Manitowoc 2250

Service/Maintenance Manual

Grove Manitowoc National Crane Potain

Manitowoc

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 11-06-15, Control # 040-13

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THE ORIGINAL LANGUAGE OF THIS PUBLICATION IS ENGLISH

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SECTION 2 . . . . Hydraulic and Air Systems

SECTION 5 . . . . . Hoists

SECTION 1
INTRODUCTION

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SECTION 1

INTRODUCTION

WARNING

California Proposition 65

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

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

California Spark Arrestor

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

CONTINUOUS INNOVATION

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

SAFETY MESSAGES

General

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

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

Safety Alert Symbol

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

Signal Words

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

CAUTION

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

NOTE: Highlights operation or maintenance procedures.

SAFE MAINTENANCE PRACTICES

WARNING

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

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

Maintenance Instructions

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

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

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

Safe Maintenance Practices

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

   a. Park the crane where it will not interfere with other equipment or operations.

   b. Lower all loads to the ground or otherwise secure them against movement.

   c. Lower boom onto blocking at ground level, if possible, or otherwise secure boom against dropping.

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

   e. Stop engine and render starting means inoperative.

   f. Place a warning sign at start controls alerting other personnel that crane is being serviced and the engine must not be started. *Do not remove sign until it is safe to return crane to service.*

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

If the engine must be run, perform the following steps to prevent injury:

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

⚠ WARNING

Burn and Inhalation Hazards!

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

To prevent death or serious injury:

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

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3. Wear clothing that is relatively tight and belted.

4. Wear appropriate eye protection and approved hard hat.

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

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

6. Boom and gantry are not intended as ladders. Do not attempt to climb lattice work of boom or gantry to get to maintenance points. If boom or gantry is not equipped with an approved ladder, lower them before performing maintenance or repair procedures.

7. Do not remove cylinders until working unit has been securely restrained against movement.

8. Pinch points are impossible to eliminate; watch for them closely.

9. Pressurized air, coolant, and hydraulic oil can cause serious injury. Make sure all air, coolant, and hydraulic lines, fittings, and components are tight and serviceable.

Do not use your hands to check for air and hydraulic oil leaks:

- Use a soap and water solution to check for air leaks (apply to fittings and lines and watch for bubbles).
- Use a piece of cardboard or wood to check for coolant and hydraulic oil leaks.

10. Relieve pressure before disconnecting air, coolant, and hydraulic lines and fittings.

11. Do not remove radiator cap while coolant is hot or under pressure. Stop the engine, wait until pressure drops and coolant cools, then slowly remove cap.

12. Avoid battery explosion: do not smoke while performing battery maintenance, do not short across battery terminals to check its charge.

13. Read safety information in battery manufacturer's instructions before attempting to charge a battery.

14. Avoid battery acid contact with skin and eyes. If contact occurs, flush area with water and immediately consult a doctor.

15. Stop engine before refueling the crane.

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

17. Use a safety-type can with an automatic closing cap and flame arrestor for refueling.

18. Hydraulic oil can also be flammable. Do not smoke or allow open flames in area when filling hydraulic tanks.

19. Never handle wire rope with bare hands. Always wear heavy-duty gloves to prevent being cut by broken wires.

20. Use extreme care when handling coiled pendants. Stored energy can cause coiled pendants to uncoil quickly with considerable force.

21. When inflating tires, use a tire cage, a clip-on inflator, and an extension hose which permits standing well away from tire.

22. Only use cleaning solvents which are non-volatile and non-flammable.

23. Do not attempt to lift heavy components by hand. Use a hoist, jacks, or blocking to lift components.

24. Use care while welding or burning on crane. Cover all hoses and components with non-flammable shields or blankets to prevent a fire or other damage.

25. To prevent damage to crane parts (bearings, cylinders, swivels, slewing ring, computers, etc.), perform the following steps ***before welding on crane***:

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

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

26. Disconnect and lock power supply switch before attempting to service high voltage electrical components and before entering tight areas (such as carbody openings) containing high voltage components.

27. When assembling and disassembling booms, jibs, or masts on ground (with or without support of boom rigging pendants or straps), securely block each section to provide adequate support and alignment.

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

28. Unless authorized in writing by Manitowoc, do not alter the crane in any way that affects crane's performance (to include welding, cutting, or burning of structural members or changing pressures and flows of air/hydraulic components). Doing so will invalidate all warranties and capacity charts and make crane owner/user liable for any resultant accidents.

29. ***Keep crane clean.*** Accumulations of dirt, grease, oil, rags, paper, and other waste will not only interfere with safe operation and maintenance but also create a fire hazard.

30. Store tools, oil cans, spare parts, and other necessary equipment in tool boxes. Do not allow these items to lie around loose in operator's cab or on walkways and stairs.

31. Do not store flammable materials on crane.

32. Do not return crane to service at completion of maintenance or repair procedures until all guards and covers have been reinstalled, trapped air has been bled from hydraulic systems, safety devices have been reactivated, and all maintenance equipment has been removed.

33. Perform a function check to ensure proper operation at completion of maintenance or repair.

ENVIRONMENTAL PROTECTION

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

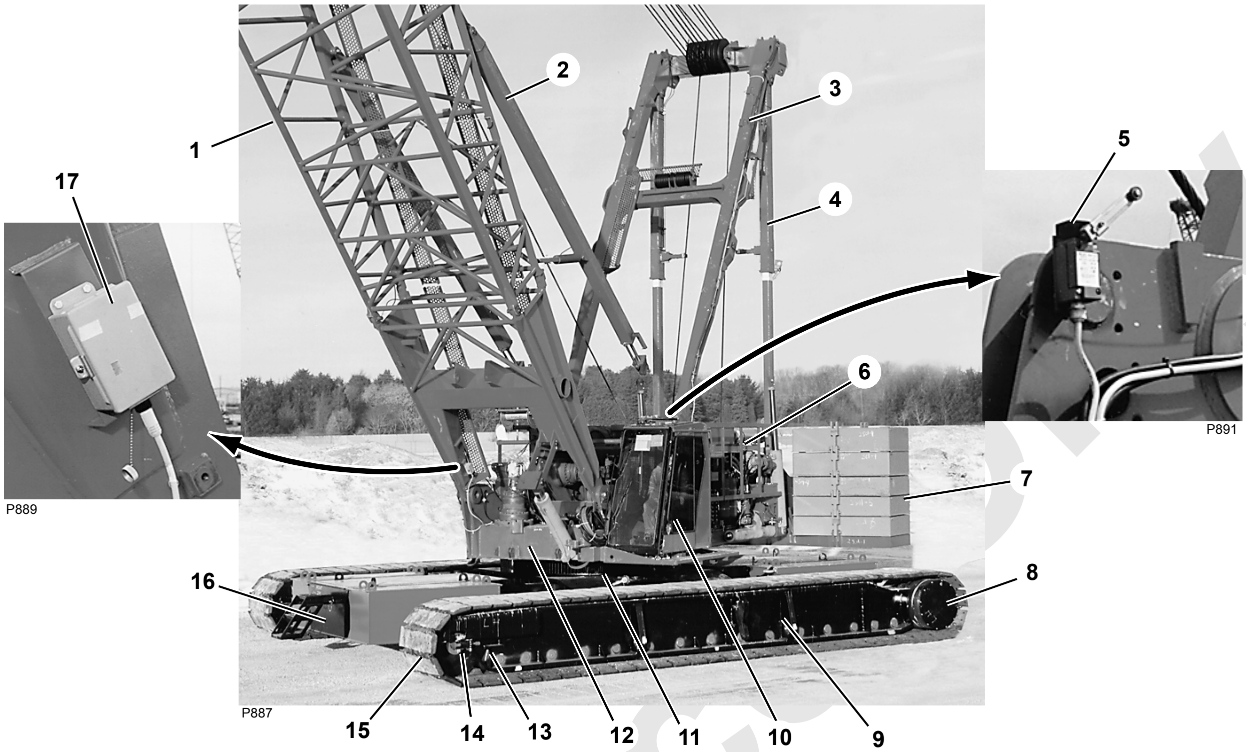
Potentially harmful waste used in Manitowoc cranes includes — but is not limited to — oil, fuel, grease, coolant, air conditioning refrigerant, filters, batteries, and cloths which have come into contact with these environmentally harmful substances.

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

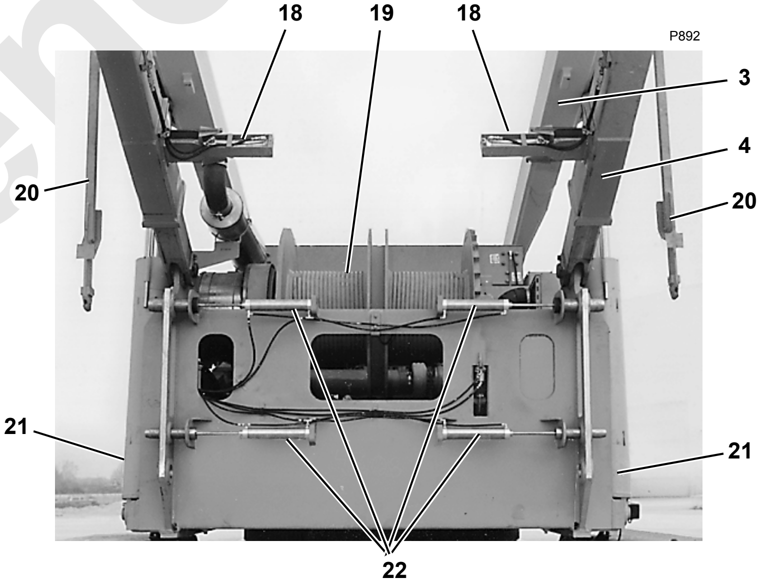
When filling and draining crane components, do not pour waste fluids onto the ground, down any drain, or into any source of water.

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

IDENTIFICATION AND LOCATION OF COMPONENTS



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



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

FIGURE 1-1

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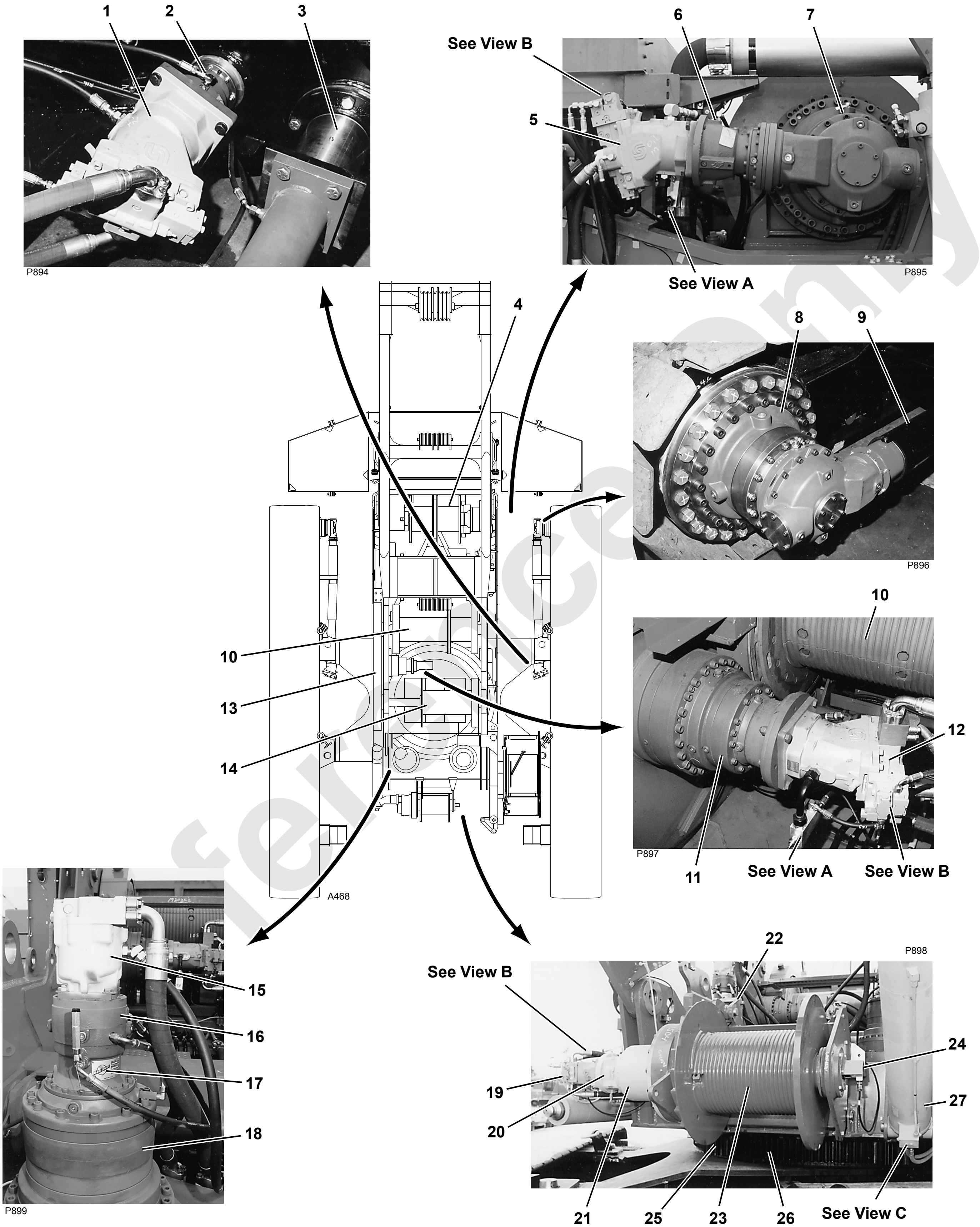
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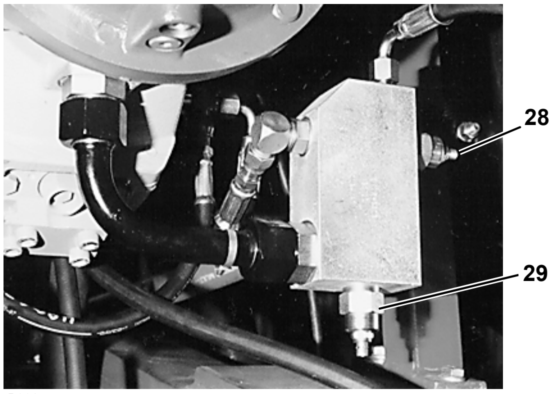
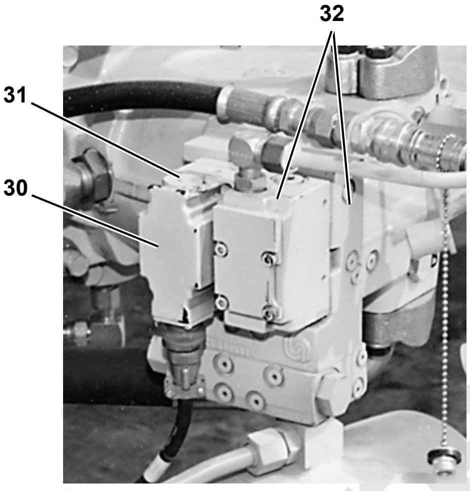
See View C

FIGURE 1-2



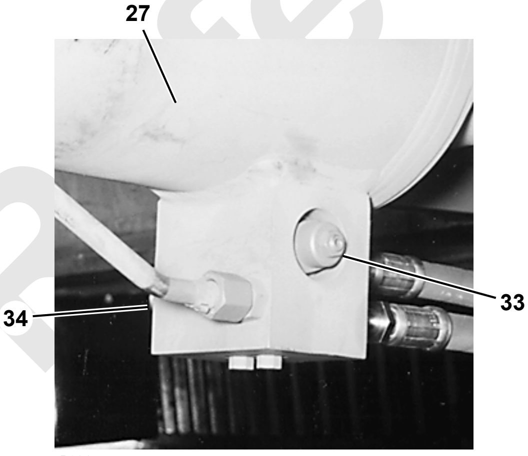
View A

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 Lock (Past Production)
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

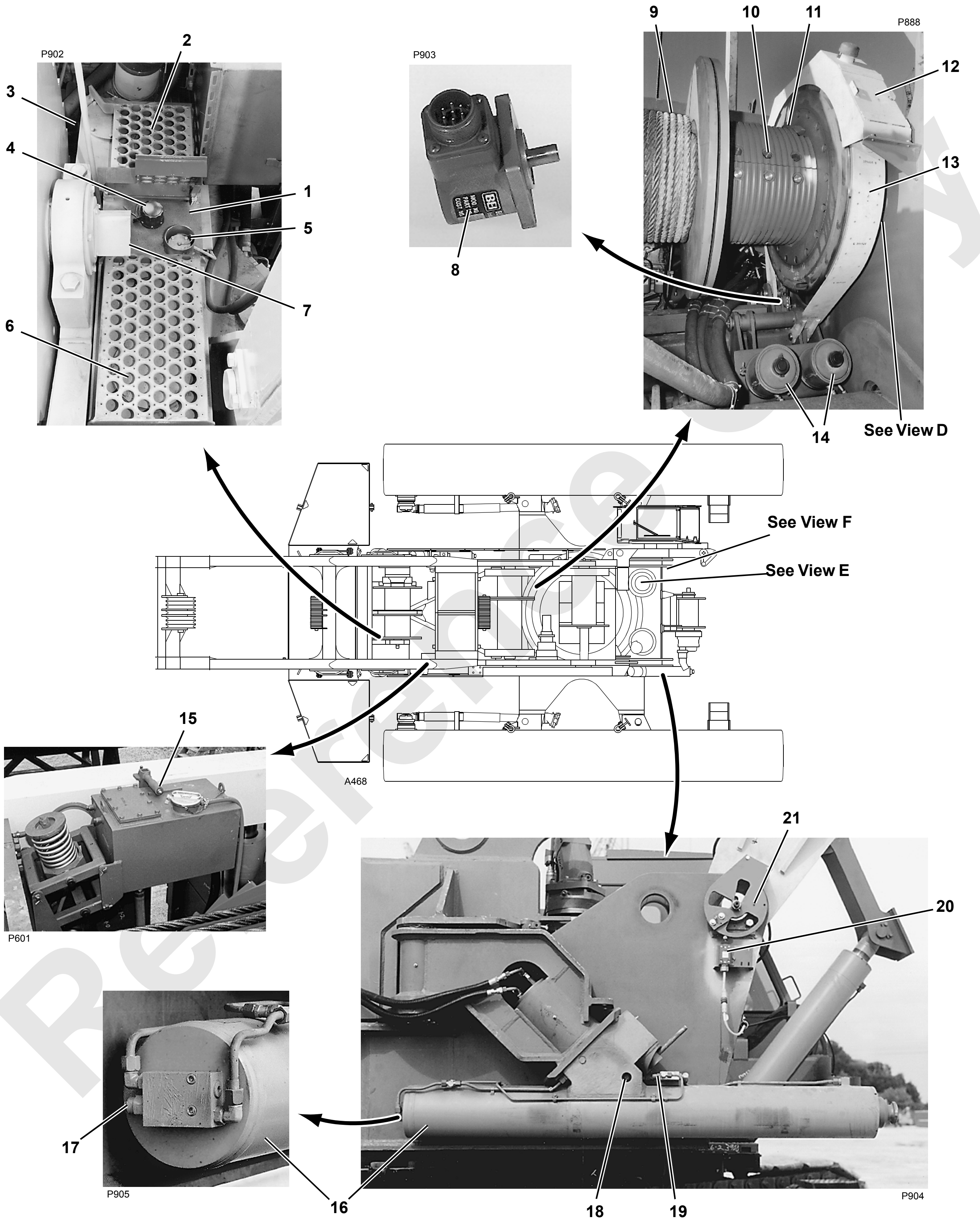

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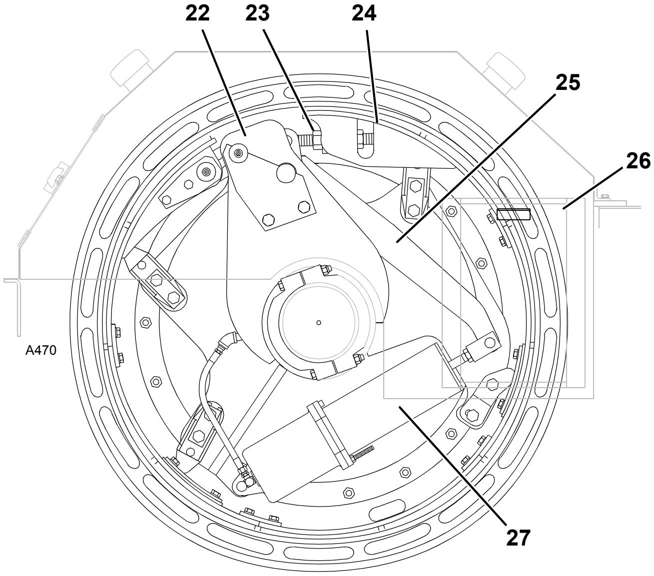
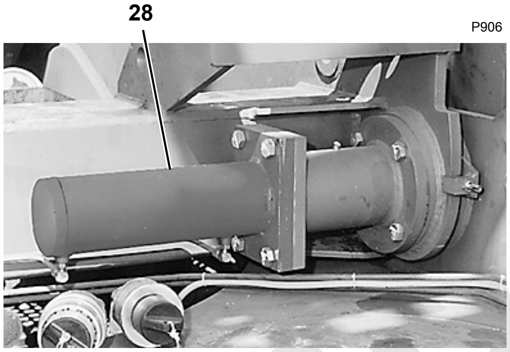
FIGURE 1-3

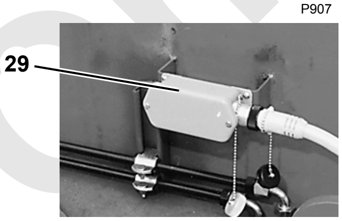


View D

Typical Outboard End of
Each Drum Shaft



View E
Typical Four Places



View F

Item	Description
1	Hydraulic Tank
2	Hydraulic Tank Filters (under grate in tank)
3	Hydraulic Tank Vacuum and Temperature Senders (inboard side)
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 Cylinders (air and spring applied)
15	Radiator Auxiliary Tank
16	Rotating Bed Jacking Cylinder (4 places)
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 4 places)
29	Block-Up Limit Shorting Plug Junction Box

FIGURE 1-3 continued

See Operating Control topic in Section 3 of the Crane Operator Manual for complete list of operating controls

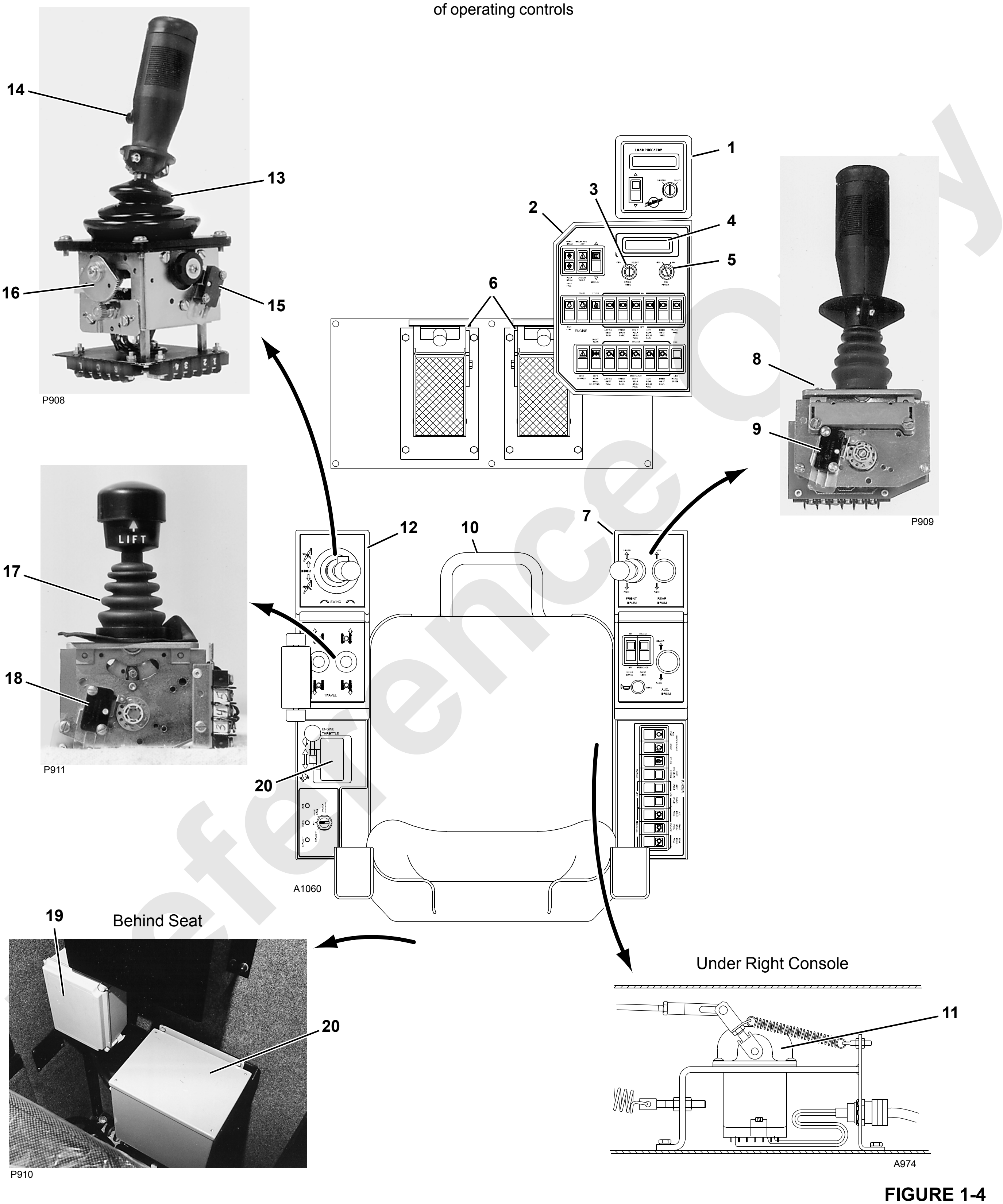
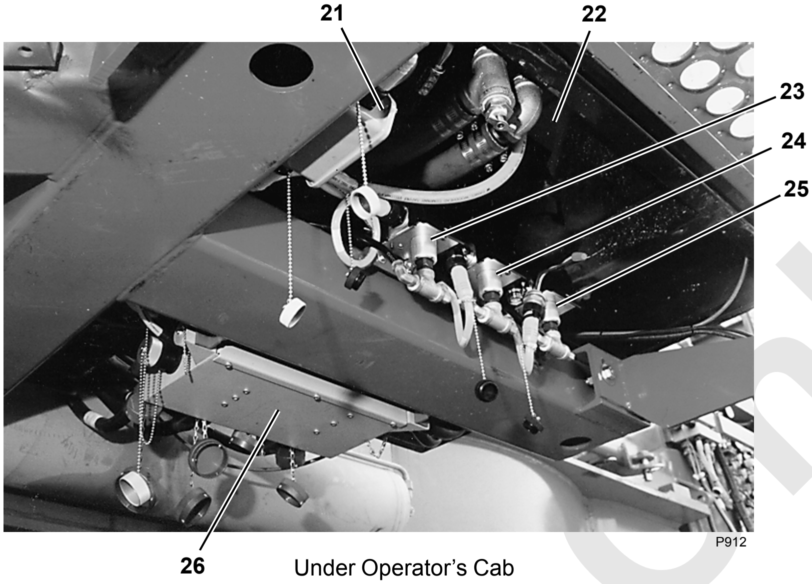


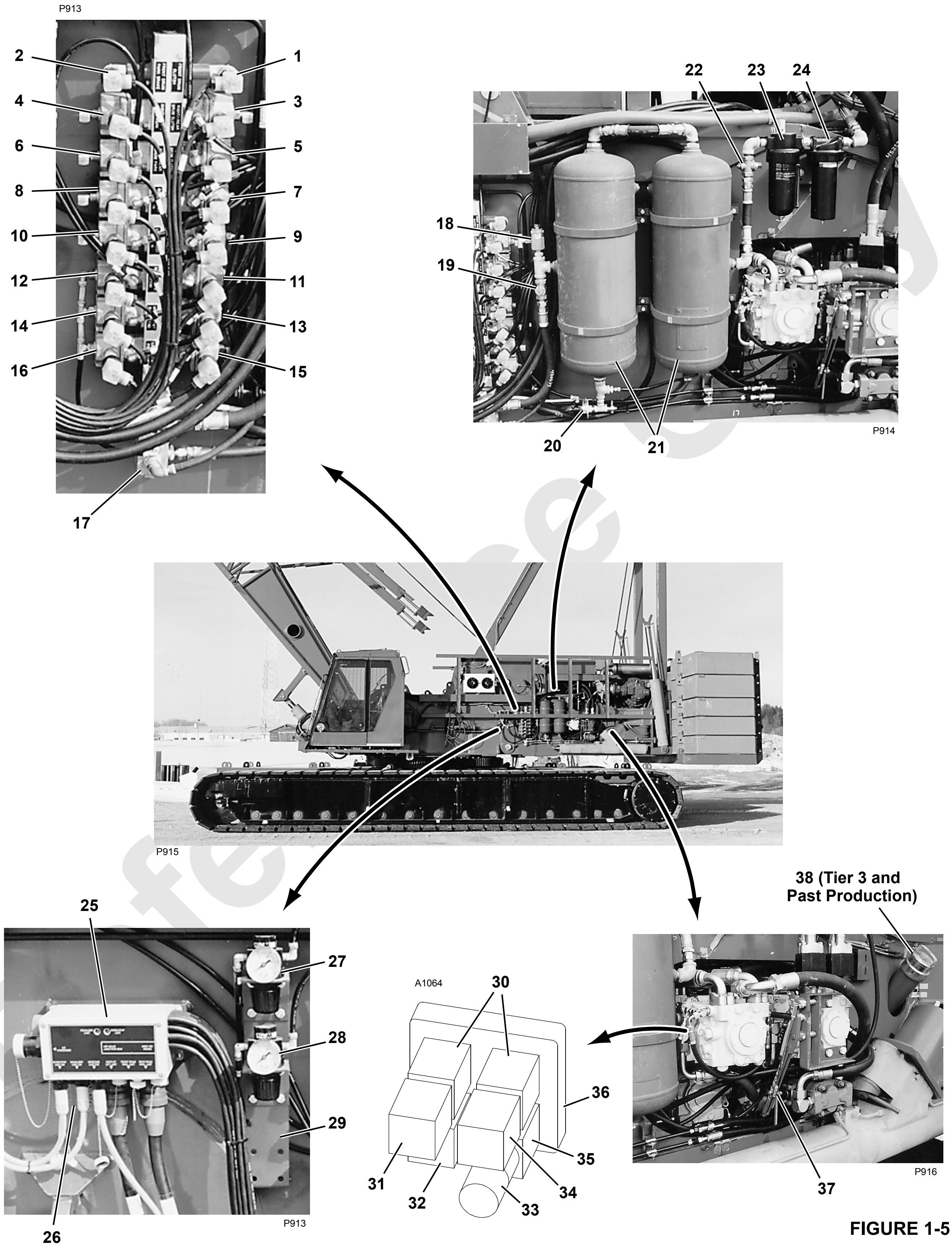
FIGURE 1-4



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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38 (Tier 3 and Past Production)
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P916

FIGURE 1-5

Item	Description
1	Front Drum Clutch Solenoid Valve
2	Front Drum Parking Brake Solenoid Valve
3	Rear or Right Rear Drum Clutch Solenoid Valve
4	Rear or Right Rear Drum Parking Brake Solenoid Valve
5	Left Rear Drum Clutch Solenoid Valve
6	Left Rear Drum Parking 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
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

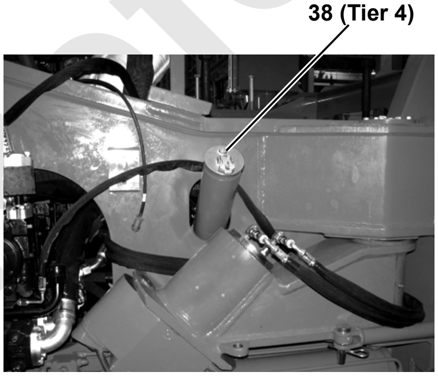
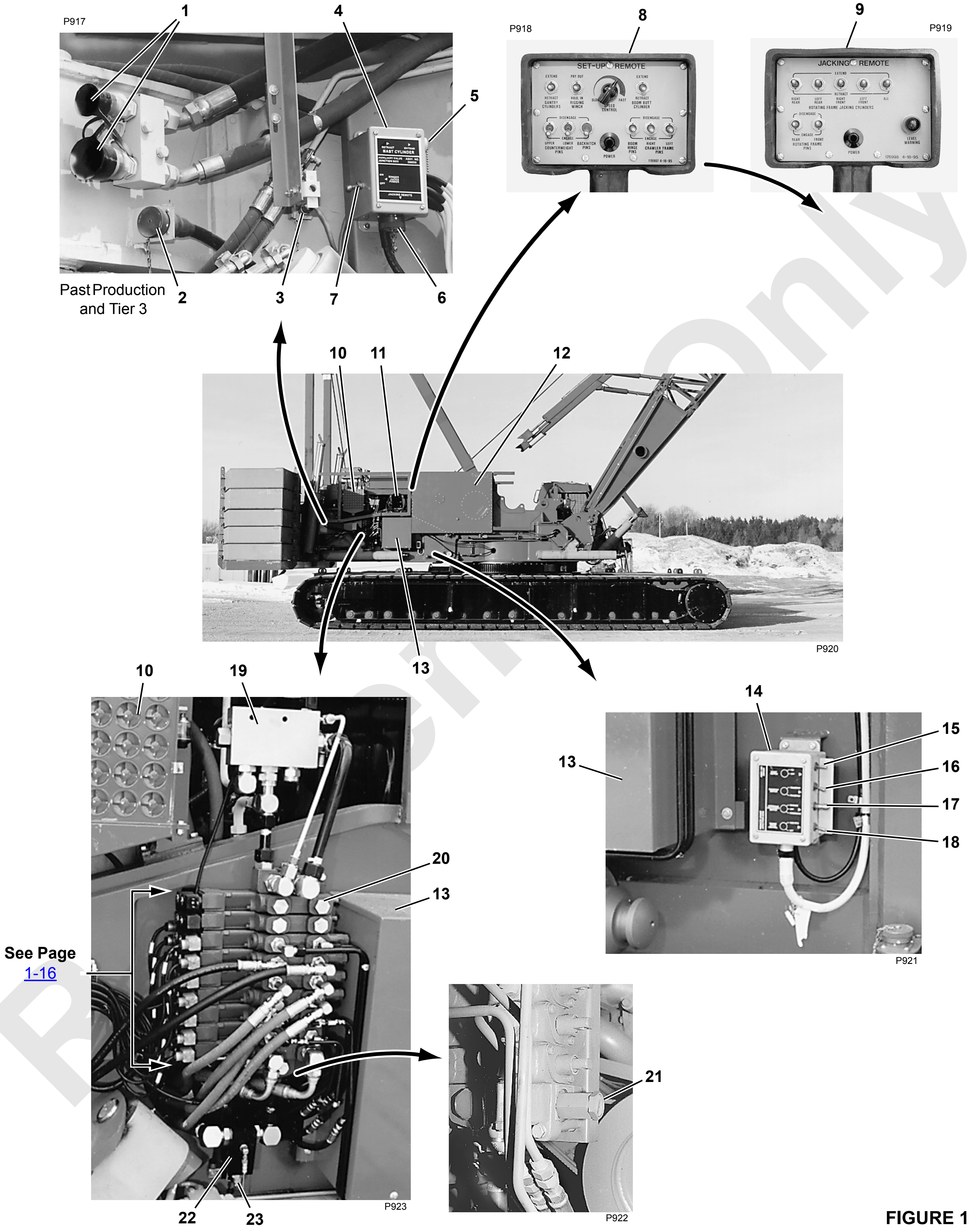


FIGURE 1-5 continued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Past Production
and Tier 3
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P918
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SET-UP REMOTE
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P919
JACKING REMOTE
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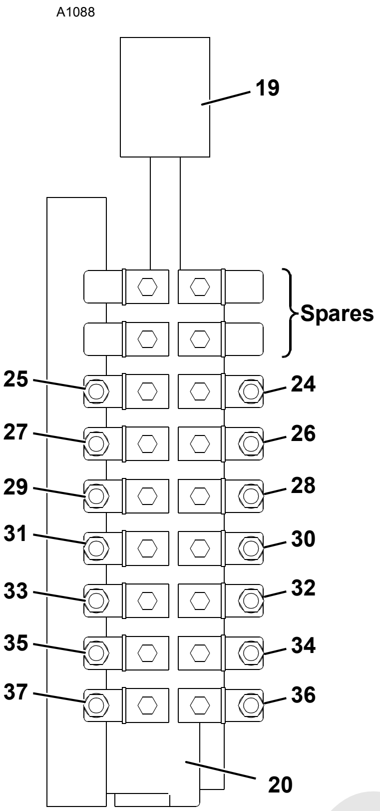
FIGURE 1-6

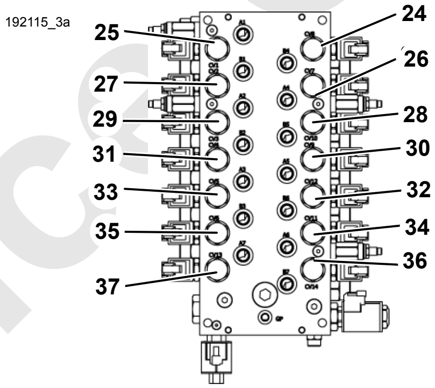
Item	Description
1	MAX-ER Hydraulic Quick-Couplers
2	MAX-ER Electric Receptacle
3	MAX-ER Load Sensing Storage Receptacle
4	Auxiliary Valves Junction Box
5	Not Used
6	Jacking Remote Control Receptacle
7	Not Used
8	Setup Remote Control
9	Jacking Remote Control
10	Engine Air Cleaner (Past production and Tier 3 shown)
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 Valve
23	Auxiliary System Disable Manual Override

FIGURE 1-6 continued



End View

Past Production



End View

Current Production

Item	Description
24	Right Front Jack Retract Solenoid Valve
25	Right Front Jack Extend Solenoid Valve
26	Right Rear Jack Retract Solenoid Valve
27	Right Rear Jack Extend Solenoid Valve
28	Left Rear Jack Retract Solenoid Valve
29	Left Rear Jack Extend Solenoid Valve
30	Left Front Jack Retract Solenoid Valve
31	Left Front Jack Extend Solenoid Valve
32	Front Frame Pins Retract Solenoid Valve
33	Front Frame Pins Extend Solenoid Valve
34	Rear Frame Pins Retract Solenoid Valve
35	Rear Frame Pins Extend Solenoid Valve
36	Gantry Cylinders Retract Solenoid Valve
37	Gantry Cylinders Extend Solenoid Valve

Item	Description
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	From 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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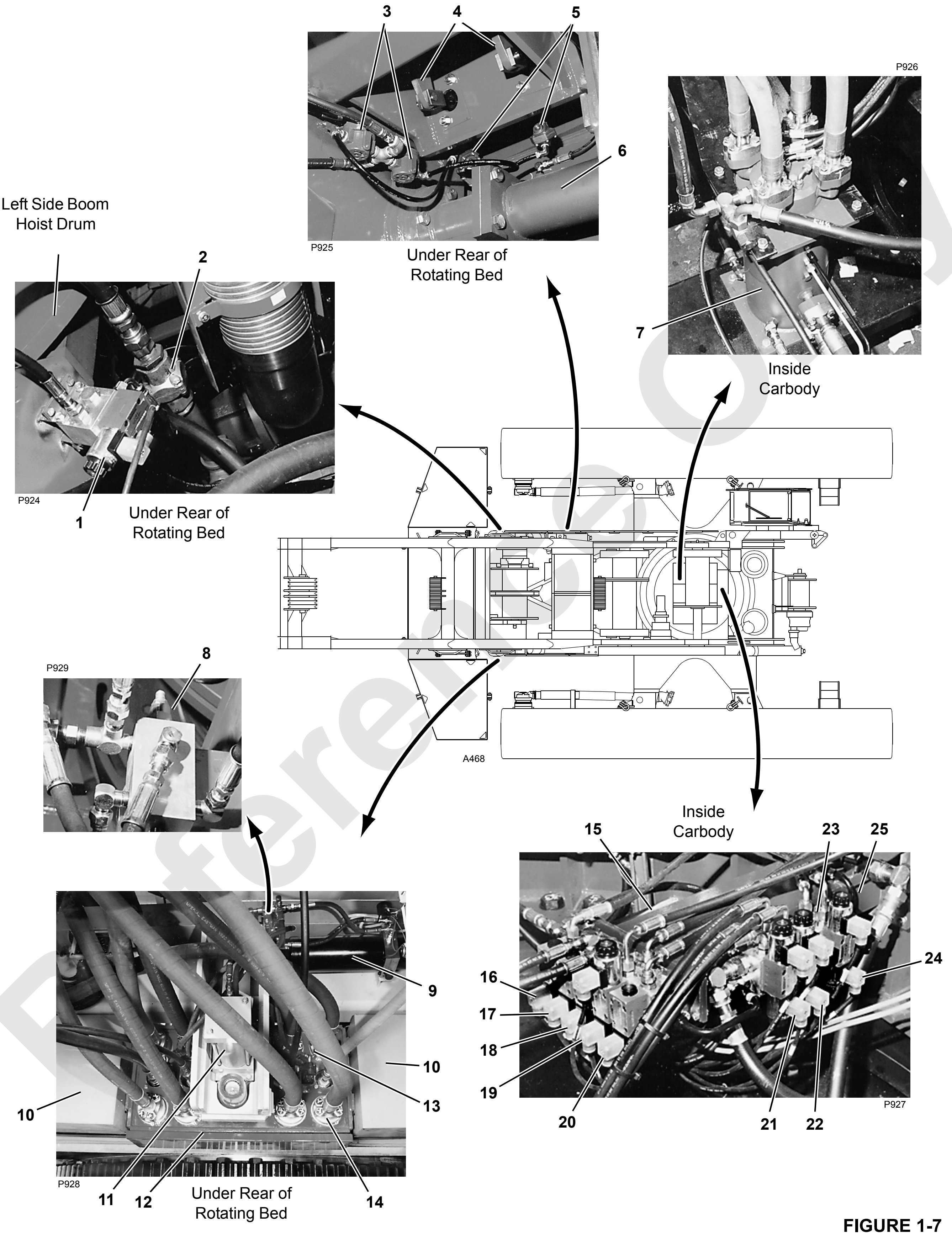
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P925
Under Rear of Rotating Bed
P926
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Inside Carbody
Left Side Boom Hoist Drum
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Under Rear of Rotating Bed
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Inside Carbody
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9
10
10
13
P928
11
12
Under Rear of Rotating Bed
14

FIGURE 1-7

Item	Description
1	Boom Hoist Brake Solenoid Valve
2	Return Oil Check Valve (3 places)
3	Drum Brake Relay Valve (2 each drum brake)
4	Drum Brake Lever
5	Drum Brake Quick-Release Valve (2 each drum brake)
6	Adapter Frame Connecting Pin Cylinder (4 places)
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	Swing Lock Solenoid Valve (top disengaged / bottom engaged) Past Production Shown, Current Production Swing Lock is disabled
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

PAST PRODUCTION AND TIER 3 ENGINE COMPONENTS

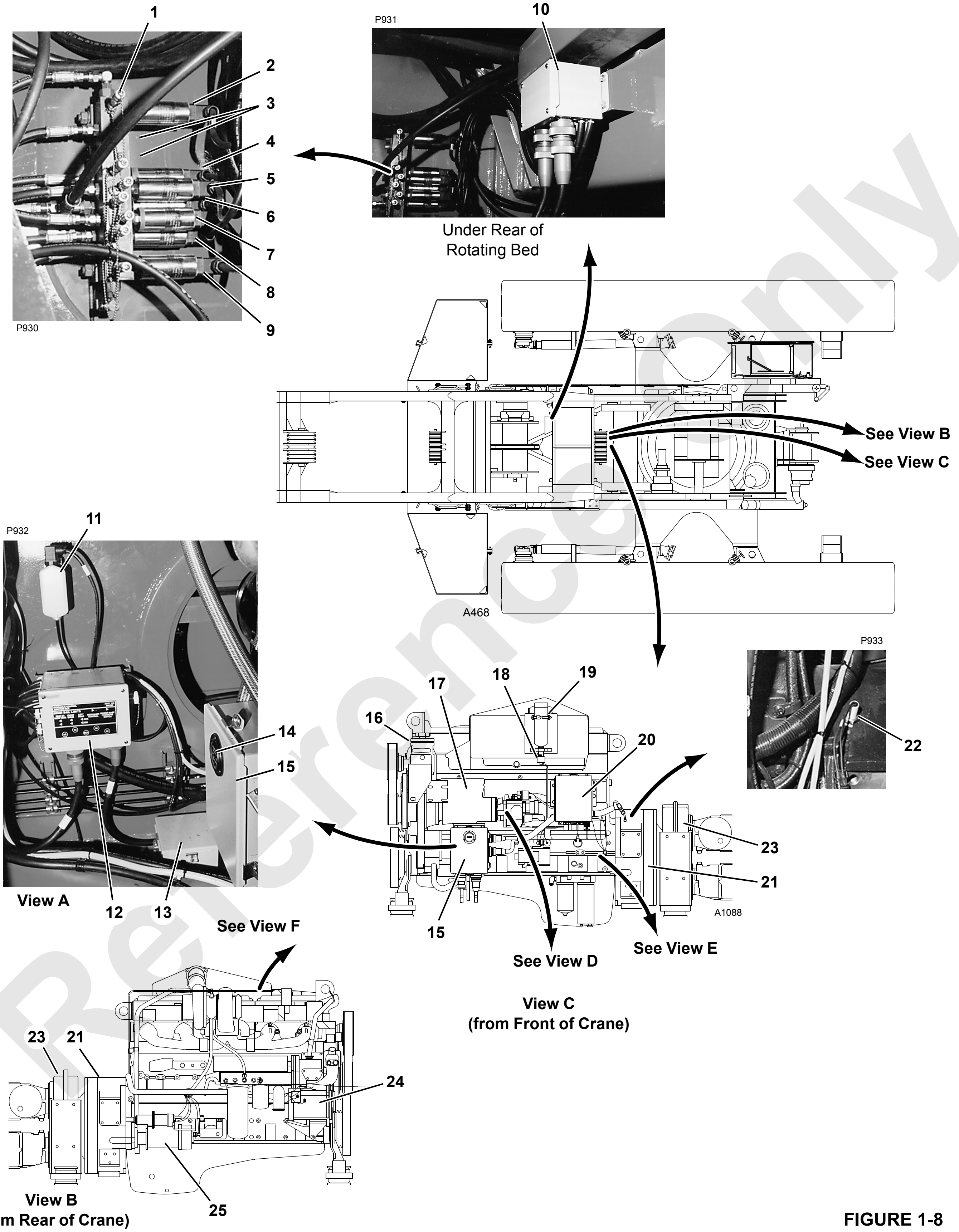
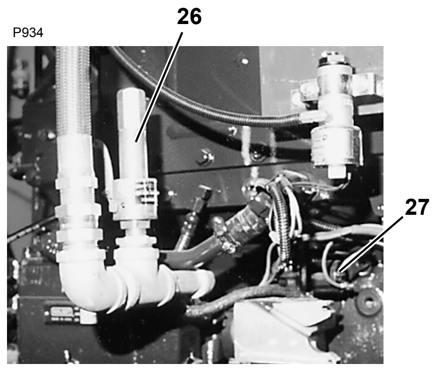
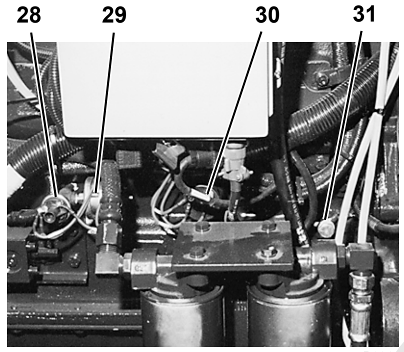


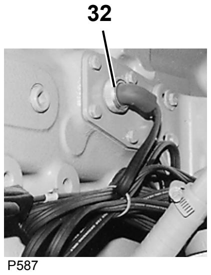
FIGURE 1-8

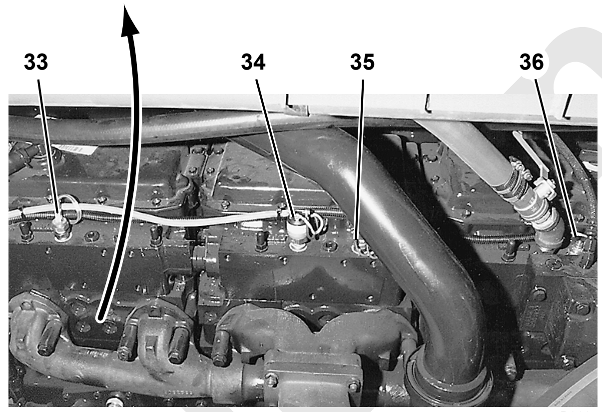


View D

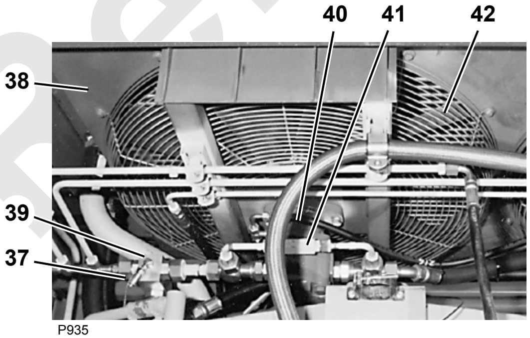


View E





View F



View from Front
of Crane Above Engine
(typical 2 places)

Item	Description
1	Diagnostic Gauge Coupler (typical each sender)
2	Right Travel Pressure Sender
3	Spares
4	Boom Hoist Pressure Sender
5	Load Drum System Pressure Sender
6	Load Drum Charge Pressure Sender
7	Swing Right "B" Pressure Sender
8	Swing Left "A" Pressure Sender
9	Left Travel Pressure Sender
10	Pump Control Junction Box
11	Suction Line Pressure Sender Junction Box
12	Hydraulic Control Junction Box
13	Leveling Sensor Junction Box
14	Engine Hour Meter
15	Engine Junction Box
16	Air Conditioner Compressor
17	Air System Compressor
18	Ether Start Solenoid Valve
19	Ether Start Tank
20	Electronic Fuel Control Junction Box
21	Engine Fly Wheel
22	Engine Speed Sender (Production before Tier 1 engine)
23	Pump Drive
24	Engine Starter
25	Alternator
26	Air System Safety Valve
27	Electronic Fuel Control Actuator
28	Engine Oil Pressure Switch
29	Engine Oil Pressure Sender
30	Engine Oil Pressure Switch (disables hydraulic disconnect if engine is running)
31	Ground Stud
32	Engine Block Heater (1500W 120V with extension cord)
33	Ether Start Disable Switch (Past Production Only)
34	Fan Switch (with cold weather package only)
35	Engine Coolant Temperature Switch
36	Engine Coolant Temperature Switch Sender
37	Diagnostic Gauge Coupler
38	Engine Coolant Radiator (top portion) Hydraulic Oil Cooler (bottom portion)
39	Fan Relief Valve
40	Fan Motor
41	Fan Anti-Cavitation Check Valve
42	Radiator and Oil Cooler Fan

FIGURE 1-8 continued

TIER 4 ENGINE COMPONENTS

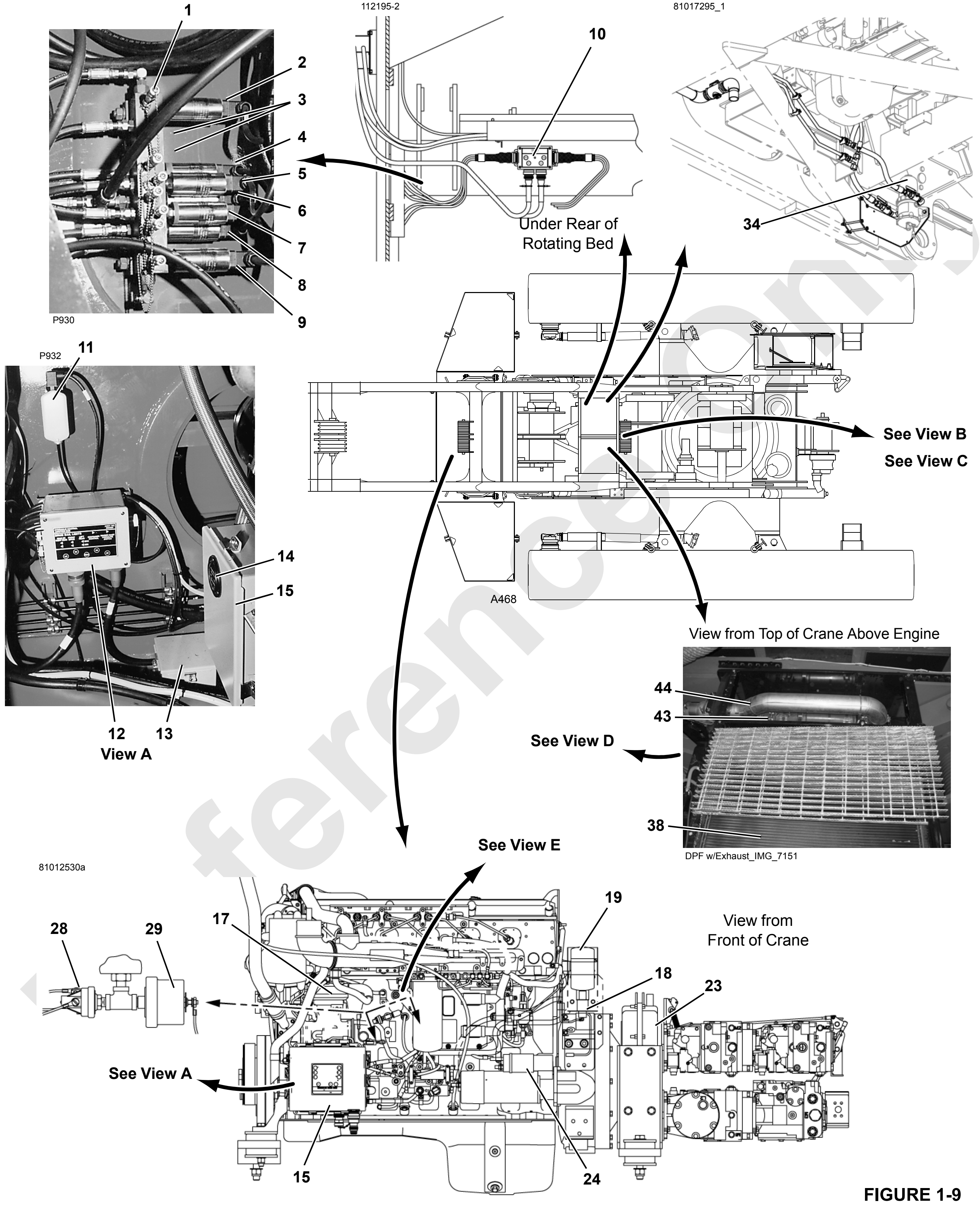
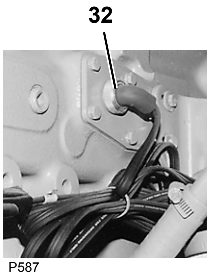
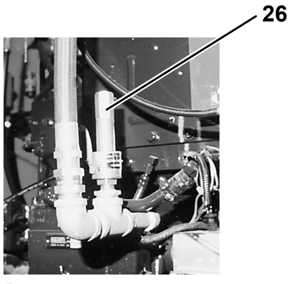
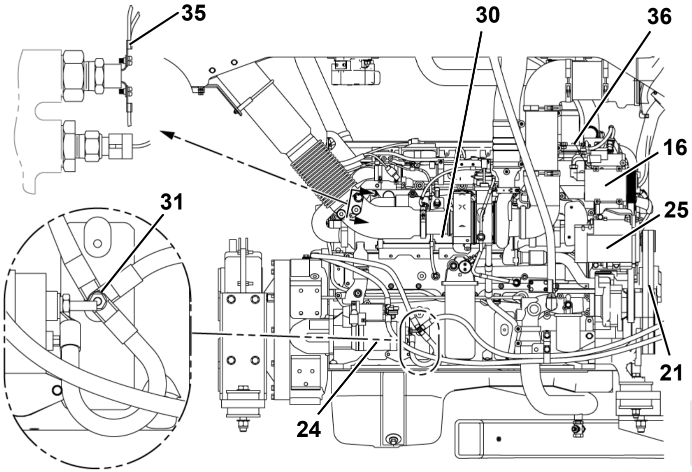


FIGURE 1-9

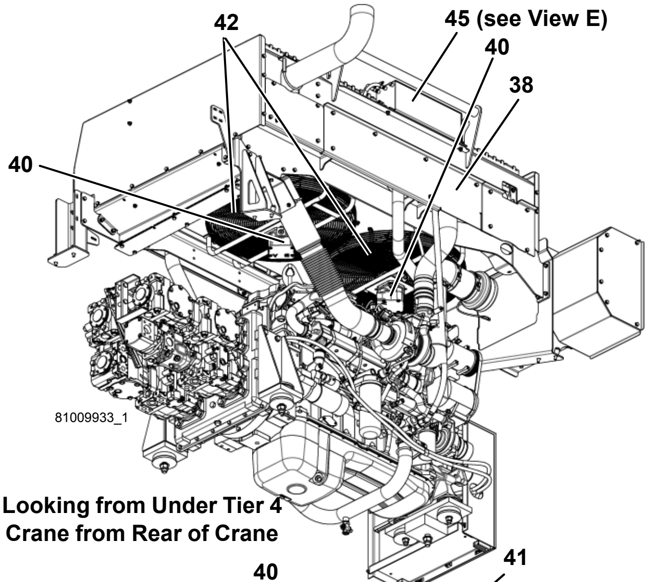




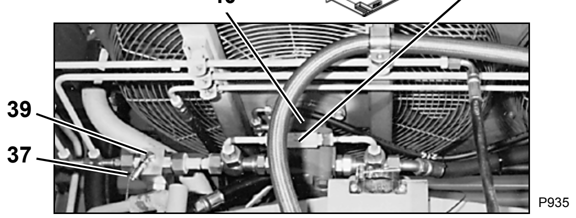
View E



View B (from Rear of Crane)



Looking from Under Tier 4 Crane from Rear of Crane



Looking Up From Front of Crane (T3 shown, similar for T4)

Item	Description
1	Diagnostic Gauge Coupler (typical each sender)
2	Right Travel Pressure Sender
3	Spares
4	Boom Hoist Pressure Sender
5	Load Drum System Pressure Sender
6	Load Drum Charge Pressure Sender
7	Swing Right "B" Pressure Sender
8	Swing Left "A" Pressure Sender
9	Left Travel Pressure Sender
10	Pump Control Junction Box
11	Suction Line Pressure Sender Junction Box
12	Hydraulic Control Junction Box
13	Leveling Sensor Junction Box
14	Engine Hour Meter
15	Engine Controller Node
16	Air Conditioner Compressor
17	Air System Compressor
18	Ether Start Solenoid Valve
19	Ether Start Tank
20	NA
21	Engine Fly Wheel
22	NA
23	Pump Drive
24	Engine Starter (2)
25	Alternator
26	Air System Safety Valve
27	NA
28	Engine Oil Pressure Switch
29	Engine Oil Pressure Sender
30	Engine Oil Pressure Switch (disables hydraulic disconnect if engine is running)
31	Ground Point
32	Engine Block Heater (1500W 120V with extension cord)
33	NA
34	Fuel Filter
35	Engine Coolant Temperature Switch
36	Engine Coolant Temperature Switch Sender
37	Diagnostic Gauge Coupler
38	Engine Cooler
39	Fan Relief Valve
40	Hydraulic Fan Motor (2)
41	Fan Anti-Cavitation Check Valve (1 each fan)
42	Cooling System Hydraulic Variable-Speed Fan (2)
43	Diesel Particulate Filter
44	Exhaust
45	Cooling System Surge Tank

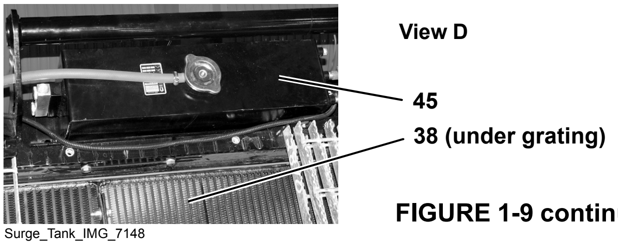


FIGURE 1-9 continued

CRANE DESCRIPTION OF OPERATION

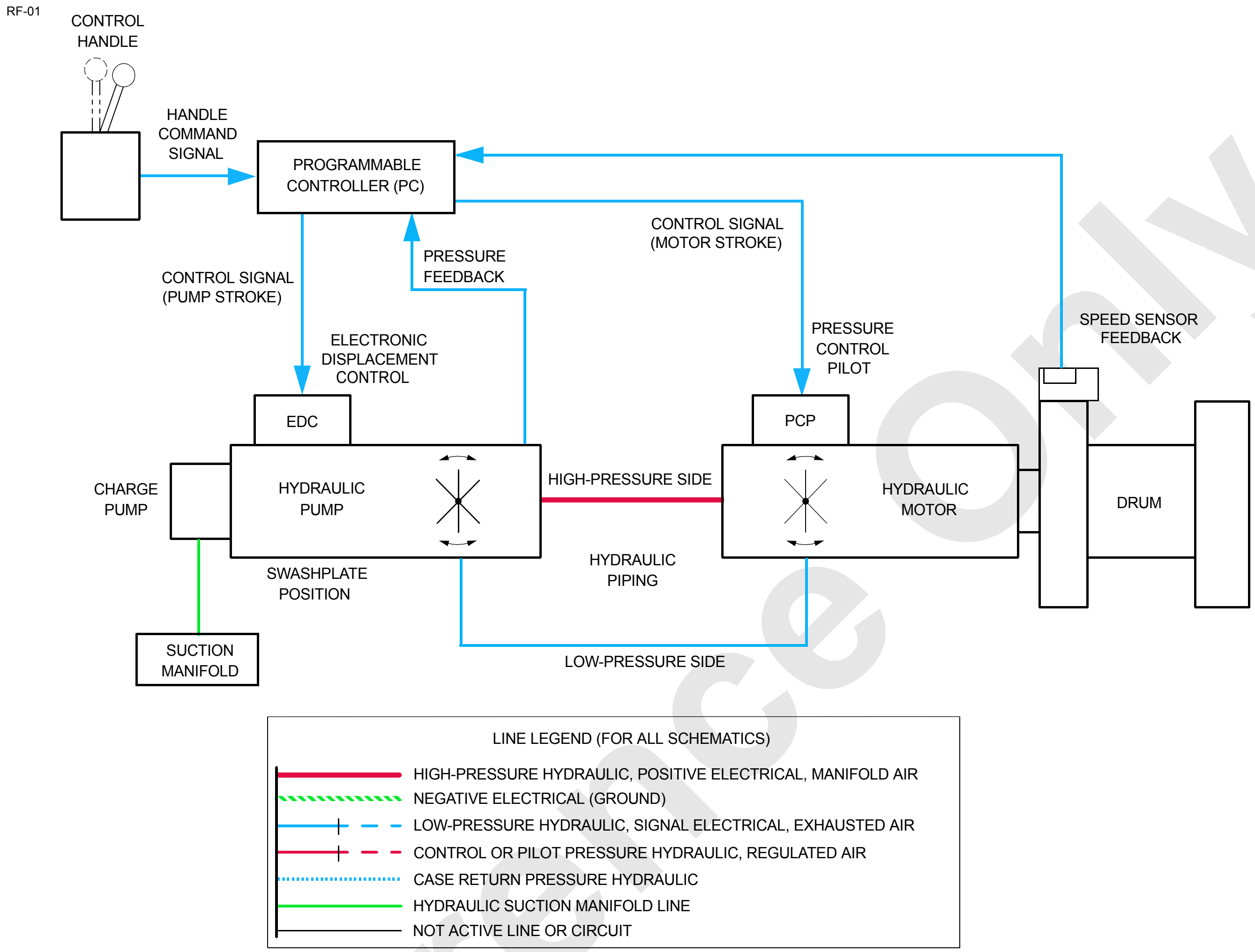


FIGURE 1-10

General Operation

See Figure 1-10 for the following procedure.

This section describes the model 2250 powered with the Cummins QSX15 or the Caterpillar 3406C engine. Standard and optional equipment available for the crane is included. Disregard any equipment your 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 topic in this section.

The Model 2250 operating system is an EPIC (Electrical Processed Independent Control). Through the PC (Programmable Controller) 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 digital display screen in operator's cab.

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

Hydraulic Components

See Hydraulic Schematic Drawing at the end of this section.

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

Each hydraulic solenoid valve in this section is assigned an HS number. The HS number identifies each hydraulic solenoid valve.

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	Swing Lock Engaged (Past Production Only)
HS-9	Swing Lock Disengaged
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

Hydraulic tank has a vented fill cap, high and low level sight gauges, vacuum sensor, temperature sensor, and fluid level sensor. Digital display indicates temperature and pressure (vacuum) of fluid in the reservoir. Hydraulic fluid vacuum is displayed as a pressure between 7 and 18 psi (0.5 and 1.2 bar absolute) depending on engine speed, ambient temperature, and filter condition. The breather protects the tank from excessive pressures by opening at 3 psi (0,21 bar) or vacuum opens at 1.5 in HG (38 mm HG).

Hydraulic tank has two sections: a suction section and a return section. The suction section has a 100 micron mesh strainer that allow fluid bypass around strainer at 3 psi (0,21 bar) if plugged. Two spin-on filters also filter hydraulic suction fluid. Replace filter elements when a pressure of 7 (0,5 absolute) is shown on digital display.

Return section inlets are through check valves. A diffuser inside tank return line reduces turbulence created by fluid returning to tank.

NOTE: See Lubrication in Section 9 for recommended replacement of hydraulic fluid.

Shutoff Valve

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

Suction Manifold

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

Return Manifolds

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

Hydraulic Fluid Cooler

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

Hydraulic Pumps

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

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

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

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

Each pump contains:

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

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

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

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

Table 1-1
Multifunction Valve Pressure Limit Settings

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

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

Charge Pressure

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

If boom/luffing jib charge pressure system drops, the brake begins to apply at approximately 295 psi (20 bar) for boom hoist and 260 psi (18 bar) for luffing jib. Brakes are fully applied at 219 psi (15 bar) for boom hoist and 140 psi (10 bar) for 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 internal flushing valve. Motors in load drum and boom hoist systems have a PCP (Pressure Control Pilot) valve that controls output speed/torque of the motor.

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

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

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

Main Pressure Monitoring

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

Basic Operation

See Figure 1-11 or Figure 1-12 for the following procedure.

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

In travel pumps, the pressure relief and pressure-limiting sections of multifunction valves respond when relief pressure is reached. If travel pump pressure exceeds preset pressure limit, the pumps de-stroke to prevent overheating of system fluid. The hydraulic fluid pressure overcomes spring resistance in pressure limiting relief valve (1, Figure 1-12), shifting spool to open a line for fluid pressure. Servo check valve (2) is spring loaded with an opening pressure of 750 psi (52 bar). Hydraulic fluid from pressure limiting relief valve flows through exhaust port of displacement control valve (3). The exhaust port has a restricted orifice that develops pressure for servo control cylinder (4) to pressurize and de-strokes pump to limit system pressure. When rapid loading produces pressure spikes, system relief valve (5) shifts. This allows high-pressure fluid to return to tank through charge pump relief valve (6). Alternatively, fluid transfers to low-pressure side of closed-loop system through charge flow make-up check valve (7).

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

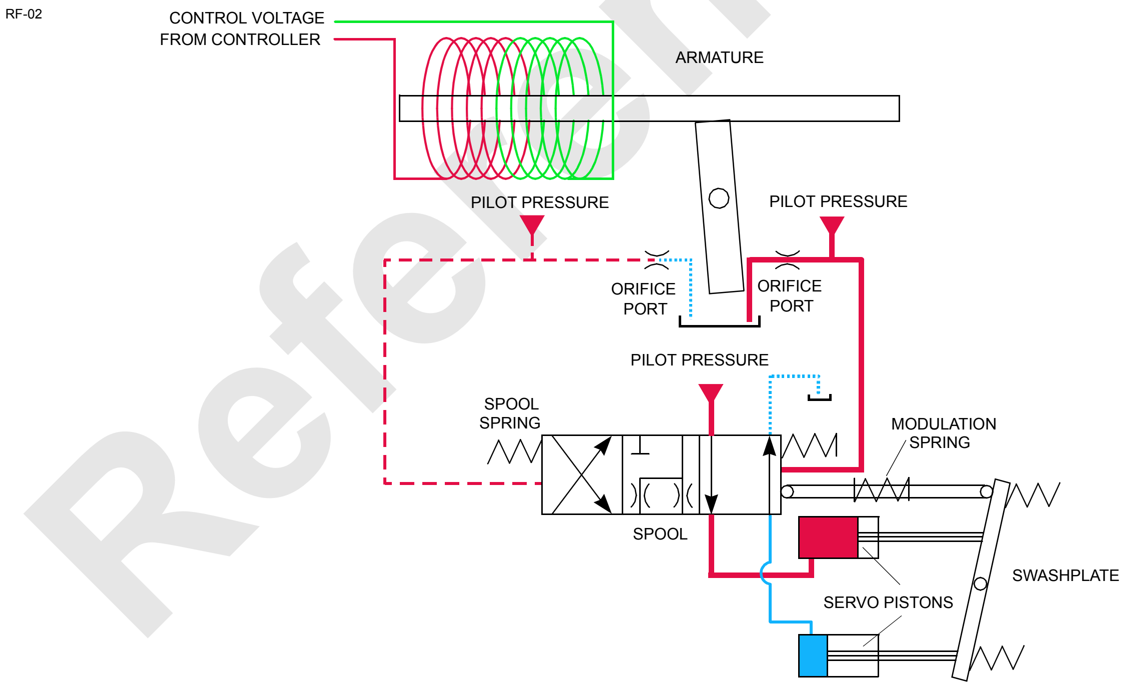


FIGURE 1-11

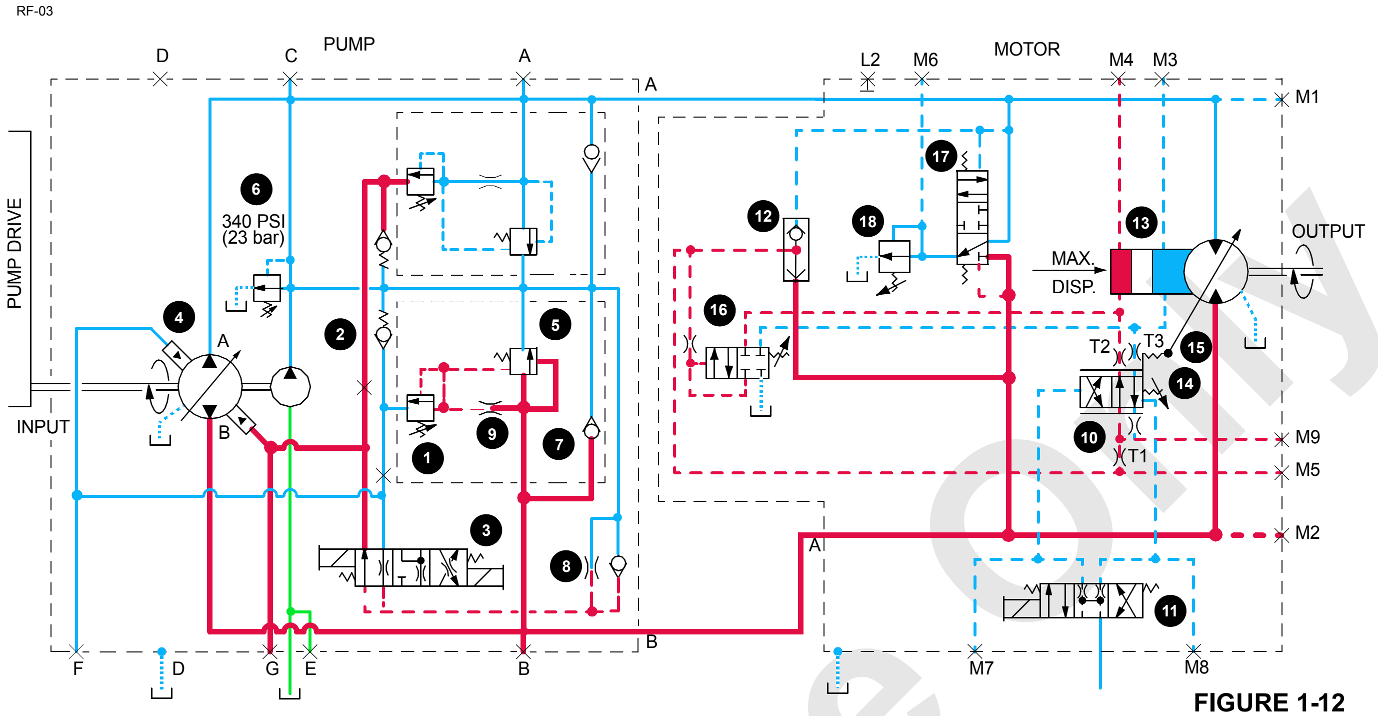


FIGURE 1-12

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

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

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

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

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

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

The Optional dual motor drive for split rear drum shaft (Figure 1-29) has one bi-directional, variable displacement motor with 12 volt proportional solenoid control along with one fixed displacement motor mounted in tandem. Proportional motor displacement is set to override to maximum (high torque) at 4,500 psi (310 bar) preventing high pressure motor failure.

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

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

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

Loop flushing (purge) system consists of control valve (17) and relief valve (18). If system pressure is above 200 psi (14 bar), loop flushing removes 4 gallons per minute (15 l/m) of hot fluid from system for added cooling. If system pressure is under 200 psi (14 bar) loop flush is disabled.

Accessory Systems

See Figure 1-13 for the following procedure.

Auxiliary pump obtains fluid from hydraulic tank through suction manifold. Auxiliary pump supplies fluid to all hydraulic cylinder systems. Fluid flow is from accessory pump through auxiliary system disable valve, upper accessory valve, proportional flow control valve, and to lower accessory valve.

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

When a component of auxiliary system is enabled, auxiliary system disable relief valve HS-12 shifts to block flow to tank. Accessory system pressure builds up to 3,500 psi (241 bar) allowing fluid to the auxiliary systems through auxiliary system relief valve.

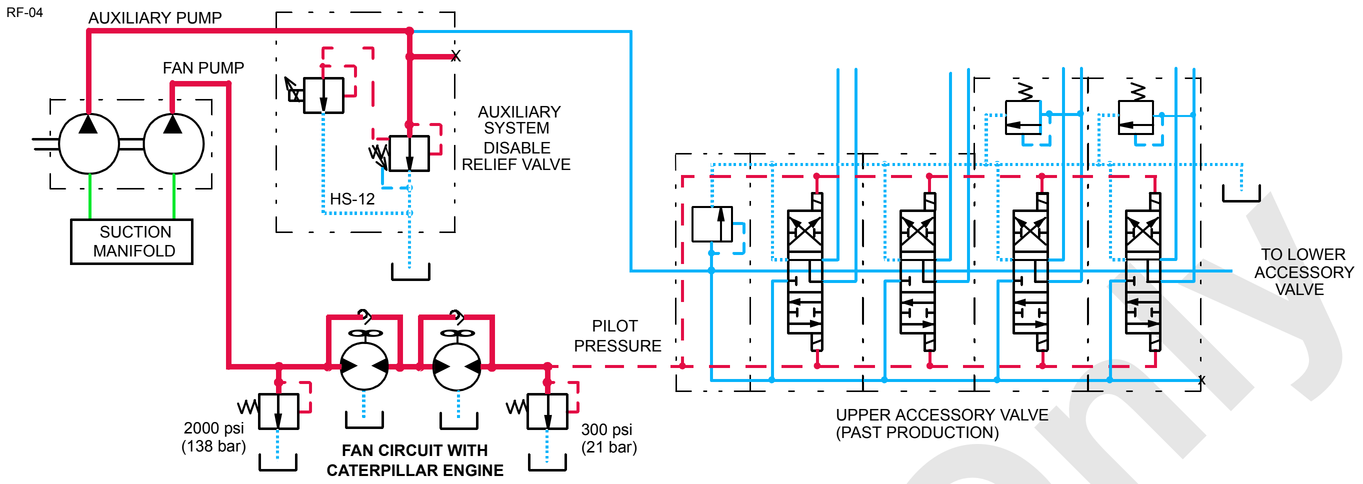
The suction manifold supplies hydraulic fluid to fan pumps. Fan pump supplies hydraulic fluid to drive two fan motors and provides pilot pressure to upper accessory valve with Caterpillar engine. Fan relief valves protect fan pump and two fan motors from damage by limiting the fans system pressure to 3,250 psi (224 bar) with Cummins engine or 2,000 (172 bar) with Caterpillar engine. System pressure after the fans is limited by relief valve to 300 psi (21 bar) for pilot pressure or fluid return to tank.

The upper accessory valve includes:

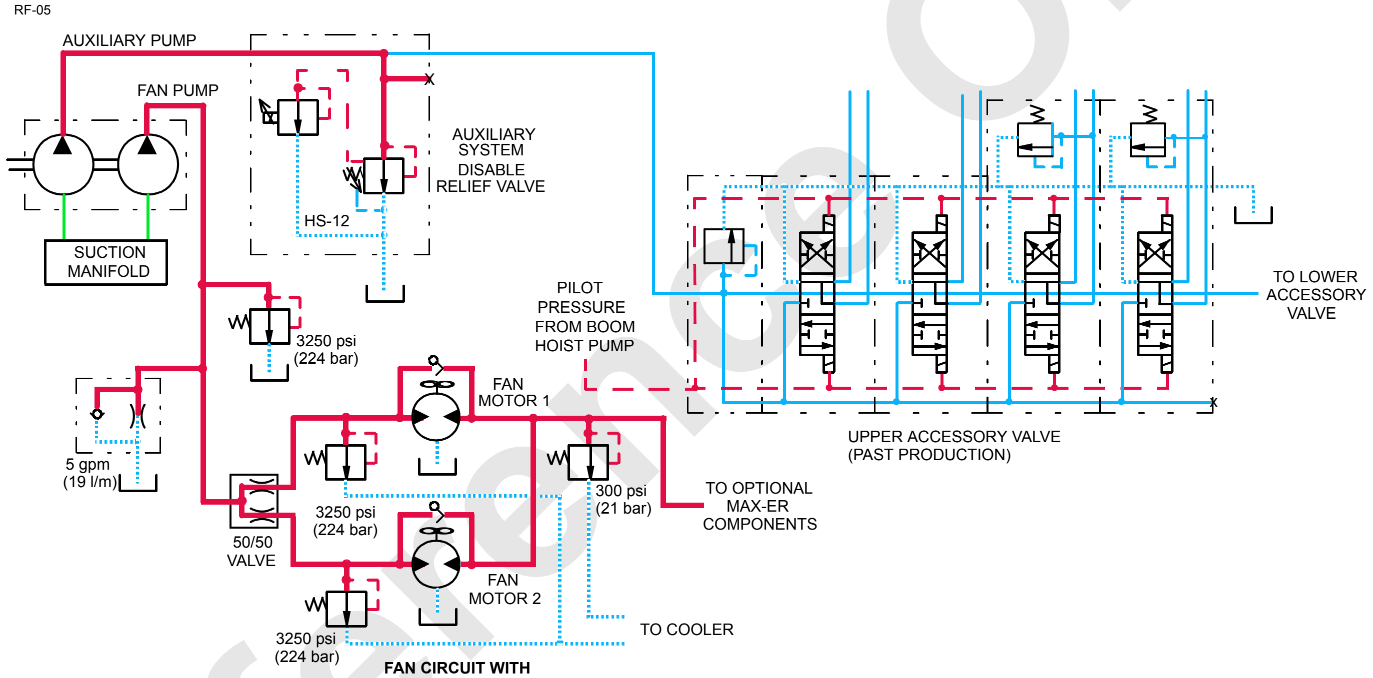
- Rotating bed jacking cylinders (four)
- Front and rear adapter frame pin cylinders (four)
- Gantry raising cylinders (two)

The lower accessory valve includes:

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



FAN CIRCUIT WITH CATERPILLAR ENGINE



FAN CIRCUIT WITH CUMMINS ENGINE (PAST PRODUCTION)

FIGURE 1-13

Pressurized Air Supply

See Figure 1-14 for the following procedure.

Pressurized air is provided to the crane's air cylinder systems — boom hoist pawl, luffing hoist pawl, load drum pawls, load drum brakes, load drum clutches, counterweight pin cylinders, back hitch pin cylinders, and optional boom stop cushion cylinders. See Air Schematic drawing in Section 5.

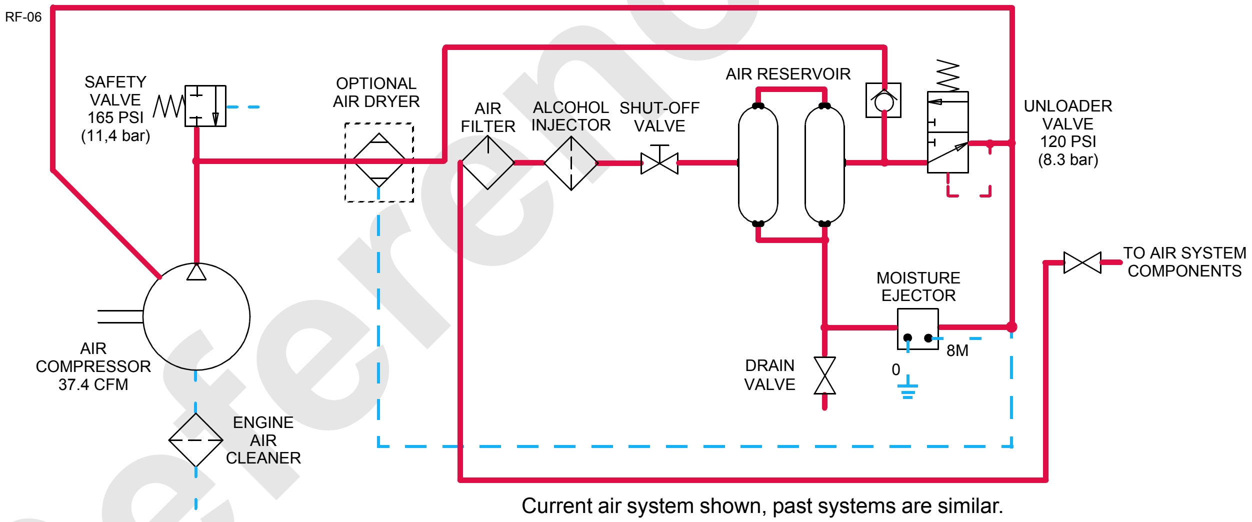
Airflow from compressor passes through air dryer before entering air tanks. An optional alcohol injector provides de-icing and condensation is eliminated through an electrical moisture ejector.

Unloader valve adjusts compressor delivery rate by briefly opening compressor's intake valve at 132 psi (9 bar). Safety relief valve limits pressure in the system to 165 psi (11,4 bar). Another shut-off valve isolates supply from air system.

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

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

AS-1	Back Hitch Pins Extend
AS-2	Back Hitch 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



Current air system shown, past systems are similar.

FIGURE 1-14

Engine Controls

See the engine manufacturer's manual for instructions.

The engine is started and stopped with engine key switch.

Engine RPM is controlled with the hand throttle or foot throttle. The PC and engine control module monitor engine information and display the information on a digital screen.

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

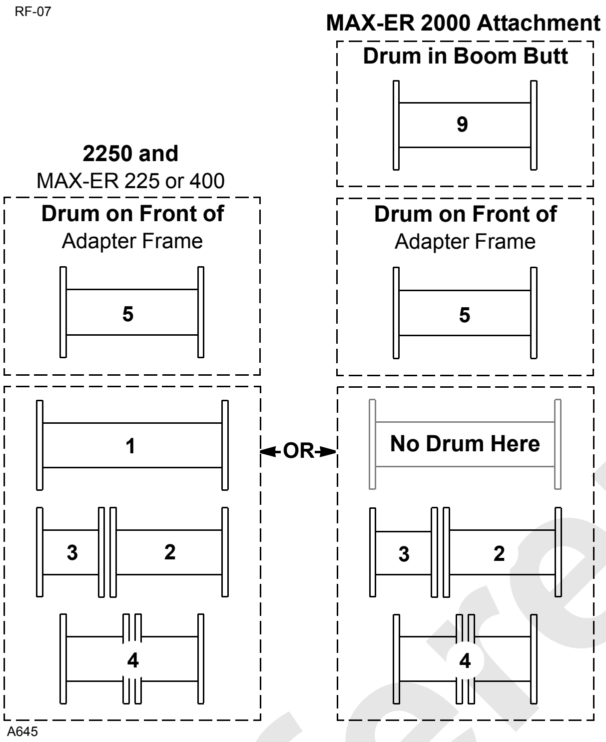
Use the engine stop push button only in an emergency as all brakes apply and any function stops abruptly.

Three engine diagnostic lights are mounted on front console, see Engine Diagnostics in Section 10 for diagnostic light information.

Drum Identification

See Figure 1-15 for the following procedure.

Current production 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 and MAX-ER 225 or 400	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 1-15

EPIC® Programmable Controller (PC)

See Figure 1-16 for the following procedure.

The Model 2250 crane's boom, load lines, swing, crawler tracks, and accessory components are controlled electronically with the EPIC (Electrical Processed Independent Control) system. This simplifies the crane's electrical control system by avoiding mechanical control switches and relays. Standard or custom programming allows the PC (Programmable Controller) to automatically adjust each operational mode's acceleration rate and speed, apply brakes, and engage 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 volt 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 crane control devices. See Crane Diagnostics topic in Section 10 of this manual.

Digital Display

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

Rated Capacity Indicator/Limiter (RCL)

The RCL system has its own PC (Programmable Controller) and is part of the EPIC system. Load charts are specific for each crane model. For complete information see 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 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.

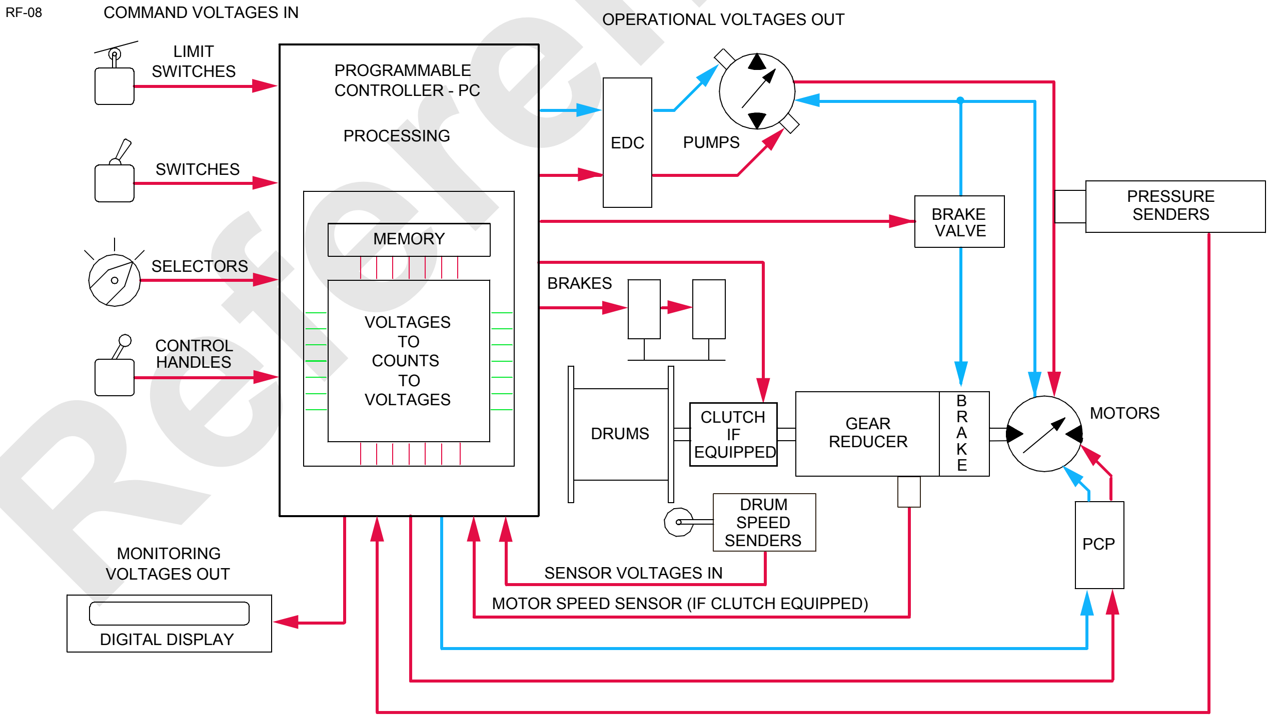


FIGURE 1-16

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

Electrical Power to Operator's Cab

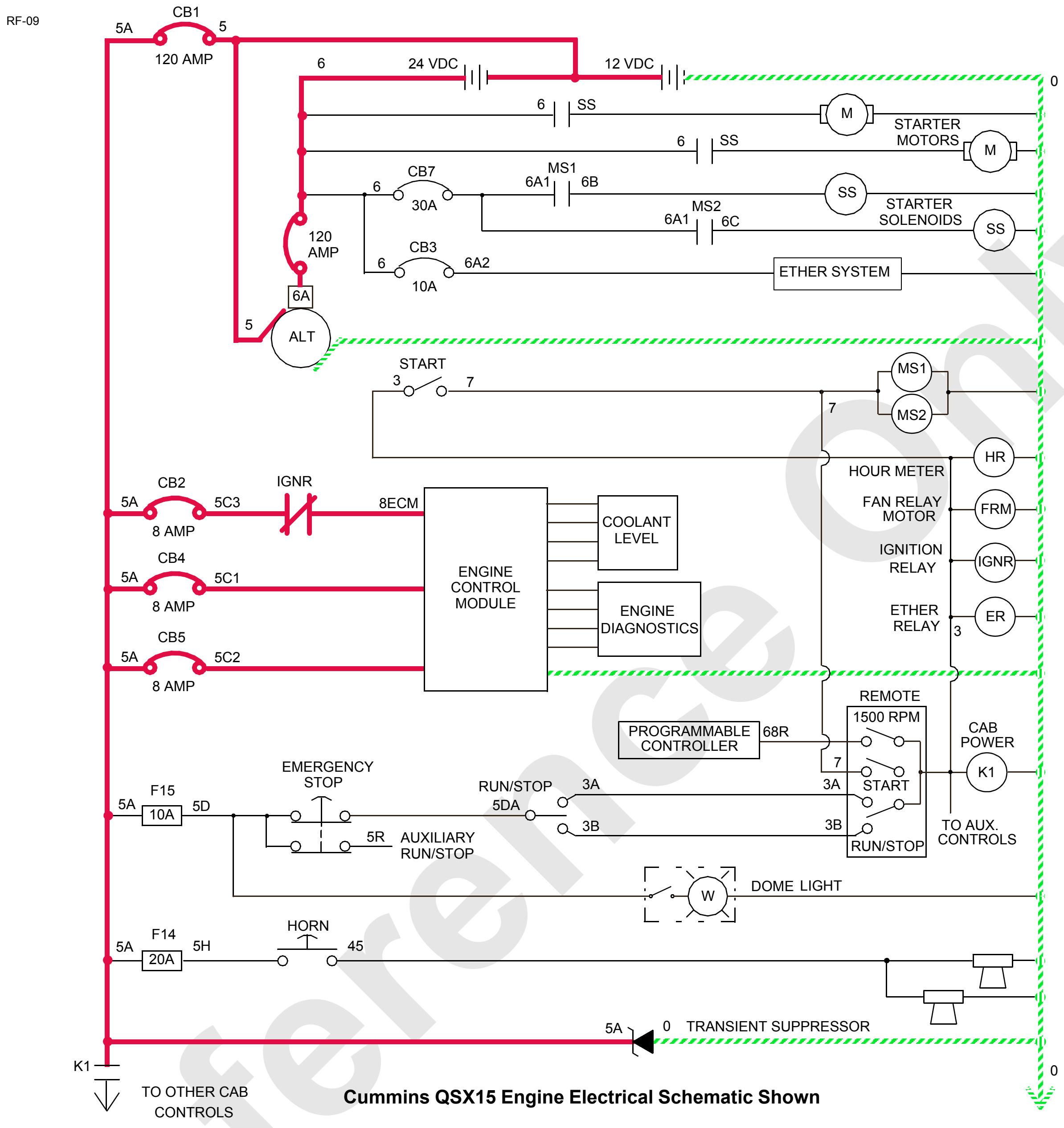
See Figure 1-17 for the following procedure.

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

When the engine run/stop switch is placed in the run position, voltage is available at the key-operated engine start switch and other cab controls.

Contacts of start switch and remote run/stop switches must be enabled to start engine. When both switches are enabled, voltage is available to:

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



Cummins QSX15 Engine Electrical Schematic Shown

FIGURE 1-17

Pressure Senders and Speed Sensors

See Figure 1-18 for the following procedure.

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

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

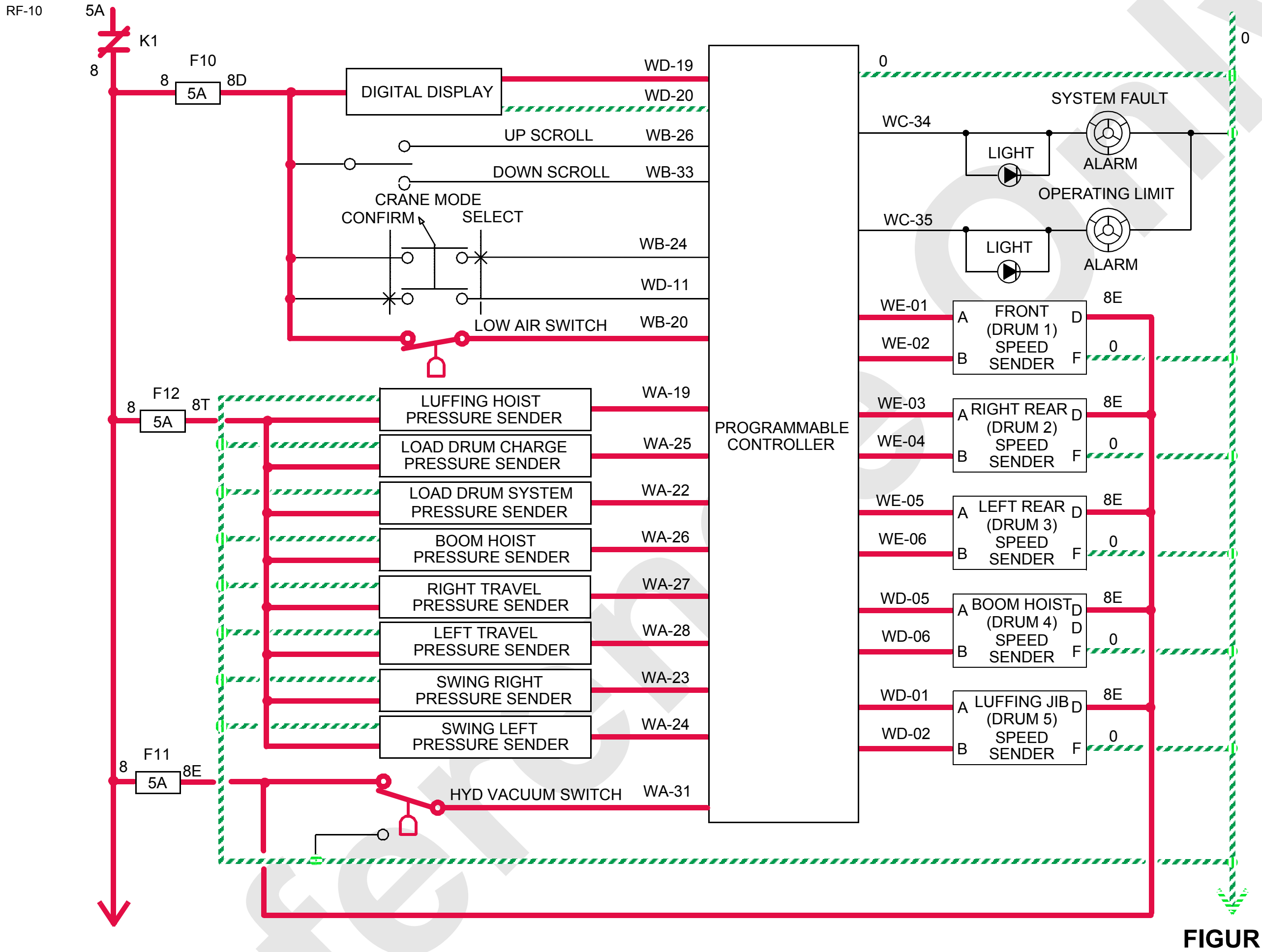


FIGURE 1-18

Limit Switches and Faults

See Figure 1-19 for the following procedure.

When operating, all limit switches are closed, sending an input voltage to the PC. If a limit switch is tripped, the PC sends a 0 volt output to system pump EDC and brake solenoid. System pump de-strokes and system brake solenoid valve shifts to apply brake. Move component in the opposite direction away from limit to correct the problem.

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

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 selected brake switch in off position. The PC releases swing brake and swing lock immediately when swing brake switch is placed in off position (Past Production). The PC controls release of other brakes with control handle movement.

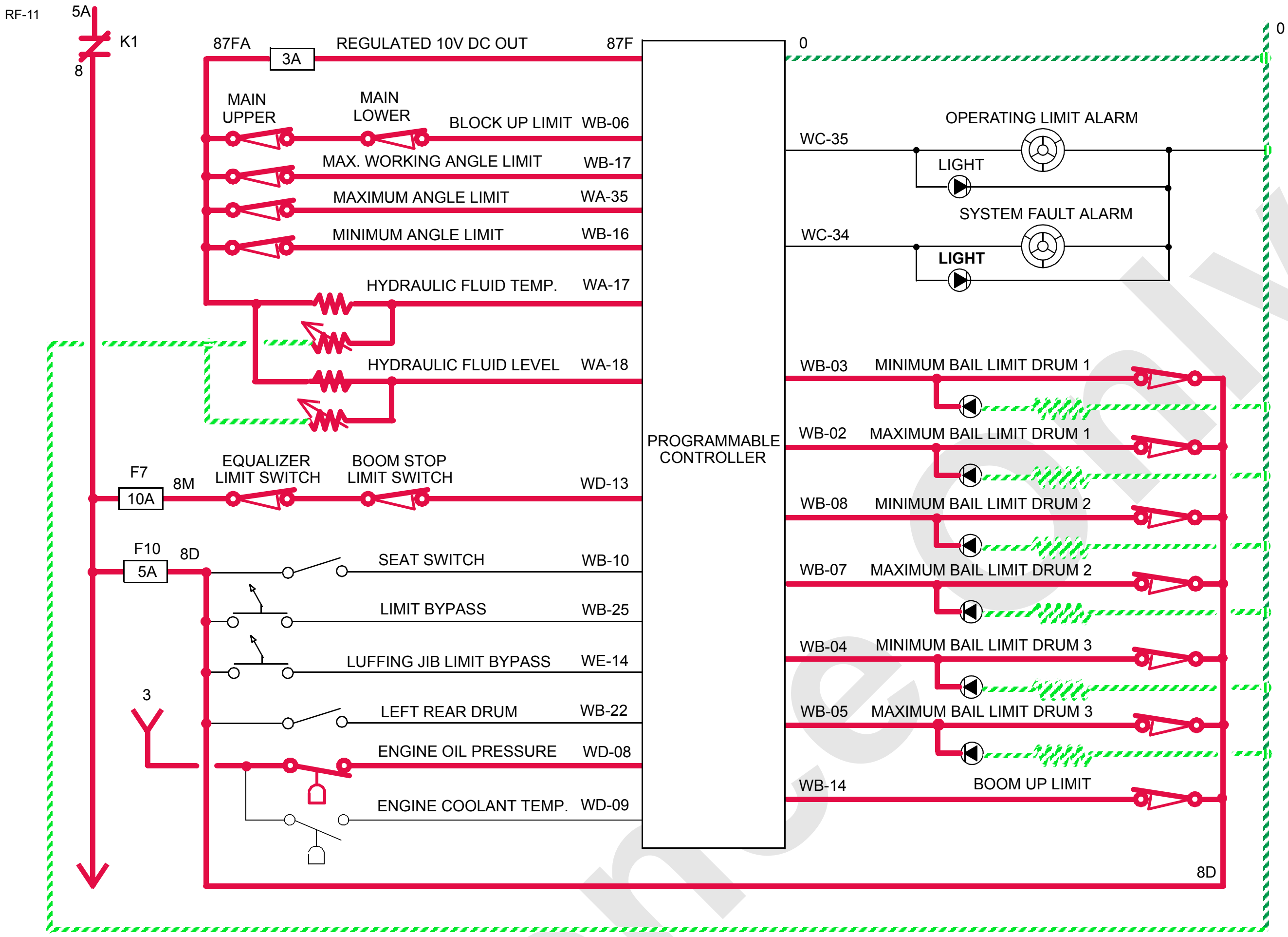


FIGURE 1-19

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

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

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

Load Drum Air Brakes

See Figure 1-20 for the following procedure.

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 part of the first cylinder 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 brake cylinder chamber is not used.

Release the load drum brakes by placing selected load drum brake switch in off position. The PC enables the brake solenoid when 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 brake relay. This allows manifold air to close quick release valves. Air flows to brake cylinder chambers, compressing the springs to release brake. With selected load drum brake released, load drum motor can hold the load when operating in full-power operation.

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

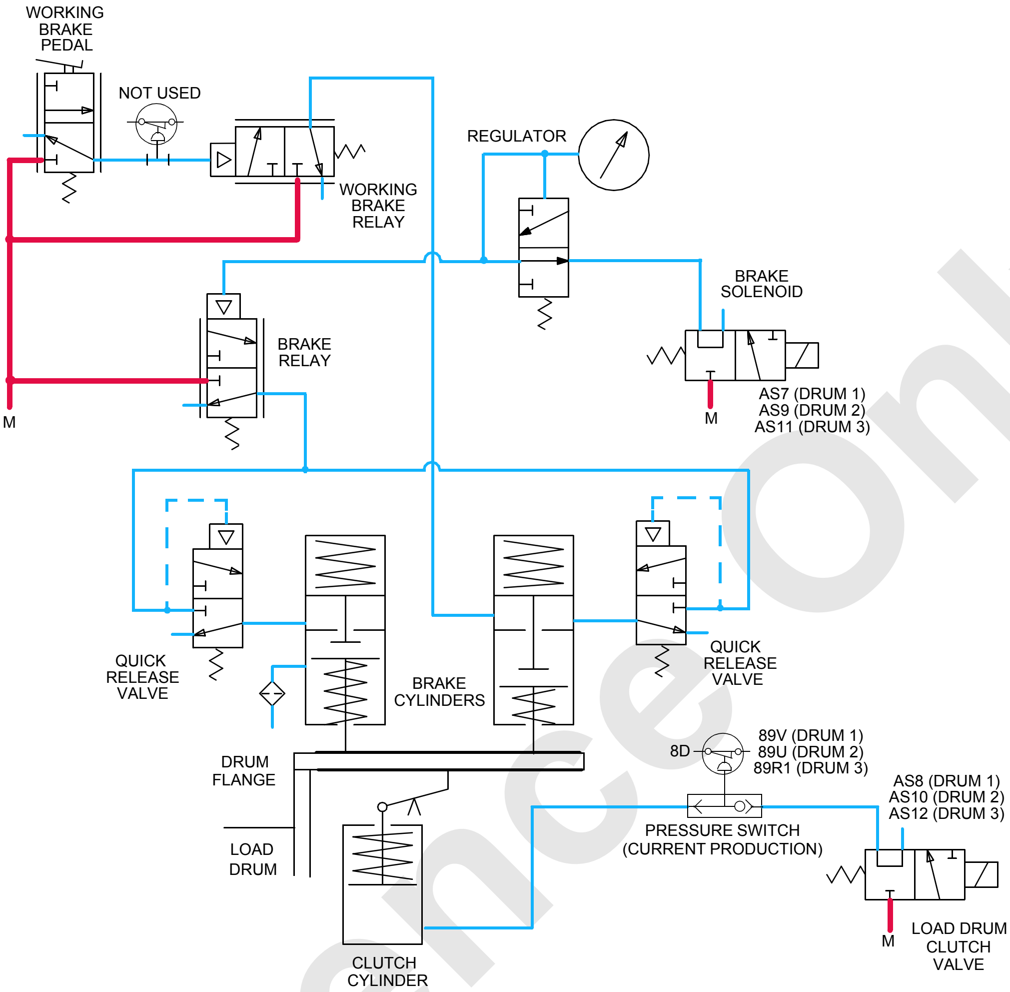


FIGURE 1-20

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

Working (Service) Brakes

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

Pressure applied by brake is in proportion to brake pedal movement. Full brake application is obtained when brake pedal is applied and latched. When brake pedal is released, 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, selected load drum control handle movement, depending on mode and circuit requirements. The PC monitors air pressure switches when operator switches from one load drum to another. The clutch and brake air lines are connected through shuttle valve to pressure switch. The PC waits until pressure switch closes before stroking the pump and releasing the selected drum brake.

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

When selected load drum control handle is moved an input signal is sent to the PC. The PC sends an output signal to clutch solenoid AS-8, AS-10, or AS-12. The PC selects which clutches are released, depending on control handle command and 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 boom hoist, luffing hoist, front drum, rear drum, and auxiliary drum (if equipped).

With ***current*** production pawl operation is controlled with selected drum brake switch. With ***past*** production pawl operation is controlled with selected pawl switch.

If a pawl is engaged during hoisting up, a hoist operating drive fault occurs when stopped because the PC cannot command down against 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 motor end of drum shaft enables and the pump de-strokes to stop the function. The PC delays the engage signal to pawl engage air solenoid so the pawl does not engage for approximately 10 seconds after hoist stops. Load drum pawls respond similarly, but front and rear load drum brakes are spring applied and air released.

Swing System Operation

NOTE: References to “swing lock” are for past production cranes as the swing lock is disabled on current production.

General

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

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 PC. The swing control handle is inoperable when swing brake is applied or the swing lock is engaged. The motor driven swing gearbox drives a tooth gear that is meshed with 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 swing left and swing right sides of 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 swing control handle is in neutral position, swing brake is released, and swing lock is disengaged.

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

An orifice across 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 type of work being performed by referring to Speeds screen in Crane Diagnostics in Section 10 of this manual.

Swing Brake and Swing Holding Brake

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

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

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

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

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

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

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

Swing Lock (Past Production)

The swing lock is a mechanical brake that places locking pins into slots in shaft locking flange of gearbox.

When swing lock switch is placed in disengaged position, an input signal is sent to enable disengage solenoid valve HS-9 and a 0 volt output to disable engage solenoid valve HS-8. Swing lock valves shifts to supply pilot pressure from boom hoist charge pump to rod end of swing lock cylinder. Fluid from the piston end of swing lock cylinder exhausts to tank through swing lock solenoid valve. The cylinder retracts, disengaging mechanical locking pins from slots in shaft locking flange, allowing crane to swing in either direction when swing motor brake is released.

When swing lock switch is placed in engaged position, an input signal is sent to disable solenoid valve HS-9 and to enable HS-8. Swing lock valve shifts to supply pilot pressure from boom hoist charge pump to piston end of swing lock cylinder. Fluid from rod end of swing lock cylinder exhausts to tank through swing lock solenoid valve. The cylinder extends, to engage mechanical locking pins into shaft locking flange.

Swing Right or Left

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

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

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

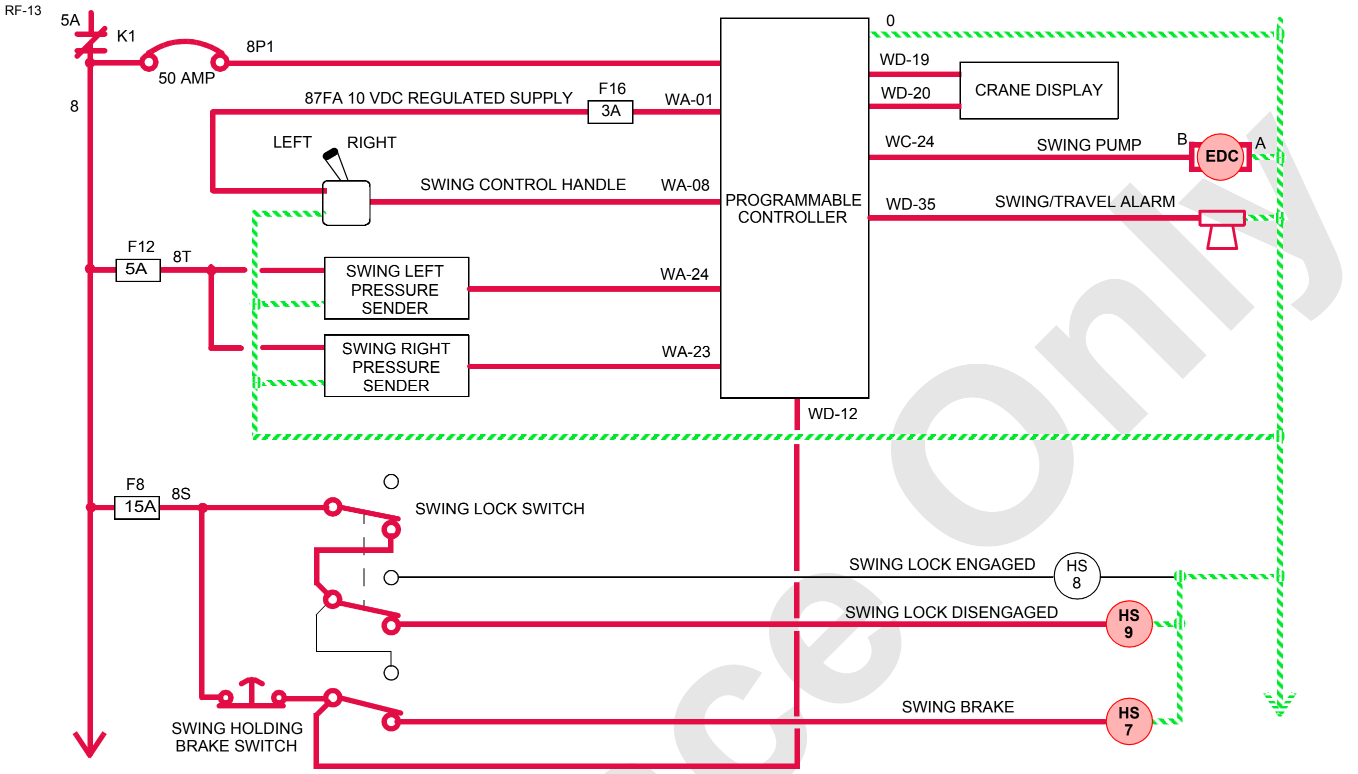


FIGURE 1-21

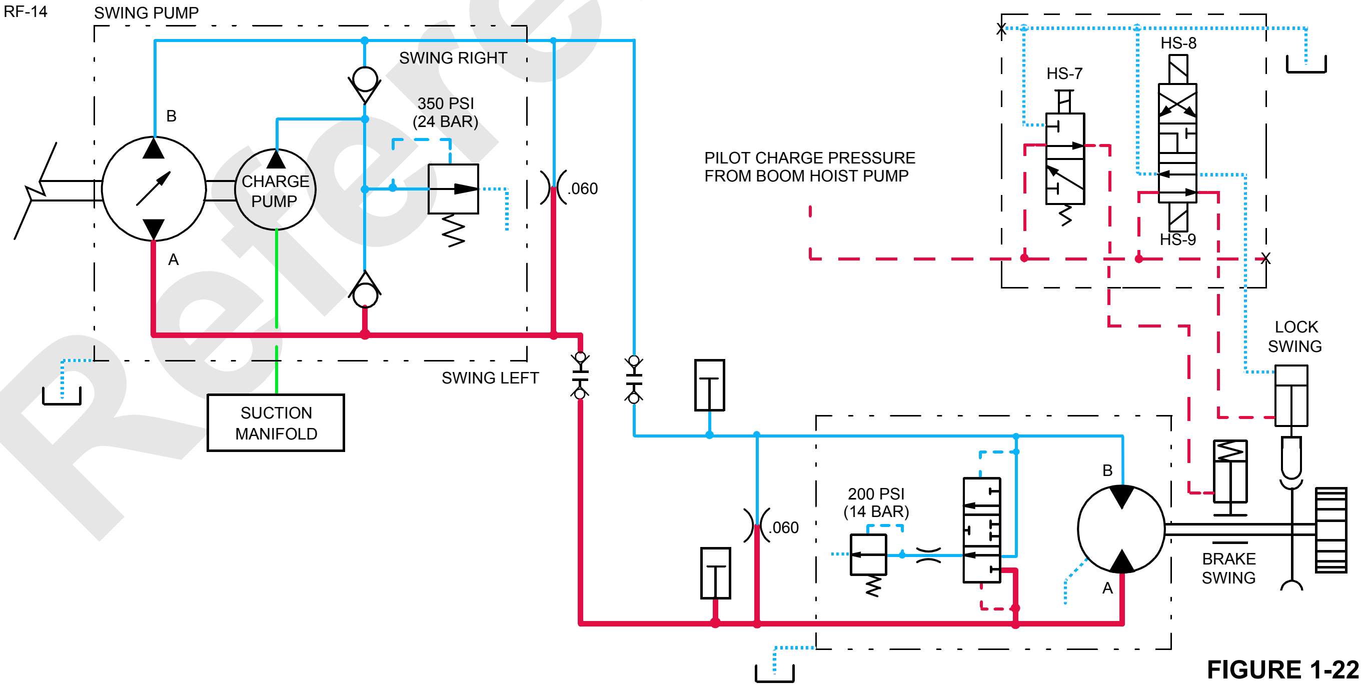


FIGURE 1-22

Travel System Operation

General

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

Each travel hydraulic pump drives one crawler system motor and gearbox. Each hydraulic pump and motor is controlled with travel control handle movement and the PC. Travel control handles are inoperable when travel brake is applied. Gearbox for each crawler is driven with a flexible shaft connected between motor output and drive gearbox input.

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

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

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

Travel Brakes

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

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

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

Two-Speed Travel Operation

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

When travel speed switch is in low speed position, the PC sends a 12 volt output to enable 2-speed travel solenoid valve HS-35, shifting valve to direct hydraulic pilot pressure to end of P/C valve. The P/C valve shifts PCOR (Pressure Compensated Over-Ride) spool placing travel motor in maximum displacement (high torque, low speed) position. Travel motors remain in this position until travel speed switch is placed in high speed position.

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

Travel Detent Selector

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

Travel Forward and Reverse

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

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

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

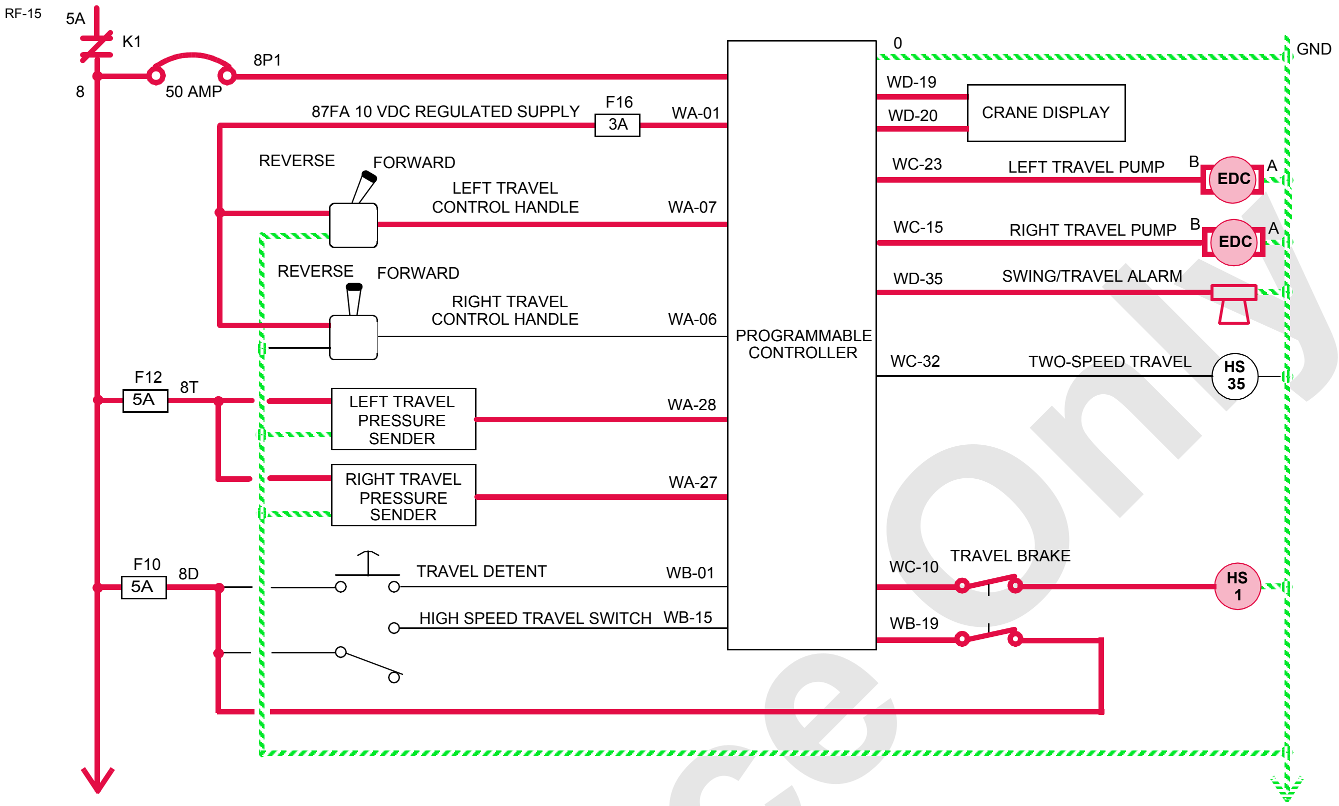


FIGURE 1-23

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

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

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

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

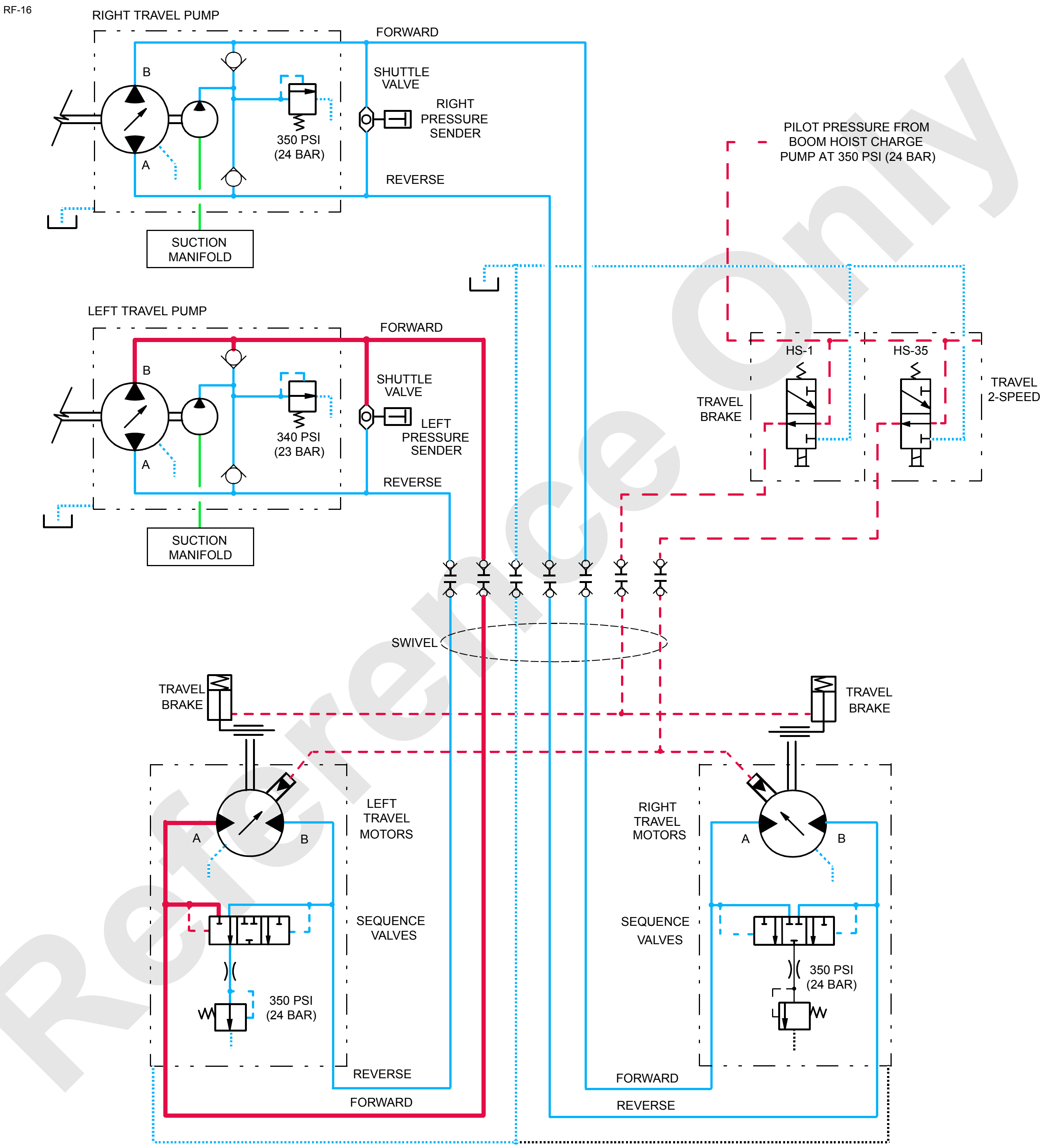

RF-16
RIGHT TRAVEL PUMP
FORWARD
B
SHUTTLE VALVE
RIGHT PRESSURE SENDER
350 PSI (24 BAR)
A
REVERSE
SUCTION MANIFOLD
PILOT PRESSURE FROM BOOM HOIST CHARGE PUMP AT 350 PSI (24 BAR)
LEFT TRAVEL PUMP
FORWARD
B
SHUTTLE VALVE
LEFT PRESSURE SENDER
340 PSI (23 BAR)
A
REVERSE
SUCTION MANIFOLD
HS-1
HS-35
TRAVEL BRAKE
TRAVEL 2-SPEED
SWIVEL
TRAVEL BRAKE
TRAVEL BRAKE
A
B
LEFT TRAVEL MOTORS
RIGHT TRAVEL MOTORS
A
B
SEQUENCE VALVES
SEQUENCE VALVES
350 PSI (24 BAR)
350 PSI (24 BAR)
REVERSE
FORWARD
FORWARD
REVERSE

FIGURE 1-24

Boom Hoist/Luffing Jib System Operation

General

See Figure 1-25, Figure 1-26, and Figure 1-27 for the following procedure.

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

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

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

Continuous changing of system fluid occurs through leakage in pump, motor, and external sequence/flow valve. Sequence/flow valve opens at 275 psi (19 bar) and removes 4 gallons per minute (15 l/m) of hot fluid from system by dumping into the motor case where fluid returns to tank.

Brake and Pawl

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

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

When selected brake switch is placed in off position, boom hoist or luffing jib brake remains applied, waiting for a control handle command. The PC sends a 0 volt 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 volt 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 air pressure from piston end of pawl cylinder and to supply manifold air pressure to rod end of cylinder. The cylinder retracts the pawl out of drum flange.

Boom Hoist/Luffing Jib Raise

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

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

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

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

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

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

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

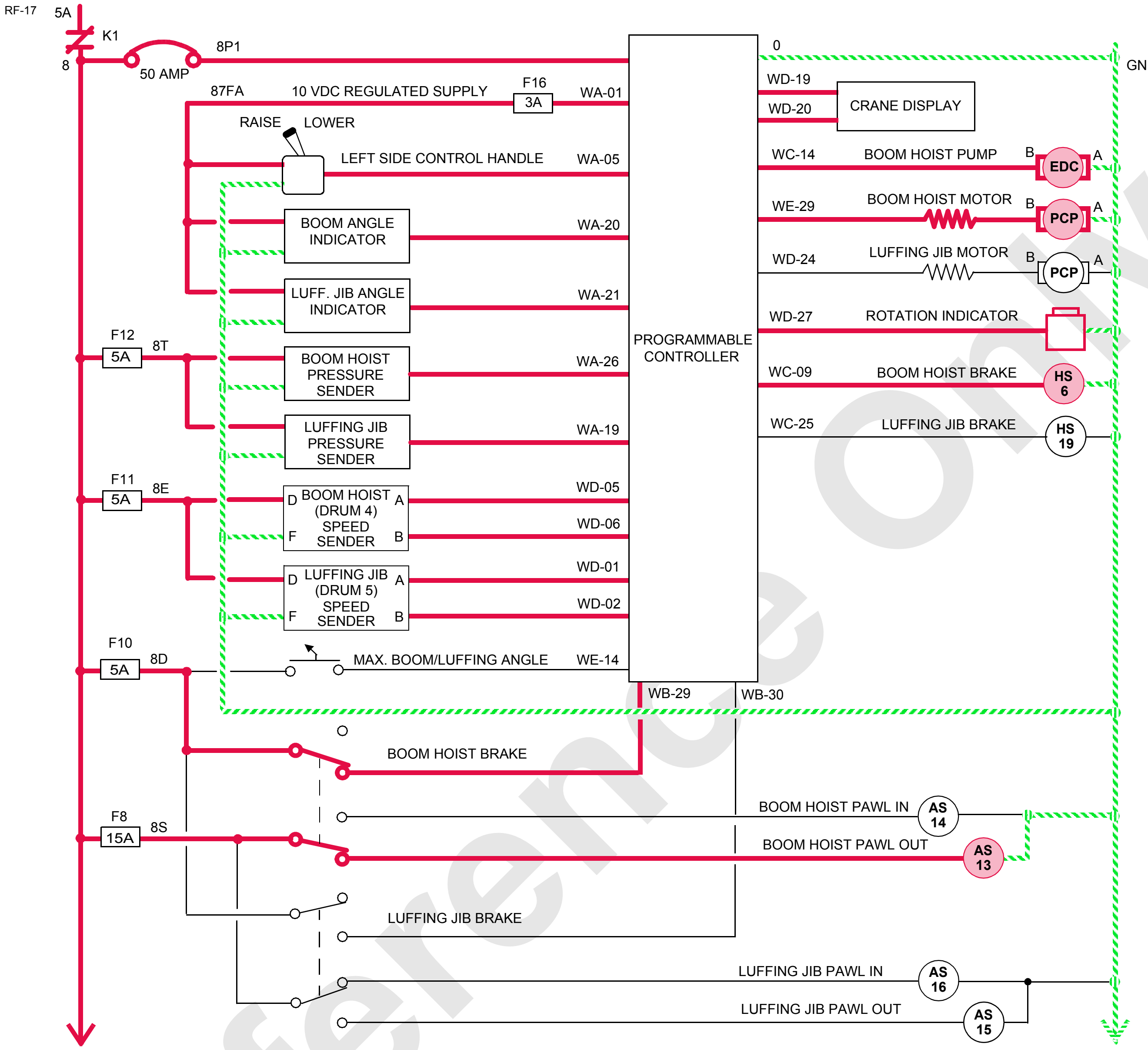


FIGURE 1-25

Boom Hoist/Luffing Jib Lower

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

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

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

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

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

The PC is continuously balancing the system pressure and the motor displacement angle so the motor displacement goes to minimum when control handle is fully forward, if the motor torque 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 boom attempts to drive motor faster than return fluid can return to low-pressure side of pump. System charge pump maintains fluid supply at a positive pressure to motor. Pump swashplate position restricts the returning fluid flow. Pressure builds on fluid return side of closed-loop, acting as a hydraulic brake to control lowering speed.

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

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

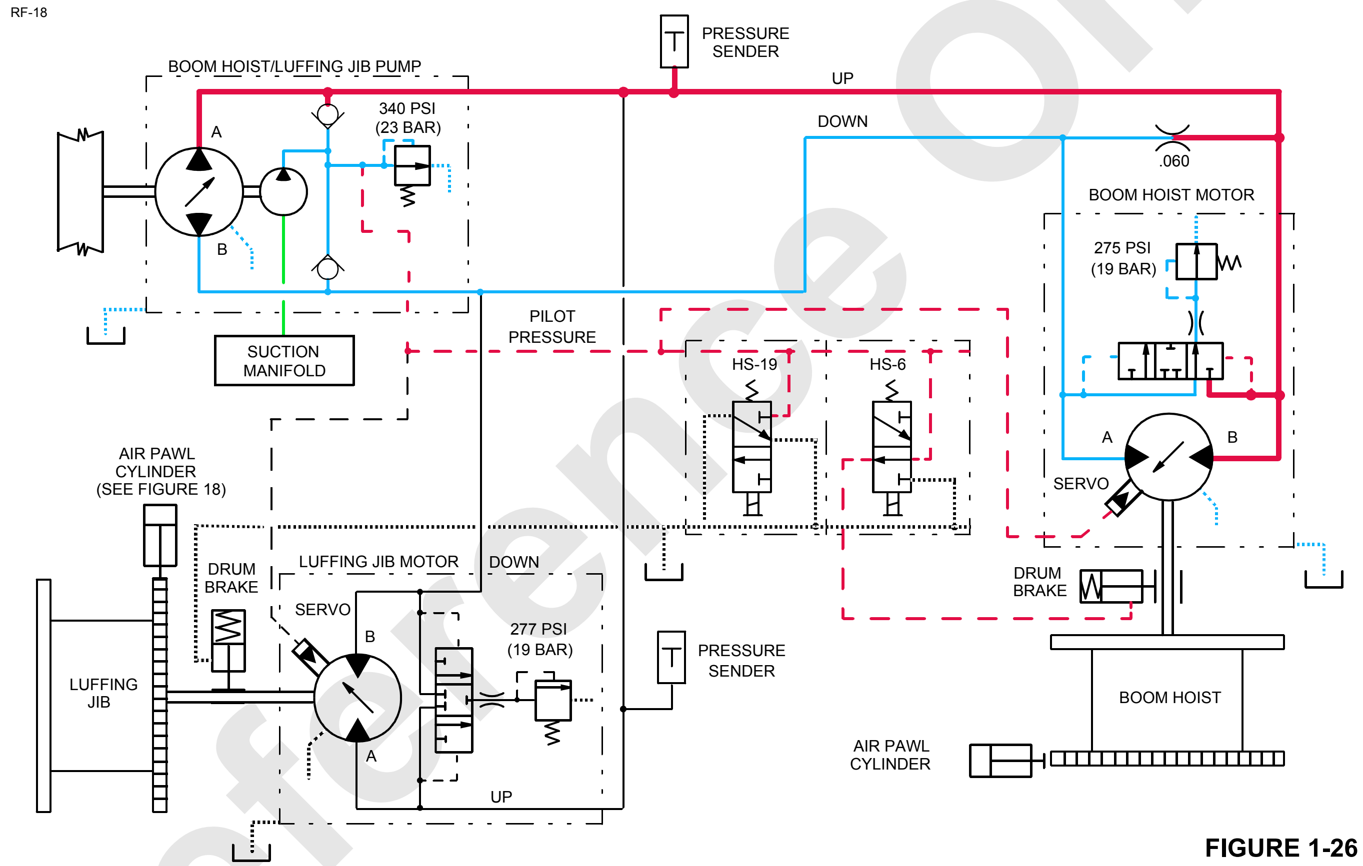


FIGURE 1-26

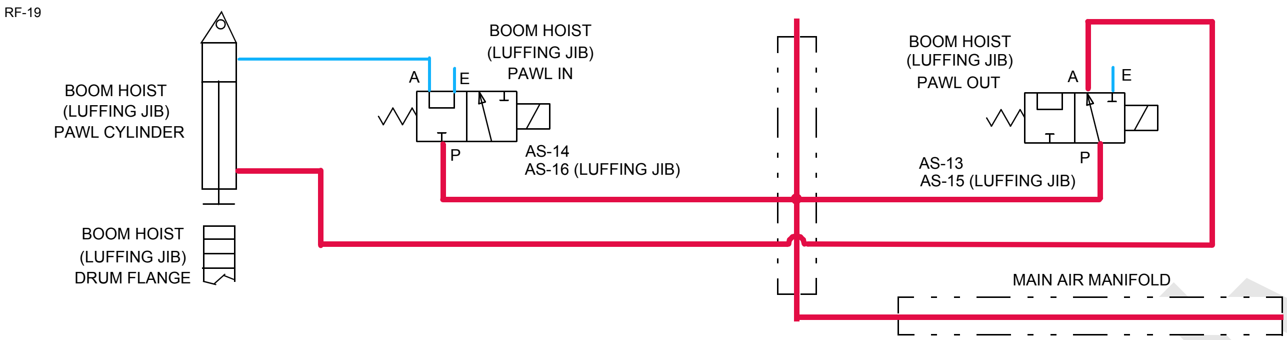


FIGURE 1-27

Load Drum System — Full Power

General

See Figure 1-28, Figure 1-29, and Figure 1-30 for the following procedure.

