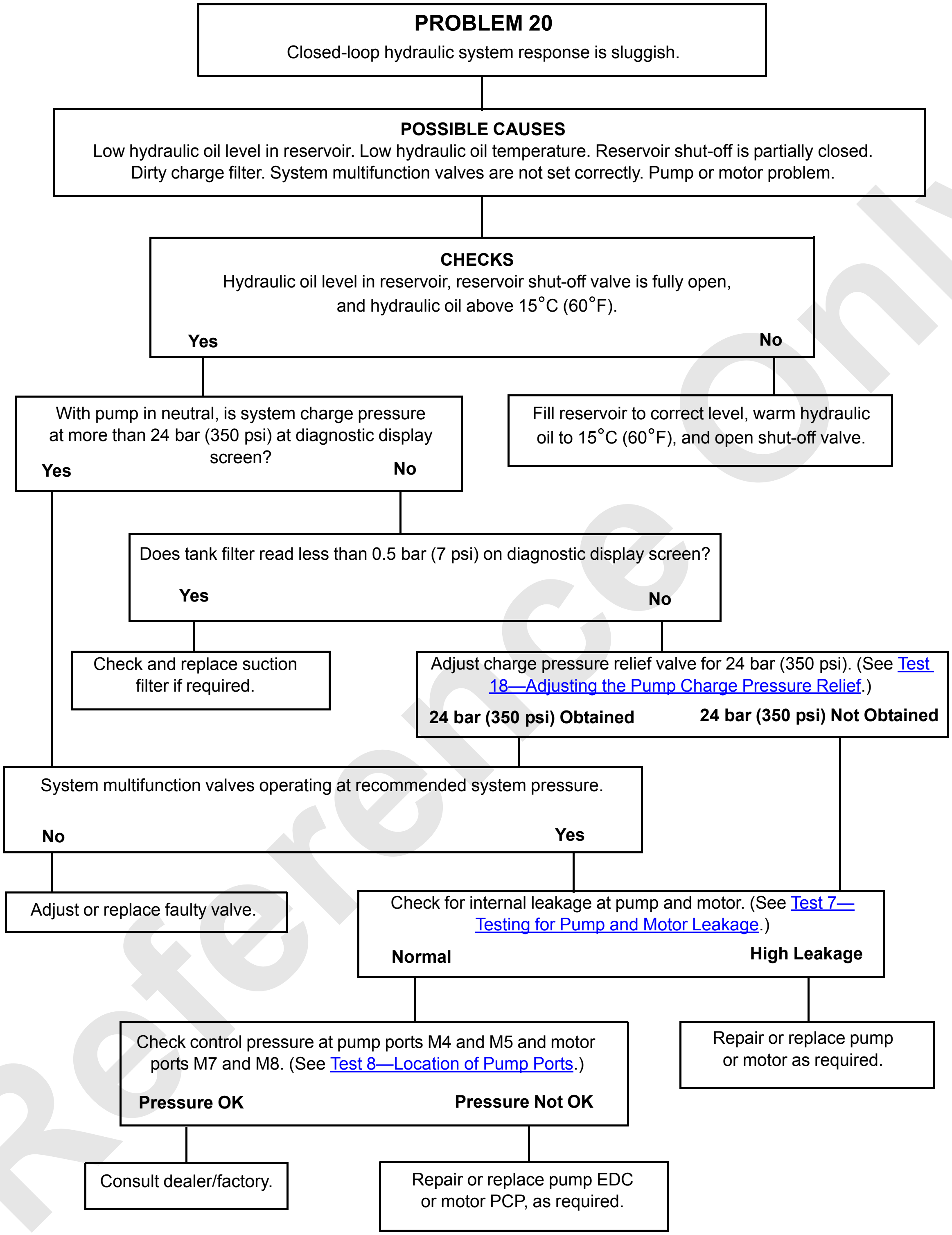
Travel system response should be correct.

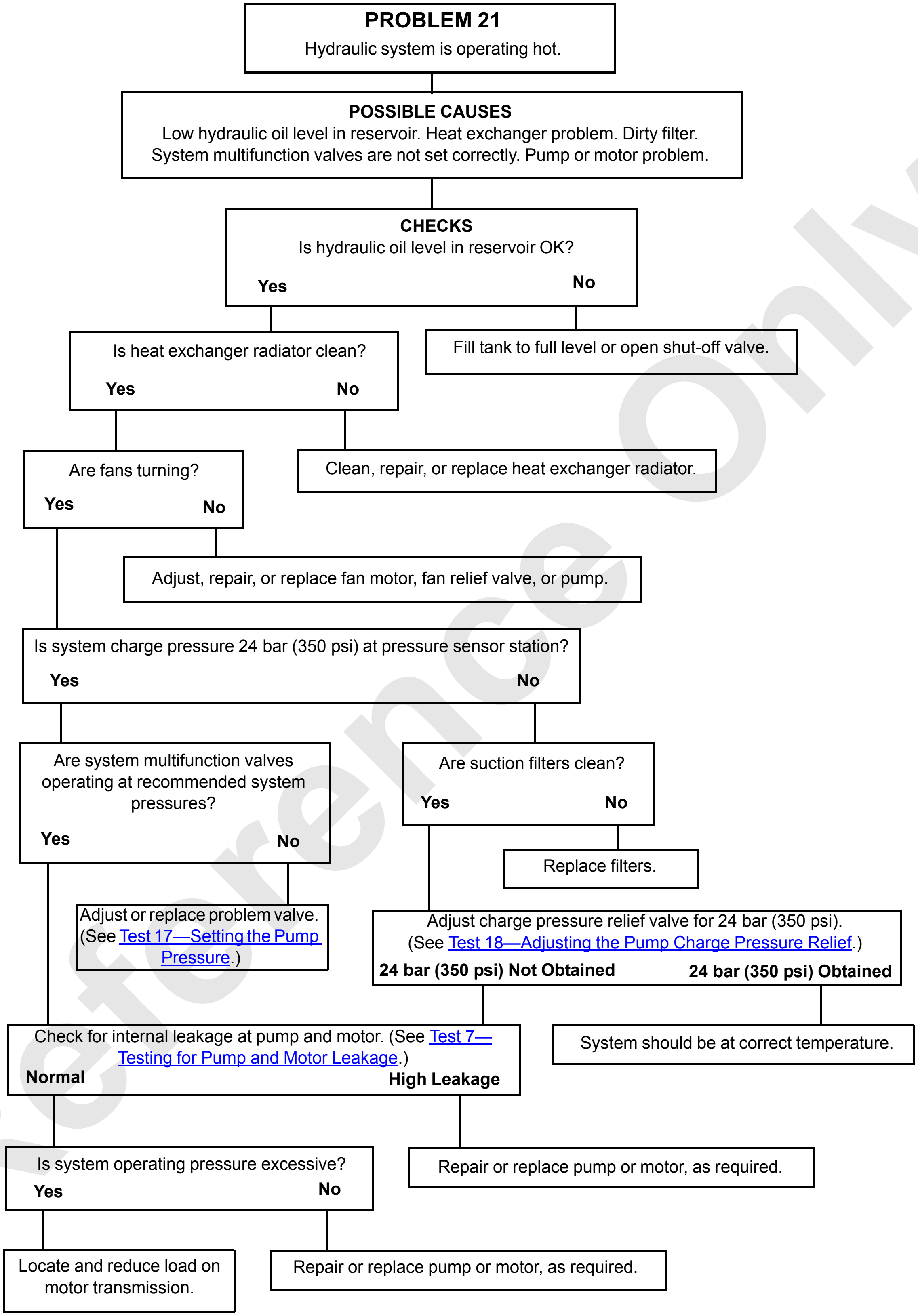
Check for leakage at motor. (See Test 7—Testing for Pump and Motor Leakage.)

Repair or replace travel motor.

Check for leakage at pump. (See Test 7—Testing for Pump and Motor Leakage.)

Repair or replace travel pump.


PROBLEM 20
Closed-loop hydraulic system response is sluggish.
POSSIBLE CAUSES
Low hydraulic oil level in reservoir. Low hydraulic oil temperature. Reservoir shut-off is partially closed. Dirty charge filter. System multifunction valves are not set correctly. Pump or motor problem.
CHECKS
Hydraulic oil level in reservoir, reservoir shut-off valve is fully open, and hydraulic oil above 15°C (60°F).
Yes
No
With pump in neutral, is system charge pressure at more than 24 bar (350 psi) at diagnostic display screen?
Yes
No
Fill reservoir to correct level, warm hydraulic oil to 15°C (60°F), and open shut-off valve.
Does tank filter read less than 0.5 bar (7 psi) on diagnostic display screen?
Yes
No
Check and replace suction filter if required.
Adjust charge pressure relief valve for 24 bar (350 psi). (See Test 18—Adjusting the Pump Charge Pressure Relief.)
24 bar (350 psi) Obtained
24 bar (350 psi) Not Obtained
System multifunction valves operating at recommended system pressure.
No
Yes
Adjust or replace faulty valve.
Check for internal leakage at pump and motor. (See Test 7—Testing for Pump and Motor Leakage.)
Normal
High Leakage
Check control pressure at pump ports M4 and M5 and motor ports M7 and M8. (See Test 8—Location of Pump Ports.)
Pressure OK
Pressure Not OK
Repair or replace pump or motor as required.
Consult dealer/factory.
Repair or replace pump EDC or motor PCP, as required.



PROBLEM 21

Hydraulic system is operating hot.

POSSIBLE CAUSES

Low hydraulic oil level in reservoir. Heat exchanger problem. Dirty filter. System multifunction valves are not set correctly. Pump or motor problem.

CHECKS

Is hydraulic oil level in reservoir OK?

Fill tank to full level or open shut-off valve.

Is heat exchanger radiator clean?

Clean, repair, or replace heat exchanger radiator.

Are fans turning?

Adjust, repair, or replace fan motor, fan relief valve, or pump.

Is system charge pressure 24 bar (350 psi) at pressure sensor station?

Are system multifunction valves operating at recommended system pressures?

Adjust or replace problem valve. (See Test 17—Setting the Pump Pressure.)

Are suction filters clean?

Replace filters.

Adjust charge pressure relief valve for 24 bar (350 psi). (See Test 18—Adjusting the Pump Charge Pressure Relief.)

System should be at correct temperature.

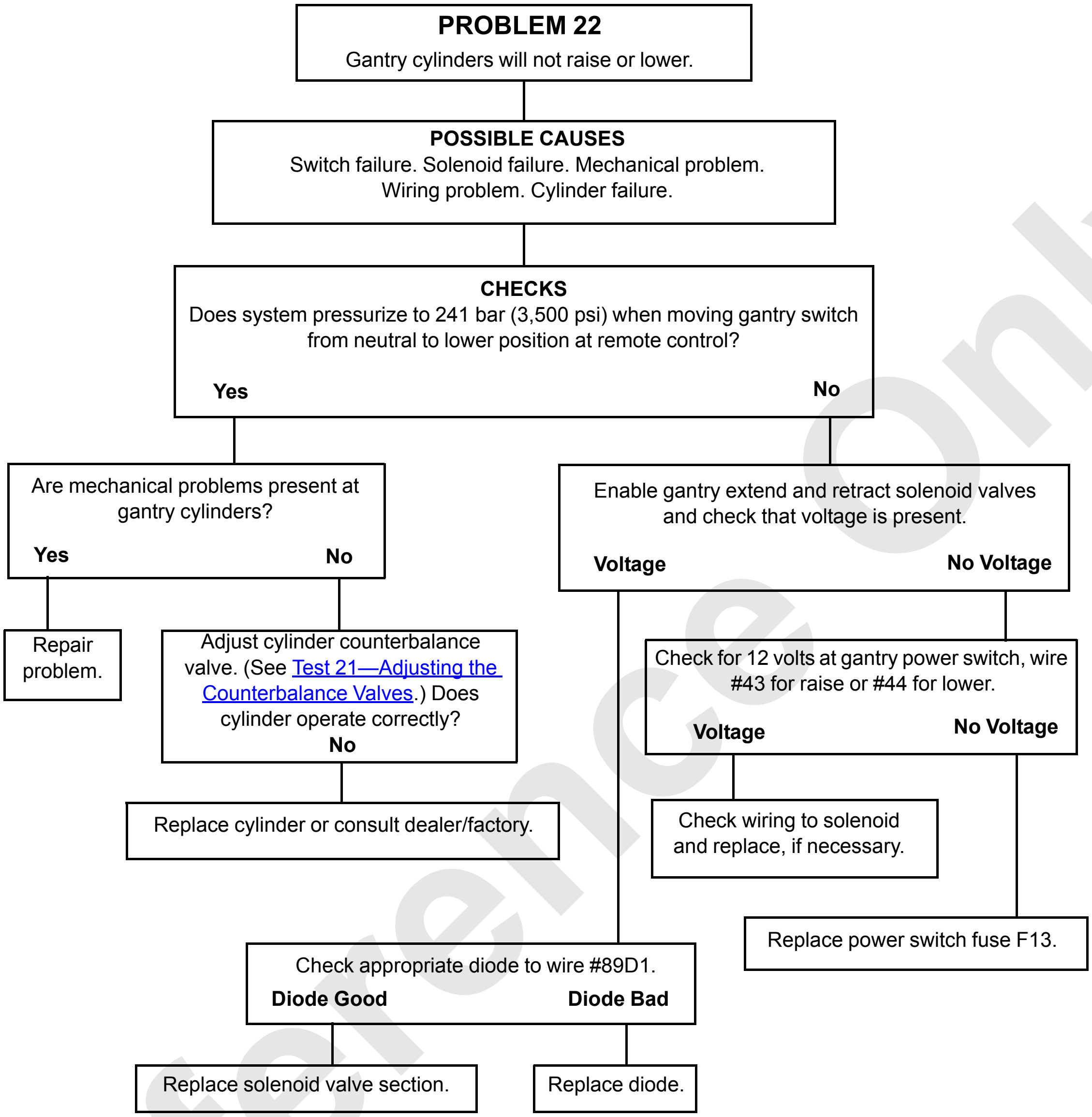
Check for internal leakage at pump and motor. (See Test 7—Testing for Pump and Motor Leakage.)

Repair or replace pump or motor, as required.

Is system operating pressure excessive?

Locate and reduce load on motor transmission.

Repair or replace pump or motor, as required.



PROBLEM 22

Gantry cylinders will not raise or lower.

POSSIBLE CAUSES

Switch failure. Solenoid failure. Mechanical problem. Wiring problem. Cylinder failure.

CHECKS

Does system pressurize to 241 bar (3,500 psi) when moving gantry switch from neutral to lower position at remote control?

Yes **No**

Are mechanical problems present at gantry cylinders?

Yes **No**

Repair problem.

Adjust cylinder counterbalance valve. (See Test 21—Adjusting the Counterbalance Valves.) Does cylinder operate correctly?

No

Replace cylinder or consult dealer/factory.

Enable gantry extend and retract solenoid valves and check that voltage is present.

Voltage **No Voltage**

Check for 12 volts at gantry power switch, wire #43 for raise or #44 for lower.

Voltage **No Voltage**

Check wiring to solenoid and replace, if necessary.

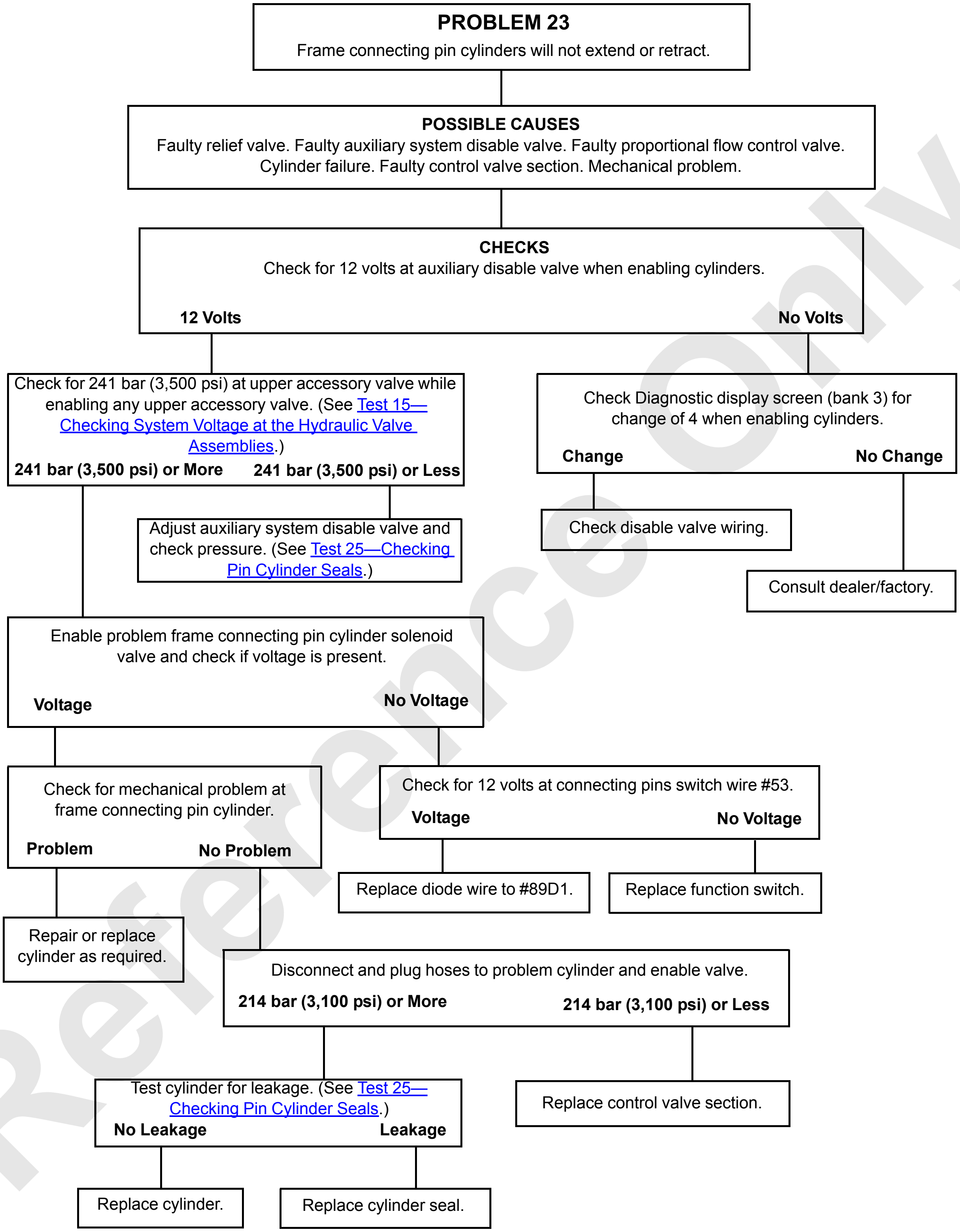
Replace power switch fuse F13.

Check appropriate diode to wire #89D1.

Diode Good **Diode Bad**

Replace solenoid valve section.

Replace diode.



PROBLEM 23

Frame connecting pin cylinders will not extend or retract.

POSSIBLE CAUSES

Faulty relief valve. Faulty auxiliary system disable valve. Faulty proportional flow control valve. Cylinder failure. Faulty control valve section. Mechanical problem.

CHECKS

Check for 12 volts at auxiliary disable valve when enabling cylinders.

12 Volts **No Volts**

Check for 241 bar (3,500 psi) at upper accessory valve while enabling any upper accessory valve. (See Test 15—Checking System Voltage at the Hydraulic Valve Assemblies.)

241 bar (3,500 psi) or More **241 bar (3,500 psi) or Less**

Check Diagnostic display screen (bank 3) for change of 4 when enabling cylinders.

Change **No Change**

Check disable valve wiring.

Consult dealer/factory.

Adjust auxiliary system disable valve and check pressure. (See Test 25—Checking Pin Cylinder Seals.)

Enable problem frame connecting pin cylinder solenoid valve and check if voltage is present.

Voltage **No Voltage**

Check for mechanical problem at frame connecting pin cylinder.

Problem **No Problem**

Check for 12 volts at connecting pins switch wire #53.

Voltage **No Voltage**

Replace diode wire to #89D1.

Replace function switch.

Repair or replace cylinder as required.

Disconnect and plug hoses to problem cylinder and enable valve.

214 bar (3,100 psi) or More **214 bar (3,100 psi) or Less**

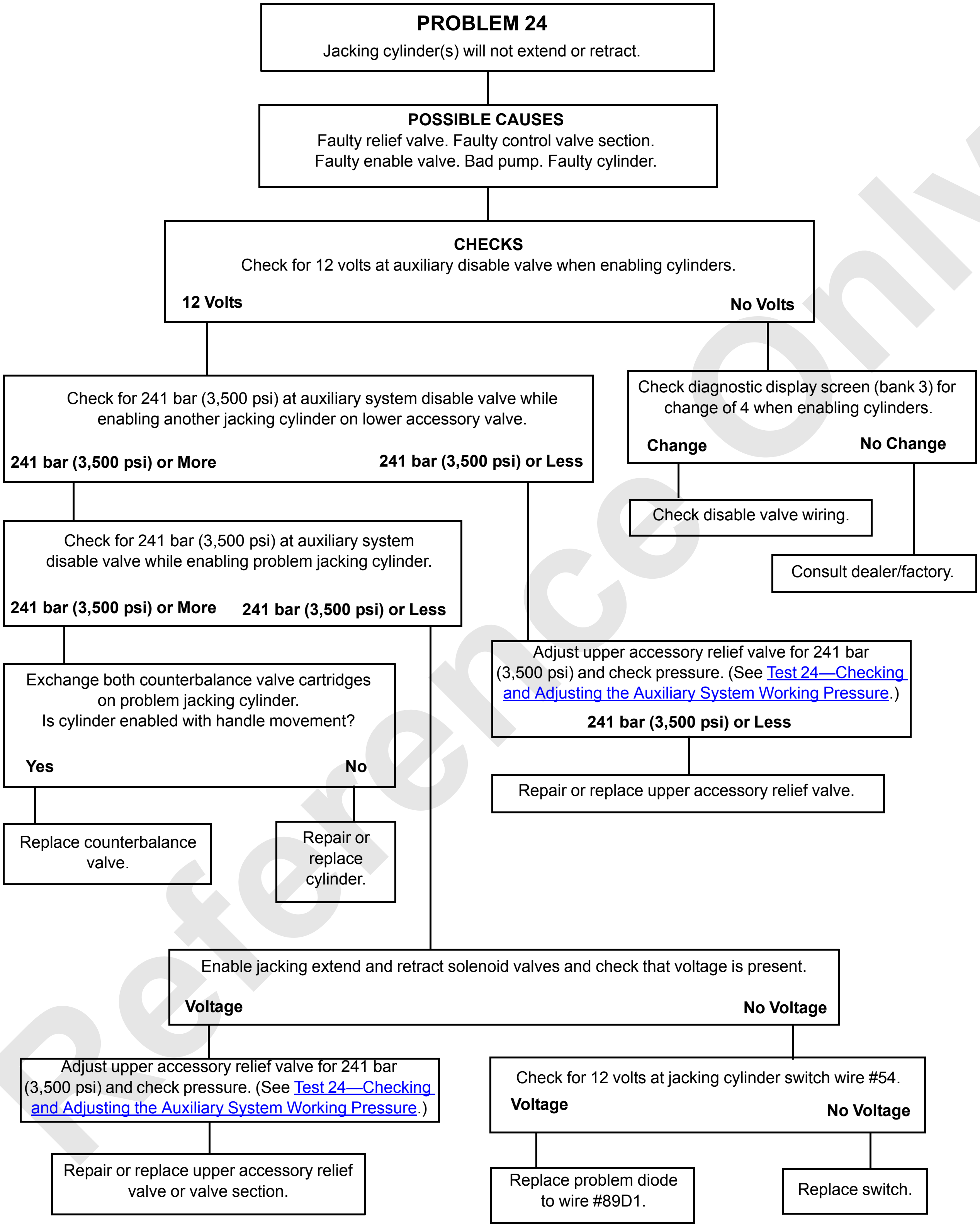
Test cylinder for leakage. (See Test 25—Checking Pin Cylinder Seals.)

No Leakage **Leakage**

Replace control valve section.

Replace cylinder.

Replace cylinder seal.



PROBLEM 24

Jacking cylinder(s) will not extend or retract.

POSSIBLE CAUSES

Faulty relief valve. Faulty control valve section. Faulty enable valve. Bad pump. Faulty cylinder.

CHECKS

Check for 12 volts at auxiliary disable valve when enabling cylinders.

Check for 241 bar (3,500 psi) at auxiliary system disable valve while enabling another jacking cylinder on lower accessory valve.

Check diagnostic display screen (bank 3) for change of 4 when enabling cylinders.

Check disable valve wiring.

Consult dealer/factory.

Check for 241 bar (3,500 psi) at auxiliary system disable valve while enabling problem jacking cylinder.

Adjust upper accessory relief valve for 241 bar (3,500 psi) and check pressure. (See Test 24—Checking and Adjusting the Auxiliary System Working Pressure.)

Repair or replace upper accessory relief valve.

Exchange both counterbalance valve cartridges on problem jacking cylinder. Is cylinder enabled with handle movement?

Replace counterbalance valve.

Repair or replace cylinder.

Enable jacking extend and retract solenoid valves and check that voltage is present.

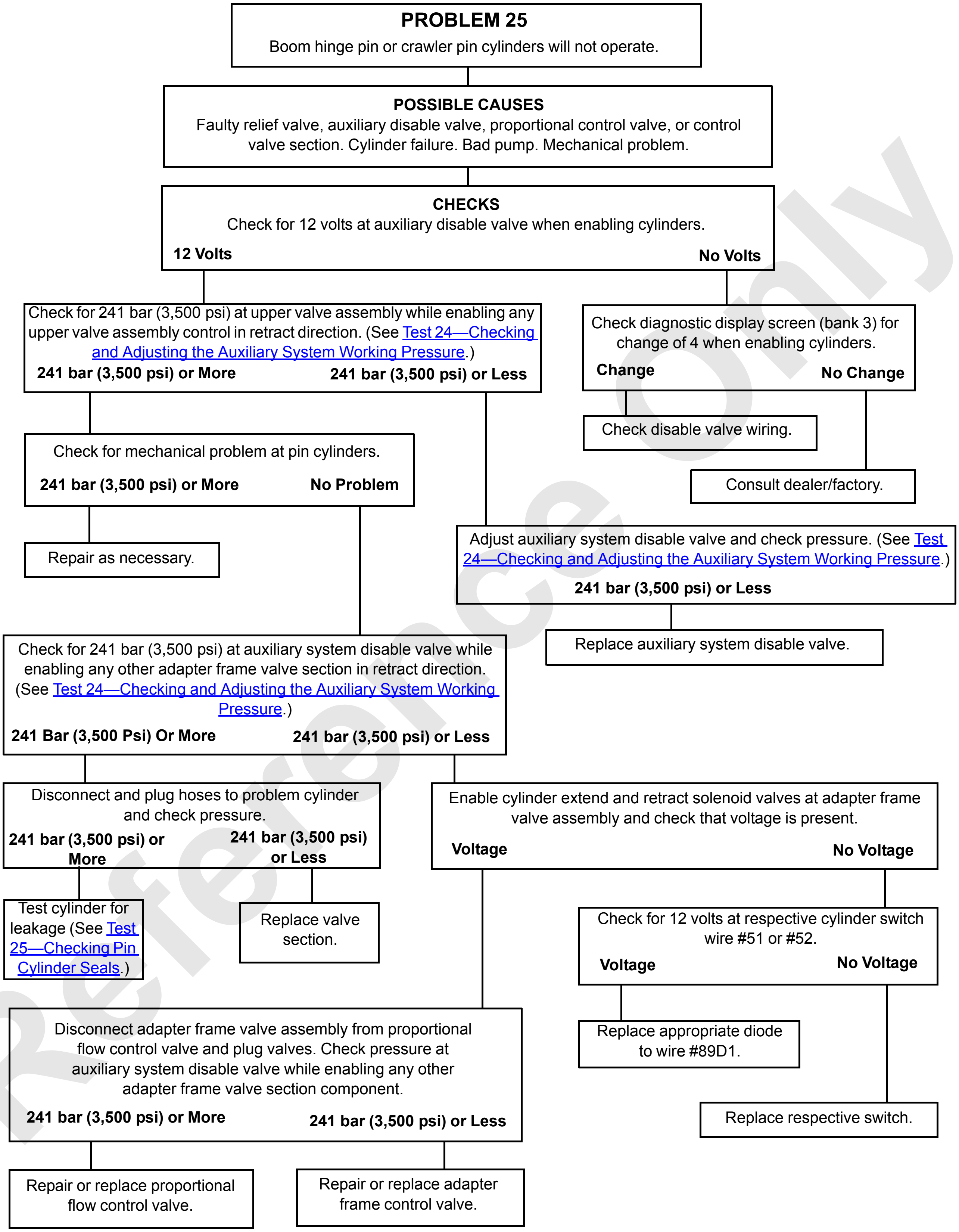
Adjust upper accessory relief valve for 241 bar (3,500 psi) and check pressure. (See Test 24—Checking and Adjusting the Auxiliary System Working Pressure.)

Repair or replace upper accessory relief valve or valve section.

Check for 12 volts at jacking cylinder switch wire #54.

Replace problem diode to wire #89D1.

Replace switch.



PROBLEM 25

Boom hinge pin or crawler pin cylinders will not operate.

POSSIBLE CAUSES

Faulty relief valve, auxiliary disable valve, proportional control valve, or control valve section. Cylinder failure. Bad pump. Mechanical problem.

CHECKS

Check for 12 volts at auxiliary disable valve when enabling cylinders.

Check for 241 bar (3,500 psi) at upper valve assembly while enabling any upper valve assembly control in retract direction. (See Test 24—Checking and Adjusting the Auxiliary System Working Pressure.)

Check diagnostic display screen (bank 3) for change of 4 when enabling cylinders.

Check disable valve wiring.

Consult dealer/factory.

Check for mechanical problem at pin cylinders.

Repair as necessary.

Adjust auxiliary system disable valve and check pressure. (See Test 24—Checking and Adjusting the Auxiliary System Working Pressure.)

Replace auxiliary system disable valve.

Check for 241 bar (3,500 psi) at auxiliary system disable valve while enabling any other adapter frame valve section in retract direction. (See Test 24—Checking and Adjusting the Auxiliary System Working Pressure.)

Disconnect and plug hoses to problem cylinder and check pressure.

Test cylinder for leakage (See Test 25—Checking Pin Cylinder Seals.)

Replace valve section.

Enable cylinder extend and retract solenoid valves at adapter frame valve assembly and check that voltage is present.

Check for 12 volts at respective cylinder switch wire #51 or #52.

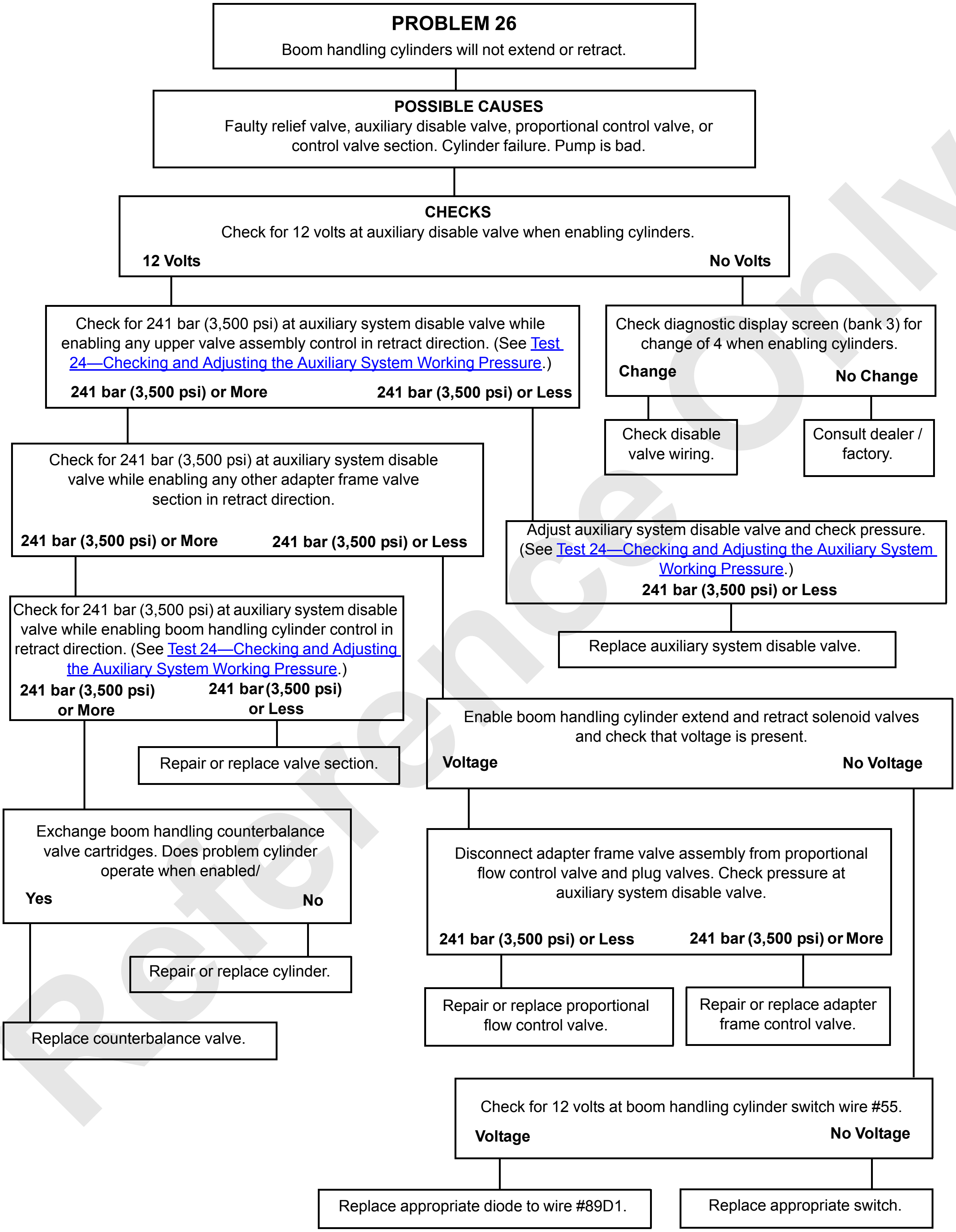
Replace appropriate diode to wire #89D1.

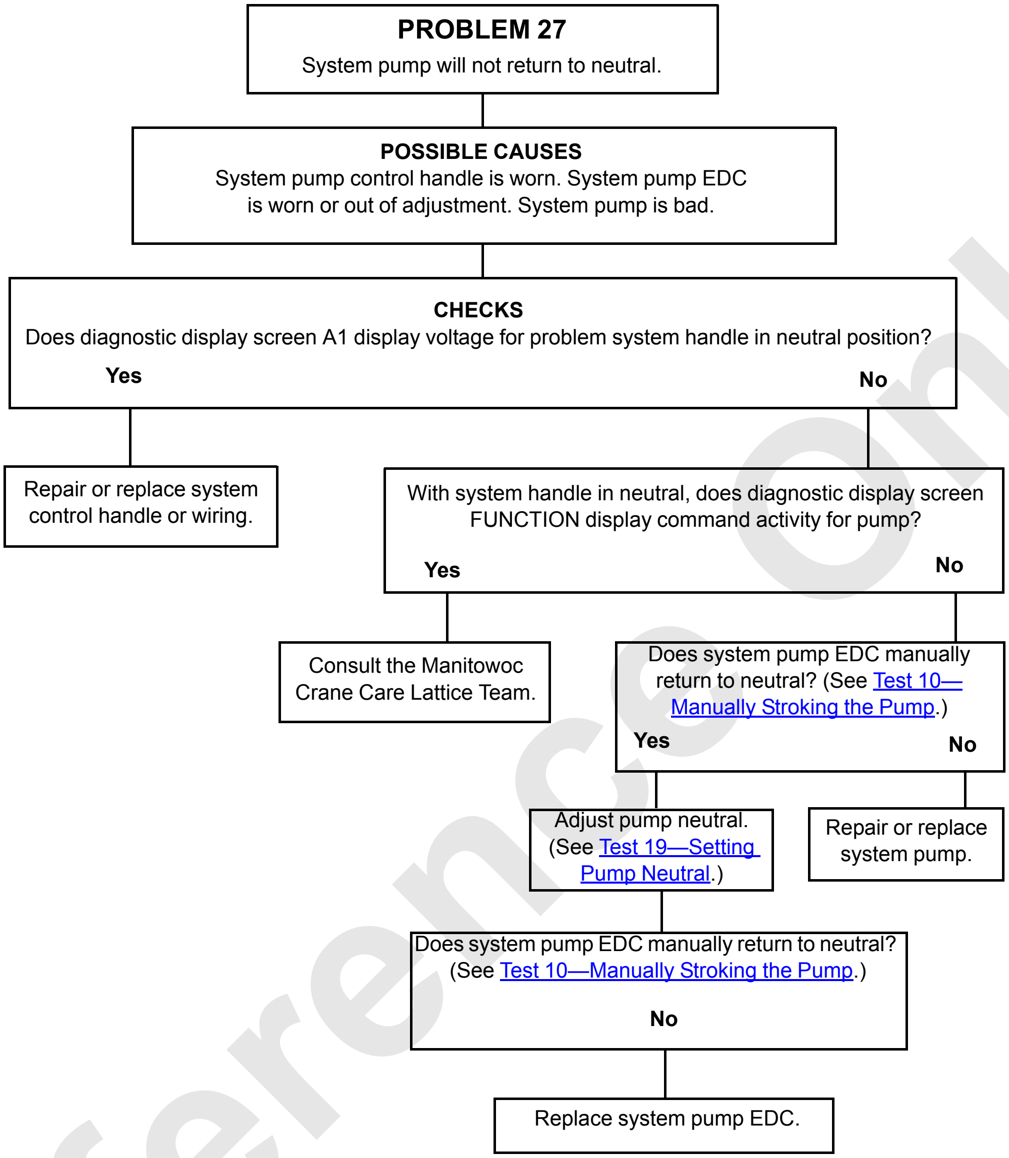
Replace respective switch.