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 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 drum shaft is determined either by the PC or the operator. The PC engages the last selected drum clutch to drum shaft and disengages the other clutches from the drive shaft. The operator selects the desired load drum with load drum handle movement.

Depending on crane load drum configuration, the left load drum control handle on the right console normally operates either 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 full rear (Drum 2) or left-rear drum (Drum 3). See Figure 1-11 for handle-to-drum identification.

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

Hydraulic charge pressure from system charge pumps supplies hydraulic pilot pressure to operate motor servo. A pressure sender in 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 rotation indicator in control handle. As drum rotates faster, the rotation indicator on top of control handle pulsates to indicate drum rotational speed. The drum speed is also show on the selected drum display screen.

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

Drum Brake

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

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

Load Drum Hoisting

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 other load drums is similar.

When right load drum control handle is moved back for ***hoisting***, an input voltage of 5 volts or more is sent to the PC. The PC sends a variable minus 0 to 2.8 volt output that is applied to both load drum pump EDC's. The PC sends a variable 0 to 2.19 volt output that is applied to load drum motor PCP. The PC checks that 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 volt output signal to enable front drum clutch solenoid AS-8 and left-rear drum clutch solenoid AS-12. The valves shift to allow manifold air pressure flow to clutch cylinders and compress the springs to release the clutches from drum shaft. The right-rear drum clutch solenoid AS-10 air pressure is exhausted so clutch remains spring-applied to drum shaft.

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

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

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

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

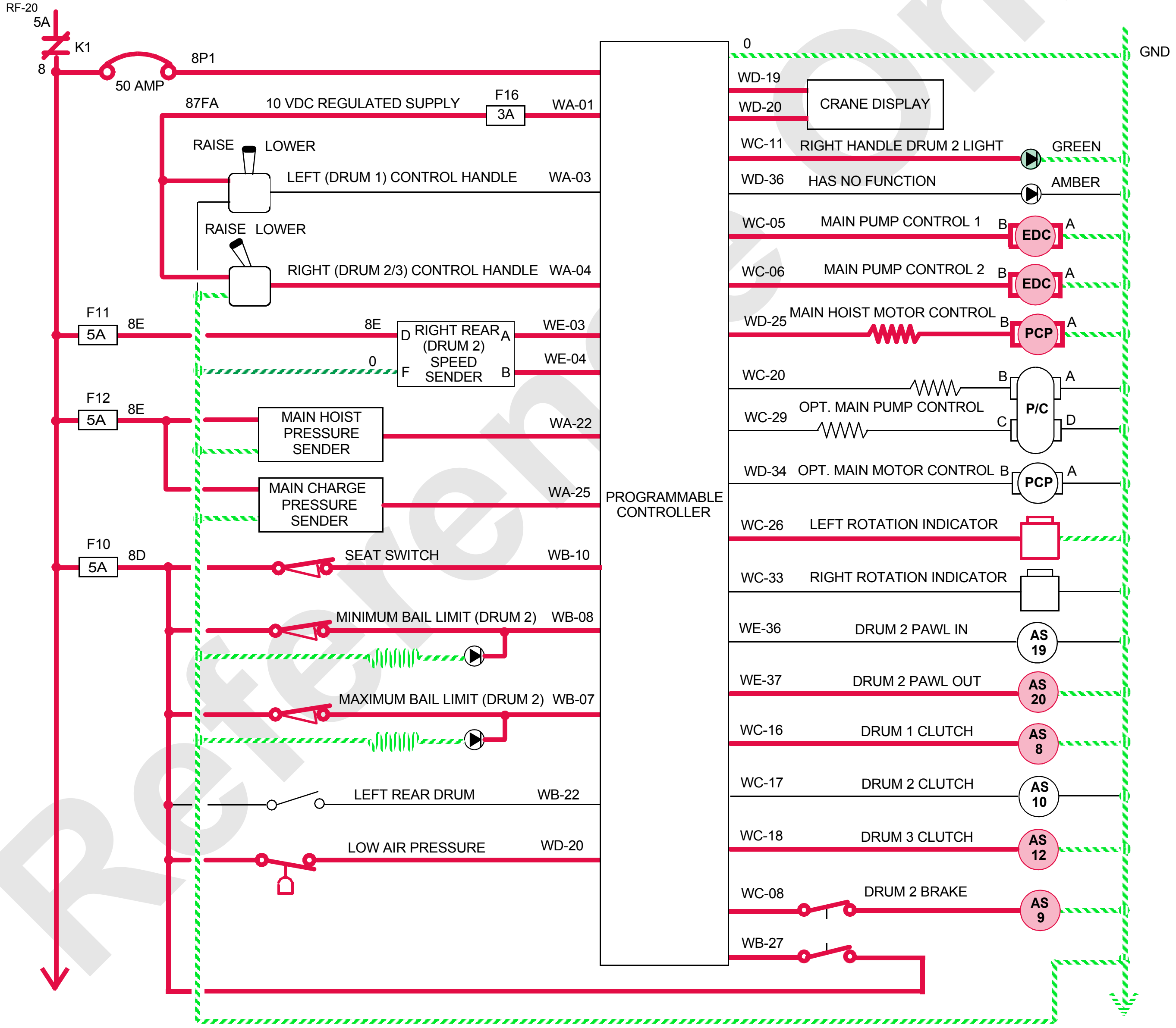


FIGURE 1-28

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

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

Load Drum Lowering

When right load drum control handle is moved forward for ***lowering***, an input voltage of 5 volts or less is sent to the PC. The PC sends a variable plus 0 to 2.8 volt output that is applied to both load drum pump EDC's. The PC sends a variable 0 to 2.19 volt output that is applied to load drum motor PCP. The PC checks that 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 volt output signal to enable front drum clutch solenoid AS-8 and left-rear drum clutch solenoid AS-12. The valves shift to allow manifold air pressure flow to clutch cylinders and compress the springs to release the clutches from drum shaft. The right-rear drum clutch solenoid AS-10 air pressure is exhausted so clutch remains spring-applied to drum shaft.

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

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

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

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

The PC is continuously balancing the system pressure and the motor displacement angle so the motor displacement goes to minimum when control handle is fully forward, if the motor torque 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 motor faster than return fluid can return to low-pressure side of pump. System charge pump maintains fluid supply at a positive pressure to motor. Pump swashplate position restricts the returning fluid flow. Pressure builds on fluid return side of closed-loop, acting as a hydraulic brake to control lowering speed.

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

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

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

Dual Load Drum Motor Operation

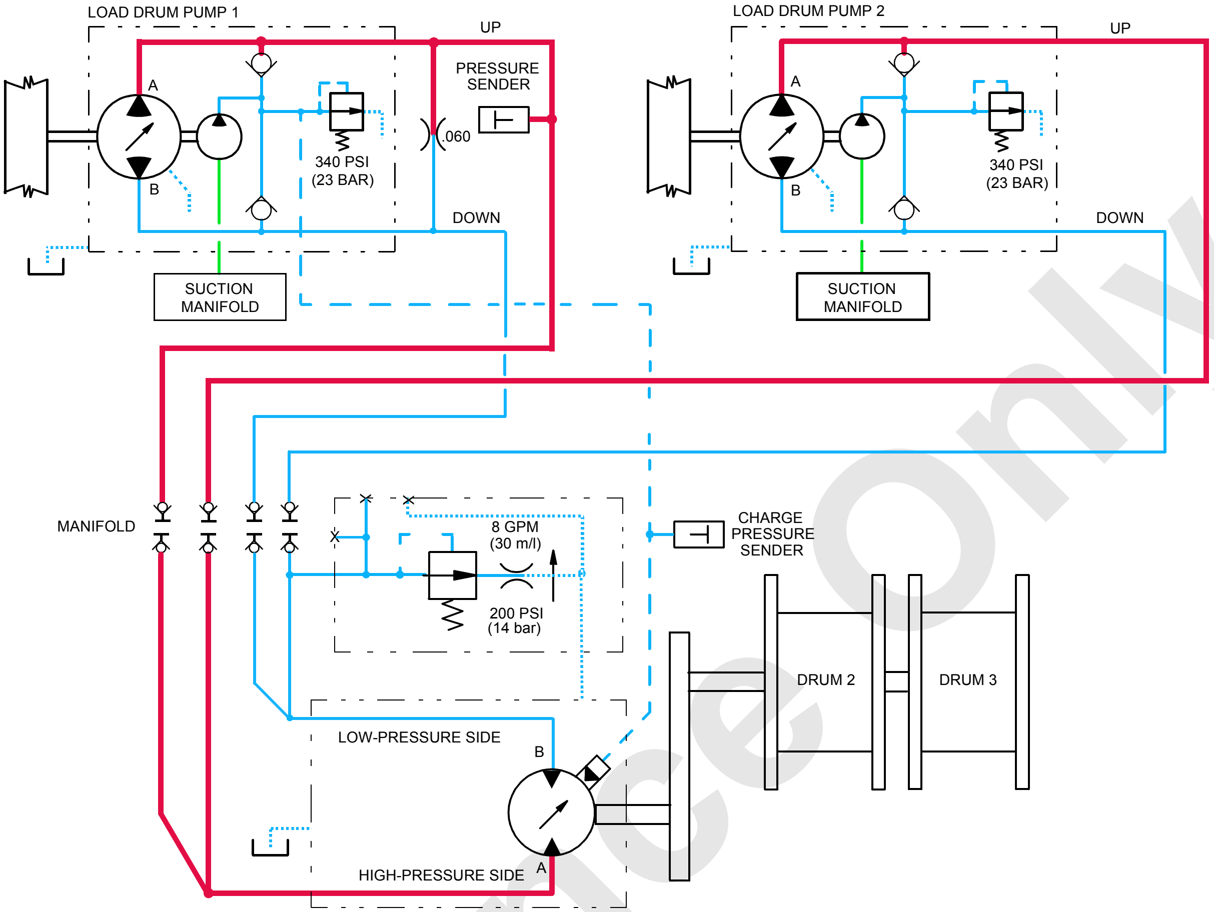
See Figure 1-28, Figure 1-29, and Figure 1-30 for the following procedure.

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. Operation of brakes and clutches is the same. The operation that is different includes:

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

There is no hydraulic servo system to motors. The servo PC valve and the PCOR (Pressure Compensating Over-Ride) valve is replaced with the proportional solenoid.

RF-20



RF-21

DUAL LOAD DRUM MOTORS HYDRAULIC CIRCUIT (OPTIONAL)

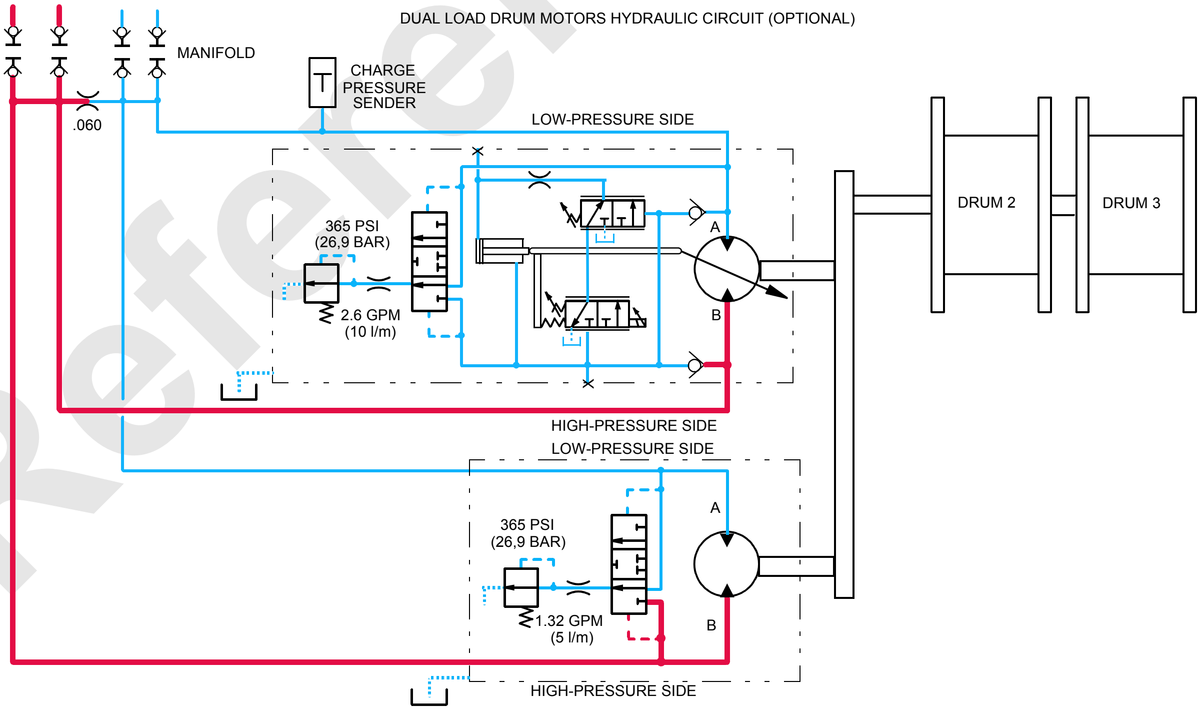


FIGURE 1-29

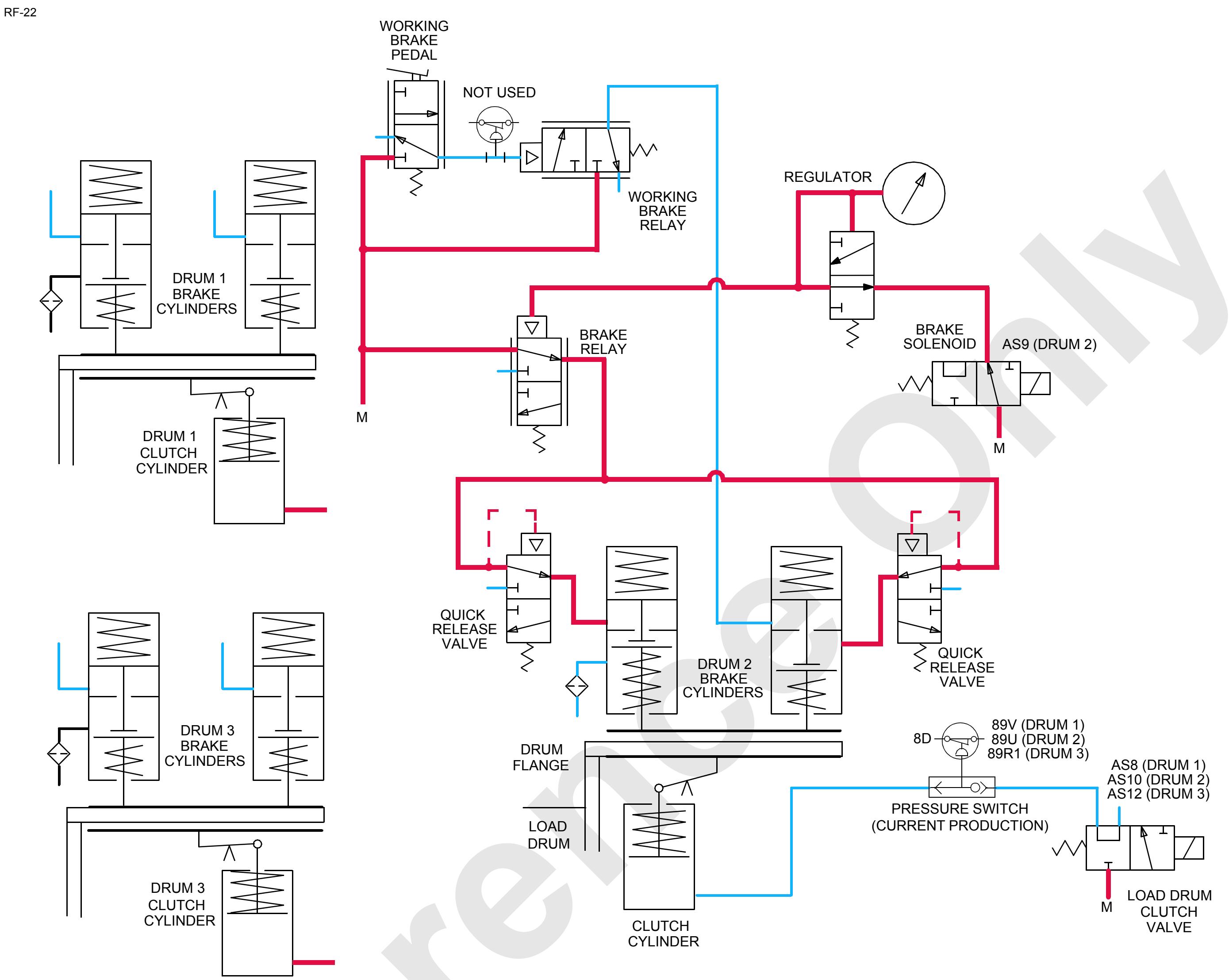

RF-22
WORKING BRAKE PEDAL
NOT USED
WORKING BRAKE RELAY
REGULATOR
DRUM 1 BRAKE CYLINDERS
BRAKE RELAY
BRAKE SOLENOID
AS9 (DRUM 2)
M
M
DRUM 1 CLUTCH CYLINDER
QUICK RELEASE VALVE
DRUM 2 BRAKE CYLINDERS
QUICK RELEASE VALVE
DRUM 3 BRAKE CYLINDERS
8D
89V (DRUM 1)
89U (DRUM 2)
89R1 (DRUM 3)
DRUM FLANGE
AS8 (DRUM 1)
AS10 (DRUM 2)
AS12 (DRUM 3)
PRESSURE SWITCH (CURRENT PRODUCTION)
LOAD DRUM
DRUM 3 CLUTCH CYLINDER
M
LOAD DRUM CLUTCH VALVE
CLUTCH CYLINDER

FIGURE 1-30

Load Drum System — Free Fall

General

See Figure 1-31 and Figure 1-32 for the following procedure.

In Free Fall mode the load can be lowered with control handle (Standard mode) or working brake pedal (Free Fall mode). Depending on crane 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:

- Apply and latch working brake pedal for the drum being used.
- For right-rear drum operation, place the load drum selector switch in right-rear (Drum 2) position.
- Select DRUM 2 FFALL on crane mode switch then turn switch to confirm position.
- Turn Drum 2 park brake switch to ***off***.

When selected load drum control handle is at off position, load drum pumps do not stroke. If the selected load drum control handle is in off position when charge pressure is lost, the PC applies selected drum brake, but clutch remains released from drum shaft.

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

WARNING

Falling Load Hazard!

When operating in Free Fall mode, load will lower uncontrolled if drum brake is not applied with working brake pedal when control handle is moved to off.

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

Load Drum Hoisting — Free Fall

The following description is for hoisting right-rear load drum (Drum 2) while operating in the 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 brake is released by the PC. See Load Drum Hoisting topic in previous section.

WARNING

Dropping Load Hazard!

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

Hoisted load will drop momentarily if working brake pedal is not applied!

When control handle is moved to off, the selected load drum brake remains released from drum. The PC sends a 12 volt output signal to right-rear drum clutch solenoid AS-10 to release the drum clutch. This applies air pressure to cylinder of right-rear drum clutch to release from drum shaft, returning drum to Free Fall mode. ***The load will fall uncontrolled if working brake pedal is not applied before moving control handle to off!***

Load Drum Lowering — Free Fall

The following description is for lowering right-rear load drum (Drum 2) while operating in the 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 off, the PC sends an output signal to right-rear drum clutch solenoid AS-10. This exhausts air pressure from selected drum clutch cylinder. Clutch spring-applies to connect drum shaft to 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 off while a load is free falling. Damage to clutch and/or motor drive system could occur. Stop the load with working brake pedal before moving a load drum control handle in either direction.

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

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

WARNING

Falling Load Hazard!

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

Begin applying load drum working brake pedal as selected control handle is moved to off to hold the load when the PC releases the clutch from drum shaft. ***The load will fall uncontrolled if working brake pedal is not applied before moving control handle to off!***

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

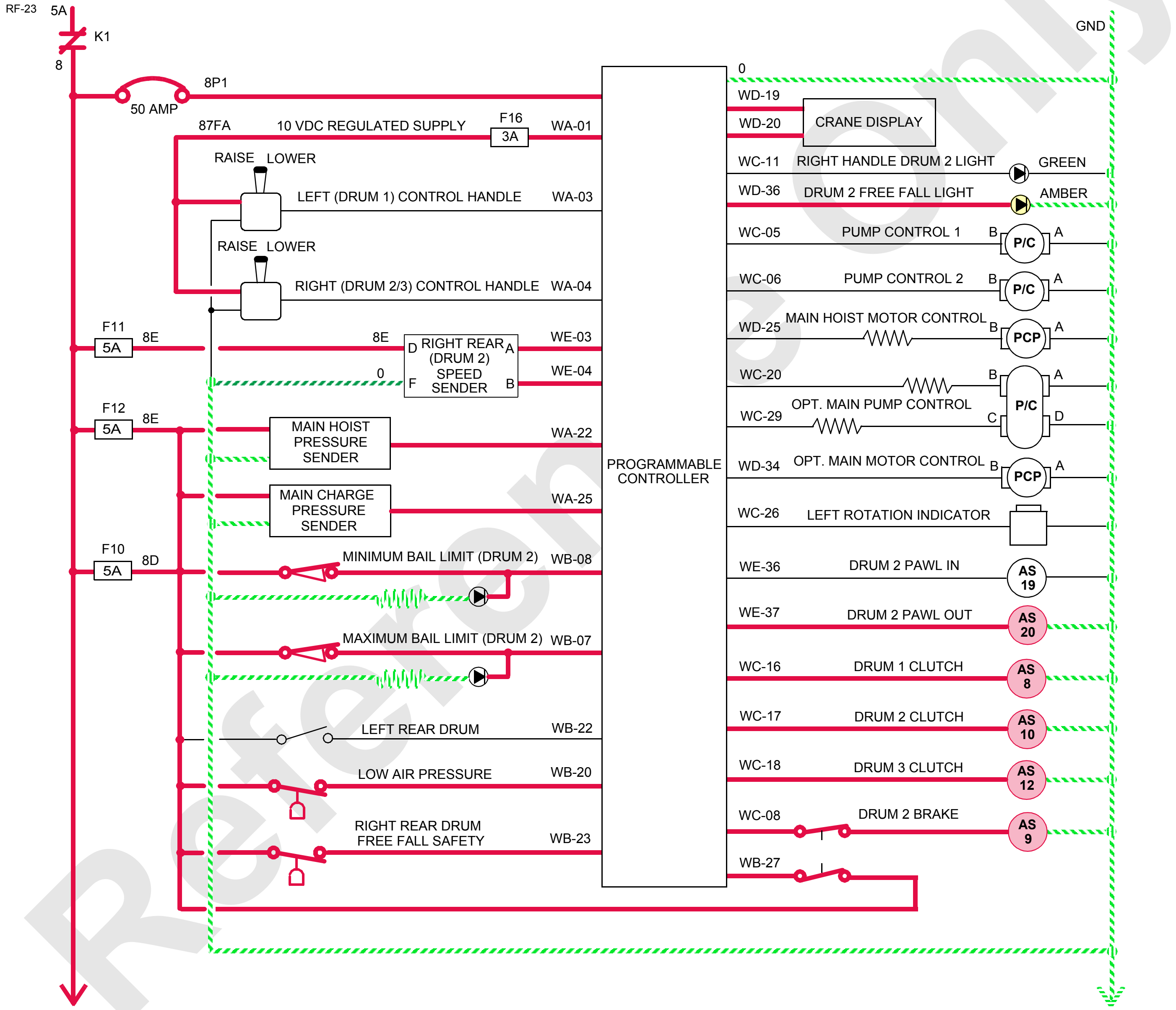


FIGURE 1-31

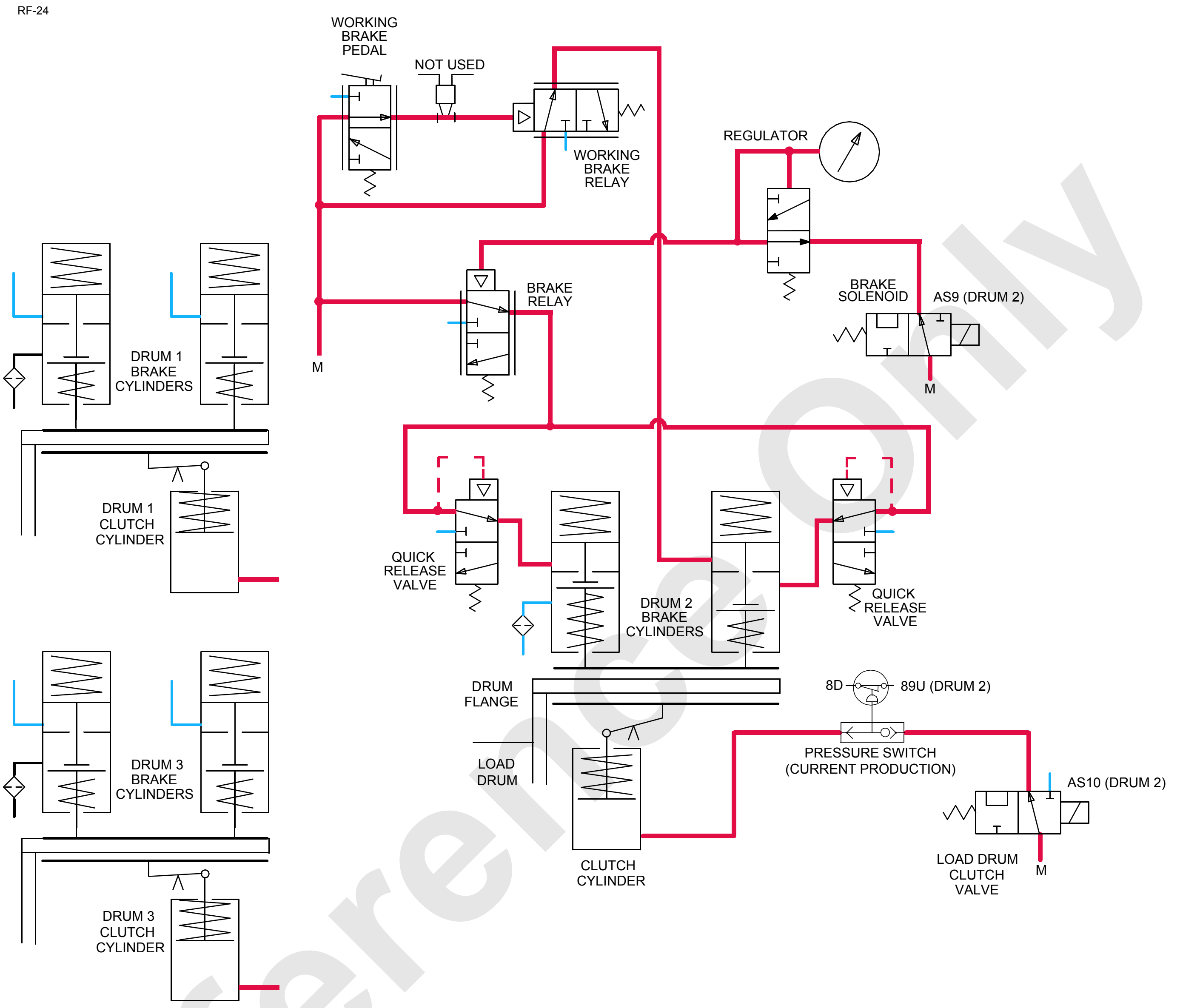

RF-24
WORKING BRAKE PEDAL
NOT USED
WORKING BRAKE RELAY
REGULATOR
BRAKE RELAY
BRAKE SOLENOID
AS9 (DRUM 2)
M
M
DRUM 1 BRAKE CYLINDERS
DRUM 1 CLUTCH CYLINDER
QUICK RELEASE VALVE
DRUM 2 BRAKE CYLINDERS
QUICK RELEASE VALVE
DRUM FLANGE
8D
89U (DRUM 2)
PRESSURE SWITCH (CURRENT PRODUCTION)
LOAD DRUM
AS10 (DRUM 2)
DRUM 3 BRAKE CYLINDERS
CLUTCH CYLINDER
LOAD DRUM CLUTCH VALVE
M
DRUM 3 CLUTCH CYLINDER

FIGURE 1-32

Upper Accessory System Components

General

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 tank port of valve spool section are connected in center position and open to tank.

Setup mode must be selected for operating the accessory system components. In Setup mode, the PC supplies power to 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 accessory system components. Hydraulic fluid from auxiliary pump flows through auxiliary system disable relief valve HS-12. Hydraulic fluid enters upper accessory valve and flows through to the lower accessory valve.

Auxiliary system disable relief valve HS-12 is controlled by the PC. During normal operation the relief valve is open and excess supply flow from auxiliary pump is dumped through valve to tank. When a component of either accessory system is enabled, an input signal is sent to the PC. The PC sends a 12 volt output signal to auxiliary system enable relief that adjust system pressure to 3,500 psi (241 bar).

Hydraulic pilot pressure to shift upper accessory valves is from boom hoist charge pump at 350 psi (24 bar) with Cummins engine or from fan pump circuit at 300 psi (21 bar) with Caterpillar engine.

Jacking Cylinders

See Figure 1-33 and Figure 1-34 for the following procedure.

Jacking cylinders are mounted on each corner of rotating bed. Jacking cylinder operation is controlled with switches on 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.

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

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

WARNING

Collapsing Hazard!

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

When 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 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 tank. This prevents inline pressure from opening counterbalance valve, holding rotating bed load in position by the counterbalance valve.

Jacking Cylinders Extend

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

When 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 volt output signal to the auxiliary system disable relief valve HS-12 that adjust system pressure to 3,500 psi (241 bar).

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

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

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

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

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

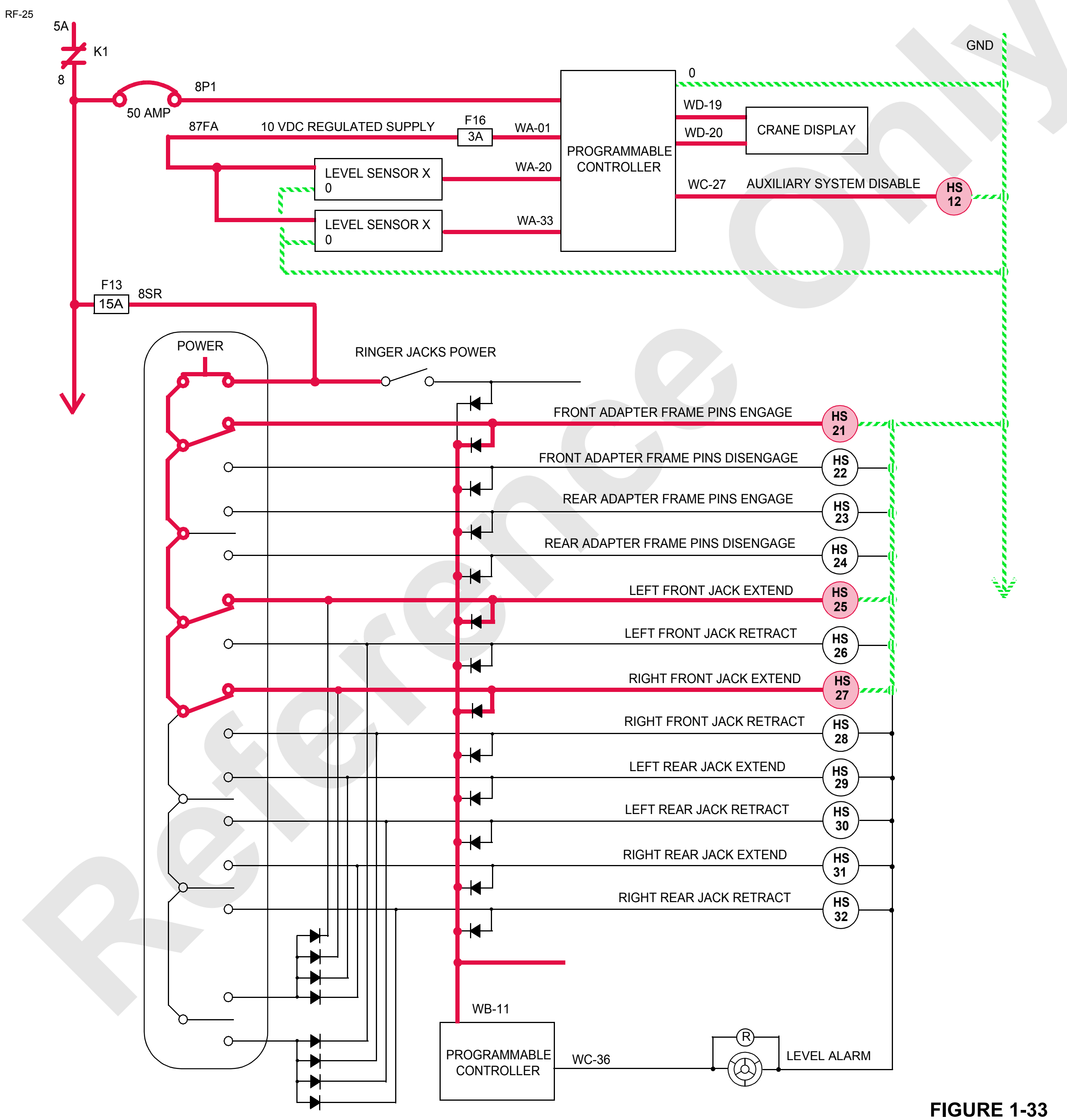


FIGURE 1-33

Jacking Cylinders Retract

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

When 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 volt output signal to auxiliary system disable relief valve HS-12 that adjust system pressure to 3,500 psi (241 bar).

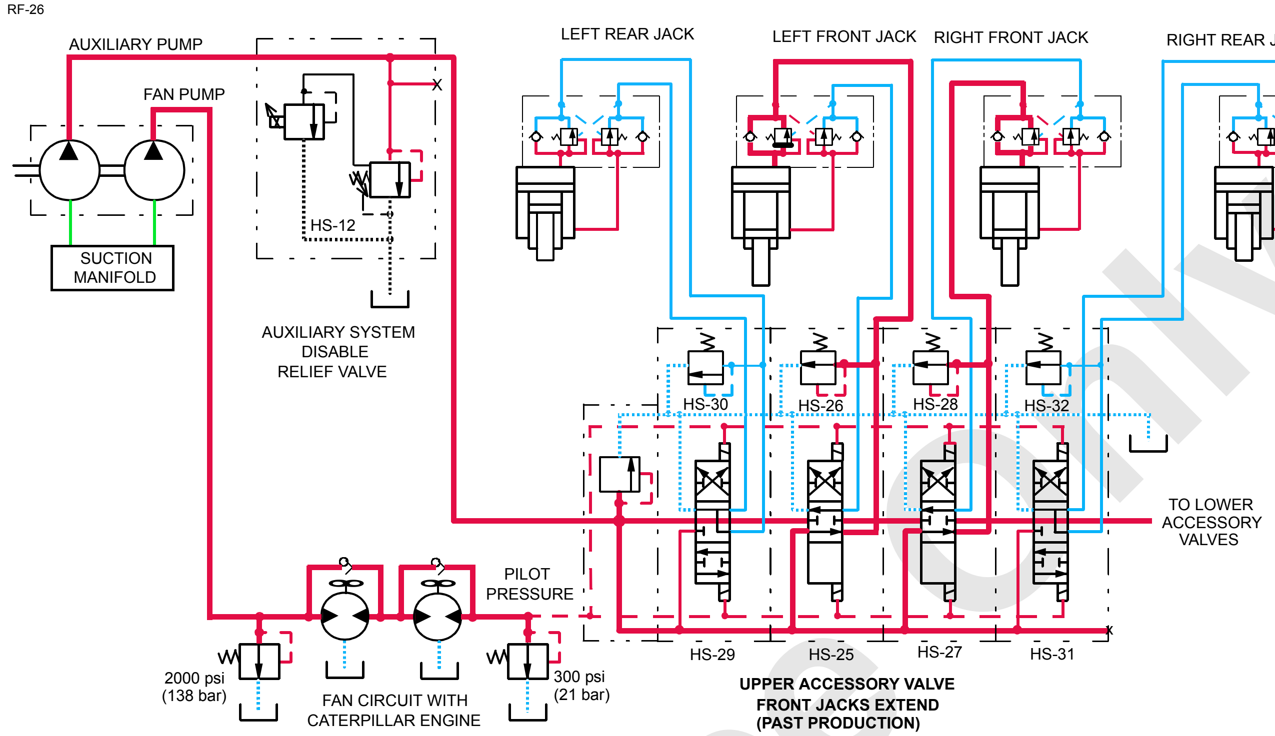
The PC also sends a 12 volt output signal to enable jacking solenoids HS-26 and HS-28 to extend left and right front jacks. Hydraulic pilot pressure at 350 psi (24 bar) or 300 psi (21 bar) shifts the valve(s) in the selected direction.

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

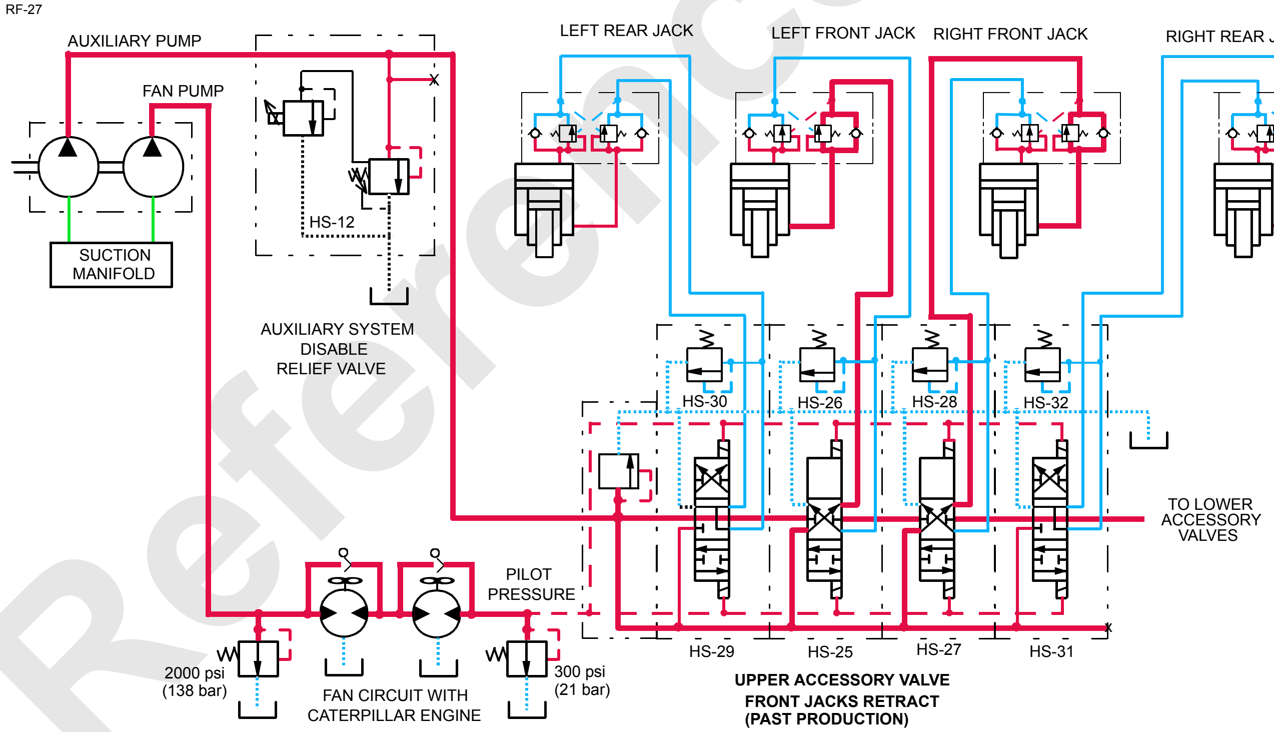
Fluid exhausting from piston end of jacking cylinders is blocked by free-flow check valve sections of counterbalance valves. From counterbalance valve flow is through flow restraining section that has a relief setting of 2,500 psi (172 bar). Counterbalance valve acts as a deceleration control and functions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

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

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



UPPER ACCESSORY VALVE
FRONT JACKS EXTEND
(PAST PRODUCTION)



UPPER ACCESSORY VALVE
FRONT JACKS RETRACT
(PAST PRODUCTION)

FIGURE 1-34

Adapter Frame Pin Cylinders

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

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

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

Adapter Frame Pins Engage

When power button is pressed and 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 volt output signal to the to auxiliary system disable relief valve HS-12 that adjust system pressure to 3,500 psi (241 bar).

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

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

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

Adapter Frame Pins Disengage

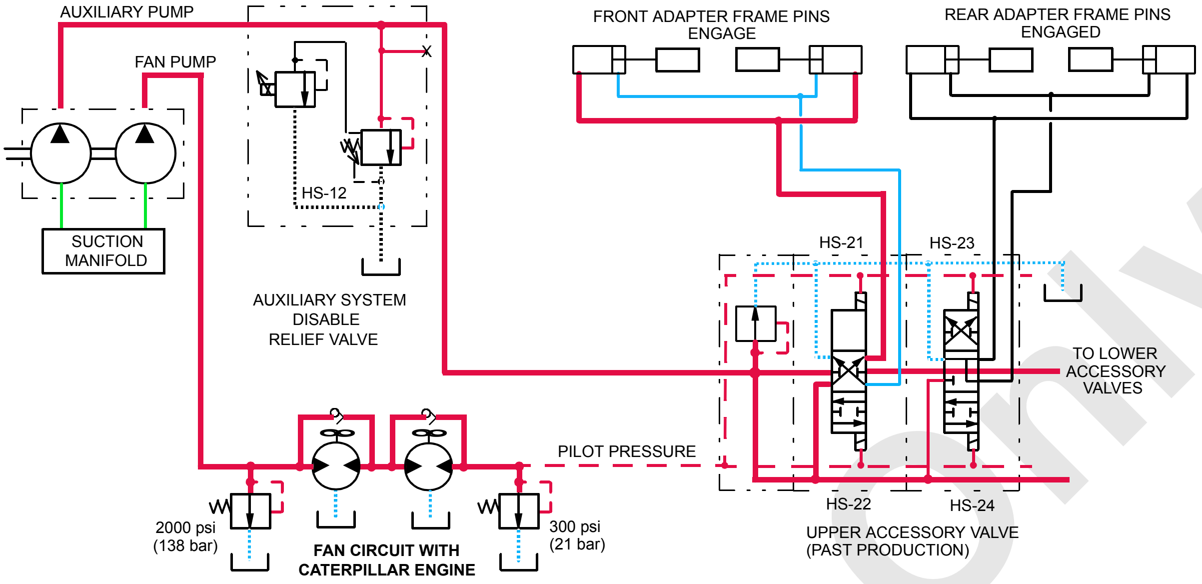
When power button is pressed and front adapter frame pin switch is held in the down ***disengage*** position, an input voltage is sent through a diode to the PC. The PC sends a 12 volt output signal to the auxiliary system disable relief valve HS-12 that adjust system pressure to 3,500 psi (241 bar).

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

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

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

RF-28



RF-29

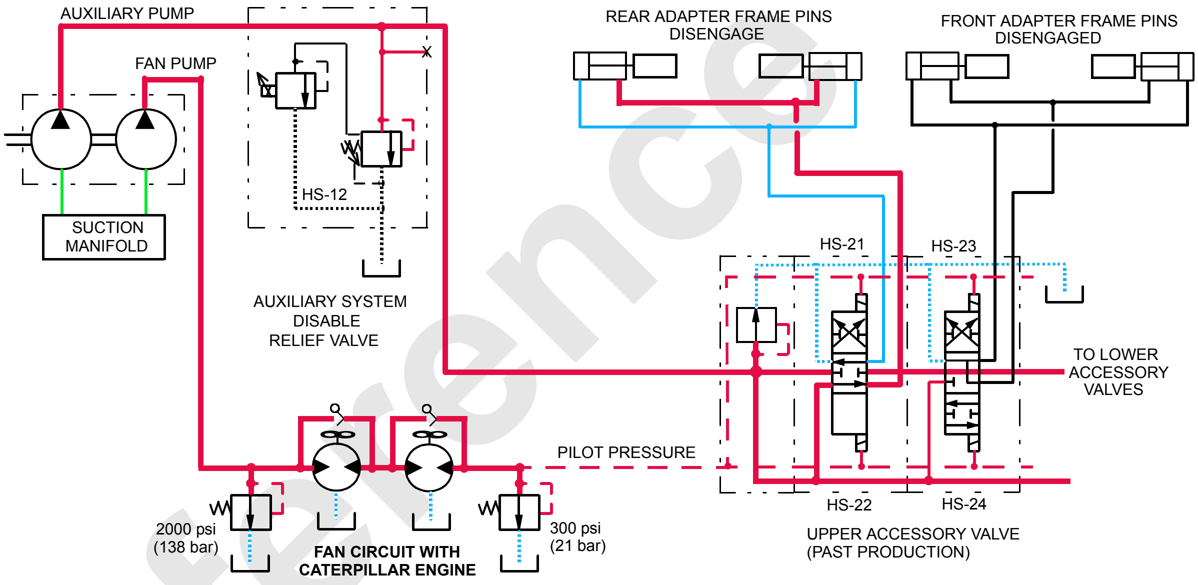


FIGURE 1-35

Gantry Cylinders

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

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 topic in the Operator Manual for gantry raising and lowering procedure.

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

Gantry Cylinders Extend

When power button is pressed and gantry cylinders switch is held in the up ***extend*** position, an input voltage is sent to the PC. The PC sends a 12 volt output signal to auxiliary system disable relief valve HS-12 that adjust system pressure to 3,500 psi (241 bar).

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

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

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

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

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

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

Gantry Cylinders Retract

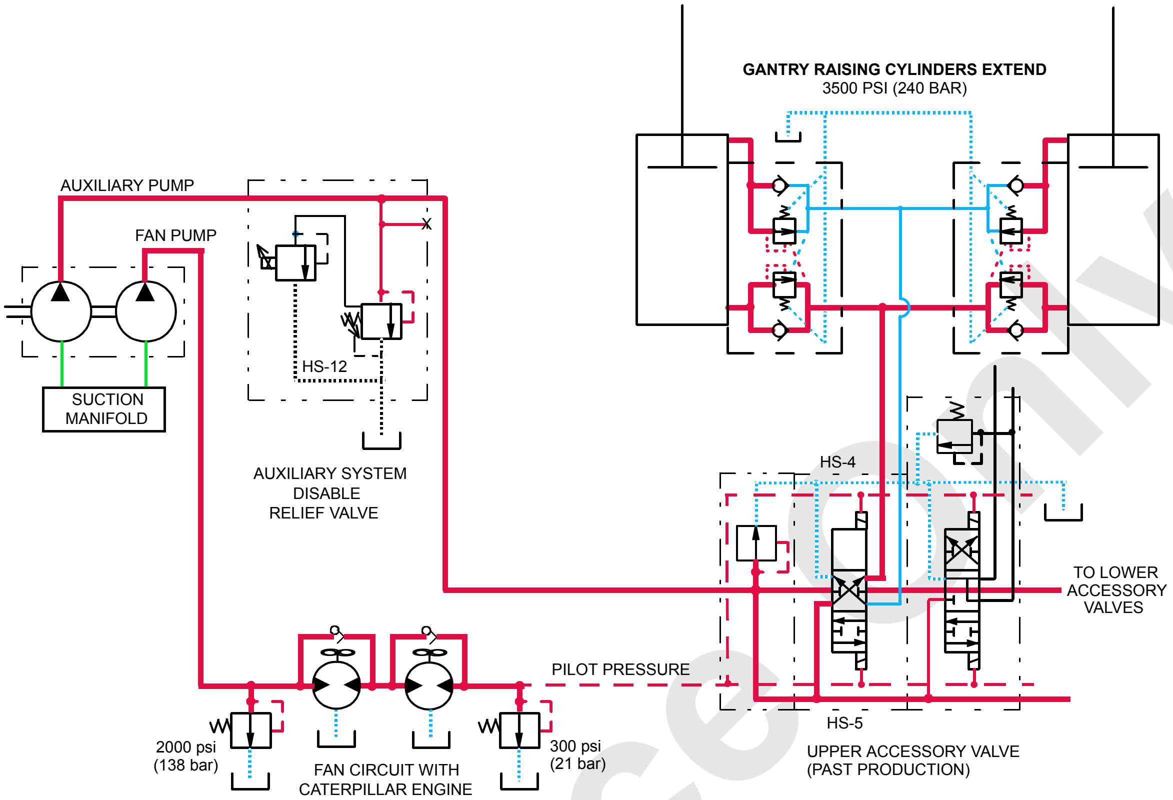
When power button is pressed and gantry cylinders switch is held in the down ***retract*** position, an input voltage is sent to the PC. The PC sends a 12 volt output signal to auxiliary system disable relief valve HS-12 that adjust system pressure to 3,500 psi (241 bar).

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

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

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

RF-30



RF-31

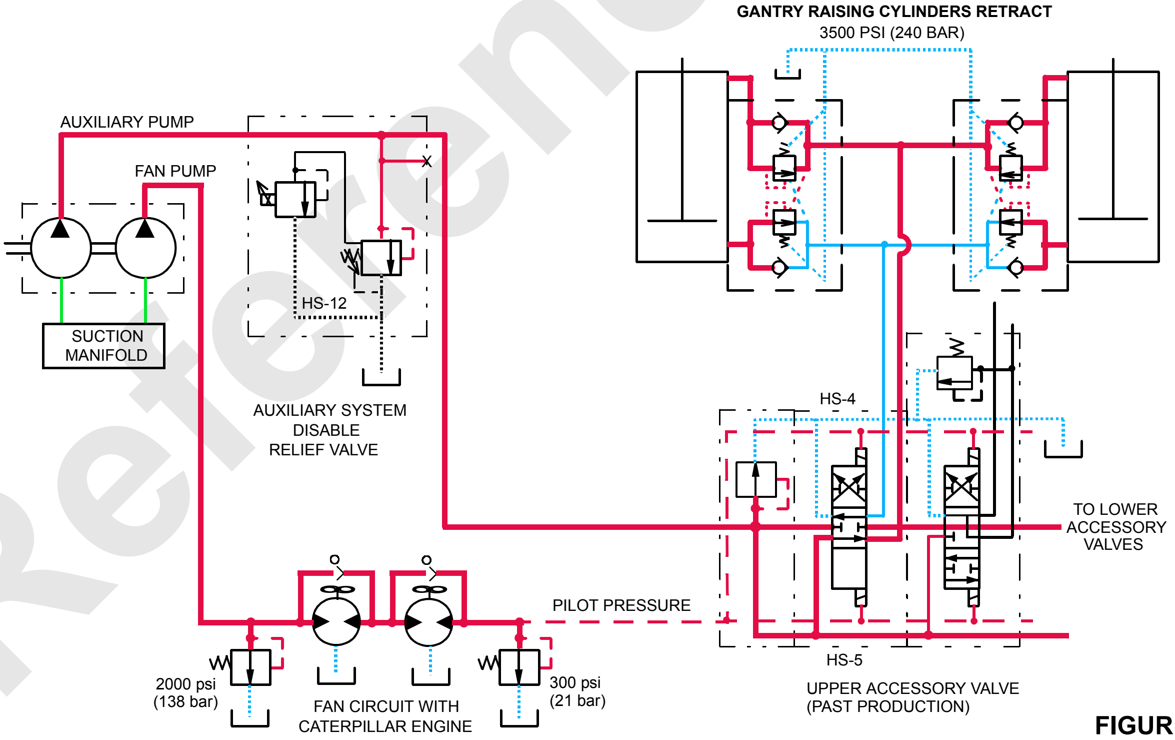


FIGURE 1-36

Lower Accessory System Components

General

Lower accessory system components include 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 valve spool section are connected in center position and open to tank.

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

The auxiliary system disable relief valve HS-12 is controlled by the PC. During normal operation the relief valve is open and excess supply flow from auxiliary pump is dumped through valve to tank. When a component of either accessory system is enable, an input signal is sent to the PC. The PC sends a 12 volt output signal to auxiliary system enable relief that adjust system pressure to 3,500 psi (241 bar).

When a lower accessory system switch is enabled the PC sends a variable 0 to 12 volt output signal to variable output control valve HS-20. The variable control valve output is adjustable from 0 to 15 GPM (57 L/min) with speed control rotary switch on setup remote control.

Boom Hinge Pins

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

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

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

Boom Hinge Pins Engage

When the power button is pressed and the boom hinge pins switch is held down in the ***engage*** position, an input signal is sent to the PC. The PC sends a 12 volt output signal to auxiliary system disable relief valve HS-12 that adjust system pressure to 3,500 psi (241 bar).

Boom hinge pins engage solenoid HS-10 is enabled by the PC to shift the solenoid valve in the engage position. Hydraulic fluid enters upper accessory valve and flows through 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 piston end of hinge pin cylinders, engaging the pins to connect the boom to adapter frame. Fluid from rod end of cylinders flows through valve assembly through hydraulic quick disconnect and to tank.

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

Boom Hinge Pins Disengage

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

Boom hinge pins engage solenoid HS-11 is enabled by the PC to shift the boom hinge pin solenoid valve in the disengage position. Hydraulic fluid enters upper accessory valve and flows through 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 rod end of hinge pin cylinders, disengaging the pins from boom and adapter frame. Fluid from piston end of cylinders flows through valve assembly through hydraulic quick disconnect and to tank.

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

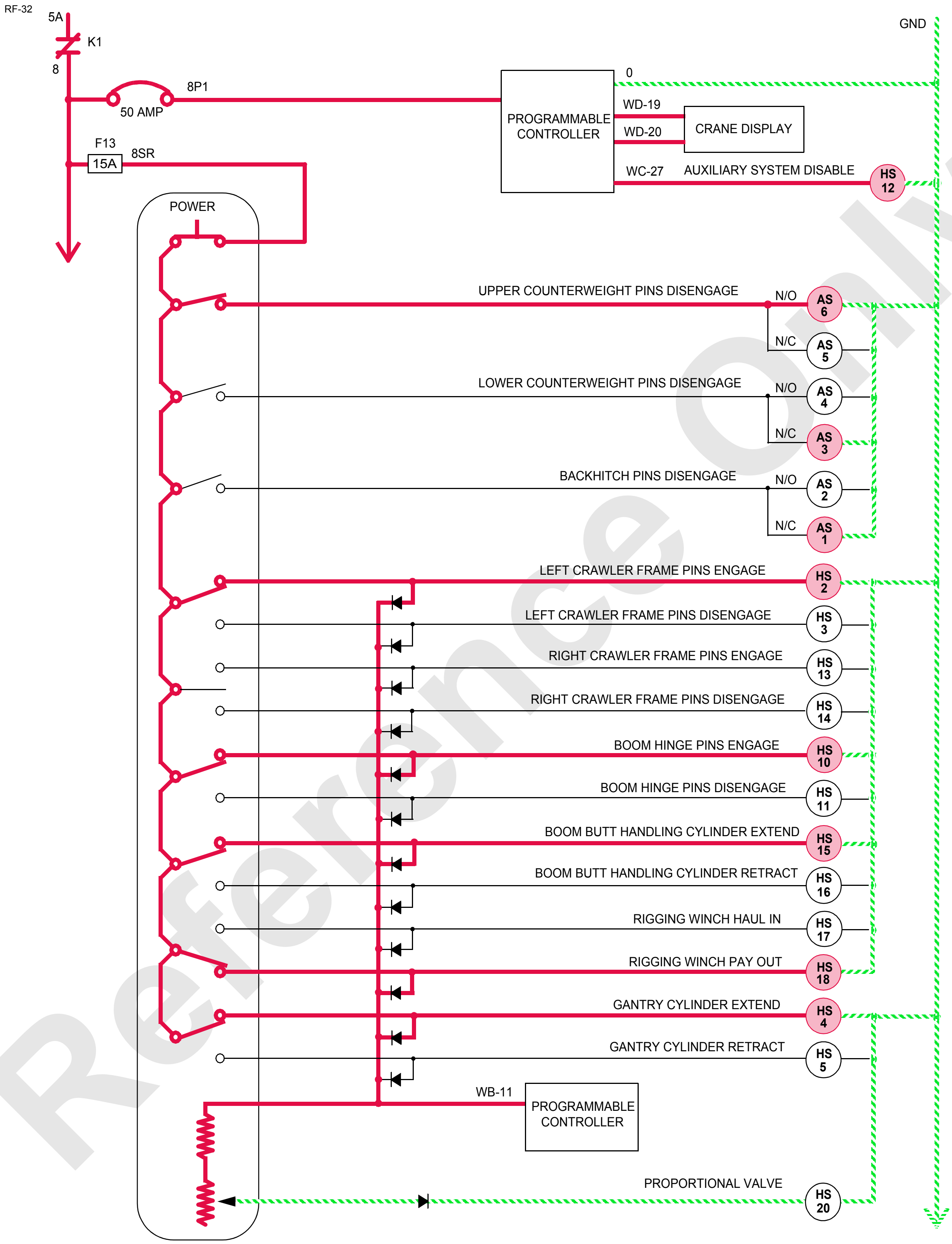

RF-32
5A
K1
8
50 AMP
8P1
F13
15A
8SR
GND
0
PROGRAMMABLE CONTROLLER
WD-19
WD-20
CRANE DISPLAY
WC-27
AUXILIARY SYSTEM DISABLE
HS 12
POWER
UPPER COUNTERWEIGHT PINS DISENGAGE
N/O
AS 6
N/C
AS 5
LOWER COUNTERWEIGHT PINS DISENGAGE
N/O
AS 4
N/C
AS 3
BACKHITCH PINS DISENGAGE
N/O
AS 2
N/C
AS 1
LEFT CRAWLER FRAME 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 1-37

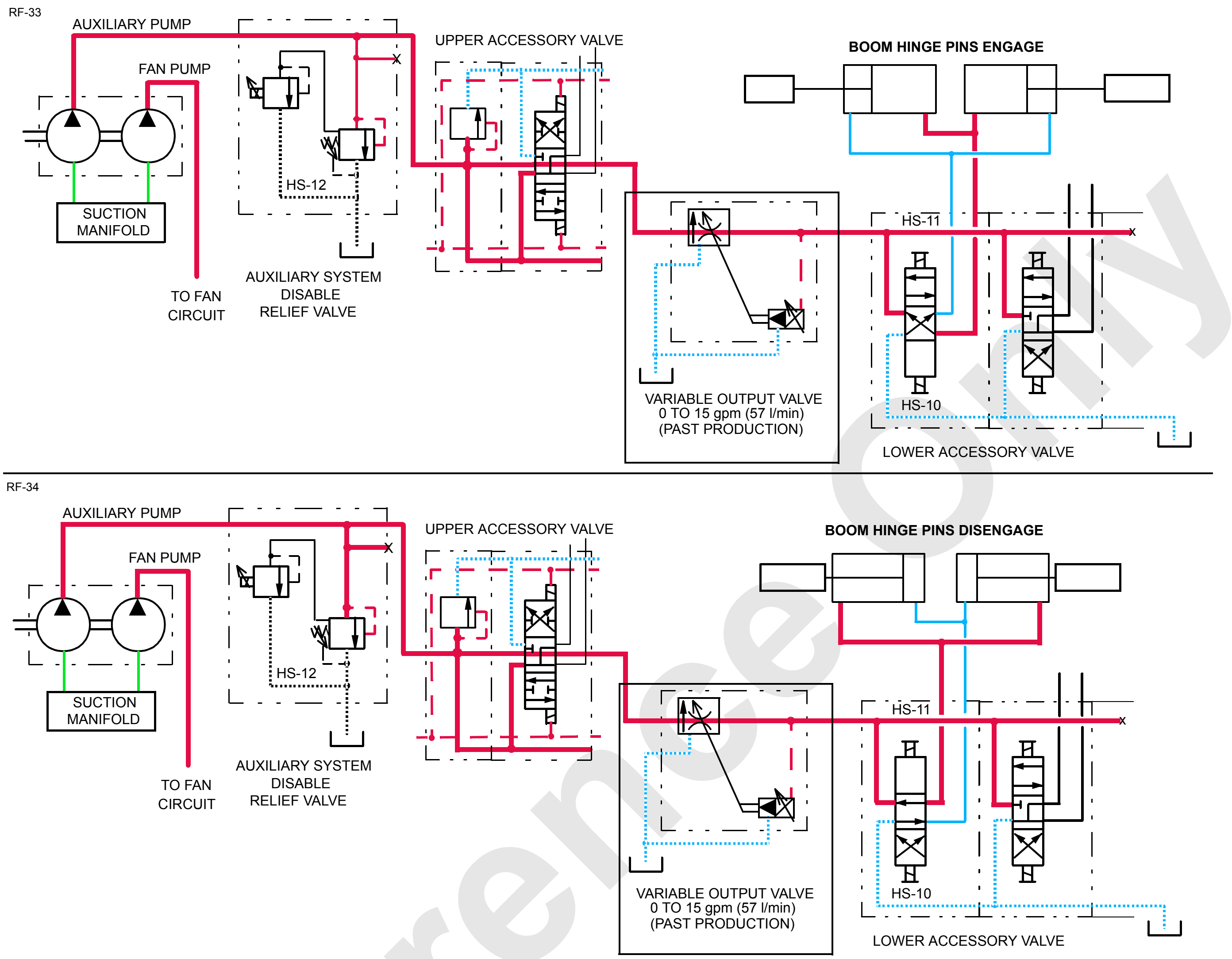


FIGURE 1-38

Boom Butt Handling Cylinder

See Figure 1-37 and Figure 1-39 for the following procedure.

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

Boom Butt Handling Cylinder Extend

When power button is pressed and boom butt cylinder switch is held in the up ***extend*** position, an input signal is sent to the PC. The PC sends a 12 volt output signal to auxiliary system disable relief valve HS-12 that adjust system pressure to 3,500 psi (241 bar).

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

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

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

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

Boom Butt Handling Cylinder Retract

When power button is pressed and boom butt cylinder switch is held in the down ***retract*** position, an input signal is sent to the PC. The PC sends a 12 volt output signal to auxiliary system disable relief valve HS-12 that adjust system pressure to 3,500 psi (241 bar).

Boom butt cylinder engage solenoid HS-16 is enabled by the PC to shift the solenoid valve in the retract position. Hydraulic fluid enters upper accessory valve and flows through variable output control valve HS-20 and 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 counterbalance valve. Hydraulic fluid then enters rod end of boom butt handling cylinder, retracting the cylinder to lower the boom butt.

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

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

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

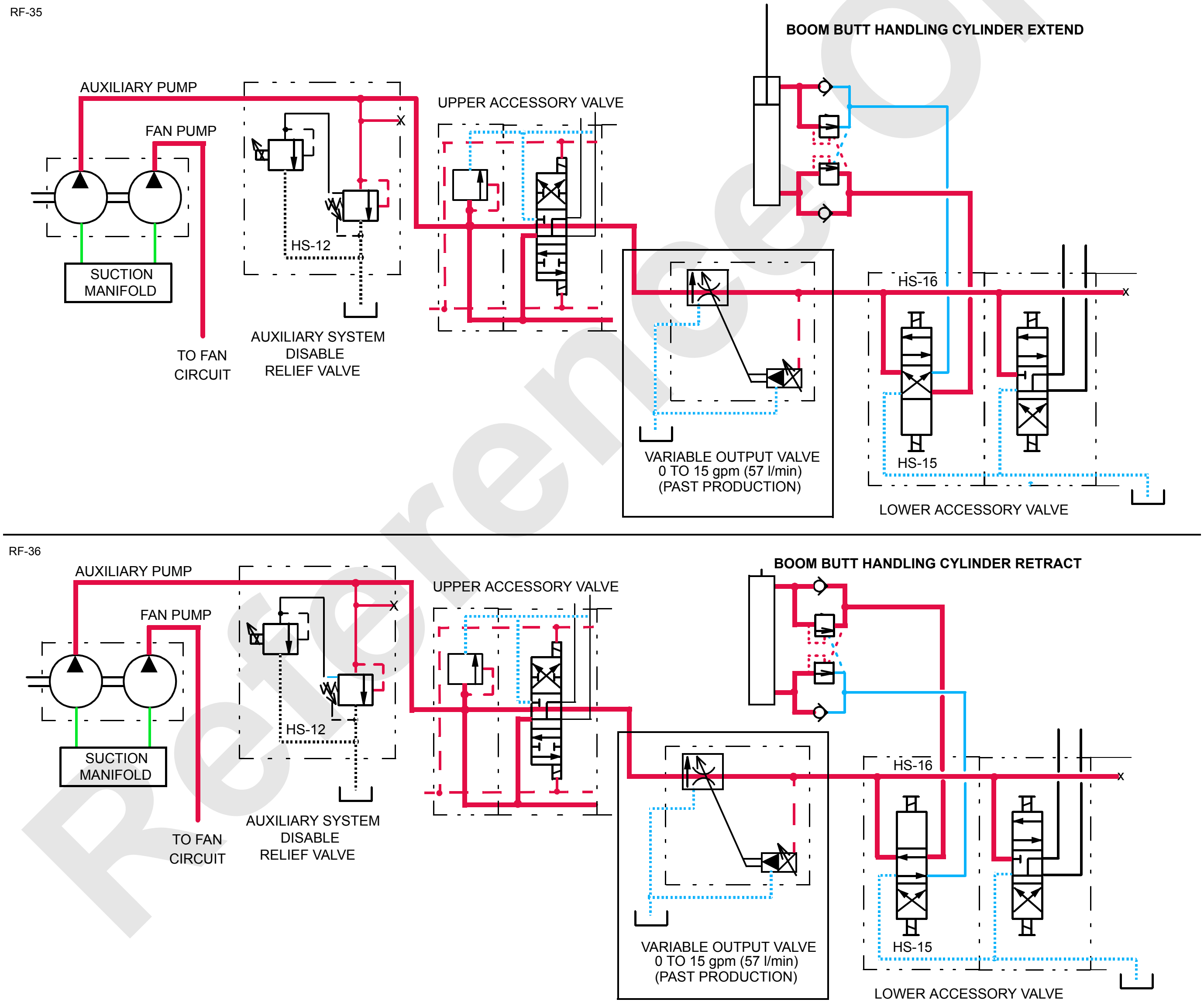


FIGURE 1-39

Rigging Winch

See Figure 1-37 and Figure 1-40 for the following procedure.

The optional rigging winch is located in the boom butt.

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

Rigging Winch Pay Out

When power button is pressed and rigging winch switch is held in the up ***pay out*** position, an input signal is sent to the PC. The PC sends a 12 volt output signal to auxiliary system disable relief valve HS-12 that adjust system pressure to 3,500 psi (241 bar).

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

Rigging winch pay out 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 pay out side of winch motor to turn the drum to pay out wire rope at a fixed speed. Return hydraulic fluid from motor leaves accessory system valve and returns to tank.

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

Rigging Winch Haul In

When 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 volt output signal to auxiliary system disable relief valve HS-12 that adjust system pressure to 3,500 psi (241 bar).

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

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 haul in side of winch motor to turn the drum to haul in wire rope at a fixed speed. Return hydraulic fluid from motor leaves accessory system valve and returns to tank.

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

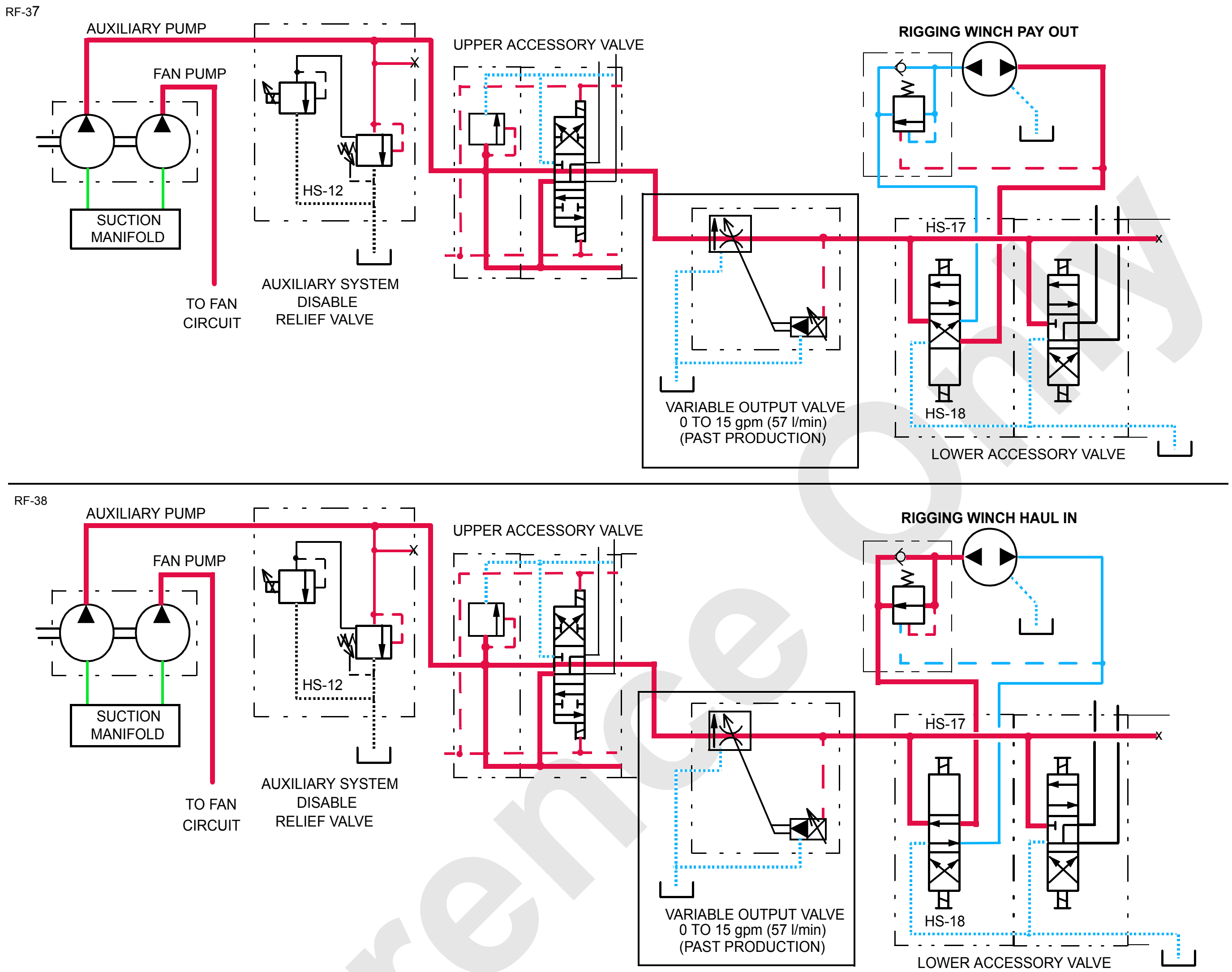


FIGURE 1-40

Crawler Frame Pins

See Figure 1-37 and Figure 1-41 for the following procedure.

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

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

Crawler Frame Pins Engage

When power button is pressed and 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 volt output signal to auxiliary system disable relief valve HS-12 that adjusts system pressure to 3,500 psi (241 bar).

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

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

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

Crawler Frame Pins Disengage

When power button is pressed and 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 volt output signal to auxiliary system disable relief valve HS-12 that adjust system pressure to 3,500 psi (241 bar).

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 rod end of left crawler frame pin cylinders, disengaging the pins from crawler frame. Fluid from piston end of cylinders flows through valve assembly through hydraulic quick disconnect and to tank.

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

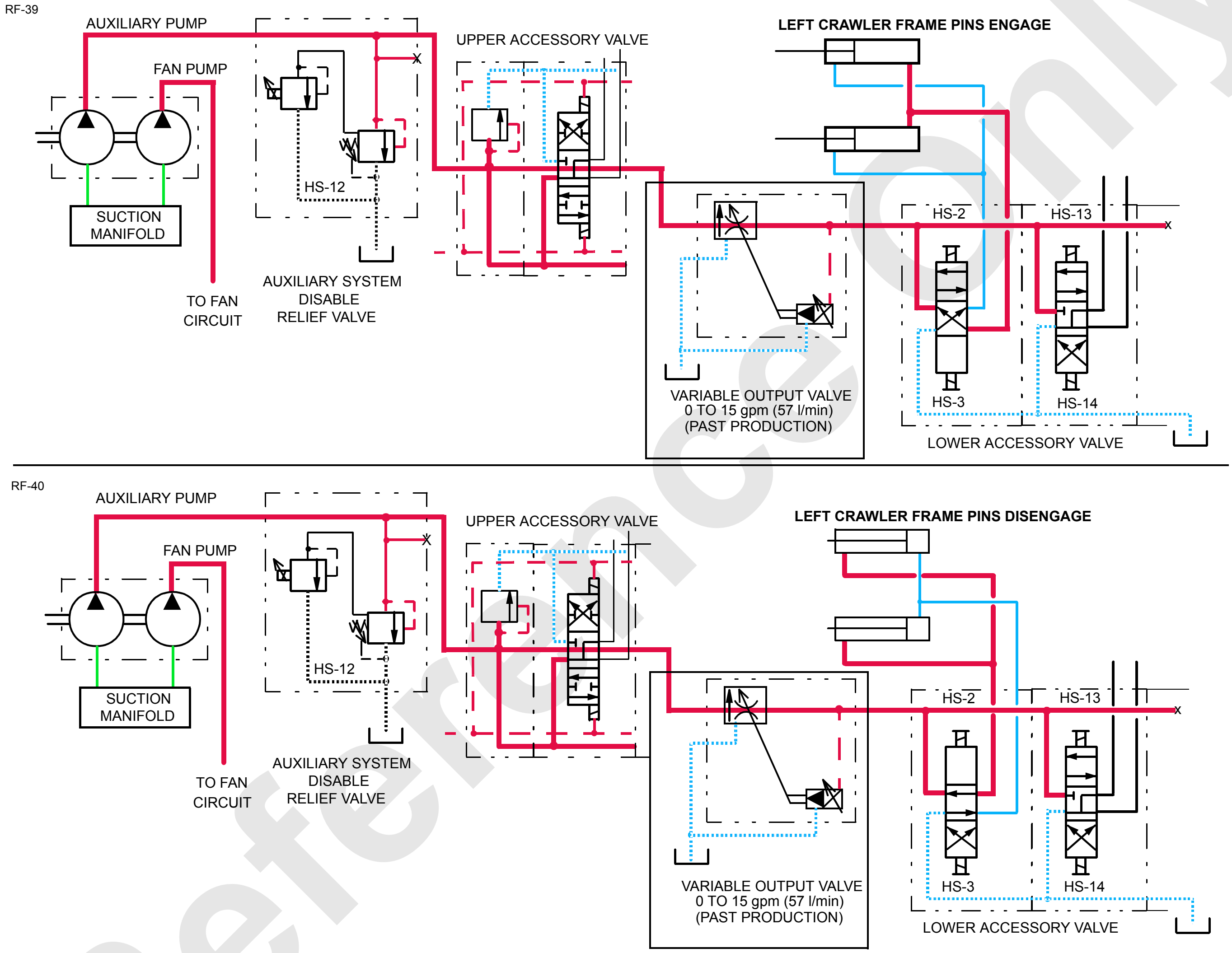


FIGURE 1-41

Air System Components

Counterweight/Back Hitch Pins

See Figure 1-37 and Figure 1-42 for the following procedure.

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

Counterweight/Back Hitch Pins Extend

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

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

Counterweight/Back Hitch Pins Retract

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

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

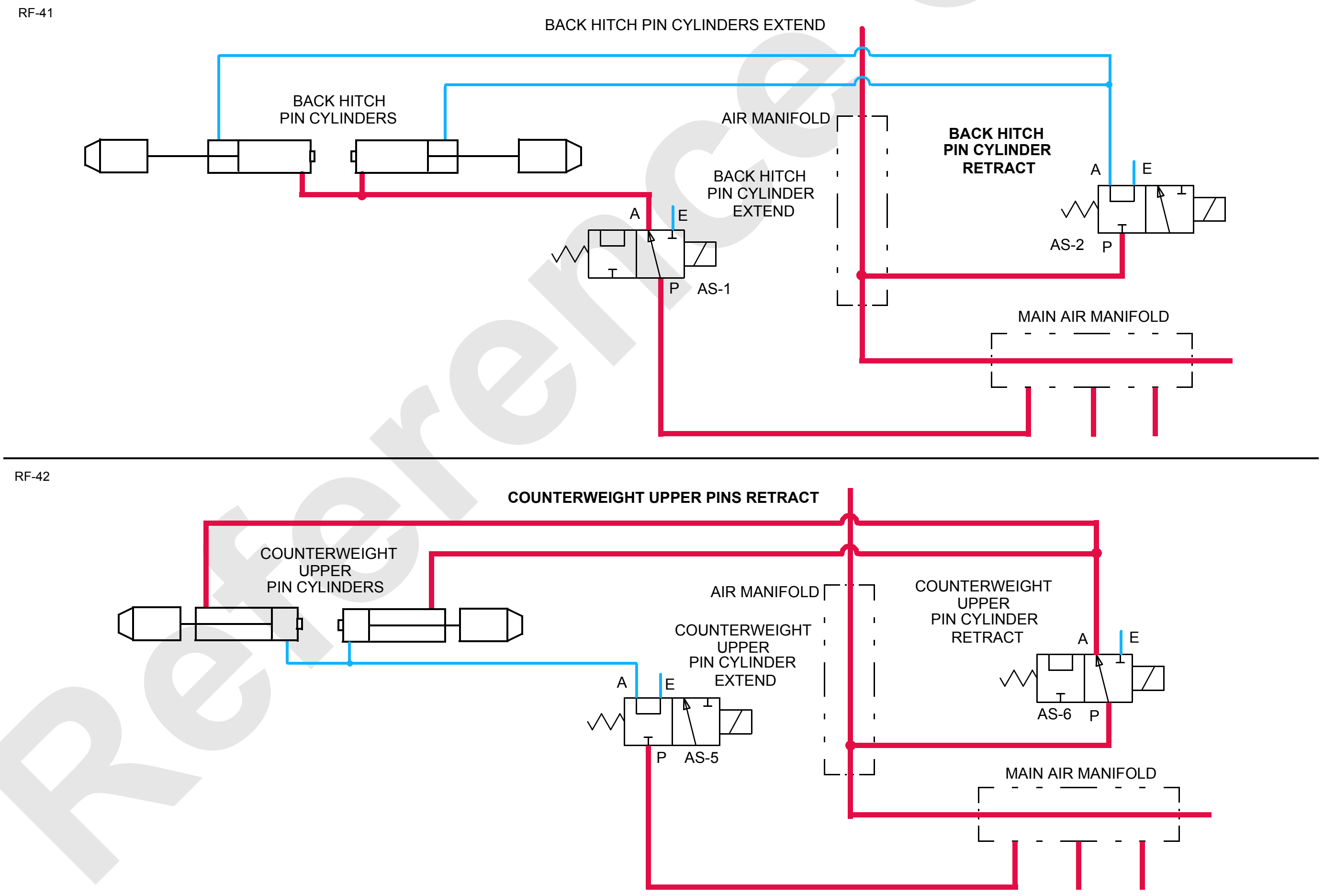


FIGURE 1-42

Hydraulic Quick Disconnect

General

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

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

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

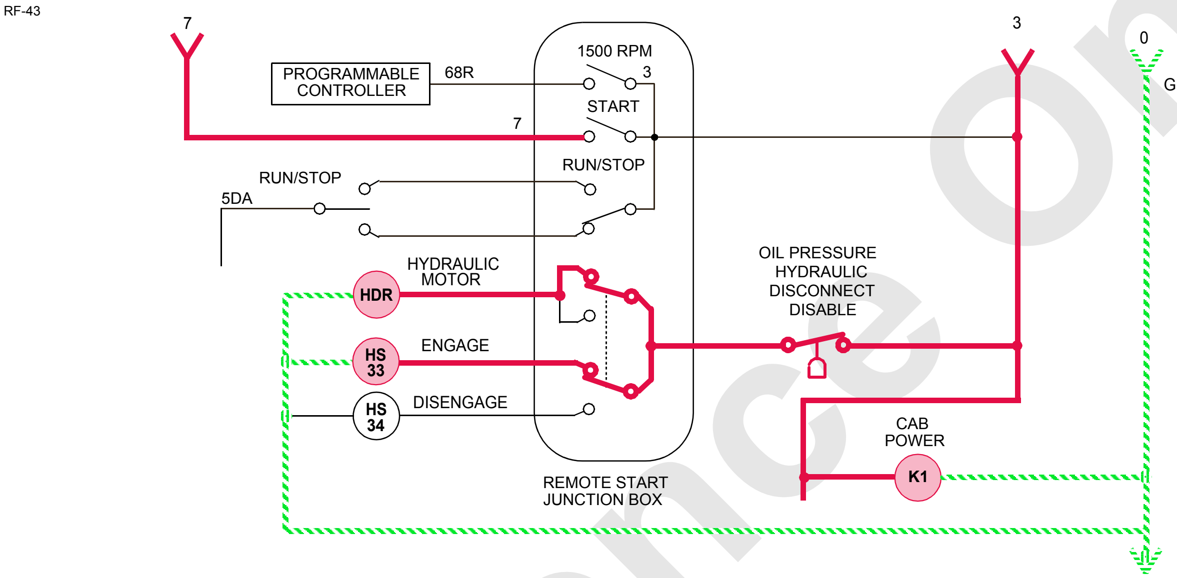


FIGURE 1-43

Hydraulic Quick Disconnect Engage

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

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

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

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

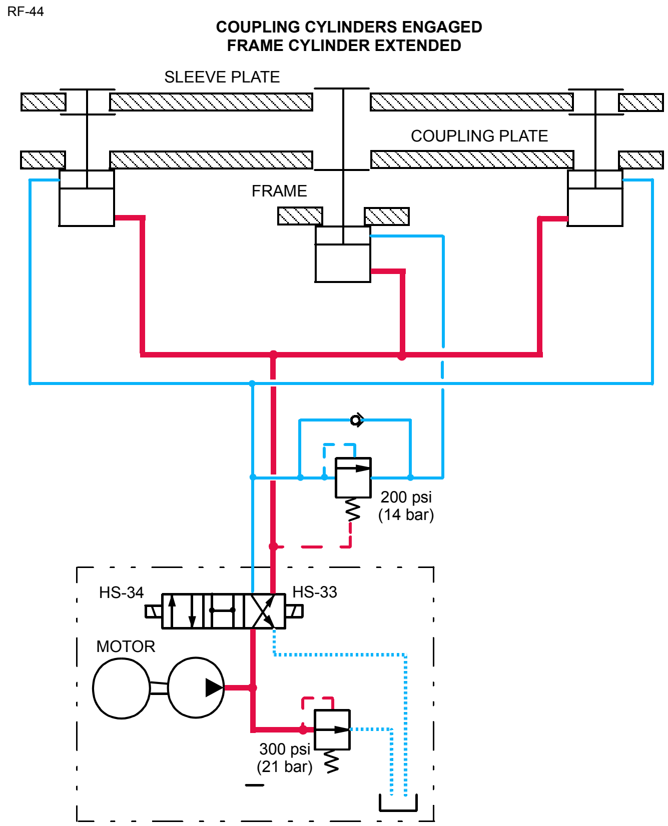
Hydraulic Quick Disconnect Disengage

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

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

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

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


RF-44
COUPLING CYLINDERS ENGAGED
FRAME CYLINDER EXTENDED
SLEEVE PLATE
COUPLING PLATE
FRAME
200 psi
(14 bar)
HS-34
HS-33
MOTOR
300 psi
(21 bar)

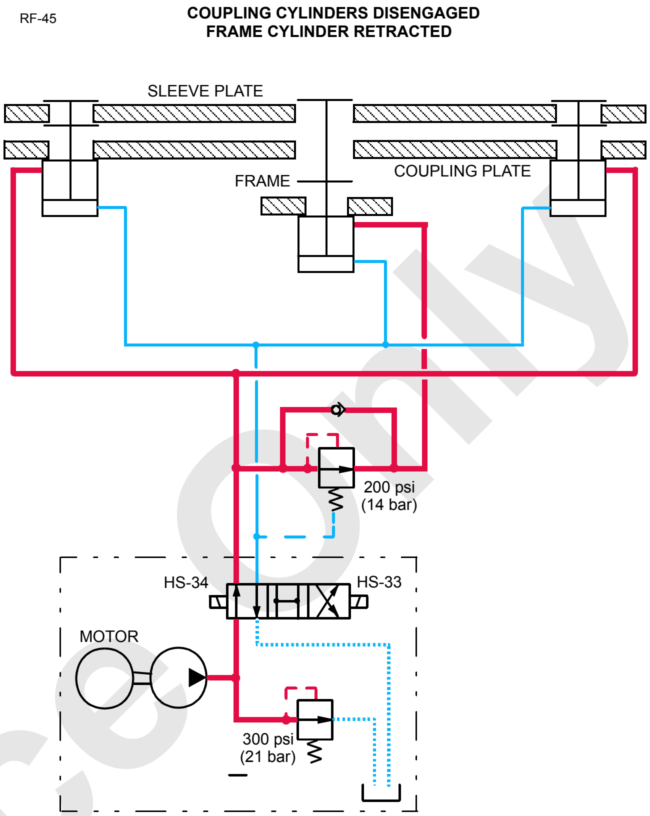

RF-45
COUPLING CYLINDERS DISENGAGED
FRAME CYLINDER RETRACTED
SLEEVE PLATE
FRAME
COUPLING PLATE
200 psi
(14 bar)
HS-34
HS-33
MOTOR
300 psi
(21 bar)

FIGURE 1-44

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MAX-ER™ 2000 DESCRIPTION OF OPERATION

MAX-ER Components

The line legend for all schematic is shown in Figure 1-45.

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 described in this section, as it is usually part of most MAX-ER 2000's. See Operation topic in Section 3 of MAX-ER 2000 Operator Manual for MAX-ER attachment operation instructions or luffing jib attachment operation instructions.

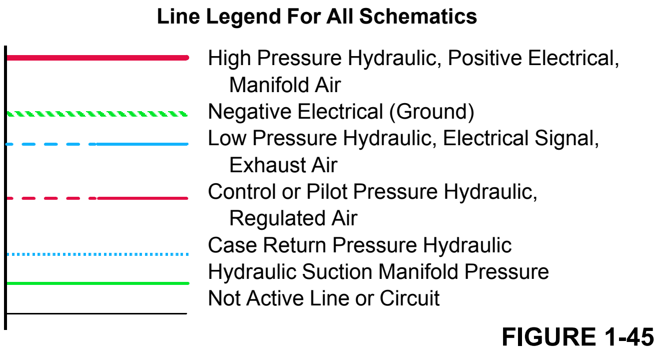


FIGURE 1-45

The MAX-ER 2000 wheeled counterweight assembly consists of the following components (see Figure 1-46):

- **Wheeled Counterweight Assembly -** is suspended from mast by straps and hydraulic cylinders. An arm connects the wheeled counterweight trailer to the rear of the crane. Trailer wheels can be turned to permit crane travel or swing when trailer wheels are on the ground.
- **Counterweight Straps and Cylinders** - suspends wheeled counterweight assembly from the mast. The strap cylinders automatically raise and lower the counterweight in response to changes in load (weight of lifted load and boom angle).
- **Load Sensing Pin –** in the gantry left side back hitch measures load tension created by the lifted load. The load-sensing pin sends a proportional 0.8 to 8.0 voltage signal to the crane PC. The crane PC enables electrical and hydraulic systems to automatically extend and retract the counterweight strap cylinders to raise and lower wheeled counterweight assembly in response to changes in back hitch tension.
- **Crane Programmable Controller (PC) -** controls crane and MAX-ER systems.
- **MAX-ER Programmable Controller (PC) -** 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** - limits how high the wheeled counterweight assembly is raised.

MAX-ER Hydraulic Attachments

See Hydraulic Schematic in Section 2 of this manual.

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

In this section a hydraulic system that is ***open*** means fluid can flow in the circuit. Each hydraulic solenoid valve in this manual is assigned an HS number. The HS number identifies each hydraulic solenoid valve.

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

NOTE: ***Past*** MAX-ER's have unloader valves that allow hydraulic pressure up to 3,500 psi (241 bar).

MAX-ER Accessory Valve

See Figure 1-46 for the following procedure.

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

Past units have an unloader valve that cuts in at 2,300 psi (159 bar) and cuts out at 2,900 psi (200 bar).

Auxiliary system disable valve is set at 3,500 psi (241 bar) and protects the MAX-ER systems from excessive pressure by opening to tank when accessory items are disabled.

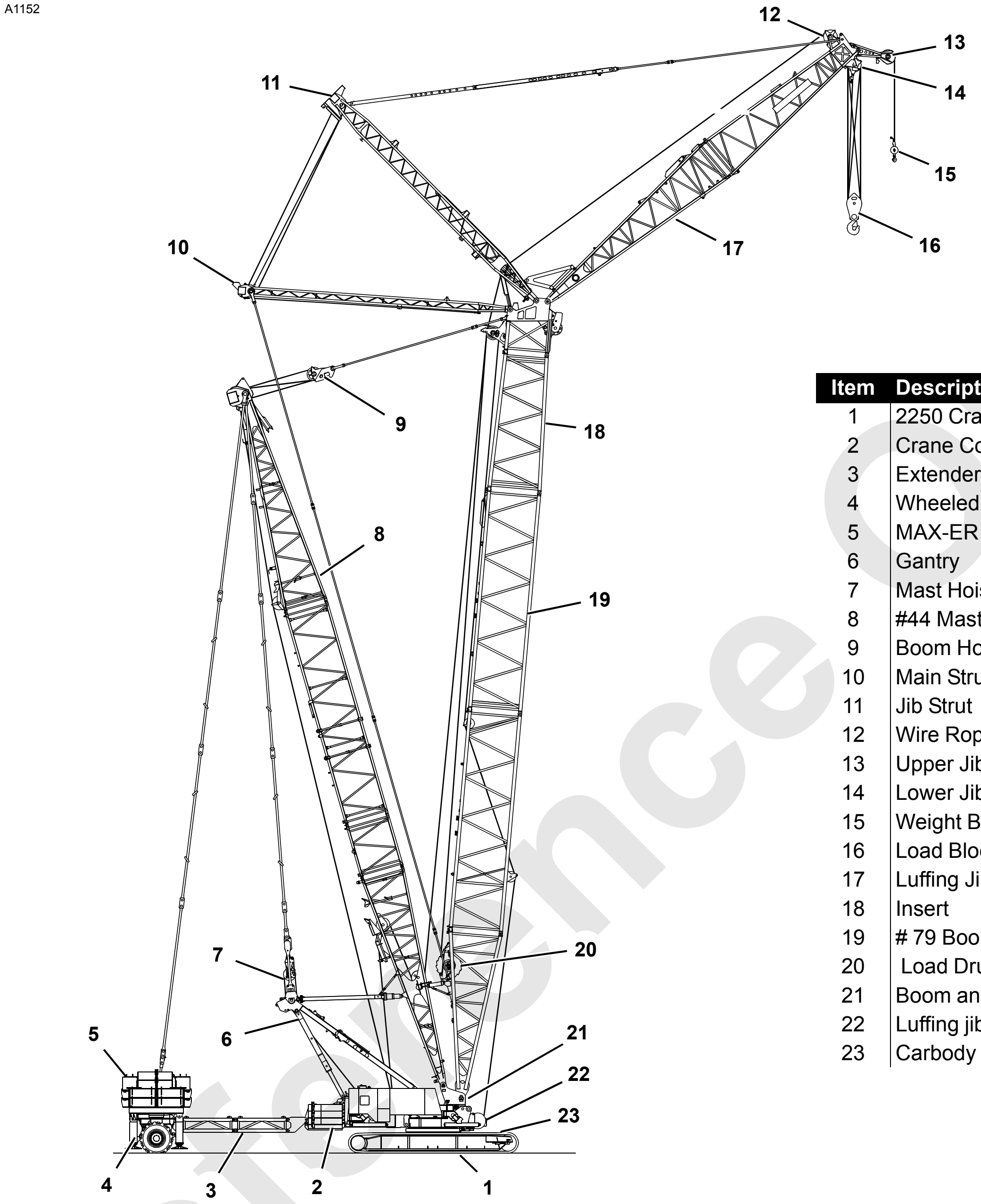
MAX-ER accessory valve manifold contains eight four-way three position spool valve sections. Six of these sections are open centered motor spooled and two sections are closed centered. Each spool section is electrically enabled (12 volts DC) with switches and/or the PC. Each valve is actuated by an internal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

MAX-ER Pressurized Air Supply

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

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

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 1-46

EPIC® Programmable Controller

See Figure 1-47 for the following procedure.

The MAX-ER's solenoid valves, cylinders, and motors are monitored and controlled with electronic components of the EPIC (Electrical Processed Independent Control) system. The crane PC (Programmable Controller) and MAX-ER PC are ***interfaced*** with serial wire RX3 (36) and TX3 (37). In this section, 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 signals are 12 volt nominal voltages that are either ***on*** or ***off***.

The PC uses the binary system. The binary system is based on multiples of 2, and only recognizes 0 for ***off*** or 1 for ***on*** voltages. Basic counts of this system are exponents of the number 2. 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 to the controller. The controller processes this information by comparing it to programming requirements and data information. The PC then provides appropriate output commands to control devices.

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

NOTE: Rated Capacity Indicator/Limiter (RCL) system has its own programmable controller and is part of the EPIC system. For complete information see separate Rated Capacity Indicator/Limiter Operation manual.

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

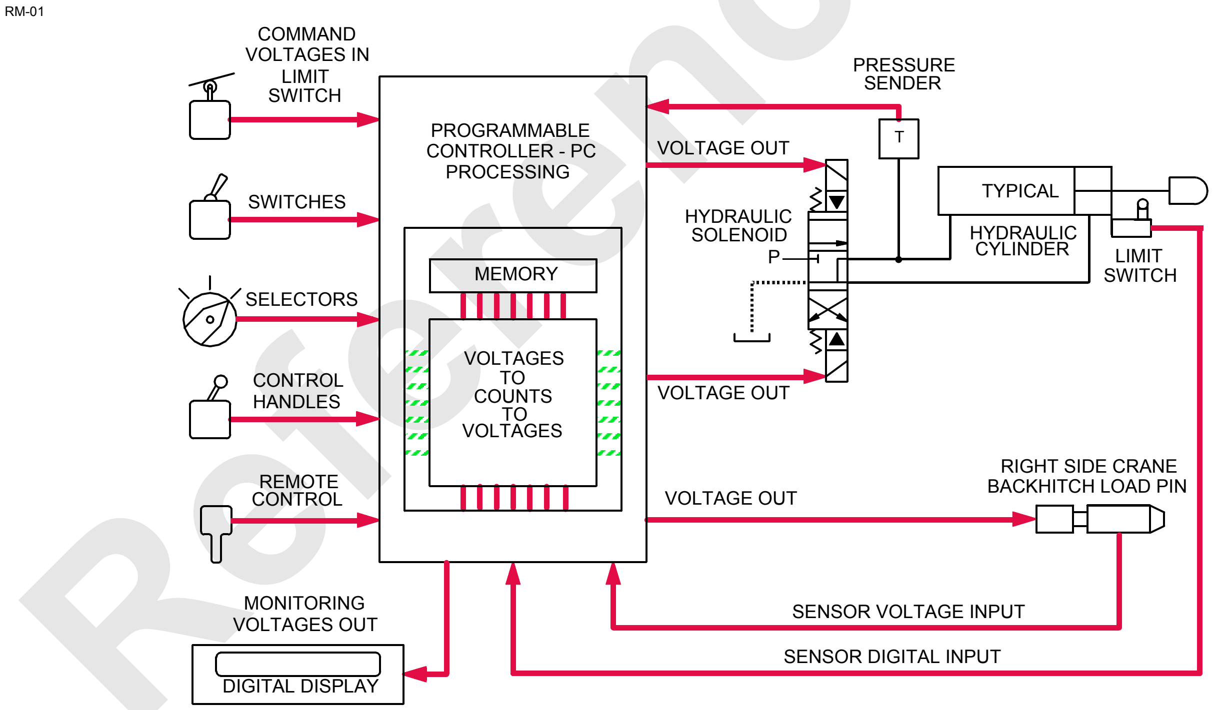


FIGURE 1-47

MAX-ER Modes

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

In Luffing Jib mode, drum 5 cannot operate unless drum 4 is parked. In Standard mode, drum 4 can not 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 crane 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 MAX-ER programmable controller on crane to MAX-ER junction box on wheeled counterweight trailer provides electrical wiring to MAX-ER components.

MAX-ER electrical components include:

- 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 crane include:

- Load pin sensor
- Mast back hitch 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 back hitch pins remote switch assembly

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

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

MAX-ER Remote Switch Assembly

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

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

Past units have an unloader valve that cuts in at 2,300 psi (159 bar) and cuts out at 2,900 psi (200 bar).

Auxiliary system disable valve is set at 3,500 psi (241 bar) and protects the MAX-ER systems from excessive pressure by opening to tank when accessory items are disabled.

Mast Back Hitch Pins Remote Switch

Power is available to mast back hitch pins remote switch when power cable (W29) is plugged into receptacle at bottom main junction box at left side of crane and engine is running.

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

Digital Display

Scroll to CTWT BHITCH screen of digital display to observe counterweight position. CTWT indicates up or down position of wheeled counterweight assembly. BHITCH indicates back hitch loading in U.S. tons.

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

Pressure Senders and Speed Senders

See Figure 1-48 for the following procedure.

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

Drum 9 flange mounted speed sender (encoder) detects speed and direction of drum 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 pump flow.

Limit Switches

See Figure 1-48 for the following procedure.

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 affected system to stop and apply system brake. Move control in the opposite direction away from limit 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 display switch to scroll up or down to identify and display operating limit.

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

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 PC detects a load pin fault (output voltage from the pin that is greater than 9.8 volts).

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

LOAD PIN - the MAX-ER counterweight assembly stops and remains in last position and boom hoist stops and is inoperable in up direction. All other crane functions remain operable.

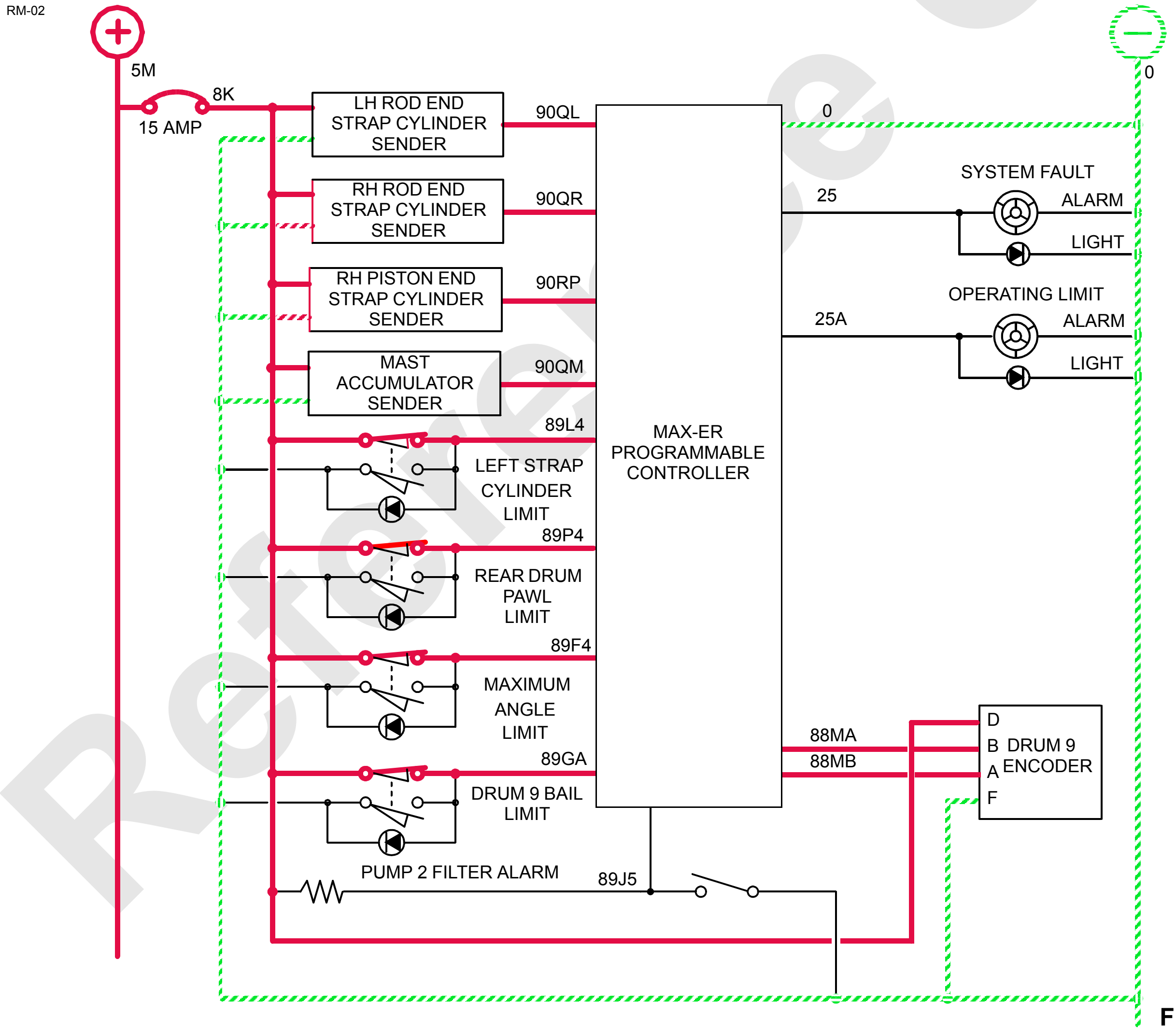


FIGURE 1-48

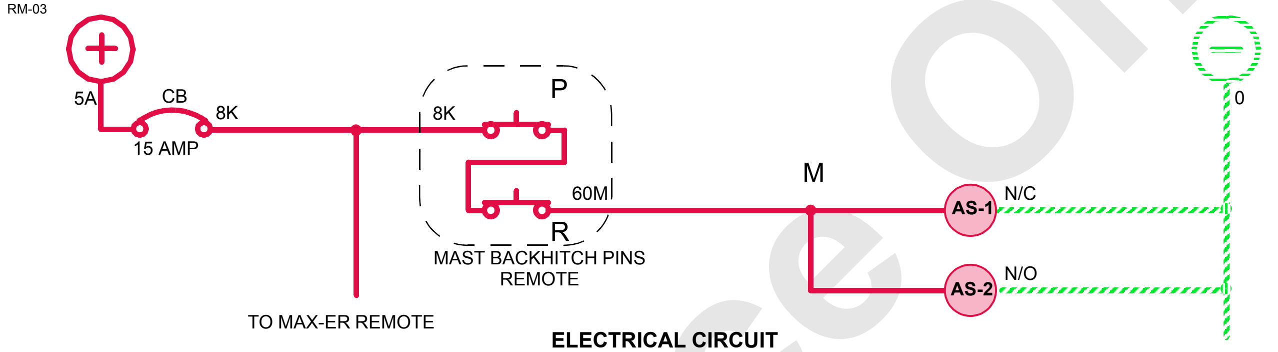
Back Hitch Pins

See Figure 1-49 for the following procedure.

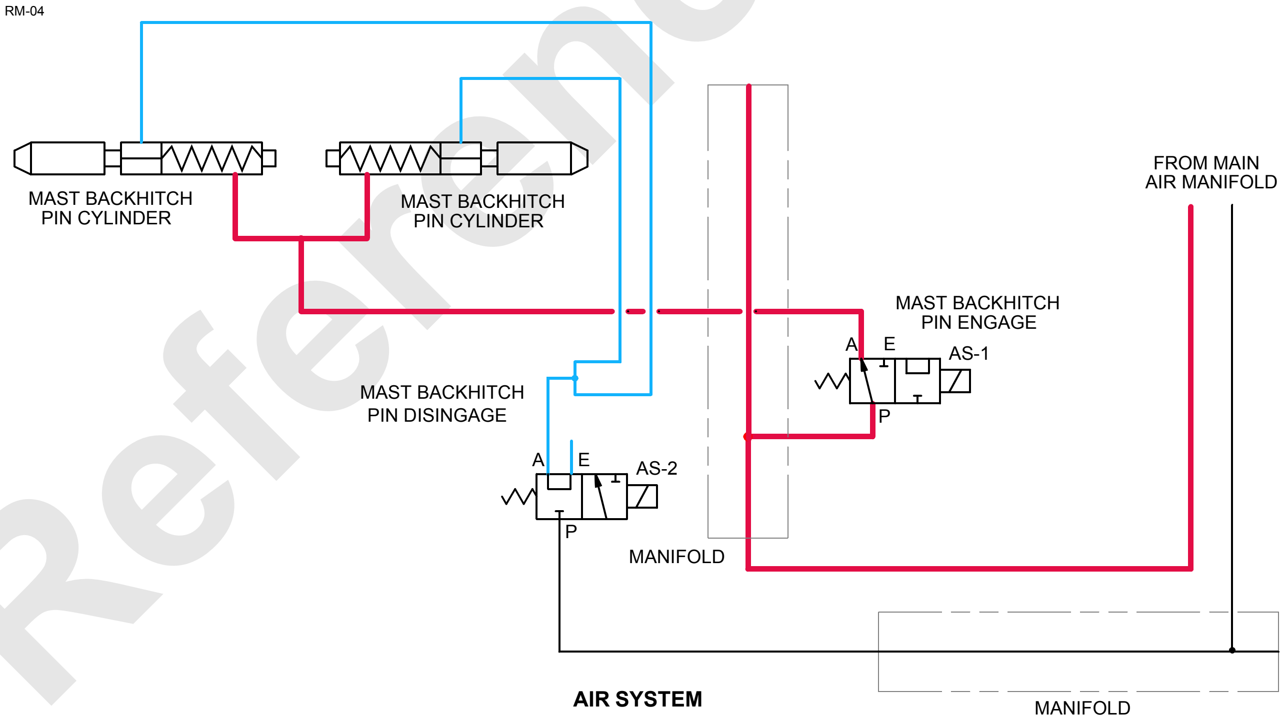
Back hitch pins are retracted from telescopic back hitch strap at assembly/disassembly. Power is available to mast back hitch pins remote switch when power cable (W29) is plugged into receptacle at bottom of main junction box at left side of crane and engine is running. The mast back hitch pins remote switch is operative only if crane is in Standard or Setup mode.

Back Hitch Pins Extend/Retract

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



ELECTRICAL CIRCUIT



AIR SYSTEM

FIGURE 1-49

Tongue Cylinder

See Figure 1-50 and Figure 1-51 for the following procedure.

Tongue cylinder aligns the wheeled counterweight trailer for attachment to crane and levels the counterweight tray before positioning steering wheels. Wheeled counterweight tray pins must be in proper position for leveling. See MAX-ER Assembly/Disassembly topic in Section 4 of Operator Manual for pin positions. After wheeled counterweight trailer is leveled, return tray pins to operating position.

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

Tongue Cylinder Extend

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

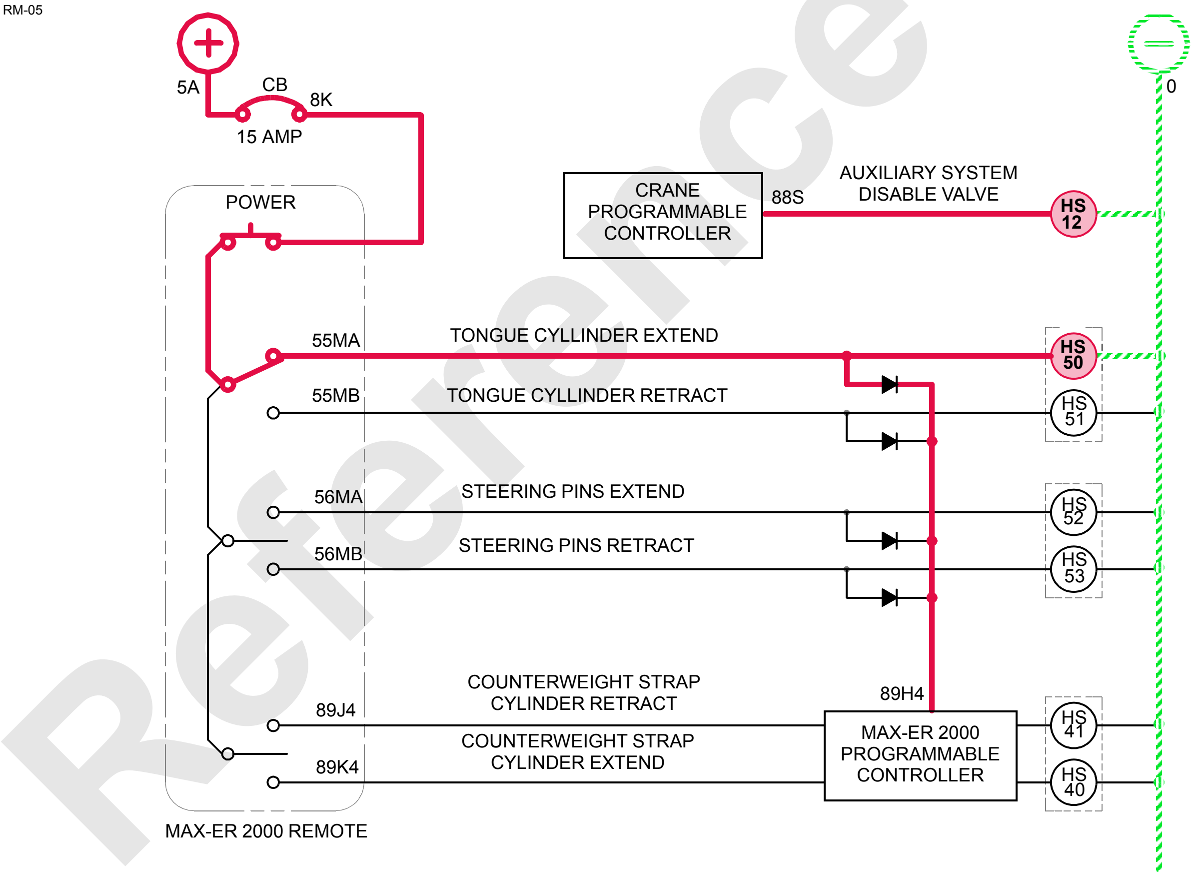


FIGURE 1-50

Tongue Cylinder Retract

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

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

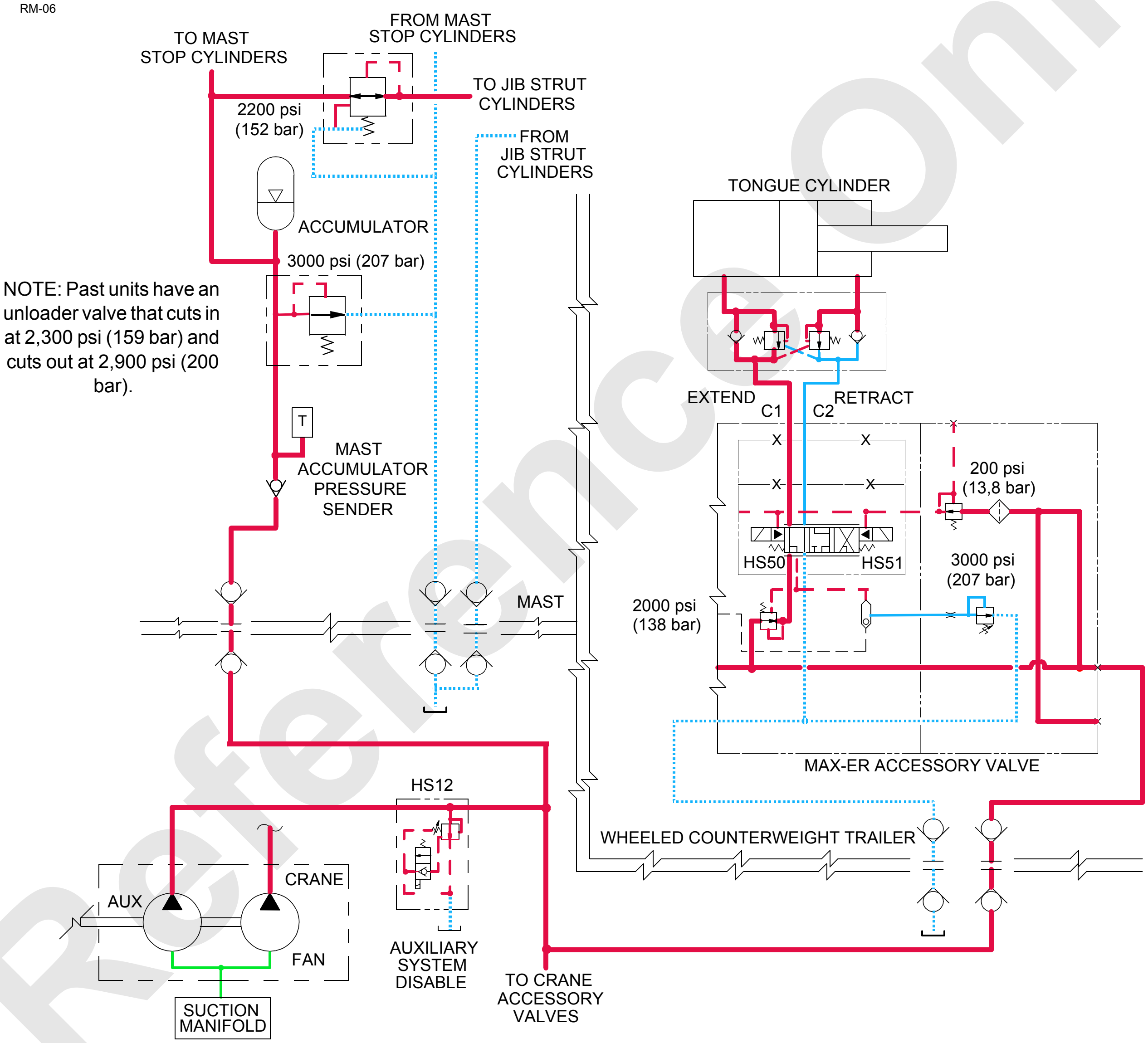


FIGURE 1-51

Counterweight Jack Cylinders

See Figure 1-52 and Figure 1-53 for the flowing 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 for raising wheels off ground to move steering arms to desired steering position. The jacks allow the counterweight trailer to stand by itself when not attached to crane and to aid in tire maintenance. Axle wedges help stabilize the counterweight trailer when it is not attached to the crane and the jacks are retracted.

DANGER

Tipping Hazard!

Wheeled counterweight assembly can tip:

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

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

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

Jack Cylinder(s) Extend

When selected left, right, center, or extend all switch is held in the UP extend position, an input signal is sent to the PC. A 12-volt output signal from PC enables the jack cylinder extend solenoid HS-44, HS-46, and/or HS-48. Internal pilot supply pressure of 200 psi (14 bar) enables spool to shift the selected jack cylinder solenoid valve(s). 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 PC sends an output signal to shift crane auxiliary system disable valve HS-12, to block valve bypass. Accessory system pressure increases to operate accessory items. Accessory system fluid enters MAX-ER accessory valve and flows to free-flow check valve section of counterbalance valve. Fluid pressure on piston end of selected jack cylinder extends jack cylinder to raise the counterweight trailer.

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

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

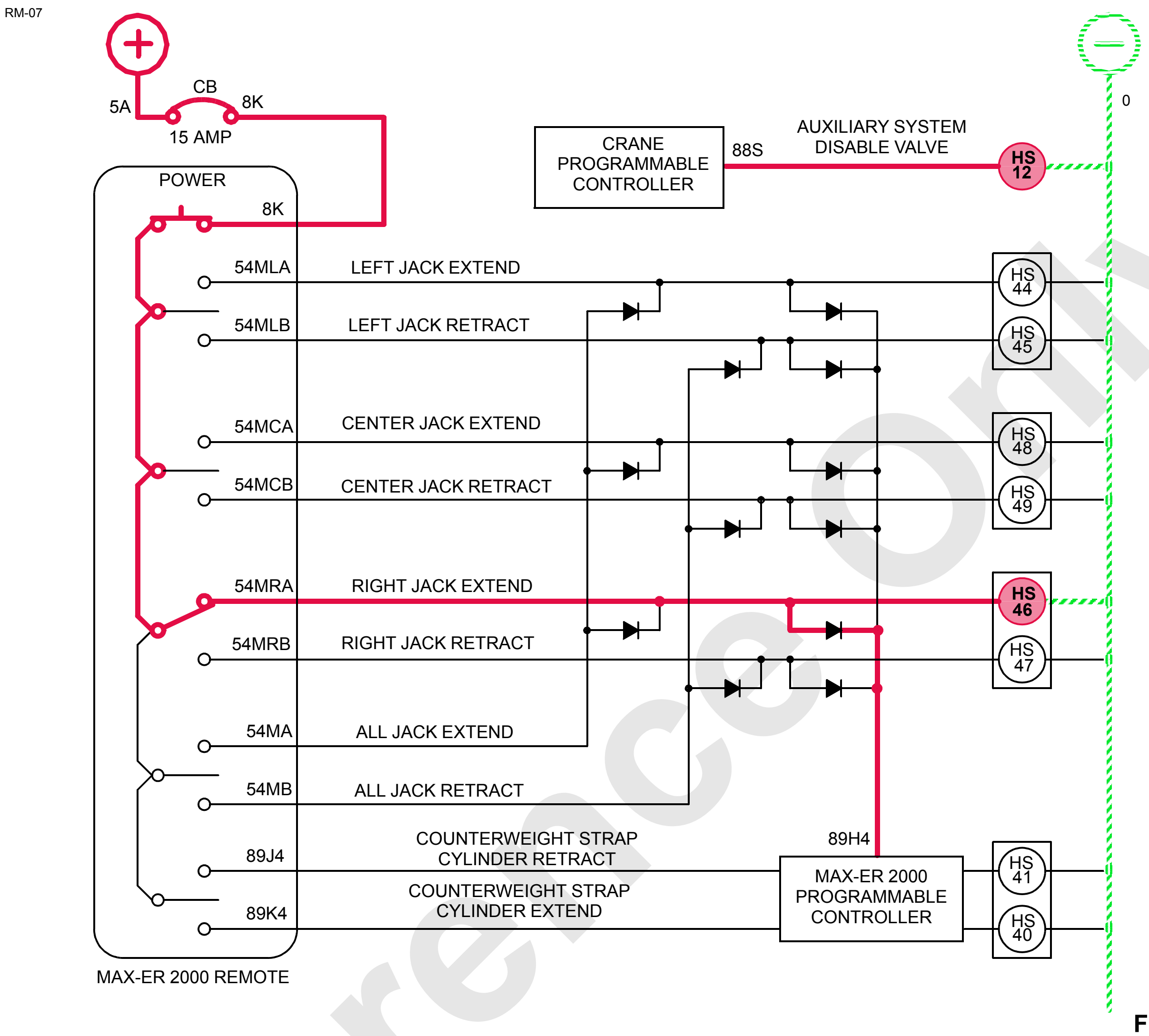


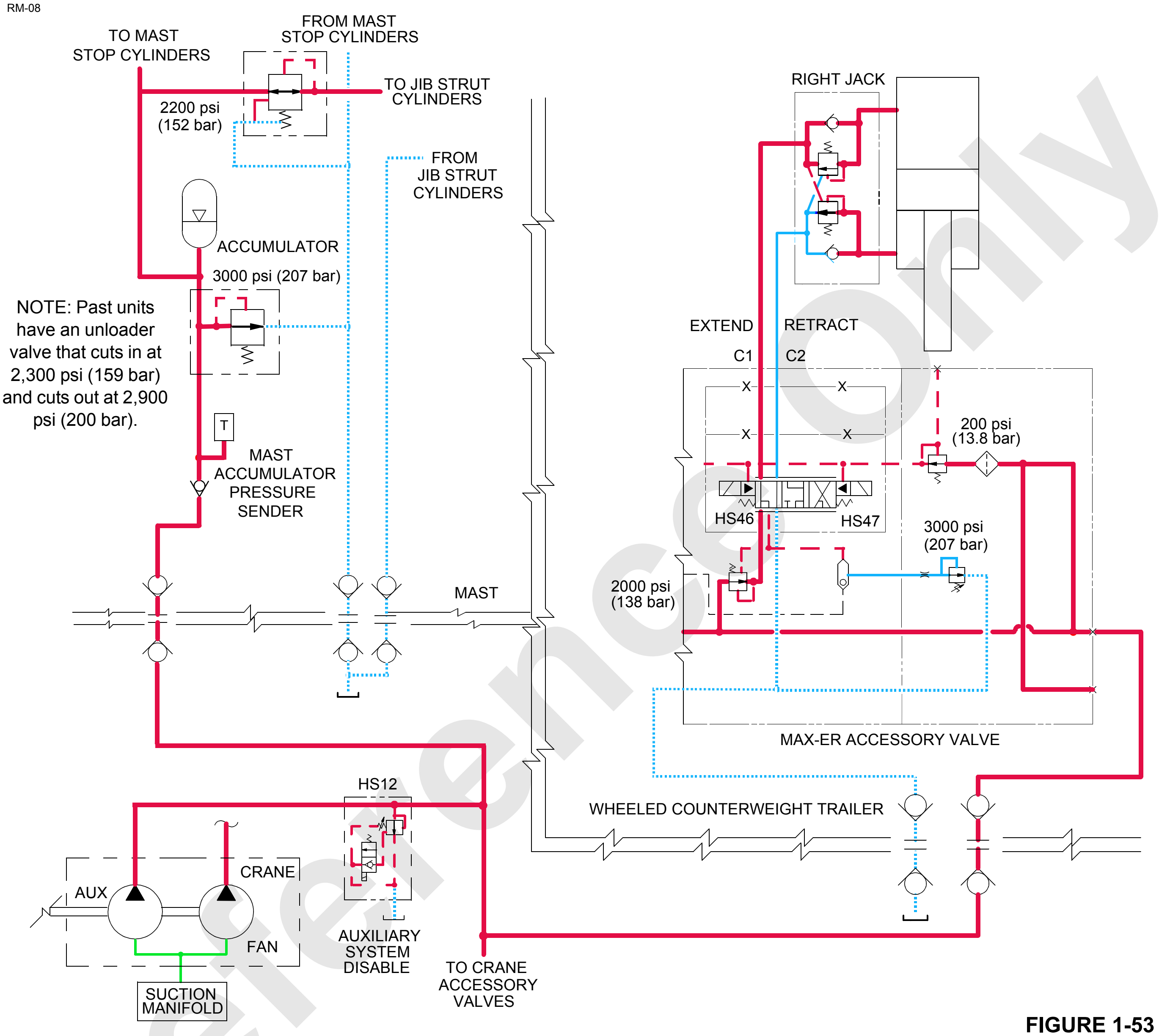
FIGURE 1-52

Jack Cylinder(s) Retract

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

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

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



NOTE: Past units have an unloader valve that cuts in at 2,300 psi (159 bar) and cuts out at 2,900 psi (200 bar).

FIGURE 1-53

Steering Pin Cylinders

See Figure 1-54 and Figure 1-55 for the following procedure.

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

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

Steering Pin Cylinders Disengage

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

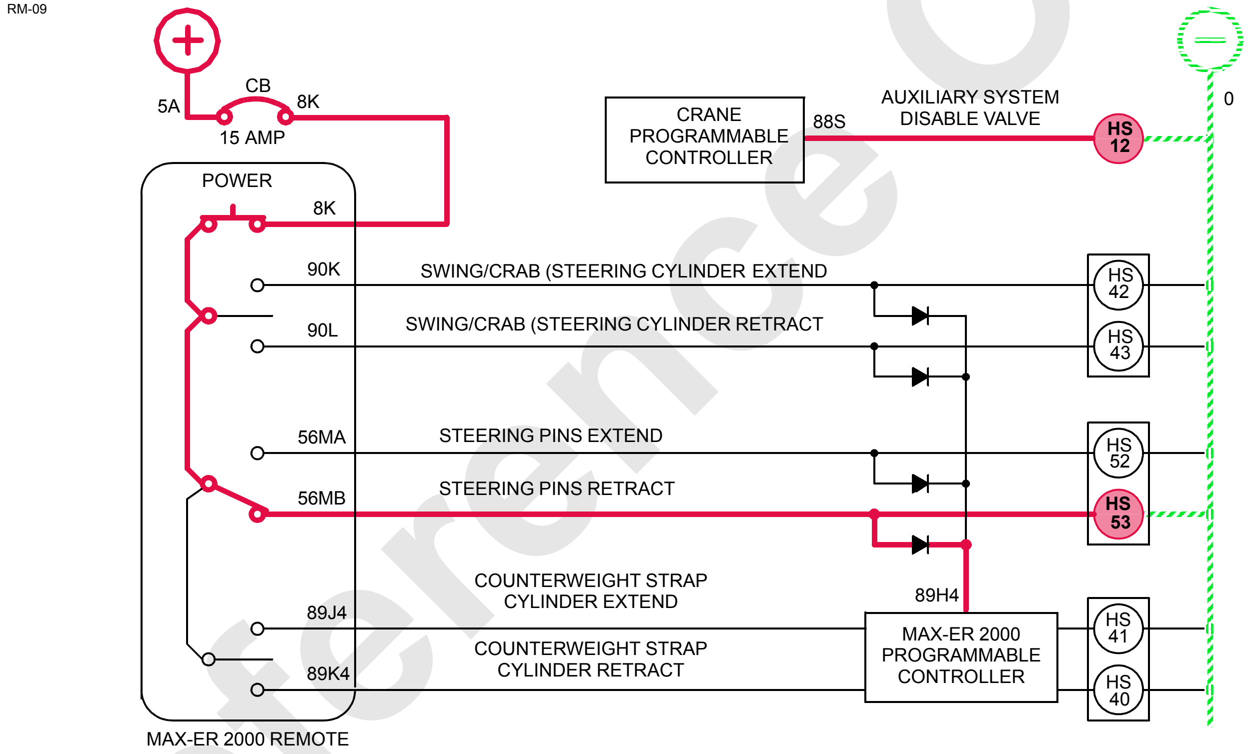


FIGURE 1-54

Steering Pin Cylinders Engage

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

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

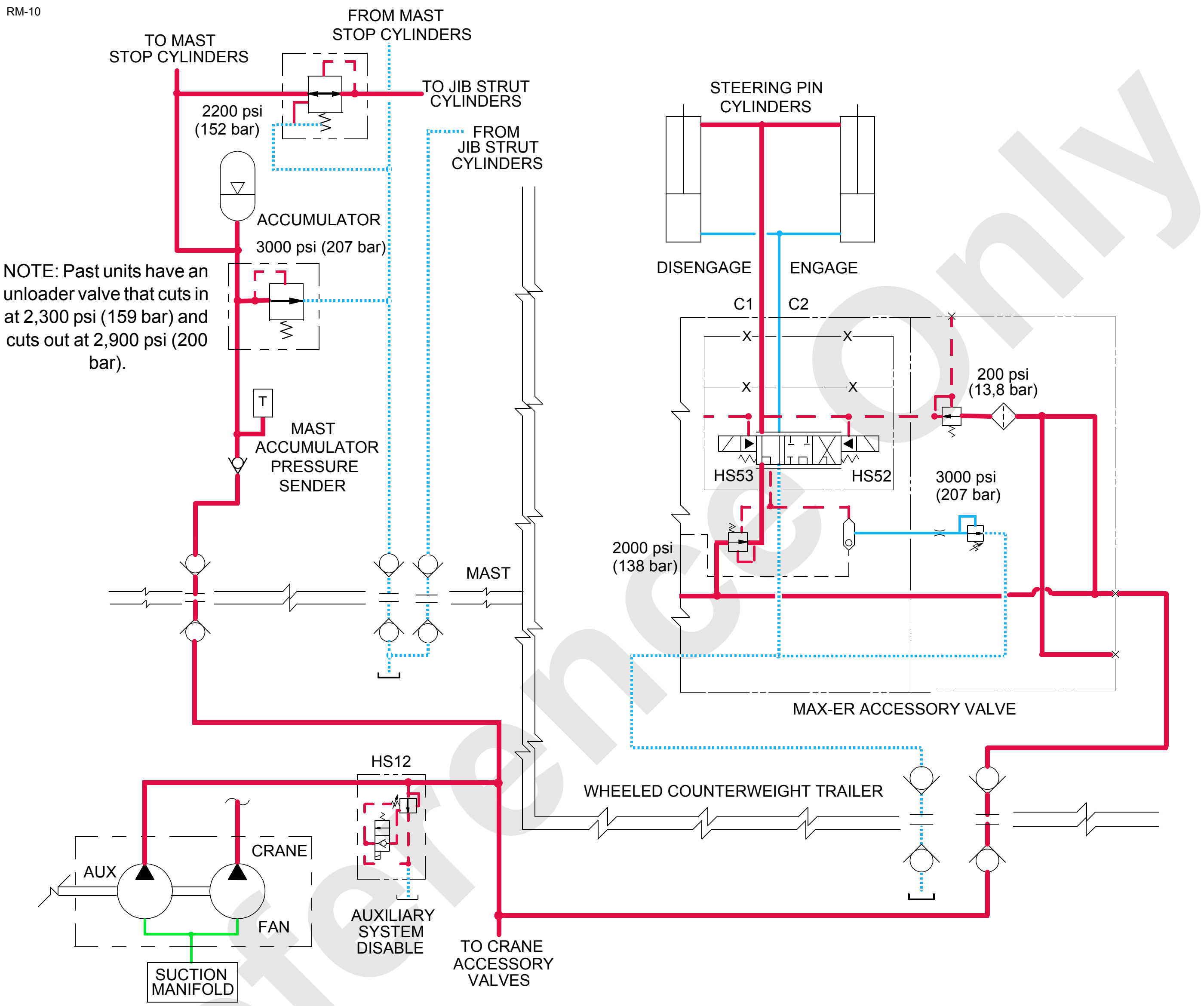

RM-10
TO MAST STOP CYLINDERS
FROM MAST STOP CYLINDERS
TO JIB STRUT CYLINDERS
FROM JIB STRUT CYLINDERS
2200 psi (152 bar)
ACCUMULATOR
3000 psi (207 bar)
NOTE: Past units have an unloader valve that cuts in at 2,300 psi (159 bar) and cuts out at 2,900 psi (200 bar).
T
MAST ACCUMULATOR PRESSURE SENDER
MAST
STEERING PIN CYLINDERS
DISENGAGE
ENGAGE
C1
C2
200 psi (13,8 bar)
HS53
HS52
3000 psi (207 bar)
2000 psi (138 bar)
MAX-ER ACCESSORY VALVE
HS12
WHEELED COUNTERWEIGHT TRAILER
AUX
CRANE
FAN
SUCTION MANIFOLD
AUXILIARY SYSTEM DISABLE
TO CRANE ACCESSORY VALVES

FIGURE 1-55

Steering Arm Cylinders

See Figure 1-56 and Figure 1-57 for the following procedure.