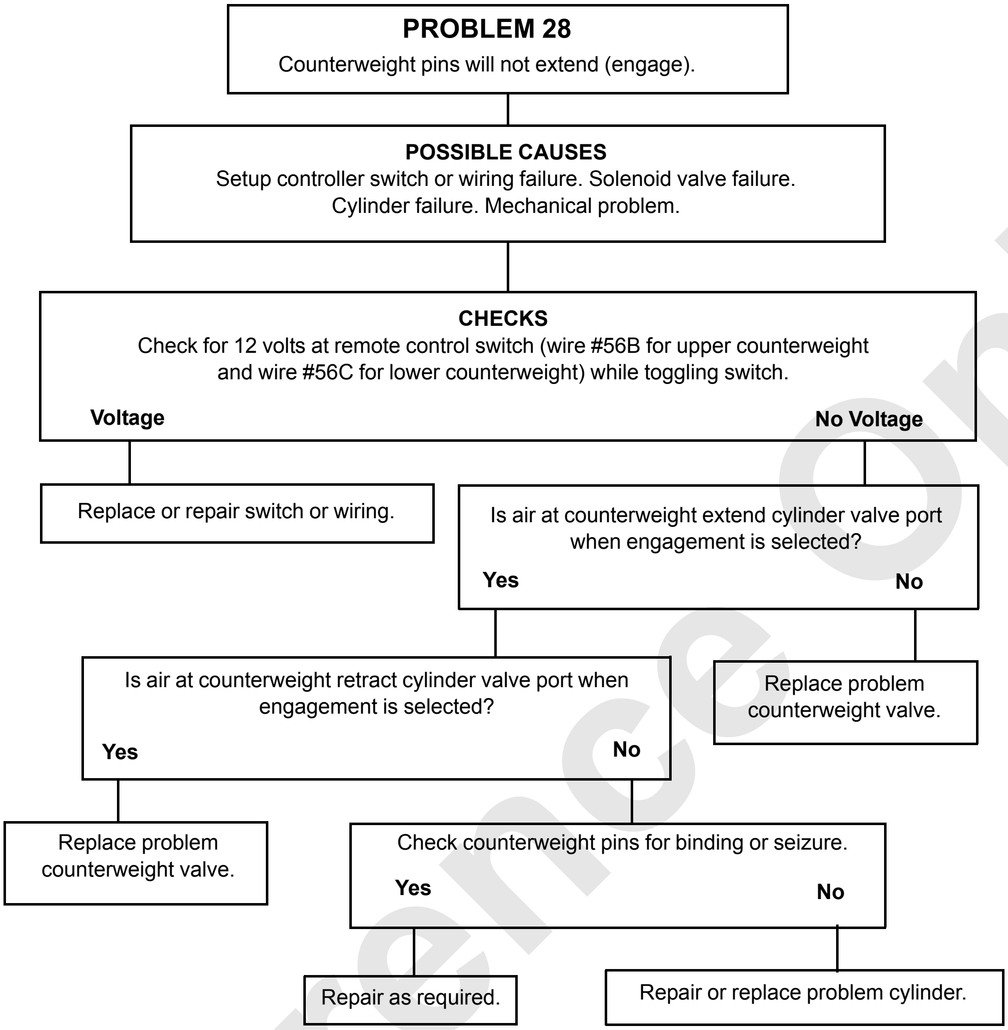
Disconnect adapter frame valve assembly from proportional flow control valve and plug valves. Check pressure at auxiliary system disable valve while enabling any other adapter frame valve section component.

Repair or replace proportional flow control valve.

Repair or replace adapter frame control valve.


PROBLEM 26
Boom handling cylinders will not extend or retract.
POSSIBLE CAUSES
Faulty relief valve, auxiliary disable valve, proportional control valve, or control valve section. Cylinder failure. Pump is bad.
CHECKS
Check for 12 volts at auxiliary disable valve when enabling cylinders.
12 Volts
No Volts
Check for 241 bar (3,500 psi) at auxiliary system disable valve while enabling any upper valve assembly control in retract direction. (See Test 24—Checking and Adjusting the Auxiliary System Working Pressure.)
241 bar (3,500 psi) or More
241 bar (3,500 psi) or Less
Check diagnostic display screen (bank 3) for change of 4 when enabling cylinders.
Change
No Change
Check disable valve wiring.
Consult dealer / factory.
Check for 241 bar (3,500 psi) at auxiliary system disable valve while enabling any other adapter frame valve section in retract direction.
241 bar (3,500 psi) or More
241 bar (3,500 psi) or Less
Adjust auxiliary system disable valve and check pressure. (See Test 24—Checking and Adjusting the Auxiliary System Working Pressure.)
241 bar (3,500 psi) or Less
Replace auxiliary system disable valve.
Check for 241 bar (3,500 psi) at auxiliary system disable valve while enabling boom handling cylinder control in retract direction. (See Test 24—Checking and Adjusting the Auxiliary System Working Pressure.)
241 bar (3,500 psi) or More
241 bar (3,500 psi) or Less
Repair or replace valve section.
Enable boom handling cylinder extend and retract solenoid valves and check that voltage is present.
Voltage
No Voltage
Exchange boom handling counterbalance valve cartridges. Does problem cylinder operate when enabled/
Yes
No
Repair or replace cylinder.
Replace counterbalance valve.
Disconnect adapter frame valve assembly from proportional flow control valve and plug valves. Check pressure at auxiliary system disable valve.
241 bar (3,500 psi) or Less
241 bar (3,500 psi) or More
Repair or replace proportional flow control valve.
Repair or replace adapter frame control valve.
Check for 12 volts at boom handling cylinder switch wire #55.
Voltage
No Voltage
Replace appropriate diode to wire #89D1.
Replace appropriate switch.


PROBLEM 27
System pump will not return to neutral.
POSSIBLE CAUSES
System pump control handle is worn. System pump EDC is worn or out of adjustment. System pump is bad.
CHECKS
Does diagnostic display screen A1 display voltage for problem system handle in neutral position?
Yes
No
Repair or replace system control handle or wiring.
With system handle in neutral, does diagnostic display screen FUNCTION display command activity for pump?
Yes
No
Consult the Manitowoc Crane Care Lattice Team.
Does system pump EDC manually return to neutral? (See Test 10—Manually Stroking the Pump.)
Yes
No
Adjust pump neutral. (See Test 19—Setting Pump Neutral.)
Repair or replace system pump.
Does system pump EDC manually return to neutral? (See Test 10—Manually Stroking the Pump.)
No
Replace system pump EDC.



PROBLEM 28

Counterweight pins will not extend (engage).

POSSIBLE CAUSES

Setup controller switch or wiring failure. Solenoid valve failure. Cylinder failure. Mechanical problem.

CHECKS

Check for 12 volts at remote control switch (wire #56B for upper counterweight and wire #56C for lower counterweight) while toggling switch.

Replace or repair switch or wiring.

Is air at counterweight extend cylinder valve port when engagement is selected?

Is air at counterweight retract cylinder valve port when engagement is selected?

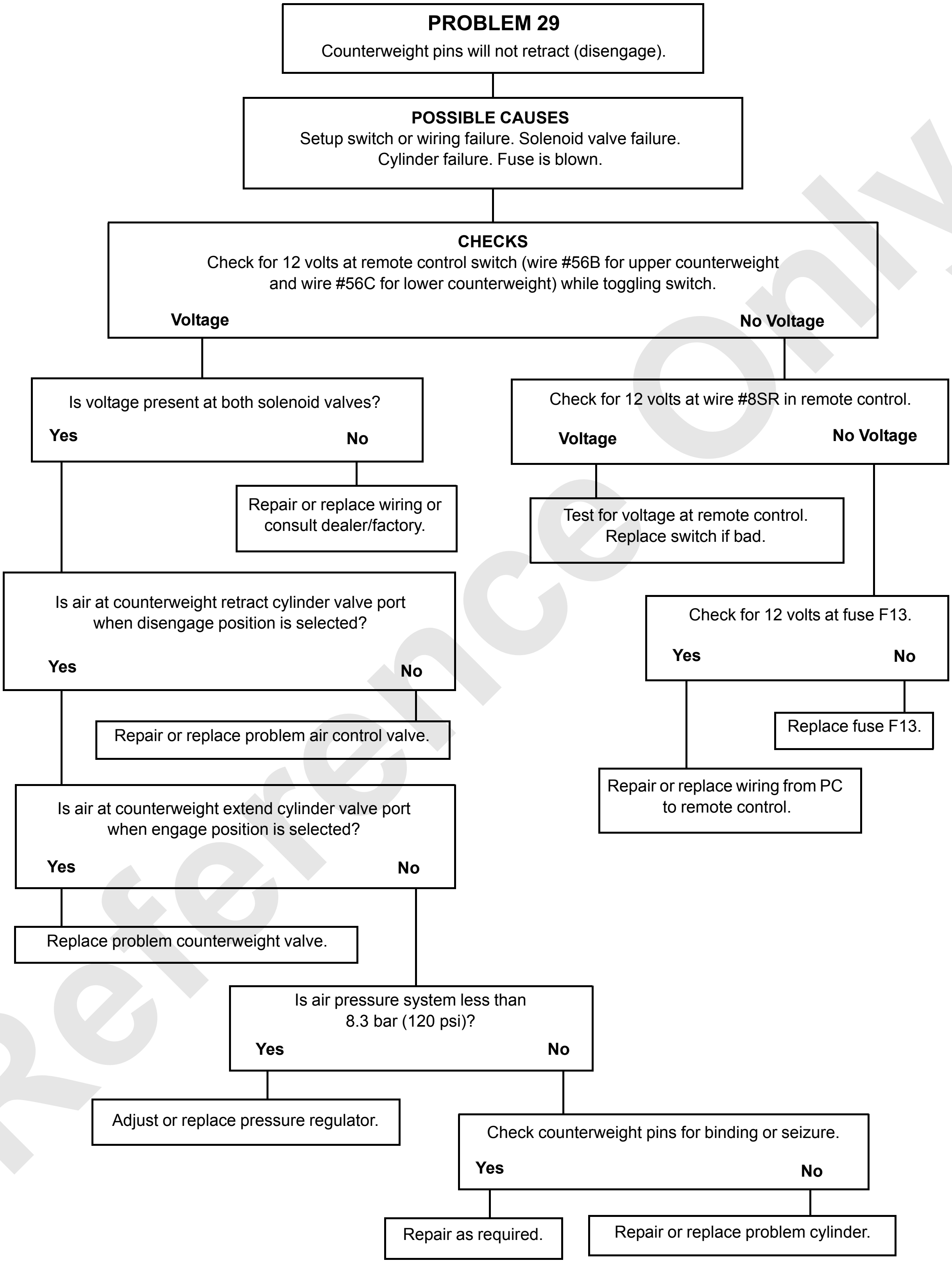
Replace problem counterweight valve.

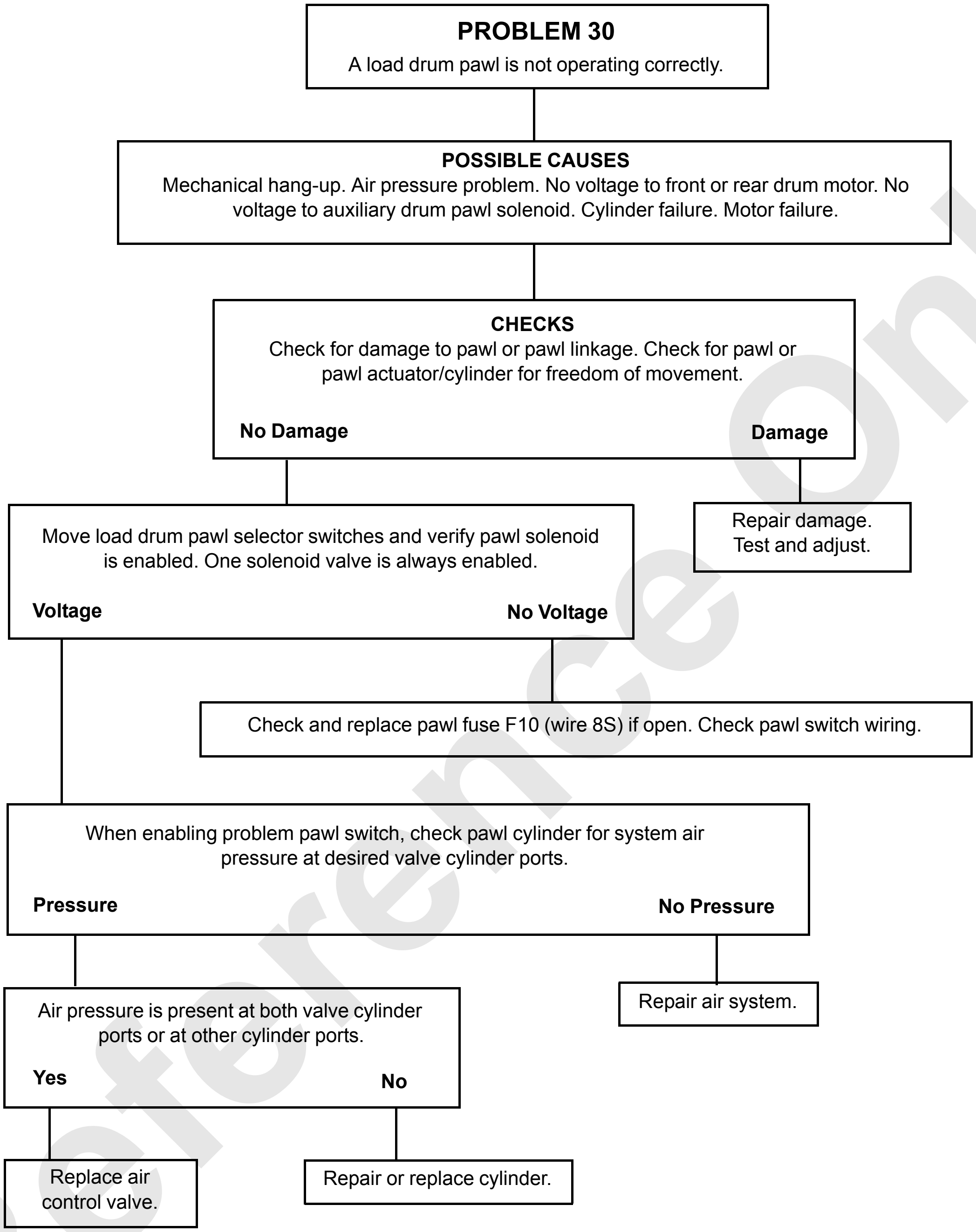
Replace problem counterweight valve.

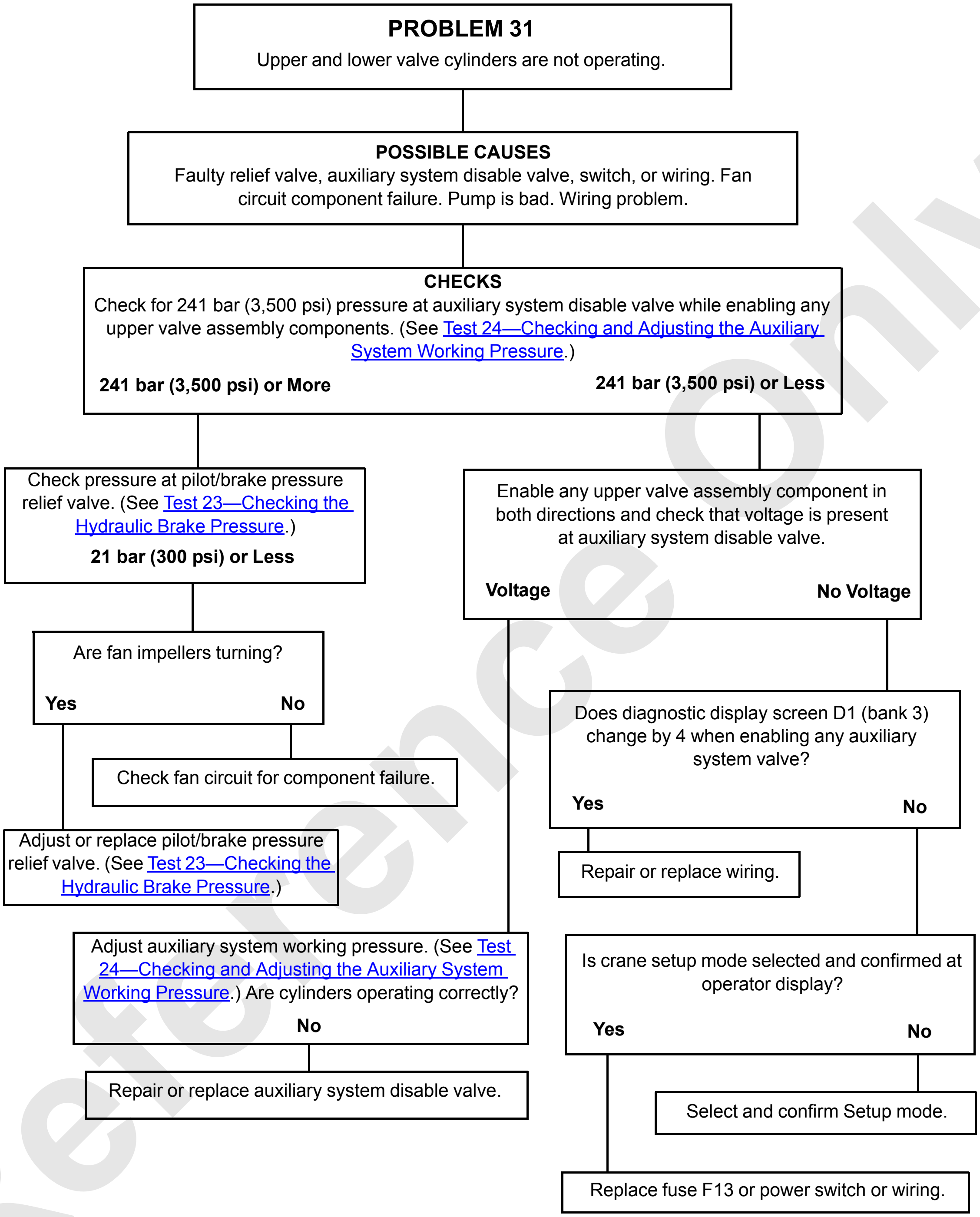
Check counterweight pins for binding or seizure.

Repair as required.

Repair or replace problem cylinder.


PROBLEM 29
Counterweight pins will not retract (disengage).
POSSIBLE CAUSES
Setup switch or wiring failure. Solenoid valve failure.
Cylinder failure. Fuse is blown.
CHECKS
Check for 12 volts at remote control switch (wire #56B for upper counterweight and wire #56C for lower counterweight) while toggling switch.
Voltage
No Voltage
Is voltage present at both solenoid valves?
Yes
No
Repair or replace wiring or consult dealer/factory.
Is air at counterweight retract cylinder valve port when disengage position is selected?
Yes
No
Repair or replace problem air control valve.
Is air at counterweight extend cylinder valve port when engage position is selected?
Yes
No
Replace problem counterweight valve.
Is air pressure system less than 8.3 bar (120 psi)?
Yes
No
Adjust or replace pressure regulator.
Check counterweight pins for binding or seizure.
Yes
No
Repair as required.
Repair or replace problem cylinder.
Check for 12 volts at wire #8SR in remote control.
Voltage
No Voltage
Test for voltage at remote control. Replace switch if bad.
Check for 12 volts at fuse F13.
Yes
No
Replace fuse F13.
Repair or replace wiring from PC to remote control.


PROBLEM 30
A load drum pawl is not operating correctly.
POSSIBLE CAUSES
Mechanical hang-up. Air pressure problem. No voltage to front or rear drum motor. No voltage to auxiliary drum pawl solenoid. Cylinder failure. Motor failure.
CHECKS
Check for damage to pawl or pawl linkage. Check for pawl or pawl actuator/cylinder for freedom of movement.
No Damage
Damage
Repair damage. Test and adjust.
Move load drum pawl selector switches and verify pawl solenoid is enabled. One solenoid valve is always enabled.
Voltage
No Voltage
Check and replace pawl fuse F10 (wire 8S) if open. Check pawl switch wiring.
When enabling problem pawl switch, check pawl cylinder for system air pressure at desired valve cylinder ports.
Pressure
No Pressure
Repair air system.
Air pressure is present at both valve cylinder ports or at other cylinder ports.
Yes
No
Replace air control valve.
Repair or replace cylinder.



PROBLEM 31

Upper and lower valve cylinders are not operating.