Steering arms and stop pins must be properly positioned depending on swing radius and type of crawler travel or swing. See MAX-ER Assembly/Disassembly topic in Section 4 of Operator Manual for information on positioning steering wheels.

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

CAUTION

Machinery Damage!

Wheeled counterweight assembly must be supported on jacks before changing wheel position:

- Check that strut and draw bar pins are in proper positions. Hydraulic cylinders and other wheeled counterweight trailer components may be damaged.
- Extend jacks to bear most of counterweight trailer load until bulge is out of tires. Failure to do so may cause tires to separate from rims as wheels are positioned.

Steering Cylinders Extend (Swing/Crab)

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

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

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

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

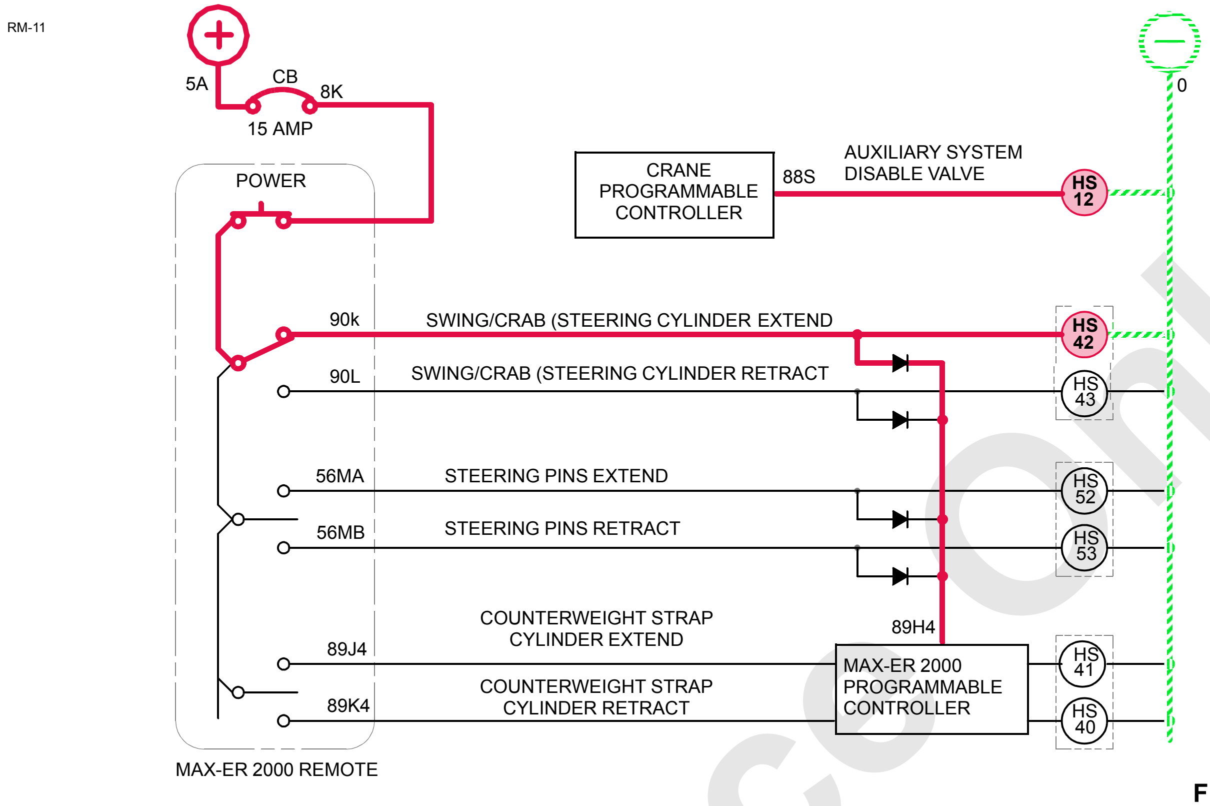


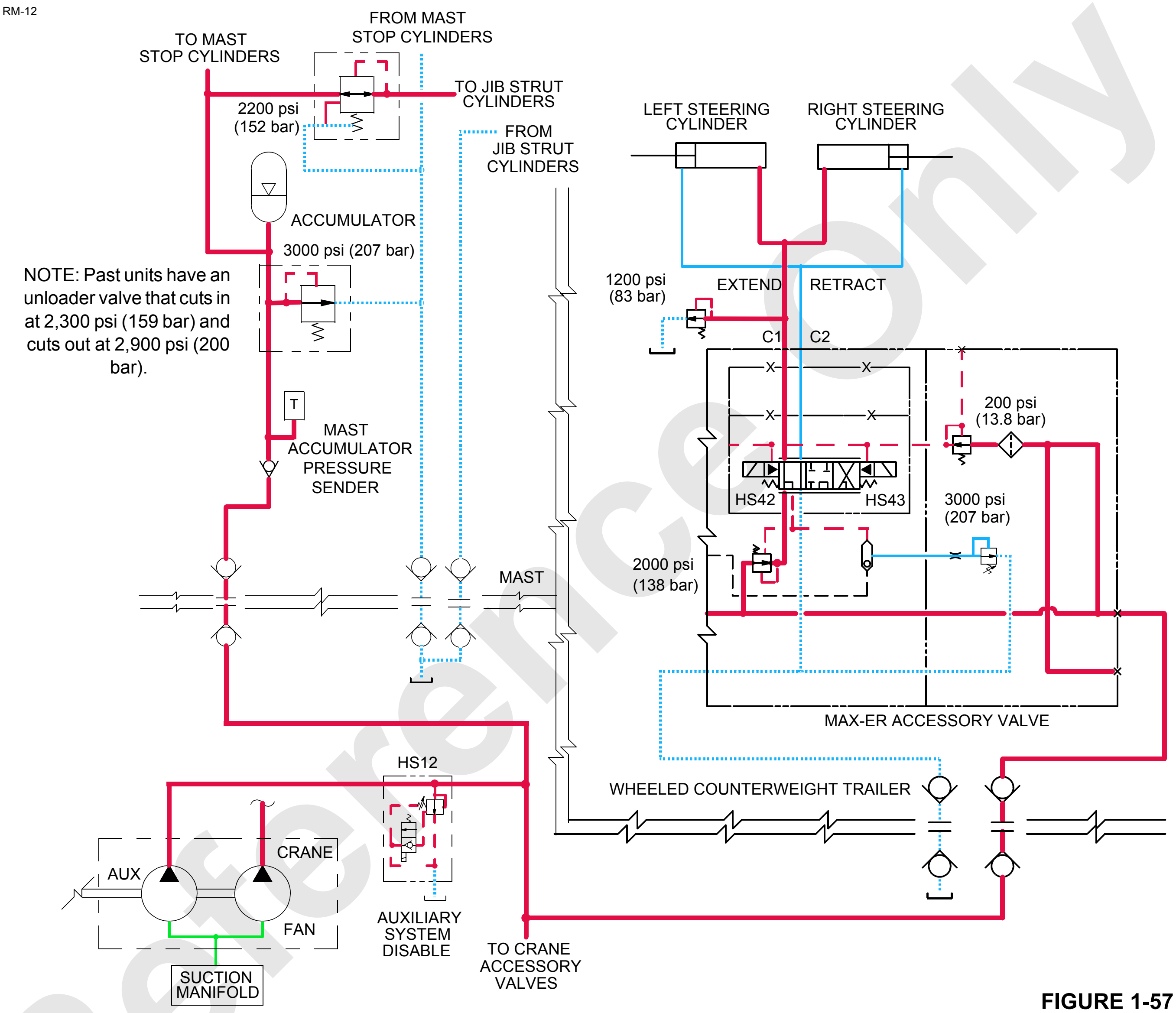
FIGURE 1-56

Steering Cylinders Retract (Straight)

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

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

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



NOTE: Past units have an unloader valve that cuts in at 2,300 psi (159 bar) and cuts out at 2,900 psi (200 bar).

FIGURE 1-57

Counterweight Strap Cylinders

See Figure 1-58 and Figure 1-59 for the following procedure.

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

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

DANGER

Collapsing Mast!

After straps are pinned to strap cylinders, do not manually retract cylinders. Mast can be pulled over backwards. Strap cylinders automatically adjust when MAX-ER mode is selected.

Tipping Hazard!

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

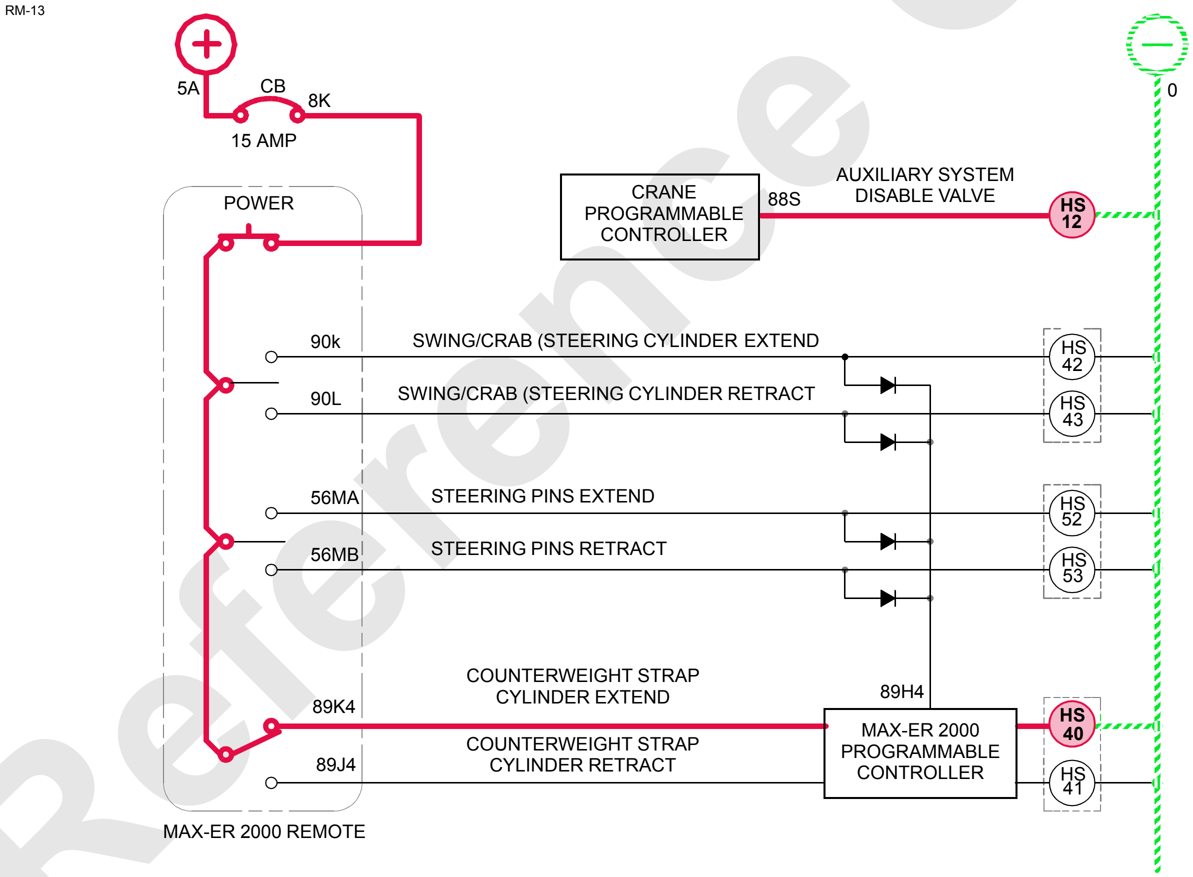


FIGURE 1-58

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

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

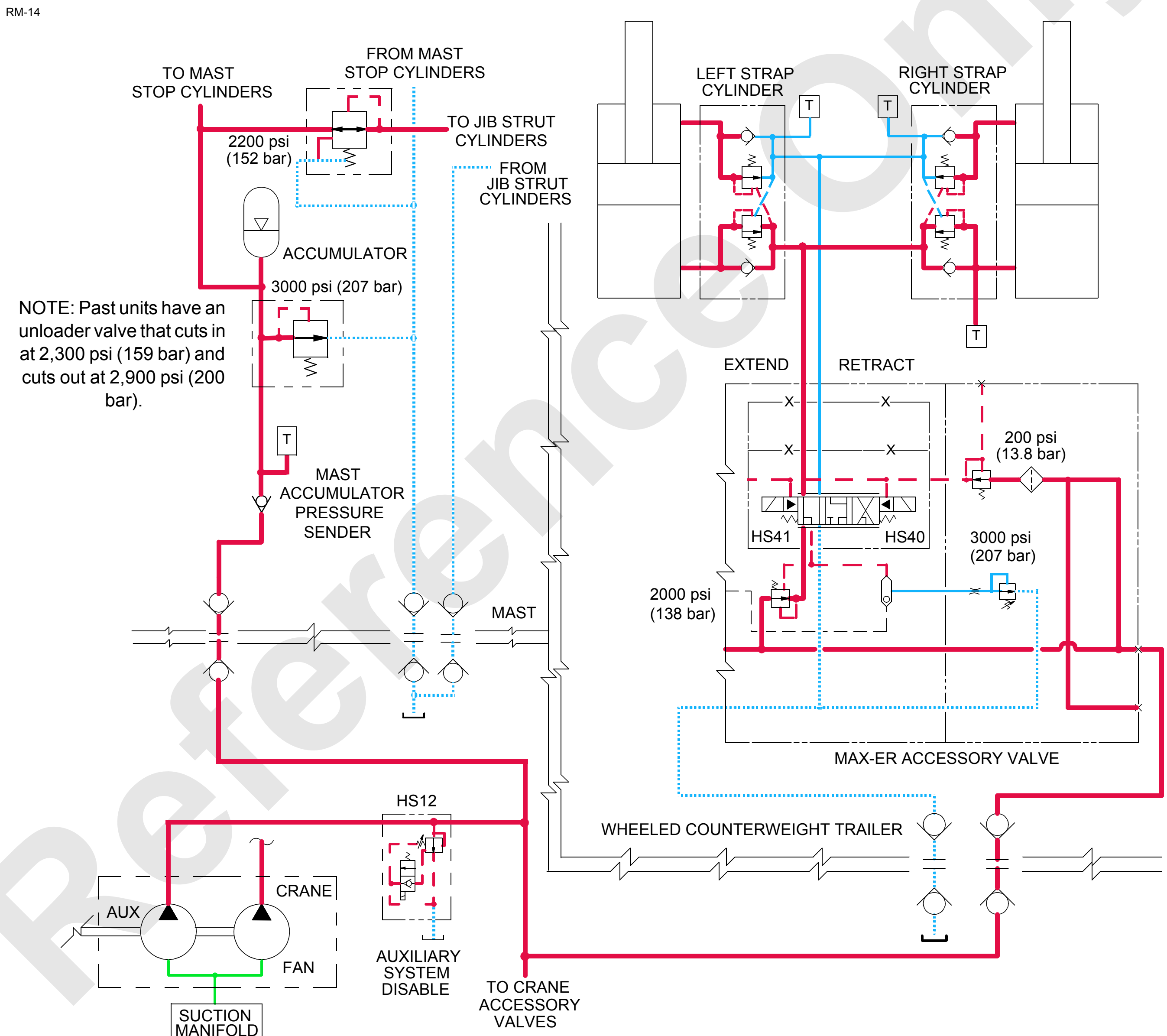


FIGURE 1-59

Counterweight Switch

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

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

Counterweight Strap Cylinders Lower

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

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

Counterweight Strap Cylinders Raise

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

Mast Stop Raising And Boom Stop

Mast Stop Raising Cylinders

See Figure 1-60 for the following procedure.

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

When the engine is started, pressurized air at 120 to 132 psi (8.2 to 9,1 bar) from crane's engine compressor provides air to operate mast stop raising cylinders. An air line from crane manifold goes to quick disconnect at mast base. After the quick disconnect there is a tee that splits, with one line going to mast stop raising cylinders on mast and the other line going to boom stop cushion cylinders on boom butt. The mast stop raising cylinder rods extend and push mast stops to working position. The physical mast stop ends rest on gantry pins. A fixed restriction at piston end of each cylinder acts as a cylinder shock cushion.

Boom Stop Cushion Cylinders

See Figure 1-60 for the following procedure.

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

When engine is started, pressurized air at 120 to 132 psi (8.2 to 9,1 bar) from crane's engine compressor provides air to boom stop cushion cylinders. An air line from crane manifold goes to quick disconnect at mast base. After the quick disconnect there is a tee that splits, with one line going to mast stop raising cylinders on mast and the other line going to boom stop cushion cylinders on boom butt.

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

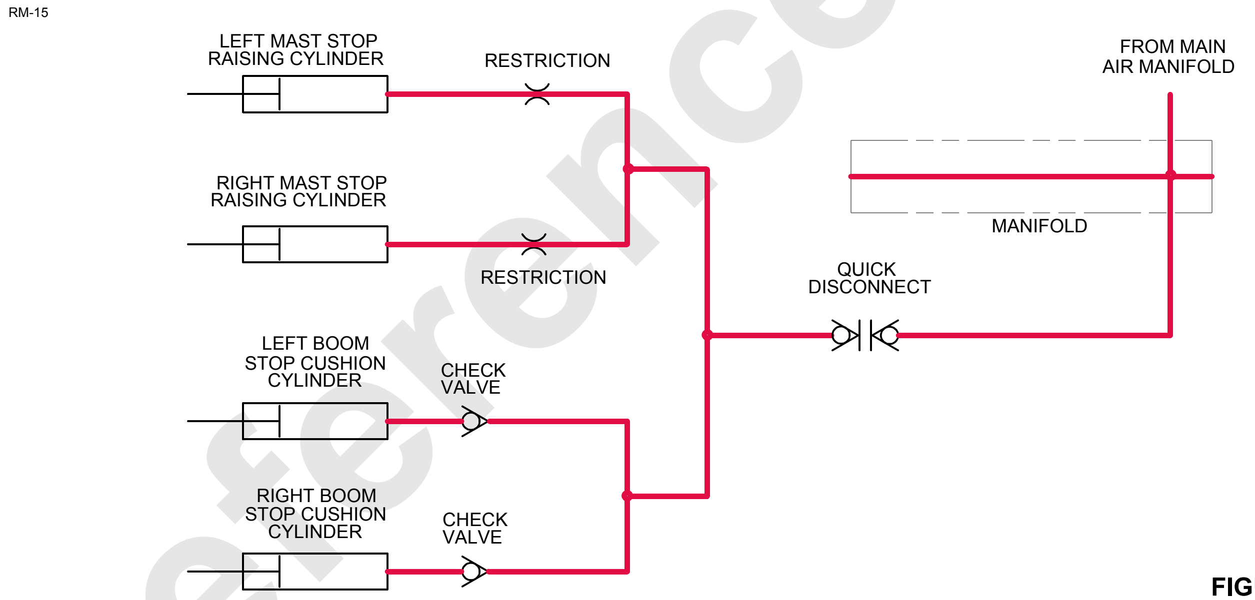


FIGURE 1-60

Mast Stop

Mast Stop Cylinders

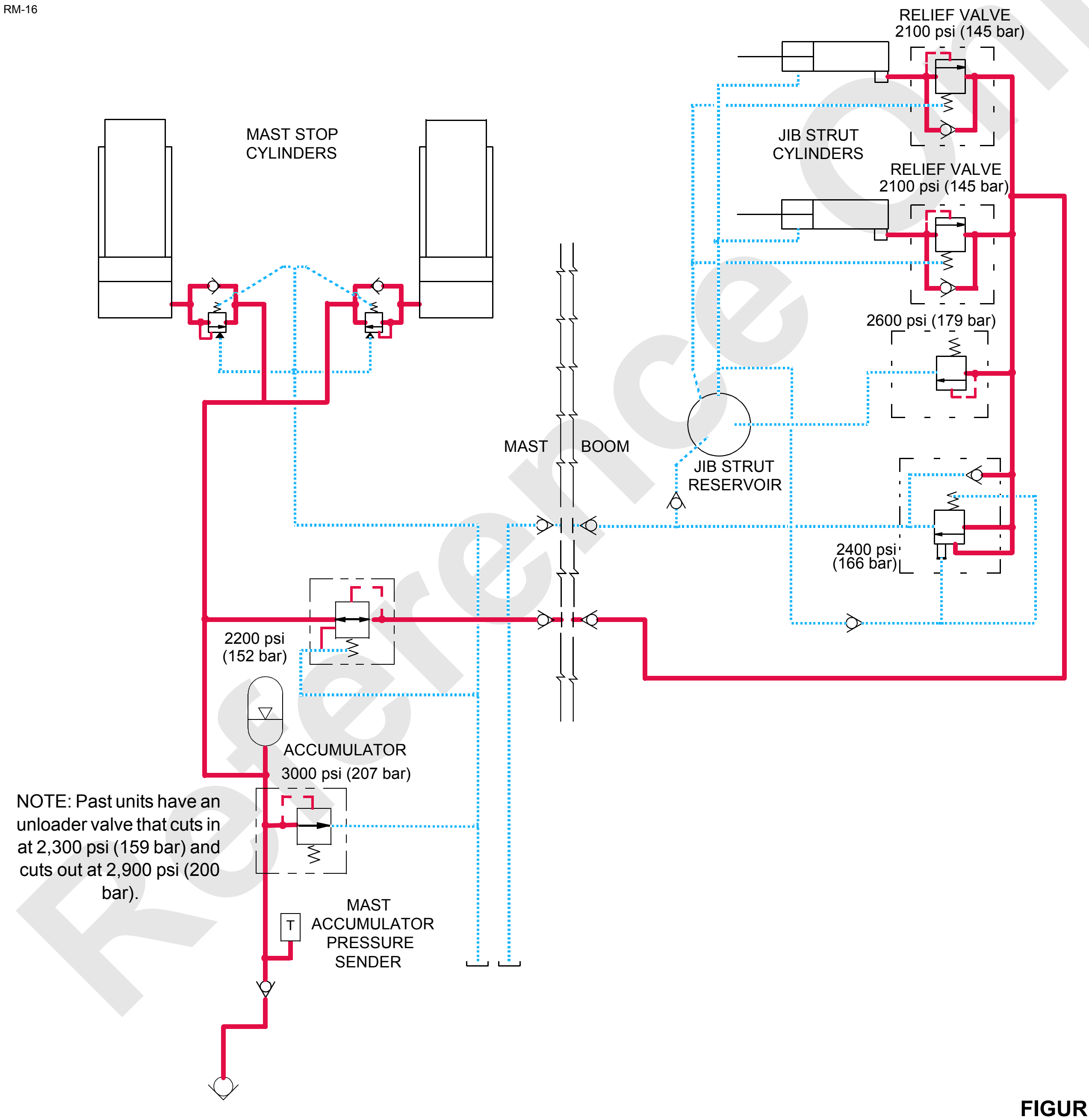
See Figure 1-61 for the following procedure.

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 contact the gantry. After a certain distance, the mast stop cylinders bottom out to stop mast travel.

Mast Stop System Operation

See Figure 1-61 for the following procedure.

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



NOTE: Past units have an unloader valve that cuts in at 2,300 psi (159 bar) and cuts out at 2,900 psi (200 bar).

FIGURE 1-61

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

Past units have an unloader valve that cuts in at 2,300 psi (159 bar) and cuts out at 2,900 psi (200 bar).

Auxiliary system disable valve is set at 3,500 psi (241 bar) and protects the MAX-ER systems from excessive pressure by opening to tank when 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 3,000 psi (207 bar) in cylinders to cushion mast.

Jib Stop Cylinders

See Figure 1-61 for the following procedure.

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

Jib Stop System Operation

See Figure 1-61 for the following procedure.

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

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

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

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

Drum 9 Operation

See Figure 1-62 through Figure 1-65 for the following procedure.

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

The left control handle controls drum 9 operation. The corresponding number 9 green light comes on behind left control handle. The PC applies drum 9 brakes, controls crawler travel pump speed, and selects control handle operation depending on crane mode version. See Operating Controls topic in Section 3 of MAX-ER Operator Manual for MAX-ER operation.

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

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

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

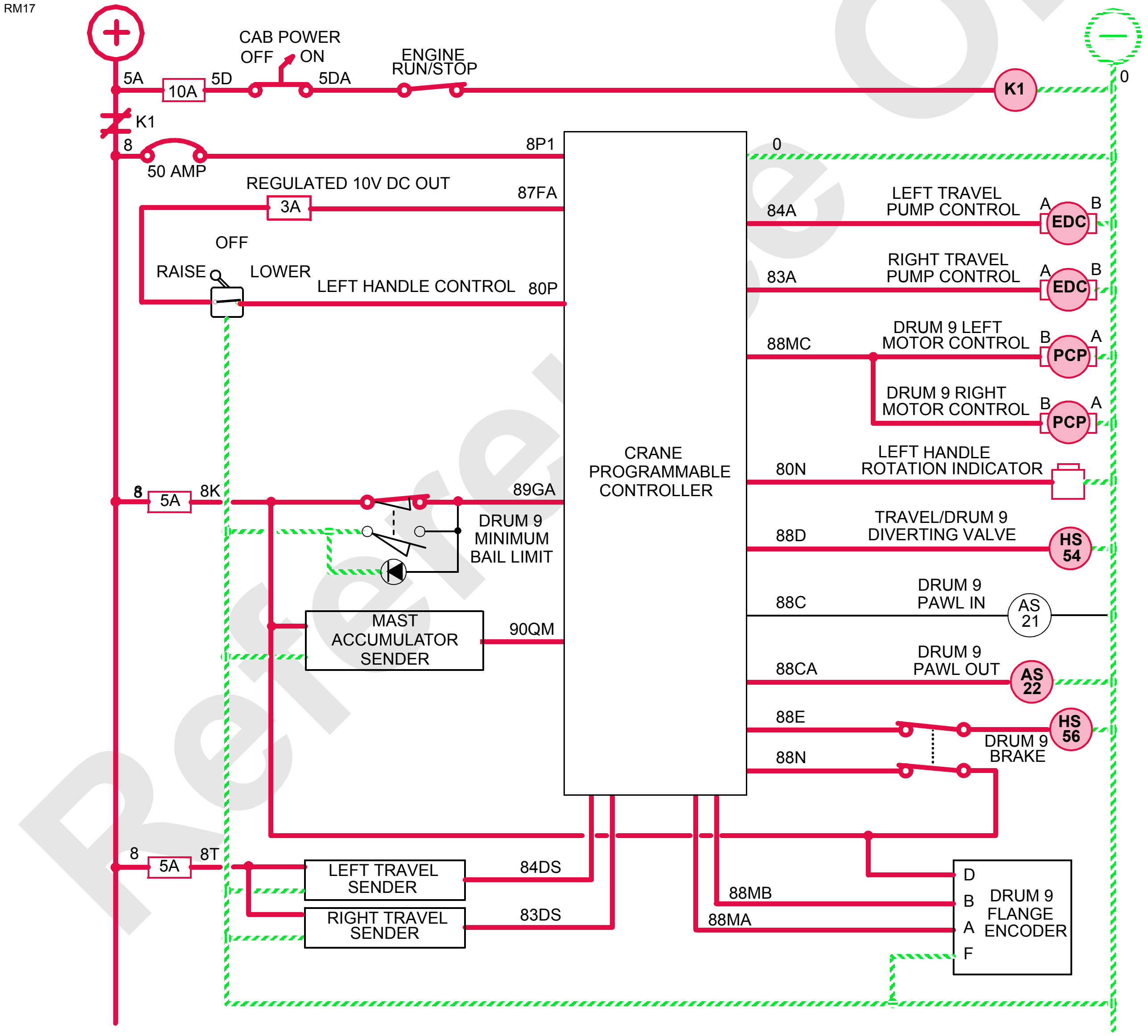


FIGURE 1-62

Drum 9 Brake

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

Drum 9 Hoisting (MAX-ER Mode)

See Figure 1-62 and Figure 1-63 for the following procedure.

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

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

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

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

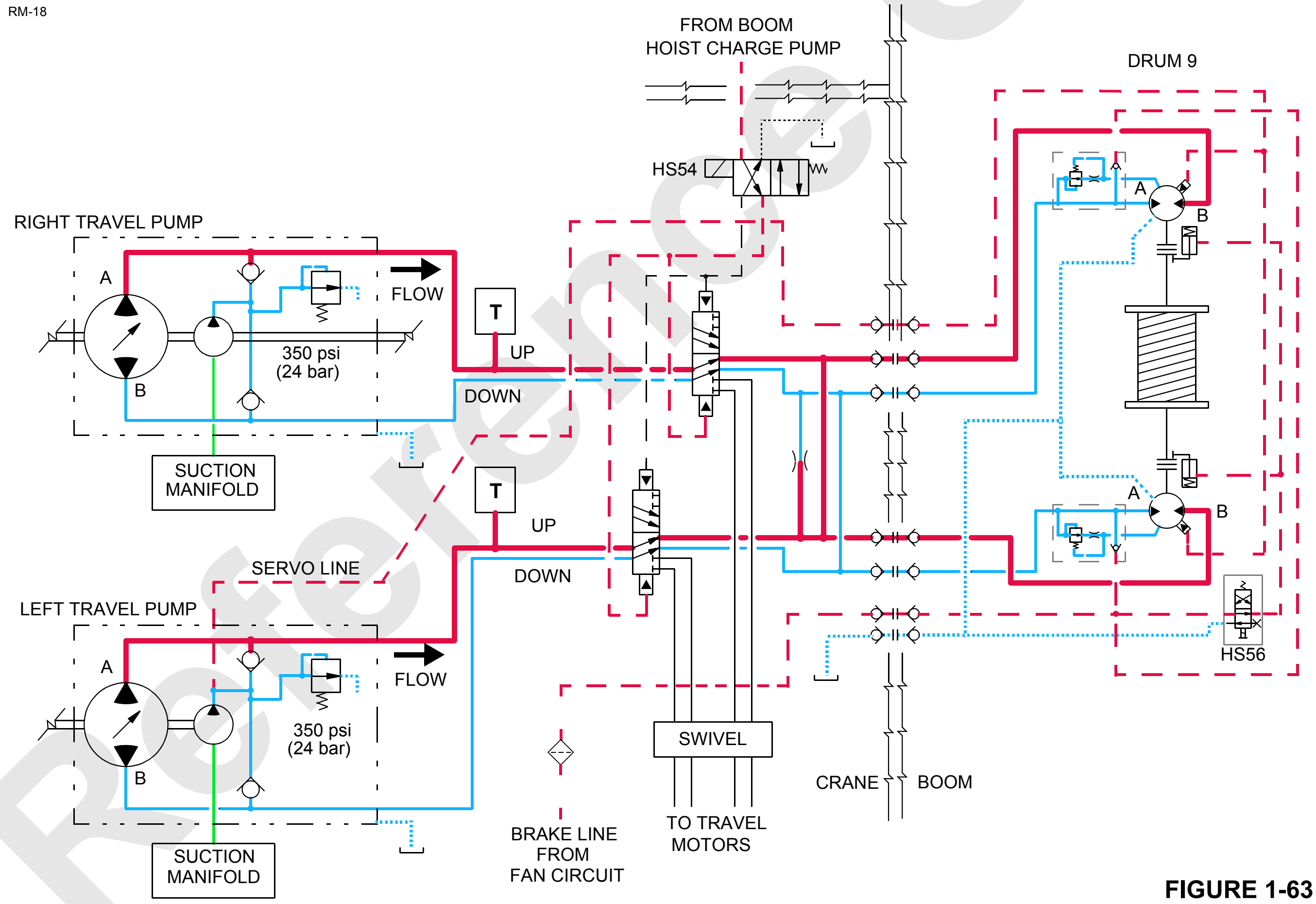


FIGURE 1-63

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

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

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

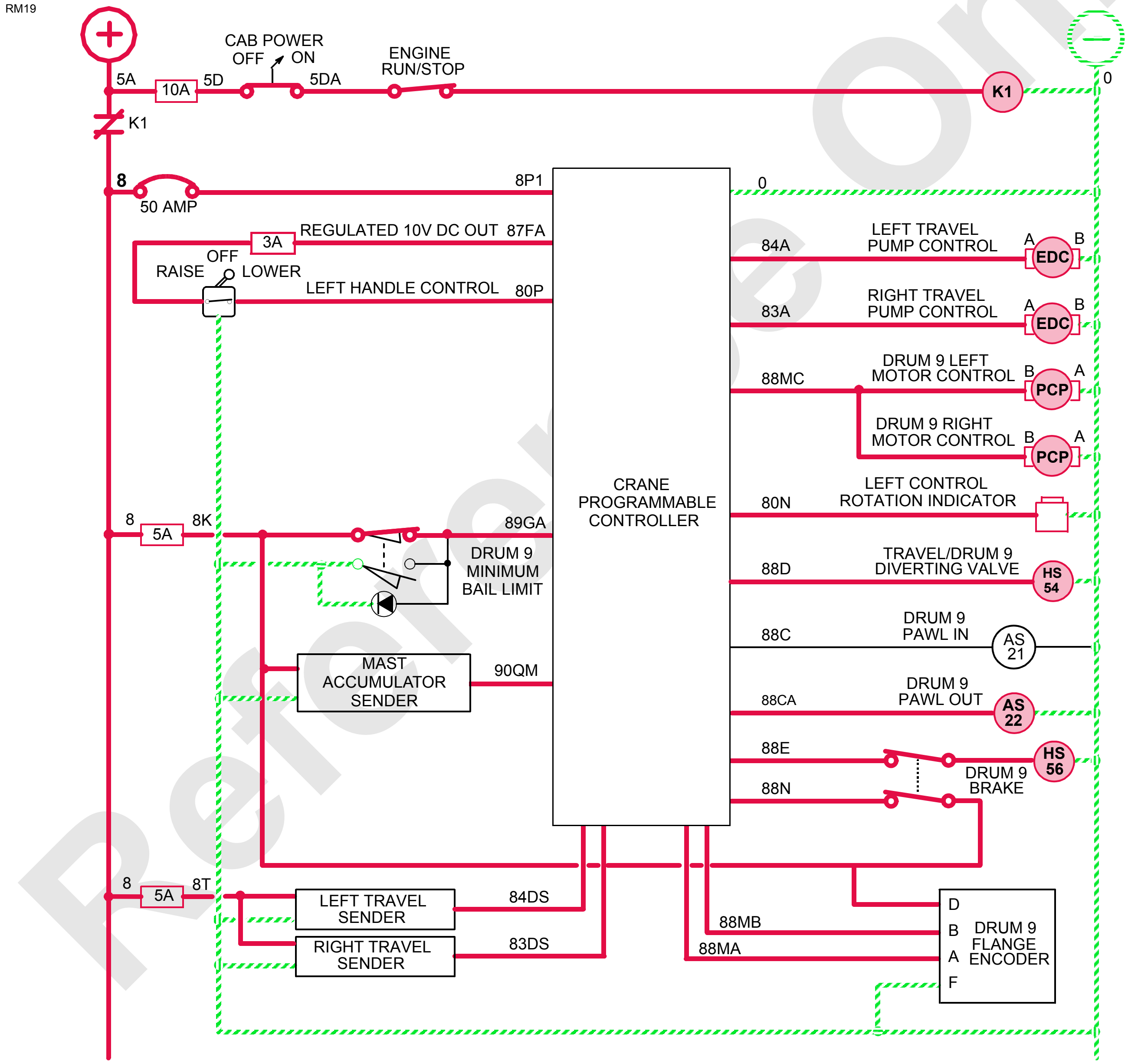


FIGURE 1-64

Drum 9 Lowering (MAX-ER Mode)

See Figure 1-64 and Figure 1-65 for the following procedure.

See Hydraulics Schematics supplied with crane to confirm whether Drum 9 hydraulics are used for Propel (travel) or Swing functions.

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

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

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

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

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

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

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

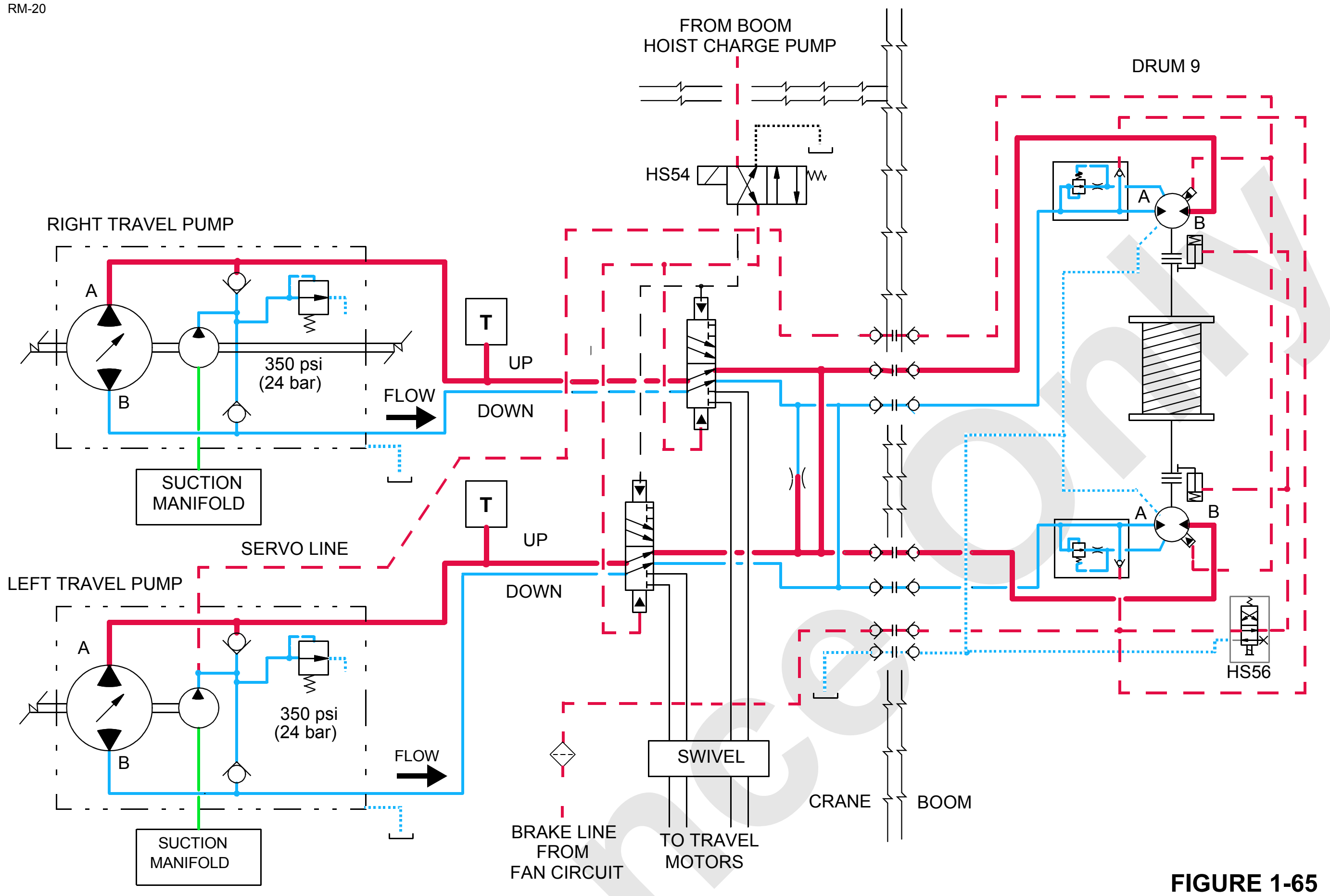

RM-20
FROM BOOM
HOIST CHARGE PUMP
DRUM 9
HS54
RIGHT TRAVEL PUMP
A
B
350 psi
(24 bar)
FLOW
T
UP
DOWN
SUCTION
MANIFOLD
SERVO LINE
LEFT TRAVEL PUMP
A
B
350 psi
(24 bar)
FLOW
T
UP
DOWN
SUCTION
MANIFOLD
A
B
A
B
HS56
SWIVEL
CRANE
BOOM
BRAKE LINE
FROM
FAN CIRCUIT
TO TRAVEL
MOTORS

FIGURE 1-65

HYDRAULIC COOLER FAN DRIVE — TIER 4 ONLY

See Figure 1-66 for the following procedure.

Description

The Cooler Fan Drive assembly includes two hydraulic motor driven, variable-speed fans. Each fan is 29.5 inches diameter and has seven blades. The accessory pump supplies the pressure to run the fan motors. As 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 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 (IMT), hydraulic oil temperature and the state of the air conditioning clutch. The system monitors these inputs every ten seconds and adjusts the fan speed depending on the input readings.

A 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.

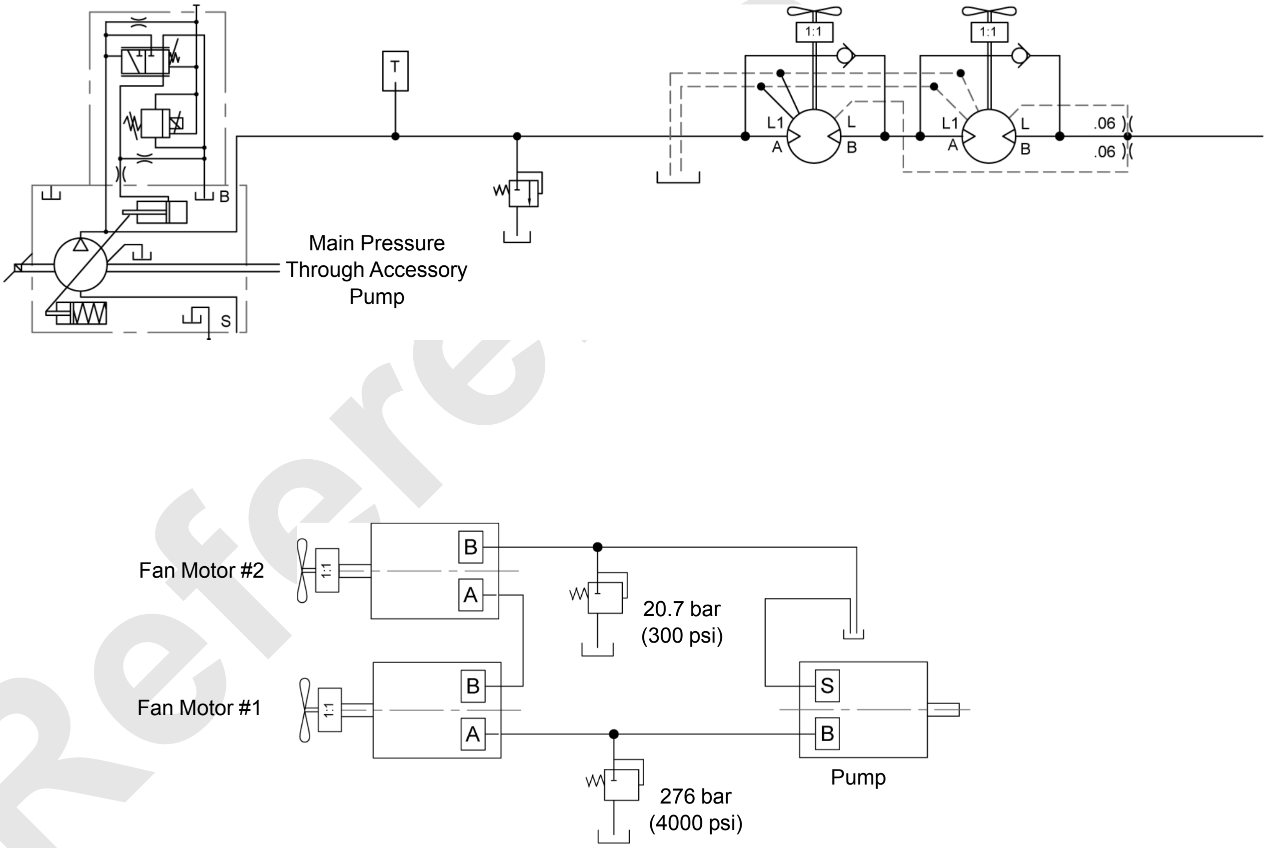


FIGURE 1-66

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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 hydraulic system 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 the procedures described this section. The technicians shall read, understand, and comply with the instructions in this section and to the display screen instructions in Section 3 of the Operator Manual.

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

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

CAUTION

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

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

CHECKING AND REPLACING HYDRAULIC HOSES

CAUTION

Burn Hazard!

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

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

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

    If any of these conditions exist, address them appropriately

    See Table 2-1 below for the following items.
3. 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 65°F (18°C). Latitude: 15° - 25° N & S
B	Dry or Arid: Deficient precipitation most of the year. Latitude: 20° - 35° N & S
C	Moist Mid-Latitude: Temperate with mild winters. Latitude: 30° - 50° N & S
D	Moist Mid-Latitude: Cold winters. Latitude 50° - 70° N & S
E	Polar: Extremely cold winters and summers. Latitude: 60° - 75° N & S

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

HYDRAULIC SYSTEM MAINTENANCE

Safety

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

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

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

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

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

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

Storing and Handling Oil

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

Storing and Handling Parts

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

   Do not use rags to plug openings. Use clean plastic shipping plugs and caps.

Inspecting System

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

A good inspection program will include the following checks:

1. Keep accurate records so future maintenance needs can be projected.
2. Only use approved hydraulic oil in system (see Section 9 of this manual).
3. Check oil level in tank daily. Carefully ***clean*** area around fill cap before removing it to add oil. When adding oil to tank, filter oil through 10-micron filter.
4. Clean exterior of system often; do not let dirt accumulate on or around any part of system.
5. Check for external leaks. Leaks are not only unsafe; they also attract dirt and in some cases allow air and water to enter system. Do not return leakage oil back to hydraulic tank.

   Do not use your hands to check for leaks.

   - Look for oil leaking from fittings and from between parts that are bolted together. Tighten loose fittings and attaching bolts to proper torque, and do not over tighten.

     If leaks continue, replace seals or gaskets.

   - Look for oil leaking from pump and motor shaft ends, from valve spool ends, and from cylinder shaft ends. Replace seal if leakage is found at any of these points.

- Replace tubes that are cracked, kinked, or bent.
- Replace hoses that are cracked, split, or abraded.
- Listen to pumps and motors for unusual noises. A high pitched whine or scream can indicate that air is being drawn in.

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

  Do not return leakage oil back to hydraulic tank.

6. Look for signs of overheating: heat peeled parts, burned and scorched oil odor, and darkening and thickening of oil. Maximum temperature of oil in tank must not exceed 180°F (82°C).
7. Have hydraulic oil analyzed at regular intervals to determine condition of oil and extent of system contamination.

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

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

Servicing Pumps

It is not necessary to drain the hydraulic tank when servicing the hydraulic pumps. To service the pumps, close the shut-off valve (Figure 2-1) in the pump suction line.

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

CAUTION

Avoid Damage to Pumps!

Open hydraulic tank shut-off valve (Figure 2-1) before starting the engine. Failing to perform this step will result in damage to pumps from cavitation.

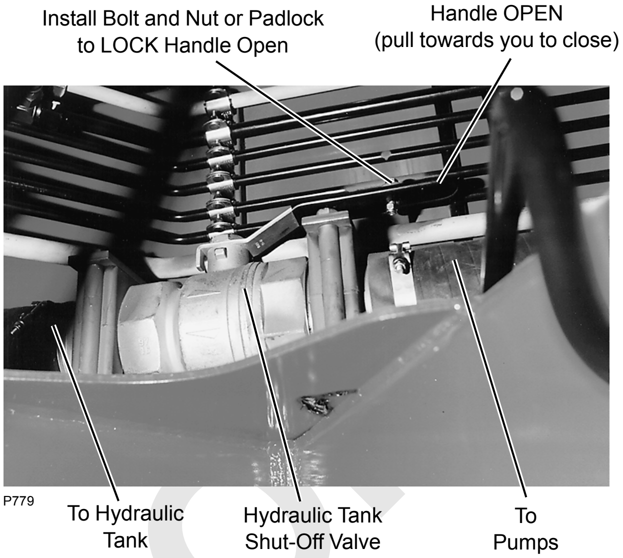


FIGURE 2-1

Cleaning Fill Cap Assembly

See Figure 2-2 for the following procedure.

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

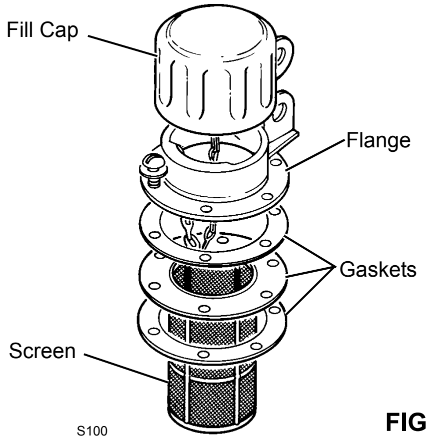


FIGURE 2-2

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

c. Thoroughly clean fill cap and screen in clean, nonflammable solvent and blow dry with compressed air.

d. Replace screen if it is damaged.

e. Install new gaskets, if necessary.

f. Assemble screen, gaskets, and flange to tank; tighten screws evenly.

g. Securely fasten fill cap to flange.

Replacing 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 Digital Display Readings topic in Section 3 of the Operator Manual).

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

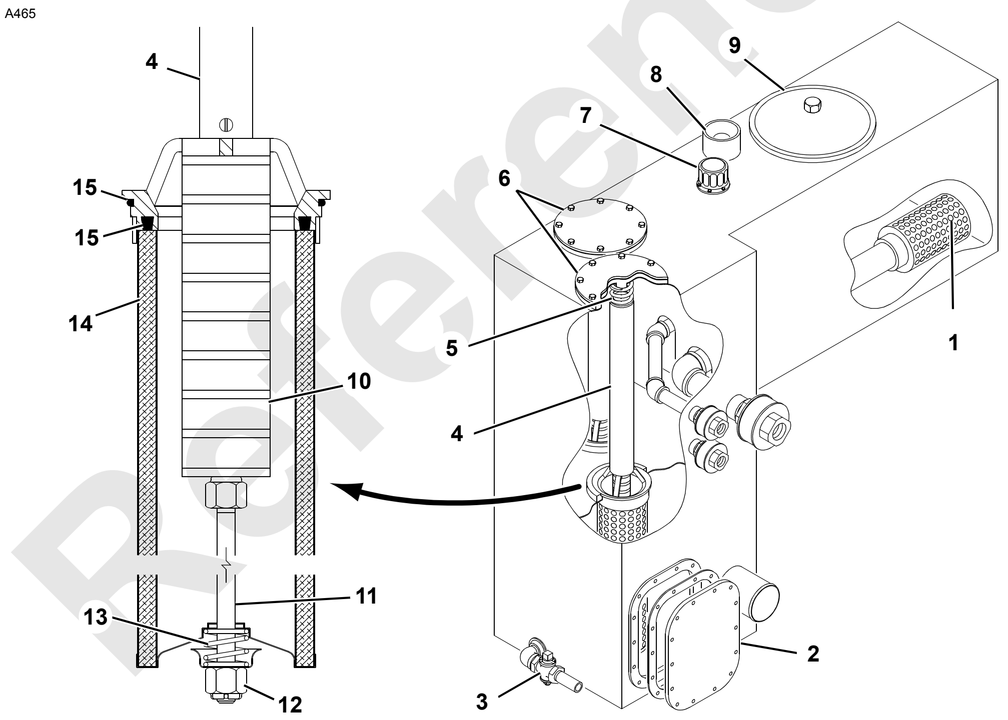
NOTE: Hydraulic tank does not have to be drained to replace filter elements (except when changing oil).

1. Stop the engine.
2. Remove filter access cover.
3. Remove spring.
4. Lift filter assembly out of tank using insert.
5. Remove bypass spring assembly.
6. Remove filter element by twisting off and discard.
7. Clean magnetic core with a lint free cloth.
8. Check all seals for damage and replace if necessary.
9. Lubricate 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 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 bypass spring assembly. Tighten nut until snug.
12. Reinstall filter assembly in tank housing.
13. Reinstall filter spring, gasket, and filter access cover.
14. Evenly tighten cap screws holding cover in place.
15. Perform steps 2 through 14 for the other element.
16. Fill hydraulic tank to specified level with proper hydraulic oil (Section 9 of this manual).

Filter oil with a 10-micron element as oil is added to tank.



Suction Filter
(2 each)
View B

Hydraulic Tank
(right corner of rotating bed)
View A

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

FIGURE 2-3

Changing 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.

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

CAUTION

Air System Contamination!

Clean outside of air piping to prevent dust and dirt from entering air system when air piping connection is opened to access hydraulic tank clean-out covers.

Hydraulic Oil Contamination!

Take precautions to prevent dust and wind-blown dirt from entering tank while covers are off.

---

4. Disconnect air piping at connections to fully access clean-out covers.
5. Clean all dirt off access covers on hydraulic tank. Then remove covers from tank and proceed as follows:
    - **a.** Clean out any sediment inside tank.
    - **b.** Remove diffusers (Figure 2-3, View A) from inside tank.

      Soak diffusers in diesel fuel and blow clean and dry with compressed air. Replace any damaged parts.
    - **c.** Reinstall diffusers after cleaning.
6. Use new seals and fasten access covers to tank.
7. Replace suction filter elements.
8. Clean fill cap assembly.
9. Fill hydraulic tank to specified level with proper hydraulic oil (see Lubrication in Section 9 of this manual).

   Filter oil with a 10-micron element as oil is added to tank.
10. Start and run engine at low speed for 10 – 15 minutes to fill all lines with oil and to bleed any air from system.
11. Stop engine and fill hydraulic tank to specified level.

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

Table 2-2 Hydraulic System Specifications

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

Notes	
1	Controlled by multi-function valves in each pump.
2	Controlled by crane's programmable controller.
3	Speeds based on engine at high idle, no load (no rope on drums), and handles moved fully forward or back.
4	Same pump is used for split rear drum 2 **or** 3. Active drum is selected by first handle moved.
5	Pump used for Boom Hoist 4 **or** Luffing Jib Hoist 5. Active drum will not hoist until alternate drum is parked.
6	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 clam operation.
8	Accessory pumps are the source of hydraulic pressure for accessory system and high pressure accessory components. Items include swing and travel brakes, Boom hinge pin cylinders, rotating bed jacking cylinders, front and rear adapter frame pin cylinders, mast pins and raising cylinders, cab tilt cylinder, rigging winch, crawler pin cylinders, and MAX-ER 2000. Computer controls pump pressure depending on accessory selected.
9	Optional Front Drum 1 is not present in MAX-ER configuration.
10	Fixed displacement fan pump also supplies low pressure to MAX-ER Drum 9 accessory.

TIGHTENING HYDRAULIC CONNECTIONS

General

1. Make sure fittings and o-rings being used are the proper size and style.
2. Flush sealing surfaces with clean hydraulic oil to remove any dirt.
3. Carefully inspect 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 to fittings.
6. Be careful not to cut o-rings when assembling to fittings. Use thimble as shown in Figure 2-4 when assembling o-ring over threads.

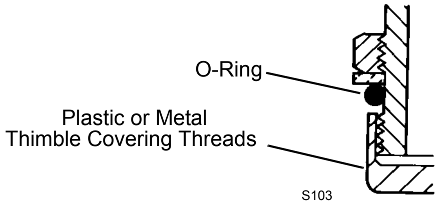


FIGURE 2-4

Pipe Thread Connection

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

CAUTION

Hydraulic System Damage!

Do not use FTE-fluorocarbon tape to seal threads; pieces of tape will enter hydraulic system and cause damage

---

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

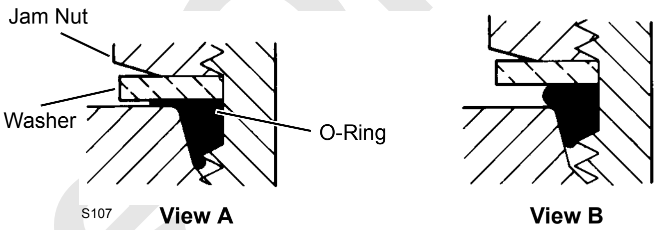
Table 2-3 Pipe Thread Leakages

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

SAE Straight Thread Connection

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

When the jam nut and washer are not backed up, there is not enough room for the o-ring when the squeeze takes place and the washer cannot seat properly as shown in Figure 2-5, View A. The compressed rubber between the washer and the spot face will cold flow out of compression, causing the fitting to loosen and leak as shown in Figure 2-5, View B.



View A

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

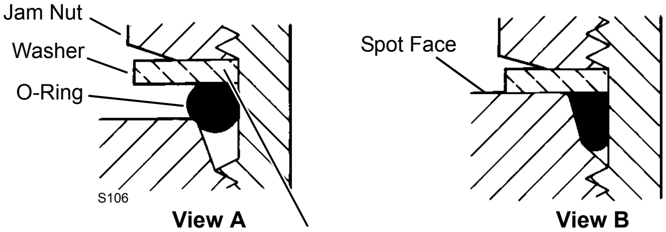
View B

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

FIGURE 2-5

Tighten SAE straight thread connections, as follows:

1. Back up jam nut and washer to end of smooth portion on fitting as shown in Figure 2-6, View A.



View A **View B**

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

FIGURE 2-6

2. It is very important to lubricate o-ring with clean oil.
3. Thread fitting into port until washer bottoms against spot face as shown in Figure 2-6, View B.

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

4. Tighten jam nut. When fitting is properly installed, O-ring will completely fill seal cavity and washer will be tight against spot face as shown in Figure 2-6, View B.

Table 2-4
Straight Thread Leakage

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

ORS Connection

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

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

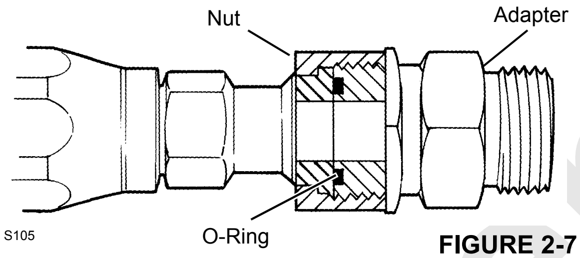


FIGURE 2-7

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

Table 2-5
ORS Assembly Torque

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

Table 2-6
ORS Leakage

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

Split Flange Connection

1. Lubricate and install o-ring in shoulder groove (see Figure 2-8).

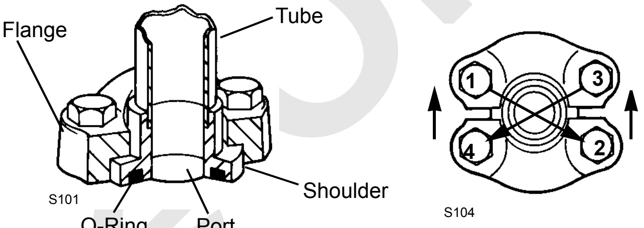


FIGURE 2-8

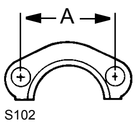
2. Align shoulder with port and assemble flanges over shoulder.

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

3. Snug bolts in a diagonal manner (see Figure 2-8) to 1/3 of torque given in Table 2-7.

4. Repeat above step to 2/3 of final torque. Repeat above step to final torque.

Table 2-7
Split Flange Assembly Torque

A Dimension inch 	Flange Size	Torque in-lb	Torque N•m
Standard Pressure Series			
1-1/2	-08	175 – 225	20 – 25
1-7/8	-12	225 – 350	25 – 40
2-1/16	-16	325 – 425	37 – 48
2-5/16	-20	425 – 550	48 – 62
2-3/4	-24	550 – 700	62 – 79
3-1/16	-32	650 – 800	73 – 90
High Pressure Series			

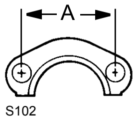
A Dimension inch 	Flange Size	Torque	
		in-lb	N•m
1-9/16	-08	175 – 225	20 – 25
2	-12	300 – 400	34 – 45
2-1/4	-16	500 – 600	57 – 68
2-5/8	-20	750 – 900	85 – 102
3-1/8	-24	1400 – 1600	158 – 181
3-13/16	-32	2400 – 2600	271 – 294

Table 2-8

Split Flange Leakage

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

SAE Flare Connection

1. Tighten nut finger tight until sealing surfaces touch.
2. Mark a line (use felt pen or marker) on adapter and extend it onto connector nut (Figure 2-9, View A).
3. Using wrenches, tighten connector nut the number of flats shown in Table 2-9 (Figure 2-9, View B).
4. Misalignment of marks will show how much nut has been tightened, and best of all that it has been tightened.

Table 2-9

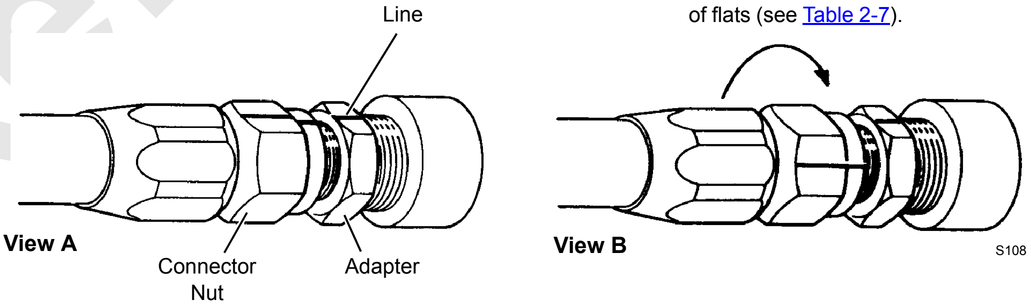
SAE 37° Flare Tightening

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 – 2
1-1/4	-12	1
1-1/2	-16	3/4 – 1
2	-20	3/4 – 1
2-1/4	-24	1/2 – 3/4

Table 2-10

SAE 37° Flare Leakage

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



Turn connector nut required number of flats (see Table 2-7).

FIGURE 2-9

PROGRAMMABLE CONTROLLER CALIBRATION PROCEDURES — PAST

General

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

Controls Calibration

The controls must be calibrated at the following intervals:

- When a pump is replaced
- When a pump control (EDC or PCP) is replaced
- When a new programmable controller is installed
- When a new CPU board is installed
- When a new controller chip is installed
- 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 6 months

To calibrate the controls, proceed as follows:

1. Engage swing lock (past production) or park brake.
2. Calibrate pressure senders.
3. Start and run the engine at 2,100 RPM or higher.
4. Depress and hold swing holding brake switch (on swing handle) for one minute.
5. Repeat steps 3. and 4 a second time.

Pressure Sender Calibration

The pressure senders must be calibrated (zeroed) at the following intervals:

- A new programmable controller is installed
- A new CPU board is installed
- A new controller chip is installed
- A pressure sender is replaced (see Pressure Sender Replacement topic in this section).
- Displayed pressure is wrong

  Be aware that if there is any residual pressure in the system during the calibration process, the display pressure reading in the cab may not reflect actual system pressure. See Note regarding replacing a pressure sender at the end of this procedure.
- Every 6 months

To calibrate the pressure senders, proceed as follows:

1. Stop the engine.
2. Turn ***on*** cab power switch.
3. Turn crane mode selector key counterclockwise to ***confirm*** position and hold.
4. Press engine run/stop switch to ***run*** position.
5. Continue to hold crane mode selector key in ***confirm*** position for one minute after performing above step.
6. Confirm that pressure senders are properly calibrated by checking charge pressure on diagnostic screens (see Diagnostic Display topic in Section 10 of this manual).
   - **a.** With engine off (key in ***run*** position), charge pressure for each crane function should be 50 psi (3,4 bar) or less.
   - **b.** With engine running, charge pressure for each crane function should be within normal operating range – approximately 275 (19 bar) at low idle to 400 psi (27,6 bar) at high idle.

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

Before replacing a pressure sender, do the following:

- Perform pressure sender calibration steps.
- Attach an accurate hydraulic pressure gauge to the quick-coupler at the suspect pressure transducer (see Section 2).
- If pressure appears on the gauge, bleed the corresponding system so the gauge reads zero pressure.
- Repeat calibration steps and check pressure on the display in the cab with the engine running at idle – the display reading and the gauge reading should be the same.
- Before replacing a pressure sender, check the signal voltage at the sender. It should be 1.0 volt against ground at 0 psi.

PROGRAMMABLE CONTROLLER CALIBRATION PROCEDURES — CURRENT

General

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

Pressure Sender Calibration

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 intervals:

- A new programmable controller is installed
- A new CPU board is installed
- A new controller chip is installed
- A pressure sender is replaced
- Every 6 months
- Displayed pressure is wrong

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

To calibrate pressure senders, proceed as follows:

1. Access diagnostic screens by pressing limit bypass switch while scrolling up with scroll switch.
2. Scroll until control calibration screen (Figure 2-10) appears.

```
PRESS SENDER CAL
BYPASS TO START
```

FIGURE 2-10

3. Stop the engine (leave ignition and cab power switches on), turn limit bypass key clockwise and hold. It is normal for yellow operating limits light to come on during this procedure.
4. Calibration will not start if engine is running and following screen appears. Likewise, calibration stops and following screen appears if engine is started during calibration.

```
PRESS SENDER CAL
ENGINE MUST BE OFF
```

FIGURE 2-11

5. Repeat step 3.
6. When calibration starts, following screen appears to indicate percent of completion as shown in Figure 2-12. It takes approximately 1 minute to complete process.

```
PRESS SENDER CAL
___% COMPLETE
```

FIGURE 2-12

7. When calibration is complete, start screen in Figure 2-10 reappears.
8. 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(s) is displayed.

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 & Luffing Drums)
32	4	System Pressure (Travel/Drum 9 on MAX-ER)
64	5	System Pressure (Left Travel)
128	0	System Pressure (Independent Luffing)

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

Before replacing a pressure sender, do the following:

- Perform pressure sender calibration steps.
- Attach an accurate hydraulic pressure gauge to the quick-coupler at the suspect pressure transducer (see Section 2).
- If pressure appears on the gauge, bleed the corresponding system so the gauge reads zero pressure.
- Repeat calibration steps and check pressure on the display in the cab with the engine running at idle – the display reading and the gauge reading should be the same.
- Before replacing a pressure sender, check the signal voltage at the sender. It should be 1.0 volt against ground at 0 psi.

Controls Calibration

The controls must be calibrated at the following intervals:

- When a pump is replaced
- When a pump control (EDC or PCP) is replaced
- When a new programmable controller is installed
- When a new CPU board is installed
- When a new controller chip is installed
- 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 6 months

To calibrate the controls, proceed as follows:

1. Access diagnostic screens by pressing limit bypass switch while scrolling up with scroll switch.
2. Scroll until control calibration screen (Figure 2-13) appears.

```
CONTROL CALIBRATION
BYPASS TO BEGIN
```

FIGURE 2-13

3. Increase engine speed to high idle and press limit bypass switch.

NOTE: It is normal for yellow operating limits light to come on during this procedure.

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

```
CONTROL CALIBRATION
HIGH IDLE REQUIRED
```

FIGURE 2-14

5. Repeat step 3.
6. When calibration process starts, the percent of completion screen appears as shown in Figure 2-15. It takes approximately 2 minutes to complete process.

```
CONTROL CALIBRATION 6
___% COMPLETE
```

FIGURE 2-15

7. When calibration is complete, start screen in Figure 2-13 reappears.
8. Check the data bank in the upper right corner of the screen. If a control/pump failed the test, the fail item(s) binary number(s) is displayed.

Table 2-12 Controls Binary Numbers

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

PRESSURE SENDER REPLACEMENT

See Figure 2-16 for identification of pressure senders.

General

The instructions in this folio must be followed to ensure safe removal of faulty pressure senders and to ensure proper operation after installation of new pressure senders.

WARNING

High Pressure Oil Hazard!

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

---

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

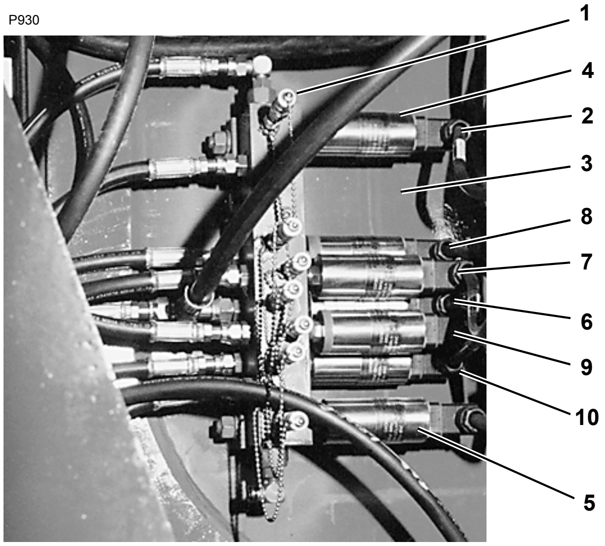
   Perform steps 5-9 only at faulty pressure senders.

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

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

9. Bleed pressure senders as follows:
   - **a.** Connect bleed lines with shut-off valves to couplers on pressure sender manifold. Open valve in bleed lines. Use a suitable container to catch oil flow.
   - **b.** With all control handles off, start engine and allow it to idle at 950 – 1,000 RPM.
   - **c.** Observe oil flowing from bleed lines.
   - **d.** Close valve in bleed lines when clear oil flows (no air bubbles in oil).
   - **e.** Stop the engine.
   - **f.** Remove bleed lines from couplers at pressure senders.
10. Calibrate pressure senders.

P930



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

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. Figure 2-17 shows brake and brake solenoid valve locations.

Operational Test

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

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

CAUTION

Overheat Hazard!

Do not hold any function on stall for more than 10 seconds. Damage to system components may occur.

1. Start 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 crane is in full power mode.

3. Disconnect electrical plug for brake being checked.

4. Scroll to corresponding diagnostics screen for brake being checked. Monitor *pump pressure* and *pump command* while moving control handles.

5. For all functions, move control handle in both directions, one at a time, to check brake operation in both directions.

6. Slowly move handle for function being checked. Specified system pressure must be reached before 50% pump command is reached and ***brake must not slip***.

WARNING

Falling Load/Moving Crane Hazard!

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

For load drums with a disc brake on both ends of drum, repair or replace both disc brakes.

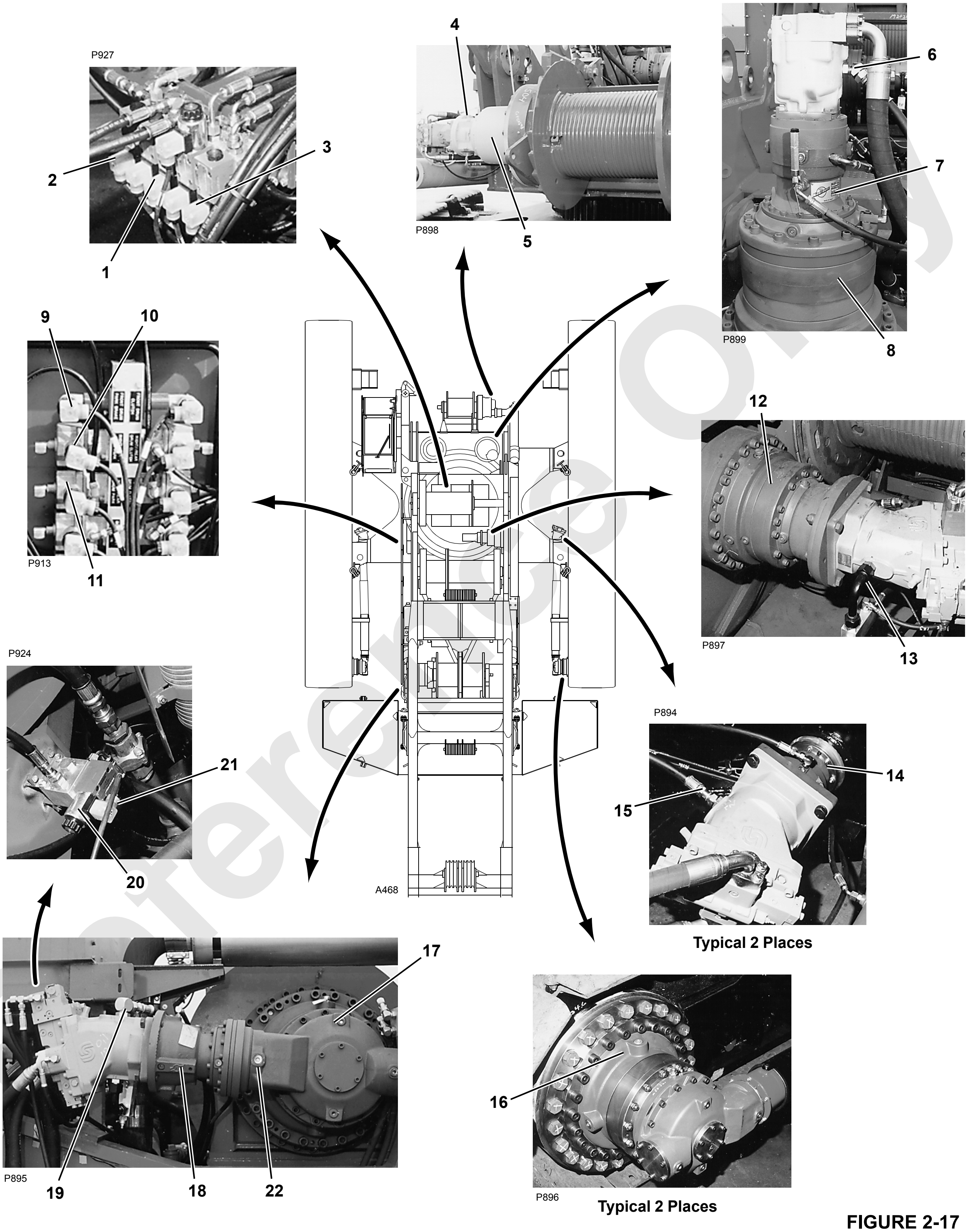
See planetary manufacturer's manual for disc brake repair instructions.

7. Reconnect electrical plugs at all brake solenoid valves at completion of operational test.

8. If disc brakes were repaired or replaced, retest 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 Disc Brake
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
15	Case Drain Port
16	Crawler Input Planetary
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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P899
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P913
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P897
P924
20
21
A468
P894
14
15
Typical 2 Places
17
18
19
22
P895
16
P896
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 the procedures in this section. These technicians shall read, understand, and comply with the instructions in this section.

All adjustments identified in this section 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 in this section. 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 of manual.

During many of the procedures described in this section, it will be necessary to monitor data on the diagnostic screens of the digital display. See Diagnostic Display topic in Section 3 for 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 Pumps
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 Components

Item	Description
A	System Pressure Port A
B	System Pressure Port B
1	Multifunction 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

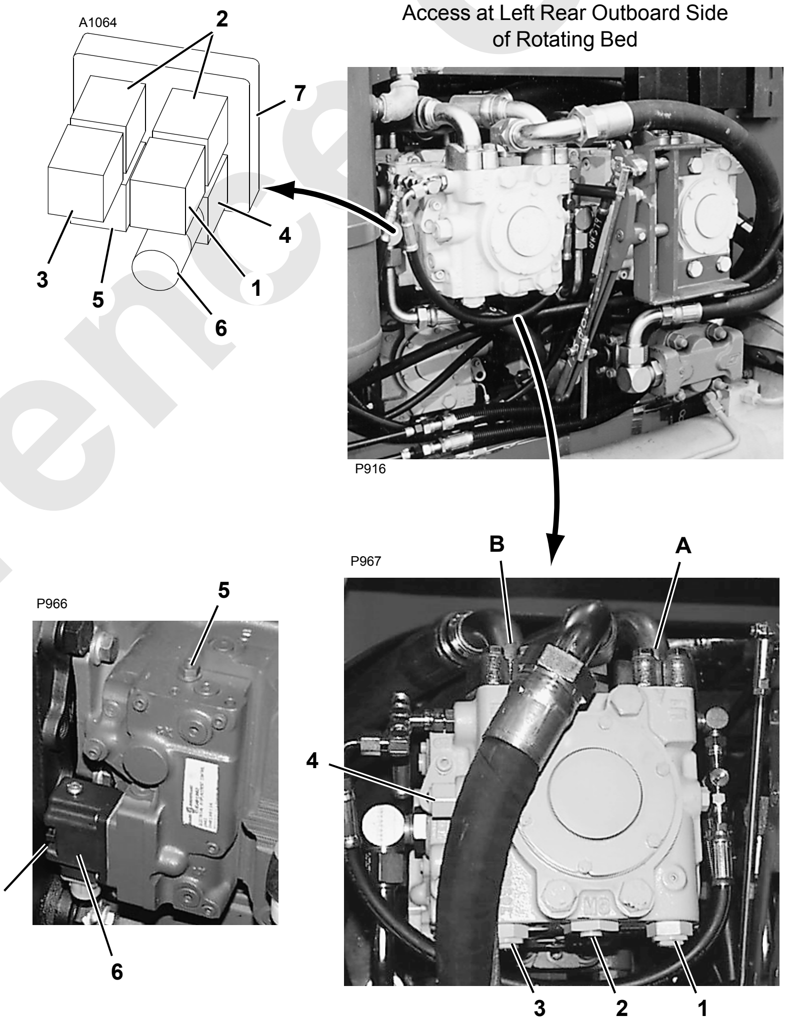
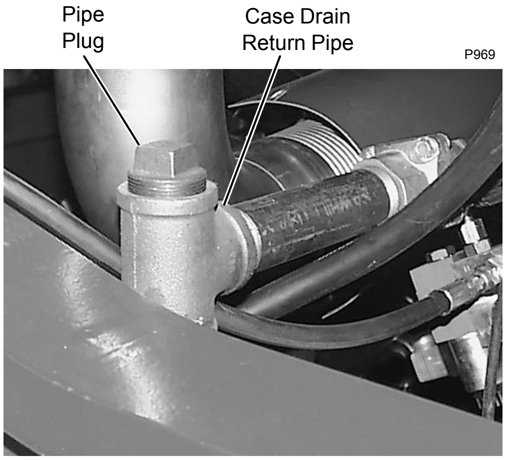
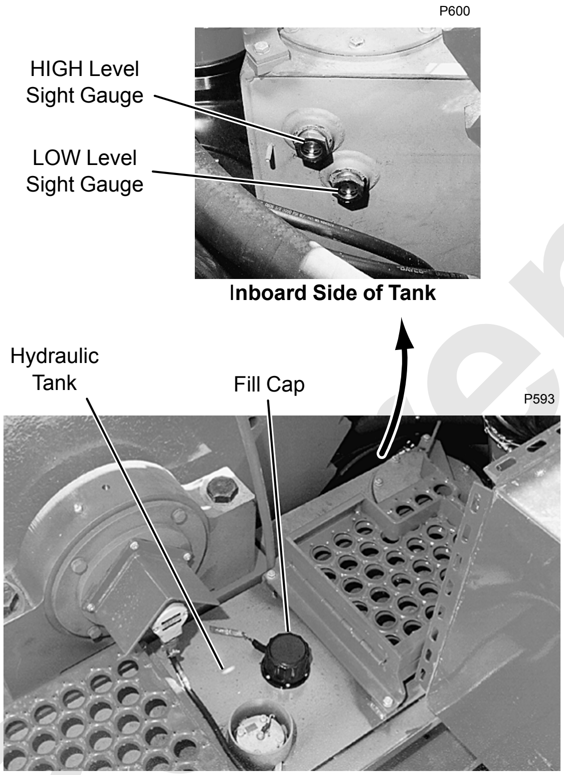


FIGURE 2-18



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

Initial Oil Fill

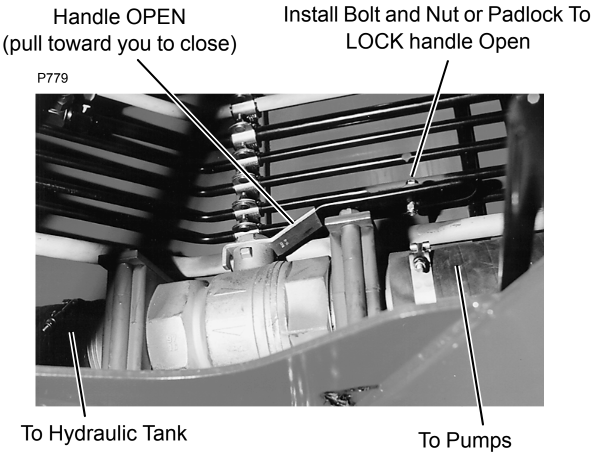
NOTE: Use proper viscosity new hydraulic oil filtered through at least a 10-micron filter.

1. Fill each motor case with clean oil to level of case drain port (Figure 2-18).
2. Fill pump cases as follows:
   a. Remove pipe plug from case drain pipe (Figure 2-19).
   b. Slowly fill pipe with clean oil. Air will gurgle out of pipe as oil is added.
   c. Stop filling pipe when oil stops gurgling and pipe is full.
   d. Securely install pipe plug.
3. Fill hydraulic tank with clean oil to middle of FULL level sight gauge (Figure 2-20).

Pressure Sender Calibration

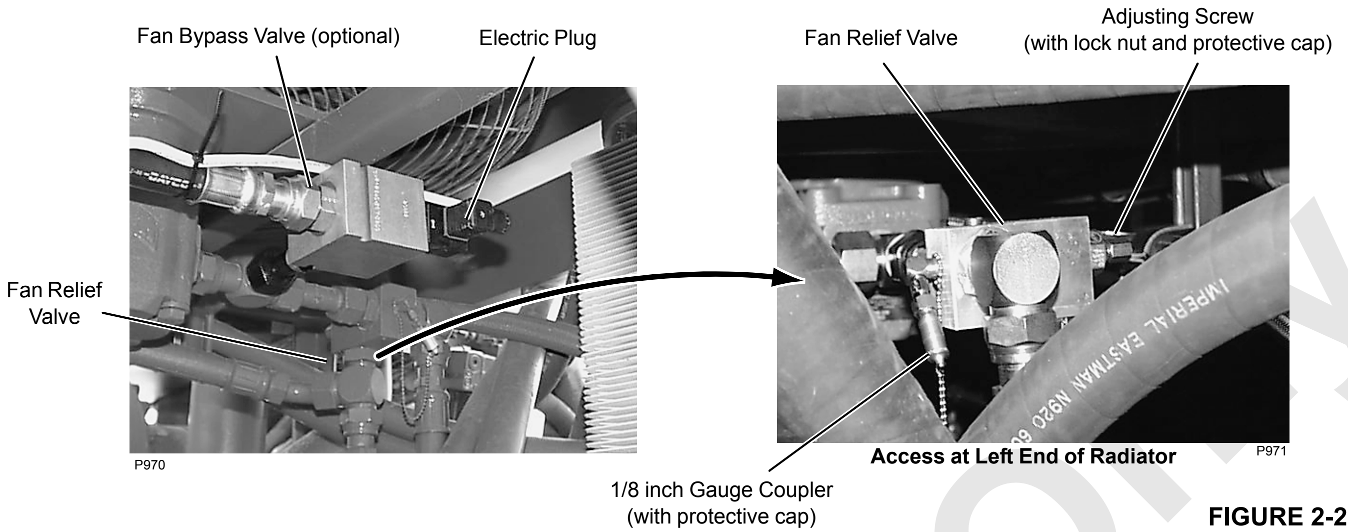
Perform this procedure before Initial Start-Up.

1. Turn ***on*** cab power switch.
2. Turn crane mode selector key counterclockwise to ***confirm*** position and hold.
3. Press engine run/stop switch to ***run*** position.
4. Continue to hold crane mode selector key in ***confirm*** position for one minute after performing 3.
5. Confirm for proper calibration — **with engine off (key in *run*)**, charge pressure on diagnostic screen for each crane function should be 50 psi (3,4 bar) or less.



Access at Rear Inboard Side of **Rotating Bed**
(above fuel tank)

FIGURE 2-21



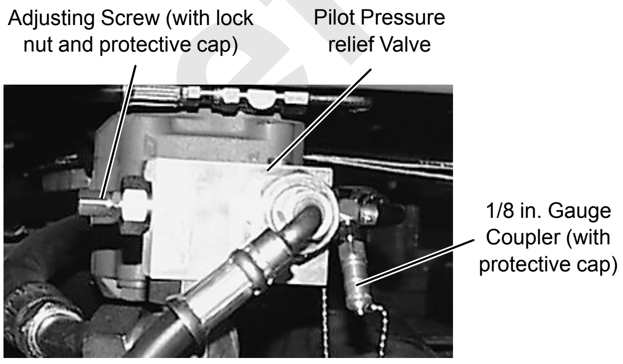
Access at Left End of Radiator

FIGURE 2-22

Initial Start-Up

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

1. Calibrate pressure senders as described in above topic.
2. Open shut-off valve in pump suction line (Figure 2-21). ***Pumps can be damaged from cavitation if this step is not performed.***
3. Connect bleed lines equipped with shut-off valves to gauge coupler at each pressure sender (Figure 2-16).
4. Open shut-off valve in each bleed line. Use a suitable container to catch oil.
5. Remove adjusting screw from fan and pilot pressure relief valves (Figure 2-22 and Figure 2-23). Then reinstall screws approximately 1/4 in (6 mm) and securely tighten lock nuts. Serious damage can occur to system components if this step is not performed before starting engine first time.



Access at Right End of Radiator

FIGURE 2-23

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

CAUTION

Equipment Damage!

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

---

9. On diagnostic screens, check pump pressures for load drums, boom hoist, swing, and travel pumps:
   a. Make sure pressure reading for each pump is 200 – 500 psi (13.8 – 34,5 bar). Pump pressures will be adjusted to final setting later in this procedure.
   b. If pump pressures are not within specified range, ***stop engine immediately***. Determine cause of faulty pressure and correct.
10. Stop the engine.
11. Remove bleed lines from gauge couplers at each pressure sender.

12. Perform the following procedures:
    a. Engine throttle adjustment (MCC Electrician). Do not perform remaining procedures until engine throttle is adjusted to proper speeds:
    b. 950 – 1,000 RPM low idle
    c. 2,100 – 2,125 RPM high idle
    d. Fan and pilot pressure adjustment
    e. Charge pressure checks
13. With engine at low idle, extend and retract all cylinders (jacking, boom butt handling, gantry) three times.
14. With engine running at low idle, slowly cycle each crane function in both directions for at least five minutes to vent any remaining air from hydraulic system.
15. Be sure all crane functions operate in proper direction with relation to control handle movement.
16. Check for hydraulic leaks, and correct cause if found.
17. Stop engine and fill hydraulic tank to 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 appropriate Quality Verification Form for crane you are working on.

Controls Calibration

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

Fan and Pilot Pressure Adjustment

1. Stop the engine.
2. If crane has cold weather option, disconnect electric plug from fan bypass valve (Figure 2-22) before starting.
3. Connect accurate hydraulic pressure gauges to gauge couplers, as follows:
    a. 0 to 5,000 psi (0 to 345 bar) at fan relief valve (Figure 2-22).
    b. 0 to 1,000 psi (0 to 69 bar) at pilot pressure relief valve (Figure 2-23).
4. Remove adjusting screw from both valves. Then reinstall them approximately 1/4 in (6 mm).
5. Start the engine.
6. With engine running at low idle, turn fan relief valve adjusting screw (Figure 2-22) in until gauge reads approximately 1,000 psi (69 bar).
7. With engine running at high idle, turn pilot pressure relief valve adjusting screw (Figure 2-23) in until gauge reads 325 to 375 psi (22,4 to 25,8 bar). Hold adjusting screw in position and securely tighten lock nut.
8. With engine running at high idle, adjust fan relief valve:
    a. Slowly turn adjusting screw out to decrease pressure until fans start to slow down and pressure starts to drop on gauge.
    b. Slowly turn adjusting screw in. Fan speed and pressure will increase.
    c. Continue to slowly turn adjusting screw in until pressure stops increasing. Then turn adjusting screw in an additional 1/2 turn.

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

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

       If pressure is not okay, ***determine cause and correct***.
9. Stop the engine.
10. Remove gauges and install protective caps over adjusting screws and gauge couplers.
11. If crane has cold weather option, connect electric plug to fan bypass valve (Figure 2-22).

Charge Pressure Checks

Check charge pressure for 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 1,000 psi (0 to 69 bar) hydraulic pressure gauge to gauge coupler for desired pump (Figure 2-16).
3. Start and run the engine at low idle.
4. Note and record gauge reading. Gauge should read 325 to 375 psi (22,4 to 25,8 bar).

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

5. If proper pressure is not obtained, adjust charge pressure relief valve for corresponding pump. See instructions in pump manufacturer’s manual.
6. Stop engine and remove gauge from coupler (Figure 2-16). Install protective cap over coupler.

Operating Pressure Checks

It will be necessary to monitor 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!

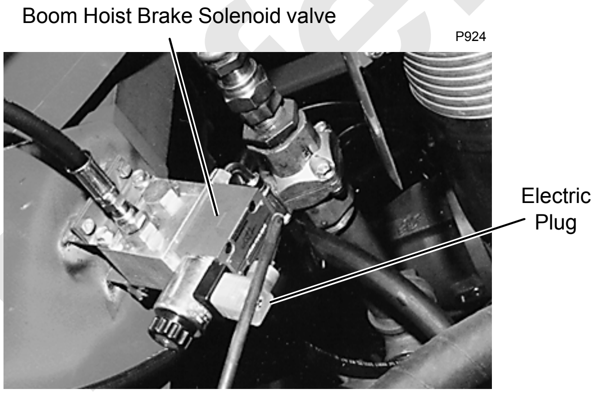
Do not stall hydraulic system longer than 10 seconds during following pressure checks or components may be damaged from overheating.

Boom Hoist Down

1. Stop the engine.
2. Loosen lock nut on adjusting screw at down multifunction valve in boom hoist pump.
3. Turn adjusting screw out until it stops. Then turn adjusting screw in 1-3/4 turns.
4. Start and run engine at 1,500 RPM and operate boom hoist in down direction (no wire rope or load on drums) Drum should turn freely. If not, proceed as follows:
    - **a.** Stop boom hoist drum.
    - **b.** Turn down adjusting screw in 1/4 turn.
    - **c.** Repeat steps 4 through 4b until drum turns freely.
5. Hold adjusting screw and securely tighten lock nut.

Boom Hoist Up

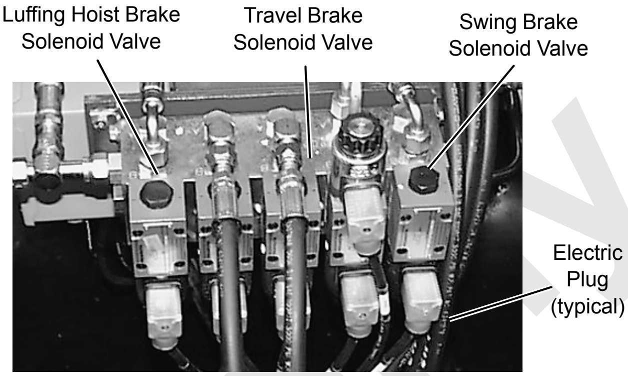
1. Stop the engine.
2. Disconnect electric plug from boom hoist brake solenoid valve (Figure 2-24). This will stall boom hoist pump.



Access at Left Rear Inboard Side of Rotating Bed

FIGURE 2-24

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

Swing

1. Stop the engine.
2. Disconnect electric plug from swing brake solenoid valve (Figure 2-25). This will stall swing pump.
3. Start and run the engine at 1,500 RPM.
4. Scroll to SWING diagnostic screen. Monitor *pump pressure* and *command* while moving control handle.
5. Slowly move swing control handle in both directions, one at a time, to check swing pressure.
6. Swing pressure in both directions should be 5,500 to 6,500 psi (379 to 448 bar) before 50% pump command is reached, and brake must not slip.
7. If specified pressure is not indicated in either direction or brake slips, ***determine cause and correct***.
8. Connect electric plug to swing brake solenoid valve (Figure 2-25).

Travel

1. Stop the engine.
2. Disconnect electric plug from travel brake solenoid valve (Figure 2-25). This will stall travel pumps.
3. Start and run the engine at 1,500 RPM.
4. Scroll to TRACK diagnostic screen. Monitor pump pressure and command while moving control handles.
5. Slowly move both travel control handles in both directions, one handle at a time.
6. Travel pressure for each crawler in both directions should be 5,500 to 6,500 psi (379 to 448 bar) before 50% pump command is reached, and brake must not slip.
7. If specified pressure is not indicated in either direction or brake slips, ***determine cause and correct.***
8. Connect electric plug to travel brake solenoid valve (Figure 2-25).

Load Drums

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

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

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

Auxiliary System Pressure Checks

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

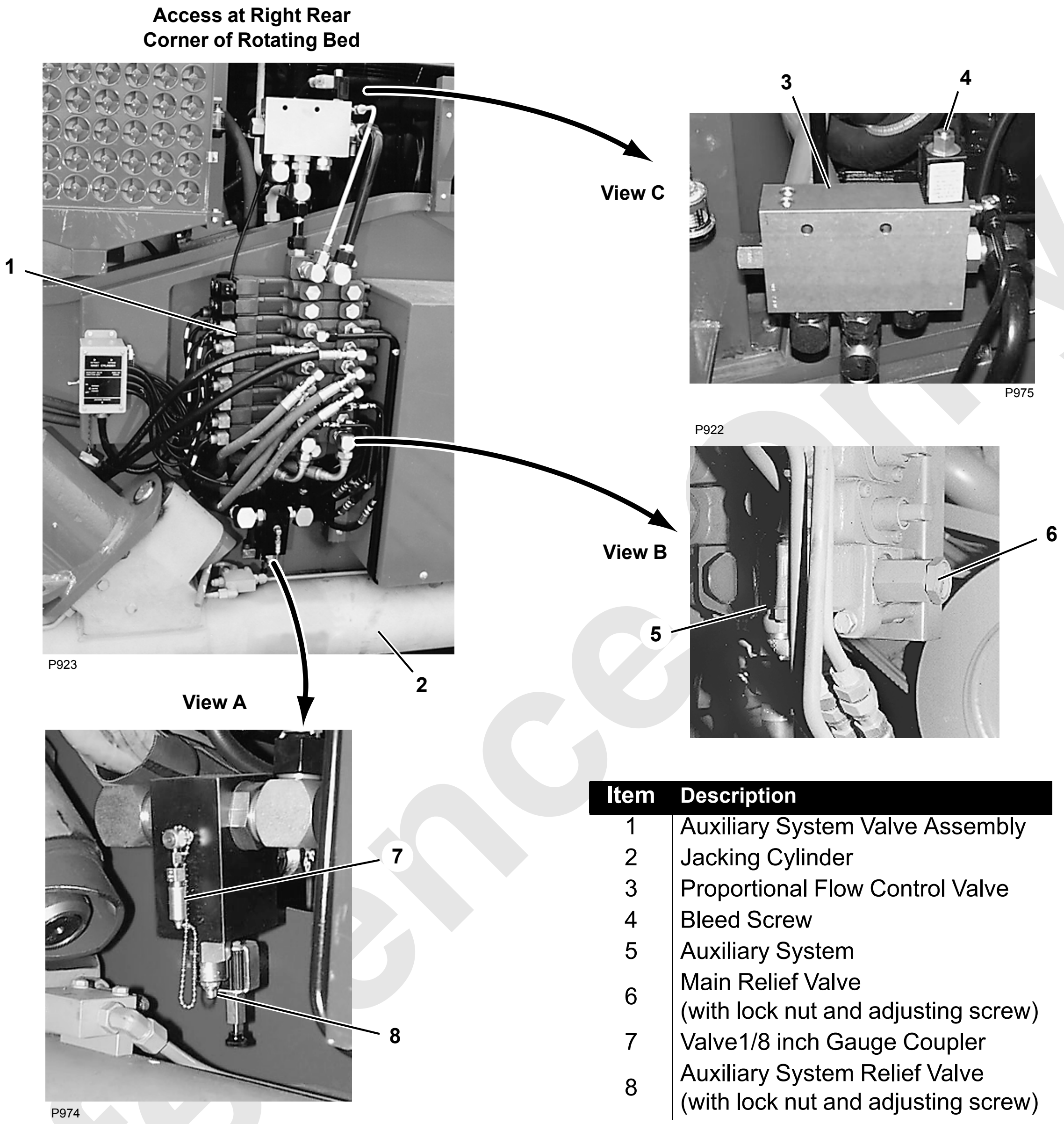
CAUTION

Overheating Damage!

It is necessary to stall hydraulic system during the following pressure checks. Do not stall system longer than necessary to read pressures and make adjustments, or components may be damaged from overheating.

Auxiliary System Relief Valve

1. Stop the engine.
2. Connect an accurate 0 – 6,000 psi (0 – 413 bar) hydraulic pressure gauge to gauge coupler at auxiliary system relief valve (Figure 2-26, View A).
3. At main relief valve on auxiliary system control valve (Figure 2-26, View B), loosen lock nut and turn adjusting screw in one full turn. Securely tighten lock nut.
4. Start and run engine at 1,500 RPM.
5. Fully retract both gantry cylinders until they bottom out (stall hydraulic system). Gauge pressure should be 3,500 to 3,600 (241 to 248 bar).
6. If specified pressure is not indicated, proceed as follows:
   a. Loosen lock nut on adjusting screw for auxiliary system relief valve (Figure 2-26, View A).
   b. Turn adjusting screw in to increase or out to decrease pressure.
   c. Repeat step 5 through 6b until specified pressure is obtained, and securely tighten lock nut.
7. Stop engine and remove gauge from coupler on auxiliary system relief valve (Figure 2-26, View A). Install protective cap over coupler.



Item	Description
1	Auxiliary System Valve Assembly
2	Jacking Cylinder
3	Proportional Flow Control Valve
4	Bleed Screw
5	Auxiliary System
6	Main Relief Valve (with lock nut and adjusting screw)
7	Valve1/8 inch Gauge Coupler
8	Auxiliary System Relief Valve (with lock nut and adjusting screw)

FIGURE 2-26

Rotating Bed Jacking Cylinders

1. Stop the engine.
2. Jacking cylinders will be extended during this procedure.
   a. Rotate jacking cylinders away from rotating bed so they cannot contact anything.
   b. ***Warn all personnel to stand clear of cylinders***.
3. Connect an accurate 0 to 6,000 psi (0 to 413 bar) hydraulic pressure gauge to gauge coupler on auxiliary system relief valve (Figure 2-26, View A).
4. Start and run the engine at 1,500 RPM.
5. Fully extend one jacking cylinder until it bottoms out (stall hydraulic system). Gauge pressure should be 2,200 to 2,300 psi (152 to 158 bar).
6. Repeat steps 4 and 5 for each jacking cylinder, one at a time.
7. If specified pressure is not indicated for any cylinder, ***determine cause and correct***.
8. Fully retract and store cylinders when done.
9. Stop engine and remove gauge from coupler on auxiliary system relief valve (Figure 2-26, View A). Install protective cap over 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. Check that:
   a. Cylinders operate in proper directions with relation to controls.
   b. All cylinders fully extend and retract smoothly without resistance.
3. If any cylinder does not operate properly, ***determine cause and correct***.

Boom Butt Handling Cylinder

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

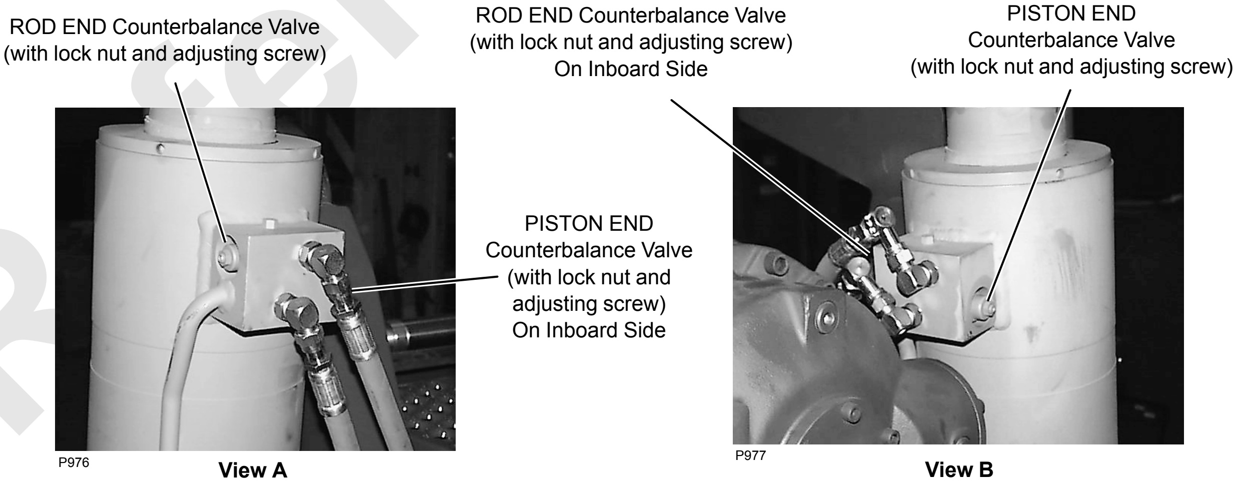
1. Start and run the engine at 1,500 RPM.
2. Fully retract cylinder until it bottoms out, and proceed as follows:
   a. Crack open bleed screw on proportional flow control valve (Figure 2-26, View C).
   b. Securely close bleed screw when a steady stream of clear oil appears.
3. Set speed control on setup remote control to fast.
4. Fully retract and then fully extend boom butt handling cylinder. Extension time should be approximately 60 seconds. If not, ***determine cause and correct***.
5. Once fully extended, cylinder must hold boom butt in position without retracting.
6. If cylinder does not hold, ***determine cause and correct***.
7. Cylinder must extend and retract smoothly. If not, ***determine cause and correct***.

Gantry Cylinders

See Figure 2-27 for the following procedure.

Perform steps 1 and 2 with gantry removed.

1. Start and run engine at 1,500 RPM.
2. Extend gantry cylinders. Both cylinders should extend at same speed. If they do, go to step 4. If they do not, proceed as follows:
   a. At faster cylinder, loosen lock nut and turn rod end counterbalance valve adjusting screw out in small increments until both cylinders extend at same speed.
   b. Securely tighten lock nut.
3. Perform the remaining steps with gantry installed.
4. Fully retract cylinders and attach counterweights (Series 1 at least).
5. Extend cylinders to raise counterweights approximately 1 ft (0,3 m) off ground and stop.
6. Cylinders must hold counterweights in position. If they do, go to step 7. If they do not, proceed as follows:
   a. Lower counterweights to ground (retract cylinders).
   b. At piston end counterbalance valve in both cylinders, loosen lock nut and turn adjusting screw out 1/2 turn.
   c. Repeat steps 5 through 6b until cylinders hold counterweight in position.
   d. Securely tighten 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 cylinders to raise counterweights approximately 1 ft (0,3 m) off ground and stop.
8. Retract cylinders to lower counterweights to ground. Both cylinders should retract at same speed. If they do, go to step 9. If they do not, proceed as follows:
    a. At faster cylinder, loosen lock nut and turn piston end counterbalance valve adjusting screw out in small increments until both cylinders retract at same speed.
    b. Securely tighten lock nut.
9. Repeat steps 5 through 6b with counterweights raised approximately 3 ft (0,9 m) off ground.

System Speed Checks

Check minimum operating speed of each crane function with the engine running at high idle (see Table 2-2 on page 2-6).

Load drum speeds are shown on diagnostics screen for each pump.

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

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

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

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 100 ft (30 m). Check track prints on ground.
5. Track prints must be straight to within 1 ft (0,3 m) in 100 ft (30 m). If not, ***determine cause and correct.***

UNLOADER PILOT VALVE MAINTENANCE

General

See Figure 2-28 for the following procedure.

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] psi (bar)	Cut-Out[2] psi (bar)	
2250	120 (8,3)	132 (9,1)	165 psi (11,4 bar)

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

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

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

As air system pressure increases, unloader valve moves up against the resistance of unloader spring (5). When air pressure reaches the cut-out setting, the unloader valve seats against unloader cap (4). This action closes the exhaust port in 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, unloader spring (6) forces unloader valve (8) down, seating it against unloader body (7). This action closes the flow path from the air tank and opens the exhaust port in 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 12 psi (0,83 bar) 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.

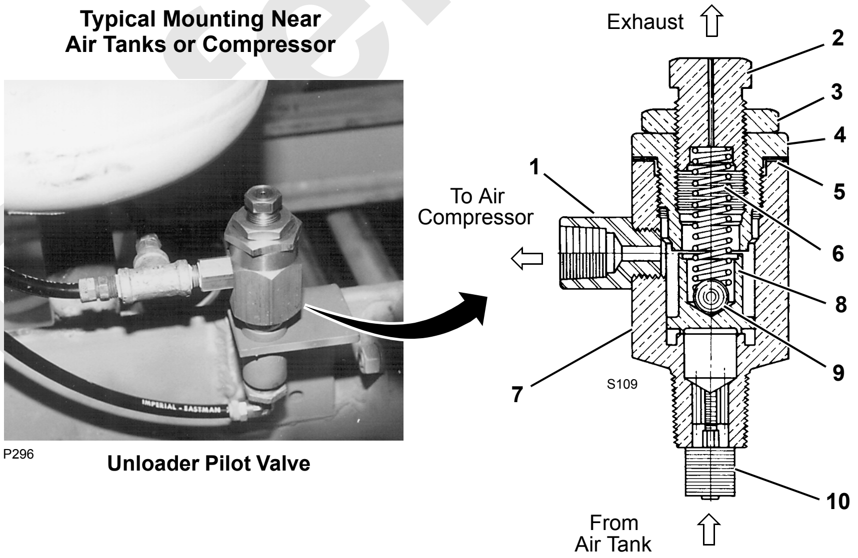
To adjust the cut-out setting, loosen lock nut (3) and turn adjusting screw (2) ***in*** to ***increase*** the pressure or ***out*** to ***decrease*** the pressure. Hold the adjusting screw and securely tighten the lock nut.

Maintenance

If the unloader pilot valve sticks or flutters, take it apart and clean it thoroughly in non-flammable solvent. Be sure to clean filter (10) by removing it and washing it thoroughly in non-flammable solvent. Be sure to reinstall the filter, as 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 Air Compressor manual).
2. Disconnect the air line from the air tank at the unloader pilot valve, and blow out all oil, sludge, scale, etc.
3. Disassemble the entire unloader pilot valve. Wash all parts in non-flammable solvent, and reassemble.
4. In case of major repair work, it is recommended that the unloader pilot valve be returned to the valve manufacturer, due to 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 procedure.

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.

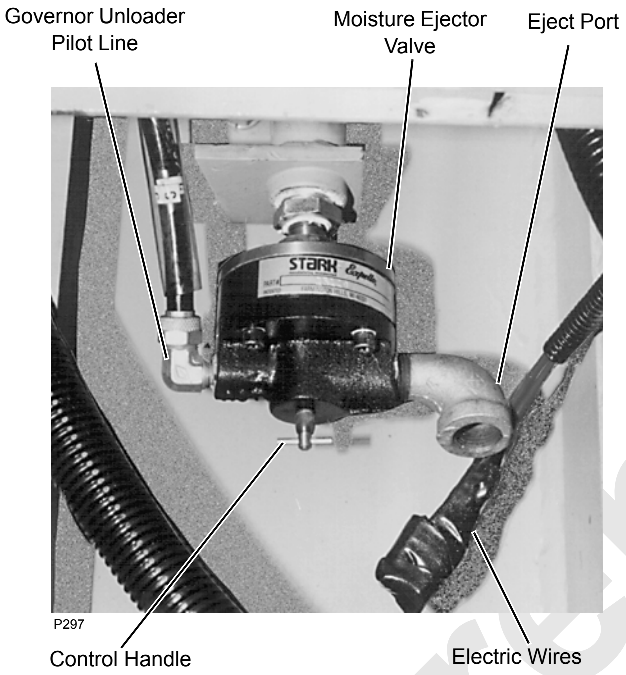


FIGURE 2-29

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 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 cut-outs at the high pressure setting. See Table 2-13 for air system pressure settings.

   If the valve does not operate properly, check 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.
3. The valve should feel warm to the touch within 60 seconds after starting the engine when the outside temperature is 35°F (2°C) or less.

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

   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 electric schematic in Operator Manual or this manual).

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

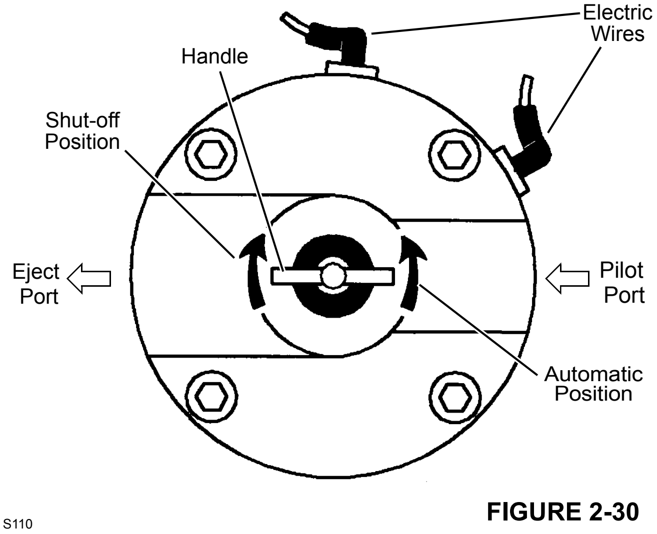


FIGURE 2-30

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

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

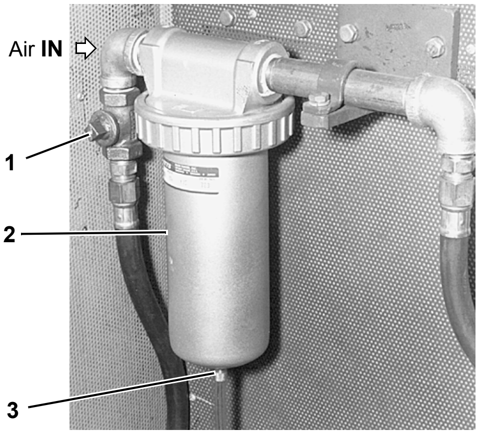
Monthly Maintenance

Replace the filter element as follows:

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

1. Stop engine and de-pressurize filter. If a shut-off valve is provided, close the shut-off valve and open the manual drain valve 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. See Figure 2-31 and disassemble the filter.

P307



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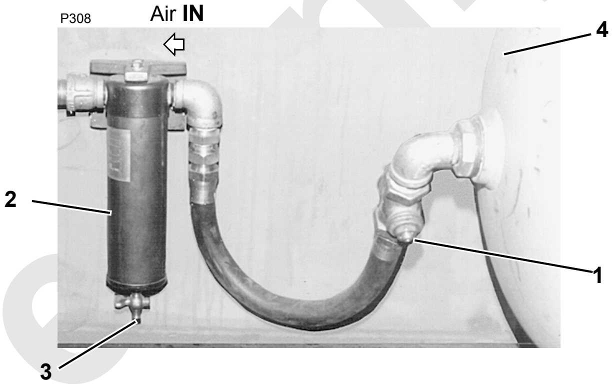

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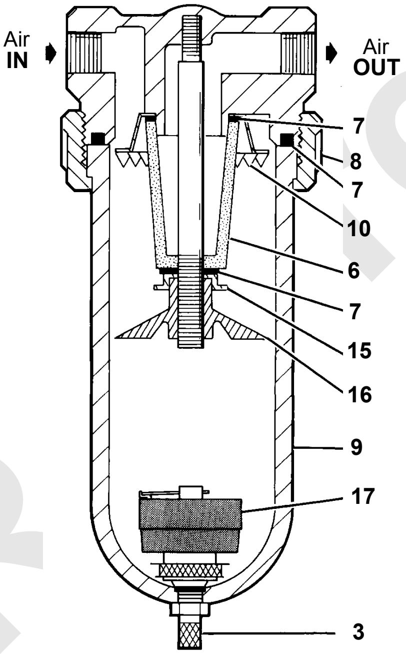
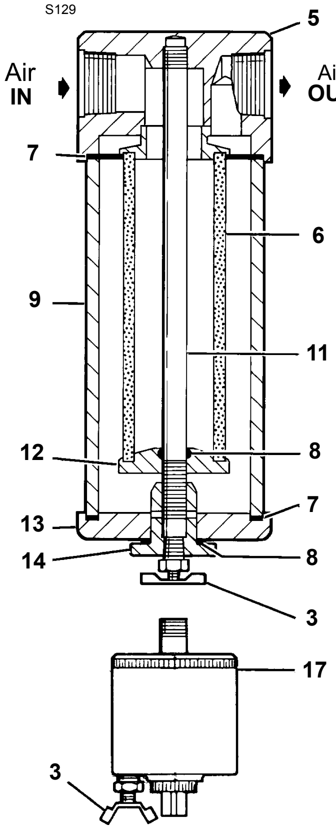


Type A Air Filter

Item	Description
1	Shut-Off Valve
2	Air Filter
3	Manual Drain Valve
4	Air Tank
5	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

S129



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. See Figure 2-31 and 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

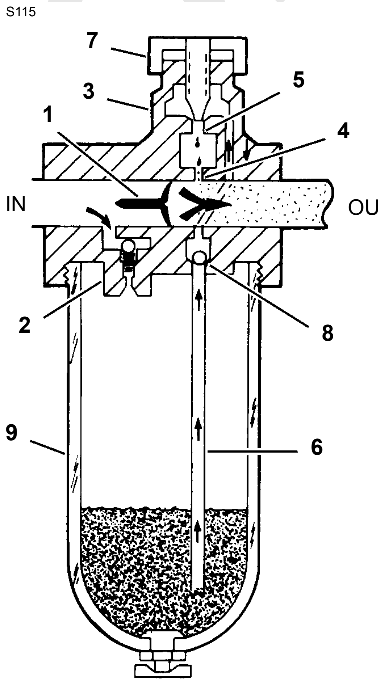
Operation

See Figure 2-32 for the following procedure.

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

Flow sensor functions as a variable restriction in the throat of the de-icer to produce a pressure drop of up to 5 psi (0,3 bar) 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 like 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.

Charge valve (2) controls the rate of reservoir pressurization and allows rapid de-pressurization for refilling without shutting off the air pressure. When anti-freeze 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 anti-freeze. When the fill plug is replaced, the reservoir re-pressurizes through the charge valve at a nominal rate. The charge valve opens fully when inlet pressure is reached.



Item	Description	Item	Description
1	Flow Sensor	6	Siphon Tube
2	Check Valve (charge)	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 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 green lock ring downward to lock setting after final adjustment. To release, pull lock ring upward.

Maintenance

See Figure 2-33 for the following procedure.

To service the de-icer, shut off the air pressure. De-icer may be disassembled without removal from air line.

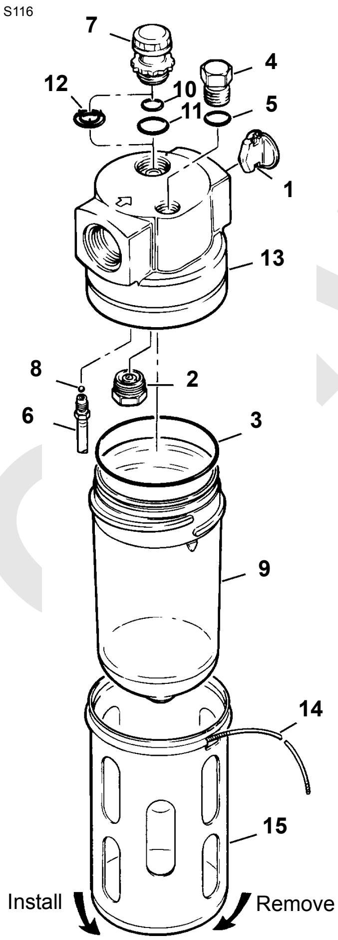
If de-icer has transparent reservoir, remove guard (15) by rotating guard around body (13) to wind out retaining spring (14) through cutout in guard. Slide guard off body.

Unscrew and remove reservoir (9). Remove o-ring (3), fill plug (4) and o-rings, (10 and 11) or seal (12), charge valve (2), if used, siphon tube assembly (6) and check ball (8).

Flow sensor (1) should not be removed unless obviously damaged. If removal is necessary, insert needle nose pliers into inlet port in body (13) and grasp point of flow sensor. Turn sensor approximately 1/4-turn either direction and push out through outlet port of body.

Clean transparent reservoir using clear, warm water only. Clean other pars using soap and water. Dry parts and blow out internal passages using clean, dry compressed air. Inspect each part carefully. Replace any parts which are damaged.

At reassembly, make sure to reinstall flow sensor (1), if removed, with point in direction opposite to flow arrow on body (13). Apply a wipe coat of 44M grease (or equivalent) to O-ring (3). Torque dome assembly (7) and charge valve (2), if used, to 30 to 35 in/lb (3,4 to 4,4 N•m). Tighten siphon tube (6) until snug only. Tighten reservoir (9) by hand until arrowhead on reservoir is in line with or to the right of arrowhead on body. Slide guard (15) onto body and align retaining spring bead in guard with groove in body. Start retaining spring (14) into groove through cutout in guard. Rotate guard around body to 'wind in' the spring.



Item	Description	Item	Description
1	Flow Sensor	9	Reservoir
2	Check Valve (charge)	10	O-Ring
3	O-Ring	11	O-Ring
4	Fill Plug	12	Seal
5	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 reservoir with a good quality desiccant to level indicated by maximum fill line. Do not overfill.

Item	Description
1	O-Ring
2	Exhaust Diaphragm
3	Self-Tapping Screw
4	Purge Valve Lock Nut
5	O-Ring
6	O-Ring
7	O-Ring
8	Purge Valve Housing
10	O-ring
11	Purge Valve
13	Spring
14	O-Ring
15	Check Valve
16	Cap Screw
17	Special Washer
18	Cap Screw (Long)
19	Lock Nut
20	Lower Mounting Bracket
21	O-Ring
22	Desiccant Cartridge
23	O-Ring
24	Housing
25	Upper Bracket Cap Screw
26	Upper Bracket Strap
27	Upper Mounting Bracket
28	Lock Washer
29	Lock Nut
30	Exhaust Cover
31	Bolt
32	Exhaust Diaphragm Washer
33	Purge Piston

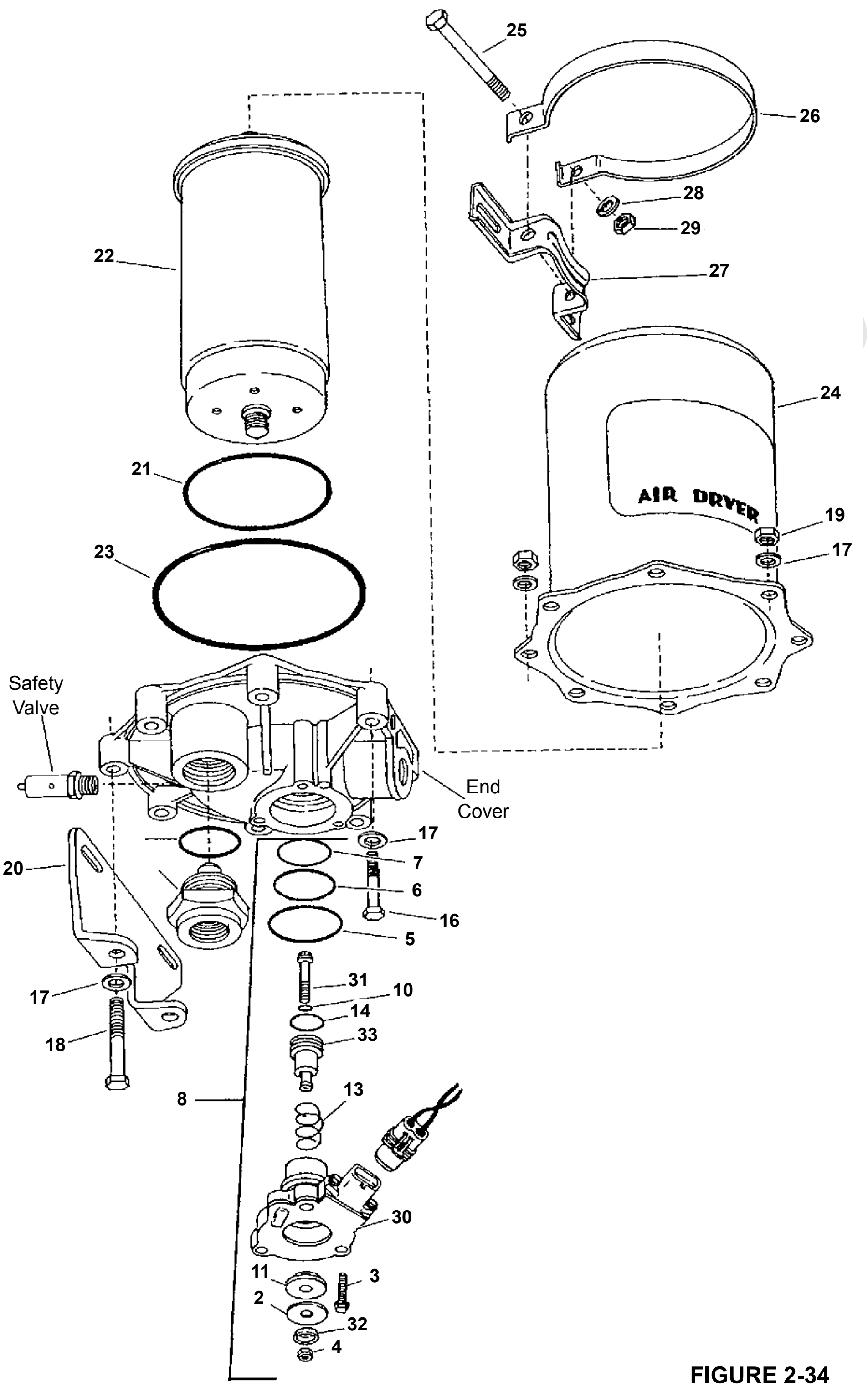


FIGURE 2-34

AIR DRYER MAINTENANCE (CURRENT PRODUCTION)

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 screw in type. Servicing of the screw-in desiccant cartridge requires removal of air dryer from the crane.

Operation and Leak Test

1. Test the outlet port check valve by building the air system to governor cut-out and observing a test air gauge installed on the reservoir. A rapid loss of pressure could indicate a failed outlet port check valve. This can be confirmed by bleeding the system down, removing the check valve from the end cover, subject air pressure to the unit and apply a soap solution to the check valve side. Leakage should not exceed a 1 inch bubble in one second.
2. Check for excessive leakage around the purge valve. With the compressor in loaded mode (compressing air), apply a soap solution to the purge valve housing exhaust port and observe that leakage does not exceed a 1 inch bubble in one second. If the leakage exceeds the maximum specified, service purge valve.
3. Close all reservoir drain cocks. Build up system pressure to governor cut-out and note that air dryer purges with an audible escape of air. Fan the service brakes to reduce system air pressure to governor cut-in.

   System once again builds to full pressure and is followed by an purge cycle.
4. Check the operation of the safety valve by pulling the exposed stem while the compressor is loaded (compressing air). There must be an exhaust of air while the stem is held and the valve should re-seat when the stem is released.
5. Check all lines and fittings leading to and from the air dryer for leakage and integrity.
6. Check the operation of the end cover heater and thermostat during cold weather operation as follows:
7. Electric Power to the Dryer:

   With the ignition or engine kill switch in the ON position, check for voltage to the heater and thermostat using a voltmeter or test light.

   Unplug the electrical connector at the air dryer and place the test leads on each of the pins of the male connector. If there is no voltage, look for a blown fuse, broken wires, or corrosion in the crane wiring harness. Check to see if a good ground path exists.
8. Thermostat and Heater Operation:

   Turn off the ignition switch and cool the end cover to below 40°F (4°C). Using an ohmmeter, check the resistance between the electrical pins in the female connector. The resistance should be 1.5 to 3.0 ohms for the 12 volt heater and 6.8 to 9.0 ohms for the 24 volt heater.

   Warm the end cover to over 90°F (32°C)and again check the resistance. The resistance should exceed 1000 ohms. If the resistance values obtained are within the stated limits, the thermostat and heater is operating properly. If the resistance values obtained are outside the stated limits, replace the purge valve housing, which includes the heater and thermostat.

Disassembly

See Figure 2-34 for the following procedure.

1. Park the crane on a level surface and prevent movement by means other than the brakes.
2. Drain all reservoirs to 0 psi (0 kPa).
3. Identify and disconnect the three air lines from the end cover and note the position of end cover ports relative to the crane.
4. Unplug wiring harness from the heater and thermostat connector on the purge valve housing.
5. Loosen the hex bolt securing the upper mounting strap.
6. Remove, retain and mark the two end cover cap screws (18), lock nuts (19) and four special washers (17) that retain the lower mounting bracket to the end cover, also mark these two holes of the end cover. (These bolts are longer than the other 6 bolts.)
7. Remove the air dryer from its mounting brackets on the crane.

NOTE: Several replacement parts and maintenance kits are available which do not require full disassembly. The instructions provided with these parts and kits should be followed.

8. Remove the delivery, check valve (15) and o-ring. Remove the o-ring from the check valve.

9. Remove three self-tapping screws (3) that secure the purge valve housing to the end cover. Pull the purge valve housing out of the end cover. Remove the three o-rings (5,6 & 7) from exterior of purge valve housing.

10. Purge Valve Disassembly:

In most cases a flat exhaust cover (30) is used. This cover should be left intact while servicing the purge valve housing. If an extended type exhaust cover is in used, the exhaust cover must be carefully peeled off the purge valve housing. Use a thin flat blade to pry the exhaust cover off, taking care not to damage the potting material (RTV sealant) under the cover.

To remove the piston from the purge valve housing requires a special socket or a twelve point socket to hold the head of the purge valve bolt (31).

- **a.** Remove nut (4) from the bottom of purge valve housing. Use wrench and socket to hold the head of bolt (31). Remove the diaphragm washer (32), and the diaphragm (2), and purge valve (11) from purge valve housing.
- **b.** Remove bolt (31) from opposite end, then the purge piston (33), return spring (13) and two O-rings (10 and 14), one on the outside diameter and the other in the inside of purge piston.

NOTE: Do not attempt to remove the heater and thermostat, as it will be damaged during the removal process and is not available as a service part. If the heater and thermostat are defective, replace the entire purge valve housing which includes these items.

11. Remove remaining six cap screws (16), lock nuts (19) and twelve special washers (17) that secure the end cover to the housing (24). Separate the end cover and desiccant cartridge (22) from the housing.

12. Remove end cover to outer housing o-ring (23).

13. Do not remove the safety valve from the end cover unless it has been proven defective. If replacement is required, apply thread sealant or teflon tape on the threads of the replacement valve and torque to 120 to 400 in/lbs (14 to 45 Nm).

14. Place a strap or chain wrench around the desiccant cartridge (22) so that it is approximately 2 to 3 in (50,8 to 76,2 mm) away from the end cover. Rotate cartridge counterclockwise until it separates from the end cover.

15. Remove the desiccant cartridge o-ring (21) from the end cover.

Cleaning and Inspection

1. Using mineral spirits or an equivalent solvent, clean and thoroughly dry all metal parts.

2. Inspect the interior and exterior of all metal parts that will be reused for severe corrosion, pitting and cracks.

3. Superficial corrosion and or pitting on the exterior portion of the upper and lower body halves is acceptable.

4. Inspect the bores of both the end cover and the purge valve housing for deep scuffing or gouges.

5. Make certain that all purge valve housing and end cover passages are open and free of obstructions.

6. reinspect the pipe threads in the end cover. Make certain they are clean and free of thread sealant.

7. Inspect purge valve housing bore and seats for excessive wear and scuffing.

8. Inspect the purge valve piston seat for excessive wear.

9. Inspect all air line fittings for corrosion. Clean all old thread sealant from the pipe threads.

10. All o-rings removed should be discarded and replaced with new o-rings provided in appropriate kit(s). Any component exhibiting a condition described above steps should be replaced.

Assembly

Before assembly, coat all o-rings, o-ring grooves, and bores with a generous amount of barium base lubricant.

1. Purge Valve Housing:

- **a.** Install O-ring (14) in groove on outside diameter of the purge piston. Place the return spring (13) in the purge valve housing. Place o-ring (10) into recess in the bore of purge piston. reinstall bolt (31) into inside diameter of the purge piston. Insert purge piston (33) into inside diameter of the spring (13). Push purge piston into the bottom of piston housing.
- **b.** While depressing purge piston with the wrench, install following parts over the purge valve bolt (31) from the opposite end of the purge valve housing; the purge valve (11) with rubber side first, followed by the diaphragm (2) diaphragm washer (32) or the flat washer and the lock nut (4).

  Torque the purge valve nut and bolt (4 and 31) to between 60 to 80 in/lbs (7 to 9 Nm).

   c. Install three o-rings (5, 6, and 7) on purge valve housing placing each in its appropriate location. If the exhaust cover (30) was removed during disassembly, install it on the purge valve housing making certain the bubble portion is positioned over the thermostat. Install the assembled purge valve housing in the end cover making certain to orient both parts such that the connector is approximately 10 degrees clockwise from the supply port, while making certain the purge valve housing is fully seated against the end cover. Secure the purge valve housing to the end cover using the three self-tapping screws (3). Start all three screws by hand then torque to 50 to 80 in/lbs (5,6 to 9 Nm).

2. Install the o-ring on the check valve (15), then install the check valve in the end cover.

3. Install the desiccant cartridge o-ring (21) in its groove in the end cover. Using a light coat of barium grease, lubricate the bottom of the desiccant cartridge in the area that will contact the o-ring (21) and end cover. Screw the desiccant cartridge into the end cover until contact is made between it and the o-ring.

4. Using a strap or chain wrench positioned 2 to 3 in (50.8 to 76,2 mm) from the bottom of the cartridge, turn the desiccant cartridge clockwise 180 to 225 degrees beyond the position where initial contact was made between the cartridge and end cover o-ring.

Torque should not exceed 50 ft/lbs (68 Nm).

5. Install the end cover outer housing o-ring (23) on the shoulder in the end cover. Place the housing (24) over the desiccant cartridge and align the holes. Install the six cap screws (16), lock nuts (19) and twelve special washers (17) making certain they are in the proper position as marked during disassembly. The two longer cap screws (18) will be used to secure the air dryer to mounting bracket.

Tighten the six cap screws and nuts in a star pattern, depending on lower bracket location. Torque 270 to 385 in/lbs (31 to 44 Nm)

NOTE: The two remaining bolt holes in the end cover and two cap screws must be the ones marked during disassembly to assure proper orientation of the ports and adequate length of the cap screws.

6. Install the assembled air dryer back onto the crane by slipping it into the upper mounting bracket. Align the two unused holes in the end cover with the bottom mounting bracket such that the bottom bracket 9 supports air dryer. The AD-9 end cover should rest on the bracket. Using the remaining two cap screws (I8), four special washers (17), and two lock nuts (19), secure the air dryer to the lower bracket. Tighten, then torque the two remaining cap screws to 270 to 385 in/lbs (31 to 44 Nm).

7. Tighten the bolt (25) and nut (29) on the upper mounting bracket. Torque to 80 to 120 in/lbs (9 to 14 Nm).

8. Reconnect the three airlines to the proper ports on the end cover (identified during disassembly).

9. Reconnect wiring harness to the air dryer heater and thermostat connector by plugging it into the air dryer connector until its lock tab snaps in place.

10. Before placing crane back into service, perform the Operation and Leakage Tests above.

Preventive Maintenance

Maintenance intervals will vary depending on crane operation.

Every 500 operating hours or every three months

1. Check for moisture in the air brake system by opening reservoirs, drain cocks, or valves and checking for presence of water. If moisture is present, the desiccant may require replacement. The following conditions can also cause water accumulation and should be considered before replacing the desiccant:

   a. An outside air source has been used to charge the system. This air did not pass through the drying bed.

   b. Air usage is exceptionally high and not normal for a crane. This may be due to accessory air demands or some unusual air requirement that does not allow the compressor to load and unload (compressing and non-compressing cycle) in a normal fashion. Check for high air system leakage.

   c. The air dryer has been installed in a system that has been previously used without an air dryer. This type system will be saturated with moisture and several weeks of operation may be required to dry it out.

   d. Location of the air dryer is too close to the air compressor.

   e. In areas where more than a 30 degree range of temperature occurs in one day, small amounts of water can accumulate in the air brake system due to condensation. Under these conditions, the presence of small amounts of moisture is normal and should not be considered as an indication that the dryer is not performing properly.

NOTE: A small amount of oil in the system may be normal and should not, in itself, be considered a reason to replace the desiccant. Oil stained desiccant can function adequately.

2. Check mounting bolts for tightness. Torque 270 to 385 in/lbs (31 to 44 Nm).

3. Perform the Operation and Leakage Tests listed in this section.

Every 6,000 hours or 36 months

Rebuild the air dryer including the desiccant cartridge.

The desiccant change interval may vary from crane to crane. Although typical desiccant cartridge life is three years, many will perform adequately for a longer period of time. In order to take maximum advantage of desiccant life and assure that replacement occurs only when necessary, it is important that Operation and Leakage tests be performed.

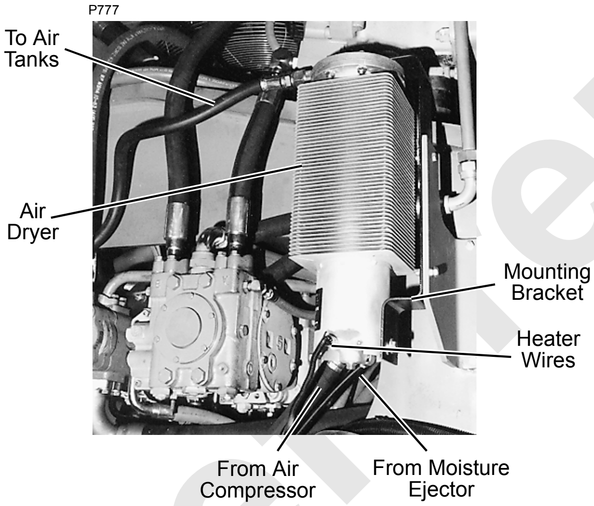
AIR DRYER MAINTENANCE (PAST PRODUCTION)

Description

See Figure 2-35 for the following procedure.

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

Compressed air enters the air dryer where oil, water and solid contaminants are removed and collected in a sump. Air then flows up through the air dryer where any remaining moisture is removed before the air enters the air tank. All contaminants and any air remaining in the air dryer are then discharged through an unloader valve during the compressor cutout cycle.



Air Dryer Installation (Left Side of Rotating Bed)

FIGURE 2-35

Operation

Compressor Cut-In

See Figure 2-36 for the following procedure.

1. When pressure in the air tanks drops to the cut-in pressure, the compressor unloader valve closes.
2. The compressor unloader valve then exhausts the air from the pilot lines. This action closes the air dryer unloader valve and signals the compressor to start compressing air.

NOTE: For operation of moisture ejector, see Moisture Ejector Valve Maintenance topic in this section.

3. Air from the compressor enters the air dryer where oil, water and other solid contaminants are removed and the air is dried.
4. The air flows through the check valve in the top of the air dryer and into the air tanks.

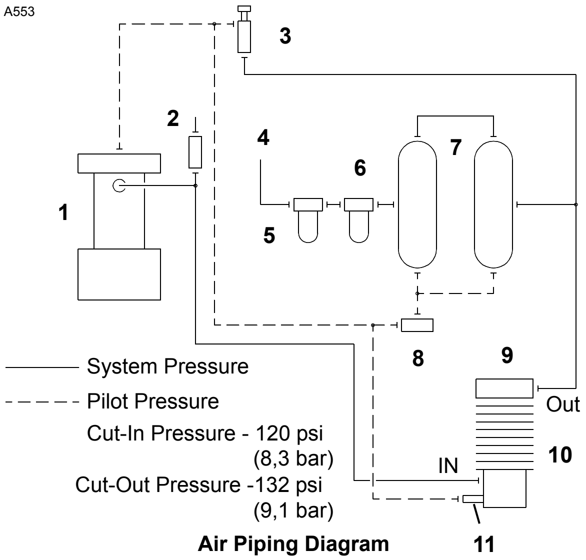
Compressor Cut-Out

See Figure 2-36 for the following procedure.

1. When pressure in the air tanks reaches the cut-out pressure, the compressor unloader valve opens. This action signals the compressor to stop compressing air.

NOTE: The check valve in the top of the air dryer closes to prevent the air in the system from exhausting through the air dryer unloader valve.

2. Pressure in the pilot line to the air dryer unloader valve causes it to open, allowing air, oil, water and dirt to discharge from the air dryer.



Item	Description
1	Compressor
2	Safety Valve
3	Compressor Unloader Valve
4	To Air Valve
5	De-icer
6	Air Filter
7	Air Tanks
8	Moisture Ejector
9	Check Valve
10	Air Dryer
11	Air Dryer Unloader Valve

FIGURE 2-36

Maintenance

See Figure 2-37 for the following procedure.

Once every 1,000 hours or 6 months (whichever comes first) clean the strainer plates and filter in the top of the air dryer as follows.

NOTE: It may be necessary to shorten interval due either to extremely dirty operating conditions or to an old air compressor that is leaking oil into the system.

Low pressure in air system is an indication that strainer plates and filter are plugged with dirt or oil.

⚠ WARNING

Avoid Injury!

Stop engine and vent air from system before performing maintenance.

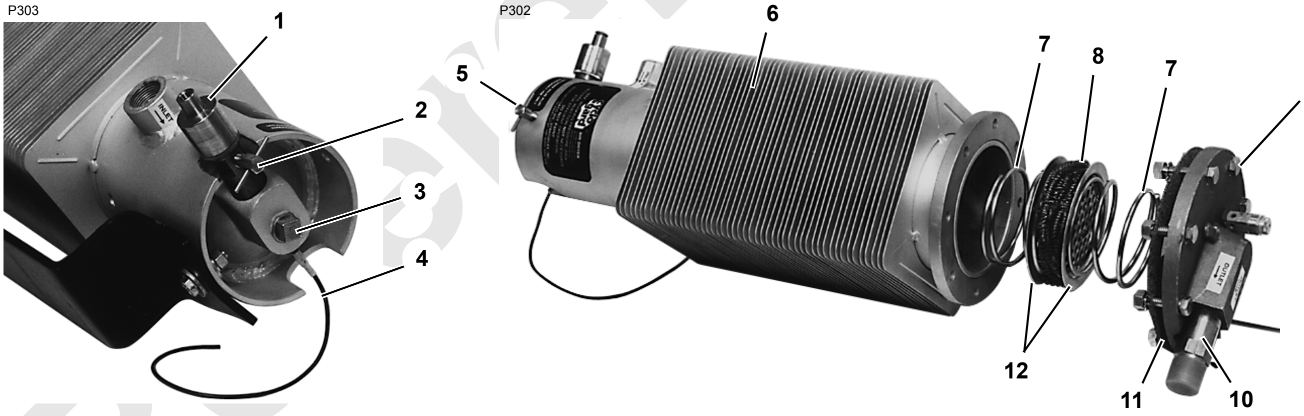
1. Disconnect air lines and electric wires from air dryer.
2. Remove bolts connecting air dryer mounting bracket to rotating bed and remove air dryer from crane.
3. Remove bolts from head of air dryer to expose strainer plates and filter.

NOTE: A slight spring force will be felt when disassembling head from air dryer body.

4. Remove and clean strainer plates and filter with solvent and blow dry.
5. Reassemble and install air dryer in reverse order.

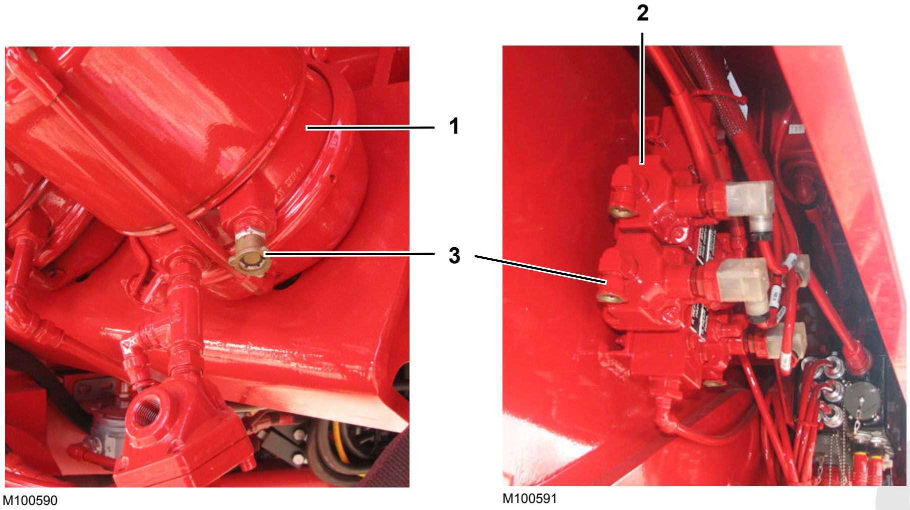
Table 2-14 Air Dryer Troubleshooting

Trouble	Probable Cause	Remedy
A. Unloader valve discharges too long.	Faulty check valve (in air dryer). Discharge should last only a few seconds. A faulty check valve allows a longer discharge period and compressor cycles constantly (30 to 50 seconds between cut-in and cut-out).	Replace check valve.
B. Air dryer unloader valve does not discharge when compressor cuts-out.	Faulty unloader valve.	Repair or replace air dryer unloader valve. **CAUTION** If it is necessary to operate crane before air dryer unloader valve can be replaced due to Trouble B, manually drain air dryer several times daily, otherwise water level will rise in sump, possibly damaging air dryer baffle.
	Faulty heater (moisture freezing in unloader valve).	Replace faulty heater.
C. Air dryer unloader valve does not close when compressor cuts-in (air system pressure does not rise to normal operating range).	Faulty compressor unloader valve, or faulty air dryer unloader valve. Perform the following check: Disconnect pilot line at air dryer unloader valve. If air dryer unloader valve closes, compressor unloader valve is faulty. If air dryer unloader valve remains open, it is faulty.	Repair or replace faulty unloader valve. **CAUTION** If it is necessary to operate crane before air dryer unloader valve can be replaced due to Trouble C, install "Emergency Pipe Plug" (Figure 2-37) in discharge hole of faulty unloader valve. Manually drain air dryer several times daily, or water level will rise in sump, possibly damaging air dryer baffle.
D. Air system pressure does not rise to normal operating range.	Strainer plates and filter plugged with dirt and oil.	Clean (see Maintenance).



Item	Description	Item	Description
1	Air Dryer Unloader Valve	7	Spring
2	Emergency Pipe Plug (installed)	8	Filter
3	Manual Drain Valve	9	Bolts
4	Heater	10	Check Valve
5	Emergency Pipe Plug (stored)	11	Head
6	Body	12	Strainer Plates

FIGURE 2-37



Item	Description
1	Brake Chamber (load drum)
2	Solenoid Valve
3	Breather Vent

FIGURE 2-38

BREATHER VENT MAINTENANCE

On current production cranes, several solenoid valves on the left side of the rotating bed and the brake chambers at the drum brakes are equipped with breather vents (see Figure 2-38).

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.

SOLENOID VALVE MAINTENANCE

Operation

Normally Closed

See Figure 2-39 for the following procedure.

Pressure is applied to inlet port ***P***. With the valve deenergized, 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 just the opposite.

Air Line Connection

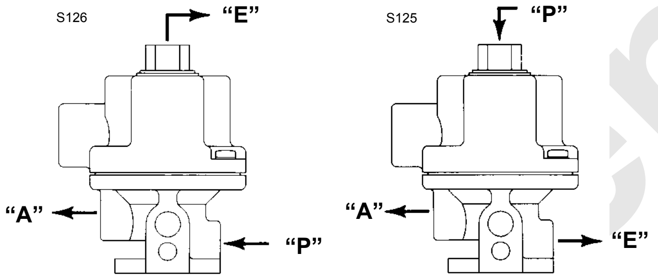
The solenoid valve has three ports identified as follows:

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 as shown in Figure 2-39.



Normally Closed **Normally Open**

FIGURE 2-39

For normally-open operation the air lines must be connected to the valve ports as shown in Figure 2-39.

NOTE: Improper connection of air lines will cause improper system operation.

Electrical Connection

See Figure 2-40 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, two housing screws must be removed and two housing plate screws must be relocated. For 180 degrees, only the two housing screws have to be removed. The screws must be reinstalled after orientation.

Maintenance

Troubleshooting

See Figure 2-40 for the following procedure.

If the valve fails to operate at all, check the coil for shorted or open turns. Also check supply current. See below if coil is not damaged.

External Leakage

If leakage occurs around the sleeve assembly, the metering pins, or the manual override stem, the o-rings should be removed and inspected for imperfections.

Sticking Or Internal Leakage

If the valve leaks internally or the plunger sticks in the energized position, examine the soft inserts in the plunger ends or inside the sleeve assembly for excessive dirt or wear. If the inserts show considerable wear, the plunger should be replaced.

Noise

If the valve develops a loud buzzing noise, first check voltage and pressure to determine if they correspond to the nameplate rating. Examine the inside of the sleeve assembly and the upper portion of the plunger and remove all foreign matter imbedded in these parts. Be careful not to damage the sleeve seat.

NOTE: Do not expose plunger assembly or o-rings to any type of commercial cleaning fluid. Plunger assembly and o-rings may be cleaned with a mild soap and water solution.

Disassembly

Shut off pressure and electricity to the valve. The valve does not have to be removed from the line.

Remove the screws from the housing. Remove the housing from the valve assembly. After removing the housing, the yoke and coil can be removed with an upward twisting motion.

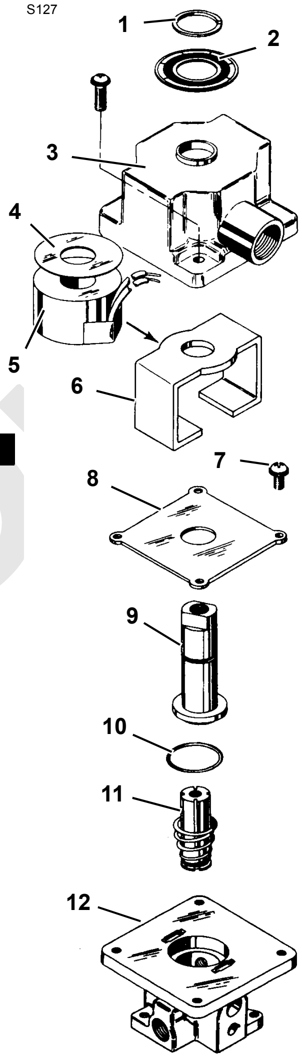
Remove the screws holding the housing plate to the body (these screws are shorter than the housing screens). The housing plate can be removed. The sleeve assembly and plunger can then be removed.

Reassembly

Place the housing plate over the sleeve assembly. Use a light oil on the o-ring flange seal. Always assemble the o-ring to the sleeve assembly before inserting in valve bodies. Make sure the plunger and the return spring are in place and then push the sleeve assembly, along with the housing plate, down in place on the body with a slight twisting motion. Hold the housing plate down and replace the two screws (these are the shorter ones). Tighten the screws to 18 ± 3 in-lb. (2 ±

0,3 N•m). The placement of these screws should be such that they give desired orientation of the housing later in reassembly. Before completing reassembly, it is advisable to apply pressure to the port which leads to the body chamber and check for leakage around the flange seal. If the valve has a sleeve port, the port at the top of the sleeve assembly must be capped to make this test.

Leakage can be noted by applying a water and soap solution to the joint and watching it for air bubbles. Once the housing plate is secure, the yoke and coil may be pushed over the sleeve assembly with a slight twisting motion. Replace the housing with two screws. Tighten the screws to 18 ± 3 in/lbs (2 ± 0,3 N•m). Repeat internal leakage check.



Item	Description
1	Nameplate Retainer
2	Nameplate
3	Housing
4	Coil Washer
5	Coil
6	Yoke
7	Screw
8	Housing Plate
9	Sleeve
10	O-Ring
11	Plunger and Spring
12	Body

FIGURE 2-40

QUICK RELEASE VALVE MAINTENANCE

General

See Figure 2-41 for the following procedure.

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.

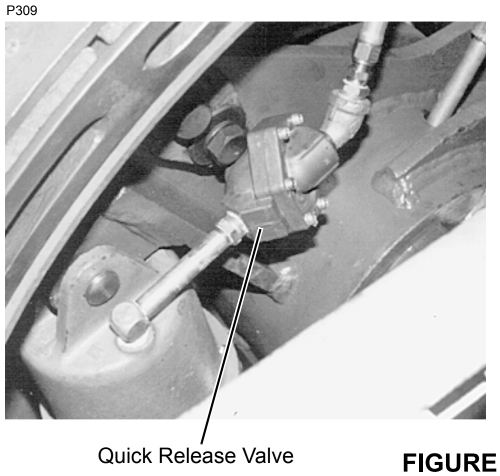


FIGURE 2-41

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 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 damaged or worn. Reassemble the valve and check for leaks during operation. No lubrication is required.

Operation

See Figure 2-42 for the following procedure.

The quick release valve has 3 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.

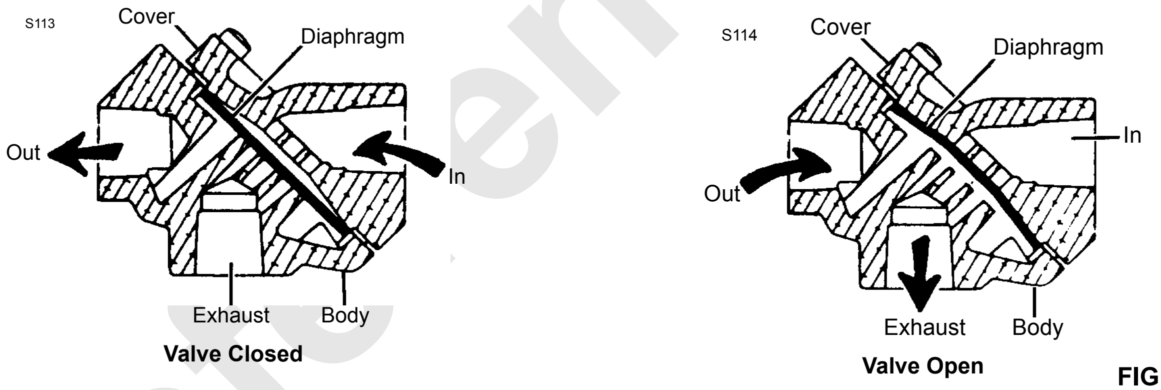


FIGURE 2-42

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AIR PRESSURE SAFETY SWITCHES MAINTENANCE

General

See Figure 2-43 for the following procedure.

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:

1. To monitor 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 N.C. (normally closed) with a trip point of 60 psi (4,14 bar).
2. To monitor 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 N.O. (normally open) with a trip point of 60 psi (4,14 bar).
3. 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 90 psi (6,21 bar).

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 pressure reaches the specified point, the adjusting screw pushes the limit switch plunger in, and 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

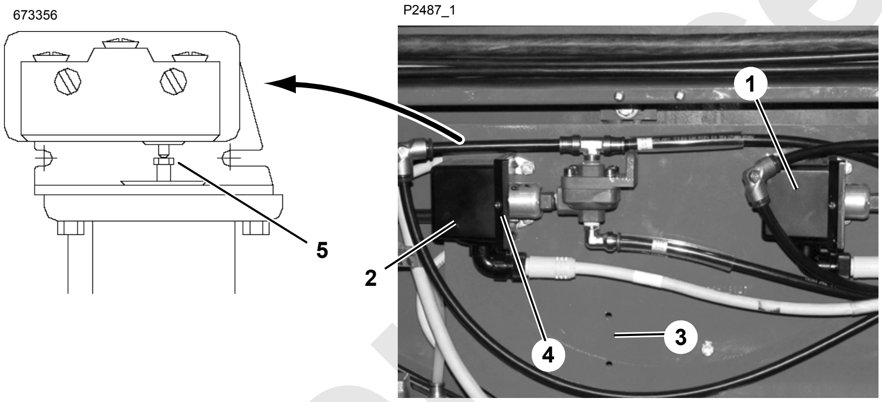
Adjustment can be performed either installed on the crane or when removed from the crane. Adjustment will be easier and more accurate when done with the pressure switch removed from the crane. The following items will be required to perform the adjustment:

1. Air supply capable of being regulated up to 120 psi (8,27 bar)
2. Calibrated 0-150 psi (0-10,34 bar) air gauge
3. D.C. voltage power supply
4. Bulb-type continuity tester
5. 1/4” open end wrench

NOTE: Air pressure and electric current from the crane source can be used for this adjustment.

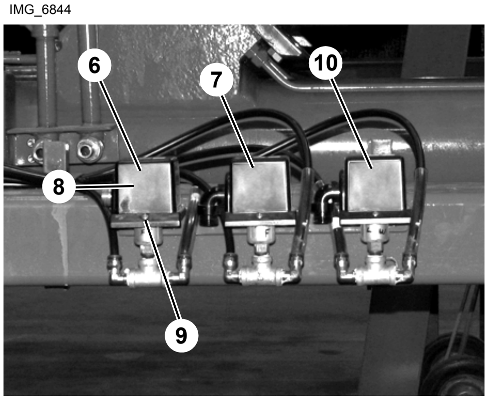
Adjustment

1. Shut down the crane.
2. Discharge system air pressure.
3. Disconnect crane source air line piping at pressure switch that needs adjustment.
4. Remove cover screw (4) and cover.
5. Connect a calibrated pressure source with 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 N.C. terminal or the N.O. terminal of the limit switch, depending on the circuit application. Ground the other lead of the tester.
7. Connect the D.C. voltage power supply to the COM (common) terminal of the limit switch.
8. If the pressure switch is wired **normally closed,** proceed as follows:
    - **a.** Turn the adjusting screw all the way in and then out until it just touches the plunger.
    - **b.** Increase air pressure to the specified point (tester light should go OFF).
    - **c.** Turn the adjusting screw IN until the tester light comes ON.
9. If the pressure switch is wired **normally open,** proceed as follows:
    - **a.** Turn the adjusting screw all the way in.
    - **b.** Increase air pressure to the specified point.
    - **c.** Turn the adjusting screw OUT until the tester light comes ON.
10. Always recheck set points after adjustments are made.
11. Disconnect the D.C. voltage power supply, calibrated air supply, and tester.
12. Reinstall air pressure switch.
13. Start crane and allowing system to reach operating pressure. Activate corresponding circuit to test and confirm 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 2-43

SHUTTLE VALVE MAINTENANCE

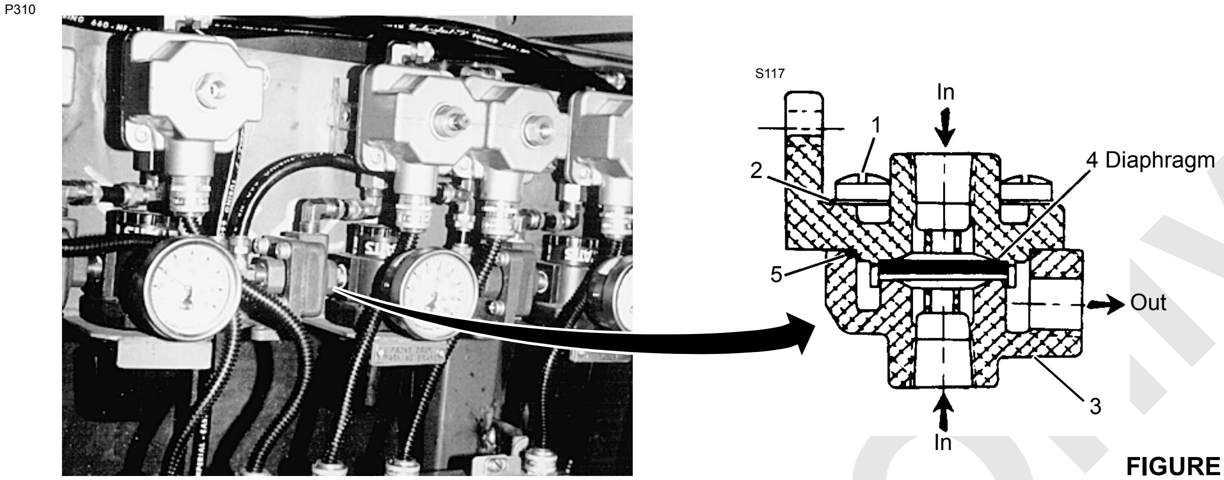


FIGURE 2-44

General

See Figure 2-44 for the following procedure.

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 3 ports. When a pressure differential of 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 screws (1) and washers (2), body (3) can be removed for easy replacement of diaphragm (4) without disturbing 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 diaphragm (4) and gasket (5) if damaged or worn. Reassemble the valve and check for leaks during operation. No lubricant is required.

TYPE A AIR REGULATOR MAINTENANCE

Installation

See Figure 2-45 for the following procedure.

Before installing, blow out the air line to remove scale and other foreign matter. This unit has Dryseal pipe threads: use pipe compound or tape sparingly to male threads only. Install the regulator in the air lines so air will flow in the direction of the arrow stamped on the body.

Adjustment

To unlock the adjustment, push the knob 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

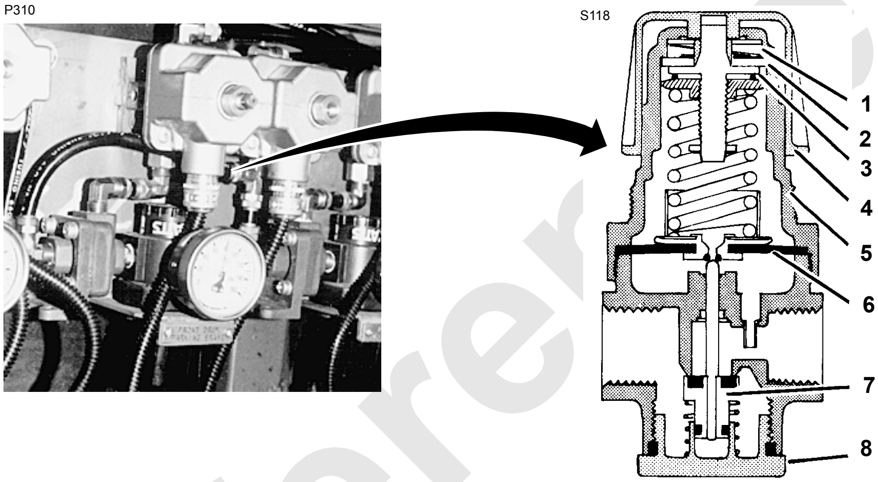
CAUTION

Cleaning Instructions!

Never use carbon tetrachloride, trichlorethylene, thinner, acetone, or similar solvents in cleaning any part.

To clean, it is not necessary to remove 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, shut off the air pressure and disassemble the regulator. Clean all parts with denatured alcohol and blow out the body with compressed air. When reassembling, make sure the disc stem fits into the center hole of the diaphragm assembly. If the diaphragm assembly is replaced, make sure the disc stem fits into its center hole. Tighten the bonnet slightly more than hand tight 45 in-lb (5,1 N•m).



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 2-45

N-1 PRESSURE REDUCING VALVE MAINTENANCE

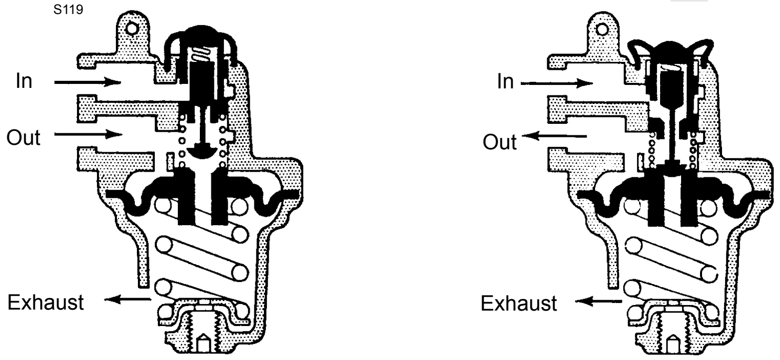
Operation

See Figure 2-46 and Figure 2-47 for the following procedures.

Air pressure from the main supply passes from the in port to the out port through the unseated inlet valve of inlet and exhaust valve unit (1). The inlet valve is held off of its seat by control spring (2) which forces diaphragm (3) and seat (4) upward. While 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 diaphragm. When the pressure at the out port reaches the setting of 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 will remain closed.

The valve will automatically compensate 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 will deflect downward moving exhaust valve seat away from the inlet and exhaust valve unit and vent the excess pressure. If pressure drops below that called for by the spring setting, control spring forces diaphragm upward and exhaust valve seat moves the inlet valve from its seat, opening the in port to the out port to restore the pressure called for.



Decreasing Pressure

Increasing Pressure

FIGURE 2-46

Maintenance

See Figure 2-47 for the following procedures.

Maintenance periods should be scheduled in accordance with frequency of use and working conditions of 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 "stand-by" 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.

Remove the valve portion by loosening nut (5) and stud (6).

No special tools are required to maintain the valve.

Completely disassemble the valve. Wash all metal parts in non-flammable solvent and all rubber parts in soap and water. Rinse each part thoroughly and blow dry with a low-pressure air jet. Arrange the parts on a clean surface in the order of the exploded view.

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.

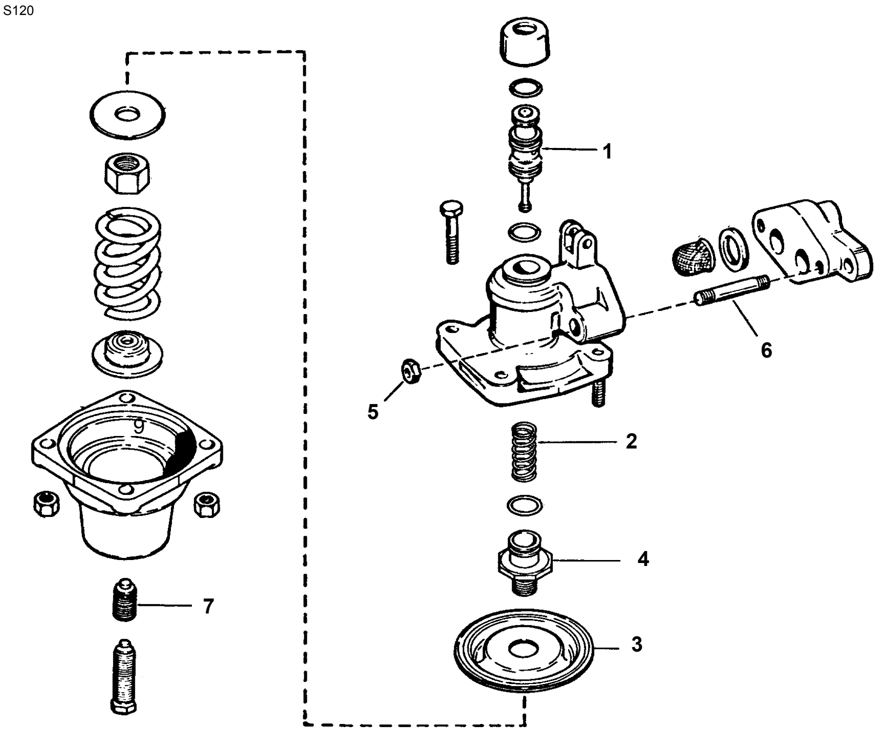
Reassemble the valve using the exploded view in Figure 2-47 as a guide. Lubricate each part before it is put into place. Use No. 107 Lubriplate on all metal to metal surfaces and No. 55 Pneumatic Grease on all rubber parts. Equivalent greases to those recommended can be used.

Store the reconditioned valve in a moisture proof bag.

Adjustments

See Figure 2-47 for the following procedures.

Use adjusting screw (7) to adjust the valve. Turning the adjusting screw in raises the outlet pressure and turning it out lowers 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 2-47

TYPE S RELAY VALVE MAINTENANCE

General

See Figure 2-48 for the following procedures.

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.

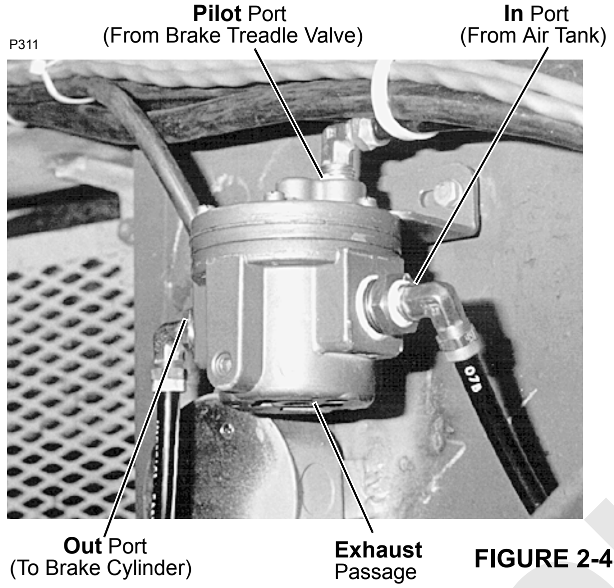


FIGURE 2-48

Operation

Increasing Pressure

See Figure 2-49 for the following procedure.

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).

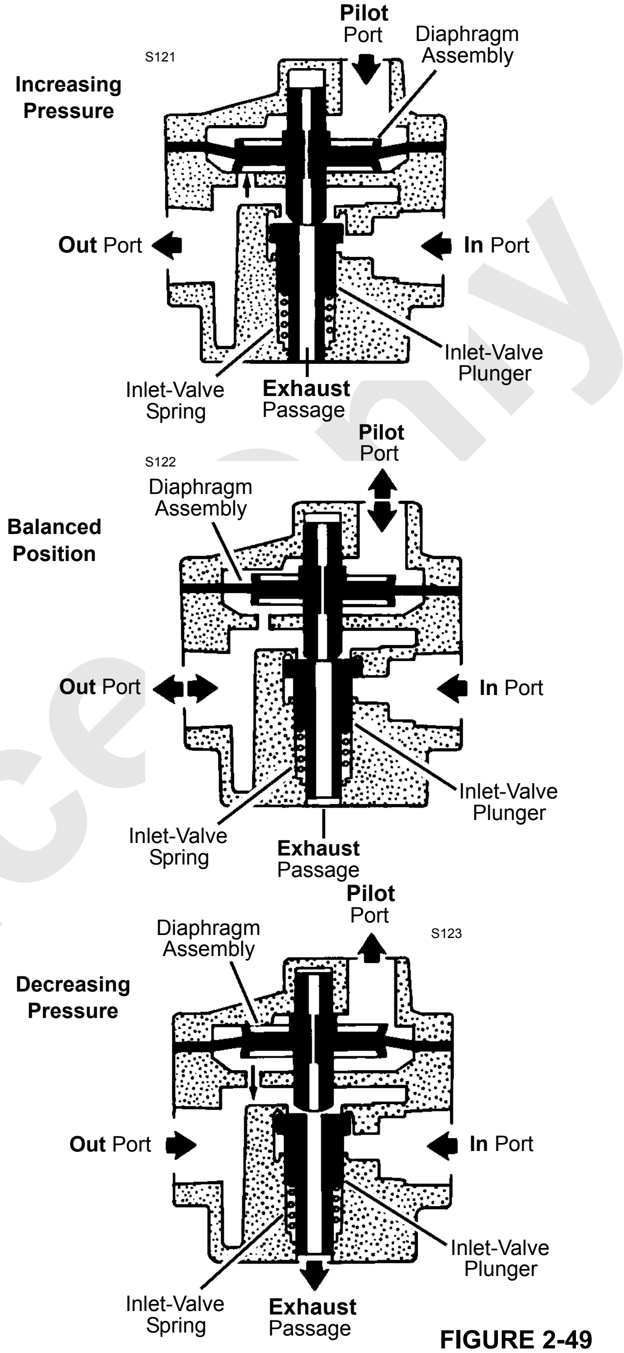


FIGURE 2-49

Balanced Position

See Figure 2-49 for the following procedure.

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.

Decreasing Pressure

See Figure 2-49 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 brake released position. Pressure at the out port then becomes equal to pressure at the pilot port (see Balanced Position).

Maintenance

See Figure 2-50 for the following procedure.

The relay valve does not require periodic maintenance or adjustment.

Overhaul 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.

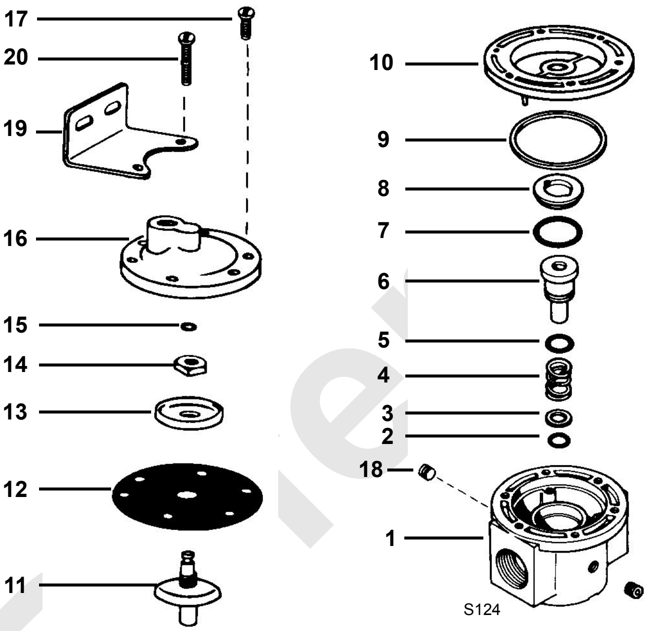
CAUTION

Avoid Injury!

Drain air system before removing relay valve cover.

---

1. Completely disassemble the relay valve. No special tools are required.
2. Clean all metal parts with a non-flammable solvent. Wash all rubber parts with soap and water.
3. Rinse all parts in clean water and blow dry 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 Figure 2-50.
6. Reassemble the relay valve.
7. As assembly proceeds, lubricated 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; 4 each)
8	Inlet-Valve Seat*	18	1/8 Pipe Plug (2 each)
9	O-Ring*	19	Mounting Bracket
10	Baffle*	20	Screw (long; 2 each)

*Parts in Repair Kit

FIGURE 2-50

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SECTION 3
ELECTRIC SYSTEM

TABLE OF CONTENTS

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SECTION 3

ELECTRIC SYSTEM

ELECTRICAL DRAWINGS AND SCHEMATICS

Applicable electrical system drawings and schematics are located at the end of this section.

CHECKING OR REPLACING ELECTRICAL COMPONENTS

DANGER

Electrical Shock Hazard!

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

---

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

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

    If any of these conditions exist, address them appropriately.

    See Table 3-1 below for the following items.
3. Harness and battery cables operating in Zone C are recommended to be replaced after 10,000 hours of service life.
4. Harness and cables operating in Zone A and 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 8000 hours of service life.
5. Harness and cable assemblies operating in climate Zone D and Zone E should expect a degrade of mechanical properties and long term exposure to these cold temperatures will negatively impact service life. It is recommended for these electrical harnesses and cable assemblies to be inspected to step 1. above as service life may be more than 10,000 hours.
6. Harness and cable assemblies operating in salt water climates could see a significant reduction in service life. Therefore, it is recommended for these electrical harnesses and cable assemblies to be inspected to step 1 above as service life may be more than 8,000 hours.

Table 3-1 Climate Zone Classification:

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

CIRCUIT BREAKER AND FUSE ID

General

This section identifies the fuses and circuit breakers.

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 3-8.

Circuit breakers are mounted in the following locations:

- Fuse Junction Box, Figure 3-1
- Engine Junction Box, Figure 3-4 or Figure 3-5
- Cold Weather Package Junction Boxes, Figure 3-6
- MAX-ER Junction Box, Figure 3-7
- Power Plant, Figure 3-8

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	10VDC Regulated Power Supply
F17	15	5E	Accessory Outlet
S1	50 CB	8P1	12 VDC to Programmable Controller
S2	40 CB	58	Air Conditioning and Accessory

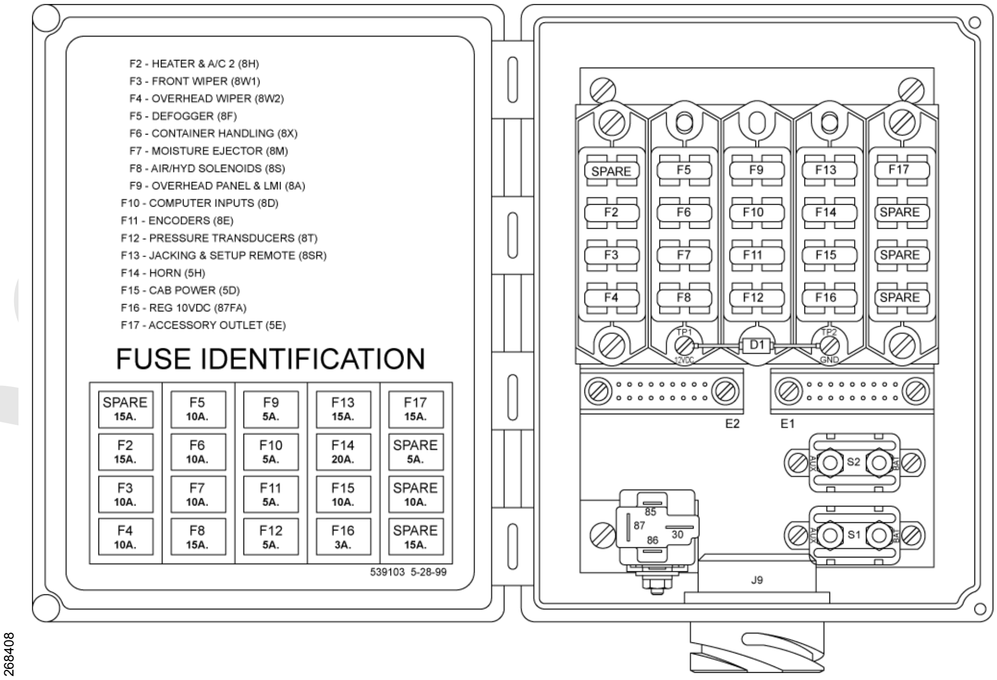


FIGURE 3-1

Circuit Breaker	Amps	Wire No.	Description of Items Protected
Engine Junction Box For Cummins N14-C525E Power Plant			
CB Numbers are per the Electrical Schematic			
CB-1	15	5A	Ignition Relay
CB-2	15	5C3	Electronic Control Module (Cummins)
CB-3	15	6A2	Electronic Control Module (Cummins)
CB-4	30	5C1	Cooling Fan Motor Relay
CB-5	120	5C2	Main System 12-Volt Power

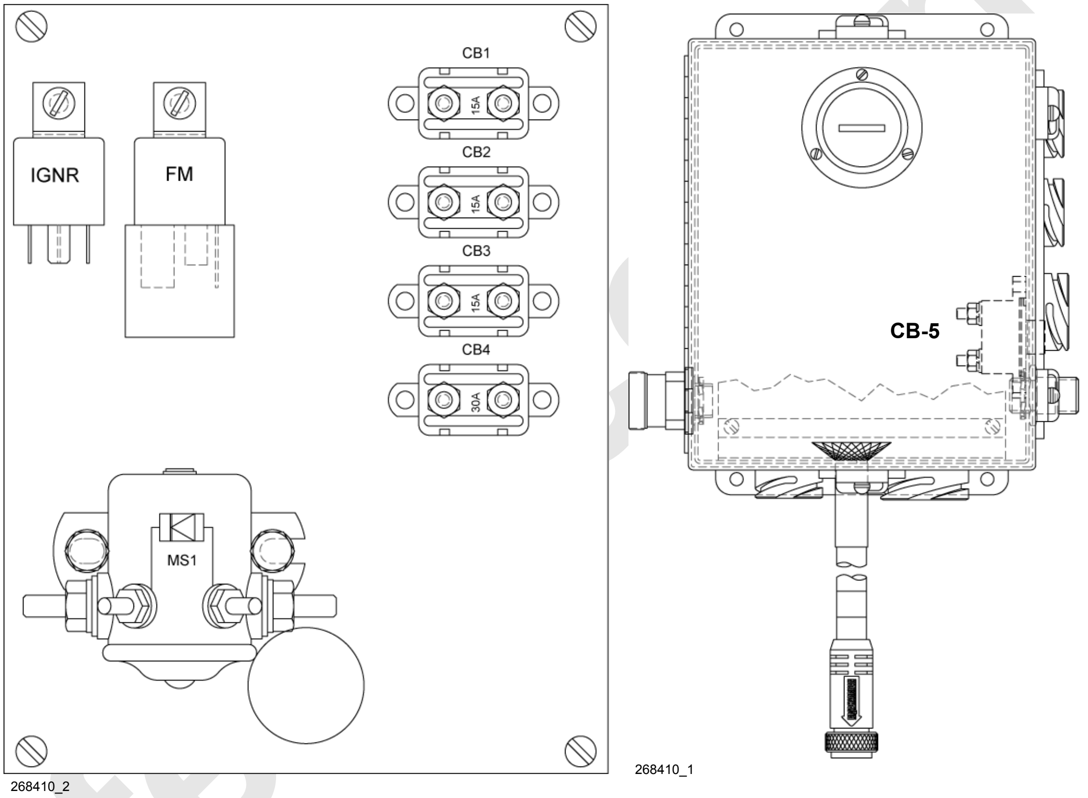


FIGURE 3-2

Circuit Breaker	Amps	Wire No.	Description of Items Protected
Engine Junction Box For Cummins N15-E450 and Cat 3406C Power Plants			
CB-1	15	5B	Electronic Control Module (Cummins) Ignition Relay
CB-2	120	5	Main System 12-Volt Power

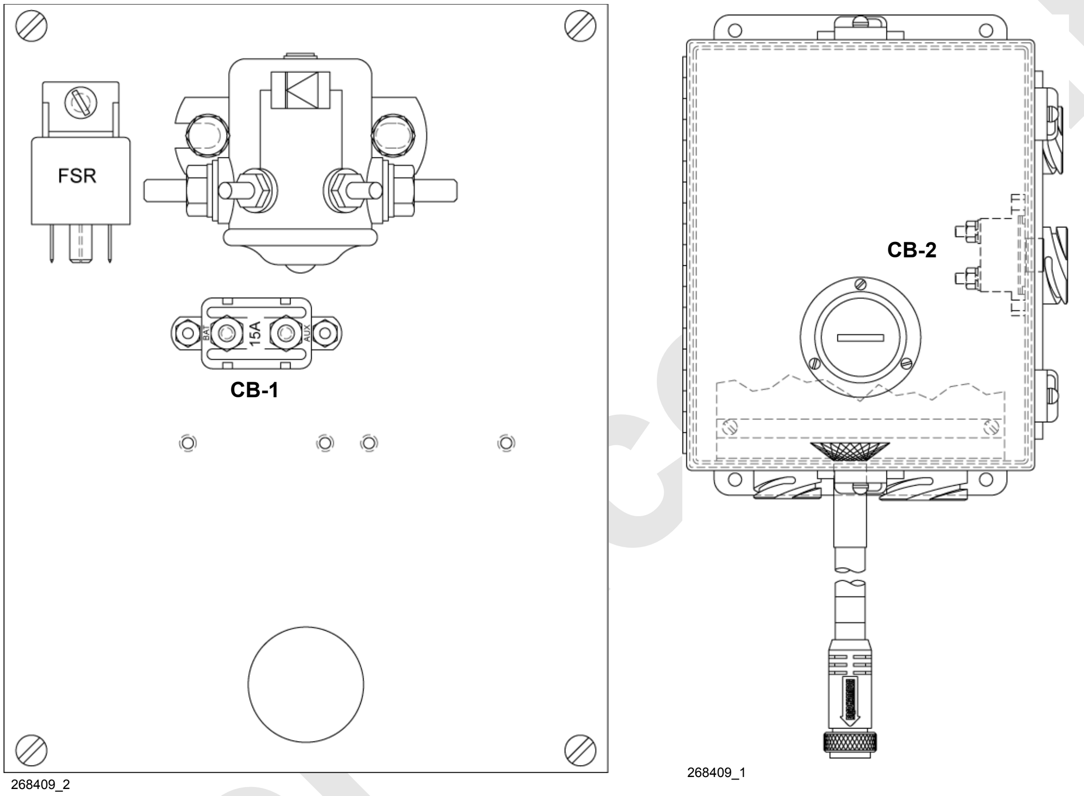
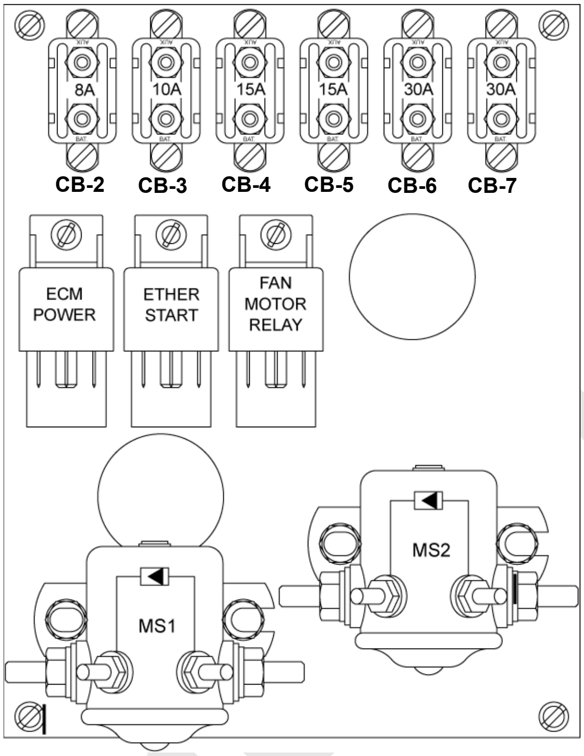


FIGURE 3-3

Circuit Breaker	Amps	Wire No.	Description of Items Protected
Engine Junction Box For Cummins QSX15-C500 Power Plant			
CB Numbers are per the Electrical Schematic			
CB-1	120	5A	Main System 12-Volt Power
CB-2	8	5C3	Electronic Control Module (Cummins) Ignition Relay
CB-3	10	6A2	Ether System Start Relay
CB-4	15	5C1	Electronic Control Module (Cummins)
CB-5	15	5C2	Electronic Control Module (Cummins) Engine Diagnostics
CB-6	30	5B	Cooling Fan Motor Relay
CB-7	30	6A1	MS1/MS2 Starter Solenoid Relay



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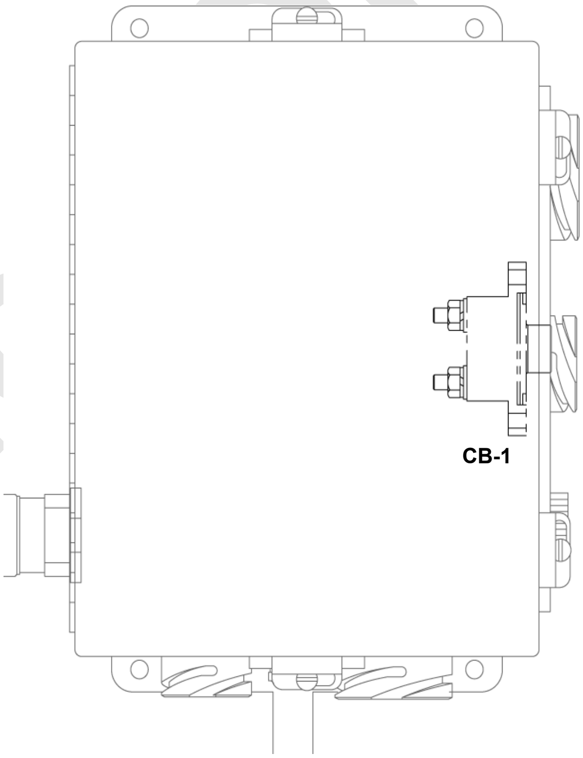

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FIGURE 3-4

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-5	15	6A3	CAN Power
CB-6	15	6A4	Autolube
CB-7	30	6A1	Starter Solenoid
CB-2	8	5C3	Engine ECM
CB-3	10	5C2	Engine Diagnostics
CB-4	30	5C1	Engine ECM
CB-8	30	58	A/C Clutch

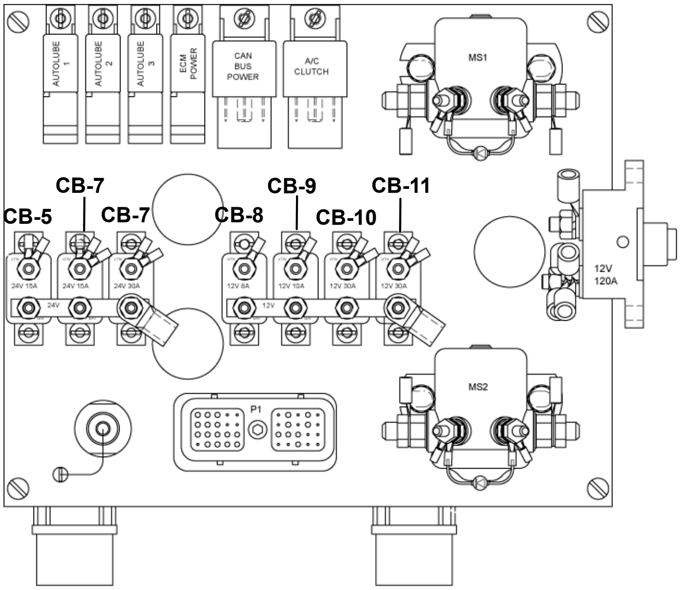

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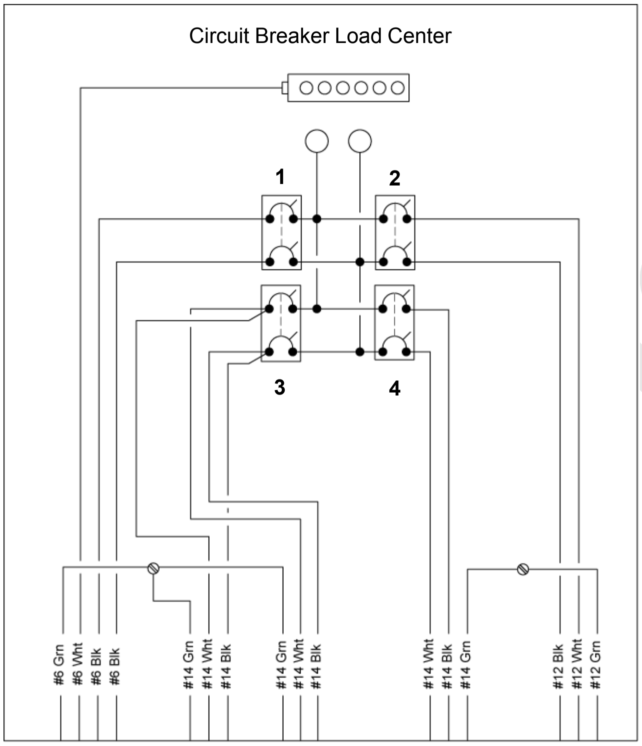
FIGURE 3-5

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	15	Air Dryer
6	15	Moisture Ejector
7	25	Air Dryer and Moisture Ejector Junction Box Main Breaker



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Air Dryer and Moisture Ejector Junction Box

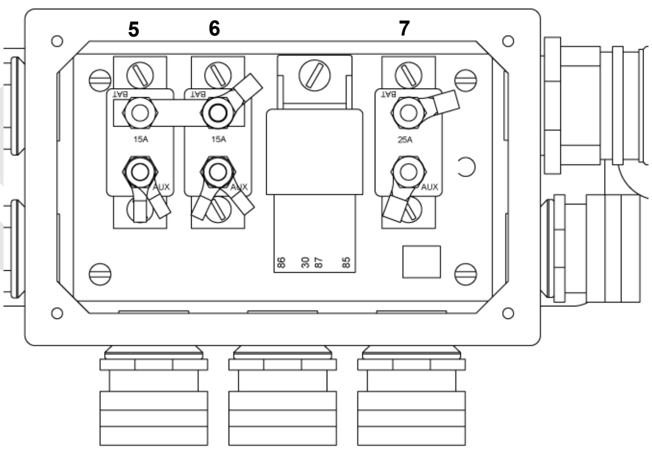

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FIGURE 3-6

Circuit Breaker	Amps	Wire No.	Description of Items Protected
MAX-ER 2000 Enclosure Junction Box			
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

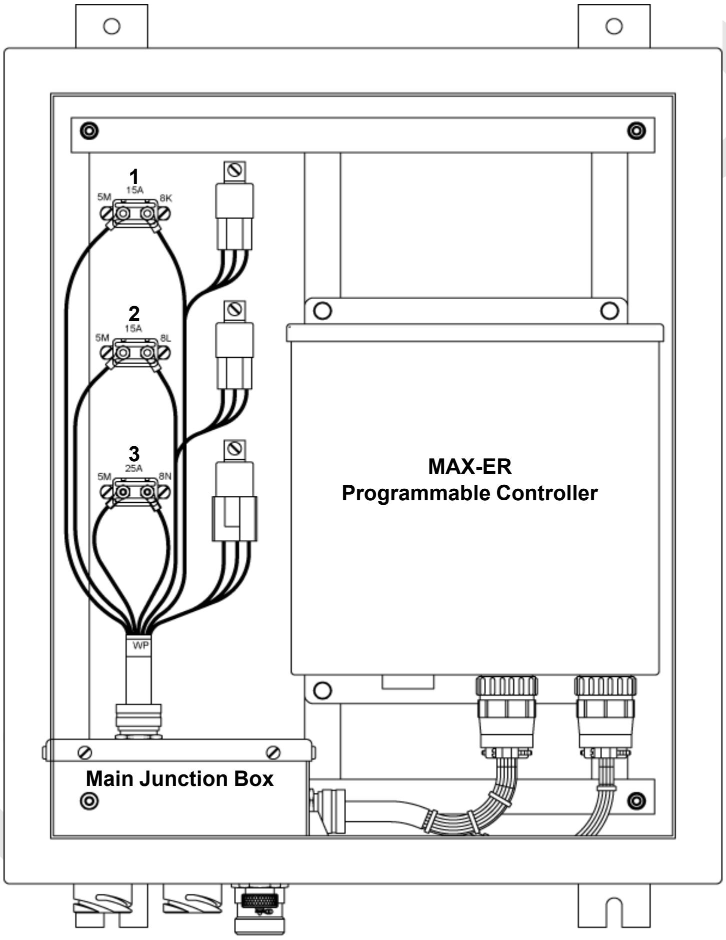
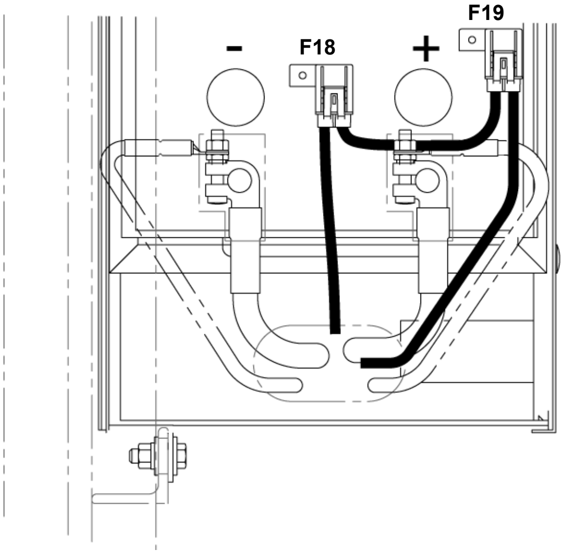


FIGURE 3-7

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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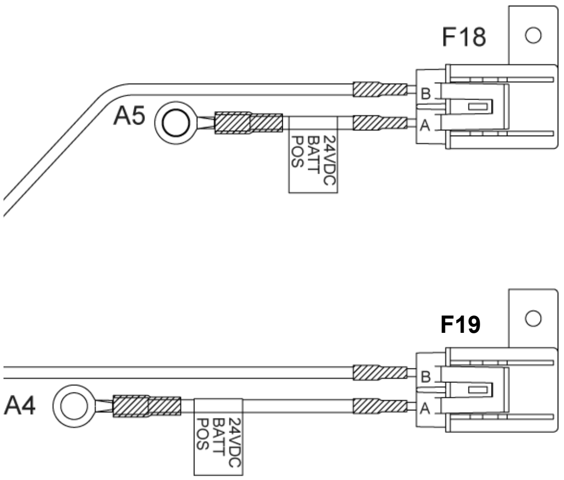

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Circuit Breaker	Amps	Wire No.	Description of Items Protected
Alternator Circuit Breaker Located on Main Power Plant and Aux Power Plant			
1	120	6A	Alternator 24VDC Main Supply

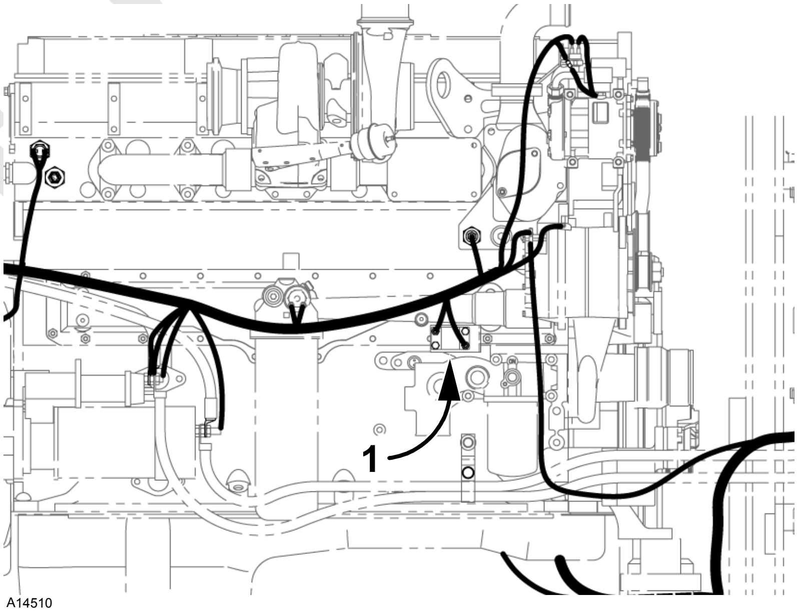

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FIGURE 3-8

Circuit Breaker	Amps	Wire No.	Description of Items Protected
Auxiliary Power Plant Programmable Controller Junction Box Enclosure			
CB1	25	8PR	Aux Power Plant Programmable Controller Power Supply

Fuse	Amps	Wire No.	Description of Items Protected
F1	5	8ER	Not Used
F2	5	8DR	Aux Hydraulic Tank Filter Alarm 1 and 2
F3	5	8TR	Not Used
F4	10	8MR	Air Dryer

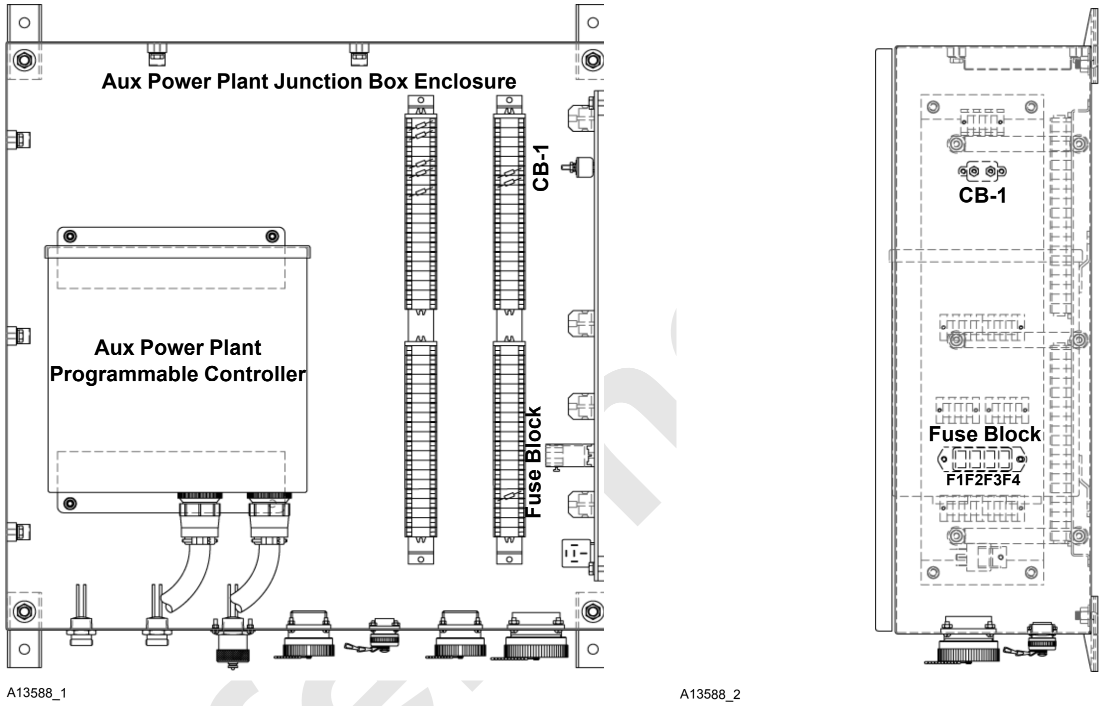

FIGURE 3-9

TEST VOLTAGES FOR CRANE CONTROLLER

General

This section contains test voltages sorted into four categories:

- Pin Identification
- Wire Identification
- Description Identification
- Master Node Pin Identification

NOTE: Master Node 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 left side of 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
lbs	=	Pounds
N/C	=	No Connection
Press.		Pressure
psi	=	Pounds per Square Inch

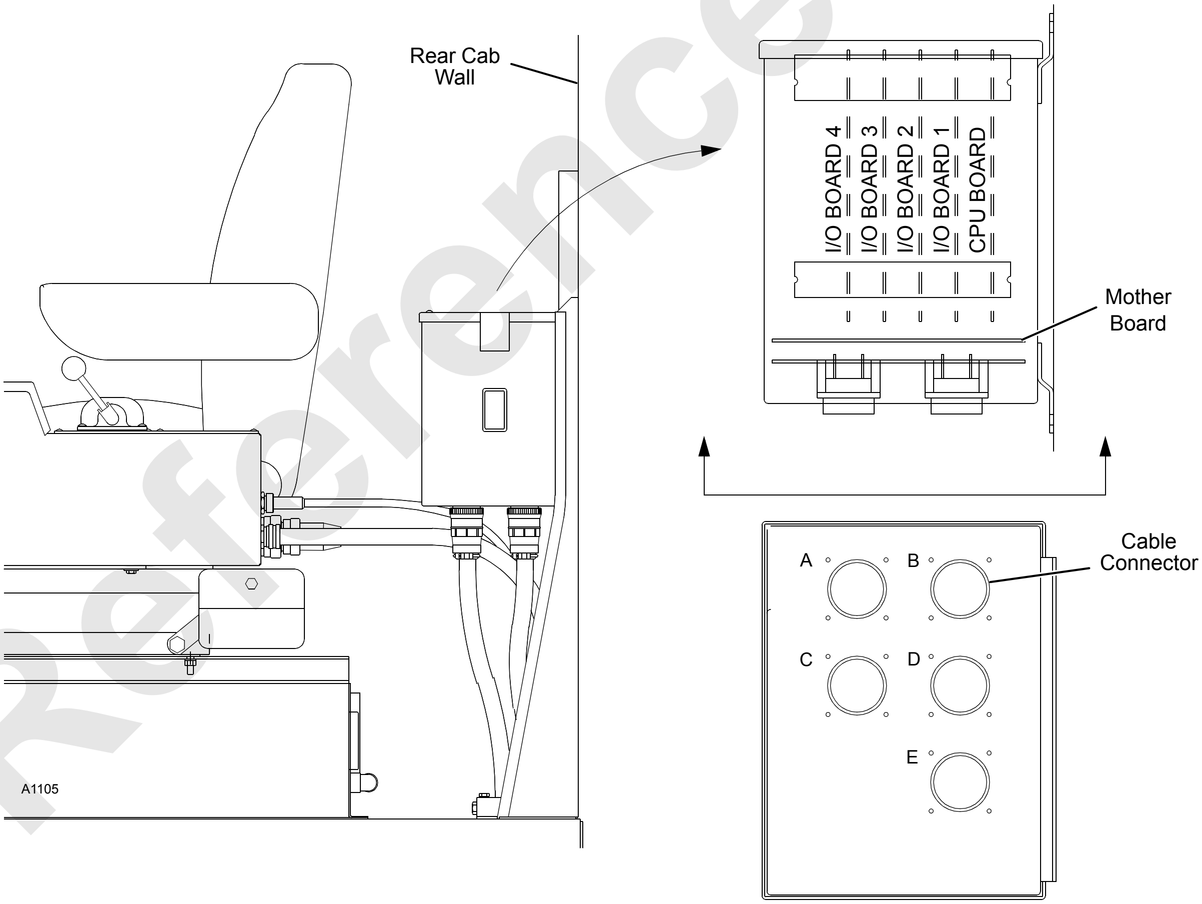

FIGURE 3-10

Crane Controller Pin 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	89N3	Counterweight Raise Sw. (MAX-ER 225/440)	12 volts Nominal	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 (Current)	0.101 to 10.09 Volts	I/O 1 (AI)
A-10	68K	Engine Throttle Input/Output (Current)	Variable	I/O 1 (AI)
A-11		Not Used		(SHIELD)
A-12	83PF	Drum 5 Tagline Foot Pedal	0 volts Neutral; 1.4 to 5 volts Reverse; 5 to 8.6 volts Forward	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		Not Used		I/O 2 (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; 1.2 volts High	I/O 2 (AI)
A-19	87QS	Ind. Luffing Hoist Hydraulic System Pressure 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 Pressure 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	(Past) 1.5 V at No Load; 9.5 V at Max. Load; (Current) 3.15 V at No Load; Compression 0.804 V at 180,000 lbs; Tension 8.04 V at 375,000 lbs	CPU (AI)

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
A-31	98Q	Hydraulic Vacuum Switch	1 volt at 30 in (762 mm) 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	89D4	Jacking/Set Up 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	89M3	Right Drum Pawl In Switch (Past)	12 volts Nominal	I/O 2 (DI)
B-22	89J1	Left Rear Drum Selector Switch	12 volts Nominal	I/O 2 (DI)
B-23		Not Used		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	89L3	Front Drum Pawl In Switch (Past)	12 volts Nominal	I/O 3 (DI)
B-32	89F1	Pendant Cylinder Limit Switch (MAX-ER 225/400)	12 volts Nominal	I/O 3 (DI)
B-33	89K	Display Scroll Down Switch	12 volts Nominal	I/O 3 (DI)

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
B-34		Not Used		I/O 3 (DI)
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% (-110Ma) 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)

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
C-34	25	System Fault Beeper & Light	12 volts Nominal	I/O 2 (DO)
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		Not Used		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)

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
D-30	90C	Pendant Cylinder Retract Solenoid (MAX-ER 225/400)	12 volts Nominal	I/O 3 (DO)
D-31	90D	Pendant Cylinder Extend Solenoid (MAX-ER 225/400)	12 volts Nominal	I/O 3 (DO)
D-32	69B	Proportional Valve (MAX-ER 225/400)	12 volts Nominal	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	25X	Swing & Travel Alarm (MAX-ER 225/400)	12 volts Nominal	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	89K3	Counterweight Lower Switch (MAX-ER 225/400)	12 volts Nominal	I/O 2 (AI)
E-10		Not Used		
E-11		Not Used		
E-12		Not Used		
E-13	89D3	Counterweight Up Limit Switch	12 volts Nominal	I/O 4 (DI)
E-14	89ZZ	Max. Boom & Luffing Angle/Limit Bypass Past Production Only	12 volts Nominal	I/O 4 (DI)
E-15	89V2	Pawl Limit Switch - Front Drum (Past)	12 volts Nominal	I/O 4 (DI)
E-16	89W2	Pawl Limit Switch - Rear Drum (Past) Maximum Angle Limit (Current)	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)

Pin	Wire	Description	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
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		
E-32		Not Used		
E-33	85B	MAX-ER 2000 Power Relay (Current)	12 volts Nominal	I/O 4 (DO)
E-34	85B	2-Speed Swing Selector - Ringer (Past)	12 volts Nominal	I/O 4 (DO)
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)

Crane Controller Wire Identification

Wire	Pin	Description	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
0	C-02	Computer Ground	0 volts	
0	C-04	Computer Ground	0 volts	
0	C-13	Computer Ground	0 volts	
0	C-22	Computer Ground	0 volts	
0	C-31	Computer Ground	0 volts	
24	D-07	Engine RPM Sender	7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 1 (DI)
25	C-34	System Fault Beeper & Light	12 volts Nominal	I/O 2 (DO)
25A	C-35	Operating Limit Buzzer & Light	12 volts Nominal	I/O 2 (DO)
25B	C-36	Jacking Remote Level Alarm & Light	12 volts Nominal	I/O 2 (DO)
25X	D-35	Swing & Travel Alarm (MAX-ER 225/400)	12 volts Nominal	I/O 3 (DO)
30 RS-0	D-18	Main Display CPU Receive/Transmit	Variable 6 to 7 Volts Nominal	CPU (Comm)
30 RS-0	D-20	Main Display Receive./Transmit	Variable 6 to 7 Volts Nominal	CPU (Comm)
31 TX2	D-19	Main Display Transmit	Variable 6 to 7 Volts Nominal	CPU (Comm)
34 TX1	D-17	RCL Display Transmit (w/o Master Node) w/Master Node, Transmit from Controller	Variable 6 to 7 Volts Nominal	CPU (Comm)
35 RX1	D-16	RCL Display Receive (w/o Master Node) w/Master Node, Receive To Controller	Variable 6 to 7 Volts Nominal	CPU (Comm)
36 TX3	D-22	MAX-ER PC Transmit	Variable 6 to 7 Volts Nominal	CPU (Comm)
37 RX3	D-21	MAX-ER PC Receive	Variable 6 to 7 Volts Nominal	CPU (Comm)
38	C-11	Jumper to Signal Board Controller (Lights)	12 volts Nominal	I/O 1 (DO)
39	B-09	Jumper to Single Board Controller (Lights)	12 volts Nominal	I/O 1 (DI)
42	A-17	Hydraulic Fluid Temperature Sender	1.3 volts at 155°F; 5.56 volts at 95°F	I/O 2 (AI)
68KA	A-09	Engine Throttle (Current)	0.101 Volts to 10.09 Volts	I/O 1 (AI)
68K	A-10	Engine Throttle Input/Output (Current)	Variable	I/O 1 (AI)
68KB	TBD	Cooler Fan Pump Control	TBD	TBD
68R	D-14	Remote Start	12 volts Nominal	I/O 4 (DI)
69B	D-32	Proportional Valve (MAX-ER 225/400)	12 volts Nominal	I/O 3 (DO)
80A	C-05	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)
80C	D-33	Front Drum Pawl In Solenoid	12 volts Nominal	I/O 3 (DO)
80CA	E-35	Front Drum Pawl Out Solenoid	12 volts Nominal	I/O 4 (DO)
80DS		Not Used		I/O 3 (DO)
80E	C-07	Front Drum Parking Brake Solenoid	12 volts Nominal	I/O 1 (DO)
80F	C-16	Front Drum Clutch Solenoid	12 volts Nominal	I/O 1 (DO)
80MA	E-01	Front Drum Flange Encoder CHA	Above 7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 2 (DI)

Wire	Pin	Description	**Test Voltage** (DC unless otherwise specified)	**Board** (Signal Type)
80MB	E-02	Front Drum Flange Encoder CHB	Above 7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 2 (DI)
80N	C-26	Front or Right Rear Drum Rotation Indicator	12 volts Nominal	I/O 2 (DO)
80P	A-03	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)
81A	C-06	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)
81C	E-36	Rear Drum Pawl In Solenoid	12 volts Nominal	I/O 4 (DO)
81CA	E-37	Rear Drum Pawl Out Solenoid	12 volts Nominal	I/O 4 (DO)
81DS		Not Used		I/O 4 (DO)
81DSL		Not Used		I/O 4 (DO)
81E	C-08	Rear or Right Rear Drum Parking Brake Sol.	12 volts Nominal	I/O 1 (DO)
81EL	C-19	Left Rear Drum Parking Brake Solenoid	12 volts Nominal	I/O 1 (DO)
81F	C-17	Rear or Right Rear Drum Clutch Solenoid	12 volts Nominal	I/O 1 (DO)
81FL	C-18	Left Rear Drum Clutch Solenoid	12 volts Nominal	I/O 1 (DO)
81MAL	E-05	Left Rear Drum Flange Encoder CHA	Above 7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 3 (DI)
81MAR	E-03	Right Rear Drum Flange Encoder CHA	Above 7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 3 (DI)
81MBL	E-06	Left Rear Drum Flange Encoder CHB	Above 7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 3 (DI)
81MBR	E-04	Right Rear Drum Flange Encoder CHB	Above 7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 3 (DI)
81MC	D-34	Main Hoist Motor Control (Rexroth)	0 volts to 12 volts	I/O 3 (DO)
81MD	D-25	Main Hoist Motor Control (Sauer-Danfoss)	0.98 volts to 8.01 volts: 0% to 100% Motor Command	I/O 2 (AO)
81N	C-33	Rear or Left Rear Drum Rotation Indicator	12 volts Nominal	I/O 2 (DO)
81P	A-04	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)
81Q	A-25	Main Hoist Hydraulic Charge Press. Sender	2.6 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
81QS	A-22	Main Hoist Hydraulic System Press. Sender	1.2 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
82 BAR	E-08	Not Used		
82A	C-14	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)
82BA	A-20	Boom Angle Indicator	1.9 volts Boom at 0°; 6.9 volts Boom at 60°; 8.7 volts Boom at 82°	CPU (AI)
82E	C-09	Boom Hoist Brake Solenoid	12 volts Nominal	I/O 1 (DO)
82MA	D-05	Boom Hoist Shaft Encoder CHA	7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 2 (DI)
82MB	D-06	Boom Hoist Shaft Encoder CHB	7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 2 (DI)
82MD	E-29	Boom Hoist Motor Control	0.98 volts to 8.01 volts: 0% to 100% Motor Command	I/O 3 (AO)
82N	D-27	Boom or Luffing Hoist Rotation Indicator	12 volts Nominal	I/O 3 (DO)

Wire	Pin	Description	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
82P	A-05	Boom Hoist Handle	0 volts Neutral; 1.4 to 5 volts Reverse; 5 to 8.6 volts Forward	I/O 1 (AI)
82QS	A-26	Boom Hoist Hydraulic System Press. Sender	1.2 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
83A	C-15	Right Track Pump Control	0 to 2.8 ± 10% (110 Ma) volts Reverse; 0 to -2.8 ± 10% (-110Ma) volts Forward	I/O 2 (AO)
83P	A-06	Right Track Handle	0 volts Neutral; 1.4 to 5 volts Reverse; 5 to 8.6 volts Forward	I/O 1 (AI)
83QS	A-27	Right Track Hydraulic System Press. Sender	1.2 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
84A	C-23	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)
84E	C-10	Travel Brake Solenoid	12 volts Nominal	I/O 1 (DO)
84P	A-07	Left Track Handle	0 volts Neutral; 1.4 to 5 volts Reverse; 5 to 8.6 volts Forward	I/O 1 (AI)
84QS	A-28	Left Track Hydraulic System Pressure Sender	1.2 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
85A	C-24	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)
85B	E-33	MAX-ER 2000 Power Relay (Current)	12 volts Nominal	I/O 4 (DO)
85B	E-34	Not Used		
85P	A-08	Swing Handle	0 volts Neutral; 1.7 to 5 volts Right; 5 to 8.3 volts Left	I/O 1 (AI)
85QL	A-24	Swing Left Hydraulic System Press. Sender	1.2 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
85QR	A-23	Swing Right Hydraulic System Press. Sender	1.2 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
86N	C-28	Auxiliary Drum Rotation Indicator	12 volts Nominal	I/O 2 (DO)
86P	A-29	Luffing Hoist Handle	0 volts Neutral; 1.4 to 5 volts Lower; 5 to 8.6 volts Raise	CPU (AI)
87A	C-20	Ind. Luffing Hoist Pump Control 1	0 to 2.8 volts Engine Running; 0 to 2.4 volts Engine Off	I/O 1 (DO)
87B	C-29	Independent Hoist Pump Control 2	0 to 2.8 volts Engine Running; 0 to 2.4 volts Engine Off	I/O 2 (DO)
87BA	A-21	Luffing Jib Angle Indicator	4.7 volts Boom at 0°; 8.0 volts Boom at 60°; 9.2 volts Boom at 82°	CPU (AI)
87E	C-25	Luffing Hoist Brake Solenoid	12 volts Nominal	I/O 2 (DO)
87F	A-01	10 VDC Regulated Supply Out	10 volts	CPU (VDC)
87MA	D-01	Luffing Hoist Drum Flange Encoder CHA	7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 1 (DI)
87MB	D-02	Luffing Hoist Drum Flange Encoder CHB	7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 1 (DI)
87MD	D-24	Luffing Hoist Motor Control	0.98 volts to 8.01 volts: 0% to 100% Motor Command	I/O 1 (AO)
87QS	A-19	Independent Luffing Hoist Hydraulic System Pressure Sender	1.2 volts at 300 psi; 1 volt at 0 psi	I/O 2 (AI)
88QS	TBD	Cooler Fan Transducer	TBD	TBD
88R	C-32	Travel 2-Speed Solenoid	12 volts Nominal	I/O 2 (DO)
88S	C-27	Auxiliary System Disable Solenoid	12 volts Nominal	I/O 2 (DO)

Wire	Pin	Description	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
89A3	E-22	Not Used		
89A4	B-29	Boom Hoist Park Switch	12 volts Nominal	I/O 3 (DI)
89B2	D-12	Swing Holding Brake On	12 volts Nominal	I/O 3 (DI)
89B3	E-23	Not Used		
89B4	B-19	Travel Park Switch	12 volts Nominal	I/O 2 (DI)
89C2	D-13	Equalizer & Physical Boom Stop Limit Sw.	12 volts Nominal	I/O 3 (DI)
89C3	E-24	Remote Rigging Winch (Current)	0 Volts Off; 12 Volts On	I/O 4 (DI)
89C4	B-30	Luffing Hoist Park Switch	12 volts Nominal	I/O 3(DI)
89D1	B-11	Jacking Remote/MAX-ER Steering System	12 volts Nominal	I/O 1 (DI)
89D3	E-13	Counterweight Up Limit Switch	12 volts Nominal	I/O 4 (DI)
89D4	B-12	Jacking/Set Up Remote	12 volts Nominal	I/O 1 (DI)
89E3	E-12	Not Used		
89F1	B-32	Pendant Cylinder Limit Switch	12 volts Nominal	I/O 3 (DI)
89F3	E-11	Not Used		
89G3	E-10	Not Used		
89J	B-26	Display Scroll Up Switch	12 volts Nominal	I/O 2 (DI)
89J1	B-22	Left Rear Drum Selector Switch	12 volts Nominal	I/O 2 (DI)
89K	B-33	Display Scroll Down Switch	12 volts Nominal	I/O 3 (DI)
89K3	E-09	Counterweight Lower Switch (MAX-ER 225/400)	12 volts Nominal	I/O 2 (AI)
89L	B-25	Limit Bypass Switch	12 volts Nominal	I/O 2 (DI)
89L1	B-15	High Speed Travel Switch	12 volts Nominal	I/O 2 (DI)
89L3	B-31	Front Drum Pawl In Switch (Past)	12 volts Nominal	I/O 3 (DI)
89M		Not Used		I/O 2 (DI)
89M3	B-21	Right Drum Pawl In Switch (Past)	12 volts Nominal	I/O 2 (DI)
89N	B-13	Boom Hoist Pawl In Switch	12 volts Nominal	I/O 1 (DI)
89N3	A-02	Counterweight Raise Sw. (MAX-ER 225/440)	12 volts Nominal	CPU (AI)
89P	D-10	Rated Capacity Indicator/Limiter Switch	12 volts Nominal	I/O 3 (DI)
89P2	E-21	Not Used		
89Q1	B-04	Minimum Bail Limit Switch Left Rear Drum	12 volts Nominal	I/O 1 (DI)
89Q2	E-17	Boom Up Limit Switch - Ringer	12 volts Nominal	I/O 4 (DI)
89Q3	E-17	Not Used		
89R	B-14	Boom Up Limit Switch	12 volts Nominal	I/O 1 (DI)
89R1	B-05	Drum 3 Clutch/Brake Maximum Air Pressure	12 volts Nominal	I/O 1 (DI)
89S	B-08	Min. Bail Limit Switch Rear/Right Rear Drum	12 volts Nominal	I/O 1 (DI)
89S1	B-16	Luffing Jib Minimum Angle Limit Switch	10 volts	I/O 2 (DI)
89S2	B-24	Crane Mode Select Switch	12 volts Nominal	I/O 2 (DI)
89T	B-03	Minimum Bail Limit Switch Front Drum	12 volts Nominal	I/O 1 (DI)
89T2	D-11	Crane Mode Confirm Switch	12 volts Nominal	I/O 3 (DI)
89T3	D-08	Engine Oil Pressure Switch	12 volts Nominal	I/O 3 (DI)
89U	B-07	Drum 2 Clutch/Brake Maximum Air Pressure	12 volts Nominal	I/O 1 (DI)
89U3	D-09	Engine Coolant Temperature Switch	12 volts Nominal	I/O 3 (DI)

Wire	Pin	Description	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
89V	B-02	Drum 1 Clutch/Brake Maximum Air Pressure	12 volts Nominal	I/O 1 (DI)
89V2	E-15	Pawl Limit Switch - Front Drum (Past)	12 volts Nominal	I/O 4 (DI)
89V3	B-20	Low Air Pressure Switch	3.2 volts at 110 psi; 1 volt at 0 psi	I/O 2 (DI)
89W	B-06	Block Up Limit Switches	10 volts	I/O 1 (DI)
89W1	B-17	Luffing Jib Max. Angle Limit Switch	10 volts	I/O 2 (DI)
89W2	E-16	Pawl Limit Switch - Rear Drum (Past) Maximum Angle Limit (Current)	12 volts Nominal	I/O 4 (DI)
89X	B-01	Travel Detent Set & Cancel	12 volts Nominal	I/O 1 (DI)
89X2		Not Used		I/O 4 (DI)
89X3	B-27	Rear or Right Rear Drum Park Switch	12 volts Nominal	I/O 2 (DI)
89Y2	E-19	Not Used		
89Y3	B-18	Front Drum Park Switch	12 volts Nominal	I/O 2 (DI)
89Z3	B-28	Left Rear Drum Park Switch	12 volts Nominal	I/O 2 (DI)
89ZZ	E-14	Max. Boom & Luffing Angle Limit Bypass Past Production Only	12 volts Nominal	I/O 4 (DI)
8P1	C-01	Computer Input	12 volts Nominal	
8P1	C-03	Computer Input	12 volts Nominal	
8P1	C-12	Computer Input	12 volts Nominal	
8P1	C-21	Computer Input	12 volts Nominal	
8P1	C-30	Computer Input	12 volts Nominal	
90C	D-30	Pendant Cylinder Retract Solenoid (MAX-ER 225/400)	12 volts Nominal	I/O 3 (DO)
90D	D-31	Pendant Cylinder Extend Solenoid (MAX-ER 225/400)	12 volts Nominal	I/O 3 (DO)
90E	A-30	Backhitch Load Sensor	(Past) 1.5 V at No Load; 9.5 V at Max. Load; (Current) 3.15 V at No Load; Compression 0.804 V at 180,000 lbs; Tension 8.04 V at 375,000 lbs	CPU (AI)
98F	A-18	Hydraulic Fluid Level Sender	5.2 volts Low Level; 1.2 volts High Level	I/O 2 (AI)
98Q	A-31	Hydraulic Vacuum Switch	1 volt at 30 inches of Mercury (Hg); 2.3 volts at 0 psi	I/O 3 (AI)
99	A-32	Level Sensor - X Dimension	5 volts at 0°; 0.5 volts Change Per Degree	I/O 3 (AI)
99A	A-33	Level Sensor - Y Dimension	5 volts at 0°; 0.5 volts Change Per Degree	I/O 3 (AI)
SIG1V	A-34	Lower Boom Point Load Pin	0.8 volts 0 Load; 7 volts 30,000 lb.	CPU (AI)
SIG2V	A-35	Upper Boom Point Load Pin	0.8 volts 0 Load; 7 volts 30,000 lb.	CPU (AI)
SIG3V	A-36	Lower Jib Load Pin	0.8 volts 0 Load; 7 volts 30,000 lb.	CPU (AI)
SIG4V	A-37	Upper Jib Load Pin	0.8 volts 0 Load; 7 volts 30,000 lb.	CPU (AI)

Crane Controller Description Identification

Description	Pin	Wire	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
10 VDC Regulated Supply Out	A-01	87F	10 volts	CPU (VDC)
MAX-ER 2000 Power Relay (Current)	E-33	85B	12 volts Nominal	I/O 4 (DO)
Auxiliary Drum Rotation Indicator	C-28	86N	12 volts Nominal	I/O 2 (DO)
Auxiliary System Disable Solenoid	C-27	88S	12 volts Nominal	I/O 2 (DO)
Backhitch Load Sensor	A-30	90E	(Past) 1.5 V at No Load; 9.5 V at Max. Load; (Current) 3.15 V at No Load; Compression 0.804 V at 180,000 lbs; Tension 8.04 V at 375,000 lbs	CPU (AI)
Block Up Limit Switches	B-06	89W	10 volts	I/O 1 (DI)
Boom Angle Indicator	A-20	82BA	1.9 volts Boom at 0°; 6.9 volts Boom at 60°; 8.7 volts Boom at 82°	CPU (AI)
Boom Hoist Brake Solenoid	C-09	82E	12 volts Nominal	I/O 1 (DO)
Boom Hoist Handle	A-05	82P	0 volts Neutral; 1.4 to 5 volts Reverse; 5 to 8.6 volts Forward	I/O 1 (AI)
Boom Hoist Hydraulic System Press. Sender	A-26	82QS	1.2 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
Boom Hoist Motor Control	E-29	82MD	0.98 volts to 8.01 volts: 0% to 100% Motor Command	I/O 3 (AO)
Boom Hoist Park Switch	B-29	89A4	12 volts Nominal	I/O 3 (DI)
Boom Hoist Pawl In Switch	B-13	89N	12 volts Nominal	I/O 1 (DI)
Boom Hoist Pump Control	C-14	82A	0 to 2.8 ±10% (110 Ma) volts Down; 0 to -2.8 ± 10% (-110 Ma) volts Up	I/O 2 (AO)
Boom Hoist Shaft Encoder CHA	D-05	82MA	7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 2 (DI)
Boom Hoist Shaft Encoder CHB	D-06	82MB	7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 2 (DI)
Boom or Luffing Hoist Rotation Indicator	D-27	82N	12 volts Nominal	I/O 3 (DO)
Boom Up Limit Switch	B-14	89R	12 volts Nominal	I/O 1 (DI)
Computer Ground	C-02	0	0 volts	
Computer Ground	C-04	0	0 volts	
Computer Ground	C-13	0	0 volts	
Computer Ground	C-22	0	0 volts	
Computer Ground	C-31	0	0 volts	
Computer Input	C-01	8P1	12 volts Nominal	
Computer Input	C-03	8P1	12 volts Nominal	
Computer Input	C-12	8P1	12 volts Nominal	
Computer Input	C-21	8P1	12 volts Nominal	
Computer Input	C-30	8P1	12 volts Nominal	
Cooler Fan Pump Control	TBD	68KB	TBD	TBD
Cooler Fan Transducer	TBD		TBD	TBD
Counterweight Lower Switch (MAX-ER 225/400)	E-09	89K3	12 volts Nominal	I/O 2 (AI)
Counterweight Raise Sw. (MAX-ER 225/440)	A-02	89N3	12 volts Nominal	CPU (AI)
Counterweight Up Limit Switch	E-13	89D3	12 volts Nominal	I/O 4 (DI)
Crane Mode Confirm Switch	D-11	89T2	12 volts Nominal	I/O 3 (DI)

Description	Pin	Wire	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
Crane Mode Select Switch	B-24	89S2	12 volts Nominal	I/O 2 (DI)
Display Scroll Down Switch	B-33	89K	12 volts Nominal	I/O 3 (DI)
Display Scroll Up Switch	B-26	89J	12 volts Nominal	I/O 2 (DI)
Engine Oil Pressure Switch	D-08	89T3	12 volts Nominal	I/O 3 (DI)
Engine RPM Sender	D-07	24	7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 1 (DI)
Engine Coolant Temperature Switch	D-09	89U3	12 volts Nominal	I/O 3 (DI)
Engine Throttle (Current)	A-09	68KA	0.101 Volts to 10.09 Volts	I/O 1 (AI)
Engine Throttle Input/Output (Current)	A-10	68K	Variable	I/O 1 (AI)
Equalizer & Physical Boom Stop Limit Sw.	D-13	89C2	12 volts Nominal	I/O 3 (DI)
Front Drum Clutch Solenoid	C-16	80F	12 volts Nominal	I/O 1 (DO)
Front Drum Flange Encoder CHA	E-01	80MA	Above 7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 2 (DI)
Front Drum Flange Encoder CHB	E-02	80MB	Above 7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 2 (DI)
Front Drum Free Fall Light	D-26	80DS	12 volts Nominal	I/O 3 (DO)
Front Drum Park Switch	B-18	89Y3	12 volts Nominal	I/O 2 (DI)
Front Drum Parking Brake Solenoid	C-07	80E	12 volts Nominal	I/O 1 (DO)
Front Drum Pawl In Solenoid	D-33	80C	12 volts Nominal	I/O 3 (DO)
Front Drum Pawl In Switch (Past)	B-31	89L3	12 volts Nominal	I/O 3 (DI)
Front Drum Pawl Out Solenoid	E-35	80CA	12 volts Nominal	I/O 4 (DO)
Front or Right Rear Drum Handle	A-03	80P	0 volts Neutral; 1.4 to 5 volts Lower; 5 to 8.6 volts Raise	I/O 1 (AI)
Front or Right Rear Drum Rotation Indicator	C-26	80N	12 volts Nominal	I/O 2 (DO)
Front or Right Rear Free Fall Safety Switch	B-23	89M	12 volts Nominal	I/O 2 (DI)
High Speed Travel Switch	B-15	89L1	12 volts Nominal	I/O 2 (DI)
Hydraulic Fluid Level Sender	A-18	98F	5.2 volts Low Level; 1.2 volts High Level	I/O 2 (AI)
Hydraulic Fluid Temperature Sender	A-17	42	1.3 volts at 155°F; 5.56 volts at 95°F	I/O 2 (AI)
Hydraulic Vacuum Switch	A-31	98Q	1 volt at 30 inches of Mercury (Hg); 2.3 volts at 0 psi	I/O 3 (AI)
Independent Hoist Pump Control 1	C-20	87A	0 to 2.8 volts Engine Running; 0 to 2.4 volts Engine Off	I/O 1 (DO)
Independent Hoist Pump Control 2	C-29	87B	0 to 2.8 volts Engine Running; 0 to 2.4 volts Engine Off	I/O 2 (DO)
Independent Luffing Hoist Hydraulic System Pressure Sender	A-19	87QS	1.2 volts at 300 psi; 1 volt at 0 psi	I/O 2 (AI)
Jacking/Set Up Remote	B-12	89D4	12 volts Nominal	I/O 1 (DI)
Jacking Remote Level Alarm & Light	C-36	25B	12 volts Nominal	I/O 2 (DO)
Jacking Remote or MAX-ER Steering System	B-11	89D1	12 volts Nominal	I/O 1 (DI)
Jumper to Signal Board Controller (Lights)	C-11	38	12 volts Nominal	I/O 1 (DO)
Left Rear Drum Clutch Solenoid	C-18	81FL	12 volts Nominal	I/O 1 (DO)
Left Rear Drum Flange Encoder CHA	E-05	81MAL	Above 7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 3 (DI)
Left Rear Drum Flange Encoder CHB	E-06	81MBL	Above 7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 3 (DI)

Description	Pin	Wire	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
Left Rear Drum Free Fall Light	D-37	81DSL	12 volts Nominal	I/O 4 (DO)
Left Rear Drum Park Switch	B-28	89Z3	12 volts Nominal	I/O 2 (DI)
Left Rear Drum Parking Brake Solenoid	C-19	81EL	12 volts Nominal	I/O 1 (DO)
Left Rear Drum Selector Switch	B-22	89J1	12 volts Nominal	I/O 2 (DI)
Left Track Handle	A-07	84P	0 volts Neutral; 1.4 to 5 volts Reverse; 5 to 8.6 volts Forward	I/O 1 (AI)
Left Track Hydraulic System Pressure Sender	A-28	84QS	1.2 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
Left Track Pump Control	C-23	84A	0 to 2.8 ± 10% (110 Ma) volts Reverse; 0 to -2.8 ± 10% (-110 Ma) volts Forward	I/O 3 (AO)
Level Sensor - X Dimension	A-32	99	5 volts at 0°; 0.5 volts Change Per Degree	I/O 3 (AI)
Level Sensor - Y Dimension	A-33	99A	5 volts at 0°; 0.5 volts Change Per Degree	I/O 3 (AI)
Limit Bypass Switch	B-25	89L	12 volts Nominal	I/O 2 (DI)
Rated Capacity Indicator/Limiter Switch	D-10	89P	12 volts Nominal	I/O 3 (DI)
Low Air Pressure Switch	B-20	89V3	3.2 volts at 110 psi; 1 volt at 0 psi	I/O 2 (DI)
Lower Boom Point Load Pin	A-34	SIG1V	0.8 volts 0 Load; 7 volts 30,000 lb.	CPU (AI)
Lower Jib Load Pin	A-36	SIG3V	0.8 volts 0 Load; 7 volts 30,000 lb.	CPU (AI)
Luffing Hoist Brake Solenoid	C-25	87E	12 volts Nominal	I/O 2 (DO)
Luffing Hoist Drum Flange Encoder CHA	D-01	87MA	7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 1 (DI)
Luffing Hoist Drum Flange Encoder CHB	D-02	87MB	7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 1 (DI)
Luffing Hoist Handle	A-29	86P	0 volts Neutral; 1.4 to 5 volts Lower; 5 to 8.6 volts Raise	CPU (AI)
Luffing Hoist Motor Control	D-24	87MD	0.98 volts to 8.01 volts: 0% to 100% Motor Command	I/O 1 (AO)
Luffing Hoist Park Switch	B-30	89C4	12 volts Nominal	I/O 3 (DI)
Luffing Jib Angle Indicator	A-21	87BA	4.7 volts Boom at 0°; 8.0 volts Boom at 60°; 9.2 volts Boom at 82°	CPU (AI)
Luffing Jib Maximum Angle Limit Switch	B-17	89W1	10 volts	I/O 2 (DI)
Luffing Jib Minimum Angle Limit Switch	B-16	89S1	10 volts	I/O 2 (DI)
Main Display CPU Receive/Transmit	D-18	30 RS-0	Variable 6 to 7 Volts Nominal	CPU (Comm)
Main Display Transmit	D-19	31 TX2	Variable 6 to 7 Volts Nominal	CPU (Comm)
Main Display Receive/transmit	D-20	30 RS-0	Variable 6 to 7 Volts Nominal	CPU (Comm)
Main Hoist Hydraulic Charge Press. Sender	A-25	81Q	2.6 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
Main Hoist Hydraulic System Press. Sender	A-22	81QS	1.2 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
Main Hoist Motor Control (Sauer-Danfoss)	D-25	81MD	0.98 volts to 8.01 volts: 0% to 100% Motor Command	I/O 2 (AO)
Main Hoist Motor Control (Rexroth)	D-34	81MC	0 volts to 12 volts	I/O 3 (DO)
Main Hoist Pump Control 1	C-05	80A	0 to 2.8 ± 10% (110 Ma) volts Down; 0 to -2.8 ± 10% (-110 Ma) volts Up	I/O 1 (AO)
Main Hoist Pump Control 2	C-06	81A	0 to 2.8 ± 10% (110 Ma) volts Down; 0 to -2.8 ± 10% (-110 Ma) volts Up	I/O 1 (AO)

Description	Pin	Wire	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
Remote Rigging Winch (Current)	E-24	89C3	0 Volts Off; 12 Volts On	I/O 4 (DI)
Drum 2 Clutch/Brake Maximum Air Pressure	B-07	89U	12 volts Nominal	I/O 1 (DI)
Max. Boom & Luffing Angle Limit Bypass Past Production Only	E-14	89ZZ	12 volts Nominal	I/O 4 (DI)
Drum 1 Clutch/Brake Maximum Air Pressure	B-02	89V	12 volts Nominal	I/O 1 (DI)
MAX-ER PC Transmit	D-22	36 TX3	Variable 6 to 7 Volts Nominal	CPU (Comm)
MAX-ER PC Receive	D-21	37 RX3	Variable 6 to 7 Volts Nominal	CPU (Comm)
Min. Bail Limit Switch Rear /Right Rear Drum	B-08	89S	12 volts Nominal	I/O 1 (DI)
Minimum Bail Limit Switch Front Drum	B-03	89T	12 volts Nominal	I/O 1 (DI)
Minimum Bail Limit Switch Left Rear Drum	B-04	89Q1	12 volts Nominal	I/O 1 (DI)
Drum 3 Clutch/Brake Maximum Air Pressure	B-05	89R1	12 volts Nominal	I/O 1 (DI)
Operating Limit Buzzer & Light	C-35	25A	12 volts Nominal	I/O 2 (DO)
Pawl Limit Switch - Front Drum (Past)	E-15	89V2	12 volts Nominal	I/O 4 (DI)
Pawl Limit Switch - Rear Drum (Past) Maximum Angle Limit (Current)	E-16	89W2	12 volts Nominal	I/O 4 (DI)
Remote Start	D-14	68R	12 volts Nominal	I/O 4 (DI)
Pendant Cylinder Extend Solenoid (MAX-ER 225/400)	D-31	90D	12 volts Nominal	I/O 3 (DO)
Pendant Cylinder Limit Switch	B-32	89F1	12 volts Nominal	I/O 3 (DI)
Pendant Cylinder Retract Solenoid (MAX-ER 225/400)	D-30	90C	12 volts Nominal	I/O 3 (DO)
Proportional Valve (MAX-ER 225/400)	D-32	69B	12 volts Nominal	I/O 3 (DO)
RCL Display Receive (w/o Master Node) w/Master Node, Receive To Controller	D-16	35 RX1	Variable 6 to 7 Volts Nominal	CPU (Comm)
RCL Display Transmit (w/o Master Node) w/Master Node, Transmit From Controller	D-17	34 TX1	Variable 6 to 7 Volts Nominal	CPU (Comm)
Rear & Left Rear Free Fall Safety Switch	D-15	89X2	12 volts Nominal	I/O 4 (DI)
Rear Drum Free Fall Light	D-36	81DS	12 volts Nominal	I/O 4 (DO)
Rear Drum Pawl In Solenoid	E-36	81C	12 volts Nominal	I/O 4 (DO)
Rear Drum Pawl Out Solenoid	E-37	81CA	12 volts Nominal	I/O 4 (DO)
Rear or Left Rear Drum Handle	A-04	81P	0 volts Neutral; 1.4 to 5 volts Lower; 5 to 8.6 volts Raise	I/O 1 (AI)
Rear or Left Rear Drum Rotation Indicator	C-33	81N	12 volts Nominal	I/O 2 (DO)
Rear or Right Rear Drum Clutch Solenoid	C-17	81F	12 volts Nominal	I/O 1 (DO)
Rear or Right Rear Drum Park Switch	B-27	89X3	12 volts Nominal	I/O 2 (DI)
Rear or Right Rear Drum Parking Brake Sol.	C-08	81E	12 volts Nominal	I/O 1 (DO)
Right Drum Pawl In Switch (Past)	B-21	89M3	12 volts Nominal	I/O 2 (DI)
Right Rear Drum Flange Encoder CHA	E-03	81MAR	Above 7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 3 (DI)
Right Rear Drum Flange Encoder CHB	E-04	81MBR	Above 7.5 volts or 0 volts Not Moving; 3.5 volts Moving	I/O 3 (DI)
Right Track Handle	A-06	83P	0 volts Neutral; 1.4 to 5 volts Reverse; 5 to 8.6 volts Forward	I/O 1 (AI)
Right Track Hydraulic System Pressure Sender	A-27	83QS	1.2 volts at 300 psi; 1 volt at 0 psi	CPU (AI)

Description	Pin	Wire	**Test Voltage** (DC unless otherwise specified)	**Board** (Signal Type)
Right Track Pump Control	C-15	83A	0 to 2.8 ± 10% (110 Ma) volts Reverse; 0 to -2.8 ± 10% (-110Ma) volts Forward	I/O 2 (AO)
Seat Switch	B-10	89Q3	12 volts Nominal	I/O 1 (DI)
Swing & Travel Alarm (MAX-ER 225/400)	D-35	25X	12 volts Nominal	I/O 3 (DO)
Swing Handle	A-08	85P	0 volts Neutral; 1.7 to 5 volts Right; 5 to 8.3 volts Left	I/O 1 (AI)
Swing Holding Brake On	D-12	89B2	12 volts Nominal	I/O 3 (DI)
Swing Left Hydraulic System Press. Sender	A-24	85QL	1.2 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
Swing Pump Control	C-24	85A	0 to 2.8 ± 10% (110 Ma) volts Left; 0 to -2.8 ± 10% (-110 Ma) volts Right	I/O 3 (AO)
Swing Right Hydraulic System Press. Sender	A-23	85QR	1.2 volts at 300 psi; 1 volt at 0 psi	CPU (AI)
System Fault Beeper & Light	C-34	25	12 volts Nominal	I/O 2 (DO)
Travel 2-Speed Solenoid	C-32	88R	12 volts Nominal	I/O 2 (DO)
Travel Brake Solenoid	C-10	84E	12 volts Nominal	I/O 1 (DO)
Travel Detent Set & Cancel	B-01	89X	12 volts Nominal	I/O 1 (DI)
Travel Park Switch	B-19	89B4	12 volts Nominal	I/O 2 (DI)
Upper Boom Point Load Pin	A-35	SIG2V	0.8 volts 0 Load; 7 volts 30,000 lb.	CPU (AI)
Upper Jib Load Pin	A-37	SIG4V	0.8 volts 0 Load; 7 volts 30,000 lb.	CPU (AI)

Master Node Pin Identification

Cranestar and Tier 4 equipped machines.

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
P11-08	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
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
P12-08	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	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		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
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		DPF Regen Disable	24 Volts Nominal

Pin #	Function Type	Description	Test Voltage (DC unless otherwise specified)
P12-34		DPF Regen Initiate	24 Volts Nominal
P12-39	DO-15 Grd	CAN System Ground	Ground
P12-40	DO-16 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

Aux Power Plant Controller Pin Identification

Reference Electrical Schematic A14752.

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-20	42R	Hydraulic Fluid Temperature Sender	10 volts Nominal	CPU (AI)
A-21	98FR	Hydraulic Tank Level Sensor	10 volts Nominal	CPU (AI)
B-01	89T3R	Aux Engine Oil Pressure	12 volts Nominal	I/O 1 (DI)
B-02	89U3R	Aux Engine Coolant Temperature	12 volts Nominal	I/O 1 (DI)
B-03	89D4R	Hydraulic Filter Alarm 1	12 volts Nominal	I/O 1 (DI)
B-04	89E4R	Hydraulic Filter Alarm 2	12 volts Nominal	I/O 1 (DI)
C-01	8PR	Computer Input	12 volts Nominal	
C-02	0R	Computer Ground	0 volts	
C-03	8PR	Computer Input	12 volts Nominal	
C-04	0R	Computer Ground	0 volts	
C-05	80AR	Rear Drum Pump Control 1	0 to 2.8 ± 10% (110 Ma) volts Left; 0 to -2.8 ± 10% (-110 Ma) volts Right	I/O 1 (AO)
C-06	81AR	Rear Drum Pump Control 2	0 to 2.8 ± 10% (110 Ma) volts Left; 0 to -2.8 ± 10% (-110 Ma) volts Right	I/O 1 (AO)
C-12	8PR	Computer Input	12 volts Nominal	
C-13	0R	Computer Ground	0 volts	
C-14	87AR	Swing Pump Control	0 to 2.8 ± 10% (110 Ma) volts Left; 0 to -2.8 ± 10% (-110 Ma) volts Right	I/O 2 (AO)
C-21	8PR	Computer Input	12 volts Nominal	
C-22	0R	Computer Ground	0 volts	
C-30	8PR	Computer Input	12 volts Nominal	
C-31	0R	Computer Ground	0 volts	
D-16	35	Aux CPU RS232 RX1	Variable 6 to 7 Volts Nominal	CPU (Comm)
D-17	34	Aux CPU RS232 TX1	Variable 6 to 7 Volts Nominal	CPU (Comm)
D-18	30	Aux CPU RS232 Ground	0	CPU (Comm)

MODEL 2250 MAX-ER 2000™ TEST VOLTAGES

General

This Section contains MAX-ER 2000 test voltages sorted into three categories:

TABLE 1	Pin Identification
TABLE 2	Wire Identification
TABLE 3	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
lbs	=	Pounds
N/C	=	No Connection
psi	=	Pounds per Square Inch

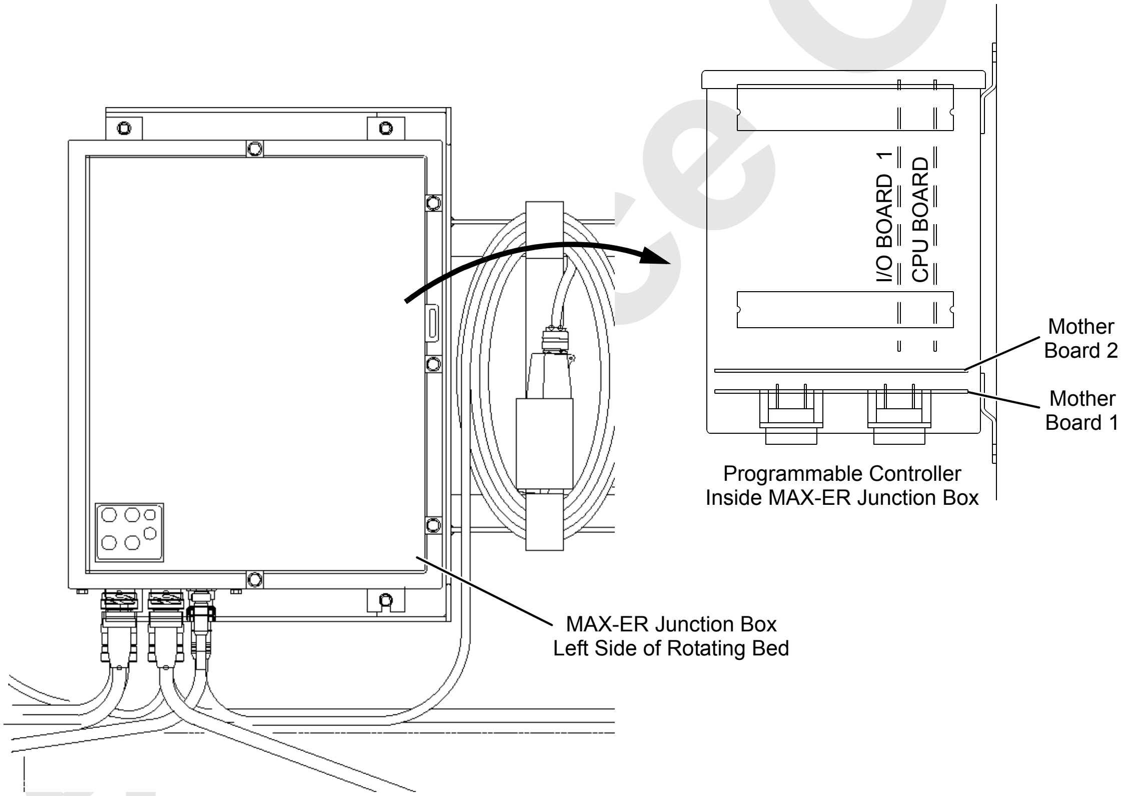

FIGURE 3-11

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	
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)

MAX-ER Controller Wire Identification

Wire	Pin	Description	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
0	C-02	MAX-ER PC Ground	Ground	
0	C-04	MAX-ER PC Ground	Ground	
0	C-13	MAX-ER PC Ground	Ground	
0	C-22	MAX-ER PC Ground	Ground	
0	C-31	MAX-ER PC Ground	Ground	
DO-5	C-11	Spare		
25XM	C-10	Swing/Travel Alarm	12 Volts Nominal	
36 (RX3)	D-21	MAX-ER PC Receive	Variable	
37 (TX3)	D-22	MAX-ER PC Transmit	Variable	
8N	C-01	MAX-ER PC Power	12 Volts	
8N	C-03	MAX-ER PC Power	12 Volts	
8N	C-12	MAX-ER PC Power	12 Volts	
8N	C-21	MAX-ER PC Power	12 Volts	
8N	C-30	MAX-ER PC Power	12 Volts Nominal	
81C	C-19	Rear or Right Rear Drum Pawl In Air Solenoid	12 Volts Nominal	(DO)
81CA	C-20	Rear or Right Rear Drum Pawl Out Air Solenoid	12 Volts Nominal	(DO)
87FM	A-01	10 Volt Regulated Supply	10 Volts	
88C	C-17	Drum 9 Pawl In Relay	12 Volts Nominal	(DO)
88CA	C-18	Drum 9 Pawl Out Relay	12 Volts Nominal	(DO)
88D	C-07	Travel/Drum 9 Diverting Valve Solenoid	12 Volts Nominal	(DO)
88DP	D-37	Main Hoist Pump 2/Drum 9 Diverting Valve Solenoid	12 Volts Nominal	(DO)
88E	C-16	Drum 9 Brake	12 Volts Nominal	(DO)
88MA	D-01	Drum 9 Flange Encoder 1	7.5 or 0 Volts Not Moving; 3.5 Volts Moving	CH-A
88MB	D-02	Drum 9 Flange Encoder 1	7.5 or 0 Volts Not Moving; 3.5 Volts Moving	CH-B
88MC	C-05	Drum 9 Left and Right Motor Control	-5 volts to 5 volts	(DO)
89F4	A-03	Mast Angle Limit	12 Volts Nominal	(AI)
89G4	A-04	Drum 9 Minimum Bail Limit Switch	12 Volts Nominal	(AI)
89H4	A-05	Remote Switches	12 Volts Nominal	(AI)
89J4	A-06	Counterweight Raise Pendant Cylinder Retract	12 Volts Nominal	(AI)
89K4	A-07	Counterweight Lower Pendant Cylinder Extend	12 Volts Nominal	(AI)

89L4	A-08	Left Pendant Cylinder Limit Switch	12 Volts Nominal	(AI)
89P4	A-23	Rear Drum Pawl Limit Switch	12 Volts Nominal	(AI)
89YY	E-20	RCL Override (CE Option Only)	12 Volts Nominal	(DI)
90CR	C-08	Pendant Cylinder Extend Solenoid	12 Volts Nominal	(DO)
90DR	C-09	Pendant Cylinder Retract Solenoid	12 Volts Nominal	(DO)
90QL	A-20	Left Pendant Cylinder Rod Pressure Sender	1.2 Volts at 300 psi; 1 Volt at 0 psi	(AI)
90QM	A-36	Mast Accumulator Pressure Sender	1.2 Volts at 300 psi; 1 Volt at 0 psi	(AI)
90QR	A-21	Right Pendant Cylinder Rod Pressure Sender	1.2 Volts at 300 psi; 1 Volt at 0 psi	(AI)
90RP	A-24	Right Pendant Cylinder Piston Pressure Sender	1.2 Volts at 300 psi; 1 Volt at 0 psi	(AI)
99B	A-22	Counterweight Level Sensor	5 Volts at 0°; 0.5 Volts Change Per 1°	(AI)

MAX-ER Controller Description ID

Description	Pin	Wire	Test Voltage (DC unless otherwise specified)	Board (Signal Type)
10 Volt Regulated Supply	A-01	87FM	10 Volts	
Counterweight Level Sensor	A-22	99B	5 Volts at 0°; 0.5 Volts Change Per 1°	(AI)
Counterweight Lower Pendant Cylinder Extend	A-07	89K4	12 Volts Nominal	(AI)
Counterweight Raise Pendant Cylinder Retract	A-06	89J4	12 Volts Nominal	(AI)
Drum 9 Brake	C-16	88E	12 Volts Nominal	(DO)
Drum 9 Flange Encoder CHA	D-01	88MA	7.5 or 0 Volts Not Moving; 3.5 Volts Moving	CH-A
Drum 9 Flange Encoder CHB	D-02	88MB	7.5 or 0 Volts Not Moving; 3.5 Volts Moving	CH-B
Drum 9 Left and Right Motor Control	C-05	88MC	-5 volts to 5 volts	(DO)
Drum 9 Minimum Bail Limit Switch	A-04	89G4	12 Volts Nominal	(AI)
Drum 9 Pawl In Relay	C-17	88C	12 Volts Nominal	(DO)
Drum 9 Pawl Out Relay	C-18	88CA	12 Volts Nominal	(DO)
Left Pendant Cylinder Limit Switch	A-08	89L4	12 Volts Nominal	(AI)
Left Pendant Cylinder Rod Pressure Sender	A-20	90QL	1.2 Volts at 300 psi; 1 Volt at 0 psi	(AI)
Main Hoist Pump 2/Drum 9 Diverting Valve Solenoid	D-37	88DP	12 Volts Nominal	(DO)
Mast Accumulator Pressure Sender	A-36	90QM	1.2 Volts at 300 psi; 1 Volt at 0 psi	(AI)
Mast Angle Limit	A-03	89F4	12 Volts Nominal	(AI)
MAX-ER PC Receive	D-21	36 (RX3)	Variable	
MAX-ER PC Transmit	D-22	37 (TX3)	Variable	
MAX-ER PC Ground	C-02	0	Ground	
MAX-ER PC Ground	C-04	0	Ground	
MAX-ER PC Ground	C-13	0	Ground	
MAX-ER PC Ground	C-22	0	Ground	
MAX-ER PC Ground	C-31	0	Ground	
MAX-ER PC Power	C-01	8N	12 Volts	
MAX-ER PC Power	C-03	8N	12 Volts	
MAX-ER PC Power	C-12	8N	12 Volts	
MAX-ER PC Power	C-21	8N	12 Volts	
MAX-ER PC Power	C-30	8N	12 Volts Nominal	
Pendant Cylinder Extend Solenoid	C-08	90CR	12 Volts Nominal	(DO)
Pendant Cylinder Retract Solenoid	C-09	90DR	12 Volts Nominal	(DO)
RCL Override (CE Option Only)	E-20	89YY	12 volts Nominal	(DI)

Rear Drum Pawl Limit Switch	A-23	89P4	12 Volts Nominal	(AI)
Rear or Right Rear Drum Pawl In Air Solenoid	C-19	81C	12 Volts Nominal	(DO)
Rear or Right Rear Drum Pawl Out Air Solenoid	C-20	81CA	12 Volts Nominal	(DO)
Remote Switches	A-05	89H4	12 Volts Nominal	(AI)
Right Pendant Cylinder Piston Pressure Sender	A-24	89M4	1.2 Volts at 300 psi; 1 Volt at 0 psi	(AI)
Right Pendant Cylinder Rod Pressure Sender	A-21	90QR	1.2 Volts at 300 psi; 1 Volt at 0 psi	(AI)
Spare	C-11	DO-5		
Swing/Travel Alarm	C-10	25XM	12 Volts Nominal	(DO)
Travel/Drum 9 Diverting Valve Solenoid	C-07	88D	12 Volts Nominal	(DO)

DIGITAL DISPLAY READINGS

General

The digital display and selector (see Operating Controls topic) allow the operator to monitor three groups of crane information: operating conditions, operating limits, and system faults.

Depress top or bottom of selector to scroll up and down through the display readings. Release selector when the desired information is displayed.

To display diagnostic operating conditions listed in Table 3-2, depress limit bypass switch while scrolling up with selector. To turn off the diagnostic operating conditions, depress limit bypass while scrolling down with selector or turn off cab power.

See Table 3-5 for a list of abbreviations and notes used in the tables. See Drum Identification topic for identification of the drums.

NOTE: This section identifies display readings for all modes and configurations the 2250 can be used in (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 which 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 displays (see Figure 3-12).

ENGINE SPEED
900 RPM

FIGURE 3-12

Operating Limits

Table 3-3 lists operating limits which can be displayed.

When one or more operating limit is reached, the operating limit alert (yellow light and buzzer in cab) turns on to warn the operator. At the same time, the operating limit display immediately appears (see Figure 3-13) and automatically scrolls through the names of the limits, stopping at each for approximately three seconds.

OPERATING LIMIT
BLOCK UP

FIGURE 3-13

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. Name of limit appears on display
2. Cause of 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 3-14) when there are no limits.

OPERATING LIMIT
NO FAULT

FIGURE 3-14

System Faults

Table 3-4 lists system faults which 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 3-15) and automatically scrolls through the names of the faults, stopping at each for approximately three seconds.

SYSTEM FAULT
LOAD PIN

FIGURE 3-15

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. Name of fault appears on display
2. Cause of 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 3-16) when there are no faults.

SYSTEM FAULT
NO FAULT

FIGURE 3-16

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 limit bypass switch.
2. Turn crane mode selector key to “confirm” position.

Repeat the steps until the screen displays the desired language.

Table 3-2
Operating Conditions

Listed below are the operating conditions which can be viewed on the digital display.

	Display Reading	Unit of Measure	Operating Range
	Normal Operating Conditions The operating conditions listed below are displayed by scrolling up or down with the digital display selector.		
	ENGINE OIL PRESSURE	PSI	See Engine Manual for specifications.
*	AUX ENGINE OIL PRESS		
	ENGINE SPEED	RPM	900 rpm low idle; 2,300 rpm high idle; 2,100 rpm full load governed.
*	AUX ENGINE SPEED		
	AIR PRESSURE	PSI	120 - 132 psi (8 - 9 bar).
	ENGINE TEMPERATURE	DEG F	See Engine Manual for specifications.
*	AUX ENGINE TEMP		
	MACHINE LEVEL FRONT	DEG IN	Each screen displays two numbers. First number is angle (+ or - degrees) that crane is out of level in indicated direction from horizontal. Second number is approximate amount (inch) of blocking needed to level crane in required direction.
	MACHINE LEVEL RIGHT		
	BOOM ANGLE	DEG	Degrees boom is positioned above horizontal.
*	BOOM ANGLE LUFF ANGLE	DEG	Degrees boom is positioned above horizontal. Degrees luffing jib is positioned above horizontal.
*	BOOM TO LUFF JIB ANG	DEG	Degrees between centerline of boom and centerline of luffing jib.
*	CTWT UP DOWN BHITCH XX.X	—	Indicates position of counterweight (UP, DOWN) and back hitch loading during MAX-ER 225, 400, or 2000 operation.
	CLAM CLOSING PRESS	PSI	See Clamshell Operation instructions for procedure to adjust pressure.
	CRANE MODE (Name of Mode)	—	See Crane Mode Selector instructions for procedure to select and confirm 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 diagnostic screens, depress limit bypass switch and scroll down or stop and restart engine.		
	HYDRAULIC TANK TEMP	DEG F	Oil temperature varies depending on load and ambient temperature. Will not accurately read temperature less than approximately 90°F (32°C).
*	AUX HYD TANK TEMP		
	HYDRAULIC TANK PRESS	PSIA	7 - 18 psia (0,5 - 1,2 bar absolute) depending on filter condition and oil temperature.
	HYDRAULIC TANK LEVEL	%	75 - 100% of oil remaining in tank.
	DRUM (10 screens)	2 Rows of Numbers in Multiple Display Screens	Numbers are used to monitor operation of programmable controller and system functions. See Diagnostics Display instructions in this Section of the manual for detailed explanation of these screens. The Manitowoc Crane Care Lattice Team will request these numbers when troubleshooting crane.
	SWING		
	AUX SWING		
	TRACKS		
	A1, A2, A3		
	D1, D2, D3		
	MXR	2 Rows of Numbers	Numbers are used to monitor operation of programmable controller and system functions ***for MAX-ER 2000 only***. See Diagnostics Display instructions in this Section of the manual for detailed explanation of 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 which 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 will 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 operator's seat.
BLOCK UP	Load drum stops hoisting and boom hoist stops lowering.	Lower load or raise boom.
* MAXIMUM BAIL	Load on corresponding drum stops hoisting.	Lower load.
* MINIMUM BAIL	Load on corresponding drum stops lowering.	Hoist load.
* PAWL IN [1]	Corresponding drum does not lower or stops lowering.	Disengage pawl. It may be necessary to hoist slightly before pawl will disengage.
PAWL OUT [1] or FUNCTION NOT PARKED [2]	For standard crane equipped with luffing jib (Drum 5), boom hoist (Drum 4) cannot be operated until luffing hoist pawl is engaged or luffing hoist is parked, and vice versa.	Engage corresponding pawl or park corresponding drum.
FUNCTION NOT PARKED [2]	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 corresponding drum.
BOOM MAXIMUM UP [3]	Boom stops hoisting when maximum limit is reached.	Lower boom.
BOOM MAXIMUM DOWN	Boom stops lowering (limit usually set at 0°).	Raise boom.
* MAST MAXIMUM UP	Mast stops hoisting 80°. Operable only in standard mode. (MAX-ER 2000 only).	Lower boom. To raise mast above limit, switch to standard set-up mode to bypass limit.
* LOAD MOMENT	If equipped with shutdown option, corresponding load drum stops hoisting and boom hoist stops lowering. Other load drums are inoperable. If not equipped with shutdown option, operating limit light and buzzer will come on to alert operator to overload condition.	Land load on corresponding load drum or raise boom.
CRANE OUT OF LEVEL	All functions operable, crane 3° out of level.	Level crane.
* LUFFING JIB MAX UP 1	Luffing jib stops rising when boom to jib angle is 168°. On current production units 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 luffing jib.
LUFFING JIB MAX UP 2	Luffing jib stops rising when 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 boom is below 50°.	Lower luffing jib.

Display Reading	Function Response	Corrective Action
* LUFFING JIB MAX DOWN	Luffing jib stops lowering when boom to jib angle is 60° (70° on #44 luffing jib).	Raise luffing jib.
EQUALIZER**BOOM STOP	Boom hoist stops hoisting when equalizer is pulled back against stops on gantry and when physical boom stops are within 1 in (25 mm) of bottoming out.	Pay out (lower) boom hoist wire rope.
SETUP MODE ENGAGED	All functions operable. For crane setup only, travel operates at 1/2 speed and automatic boom stop is disabled.	Turn off setup selector. (Select and confirm desired operating mode.)
* JIB BELOW HORIZONTAL	Luffing jib is operable. See Capacity Chart for luffing jib minimum operating angles.	Raise luffing jib above horizontal.
* CTWT OFF RING	Alert only. Does not stop boom hoist or load drum operation.	Crane's capacity has been exceeded. Stop lowering boom or hoisting load immediately. Land load slowly and smoothly.
CONFIRM MODE	Load drums inoperable until mode in effect is confirmed or another mode is selected and confirmed.	Confirm mode in effect or select and confirm a different mode.
DRUM AIR VALVES	Selected drum air pressure switch is open for more than 4 seconds.	Brakes and clutches of all drums on main shaft are applied. Fault cannot be cleared until the crane is shutdown and restarted.

* = Optional

Table 3-4
System Faults

Listed below are the faults which 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 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 load drum pump.	Load drum brake applies and pump strokes to neutral to stop load drum. If drop in charge pressure is intermittent, operation may be resumed once load drum control handle is returned to off. Verify that cause of fault is low pressure and correct cause as soon as possible. If pressure is correct, replace pressure sender.
BOOM ANGLE SENDER * LUFF JIB ANGLE SENDER	Sender output voltage 0.0 volts or above 9.7 volts.	All functions operable. Machine level or boom and luffing jib angle displays will not be correct. Correct cause of sender fault as soon as possible. Neither fault is active when crane is operated in SETUP mode.
LOW AIR PRESSURE	Manifold air pressure below 90 psi (6,2 bar).	If air pressure continues to drop, load drum parking brakes will apply.
HYD TANK LEVEL	Less than 75% level.	Stop and check oil level - fill tank (reservoir).
LOAD PIN	Zero (0) output voltage from pin.	MAX-ER counterweight stops and remains in last position and boom hoist stops and is inoperable in up direction.
MOTION	Deselected drum turns.	If a deselected load drum moves, all drum brakes and clutches apply and pumps shift to neutral to ***stop all load drums***. If a selected load drum rotates down when handle is in UP or NEUTRAL position, all drum brakes and clutches apply and pumps shift to neutral to ***stop all load drums***. If a deselected boom or luffing hoist drum moves, brakes apply and pumps shift to neutral to ***stop both hoists***. Stop and restart engine to correct fault (reboot programmable controller).
* MAX-ER SYSTEM	One of three MAX-ER transducers not in operating range of 0.6 to 9 volts. Differential pressure between left/right side strap cylinders is 1,200 psi (83 bar). Counterweight tray level is over 3° in right or left direction.	MAX-ER counterweight stops and remains in last position. Check and replace faulty transducer(s). Check hydraulic system and repair. Level counterweight tray.
MAST ACCUMULATOR	Mast stop cylinders, MAX-ER luffing jib stop cylinders, or accessory system pressure is not in range.	See ACCUM diagnostic screen to determine cause of fault and correct problem as soon as possible.