POSSIBLE CAUSES

Faulty relief valve, auxiliary system disable valve, switch, or wiring. Fan circuit component failure. Pump is bad. Wiring problem.

CHECKS

Check for 241 bar (3,500 psi) pressure at auxiliary system disable valve while enabling any upper valve assembly components. (See Test 24—Checking and Adjusting the Auxiliary System Working Pressure.)

241 bar (3,500 psi) or More

241 bar (3,500 psi) or Less

Check pressure at pilot/brake pressure relief valve. (See Test 23—Checking the Hydraulic Brake Pressure.)

21 bar (300 psi) or Less

Are fan impellers turning?

Yes **No**

Check fan circuit for component failure.

Adjust or replace pilot/brake pressure relief valve. (See Test 23—Checking the Hydraulic Brake Pressure.)

Adjust auxiliary system working pressure. (See Test 24—Checking and Adjusting the Auxiliary System Working Pressure.) Are cylinders operating correctly?

No

Repair or replace auxiliary system disable valve.

Enable any upper valve assembly component in both directions and check that voltage is present at auxiliary system disable valve.

Voltage **No Voltage**

Does diagnostic display screen D1 (bank 3) change by 4 when enabling any auxiliary system valve?

Yes **No**

Repair or replace wiring.

Is crane setup mode selected and confirmed at operator display?

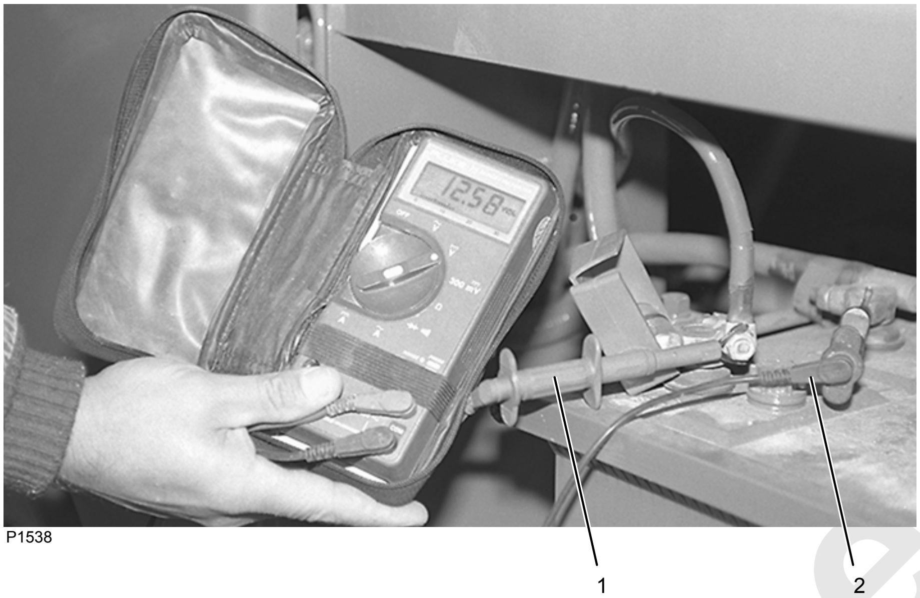
Yes **No**

Select and confirm Setup mode.

Replace fuse F13 or power switch or wiring.

TESTING COMPONENTS

Test 1—Testing the Battery (12 and 24 volts DC)



12 Volts DC

Item	Description
1	Positive Lead
2	Negative Lead

FIGURE 10-1

Test the 12-volt DC accessory system voltage with a digital multimeter. Record the voltage before and during engine cranking.

A voltage reading of 12 volts or less before engine cranking may indicate a charging system fault. A drop of 4 volts or more indicates the battery is failing.

24 Volts DC

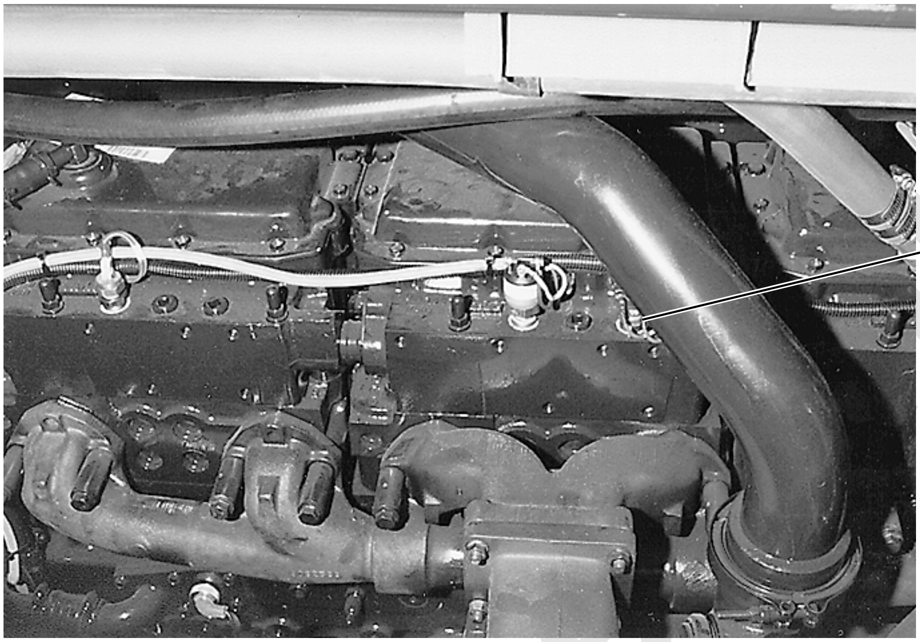
Item	Description
1	Positive Lead
2	Negative Lead

FIGURE 10-2

Test the 12-volt DC starting batteries in series for 24 volts using a digital multimeter. Record the voltage before and during engine cranking.

A voltage reading of 24 volts or less before engine cranking may indicate a charging system fault. A drop of 8 volts or more indicates the battery is failing.

Test 2—Checking Resistance at the Engine Temperature Switch

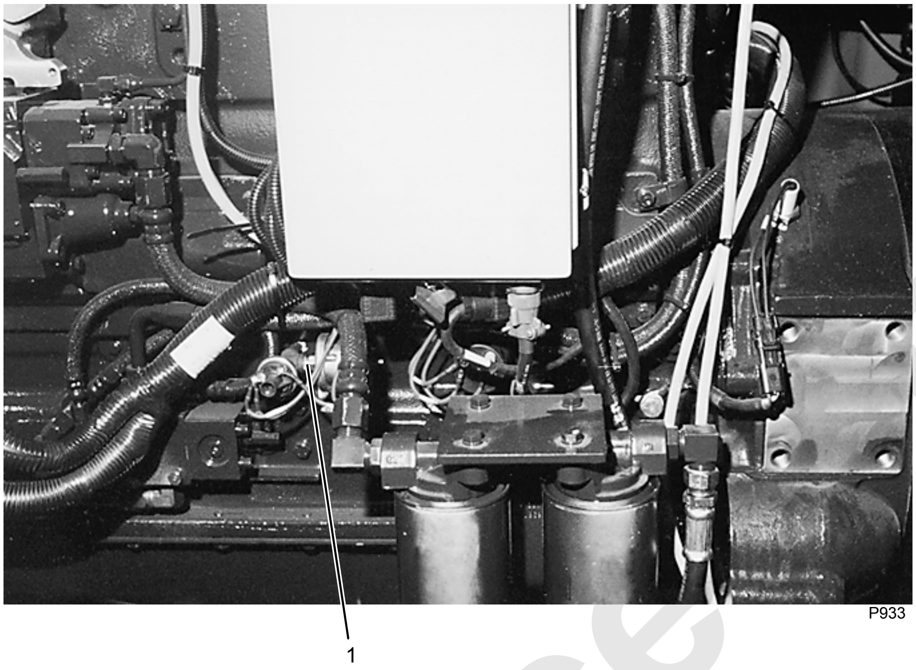


Item	Description
1	Engine Temperature Switch

FIGURE 10-3

Set the digital multimeter to test resistance. Make the required connections to the test lead adapter at the meter. Connect the negative lead to a grounded component on the crane and the positive lead to the engine temperature switch (1) wire terminal. With the engine cold, check for a resistance of approximately 0.67 ohms.

Test 3—Checking Resistance at the Engine Oil Pressure Switch

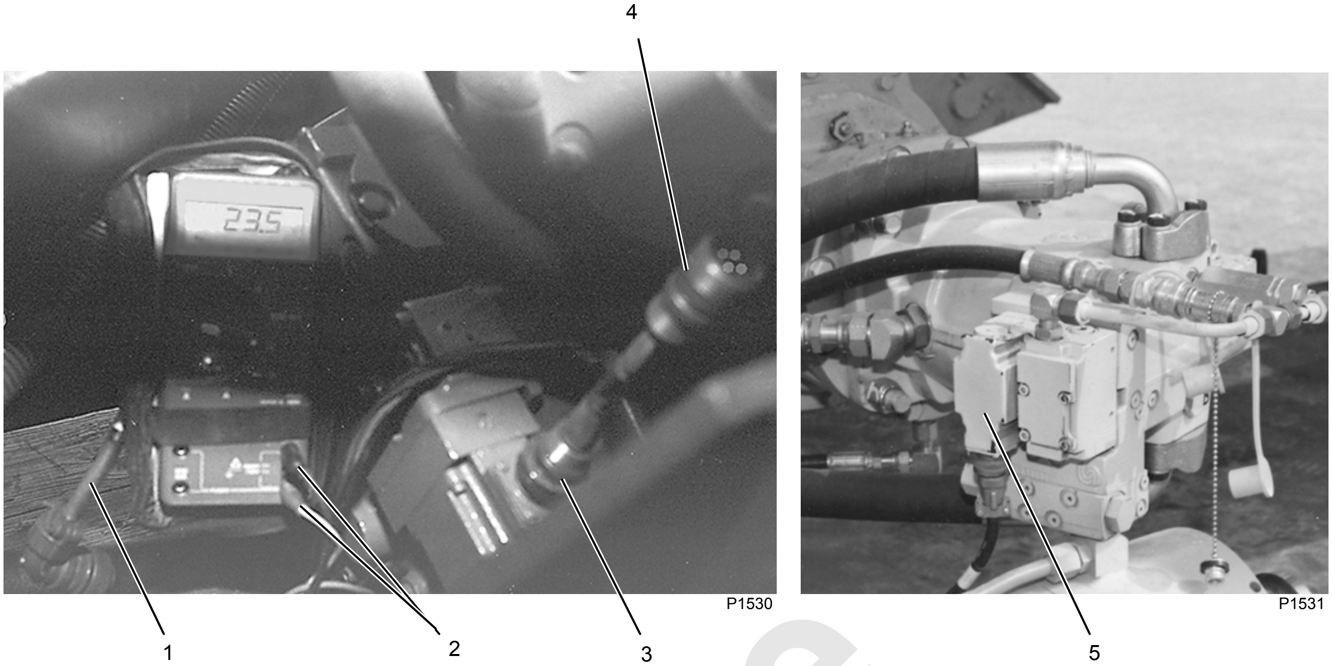


Item	Description
1	Oil Pressure Switch

FIGURE 10-4

Set the digital multimeter to test resistance. Make the required connections to the test lead adapter at the meter. Connect the negative lead to a grounded component on the crane and the positive lead to the oil pressure switch (1) wire terminal. With the engine cold, check for a resistance of approximately 240 ohms.

Test 4—Testing the Pump EDC and Motor PCP



Item	Description
1	PC Input Cable
2	Adapter Cable Connections
3	Pump Electric Displacement Control (EDC)
4	Test Plug Adapter
5	Motor Pressure Control Pilot (PCP)

FIGURE 10-5

Testing a pump electric displacement control (EDC) (3) or motor pressure control pilot (PCP) (5) requires a standard test plug adapter (4) (can be ordered from Manitowoc Cranes) and a digital multimeter. To test a pump function, proceed as follows.

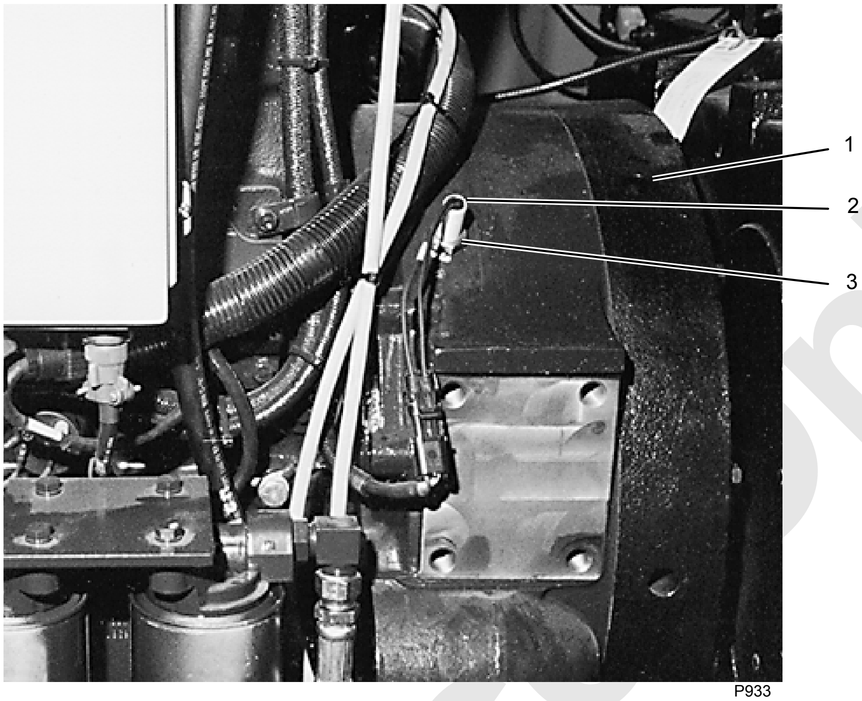
1. Disconnect the PC input cable (1) from the pump EDC to be tested.
2. Connect the double-ended test plug adapter EDC.
3. Leave the PC end of the test plug disconnected.
4. Set the digital multimeter for testing resistance.
5. Connect the white (positive) and black (negative) wires from the adapter cable to the digital multimeter jacks.
6. Make sure the EDC resistance is between 15 and 19 ohms.

Leave the test plug adapter installed at the pump EDC and proceed as follows.

1. Set the digital multimeter for testing volts DC.
2. Connect the PC input cable to the PC end of the test plug adapter.
3. With the engine running, slowly enable the test system control handle.
4. Make sure the range of voltage change is between 0 and +/-2.45 volts DC.
5. Measure the load current by connecting the red and white wires from the adapter cable to the digital multimeter jacks.

To test motor function, remove the PC input line from the motor PCP and connect the test plug adapter. Perform the resistance and voltage tests as described for the pump EDC. The motor PCP coil resistance should be between 23 and 26 ohms. The voltage should be between 0 and 1.96 volts DC.

Test 5—Cleaning and Adjusting the Engine RPM Transducer



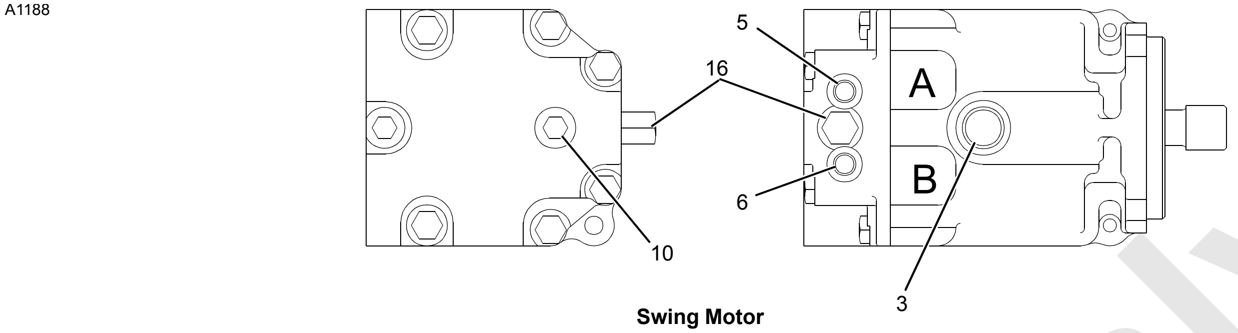
Item	Description
1	Flywheel Housing
2	RPM Transducer
3	Lock Nut

FIGURE 10-6

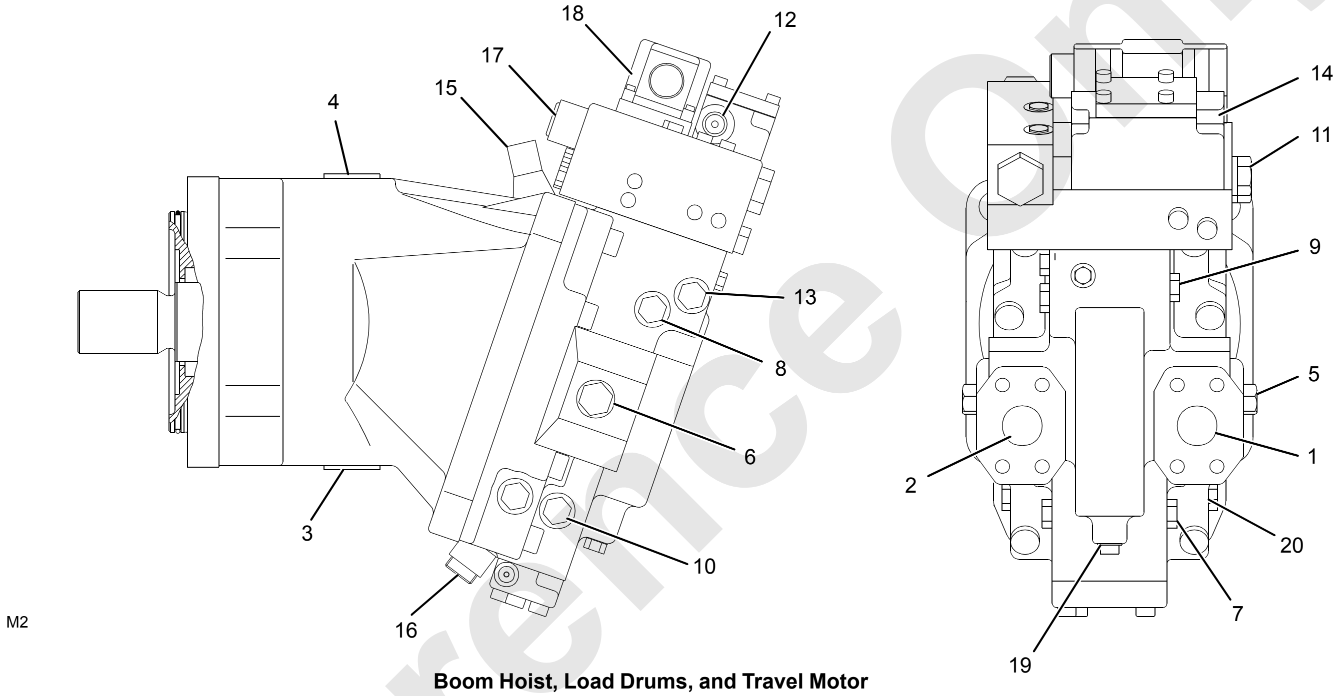
To clean and adjust the engine RPM transducer (2), perform the following procedure.

1. Loosen the lock nut (3) and remove the threaded transducer from the flywheel housing (1).
2. Clean any metallic debris from the magnetic pickup on the transducer with a cleaning solvent.
3. Reinstall the transducer so the magnetic pickup makes contact with the flywheel.
4. Back the flywheel off 1/2 turn and secure the lock nut.