Display Reading	Cause of Fault	Function Response
BATTERY VOLTAGE LOW	System voltage below 11 volts.	Handle commands disabled.
IO BOARD FAULT n	CPU not communicating with 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 (I.e. if *n*=6, the second and third I/O boards after the CPU may have failed)	Check for 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 motherboard or the CPU board. See procedures in Folio 2238 at the end of this section.

* = Optional

Table 3-5 Table Note and Abbreviations

*	Optional item
[1]	Past production
[2]	Current production
[3]	Maximum angle at which boom will stop varies with each attachment. See Boom Stop Adjustment in Section 4 of this manual for maximum angle at which 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 and MAX-ER 225 or 400	MAX-ER 2000	50,000 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	—

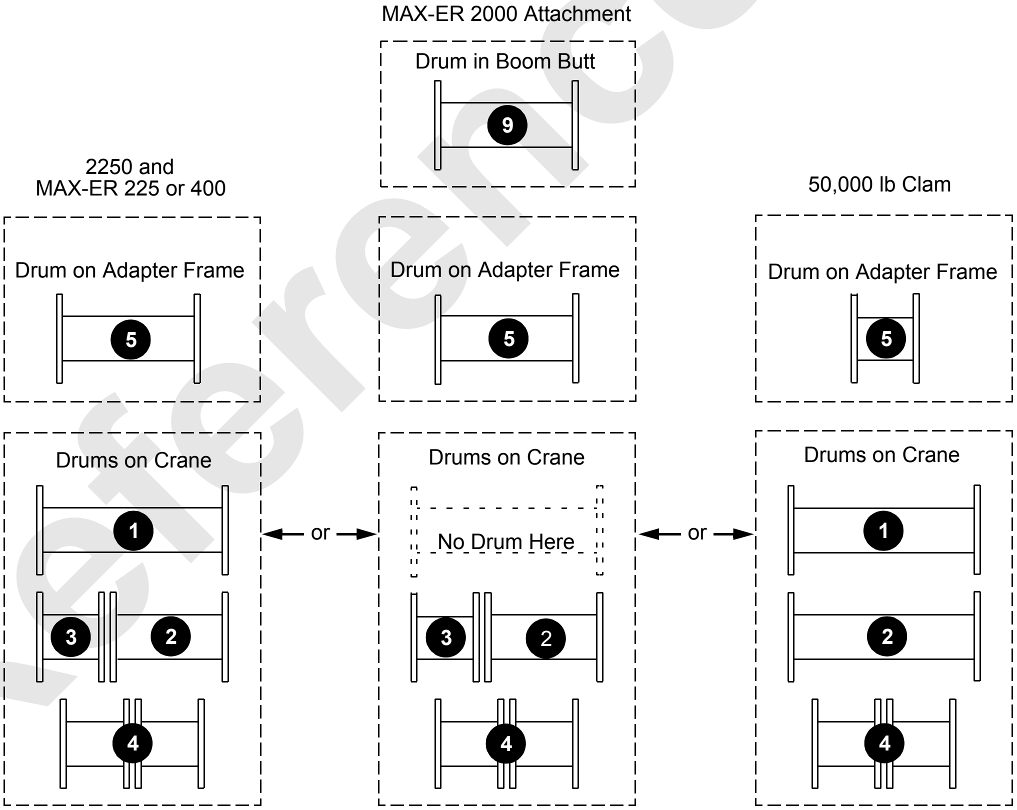


FIGURE 3-17

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:

- 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 3-17 for drum identification.

Drums 1, 2, and 3 (Crane Load Drums)

1	2	3	4	
5	6	7	8	**DRUM X**

1. 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. Pump command in percent from neutral (+ raise, – lower).
3. Motor command in percent (0% max displacement, 100% min displacement).
4. Measured drum speed in rpm (+ raise, – lower).
5. Command to parking brake (1 release, 0 apply).
6. Command to clutch (1 disengage, 0 engage).
7. Measured pump system pressure (port A) in psi.
8. Measured pump charge pressure in psi.

NOTE: X = Corresponding drum number appears.

Drum 4 (Boom Hoist)

1	2	3	4	
5	6			**DRUM X**

1. 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. Pump command in percent from neutral (+ raise, – lower).
3. Motor command in percent (0% max displacement, 100% min displacement).
4. Measured drum speed in rpm (+ raise, – lower).
5. Command to parking brake (1 release, 0 apply).
6. Measured pump system pressure (port B) in psi.

NOTE: X = Corresponding drum number appears.

Drum 5 (Luffing or Auxiliary Hoist)

1	2	3	4	
5	6			**DRUM X**

1. 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. Pump command in percent from neutral (+ raise, – lower).
3. Motor command in percent (0% max displacement, 100% min displacement).
4. Measured drum speed in rpm (+ raise, – lower).
5. Command to parking brake (1 release, 0 apply).
6. Measured pump system pressure (port B) in psi.

NOTE: X = Corresponding drum number appears.

Drum 9 (MAX-ER 2000 Load Drum)

1	2	3	4	
5	6			**DRUM X**

1. 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. Pump command in percent from neutral (+ raise, – lower).
3. Motor command in percent (0% max displacement, 100% min displacement).
4. Measured drum speed in rpm (+ raise, – lower).
5. Command to parking brake (1 release, 0 apply).
6. Measured pump system pressure (port B) in psi.

NOTE: X = Corresponding drum number appears.

Swing (Crane)

```
_ _1_ _     _ _2_ _     _ _3_ _      _ _4_ _     _ _5_ _
_ _6_ _     _ _7_ _     _ _8_ _                     SWING
```

1. 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. Crane swing pump command in percent from neutral (+ right, – left).
3. Measured pump pressure swing right (port B) in psi.
4. Measured pump pressure swing left (port A) in psi.

NOTE: Banks 5-7 appear only on current production cranes without a swing lock.

5. Measured swing brake pressure (0-750 psi)
6. MAX-ER 2000 shorting plug status:

   0 = MAX-ER 2000 enabled
   1 = MAX-ER 2000 shorting plug installed
   2 = MAX-ER 225 enabled
   4 = MAX-ER 225 shorting plug installed

7. MAX-ER 2000 travel status:

   0 = travel disabled
   1 = travel enabled

   MAX-ER 2000 travel status is determined by swing brake pressure and MAX-ER shorting plug status. If swing pressure is less than 150 psi AND MAX-ER shorting plug is absent, travel is disabled.

8. Swing limiter sensor status (appears only if equipped with swing limiter):

   + = swing right
   - = swing left

Track (Crane Crawlers)

```
_ _1_ _     _ _2_ _     _ _3_ _      _ _4_ _
_ _5_ _     _ _6_ _       7                  TRACK
```

1. 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. Right pump command in percent from neutral (+ forward, – backward).
3. 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. Left pump command in percent from neutral (+ forward, – backward).
5. Measured system pressure right track in psi.
6. Measured system pressure left track in psi.
7. Command to parking break (1 release, 0 engage).

Mast Accumulator

```
_ _1_ _     _ _2_ _
_ _3_ _     _ _4_ _                     ACCUM
```

1. 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. Accumulator Pressure (psi).
4. Accessory Pump Pressure (will display if equipped).

MXR (MAX-ER 2000)

```
_ _1_ _     _ _2_ _     _ _3_ _     _ _4_ _     _ _5_ _
_ _6_ _     _ _7_ _     _ _8_ _     _ _9_ _        MXR
```

1. Counterweight Level Indicator (+ = degrees high on right side or
   - = degrees low on left side).
2. Backhitch Load (US Tons + = tension, and - = compression).
3. MAX-ER Switches (see below).

MAX-ER 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 20,000 lbs. 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 2100 psi more than other side.
   128 = Piston pressure transducer out of range (below 0.6 or above 9.0 volts).
5. **Current Production:** 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.
   Past Production: Proportional Cylinder Command
   0 = Off and 254 = On.
6. Right Strap Cylinder Rod Side Pressure (0-3,000 psi [0-207 bar])
7. Left Strap Cylinder Rod Side Pressure (0-3,000 psi [0-207 bar]).
8. Strap Cylinder Piston Side Pressure (0-3,000 psi [0-207 bar])
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.

```
 _1_       _2_        _3_        _4_      _5_
 _6_       _7_                                  A1
```

Banks:

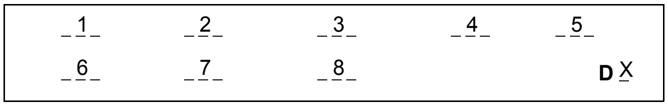
1. Handle 1 - Right Rear or Front Load Drum
2. Handle 2 - Left Rear or Rear Load Drum
3. Handle 3 - Boom/Luffing/Mast Hoist
4. Handle 5 - Right Track
5. Handle 6 - Left Track
6. Handle 4 - Swing
7. Handle 7 - Auxiliary Load Drum or Luffing Hoist with Independent Pump

A2 (Programmer's Screen)

```
            Disregard information in this screen.
            For factory programmer's use only
                                                  A2
```

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.



1. 1 - 8 = Bank number

NOTE: X = 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 – 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 3-6 and Table 3-7.

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 4. In the corresponding row the identifier numbers that are ***on*** (active) in the bank are shaded black.

Use Tables 2 and 3 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 3-8. 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 3-7, 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 3-6 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 3-8. 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 (brake valve, clutch valve, etc.), 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 3-6 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	
1	Pulse Width Modulation to Split Drum 2/3 Hoist Motor
2	Swing/Travel Alarm
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 3-7 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	Pendant Cylinder Limit Switch (MAX-ER 225 & 400)
16	Digital Display Selector (Scroll Down)
32	Spare
64	Counterweight Lower
128	MAX-ER 225 Removed
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	MAX-ER 225 Enabled
16	Mast Maximum Up Limit
32	Rigging Winch Enable Input

Table 3-8 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 3-9 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	■	■	■	■	■	■	■	■

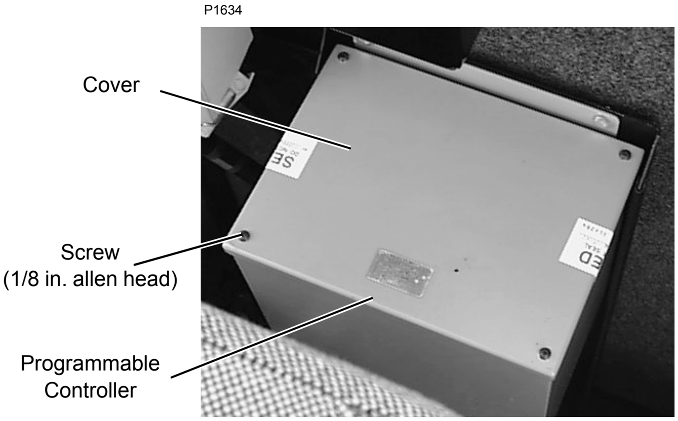
Dark shaded boxes indicate ON; white boxes OFF.

EPROM REPLACEMENT

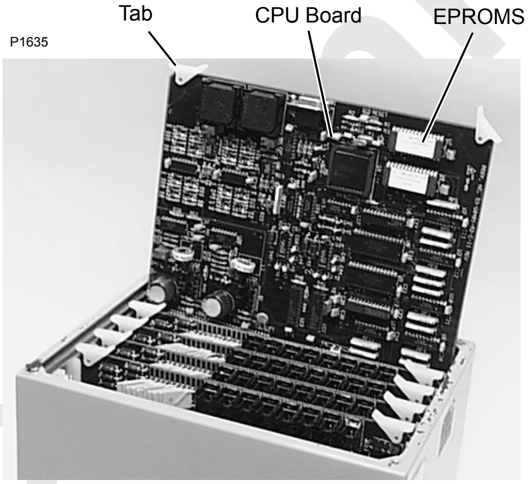
See Figure 3-18 for the following procedure.

To ensure proper operation of EPIC cranes, extreme care must be taken to properly install EPROMs (computer chips) in the field.

1. Lower any suspended loads to ground and apply all parking brakes and locks.
2. Turn engine run/stop switch to STOP position and turn cab power switch to OFF position.
3. Remove cover from top of programmable controller.
4. Remove CPU board from programmable controller by pulling up on tabs on sides of board (CPU board is board closest to mounting brackets on box).
5. Carefully remove both EPROMs from upper right corner of CPU board. An EPROM remover should be used.
6. Each EPROM has a label containing a Manitowoc program number, configuration number, and bit indicator.



View Behind Operator's Cab Seat



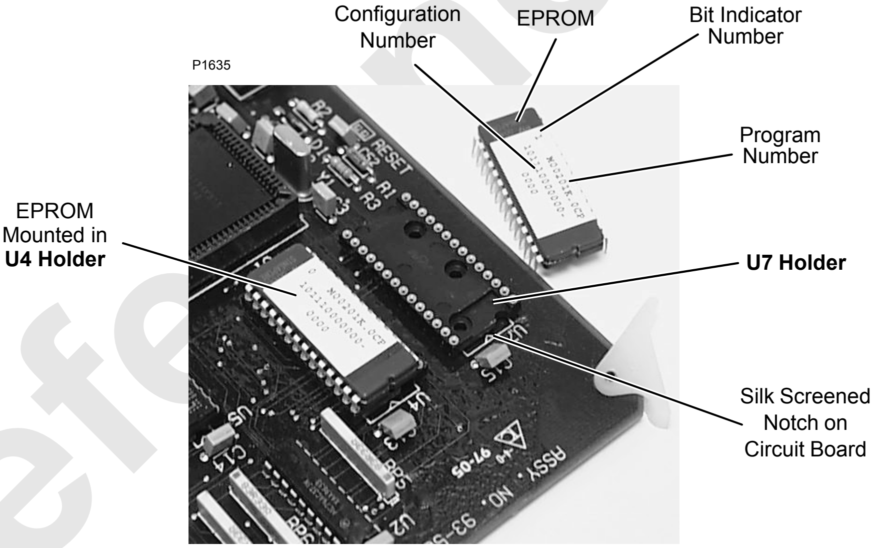


FIGURE 3-18

7. Install new EPROMs on CPU board.
8. Notch in each EPROM must line up with silk screened notch at end of each EPROM holder.
    a. Install EPROM with bit indicator number of 1 in EPROM holder U7.
    b. Install EPROM with bit indicator number of 0 in EPROM holder U4.
    c. Use care not to bend prongs on EPROMs, as each prong engages corresponding terminal hole in holder.
9. Reinstall CPU board in programmable controller.
10. Reinstall cover on programmable controller.
11. Read all publications sent with new EPROMs.

12. Before starting the engine, power up programmable controller (cab power switch ON and engine run/stop switch in RUN) and set any operator programmable control features (i.e. swing speed and torque, tagline tension, etc.) if equipped.

13. Follow instructions in the Operator Manual to calibrate pressure senders (transducers) and pump control thresholds (feed forward).

14. Test all crane functions.

15. If you have any problems with the new software, contact the Manitowoc Crane Care Lattice Team.

16. Return old EPROMs to your area Regional Service Manager or the Manitowoc Crane Care Lattice Team.

DIELECTRIC GREASE

The following figures show the proper application of dielectric grease on J - tech type connectors.

Dielectric grease is need when assembling J - tech type connectors. A bead of grease needs to be applied on o-ring and face of the socket (female) connector ***and only on the o-ring for a pin (male) connector.***

FIGURE 3-19

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

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

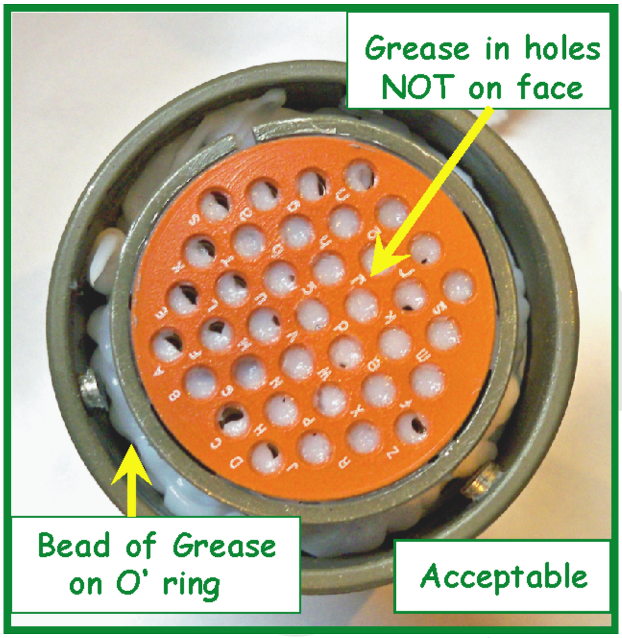


FIGURE 3-20

Place a small amount of grease on your finger for the application on the connector's face. Wipe your finger across the face leaving grease inside the socket holes and less than 0.001 inch (0,025 mm) on the connector's face. This helps assure that water will be kept out of the connectors and keep the pins from fretting.

FIGURE 3-21

SECTION 4
BOOM

TABLE OF CONTENTS

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SECTION 4
BOOM

AUTOMATIC BOOM STOP ADJUSTMENT

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 procedure.

- 83° maximum (MAX) without layout luffing jib
- 88° maximum (MAX) with layout luffing jib when the boom up limit ***can be bypassed***
- 89° maximum (MAX) with layout luffing jib when the boom up limit ***cannot be bypassed***

  To determine if the boom up limit can be bypassed on your crane, perform the Limit Bypass Test, given on page 4-2.
- 0° minimum (MIN) the minimum boom stop is optional. It can be adjusted to any angle between 4° above or below horizontal.

NOTE: For MAX-ER 2000 boom angles, refer to the Operator Manual supplied with the MAX-ER.

Setup Angle

- 89° with boom butt in crane setup mode

  The operating angle is bypassed when the crane is in the setup mode. The setup angle is bypassed when the setup selector is switched off.

Operation

See Figure 4-2 for the following description.

When the boom is below the maximum angle, limit switch (2a) is closed. The boom hoist can be operated.

When the boom is raised to the maximum angle, actuator (3a) opens limit switch (2a). Boom hoist operation stops automatically because the open limit switch turns off power to the boom hoist electric circuit. The boom hoist pump shifts to neutral and the boom hoist brake applies to stop boom movement.

⚠ WARNING

Falling Attachment Hazard!

If boom fails to stop for any reason, stop engine immediately. Troubleshoot system to determine problem.

Do not resume operation until problem has been corrected.

NOTE An optional minimum boom stop is available. It operates the same as the maximum boom stop, but in the down direction.

Maintenance

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

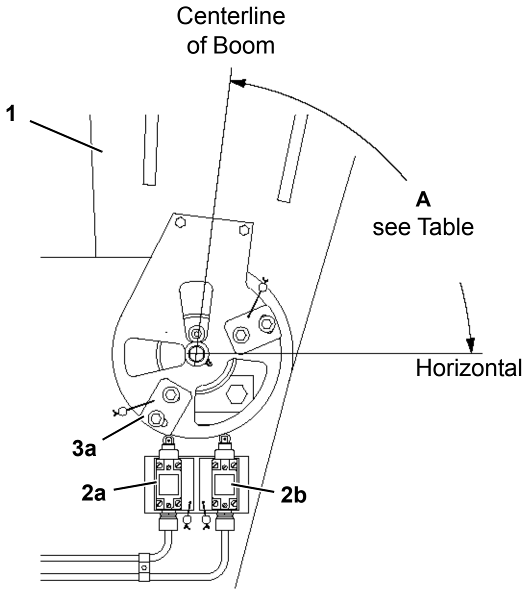
Once the automatic boom stop is properly adjusted, it should not require periodic adjustment. Adjustment is required, however, when:

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

⚠ WARNING

Falling Attachment Hazard!

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



VIEW A
Crawler or Truck Crane

Item	Description
1	Boom Butt
2a	Limit Switch (Maximum Angle)
2b	Limit Switch (Minimum Angle)
3a	Actuator

Automatic Boom Stop Maximum Angles

Maximum Angle A	Attachment
M250 and 2250 (Crawler and Truck), View A	
83°	#44 HL Boom and #44 LR Boom.
88°	#44 HL Boom with #133 or 133A Luffing Jib when the boom up limit ***can be bypassed***[1].
89°	#44 HL Boom with #133 or 133A Luffing Jib when the boom up limit ***cannot be bypassed***[1].

[1] The boom up limit cannot be bypassed on current production cranes. To determine if the boom up limit can be bypassed on your crane, perform the Limit Bypass Test below.

FIGURE 4-1

Limit Bypass Test

Perform the following test to determine if the boom up limit on your crane can be bypassed or not:

⚠ WARNING

Crush Hazard!

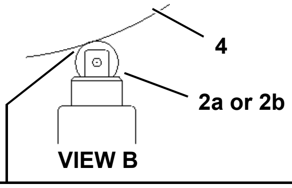
Maintain constant communication between operator and assistant during the following steps.

Stay clear of moving parts.

---

1. Lower the boom onto blocking at ground level.
2. Have an assistant push boom up limit switch plunger in to trip the limit switch open.
3. Rotate limit bypass key to the bypass position and hold.
4. Try to boom up SLOWLY — do not raise the boom any higher than necessary to perform the test:
    - **a.** If the boom rises, your boom up limit can be bypassed.
    - **b.** If the boom does not rise, your boom up limit cannot be bypassed.

The test is complete: release the limit bypass key and the boom stop rod to the normal operating positions.



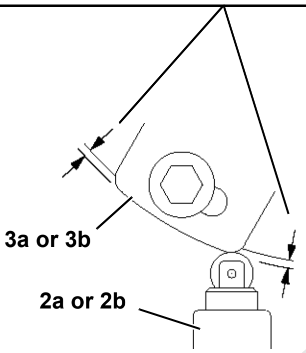
VIEW B

CAUTION

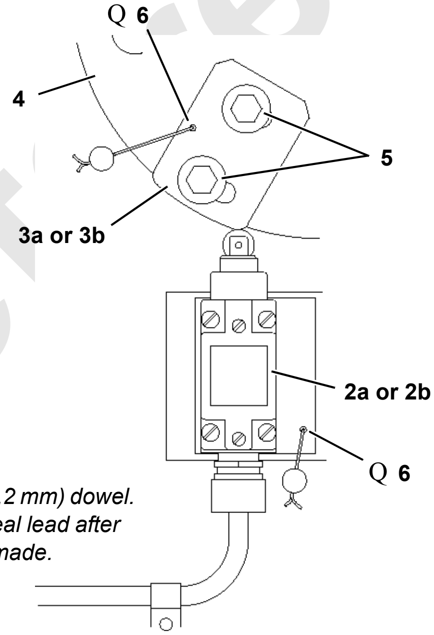
Before adjusting limit switch, move limit switch up or down in slots so edge of roller is even with edge of actuator bracket. Limit switch will not trip open if positioned too low in slots. Limit switch could be damaged from over-travel if positioned too high in slots.

CAUTION

Check this distance after adjusting limit switch. Distance from both ends of MAX actuator to outside edge of actuator bracket must be equal. Limit switch could be damaged from over-travel if either end of actuator is cocked.

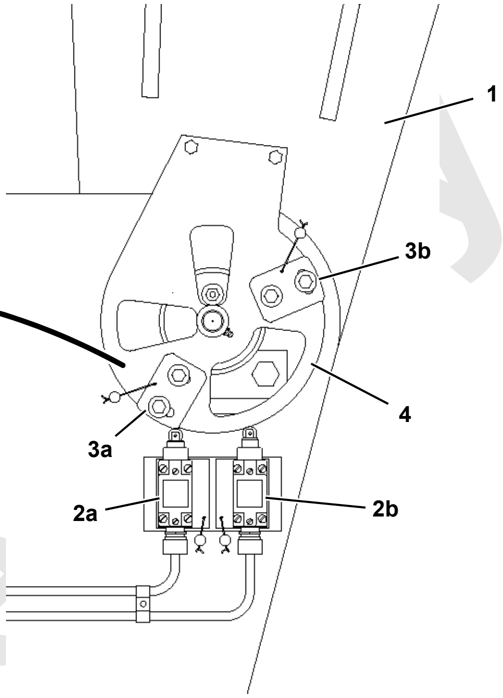


VIEW C



Q *Drill for 1/8 in (3,2 mm) dowel. Install wire and seal lead after adjustments are made.*

VIEW D
(typical)



VIEW A

Item	Description
1	Boom Butt
2a	Limit Switch (MAX)
2b	Limit Switch (MIN)
3a	Actuator (MAX)
3b	Actuator (MIN)
4	Actuator Bracket
5	Cap Screw with Flat Washer and Lock Washer
6	Dowel Roll Pin with Seal Lead and Wire
7	Digital Level (see Figure 4-3)
8	Level Support (see Figure 4-3)

FIGURE 4-2

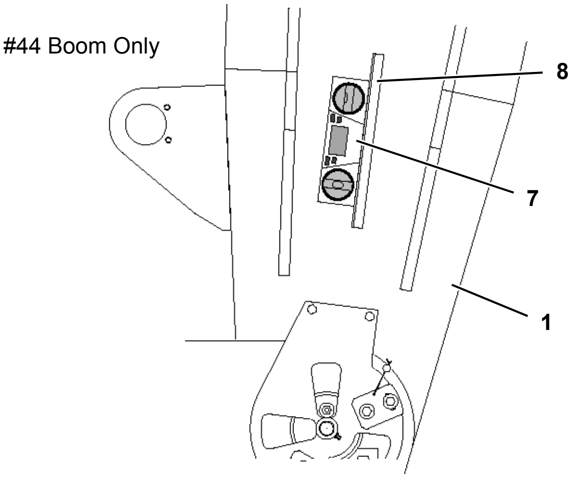


FIGURE 4-3

Adjustment

Maximum (MAX) Boom Stop

See Figure 4-2 for the following procedure.

1. For a crawler crane, travel the crane onto a firm level surface or level the crane by blocking under the crawlers.

   For a truck crane, level the crane with the outriggers.
2. If necessary, adjust the position of limit switch (2a) with relation to actuator bracket (4) as instructed in View B.
3. Loosen cap screws (5, View D) retaining MAX actuator (3a) to actuator bracket (4).
4. Rotate MAX actuator (3a) CLOCKWISE in its slots so it does not contact the limit switch roller when step 5 is performed.
5. Raise the boom to specified **Maximum Angle A** (Figure 4-1) while monitoring the angle on the on the mechanical indicator or on the operating conditions screen of the front-console display.
6. Verify that the boom is at the proper maximum angle:
   - **a.** Place an accurate digital level (7, Figure 4-3) on the centerline of the boom butt. **Maximum Angle A** given in Figure 4-1 should appear on digital level.
   - **b.** Raise or lower the boom as necessary.
7. Rotate MAX actuator (3a, View A) against the roller of limit switch (2a) until the limit switch just “clicks” open and hold.
8. Check the position of MAX actuator (2a) with relation to actuator bracket (4) as instructed in View C).
9. Securely tighten cap screws (5) to secure actuator (3a).
10. Test the adjustment as follows:
    - **a.** Lower the boom several degrees below the specified maximum angle.
    - **b.** Slowly raise the boom.
    - **c.** ***Boom must stop at specified Maximum Angle A.*** If the boom does not stop at the specified angle:
      - Stop raising the boom (move control handle to off).
      - Lower the boom several degrees below the specified angle.
      - Repeat adjustment steps 5 through 10.
11. Seal the adjustment as shown in Figure 4-2, View D.

Minimum (MIN) Boom Stop

See Figure 4-2 for the following procedure.

NOTE The slots in MIN actuator (2b) allow the minimum boom angle to be adjusted to any angle between 4° above or below horizontal.

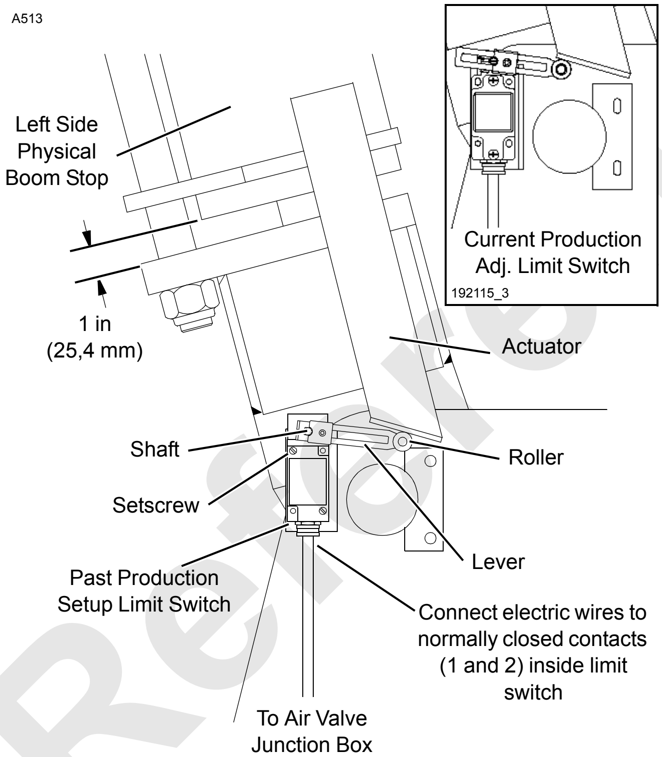
1. If necessary, adjust the position of limit switch (2b) with relation to actuator bracket (4) as instructed in View B.
2. Loosen cap screws (5, View D) retaining MIN actuator (2b) to actuator bracket (4).
3. Rotate MIN actuator (3b) COUNTERCLOCKWISE in its slots so it does not contact the limit switch roller when step 4 is performed.
4. Lower the boom to the desired minimum angle.
5. Rotate MIN actuator (3b) against the roller of limit switch (2b) until the limit switch just “clicks” open and hold.
6. Check the position of MIN actuator (3b) with relation to actuator bracket (4) as instructed in View C.
7. Securely tighten cap screws (5) to secure actuator (3b).
8. Test 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 the boom does not stop at the desired angle:
     - Stop lowering the boom (move control handle to off).
     - Raise the boom several degrees above the desired minimum angle.
     - Repeat adjustment steps 4 through 8.
9. Seal the adjustment as shown in Figure 4-2, View D.

SETUP BOOM ANGLE

See Figure 4-4 for the following procedure.

Perform the following steps when the crane is in the setup mode and rigged only with the boom butt.

1. Loosen setscrew in limit switch lever so lever is free to rotate on shaft.
2. Raise boom butt until physical boom stops are 1 in (25,4 mm) from bottoming out as shown in Figure 4-4 (approximately 89° boom angle).
3. Hold roller on lever against actuator. The length of the lever can be adjusted if a current production limit switch.
4. Turn limit switch shaft CLOCKWISE (viewing switch) until switch ***clicks*** open and hold.
5. Securely tighten setscrew in lever.
6. Lower boom butt several degrees.
7. Slowly raise boom butt.
8. Boom butt must stop at point specified in step 2. If not, repeat Setup Boom Angle Adjustment steps.



NOTE: Standard mounting shown. Mounting is raised approximately 2 ft (0,61 m) when equipped with fold-under luffing jib.

NOTE: Past Production limit switch has fixed arm.
Current Production limit switch has adjustable arm.

FIGURE 4-4

PHYSICAL BOOM STOP

General

The physical boom stop assembly (Figure 4-5) serves the following functions:

- Assist in stopping the boom smoothly at any angle above 80°.
- Assist in preventing the boom rigging from pulling the boom back when traveling or setting loads with the boom at any angle above 80°.
- Assist in moving the boom forward when lowering the boom from any angle above 80°.
- Provide 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.

WARNING

Boom Hazard!

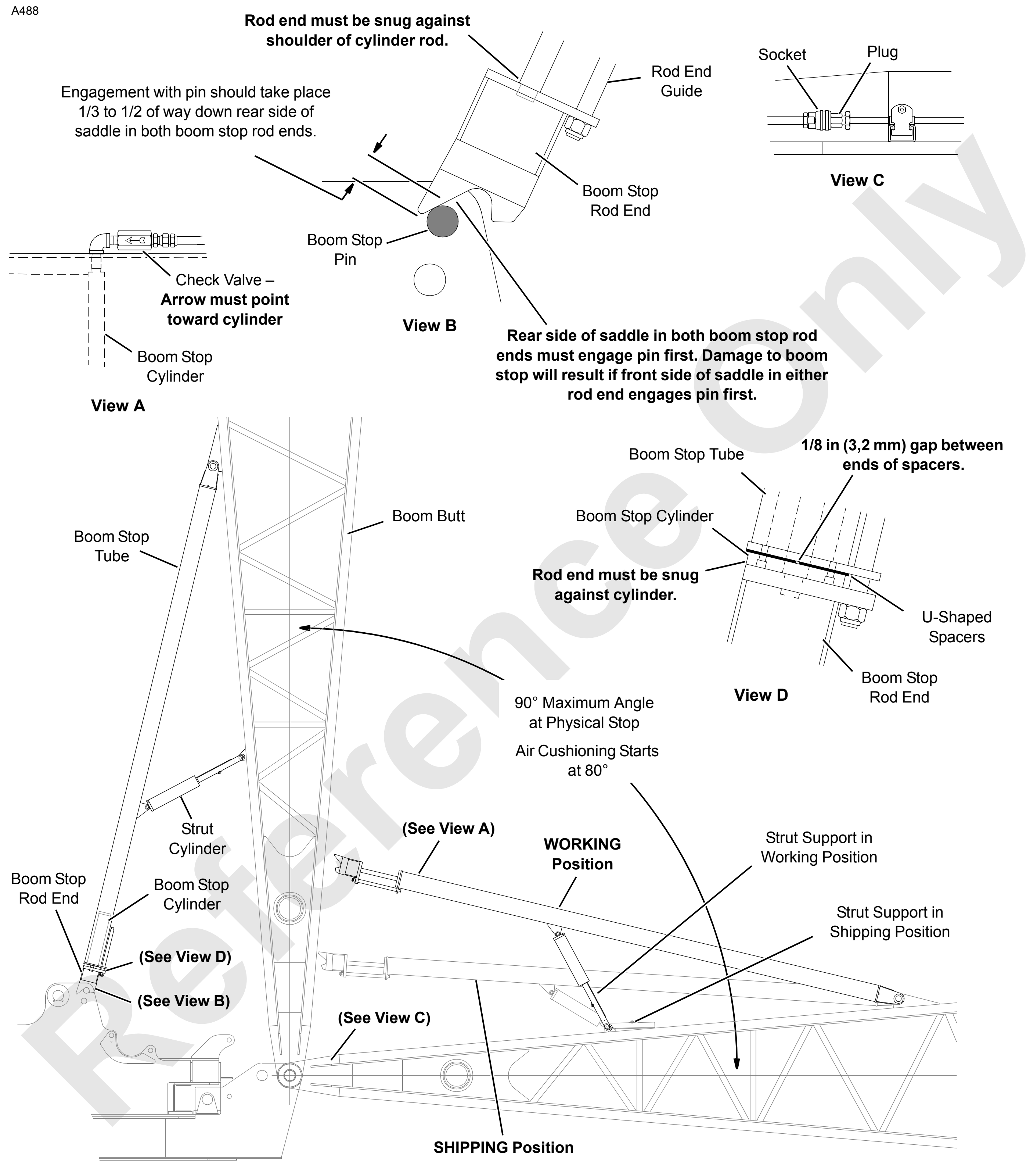
Physical boom stop must be installed for all crane operations.

Physical boom stop does not automatically stop boom at maximum operating angle. Automatic boom stop must be installed and properly adjusted (see Automatic Boom Stop topic in this section).

Operation

See Figure 4-5 for the following procedure.

1. Air system pressure of 125 to 137 psi (8,6 to 9,4 bar) is trapped in boom stop cylinders by a check valve connected to each cylinder's inlet port (Figure 4-5, View A).
2. When boom is raised to 80°, boom stop rod ends contact pins in adapter frame (Figure 4-5, View B).
3. Cylinder rods then start to compress air trapped in boom stop cylinders by check valves.
4. As boom is raised higher, pressure of trapped air increases to exert greater force against boom.
5. If for any reason boom is raised to 90°, boom stop cylinders will fully compress air and bottom out to provide a physical stop.



Physical Boom Stop Assembly

FIGURE 4-5

Maintenance

1. ***Weekly***, check air cylinders and piping for air leaks.
2. ***Quarterly***, squirt a few drops of light engine oil into inlet port of each air cylinder.
3. It will be necessary to exhaust the air from the cylinders before performing Maintenance step 2.

   To exhaust the air, lower the boom stop to the SHIPPING position (see procedure which follows). Then crack open the air line at each check valve to exhaust the air from the boom stop cylinders.

Lowering Boom Stop to Shipping Position

1. Lower boom onto blocking at ground level.
2. Keep the engine running to ensure that there is sufficient air pressure to fully extend strut cylinders.
3. Remove quick-release pin from both strut supports and rotate supports to ***shipping*** position as shown in Figure 4-5.
4. Reinstall quick-release pins in strut supports.
5. Stop the engine.

WARNING

Crushing Injury Hazard!

Stand clear of boom stop tubes while performing step 6. Strut cylinders will retract as air pressure exhausts.

---

6. Disconnect socket from plug in air supply line near right side boom hinge pin (Figure 4-5, View C)

   Socket will block supply air. Air pressure in lines and cylinders exhaust through plug.

Raising Boom Stop to Working Position

WARNING

Crushing Injury Hazard!

Stand clear of boom stop tubes while performing steps 1 and 2. Strut cylinders will extend as air pressure is supplied.

---

1. Connect socket to plug in air supply line near right side boom hinge pin (Figure 4-5, View C).
2. Start the engine. Strut cylinders will extend to raise boom stop tubes as air pressure is supplied.
3. Remove quick-release pin from both strut supports and rotate supports to ***working*** position as shown in Figure 4-5.
4. Reinstall quick-release pins to lock struts in position.

Adjustments

The physical boom stop was adjusted at the factory and does not require periodic adjustment. The following items must be checked and adjusted at assembly, however, if the boom stop is disassembled for repair or parts replacement.

Boom Stop Rod Ends

Each boom stop rod end (Figure 4-5, View B) must be threaded all the way onto the cylinder rod so the rod end is snug against the shoulder on the rod. ***Be sure to install rod guides***. They keep the rod ends in proper alignment.

Boom Stop Engagement

Watch the boom stop rod ends while slowly raising the boom butt. Both rod ends must engage the boom stop pins in the rotating bed at the same time and at the approximate point shown in Figure 4-5, View B. Adjust the rod end for each strut cylinder to provide proper engagement.

Boom Stop Compression

Watch the boom stop rod ends while slowly raising the boom butt. With the boom butt at 90° both rod ends should be bottomed out against the cylinders to within 1/8 in (3,2 mm) of each other (Figure 4-5, View D).

Install U-shaped spacers between the cylinder flanges and boom stop tubes (Figure 4-5, View D) to limit the maximum angle to 90° and to bottom out the rod ends to within 1/8 in (3,2 mm) of each other.

ANGLE INDICATOR ADJUSTMENT

General

An angle sending unit is mounted on the boom butt and, if equipped, on the luffing jib butt (see Figure 4-6).

Each sending unit houses a pendulum-type potentiometer which sends an electric signal to the crane's programmable controller. The programmable controller converts the electric signal into an angle which can be monitored on the digital display in the operator's cab.

Three angles (Figure 4-7) can be monitored:

- Boom angle
- Luffing jib angle
- Boom to luffing jib angle

The sending unit for the boom and for the luffing jib are identical in appearance. ***The two units are different, however, and must not be interchanged.***

The sending unit for the boom has a 120° potentiometer. This potentiometer is labeled CP17-0693-1.

The sending unit for the luffing jib has a 178° potentiometer. This potentiometer is labeled CP17-0694-1.

Layout luffing jib shown.
Fold-under luffing jib similar.

Item	Description
A	Shorting Plug for Luffing Jib Angle
B	Electric Cord to Luffing Angle Sending Unit

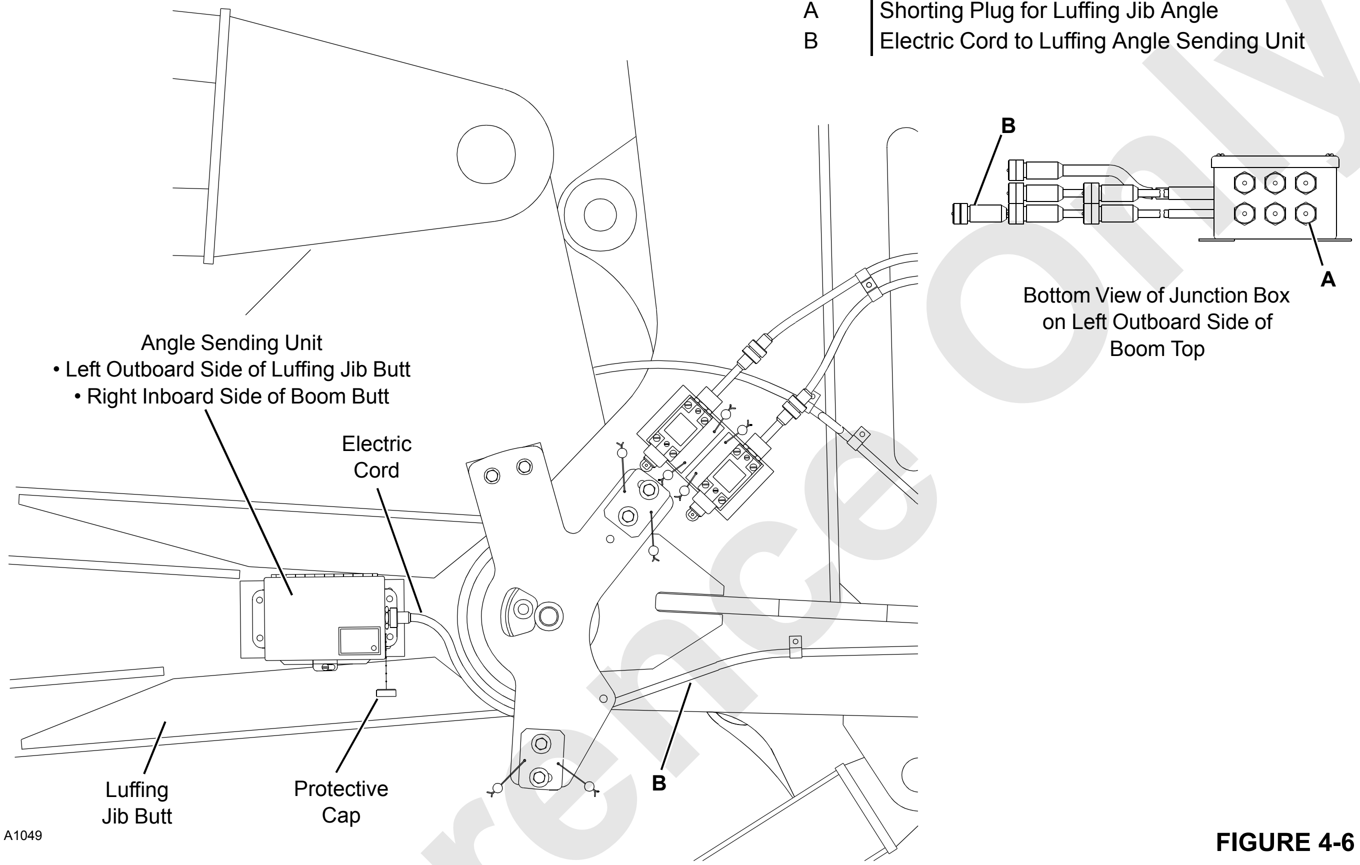


FIGURE 4-6

Boom and Jib Angle Identification

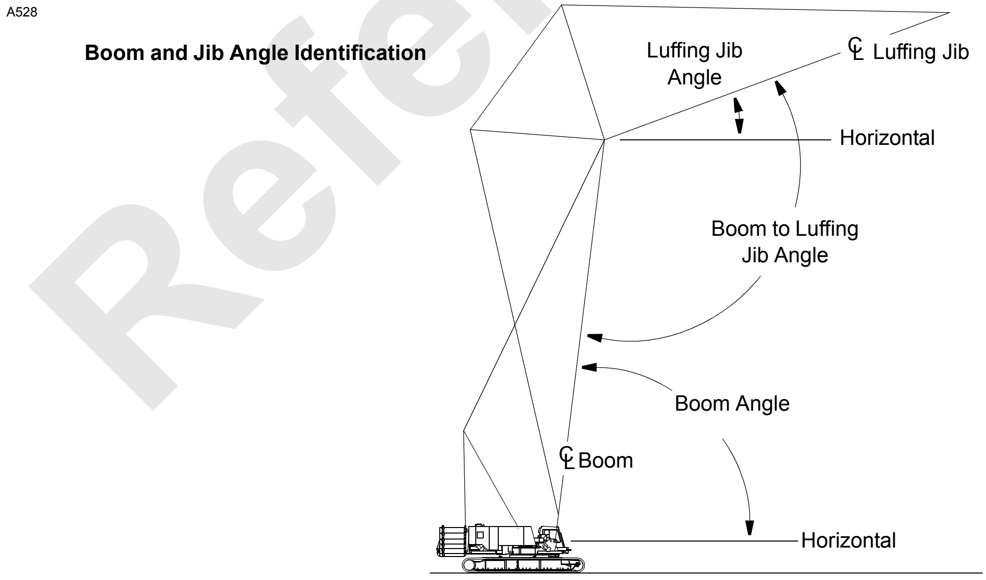


FIGURE 4-7

Disconnecting Luffing Jib Angle Indicator

See Figure 4-6 for the following procedure.

1. Unplug electric cord (B) from receptacle on sending unit.
2. Connect protective cap to receptacle on sending unit.
3. Connect electric cord to receptacle (A) on boom point junction box.

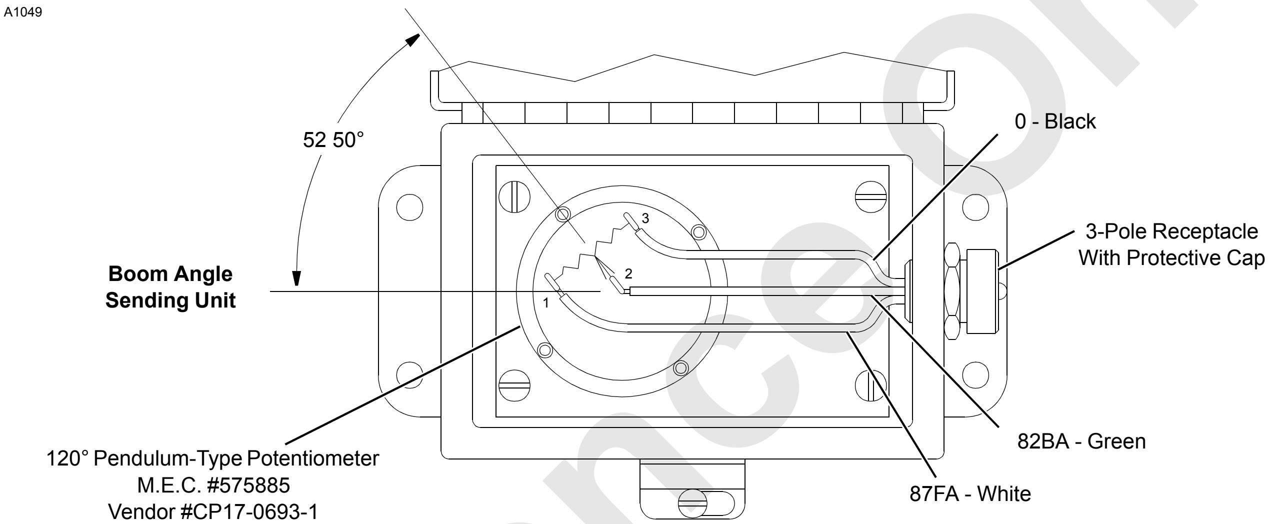
Sending Unit Assembly

Replacement sending units can be either the pendulum-type potentiometer (past production) or solid state sensor (current production).

Pendulum-Type Potentiometer

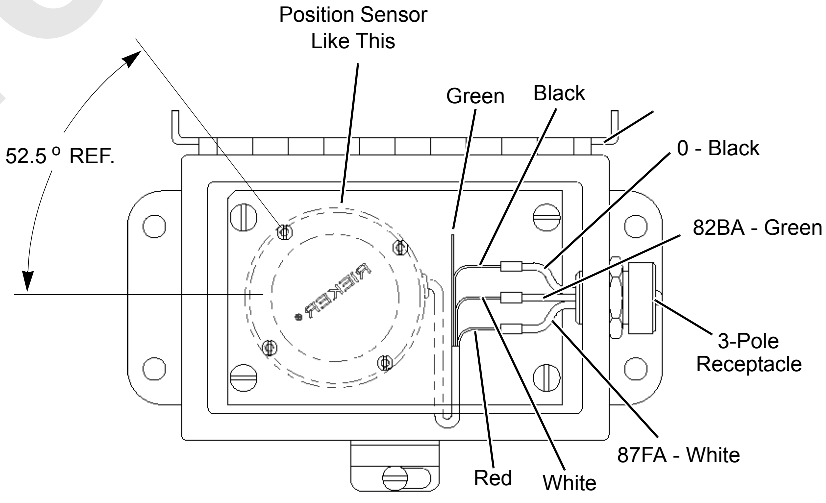
When replacing parts in the pendulum-type potentiometer sending unit, take the following precautions (Figure 4-8 and Figure 4-10, View A):

1. Mount potentiometer at angle shown.
2. Connect black, green, and white wires from receptacle to proper terminals on terminal strip.
3. Connect wires from potentiometer to proper terminals on terminal strip.
4. Make sure all parts are securely fastened to their mounting position.



VIEW A

Input Wires Color	Sensor Wires Color	Operation Code
From	To	
Black	Black	Ground
Green	White	Signal
White	Red	10 Volts DC
	Green	N/C



VIEW B

FIGURE 4-8

Solid State Sensor

When replacing existing pendulum-type potentiometer with current production solid state sensor, take the following precautions (see Figure 4-8 and Figure 4-10, View B):

Identify all input wires to existing potentiometer.

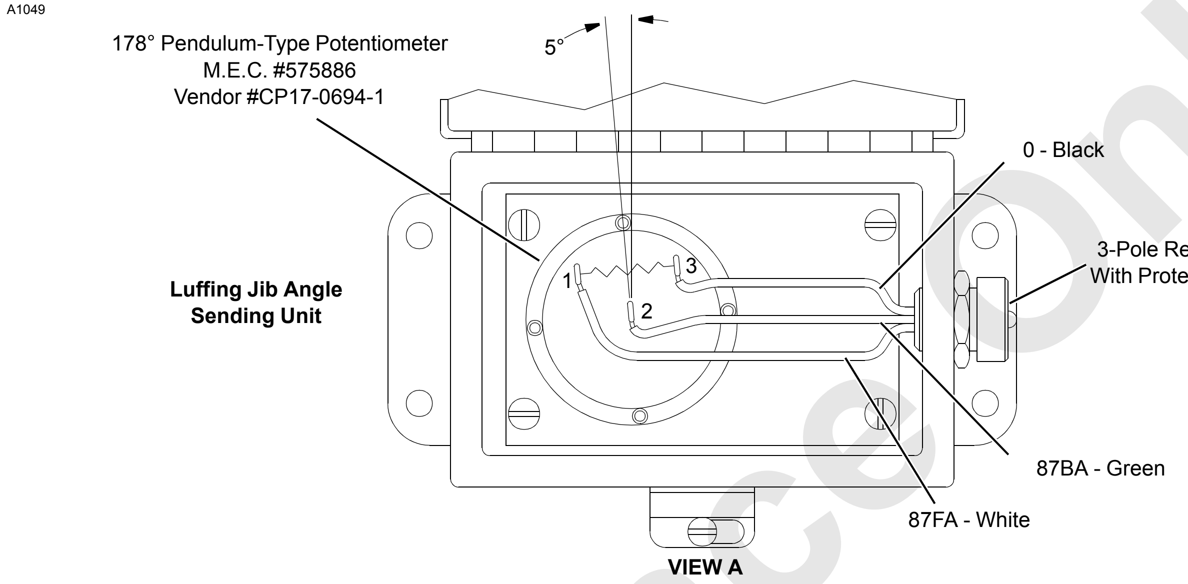
Cut existing input wires near terminal strip (if used) to allow for splicing.

Remove existing potentiometer and terminal strip (if used).

Mount new sensor in existing holes as shown in View B.

See wiring chart in View B and parallel splice sensor wires to existing input wires with crimp, solder, and heat shrink tubing.

Seal green wire on sensor with heat shrink tubing and coil up.



Solid State Sensor (+/- 90°)
M.C.C. #A10648
Vendor #CS17

Input Wires Color	Sensor Wires Color	Operation Code
From	To	
Black	Black	Ground
Green	White	Signal
White	Red	10 Volts DC
	Green	N/C

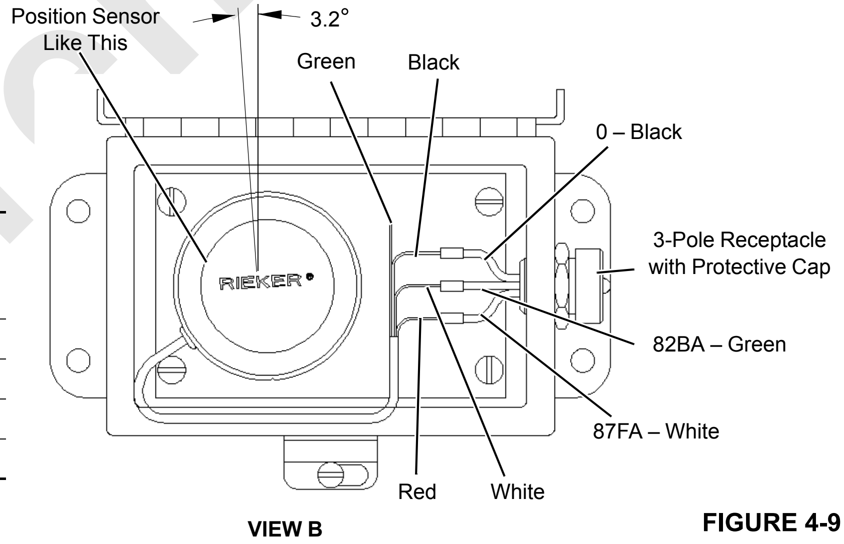


FIGURE 4-9

Adjusting Angle Indicator

See Figure 4-10 for the following procedure.

Perform the following adjustment steps at initial installation, after installing a new sending unit or potentiometer, and at least monthly when boom/jib is lowered to ground.

1. Lower boom or boom and luffing jib onto blocking at ground level.
2. Scribe a line through centerline of boom/jib butt as shown in Figure 4-10.
3. Hold a protractor-level along scribed line.
4. Record angle indicator on protractor-level.

5. Scroll to desired angle on digital display in operator's cab.
6. Angle shown on digital display must match angle recorded in step 4 plus or minus one degree.
7. If necessary, loosen mounting screws and rotate sending unit in mounting slots until reading on digital display matches angle on protractor-level.
8. Securely tighten mounting screws to lock adjustment.

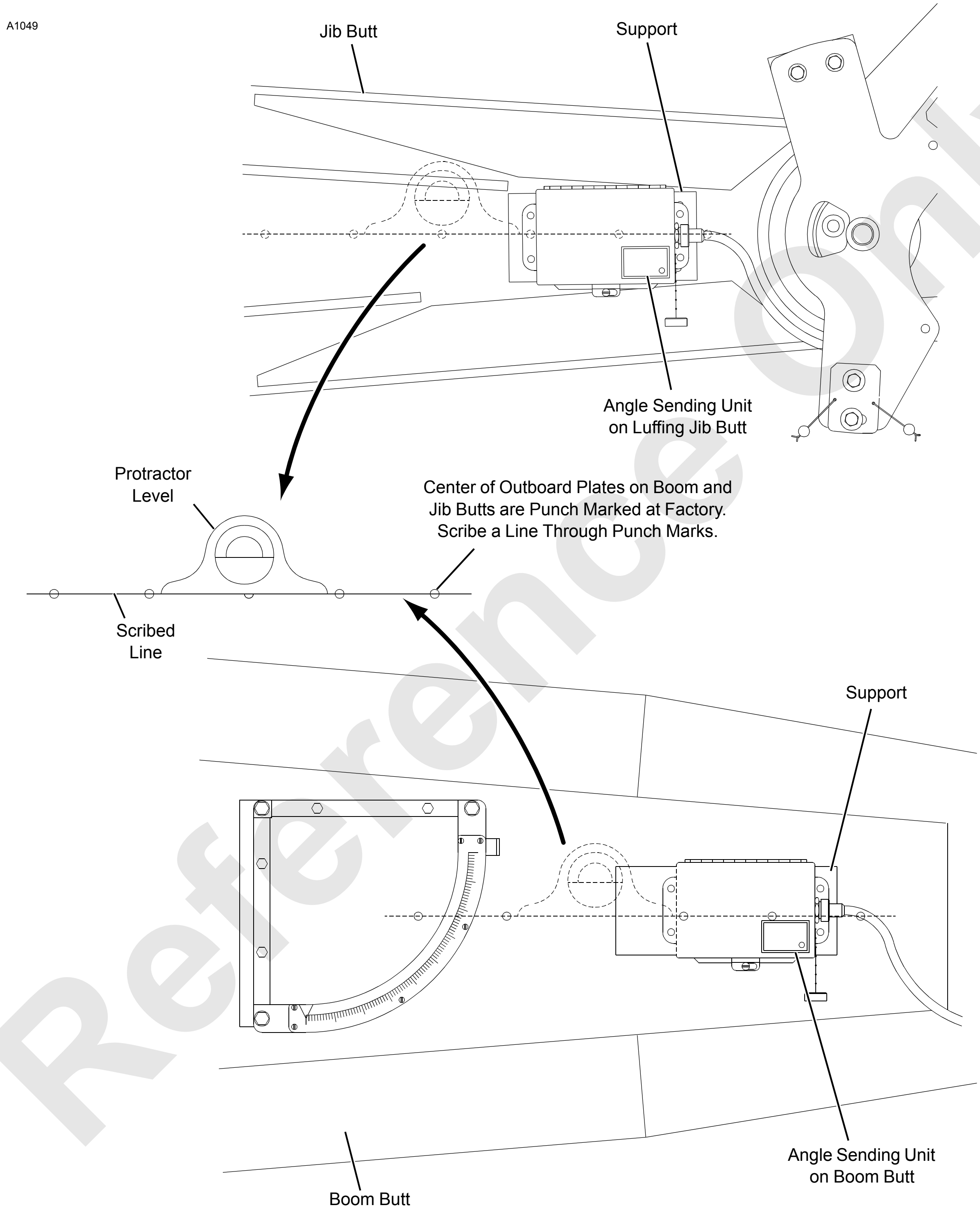


FIGURE 4-10

BOOM HOIST RATCHET AND PAWL ADJUSTMENT

General

See Figure 4-11 for the following procedure.

This section applies only to the ratchet and pawl provided on the right rear drum (Drum 2 used for boom hoist on MAX-ER 2000).

The pawl limit switch must be properly adjusted to ensure proper operation of the drum.

When drum 2 park switch is ***on***, drum 2 park brake is applied, the control handle is disabled, and the pawl is engaged. When the pawl is engaged, the limit switch closes the electric circuit to the crane's programmable controller. This action prevents drum 2 from being operated in either direction. Drum 3 is operable when drum 2 is parked.

When drum 2 park switch is ***off***, drum 2 park brake is released, the control handle is enabled, and pawl is disengaged. When the pawl is disengaged, the limit switch opens the electric circuit to the crane's programmable controller. This action allows drum 2 to be operated in either direction as long as drum 3 is parked.

If the operator attempts to operate either drum (2 or 3) when the other drum is not parked, the operating limit alert will come on and FUNCTON NOT PARKED will appear on the digital display.

WARNING

Moving Parts Hazard!

To make adjustments, engine must be running and drums and pawl must be operated.

Avoid injury from moving machinery. Stay clear of drums and pawl while either is being operated.

Maintain constant communication between operator and adjuster so drums and pawl are not operated while adjuster is in contact with parts.

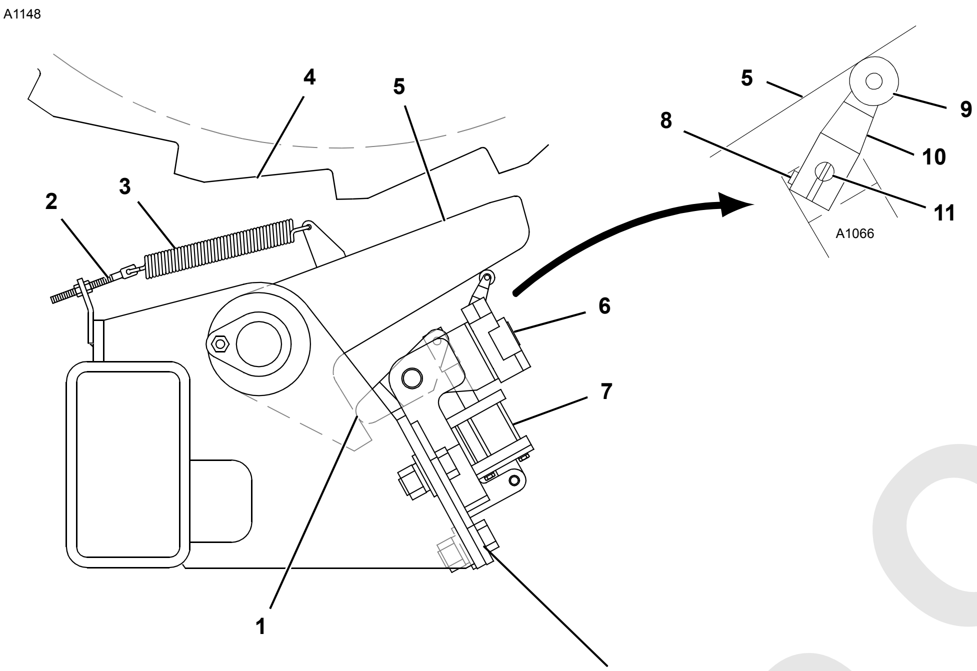
Pawl limit switch is factory set and does not require periodic adjustment. The limit switch must be adjusted if parts are replaced and checked if the drum is not operating properly.

Limit Switch Adjustment

1. Loosen screw so limit switch lever is free to rotate on shaft.
2. Disengage drum 2 pawl by toggling drum 2 park switch to ***off***. It may be necessary to hoist slightly before pawl will disengage ratchet.
3. Rotate lever and hold it so roller is against pawl.
4. Turn limit switch shaft, ***not the lever***, counterclockwise until limit switch clicks open and hold.
5. Make sure roller is against pawl and securely tighten screw in lever to lock adjustment.
6. Check for proper operation:
   - Engage drum 2 pawl by toggling 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 drum 2 pawl by toggling drum 2 park switch to ***off***. Toggle 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 limit switch if required.

Return Spring

Adjust the eyebolt so the return spring has enough tension to fully engage and hold the pawl against the ratchet.



Item	Description
1	Cam
2	Eyebolt
3	Spring
4	Ratchet
5	Pawl
6	Limit Switch
7	Cylinder
8	Screw
9	Roller
10	Lever
11	Shaft

FIGURE 4-11

STRAP INSPECTION AND MAINTENANCE

This section is a guide to the crane owner for properly inspecting and maintaining straps in the field. It is impossible to predict whether or when a strap may fail. Frequent and periodic inspections can help reveal potential for failure. Straps are to be inspected regularly by a ***qualified person*** as part of the crane's preventive maintenance program. Dated records should also be kept.

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

⚠ WARNING

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

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

Inspection

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

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

Frequent Inspection

Visually inspect all straps once each work shift for obvious damage which poses an immediate hazard. Pay particular attention to areas where wear and other damage is likely to occur. Look for straps that are disconnected, loose or sagging excessively and for distortion such as kinking or twisting. If any strap looks like it is damaged, strap must be checked to make sure it is within specifications given in this section.

Periodic Inspection

Periodic inspection must be performed at least monthly. During this inspection, entire length of strap must be inspected to assure that it is within specifications. ***Strap must be within all specifications identified in this section***. Any damage found must be recorded and a determination made as to whether continued use of strap is safe.

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

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

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

Cranes Not In Regular Use

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

Identifying Straps

To aid in identification, a part number is stamped into both ends of each strap as shown in Figure 4-12.

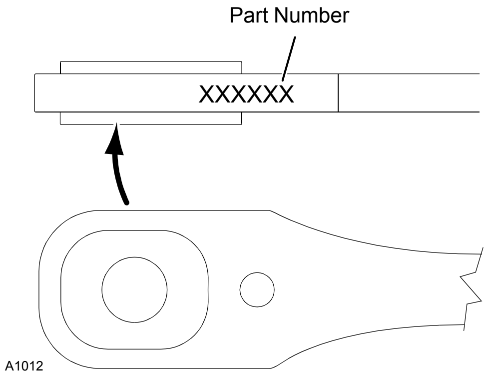


FIGURE 4-12

Replacement Specifications

Any strap not within the specifications listed in Table 4-1 must be replaced.

WARNING

If damage to strap exceeds that allowed within specifications, do not operate the crane until strap has been replaced.

Operating the crane with a damaged strap can cause structural failure or collapse of the boom, jib, mast, or other crane components.

Table 4-1Strap Specifications

Condition	Reference	Allowable Tolerance or Deviation	Corrective Action
Dent	Figure 4-13	< 0.12 in (3,175 mm)	Monitor condition.
		≥ 0.12 in (3,175 mm)	Remove strap from service.
Kink	Figure 4-14	None	Remove strap from service.
Crack or Break	Figure 4-15	None	Remove strap from service.
Corrosion or Abrasion	Figure 4-16	<6% of strap thickness	Sandblast and paint to maintain continuous protective coating.
		≥6% of strap thickness	Remove strap from service.
Straightness (gradual or sweeping bend)	Figure 4-17	Varies depending on strap length	Remove strap from service if deviation exceeds maximum allowed.
Flatness (includes twisted straps)	Figure 4-18	Varies depending on strap length	Remove strap from service if deviation exceeds maximum allowed.
Elongated Holes	Figure 4-19	None	Remove strap from service.
Length	Figure 4-20	None	Remove strap from service.

< = less than
≥ = equal to or greater than

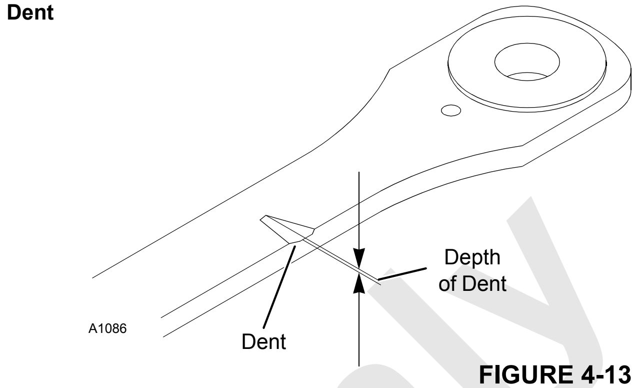
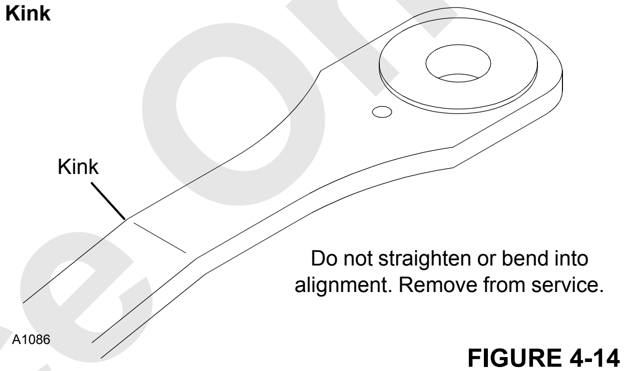
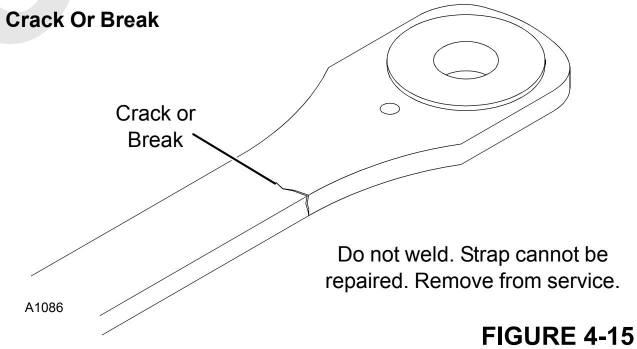


FIGURE 4-13



Do not straighten or bend into alignment. Remove from service.

FIGURE 4-14



Do not weld. Strap cannot be repaired. Remove from service.

FIGURE 4-15

Corrosion Or Abrasion

See Figure 4-16 for the following procedure.

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

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

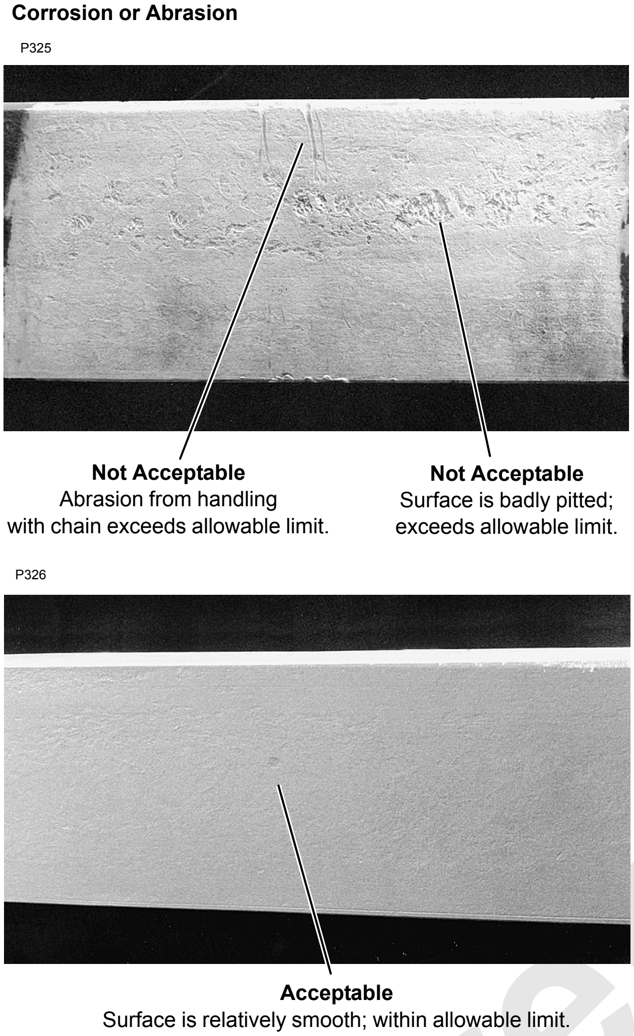


FIGURE 4-16

Straightness

See Figure 4-17 for the following procedure.

1. Stretch a line (string or wire) from pin storage hole at one end of strap.
2. Stretch line as tight as possible and tie it off at other end.
3. Mark strap center line. ***Do not use center punch!***
4. If string does not align with center line, measure distance from center line to line.
5. If deviation from straight is greater than maximum allowed, remove strap from service.

Strap Length (L)	Maximum Deviation Allowed
5 to <10 ft (1,5 to <3,0 m)	0.060 in (1,5 mm)
10 to <20 ft (3,0 to <6,1 m)	0.125 in (3,2 mm)
20 to <30 ft (6,1 to <9,1 m)	0.125 in (6,4 mm)
30 to <40 ft (9,1 to <12,2 m)	0.375 in (9,5 mm)
40 to <50 ft (12,2 to <15,2 m)	0.50 in (12,7 mm)
< = less than	

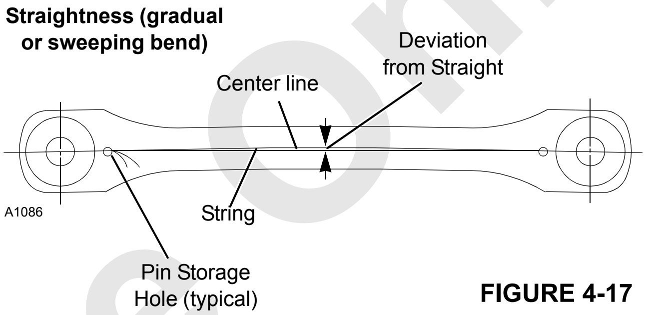


FIGURE 4-17

Flatness

See Figure 4-18 for the following procedure.

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

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

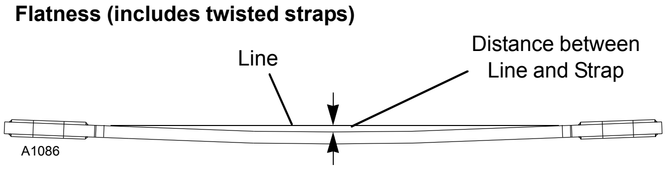


FIGURE 4-18

Elongated Hole

See Figure 4-19 for the following procedure.

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

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

   If two dimensions are identical, but greater than 0.030 in (0,8 mm), contact the Manitowoc Crane Care Lattice Team.

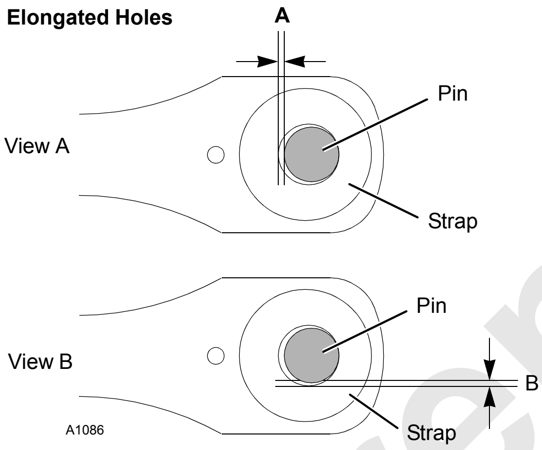


FIGURE 4-19

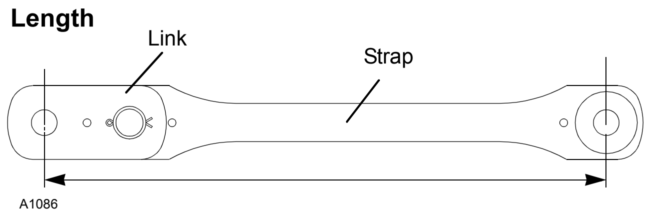
Length

See Figure 4-20 for the following procedure.

Strap Length (L) ft (m)	Maximum Deviation Allowed	
	1 to <2 in (25,4 to <50,8 mm) Thick	**2 to <4 in (50,8 to <101,6 mm) Thick**
<3 (<0,9)	0.17 (4,3)	0.50 (12,7)
3 to <4 (0,9 to <1,2)	0.63 (15,9)	0.56 (14,3)
4 to <5 (1,2 to <1,5)	0.75 (19,1)	0.70 (17,5)
5 to <6 (1,5 to <1,8)	0.80 (20,6)	0.75 (19,1)
6 to <7 (1,8 to <2,1)	0.88 (22,2)	0.75 (19,1)
7 to <8 (2,1 to <2,4)	0.94 (23,8)	0.75 (19,1)
8 to <9 (2,4 to <2,7)	1.0 (25,4)	0.75 (19,1)
9 to <10 (2,7 to <3,0)	1.0 (25,4)	0.88 (22,2)
10 to <12 (3,0 to <3,7)	1.0 (25,4)	1.0 (25,4)
≥12 (≥3,7)	Deviation not to exceed 1 in (25,4 mm) in any 12 ft (3,7 m) length of strap	

< = less than

≥ = equal to or greater than



Measure to check length. See appropriate Rigging Drawing in Operator Manual for original length. Strap length includes connecting link. If change in length is detected, remove strap from service.

FIGURE 4-20

Storing Straps

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

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

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

Removing Straps from Service

Straps removed from service should be clearly marked to prevent accidental future use. Rendering the strap useless in some way, such as cutting off an end, is recommended.

Inspection Checklist

A Strap Inspection Checklist is provided at the end of this section. The checklist can be reproduced as needed.

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

If no damage is found or damage is within 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.

Inspector's Name ________________ **Signature** ________________ **Date** ____________

Length ____________ mm (ft) Part Number ________________

☐ Dents ☐ Kinks ☐ Cracks ☐ Breaks ☐ Corrosion

☐ Abrasion ☐ Length ☐ Straightness ☐ Flatness ☐ Elongated Holes

☐ Other ____

Length ____________ mm (ft) Part Number ________________

☐ Dents ☐ Kinks ☐ Cracks ☐ Breaks ☐ Corrosion

☐ Abrasion ☐ Length ☐ Straightness ☐ Flatness ☐ Elongated Holes

☐ Other ____

Length ____________ mm (ft) Part Number ________________

☐ Dents ☐ Kinks ☐ Cracks ☐ Breaks ☐ Corrosion

☐ Abrasion ☐ Length ☐ Straightness ☐ Flatness ☐ Elongated Holes

☐ Other ____

Length ____________ mm (ft) Part Number ________________

☐ Dents ☐ Kinks ☐ Cracks ☐ Breaks ☐ Corrosion

☐ Abrasion ☐ Length ☐ Straightness ☐ Flatness ☐ Elongated Holes

☐ Other ____

Length ____________ mm (ft) Part Number ________________

☐ Dents ☐ Kinks ☐ Cracks ☐ Breaks ☐ Corrosion

☐ Abrasion ☐ Length ☐ Straightness ☐ Flatness ☐ Elongated Holes

☐ Other ____

NOTES

DRAW SKETCHES OR ATTACH PHOTOGRAPHS HERE AND NEXT PAGE

SECTION 5
HOISTS

TABLE OF CONTENTS

SECTION 5
HOISTS

MINIMUM BAIL LIMIT ADJUSTMENT

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

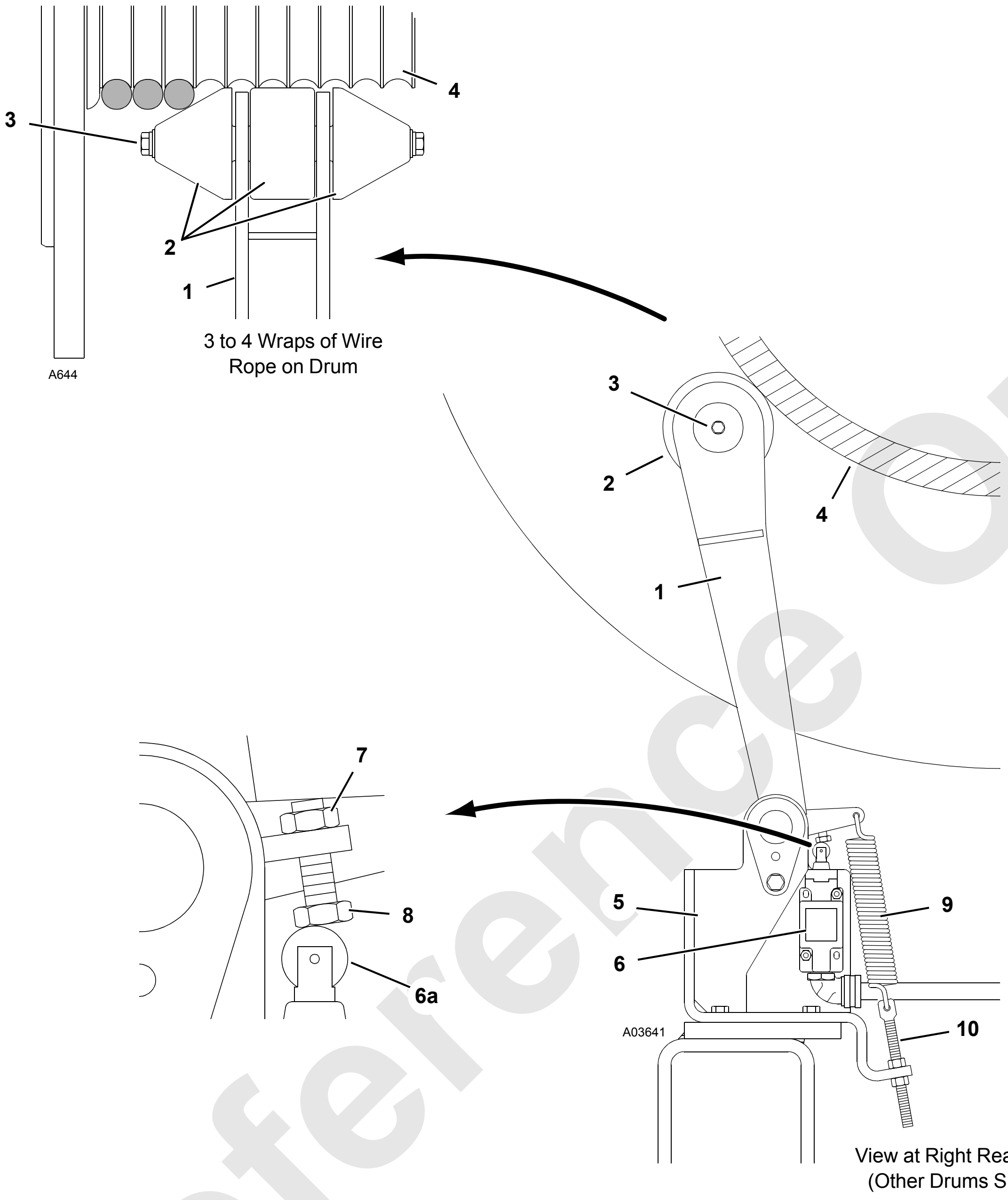
Falling Load Hazard!

Do not operate either load drum with less than three full wraps of wire rope on drum. Wire rope can be pulled out of drum and load will drop.

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 load
   b. Pay out wire rope from load drum.
   c. Load drum must stop when there are three to four wraps of wire rope remaining on drum.
2. Check that cap screws (3) holding rollers (2) on bail limit lever (1) are tight.
3. Check tension of each return spring (9). If necessary, adjust eyebolt (10) so spring holds rollers snugly against drum.



Item	Description	Item	Description
1	Lever	6a	Roller
2	Rollers	7	Lock Nut
3	Cap Screw	8	Adjusting Screw
4	Drum	9	Return Spring
5	Mounting Bracket	8	Eyebolt
6	Limit Switch		

FIGURE 5-1

Wire Rope Removal

To remove wire rope from a load drum:

1. Land load and lower boom onto blocking at ground level.
2. Pay out wire rope from load drum until limit switch stops drum from turning.
3. Move limit bypass switch to BYPASS position and hold.
4. Operate load drum in lower direction to pay out remaining wire rope from drum.

Electric Wiring

See the Electric Schematic at the end of Section 3 in this manual for proper wiring of the limit switch.

Minimum Bail Limit Adjustment

See Figure 5-1 for the following procedure.

1. Loosen lock nut (7) and turn adjusting screw (8) up as far as possible.
2. Pay out wire rope from drum (4) until rollers (2) are against lagging with 3 to 4 wraps of wire rope remaining on drum.
3. Turn adjusting screw (8) down against limit switch roller (6a) until limit switch “clicks open” and stop.
4. Spool 6-7 wraps of wire rope onto drum, and then pay out wire rope.
5. Drum must stop when rollers (2) are against drum lagging with 3 to 4 wraps of wire rope remaining on drum.

   If necessary, turn adjusting screw (8) in or out slightly and recheck adjustment.
6. Securely tighten lock nut against mounting plate to lock adjustment.
7. Adjust eyebolt (10) so return spring (9) has sufficient tension to hold rollers (2) snugly against bare drum.

Item	Description
1	Upper Boom Point
2	Limit Switch Assembly
3	Lower Boom Point
4	Junction Box
5	Chain
6	Weight
7	Lift Block
8	Weight Ball
9	Lift Plate
10	Load Block
11	Electric Cord to Reel on Boom Butt
12	Block Angle Transmitter (optional)
13	Angle Sensor
14	Batteries
15	Push to Install Button

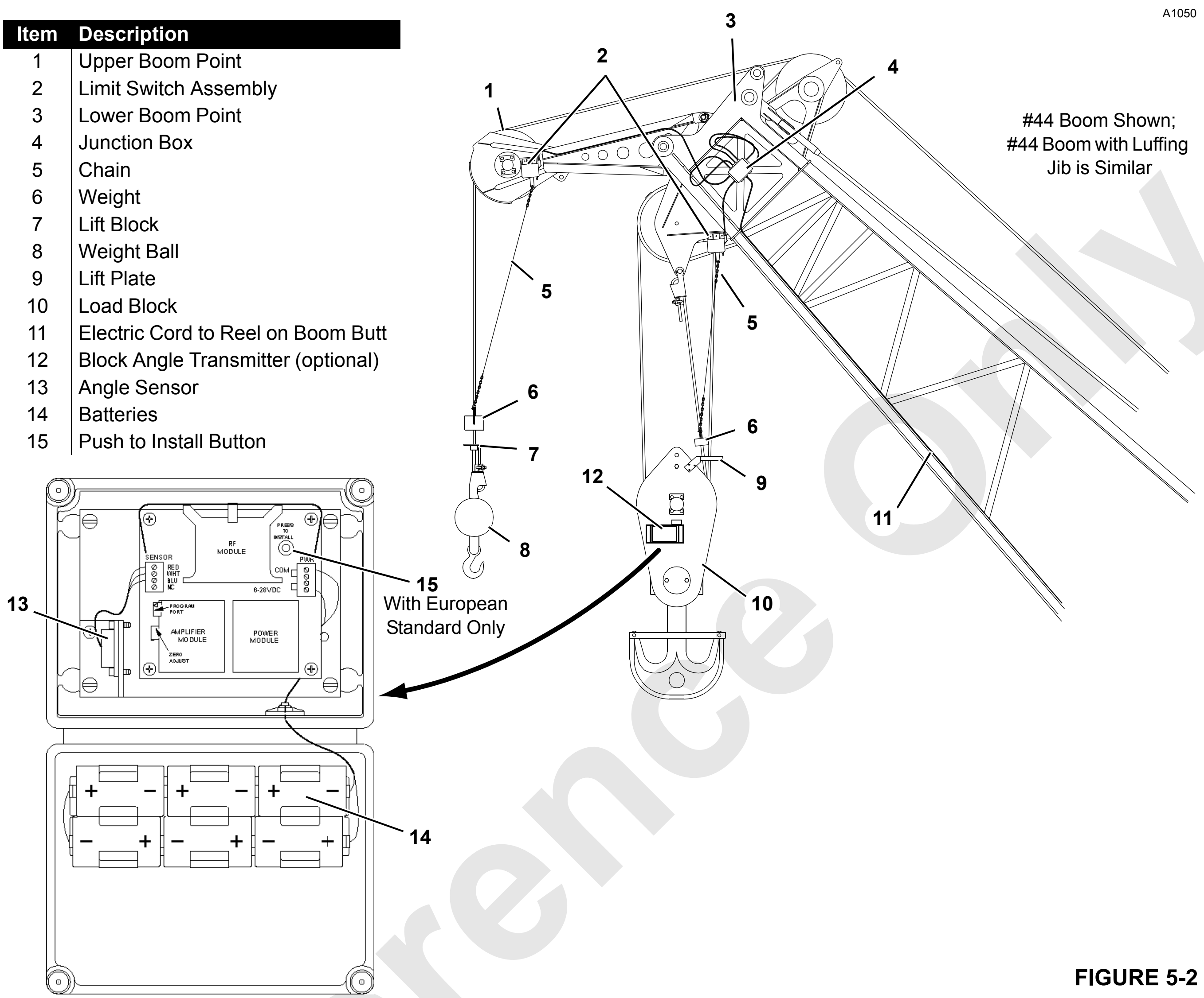


FIGURE 5-2

BLOCK-UP LIMIT CONTROL ADJUSTMENT

General

The block-up limit control (also called anti two-block 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.

DEFINITION: Two-blocking is the unsafe condition in which the load block or the weight ball contacts the sheave assembly from which either is suspended.

Two-blocking can result in failure of sheaves and wire rope, possibly causing load to fall.

The block-up limit controls must be installed according to Boom Wiring, Limits and Load Indicator Electrical Assembly drawing in your Operator Manual.

WARNING

Two-Blocking Hazard!

Block-up limit control is a protective device designed only to assist operator in preventing a two-blocking condition. Any other use is neither intended nor approved.

Block-up limit control may not prevent two-blocking when load is hoisted at maximum single line speed. Operator shall determine fastest line speed that will allow block-up limit control to function properly and, thereafter, not exceed that line speed.

The block-up limit control consists of the following components (see Figure 5-2):

1. Normally closed limit switch assembly fastened at any or all of the following locations (multiple limit switches are wired in series):
    a. Lower boom point
    b. Upper boom point (standard or extended)
    c. Fixed jib point
    d. Luffing jib point
2. Weight freely suspended by chain from each limit switch actuating lever (weight encircles load line).
3. Lift block clamped to single-part load line or lift plates fastened to multiple-part load block.

For detailed drawings of limit switch locations, see Boom Wiring and Limits Drawing in Section 4 of Operator Manual.

Block-Up Limit Control Operation

During normal operation, the weight overcomes spring force and rotates the actuating lever away from the limit switch lever. This action allows the limit switch to close the load drum ***up*** and boom/luffing jib ***down*** electric 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 limit switch lever. This action causes the corresponding limit switch to open the load drum ***up*** and boom/luffing jib ***down*** electric circuits.

The load drum and boom hoist pumps stroke to off. At the same time, the load drum and boom/luffing jib parking brakes apply to stop the load drum from hoisting and the boom/luffing jib from lowering.

Load Block Level Transmitter

See Figure 5-2 for the following procedure.

The optional load block level transmitter is only used with tandem drum operation. See load block level screen topic in Section 10 of this manual. The wireless screen on digital display indicates load block level battery status.

1. Load block level transmitter is mounted on block (10). Locate on block where there are no obstructions between transmitter and receiver on boom top.
2. When reeved, load block level transmitter must be on left side of load block when viewed from operator's cab.
3. Use a smart level to check level sensor zero. Follow the procedure below if a zero adjustment is required:
    a. Open enclosure.
    b. If European Standard transmitter is used, ***press to install button*** must be pressed to enable.
    c. Loosen screw on each side of sensor (Item 15) and turn sensor slightly either way until sensor is zeroed.
    d. Tighten screws on each side of sensor when adjustment is complete.

The transmitter is shipped with six ***Alkaline*** type size D batteries. We recommend replacing batteries with six ***Lithium*** type size D batteries for longer battery life.

Installation

See Figure 5-4 for installation of the weights.

The block-up limit control must be installed according to the assembly drawing following this section.

Securely fasten the electric cords to the boom and jib with the metal straps and nuts provided.

When equipped with more than one block-up limit switch, wire limit switches in series.

Connect the electric wires to the normal-closed contacts inside each limit switch.

Storing Electric Cord

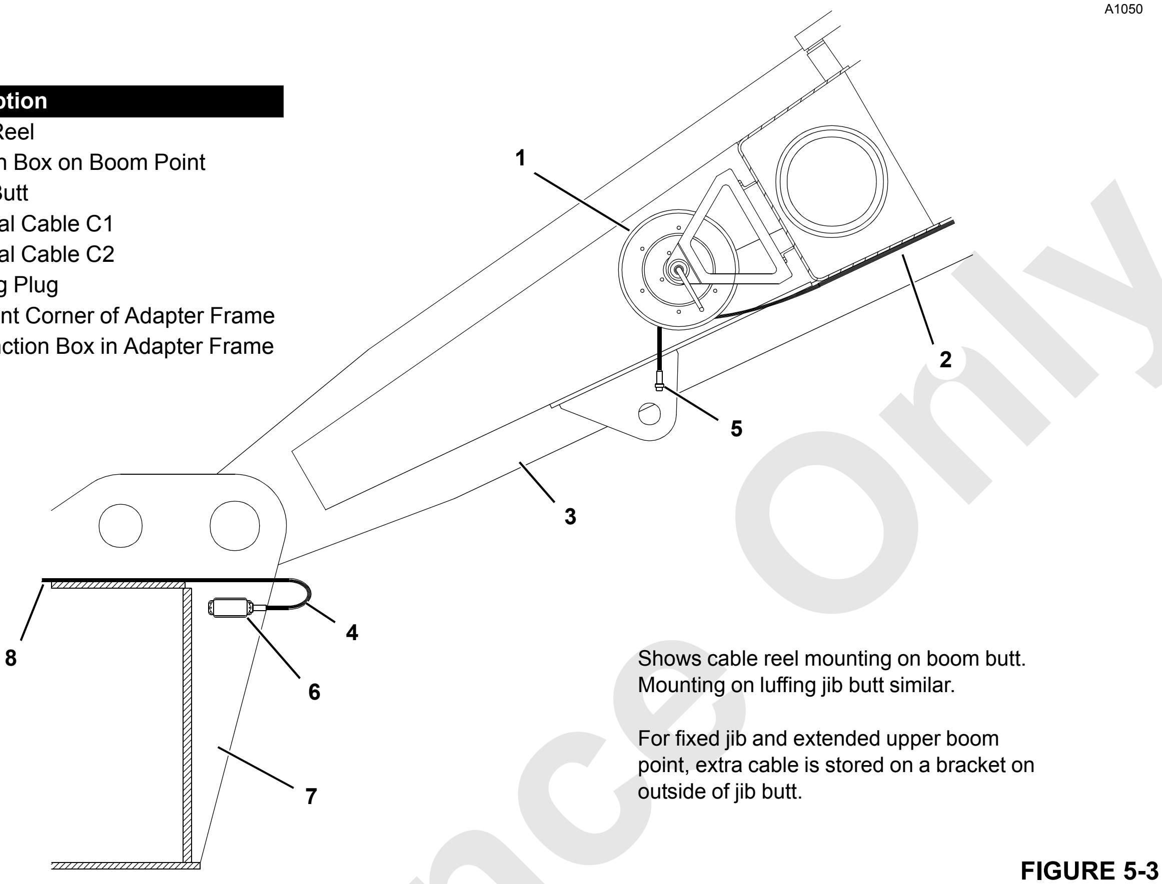
The electric cords for the boom, fixed jib, and luffing jib are long enough to accommodate the maximum length of each attachment.

Store the excess cord for the boom and luffing jib on the reel mounted on either butt (Figure 5-3).

Disengage the 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 electric 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



Shows cable reel mounting on boom butt. Mounting on luffing jib butt similar.

For fixed jib and extended upper boom point, extra cable is stored on a bracket on outside of jib butt.

FIGURE 5-3

Disconnecting Block-Up Limit Control

A shorting plug (Figure 5-3) is provided on the left front corner of the adapter frame so the block-up limit system can be disconnected for the following reasons:

- Crane setup and rigging
- Maintenance
- Operations not requiring use of a block-up limit control (clamshell and dragline)

To disconnect the block-up limit system, proceed as follows (see Figure 5-3):

1. Disconnect electric cord (C1) from cable reel.
2. Remove the closure cap from shorting plug.
3. Connect electric cord (C2) to shorting plug.
4. Reverse steps to reconnect block-up limit control.

Removing Jib or Boom Point

For identification of junction boxes, electric cords, and shorting plugs, see the Block-Up Limit Control Assembly drawing following this section.

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 is equipped with a block-up limit switch, the electric cord from the limit switch must be connected to the proper shorting plug when the corresponding attachment is removed.

Failing to perform this step will prevent the load drum from hoisting and the boom from lowering. Also the operating limit alert will come on.

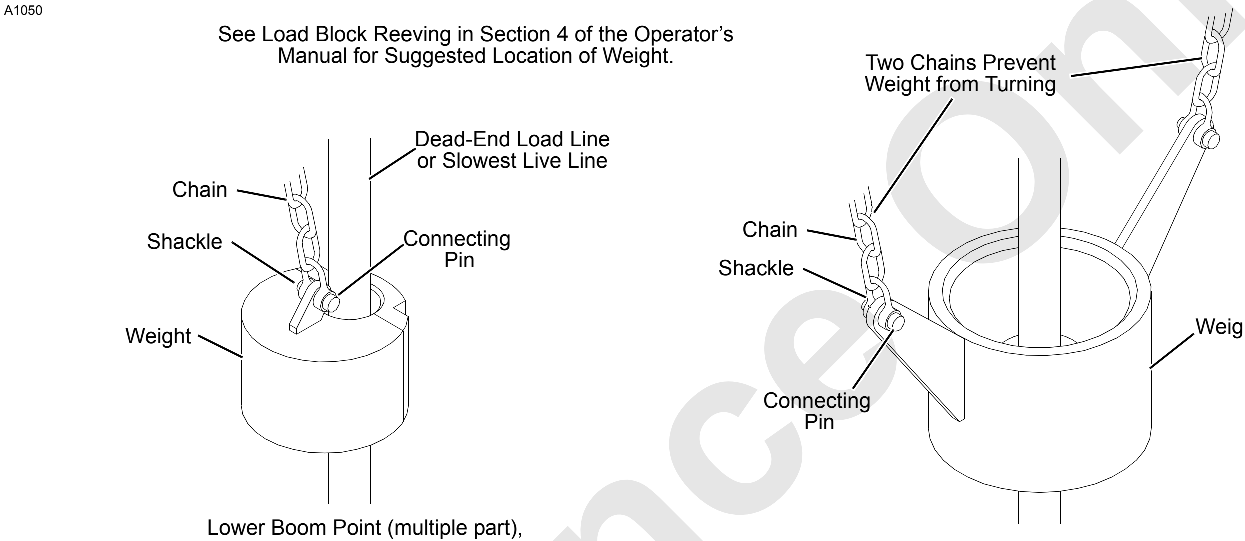
Reconnect electric cord to proper block-up limit switch when corresponding attachment is reinstalled.

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:
   - **a.** Inspect each limit switch lever and actuating lever for freedom of movement. Apply one-half shot of grease to the fitting on the actuating lever. Wipe away any excess grease.
   - **b.** Inspect each weight for freedom of movement on the load line.
   - **c.** Inspect each weight, each chain, each shackle and each connecting pin for excessive or abnormal wear. Make sure cotter pins for shackles are installed and spread.
   - **d.** Inspect the entire length of electric cords for damage.
   - **e.** Check that the electric cords are clear of all moving parts on the boom and jib and that the cords are securely fastened to the boom and jib with metal straps.
   - **f.** Check that all plugs are securely fastened.



Lower Boom Point (multiple part),
#132 or #140 Fixed Jib (4 part),
Extended Upper Boom Point (4 part), or
Lower Luffing Jib Point (multiple part)

#132 or #140 Fixed Jib (1-3 part),
Standard or Extended Upper Boom Point (1-3 part),
Upper Luffing Jib Point (1 part)

FIGURE 5-4

2. Test the block-up limit control for proper operation using either of the following methods:
   - **a.** BOOM LOWERED: Manually lift each weight, one at a time, while the engine is running. The load drum should not operate in the ***hoist*** direction and the boom hoist should not operate in the ***lower*** direction.
   - **b.** 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.

CAUTION

Two-Blocking Hazard!

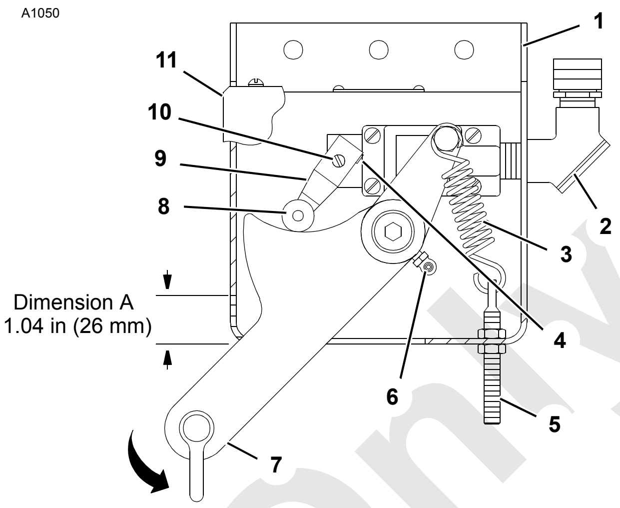
Use extreme care when testing block-up limit control when boom is raised. If block-up limit control fails to stop load, immediately stop load by moving drum control handle to off or by applying drum working brake to prevent two-blocking.

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 spring tension so there is enough force to lift the weight of the chain and rotate the actuating lever when the weight is lifted.
2. Loosen the setscrew in the limit switch lever so the lever is free to rotate.
3. Manually lift the weight to allow the actuating lever to rotate upward.
4. Hold lever at Dimension A.
5. Hold the roller on the limit switch lever against the actuating lever while performing step 6.
6. Turn the limit switch shaft ***clockwise*** only enough for limit switch to click open and hold. Then securely tighten the setscrew 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	Setscrew
5	Adjusting Screw (spring Tension)
6	Grease Fitting
7	Actuating Lever
8	Roller
9	Limit Switch Lever
10	Shaft
11	Cover

FIGURE 5-5

DRUM BRAKE INSPECTION AND ADJUSTMENT

Description

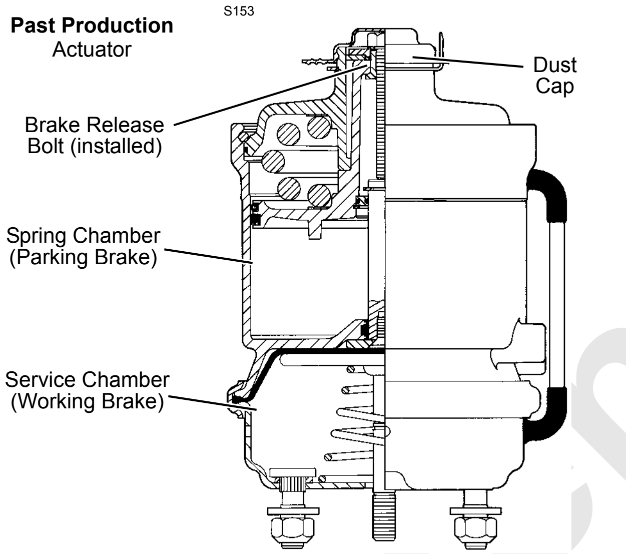
Each drum brake consists of an external, contracting band-type brake and two actuators. On single drum shafts, the brake is mounted on the left end of the drum. On split drum shafts, a brake is mounted on the outboard end of both drums. Independent drum drive has two brakes, one mounted on the left end of drum shaft and the other mounted on the right end.

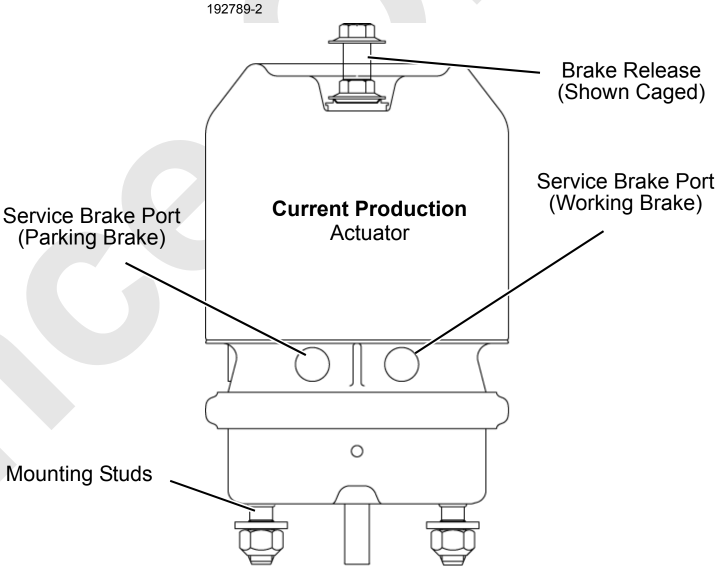
NOTE: There are two types of brake actuators used. A ***past production*** type actuator and a ***current production*** type actuator is shown in Figure 5-6. Customers ordering replacement brake actuators will receive the current type.

Each actuator has two chambers which provide two separate braking systems for each load drum:

- The spring chamber provides a spring-applied, air-released parking brake. In the full power mode, the parking brake is applied and released automatically by the load drum control.
- 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.

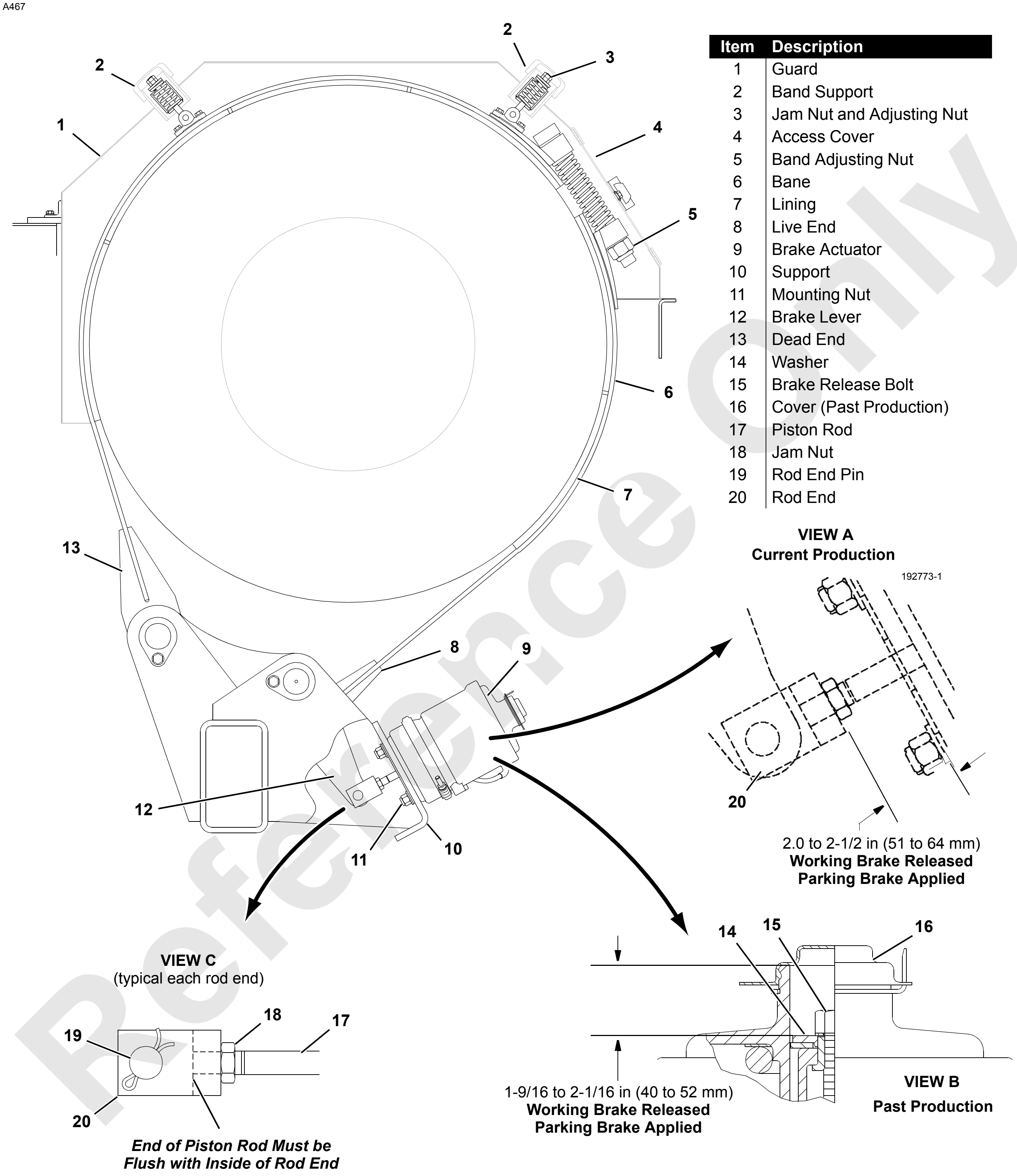
The operator shall be seated and the engine must be running to operate the drum controls and parking brakes during the inspection, adjustment, and overhaul steps. The drums are automatically parked and the handles are inoperable when the operator is out of the seat or the engine is off.





Drum Brake Actuator Identification
(shown with working and parking brakes released)

FIGURE 5-6



Item	Description
1	Guard
2	Band Support
3	Jam Nut and Adjusting Nut
4	Access Cover
5	Band Adjusting Nut
6	Bane
7	Lining
8	Live End
9	Brake Actuator
10	Support
11	Mounting Nut
12	Brake Lever
13	Dead End
14	Washer
15	Brake Release Bolt
16	Cover (Past Production)
17	Piston Rod
18	Jam Nut
19	Rod End Pin
20	Rod End

Left Rear Drum Brake
(all other drum brakes similar)

FIGURE 5-7

Brake Inspection and Adjustment

CAUTION

Moving Machinery Hazard!

It is necessary to rotate load drum and apply and release drum parking brake during inspection, adjustment, and overhaul steps.

Drum brake inspection, adjustment, and overhaul requires two people: one to operate drum and brake controls and one to perform inspection, adjustment, and overhaul steps. Maintain constant communication between adjuster and operator so drum and brake are not operated while adjuster is in contact with parts.

Lower load block or weight ball onto ground so wire rope is slack on drum being serviced.

- Adjuster stay clear of all moving parts while drum and brake are being operated.
- Operator do not operate drum or brake controls until adjuster is clear of moving parts.

---

1. Inspect all pins and linkage for excessive wear, and replace parts as required. Worn pins and linkage will make it difficult to obtain proper drum-to-lining clearance.
2. Lubricate pins in linkage with a few drops of engine oil. Lubricate grease fittings according to lubrication topic in Section 9 of this manual.
3. Check linings for excessive wear. Linings normally wear faster at dead end of brake band. Check this area first.

   Brake lining is 1/2 in (12,7 mm) thick when new. Replace lining when thinnest area has worn to 7/32 in (6 mm) thick.

WARNING

Falling Load Hazard!

Only use Manitowoc original equipment lining. Other lining may not provide proper brake torque. Brake could slip, allowing load to drop.

---

4. Thoroughly inspect the brake bands for cracks and corrosion when the bands are removed for relining. This inspection procedure also applies to band assemblies that are received in exchange for bands that were removed for relining.

   The inspection method must include non-destructive testing — magnetic particle (MT) or ultrasound (UT).

   The primary area to inspect is the dead-end attachment area on the band (see Figure 5-8).

   If there is evidence of cracks or 10% reduction in area due to corrosion, destroy and discard the band and replace with it a new band or a band that has passed non-destructive test/inspection. Contact your Manitowoc dealer for brake band thickness. Please have the band part number available at the time of the request.

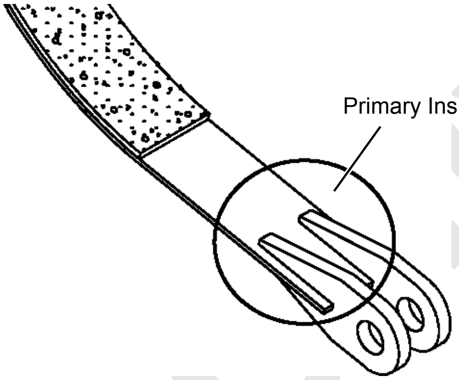


FIGURE 5-8

5. Perform treadle valve checks and make necessary adjustments.
6. Check each brake band for proper adjustment as follows (see Figure 5-7):

NOTE: Check band adjustment when linings are cold for lift-crane work or warm from duty-cycle work.

   a. Lower load block, weight ball, or bucket to ground from drum being serviced so wire rope is slack.
   b. If equipped with three drums, use drum selector to select desired rear drum, right or left.
   c. Turn on free-fall for drum being serviced.
   d. Release drum working brake (brake pedal up fully).
   e. Turn on drum park for drum being serviced. Drum parking brake will spring apply.
   f. Check for the following dimension:

      Current Production — Measure distance from bottom of actuator to top of rod end as shown in Figure 5-7, View A.

      - Dimension must be 2.0 to 2-1/2 in (51 to 64 mm)
      - Readjust brake when 2-1/2 in (64 mm) is reached

      Past Production — Measure distance from top of actuator to washer inside actuator as shown in Figure 5-7, View B. Dimension can be measured at either actuator on drum being serviced.

      - Dimension must be 1-9/16 to 2-1/16 in (40 to 52 mm)

  - Readjust brake when 2-1/16 in (52 mm) is reached.

g. If proper dimension is not obtained, turn off drum park to release brake for drum being serviced.

h. Tighten band adjusting nut one to two flats at a time.

i. Repeat step 6f until proper dimension is obtained.

j. Turn off drum park for drum being serviced. Drum parking brake will release.

k. Check for clearance between brake lining and drum flange:

  - Grasp brake band at band adjusting nut. Band should move back and forth freely by hand.
  - As a further check, drum should turn freely when load line is pulled by hand (clutch and parking brake released). If drum does not turn freely by hand and band is loose, clutch may not be releasing. See Drum Clutch Inspection and Adjustment topic in this section.
  - If necessary, loosen jam nut at band supports (Figure 5-7). Turn adjusting nuts in required direction to provide clearance between lining and drum flange. Securely tighten jam nuts to lock adjustment.

l. For independent drum drive, repeat steps 6d through 6k for brake on opposite side.

Dimension measured in step 6f must be identical for each brake on drum to provide balanced braking.

7. Band adjustment is now complete. Select and confirm desired operating mode.

CAUTION

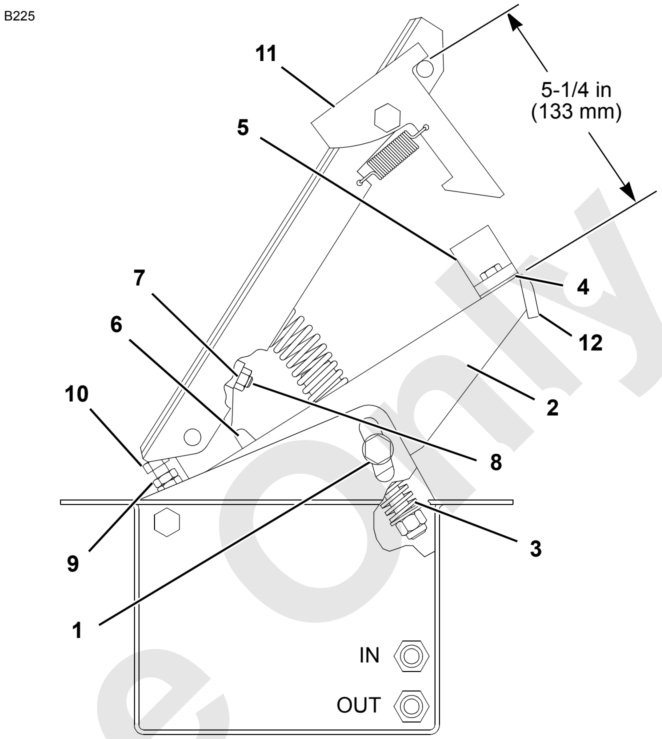
Drum Flange Damage!

Brake lining must not rub against drum flange when brake is released. Otherwise, lining will overheat, possibly resulting in cracks in drum flange.

Treadle Valve Checks

See Figure 5-9 for the following procedure.

1. Check each pedal latch and latch bar for wear. ***Pedal latch must hold pedal down in fully applied position.***
2. Connect 0 to150 psi (0 to 10,3 bar) air pressure gauge to in and out ports of valve:
   - Air pressure at in port should be 120 to 132 psi (8,3 to 9,1 bar).
   - Air pressure at out port should modulate from 0 to 75 psi (0 to 5,2 bar) as pedal is slowly depressed and then go to 120 to 132 psi (8,3 to 9,1 bar).



Item	Description	Item	Description
1	Cap Screw	7	Jam Nut
2	Valve Support	8	Set Screw
3	Spring	9	Jam Nut
4	Shims	10	Screw
5	Bumper	11	Pedal Latch
6	Valve	12	Latch Bar

FIGURE 5-9

Treadle Valve Adjustments

See Figure 5-9 for the following procedure.

1. ***Lower load for treadle valve being adjusted to ground so load line is slack.***
2. Adjust pedal to desired height:
   - **a.** Latch pedal down.
   - **b.** Loosen four cap screws (1).
   - **c.** Move valve support (2) to desired height.
   - **d.** Securely tighten cap screws.
3. Adjust spring (3) for a 2-7/8 in (73 mm) preload.
4. Install shims (4) under bumper (5) so pedal compresses bumper 1/32 in (0,8 mm) when pedal is latched.
5. Adjust valve (6) as follows:
   - **a.** Release brake pedal to fully raised position.

b. Connect a 0 to 150 psi (0 to 10,3 bar) air pressure gauge to out port between valve and actuator.

c. Depress pedal so it is approximately 1/32 in (0,8 mm) from touching bumper. Gauge should read 115 to 125 psi (7,9 to 8,6 bar).

Do not set pressure higher than 125 psi (8,6 bar).

d. If required, loosen jam nut (7) and ***tighten*** set screw (8) to ***increase*** pressure. ***Loosen*** set screw to ***decrease*** pressure. Securely tighten jam nut to lock adjustment.

e. Release brake pedal to fully raised position; gauge should read 0 psi (0 bar). If required, loosen jam nut (9) and turn screw (10) in until pressure is 0 psi (0 bar). Securely tighten jam nut to lock adjustment.

f. Remove gauge.

g. Repair or replace valve if correct pressures cannot be obtained.

Brake Actuator Overhaul

WARNING

Personnel Injury Hazard!

Actuator is spring loaded; do not attempt to disassemble actuator while it is on crane. Remove actuator according to the following instructions.

See instructions in manufacturer's service manual for proper disassembly of actuator. Otherwise, actuator will fly apart with dangerous force.

Removal

See Figure 5-7 for the following procedure.

1. ***Read precautionary steps*** given after heading.
2. Lower load block, weight ball, or bucket to ground from drum being serviced so wire rope is slack.
3. If equipped with three drums, use drum selector to select desired rear drum, right or left.
4. Fully release drum working brake (brake pedal up fully).
5. Turn on free-fall and turn off drum park for drum being serviced. Drum parking brake will release.
6. Cage power spring in actuator, as follows:

Current Production:

a. Using a 3/4 in (19 mm) deep-socket wrench, turn release bolt counter-clockwise 22 to 23 turns.

Past Production:

a. Unsnap dust cap from top of actuator.

Using a 3/4 in (19 mm) deep-socket wrench, turn release bolt counter-clockwise until bolt and washer are completely removed.

7. Stand clear of actuator. Turn on drum park for drum being serviced. Parking brake will spring apply. Piston rod may extend slightly when this step is performed.
8. Tag air lines for proper identification when reinstalling actuator; then disconnect air lines from actuator.
9. Remove rod end pin to disconnect rod end from brake lever.
10. Remove mounting nuts and remove actuator from support. Actuator weighs approximately 30 lb (14 kg).

Repair

Follow instructions in manufacturer's service manual to properly repair actuator.

Rework – Current Production Actuators

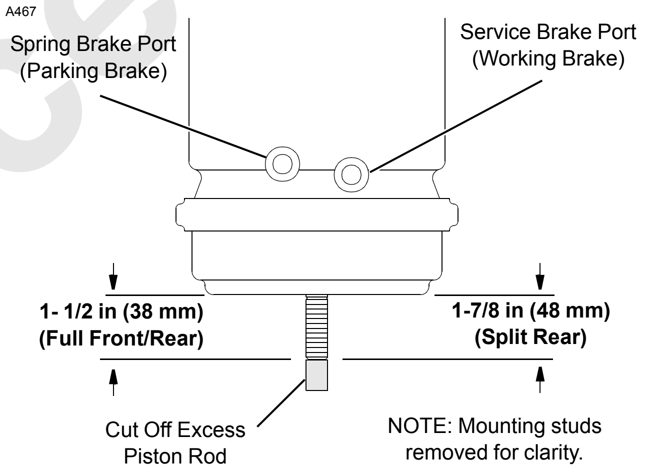


FIGURE 5-10

See Figure 5-10 for the following procedure.

Before installing a new or rebuilt actuator, rework it according to the following steps:

1. Remove jam nut from piston rod end.
2. Turn spring brake release bolt clockwise until tight and torque to 74 ft-lb (100 N•m).
3. Apply at least 90 psi (6,2 bar) air pressure to spring brake port of actuator.
4. Cut off piston rod at 1-7/8 in (48 mm) as shown in Figure 5-10 for standard actuators and 1-1/2 in (38 mm) for clamshell drum actuators.

5. With air still applied to actuator, perform removal step 6 to cage power spring in actuator.

NOTE: For independent drum drive, with air still applied to actuator, cage power spring in actuator with a 3/4 in. (19 mm) deep-socket wrench, turn release bolt counter-clockwise 22 to 23 turns.

6. Turn off and exhaust air from actuator.

Rework – Past Production Actuators

See Figure 5-10 for the following procedure.

Before installing a new or rebuilt actuator, rework it according to the following steps:

1. Remove jam nut from piston rod.
2. Install brake release bolt and washer hand tight and then torque bolt to 20 to 25 ft-lb (27 to 34 N•m).
3. Apply at least 90 psi (6,2 bar) air pressure to spring brake port of actuator.
4. Cut off piston rod at dimension given in Figure 5-10 for ***past production*** actuators.
5. With air still applied to actuator, perform removal step 6 to cage power spring in actuator.

NOTE: For independent drum drive, with air still applied to actuator, cage power spring in actuator as follows:

- Unsnap dust cap from top of actuator.
- Turn release bolt counterclockwise until bolt and washer are removed.

6. Turn off and exhaust air from actuator.

Installation

See Figure 5-7 for the following procedure.

1. Perform rework steps.
2. Install jam nut and rod end on piston rod as shown in Figure 5-7, View C. ***End of piston rod must be flush with inside of rod end.*** Tighten jam nut against rod end.
3. Connect quick-release valve to spring brake port of actuator.
4. Attach actuator to support with mounting plate, two flat washers, and two nuts; tighten nuts to 133 to 155 ft-lb (180 to 210 N•m).
5. Connect air lines to proper ports of actuator (Figure 5-10):
   a. Air line from working brake treadle valve to service brake port (outboard actuator only).

      Inboard actuator has a nut bushing and breather installed in place of air line.

   b. Air line from parking brake control valve to spring brake port (port with quick-release valve).
6. Pin rod end to brake lever.
7. Stand clear of actuator. turn off drum park to release parking brake for drum being serviced.
8. Un-cage power spring in actuator, as follows:

   Current Production:

   a. Using a 3/4 in (19 mm) deep-socket wrench, turn release bolt clockwise until tight and torque to 74 ft-lb (100 N•m).

   Past Production:

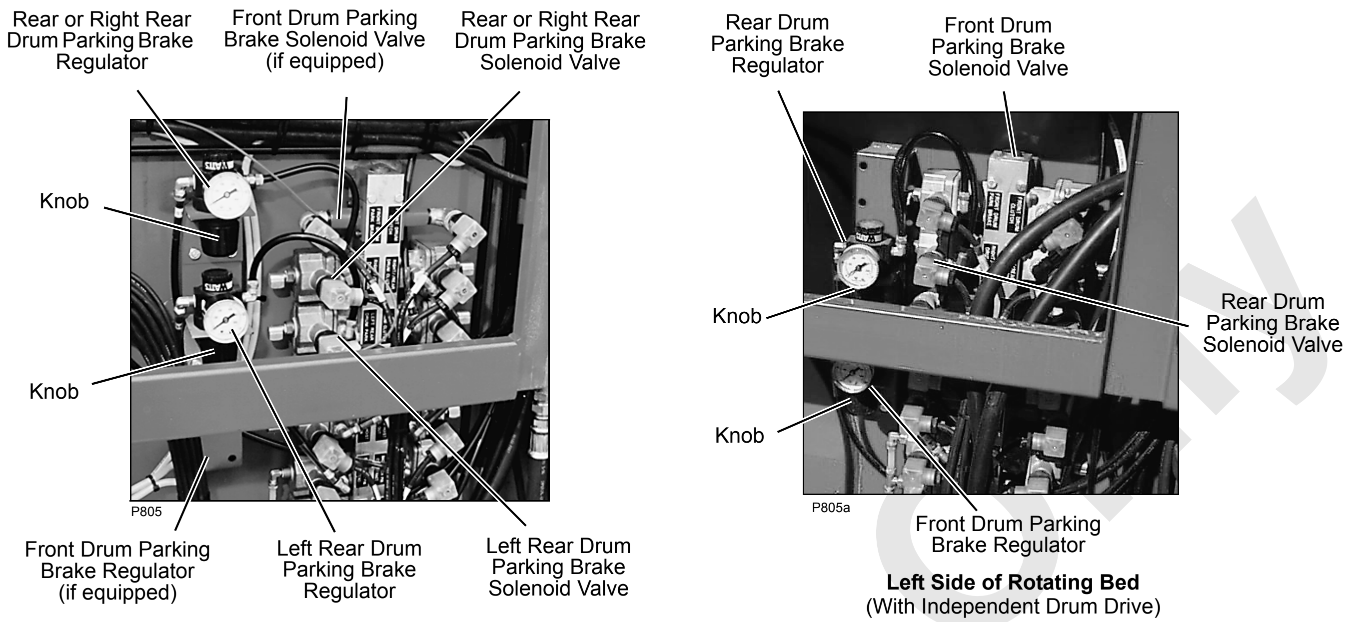
   a. Unsnap dust cap from top of actuator.
   b. Install brake release bolt and washer (Figure 5-7, View B) hand tight and then torque bolt to 20 to 25 ft-lb (27 to 34 N•m).
9. Turn on drum park to apply parking brake for drum being serviced.
10. Check brake for proper operation and adjustment.

Brake Release Adjustment

Perform 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: Corresponding drum brake must be properly adjusted before performing brake release adjustment.

1. ***Read precautionary steps*** given after heading.
2. Lower load block, weight ball, or bucket to ground from drum being serviced so wire rope is slack



Left Side of Rotating Bed

Left Side of Rotating Bed
(With Independent Drum Drive)

FIGURE 5-11

3. If equipped with three drums, use drum selector to select desired rear drum, right or left.
4. Fully release drum working brake (brake pedal up fully).
5. Turn on free-fall and turn off drum park for drum being serviced. Drum parking brake will release.
6. Push in regulator adjusting knob (Figure 5-11) for brake being adjusted.
7. Turn knob ***clockwise*** to ***increase*** pressure or ***counterclockwise*** to ***decrease*** pressure until gauge reads 60 psi (4,1 bar) *Past Production* or 70 psi (4,8 bar) *Current Production* as viewed from knob end. This is initial setting only.
8. Adjust regulator:

   Current Production — Until the distance from bottom of actuator to top of rod end is 1.0 inch (25,4 mm) as shown in Figure 5-12.

   Past Production — Until distance from top of actuator to washer inside actuator is 9/16 in (14 mm) as shown in Figure 5-12. This measurement can be checked at either actuator.
9. If proper dimension is not obtained, turn regulator knob ***clockwise*** to ***decrease*** or ***counterclockwise*** to ***INCREASE*** (directions viewed from knob end).
10. Pull out knob to lock regulator setting when proper dimension is obtained.

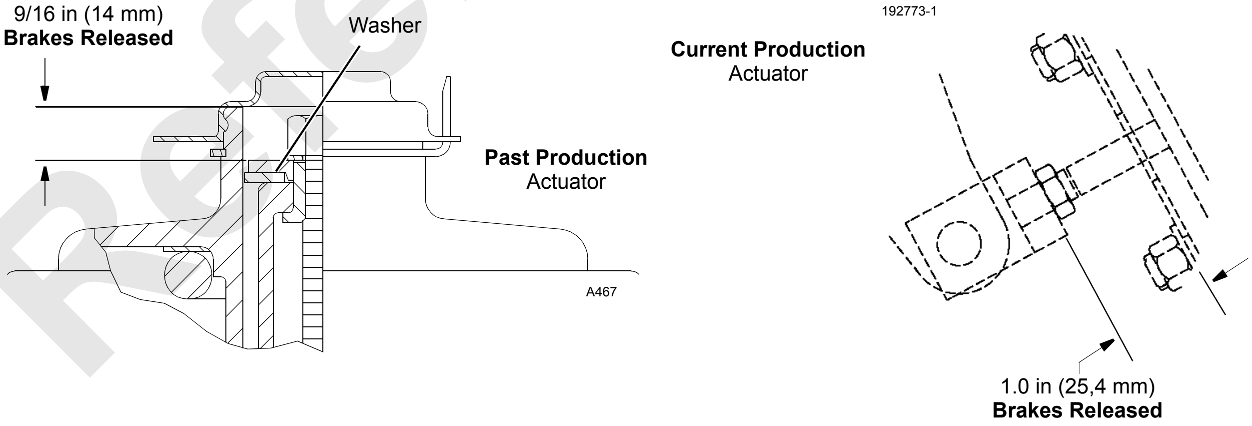


FIGURE 5-12

DRUM CLUTCH INSPECTION AND ADJUSTMENT — STANDARD

Description

See Figure 5-13 for the following procedure.

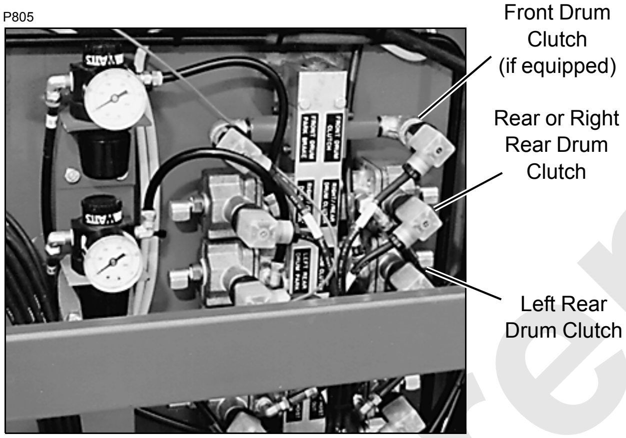
The drum clutch is an internal, expanding band-type clutch that is spring applied and air released.

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 2-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 load drum and apply/release drum clutch during inspection, adjustment, and overhaul steps.

Drum clutch inspection, adjustment, and overhaul require two people: one to operate drum controls and one to perform inspection, adjustment, and overhaul steps. Maintain constant communication between adjuster and operator so drum is not operated while adjuster is in contact with parts.

Lower load block or weight ball onto ground so wire rope is slack on drum being serviced.

- Adjuster, stay clear of all moving parts while load drum and clutch are being operated.
- Operator, do not operate drum controls until adjuster is clear of moving parts.

See Figure 5-14 for the following procedure.

Make sure the air system pressure is 120 to 132 psi (8,3 to 9,1 bar) at all times during inspection and adjustment procedure.

1. Lower load block or weight ball to ground so wire rope is slack on drum being serviced.

2. Select STANDARD mode and confirm.

3. To position clutch parts in access hole during inspection and adjustment steps, proceed as follows:

   a. Remove cover from over access hole.

   b. ***Stand clear of clutch*** while drum is turning.

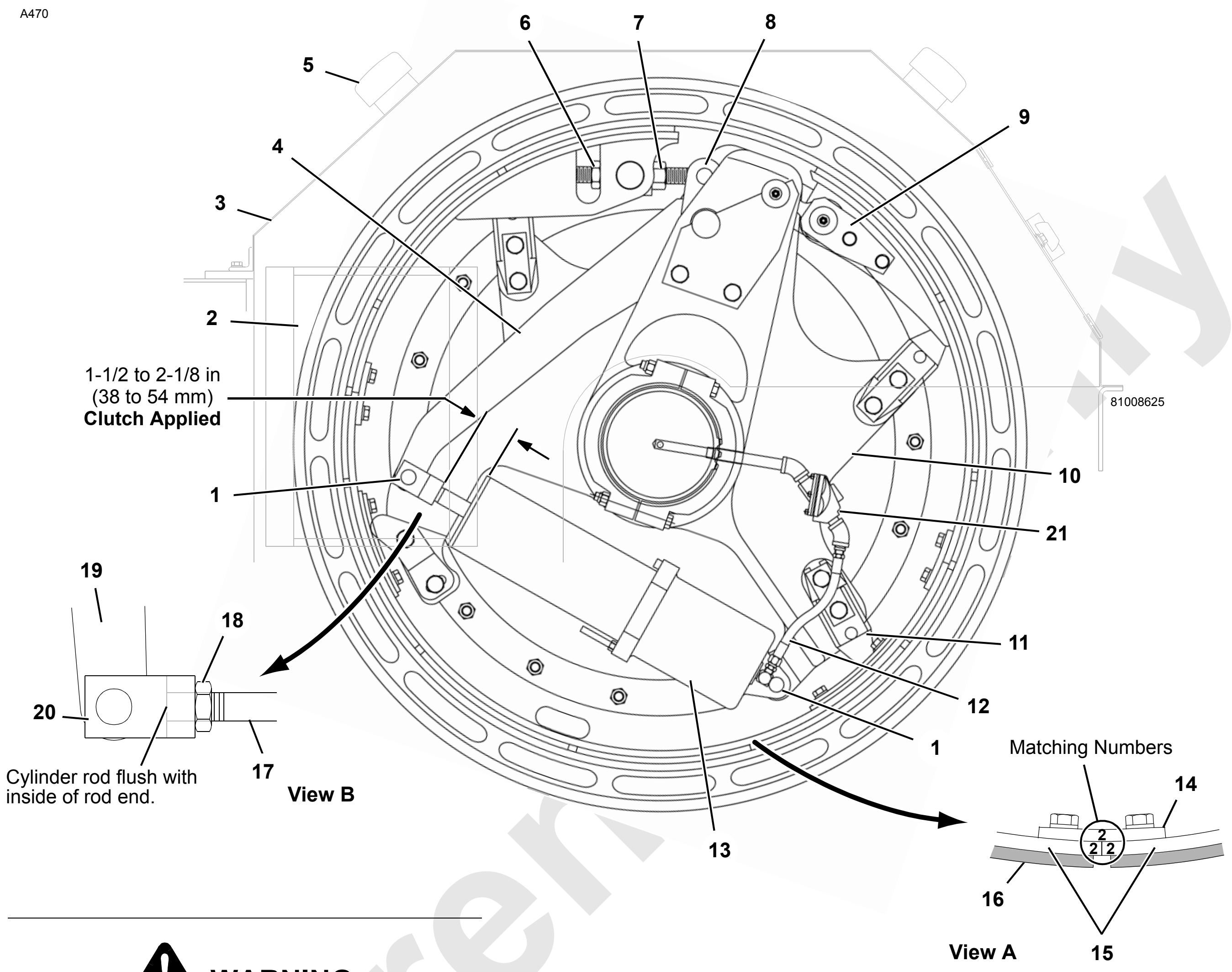
   c. Move drum handle for clutch being serviced in either direction from off to turn clutch and drum.

   d. Release drum handle to off to stop clutch and drum when desired part is accessible through access hole.

   Adjuster, signal operator when to stop drum.

4. Position live end of clutch band in access hole and inspect lining wear.

The clutch lining is 3/8 in (10 mm) thick when new. Replace the lining before its thickness is less than 1/4 in (6 mm) or ***drum will be scored by lining rivets***.



WARNING

Falling Load Hazard!

Apply Loctite #242 to threads of rod end before assembly.

Cylinder rod can back out of rod end during operation if this step is not performed — ***load could drop if this occurs.***

Item	Description	Item	Description
1	Pin	12	Air Line
2	Access Hole	13	Air Cylinder
3	Guard	14	Connecting Plate
4	Clutch Lever	15	Band Sections
5	Brake Band Support	16	Lining
6	Jam Nut	17	Cylinder Rod
7	Adjusting Nut	18	Jam Nut (Past)
8	Live End	19	Clutch Lever
9	Dead End	20	Rod End
10	Clutch Spider	21	Quick Release Valve
11	Band Guide (4 ea clutch)		

FIGURE 5-14

WARNING

Falling Load Hazard!

Only use Manitowoc original equipment lining. Other lining may not provide proper clutch torque. Clutch could slip, allowing load to drop.

---

5. Inspect all pins and linkage for excessive wear; replace parts as required. Excessively worn pins and linkage will make it difficult to properly adjust clutches.

Lubricate clutch linkage according to lubrication in Section 9 of this manual.

6. Position rod end of clutch cylinder in access hole.

Dimension between end of cylinder and rod end must be 1-1/2 to 2-1/8 in (38 to 54 mm).

- If dimension is within specified range, no further adjustment is required. Go to step 9.
- Perform steps 7-9 when minimum dimension is reached.

7. When dimension reaches 1-1/2 in (38 mm), proceed as follows:

a. Position adjusting nut in access hole.

b. Loosen jam nut several turns.

c. Release clutch. See procedure in Table 5-1.

d. Tighten adjusting nut as required. Turning adjusting nut one flat will move cylinder rod out approximately 9/16 in (14 mm).

e. Apply clutch. See procedure in Table 5-1.

f. Repeat steps 6 and 7a through 7e until dimension is 2-1/8 in (54 mm).

g. Repeat step 7a and securely tighten jam nut to lock adjustment.

8. Adjust each band guide as follows:

a. Position band guide in access hole.

b. With clutch applied, check clearance between band guide and clutch band with a feeler gauge. Clearance should be 1/32 in (1 mm).

c. If necessary, loosen mounting screws and reposition band guide to obtain specified clearance. Then securely tighten mounting screws.

9. Reinstall cover over 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 Front Drum Handle	Pull Back Rear Drum Handle
Right Rear Select right with Rear Drum Selector Switch	Pull Back Front Drum Handle	Pull Back Rear Drum Handle
Front	Pull Back Rear Drum Handle	Pull Back Front Drum Handle
TWO DRUM SPLIT REAR CONFIGURATION		
Left Rear	Pull Back Right Drum Handle	Pull Back Left Drum Handle
Right Rear	Pull Back Left Drum Handle	Pull Back Right Drum Handle
TWO DRUM INDEPENDENT CONFIGURATION		
Front	Pull Back Rear Drum Handle	Pull Back Front Drum Handle
Rear	Pull Back Front Drum Handle	Pull Back Rear Drum Handle

NOTE: Pull back specified handle only enough to release and apply clutch without turning drum. Listen for exhausting air from clutch cylinder. Air will exhaust from cylinder on clutch being serviced when clutch applies. Air will exhaust from cylinder on opposite clutch when clutch being serviced releases.

Band Disassembly and Assembly Notes

Each clutch band consists of five segments fastened together with a connecting plate and cap screws as shown in Figure 5-14, View A. 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 plates for proper assembly.

CAUTION

Component Assembly!

Do not mix band segments from one drum with those from another drum. Always keep band segments in a matched set, or assembly will be difficult.

Clutch Cylinder Overhaul

WARNING

Personal Injury Hazard!

Clutch cylinder is spring loaded. Disassemble cylinder according to following instructions, otherwise, cylinder will fly apart with dangerous force.

Cylinder Removal

See Figure 5-14 for the following procedure.

1. ***Read precautionary steps*** given after Inspection and Adjustment heading.
2. Remove guard covering brake flange and clutch assembly.

   To remove guard, it will be necessary to remove nuts retaining brake band supports.
3. Rotate clutch cylinder to its most accessible position.
4. Release clutch (see procedure in Table 5-1)
5. Support rod end of cylinder and remove rod end pin.
6. Stand clear of cylinder and apply clutch (cylinder rod will retract). See procedure in Table 5-1.
7. Disconnect air line from end of cylinder.
8. Remove head end pin and remove cylinder from crane. Cylinder weighs approximately 70 lb (32 kg).

Cylinder Disassembly

See Figure 5-15 for the following procedure.

1. Remove four socket head cap screws 5/16 in (8 mm).
2. Working in a crisscross manner, alternately loosen nuts on threaded rods until bonnet is removed from cylinder.

   Make sure threaded rods do not back out when loosening nuts.
3. Disassemble cylinder using Figure 5-15 as a guide.

Cylinder Assembly

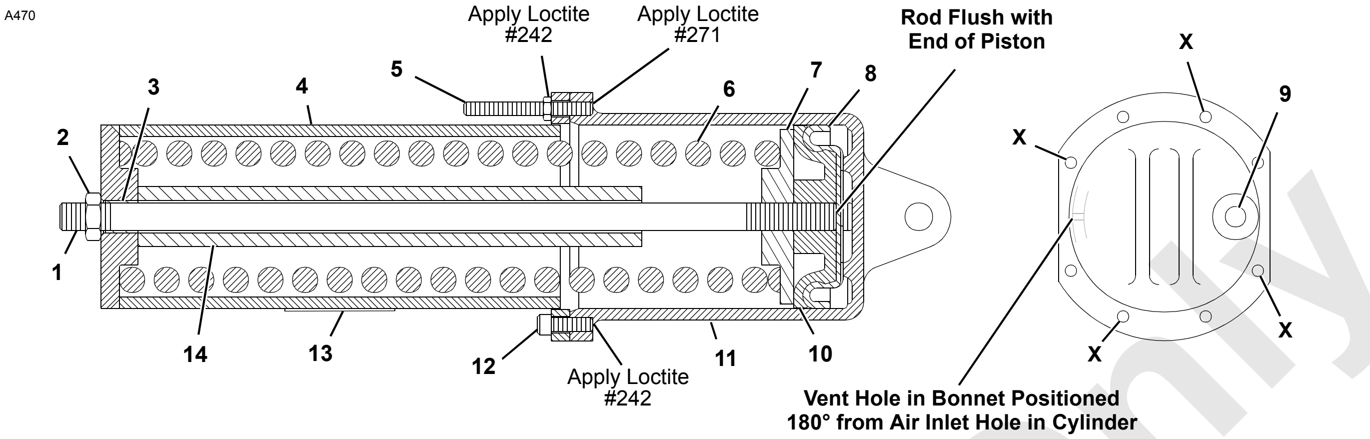
See Figure 5-15 for the following procedure.

1. Apply Loctite No. 271 to threads of threaded rods and install them in tapped holes marked “X”.
2. Apply Loctite No. 242 to exposed threads of threaded rods and to threads of socket head cap screws.
3. Lubricate all parts with a light coat of air cylinder grease.
4. Assemble cylinder and observe following precautions:
   a. Piston rod must be flush with back edge of piston.
   b. Packing cup must be snug against back side of piston.
   c. Vent hole in bonnet must be positioned 180° from air inlet hole in cylinder.
5. Align holes in bonnet with threaded rods and install nuts.
6. Working in a crisscross manner, alternately tighten nuts on threaded rods until bonnet flange is tight against cylinder flange.
7. Securely install four socket head cap screws.
8. Apply Loctite No. 242 to threads of rod end and jam nut and assemble them to piston rod as shown in Figure 5-14, View B. Securely tighten jam nut.

Cylinder Installation

See Figure 5-14 for the following procedure.

1. Pin cylinder to clutch spider so air inlet port is toward outside. ***Be sure to install cotter pin.***
2. Connect air line to cylinder.
3. Block cylinder in position.
4. ***Stand clear of clutch*** and release clutch. Cylinder rod will extend. See Table 5-1 for procedure.
5. Pin cylinder rod to clutch lever. Be sure to install cotter pin.
6. Apply clutch (see Table 5-1 for procedure).
7. Adjust clutch.
8. Install guard over drum flange and clutch assembly.
9. Adjust brake band supports to provide proper drum to lining clearance.



Item	Description	Item	Description
1	Rod	8	Packing Cup
2	Jam Nut (Past)	9	Air Inlet Hole in Cylinder
3	Bushing	10	Piston
4	Bonnet	11	Cylinder
5	Threaded Rod With Nut (4)	12	Socket Head Cap Screw (4)
6	Spring	13	Warning Plate
7	Spring Guide	14	Spacer

FIGURE 5-15

DRUM CLUTCH INSPECTION AND ADJUSTMENT — RIGHT REAR DRUM CLUTCH (421339)

General

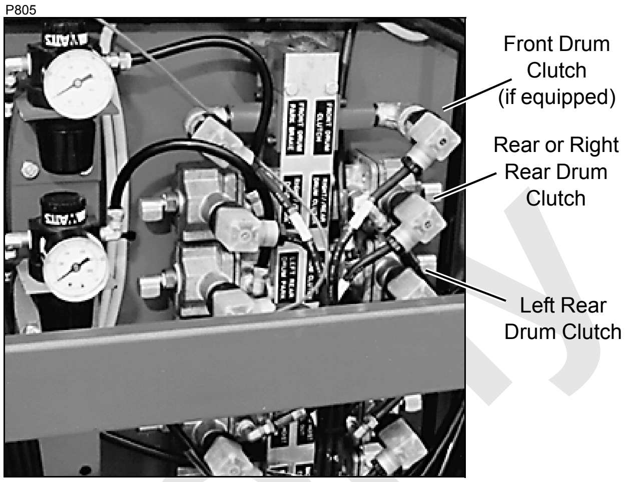
See Figure 5-16 for the following procedure.

The right rear drum clutch used for operation in the 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 2-position (on/off) normally-open solenoid valve located on the left side of the rotating bed.

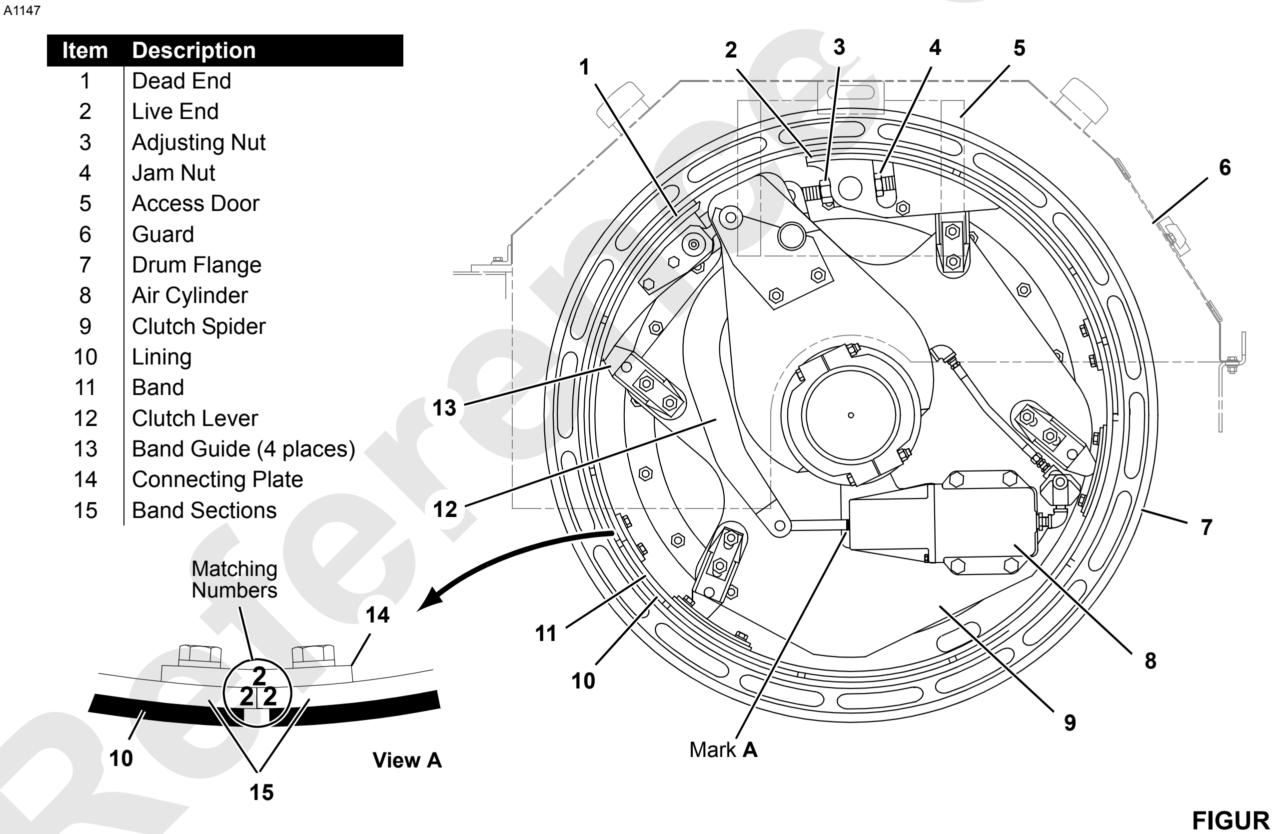
A clutch access hole with a removable cover is provided in the guard over the drum brake and clutch.

Make all inspections and adjustments when the clutch lining is warm from operation.



Solenoid Valves on Left Side of Rotating Bed

FIGURE 5-16



Item	Description
1	Dead End
2	Live End
3	Adjusting Nut
4	Jam Nut
5	Access Door
6	Guard
7	Drum Flange
8	Air Cylinder
9	Clutch Spider
10	Lining
11	Band
12	Clutch Lever
13	Band Guide (4 places)
14	Connecting Plate
15	Band Sections

FIGURE 5-17

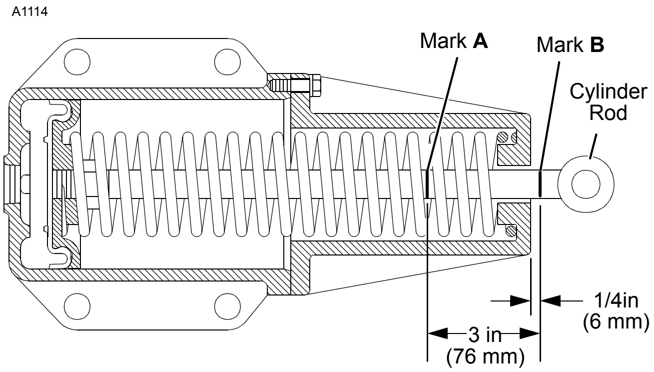


FIGURE 5-18

Inspection and Adjustment

CAUTION

Moving Machinery Hazard!

It is necessary to rotate load drum and apply/release drum clutch during inspection, adjustment, and overhaul steps.

Drum clutch inspection, adjustment, and overhaul require two people: one to operate drum controls and one to perform inspection, adjustment, and overhaul steps. Maintain constant communication between adjuster and operator so drum is not operated while adjuster is in contact with parts.

Lower load block or weight ball onto ground so wire rope is slack on drum being serviced.

- Adjuster stay clear of all moving parts while load drum and clutch are being operated.
- Operator do not operate drum controls until adjuster is clear of moving parts.

See Figure 5-17 for the following procedure.

NOTE: Make sure air system pressure is 120 to 132 psi (8,3 to 9,1 bar) at all times during inspection and adjustment procedure.

1. Lower bucket to ground. Pay out enough wire rope so drums can be operated without hoisting bucket.

2. Select RIGHT rear drum if not already done.

3. Note air pressure indicated on pressure gauge in right rear console and turn off pressure regulator.

4. Select STANDARD mode and confirm.

5. Remove cover over access hole at clutch.

6. To position right rear drum clutch parts in access hole for inspection and adjustment steps, proceed as follows:

   a. ***Stand clear of clutch*** while right rear drum is turning.

   b. Move rear drum handle in either direction from off to turn clutch and drum.

   c. Release rear drum handle to off to stop clutch and drum when desired part is accessible through access hole.

   Adjuster, signal operator when to stop drum.

7. Position live end of clutch band in access hole and inspect lining wear.

The clutch lining is 3/8 in (10 mm) thick when new. Replace the lining before its thickness is less than 1/4 in (6 mm) or drum will be scored by lining rivets.

WARNING

Falling Load Hazard!

Only use Manitowoc original equipment lining. Other lining may not provide proper clutch torque. Clutch could slip, allowing load to drop.

---

8. Inspect all pins and linkage for excessive wear and replace parts as required. Excessively worn pins and linkage will make it difficult to properly adjust clutches.

Lubricate clutch linkage according to lubrication in Section 9 of this manual.

9. Rotate rear drum clutch so cylinder rod is in access hole.

If Mark A is flush with end of cylinder, no further adjustment is required. Proceed to step 10.

10. If Mark A is not flush with end of cylinder, proceed with remaining steps 10a through 10f, 11, and 12.

   a. Rotate rear drum clutch so adjusting nut and jam nut are in access hole.

   b. Loosen jam nut several turns.

   c. Release rear drum clutch — pull front drum handle back until front drum just starts to turn and stop (this releases rear drum clutch).

   d. Tighten adjusting nut as required. Turning adjusting nut one flat will move cylinder rod and Mark A approximately 9/16 in (14 mm).

   e. Repeat steps 9 and 10a through 10d until Mark A is flush with end of cylinder.

   f. Repeat step 10a and securely tighten jam nut to lock adjustment.

11. Adjust each band guide as follows:
    a. Rotate rear drum clutch so band guide is in access hole.
    b. With rear drum clutch applied, check clearance between band guide and clutch band with a feeler gauge. Clearance should be 1/32 in (1 mm).
    c. If necessary, loosen mounting screws and reposition band guide to obtain specified clearance. Then securely tighten mounting screws.
12. Reinstall cover over access hole.

Band Disassembly and Assembly Notes

Each clutch band consists of three segments fastened together with a connecting plate and cap screws as shown in Figure 5-17, View A. 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 plates for proper assembly.

CAUTION

Do not mix band segments from one drum with those from another drum. Always keep band segments in a matched set, or assembly will be difficult.

Cylinder Rod Marking

See Figure 5-18 for the following procedure.

If a new cylinder is installed, it must be marked before installation to assure proper clutch adjustment. You will need a 100 psi (6,9 bar) shop air supply.

1. With cylinder fully retracted, place a temporary mark on cylinder rod flush with cylinder body. Use a marker; do not use a file or hacksaw blade.

   When cylinder rod is retracted, distance from cylinder end to center of cylinder rod hole is 1-1/16 in (27 mm).
2. Apply air to extend cylinder so temporary mark is 3/8 in (10 mm) from end of cylinder.
3. Mark cylinder rod 1/4 in (6 mm) from end of cylinder with file or hacksaw blade (see Mark B, Figure 5-18).
4. Apply air to fully extend cylinder rod. Make second mark on cylinder rod 3 in (76 mm) down from Mark B (see Mark A, Figure 5-18).
5. Remove temporary mark.

GEARBOX COOLING BLOWER

See Figure 5-19 for the following procedure.

Remove the blower assemblies and thoroughly clean them at the following intervals:

Every 200 hours of Operation: Humid climate when operating in extremely dusty conditions (example: combination of cement dust and humidity).

Every 500 hours of Operation: Normal operating conditions.

Disconnect electric plug (1) from plug on crane.

Support blower (2) so it cannot fall and remove bolts (3).

Remove blower, guard (4), and inlet elbow (5).

Thoroughly clean inside of blower using compressed air jet. Use a putty knife to loosen material as required.

Make sure squirrel cage turns freely.

Thoroughly clean inlet elbow.

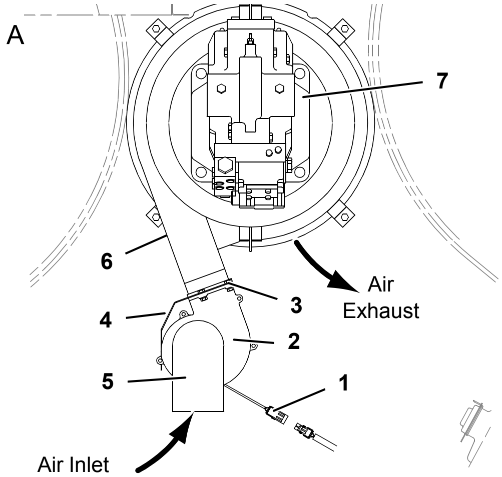
Make sure exhaust hole in shroud (6) is open.

Reassemble guard (4) and blower (2) to shroud (6).

Clamp inlet elbow (5) to blower so ***elbow points down***.

Connect electric plug (1) to plug on crane.

Start engine and test blower for proper operation. Air should flow freely from exhaust hole.



Item	Description
1	Electric Plug
2	Blower
3	Bolts with Nut and Lock Washer (4)
4	Guard
5	Inlet Elbow
6	Shroud
7	Drum Motor

FIGURE 5-19

SLACK LINE SENSOR ADJUSTMENT

General

See Figure 5-20 for the following procedure.

A laser light sensor mounted on the boom butt wire rope guide detects a slack load line condition at either front or rear drum. The 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:

- Operating limit alert comes on (yellow light and buzzer in operator’s cab)
- SLACK LINE INDICATOR message appears on display screen
- Drum inoperable in down direction

To correct a slack line condition, haul-in load line on 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 and receiver. ***Operating limit alert could be accidentally activated if either lens is dirty***.

Light Sensor Adjustment

Lower the boom onto blocking at horizontal to service the slack line sensor. The transmitter mounted at the sensor junction box is fixed. Make all adjustments at the receiver.

1. Stop crane engine and place run/stop switch in RUN position.
2. Check that transmitter is emitting a light beam.
3. Loosen bracket screws at receiver.
4. Position receiver in line with transmitter light beam by moving brackets in slots.

NOTE: The yellow LED on the receiver turns on when the light beam is received by the transmitter.

5. Tighten bracket screws when light beam is correct.
6. If above procedure does not correct the problem, calibrate the slack line indicator.

Slack Line Indicator Calibration

To calibrate slack line indicator, lower all load blocks/weight balls to the ground. Leave a little slack line at the first fall.

1. Scroll through diagnostics to slack line calibration screen.
2. Confirm slack line screen to begin calibration process.

SLACK LINE INDICATOR
CONFIRM TO BEGIN

3. The screen will ask what load sheave you are using, 1 through 4.

SLACK LINE INDICATOR
SHEAVE 1 IN USE? YES

4. To change an answer, use the select switch.
5. To verify an answer is correct, press confirm switch and move on to next sheave.
6. After all four sheaves have been verified YES or NO, the controller starts to calibrate load cells.

SLACK LINE INDICATOR
0% COMPLETE

After 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 Screws and Brackets

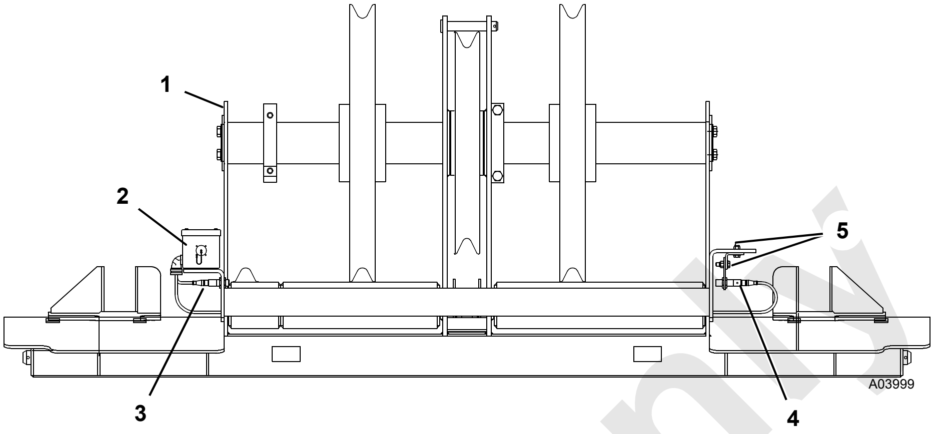


FIGURE 5-20

DRUM PAWL ADJUSTMENT

General

This section applies only to the ratchet and pawl provided on the 73 in (1,9 m) 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 electric 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 electric 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 will come on and PAWL IN will appear on the digital display.

CAUTION

Moving Parts Hazard!

To make adjustments, engine must be running and drums and pawl must be operated.

Avoid injury from moving machinery. Stay clear of drum and pawl while either is being operated.

Maintain constant communication between operator and adjuster so drum and pawl are not operated while 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.

Limit Switch Adjustment

1. Loosen screw so limit switch lever is free to rotate on shaft.
2. Disengage corresponding drum pawl. It may be necessary to hoist slightly before the pawl will disengage the ratchet.
3. Rotate lever and hold it so roller is against pawl.
4. Turn limit switch shaft, not the lever, ***counterclockwise*** until limit switch clicks open and hold.
5. Make sure roller is against pawl and securely tighten screw in lever to lock adjustment.
6. Check for proper operation:
   - Engage pawl and try to operate drum. ***Drum should not operate in lower direction.***
   - Disengage pawl and try to operate drum. Drum should operate in lower direction.
7. Readjust limit switch if required.

Return Spring

Adjust the eyebolt so the return spring has enough tension to fully engage and hold the pawl against the ratchet.

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	Spring

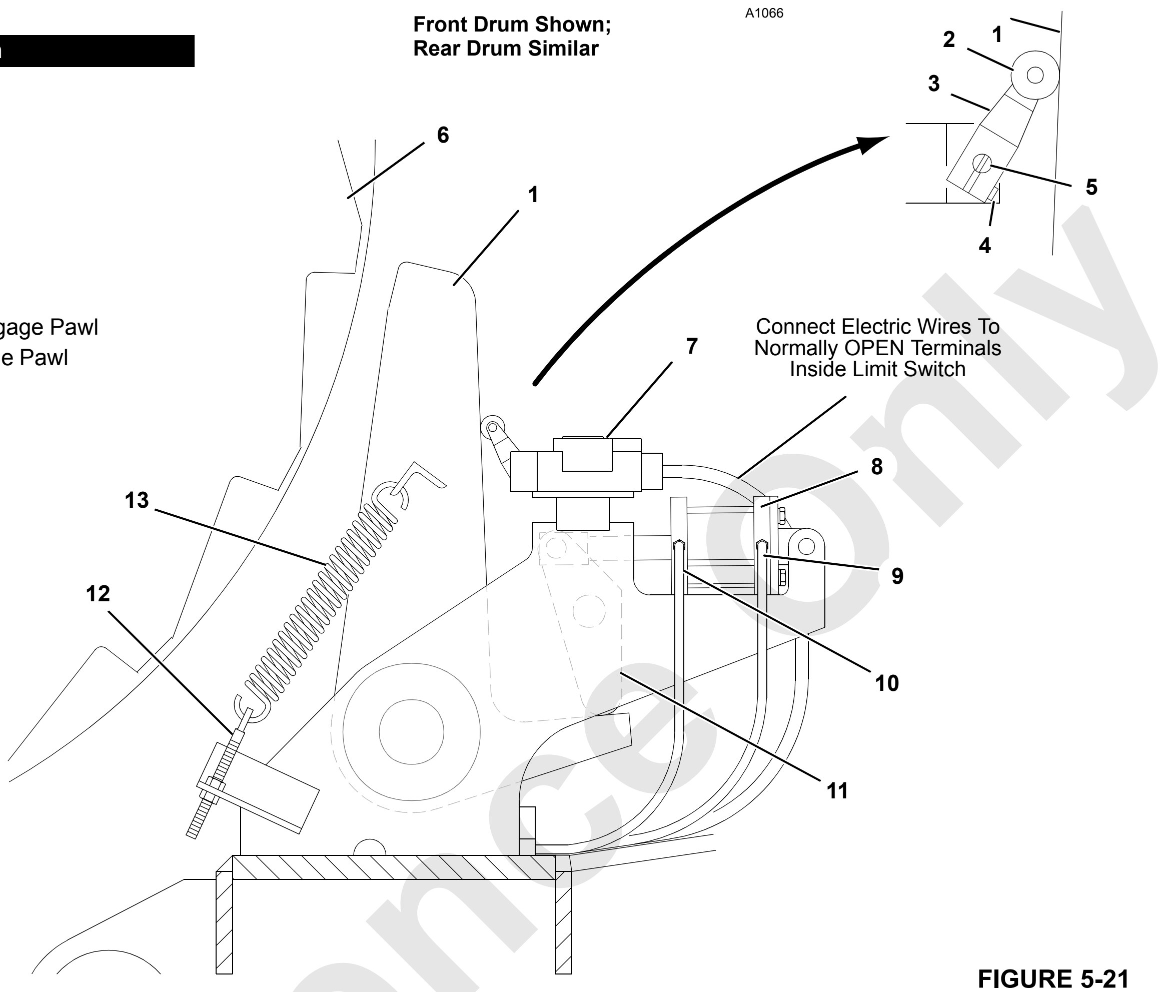


FIGURE 5-21

WIRE ROPE LUBRICATION

Refer to Section 9.

WIRE ROPE INSPECTION AND REPLACEMENT

General

The inspection and replacement guidelines which follow comply with United States regulations.

It is impossible to predict when a wire rope will fail; however, frequent and periodic careful inspection by a qualified inspector will indicate when the potential for failure exists.

See Wire Rope Lubrication topic in Section 9 of this manual.

Keeping Records

A signed and dated report of the wire rope's condition at each periodic inspection must be kept on file at all times. The report must cover all inspection points listed in this section.

The information in the records can then be used to establish data which can be used to determine when a wire rope should be replaced.

It is recommended that the wire rope inspection program include reports on the examination of wire rope removed from service. This information can be used to establish a relationship between visual inspection and the rope's actual internal condition at the time of removal from service.

Inspecting Wire Rope

Frequent Inspection

Visually inspect all running ropes in service once each work shift and observe the rope during operation. Pay particular attention to areas of the rope where wear and other damage is likely to occur:

- **Pick-Up Points** — sections of wire rope that are repeatedly stressed during each lift, such as those sections in contact with sheaves.

- **End Attachments** — the point where a fitting is attached to the wire rope or the point where the wire rope is attached to the drum.
- **Abuse Points** — the point where the wire rope is subjected to abnormal scuffing and scraping.

Inspect all rope which can be reasonably expected to be in use during operation for obvious damage which poses an immediate hazard, such as the following:

- Rope distortion such as kinking, crushing, un-stranding, 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 topic for additional information)
- Core failure in rotation resistant rope (indicated by lay lengthening and reduction in diameter).

Periodic Inspection

The periodic inspection interval must be determined by a qualified inspector and be based on the following factors:

- Expected rope life as indicated by the rope manufacturer or past experience as determined by 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 for the following types of damage. Any damage found must be recorded and a determination made as to whether continued use of the rope is safe.

- All points listed under frequent inspection
- Reduction in rope diameter below the nominal diameter caused by loss of core support, internal or external corrosion, or wear of the outside wires
- Severely corroded or broken wires at end attachments
- Severely corroded, cracked, bent, worn, or improperly applied end attachments

Inspecting Rope Not In Regular Use

Wire rope must be given a complete inspection if it has been idle for a month or more due to shutdown or storage of the crane on which the rope is installed. The inspection must be performed by a qualified inspector looking for the damage identified under both Frequent and Periodic Inspection.

Replacing Wire Rope

The final decision as to when a wire rope should be replaced is the responsibility of the qualified inspector. Discovery of any of the following conditions is sufficient reason for questioning a wire rope's safety and for replacing it.

Wire Rope Diameter

Measure and record the diameter of a new wire rope after initial loading for comparison with future inspections. A reduction in rope diameter is often the first outward sign that the wire rope core is damaged. When reduction in diameter is noted, the rope must be removed from service.

Measure the rope's diameter across crowns of the strands so the true diameter is measured as shown in Figure 5-22.

Wire rope must be taken out of service when the reduction from its nominal diameter is more than 5 percent.

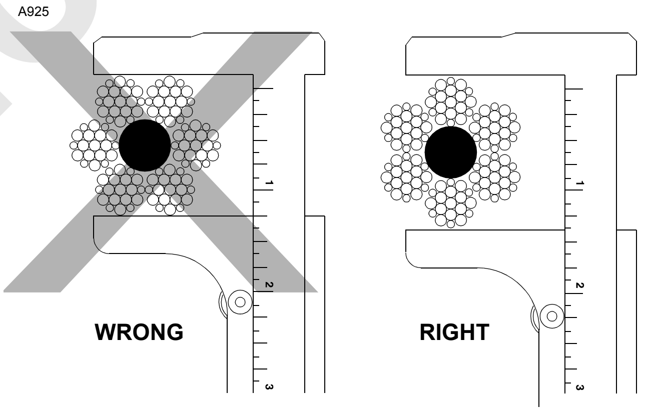


FIGURE 5-22

Broken Wires

Thoroughly clean the wire rope so breaks can be seen. Relax the rope, move it off "pick-up points," and flex it as much as possible. Use a sharp awl to pick and probe between wires and strands, lifting any wire which appears loose or moves excessively.

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

See Figure 5-23 for an explanation of lay length.

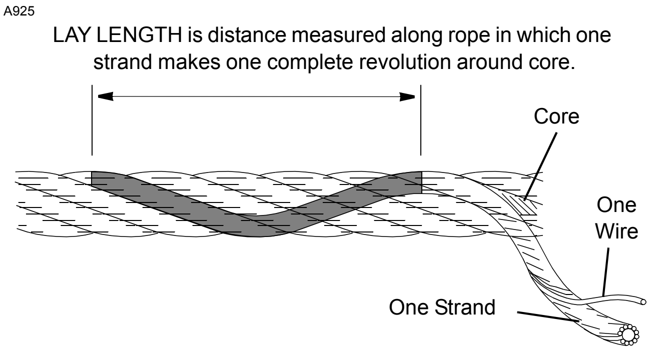


FIGURE 5-23

- **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 six rope diameters or four randomly distributed broken wires in thirty rope diameters.
- **Standing Ropes** (pendants) — more than two broken wires in one lay length in sections beyond the end attachment, or more than one broken wire at the end attachment (Figure 5-24).
- **All Ropes** — one outer wire broken at the point of contact with the core. The broken wire protrudes or loops out of the rope structure.

  United States Steel states “***Replacement criteria for galvanized strand boom suspension pendants are 25 percent of the outer wires fractured, or 10 percent of the total numbers, whichever comes first.”***

⚠ WARNING

Replace wire rope when more than one broken wire appears at point marked by arrow.

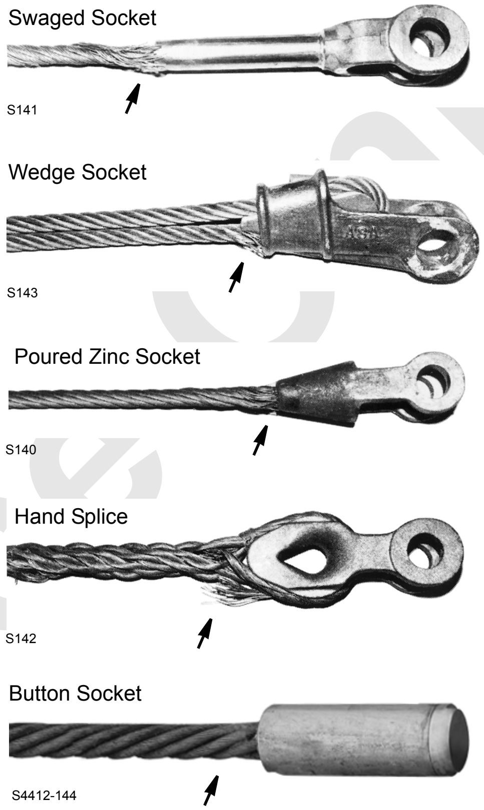


FIGURE 5-24

Wear and Other Damage

See Figure 5-25 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:

- Rope core protrudes from between outer strands
- Severed corrosion – indicated by pitting – exists
- Obvious damage exists from any heat source to include – 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 specifications given in the following publications supplied with your crane.

- Wire Rope Specifications Chart located in the Capacity Chart Manual (for load lines)
- Boom or Jib Assembly Drawings located in Crane Operator Manual (for boom or luffing hoist)
- Mast Assembly Drawing located in Parts Manual

DISTRIBUTING WIRE ROPE WEAR

Wire rope wear at the ***"critical wear points***" can be reduced and the life of the wire rope extended by moving the rope at regular intervals so different sections of rope are subjected to the wear points. This practice can also help correct spooling problems and rope vibration.

To move the wire rope, cut off a piece of wire rope at the drum and refasten it. The piece cut off should be long enough to move wire rope at least one full drum wrap.

If the wire rope is too short to allow cutting off a piece of it, reverse the rope end for end and refasten it.

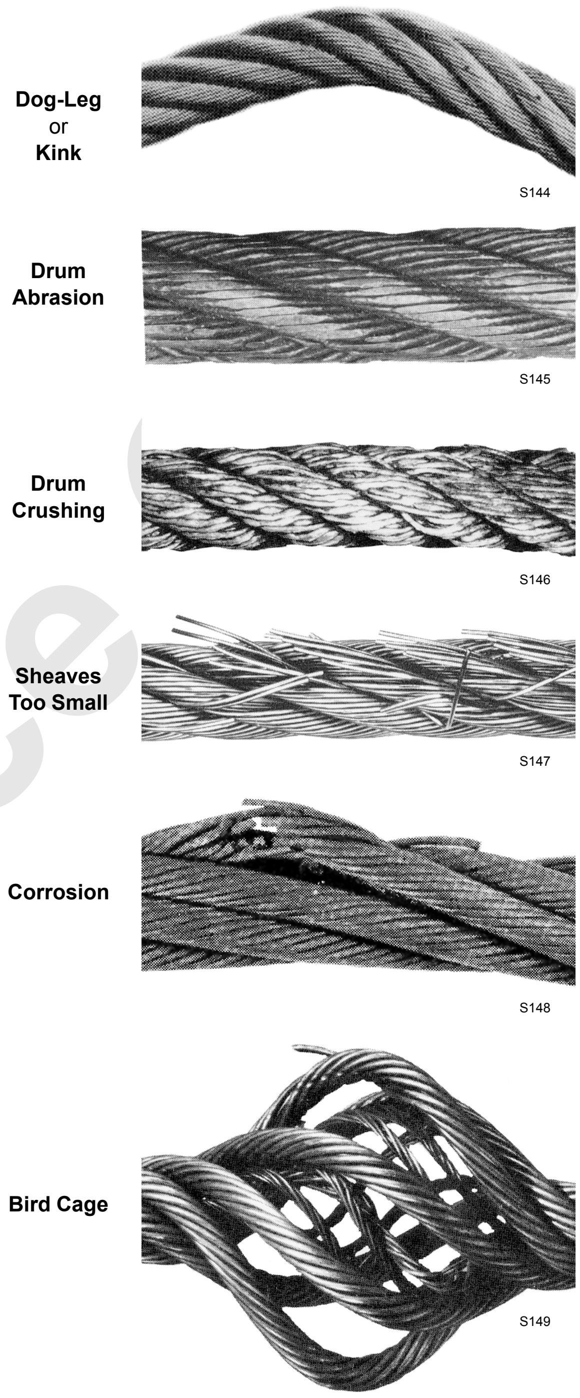


FIGURE 5-25

SHEAVE, ROLLER, AND DRUM INSPECTION

Perform the following inspections WEEKLY.

1. Check drum clutches and brakes for proper adjustment.
2. Check all sheaves, rollers, and drums for the following conditions:
    - a. Unusual noises
    - b. Freedom of movement -- must turn freely by hand. Wire rope may have to be loosened to perform this inspection.
    - c. Wobble -- must turn true with very little side-to-side or up-and-down play
    - d. Signs of rust (indicating that water may have entered bearing)
    - e. Grease leaks (indicating a faulty seal or water in grease)

    Above problems indicate bearing damage. If found, the corresponding sheave, roller, or drum should be disassembled for further inspection. New bearings should be installed.

    For sheaves not equipped with grease fittings, be sure to pack new bearings with grease at assembly.

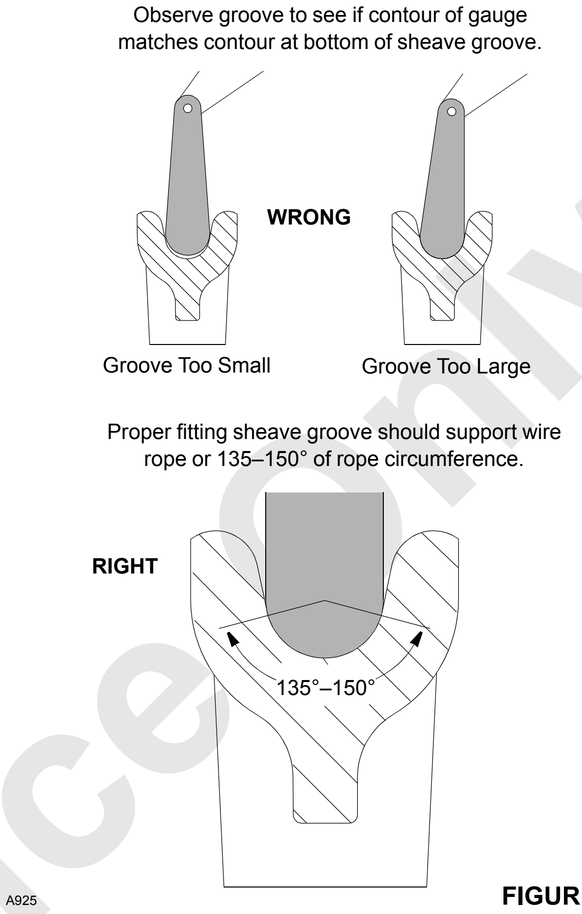


FIGURE 5-26

3. For steel sheaves, check depth, width, and contour of each sheave using a groove gauge as shown in Figure 5-26. Replace sheaves that have over or under size grooves.
4. Replace grooved drums that allow one wrap of wire rope to contact next wrap as rope spools onto drum.
5. Inspect sheaves to verify they **do not** contact another sheave or structural plate work. There should be uniform clearance between sheaves in a cluster. Repair or replace worn or damaged sheaves.

6. Re-machine or replace steel sheaves, drums, or rollers that have been corrugated by the wire rope's print as shown in Figure 5-27.

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***.

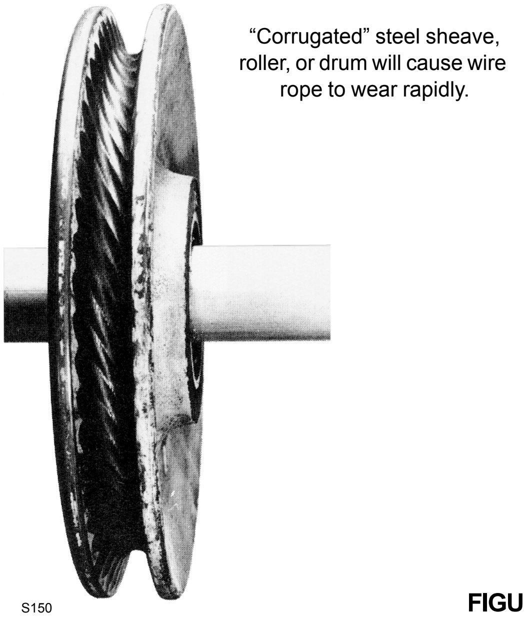


FIGURE 5-27

7. Inspect nylon sheaves for excessive measured for excessive tread diameter wear at locations E in Figure 5-29. Measure at three positions to check for uneven wear.

   Wear must not exceed limits given in table. Replace worn or damaged sheave.

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

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

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

8. Inspect nylon sheaves to verify they have not separated and "walked off" steel inserts or bearings as shown in Figure 5-28. Maximum sideways displacement is 1/8 in. (3 mm). Replace worn or damaged sheaves.

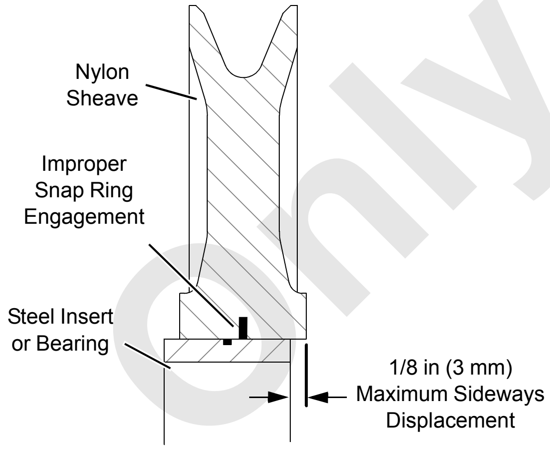


FIGURE 5-28

9. Make sure sheaves, drums, and rollers are properly lubricated according to lubrication instructions in Section 9.

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

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

NOTE: For some sheaves, the seals are an integral part of the bearing. Therefore, if a seal is damaged during repacking, the complete bearing may have to be replaced.

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	27.00	685.8	23.00	584.2	3.00	76.2	1	25
631103								
A00051								
631096	27.00	685.8	23.00	584.2	3.00	76.2	1.18	28
A00050								
631100	30.00	762.0	27.00	685.8	3.00	76.2	1-1/8	29

B = tread diameter, new sheave
E = tread diameter, used sheave
B minus E = total wear
If total wear is 5 mm (3/16 in) or more, the sheave should be replaced.
If a tread print exists in the root of the sheave groove, measure to the maximum tread diameter.

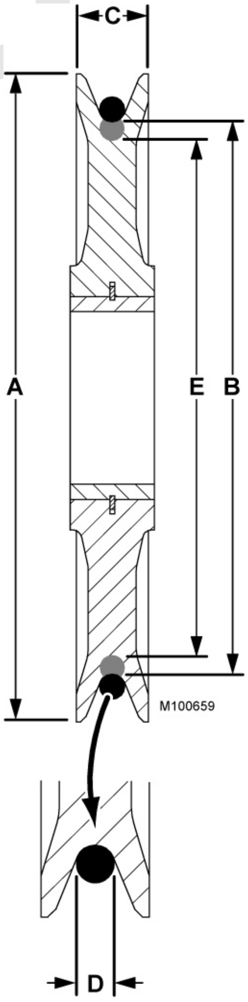


FIGURE 5-29

LOAD BLOCK AND HOOK-AND-WEIGHT BALL INSPECTION

WARNING

Falling Load Hazard!

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

- Only use a load block or a hook-and-weight ball which has a capacity equal to or greater than load to be handled.
- Do not remove or deface nameplate (Figure 5-30) attached to load blocks and hook-and-weight balls.
- See Duplex Hook topic in Section 4 of Operator Manual for recommended sling angles and capacity restrictions when load block has duplex or quadruplex hook.

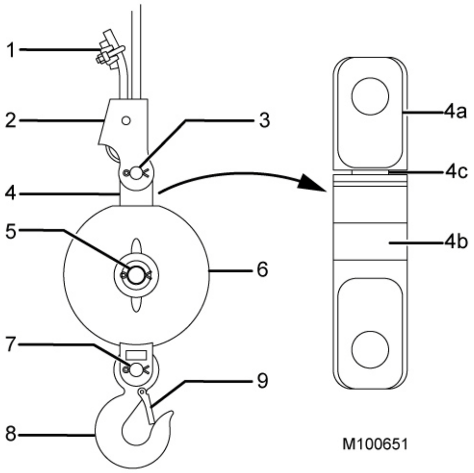
Item	Description
1	Working Load Limit (ton (US and metric)
2	Wire Rope Diameter (in and mm)
3	Block Weight (lb and kg)
4	Block Serial Number
5	Block Part Number (OEM and Manitowoc)
6	Design Factor

FIGURE 5-30

The operating condition of the load block and the hook-and-weight ball can change daily with use; therefore, they must be inspected daily (at start of each shift) and observed during operation for any defects which could affect their safe operation. Correct all defects before using the load block or the hook-and-weight ball.

Daily inspection and maintenance will include the following points (see Figure 5-31 and Figure 5-32):

1. Clean load block or the hook-and-weight ball.
2. Lubricate sheaves (if fittings provided), hook trunnion, hook swivel, and any other part with a grease fitting at the intervals specified in Section 9.
3. Tighten loose tie-bolts, cap screws, and set screws. Check that all cotter keys are installed and opened.
4. Check sheaves for uneven wear in the grooves and on the flanges. Check for loose or wobbly sheaves. These conditions indicate faulty bearings or bushings.



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 5-31

5. Check the fit of wire rope in the groove of each sheave. An oversize wire rope can crack the lip of sheave flange causing rapid wear of wire rope and sheave. The groove must be larger than wire rope, and the groove must be free of rough edges and burrs.
6. Check that hook, trunnion, and swivel rotate freely without excessive play. Faulty operation indicates faulty bushings or bearings or inadequate lubrication.
7. Check swivel of hook-and-weight ball for the following conditions:
    - Overloading: Spin swivel by hand. If the motion is rough or has a ratchet-like effect, swivel bearings are damaged.

- Side loading: Swivel will turn freely in one spot and lock-up in another. This condition can also be checked by looking at the gap (see Figure 5-31) between barrel and shank (swivel must be removed from weight ball to check). If the gap is wide on the side and closed on the other, damage is present.

NOTE: The gap between barrel and shank is normally 0.020 to 0.050 inches. If the gap increases, swivel-bearing failure is indicated.

8. Check the load block for signs of overloading: spread side plates, elongated holes, bent or elongated tie-bolts, and cracks.

9. Check all welds for defects and cracks.

Item	Description
1	Socket and Wedge
2	Center Plates
3	Tie Bolt
4	Sheaves
5	Sheave Shaft
6	Name Plate
7	Locking Cap
8	Hook Nut
9	Trunnion
10	Thrust Bearing
11	Latch
12	Hook

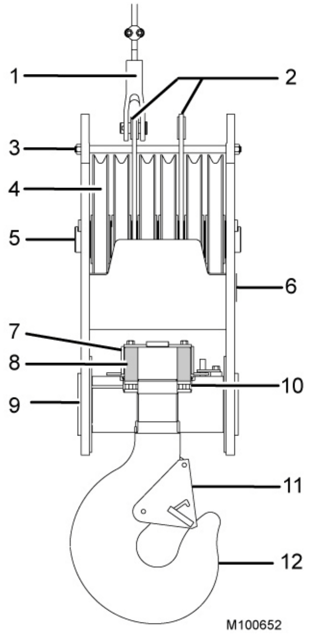


FIGURE 5-32

10. Check the wire rope for wear and broken wires at the point the wire rope enters the dead-end socket. Check the socket for cracks. Tighten the wire-rope clips at the dead end of the wire rope.

11. Check that each hook has a hook latch and that the hook latch operates properly. ***Latch must not be wired open or removed.***

WARNING

Falling Load Hazard!

To prevent load from dropping hook latch must retain slings or other rigging in hook under slack conditions.

Hook latch is not intended as anti-fouling device, and caution must be taken to prevent hook latch from supporting any part of load.

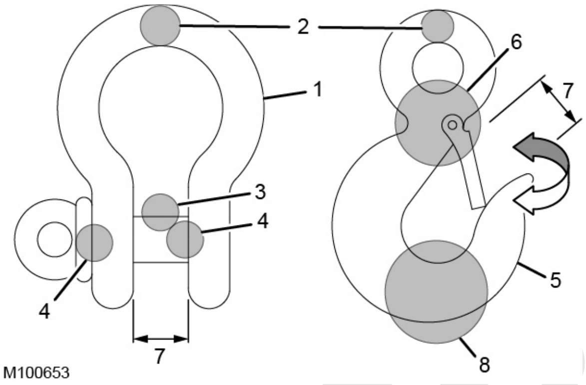
Slings or other rigging must be seated in hook when handling load; they must never be in position to foul hook latch.

12. Inspecteach hook and shackle for damage as shown in Figure 5-33.
13. 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
    - **Toll free phone**—US & Canada 800-843-2763, Mexico 95-800-843-2763, Universal 973-882-1167
    - **Fax**—973-882-1717 or 973-882-515
    - **E-mail**— *infocentral@asme.org*).
14. Contact the supplier of your hooks, shackles, blocks, and other rigging for repair instructions.
15. Check each hook and shackle at least yearly for cracks using a dye penetrant test, MAG particle test, ultrasonic test, or by X-ray.

WARNING

Falling Load Hazard!

To prevent load from dropping due to hook or shackle failure, do not attempt to repair cracks in hooks and shackles by welding. Furthermore, do not weld on any load bearing component unless proper welding methods are used (contact the Manitowoc Crane Care Lattice Team for material and welding specifications).



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

FIGURE 5-33

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SECTION 6

SWING

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SECTION 6
SWING

MANUAL RELEASE OF SWING BRAKE AND LOCK

See Figure 6-1 for the following procedure.

NOTE: All references to the swing lock are for past production only. On current production cranes the swing lock has been disabled and the hydraulic swing lock ports are plugged.

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

WARNING

Unexpected Crane Movement!

Crane can swing suddenly when swing brake is released. Before releasing swing brake, secure crane by lowering boom onto blocking at ground level to prevent sudden uncontrolled swinging.

The procedure given in this section is for servicing purposes only. Swing brake and swing lock must be fully operational when operating crane.

Figure 6-1 shows the swing planetary and the type of swing lock.

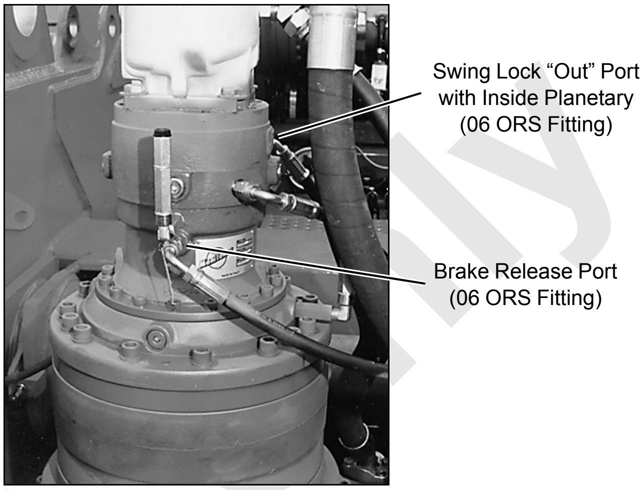

FIGURE 6-1

Manual Release Procedure

Hydraulic hand pumps with pressure gauge are needed to manually release the swing brake and swing lock.

1. Disconnect hoses from fitting at brake release port and, if equipped, at swing lock out port.
2. Attach hand pump to each port — brake release and swing lock out.
3. Pressurize brake and swing lock to 350 psi (24 bar).
4. Proceed to remove or install swing planetary.
5. Relieve pressure and remove hand pumps.

CAUTION

Avoid damage to parts!

Do not exceed 350 psi (24 bar) pressure when releasing swing brake or swing lock.

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SECTION 7
POWER TRAIN

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SECTION 7
POWER TRAIN

BATTERY MAINTENANCE

Safety Information

WARNING

Battery gases are explosive!

Batteries can explode with great violence and spraying of acid if a spark or flame is brought too near them. The room or compartment in which batteries are stored must be ventilated and away from flames or sparks.

Avoid sparks while charging batteries. Do not disturb connection between batteries until charger is ***off***.

Another source of explosion lies in the reverse connection of charging equipment. This hazard is present with all types of chargers, but particularly in the case of high-rate equipment. Carefully check the connections before turning the charger ***on***.

Improper use of a “booster” battery to start a crane when the normal battery is inadequate presents a definite explosion hazard. To minimize this hazard, the following procedure is suggested:

1. First connect both jumper cables to the battery on the crane to be started. Do not allow ends of cables to touch.
2. Then connect the positive cable to the positive terminal of the booster battery.
3. Finally, connect the remaining cable to the frame or block of the starting vehicle. ***Never*** connect it to the grounded terminal of the starting vehicle.

If electrolyte comes in contact with eyes, skin, or clothing, the area must be immediately flushed with large amounts of water. Seek first aid if discomfort continues.

Causes Of Battery Failure

Overcharging

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

Excessive heat is the result of overcharging. Overheating causes the plates to warp which can damage separators and cause a short circuit within a cell. This 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 is not only unable to deliver power, but may freeze (see Table 7-1).

Table 7-1
Battery Freeze Points

State of Charge	Specific Gravity	Freeze Point	
		°F	°C
100%	1.26	-70	-57
75%	1.23	-39	-38
50%	1.20	-16	-26
25%	1.17	-2	-19
DISCHARGED	1.11	+17	-8

The sulfate condition can eventually be converted to metallic lead which can short the positive and negative plates. These small shorts can cause low cell voltage when the battery is charged.

Lack of Water

The plates must be completely covered. If the plates are exposed, the 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 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 electric devices which will drain the battery and may cause excessive heat.

Multiple Battery System

Multiple battery systems are connected either in series or in parallel. ***Always refer to your wiring diagram for correct connection.***

NOTE: Installing batteries with reversed electrical connections will damage batteries and also crane's electrical system, voltage regulator, and/or alternator.

Maintenance

Weekly – Check Electrolyte Level

1. Clean the top of the battery before removing the vent caps. Keep foreign material out.
2. Distilled water should be used. Drinking water is, however, satisfactory. Water with a high mineral content (well, creek, pond) must not be used.
3. Never overfill the cells. Overfilling will cause electrolyte to pump out, and corrosion damage will result.

   Any spills on painted or metal surfaces must be immediately cleaned and acid neutralized with baking soda or ammonia.
4. Look for heavy deposits of black lead like mineral on the bottom of the vent caps. This indicates that active material is being shed (a 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 – Test 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. Likewise, readings should not be taken after a battery has been discharged at a high rate, such as cranking.
4. When reading a hydrometer, hold the barrel vertical with the float freely suspended.
5. Draw the electrolyte in and out several times to bring the float temperature to that of the electrolyte.
6. Take the reading across the bottom of the liquid level; disregard curvature of the liquid.
7. Readings must be temperature corrected. Subtract 0.004 from the reading for each 10° below 80°F. Add 0.004 for each 10° above 80°F.

NOTE: It is the electrolyte temperature which is important, not air temperature.

8. See Table 7-2 to interpret the readings.

Table 7-2
Hydrometer Readings

Temperature corrected hydrometer readings may be interpreted as follows:

Hydrometer Reading — SP. GR.	% 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 SP. GR.) variation, try to recharge the battery. If the variation persists, the battery should be replaced

NOTE: For more specific hydrometer test information, see the instructions provided with your hydrometer.

Open-Circuit Voltage Test

A sensitive voltmeter can be used to determine a battery's state-of-charge as shown in Table 7-3.

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 volts 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 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 they leak.
7. Ensure good contact (tight) between the clamp terminals and battery posts.

Make sure the hold-downs are tight enough to prevent battery movement but not so tight to cause distortion.

Charging

If at all possible, the battery should be at room temperature when recharging. Before a battery is recharged, it must be thoroughly cleaned. Take care not to allow dirt to enter the cells.

A battery should be recharged in the way it was discharged. If it was discharged over a long period of time, it should be recharged slowly at 6 to 10 amps 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 amps.

If a battery was discharged rapidly (cranking until dead), it can be recharged on a fast charger with an output of up to 40 amps for a maximum of 2 hours. If the electrolyte temperature reaches 125°F (51,6°C) or if it gases violently, the charging current must be reduced or halted to avoid battery damage.

For optimum charging results, adhere to the charger manufacturer's instructions.

Storage

When the 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 procedure.

A battery disconnect switch is provided on the right side of upperworks next to the batteries. Use the switch to disconnect the batteries when servicing the electrical control system.

See Section 3 of Crane Operator Manual for operation of the battery disconnect switch.

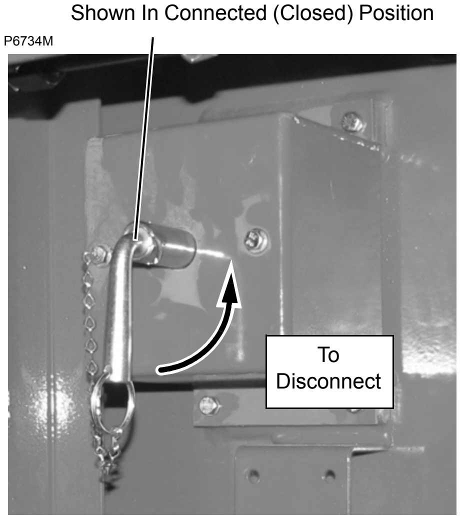
CAUTION

Engine Damage!

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

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

Make sure engine ignition switch has been off five minutes before disconnecting batteries.



Right Side of Rotating Bed

FIGURE 7-1

ENGINE DIAGNOSTICS (CELECT PLUS ENGINE)

General

The Cummins Industrial Celect Plus Engine has two diagnostic modes:

- Off-board diagnostics that require Cummins Insite™ hardware and software, available from your local Cummins dealer.
- On-board diagnostics that utilize warning lights to alert the operator to engine problems during operation (engine running) and fault codes to identify specific problems when the engine is not running.

Controls

Figure 7-2 shows a typical arrangement of the diagnostic and start/stop controls Manitowoc provides for the engine. The controls are mounted either on the front console or on the right console in the operator's cab.

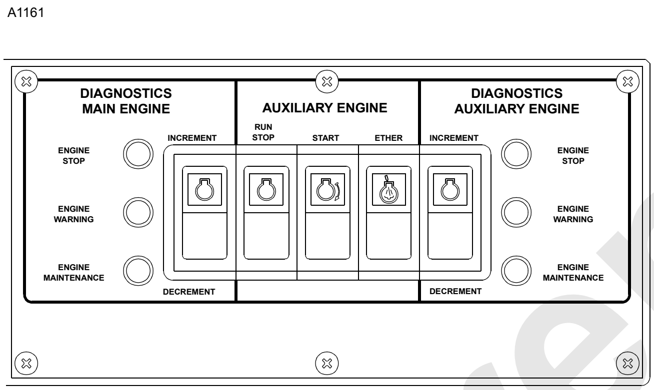


FIGURE 7-2

Engine Running Diagnostics

Engine Stop Light

When lit, the red engine stop light indicates the need to ***stop engine as soon as safely possible***.

CAUTION

Engine Damage Hazard!

If possible, lower lifted loads and then stop engine as soon as possible when stop light comes on. Permanent damage can occur if engine is run while stop light is on. Do not run engine until fault is corrected.

The red engine stop light is also used with the yellow engine warning light to flash out active fault codes when the engine is off.

Engine Warning Light

When lit, the yellow warning light indicates the need to ***repair fault at first available opportunity***.

Engine Maintain Light

When lit, the white engine maintain light indicates the need to perform engine maintenance.

Engine Off Diagnostics

To identify specific faults, proceed as follows:

1. Stop engine.
2. Move run-stop rocker or key switch to ***run*** position.
3. Move cab power switch to ***on*** (if equipped).
4. Move hand throttle from low speed to high speed and back to low speed three times within five seconds.
5. If no active faults exist, warning and stop lights come on but don't flash.
6. If active faults exist, following occurs. See Table 7-4 for a list Engine Fault Codes that can be detected.
   a. Yellow warning light flashes indicating that a fault code is about to be flashed.
   b. There is a 1 to 2-second pause.
   c. Red stop light flashes a three-digit code to show which active fault has been detected (see Figure 7-3 for example). There is a 1 to 2-second pause between each number.
   d. When code is finished flashing in red, there is a 1 to 2-second pause and yellow warning light flashes again.
   e. Same fault code flashes a second time before advancing to next code.

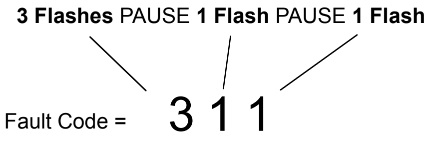


FIGURE 7-3

Table 7-4 Engine Fault Codes

Fault Code	Light	Fault
111	Red	Controller#1
115	Red	Engine Speed
121	Yellow	Engine Speed
122	Yellow	Boost Pressure
123	Yellow	Boost Pressure
131	Red	Percent Accelerator Pedal Position
132	Red	Percent Accelerator Pedal Position
135	Yellow	Engine Oil Pressure
141	Yellow	Engine Oil Pressure
143	Engine Protection	Engine Oil Pressure
144	Yellow	Engine Coolant Temperature
145	Yellow	Engine Coolant Temperature
151	Engine Protection	Engine Coolant Temperature
153	Yellow	Intake Manifold Temperature
154	Yellow	Intake Manifold Temperature
155	Engine Protection	Intake Manifold Temperature
212	Yellow	Engine Oil Temperature
213	Yellow	Engine Oil Temperature
214	Engine Protection	Engine Oil Temperature
221	Yellow	Barometric Pressure
222	Yellow	Barometric Pressure
234	Red	Engine Speed
235	Engine Protection	Coolant Level
241	Yellow	Road Speed
243	Yellow	Engine Retarder Status
245	Yellow	Fan Clutch Output Device Driver
254	Red	Fuel Shutoff Valve
311	Yellow	Injector Cylinder #1
312	Yellow	Injector Cylinder #5
313	Yellow	Injector Cylinder #3
314	Yellow	Injector Cylinder #6
315	Yellow	Injector Cylinder #2
321	Yellow	Injector Cylinder #4
322	Yellow	Injector Cylinder #1
323	Yellow	Injector Cylinder #5
324	Yellow	Injector Cylinder #3
325	Yellow	Injector Cylinder #6
331	Yellow	Injector Cylinder #2
332	Yellow	Injector Cylinder #4
343	Yellow	Controller #1
269	Red (Blink)	Anti-Theft Start Inhibit (Password Valid Indicator)
352	Yellow	5 Volts DC Supply
415	Engine Protection	Engine Oil Pressure
422	Yellow	Coolant Level
326	None	SAE J1939 Datalink
327	Yellow	SAE J1939 Datalink
431	Yellow	Percent Accelerator Pedal Position
432	Red	Percent Accelerator Pedal Position
433	Yellow	Boost Pressure

ENGINE DIAGNOSTICS (QSX 15 ENGINE)

General

The Cummins QSX15 Engine has two types of fault codes:

- Engine electronic fuel system fault codes
- Engine protection system fault codes

All fault codes are either active or inactive. Active fault codes can be read with red engine stop light and yellow engine warning light on the front console. Inactive faults can only be read with electronic service tool supplied by the engine manufacturer.

Diagnostic Lights

The engine diagnostic lights are mounted on the front console in the operator's cab as shown in Figure 7-4.

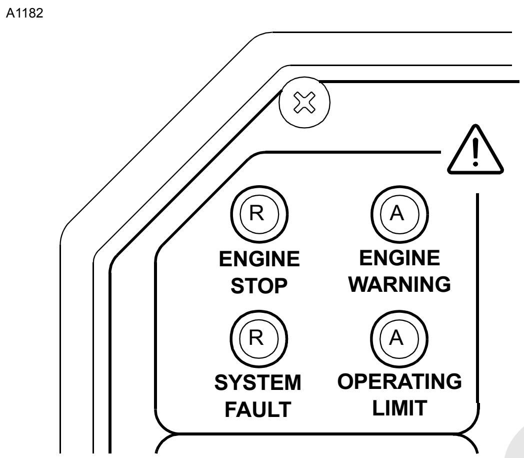


FIGURE 7-4

Engine Stop Light

When on, the red engine stop light indicates the need to ***stop engine as soon as safely possible*** and correct the fault.

CAUTION

Engine Damage Hazard!

If possible, lower lifted loads and then stop engine as soon as possible when red engine stop light comes on. Permanent damage can occur if engine is run while red Engine Stop light is on. Do not run engine until fault is corrected.

Engine Warning Light

When on, the yellow engine warning light indicates that engine can be run but the fault should be corrected as soon as possible.

High Exhaust System Temperature — Tier 4 Only

See Figure 7-5 and the Operator Manual for details.

DPF ON — Tier 4 Only

See Figure 7-5 and the Operator Manual for details.

DPF Regeneration Inhibit — Tier 4 Only

See Figure 7-5 and the Operator Manual for details.

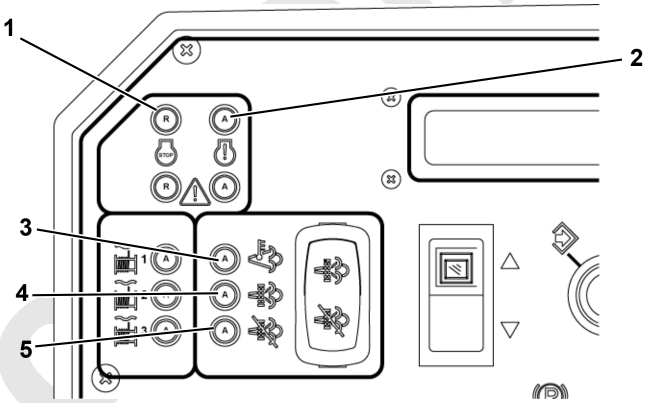


FIGURE 7-5

Engine Off Diagnostics

To identify active faults, proceed as follows. A laminated list of fault codes is located in the operator's cab.

1. Stop engine.
2. Move run/stop/run key switch to either ***run*** position to turn on display screen.
3. Move hand throttle from low speed to high speed and back to low speed three times within five seconds.
4. If no active faults exist, red engine stop and yellow engine warning lights come on but don't flash.
5. If active faults exist, the following occurs:
    - **a.** 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.** Red engine stop light flashes a three-digit code to show which active fault has been detected (see Figure 7-6 for example). There is a 1 to 2-second pause between each number.

d. When code is finished flashing in red, there is a 1 to 2-second pause and yellow engine warning light flashes again.

e. Same fault code flashes a second time before advancing to next code.

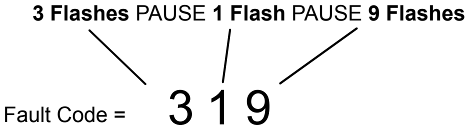


FIGURE 7-6

ENGINE AIR CLEANER MAINTENANCE — TIER 3 ENGINE

Servicing the engine air cleaner is an important maintenance function:

- A clogged air cleaner filter will prevent adequate air flow to the engine, resulting in poor starting and increased exhaust emissions.
- An improperly installed or damaged air cleaner can allow dirty air to be drawn directly into the engine.

Either condition can result in engine damage.

Inspection

See Figure 7-7 for the following procedure.

To maintain engine protection and filter service life, inspect the following areas at regular intervals:

Daily

Check service indicator daily with engine running.

- Yellow flag in indicator rises as filter fills with dirt.

  Replace filter when yellow flag rises to red ring at top of indicator and locks in place with engine off.
- Push button in on bottom of indicator to reset flag after filter is replaced.

Daily

1. Inspect rubber elbows and tubes between air cleaner and engine for cracks or other damage which might allow unfiltered air to enter engine. Replace worn parts.
2. Check air cleaner housing for dents or other damage that may allow unfiltered air to enter engine. Replace housing if damaged.
3. Check for loose tubing clamps and pre-cleaner clamps. Tighten loose parts.
4. Check that pre-cleaner is free of obstructions.
5. Check that ejector valve is in place in pre-cleaner dust bin. Check that valve is in a good, soft, pliable condition and replace valve if damaged.

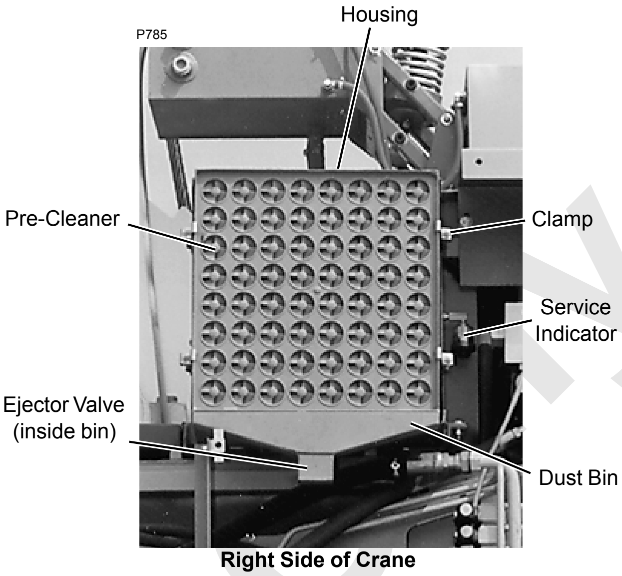


FIGURE 7-7

Service

CAUTION

Engine Damage!

Stop engine before servicing air cleaner, or unfiltered air will enter engine.

Do not attempt to clean and reuse old filter. Discard old filter and install a new one.

1. Loosen clamps on housing and remove pre-cleaner.
2. Remove and ***discard old filter*** as follows:
   a. Insert fingers into tube openings as shown in Figure 7-8.

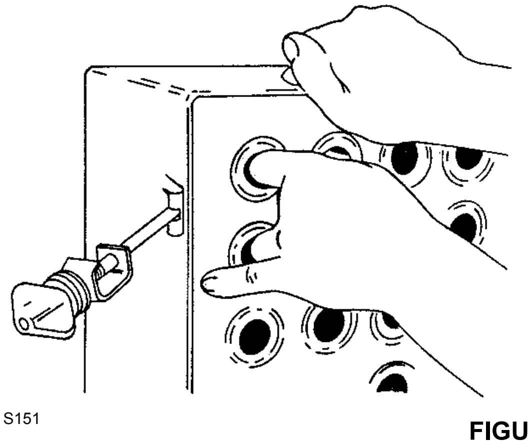


FIGURE 7-8

   b. Loosen seal in all four corners of filter one at a time by pulling it straight out.

   c. It may be necessary to loosen seal along edges of element in a similar manner.

   d. After seal is loose, grasp filter as shown in Figure 7-9 and pull filter straight out and slightly up so filter clears edges of housing.

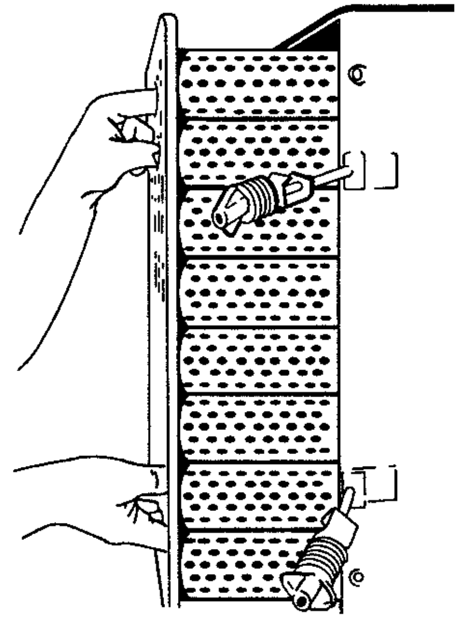


FIGURE 7-9

3. Clean inside of housing with a damp cloth. Make sure housing is free of all foreign matter.

   Use care not to allow foreign matter to enter tubing in air inlet hole to engine.

4. Wipe off face of pre-cleaner. If desired, pre-cleaner can be steam cleaned.

5. Install new filter, as follows:

   a. Grasp filter as shown in Figure 7-9.

   b. Insert filter in housing. Avoid hitting element tubes against sealing flanges on edges of housing.

   c. Make sure filter is seated properly in housing. Firmly press all edges and corners of element into place to form a positive seal against flanges in housing.

   Do not pound filter in place.

6. Assemble pre-cleaner to housing with clamps. Tighten nuts in a crisscross manner to 70 in-lbs (8 N•m).

7. Check that ejector valve is installed in dust bin of pre-cleaner.

8. Reset filter indicator.

ENGINE AIR CLEANER MAINTENANCE — TIER 4 ENGINE

See Figure 7-10 for the following procedure.

The air cleaner is mounted and fastened to the engine air intake (6) with a rubber elbow reducer (5), clamps (3), tubes (2) and reducer (4). Servicing the air cleaner is an important function because:

- Clogged air cleaner filters will prevent adequate air flow to the engine, causing poor starting and increased exhaust emissions.
- An improperly installed or damaged air cleaner can allow dirty air to be drawn directly into the engine.

Either condition can cause engine damage.

Inspection

To maintain engine protection and filter service life, inspect the following areas at regular intervals:

Daily

Check service indicator (8) with engine running. The indicator gives a visual indication when it is time to replace the filters.

- A yellow flag in the indicator window (8a) extends as the filters become plugged. ***Replace filters when the yellow indicator reaches the red zone at the end of the indicator.***
- The yellow flag remains locked in place after the engine is stopped. When the filters are replaced, push button (8b) ***in*** to reset the indicator.

Weekly

1. Inspect rubber reducers (4 and 5) between air cleaner and engine for cracks or other damage which might allow unfiltered air to enter the engine. Replace worn or damaged parts.

2. Check housing (1e) for dents or other damage that may allow unfiltered air to enter engine. Replace housing if damaged.

3. Check for loose clamps (3). Tighten if necessary.

4. Inspect engine intake (6) for obstructions. Clean as required.

CAUTION

Engine Damage!

STOP ENGINE before servicing air cleaner or unfiltered air will be drawn directly into engine.

Before servicing clean fittings, mounting hardware and area around component(s) to be removed.

Never operate engine without air cleaner.

Replace secondary filter as quickly as possible to avoid engine ingestion of contaminants.

Do not attempt to clean and resuse old filters. Discard old filters and install new filters. Cleaning filter elements by impact or compressed air voids the warranty and can degrade or damage the filter media, leading to malfunction.

Service

1. Carefully Remove Service Cover:

Unlatch and remove service cover (1a). The air cleaner has two sets of filters: primary (1c) and secondary (1d). The filters should be removed gently to reduce the amount of dust dislodged. There will be some initial resistance, similar to breaking the seal on a jar. Using tabs on filters, move end of primary filter back and forth to break seal.

2. Avoid Dislodging Dust from Filters:

Using tabs, gently pull primary filter (1c) out of housing (1e). Avoid knocking filter against housing.

Pull on the plastic tabs to remove the secondary filter (1d).

NOTE: The secondary element should be replaced every third time the primary element is replaced. Inspect the secondary element and replace as necessary.

3. Clean Sealing Surfaces in Housing:

Use a clean cloth to wipe clean sealing surfaces and inside of housing. Dust on sealing surfaces could render seal ineffective and cause leakage. Ensure all contamination is removed before new filters are installed.

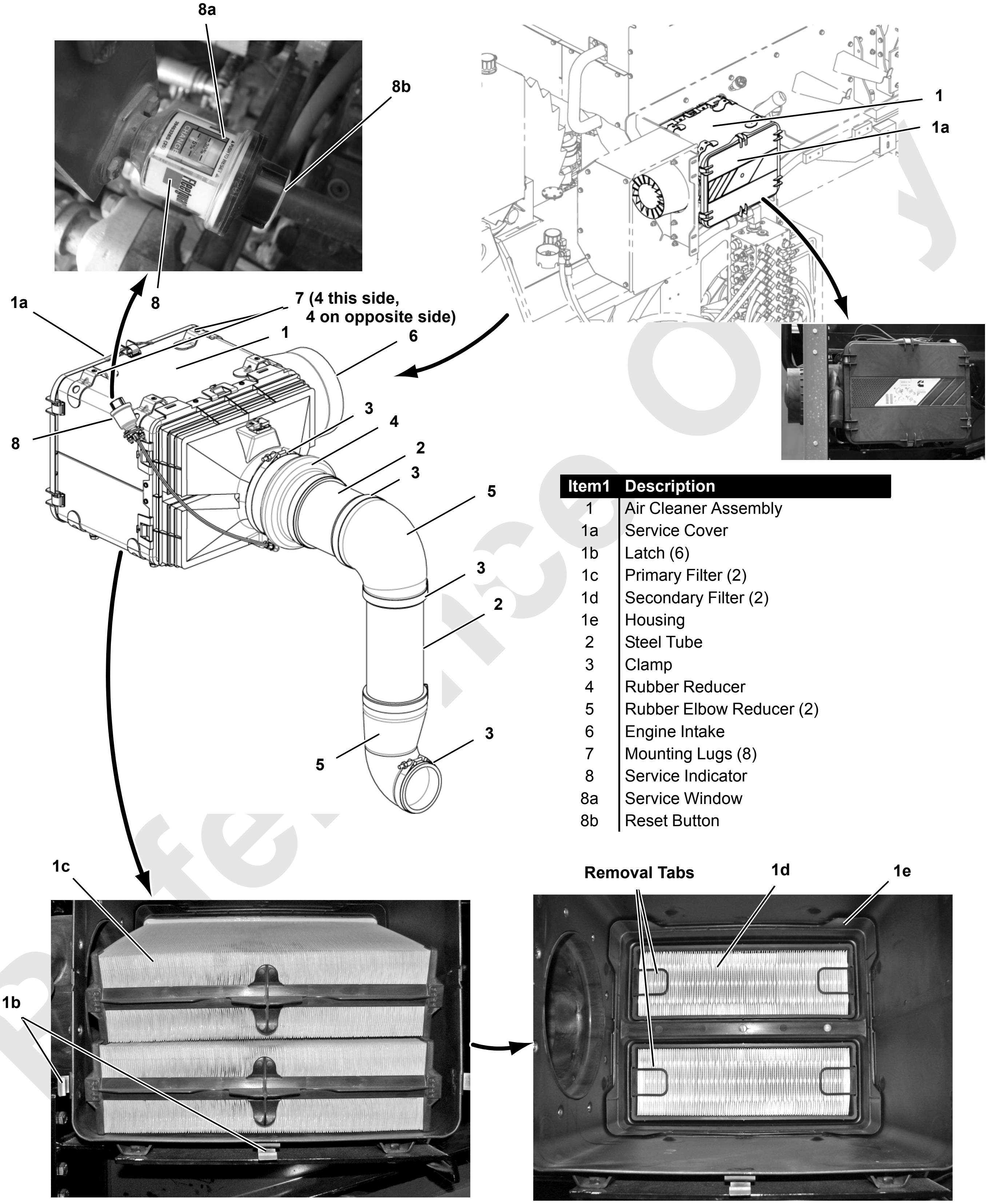
4. Clean Inside of Outlet Tube:

Carefully wipe inside of outlet tube with a clean cloth. Dirt accidentally transferred to inside of outlet tube will reach the engine and cause wear (engine manufacturers say that it takes only a few grams of dirt to destroy and engine). Be careful not to damage the sealing area of the tube.

5. Check Old Filters for Leak Clues:

Visually inspect old filters for any sign of leaks. A streak of dust on the clean side of the filter is a telltale sign. Remove any cause of leaks before installing a new filter.

AIR CLEANER — TIER 4 ONLY



Item1	Description
1	Air Cleaner Assembly
1a	Service Cover
1b	Latch (6)
1c	Primary Filter (2)
1d	Secondary Filter (2)
1e	Housing
2	Steel Tube
3	Clamp
4	Rubber Reducer
5	Rubber Elbow Reducer (2)
6	Engine Intake
7	Mounting Lugs (8)
8	Service Indicator
8a	Service Window
8b	Reset Button

FIGURE 7-10

ENGINE COOLING SYSTEM — PAST PRODUCTION

General

The cooling system consists of a horizontal radiator (mounted above engine), a hydraulically driven blower-type fan, and an auxiliary tank.

Cooling System Operation

Cooling system flow is illustrated in Figure 7-11.

The cooling system is of the deaeration type, which continually removes air from the system, as follows:

1. A small percentage of total coolant flow is circulated through vent lines to auxiliary tank.
2. Since coolant circulation is very slow in auxiliary tank, air separates from coolant.
3. Air collects at top of auxiliary tank. When pressure rises to 7 psi (0,5 bar), relief in fill cap opens to exhaust air through overflow line.
4. Deaerated coolant returns to system through make-up line.

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Item	Description	Item	Description	Item	Description
1	Engine	5	Make-Up Line	9	Radiator
2	Water Pump Housing	6	Vent Lines	10	Fan
3	Thermostat Housing	7	Auxiliary	11	Motor
4	Bypass Line	8	Fill Cap		

➡ MAIN FLOW
→ MAKE-UP FLOW
∘∘∘∘∘ DEAERATION FLOW

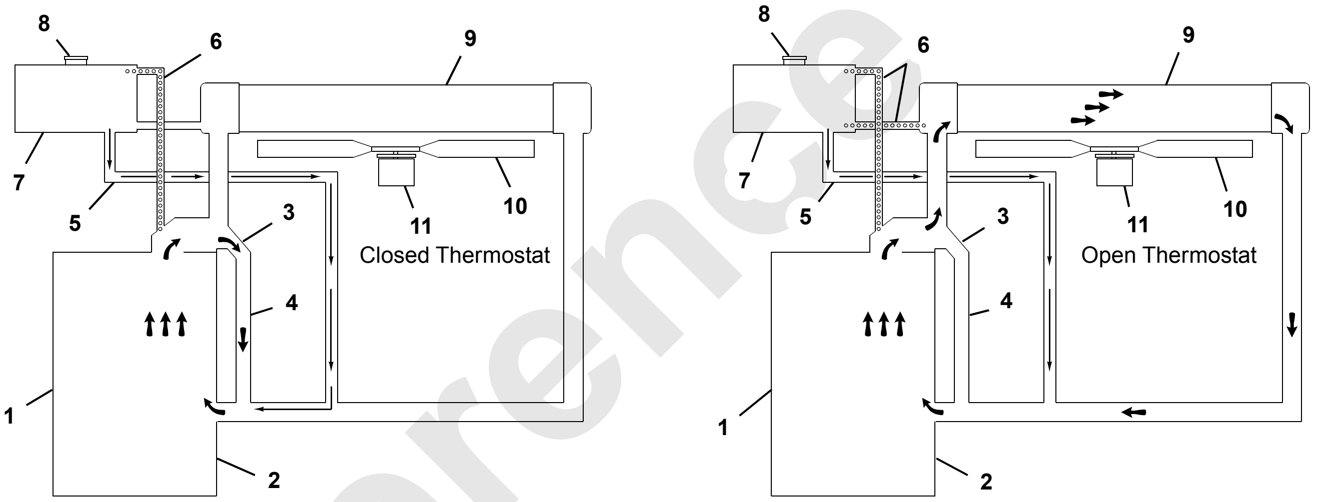


FIGURE 7-11

Auxiliary Tank Mounting

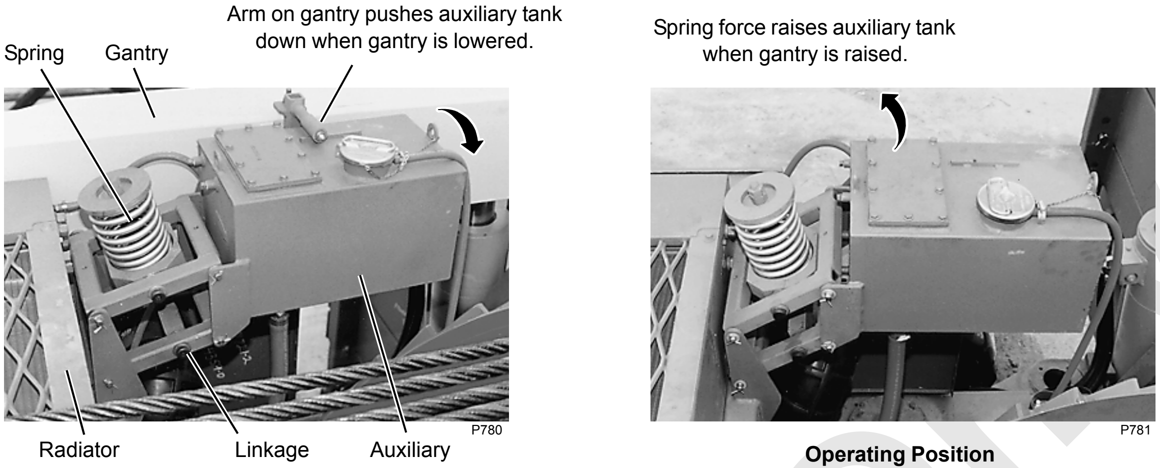
The auxiliary tank is fastened to the rear of the radiator with spring-loaded linkage which provides two positions:

Operating Position (Figure 7-12) places the auxiliary tank at a level higher than the radiator. The tank must be in this position to ensure proper deaeration of the cooling system.

The tank is raised to the operating position by spring force when the gantry is raised.

Storage Position (Figure 7-12) which places the auxiliary tank below the maximum shipping height.

The tank is lowered to the storage position by the arm on the gantry when the gantry is lowered.



Storage Position

Operating Position

FIGURE 7-12

Maintenance

WARNING

Burn Hazard!

Avoid personal injury from heated coolant spray or steam — do not remove radiator cap from hot engine. Stop engine and wait until coolant temperature is below 120°F (50°C). Then:

- Place a protective covering over fill cap,
- Slowly turn fill cap counterclockwise until it stops at safety detent,
- Wait until pressure (indicated by hissing sound) is completely relieved,
- Depress fill cap and turn counterclockwise to remove.

CAUTION

Overheating Hazard!

Avoid engine damage from overheating — raise auxiliary tank before checking level or adding coolant. Cooling system will not fill properly if tank is down.

Do not allow coolant level to go below low level gauge.

Daily Maintenance (Start of Each Shift)

1. Check coolant level when cold (see Figure 7-13):

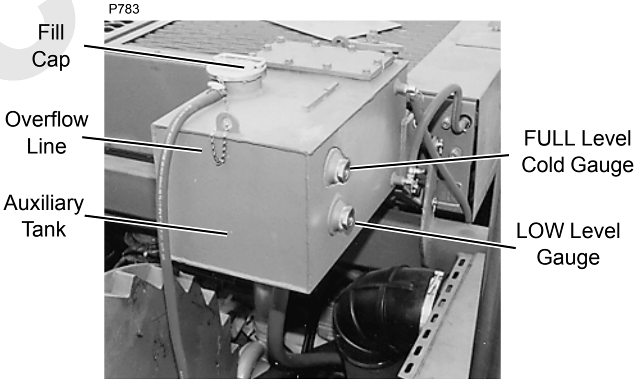
  a. Raise gantry to raise auxiliary tank.

  b. Coolant should be at middle of full level cold gauge or at bottom of fill neck if not equipped with gauge.

  c. Fill cooling system as required with coolant.

  See engine manufacturer's manual for antifreeze and coolant additive recommendations.

2. Look for coolant leaks while engine is running and correct if found.



Right Rear Corner of Radiator

FIGURE 7-13

Semiannual Checks

1. Inspect fill cap and thermostat for proper operation and replace worn parts:

  - Fill cap relieves at 7 psi (0,5 bar).
  - Thermostat closes at 175°F (79°C) and opens fully at 197°F (92°C).

2. Inspect water pump belts for wear and proper adjustment (see engine manufacturer's manual).

3. Inspect cooling system hoses for deterioration and other defects. Replace as necessary.

4. Tighten hose clamps.

5. Clean all dirt and other debris from outside of radiator.
6. Check that overflow line on auxiliary tank is open.
7. Drain and refill cooling system, as follows:
   - **a.** Raise gantry to raise auxiliary tank.
   - **b.** Stop engine.
   - **c.** Remove fill cap from auxiliary tank (Figure 7-14).
   - **d.** Open petcock at both ends of radiator (Figure 7-14).

Typical Both Ends of Radiator

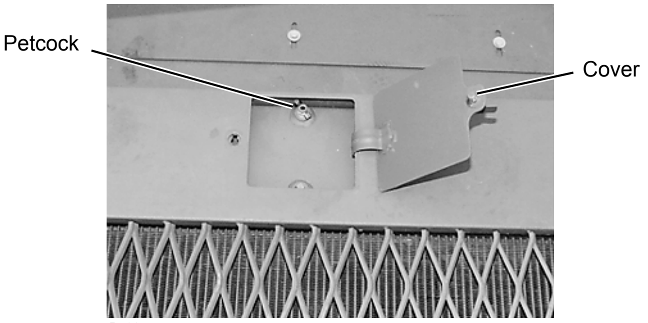
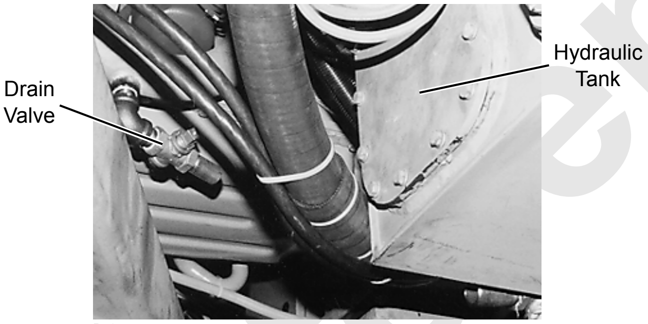


FIGURE 7-14

   - **e.** Open drain valve (Figure 7-15) and drain coolant into suitable container.



View Under Rear of Engine

FIGURE 7-15

   - **f.** Close drain valve once system is completely drained.
   - **g.** Fill cooling system through auxiliary tank to middle of full level cold gauge or to bottom of fill neck.

     Close petcocks on radiator once clear coolant appears.

     See Lubrication Guide in Section 9 of this manual for cooling system capacity.

     See engine manufacturer's manual for antifreeze and coolant additive recommendations.
   - **h.** Install fill cap and run engine at high idle until engine is hot — approximately 197°F (92°C).

     Look for coolant leaks while engine is running; correct if found.
   - **i.** Stop engine, wait until engine is cool, and refill auxiliary tank to proper level.

ENGINE COOLING SYSTEM WITH CUMMINS QSX-15 ENGINE — CURRENT TIER 3

General

The cooling system consists of a horizontal radiator (mounted above engine) and a hydraulically driven blower-type fan.

Cooling System Operation

Cooling system flow is illustrated in Figure 7-16.

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 vent line to radiator.
- Since coolant circulation is very slow in radiator, air separates from coolant.
- Air collects at top of radiator. When pressure rises to 14 psi (0,97 bar), relief in fill cap opens to exhaust air through overflow line.
- Deaerated coolant returns to system through make-up line.

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Item	Description	Item	Description
1	Engine	6	Vent Line
2	Water Pump Housing	7	Fill Cap
3	Thermostat Housing	8	Cooler Assembly
4	Bypass Line	9	Fan
5	Make up Line	10	Motor

➡ MAIN FLOW
→ MAKE-UP FLOW
○○○○○ DEAERATION FLOW

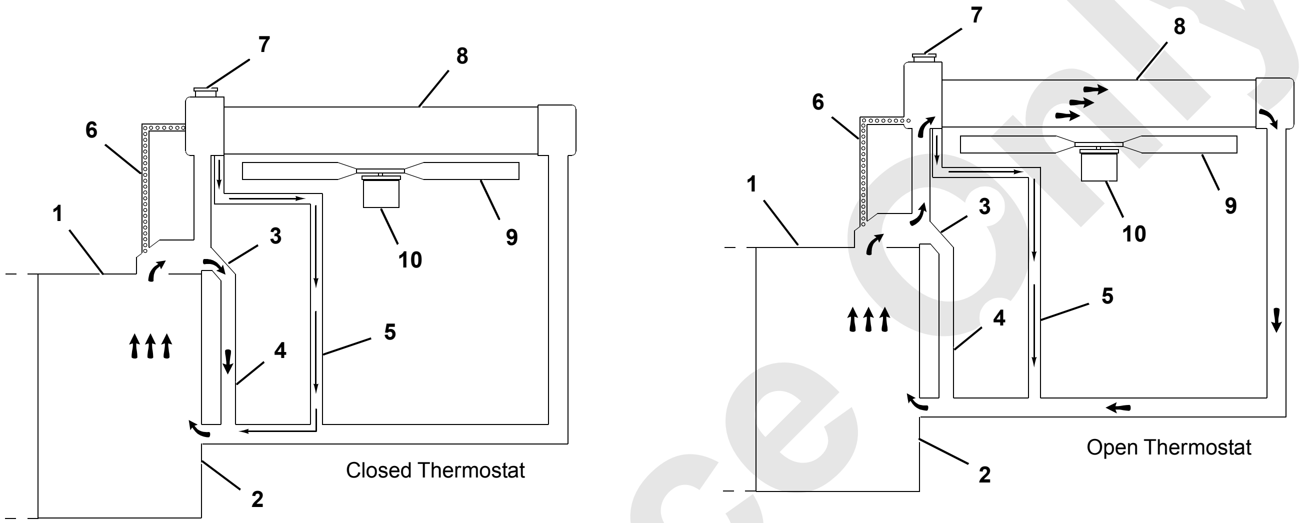


FIGURE 7-16

Maintenance

CAUTION

Overheating Hazard!

Avoid engine damage from overheating — do not allow coolant level to go below low level on gauge.

⚠ WARNING

Burn Hazard!

Avoid personal injury from heated coolant spray or steam — do not remove radiator cap from hot engine. Stop engine and wait until coolant temperature is below 120°F (50°C). Then:

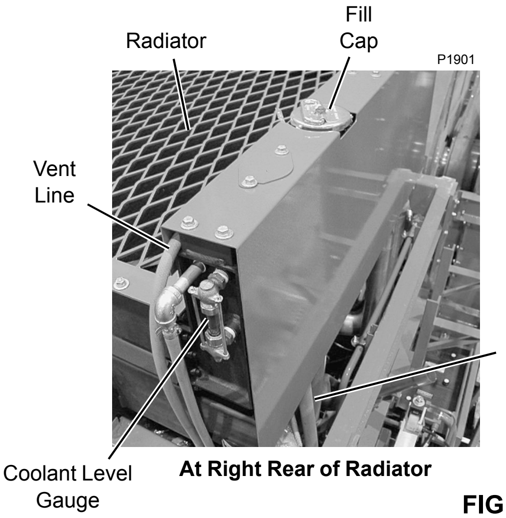
- Place a protective covering over fill cap.
- Slowly turn fill cap counterclockwise until it stops at safety detent.
- Wait until pressure (indicated by hissing sound) is completely relieved.
- Depress fill cap and turn counterclockwise to remove.

Daily Maintenance (Start of Each Shift)

Check coolant level when cold (see Figure 7-17):

1. Coolant should be at full level of cold gauge.
2. Fill cooling system as required with coolant. To ensure adequate fill, do not add coolant at a rate greater than 3 gallons/minute (11 liters/minute).

   See engine manufacturer’s manual for antifreeze and coolant additive recommendations.
3. Look for coolant leaks while engine is running; correct if found.



At Right Rear of Radiator

FIGURE 7-17

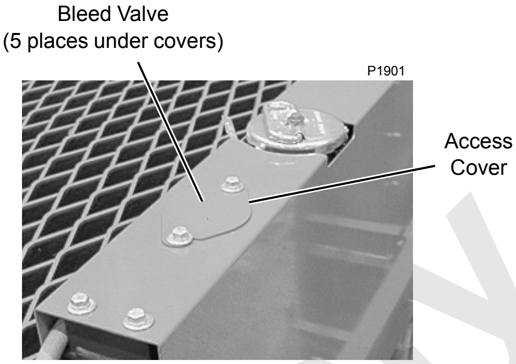
Semiannual Checks

1. Inspect fill cap and thermostat for proper operation and replace worn parts:
    - Fill cap relieves at 14 psi (0,97 bar).
    - Thermostat closes at 218°F (103°C) and opens fully at 238°F (114°C).
2. Inspect water pump belts for wear and proper adjustment (see engine manufacturer's manual).
3. Inspect cooling system hoses for deterioration and other defects. Replace as necessary.
4. Tighten hose clamps.
5. Clean all dirt and other debris from outside of radiator.
6. Check that overflow line on tank is open.

Draining Radiator

Drain radiator system, as follows:

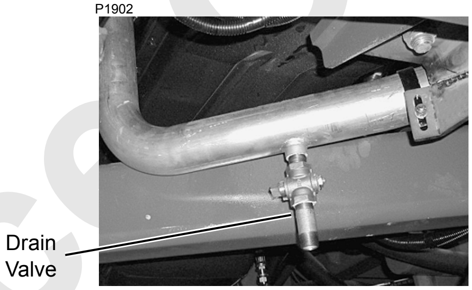
1. Stop engine.
2. Remove fill cap from radiator top (Figure 7-18).
3. Open petcock bleed valves at both ends of radiator (Figure 7-18) — three on left end and two on right end.



Typical Both Ends of Radiator

FIGURE 7-18

4. Open drain valve (Figure 7-19) and drain coolant into a suitable container.



View Under Rear of Engine

FIGURE 7-19

5. Close drain valve once system is completely drained.

Filling Radiator

NOTE: See engine manufacturer's manual for antifreeze and coolant additive recommendations.

1. Make sure petcocks are open at both ends of radiator.
2. Fill cooling system through radiator fill cap to FULL (COLD) LEVEL mark on sight gauge. Coolant system capacity is approximately 35-1/2 gallons (134 liters).
3. Close petcocks on each end of radiator once clear coolant appears.
4. Add coolant to FULL (COLD) LEVEL mark.
5. Vent cab heater core at valve under operator's cab (Figure 7-23).
6. Install fill cap and run engine at high idle until engine is hot — between 180°F (82°C) and 195°F (91°C).
7. Look for coolant leaks while engine is running; correct if found.
8. Stop engine, wait until engine is cool, and refill radiator to proper level.

ENGINE COOLING SYSTEM FILL — CURRENT PRODUCTION TIER 4

General

The cooling system consists of a horizontal radiator (mounted above the engine) and a variable-speed, hydraulically driven blower-type fan.

Cooling System Operation

Cooling system flow is illustrated in Figure 7-16.

The cooling system is of the deaeration type, which continually removes air from the system, as follows:

- A small percentage of total coolant flow is circulated through a vent line to the radiator.
- Since coolant circulation is very slow in the radiator, air separates from the coolant.
- Air collects at the top of the radiator. When pressure rises to 16 psi (1,03 bar), relief in fill cap opens to exhaust air through overflow line.
- Deaerated coolant returns to the system through a make-up line.

Maintenance

WARNING

Burn Hazard!

Avoid personal injury from heated coolant spray or steam — do not remove radiator cap from hot engine. Stop engine and wait until coolant temperature is below 120°F (50°C). Then:

- Place a protective covering over fill cap.
- Slowly turn fill cap counterclockwise until it stops at safety detent.
- Wait until pressure (indicated by hissing sound) is completely relieved.
- Depress fill cap and turn counterclockwise to remove.

CAUTION

Overheating Hazard!

Avoid engine damage from overheating — do not allow coolant level to go below low level on gauge.

Daily Maintenance (Start of Each Shift)

Check coolant level when cold (see Figure 7-17):

1. Coolant should be at full level of cold gauge.
2. Fill cooling system as required with coolant. To ensure adequate fill, do not add coolant at a rate greater than 5 gallons/minute (18.9 liters/minute).

   See engine manufacturer's manual for antifreeze and coolant additive recommendations.
3. Look for coolant leaks while engine is running and correct if found.

Semiannual Checks

1. Inspect fill cap and thermostat for proper operation and replace worn parts:
   - Fill cap relieves at 16 psi (1,03 bar)
   - Thermostat closes at 180°F (82°C) and opens fully at 202°F (94°C)
2. Inspect water pump belts for wear and proper adjustment (see engine manufacturer's manual).
3. Inspect cooling system hoses for deterioration and other defects. Replace as necessary.
4. Tighten hose clamps.
5. Clean all dirt and other debris from outside of radiator.
6. Check that overflow line on tank is open.

Draining Radiator

Drain radiator system, as follows:

1. Stop engine.
2. Remove covers over three bleed valves — two at front end of radiator and one at back end (see Figure 7-20 and Figure 7-21).
3. Open three petcock bleed valves located at both ends of radiator under access covers.
4. Remove radiator surge tank fill cap (Figure 7-17).

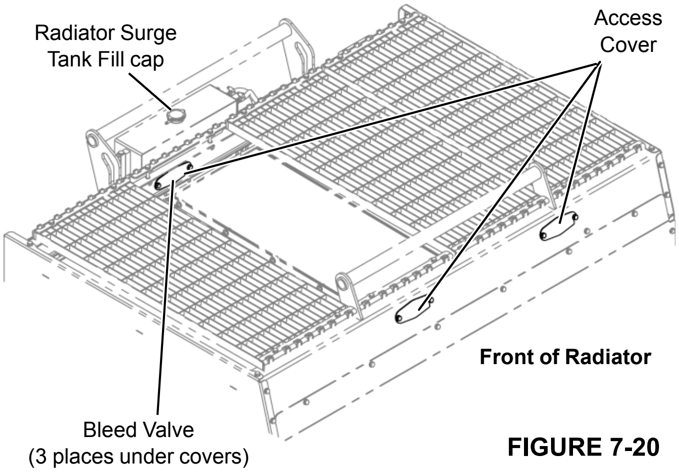
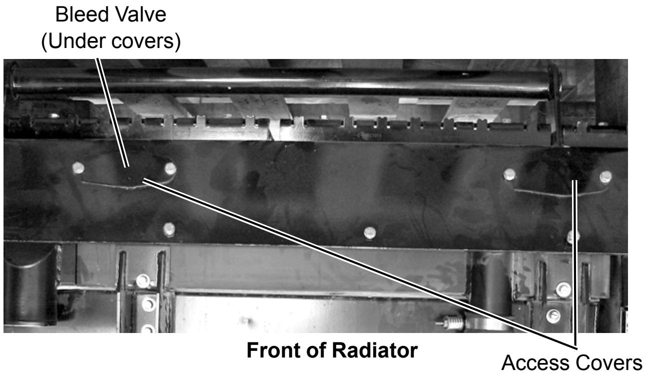


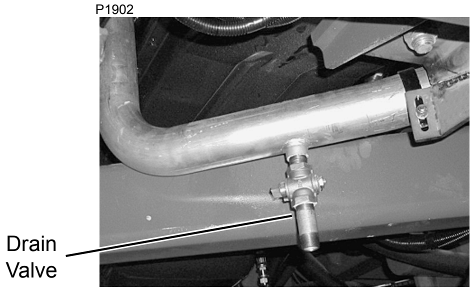
FIGURE 7-20



Front of Radiator

FIGURE 7-21

5. Open drain valve (Figure 7-22) and drain coolant into a suitable container.



View Under Rear of Engine

FIGURE 7-22

6. Close drain valve once system is completely drained.

Filling Radiator

See engine manufacturer's manual for antifreeze and coolant additive recommendations. Refer to the operator manual for detailed radiator fill instructions. Add coolant to FULL (COLD) LEVEL as determined on checks per the schedule in the engine owner's manual.

1. Fully open all three air bleed valves.
2. Fill cooling system through radiator fill cap to FULL (COLD) LEVEL mark on sight gauge. Coolant system capacity is approximately 21 gallons (79.5 liters).
3. Observe and close bleed valves once clear coolant appears at the bleed valves.
4. Continue adding coolant until the level is at the FULL (COLD) mark.

NOTE: Maximum fill rate is 5 GPM (18.9 liters/min).

5. Install fill cap and run engine until at normal operating temperature.

CAUTION!

Engine Damage!

The required coolant level must be maintained to prevent engine damage.

Do not remove the radiator fill cap from a hot engine. Allow the engine to cool below 50°C (120°F) before adding coolant.

Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool below 50°C (120°F) before adding coolant.

Coolant is toxic. Do not ingest. If not reused, dispose of in accordance with all local and other applicable environmental regulations.

---

6. Look for coolant leaks while the engine is running and correct if found.
7. Stop engine, wait until engine is cool, and refill radiator to FULL (COLD) level mark.

CAUTION!

Engine Damage!

The required Supplemental Coolant Additive (SCA) concentration must be maintained to prevent engine damage.

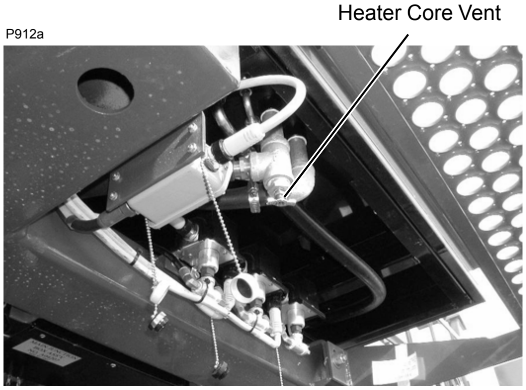
Supplemental Coolant Additive must be added to the cooling system to prevent liner pitting and for scaling protection. Check SCA concentration according to the schedule in the engine manufacturer's operator manual and per warnings, cautions and instructions in the engine manufacturer's service manual.

ENGINE THROTTLE ADJUSTMENT

Cummins N14 – C450 Engine

General

The throttle assembly consists of an electronic control module (ECM) on the engine, a hand throttle controller in the left console, a foot pedal on the cab floor, a foot throttle controller in the right console, associated linkage, and electrical connections.



Vent Under Operator's Cab

FIGURE 7-23

A reach rod in the right console connects the foot pedal to the lever on the foot throttle controller. An electric cable connects the hand throttle controller in the left control console to the foot throttle controller.

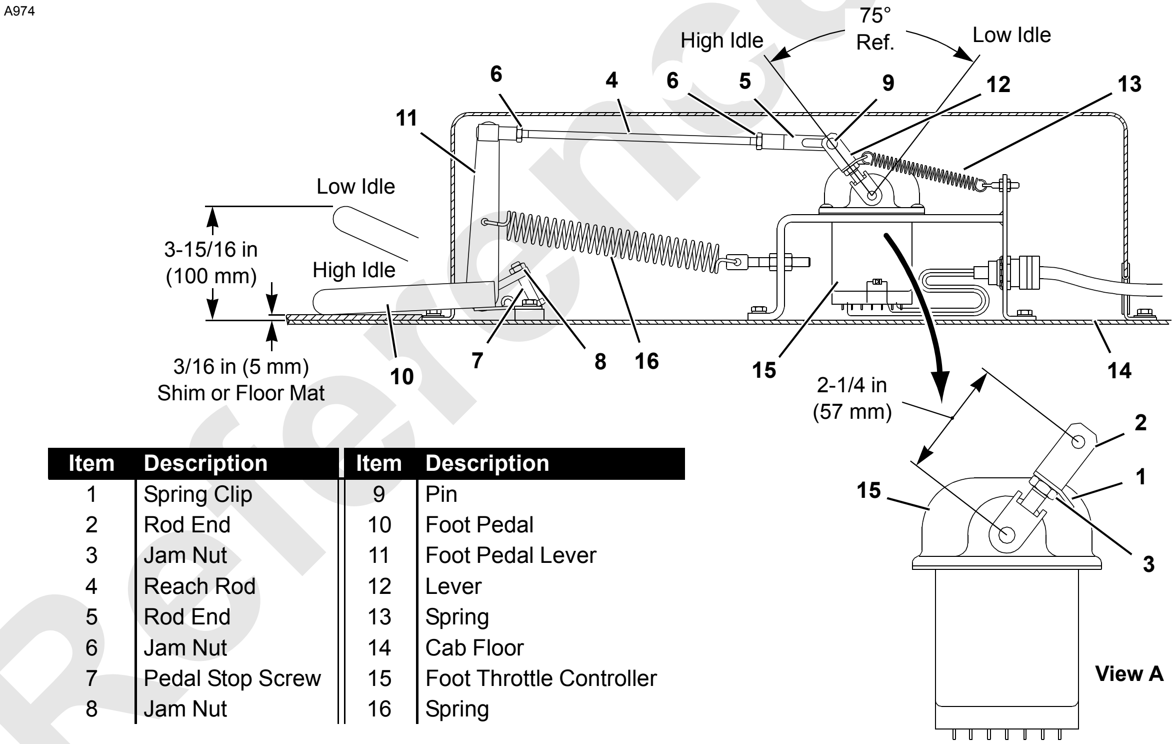
Foot Throttle Linkage Adjustment

See Figure 7-24 for the following procedure.

1. Install spring clip (1) and rod end (2) on controller lever at dimension shown in Figure 7-24, View A and securely tighten jam nut (3).
2. Insert a 3/16 in (5 mm) thick shim or piece of floor mat between foot pedal and cab floor.
3. Press foot pedal down fully to high idle position against shim or floor mat.
4. Adjust reach rod (4) and rod end (5) so controller lever is rotated fully to high idle position. Securely tighten jam nuts (6) to lock adjustment.

NOTE: Controller has internal stops at high and low idle.

5. Release foot pedal to low idle position.
6. Adjust return springs so there is sufficient force to raise pedal and rotate controller lever to low idle.
7. Adjust pedal stop screw (7). Screw must be tight against cab floor and there must be 1/8 in (31 mm) gap between pin (9) and rear end of slot in rod end (5). Securely tighten jam nut (8).
8. With foot pedal in low idle position, distance from top of pedal to cab floor should be 3-15/16 in (100 mm).



Item	Description	Item	Description
1	Spring Clip	9	Pin
2	Rod End	10	Foot Pedal
3	Jam Nut	11	Foot Pedal Lever
4	Reach Rod	12	Lever
5	Rod End	13	Spring
6	Jam Nut	14	Cab Floor
7	Pedal Stop Screw	15	Foot Throttle Controller
8	Jam Nut	16	Spring

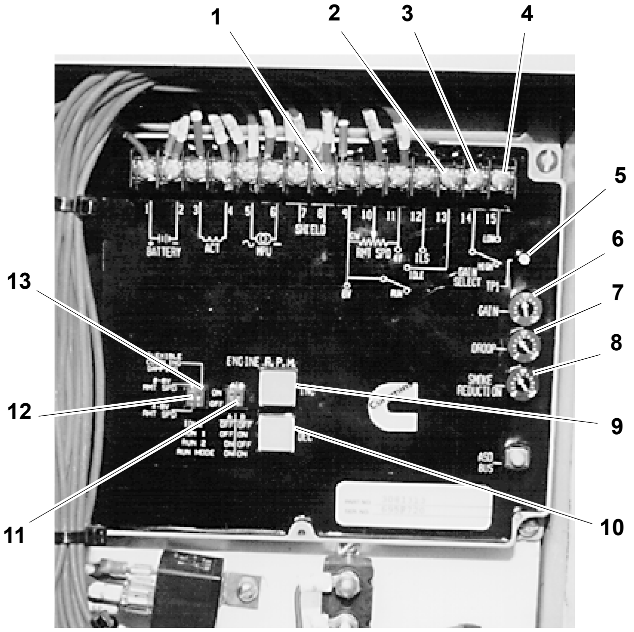
FIGURE 7-24

Electronic Fuel Control Adjustment

The electronic fuel control (mounted in junction box on engine) is adjusted at the factory to provide the following speeds and should not need further attention. Adjustment is required if the control is replaced. Adjustments are to be completed in the sequence given in this section.

- HIGH IDLE = 2,100 rpm
- LOW IDLE = 1,000 rpm

See Figure 7-25 while performing the fuel control adjustment steps.



P131 **Junction Box on Front of Engine**

Item	Description	Item	Description
1	Terminal 9	8	Smoke Reduction Potentiometer
2	Terminal 13	9	INC Button
3	Terminal 14	10	DEC Button
4	Terminal 15	11	A/B Switches
5	Terminal TP-1	12	RMT SPD Switch
6	Gain Potentiometer	13	Flexible Coupling Damping Switch
7	Droop Potentiometer		

FIGURE 7-25

The engine clutch must be engaged for all steps. It is normal for the idle speed to be as high as 1,500 rpm when engine clutch is disengaged.

If the specified engine speeds cannot be obtained during the adjustment steps, the engine speed sensor (on engine flywheel housing) may not be adjusted. To adjust engine speed sensor:

- Turn sensor out several turns.
- Turn sensor in until it lightly bottoms out against a flywheel gear tooth.
- Turn sensor out 1/2 turn.
- Securely tighten jam nut to lock sensor adjustment.

1. In cab, move hand and foot throttles to low idle.
2. Stop engine.
3. Open cover on junction box.
4. Remove jumper wire between terminals #14 and #15, if there is one.
5. Set potentiometers to following positions:
   - **a.** Gain potentiometer to mid-position (50). This setting should prevent the engine from surging.
   - **b.** Droop potentiometer fully counterclockwise (0).
   - **c.** Smoke potentiometer fully counterclockwise (0).
6. Set Flexible Coupling Damping switch to ***on*** position.
7. Set RMT SPD switch to **4-8V** position.
8. Set A/B switches to **RUN 1** position — A switch ***off*** and B switch ***on***. This is the controlled low idle setting.
9. Start engine (hand throttle fully forward and foot throttle fully raised to low idle).
10. Scroll to engine speed on digital display screen. See digital display to monitor engine speed during remaining adjustment steps.
11. Using ENGINE RPM buttons in junction box, press **INC** (increase) or **DEC** (decrease) button to set engine speed as close to 1,000 rpm without going over.
12. Stop engine.
13. Set A/B switches to **RUN 2** position — A switch ***on*** and B switch ***off.***
14. Start engine and run it at full throttle (hand throttle fully back or foot pedal fully down).
15. Press **INC** or **DEC** button to set engine speed as close to 2,100 rpm without going under.
16. Stop engine.
17. Set A/B switches to **RUN MODE** position — A switch ***on*** and B switch ***on***.
18. Test hand and foot throttles for proper full throttle operation, as follows:
    - **a.** With hand throttle pulled back fully (foot throttle up fully), engine speed must be as close to 2,100 rpm without going under.
    - **b.** With foot throttle pressed down fully (hand throttle forward fully), engine speed must be as close to 2,100 rpm without going under.
    - **c.** Repeat steps 13 – 18b until speed in RUN 2 position matches speed in RUN MODE as closely to 2,100 rpm without going under.
    - **d.** If proper speed cannot be obtained, check foot throttle linkage adjustment.

Cummins N14 – C525 Engine

General

The throttle assembly consists of an electronic control module (ECM) on the engine, a hand throttle controller in the left console, a foot pedal on the cab floor, an analog converter board, associated linkage, and electrical connections.

A reach rod in the right console connects the foot pedal to the lever on the foot throttle controller. An electric cable connects the hand throttle controller in the left control console to the foot throttle controller.

Foot Throttle Linkage Adjustment

See Figure 7-24 for the following procedure.

1. Install spring clip (1) and rod end (2) on controller lever at dimension shown in Figure 7-24, View A and securely tighten jam nut (3).
2. Insert a 3/16 in (5 mm) thick shim or piece of floor mat between foot pedal and cab floor.
3. Press foot pedal down fully to high idle position against shim or floor mat.
4. Adjust reach rod (4) and rod end (5) so controller lever is rotated fully to high idle position. Securely tighten jam nuts (6) to lock adjustment.

NOTE: Controller has internal stops at high and low idle.

5. Release foot pedal to low idle position.
6. Adjust return springs so there is sufficient force to raise pedal and rotate controller lever to low idle.
7. Adjust pedal stop screw (7). Screw must be tight against cab floor and there must be 1/8 in (31 mm) gap between pin (9) and rear end of slot in rod end (5). Securely tighten jam nut (8).
8. With foot pedal in low idle position, distance from top of pedal to cab floor should be 3-15/16 in (100 mm).

Engine Speed Calibration

See Figure 7-26 for the following procedure.

Engine speed is calibrated by the converter board mounted in the left console near the hand throttle controller. This board converts 0 – 10 VDC analog signal to 0 – 5 VDC analog signal.

High and low idle engine speeds were calibrated at the factory and should not need further attention. Calibration is required if parts (controller, converter board, linkage) is replaced.

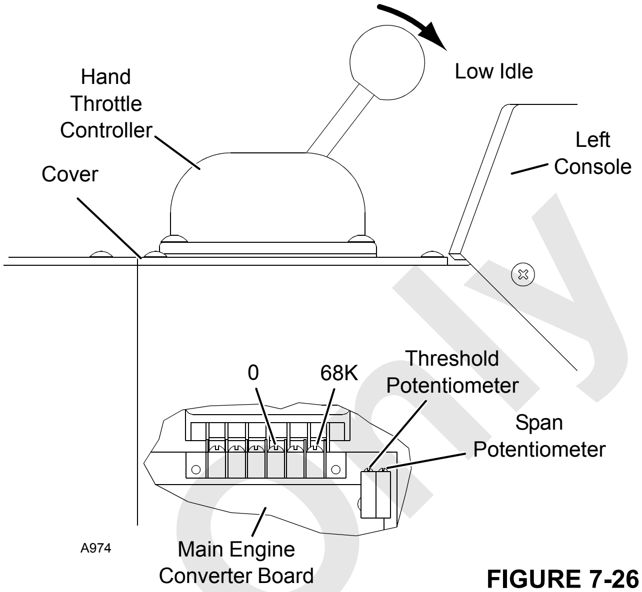


FIGURE 7-26

1. Stop engine.
2. Remove cover plate and hand throttle controller from left console. Move to side for access to converter board. Be careful not to damage electric wires.
3. Connect voltmeter to **0** and **68K** terminals on converter board.
4. Turn cab power switch ON and set engine run/stop switch to ***run*** to supply power to converter board. Do not start engine.
5. Move hand throttle to minimum (low idle) position.
6. Adjust threshold potentiometer for output voltage of **0.60 – 0.70 VDC**.
7. Move hand throttle to maximum (full throttle) position.
8. Adjust span potentiometer for output voltage of **3.90 – 4.00 VDC**.
9. Recheck low and high idle settings; refine adjustments if necessary.
10. Calibrate throttle settings to the electronic control module (ECM) on the engine:
    a. Leave run/stop switch in ***run*** position.
    b. Operate hand throttle from low idle to high idle position three times.
    c. Turn run/stop switch to ***stop*** position.
11. Remove voltmeter and start engine.

12. Verify calibration at minimum and maximum throttle positions while monitoring ENGINE SPEED on digital display in operator's cab.

    Minimum speed should be **975±25 rpm**. Maximum speed should be **2100±10 rpm**.

    Adjust threshold and span potentiometers as needed so that engine speed is within ranges specified.

13. Reinstall cover plate and hand throttle controller on console.

Cummins N14 – C525e Engine

General

The throttle assembly consists of an electronic control module (ECM) on the engine, a hand throttle controller in the left console, a foot pedal on the cab floor, a foot throttle controller in the right console, associated linkage, and electrical connections.

A reach rod in the right console connects the foot pedal to the lever on the foot throttle controller. An electric cable connects the hand throttle controller in the left control console to the foot throttle controller.

Foot Throttle Linkage Adjustment

See Figure 7-24 for the following procedure.

1. Install spring clip (1) and rod end (2) on controller lever at dimension shown in Figure 7-24, View A and securely tighten jam nut (3).
2. Insert a 3/16 in (5 mm) thick shim or piece of floor mat between foot pedal and cab floor.
3. Press foot pedal down fully to high idle position against shim or floor mat.
4. Adjust reach rod (4) and rod end (5) so controller lever is rotated fully to high idle position. Securely tighten jam nuts (6) to lock adjustment.

NOTE: Controller has internal stops at high and low idle.

5. Release foot pedal to low idle position.
6. Adjust return springs so there is sufficient force to raise pedal and rotate controller lever to low idle.
7. Adjust pedal stop screw (7). Screw must be tight against cab floor and there must be 1/8 in (31 mm) gap between pin (9) and rear end of slot in rod end (5). Securely tighten jam nut (8).
8. With foot pedal in low idle position, distance from top of pedal to cab floor should be 3-15/16 in (100 mm).

Engine Speed Calibration

To calibrate the voltage output of the hand and foot throttle controllers to the engine ECM, proceed as follows:

NOTE: Calibration is required only when either controller or the ECM is replaced.

1. Stop engine (engine must be off).
2. Turn on cab power switch.
3. Move engine run/stop switch to ***run*** position.
4. Operate hand throttle (or foot throttle) from low idle position to high idle position three times in succession.
5. Move engine run/stop switch to ***stop*** position.
6. Calibration is complete.

NOTE: It is normal for amber engine warning light to flashing fault codes when step 4 is performed. See Engine Diagnostic instructions in Section 10 of this manual.

Cummins QSC8.3, QSM11, or QSX15 Engine

The throttle assembly consists of an electronic control module (ECM) on the engine, a hand throttle controller in the left console (not part of Tier 4 assembly), a foot pedal on the cab floor, a foot throttle controller in the right console, associated linkage, and electrical connections.

A reach rod in the right console connects the foot pedal to the lever 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 7-24 for the following procedure.

1. Install spring clip (1) and rod end (2) on controller lever at dimension shown in Figure 7-24, View A and securely tighten jam nut (3).
2. Insert a 3/16 in (5 mm) thick shim or piece of floor mat between foot pedal and cab floor.
3. Press foot pedal down fully to high idle position against shim or floor mat.
4. Adjust reach rod (4) and rod end (5) so controller lever is rotated fully to high idle position. Securely tighten jam nuts (6) to lock adjustment.

NOTE: Controller has internal stops at high and low idle.

5. Release foot pedal to low idle position.
6. Adjust return springs so there is sufficient force to raise pedal and rotate controller lever to low idle.
7. Adjust pedal stop screw (7). Screw must be tight against cab floor and there must be 1/8 in (31 mm) gap between pin (9) and rear end of slot in rod end (5). Securely tighten jam nut (8).

8. With foot pedal in low idle position, distance from top of pedal to cab floor should be 3-15/16 in (100 mm).

Caterpillar 3406C Engine

General

The throttle assembly consists of an electronic control module (ECM) on the engine, a hand throttle controller in the left console, a foot pedal on the cab floor, a foot throttle controller in the right console, associated linkage, and electrical connections.

A reach rod in the right console connects the foot pedal to the lever on the foot throttle controller. An electric cable connects the hand throttle controller in the left control console to the foot throttle controller.

Foot Throttle Linkage Adjustment

See Figure 7-24 for the following procedure.

1. Install spring clip (1) and rod end (2) on controller lever at dimension shown in Figure 7-24, View A and securely tighten jam nut (3).

2. Insert a 3/16 in (5 mm) thick shim or piece of floor mat between foot pedal and cab floor.

3. Press foot pedal down fully to high idle position against shim or floor mat.

4. Adjust reach rod (4) and rod end (5) so controller lever is rotated fully to high idle position. Securely tighten jam nuts (6) to lock adjustment.

NOTE: Controller has internal stops at high and low idle.

5. Release foot pedal to low idle position.

6. Adjust return springs so there is sufficient force to raise pedal and rotate controller lever to low idle.

7. Adjust pedal stop screw (7). Screw must be tight against cab floor and there must be 1/8 in (31 mm) gap between pin (9) and rear end of slot in rod end (5). Securely tighten jam nut (8).

8. With foot pedal in low idle position, distance from top of pedal to cab floor should be 3-15/16 in (100 mm).

Electronic Fuel Control Adjustment

See Figure 7-27 for the following procedure.

The electronic fuel control was adjusted at the factory and should not need further attention. Adjustment is required if the control is replaced. Adjustments are to be completed in the sequence given in this section.

The electronic fuel control is located in the junction box mounted on the right side of the engine. Figure 7-27 shows the locations of the potentiometers and other controls inside the junction box.

Engine speeds given in this section are nominal, and can vary plus or minus 50 rpm.

Setting High Speed

1. In cab, make sure clutch is engaged.

2. Start engine.

3. Set throttle to high speed setting.

4. Turn speed pot until ENGINE SPEED on digital display shows speed is 2,100 rpm.

Low idle is determined by the value of the resistors in the circuit. Low idle should be approximately 1,000 rpm.