Test 6—Location of Motor Ports



Swing Motor

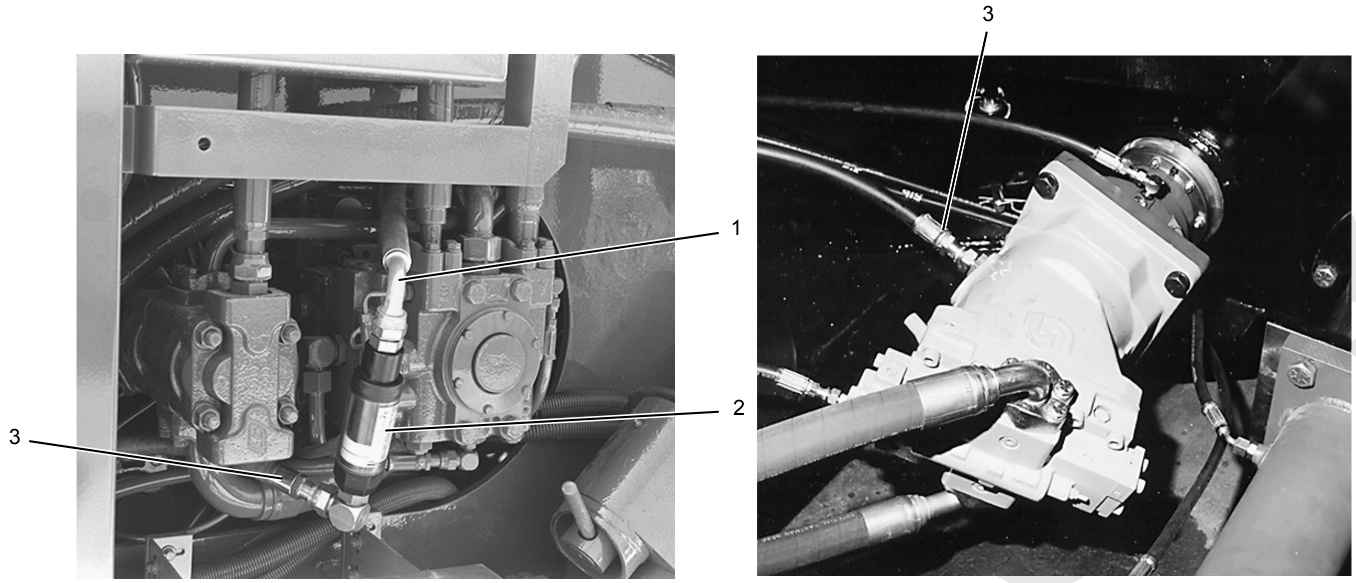


Boom Hoist, Load Drums, and Travel Motor

Item	Port	Description	Item	Port	Description
1	A	Main System Pressure	11	M7	Control Pressure
2	B	Main System Pressure	12	M8	Control Pressure
3	L1	Case Pressure	13	M9	Servo Pressure Supply
4	L2	Case Pressure	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 Gauge Port or Servo Pressure Supply	17		Pressure Compensator Adjuster
8	M4	Servo Gauge Port or Servo Pressure Supply	18		Manual Override
9	M5	Servo Pressure Supply	19		Control Start Setting
10	M6	Charge Pressure Gauge Port	20		Loop Flushing Shuttle Valve

FIGURE 10-7

Test 7—Testing for Pump and Motor Leakage



Pumps

Motors

Item	Description
1	Case Drain Hose
2	In-Line Flow Meter
3	Hose to Highest Case Drain Port

FIGURE 10-8

Testing for pump and motor leakage requires a 207 bar (3,000 psi) in-line flow meter (2) with a minimum flow rate capacity of 113 L/min (30 gpm). Flow meters can be ordered from Manitowoc Cranes.

Acceptable leakage is based on the combined case flow of the pump and motor. The combined case flow of the load drum pump and motor should be equal to a charge pump flow or 34 L/min (8.9 gpm) per 1,000 rpm of the engine.

The combined case flow of the boom hoist, swing, travel, or luffing jib hoist pump and motor should be equal to a charge pump flow or 18 L/min (4.8 gpm) per 1,000 rpm of the engine. The difference between the system charge pump flow and motor case flow at neutral is the acceptable pump case flow at neutral for the system being tested.

Motor Test

The external loop flush valve must be removed from the boom hoist motor before testing (see Test 22—Servicing the Motor Loop Flushing (Purge) Valves). To test a motor, perform the following.

1. Connect the flow meter between the motor case drain hose (1) and the highest motor case drain port.
2. With the engine running at 1,000 rpm, measure the flow rate of the motor.

   The case flow at neutral or very light loads should be approximately 19 L/min (5 gpm).
3. Record all measurements at neutral.

   At heavier loads, the normal case flow may go to 26 L/min (7 gpm).

   For motors that do not have loop flushing, the case flow at neutral should not exceed 6 L/min (1.5 gpm).

   For motors that do not have loop flushing, the case flow at heavier loads and higher rpm may increase to 17 or 21 L/min (4.5 or 5.5 gpm).
4. Reconnect the motor case drain hose to the motor drain port.

Pump Test

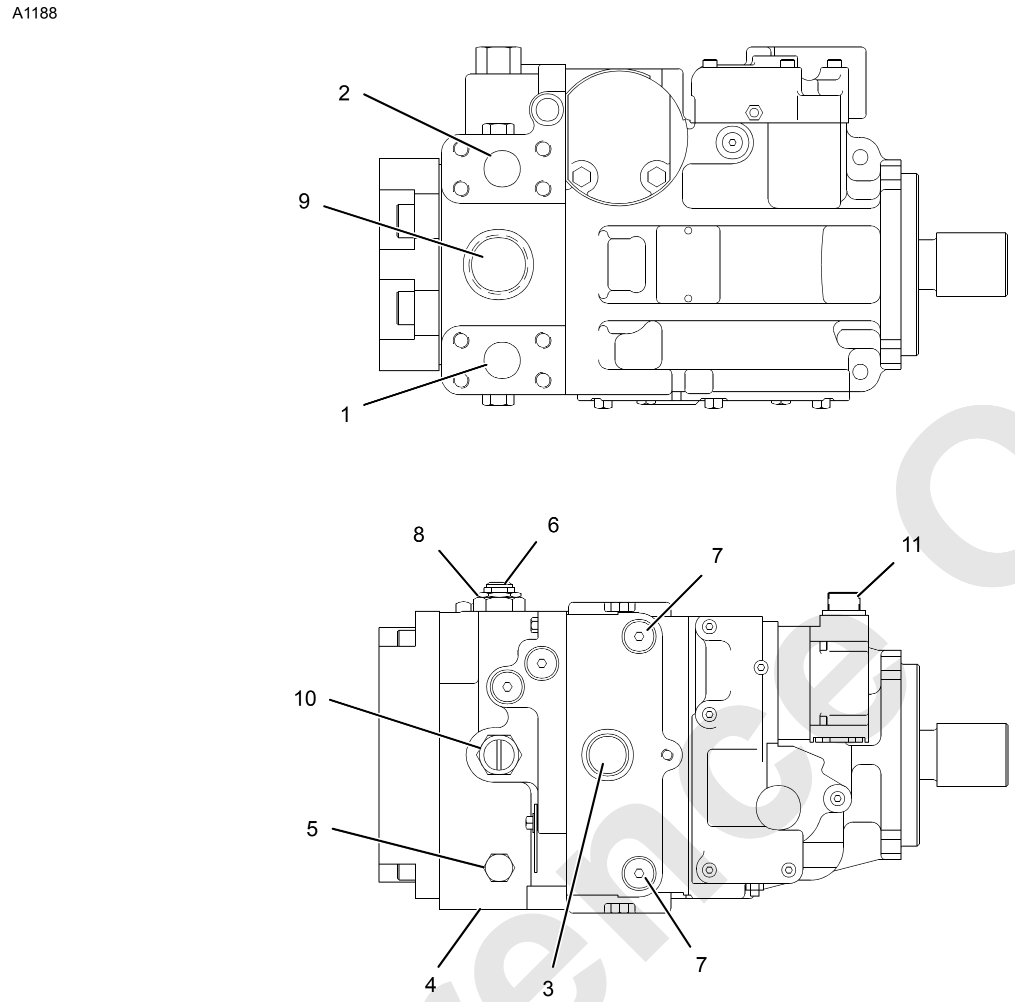
See Test 8—Location of Pump Ports for the location of the pump ports. To test a pump, perform the following.

1. Connect the flow meter between the pump case drain hose and pump port L1 or L2.

   Use the highest port for testing.
2. With the engine running at 1,000 rpm, measure the flow rate of the pump at neutral and compare it to the calculated acceptable pump case flow.

Deviations from the normal or major changes with increasing system pressure more than +/-4 L/min (1 gpm) are an indication of a pump or motor problem.

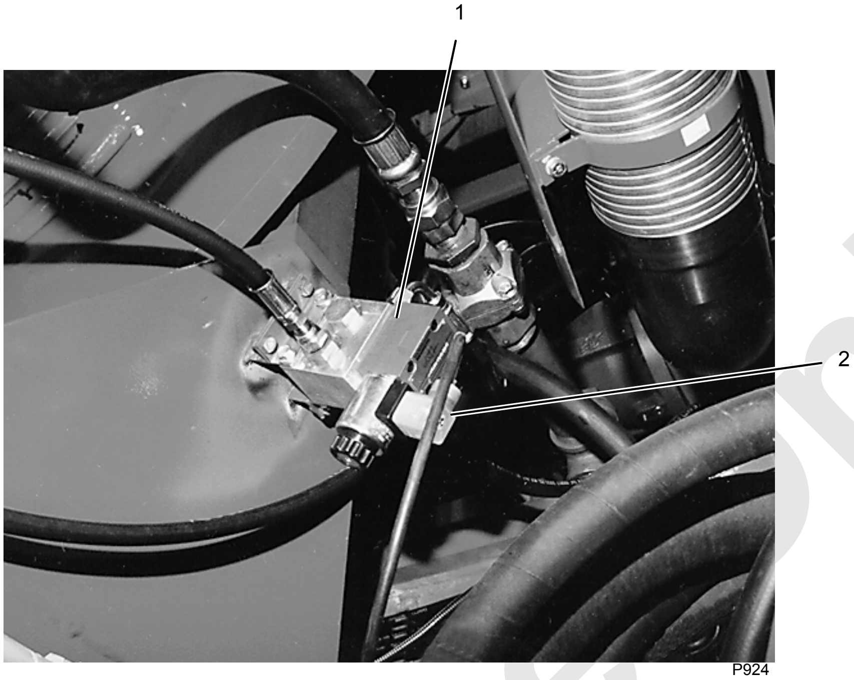
Test 8—Location of Pump Ports



Item	Description
1	Port A—Main System Pressure
2	Port B—Main System Pressure
3	Case Drain (highest port as outlet)
4	System Pressure Gauge Port A
5	System Pressure Gauge Port B (other side)
6	Charge Pressure Gauge Port (between multifunction valves)
7	Servo Pressure Gauge Port
8	Multifunction Valves
9	Charge Pump Inlet
10	Charge Pressure Relief Valve
11	Electrical Displacement Valve (EDC)

FIGURE 10-9

Test 9—Checking Voltage at the Hydraulic Brake Valve



Item	Description
1	Hydraulic Brake Valve
2	DIN Plug

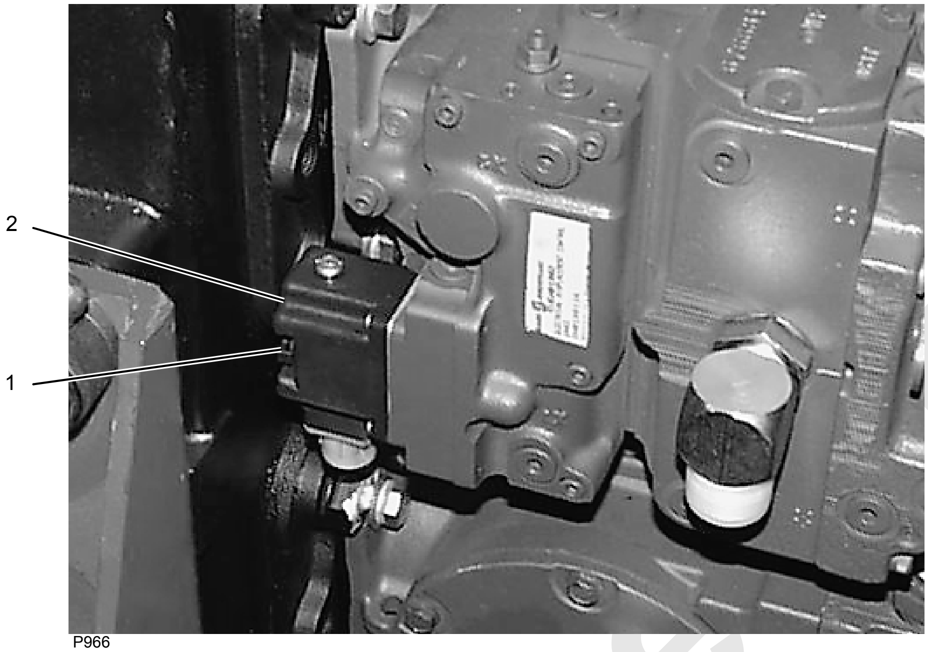
FIGURE 10-10

Testing for voltage at any hydraulic brake valve (1) requires a standard test plug adapter (can be ordered from Manitowoc Cranes) and a digital multimeter.

To test a brake valve, perform the following procedure.

1. Connect the test plug adapter between the brake valve and the DIN plug (2).
2. Connect the white (positive) and black (negative) wires from the adapter cable to the digital multimeter jacks.
3. Check for 12 volts DC while releasing the brake for the system being tested.
4. Measure load current by connecting the red and white wires from the adapter cable to the digital multimeter jacks.

Test 10—Manually Stroking the Pump



Item	Description
1	Manual Stroke Override
2	Pump Electric Displacement Control (EDC)

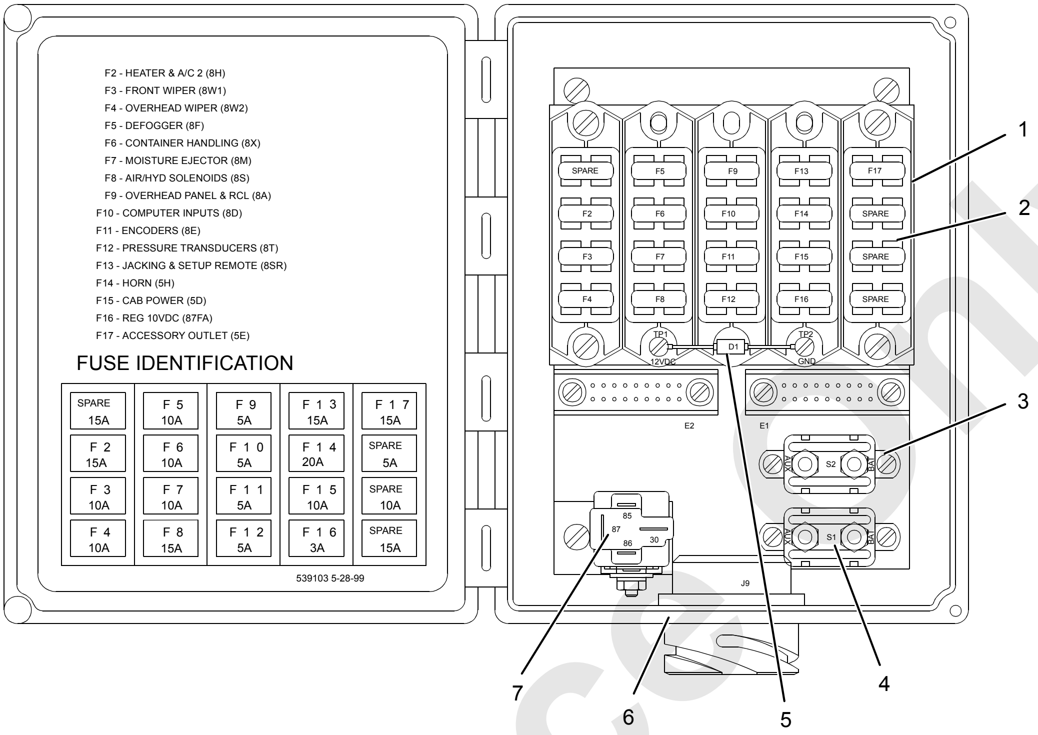
FIGURE 10-11

See Test 8—Location of Pump Ports for the location of the pump ports. To stroke the pump, perform the following procedure:

1. Start with the engine running and all brakes and locks engaged.
2. Rotate the pump manual stroke override (1) in the clockwise direction to load down and raise the pressure in port A.
3. Rotate the pump manual stroke override in the counterclockwise direction to load down and raise the pressure in port B.

Test 11—Testing for Voltage at the Fuse Box

A1188



Item	Description
1	Fuse Block
2	Metal Fuse Contact
3	Air Conditioner CB (40 amp)
4	Controller CB (50 amp)
5	Transient Suppressor Diode
6	Fuse Box Chassis
7	K1 Cab Power Relay

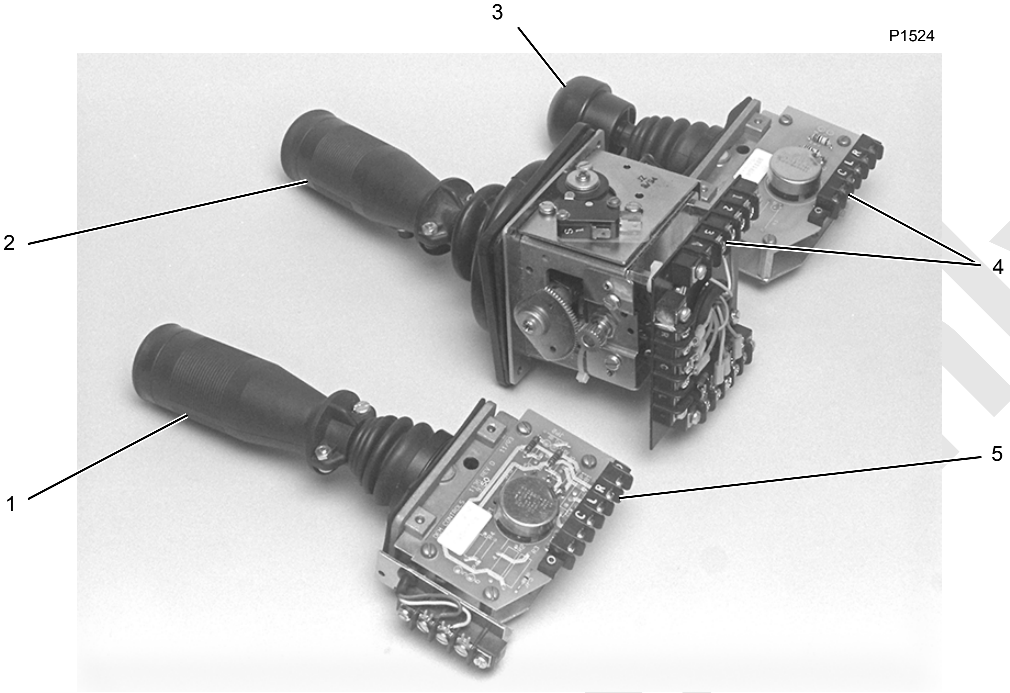
FIGURE 10-12

Use a digital multimeter for testing voltage at the fuse block (1).

To test for volts DC at any given fuse socket, place the positive lead on any metal fuse contact (2) and the negative lead on the grounded fuse box chassis (6). Repeat this procedure using the other fuse contact as a test point. All fuse sockets except F16 (3A, 10V) should be 12 volts DC.

To determine if the K1 cab power relay (7) is fully functional, ground the fuse box chassis and check for 12 volts DC at relay wire 8 when the relay is enabled. Also check for 12 volts constant at relay wire 5A.

Test 12—Checking Voltage at the Control Handle



Item	Description	Item	Description
1	Load Drum Handle	4	Test Terminal
2	Boom/Swing Handle	5	Ground Terminal R
3	Crawler Handle		

FIGURE 10-13

Perform the following procedure to determine the correct voltages at the control handle.

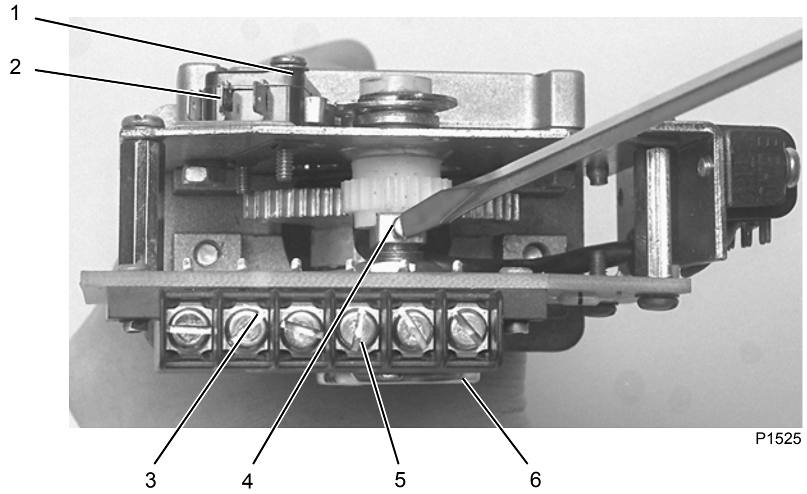
1. The engine must be off and the power on, with all brakes and locks engaged.
2. Enable the test control handle and measure the voltage with a digital multimeter.
3. Place the positive lead on the test terminal (4) and the negative lead on a grounded crane component or on ground terminal R (5).vs

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

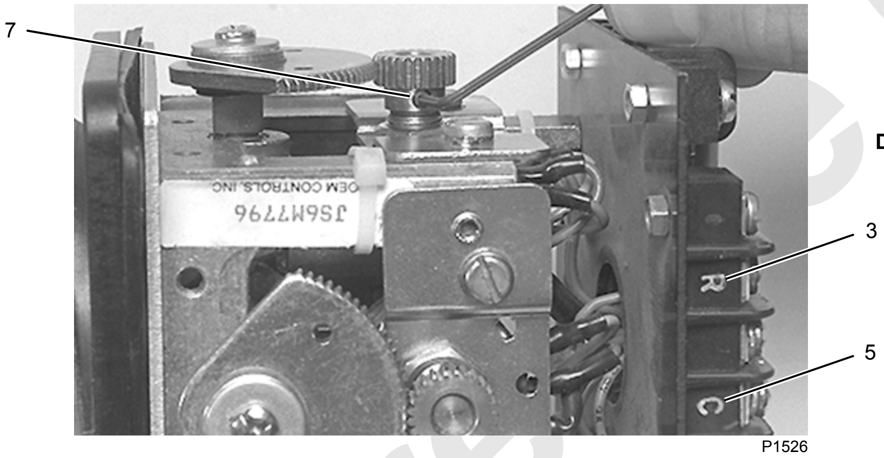
Hand Controller	Test Terminal	Wire No.	Acceptable Voltage (DC)
Swing	Left	87FA	10
	Right	0	Ground
	Center	85P	1.4 to 8.6
	3	8S Brake	12
	4	89B2 Brake	12
Boom Hoist	Left	87FA	10
	Right	0	Ground
	Center	82P	1.4 to 8.6
	1	8A	Ground
	2	82N	12
Right Travel	Left	87FA	10
	Right	0	Ground
	Center	83P	1.4 to 8.6
	3	8D	12
	4	89X	12

Hand Controller	Test Terminal	Wire No.	Acceptable Voltage (DC)
Left Travel	Left	87FA	10
	Right	0	Ground
	Center	84P	1.4 to 8.6
Front or Right Rear Load Drum	Left	87FA	10
	Right	0	Ground
	Center	80P	1.4 to 8.6
	1	0	Ground
	2	80N	12
Rear or Left Rear Load Drum	Left	87FA	10
	Right	0	Ground
	Center	83P	1.4 to 8.6
	3	0	Ground
	4	81N	12

Test 13—Adjusting the Control Handle Potentiometer



Single Axis Controller



Double Axis Controller

Item	Description
1	Neutral (snap) Switch
2	Jumper Connection (N/O)
3	Ground Terminal R
4	Slotted Setscrew
5	Center Terminal C
6	Potentiometer
7	Socket Setscrew (qty 2)

FIGURE 10-14

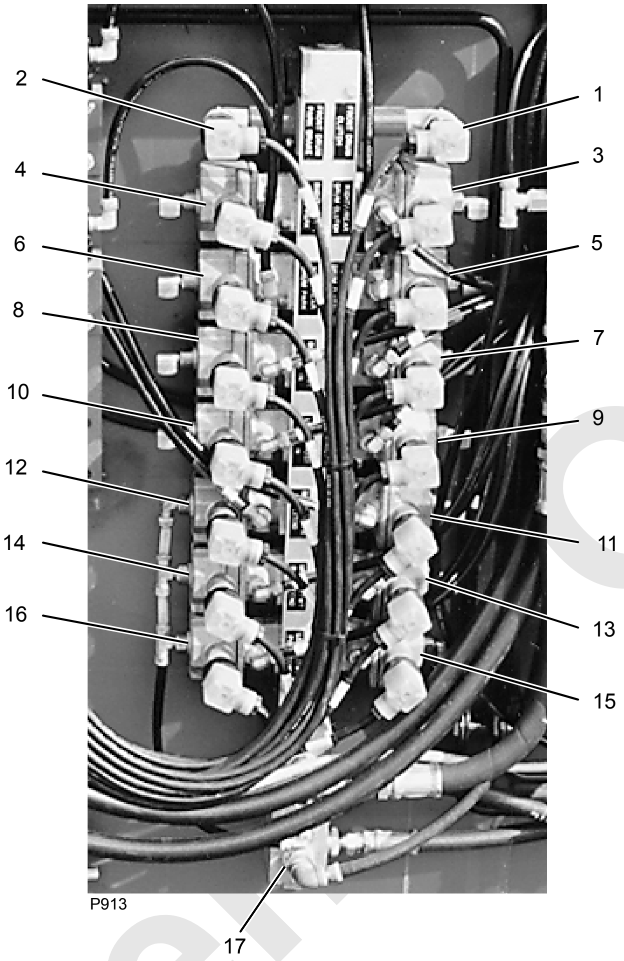
An unusual reaction to a control handle movement may indicate a misalignment of the handle potentiometer (6). Adjusting a single axis or double axis control handle requires aligning the handle and potentiometer in the neutral position. Neutral is the position where 5 volts DC is present.

To check a single axis controller, perform the following procedure.

1. Make sure the engine is off and the power is on, with all brakes and locks engaged.
2. Make a jumper connection (2) between the normally open terminal on the neutral (snap) switch (1) and center terminal C (5) on the handle terminal block.
3. Connect the positive lead of a digital multimeter to terminal C.
4. Connect the negative lead to a grounded crane component or to ground terminal R (3).
5. Loosen the slotted setscrew (4) and allow the handle to return to the neutral position.
6. Retighten the slotted setscrew and move the handle until a reading of 5 volts DC is obtained.
7. Holding the handle in the 5-volt position, loosen the slotted setscrew.
8. Allow the handle to return to the neutral position.
9. Retighten the slotted setscrew.

The double axis control handle adjustment is the same, except the two socket setscrews (7) on the gear collar are loosened.

Test 14—Checking System Voltage at the Air Solenoid Panel



Item	Description	Item	Description
1	Front Drum Clutch Solenoid	10	Luffing Hoist Pawl In Solenoid
2	Front Drum Park Brake Solenoid	11	Backhitch Pin Cylinders Retract Solenoid
3	Rear or Right Rear Drum Clutch Solenoid	12	Backhitch Pin Cylinders Extend Solenoid
4	Rear or Right Rear Drum Park Brake Solenoid	13	Upper Counterweight Pin Cylinders Retract Solenoid
5	Left Rear Drum Clutch Solenoid	14	Upper Counterweight Pin Cylinders Extend Solenoid
6	Left Rear Drum Park Brake Solenoid	15	Lower Counterweight Pin Cylinders Retract Solenoid
7	Boom Hoist Pawl-Out Solenoid	16	Lower Counterweight Pin Cylinders Extend Solenoid
8	Boom Hoist Pawl In Solenoid	17	Air Manifold
9	Luffing Hoist Pawl Out Solenoid		

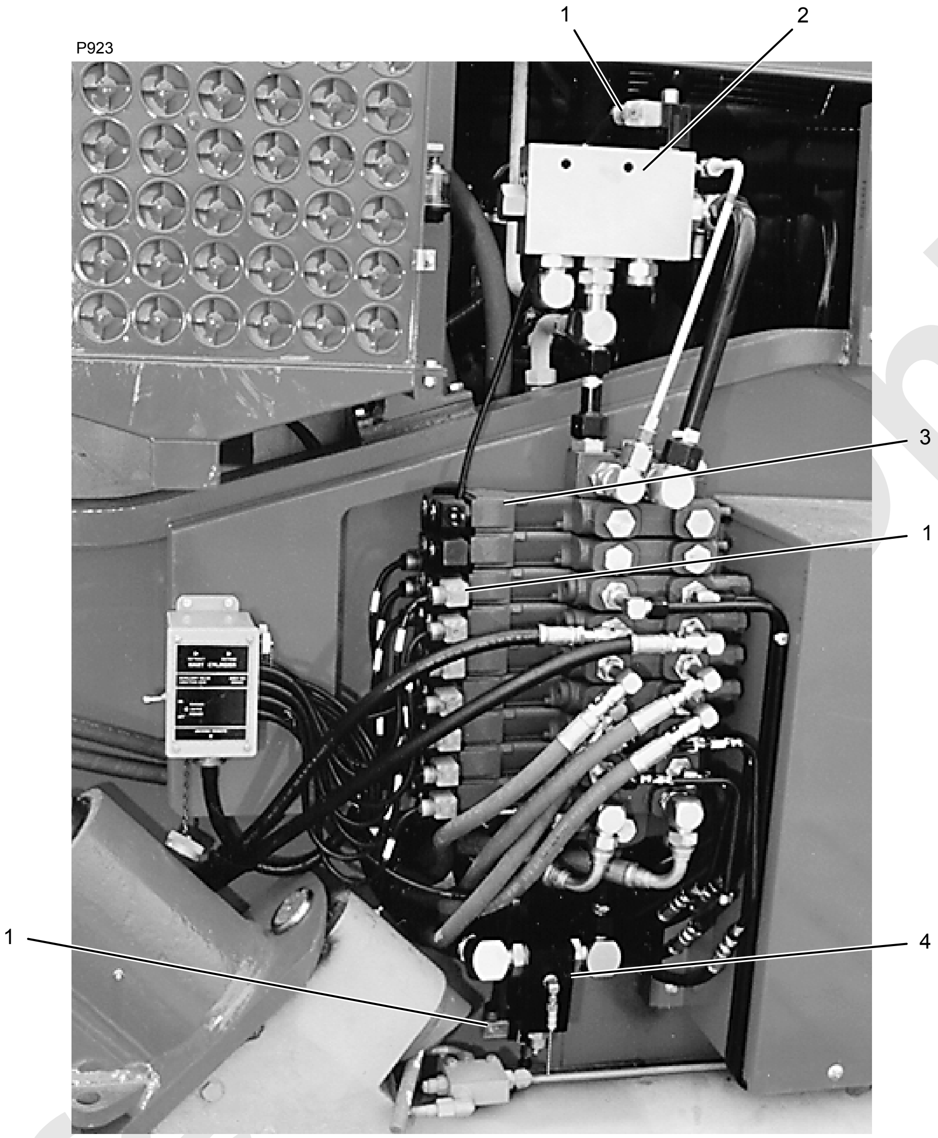
FIGURE 10-15

To determine if an air solenoid is enabled, place a screwdriver on the solenoid coil. The solenoid is enabled if the screwdriver is magnetically pulled toward the solenoid coil.

Testing air solenoid valves for correct voltage and amperage requires a standard test plug adapter (which can be ordered from Manitowoc Cranes) and a digital multimeter. Perform the following procedure to test for correct voltage and amperage.

1. Connect the test plug adapter between the solenoid valve and the electrical connector.
2. Make the connections from the adapter cable white (positive) and black (negative) wires to the digital multimeter and check for 12 volts DC while enabling the air solenoid being tested.
3. Measure load current (amps) by making the current connections (red and white) to the digital multimeter.

Test 15—Checking System Voltage at the Hydraulic Valve Assemblies



Left Side

Item	Description
1	DIN Plug
2	Proportional Flow Control Valve
3	Upper Valve Assembly (top to bottom): Spare Spare Right Front Jack Extend/Retract Solenoid Valve Right Rear Jack Extend/Retract Solenoid Valve Left Rear Jack Extend/Retract Solenoid Valve Left Front Jack Extend/Retract Solenoid Valve Front Frame Pins Extend/Retract Solenoid Valve Rear Frame Pins Extend/Retract Solenoid Valve Gantry Cylinders Extend/Retract Solenoid Valve
4	Auxiliary System Disable Valve

FIGURE 10-16

To determine if a hydraulic solenoid is enabled, place a screwdriver on the solenoid coil. The solenoid is enabled if the screwdriver is magnetically pulled toward the solenoid coil.

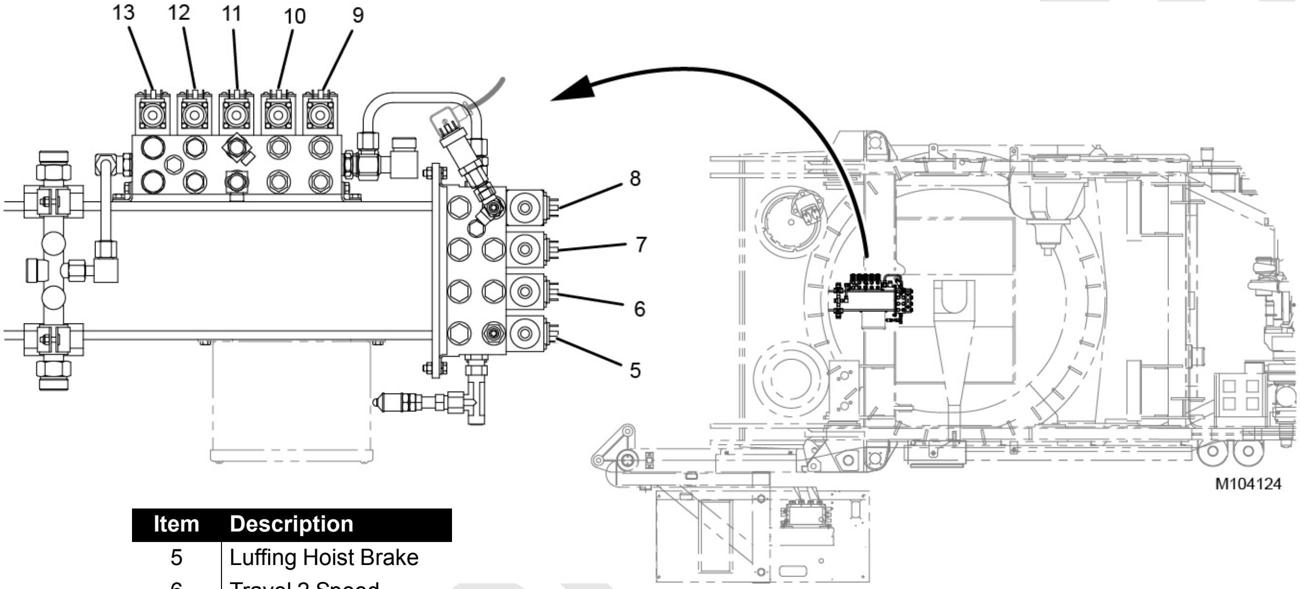
Measure the system voltage at various locations on the hydraulic valve assemblies with a standard test plug adapter (can be ordered from Manitowoc Cranes) and a digital multimeter.

See Figure 10-17 for identification of the valves.

To test a hydraulic valve, see Figure 10-16 and perform the following procedure.

1. Set the digital multimeter for testing volts DC.
2. Connect the white (positive) and black (negative) wires from the adapter cable to the digital multimeter jacks.
3. Install the test plug between the valve electrical socket and the DIN plug (1).
4. Enable the valve being tested.
5. Check for 12 volts DC at the upper valve assembly (3) and the auxiliary system disable valve (4).

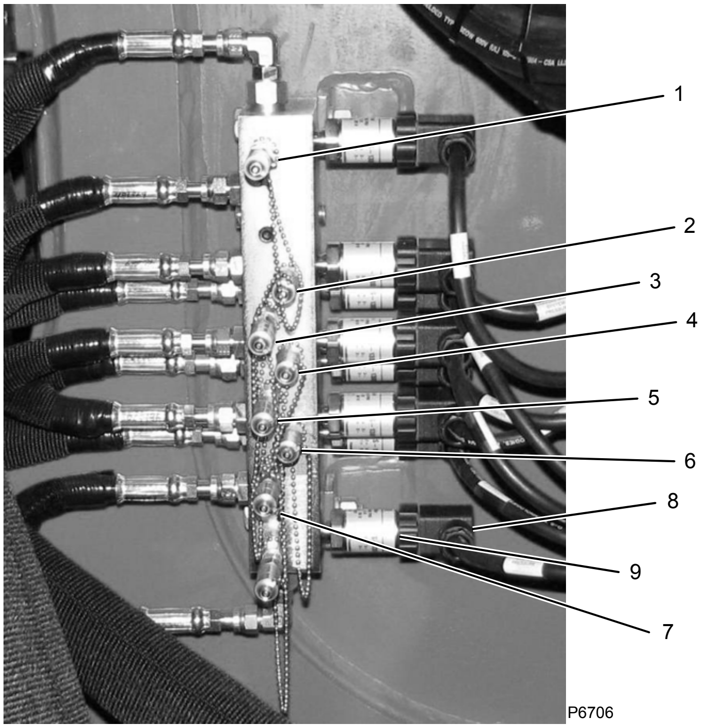
   Voltage to the proportional flow control valve (2) should be between 3.25 and 7.22 volts DC.



Item	Description
5	Luffing Hoist Brake
6	Travel 2 Speed
7	Travel Brake
8	Swing Brake
9	Left Crawler Pins
10	Right Crawler Pins
11	Boom Hinge Pins
12	Boom Butt Handling
13	Rigging Winch

FIGURE 10-17

Test 16—Checking the Pump Charge Pressure and Electrical Test



Item	Description
1	Right Travel System Pressure Port
2	Boom Hoist System Pressure Port
3	Hoist System Pressure Port (pump out-board)
4	Hoist Charge Pressure Port (pump in-board)
5	Swing Right System Pressure Port
6	Swing Left System Pressure Port
7	Left Travel Charge Pressure Port
8	DIN Connector (electrical test)
9	Pressure Transducer

FIGURE 10-18

Component charge systems can be checked at the M1, M2, or M3 gauge ports (see Test 6—Location of Motor Ports). To check the pump charge pressure, perform the following procedure.

1. Install a 0 to 42 bar (0 to 600 psi) gauge at the desired system diagnostic gauge coupler on the pressure transducer manifold.
2. Start the system and record the charge pressure at engine idle speed.