Setting Gain and Stability

1. Set throttle to high speed setting (2,100 rpm).

2. Adjust GAIN as follows:

  a. Slowly turn gain adjusting screw clockwise until engine becomes unstable (engine operation becomes erratic).

  b. Slowly turn gain adjusting screw counterclockwise until engine becomes stable.

  c. Turn gain adjusting screw an additional 1/4 turn counterclockwise to ensure stable performance.

3. Adjust STABILITY as follows:

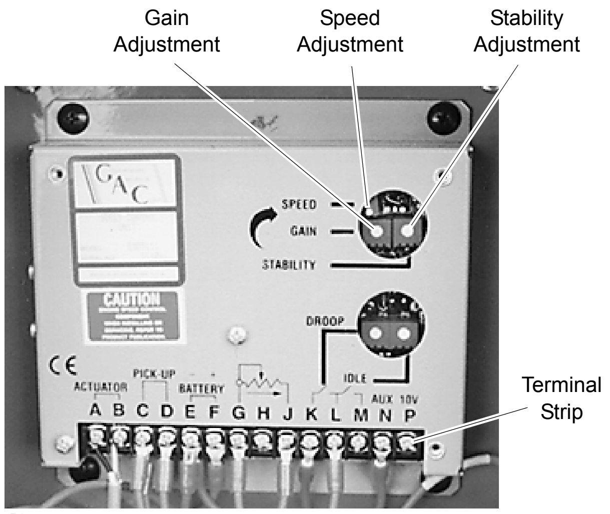
  a. Slowly turn stability adjusting screw clockwise until engine becomes unstable (engine operation becomes erratic).

  b. Slowly turn stability adjusting screw counterclockwise until engine becomes stable.

  c. Turn stability adjusting screw an additional 1/4 turn counterclockwise to ensure stable performance.

4. Test hand and foot throttles to make sure they both operate within high and low idle settings.

NOTE: Normally, adjustments made at no load achieve satisfactory performance. However, gain and stability may require minor adjustments after engine load is applied.



Junction Box on Front of Engine

FIGURE 7-27

Test Voltages

The following test voltages are provided for troubleshooting purposes and are measured at the terminal strip in junction box on the engine (Figure 7-27).

Table 7-5
DC Voltage

Operating Condition	Wire No.	Term. No.	VDC Reading to Ground
Cab Power Switch ON Run/Stop Switch - RUN	68L	G	0.005
	68J	J	5.880
	68K	L	3.848
Engine at Low Idle (1,000 rpm)	68L	G	0.007
	68J	J	5.870
	68K	L	3.812
Engine at High Idle (2,100 rpm)	68L	G	0.027
	68J	J	5.070
	68K	L	0.219

Table 7-6
AC Voltage

Operating Condition	Wire No.	Term. No.	VAC Reading
Engine at Low Idle (1,000 rpm)	24 and 0	C to D	6.580
Engine at High Idle (2,100 rpm)	24 and 0	C to D	7.480

ENGINE BELT ROUTING — TIER 4 ENGINE ONLY

Engine belt routing is shown in Figure 7-28 to help service personnel when installing a new fan belt.

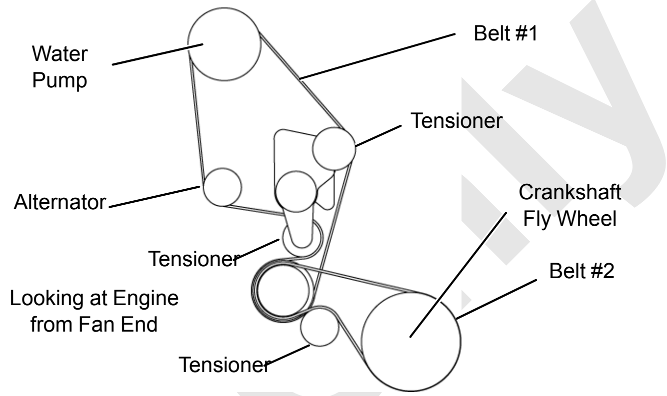


FIGURE 7-28

DIESEL PARTICULATE FILTER REGENERATION — TIER 4 ONLY

General

The Diesel Particulate Filter (DPF) — located at the rear of the upperworks — captures soot and ash from the engine exhaust.

- Soot is partially burned fuel particles that occur during normal operation (black smoke).
- Ash is partially burned engine oil particles that occur during normal operation.

Over time, both soot and ash are collected in the DPF and must be removed.

- Soot is removed by a process called **regeneration**.
- Ash is removed by manually cleaning the DPF at specified intervals (see Engine Manufacturer's Manual for detailed instructions).

Regeneration

General

Regeneration is the process of converting the soot collected in the DPF into carbon dioxide. Regeneration requires heat to occur. Two types of regeneration are used: passive and active.

Passive Regeneration

Passive regeneration occurs when exhaust temperatures are naturally high enough to oxidize the soot faster than it is collected in the DPF.

The process typically occurs when the crane is operated at high speeds and/or under heavy loads.

The operator will not know when passive regeneration is occurring.

Active Regeneration

Active regeneration occurs when exhaust temperatures are NOT naturally high enough to oxidize the soot faster than it is collected in the DPF. If this happens, the engine's controller will initiate the process (see Engine Manufacturer's Manual for detailed instructions).

The process occurs more frequently in cranes operated at low speed, light or no load, or stop and go cycles.

Active regeneration will be transparent to the operator, except that he/she may notice an increase in turbocharge noise and an increase in exhaust temperature (high exhaust temperature icon comes on).

NOTE: Use the INHIBIT switch in the operator's cab only for special circumstances where it is desirable to disable active regeneration. Prolonged engine operation with INHIBIT on will cause the DPF to fill with soot. Too much soot could cause the engine to stop. If that occurs it will be necessary to clean the DPF before the engine can be restarted.

Stationary Regeneration

Stationary regeneration is a form of active regeneration that is initiated by the operator when the crane is parked. The DPF ON light will flash to alert the operator if stationary regeneration is required (see Section 3 of Crane Operator Manual and the Engine Manufacturer's Manual for detailed instructions).

PUMP DRIVE DISCONNECT

General

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 start-up easier in cold weather. The disconnect can be engaged or disengaged only while the engine is off.

CAUTION!

Parts Damage!

Do not run engine longer than **2 minutes** with pump drive disengaged. Pump drive bearings can be damaged.

Do not engage or disengage pump drive with engine running. Gear damage could result.

Adjustment

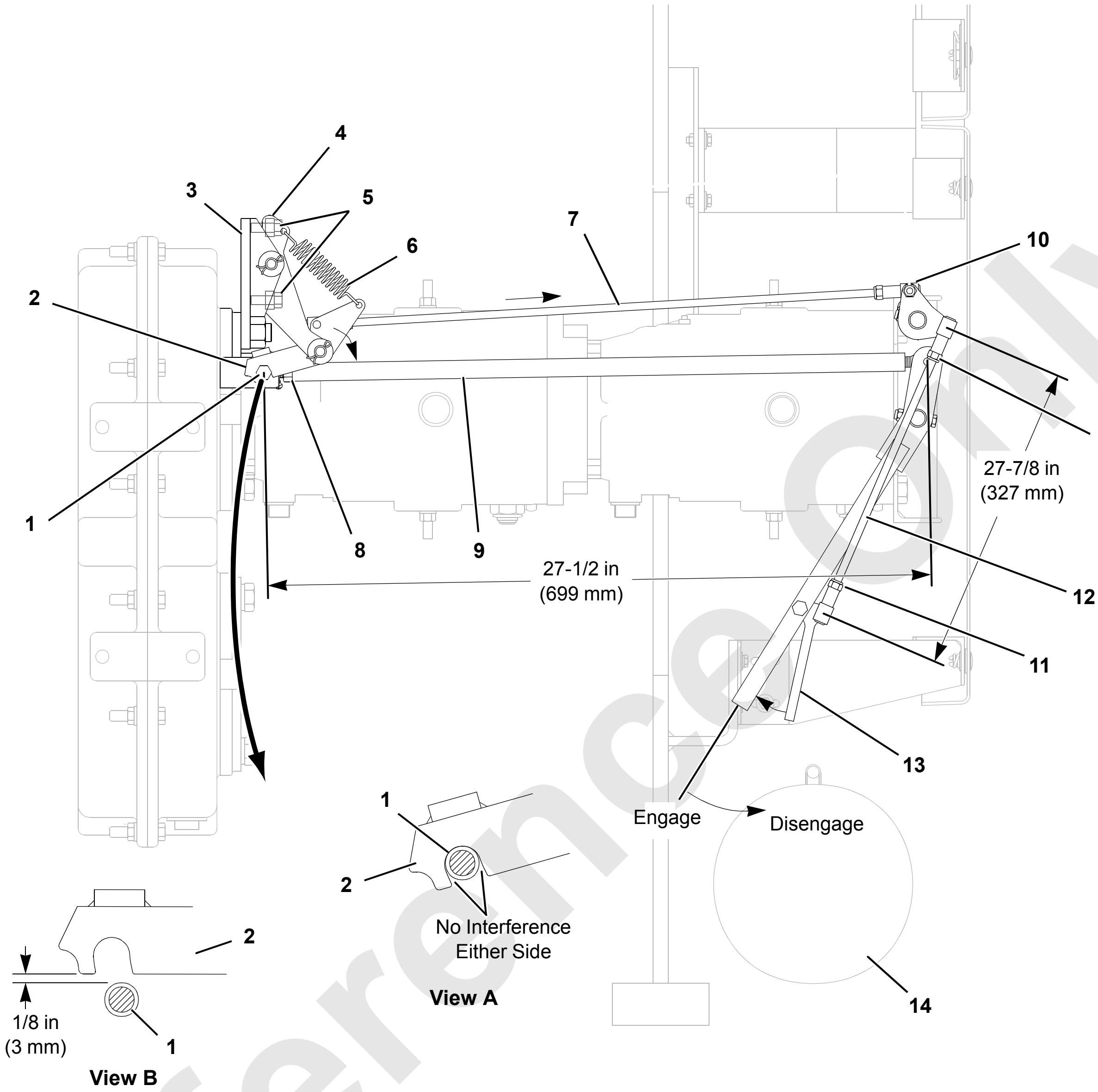
See Figure 7-29 for the following procedure.

Disconnect the pump drive for the following reasons:

- To make engine starting easier during cold weather
- When hydraulic pumps are being serviced

To adjust the pump drive disconnect:

1. Set length of shift rod to 27-1/2 in (699 mm), lock in place with hex nut, and install.
2. Set length of pull rod to 12-7/8 in (327 mm), lock in place with elastic stop nuts, and install.
3. Position rocker arm:
    a. Adjust set screws against base plate until hook can fully engage latch assembly without interference (View A).
    b. Lock set screws in place with hex nuts.
4. Install springs so hook is held in fully engaged position.
5. Install control rod:
    a. Approximate assembly length from centerline to centerline of ball joints is 24-9/16 in (624 mm).
    b. Adjust length to retain a minimum of 1/8 in (3 mm) clearance (View B) between hook and latch assembly when trigger is compressed against handle and shaft is shifted through 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
4	Rocker Arm	11	Elastic Stop Nut
5	Set Screws	12	Pull Rod
6	Spring	13	Squeeze Trigger
7	Control Rod	14	Left Rear Jacking Cylinder

FIGURE 7-29

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SECTION 8
UNDER CARRIAGE

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SECTION 8
UNDER CARRIAGE

TURNTABLE BEARING BOLT TORQUE

Bearing Installation

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 when the swing lock is engaged (this does not apply to a turret mounted crane).

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 in Figure 8-1.

Four dowel pins are installed in the inner ring as shown in Figure 8-1, View A. Use the pins to align the adapter frame with the inner ring.

Torque Requirements

WARNING

Turntable Bearing Failure!

Loose or improperly torqued bolts can cause bolts or turntable bearing to fail, possibly allowing rotating bed to break away from carbody, carrier, or turret.

Lubrication

Before installing the turntable bearing bolts, lubricate the threads of each bolt with Never-Seez (MCC 361010) or an equivalent antiseizing lubricant.

Torque Values

Torque each turntable bearing bolt to 2,100 ft-lbs (2 848 N•m).

When new bolts are installed, torque the bolts in two steps: first to 600 ft-lbs (814 N•m) and then to 2,100 ft-lbs (2 848 N•m).

Torque Sequence

Torque the bolts in the numbered sequence given in Figure 8-1.

Torque Intervals

INITIAL OPERATION: torque all bolts to the specified value after the first 50 hours of operation.

YEARLY OR EVERY 2,000 HOURS OF OPERATION (whichever comes first): torque all bolts to the specified value.

Bolt Replacement

If at the yearly inspection interval one or more bolts are found to be torqued to less than 1,680 ft-lbs (2 278 N•m), replace each loose bolt. 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 torqued to less than 1,680 ft-lbs (2 278 N•m), 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.

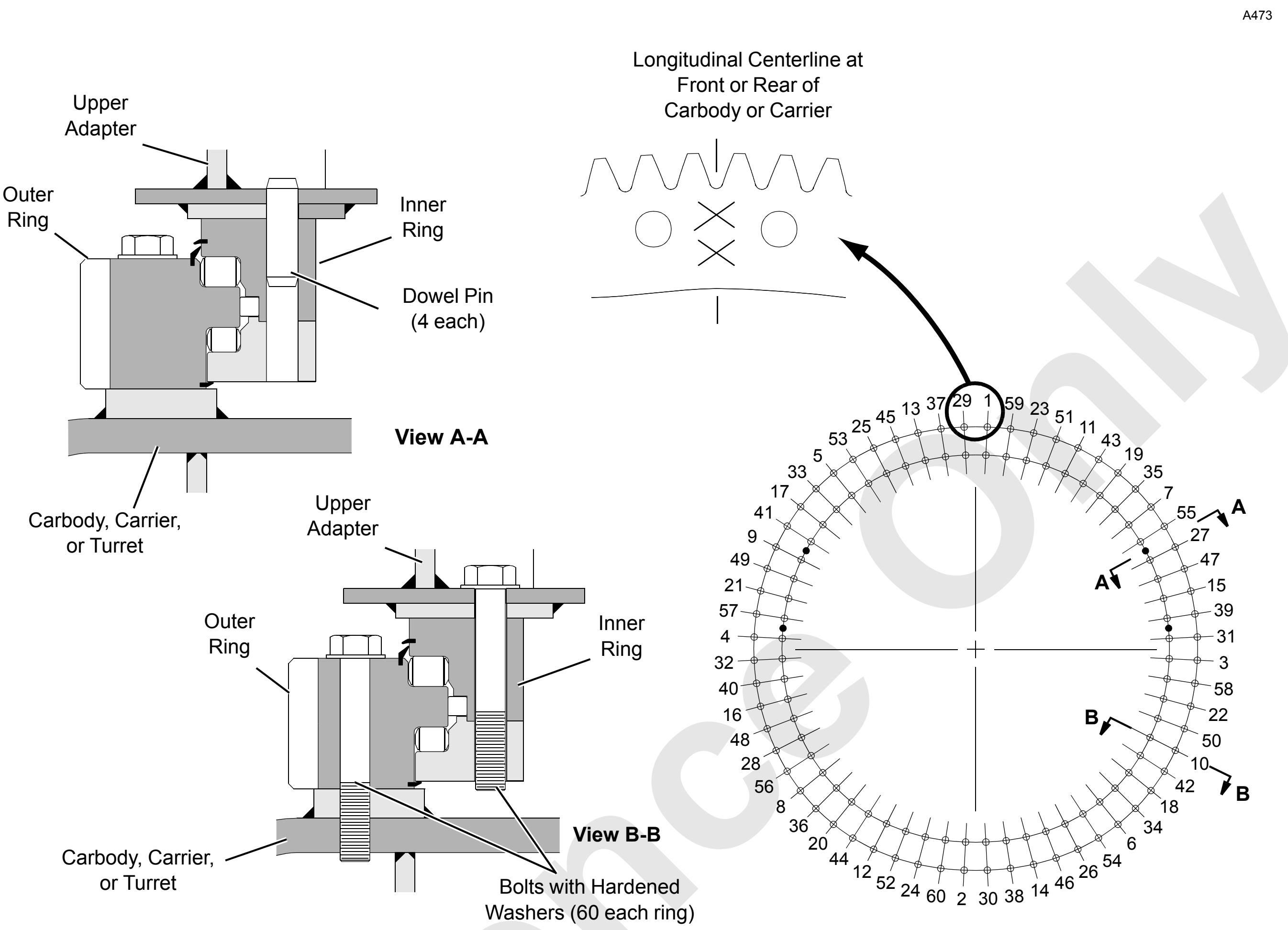


FIGURE 8-1

CRAWLER ADJUSTMENT

Maintenance

Crawler wear cannot be eliminated, but the rate of wear can be reduced through regular preventive maintenance, as follows:

- Lubricate crawlers as instructed in Lubrication, Section 9 of this manual.
- Keep crawlers clean and avoid dirt build-up when cutting.
- Keep all mounting bolts tight (see Parts Manual for applicable torque values).
- Keep treads properly adjusted.
- Inspect crawler gear cases, crawler frames, rollers, 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 damaged parts immediately to prevent further damage.

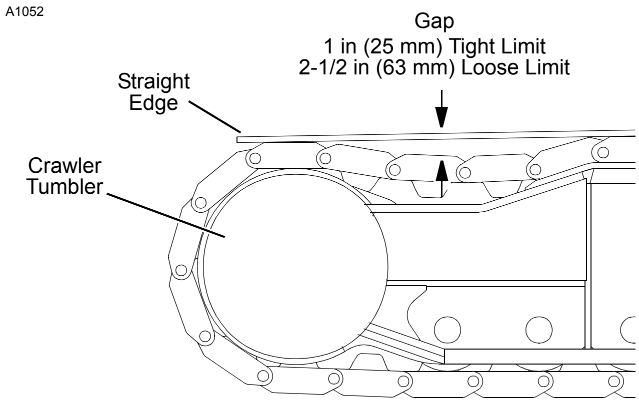


FIGURE 8-2

Tread Slack Adjustment

Adjustment Guideline

Check tread slack at the tumbler end of each crawler. Maintain equal tread slack at both crawlers.

1. Travel forward on a firm level surface so all tread slack is in top of treads at tumbler end of crawlers.
2. Place straight edge on tread as shown in Figure 8-2. Gap between straight edge and top of tread at lowest point should be between 1 in (25 mm) ***tight limit*** and 2.5 in (63 mm) ***loose limit***.
3. Adjust tread slack if gap is less than tight limit or greater than loose limit.
4. Adjust treads tighter when operating on firm ground and looser when operating on soft ground (mud or sand).

CAUTION

Pin Damage!

Do not adjust treads too tightly or the tread pins will wear rapidly and may break. Dirt build-up will tighten treads even more, increasing possibility of damage.

More torque is required to drive tight treads, which results in faster wear and more fuel consumption.

Adjustment Procedure

Adjust tread slack at front roller end of each crawler (Figure 8-3).

1. Thoroughly clean crawler to be adjusted.
2. Loosen two bolts (1) at front-roller end of the crawler (1 bolt, each side).
3. Remove cover (2) from both sides of crawler frame.
4. Place jack cylinder (3) on support (4).
5. Jack against rod (5) an equal amount on both sides of crawler frame.
6. Add or remove an equal thickness of shims (6) on both sides of crawler frame.
7. Remove jack cylinder (3).
8. Travel crane forward to tighten shims.
9. Check that dimension from center punch (A) in shaft to center punch line (B) in crawler frame is same on both sides of crawler to within 1/8 in (3 mm).

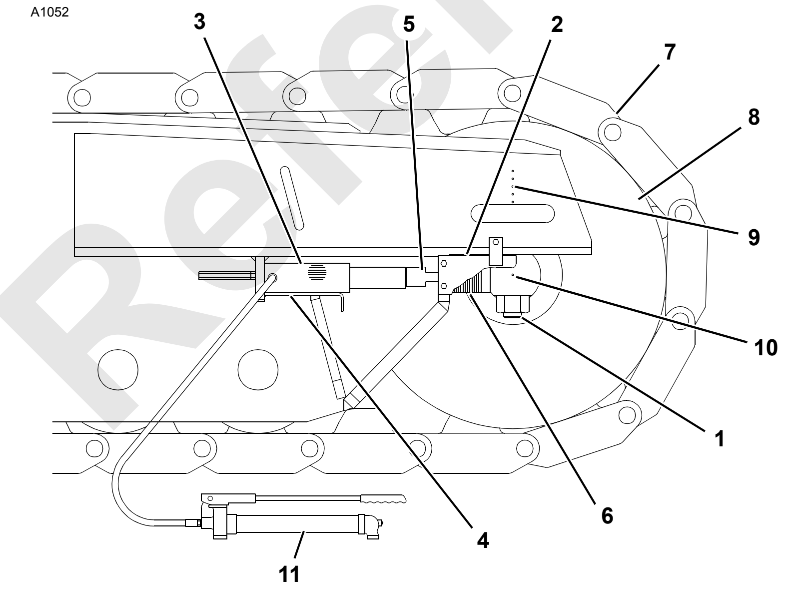
CAUTION

Excessive Part Wear!

Front roller and tumbler must be square with crawler frame to within 1/8 in (3 mm), otherwise, parts will wear rapidly.

10. Check for proper adjustment (see Adjustment Guideline) and readjust as required (steps 4 through 9).
11. Tighten nuts on bolts at front roller to 1,000 ft-lb (1 356 N•m) lubricated with Never-Seez or an equivalent oil and graphite mixture.
12. Install cover (2) on both sides of crawler frame.

NOTE: The extreme limit of tread 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
2	Cover
3	Jack Cylinder
4	Support
5	Rod
6	Shims — 0.134 in (3 mm) and 0.250 in (6 mm) Thick
7	Tread
8	Front Roller
9	Center Punch Line B
10	Center Punch A
11	Hand Pump

FIGURE 8-3

HYDRAULIC HAND PUMP

See Figure 8-4 for the following procedures.

WARNING

Prevent Possible Death or Serious Injury to Maintenance Personnel!

Manitowoc has provided hand pump and cylinder for crawler adjustment only. Any other use is neither intended nor approved.

Wear safety glasses and other personal protective gear when operating hand pump.

Do not exceed maximum pressure rating of components (pump, cylinder, hose) – 10,000 psi (700 bar). Higher pressure can cause components to explode.

Do not set pump relief valve higher than 10,000 psi (700 bar). Higher pressure can cause components to explode.

Pump is not vented. It can explode if subjected to high pressure. Do not attempt to return more oil to pump than it is capable of holding. Do not overfill pump.

In some cases, pump handle can kickback. Always keep your body to side of pump, away from line of handle force.

Do not add extensions to handle. Extensions can cause unstable operation.

Assembly

1. Connect hose from pump outlet port to cylinder inlet.
2. Use 1-1/2 wraps of a high-grade thread sealant on fittings (for example, Teflon tape).

   Do not apply sealant to first complete thread to ensure tape does not shed into hydraulic system and cause malfunctioning or damage.
3. Do not overtighten connections. Connections only need to be snug and leak free. Overtightening can cause premature thread failure and may cause fittings or castings to split at lower than their rated pressures.

Maintenance

1. Keep unit clean and stored in a safe place where it cannot be damaged.
2. Keep oil in pump at proper level. Check level as follows:
   a. Open valve and fully retract cylinder rod to return all oil to pump. ***Cylinder must be fully retracted or system will contain too much oil.***
   b. For Simplex pump:
      - Place pump in horizontal position on a flat surface.
      - Using a screw driver, remove vent/fill cap.
      - Add hydraulic oil until reservoir is 2/3 full. ***Do not overfill.***
      - Securely reinstall vent/fill cap.
   c. For Enerpac pump:
      - Place pump in vertical position with hose end down.
      - Using a screw driver, remove vent/fill cap.
      - Add hydraulic oil until it is at mark on dipstick. ***Do not overfill.***
      - Securely reinstall vent/fill cap.
   d. Test operation and remove air from system, if required. Recheck level after removing air.

Air Removal

1. Close valve finger tight only.
2. Position pump higher than cylinder and position cylinder so rod is down.
3. Operate pump to fully extend cylinder rod.
4. Open valve and retract cylinder rod to force oil and trapped air back into pump.
5. Repeat steps until cylinder operates smoothly. ***Erratic operation indicates air in system.***

Pump Operation

1. Before using pump:
   a. Check that all fittings are tight and leak free.
   b. Check oil level.
2. To pressurize cylinder and extend rod, close valve by turning clockwise until finger tight only. Then pump handle up and down.

   Pressure will be maintained until valve is opened.

   To reduce handle effort at high pressure, use short strokes. Maximum leverage is obtained in last five degrees of stroke.
3. To depressurize cylinder, push handle down fully and open valve by turning counterclockwise.
4. Pump can be operated in any position from horizontal to vertical as long as ***hose end of pump is down***.

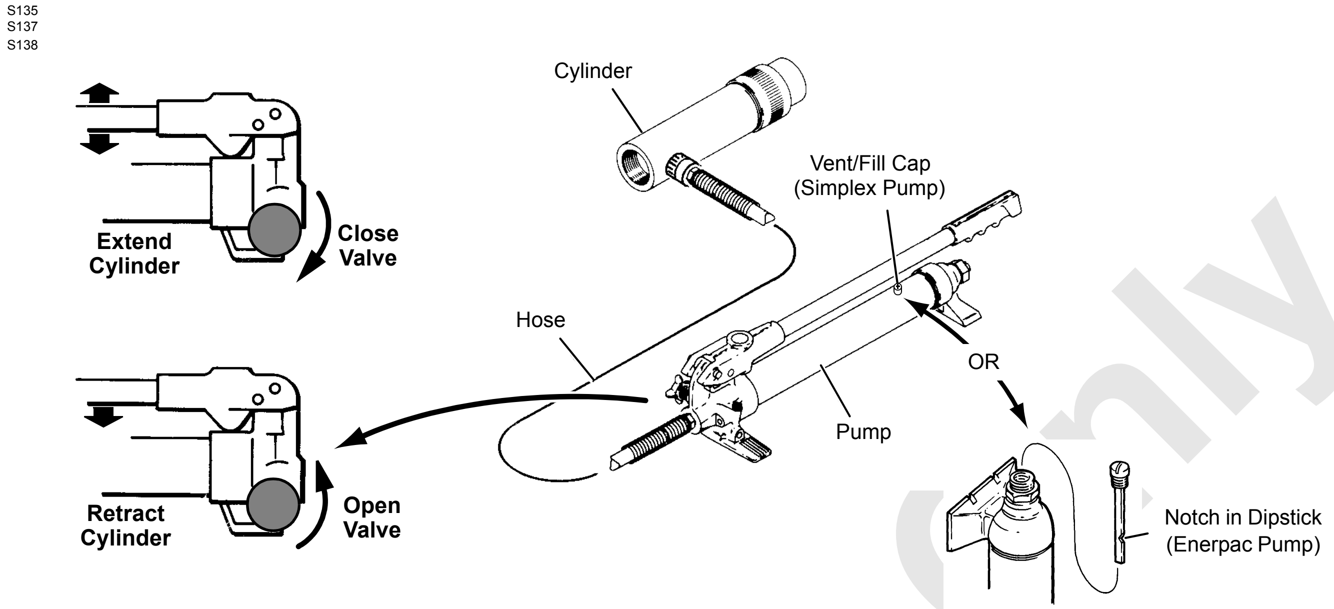

S135
S137
S138
Extend Cylinder
Close Valve
Retract Cylinder
Open Valve
Cylinder
Vent/Fill Cap (Simplex Pump)
Hose
OR
Pump
Notch in Dipstick (Enerpac Pump)

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

See Figure 8-5 for the following procedures:

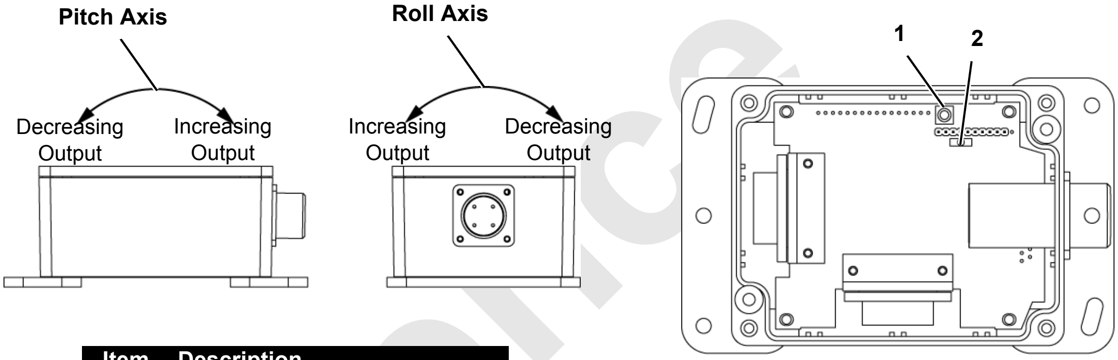
To reset (re-zero) the level sensor:

1. Mount the sensor to a horizontal mounting surface.
2. Remove the cover and apply power to the unit.
3. Ensure that both axes are within ±5° of true level. LED 023 will be lit whenever the level is within ±5° of true level.
4. Press and hold switch SW1 for one (1) second and release.
5. The new "permanent zero" is set and stored in non-volatile memory.
6. Repeat steps 2 through 5 to reset to a different setting if necessary.
7. Disconnect the power and replace the cover.

To re-calibrate the 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 re-calibrated, if necessary, as follows:

1. Turn OFF / disconnect power to the unit.
2. Press and hold down switch SW1 while reapplying power to the unit.
3. Continue to hold down SW1 for one (1) second and release.
4. The new "permanent zero" is set and stored in non-volatile memory.



Item	Description
1	Switch SW1
2	LED 023

FIGURE 8-5

SECTION 9
LUBRICATION

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SECTION 9
LUBRICATION

LUBRICATION GUIDE

See F2105 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 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 Model 2250. 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 the 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 the Model 2250 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 Crane Group 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 for your protection and keep unauthorized personnel away from the crane when troubleshooting.
- Never troubleshoot the crane alone. Always perform troubleshooting procedures with a qualified operator in the crane cab. Maintain constant communications with this operator when performing operations that require the crane to be running.
- Do not return crane to service after completion of maintenance or repair procedures until all guards and covers have been re-installed, trapped air is bled from hydraulic systems, safety devices are re-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 Crane Group cannot foresee all hazards that may occur.

You shall be familiar with the equipment, trained in testing methods, and use common sense while troubleshooting to avoid other hazards.

⚠ WARNING

Eye, Skin, And Respiratory Hazards!

Wear proper eye and skin protection and avoid direct contact with battery acid, oil, or ether spray when searching for leaks, opening connections, or installing pressure gauges.

Pressurized hydraulic oil can cause serious injury. Turn OFF engine, remove key, and relieve pressure on system before disconnecting, adjusting, or repairing any component.

Ensure that connections are made correctly, O-rings or gaskets are in place, and connectors are tight before pressurizing system.

Use necessary precautions to prevent electrical burns when checking battery charging and starter circuits.

Death or serious injury can occur if these warnings are ignored.

⚠ WARNING

Unexpected Moving Part Hazard!

Keep personnel away from crane while manually actuating a valve or pump to avoid unexpected equipment movement that can cause death or serious injury.

GENERAL GUIDELINES

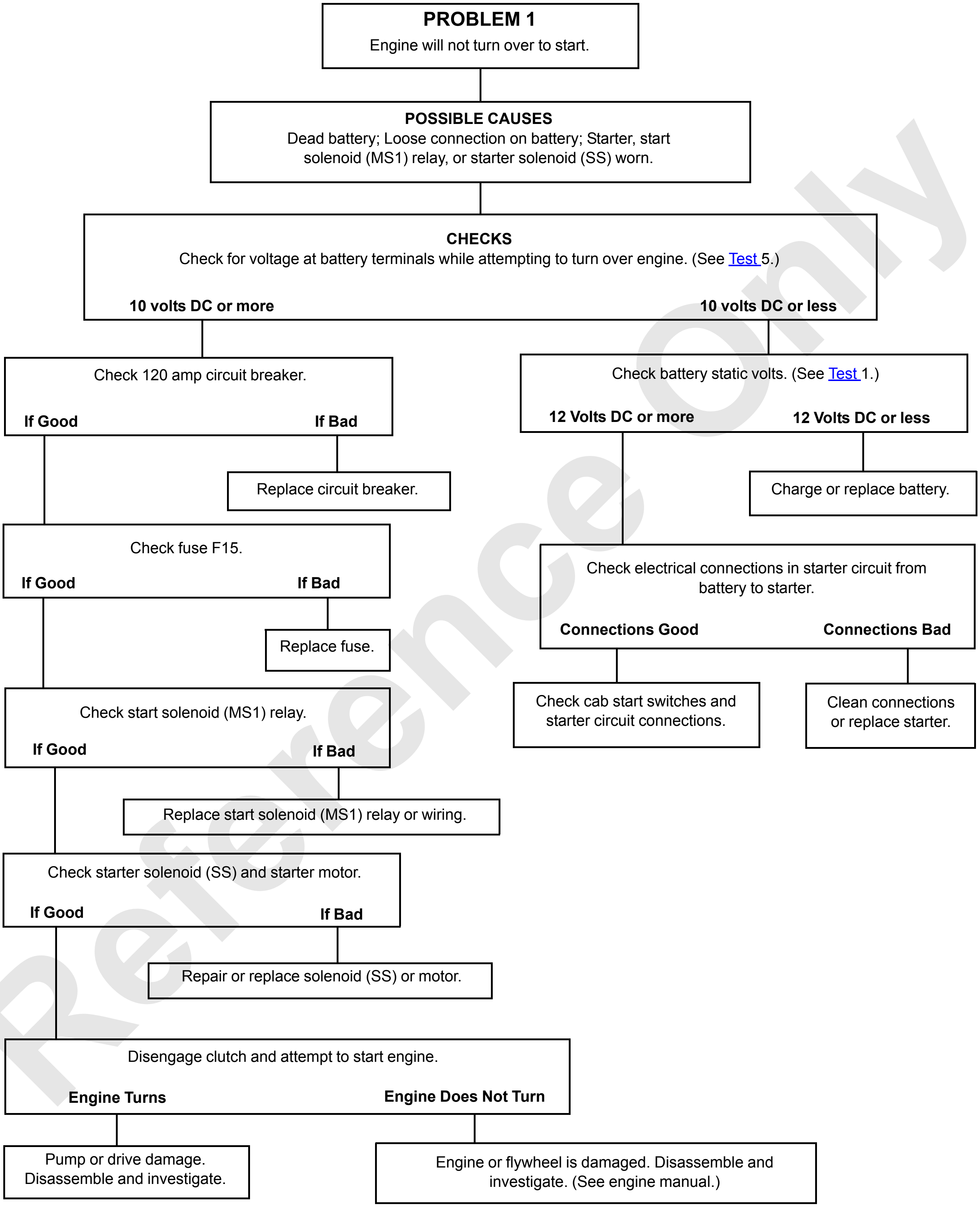
The following guidelines apply to all troubleshooting operations:

- 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 hydraulic oil 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 ground point for circuit being checked. If voltage does not register on multi-meter, use a known ground. If a value is read, the ground of the circuit under test 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 under test. Test the pump electric displacement controls (EDC) on the pump under test.
- Check each pressure sender electric supply at the system sender.
- Check the encoder electric supply at the test plug adapter of the encoder under test.
- 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 under test.
- 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 Model 2250 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 1

Engine will not turn over to start.

POSSIBLE CAUSES

Dead battery; Loose connection on battery; Starter, start solenoid (MS1) relay, or starter solenoid (SS) worn.

CHECKS

Check for voltage at battery terminals while attempting to turn over engine. (See Test 5.)

10 volts DC or more

10 volts DC or less

Check 120 amp circuit breaker.

If Good

If Bad

Replace circuit breaker.

Check fuse F15.

If Good

If Bad

Replace fuse.

Check start solenoid (MS1) relay.

If Good

If Bad

Replace start solenoid (MS1) relay or wiring.

Check starter solenoid (SS) and starter motor.

If Good

If Bad

Repair or replace solenoid (SS) or motor.

Disengage clutch and attempt to start engine.

Engine Turns

Engine Does Not Turn

Pump or drive damage. Disassemble and investigate.

Engine or flywheel is damaged. Disassemble and investigate. (See engine manual.)

Check battery static volts. (See Test 1.)

12 Volts DC or more

12 Volts DC or less

Charge or replace battery.

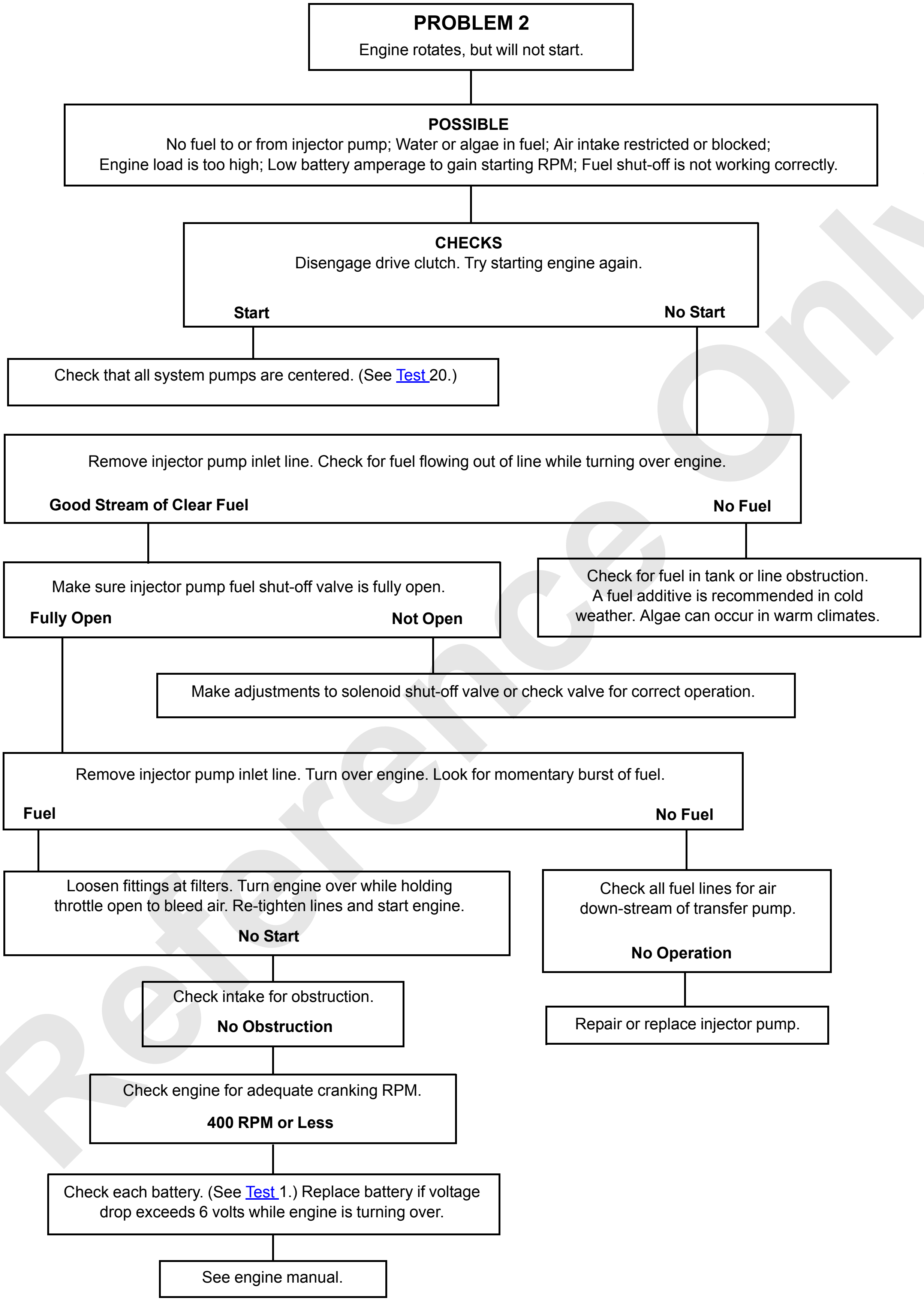
Check electrical connections in starter circuit from battery to starter.

Connections Good

Connections Bad

Check cab start switches and starter circuit connections.

Clean connections or replace starter.



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 / **No Start**

Check that all system pumps are centered. (See Test 20.)

Remove injector pump inlet line. Check for fuel flowing out of line while turning over engine.

Good Stream of Clear Fuel / **No Fuel**

Make sure injector pump fuel shut-off valve is fully open.

Fully Open / **Not Open**

Check for fuel in tank or line obstruction. A fuel additive is recommended in cold weather. Algae can occur in warm climates.

Make adjustments to solenoid shut-off valve or check valve for correct operation.

Remove injector pump inlet line. Turn over engine. Look for momentary burst of fuel.

Fuel / **No Fuel**

Loosen fittings at filters. Turn engine over while holding throttle open to bleed air. Re-tighten lines and start engine.

No Start

Check all fuel lines for air down-stream of transfer pump.

No Operation

Check intake for obstruction.

No Obstruction

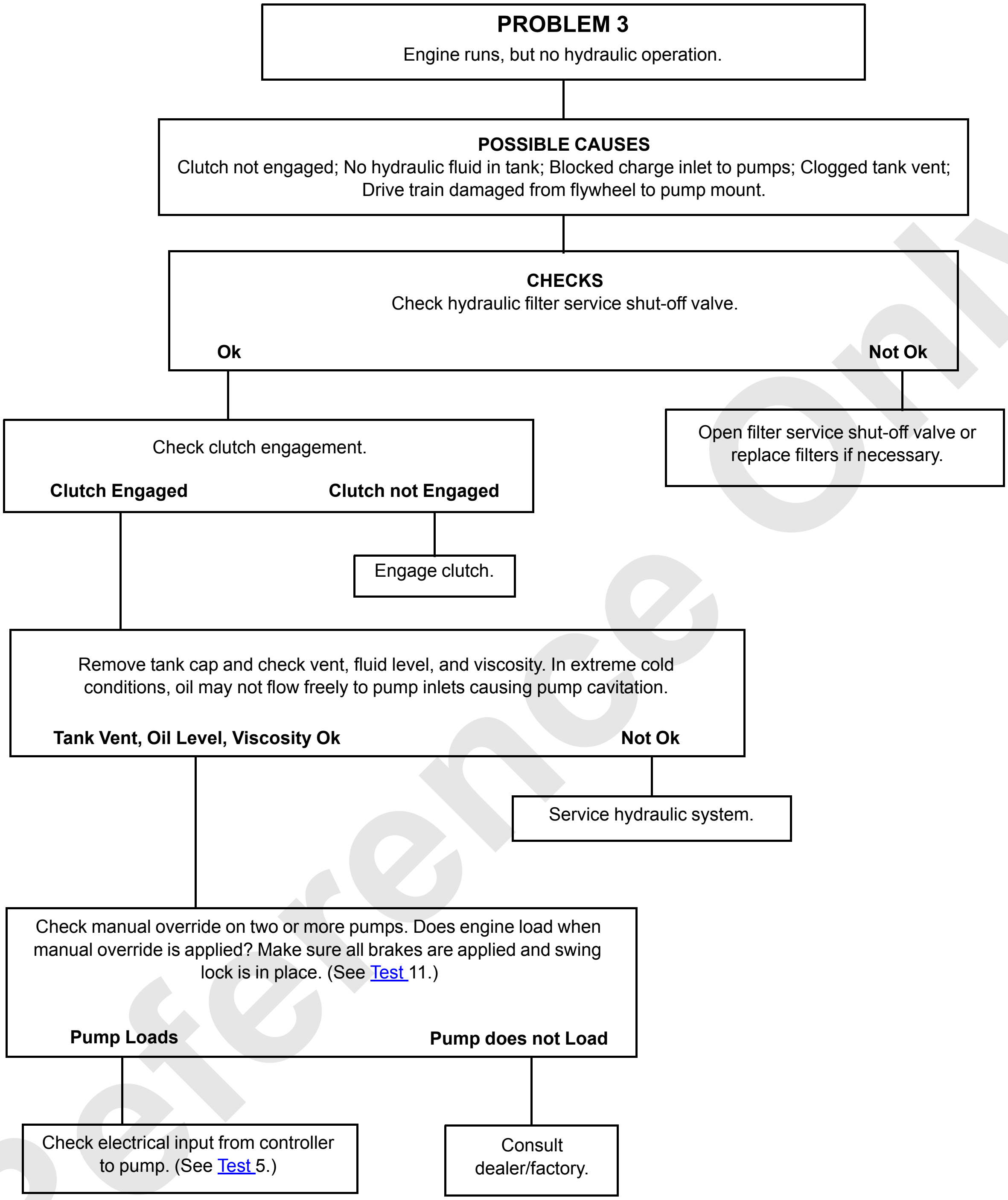
Repair or replace injector pump.

Check engine for adequate cranking RPM.

400 RPM or Less

Check each battery. (See Test 1.) Replace battery if voltage drop exceeds 6 volts while engine is turning over.

See engine manual.



PROBLEM 3

Engine runs, but no hydraulic operation.

POSSIBLE CAUSES

Clutch not engaged; No hydraulic fluid in tank; Blocked charge inlet to pumps; Clogged tank vent; Drive train damaged from flywheel to pump mount.

CHECKS

Check hydraulic filter service shut-off valve.

Ok

Not Ok

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.

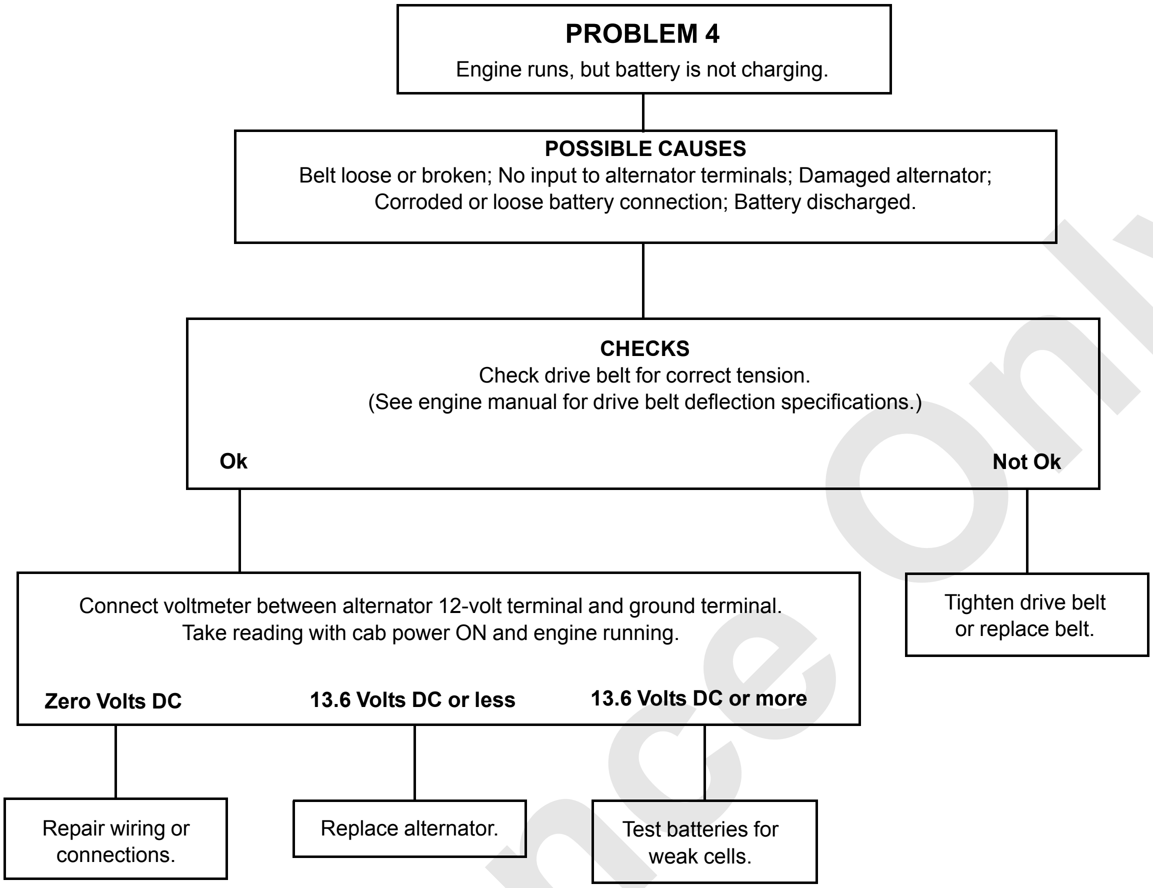
Check manual override on two or more pumps. Does engine load when manual override is applied? Make sure all brakes are applied and swing lock is in place. (See Test 11.)

Pump Loads

Pump does not Load

Check electrical input from controller to pump. (See Test 5.)

Consult dealer/factory.



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.)

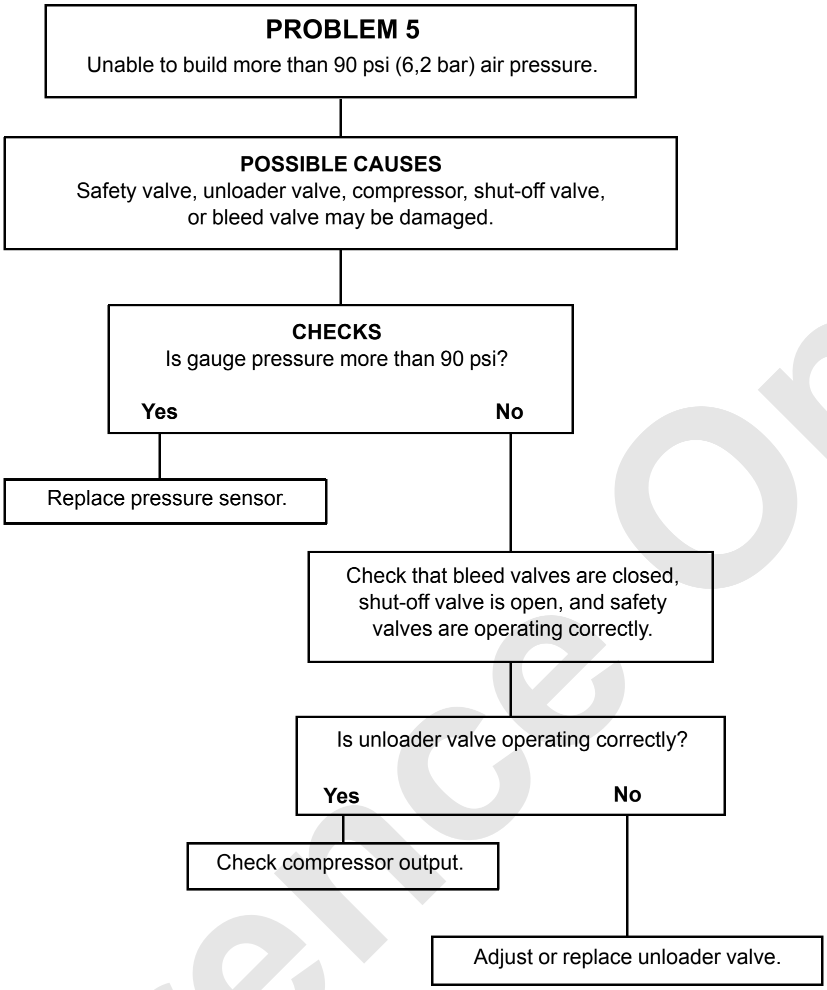
Ok

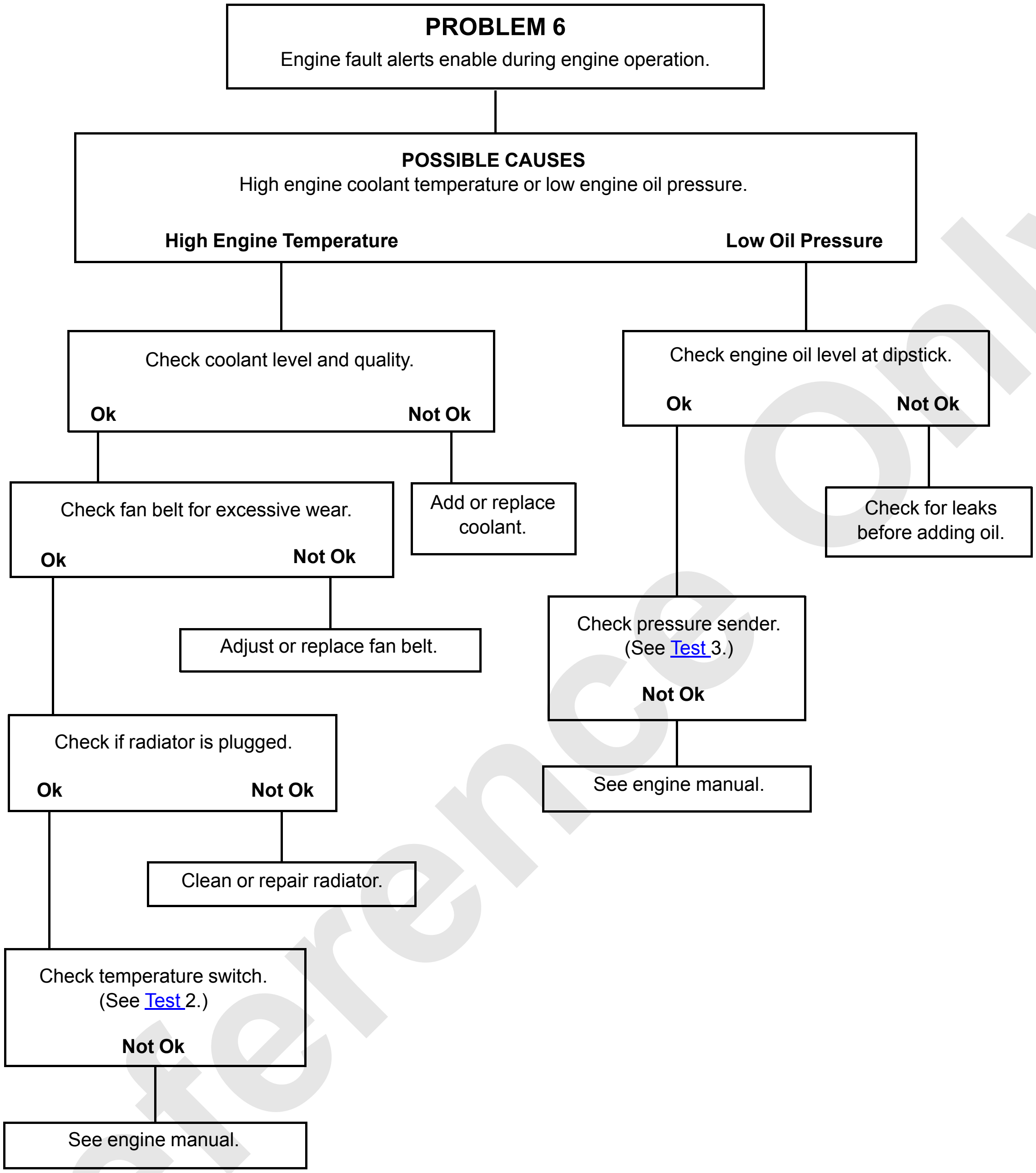
Connect voltmeter between alternator 12-volt terminal and ground terminal. Take reading with cab power ON and engine running.

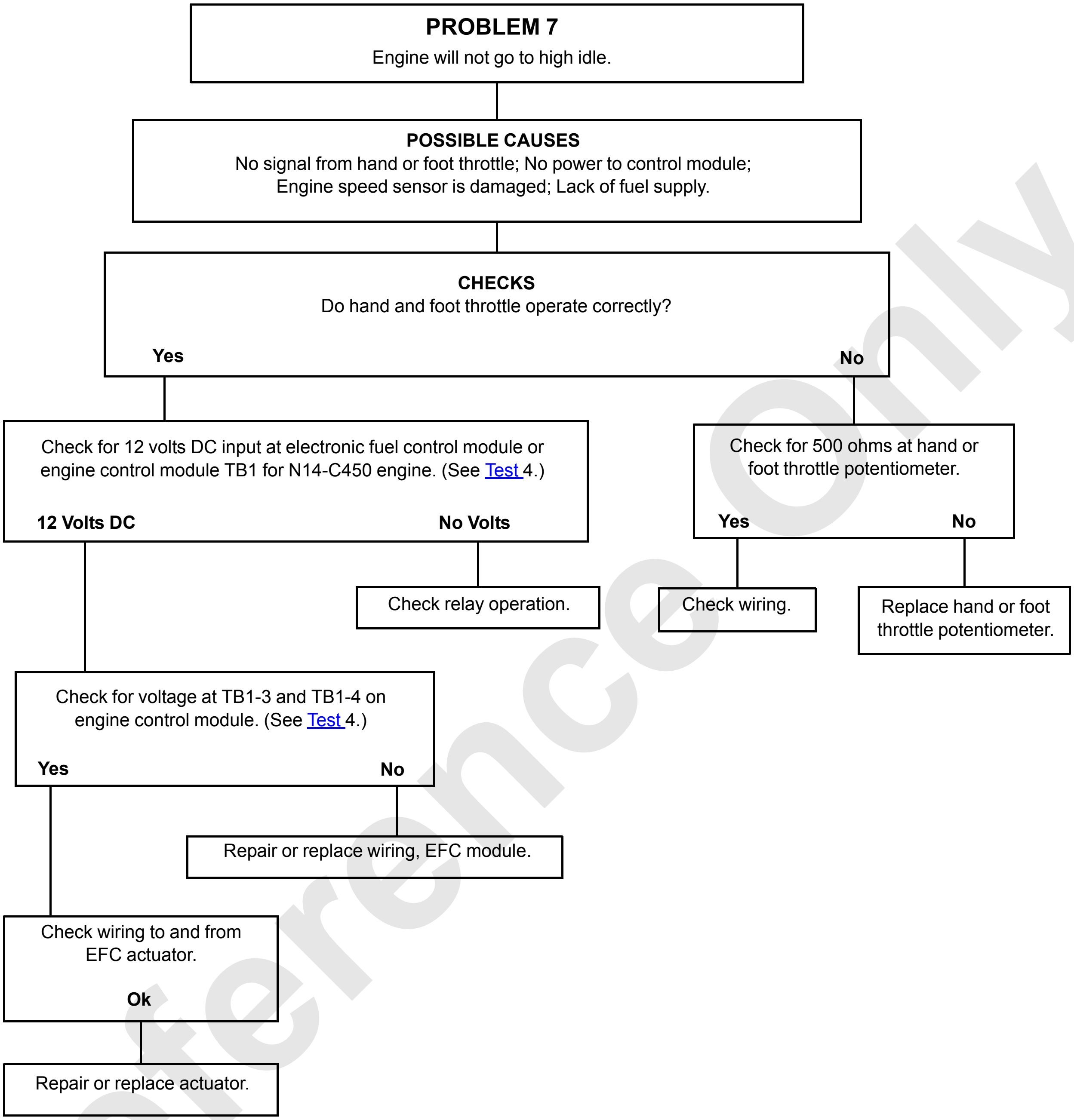
- **Zero Volts DC** – Repair wiring or connections.
- **13.6 Volts DC or less** – Replace alternator.
- **13.6 Volts DC or more** – Test batteries for weak cells.

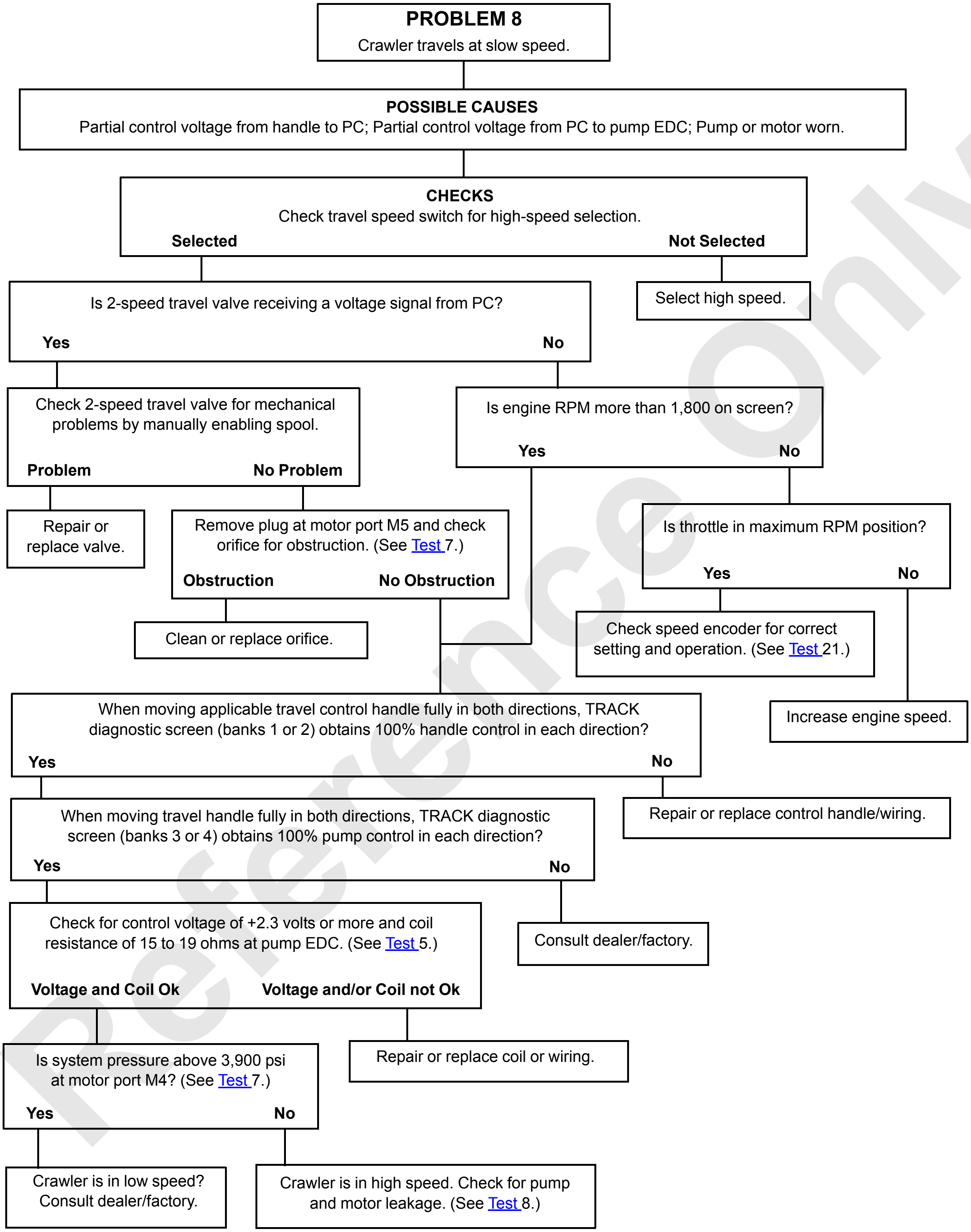
Not Ok

Tighten drive belt or replace belt.


PROBLEM 5
Unable to build more than 90 psi (6,2 bar) air pressure.
POSSIBLE CAUSES
Safety valve, unloader valve, compressor, shut-off valve, or bleed valve may be damaged.
CHECKS
Is gauge pressure more than 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
Check coolant level and quality.
Ok
Not Ok
Add or replace coolant.
Check fan belt for excessive wear.
Ok
Not Ok
Adjust or replace fan belt.
Check if radiator is plugged.
Ok
Not Ok
Clean or repair radiator.
Check temperature switch. (See Test 2.)
Not Ok
See engine manual.
Check engine oil level at dipstick.
Ok
Not Ok
Check for leaks before adding oil.
Check pressure sender. (See Test 3.)
Not Ok
See engine manual.


PROBLEM 7
Engine will not go to high idle.
POSSIBLE CAUSES
No signal from hand or foot throttle; No power to control module; Engine speed sensor is damaged; Lack of fuel supply.
CHECKS
Do hand and foot throttle operate correctly?
Yes
No
Check for 12 volts DC input at electronic fuel control module or engine control module TB1 for N14-C450 engine. (See Test 4.)
12 Volts DC
No Volts
Check relay operation.
Check for 500 ohms at hand or foot throttle potentiometer.
Yes
No
Check wiring.
Replace hand or foot throttle potentiometer.
Check for voltage at TB1-3 and TB1-4 on engine control module. (See Test 4.)
Yes
No
Repair or replace wiring, EFC module.
Check wiring to and from EFC actuator.
Ok
Repair or replace actuator.



PROBLEM 8
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**

Select high speed.

Is 2-speed travel valve receiving a voltage signal from PC?
Yes **No**

Check 2-speed travel valve for mechanical problems by manually enabling spool.
Problem **No Problem**

Repair or replace valve.

Remove plug at motor port M5 and check orifice for obstruction. (See Test 7.)
Obstruction **No Obstruction**

Clean or replace orifice.

Is engine RPM more than 1,800 on screen?
Yes **No**

Is throttle in maximum RPM position?
Yes **No**

Check speed encoder for correct setting and operation. (See Test 21.)

Increase engine speed.

When moving applicable travel control handle fully in both directions, TRACK diagnostic screen (banks 1 or 2) obtains 100% handle control in each direction?
Yes **No**

Repair or replace control handle/wiring.

When moving travel handle fully in both directions, TRACK diagnostic screen (banks 3 or 4) obtains 100% pump control in each direction?
Yes **No**

Consult dealer/factory.

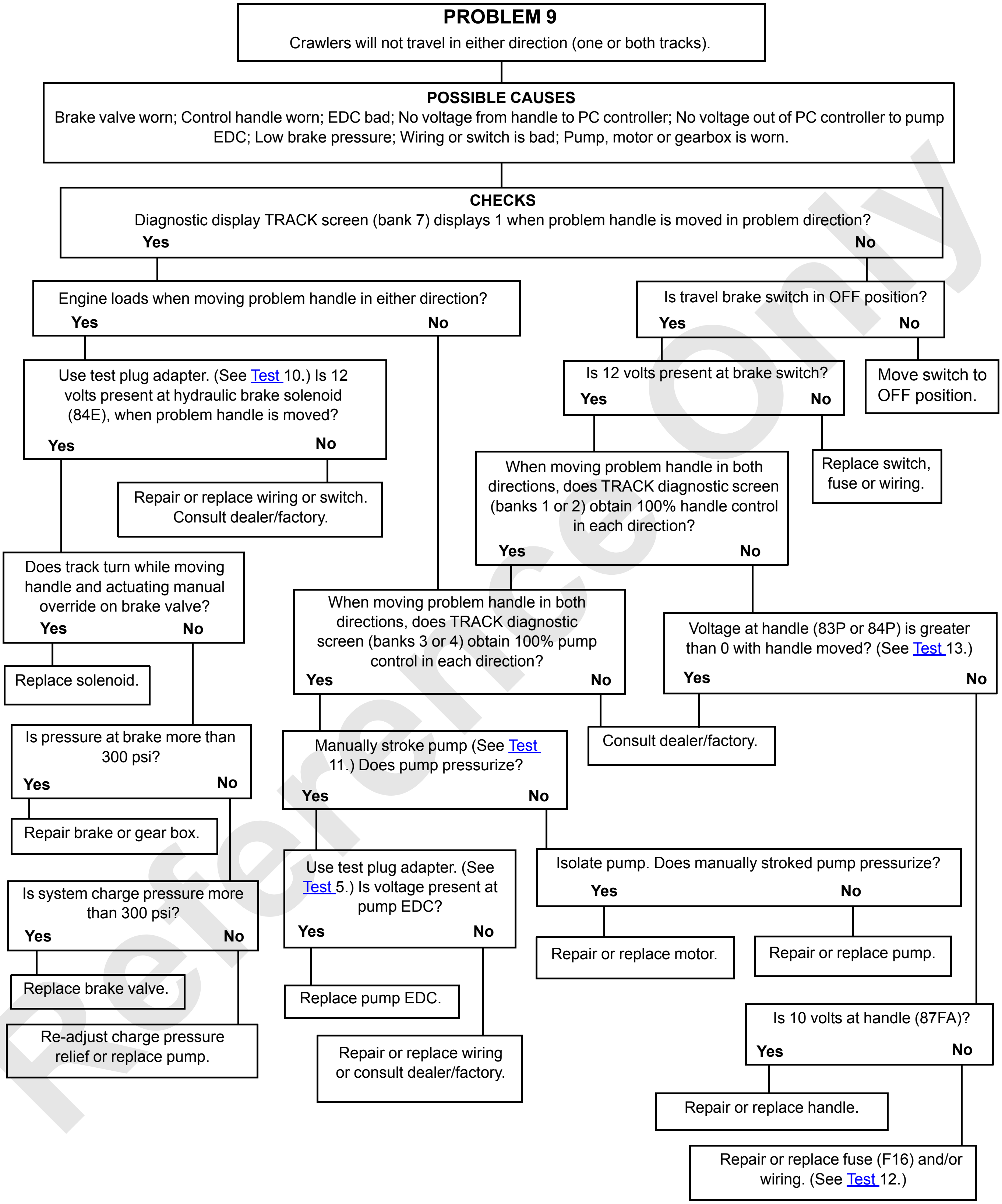
Check for control voltage of +2.3 volts or more and coil resistance of 15 to 19 ohms at pump EDC. (See Test 5.)
Voltage and Coil Ok **Voltage and/or Coil not Ok**

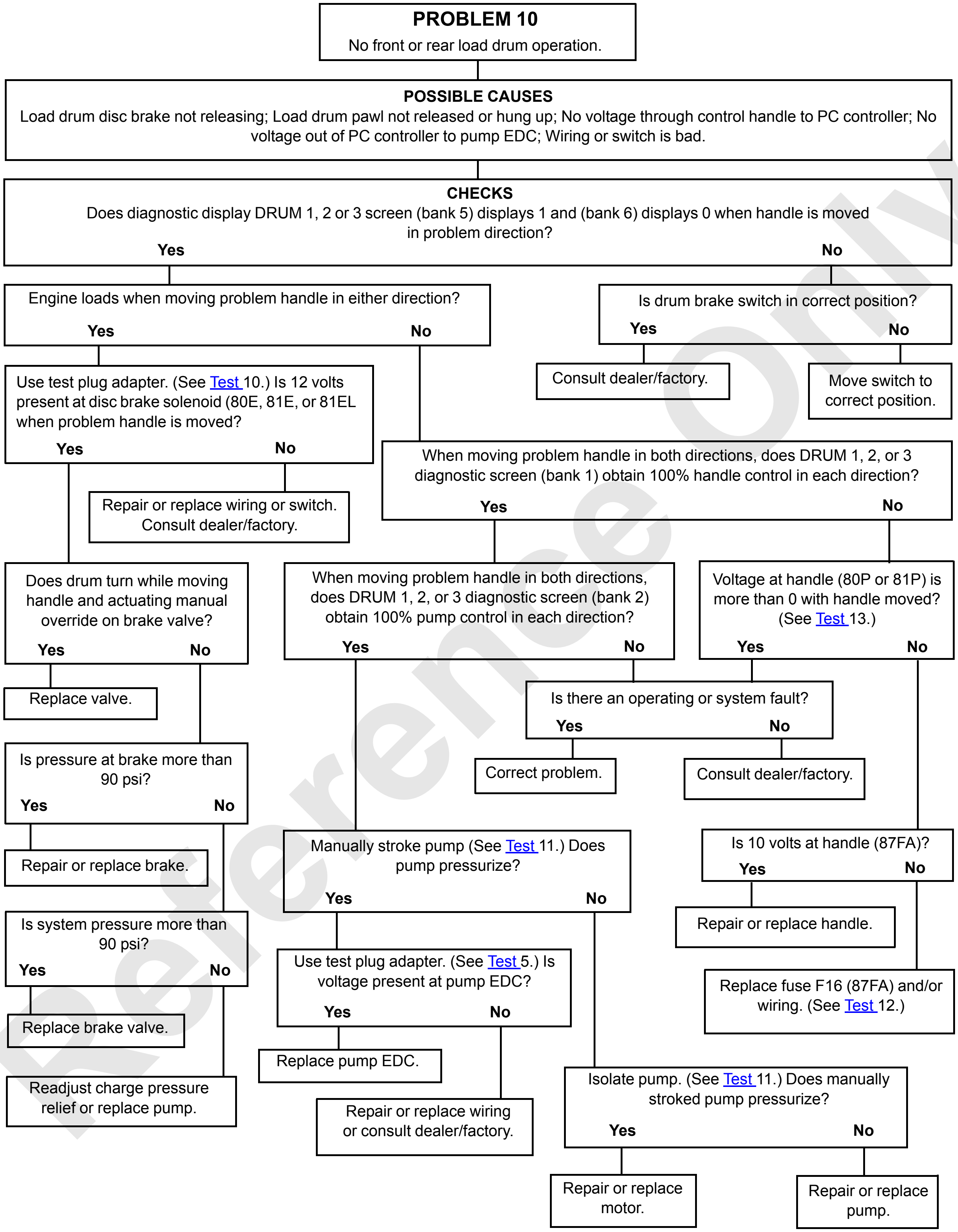
Repair or replace coil or wiring.

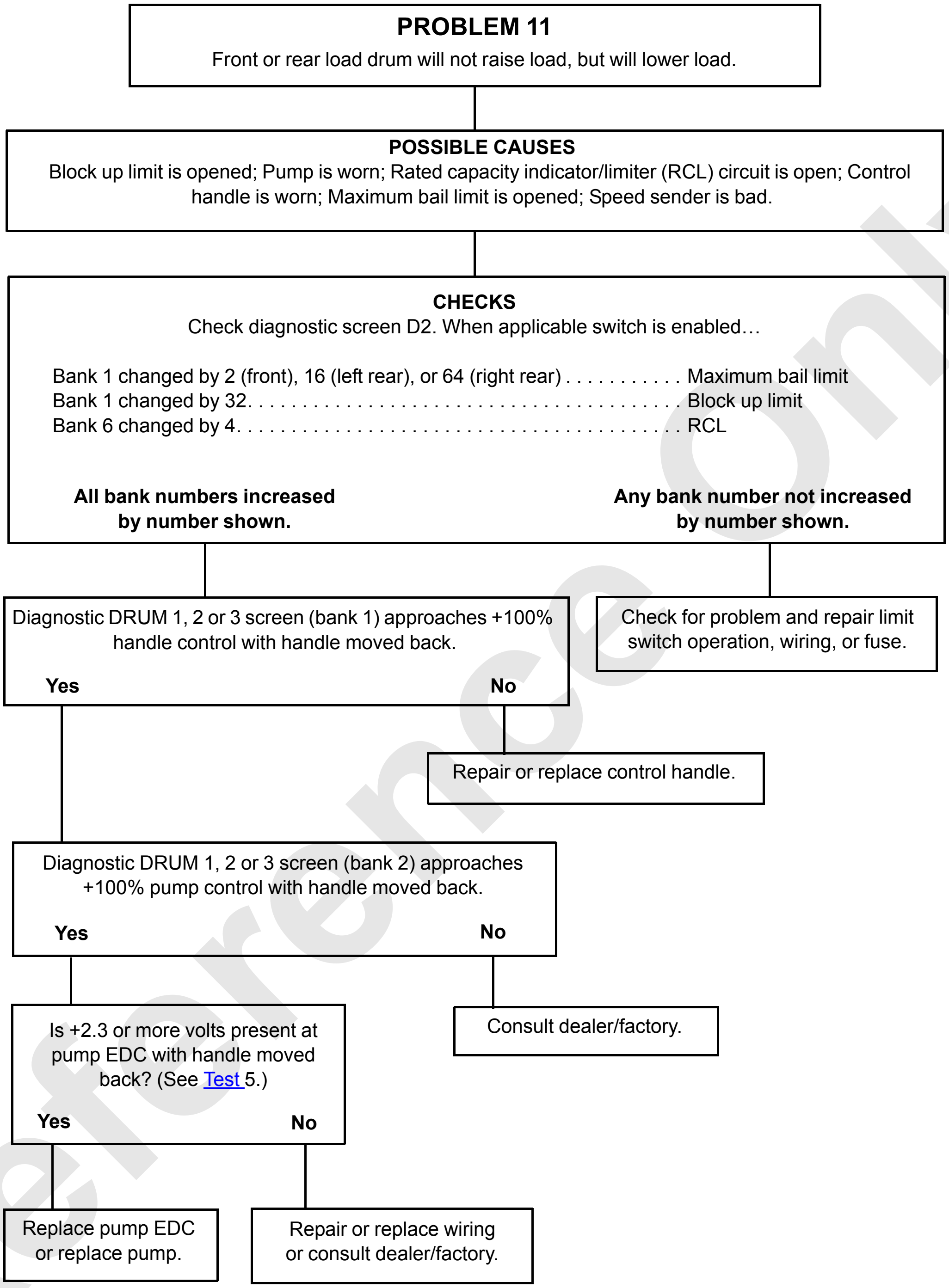
Is system pressure above 3,900 psi at motor port M4? (See Test 7.)
Yes **No**

Crawler is in low speed? Consult dealer/factory.

Crawler is in high speed. Check for pump and motor leakage. (See Test 8.)


PROBLEM 9
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
Diagnostic display TRACK screen (bank 7) displays 1 when problem handle is moved in problem direction?
Yes
No
Engine loads when moving problem handle in either direction?
Yes
No
Is travel brake switch in OFF position?
Yes
No
Use test plug adapter. (See Test 10.) Is 12 volts present at hydraulic brake solenoid (84E), when problem handle is moved?
Yes
No
Is 12 volts present at brake switch?
Yes
No
Move switch to OFF position.
Repair or replace wiring or switch. Consult dealer/factory.
When moving problem handle in both directions, does TRACK diagnostic screen (banks 1 or 2) obtain 100% handle control in each direction?
Yes
No
Replace switch, fuse or wiring.
Does track turn while moving handle and actuating manual override on brake valve?
Yes
No
When moving problem handle in both directions, does TRACK diagnostic screen (banks 3 or 4) obtain 100% pump control in each direction?
Yes
No
Voltage at handle (83P or 84P) is greater than 0 with handle moved? (See Test 13.)
Yes
No
Replace solenoid.
Is pressure at brake more than 300 psi?
Yes
No
Manually stroke pump (See Test 11.) Does pump pressurize?
Yes
No
Consult dealer/factory.
Repair brake or gear box.
Use test plug adapter. (See Test 5.) Is voltage present at pump EDC?
Yes
No
Isolate pump. Does manually stroked pump pressurize?
Yes
No
Is system charge pressure more than 300 psi?
Yes
No
Repair or replace motor.
Repair or replace pump.
Replace brake valve.
Replace pump EDC.
Re-adjust charge pressure relief or replace pump.
Repair or replace wiring or consult dealer/factory.
Is 10 volts at handle (87FA)?
Yes
No
Repair or replace handle.
Repair or replace fuse (F16) and/or wiring. (See Test 12.)


PROBLEM 10
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) displays 1 and (bank 6) displays 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 10.) Is 12 volts present at disc brake solenoid (80E, 81E, or 81EL when problem handle is moved?
Yes
No
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
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 1, 2, or 3 diagnostic screen (bank 2) obtain 100% pump control in each direction?
Yes
No
Voltage at handle (80P or 81P) is more than 0 with handle moved? (See Test 13.)
Yes
No
Replace valve.
Is there an operating or system fault?
Yes
No
Is pressure at brake more than 90 psi?
Yes
No
Correct problem.
Consult dealer/factory.
Repair or replace brake.
Manually stroke pump (See Test 11.) Does pump pressurize?
Yes
No
Is 10 volts at handle (87FA)?
Yes
No
Repair or replace handle.
Is system pressure more than 90 psi?
Yes
No
Use test plug adapter. (See Test 5.) Is voltage present at pump EDC?
Yes
No
Replace fuse F16 (87FA) and/or wiring. (See Test 12.)
Replace brake valve.
Replace pump EDC.
Readjust charge pressure relief or replace pump.
Repair or replace wiring or consult dealer/factory.
Isolate pump. (See Test 11.) Does manually stroked pump pressurize?
Yes
No
Repair or replace motor.
Repair or replace pump.



PROBLEM 11

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.

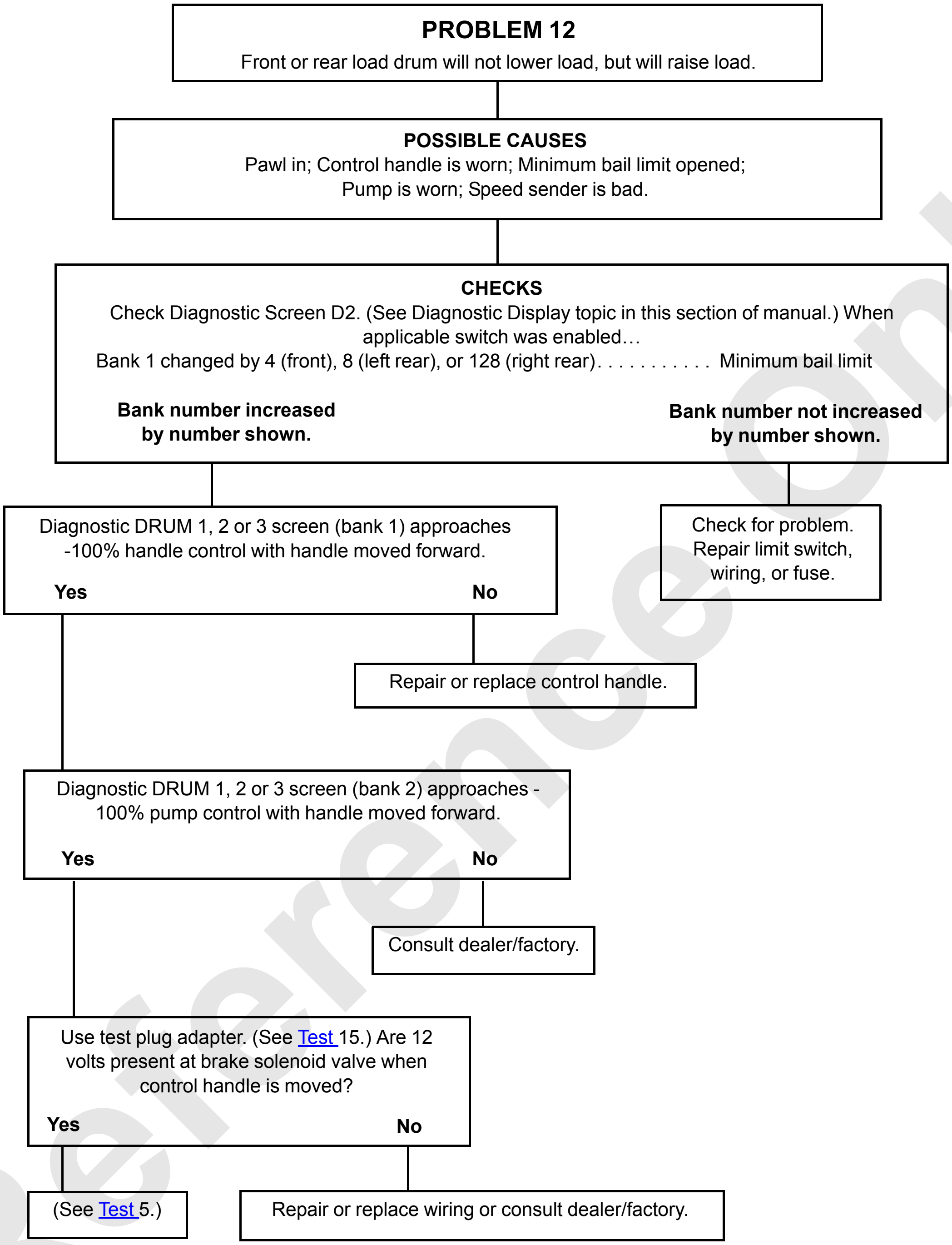
Diagnostic DRUM 1, 2 or 3 screen (bank 2) approaches +100% pump control with handle moved back.

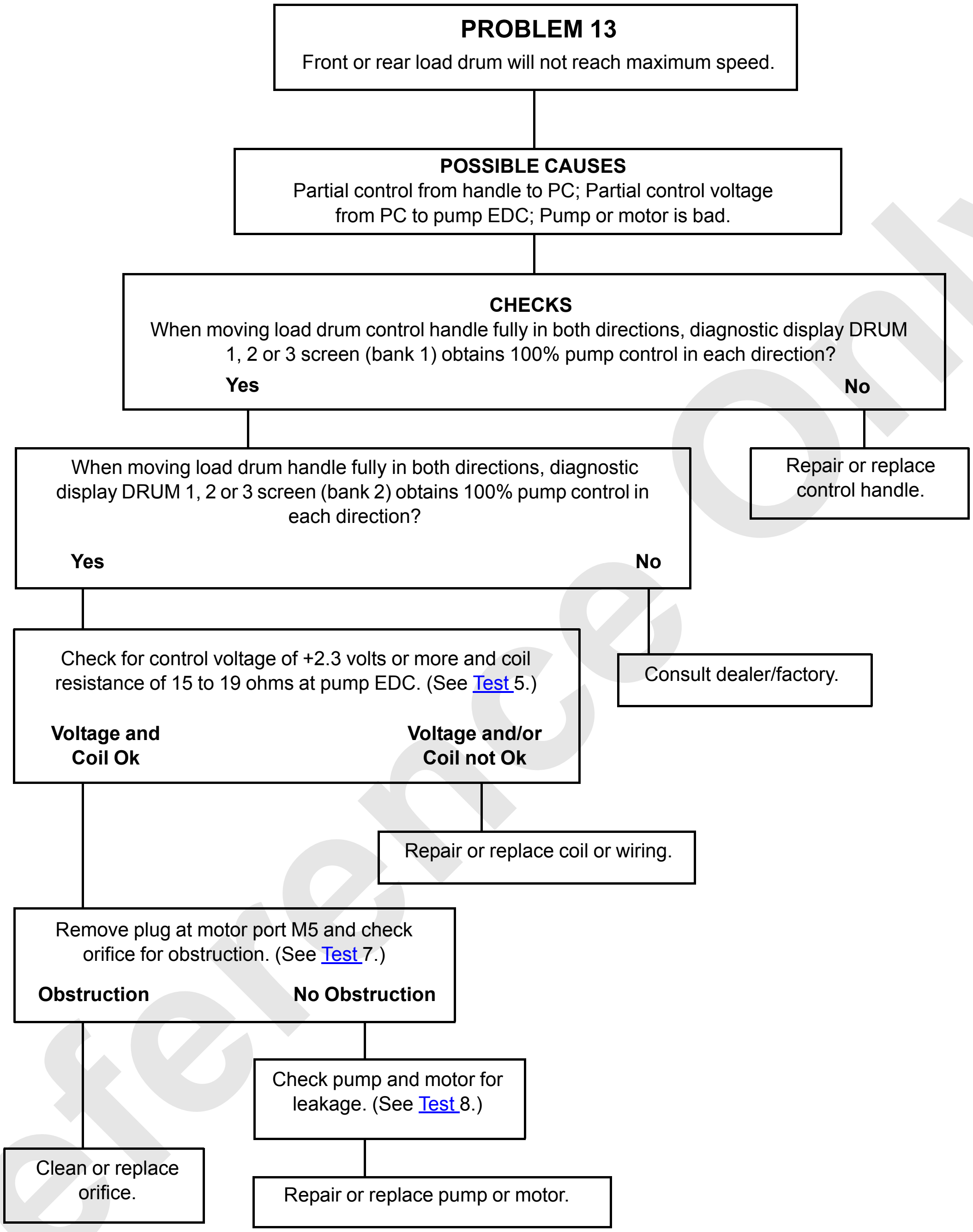
Is +2.3 or more volts present at pump EDC with handle moved back? (See Test 5.)

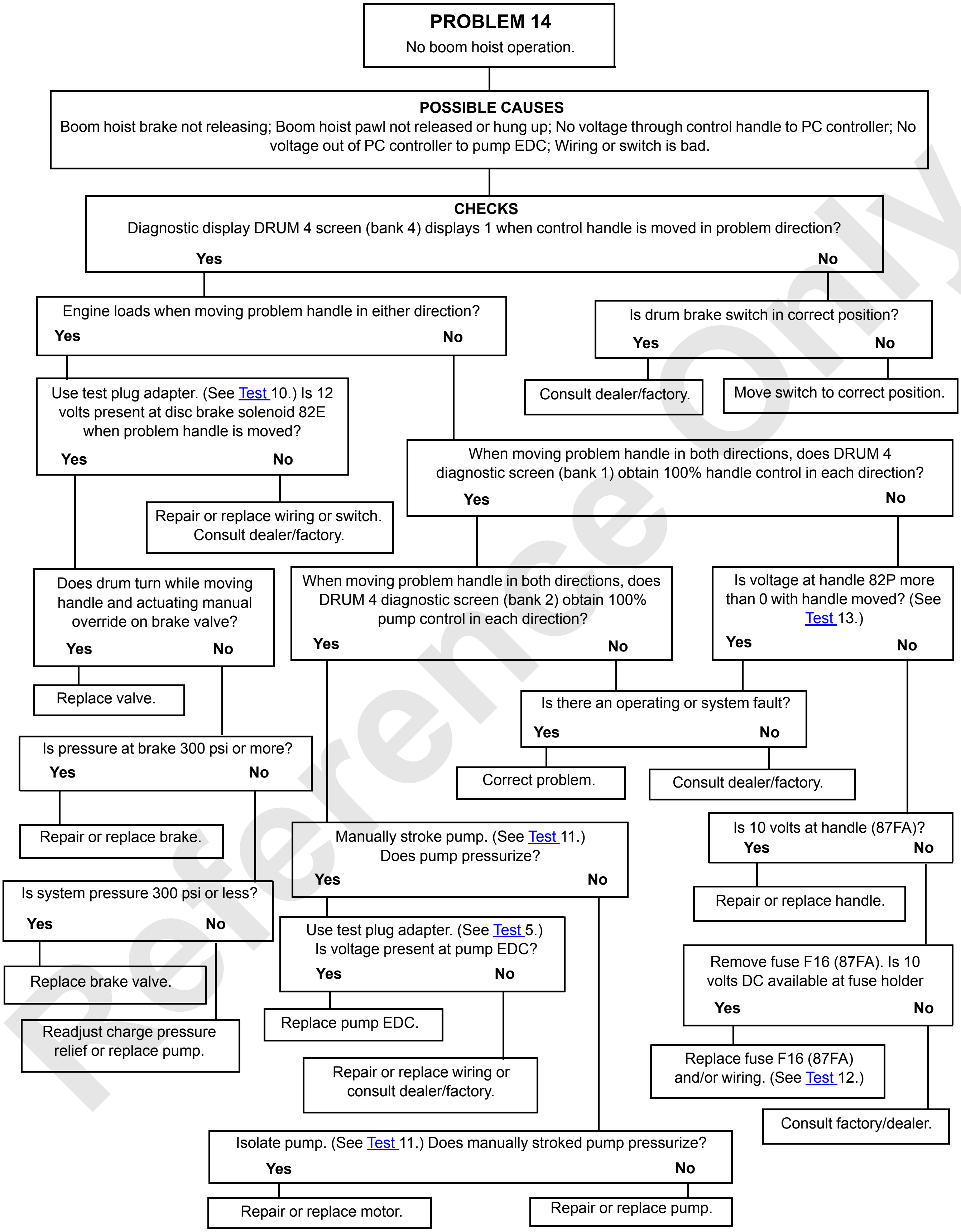
Consult dealer/factory.

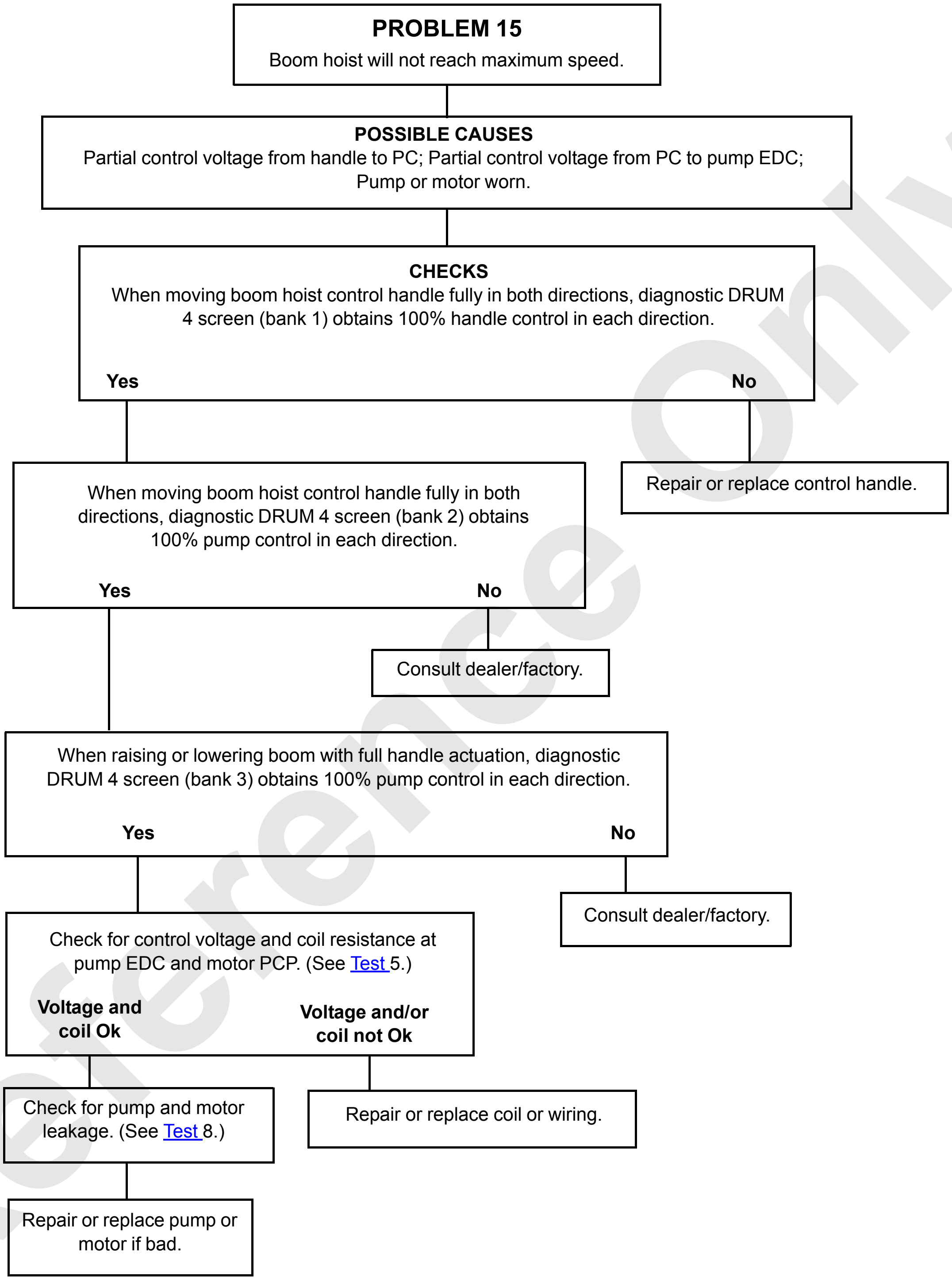
Replace pump EDC or replace pump.

Repair or replace wiring or consult dealer/factory.


PROBLEM 12
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.
Diagnostic DRUM 1, 2 or 3 screen (bank 1) approaches -100% handle control with handle moved forward.
Yes
No
Check for problem. Repair limit switch, wiring, or fuse.
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 dealer/factory.
Use test plug adapter. (See Test 15.) Are 12 volts present at brake solenoid valve when control handle is moved?
Yes
No
(See Test 5.)
Repair or replace wiring or consult dealer/factory.


PROBLEM 13
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, diagnostic display DRUM 1, 2 or 3 screen (bank 1) obtains 100% pump control in each direction?
Yes
No
Repair or replace control handle.
When moving load drum handle fully in both directions, diagnostic display DRUM 1, 2 or 3 screen (bank 2) obtains 100% pump control in each direction?
Yes
No
Consult dealer/factory.
Check for control voltage of +2.3 volts or more and coil resistance of 15 to 19 ohms at pump EDC. (See Test 5.)
Voltage and Coil Ok
Voltage and/or Coil not Ok
Repair or replace coil or wiring.
Remove plug at motor port M5 and check orifice for obstruction. (See Test 7.)
Obstruction
No Obstruction
Check pump and motor for leakage. (See Test 8.)
Clean or replace orifice.
Repair or replace pump or motor.


PROBLEM 14
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
Diagnostic display DRUM 4 screen (bank 4) displays 1 when control 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 10.) Is 12 volts present at disc brake solenoid 82E 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 4 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 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 13.)
Yes
No
Is there an operating or system fault?
Yes
No
Correct problem.
Consult dealer/factory.
Is pressure at brake 300 psi or more?
Yes
No
Repair or replace brake.
Manually stroke pump. (See Test 11.) Does pump pressurize?
Yes
No
Is 10 volts at handle (87FA)?
Yes
No
Repair or replace handle.
Is system pressure 300 psi or less?
Yes
No
Replace brake valve.
Readjust charge pressure relief or replace pump.
Use test plug adapter. (See Test 5.) Is voltage present at pump EDC?
Yes
No
Replace pump EDC.
Repair or replace wiring or consult dealer/factory.
Remove fuse F16 (87FA). Is 10 volts DC available at fuse holder
Yes
No
Replace fuse F16 (87FA) and/or wiring. (See Test 12.)
Consult factory/dealer.
Isolate pump. (See Test 11.) Does manually stroked pump pressurize?
Yes
No
Repair or replace motor.
Repair or replace pump.



PROBLEM 15

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, diagnostic DRUM 4 screen (bank 1) obtains 100% handle control in each direction.

Yes – When moving boom hoist control handle fully in both directions, diagnostic DRUM 4 screen (bank 2) obtains 100% pump control in each direction.

No – Repair or replace control handle.

When moving boom hoist control handle fully in both directions, diagnostic DRUM 4 screen (bank 2) obtains 100% pump control in each direction.

Yes – When raising or lowering boom with full handle actuation, diagnostic DRUM 4 screen (bank 3) obtains 100% pump control in each direction.

No – Consult dealer/factory.

When raising or lowering boom with full handle actuation, diagnostic DRUM 4 screen (bank 3) obtains 100% pump control in each direction.

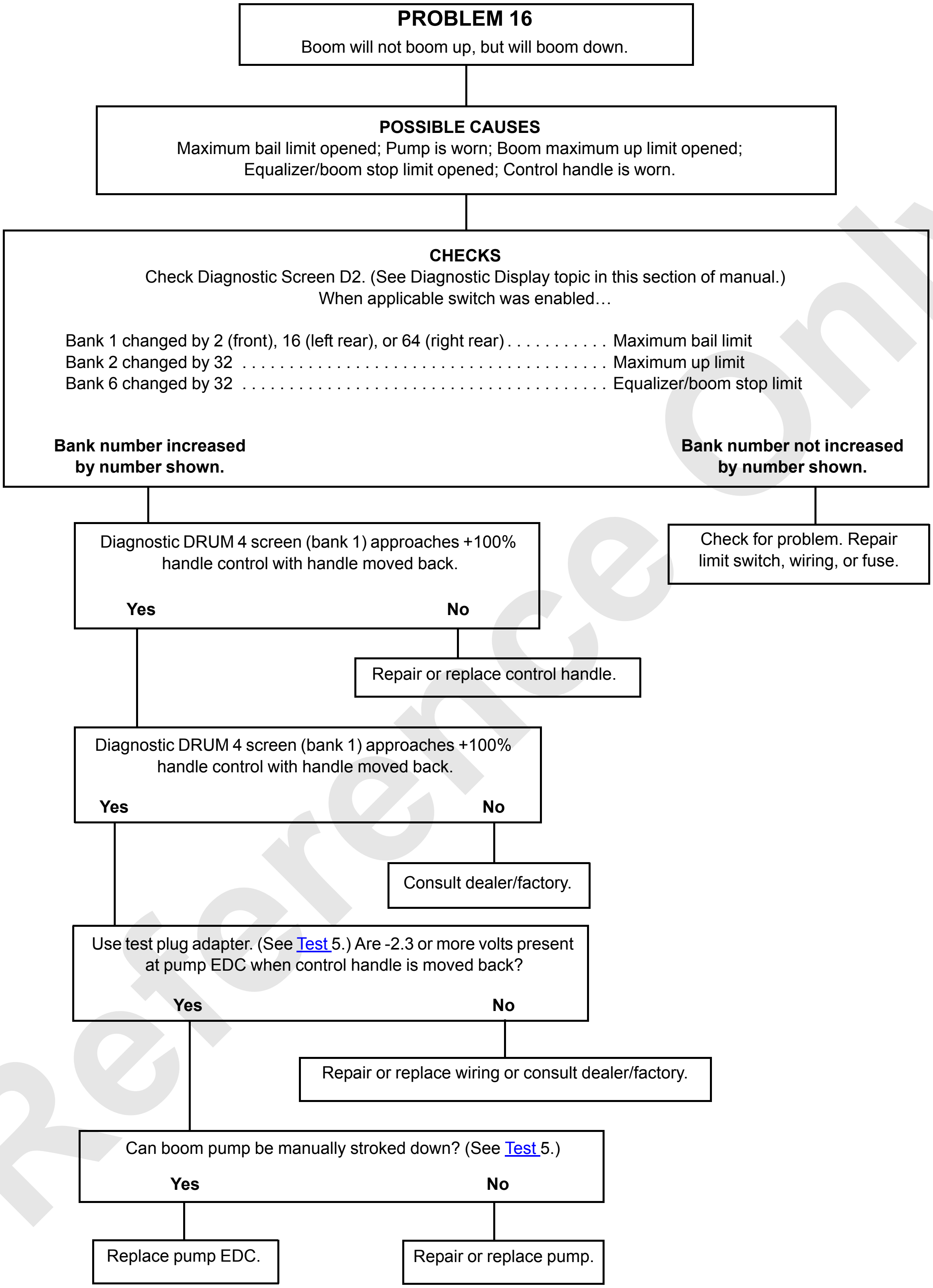
Yes – Check for control voltage and coil resistance at pump EDC and motor PCP. (See Test 5.)

No – Consult dealer/factory.

Check for control voltage and coil resistance at pump EDC and motor PCP. (See Test 5.)

Voltage and coil Ok – Check for pump and motor leakage. (See Test 8.) – Repair or replace pump or motor if bad.

Voltage and/or coil not Ok – Repair or replace coil or wiring.



PROBLEM 16

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.

Diagnostic DRUM 4 screen (bank 1) approaches +100% handle control with handle moved back.

Yes

Diagnostic DRUM 4 screen (bank 1) approaches +100% handle control with handle moved back.

Yes

Use test plug adapter. (See Test 5.) Are -2.3 or more volts present at pump EDC when control handle is moved back?

Yes

Can boom pump be manually stroked down? (See Test 5.)

Yes

Replace pump EDC.

No

Repair or replace pump.

No (pump EDC voltage)

Repair or replace wiring or consult dealer/factory.

No (second DRUM 4 check)

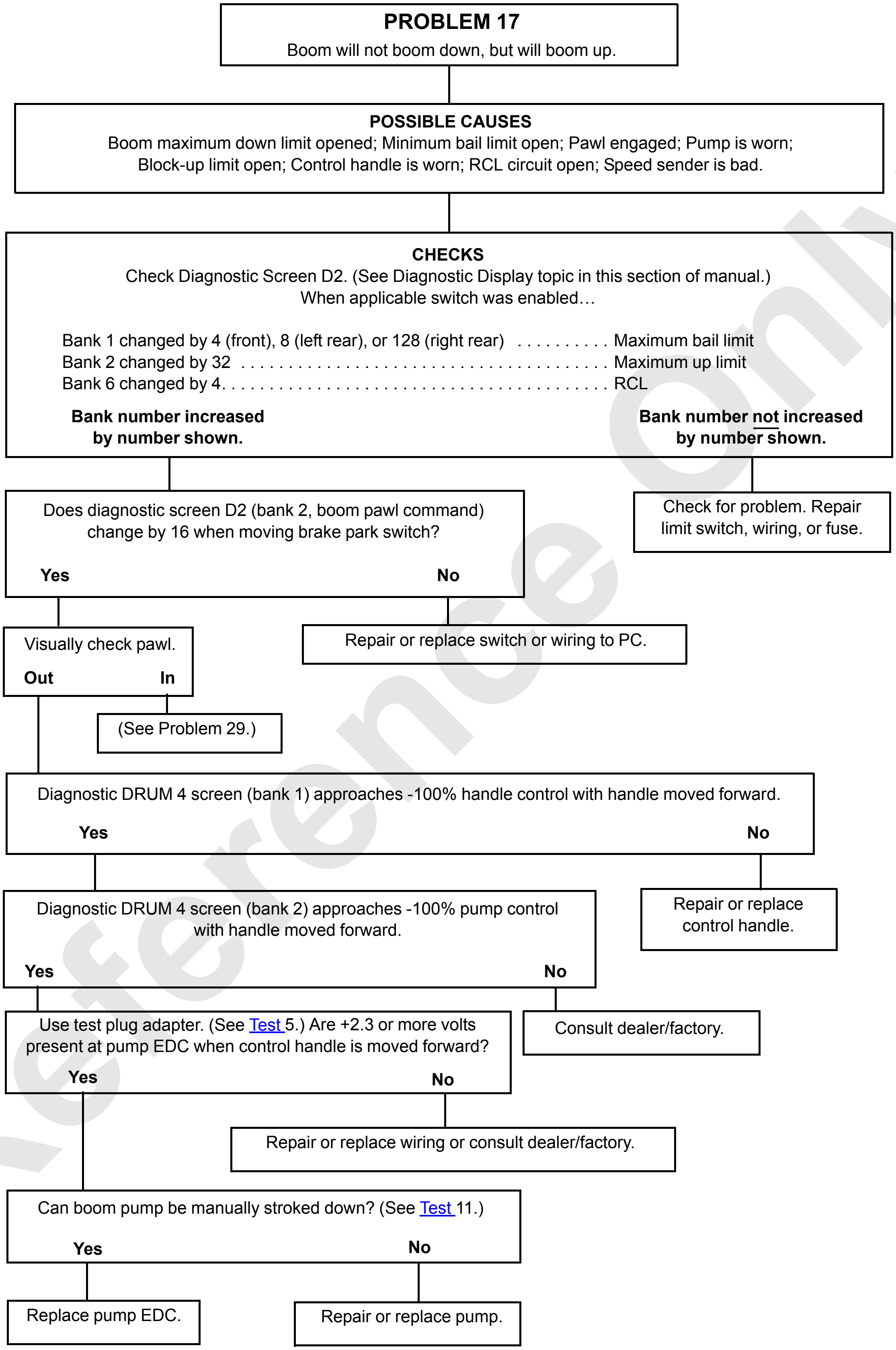
Consult dealer/factory.

No (first DRUM 4 check)

Repair or replace control handle.

Bank number not increased by number shown.

Check for problem. Repair limit switch, wiring, or fuse.



PROBLEM 17

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.)

Diagnostic DRUM 4 screen (bank 1) approaches -100% handle control with handle moved forward.

Yes **No**

Repair or replace control handle.

Diagnostic DRUM 4 screen (bank 2) approaches -100% pump control with handle moved forward.

Yes **No**

Consult dealer/factory.

Use test plug adapter. (See Test 5.) Are +2.3 or more volts present at pump EDC when control handle is moved forward?

Yes **No**

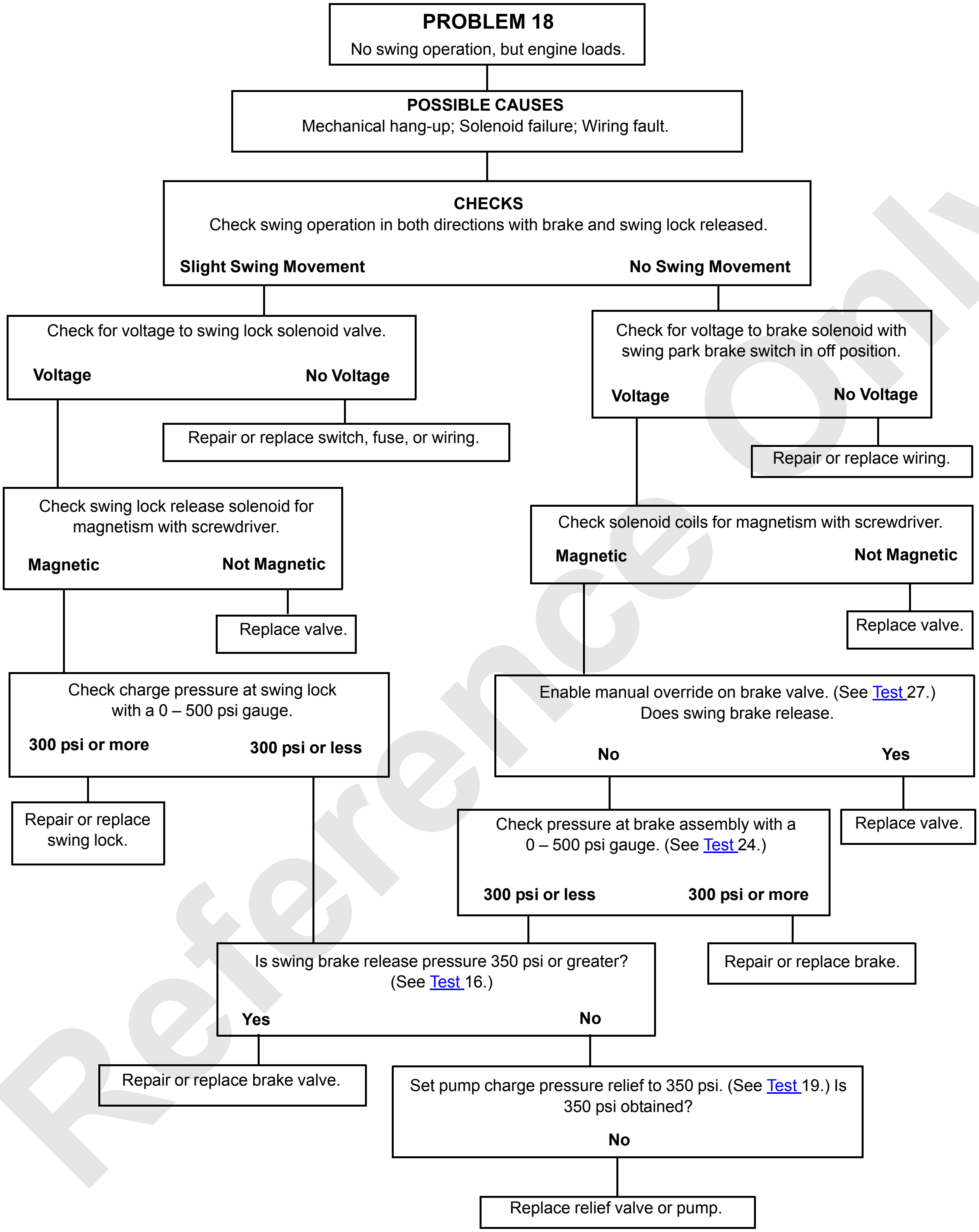
Repair or replace wiring or consult dealer/factory.

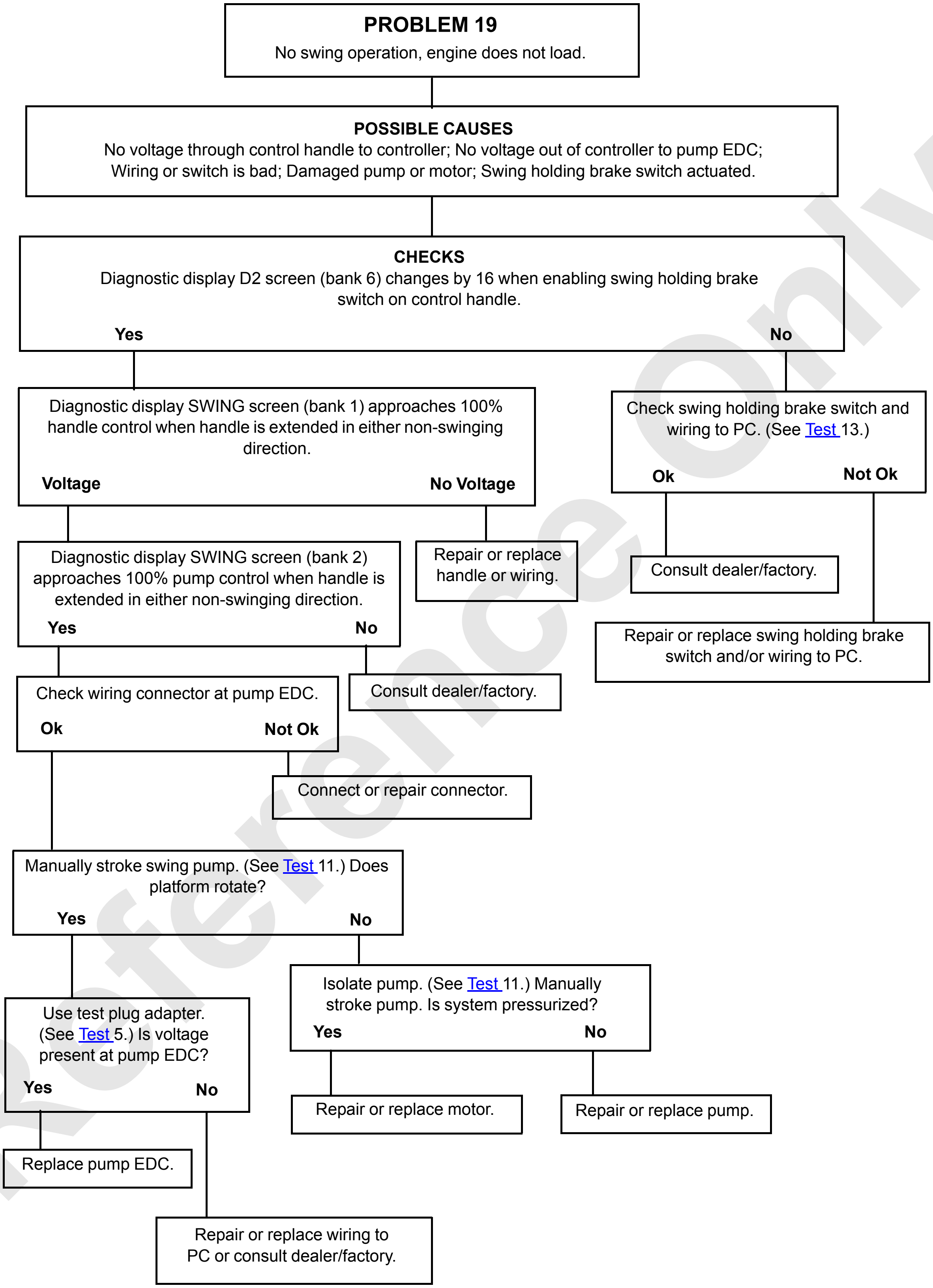
Can boom pump be manually stroked down? (See Test 11.)

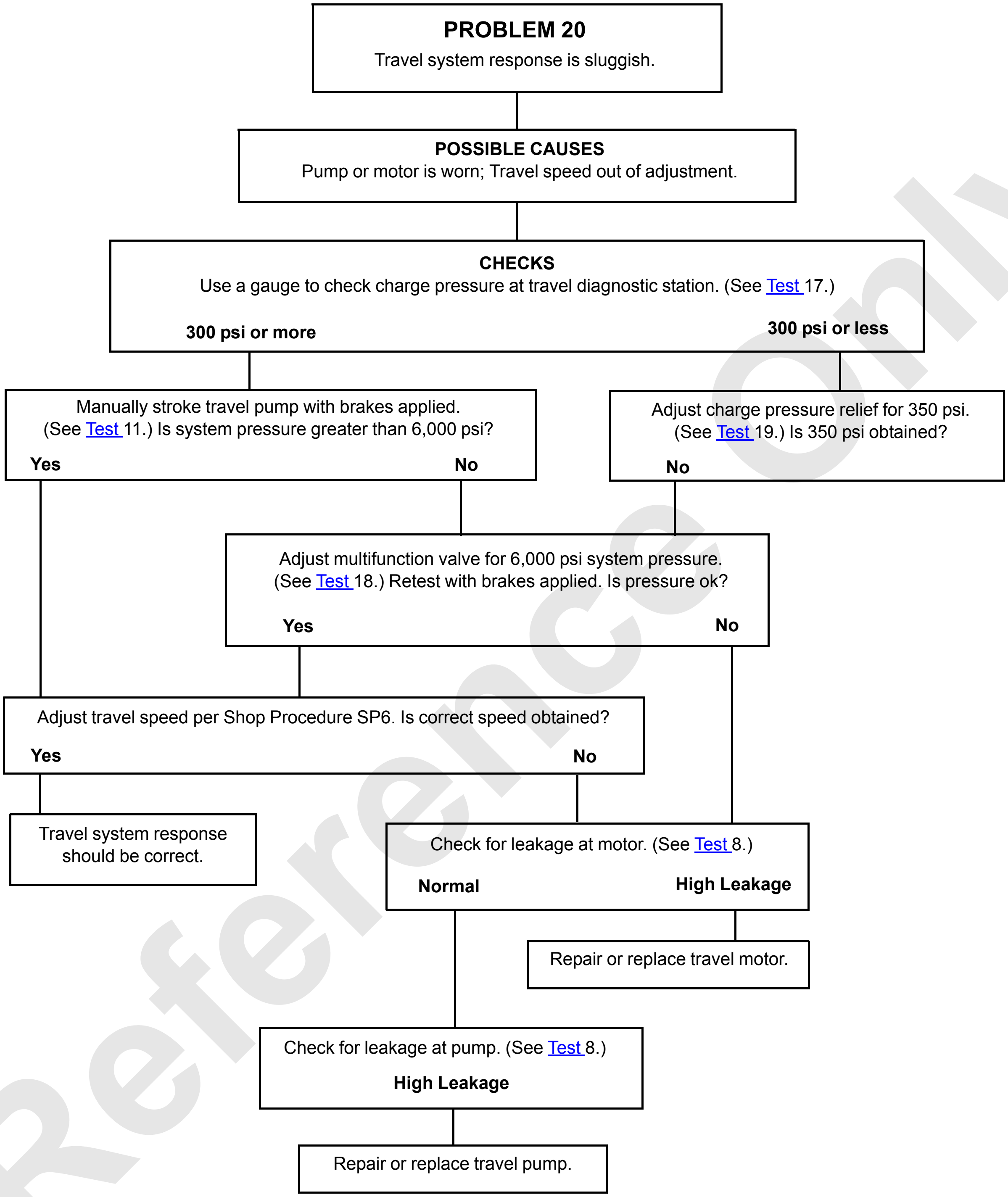
Yes **No**

Replace pump EDC.

Repair or replace pump.


PROBLEM 18
No swing operation, but engine loads.
POSSIBLE CAUSES
Mechanical hang-up; Solenoid failure; Wiring fault.
CHECKS
Check swing operation in both directions with brake and swing lock released.
Slight Swing Movement
No Swing Movement
Check for voltage to swing lock solenoid valve.
Voltage
No Voltage
Repair or replace switch, fuse, or wiring.
Check swing lock release solenoid for magnetism with screwdriver.
Magnetic
Not Magnetic
Replace valve.
Check charge pressure at swing lock with a 0 – 500 psi gauge.
300 psi or more
300 psi or less
Repair or replace swing lock.
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 27.) Does swing brake release.
No
Yes
Replace valve.
Check pressure at brake assembly with a 0 – 500 psi gauge. (See Test 24.)
300 psi or less
300 psi or more
Repair or replace brake.
Is swing brake release pressure 350 psi or greater? (See Test 16.)
Yes
No
Repair or replace brake valve.
Set pump charge pressure relief to 350 psi. (See Test 19.) Is 350 psi obtained?
No
Replace relief valve or pump.


PROBLEM 19
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
Diagnostic display D2 screen (bank 6) changes by 16 when enabling swing holding brake switch on control handle.
Yes
No
Diagnostic display SWING screen (bank 1) approaches 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 13.)
Ok
Not Ok
Diagnostic display SWING screen (bank 2) approaches 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 dealer/factory.
Connect or repair connector.
Manually stroke swing pump. (See Test 11.) Does platform rotate?
Yes
No
Isolate pump. (See Test 11.) Manually stroke pump. Is system pressurized?
Yes
No
Use test plug adapter. (See Test 5.) Is voltage present at pump EDC?
Yes
No
Repair or replace motor.
Repair or replace pump.
Replace pump EDC.
Repair or replace wiring to PC or consult dealer/factory.



PROBLEM 20

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 17.)

Manually stroke travel pump with brakes applied. (See Test 11.) Is system pressure greater than 6,000 psi?

Adjust charge pressure relief for 350 psi. (See Test 19.) Is 350 psi obtained?

Adjust multifunction valve for 6,000 psi system pressure. (See Test 18.) Retest with brakes applied. Is pressure ok?

Adjust travel speed per Shop Procedure SP6. Is correct speed obtained?

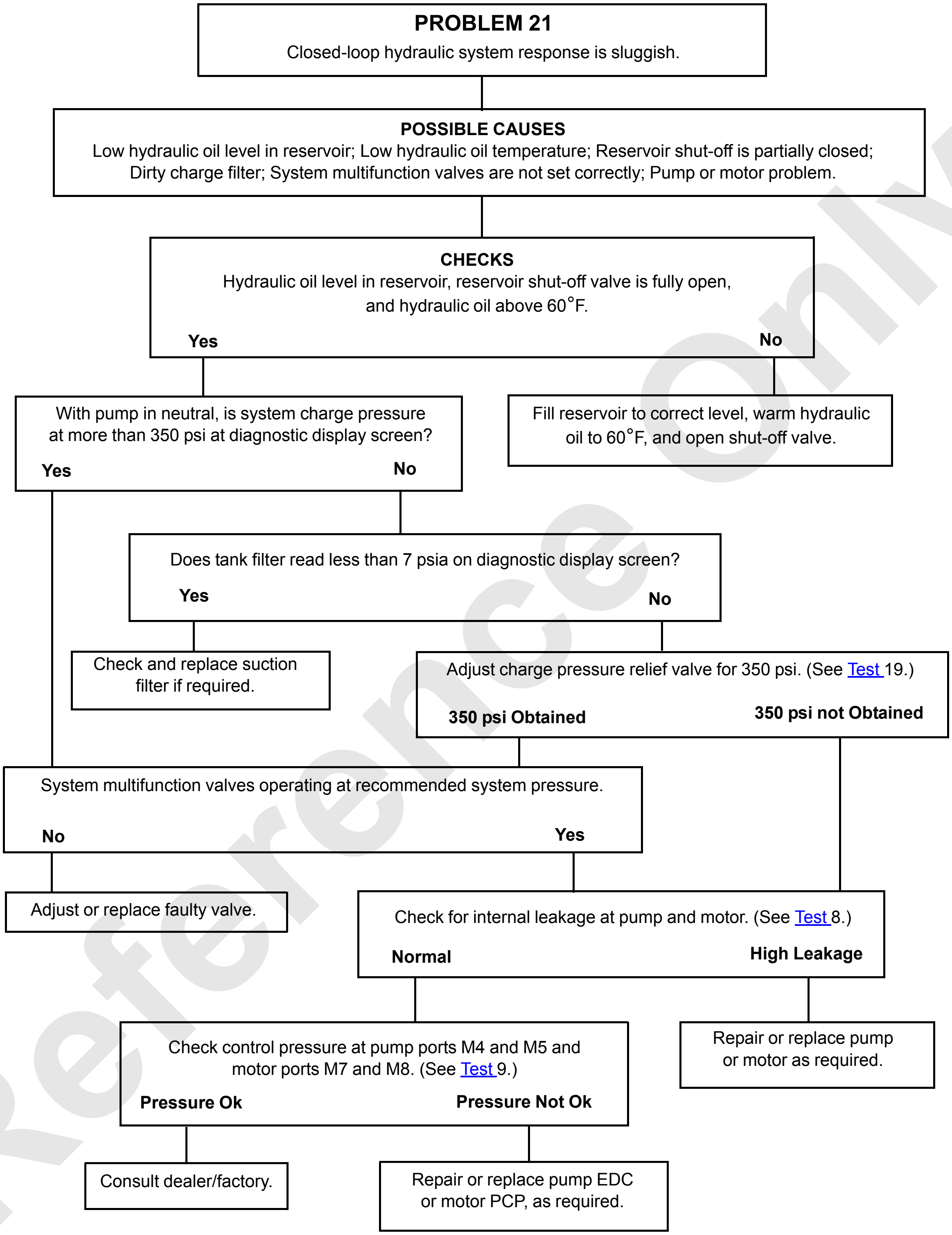
Travel system response should be correct.

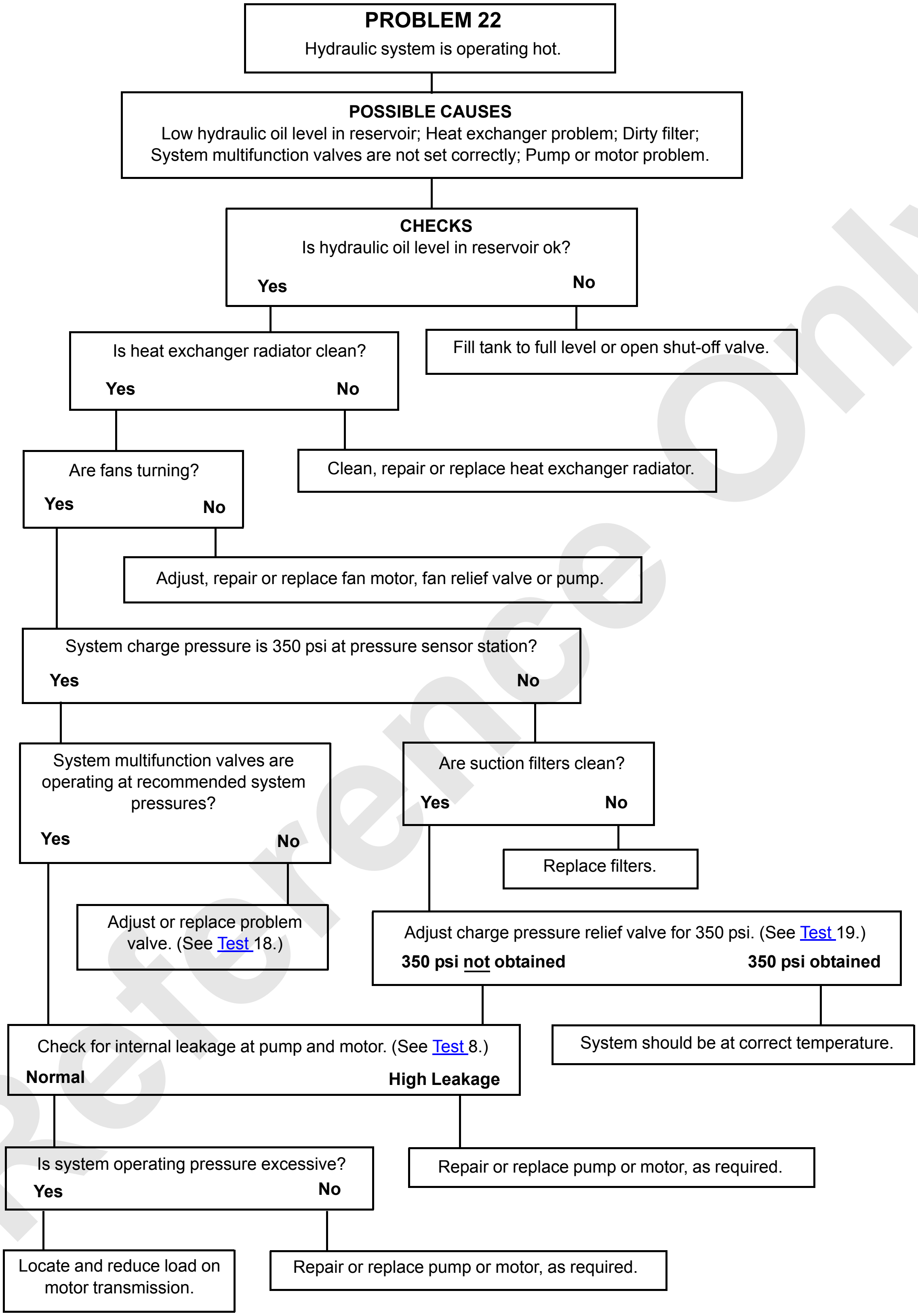
Check for leakage at motor. (See Test 8.)

Repair or replace travel motor.

Check for leakage at pump. (See Test 8.)

Repair or replace travel pump.


PROBLEM 21
Closed-loop hydraulic system response is sluggish.
POSSIBLE CAUSES
Low hydraulic oil level in reservoir; Low hydraulic oil temperature; Reservoir shut-off is partially closed; Dirty charge filter; System multifunction valves are not set correctly; Pump or motor problem.
CHECKS
Hydraulic oil level in reservoir, reservoir shut-off valve is fully open, and hydraulic oil above 60°F.
Yes
No
With pump in neutral, is system charge pressure at more than 350 psi at diagnostic display screen?
Yes
No
Fill reservoir to correct level, warm hydraulic oil to 60°F, and open shut-off valve.
Does tank filter read less than 7 psia on diagnostic display screen?
Yes
No
Check and replace suction filter if required.
Adjust charge pressure relief valve for 350 psi. (See Test 19.)
350 psi Obtained
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 8.)
Normal
High Leakage
Check control pressure at pump ports M4 and M5 and motor ports M7 and M8. (See Test 9.)
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 22

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?

Yes **No**

Is heat exchanger radiator clean?

Yes **No**

Fill tank to full level or open shut-off valve.

Are fans turning?

Yes **No**

Clean, repair or replace heat exchanger radiator.

Adjust, repair or replace fan motor, fan relief valve or pump.

System charge pressure is 350 psi at pressure sensor station?

Yes **No**

System multifunction valves are operating at recommended system pressures?

Yes **No**

Are suction filters clean?

Yes **No**

Replace filters.

Adjust or replace problem valve. (See Test 18.)

Adjust charge pressure relief valve for 350 psi. (See Test 19.)

350 psi not obtained **350 psi obtained**

Check for internal leakage at pump and motor. (See Test 8.)

Normal **High Leakage**

System should be at correct temperature.