   No hydraulic systems should be enabled.

   A reading of 24 bar (350 psi) is the system charge pressure.

   A reading of less than 24 bar (350 psi) indicates a charge pressure relief adjustment is necessary. See Test 18—Adjusting the Pump Charge Pressure Relief.

Test the voltage and resistance of a system pressure transducer with a standard test plug adapter (can be ordered from Manitowoc Cranes) and a digital multimeter.

To test the incoming power at the desired pressure transducer, perform the following procedure.

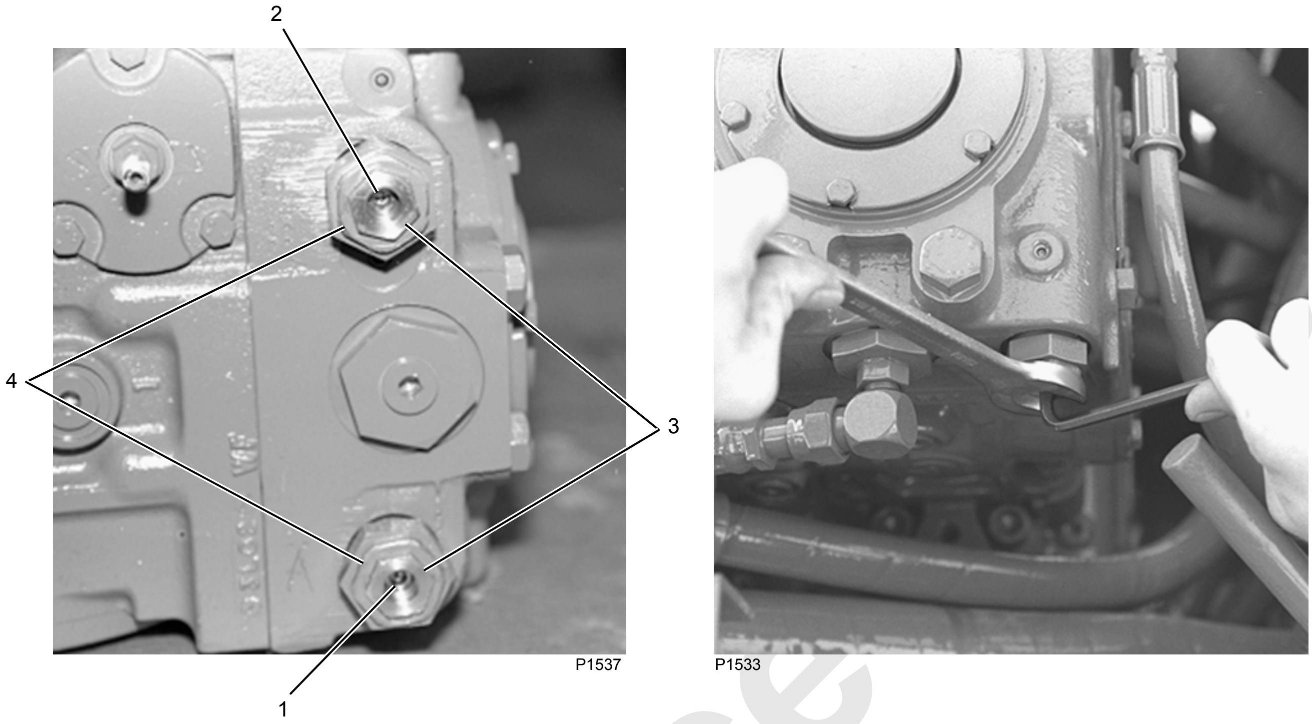
1. Connect the test plug adapter between the pressure transducer (9) and the DIN connector (8).
2. Connect the white (positive) and black (negative) wires from the adapter cable to the digital multimeter jacks.
3. Check for 12 volts DC.
4. If this reading is not obtained, check the 5 amp F12 fuse at the fuse panel (see Test 11—Testing for Voltage at the Fuse Box).

To test voltage output from the pressure transducer to the PC, perform the following procedure.

1. Make sure the engine is off and the power is on, with all brakes and locks engaged.
2. Connect the green (positive) and black (negative) wires to the digital multimeter jacks.
3. Check for 1.00 to 1.04 volts DC.

The PC null or zero routine permits the pressure transducer to operate outside the above voltage range. If the reading is less than 0.50 volts or more than 2.00 volts, the pressure transducer must be replaced.

Test 17—Setting the Pump Pressure



Item	Description
1	Multifunction Valve Adjusting Screw for Port A
2	Multifunction Valve Adjusting Screw for Port B
3	Lock Nut (qty 2)
4	Bypass Hex Nut (qty 2)

FIGURE 10-19

See Figure 10-19 and Table 10-1 for the following.

To adjust the multifunction valve, perform the following procedure.

1. Remove the protective cap from the multifunction valve and loosen the lock nut (3).
2. Insert a hex wrench into the desired multifunction valve adjusting screw.

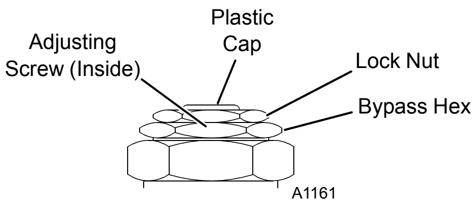
   Turning the adjusting screw clockwise will increase the relief pressure.

   Turning the adjusting screw counterclockwise will decrease the relief pressure.

NOTE: The bypass hex nut (4) is for special applications only and must not be rotated during setting of pump pressure without first consulting the pump manufacturer literature.

Table 10-1. Pump Port Control Function

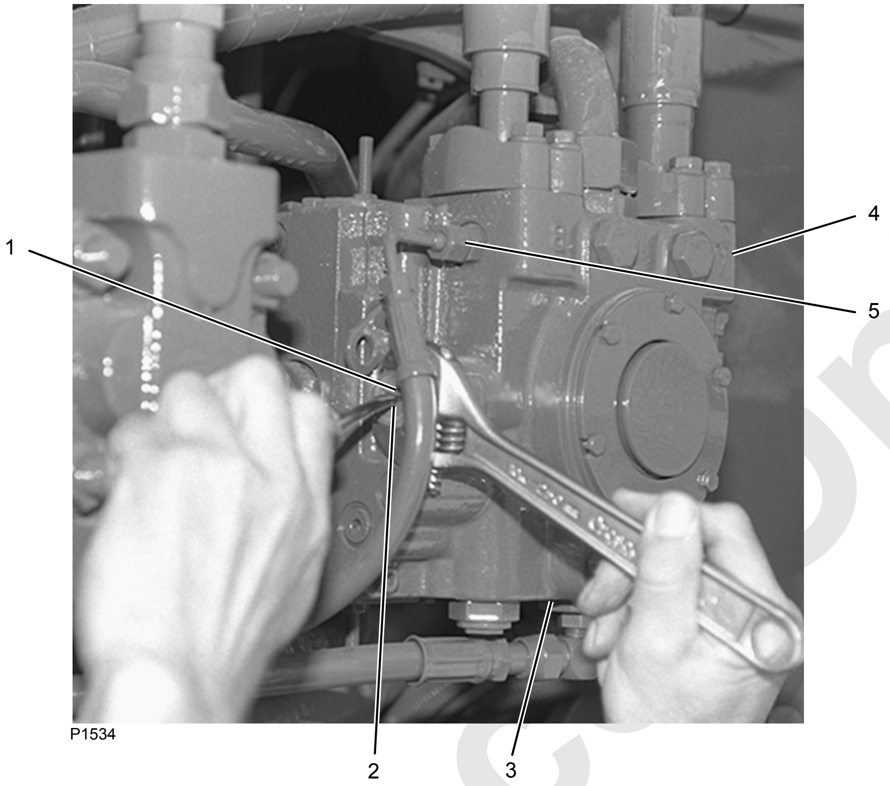
Pump	Port A	Port B
Travel	Reverse	Forward
Load Drum	Hoist	Lower
Boom Hoist	Lower	Hoist
Swing	Left	Right



Multi-Function Valve

FIGURE 10-20

Test 18—Adjusting the Pump Charge Pressure Relief



Item	Description
1	Adjusting Screw
2	Adjusting Lock Nut
3	Port M3
4	Port M1
5	Port M2

FIGURE 10-21

The pump charge pressure must be measured to accurately adjust the charge pressure relief valve. To adjust the pump charge pressure, perform the following procedure.

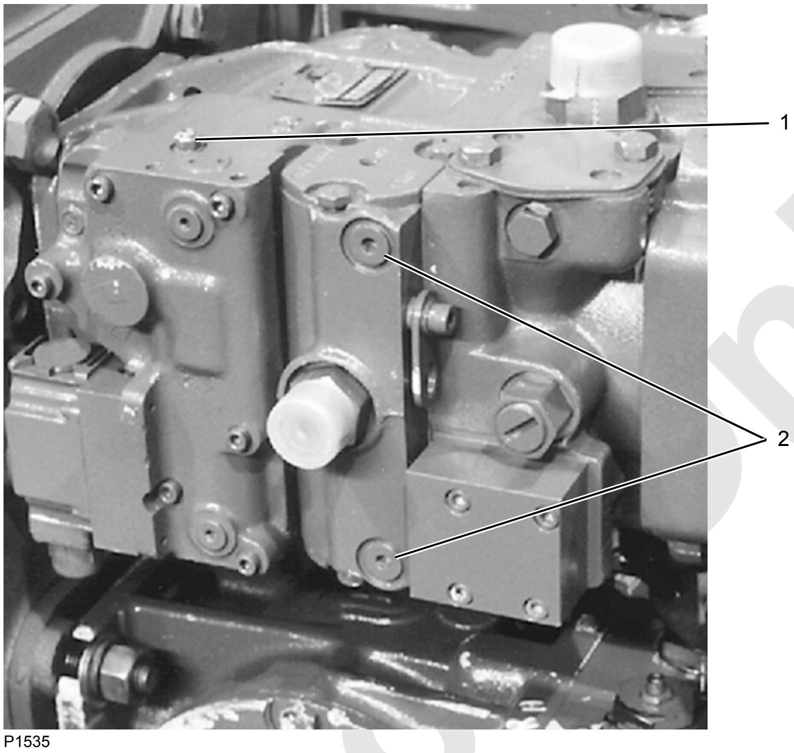
1. Install a 0 to 42 bar (0 to 600 psi) gauge at pressure gauge ports M1 (4), M2 (5), or M3 (3) if not used.

   See Test 8—Location of Pump Ports for the location of the pump test ports.

   Charge pressure can also be measured at the pressure transducer manifold (see Test 16—Checking the Pump Charge Pressure and Electrical Test).

2. Start the engine with all brakes and locks engaged.
3. Check the gauge for approximately 24 bar (350 psi).
4. To adjust the relief valve, loosen and hold the adjusting lock nut (2), then turn the adjusting screw (1) until 24 bar (350 psi) is obtained.
5. Tighten the adjusting lock nut to 46 to 56 Nm (34 to 41 ft-lb).
6. Remove the gauge and replace the port plug.

Test 19—Setting Pump Neutral



Item	Description
1	Neutral Adjusting Screw (with lock nut)
2	Servo Gauge Port (qty 2)

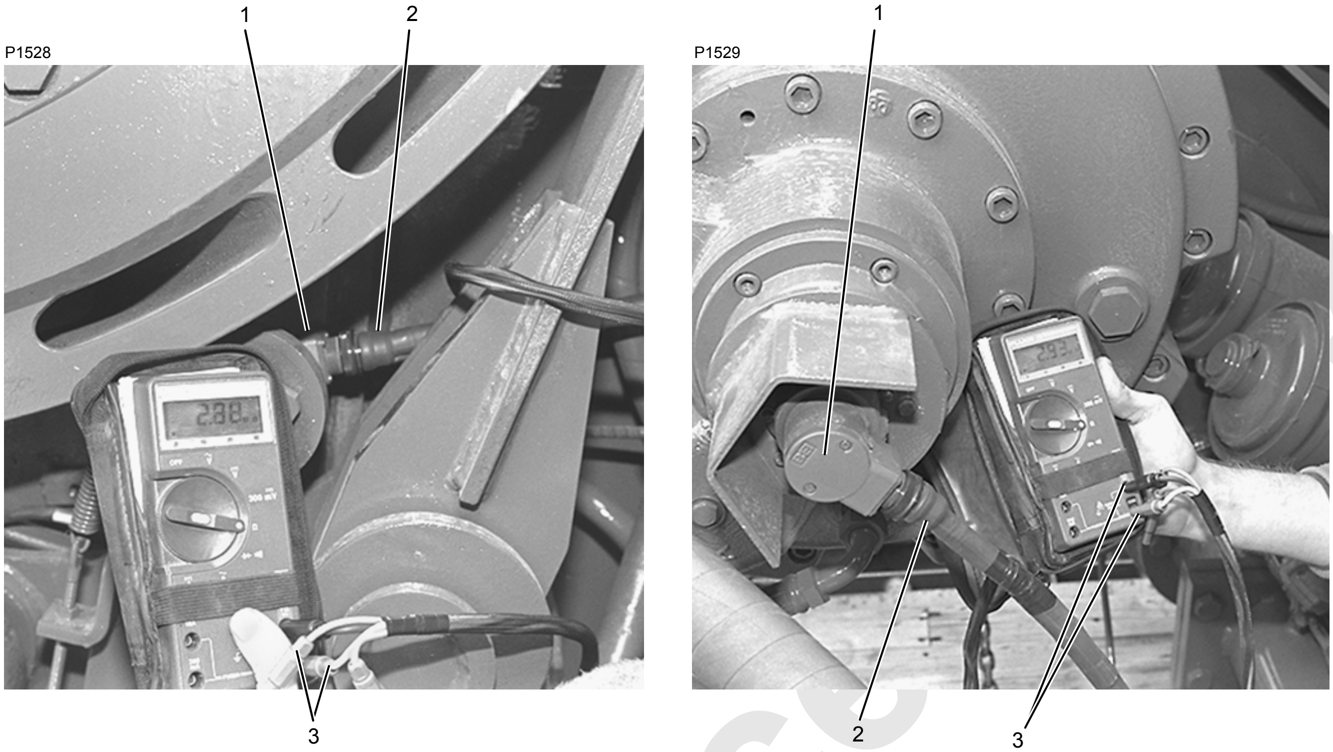
FIGURE 10-22

To set pump neutral, perform the following procedure.

1. Make sure the engine is off and the power is on, with all brakes and locks engaged.
2. Disconnect the PC from the pump EDC by removing the cable at the EDC.
3. Install a 0 to 42 bar (0 to 600 psi) gauge at each servo gauge port (2).
4. Start the engine with all brakes and locks engaged.
5. Loosen the hex lock nut and rotate the neutral adjusting screw (1) with a hex wrench until the pressure increases in one of the gauges.
6. Note the handle position of the hex wrench and without moving the wrench, rotate the neutral adjusting screw counterclockwise until the pressure increases in the other gauge.
7. Note the handle position of the hex wrench again and without moving the wrench, rotate the neutral adjusting screw clockwise halfway between the last position.

   The control should now be in neutral with both gauges reading the same case pressure.
8. Hold the neutral adjusting screw with the hex wrench and tighten the lock nut.
9. Remove the gauges and install the servo gauge port plugs.

Test 20—Checking Voltage at the Speed Encoders



Load Drum **Main Hoist Motor**

Item	Description
1	Encoder
2	Test Plug Adapter
3	Adapter Cable Connections

FIGURE 10-23

Testing the boom hoist or load drum speed encoder (1) for correct voltages requires a standard test plug adapter (2) (can be ordered from Manitowoc Cranes) and a digital multimeter.

To test incoming power at the desired speed encoder, perform the following procedure.

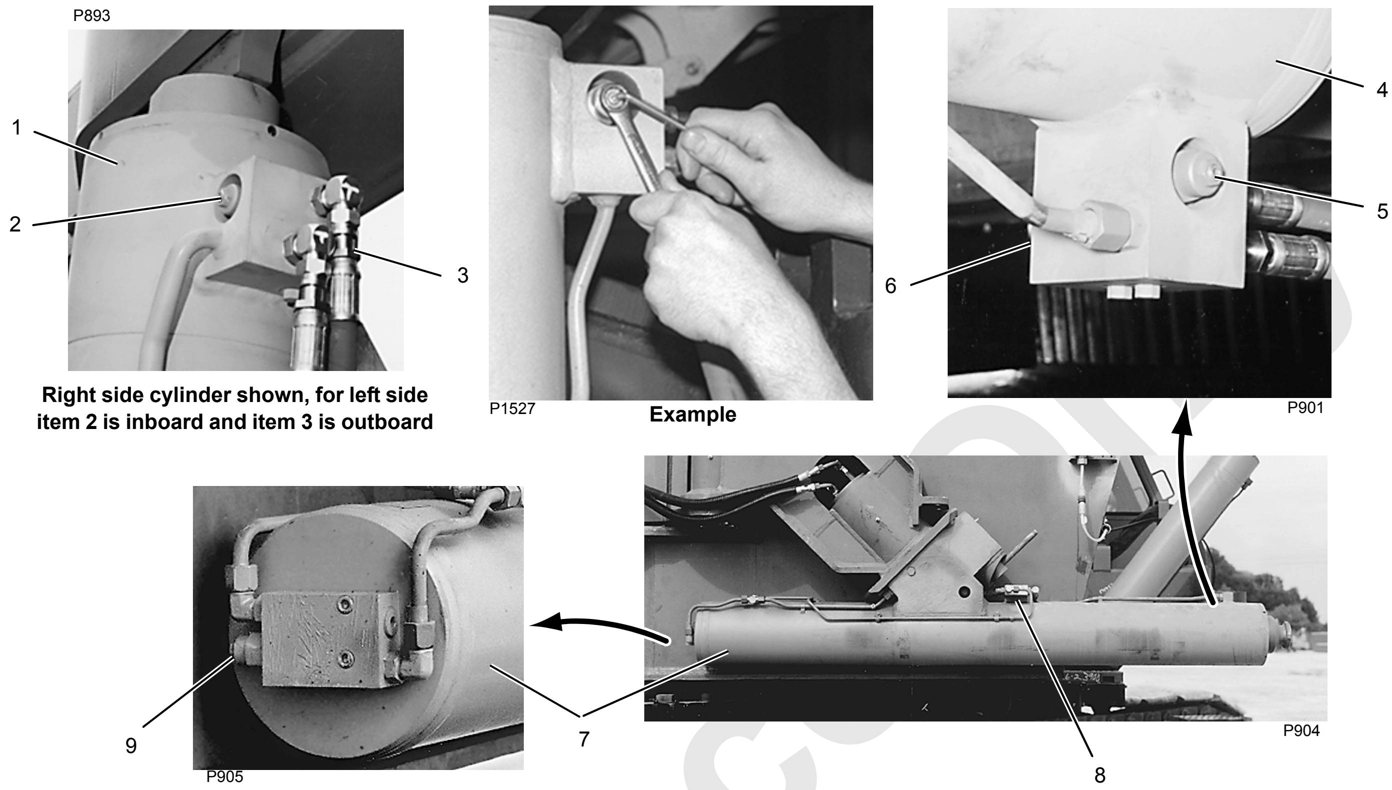
1. Make sure the engine is off and power is on, with all brakes and locks engaged.
2. Disconnect the output cable from the speed encoder connector.
3. Install the test plug adapter to the encoder.
4. Connect the test plug adapter red (positive) and black (negative) to the digital multimeter jacks.
5. Start the engine with all brakes and locks engaged.

   The motor or drum should remain at rest.
6. Check for 12 volts DC.
7. If this reading is not obtained, check the 5 amp F11 fuse at the fuse panel (see Test 11—Testing for Voltage at the Fuse Box).