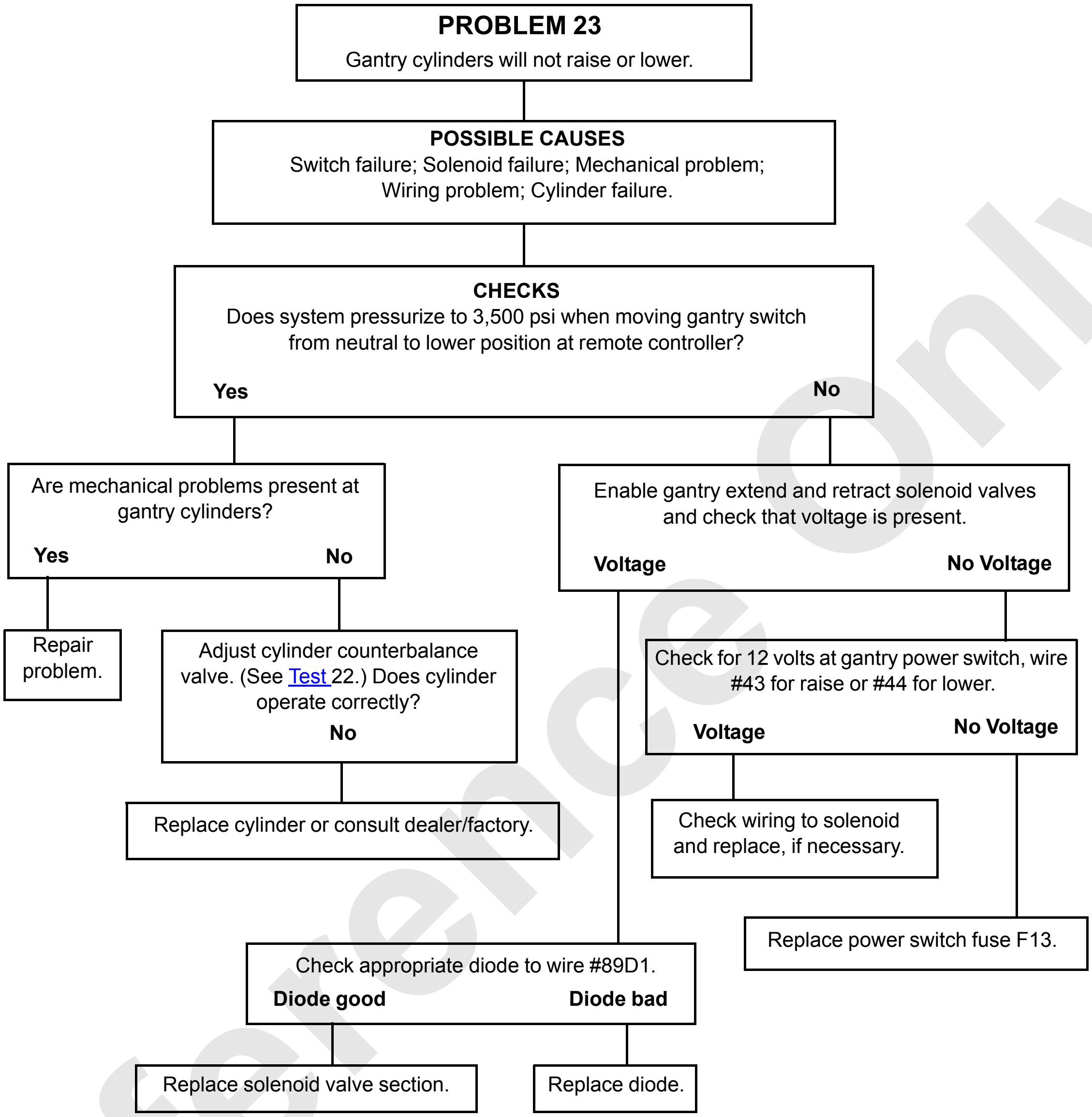
Is system operating pressure excessive?

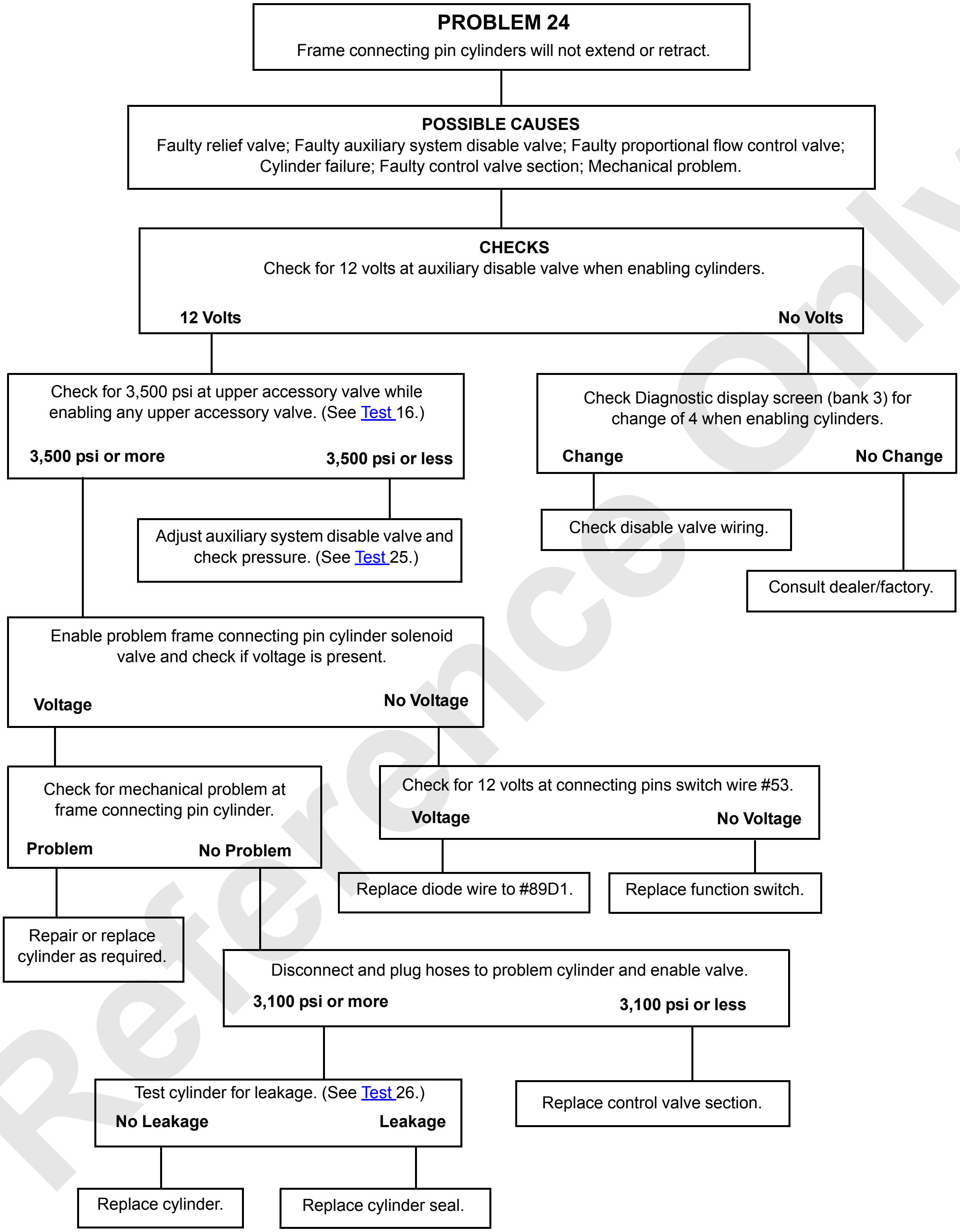
Yes **No**

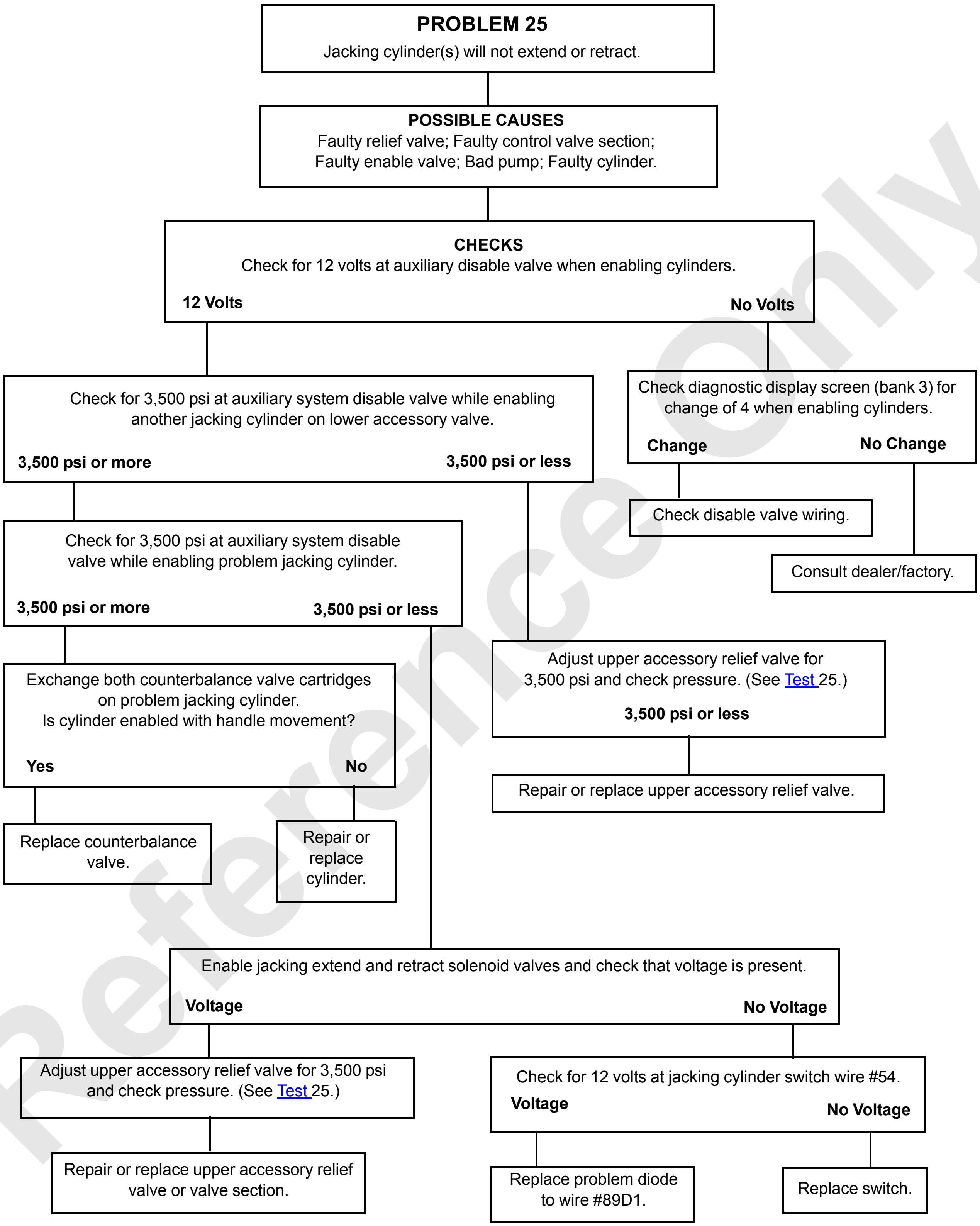
Repair or replace pump or motor, as required.

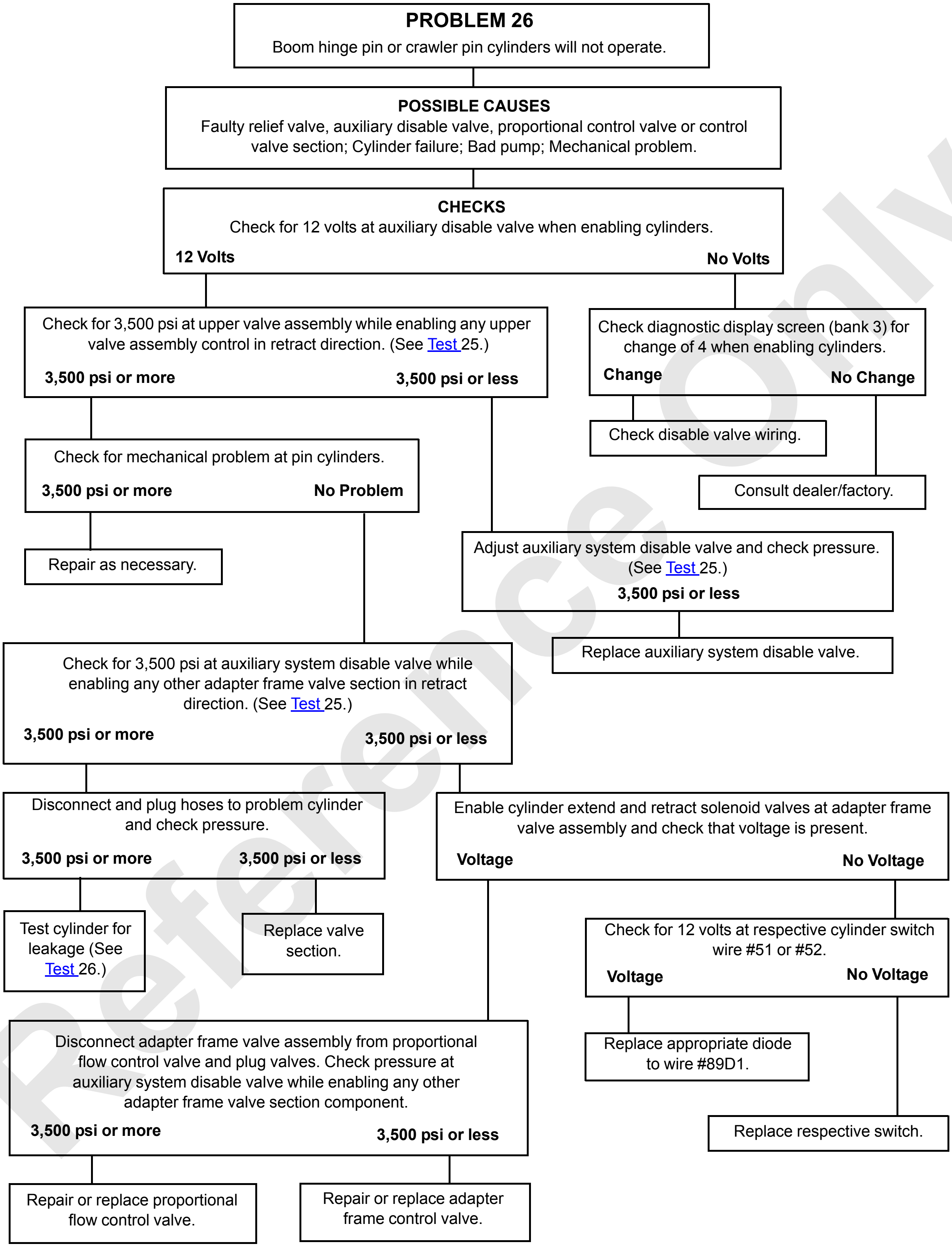
Locate and reduce load on motor transmission.

Repair or replace pump or motor, as required.


PROBLEM 23
Gantry cylinders will not raise or lower.
POSSIBLE CAUSES
Switch failure; Solenoid failure; Mechanical problem; Wiring problem; Cylinder failure.
CHECKS
Does system pressurize to 3,500 psi when moving gantry switch from neutral to lower position at remote controller?
Yes
No
Are mechanical problems present at gantry cylinders?
Yes
No
Repair problem.
Adjust cylinder counterbalance valve. (See Test 22.) 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 24
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 3,500 psi at upper accessory valve while enabling any upper accessory valve. (See Test 16.)
3,500 psi or more
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.
Adjust auxiliary system disable valve and check pressure. (See Test 25.)
Consult dealer/factory.
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.
3,100 psi or more
3,100 psi or less
Test cylinder for leakage. (See Test 26.)
No Leakage
Leakage
Replace control valve section.
Replace cylinder.
Replace cylinder seal.


PROBLEM 25
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.
12 Volts
No Volts
Check for 3,500 psi at auxiliary system disable valve while enabling another jacking cylinder on lower accessory valve.
3,500 psi or more
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 3,500 psi at auxiliary system disable valve while enabling problem jacking cylinder.
3,500 psi or more
3,500 psi or less
Adjust upper accessory relief valve for 3,500 psi and check pressure. (See Test 25.)
3,500 psi or less
Repair or replace upper accessory relief valve.
Exchange both counterbalance valve cartridges on problem jacking cylinder. Is cylinder enabled with handle movement?
Yes
No
Replace counterbalance valve.
Repair or replace cylinder.
Enable jacking extend and retract solenoid valves and check that voltage is present.
Voltage
No Voltage
Adjust upper accessory relief valve for 3,500 psi and check pressure. (See Test 25.)
Repair or replace upper accessory relief valve or valve section.
Check for 12 volts at jacking cylinder switch wire #54.
Voltage
No Voltage
Replace problem diode to wire #89D1.
Replace switch.



PROBLEM 26

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.

12 Volts **No Volts**

Check for 3,500 psi at upper valve assembly while enabling any upper valve assembly control in retract direction. (See Test 25.)

3,500 psi or more **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 mechanical problem at pin cylinders.

3,500 psi or more **No Problem**

Repair as necessary.

Adjust auxiliary system disable valve and check pressure. (See Test 25.)

3,500 psi or less

Replace auxiliary system disable valve.

Check for 3,500 psi at auxiliary system disable valve while enabling any other adapter frame valve section in retract direction. (See Test 25.)

3,500 psi or more **3,500 psi or less**

Disconnect and plug hoses to problem cylinder and check pressure.

3,500 psi or more **3,500 psi or less**

Test cylinder for leakage (See Test 26.)

Replace valve section.

Enable cylinder extend and retract solenoid valves at adapter frame valve assembly and check that voltage is present.

Voltage **No Voltage**

Check for 12 volts at respective cylinder switch wire #51 or #52.

Voltage **No Voltage**

Replace appropriate diode to wire #89D1.

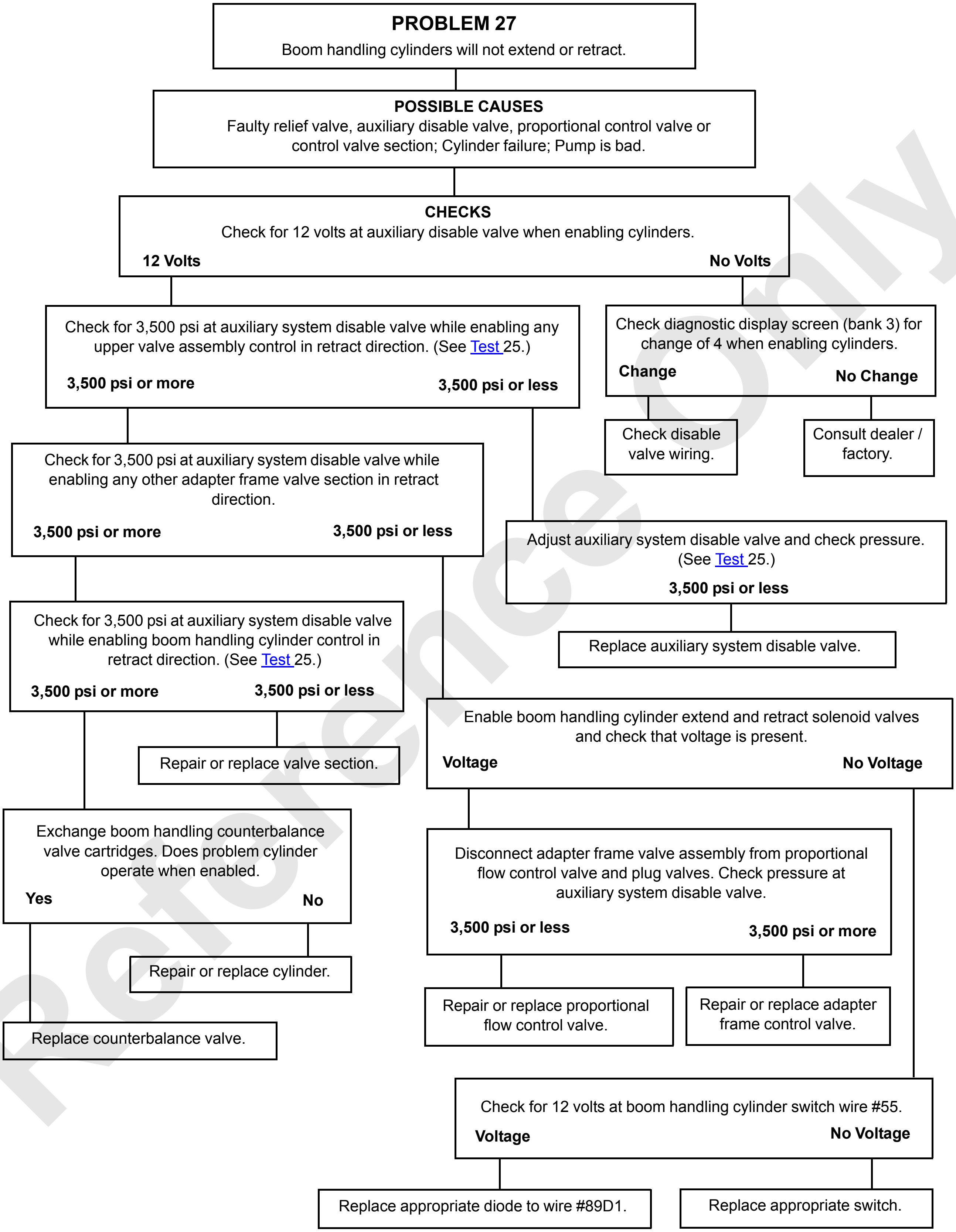
Replace respective switch.

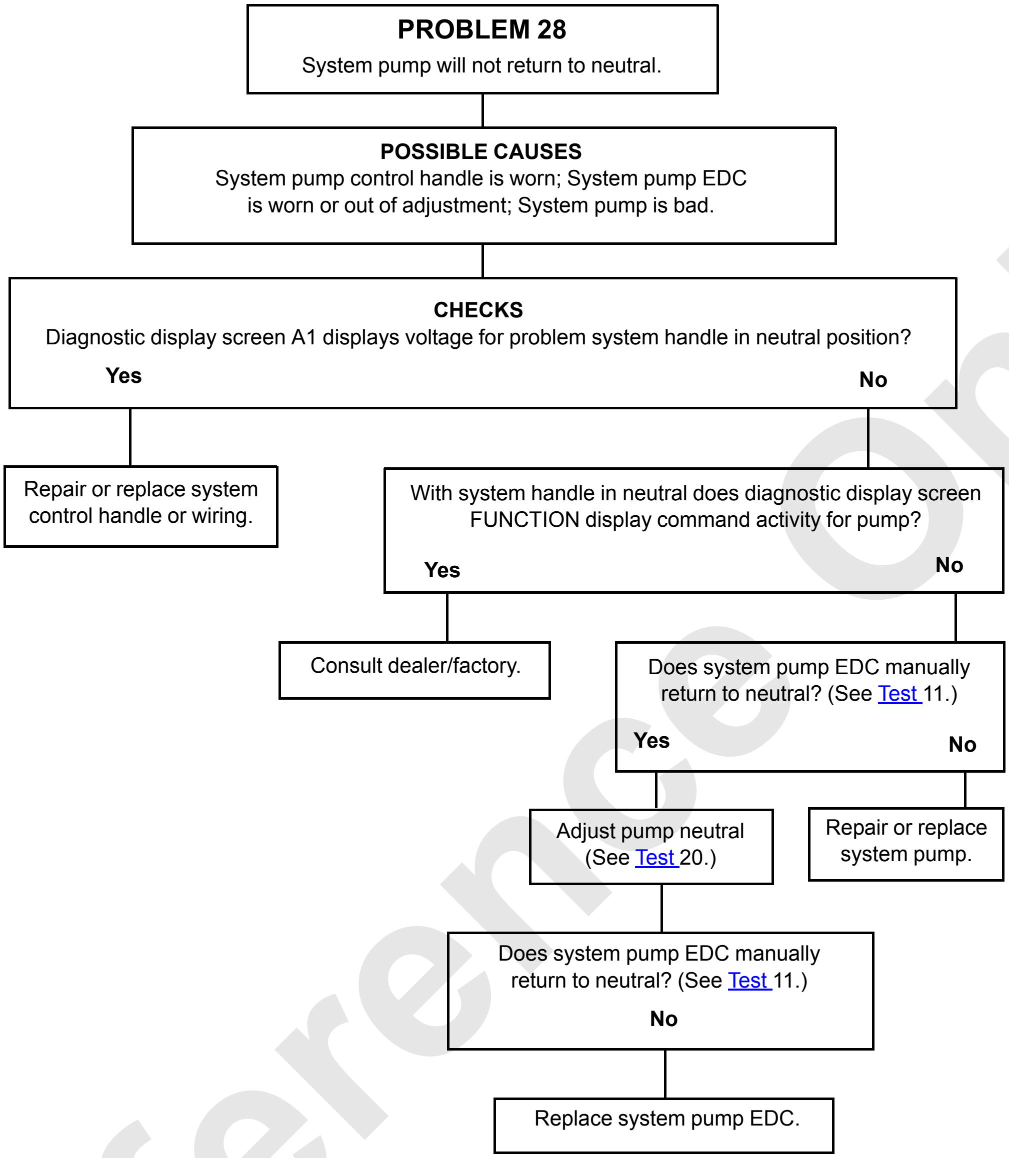
Disconnect adapter frame valve assembly from proportional flow control valve and plug valves. Check pressure at auxiliary system disable valve while enabling any other adapter frame valve section component.

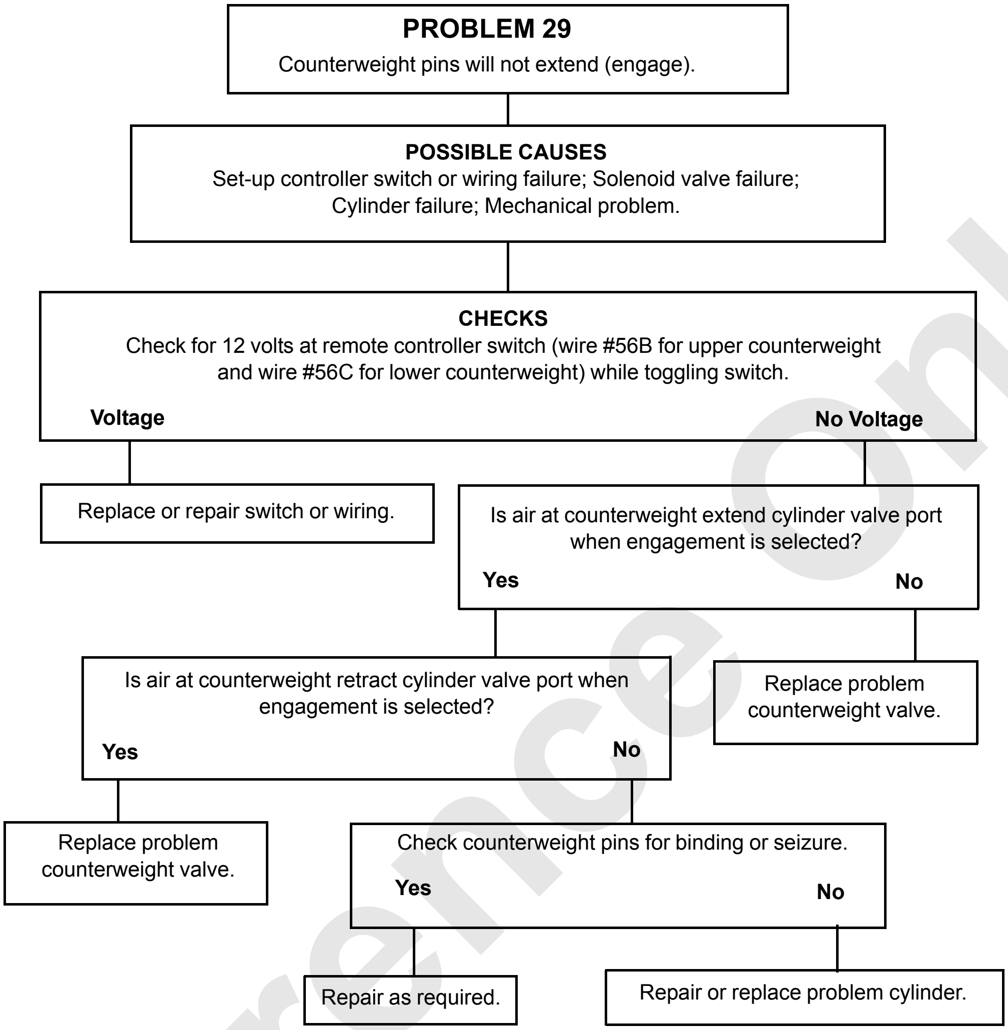
3,500 psi or more **3,500 psi or less**

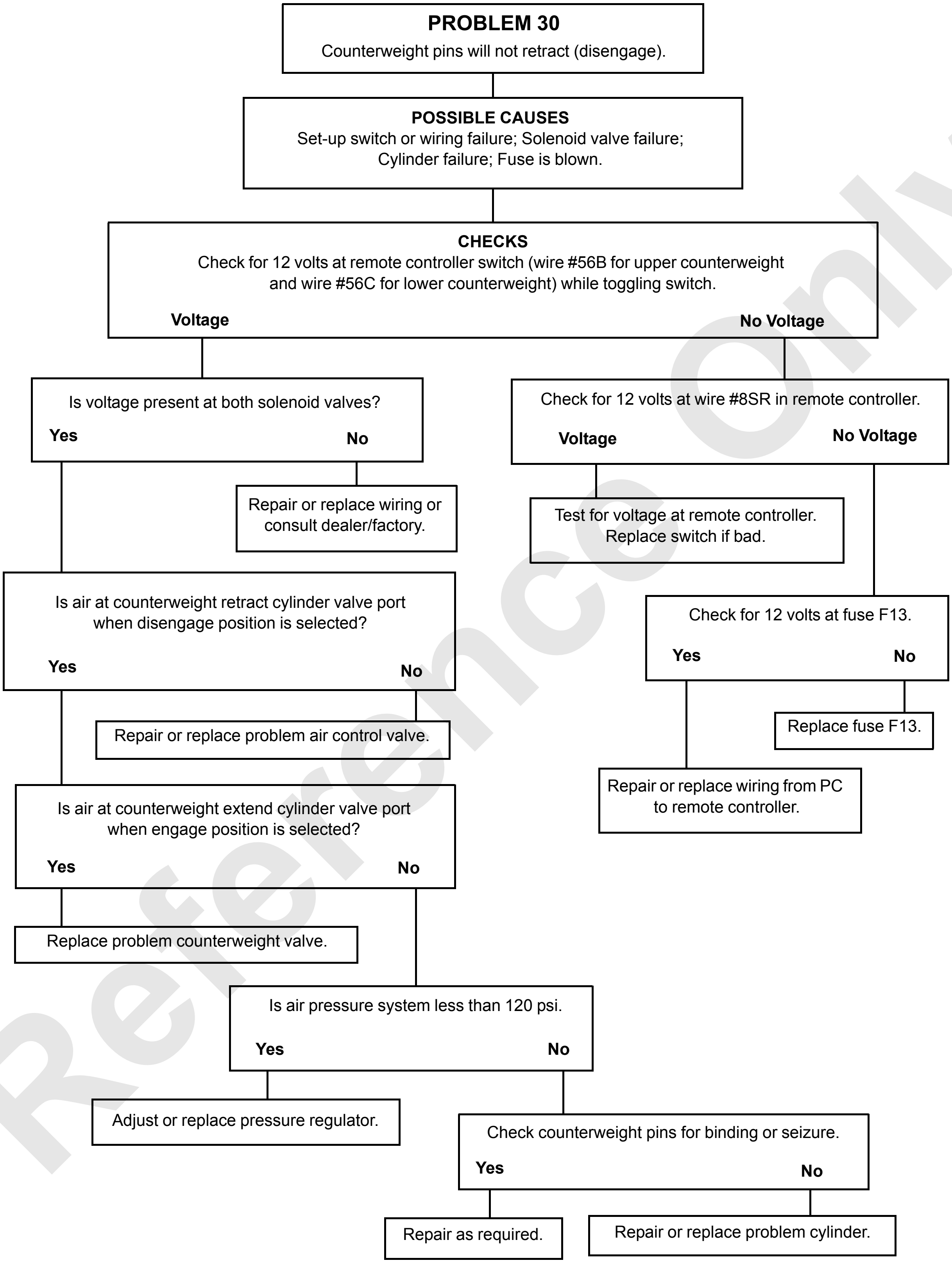
Repair or replace proportional flow control valve.

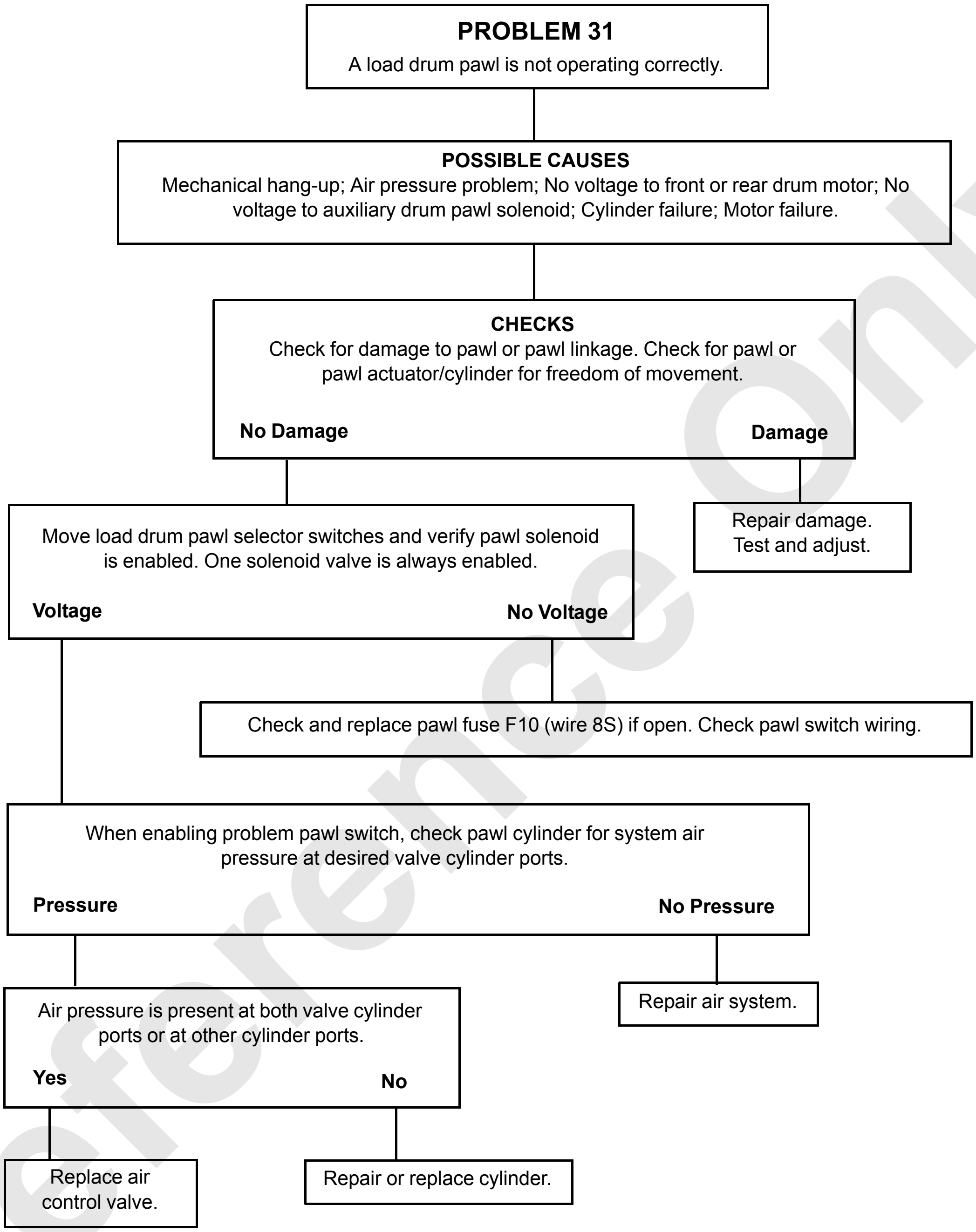
Repair or replace adapter frame control valve.


PROBLEM 27
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 3,500 psi at auxiliary system disable valve while enabling any upper valve assembly control in retract direction. (See Test 25.)
3,500 psi or more
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 3,500 psi at auxiliary system disable valve while enabling any other adapter frame valve section in retract direction.
3,500 psi or more
3,500 psi or less
Adjust auxiliary system disable valve and check pressure. (See Test 25.)
3,500 psi or less
Replace auxiliary system disable valve.
Check for 3,500 psi at auxiliary system disable valve while enabling boom handling cylinder control in retract direction. (See Test 25.)
3,500 psi or more
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.
3,500 psi or less
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 28
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
Diagnostic display screen A1 displays 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 dealer/factory.
Does system pump EDC manually return to neutral? (See Test 11.)
Yes
No
Adjust pump neutral (See Test 20.)
Repair or replace system pump.
Does system pump EDC manually return to neutral? (See Test 11.)
No
Replace system pump EDC.


PROBLEM 29
Counterweight pins will not extend (engage).
POSSIBLE CAUSES
Set-up controller switch or wiring failure; Solenoid valve failure; Cylinder failure; Mechanical problem.
CHECKS
Check for 12 volts at remote controller switch (wire #56B for upper counterweight and wire #56C for lower counterweight) while toggling switch.
Voltage
No Voltage
Replace or repair switch or wiring.
Is air at counterweight extend cylinder valve port when engagement is selected?
Yes
No
Replace problem counterweight valve.
Is air at counterweight retract cylinder valve port when engagement is selected?
Yes
No
Replace problem counterweight valve.
Check counterweight pins for binding or seizure.
Yes
No
Repair as required.
Repair or replace problem cylinder.


PROBLEM 30
Counterweight pins will not retract (disengage).
POSSIBLE CAUSES
Set-up switch or wiring failure; Solenoid valve failure; Cylinder failure; Fuse is blown.
CHECKS
Check for 12 volts at remote controller 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.
Check for 12 volts at wire #8SR in remote controller.
Voltage
No Voltage
Test for voltage at remote controller. Replace switch if bad.
Check for 12 volts at fuse F13.
Yes
No
Replace fuse F13.
Repair or replace wiring from PC to remote controller.
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 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.



PROBLEM 31

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.

Repair damage. Test and adjust.

Move load drum pawl selector switches and verify pawl solenoid is enabled. One solenoid valve is always enabled.

Check and replace pawl fuse F10 (wire 8S) if open. Check pawl switch wiring.

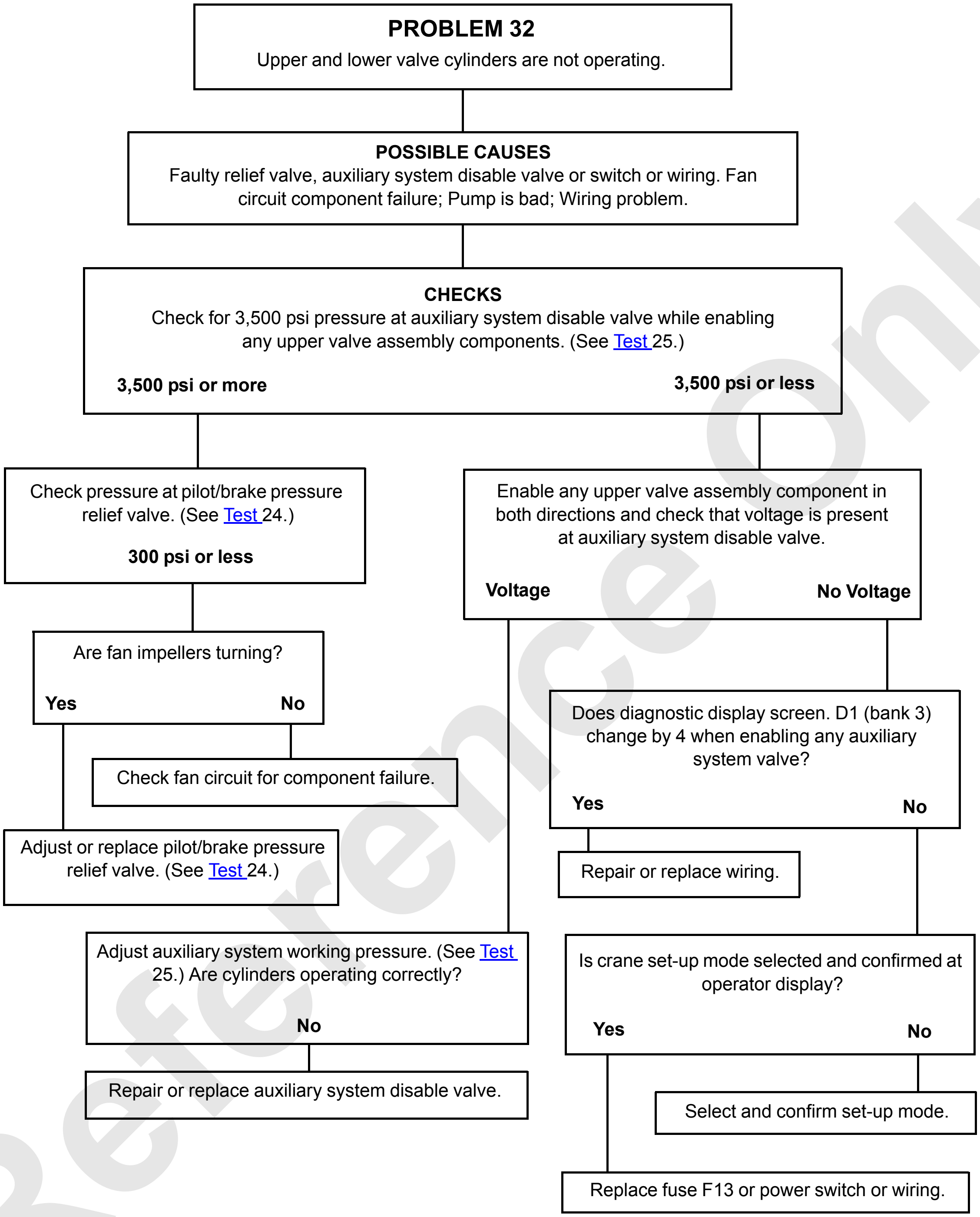
When enabling problem pawl switch, check pawl cylinder for system air pressure at desired valve cylinder ports.

Repair air system.

Air pressure is present at both valve cylinder ports or at other cylinder ports.

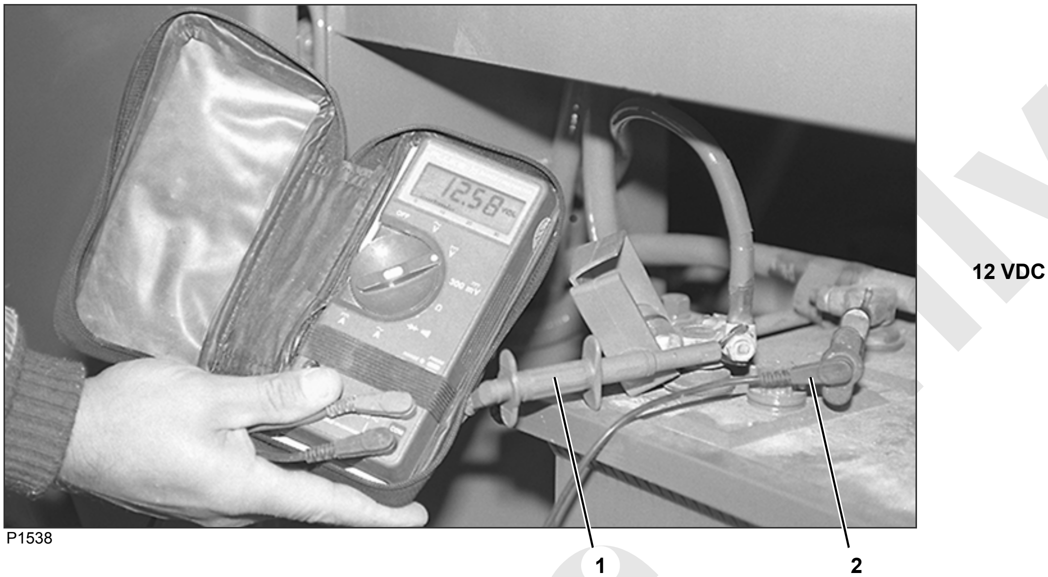
Replace air control valve.

Repair or replace cylinder.


PROBLEM 32
Upper and lower valve cylinders are not operating.
POSSIBLE CAUSES
Faulty relief valve, auxiliary system disable valve or switch or wiring. Fan circuit component failure; Pump is bad; Wiring problem.
CHECKS
Check for 3,500 psi pressure at auxiliary system disable valve while enabling any upper valve assembly components. (See Test 25.)
3,500 psi or more
3,500 psi or less
Check pressure at pilot/brake pressure relief valve. (See Test 24.)
300 psi or less
Enable any upper valve assembly component in both directions and check that voltage is present at auxiliary system disable valve.
Voltage
No Voltage
Are fan impellers turning?
Yes
No
Check fan circuit for component failure.
Adjust or replace pilot/brake pressure relief valve. (See Test 24.)
Does diagnostic display screen. D1 (bank 3) change by 4 when enabling any auxiliary system valve?
Yes
No
Repair or replace wiring.
Adjust auxiliary system working pressure. (See Test 25.) Are cylinders operating correctly?
No
Repair or replace auxiliary system disable valve.
Is crane set-up mode selected and confirmed at operator display?
Yes
No
Select and confirm set-up mode.
Replace fuse F13 or power switch or wiring.

TESTING COMPONENTS

Test 1 — Battery Test (12 and 24 volts DC)

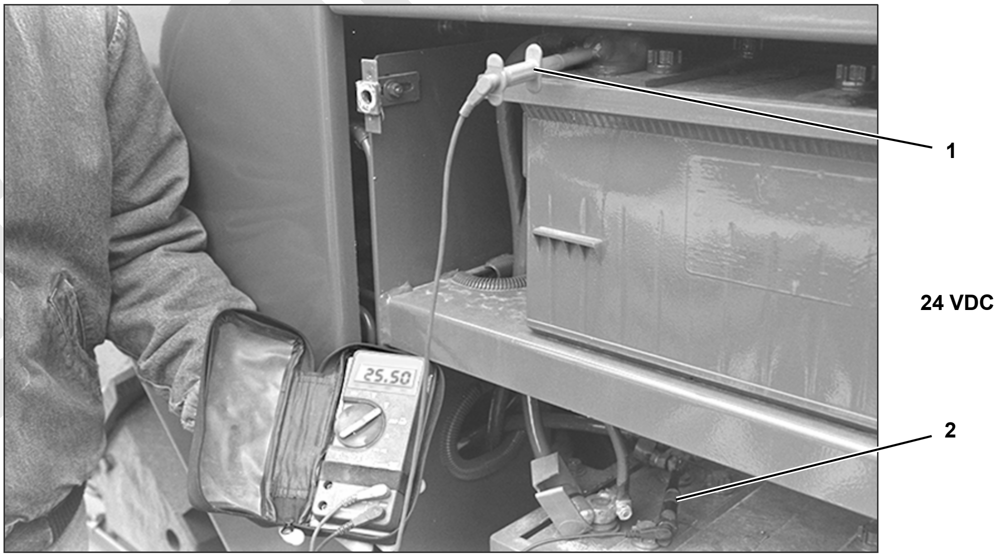


P1538

Item	Description	Item	Description
1	Positive lead	2	Negative lead

Test the 12-volt DC accessory system voltage with a digital multi-meter. Record the voltage before and during engine cranking.

A voltage reading of 12 volts or less before cranking engine may indicate a charging system fault. A drop of 4 volts or more indicates the battery is failing.

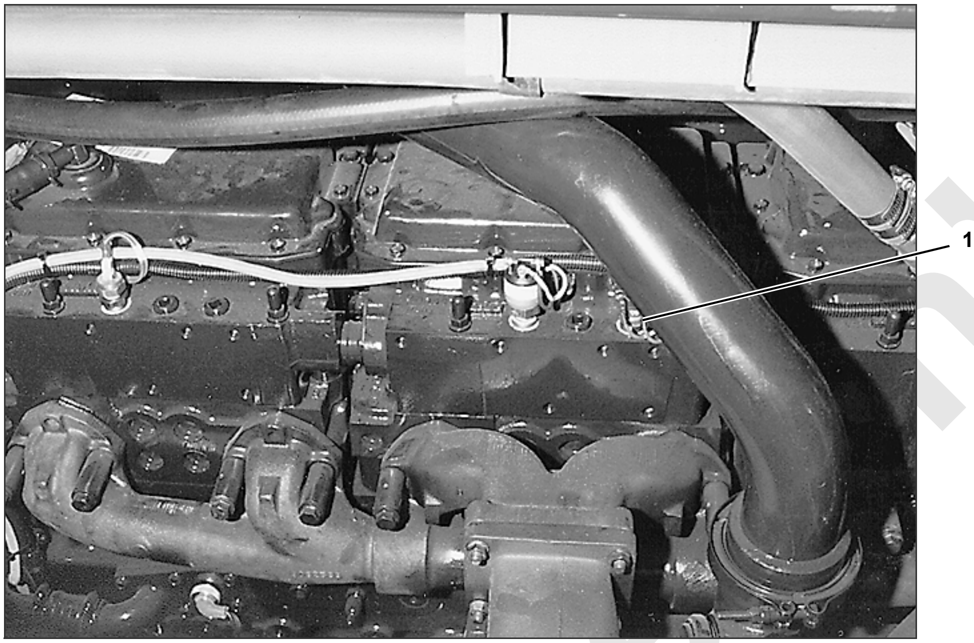


P1539

Test the 12-volt DC starting batteries in series for 24 volts using a digital multi-meter. Record the voltage before and during engine cranking.

A voltage reading of 24 volts or less before cranking engine may indicate a charging system fault. A drop of 8 volts or more indicates the battery is failing.

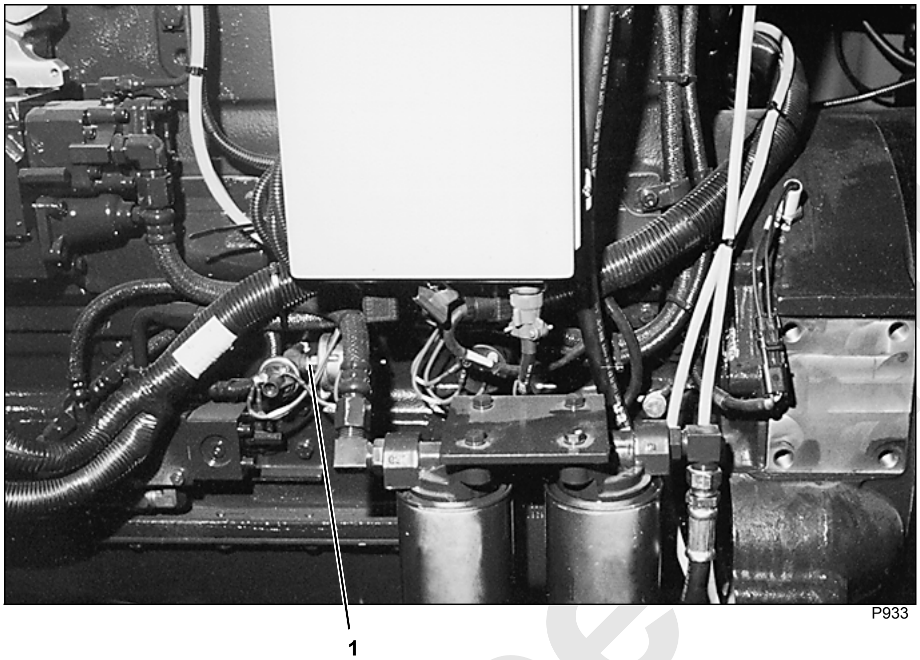
Test 2 — Checking Resistance at Engine Temperature Switch



Item	Description
1	Temperature switch

Set digital multi-meter to test resistance. Make required connections to test lead adapter at the meter. Connect negative lead to a grounded component on the crane and the positive lead to engine temperature switch wire terminal. With engine cold, check for a resistance of approximately 0.67 ohms.

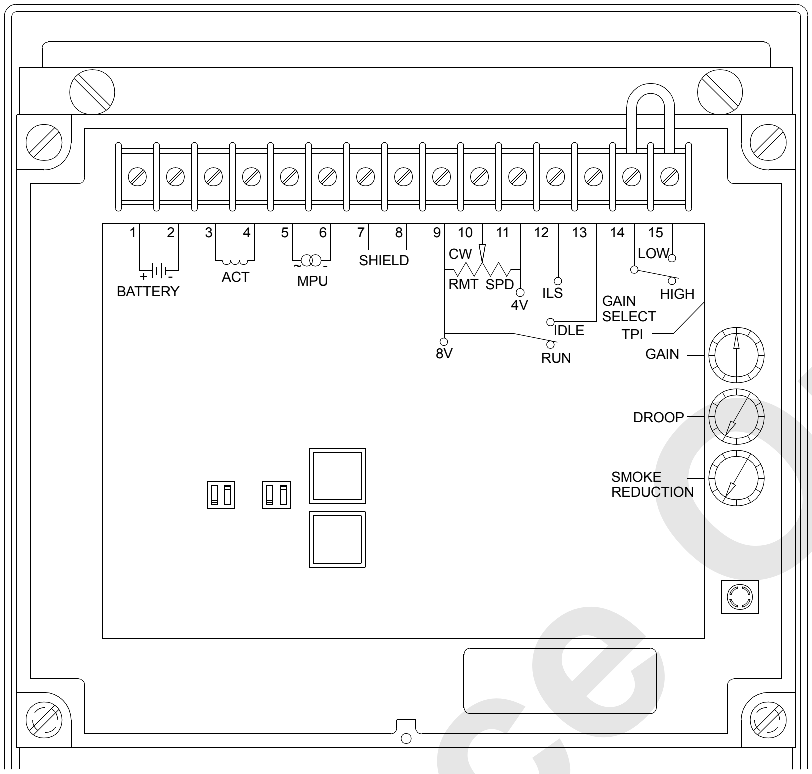
Test 3 — Checking Resistance at Engine Oil Pressure Switch



Item	Description
1	Oil pressure switch

Set digital multi-meter to test resistance. Make required connections to test lead adapter at the meter. Connect negative lead to a grounded component on the crane and the positive lead to engine pressure switch wire terminal. With engine cold, check for a resistance of approximately 240 ohms.

Test 4 — Electric Fuel Control (EFC) Box Test Points



A1161

TB1 Test Points (N14-C450 Engine only)

TB-1-1 Battery (+)
TB-1-2 Battery (-)
TB-1-3 Actuator (3EFC)
TB-1-4 Actuator (4EFC)
TB-1-5 Magnetic pickup (24)
TB-1-6 Magnetic pickup (0)
TB-1-7 Shield
TB-1-8 Shield
TB-1-9 Remote speed potentiometer (68J)
TB-1-10 Remote speed potentiometer (68K)
TB-1-11 Remote speed potentiometer (68L)
TB-1-12 No contact
TB-1-13 No contact
TB-1-14 Gain select
TB-1-15 Gain select

NOTE: The C-525 engine fuel control is internal to the engine, see engine manufacturer's literature.

With engine off and power on check for:

- 7.75 volts DC at TB1-9
- 4.40 volts DC at TB1-10
- 4.50 volts DC at TB1-11

To determine if correct voltage is available from engine RPM transducer, use a digital multi-meter to test at EFC box. While at low idle check for 5.25 volts AC between TB1-5 and TB1-6.

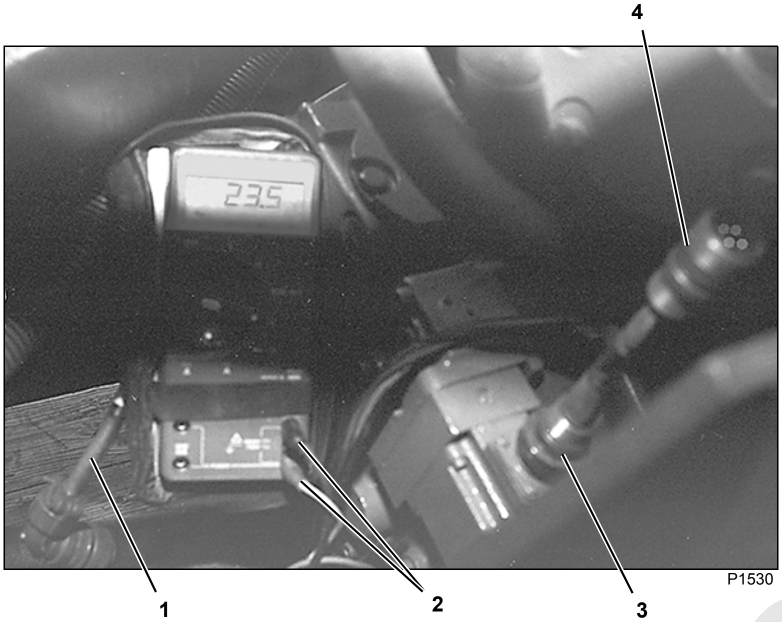
NOTE: To determine if correct voltage is available from the hand and foot throttle, use a digital multi-meter to test at EFC box. Use engine as ground contact when testing following terminals.

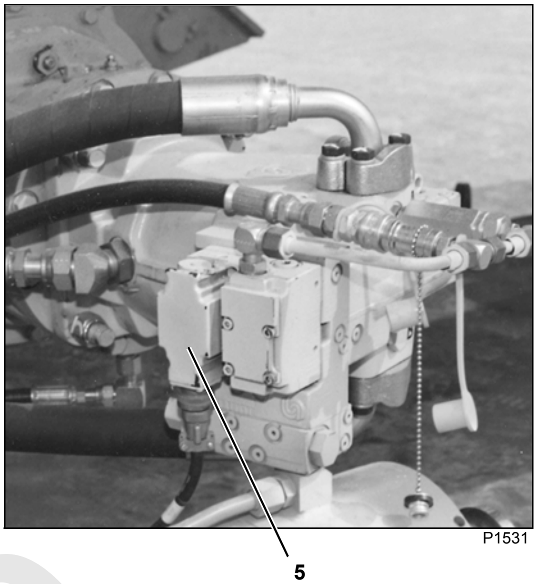
While at low idle, check for:

- 7.80 volts DC at TB1-9
- 4.70 volts DC at TB1-10
- 4.55 volts DC at TB1-11

If this reading is not obtained, engine RPM transducer may require servicing. (See Test 6 — Cleaning and Adjusting the Engine RPM Transducer.)

Test 5 — Testing the Pump EDC and Motor PCP





Item	Description
1	PC input cable
2	Adapter cable connections
3	Pump EDC
4	Test plug adapter
5	Motor PCP

Testing a pump EDC or motor PCP requires a standard test plug adapter (can be ordered from Manitowoc Cranes, Inc.) and a digital multi-meter. To test a pump function:

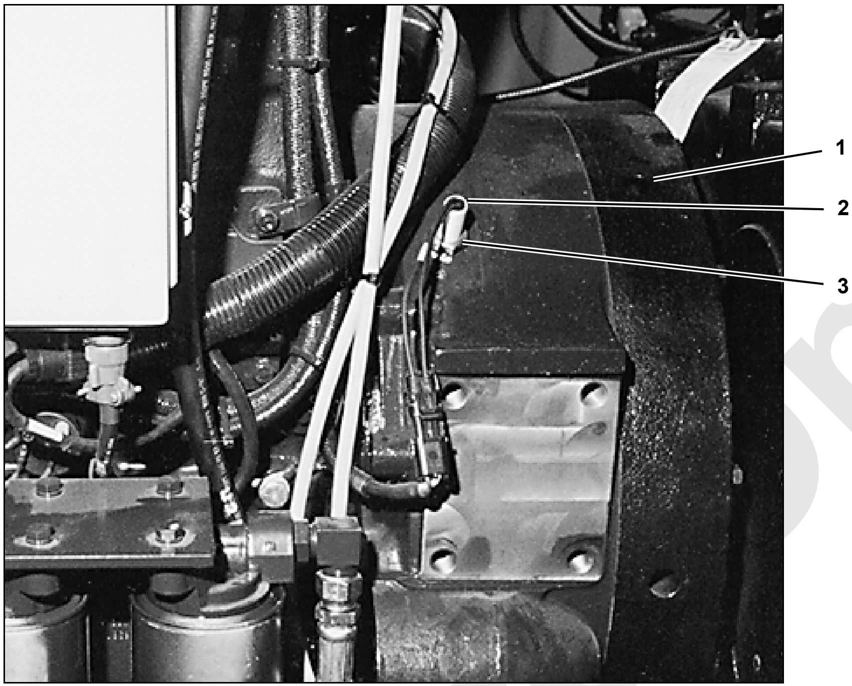
- Disconnect the PC input cable from the pump EDC to be tested.
- Connect the double-ended test plug adapter EDC.
- Leave the PC end of test plug disconnected.
- Set digital multi-meter for testing resistance.
- Connect white (positive) and black (negative) wires from adapter cable to digital multi-meter jacks.
- Check the EDC resistance is between 15 and 19 ohms.

Leave test plug adapter installed at the pump EDC:

- Set the digital multi-meter for testing volts DC.
- Connect the PC input cable to PC end of test plug adapter.
- With engine running, slowly enable test system control handle.
- Check that the range of voltage change is between 0 and
+/-2.45 volts DC.
- Measure load current by connecting red and white wires from adapter cable to digital multi-meter 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 pump EDC. Motor PCP coil resistance should be between 23 to 26 ohms. The voltage should be between 0 and 1.96 volts DC.

Test 6 — Cleaning and Adjusting the Engine RPM Transducer



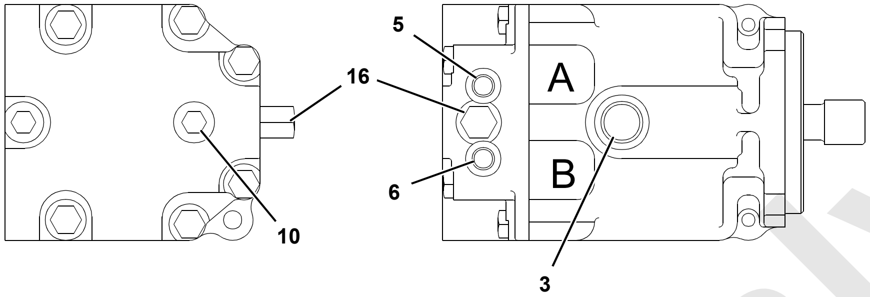
Item	Description
1	Flywheel housing
2	RPM transducer
3	Lock nut

To clean and adjust engine RPM transducer:

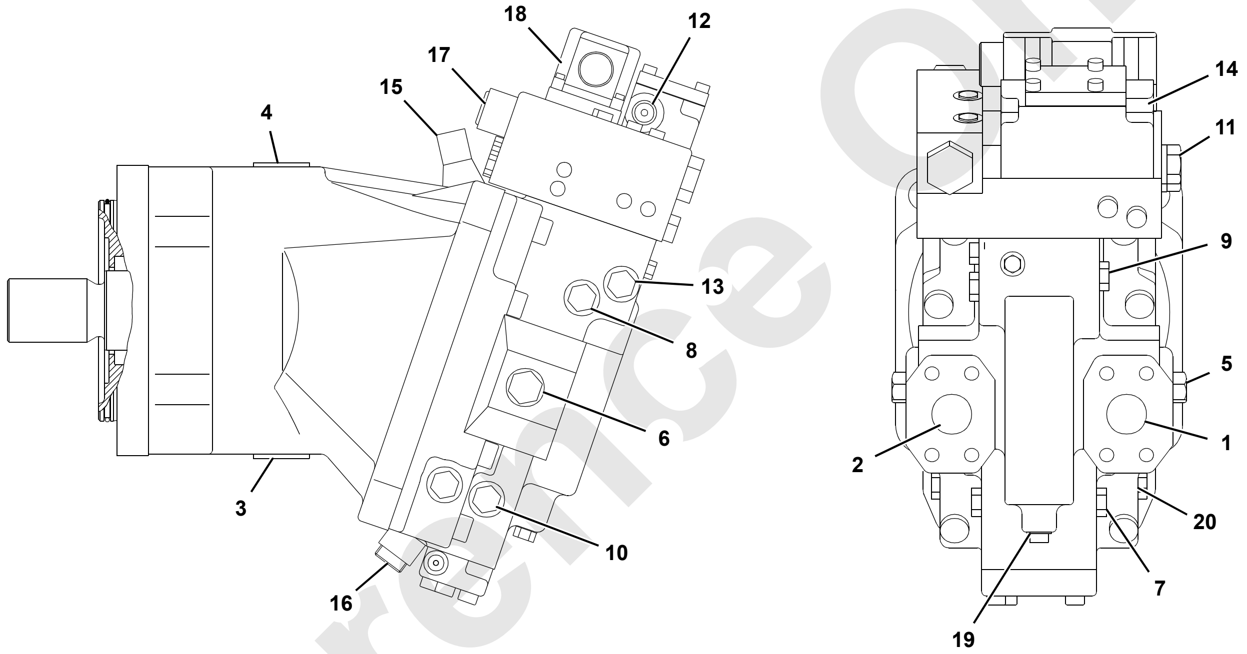
- Loosen the lock nut and remove threaded transducer from flywheel housing.
- Clean any metallic debris from the magnetic pickup on the transducer with a cleaning solvent.
- Reinstall the transducer so magnetic pickup makes contact with flywheel.
- Back off flywheel 1/2 turn and secure lock nut.

Test 7 — Location of Motor Ports

A1188



Swing Motor

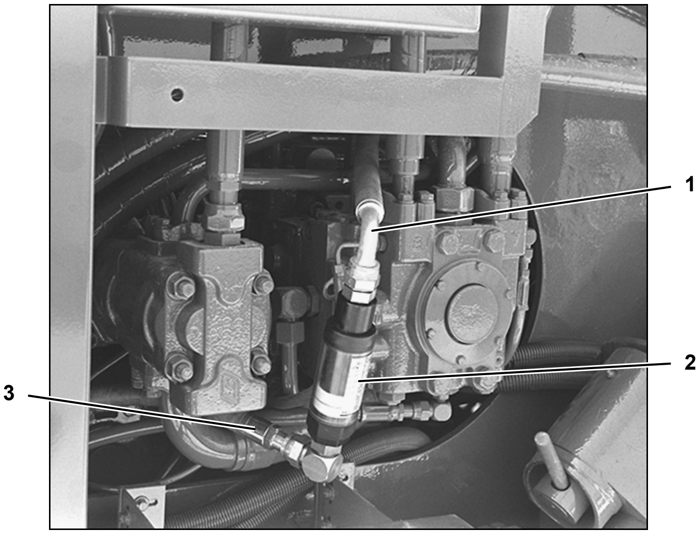


Boom Hoist, Load Drums, and Travel Motor

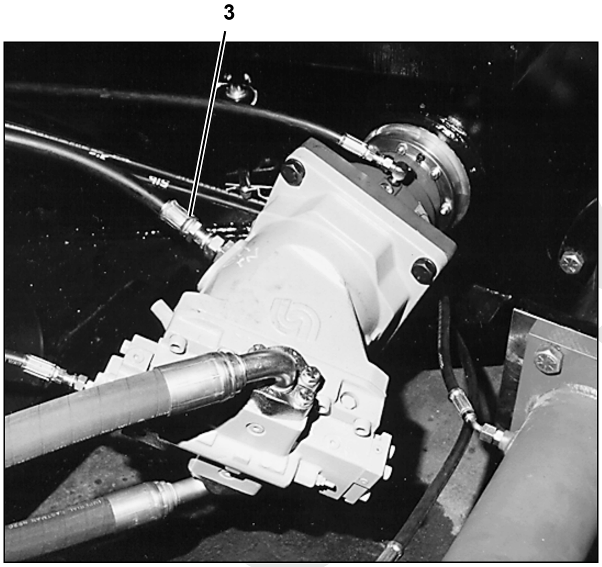
M2

Item	Port	Description
1	A	Main system pressure
2	B	Main system pressure
3	L1	Case pressure
4	L2	Case pressure
5	M1	Gauge port A
6	M2	Gauge port B
7	M3	Servo gauge port or servo pressure supply
8	M4	Servo gauge port or servo pressure supply
9	M5	Servo pressure supply
10	M6	Charge pressure gauge port
11	M7	Control pressure
12	M8	Control pressure
13	M9	Servo pressure supply
14	X1	External PCP supply pressure
15		Minimum displacement limiter
16		Charge pressure relief valve
17		Pressure compensator adjuster
18		Manual override
19		Control start setting
20		Loop flushing shuttle valve

Test 8 — 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

Testing for pump and motor leakage requires a 0 – 3,000 psi (207 bar) in line flow meter with a minimum flow rate capacity of 30 gpm (113,5 L/min). Flow meters can be ordered from Manitowoc Cranes, Inc.

Acceptable leakage is based on combined case flow of the pump and motor. Combined case flow of the load drum pump and motor should be equal to a charge pump flow or 8.9 gpm (33,7 L/min) per 1,000 rpm of the engine.

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 4.8 gpm (18,2 L/min) 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 under test.

Motor Test

The external loop flush valve must be removed from boom hoist motor before testing (see to Test 23 — Servicing the Motor Loop Flushing (Purge) Valves). To test a motor:

- Connect flow meter between the motor case drain hose and the highest motor case drain port.
- With the engine running at 1,000 rpm, measure the flow rate of the motor.
- Case flow at neutral or very light loads should be approximately 5 gpm (18,9 L/min).
- Record all measurements at neutral.
- At heavier loads, normal case flow may go to 7 gpm (26,5 L/min).
- Motors that do not have loop flushing, case flow at neutral should not exceed 1.5 gpm (5,7 L/min).
- Motors that do not have loop flushing, case flow at heavier loads and higher rpm may increase to 4.5 or 5.5 gpm (16,7 or 20,8 L/min).
- Reconnect the motor case drain hose to motor drain port.

Pump Test

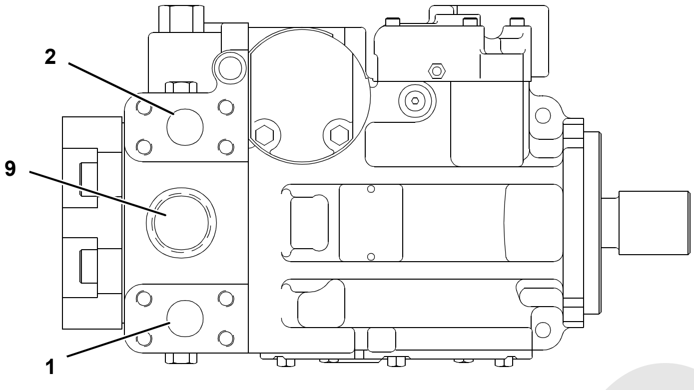
See Test 9 — Location of Pump Ports for location of pump ports. To test a pump:

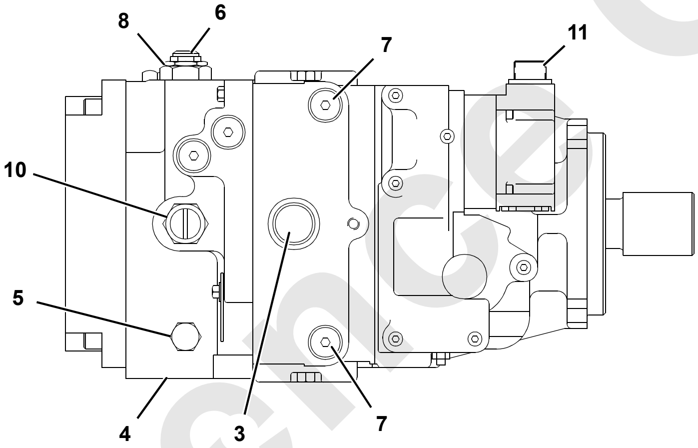
- Connect the flow meter between the pump case drain hose and pump port L1 or L2.
- Use the highest port for testing.
- With the engine running at 1,000 rpm, measure the flow rate of the pump at neutral and compare to the calculated acceptable pump case flow.

Deviations from the normal or major changes with increasing system pressure more than +/-1 gpm (3,8 L/min) are an indication of a pump or motor problem.

Test 9 — Location of Pump Ports

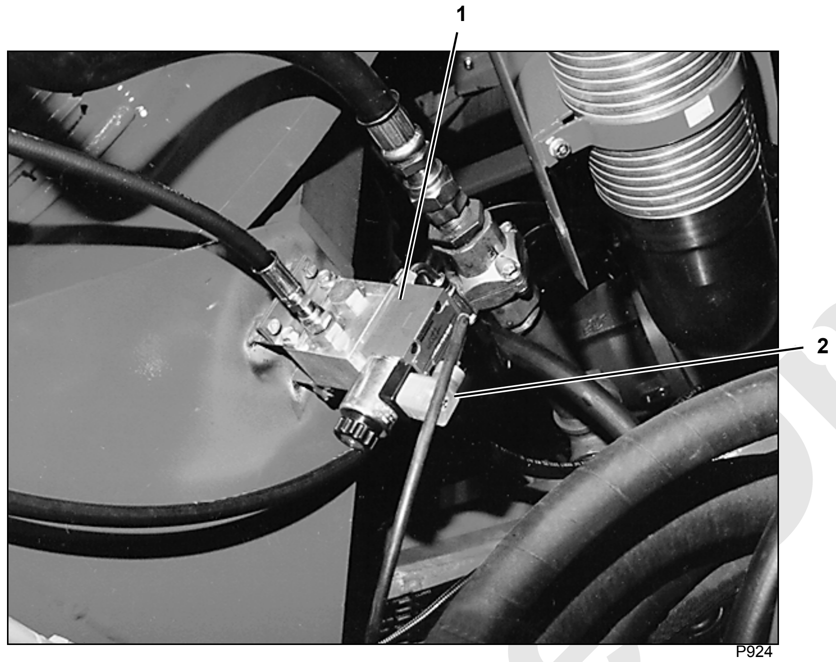
A1188





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	EDC (electrical displacement valve)

Test 10 — Checking Voltage at the Hydraulic Brake Valve



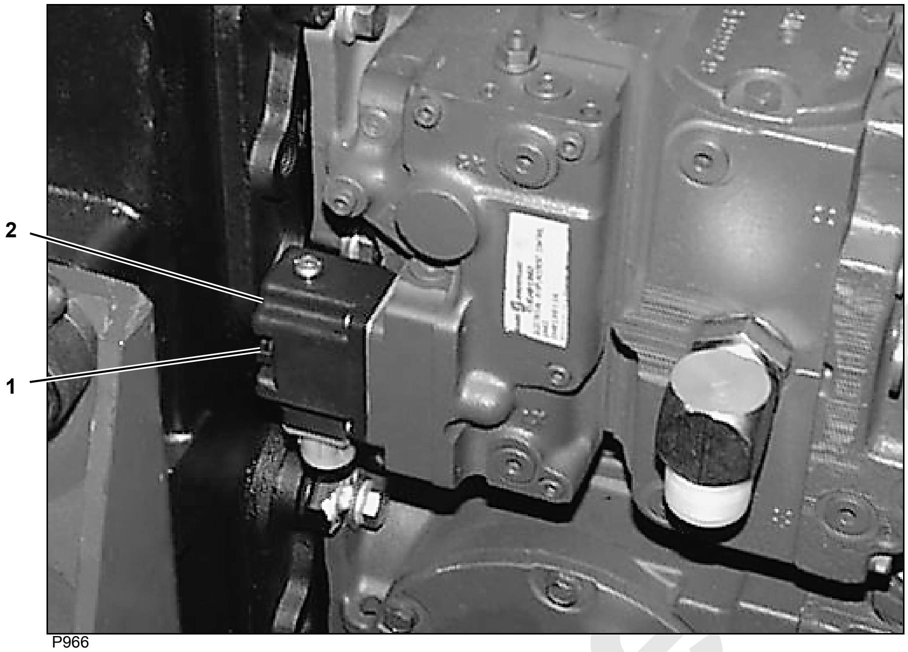
Item	Description
1	Hydraulic brake valve
2	DIN plug

Testing for voltage at any hydraulic brake valve requires a standard test plug adapter (can be ordered from Manitowoc Cranes, Inc.) and a digital multi-meter.

To test brake valve:

- Connect the test plug adapter between brake valve and DIN plug.
- Connect white (positive) and black (negative) wires from adapter cable to digital multi-meter jacks.
- Check for 12 volts DC while releasing the brake for the system being tested.
- Load current can be measured by connecting red and white wires from adapter cable to digital multi-meter jacks.

Test 11 — Manually Stroking the Pump



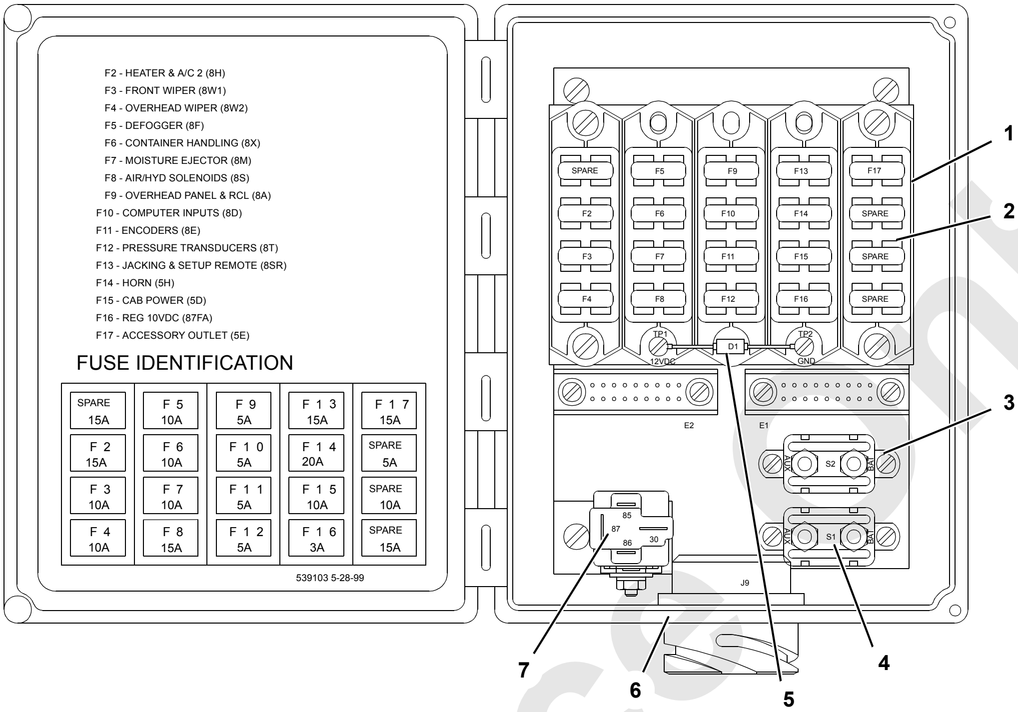
Item	Description
1	Manual stroke override
2	Pump EDC

See Test 9 — Location of Pump Ports for location of pump ports. To stroke the pump:

- Start with engine running and all brakes and locks engaged.
- Rotate the pump manual override in the clockwise direction to load down and raise pressure in port “A”.
- Rotate the pump manual override in the counter-clockwise direction to load down and raise pressure in port “B”.

Test 12 — Testing for Voltage at the Fuse Box

A1188



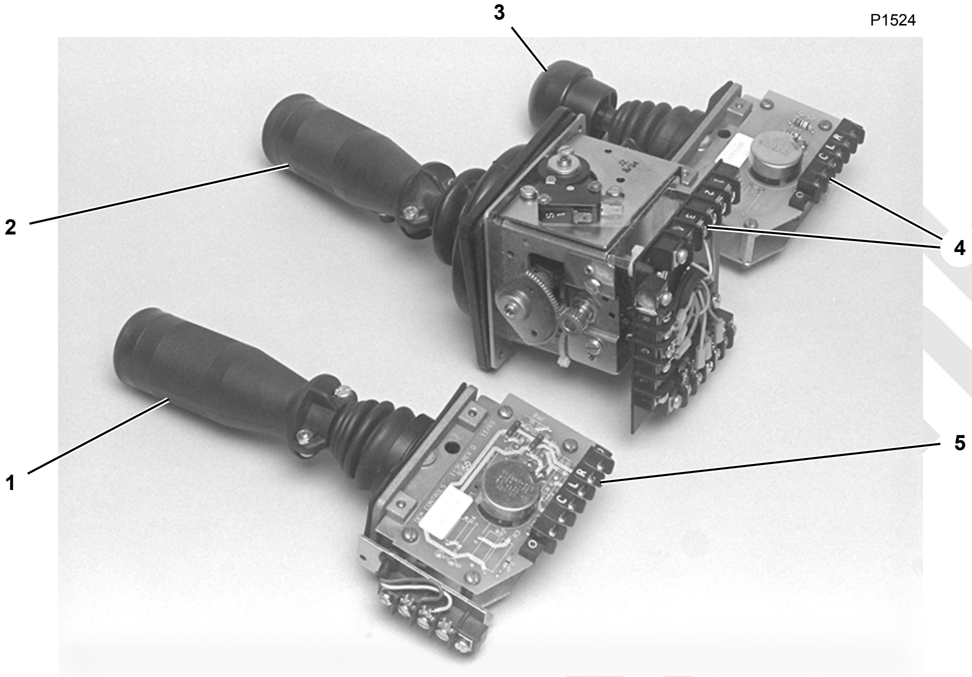
Item	Description
1	Fuse block
2	Metal fuse contact
3	Air conditioner CB (40 amp)
4	Controller CB (50 amp)
5	Transient suppressor diode
6	Fuse box chassis
7	K1 cab power relay

Use a digital multi-meter for testing voltage at the fuse box.

To test for volts DC at any given fuse socket, place the positive lead on any metal fuse contact and the negative lead on the grounded fuse box chassis. 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 relay K1 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 13 — Checking Voltage at the Control Handle



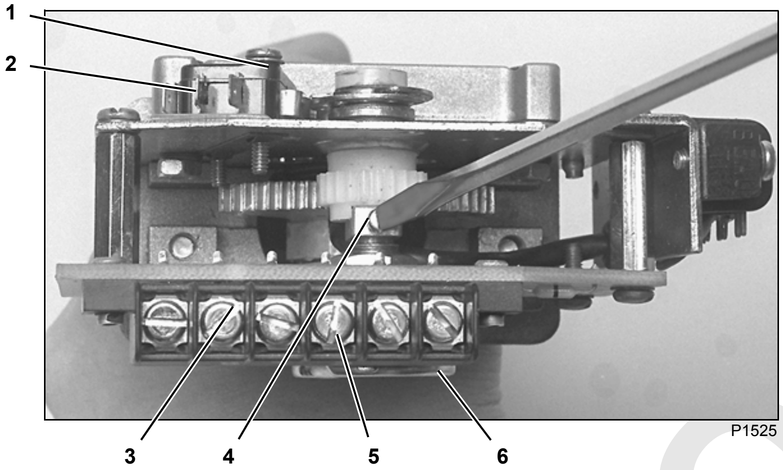
Item	Description	Item	Description
1	Load drum handle	4	Test terminals
2	Boom/swing handle	5	Ground terminal “R”
3	Crawler handle		

Use the following test points to determine the correct voltages at control handle:

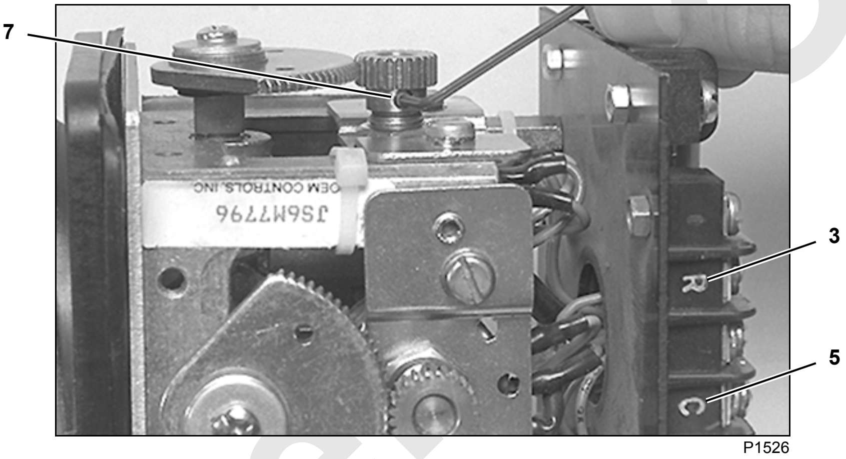
- Engine must be off and power on, with all brakes and locks engaged.
- Enable the test control handle and measure the voltage with a digital multi-meter.
- The positive lead must be placed on the test terminal and the negative lead on a grounded crane component or on terminal “R”.
- Voltages outside 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)	Hand Controller	Test Terminal	Wire No.	Acceptable Voltage (DC)
Swing	Left	87FA	10	Left Travel	Left	87FA	10
	Right	0	Ground		Right	0	Ground
	Center	85P	1.4 to 8.6		Center	84P	1.4 to 8.6
	3	8S Brake	12				
	4	89B2 Brake	12				
Boom Hoist	Left	87FA	10	Front or Right Rear Load Drum	Left	87FA	10
	Right	0	Ground		Right	0	Ground
	Center	82P	1.4 to 8.6		Center	80P	1.4 to 8.6
	1	8A	Ground		1	0	Ground
	2	82N	12		2	80N	12
Right Travel	Left	87FA	10	Rear or Left Rear Load Drum	Left	87FA	10
	Right	0	Ground		Right	0	Ground
	Center	83P	1.4 to 8.6		Center	83P	1.4 to 8.6
	3	8D	12		3	0	Ground
	4	89X	12		4	81N	12

Test 14 — Adjusting the Control Handle Potentiometer



Single Axis Controller



Double Axis Controller

Item	Description	Item	Description
1	Neutral (snap) switch	5	Center Terminal "C"
2	Jumper connection (N/O)	6	Potentiometer
3	Ground terminal "R"	7	Socket set screw (2)
4	Slotted set screw		

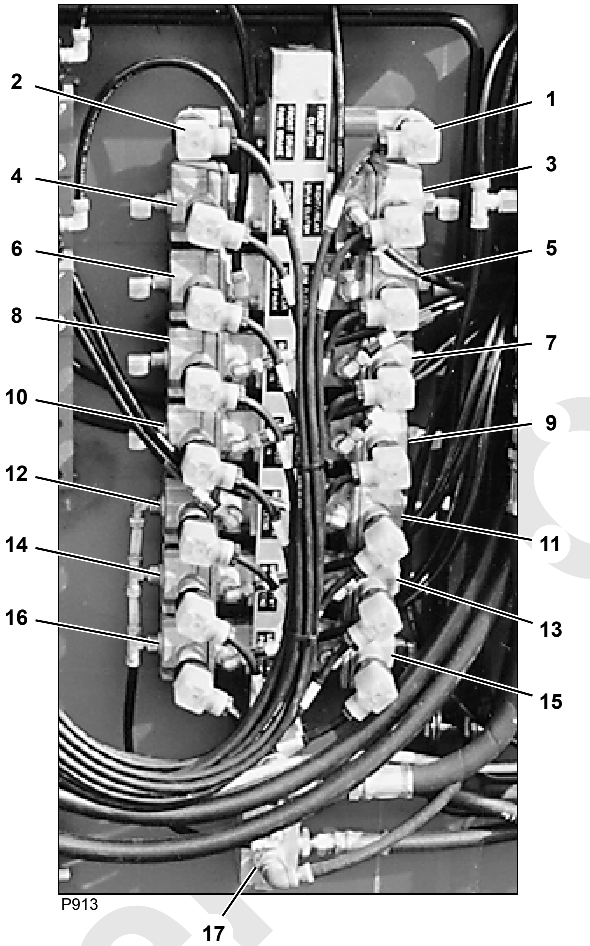
An unusual reaction to a control handle movement may indicate a misalignment or handle potentiometer. Adjusting a single axis or double axis control handle requires aligning the handle and potentiometer in the neutral position. Neutral is the position where 5 volts DC is present.

To check single axis controller:

- Engine must be off and power on, with all brakes and locks engaged.
- Connect a jumper wire between the normally open terminal on the neutral switch and terminal "C" on the handle terminal block.
- Connect the positive lead of a digital multi-meter to terminal "C".
- Connect the negative lead on a grounded crane component or on terminal "R".
- Loosen the slotted set screw (item 4) and allow handle to return to neutral position.
- Retighten slotted set screw and move handle until a reading of 5 volts DC is obtained.
- Holding the handle in the 5-volt position, loosen the slotted set screw (item 4).
- Allow handle to return to neutral position.
- Retighten slotted set screw.

Double axis control handle adjustment is the same, except the 2 socket set screws (item 7) on gear collar are loosened.

Test 15 — Checking System Voltage at the Air Solenoid Panel



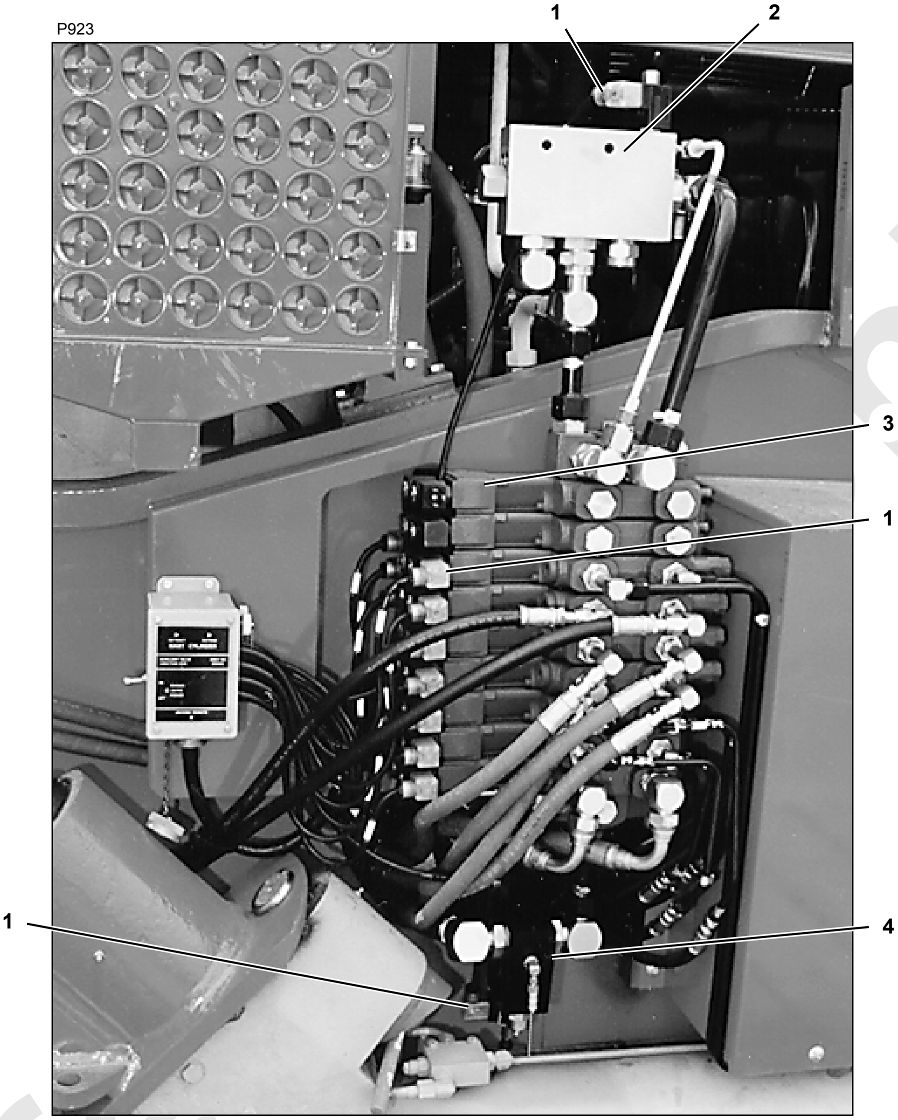
Item	Description	Item	Description
1	Front drum clutch solenoid	10	Luffing hoist pawl in solenoid
2	Front drum park brake solenoid	11	Backhitch pin cylinders retract solenoid
3	Rear or right rear drum clutch solenoid	12	Backhitch pin cylinders extend solenoid
4	Rear or right rear drum park brake solenoid	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		

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, Inc.) and a digital multi-meter.

Connect the test plug adapter between the solenoid valve and electrical connector. Make the connections form the adapter cable white (positive) and black (negative) wires to the digital multi-meter and check for 12 volts DC while enabling the air solenoid being tested. Load current (amps) can be measured by making current connections (red and white) to digital multi-meter.

Test 16 — 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
5	Inside carbody (left to right)

Item	Description
6	Luffing hoist brake solenoid valve
7	Travel 2-speed solenoid valve
8	Travel brake solenoid valve
9	Swing lock solenoid valve (top disengage/bottom engage) Current production cranes the swing lock is disabled Swing lock solenoid is not present on current production cranes
10	Swing brake solenoid valve
11	Left crawler pins solenoid valve (top retract/bottom extend)
12	Right crawler pins solenoid valve (top retract/bottom extend)
13	Boom hinge pins solenoid valve (top retract/bottom extend)
14	Boom butt handling solenoid valve (top retract/bottom extend)
15	Rigging winch solenoid valve (top pay out/bottom haul in)

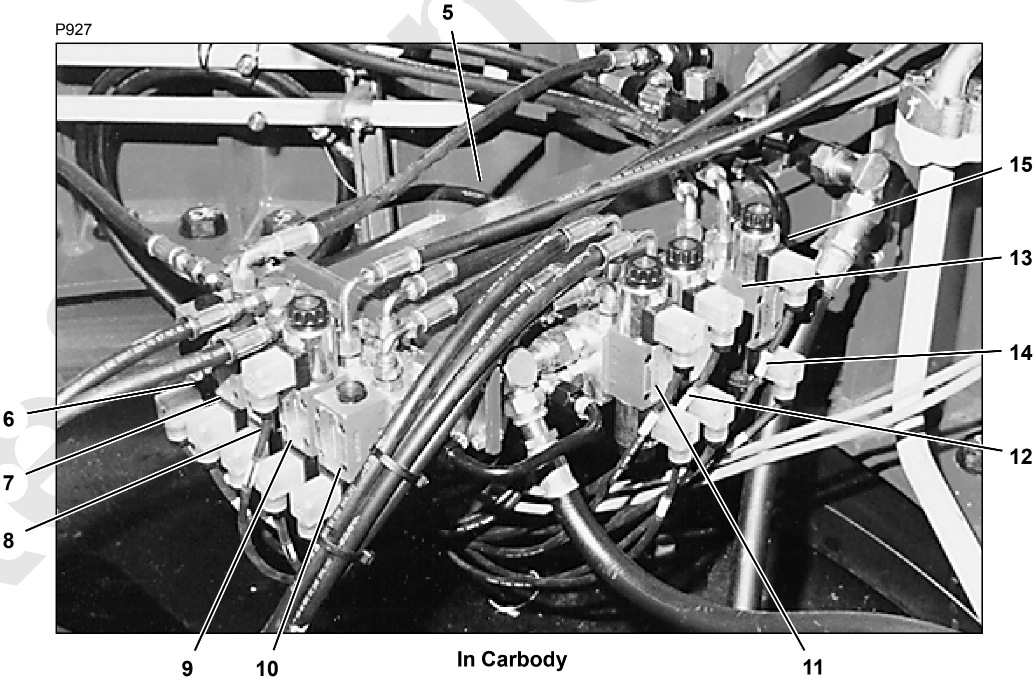
To determine if a hydraulic solenoid is enabled, place a screwdriver on the solenoid coil. The solenoid is enabled if the screwdriver is magnetically pulled toward the solenoid coil.

Measure system voltage at various locations on the hydraulic valve assemblies with a standard test plug adapter (can be ordered from Manitowoc Cranes, Inc.) and a digital multi-meter.

To test a hydraulic valve:

- Set the digital multi-meter for testing volts DC.
- Connect white (positive) and black (negative) wires from adapter cable to digital multi-meter jacks.
- Install the test plug between the valve electrical socket and the DIN plug.
- Enable the valve under test.
- Check for 12 volts DC at upper valve assembly and auxiliary system disable valve.
- Voltage to the proportional flow control valve should be between 3.25 and 7.22 volts DC.

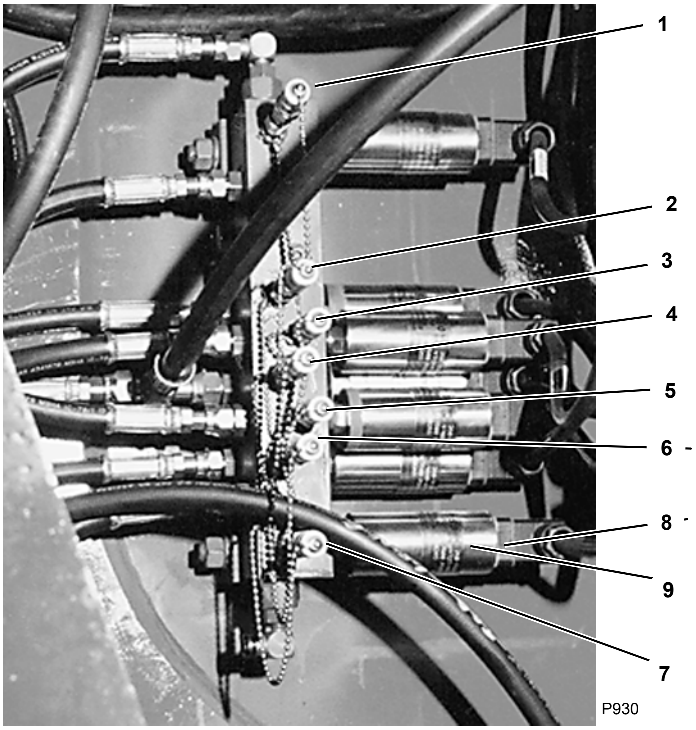
P927



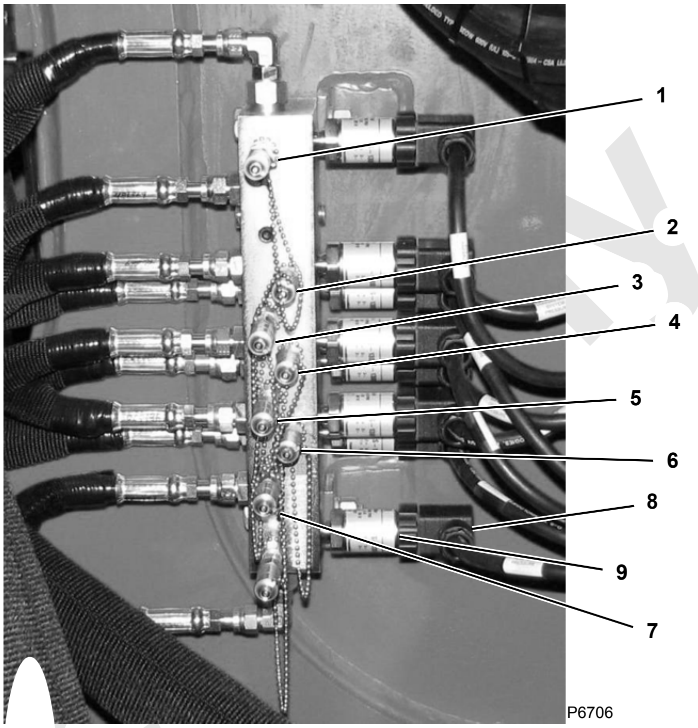
In Carbody

Test 17 — Checking Pump Charge Pressure and Electrical Test

Previous Production



Current Production –SN 2251179, 2251183, 225185 & up



Item	Description
1	Front Drum/travel (Previous) or Right travel (Current) system pressure port
2	Boom hoist system pressure port
3	Load Drum (Previous) or Hoist system (Current) pressure port (pump outboard)
4	Load Drum (Previous) or Hoist charge pressure port (pump inboard)
5	Swing right system pressure port
6	Swing left system pressure port
7	Front drum/travel (Previous) or Left travel (Current) charge pressure port
8	DIN connector (electrical test)
9	Pressure transducer

Component charge systems can be checked at the M1, M2 or M3 gauge ports (see Test 7 — Location of Motor Ports). To check pump charge pressure:

- Install a 0 – 600 (0 – 42 bar) gauge at the desired system diagnostic gauge coupler on pressure transducer manifold.
- Start the system and record the charge pressure at engine idle speed.
- No hydraulic systems should be enabled.
- A reading of 350 psi (24 bar) is system charge pressure.
- A reading of less than 350 psi (24 bar) indicates a charge pressure relief adjustment is necessary. See Test 19 — Adjusting 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, Inc.) and a digital multi-meter.

To test incoming power at desired pressure transducer:

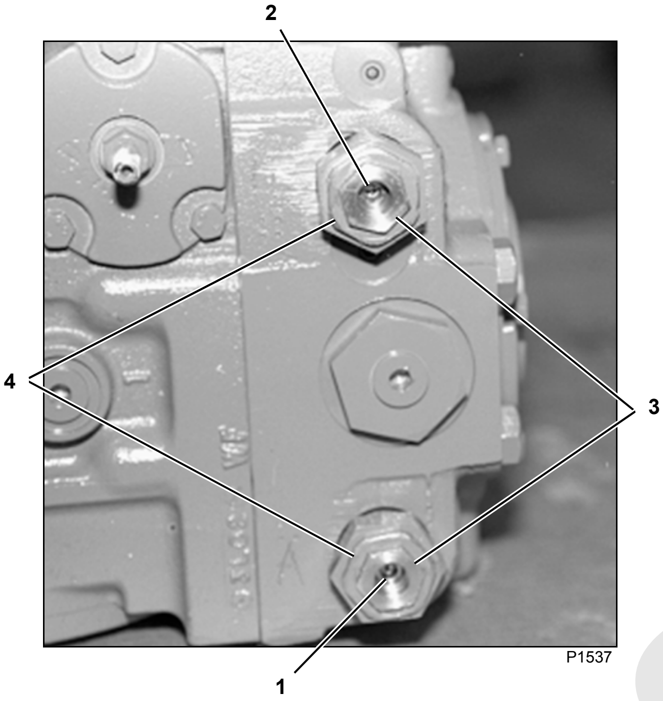
- Connect the test plug adapter between pressure transducer and DIN plug.
- Connect white (positive) and black (negative) wires from adapter cable to digital multi-meter jacks.
- Check for 12 volts DC.
- If this reading is not obtained, check 5 amp F12 fuse at fuse panel (see Test 12 — Testing for Voltage at the Fuse Box).

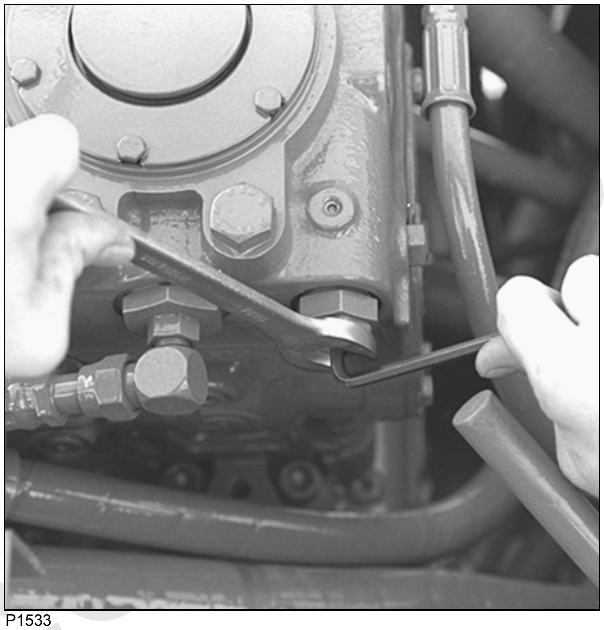
To test voltage output from pressure transducer to the PC:

- Engine must be off and power on, with all brakes and locks engaged.
- Connect green (positive) and black (negative) wires to digital multi-meter jacks.
- 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 reading is less than 0.50 volts or more than 2.00 volts, the pressure transducer must be replaced.

Test 18 — Setting the Pump Pressure



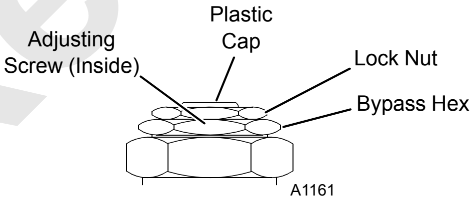


Item	Description	Item	Description
1	Multifunction valve adjusting screw for port “A”	3	Lock nut
2	Multifunction valve adjusting screw for port “B”	4	Bypass hex nut

To adjust multifunction valve:

- Remove the protective cap from the multifunction valve and loosen the lock nut.
- Insert a hex wrench into multifunction valve adjusting screw.
- Turning adjusting screw clockwise will increase relief pressure.
- Turning adjusting screw counter-clockwise will decrease relief pressure.

NOTE: The bypass hex nut is for special applications only and must not be rotated during setting of pump pressure without first consulting the pump manufacturer literature.

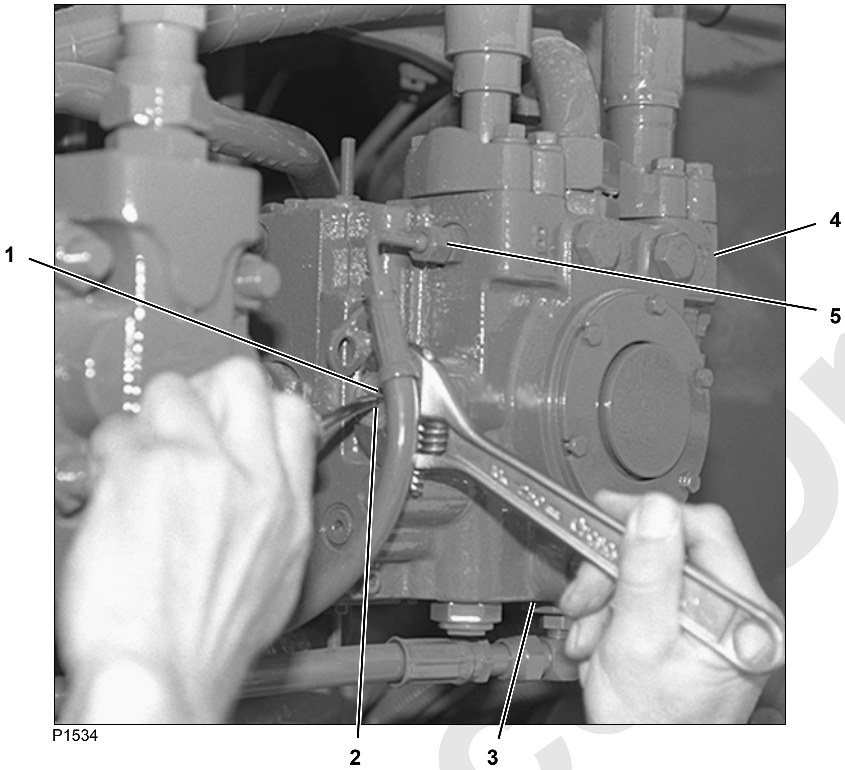


Multi-Function Valve

Pump Port Control Function

Pump	Port A	Port B
Travel	Reverse	Forward
Load Drum	Hoist	Lower
Boom Hoist	Lower	Hoist
Swing	Left	Right

Test 19 — Adjusting Pump Charge Pressure Relief

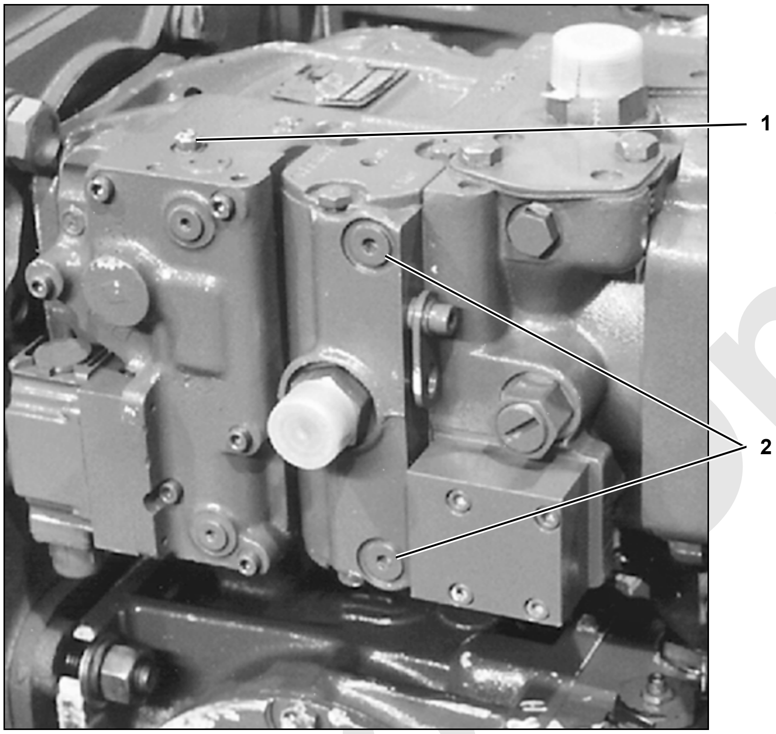


Item	Description
1	Adjusting screw
2	Adjusting lock nut
3	Port M3
4	Port M1
5	Port M2

The pump charge pressure must be measured to accurately adjust the charge pressure relief valve. To adjust pump charge pressure:

- Install a 0 – 600 psi (0 – 42 bar) gauge at pressure gauge ports M1, M2 or M3 if not used.
- See Test 9 — Location of Pump Ports for location of pump test ports.
- Charge pressure can also be measured at the pressure transducer manifold (see Test 17 — Checking Pump Charge Pressure and Electrical Test).
- Start engine with all brakes and locks engaged.
- Check gauge for approximately 350 psi (24 bar).
- To adjust relief valve, loosen and hold the adjusting lock nut, then turn adjusting screw until 350 psi (24 bar) is obtained.
- Torque adjusting lock nut 34 to 41 ft lbs. (46 to 56 Nm).
- Remove the gauge and replace the port plug.

Test 20 — Setting Pump Neutral



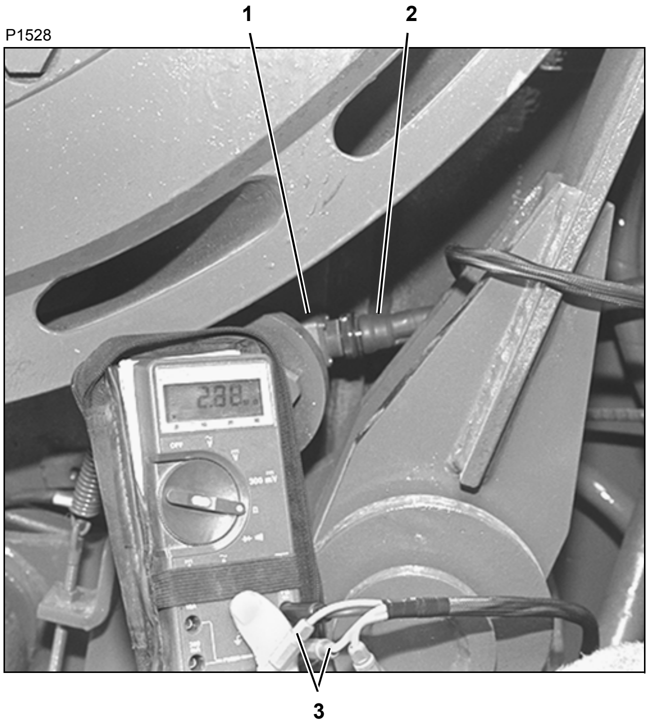
P1535

Item	Description
1	Neutral adjusting screw and lock nut
2	Servo gauge ports

To set pump neutral:

- Engine must be off and power on, with all brakes and locks engaged.
- Disconnect the PC from the pump EDC by removing the cable at the EDC.
- Install a 0 – 600 psi (0 – 42 bar) gauge at each servo gauge port.
- Start engine with all brakes and locks engaged.
- Loosen the hex lock nut and rotate the neutral adjusting screw with hex wrench until pressure increases in one of the gauges.
- Note the handle position of the hex wrench and without moving wrench, rotate the neutral adjusting screw counter-clockwise until pressure increases in the other gauge.
- Note the handle position of the hex wrench again and without moving 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.
- Hold the neutral adjusting screw with the hex wrench and tighten the lock nut.
- Remove the gauges and install the servo gauge port plugs.

Test 21 — Checking Voltage at the Speed Encoders



Load Drum

Main Hoist Motor

Item	Description
1	Encoder
2	Test plug adapter
3	Adapter cable connections

Testing the boom hoist or load drum speed encoder for correct voltages requires a standard test plug adapter (can be ordered from Manitowoc Cranes, Inc.) and a digital multi-meter.

To test incoming power at desired speed encoder:

- Engine must be off and power on, with all brakes and locks engaged.
- Disconnect the output cable from the speed encoder connector.
- Install the test plug adapter to the encoder.
- Connect the test plug adapter red (positive) and black (negative) to digital multi-meter jacks.
- Start engine with all brakes and locks engaged.
- The motor or drum should remain at rest.
- Check for 12 volts DC.
- If this reading is not obtained, check 5 amp F11 fuse at fuse panel (see Test 12 — Testing for Voltage at the Fuse Box).

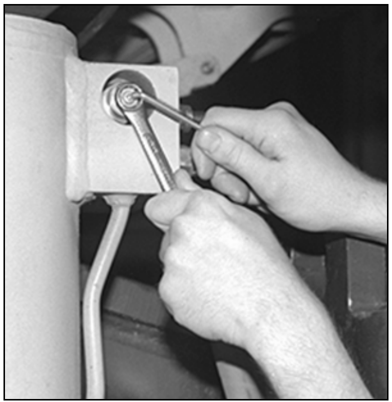
To test voltage output from the speed encoder to the PC:

- Engine must be off and power on, with all brakes and locks engaged.
- Connect green (positive) and black (negative) wires to digital multi-meter jacks.
- Check for 0.00 or 7.40 volts DC with motor or load drum at rest.
- With the motor or load drum enabled, check for 3.5 to 3.9 volts DC.
- If these readings are not obtained, check the encoder drive assembly and wiring.

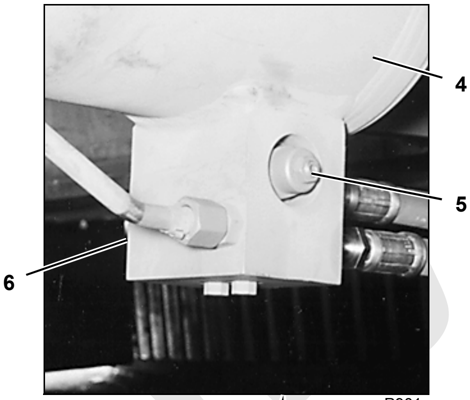
Test 22 — Adjusting the Counterbalance Valves

P893

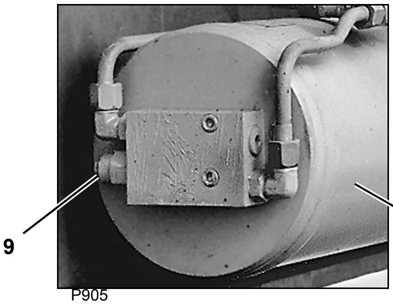
Right side cylinder shown, for left side cylinder (item 2) is inboard and (item 3) is outboard



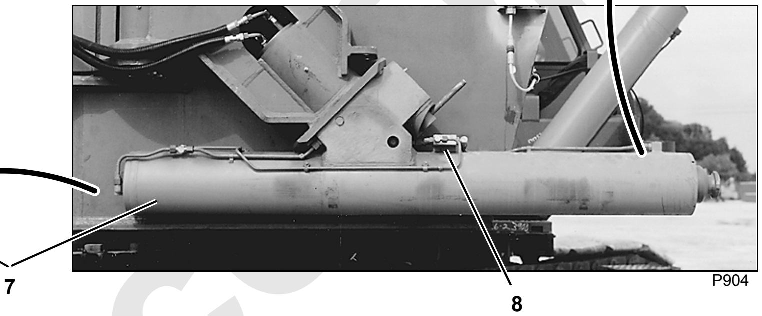
P1527 Example



P901



P905



P904

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)		

⚠ WARNING

Possible Component Damage!

Special instructions/warnings apply when adjusting gantry cylinders and boom butt cylinder counterbalance valves as specified in Shop Procedure topic, Section 2 of this manual. This procedure MUST be followed to ensure cylinder adjustments are performed safely and correctly with rod end or piston end adjusting screws. Gantry cylinders will not extend evenly without counterweights attached to crane. Gantry cylinder adjustments must be performed with counterweights installed.

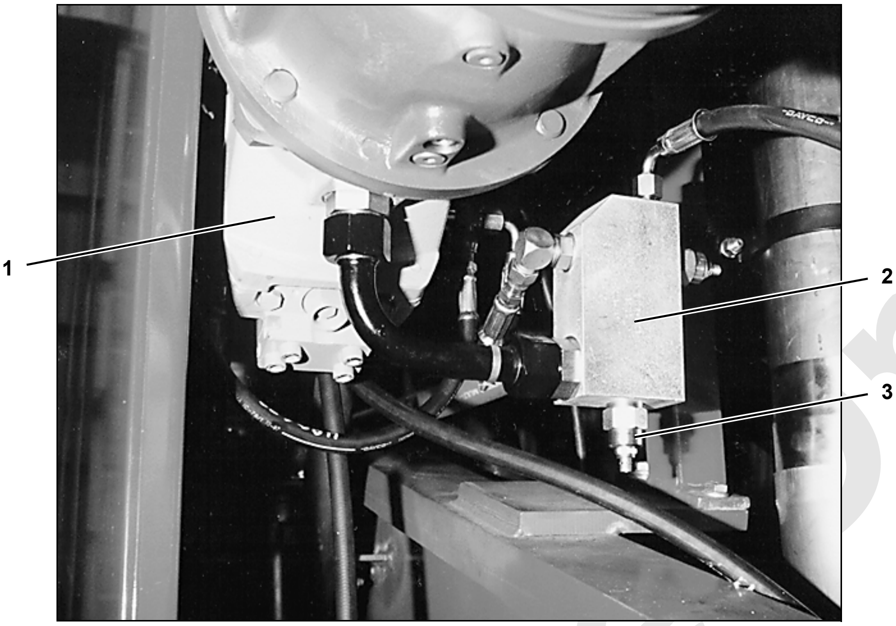
Each jacking cylinder has a single counterbalance valve at the piston end of the cylinder. The retract adjusting screw at the valve provides adjustment for each jacking cylinder load support. The extend adjusting screw allows cylinders to be adjusted for uniform operation on level ground.

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

To adjust a counterbalance valve:

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

Test 23 — Servicing the Motor Loop Flushing (Purge) Valves



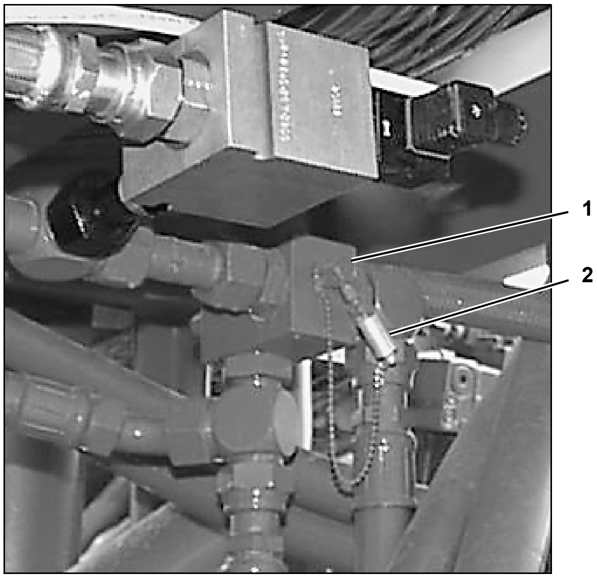
P890

Item	Description
1	Motor
2	Loop flushing (purge) valve
3	Valve flow control

Problems with a bad loop-flushing valve are best corrected by replacing the complete valve assembly. To service the loop flushing valve:

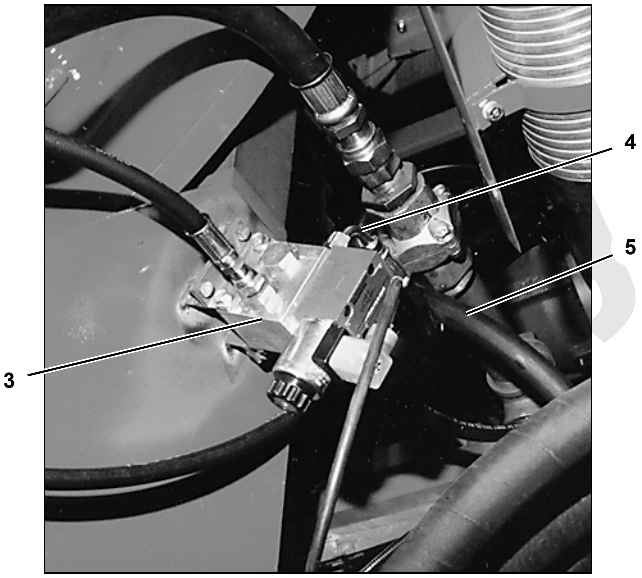
- Engine must be off and power off, with all brakes and locks engaged.
- Drain motor by removing attached hydraulic lines.
- After draining, replace hydraulic hose.
- Remove hoses from flushing valve and replace valve.
- The hydraulic fluid flow through the valve is adjusted with valve flow control on bottom of valve.

Test 24 — Checking Hydraulic Brake Pressure



P970

Swing and Travel Systems



P924

Boom/Luffing Jib System

Item	Description
1	Pilot/brake pressure relief valve
2	Test port (adjusting screw on opposite side)
3	Boom hoist brake control valve
4	90 degree elbow
5	Flexible hose

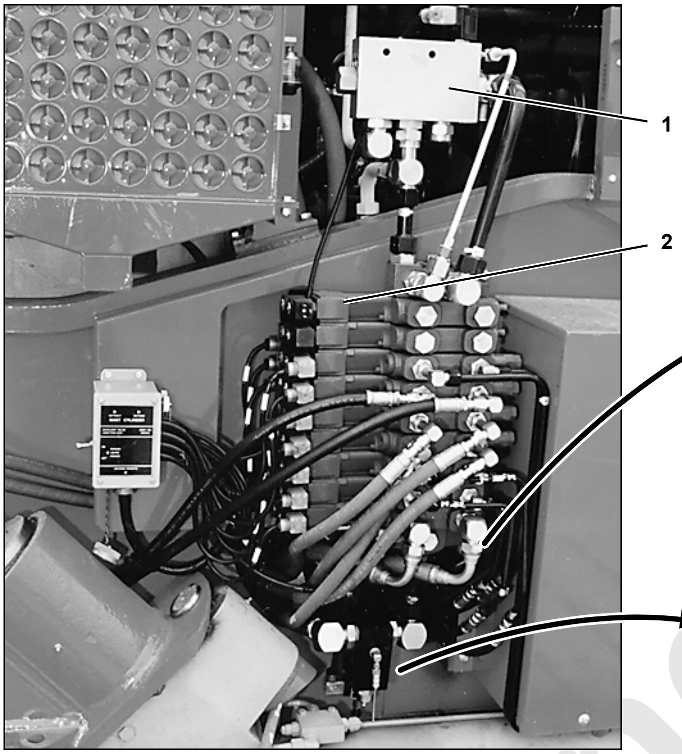
The hydraulic brakes for the swing and travel systems operate off the exhaust pressure from the fan motor system. The boom/luffing jib brakes are released off low-pressure side or boom hoist closed-loop system. To check hydraulic brake pressure for the swing and travel systems:

- Engine must be off and power off, with all brakes and locks engaged.
- Connect a 0 – 1,000 psi (69 bar) gauge at diagnostic quick-disconnect fitting on pilot/brake pressure relief valve between top of engine/radiator and oil cooler fans.
- Start the engine and set at high idle (2,000 rpm).
- Enable desired system brake and check that brake pressure is 325 to 375 psi (22 to 26 bar).
- If pressure is not within range, adjust the pilot/brake pressure relief valve.
- Loosen adjusting lock nut.
- Turn adjusting screw clockwise (in) to increase pressure until correct pressure is obtained.
- Turn adjusting screw counter-clockwise (out) to decrease pressure until correct pressure is obtained.
- Secure adjusting lock nut.
- Remove the pressure gauge and replace the fitting cap.
- If correct pressure cannot be obtained, replace the valve assembly.

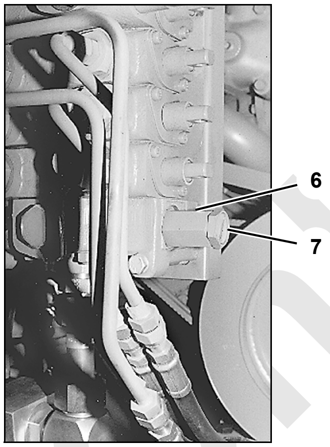
To check hydraulic brake pressure for boom hoist system:

- Engine must be off and power off, with all brakes and locks engaged.
- Connect a 0 – 1,000 psi (69 bar) gauge between the 90° elbow on the control valve and the flexible hose.
- Start the engine and set at high idle (2,000 rpm).
- Enable boom hoist system brake and check that brake pressure is 325 to 375 psi (22 to 26 bar).
- If equipped with luffing jib, system brake pressure is 500 to 550 psi (34 to 38 bar).
- If pressure is not within range, check the boom/luffing jib hoist charge pressure in Test 17 — Checking Pump Charge Pressure and Electrical Test.

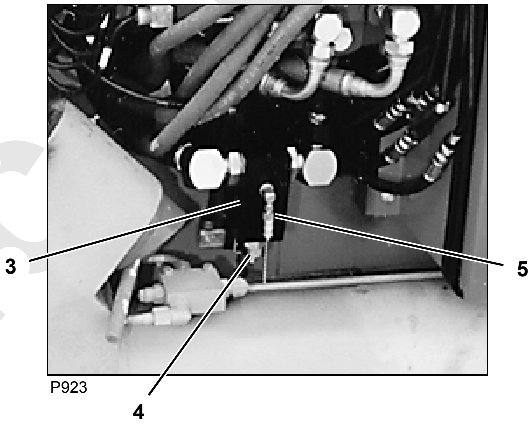
Test 25 — Checking and Adjusting Auxiliary System Working Pressure



P923



P922



P923

Item	Description
1	Proportional flow control valve
2	Upper accessory valve assembly
3	Auxiliary system disable valve
4	Disable valve adjusting screw
5	Disable valve gauge port
6	Accessory relief valve
7	Relief valve adjusting screw

To determine if piston actuation problems are related to auxiliary system low-pressure, check the pressure at auxiliary system disable valve at the upper valve assembly.

To check auxiliary system working pressure:

- Engine must be off and power off, with all brakes and locks engaged.
- Remove the cap from diagnostic gauge coupler at disable valve.
- Connect a 0 – 6,000 psi (0 – 413 bar) gauge to diagnostic gauge coupler.
- Start the engine and retract any hydraulic cylinder directly driven off upper valve assembly.

- Continue to stroke the valve section after the cylinders are fully retracted during the entire test.
- Check that pressure is 3,325 to 3,500 psi (229 to 241 bar).
- If pressure is not within range, loosen the adjusting screw lock nut on the bottom of the auxiliary system disable valve.
- Turn adjusting screw clockwise (in) to increase pressure until correct pressure is obtained.
- Turn adjusting screw counter-clockwise (out) to decrease pressure until correct pressure is obtained.

CAUTION

Possible Component Damage!

Do not over-tighten the auxiliary system disable valve adjusting screw in the clockwise (in) direction. The valve seat may be damaged.

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.

If the gauge pressure changes erratically with movement of the adjusting screw, but hydraulic pressure remains below 3,325 psi (229 bar), turn the auxiliary system disable valve adjusting screw all the way in. At the upper valve assembly relief valve, loosen the lock nut and turn the adjusting screw in until gauge shows 3,500 psi (241 bar). Secure the lock nut.

NOTE: If 3,500 psi (241 bar) cannot be obtained, the upper accessory relief valve may be damaged. Repair or replace the relief valve and recheck for correct pressure.

If pressure is correct but problem cylinder still is not working correctly, continue pressure testing at the auxiliary system disable valve to determine if the valve assembly or proportional flow control valve 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 retract direction and check pressure. If pressure is 3,325 to 3,500 psi (229 to 241 bar), repair or replace the cylinder. If the pressure is 3,325 psi (229 bar) 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 pressure. If the pressure is 3,325 psi (229 bar) or less, repair or replace the proportional flow control valve.

Test 26 — Checking Pin Cylinder Seals

P1536

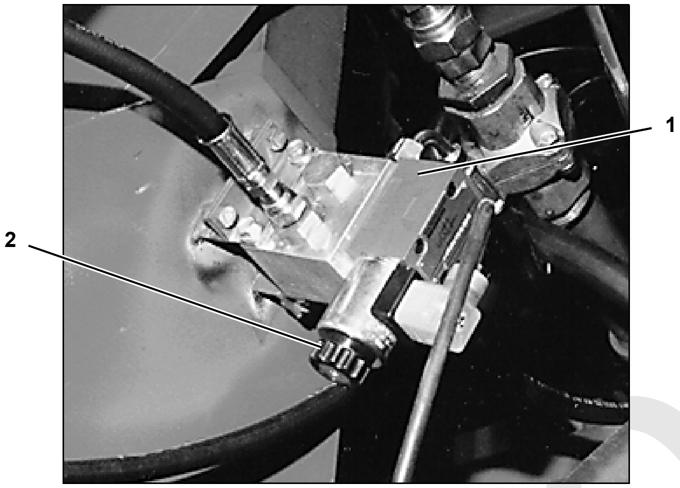
Item	Description
1	Hydraulic hose (extend)
2	Hydraulic hard line fittings
3	Hydraulic hose (retract)
4	Pin Cylinder

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.

If the problem cylinder is in the extend position, disconnect the cylinder retract hose from the hydraulic hard fitting. If in the retract position, disconnect the cylinder retract hose from the hydraulic hard fitting. Immediately plug the hard line fitting and place the flexible hose from the cylinder into a holding tank or bucket. Start the crane and pressurize the problem cylinder. Leakage from the disconnected hose indicates a damaged piston seal.

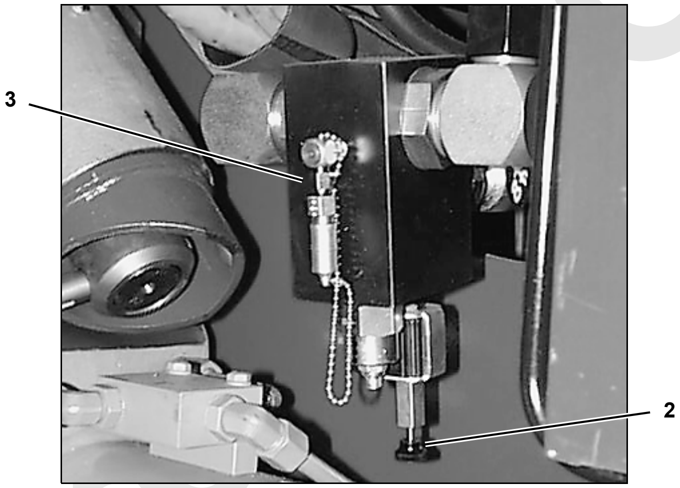
The wiper seal at the rod end of the cylinder should also be checked for leakage while enabling the cylinder in the extend direction.

Test 27 — Actuating the Solenoid Valve Manual Overrides



Brake Valve

P924



Auxiliary System Disable Valve

P974

Item	Description
1	Hydraulic brake valve
2	Valve override
3	Auxiliary system disable valve

To check that a solenoid valve or system valve is operating correctly:

- Start the engine and actuate the manual override.
- Hydraulic brake valves have an override push button in center of black nut.
- If the valve is operating correctly, the valve shifts to perform the control function.

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ALPHABETICAL INDEX