To test voltage output from the speed encoder to the PC, perform the following procedure.

1. Make sure the engine is off and power is on, with all brakes and locks engaged.
2. Connect the green (positive) and black (negative) wires to the digital multimeter jacks.
3. Check for 0.00 or 7.40 volts DC with the motor or load drum at rest.
4. With the motor or load drum enabled, check for 3.5 to 3.9 volts DC.
5. If these readings are not obtained, check the encoder drive assembly and wiring.

Test 21—Adjusting the Counterbalance Valves



Item	Description	Item	Description
1	Gantry Cylinder (right side)	6	Boom Butt-Handling Counterbalance (rod end)
2	Gantry Lifting Counterbalance (rod end—outboard)	7	Jacking Cylinder
3	Gantry Lifting Counterbalance (piston end—inboard)	8	Jacking Cylinder Extend Adjusting Screw
4	Boom Butt-Handling Cylinder	9	Jacking Cylinder Retract Adjusting Screw
5	Boom Butt-Handling Counterbalance (piston end)		

FIGURE 10-24

CAUTION

Possible Component Damage!

The gantry cylinders will not extend evenly without counterweights attached to the crane.

Follow the special instructions/warnings that apply when adjusting gantry cylinders and boom butt cylinder counterbalance valves as specified in Hydraulic and Air Systems Section 2. Perform gantry cylinder adjustments with counterweights installed.

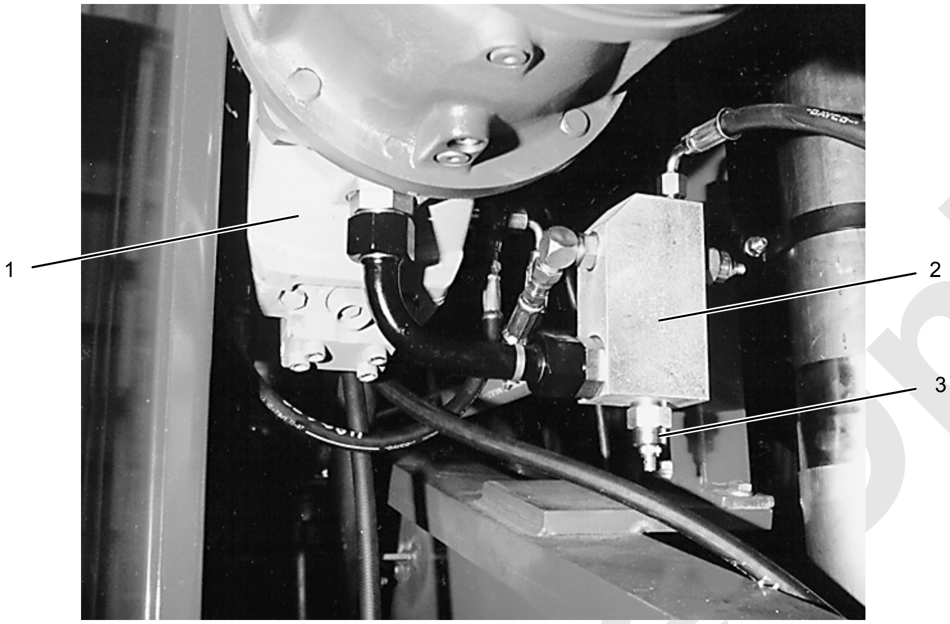
Each jacking cylinder (7) has a single counterbalance valve at the piston end of the cylinder. The retract adjusting screw at the valve provides adjustment for each jacking cylinder load support. The extend adjusting screw allows cylinders to be adjusted for uniform operation on level ground.

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, perform the following procedure.

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

Test 22—Servicing the Motor Loop Flushing (Purge) Valves



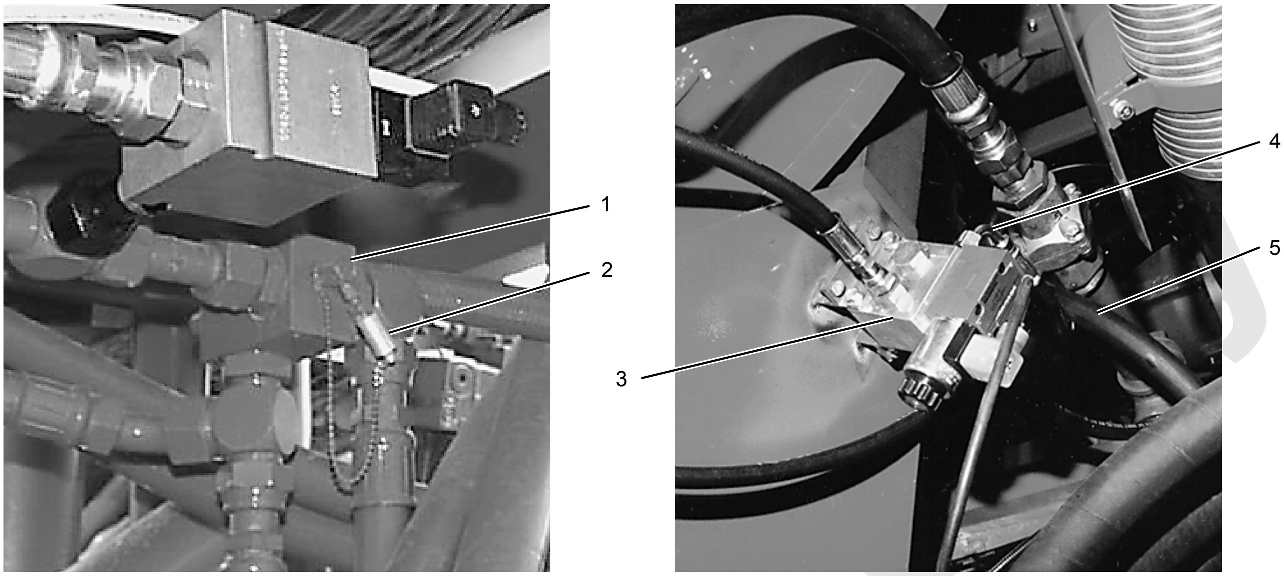
Item	Description
1	Motor
2	Loop Flushing (purge) Valve
3	Valve Flow Control

FIGURE 10-25

Problems with a bad loop flushing valve are best corrected by replacing the complete valve assembly. To service the loop flushing valve, perform the following procedure.

1. The engine must be off and the power off, with all brakes and locks engaged.
2. Drain the motor (1) by removing the attached hydraulic hoses.
3. After draining, replace the hydraulic hose.
4. Remove the hoses from the loop flushing (purge) valve (2) and replace the valve.
5. The hydraulic fluid flow through the valve is adjusted with the valve flow control (3) on the bottom of the valve.

Test 23—Checking the Hydraulic Brake Pressure



Swing and Travel Systems

Boom/Luffing Jib System

Item	Description	Item	Description
1	Pilot/Brake Pressure Relief Valve	4	90° Elbow
2	Test Port (adjusting screw on opposite side)	5	Flexible Hose
3	Boom Hoist Brake Control Valve		

FIGURE 10-26

The hydraulic brakes for the swing and travel systems operate off the exhaust pressure from the fan motor system. The boom/luffing jib brakes are released off the low-pressure side or boom hoist closed-loop system. To check hydraulic brake pressure for the swing and travel systems, perform the following procedure.

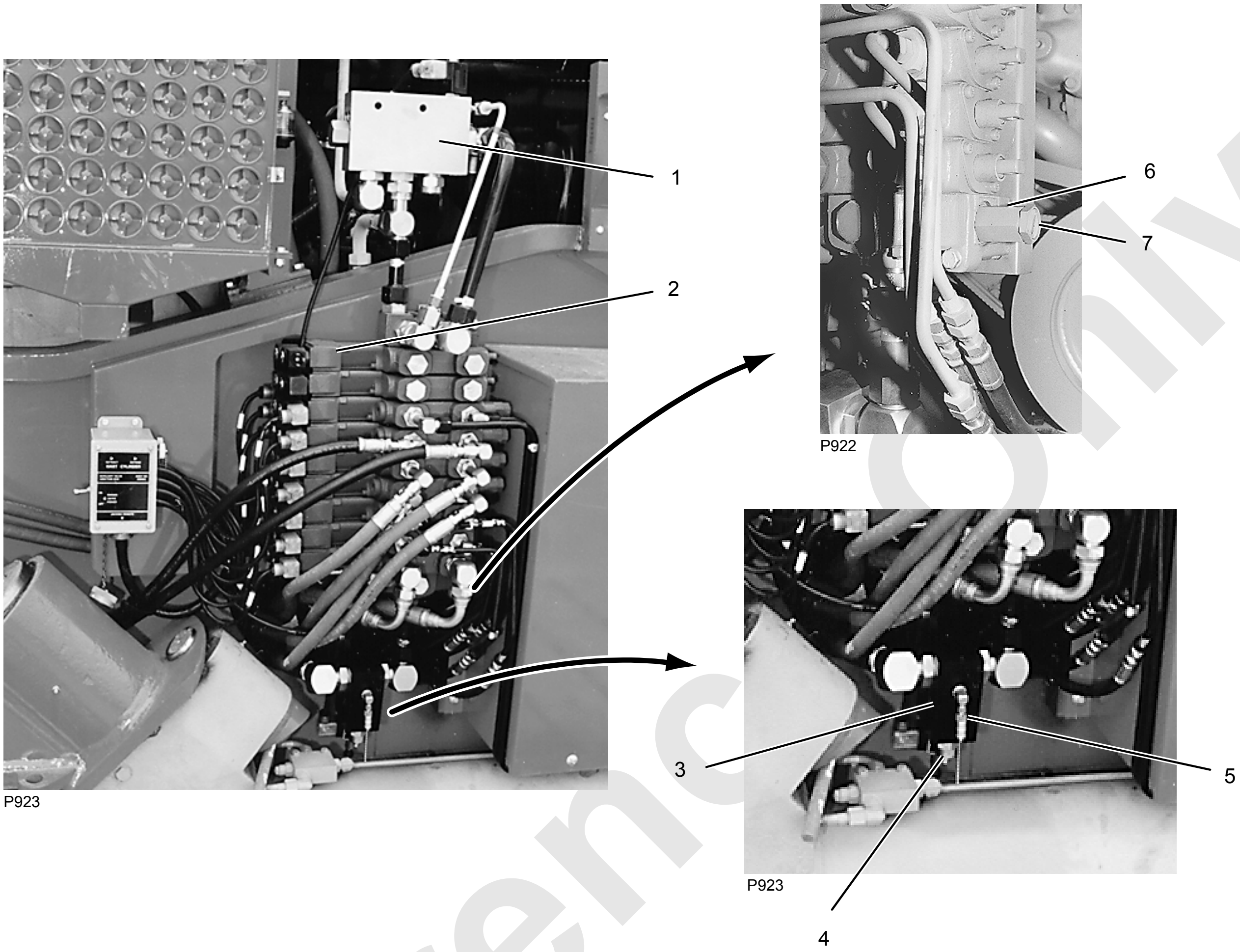
1. Make sure the engine is off and the power is off, with all brakes and locks engaged.
2. Connect a 0 to 69 bar (0 to 1,000 psi) gauge at the diagnostic quick-disconnect fitting on the pilot/brake pressure relief valve (1) between the top of the engine/ radiator and the oil cooler fans.
3. Start the engine and set it at high idle (2,000 rpm).
4. Enable the desired system brake and verify the brake pressure is 22 to 26 bar (325 to 375 psi).
5. If the pressure is not within range, adjust the pilot/brake pressure relief valve.
6. Loosen the adjusting lock nut.
7. Turn the adjusting screw clockwise (in) to increase pressure until the correct pressure is obtained.
8. Turn the adjusting screw counterclockwise (out) to decrease pressure until the correct pressure is obtained.
9. Secure the adjusting lock nut.
10. Remove the pressure gauge and replace the fitting cap.
11. If the correct pressure cannot be obtained, replace the valve assembly.

To check the hydraulic brake pressure for the boom hoist system, perform the following procedure.

1. Make sure the engine is off and the power is off, with all brakes and locks engaged.
2. Connect a 0 to 69 bar (0 to 1,000 psi) gauge between the 90° elbow (4) on the boom hoist brake control valve (3) and the flexible hose (5).
3. Start the engine and set it at high idle (2,000 rpm).
4. Enable the boom hoist system brake and verify the brake pressure is 22 to 26 bar (325 to 375 psi).

   If equipped with a luffing jib, the system brake pressure is 34 to 38 bar (500 to 550 psi).
5. If the pressure is not within range, check the boom/ luffing jib hoist charge pressure in Test 16—Checking the Pump Charge Pressure and Electrical Test.

Test 24—Checking and Adjusting the Auxiliary System Working Pressure



Item	Description
1	Proportional Flow Control Valve
2	Upper Accessory Valve Assembly
3	Auxiliary System Disable Valve
4	Auxiliary System Disable Valve Adjusting Screw
5	Disable Valve Gauge Port
6	Accessory Relief Valve
7	Relief Valve Adjusting Screw

FIGURE 10-27

To determine if piston actuation problems are related to auxiliary system low pressure, check the pressure at the auxiliary system disable valve (3) at the upper accessory valve assembly (2).

To check the auxiliary system working pressure, perform the following procedure.

1. Make sure the engine is off and the power is off, with all brakes and locks engaged.
2. Remove the cap from the diagnostic gauge coupler at the auxiliary system disable valve.
3. Connect a 0 to 413 bar (0 to 6,000 psi) gauge to the diagnostic gauge coupler.
4. Start the engine and retract any hydraulic cylinder directly driven off the upper accessory valve assembly.

5. Continue to stroke the valve section after the cylinders are fully retracted during the entire test.
6. Verify the pressure is 229 to 241 bar (3,325 to 3,500 psi).
7. If the pressure is not within range, loosen the auxiliary system disable valve adjusting screw (4) lock nut on the bottom of the auxiliary system disable valve.
8. Turn the adjusting screw clockwise (in) to increase pressure until the correct pressure is obtained.
9. Turn the adjusting screw counterclockwise (out) to decrease pressure until the correct pressure is obtained.

CAUTION

Possible Component Damage!

The auxiliary disable valve seat may be damaged if the adjusting screw is not tightened properly.

Do not overtighten the auxiliary system disable valve adjusting screw in the clockwise (in) direction.

NOTE: If the gauge pressure does not change or changes erratically with movement of the adjusting screw, the auxiliary system disable valve could be damaged. Repair or replace the auxiliary system disable valve and recheck for even pressure.

10. If the gauge pressure changes erratically with movement of the adjusting screw, but hydraulic pressure remains below 229 bar (3,325 psi), turn the auxiliary system disable valve adjusting screw all the way in.
11. At the upper valve assembly relief valve, loosen the lock nut and turn the adjusting screw in until the gauge shows 241 bar (3,500 psi).
12. Secure the lock nut.

NOTE: If 241 bar (3,500 psi) cannot be obtained, the accessory relief valve (6) may be damaged. Repair or replace the relief valve and recheck for correct pressure.

If the pressure is correct but the problem cylinder still is not working correctly, continue pressure testing at the auxiliary system disable valve to determine if the valve assembly or the proportional flow control valve (1) is damaged.

If the problem cylinder is directly driven off a valve section of the upper accessory valve, disconnect the cylinder from the valve assembly and plug the lines. Enable the problem cylinder valve in the retract direction and check the pressure. If the pressure is 229 to 241 bar (3,325 to 3,500 psi), repair or replace the cylinder. If the pressure is 229 bar (3,325 psi) or less, repair or replace the valve assembly.

If the problem cylinder is directly driven off a valve section of the lower accessory valve, disconnect the flow control valve assembly and plug the lines. Enable the problem cylinder in either direction and check the pressure. If the pressure is 229 bar (3,325 psi) or less, repair or replace the proportional flow control valve.

Test 25—Checking Pin Cylinder Seals

Item	Description
1	Cylinder Extend Hose
2	Hydraulic Hard Line Fitting (qty 2)
3	Cylinder Retract Hose
4	Pin Cylinder

FIGURE 10-28

Worn cylinder seals can cause problems associated with hydraulic cylinder piston movement. The frame connecting pin, crawler pin, and boom hinge pin cylinders do not have load-holding valves. The piston seals and rod end wiper seals can be checked for leakage as follows.

1. If the problem cylinder is in the extend position, disconnect the cylinder extend hose (1) from the hydraulic hard line fitting (2).

   If the problem cylinder is in the retract position, disconnect the cylinder retract hose (3) from the hydraulic hard line fitting.

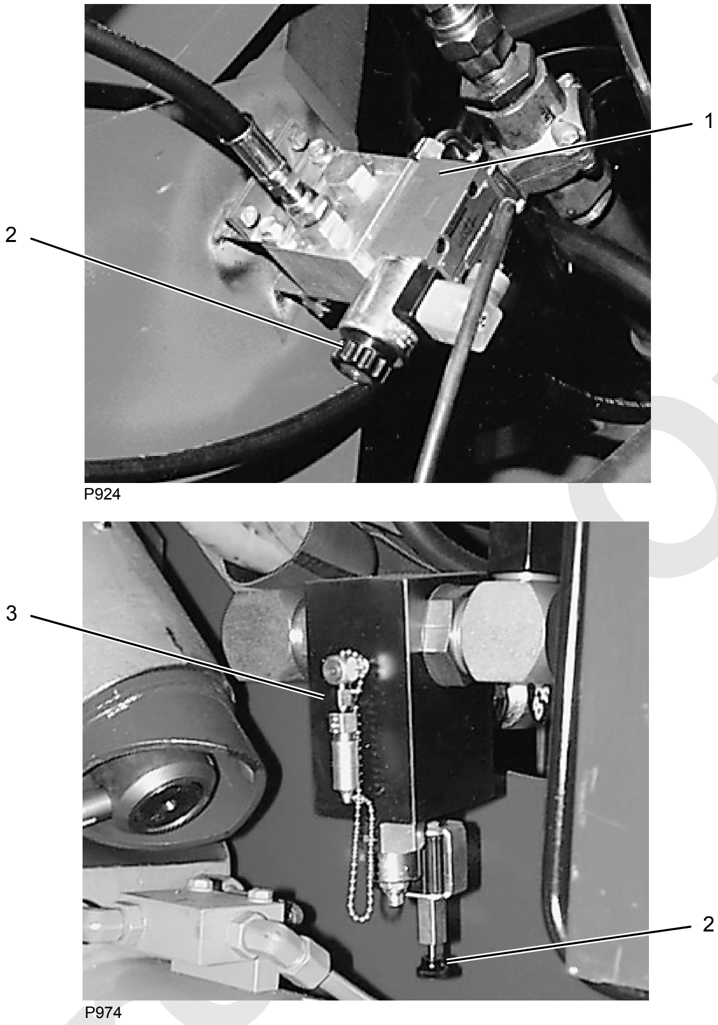
2. Immediately plug the hard line fitting and place the flexible hose from the cylinder into a holding tank or bucket.

3. Start the crane and pressurize the problem cylinder.

NOTE: Leakage from the disconnected hose indicates a damaged piston seal.

The wiper seal at the rod end of the cylinder should also be checked for leakage while enabling the cylinder in the extend direction.

Test 26—Actuating the Solenoid Valve Manual Overrides



Item	Description
1	Hydraulic Brake Valve (qty varies)
2	Valve Override
3	Auxiliary System Disable Valve (qty varies)

FIGURE 10-29

To check that a solenoid valve or system valve is operating correctly, start the engine and actuate the manual valve override (2). Observe the following:

- Hydraulic brake valves (1) have an override push button in the center of a black nut.
- If the valve is operating correctly, the valve shifts to perform the control function.

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ALPHABETICAL INDEX